Department for Environment, Food & Rural Affairs

UK Food Security Report 2024

Presented to Parliament pursuant to Section 19 of the Agriculture Act 2020

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Executive Summary

Context

The period of 2021 to 2024 began with continuing societal responses to and recovery from the COVID-19 pandemic alongside adjusting to a new relationship with European Union (EU) and European Economic Area trade (EEA) partners following the UK leaving the EU. Global supply chains dealt with consecutive declines and then surges in demand, in many cases driven by government infection and control measures followed by economic stimulus. Russia's invasion of Ukraine in February 2022 transformed the world's economic and geopolitical situation and was particularly disruptive to energy and grain supplies. This had significant consequences for global and UK food security, including widespread increase in food prices. Conflict in the Middle East further disrupted the system by altering supply routes and the navigational safety of the Red Sea, but with more limited consequences, demonstrating the ability of the global trade system to adjust to localised disruption. Extreme weather conditions in the UK and across the globe made more likely by climate change have caused further food chain disruptions but often with more localised impacts.

Findings by theme

By UKFSR **theme**, the most important takeaways are:

Theme 1: Global Food Availability

- **Continued stable growth in the production of food**, despite geopolitical and climate shocks
  Key statistic: There have been moderate increases in global food production per capita for most food groups between 2019 and 2022: meat (+3.85%), roots and tubers (+2.08%), milk (+1.59%), fruit and vegetables (+1.36%), eggs (+0.77%), and cereals (+0.53%). Total food supply available for human consumption was 2,985 kilocalories per person per day in 2022, increasing by 28 calories from 2019. (see Indicator 1.1.1 Global food production).

- **The global trading system in food has also been stable**
  Key statistic: The percentage of key global cereals, soybeans and meats traded by volume remains broadly stable with minimal fluctuations between 2021/22 and 2024/25, with the largest changes a 2.4 percentage point (pp) decrease in pigmeat, 1.3pp decrease in maize and 1.7pp increase in the share of beef and veal production traded across this period (see Indicator 1.3.3 Global production internationally traded).

- **The number of undernourished people around the world is increasing** due to poverty, conflict, climate change as well as issues in food distribution, other growing uses for commodities, and caloric efficiency. This continues a recent trend running counter to a longer-term decrease from 2005 to 2017.
  Key statistic: The number of people facing undernourishment has increased since 2017 from 541 million to 733 million in 2023 (see Indicator 1.4.1 Global food and nutrition security).

- **Climate change, nature loss and water insecurity pose significant risks** to the ability of global food production to meet demand over the longer term.
  Key statistic: Between 2015 and 2019 the amount of land globally which was reported as being degraded increased by 4.2 pp, from 11.3% to 15.5% (see Indicator 1.5.1 Global land degradation).

- **There is weak productivity growth** globally which makes this more challenging
  Key statistic: While global agricultural total factor productivity (TFP) grew at an average annual rate of 1.9% from 2000 to 2011, this figure fell to 1.1% for the period between 2011 and 2021. TFP growth has fallen across all country income groups (see Indicator 1.2.1 Global agricultural total factor productivity).

Theme 2: UK Food Supply Sources

- **The UK's overall balance of trade and production is broadly stable**. The UK continues to source food from domestic production and trade at around an overall 60:40 ratio.
  Key statistic: The production-to-supply ratio was at 62% for all food and 75% for indigenous foods (meaning those that can be grown in the UK) in 2023, showing a small increase from 61% and 74% in 2021. This is a continuation of the broadly stable trend seen in recent years (see Indicator 2.1.1 Overall sources of UK food).

- **Extreme weather events continue to have a significant effect on domestic production**, particularly arable crops, fruit and vegetables. Production levels fluctuate each year due to changes in both planted area and yields, with weather conditions having a significant influence among other factors.
  Key statistic: In 2019 UK cereal production (25.5mt) was the highest this century, whereas in 2020 production (19.0mt) was the second lowest largely due to bad weather. The published first estimate of the 2024 English cereal and oilseed harvest shows a 22% decrease (around 2.8mt) in

harvested wheat from 2023 (see Indicator 2.1.2 Arable products (grain, oilseed and potatoes)).

- **The UK continues to be highly dependent on imports to meet consumer demand for fruit, vegetables and seafood**, which are significant sources of micronutrients for consumers. Many of the countries the UK imports these foods from are subject to their own climate-related challenges and sustainability risks.
  Key statistic: domestic production of fresh fruit increased slightly from 15% of total UK supply in 2021 to 16% in 2023. While this is a continuation of the long-term upward trend from 8% in 2003 it shows ongoing consumer demand for non-indigenous produce (see Indicator 2.1.4 Fruits and vegetables).

- **Long term decline in the UK's natural capital is a pressing risk to UK food production**. Both productivity and sustainability of food production rely on ecosystem services provided by biodiversity, healthy soil and clean water. However, the decline in natural capital is slowing and levelling against some key indicators.
  Key statistic: The all-species indicator in England shows a decline in abundance to just under 70% of the 1970 value. This trend levels around the year 2000 and over the past 5 years, fluctuations in the all-species indicator are not considered to represent meaningful change (see Indicator 2.2.5 Biodiversity).

Theme 3: Food Supply Chain Resilience

- **Russia's invasion of Ukraine caused a spike in input costs such as energy and fertiliser.** This was a major development of the period between 2021 and 2024, having an effect across the food supply chain. The shock led to business uncertainty and the highest food inflation spike for consumers in 45 years. While the impacts were global, it showed the UK's and the rest of Europe's vulnerability to food inflation from high energy prices and the effect of other cost pressures in the system. UK food inflation was among the highest of the G7 countries in 2023. At no point in the last three years has the UK population faced shortages of food items for a sustained period, demonstrating a continued resilience in providing food availability through shocks.
  Key statistic: Fertiliser costs for UK farms rose from £1.5 billion in 2021 to £2 billion in 2022, before dropping to £1.4 billion in 2023. These changes contrast with a stable level of cost in the decade up to 2020. Similarly, electricity and gas prices climbed far surpassing prices in the period 2014 to 2020, doubling for electricity and nearly tripling for gas (electricity 100%,

gas 187%) significantly from mid-2022 (see Indicator 3.1.1. Agricultural Inputs and Indicator 3.1.5 Energy).

- **Agri-food sector labour shortages continue** and are compounded by significantly more restrictive access to EU labour since freedom of movement with the EU ended in 2021.
  Key statistic: Between 2021 and 2023, the workforce in the food sector in Great Britain increased from 4.04 million to 4.38 million, showing a steady upward trend. However, this does not show shortages in labour and skills in key areas of the UK's food supply chain such as the seafood sector and the veterinary profession (see Indicator 3.1.3 Labour and skills)

- **While there was a sharp fall in volume of imports of Feed Food and Drink to the UK in 2021, imports have increased slightly since then** and the EU remains the UK's largest external supplier.
  Key statistic: The EU accounted for 64% of the volume of UK imports of food, feed and drink in 2023. The volume imported from both the EU and Non-EU countries was 6% lower in 2023 compared to 2018 (see Indicator 3.2.3 Import Flows)

- **Single points of failure in food supply chains pose resilience risks** with evidence of reliance on regionally concentrated suppliers of supply chain inputs making the UK vulnerable to supplier failure (such as sunflower oil from Ukraine and inputs to flour fortification from specific regions).
  Key statistic: From 2007 to 2021 UK imports of sunflower oil were broadly stable at around 300,000 tonnes. Following the Russian invasion of Ukraine, total UK imports of sunflower oil fell to 224,000 in 2023, a 25.3% decrease, creating temporary shortfalls for key processors while driving substitution of other oils, such as rapeseed (see Indicator 3.1.1 Supply Chain Inputs)

- **Many food businesses have shown resilience and recovery** in response to shocks, but investment levels are not back to levels before the price shock in 2022.
  Key statistic: Average total quarterly investment increased by 5.7% in 2023 compared to 2022 but was 21% lower than 2021 levels (see Indicator 3.3.3 Business Resilience).

Theme 4: Household Food Security

- **While a large majority of households in the UK continue to be food secure, there has been a notable decrease in food secure households** (defined as access by all people at all times to enough food for an active, healthy life) which has coincided with increased financial pressures to household budgets from both high general inflation and high food inflation.

Key statistic: The proportion of food secure households declined from 92% in financial year ending (FYE) 2020 to 90% in FYE 2023 (see Indicator 4.1.1 Household food security status).

- **There has been a notable rise in inflation both overall and for the category of food and non-alcoholic beverages since the beginning of 2021**. Food price inflation was higher than general inflation and spiked to 45-year high in 2023. Inflation rates are now returning to pre-pandemic levels.
  Key statistic: Over the last three years, inflation for food and non-alcoholic beverages peaked in March 2023 at 19.2% while overall inflation peaked in October 2022 at 9.6% (see Indicator 4.1.3 Price changes of main food groups).

- **Most people do not meet government dietary recommendations,** with those from lower-income groups less likely to meet recommendations than those from the highest-income groups.
  Key statistic: Mean intakes of saturated fat, free sugars and salt exceeded the recommended maximum, and mean intakes of fibre, fruits and vegetables, and oily fish fell below the recommended minimum across adults in 2019. While no income group meets dietary recommendations, those on higher incomes are typically closer to meeting some of the dietary recommendations with the poorest 10% eating on average 42% less fruits and vegetables than recommended, compared to the richest who eat 13% less (see Indicator 4.3.2 Healthy diet).

- **Rates of food insecurity vary greatly by demographics, with a notable difference in levels and experiences between income groups.** Low-income and disabled groups continue to be at disproportionately high risk of household food insecurity and its potential negative impacts. General inflation including energy price increases have heightened the risk of these households needing to make difficult trade-offs with their food budgets.
  Key statistic: 84% of households with disabled people are classified as food secure compared to 94% for households without disabled people in FYE 2023 (see Indicator 4.1.1 Household food security status).

Theme 5: Consumer Confidence and Food Safety

- **The results of UK consumer surveys indicate that the levels of trust in Food Standards Agency (FSA) and Food Standards Scotland (FSS) have remained relatively high**.
  Key statistic: Consumers' trust in the Food Standards Agency (FSA) and Food Standards Scotland (FSS) to ensure that food is safe to eat remains high (>80%) (see Indicator 5.1.1 Consumer Confidence in the Food System and its Regulation).

- **There has been an increase in consumers reporting concerns (prompted) about food prices since 2021**.
  Key statistic: In 2023, food prices became the top food-related prompted concern among UK consumers. 93% of respondents surveyed in Scotland were concerned about the cost of food. 72% in England, Wales and Northern Ireland highlighted concerns about food prices. Due to differences in data collection, survey results from England, Wales and Northern Ireland cannot be compared with those from Scotland (see Indicator 5.1.2 Consumer Concerns).

- **Laboratory confirmed reports of pathogens that can cause foodborne gastrointestinal disease and the proportional trends in foodborne disease outbreak surveillance data generally remained relatively stable over the period 2019 to 2023, with the exception of the COVID-19 pandemic years**
  Key statistic: *Campylobacter* spp. continued to be the most frequently reported bacterial pathogen causing infectious gastrointestinal disease in the UK, followed by non-typhoidal *Salmonella* spp. The proportional trends in causative agents, hospitalisation rates and associated foods implicated in the investigations were generally consistent with trends observed in the last decade with the exception of STEC/other DEC in 2023. The total number of STEC/other DEC outbreaks and associated cases was notably higher in 2023 compared to previous years (See Indicator 5.2.3 Foodborne pathogen surveillance and Indicator 5.2.4 Foodborne disease outbreak surveillance).

- **Of the businesses inspected, analysis indicates an upward trend in food business hygiene compliance. However, there is still a backlog in the number of businesses awaiting inspection.**
  Key statistic: Between 2020/21 and 2023/24, an average of 96.8% of food businesses inspected in England, Wales, and Northern Ireland achieved a satisfactory or better Food Hygiene Rating Scheme (FHRS) rating. An average of 92.3% of inspected businesses in Scotland achieved a ‘Pass’ under the Food Hygiene Information Scheme (FHIS) between 2020/21 and 2023/24 (see Indicator 5.3.1 Food business compliance and food hygiene regulation).

‘Whole system’ view

The UKFSR uses an established definition of food security in 6 dimensions (see Introduction). In the recent term the different dimensions of food security (set out in **green** below) have been affected by a series of shocks. The most disruptive have been from critical sectors on which the food chain is dependent, health (COVID-19) and energy prices (Russia’s invasion of Ukraine). The dimensions have shown recovery from the shocks, but also vulnerabilities in resilience and the persistence of existing stresses in the food system, some of which are intensifying over the longer term such as risks from climate change.

The events of the last 3 years show a trend of high volatility or weakened **stability** exposing more clearly the interconnected nature of risks, with both the acute and chronic impacts triggering and compounding each other in unexpected ways. The impact of geopolitical and climate events has been to drive up prices of inputs to food production such as energy and fertiliser and food itself. This has created a challenging business environment for the food sector. As a result of the increased costs, food inflation in the UK reached its highest point in 45 years, and was higher than general consumer price inflation compared to 45 years ago. UK food price inflation was among the highest of the G7 economies in 2023, suggesting challenges to UK resilience to price shocks linked to the UK’s energy supply.

There is continued evidence of stabilising factors and resilience in the system from stable production and trade levels, which is a positive trend for food **availability.** There are also continued high levels of consumer confidence, stable trends in food safety and a return to target levels of overall and food price inflation from the inflation spike in 2022 to 2023. However, food prices remain above pre-2022 levels.

The combination of higher food prices and general inflation caused a rise in household food insecurity in the UK as household budgets were squeezed. Consumers have responded by buying cheaper goods and prioritising price over other factors (such as environment, health, and wider ethical values). Market and supply volatility has therefore weakened **access** to food and also **agency** by weakening choice. The impacts of these issues are felt most acutely by particular demographic groups, including those with lower incomes, households with children and those with disabilities. While for the majority a food security issue might mean limitation or reduced choice such as buying less meat, it could mean a significant reduction in food security for vulnerable groups. The continuing trend of most people not meeting UK dietary recommendations demonstrates ongoing issues with **utilisation** whether that’s through food environment, price, lifestyle, time or educational factors. Food insecurity and hunger is growing globally despite overall increases in production of food per person, showing there are issues beyond supply that are impacting negatively on the availability of food

The impacts of climate change, biodiversity loss and water insecurity both at home and abroad remain pressing risks to food security. They drive volatility in the present and put **sustainability** and resilience of food production at risk over the longer term. These risks are also now interacting with heightened geopolitical tensions. Labour shortages in key sectors at home are also a continuing stress factor affecting domestic food production.

Introduction

UK Food Security

Food is essential to national life; what and how the UK population eat directly affects the nation's health, wellbeing, productivity and happiness. It is therefore vital to monitor the UK's ability to access food and to eat well.

Food is at once a basic necessity and endlessly complex. A loaf of bread has many component parts, all of which are sourced from different regions of the UK and the globe. Even a simple ingredient product such as an apple follows an extensive supply chain and production process before it reaches the market: relying on seeds, water, fertilisers, pesticides, the right weather, labour force for harvesting, biosecurity, cold storage, quality control, not to mention the packaging it might come in, the labelling and the transport required to get it to consumers. Add to that the relationship of people to the food they eat: how they access it financially and physically and prepare and eat it, its impact on their health, their food preferences, allergies and more. What makes us food secure is always an ever-changing relationship between people, nature, animals, markets, nations, infrastructure, culture and more. Monitoring the security of food in the UK therefore means monitoring a whole lot more than the availability of the inputs and raw ingredients that go into food production at a national level.

Security entails stability, resilience, sustainability and the dependable mitigation of risks. But how can security be tracked in such a complex system as the food chain, with variables such as weather, markets, transport, land use, ecology and household income? While food encompasses many aspects, it also comes together as a whole system with clear outcomes. By piecing together trends in key indicators across the UK's food chain, it is possible to monitor the system and track its health. The UK Food Security Report (UKFSR) is a public instrument for doing this and aims to enable everyone in the UK to understand what drives UK food security and what its current status is.

Scope

The UKFSR is an analysis of statistical data and broader supporting evidence relating to food security in the UK. This UKFSR is the second in a series of reports which are laid in Parliament and published at least once every 3 years under the duty in Section 19 of the Agriculture Act 2020. The last UKFSR was published in December 2021 and this UKFSR reports on data available for the period of 2021 to 2024.

The UKFSR examines past, current, and future trends relevant to food security to present a full and impartial analysis of UK food security. It contains indicators covering different time periods, but always using the latest available data, at the time of writing. Due to time needed to quality assure and publish content, the UKFSR 2024 does not provide analysis of data or factors emerging from the start of October 2024, although it may point readers to new data published in the October-November period where relevant.

The UKFSR is intended as an independent evidence base to inform users rather than a policy or strategy. In practice this means that it provides government, Parliament, food chain stakeholders and the wider public with the data and analysis needed to monitor UK food security and develop effective responses to issues.

The UKFSR draws on a broad range of published data from official, administrative, academic, intergovernmental and wider sources. Quantitative and qualitative analysis of the indicators are undertaken to give a full evaluation of the evidence. ‘Qualitative analysis’ refers to ‘how’ and ‘why’ questions that are often answered using evidence obtained from people’s behaviours, perceptions, opinions and motivations.

As an impartial and independent Official Statistics publication, the UKFSR does not offer ministerial views or UK Government positions, nor does it give the position of the UK devolved governments or their ministers. It assesses a wide range of different trends affecting food security in the recent and long term and, while it does pull those trends into a single narrative, the reader is left to make their own judgments on overall UK food security based on the evidence. This means that UKFSR gives a mixed picture as it reports on both positive and negative trends, but it will always make it clear what dimensions of food security these trends affect so that the analysis remains coherent rather than contradictory.

As required by the Agriculture Act 2020, the UKFSR updates its food security evidence base on a 3- yearly basis. The UKFSR examines developments and risks arising within the t3 years, and whether they indicate stability, deterioration or improvement and whether they are long-term one-offs. While the 3 years are the primary focus, the UKFSR aims to place evidence in an appropriate timescale, including considering the evolution of trends over the longer term. To support comparison of data, some of the themes have flexibly applied a default 20 year timescale to graphs, depending on fit with the data and available years.

There have been improvements to the evidence base in the UKFSR 2024 as result of consultation with a range of experts and stakeholders. See **Annex I** for a description of the consultation process and changes to the indicators as presented in the UKFSR 2021.

Defining food security

While there are many definitions of food security, the UKFSR uses the widely used [1996 World Food Summit definition] which defines food security in broad terms as:

"*when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*."

There are many interacting factors that shape and determine the stable relationship between people and food at the core of this definition (such as physical, economic, dietary and ecological). Food security therefore cannot be reduced to a single metric or concept. It is complex and multi-faceted.

To capture the range of factors affecting food security the UKFSR approaches food security through 5 themes, dedicating a chapter to each. The 5 themes offer a systems approach that not only measures people's access to food, but the health of the various interconnected systems enabling that access. Each theme sets out a range of indicators that are considered in relation to each other and further supporting evidence. The 5 themes and the scope for each are:

1. **Global Food Availability**: supply and demand at a global level, including distribution, sustainability and dietary value of food.
2. **UK Food Supply Sources**: where the UK gets its food from across domestic production and imports and the sustainability of those sources
3. **Food Supply Chain Resilience**: the physical, human and economic infrastructure underlying the supply chain and the UK's ability to respond to shocks to the supply chain
4. **Food Security at Household Level**: the ability of households to access sufficient, healthy and affordable food
5. **Food safety and Consumer Confidence**: public perceptions and how we monitor the safety and authenticity of food in the UK

While the UKFSR is structured around the 5 themes, the indicators within them are relevant to the 4 dimensions associated with the World Food Summit definition of food security: availability, access, utilisation of food, stability. To recognise the evolving understanding of food security, the UKFSR considers 2 additional dimensions of food security (4 + 2): sustainability and agency. These were suggested by the United Nations Food and Agriculture Organisation High Level Panel of Experts on Food Security and Nutrition. The indicators included in the UKFSR give substantive coverage of each of the 6 dimensions, while coverage of the elements within the dimensions is varying. The elements with greater coverage are production, distribution, affordability, food safety and nutritional value. There is less coverage of social value, preference and allocation. Food security can also be understood as the stability of these different dimensions. (see Annex II for an explanation of the dimensions and elements).

The above ‘systems’ approach exposes the way that food security variables interact across different systems. The UKFSR 2024 has enhanced this aspect of the analysis by bringing in a wider range of areas into its analysis of indicators and doing more to link between themes and indicators.

Climate analysis

This edition of the UKFSR offers a more developed and integrated analysis of climate impacts on food security. In recognition of climate’s impacts across sectors, the impact of climate has been more integrated across indicators rather than being a single indicator as it was in 2021’s edition. This includes additional analyses of potential future climate impacts for different sectors over the short and long term provided by the Met Office’s Hadley Centre for Climate Science and Services.

Weather and climate are both drivers of food security. Over the period 2014 to 2023, warming at the global scale attributed to human influence has been at a rate of 0.26°C (0.2-0.4°C) per decade, which was faster than previous decades. 2015-2023 were the nine warmest individual years on record.

Rising global average temperatures bring increasing frequency and intensity of extreme weather events. The year 2023 was the hottest year on record by a large margin for both air temperatures and sea surface temperatures. During 2021 to 2023, the world experienced a number of record-breaking extreme weather events resulting in loss of life, destruction of property, large-scale air pollution and negative consequences for food production. Record-breaking events included Canada’s worst national wildfire season, Mexico’s driest year, extreme heat and drought in China, the USA’s largest drought event and heatwaves in North America and the Mediterranean. The UK experienced one of its hottest and driest summers in 2022 and in England it was the wettest 18-month period on record between September 2022 to February 2024.

Rising temperatures may in some cases hold opportunities for growing new crops (e.g. expansion of vineyards in the UK) and for a longer growing season. However, the climate analyses presented suggest that rising temperatures will increase the variability of weather, and increase the likelihood of extreme weather events, which represent significant overall risks to UK food security. This volatile context endangers the stability of several key pillars of food security such as availability and access. However, there are a variety of evidence gaps that complicate making a fully consistent, comprehensive, quantitative assessment of these risks to every element of the food system.

Predominantly, the climate commentary is based on evidence considering the RCP8.5/SSP5-8.5 (high forcing / low mitigation) and RCP2.6/SSP1-2.6 (low forcing / high mitigation) scenarios. Most policy-relevant research has previously used RCP8.5/SSP5-8.5, meaning there are more research findings to draw on when using this scenario. The inclusion of findings for RCP2.6/SSP1-2.6 provides additional understanding of how outcomes may vary depending on mitigation actions (see **Annex III** for explanation of the climate scenarios).

Delivery of the UKFSR

The UKFSR fulfils a duty under Part 2, Chapter 1 (Section 19) of the Agriculture Act 2020 to prepare and lay before Parliament **"a report containing an analysis on statistical data relating to food security in the United Kingdom"**.

The production of this report is the responsibility of the Department for Environment, Food and Rural Affairs (Defra). It has been produced in collaboration with relevant officials in the devolved governments, and with UK food safety bodies. An area as all-encompassing as food security touches on a wide range of government bodies. Agricultural and food supply policy is devolved to each national government. As lead departments for food as a Critical National Infrastructure (CNI) sector, Defra and the Food Standards Agency (FSA) manage risks specifically relating to National Security and Counter Terrorism across the UK. For all other areas of risk, food supply chain resilience and security are the responsibility of Defra in England; DAERA and the Department for Communities in Northern Ireland; the Scottish Government in Scotland; and the Welsh Government in Wales. The FSA is responsible for food safety and for protecting consumers and industry from food crime in supply chains in England, Northern Ireland and Wales. Food Standards Scotland are responsible for food safety, promoting healthy eating and food crime in Scotland.

The UKFSR is produced in compliance with the Code of Practice for Official Statistics and any deviations from the code (e.g. publishing at 10:30am rather than 9:30 am) have been approved via the Defra Head of Profession for Statistics with the UK Statistics Authority. Indicators throughout were chosen due to meeting data quality requirements, being relevant to the subject, and cumulative (that is each adds some unique insight to the subject under consideration)

How to read the UKFSR

As noted above food security is the combination of 5 themes in the UKFSR. No one theme can be read as fully representing UK food security. The reader should look across the themes to understand UK food security.

Each theme of the UKFSR begins with an introduction, which sets out the broader context and reasoning behind the theme, and a summary, which provides the headline conclusions. Each theme is made up of indicators, each of which sets out a specific metric or dataset relating to food security. Some indicators are supported by case studies where it is felt that additional evidence and contexts adds value.

Each indicator has a **rationale** section explaining why the indicator has been included and the data underpinning it. This is followed by a **headline evidence** section that describes trends for the headline dataset under the indicator and what this means for food security. A **supporting evidence** section puts the headline evidence in the context of related trends and longer timeframes to guide the reader to a deeper understanding of the indicator and how it fits within UK food security. Where there is an observable past or future food security trend in the data, the analysis will articulate it. These 3 sections are a restructuring of the 2021 indicator analysis. The aim of this restructuring is to enhance accessibility and usability by introducing a clearer definition of the headline statistic and supporting statistics. The indicator is combination of the headline statistic being assessed in the headline evidence and the supporting evidence in line with the UKFSR's multi-faceted and 'systems' approach to food security. Additional methodology notes are included in **Annex IV**. Alongside the annexes there is a **glossary** to support understanding technical terms.

The UKFSR is designed to update on indicators in previous reports. In some cases indicators have been renamed and grouped with other indicators as part of enhancing the evidence base. To support readers with comparing the findings of indicators to their findings in the UKFSR 2021, **Annex I** provides a table mapping the 2024 indicators to the 2021 indicators.

Theme 1: Global Food Availability

Introduction

Theme definition

Theme 1 encompasses issues related to global food supply and the sustainability of global food production, on which UK food supply depends. Food security in this theme means stable or improving trends in the ability of global food production and trading system, to meet global (including the UK's) requirements for food now and over the long term and to provide a healthy diet. This includes sustainable practices that ensure that key resources in nature are not depleted and risks to ecosystem health are mitigated. It takes into account equity in access to food globally and whether the global food system delivers for all who need it.

Some of the key variables affecting these components of food security include agricultural practices, economic stability, geopolitical circumstances, supply chains, and the climate. These factors interact to shape the global food system and have important implications for the UK, both its food imports and domestic production, which are covered in more detail in Theme 2.

This theme assesses 5 areas of global food availability in the following order: global production considered against factors of demand (Sub-theme 1); productivity and key inputs to agriculture (land, fertiliser, water) (Sub-theme 2); reliability of the global trading system (Sub-theme 3); global access to food and nutrition (Sub-theme 4); and impacts over the longer-term of global food production on the environment and biodiversity (Sub-theme 5). This edition of the UKFSR includes new indicators looking at global food and nutrition insecurity, additional commodity groups and sustainability.

Availability is a key dimension of food security in this theme with most indicators assessing trends in the production, distribution and exchange of food at the global level (see definition of terms in Annex II). This complements the analysis of UK food availability in Theme 2 UK Food Supply Sources given the reliance of UK supply on global markets. The stability and sustainability dimensions of food security are also assessed in large parts of the theme, with consideration of existing and potential future risks embedded into the supporting evidence, to provide an overall view of food security at the global level.

Accessibility and utilisation of food are covered by measuring trends in the affordability, nutritional value and safety of food where relevant to the discussion of global food availability.

Overall findings

- **Food production has continued to grow and keep up with population growth**. This means there is enough food in the world in terms of volume and dietary energy supply to meet global population needs. Supply-chain disruptions from geopolitical and climate events have led to some shocks to prices and distribution networks.
  Key statistic: There have been moderate increases in global food production per capita for most food groups between 2019 and 2022: meat (+3.78%), roots and tubers (+2.02%), milk (+1.53%), fruit and vegetables (+1.29%), eggs (+0.71%), and cereals (+0.46%) (see Indicator 1.1.1 Global food production). Total food supply available for human consumption was 2,985 kilocalories per person per day in 2022, increasing by 38 calories from 2019 (see Indicator 1.1.1 Global food production).

- **The global trading system remains stable and robust** and is a reliable source of UK food supply despite new geopolitical stress.
  Key statistic: The percentage of key global cereals, soybeans and meats traded by volume remains broadly stable with minimal fluctuations between 2021/22 and 2024/25, with the largest changes a 2.4 percentage point (pp) decrease in pigmeat, 1.3pp decrease in maize and 1.7pp increase in the share of beef and veal production traded across this period (see Indicator 1.3.3 Global production internationally traded).

- **The number of undernourished people around the world is increasing** due to poverty, conflict, climate change as well as issues in food distribution, other growing uses for commodities, and caloric efficiency. This continues a recent trend running counter to a longer-term decrease from 2005 to 2017. Meanwhile obesity rates have continued their rapid increase globally since the 1990s. These trends indicate a general increase in diet-related ill health and that the global food system has failed to adapt to address the continuing challenge from global inequality.
  Key statistic: The number of people facing undernourishment has increased since 2017, from 541 million to 733 million in 2023, while rates of obesity have doubled between 1990 and 2022 reaching around 16% of the adult world population (see Indicator 1.4.1 Global food and nutrition security).

- **The average rate of total factor productivity (TFP) growth of agriculture has fallen**. Future outlooks suggest that the world will need to reverse this trend and improve its productivity if it is to maintain current rates of production per capita over the longer term, while enabling the restoration of nature needed for productivity.
  Key statistic: While global agricultural TFP grew at an average annual rate of 1.9% from 2000 to 2011, this figure fell to 0.74% for the period between

2011 and 2022 TFP growth has fallen across all country income groups (see Indicator 1.2.1 Global agricultural total factor productivity).

- **Water and land, important agricultural inputs, are under increasing human and geopolitical competition and are being used at an unsustainable rate**. The food system's essential natural resources continue to be depleted without being recovered for future use. Global demand for both is projected to outstrip supply unless there are transformations in modes of use and demand. Agriculture plays a disproportionate role as the largest single source of land and environmental degradation, and the largest source of freshwater pollution. **Climate change exacerbates these system stressors** including weak productivity growth by driving volatility and system instability. It also compounds with geopolitical events meaning that they have more significant effect on the food system than their effects in isolation (as an example see case study on export restrictions).
  Key statistic: Between 2015 and 2019 the amount of land globally which was reported as being degraded increased by 4.2 pp, from 11.3% to 15.5% (see Indicator 1.5.1 Global land degradation).

Cross-theme links

The UK food system (covered in themes 2 to 5) is highly connected to the global food system and many of the strengths and challenges of the UK system are also international strengths and challenges. Stable trade and production trends internationally support stable UK supply with the UK relying on trade for around 42% of its supply and on global markets for key inputs to its domestic production of food. This means that the risks over the longer term internationally are risks to UK food security. Theme 2 shows that risks from climate change, nature loss and weak productivity growth seen globally in Theme 1 are also manifest in the UK.

While the UK is a high-income country, Theme 4 Food Security at Household Level shows that there are millions of people in the UK with inadequate access to a healthy diet and that this number is increasing.

Themes 3 Food Supply Chain Resilience and 4 show that shocks to the supply of inputs including energy and fertiliser at the global level were the most disruptive factors for UK food security in the last 3 years. They caused price volatility in input costs which fed into the period of exceptionally high food price and wider inflation between 2022 and 2023 in the UK. While the UK experienced the shock on the level of prices, some parts of the world dependent on Russia and Ukraine for cereals experienced challenges with food supply following changes to levels of production, depreciations in currencies and increases in import prices.

Sub-theme 1: Production

1.1.1 Global food production

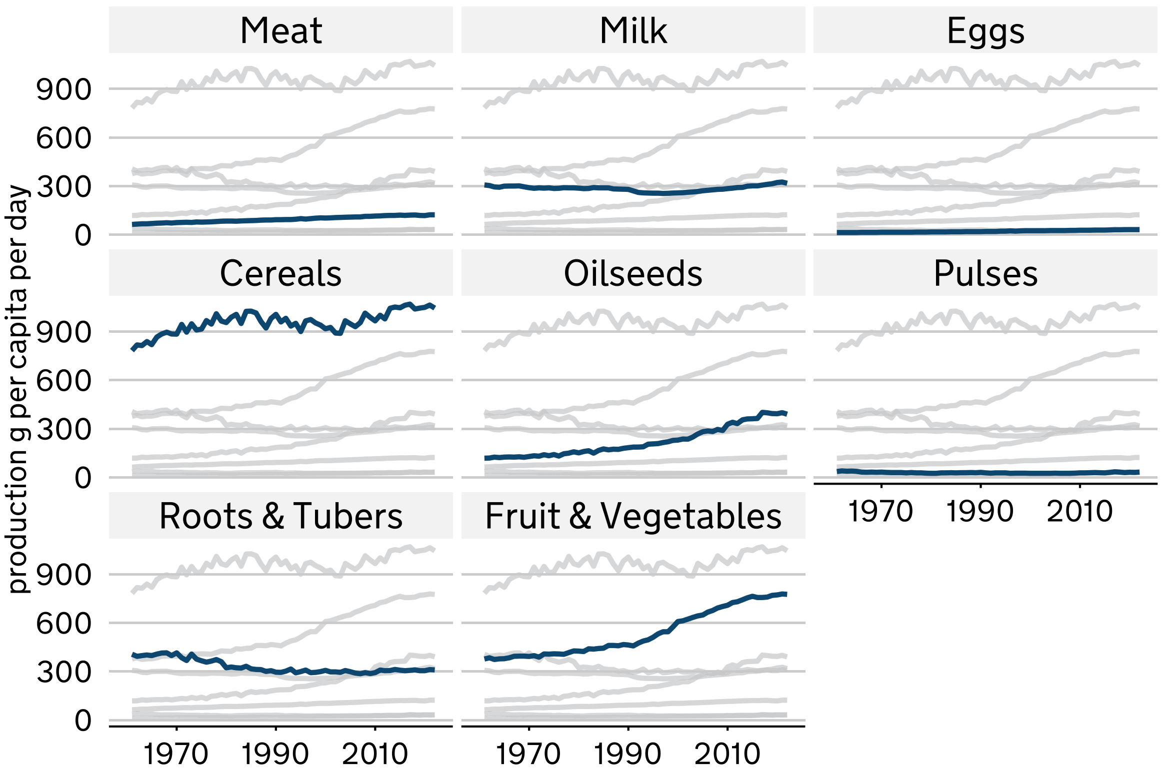
Rationale

This indicator describes global food production, a fundamental indicator of global food availability within the global food system, within which the UK food system sits. ‘Food production’ refers to all agricultural production that can be used for food, the final end product of which may be used for a range of purposes, including human consumption, animal feed and biofuels production.

Headline evidence

Figure 1.1.1a: World food production by main food groups (in grams per capita per day), 1960 to 2022

Source: [FAOSTAT Crops and livestock products, Food and Agriculture Organization of the United Nations (FAO), 2024]



Note: Calculated using population data from the (UN Department of Economic and Social Affairs (UN DESA), 2024) and divided by the number of days in the year to give a daily per capita amount.

Overall, global food production per capita has continued its upward trend over the last 3 years, with moderate increases reported for most food groups between 2019 and 2022 (Figure 1.1.1b below). This means that, despite challenges such as rising geopolitical tensions, adverse weather conditions, and supply-chain disruptions, global food production has more than kept pace with population growth. However, while the rate of food production per capita continues to rise, there are an increasing number of risks such as continued population growth, decreasing total factor productivity (TFP), unequal access to water resources, and greater competition for land which mean that the future trend is uncertain.

Figure 1.1.1b: World food production by main food groups (in grams per capita per day; 2019 and 2022).

Source: FAOSTAT, 2024

Food Type	2019	2022	Percentage Difference 2019-2022
Cereals	1044.8	1049.6	0.46%
Eggs	31.7	32.0	0.71%
Meat	119.2	123.7	3.78%
Milk	314.3	319.1	1.53%
Roots and Tubers	304.9	311.1	2.02%
Fruit and Vegetables including Citrus Fruit	769.6	779.6	1.29%
Oilseeds	393.7	392.2	-0.39%
Pulses	29.9	32.9	10.13%

Note: Calculated using population data from the (UN DESA, 2024) and divided by the number of days in the year to give a daily per capita amount.

Indicators 1.1.3 to 1.1.6 provide a more detailed description of production trends for individual food groups, including cereals, livestock, fruit and vegetables, and fish and seafood.

Supporting evidence

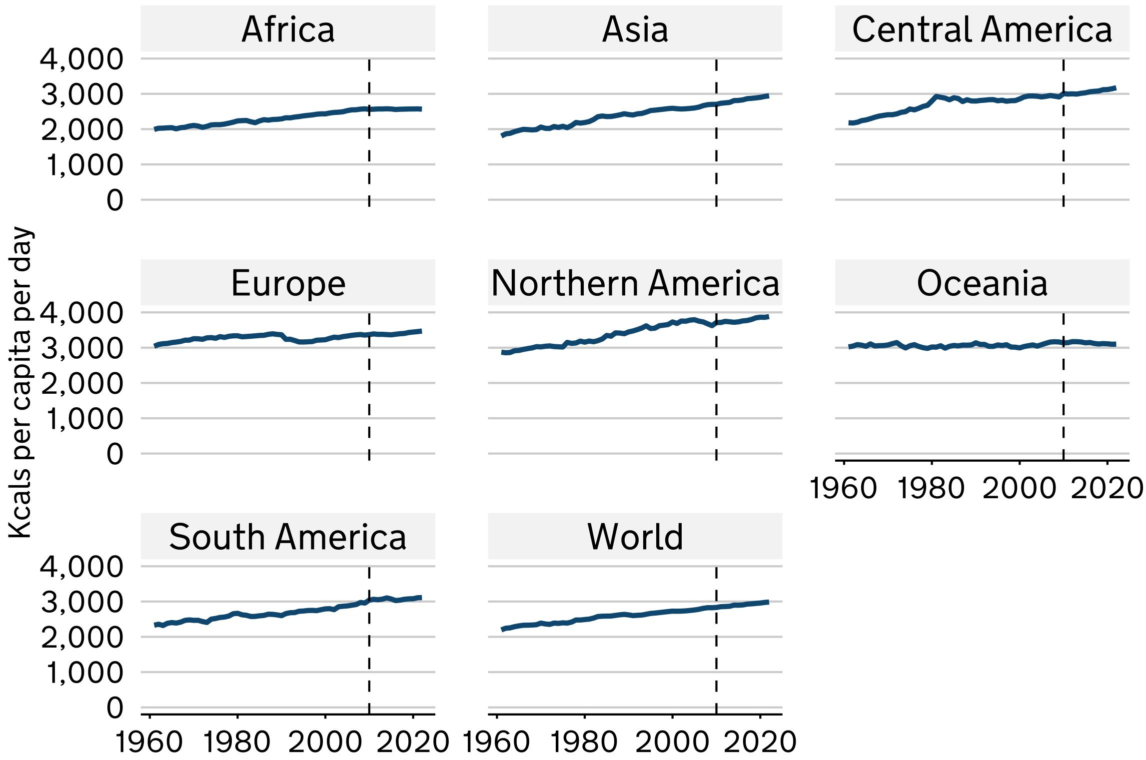
Global food production trends

The past few decades have been characterised by substantial increases in global food production per capita. Since 1961 production per capita of all food groups has risen, except in roots and tubers, which experienced a decrease during the 1970s and 1980s due to urban populations consuming more cereals (FAO, 2024), but has remained broadly stable since. Production per capita of cereals increased by 33.5% between 1961 and 2022, spurred primarily by yield growth (see Indicator 1.1.3 Global cereals production for further information on drivers of growth in cereals production). Over the same period, production per capita of eggs, fruit and vegetables, meat and milk, increased by 135.9%, 105.8%, 93.3% and 3.4% respectively.

Global food supply available for human consumption

Figure 1.1.1c: Dietary energy supply (in calories per capita per day) by region, 1961 to 2022

Source: FAOSTAT, 2024



Note: Dotted line signifies a change in methodology in 2010.

The increases in food production over the past decades have contributed to a substantial rise in food supply available for human consumption, which reached 2,985 kilocalories per person per day in 2022 (FAOSTAT,2024), an increase of 38 calories from 2019. Therefore, there are currently enough calories available globally to feed the current world population given that the current calories available per person exceeds the recommended average of 2500 kilocalories for men and 2000 kilocalories for women (NHS, 2023). Despite marked differences in dietary energy supply across global regions (Figure 1.1.1c), there are, in principle, sufficient calories available to meet the energy needs of populations in all individual regions.

However, reported values of energy supply available for human consumption do not take into account the effect of consumer food waste on the actual amount of food consumed and should therefore not be mistaken for estimates of the actual energy intake of the population (FBS methodology). Further detail on food waste is provided in Indicator 1.1.2 Global food loss and waste. Furthermore, sufficient food supply available for human consumption at the global or regional level does not guarantee sufficient availability at the national, household, or individual level, and does not ensure access to different population groups. Indicator 1.4.1 on Global food and nutrition insecurity provides information on food access and utilisation at the global level.

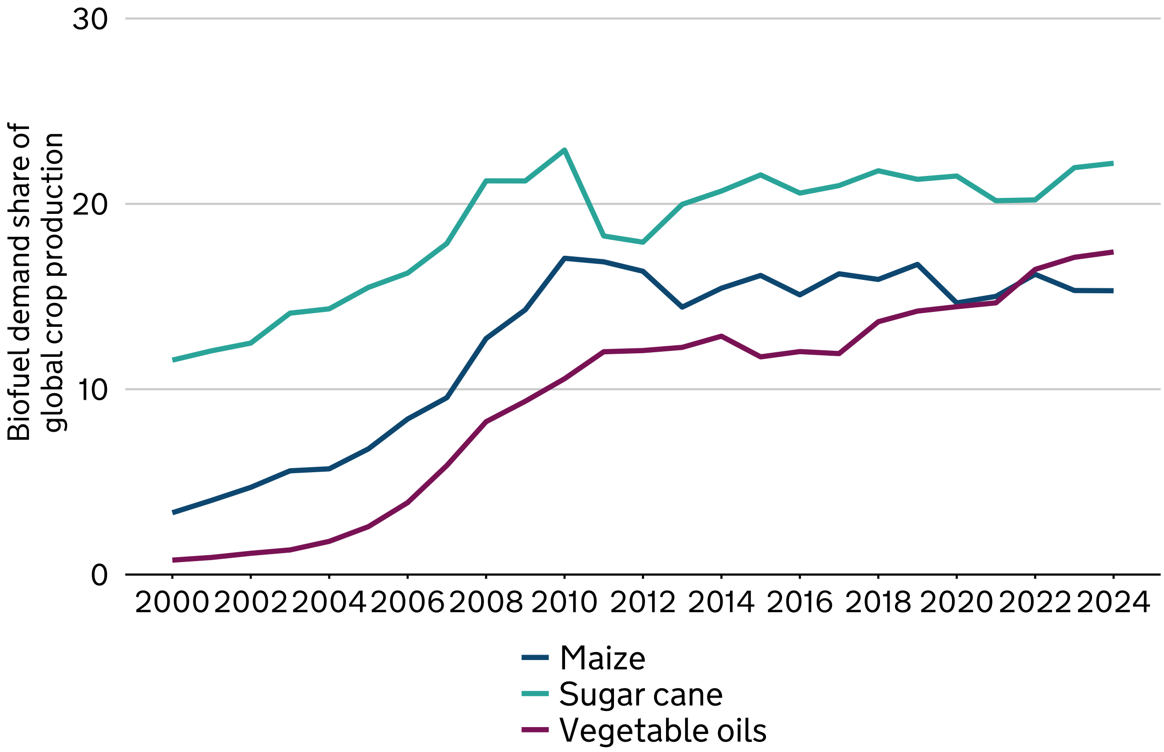
In addition, having sufficient calories available for human consumption at global and regional levels does not necessarily correspond to the availability of a healthy diet. For instance, too few wholegrains, fruit and vegetables, and legumes are consumed at the global level, while consumption of red and processed meat, starchy vegetables and free or added sugar is deemed excessive compared to NHS dietary guidelines, which would also enable adequate intake of most micronutrients (The Eatwell Guide - NHS). The leading dietary risk factors for mortality globally are diets high in sodium, low in whole grains, low in fruit, low in nuts and seeds, low in vegetables, and low in omega-3 fatty acids (Lancet, 2019). Further information on the cost of a healthy diet is covered in Indicator 1.4.1 on Global food and nutrition insecurity.

Production for purposes other than human consumption

Beyond human consumption, global food production is also used for other purposes, including industrial uses, seed and feed.

Figure 1.1.1d: Share of global production used for biofuels (selected commodities, 2000 to 2024), unit percentage

Source: Agricultural Outlook Database, Organisation for Economic Co-operation and Development (OECD)



Among industrial uses, production of biofuels has gained prominence during the last decades (Figure 1.1.1d). Biofuels are fuels made from crops such as maize, sugar cane and vegetable oils and can be considered as a renewable source of energy that can contribute to reducing carbon emissions (DOE Office of Science, 2024). However, biofuel production can also represent a food use that competes with other uses including human consumption and can generate increased pressures to enhance agricultural land use (Searchinger and Heimlich, 2015).

From 2000 to 2023, the proportion of food production used for biofuels has increased, particularly during the first decade of the century (Figure 1.1.1d). Between 2000 and 2023, the proportion of sugarcane production used for biofuels rose from 11.6% to 23.2%, of maize from 3.4% to 15.7%, and of vegetable oils from 0.8% to 16.4% (OECD, 2024). Production has been mostly concentrated in the Americas. The OECD-FAO Agricultural Outlook 2023 to 2032 indicates that around double the global average of biofuels are produced in Latin America and quadruple in North America (OECD-FAO, 2023).

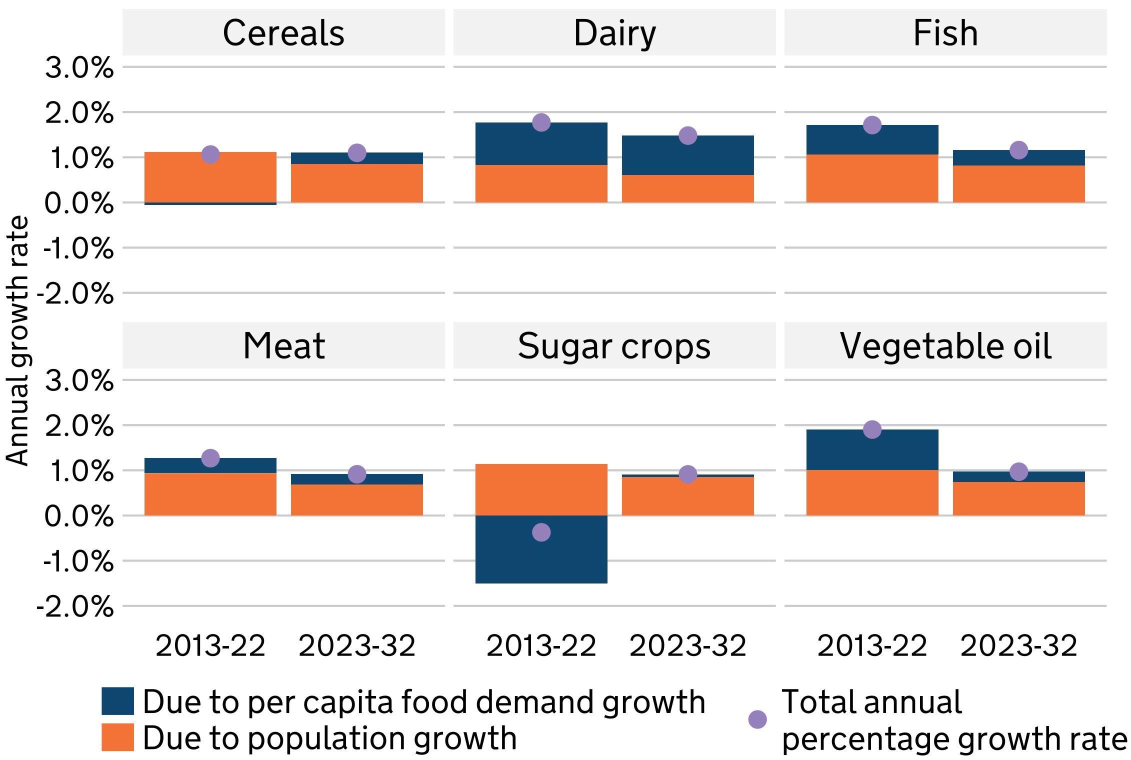
There has been a steady increase in food production used for animal feed since 2010 driven by increases in the number of animals as well as intensification of production (FAOSTAT, 2024). Growth in feed use has been driven by increased global demand for meat, particularly in Southeast Asia where the increases in production have been driving demand for animal feed (OECD-FAO, 2024). Aquaculture, which currently relies largely on fishmeal and fish oil as feeds, has also been a key area of growth across all world bank country income classes (Hamadeh, Van Rompaey and Metreau ,2023) (FAO, 2023).

Forward look

The majority of growth in production is expected from middle- and low-income countries including China, India and other Asian countries (OECD-FAO, 2024). Asia is expected to make a significant contribution to food supply in the next decade, contributing to approximately 50% of global crop production, 50% of global livestock production and 75% of global fish production (including aquaculture)(OECD-FAO, 2023).

Figure 1.1.1e: Predicted average annual growth in demand for key commodity groups, 2013 to 2022 and 2023 to 2032

Source: Agricultural Outlook 2023-2032, OECD-FAO



Although there is growing competition between food production for various uses, such as feed, food and biofuels, demand growth for these uses over the next decade is projected to slow down compared to the last 10 years (Figure 1.1.1e). This will be driven by weaker projected expansions in feed demand and biofuels and direct per capita consumption of most cereals reaching saturation levels in middle- and high-income countries (OECD-FAO, 2024).

1.1.2 Global food loss and waste

Rationale

Food loss and waste reduces the availability of food and represents a significant environmental loss within the food system. ‘Food loss’ refers to the decrease in edible food mass at the production, post-harvest and processing stages of the food chain as defined in Sustainable Development Goal (SDG) 12.3. ‘Food waste’ refers to the discarding of foods at the retail, food service provider and consumer levels (United Nations Environment Programme, 2024).

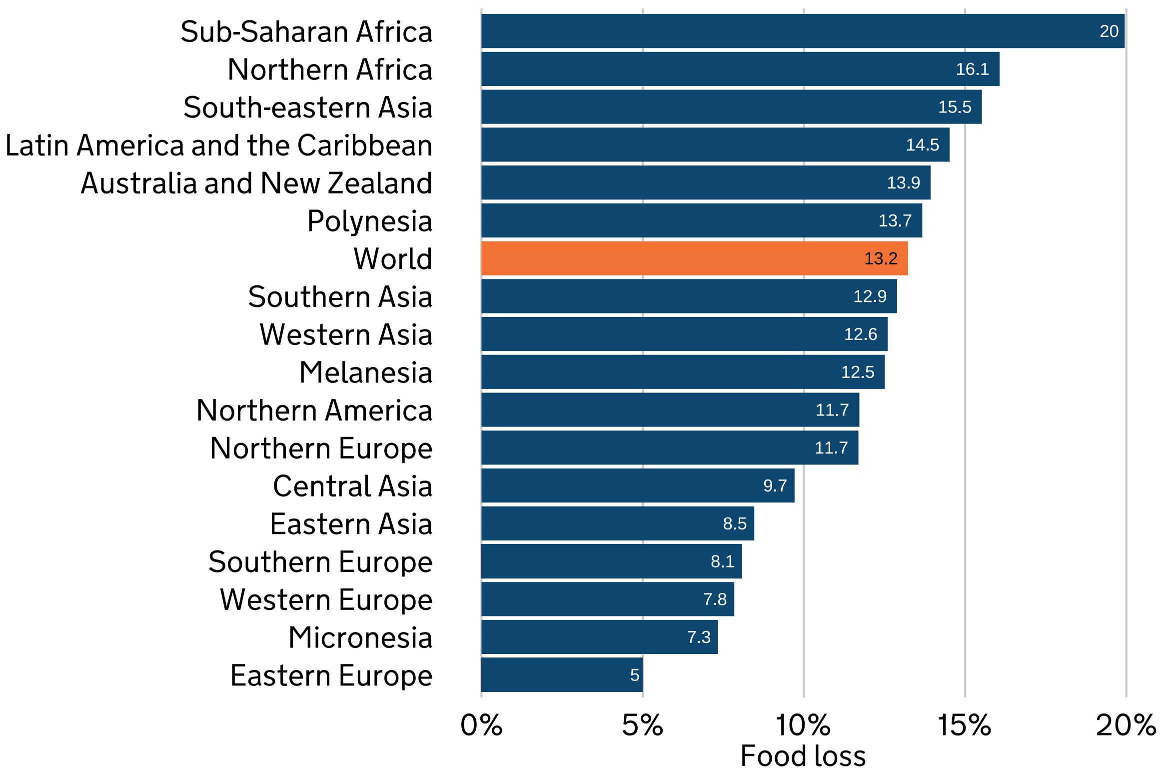
Using estimates from the United Nations Environment Programme Food Waste Index, this indicator measures how much food is lost and wasted at a global and regional level.

The relationship between food loss and waste and food security is not straightforward. Food loss and waste reduction in high-income countries is unlikely to have a significant effect on global food security. In low-income countries, a reduction of on-farm losses is likely to improve the food security status of subsistence and semi-subsistence farmers as they consume all or a significant part of their own production. Meanwhile, a reduction in losses of food sold commercially improves the availability of food beyond farming households (FAO, 2019). Studies have shown that while reducing food loss and waste can improve food security, other measures such as increased agricultural research and development spending or enhanced irrigation efficiency may prove more cost-effective (FAO, 2019).

Headline evidence

Figure 1.1.2a: UN SDG 12.3.1a Food Loss Percentage – post-harvest on farm and at the transport, storage and processing stages, 2021

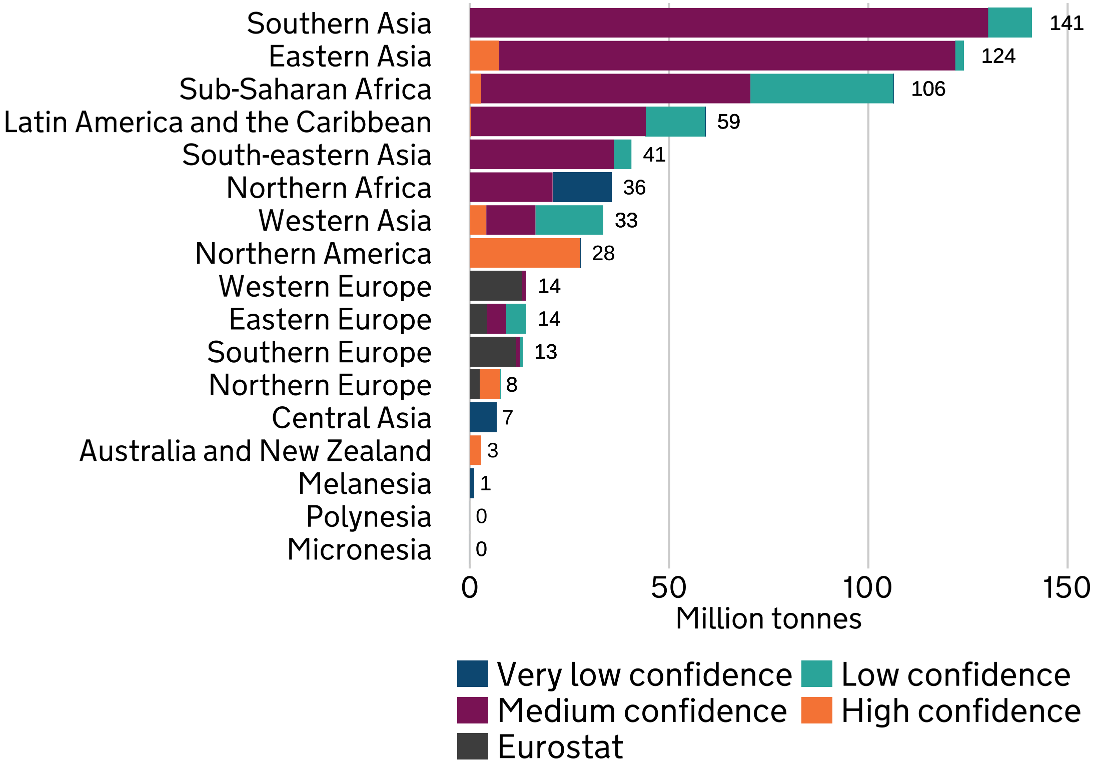
Source: FAOSTAT, 2021



Average global food loss in 2021 stood at 13.2% of food lost after harvest on farm and at the transport, storage and processing stages. This is similar to previous estimates of 13.3% and 13% in 2020 and 2016 respectively. However, given the difficulties in collecting and reporting of food loss data, care should be taken in interpreting such minimal changes. It is not currently possible to tell if there is a clear or significant trend in the data. The lowest rate of food loss was seen in Eastern Europe at 5.0%, followed by Micronesia at 7.3%, and the highest was in Sub-Saharan Africa at 20.0%, followed by Northern Africa at 16.1%.

Figure 1.1.2b: Household Food Waste (million tonnes) 2022

Source: Food Waste Index 2024, United Nations Environment Programme (UNEP)



Note: Regions may not include all countries and confidence in the data varies between countries

In 2022, global food waste was estimated to be 132 kg per capita per year or 1.05 billion tonnes, equivalent to 19% of global food supply (UNEP, 2024). Household food waste constitutes the largest component at 79 kg/capita per year, followed by food service at 36 kg/capita per year and retail at 17kg/capita per year. Household food waste is higher in Southern (100 kg/ per capita per year) and Eastern Asia (70 kg/per capita per year) than it is in North America (76 kg/per capita per year) and Europe (53-80 kg/capita per year). As Southern and Eastern Asia also have larger populations, total household food waste is also higher in these regions. On average, levels of household food waste per capita (the total of edible and inedible parts) are estimated to be similar for high-income, upper-middle income and lower-middle income countries, though there is greater variation at lower income levels (UNEP, 2024).

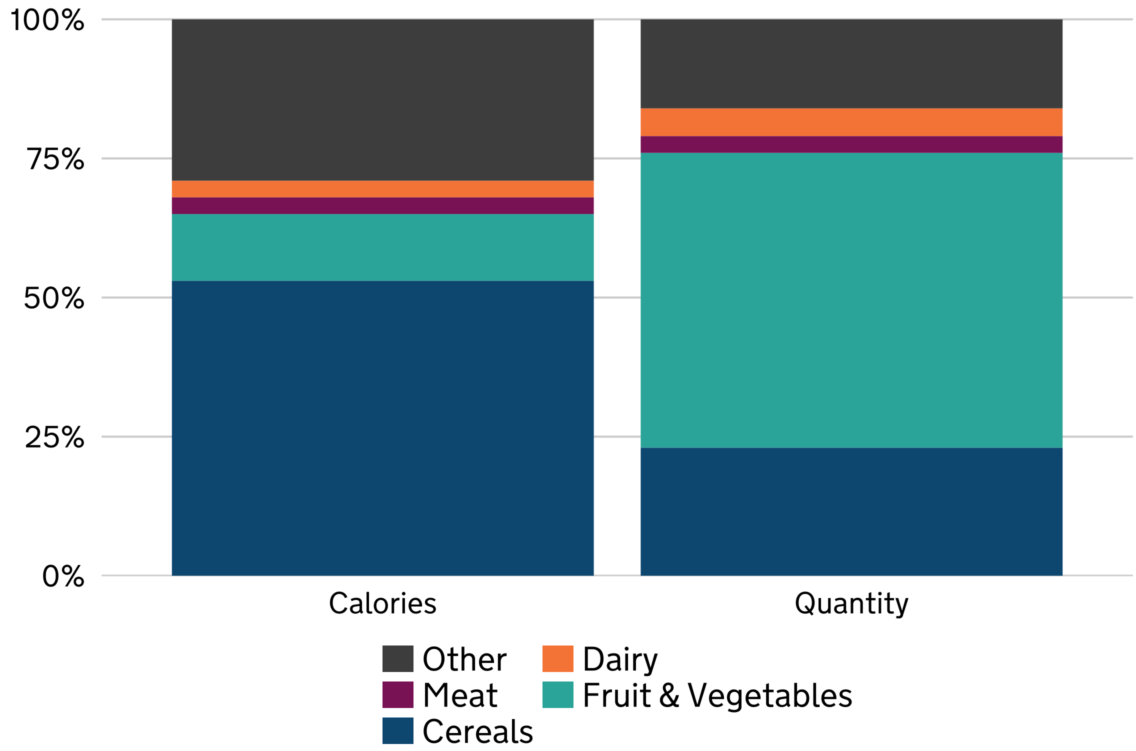
Care is needed in interpreting these figures, given the limited data available on food loss and waste and reliance on estimates. For more information on the methodology for the Global Food Loss Index and Food Waste Index, see the FAO and UNEP respectively. While there have been changes to the reported level of global food waste between 2019 and 2022, a lack of systematic monitoring means data is not of a quality necessary to understand if food loss and waste is increasing or decreasing. Only high-confidence estimates are likely to be suitable for tracking national levels of food waste over time, whereas medium-confidence estimates may be used to identify large changes in food waste, but are not geographically representative (UNEP, 2024). Low and very low confidence estimates may be useful to inform food waste strategies. A lack of domestic monitoring by countries also means it is difficult to understand where exactly in the food system the loss and waste is occurring and how this varies depending on the region, product and supply chain. Nevertheless, reported changes may reflect greater data coverage and a more accurate representation of current food waste levels.

What has been included in this indicator represents the best available current estimates, although large gaps in the data still exist.

Supporting evidence

Figure 1.1.2c: Shares of food loss and waste by commodity, 2021 to 2023

Source: Agricultural Outlook 2024-2033, OECD-FAO



While in terms of volume most food losses and waste occurs in fruit and vegetables, in terms of calories the greatest food losses and waste comes from cereals (Figure 3). The loss and waste of fruit and vegetables in some parts of the world may lead to an insufficient supply of fruit and vegetables being available to ensure a healthy diet can be maintained. Research indicates that following similar historic socioeconomic and waste trends, by 2050 the number of people living in countries with insufficient supply of fruits and vegetables will be 1.5 billion more compared with a zero-waste scenario.

Causes of food loss and food waste

Food loss and waste occurs for a variety of reasons which are context dependent. Supply chain issues, conflicting agendas between smallholder farmers and other stakeholders, power-holding, and climate change all affect food loss and management practices at the global level (World Resources Institute (WRI), 2019). Food loss and waste patterns vary across developing and developed countries. In developing countries, waste occurs mainly in the post-harvest and processing stage. This is caused by factors such as poor practices, technical and technological limitations, labour and financial restrictions and a lack of proper infrastructure for transportation and storage (Ishangulyyev, Kim, Lee, 2019). In comparison, the retail and consumption stages are typical loss points in high-income countries. This is important to understand when deciding on actions to reduce food loss and waste, as the optimal entry point for intervention depends on the context (The State of Food and Agriculture 2019).

Greenhouse Gas (GHG) Emissions

Estimates of GHG emissions from food loss and waste vary vastly from 3.3 Gigatons of CO_2 -equivalent to 9.3 Gigatons of CO_2-eqivalent per year depending on what factors are included. The type of food wasted has a significant effect on the amount of GHG emitted with meat and dairy being the most significant. Food loss and waste is thought to account for up to half of all GHG emissions from the food system. According to the OECD-FAO Agricultural Outlook 2024-2032, halving global food loss and waste by 2030 has the potential to reduce global agricultural GHG emissions by 4% and the number of undernourished people by 153 million. This is because natural resources will be used more efficiently and GHG emissions per unit of food consumed will be reduced. However, this outcome is uncertain, and the extent to which resource use and GHGs are reduced will depend on how prices change as a result of the reduction in food loss and waste and how suppliers and consumers react to those price changes (FAO, 2019).

Actions being taken to reduce food loss and waste

There is increasing evidence of initiatives to reduce food loss and waste, such as those detailed in Champions 12.3. For instance, companies are developing active programmes to reduce food loss and waste in both their operations and increasingly in their supply chains. By the end of 2021, 29 of the world’s 50 largest food companies (by revenue) had active programs targeting the reduction of food loss and waste. Additionally, in 2023 Ingka Group (IKEA) became the first company to achieve over 50% reduction in food loss and waste across all its operations (Lipinski, 2022).

In developing countries, most losses occur post-harvest and in the processing stage. Actions aimed at reducing food losses are therefore likely to be a more effective means of improving food security than actions to reduce food waste. Similarly, in developed countries, overall food insecurity is associated with poverty, so the recovery and redistribution of food may therefore help to alleviate food insecurity. Theme 2 Indicator 2.2.2 Food waste explores the redistribution of food in the UK.

Trade-off

The effects of efforts to reduce food loss and waste can be complex. For instance, in 2013 Northern Africa and the Near East engaged in efforts to reduce the amount of food lost by primary procedures. This increased efficiency in production led to a fall in domestic prices, enabling households to buy more food. However, increased efficiency meant that less labour was needed to produce the same output, which caused a fall in employment and nominal wages. The overall net effect was improved household food security and a decrease in rural poverty. The effect of efforts to reduce food loss and waste on farmers, processors, distributors, retailers and consumers will depend on how the effects of prices are transferred throughout the food chain. Some may do well while others may lose (FAO, 2019).

1.1.3 Global cereals production

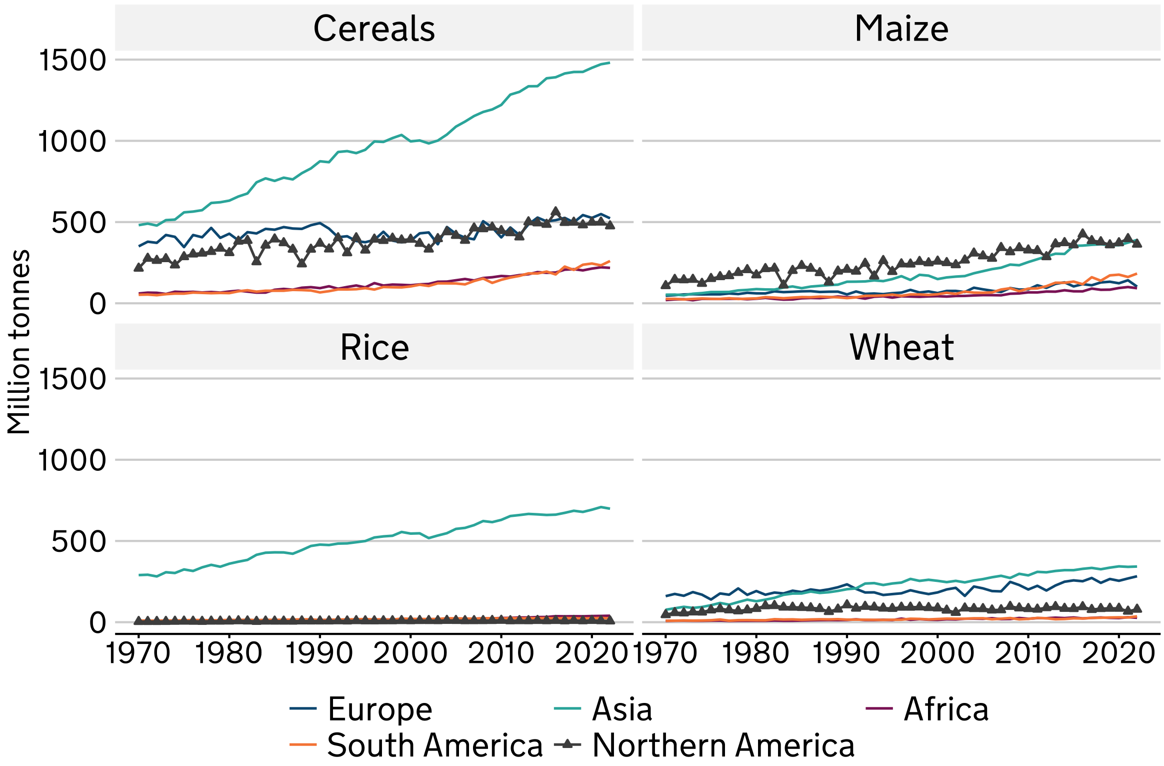
Rationale

Crops serve as the main food source for humans and animals, and are essential for a healthy balanced diet, providing a broad range of nutrients including carbohydrates, protein and fibre and a range of vitamins and minerals (FAO, 1997). Their consistent availability is a precondition for accessibility and affordability, especially in areas where other food sources might be scarce. Figure 1.1.3a shows the evolution of the production of staple cereals such as rice, wheat, and maize, in million tonnes. Directly consumed as carbohydrates, cereals provide the largest part of the human caloric intake, while as animal feed they underpin the global supply of animal products. In developing countries, maize, rice, and wheat provide 43% of total calories and 36% of total protein (FAO, 2024).

Headline evidence

Figure 1.1.3a: Total cereal production by region, 1970 to 2022 (Million Tonnes)

Source: FAO



Note: 'Cereals, primary' is defined as class 011 in the United Nations Statistics Division (UNSD) Central Product Classification and includes wheat, maize, rice, sorghum, barley, rye, oats, millet, and other miscellaneous grains.

Despite considerable external shocks during the recent past, including geopolitical tensions, adverse weather conditions, and supply-chain disruptions, global cereal production, driven by growth in yields, continues to grow at a stable rate. In 2020, cereal production reached just over 3 billion tonnes, with wheat, maize and rice being the primary contributors. The trend continued upwards in 2022, with production surpassing 3.06 billion tonnes (FAO, 2024). This marks an increase of approximately 56 million tonnes or 2% over the 3-year period, with maize, rice, and wheat remaining the most prominent grains. These production figures are likely to differ from other reputable sources such as the Agricultural Market Information System (AMIS), the International Grains Council (IGC) and United States Department of Agriculture (USDA) as a result of methodological differences and variation in cereal aggregations.

While global cereal production remains stable, disruptions to trade flows from key exporters, such as India and Ukraine, led to an increase in volatility in global markets. While macroeconomic factors, such as high inflation and a strong dollar, led to variable localised effects over the last 3 years. This has left certain countries with a considerable increase in their import bills for staples.

Supporting evidence

Selection of commodities

These commodities have been selected due to their crucial role in diets and contributing to international food security. Cereals, two thirds of which are made up of rice, wheat, and maize (IAEA,2012), represent approximately 45% of global calorie consumption (OECD-FAO, 2024). Over the last decade, demand for cereals has grown with populations in low- and lower-middle-income countries. Going forward, increased demand for wheat and rice is expected from growing Asian populations (OECD-FAO, 2024). Maize is also considered a staple food in Mexico, Central America, and Sub-Saharan Africa. 60% of global maize production is for inputs into animal feed, which is important for food security (OECD-FAO, 2024).

Regional variation

Global cereal production is concentrated in a few important regions reflecting climatic conditions and agricultural investments. The United States of America (USA), China, and India remain dominant players, collectively contributing to 30.0%, 17.0% and 25.3% of the world's output of maize, wheat, and rice respectively (FAO, 2024). Other notable contributors include the European Union (EU) and Brazil, which have expanded their coarse grain and maize outputs. Over the last 3 years, Asia’s share in global wheat production declined slightly by 1.6% to 42.4% (FAO, 2024) and the share increased for Europe and Oceania which saw an expansion from 33.7% to 35% and 2% to 4.5% respectively.

Looking across a longer time span shows that there have been shifts in global production patterns. Since the mid-1990s, both the per annum growth rate and the aggregate production of cereals have been at a similar level in Europe and North America with the two regions accounting for 16% to 22% of global output. However, there has been a reversal in this trend over the last decade and the annual growth rate of production has been higher in Europe than in North America. This has been driven by a decline in wheat production in the USA and an expansion in Russia.

Notable shifts in the cereal markets include the emergence of China as a major wheat producer during the 1980s, subsequently surpassing Europe, and the increasing importance of South America as a soybean and maize producer. Agricultural reforms in Brazil during the early 2000s led to a rapid expansion of soybean and maize production.

These shifts in the importance of countries in global cereal markets have implications for considering the effects of both short-term factors, such as harvest failures, and long-term factors, such as climate change, on global markets and food security. More information on the geopolitical implications of the shifts in the importance of major cereal exporters is covered in Indicator 1.3.3 Global production internationally traded.

Impact on livestock production

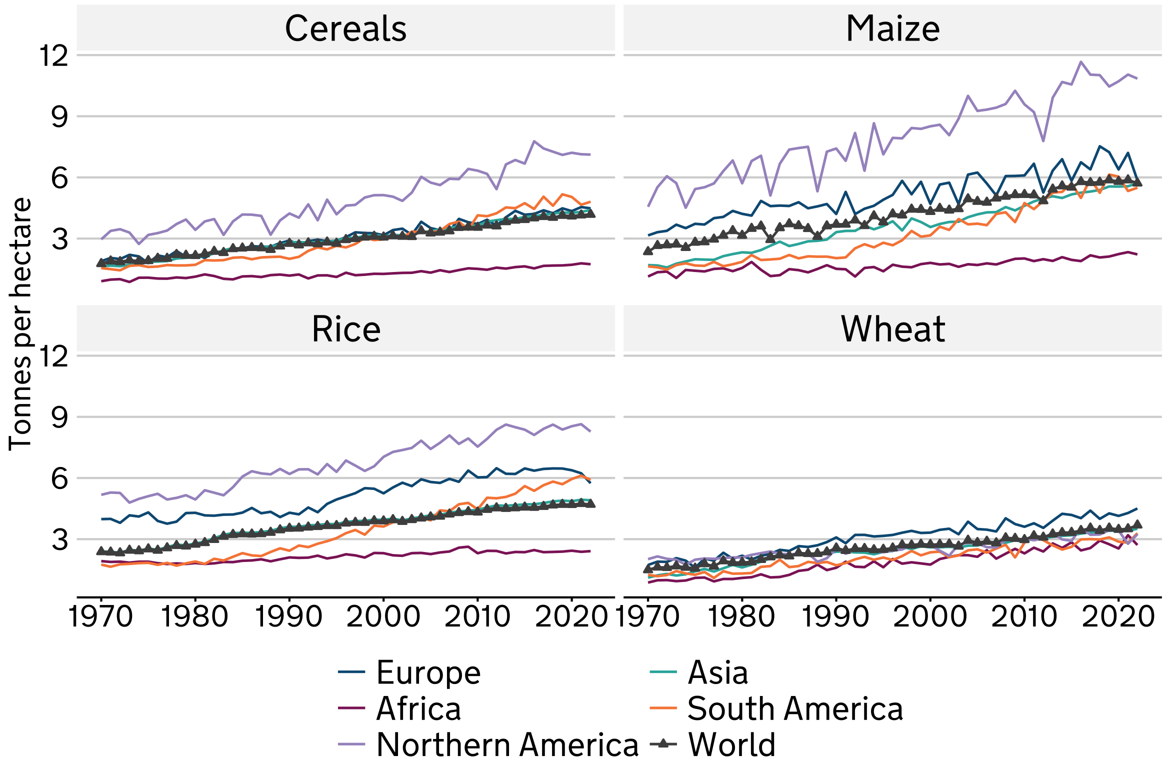
The availability of cereals also has an impact on livestock production as maize and wheat are widely used as feed to rear livestock (AMIS,2012). A greater availability of cereal stocks allows for a steadier supply of cereals, which ensures greater stability in cereal and livestock markets due to greater certainty in pricing, as well as input costs for pastoral farming. Further information on changes to global livestock production is covered in Indicator 1.1.4 Production of global livestock products.

Key drivers of production

Yield growth rates and volatility are important indicators for evaluating global food supply as they represent how much food is being produced on the same amount of land. Historically, the increase in cereal production has been driven by yield growth rather than expansion in the area used for planting crops. Increasing productivity over time can be attributed to more efficient input use, seed varieties and more advanced agricultural techniques. While overall food production is projected to increase, as outlined in Indicator 1.1.1 Global food production and Indicator 1.2.1 Global agricultural total factor productivity, per annum growth rates in cereal yields are slowing (1.8% and 1.3% in the 1970s and 2010s respectively) while cropland expansion has accelerated since the early 2000s (as shown in Indicator 1.2.2 Global land use change).

Figure 1.1.3b: Cereal yields by region, 1970 to 2022

Source: FAO, 2024



Between 2020 and 2022, cereal yields increased by approximately 2.0% from 4.1 to 4.2 tonnes per hectare. However, yields vary significantly by region, with high-income countries generally experiencing higher yields than low-income ones due to differences in technology adoption and infrastructure (Figure 1.1.3b). Despite productivity improvements expected in the latter group, a considerable productivity gap is projected to persist over the next decade which is challenging for farm incomes and domestic food security and may increase some countries' dependence on imports (OECD-FAO, 2024).

Crop yield volatility

The degree of crop yield volatility is subject to factors such as extreme weather events, climate change impacts and planting decisions; and varies considerably by region (Ray et al., 2015). Over the past decade, crop yields have not been particularly volatile, especially when compared to previous decades. The magnitude of wheat, maize and rice yield volatility (standard deviation of the log first difference) has diminished over time.

Price volatility does not seem to directly affect crop yield volatility, which has not been significantly affected by periods of crisis, except during the 1970s' food crisis.

Over the coming decades, crop yields may become more volatile as producers face the effects of the increased likelihood of extreme weather events.

Global cereal prices

Despite challenges, such as disruptions to shipping, there has been a considerable year-on-year decline in most grain prices and cereal markets exhibited less volatility over the last year during the 2023 to 2024 season. While wheat and maize prices continued their downward trend from the record levels reached in 2022 following Russia's invasion of Ukraine, 2023 prices reached their lowest levels since 2021 driven by ample supplies and strong competition among exporters. In contrast, rice markets were dominated by uncertainty on the impact of El Niño on production and export restrictions by India leading to international rice prices reaching their highest level in 15 years (in nominal terms) in 2023. Indicator 1.1.10 Global real prices covers in further detail the causes of elevated cereal prices.

Emissions and waste from cereal production

Of the 34% of global land area used by agriculture, one third is under crop cultivation (OECD-FAO, 2024). Historically, the principal indirect GHG emission's source has been land conversion from natural ecosystems to agriculture. However, historically the increase in crop production has been dominated by yield growth and productivity increases on existing land rather than an expansion in the area used for crop cultivation, though in the last couple of decades the relative contribution of yield growth has been lower than in the second half of the 20th century (government analysis of USDA PSD data). With yields projected to continue to be more important than land use expansion, the contribution of the growth in crop production to the projected increase in direct GHG emissions is expected to be limited (OECD-FAO, 2024). Among cereals, rice production is the main source of direct GHG emissions as irrigated paddy fields emit considerable quantities of methane.

Cereals not only represent a large proportion of global consumption but they account for over 50% of calories lost and wasted which are estimated to be approximately 5% of current global production (OECD-FAO, 2024). Reducing the calories lost and wasted can contribute to both reducing GHG emissions and the number of people suffering from undernourishment (OECD-FAO, 2024). Further information on global rates of food loss and waste is covered in Indicator 1.1.2 Global food loss and waste.

Forward look

Global cereal production is projected to rise from 2.9 to 3.2 billion tonnes by 2033, mainly due to increases in maize and wheat production driven by Asian countries (OECD-FAO, 2024). India is set to remain the leading rice producer and Africa and South America are expected to contribute more to cereal production growth than in the previous decade.

Going forward, this increase in the global production of cereals over the medium term is expected to follow the trend of growth driven by improvements in technology and cultivation practices led by middle-income countries in particular (OECD-FAO, 2024). With high-income countries approaching the production frontier, regional disparities are projected to remain important, in addition to growth driven by low-, and middle-income countries in Asia. Global growth in yields are projected to increase by 8% for wheat, 9% for maize, and 10% for rice by 2033 (OECD-FAO, 2024).

These medium-term projections, which give a broadly favourable picture for the global production of staples, assume normal climatic conditions. However, the impacts of climate change, such as the increasing frequency of extreme weather events, could have an effect on yields, output, and prices especially in light of the relatively high market concentration for exports.

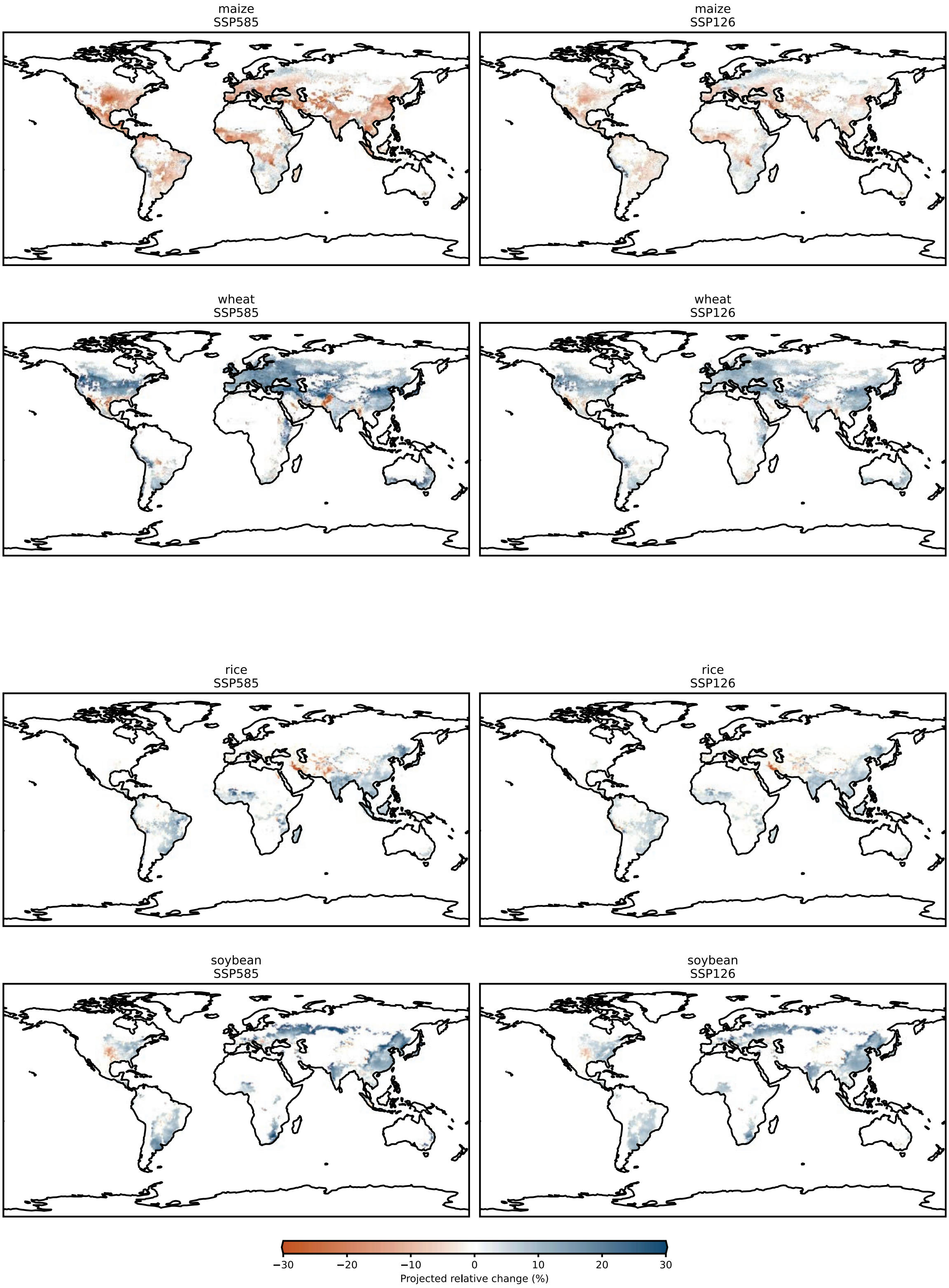
The effects of climate change on yields are projected to strengthen over time due to the increasing variability of temperatures and rainfall, and frequency and severity of extreme weather events, such as droughts and floods. For instance, between 1971 and 1980 and between 2011 and 2020, on average, the number of droughts and severe storms has doubled and tripled, respectively (OECD, 2023). Climate change will likely have a differential regional impact with some areas benefitting from longer growing periods, while others face increasingly unsuitable growing conditions.

Furthermore, as evidenced in recent years, trade disruptions due to geopolitical tensions, domestic decisions about controlling inflation, and wider macroeconomic factors can have a significant effect on future cereal markets. Disruptions in transport and the importance of choke points, as apparent from recent events, can also affect the shorter-term trajectory of cereal output (see case study on the role of maritime trade chokepoints in global food security for more information).

Climate impacts

Figure 1.1.3c: Projected relative change in crop yield (%) for 2041 to 2070 compared to 1983 to 2013 reference period

Source: Based on Global Gridded Crop Model Intercomparison



Note: Results shown are the median of climate–crop model combinations (5 global climate models × 11 crop models). Left column plots show projections under SSP585, right column plots show projections under SSP1-2.6. Top row: maize, second row: wheat, third row: rice, bottom row: soybean. Assumptions include: land-use, fertiliser application, growing seasons, crop cultivars, NO3 and NH4 deposition rates are kept constant (based on 2015), no pest and disease damage, physical cropland extent based on the MIRCA2000 (Monthly Irrigated and Rainfed Crop Areas around the year 2000) reference dataset, and no changes in management/adaptation.

Evidence from the Global Gridded Crop Model Intercomparison project (set of simulations from multiple crop and climate model combinations) show different projected trends in cereal yields across regions over the next decades (Figure 1.1.3c). These results are based on assumptions including: land-use, fertilizer application, growing seasons, crop cultivars, NO3 and NH4 deposition rates are kept constant (based on 2015), no pest and disease damage, physical cropland extent based on the MIRCA2000 (Monthly Irrigated and Rainfed Crop Areas around the year 2000) reference dataset, and no changes in management/adaptation. More research is needed to better understand potential consequences of following different adaptation strategies such as changing where crops are grown in order to mitigate the impacts of a changing climate.

Projections of yield responses to modelled climate scenarios reveal a mixed picture. Projected changes are dependent on crop, scenario and the climate and crop models used, as well as exhibiting spatial variation. Global mean yield projections between 1983 to 2013 and between 2041to 2070 indicate decreases for maize and increases for wheat and rice.

Projections show widespread *maize* yield decreases between 1983 and 2013 and between 2041 and 2070 (Jägermeyr and others, 2021), with the majority of models projecting decreases in global mean yield by approximately 3% under the SSP1-2.6 scenario and 10% under the SSP5-8.5 scenario by mid-century. Large reductions are projected in North America, Asia and West Africa. Projections for European maize yields are mixed with models typically indicating reductions in southern Europe and increases in northern Europe. Reductions in maize yield are driven in many cases by areas already being close to optimum temperature ranges for the crop.

There is good model agreement for increases in global mean *wheat* yield by the 2050s for both SSP1-2.6 and SSP5-8.5 scenarios. However, there are strong spatial patterns in the projected direction of change. Higher wheat yields are projected for Oceania, the Middle East, China and many of the northern hemisphere temperate regions, whereas reductions are projected for spring wheat growing areas in the southern USA and Mexico, parts of southern Asia and South America (Figure 1.1.3c). The projected increase in wheat yield in the outlined regions is driven by increases in temperature and CO_2, whereas areas with projected reductions in yield are regions where temperatures are already nearly optimum.

Based on the model median, global mean *rice* yield is projected to increase by approximately 5% under the SSP1-2.6 scenario and 7% under the SSP5-8.5 scenario by mid-century. Major declines in rice yields are projected in Central Asia, with increases projected in South Asia, northeastern China, West Africa and South America. It is important to note that there is a broad range in projections across the set of crop models.

There is large spread in model projections of global mean *soybean* yields by the 2050s for SSP1-2.6 and SSP5-8.5 scenarios, with more than 75% of the models projecting increases. Model projections for soybean yields predominantly show increases at higher latitudes (Jägermeyr and others, 2021); China, Eurasia, some areas of South America and southern Africa. Reductions are projected for major producing regions including the USA, parts of Brazil and Southeast Asia.

There are indications that climate change may result in substantial changes to yield variability (Liu and others, 2021). The projected changes discussed in this section are for long-term average yields, and do not consider year-to-year yield variability. More research is needed to quantify the relative influence of changes in year-to-year variability compared to the effect of the long-term trends. Managing climate-driven yield variability is likely to be a significant challenge of climate change for food prices and security. Aspects of the global food system, including food price fluctuations, are influenced by yield variability, which may arise, in part, due to climate extremes. Larger impacts are expected when yields in major production regions are affected. Several significant and prolonged shifts in food prices have been linked to food production extremes, including extreme weather impacts (Malesios and others, 2020), such as Russian wheat yield losses in 2010 (associated with drought) were a significant factor in the imposition of an export ban and rapid rise in global wheat prices (Hunt and others, 2021).

1.1.4 Production of global livestock products

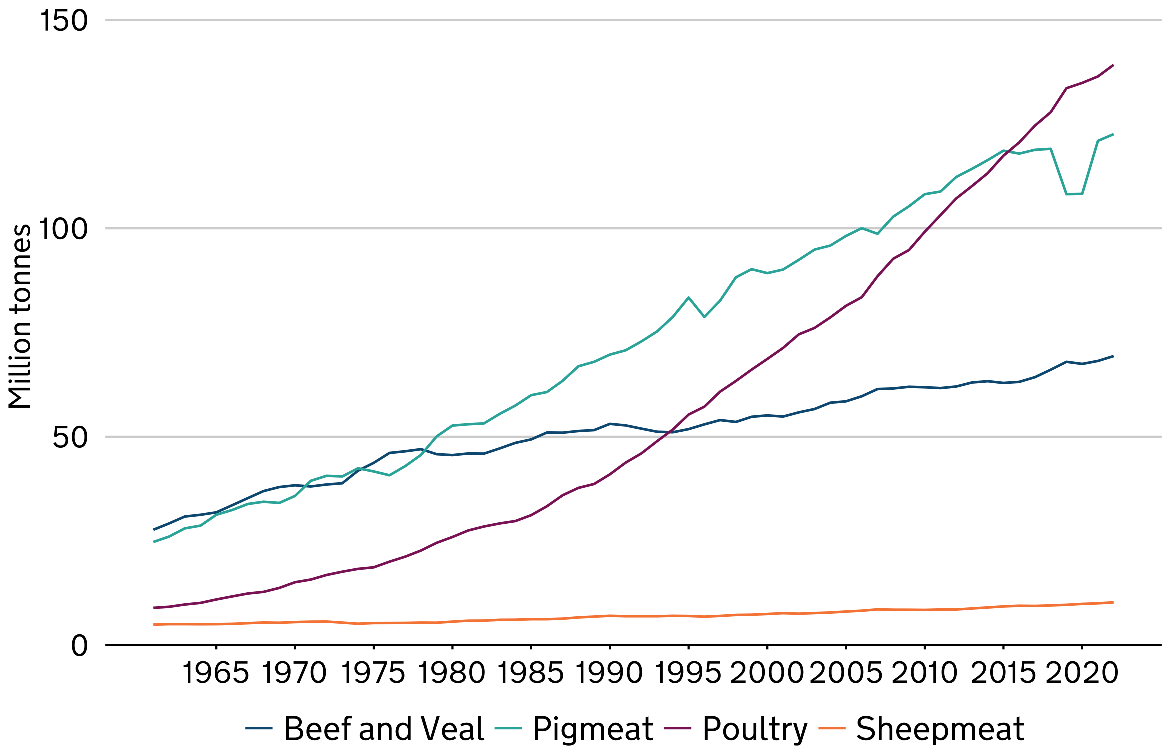
Rationale

This indicator measures the numbers of animals slaughtered for meat in million tonnes to monitor trends in this important food group. Meat, eggs and milk are an important source of macronutrients, such as protein, fats and carbohydrates, and micronutrients, such as iron, zinc and vitamin A, for a large part of the world population. They together provide 33.6% of total protein and 13.4% of total calories (FAOSTAT, 2024).

Headline evidence

Figure 1.1.4a: Global meat production, tonnes, 1961 to 2022

Source: [FAO FAOSTAT Crops and livestock products]()



In 2022, over 341 million tonnes of meat was produced, an increase of 6.9% or 22 million tonnes higher than 2019. This was driven by a rebound in pigmeat production, which saw negligible growth over the last decade (2013 to 2022), following the recovery from African Swine Fever in Asia. Over the past decade, however, poultry meat saw the greatest growth at 26.4%, equivalent to over 29 million tonnes, and a share of 64.3% of the total meat production growth. The production of poultry meat surpassed pigmeat in 2016 globally to become the most produced source of meat; it is followed by pigmeat, beef and veal.

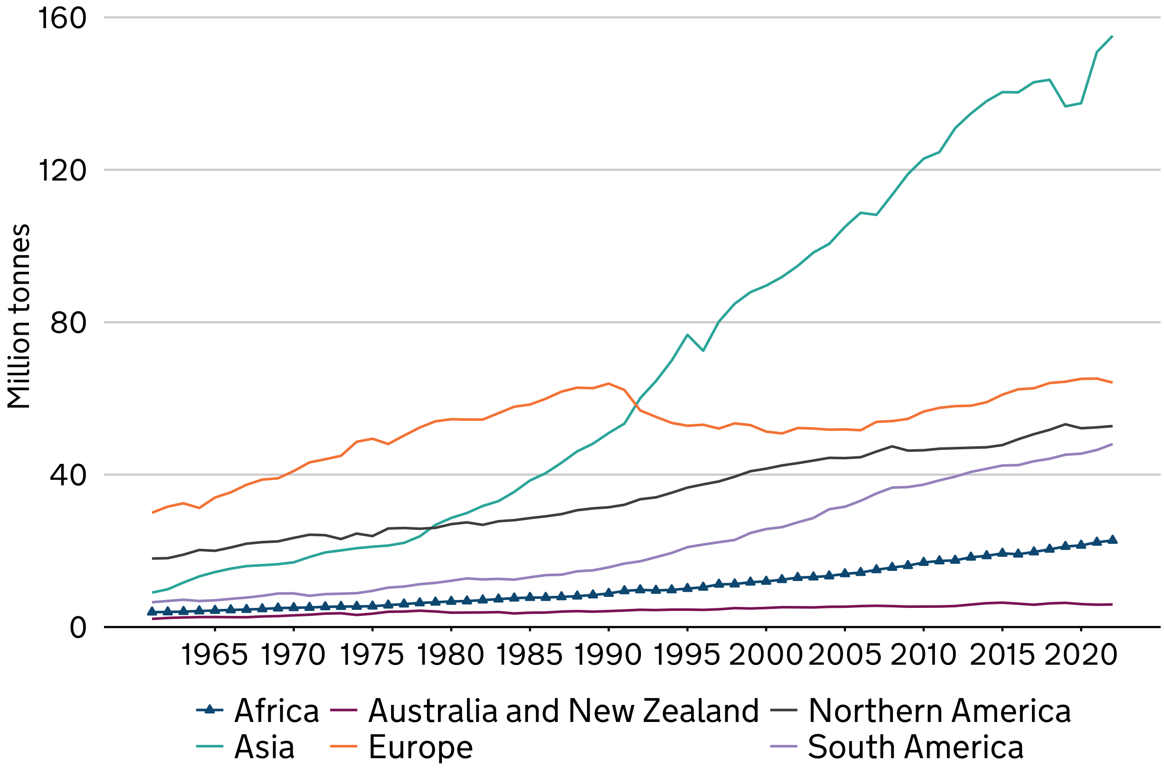
While global livestock production has been stable and is projected to grow by 12% over the next decade, this is almost half the rate of the previous decade. This is expected to originate mainly in middle-income countries and be largely made up of poultry meat, driven by accelerating demand for poultry globally, particularly in Asia, but also in the USA and Brazil. The environmental effects of expanding livestock production remain a risk in a context of feeding a growing population and maintaining global food security.

Supporting evidence

Trends in global meat production

Figure 1.1.4b: Global regional meat production, tonnes, 1961 to 2022

Source: [FAO FAOSTAT Crops and livestock products]



Asia remains the largest region for the production of meat, with a growth rate of 11.9% between 2019 and 2022 reaching 155.2 million tonnes in 2022 (Figure 1.1.4b) (FAOSTAT, 2024). Over the same period, production in Africa rose by 7.9% to 22.7 million tonnes, and in South America it increased by 5.8% to 48 million tonnes. Europe and North America recorded slight falls of 0.4% to 64.2 million tonnes and 0.9% to 52.7 million tonnes respectively. Australia and New Zealand recorded a larger fall of 7.2% to 5.9 million tonnes.

China remains the biggest single market for meat, and the recovery of its pigmeat production, following a significant outbreak of African Swine Fever between 2018 and 2021 (OECD-FAO, 2024), is one of two major contributors to this wider global growth. The other is India's increased dairy production.

The price of cereals greatly affects the cost of livestock production, particularly related to soy, which is mainly used as animal feed. This is covered in further detail in Indicator 1.1.3 Global cereals production. Although recent rises in feed costs have abated, the costs of other inputs such as labour continue to be compounded due to an increase in regulation in many areas of the world leading to higher production costs (OECD-FAO, 2024).

Impacts associated with global meat production

Meat production has a range of impacts including land use change, land degradation and elevated GHG emissions compared to non-meat alternatives, with implications for the sustainability of global food security.

Meat production drives land use change in two ways: an increased need for pastureland for extensive production and an increase in cropland to grow feed ingredients such as soybeans for more intensive production. Land use change is discussed in more detail in Indicator 1.2.2 Global land use change.

Livestock grazing is also a principal source of land degradation, and is especially problematic in Sub-Saharan Africa (FAO, 2021). Livestock production is projected to increase by 26.5% by net value over the next decade in Sub Saharan Africa, with negative possible implications for further degradation of pastures in the region (OECD-FAO, 2024). Land degradation is covered further in Indicator 1.5.1 Global land degradation.

Livestock also contributes to a high proportion of global GHGs: in 2021, livestock agrifood systems made up around 8% of all anthropogenic GHG emissions and about 54% of total emissions from the farm gate (FAO, 2021). Contribution to GHG emissions vary by livestock type. Ruminants such as cattle and sheep are associated with higher levels because they release higher rates of methane emissions. Beef (28.3 kg CO_2-eq/kg) and lamb (24.5 kg CO_2-eq/kg) produce much higher GHGs than pork (1.7 kg CO_2-eq/kg) and chicken (0.54 kg CO_2-eq/kg) (FAOSTAT, 2024).

These effects are worth considering in tandem with the other outcomes linked to meat production. The calorific efficiency of various meats varies significantly: milk (24%) and eggs (19%) are significantly more efficient than meat (Poultry 13%, Pork 8.6%, Lamb 4.4% and Beef 1.6%) in terms of converting input calories from feed into output (food) calories (Alexander and others, 2016).

Other livestock products

Global milk production remains stable and overall shows an increase, most notably in Asia. Global milk production grew by 4.3% between 2019 and 2022 and by 50.9% between 2003 and 2022 to 930 million tonnes. The yield of 1.1 tonnes per animal has also risen, by 3.9% between 2019 and 2022 and by 17.3% between 2003 and 2022 (FAOSTAT, 2024). Milk production remains much higher in Asia than it does in the rest of the world, and this is predicted to continue, driven mostly by India and Pakistan (with almost all of the product consumed domestically). Milk production in Asia overtook milk production in Europe in 2005. GHG emissions for dairy products are generally lower than for meat in the range of 1.29 kg CO_2-eq/kg for whole milk and 9.25 kg CO_2-eq/kg for butter (Clune, Crossin and Verghese, 2017). Estimates from FAOSTAT suggest a lower amount for raw cows' milk (0.97 kg CO_2-eq/kg).

Global egg production grew by 3.5% between 2019 and 2022 and by 58.7% between 2003 and 2022. Asia has the highest production of eggs of any region globally at 60.3 million tonnes and overtook Europe in 1985. Global yield rates have also grown by 4.6% between 2019 and 2022 and by 5.8% between 2003 and 2022 (FAOSTAT, 2024). The sources of eggs for the UK market are discussed in Theme 2 Indicator 2.1.3. GHGs associated with egg production are much lower than for livestock in the range of 0.6 kg CO_2-eq/kg (FAOSTAT, 2024).

Forward look

Global livestock production is projected to grow by 12% over the next decade, almost half the rate of the previous decade. Increased global meat production is expected to originate mainly in middle-income countries. This will be supported by global herd and flock expansion and improved per-animal performance through higher feed intensity, and continuous improvement in animal breeding, management, and technology (OECD-FAO, 2024).

Poultry meat is expected to remain the fastest growing meat in the livestock sector and is expected to account for half of the growth in meat production in the next decade. This is being driven by accelerating demand for poultry globally, particularly in Asia, but also in the USA and Brazil. Asia, especially India, will continue to contribute to most of this growth in production, due to better breeding and increased feed intensity. High rates of growth are also forecasted in Africa and the Near East (OECD-FAO, 2024). within middle income countries, due to the relative affordability of poultry compared to other livestock.

Global milk production is projected to grow at 1.6% per annum to reach 1,085 million tonnes in 2033 supported by increased yields per animal. More than half of the growth in production is anticipated to come from India and Pakistan which will jointly account for over 30% of global production in 2033. Projections on global egg production are not covered by the OECD-FAO Outlook.

Despite growth in the meat sector resulting in higher GHG emissions for the sector as a whole, improved breeding and advances in productivity, as well as the increasing dominance of poultry in the meat complex, are expected to reduce the amount of GHG emissions per kilogram of meat produced. The OECD-FAO projects an increase of approximately 2 billion cattle, 1 billion pigs, 32 billion poultry, and 3 billion sheep which, in turn, is expected to lead to a 6% rise in the meat industry's GHGs. However, lower overall growth in emissions (+6% by 2033) is expected when compared to the expansion in growth in production (+12% by 2033).

At the same time extreme heat stress is projected to become more pervasive with negative impacts for livestock production. Globally, the number of extreme heat stress days per year for cattle, sheep, goats, poultry and pigs is projected to double or more by the 2050s under SSP1-2.6 compared to 2000 (Thornton and others, 2021). Under SSP5-8.5, the proportion of livestock animals affected and the number of extreme heat stress days per year is projected to approximately treble from 2000 levels by the 2050s (Thornton and others, 2021). The largest impacts are expected at lower latitudes, particularly across central Africa, South Asia and America, and could challenge the viability of outdoor livestock keeping. Significant adaptions are likely to be required in some locations, which would be both cost and energy extensive, and make livestock farming unviable.

1.1.5 Global fruits and vegetable production

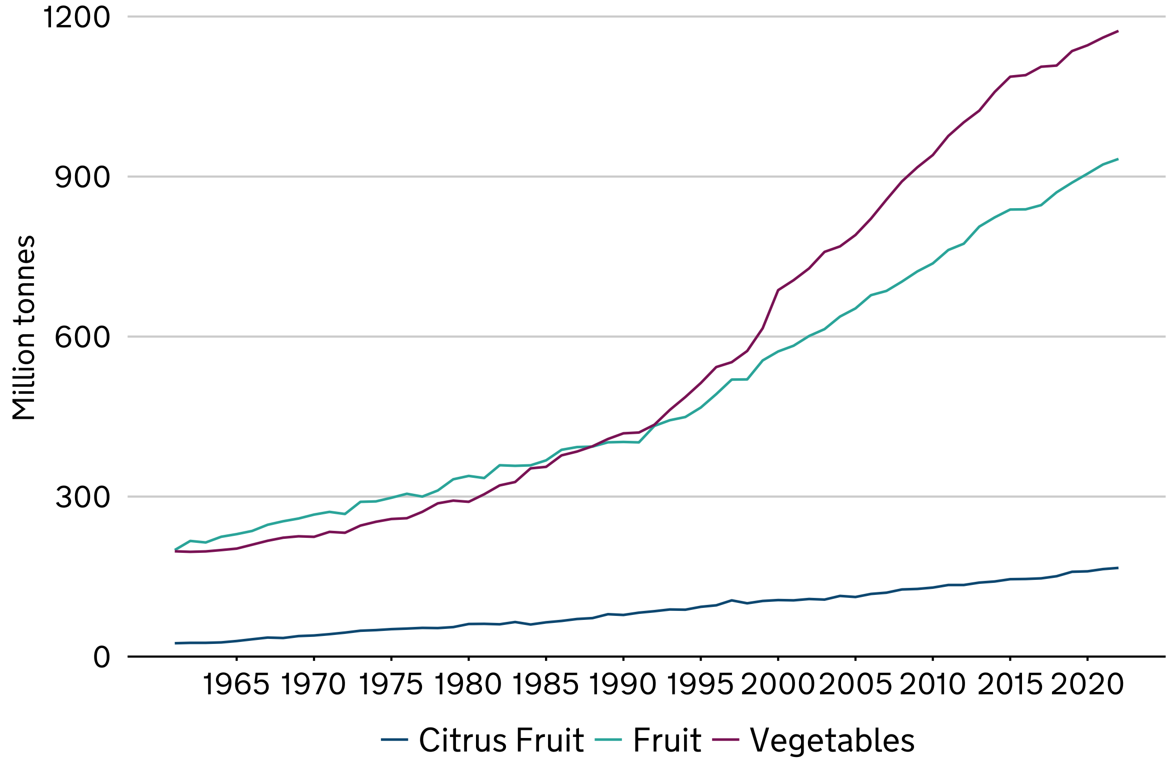
Rationale

This statistic shows the production of fruits and vegetables in million tonnes to allow tracking of this important food group. Fruits and vegetables play an important role in maintaining a nutritious diet by providing high levels of vitamins, minerals, and fibre (NHS, 2022). They together provide 8.3% of total protein and 7.5% of total calories across the world (FAOSTAT, 2024).

Headline evidence

Figure 1.1.5a: World fruit and vegetable production, tonnes, 1961 to 2022

Source: FAO FAOSTAT Crops and livestock products



Global fruit and vegetable production has increased steadily in the last sixty years, being around five to six times its 1960s level by 2020. Over the last decade from 2013 to 2022 the average annual growth rate for vegetables was 1.6% per annum compared to 1.9% per annum for fruits (excluding citrus). Between 2019 and 2022, production increased by 3.3% for vegetables, and 5% for non-citrus fruits.

The World Health Organization (WHO) recommends eating at least 400g of fruit and vegetables a day to lower the risk of non-communicable diseases (such as heart disease, stroke and some types of cancer) and ensure an adequate daily intake of dietary fibre (WHO, 2020). The current global average for fruit and vegetable supply for human consumption amounts to 650 g/per day per capita. However, this figure is much lower in South Asia (144 g/per day per capita) and Sub-Saharan Africa (77-143 g/per day per capita) (FAOSTAT, 2024). While there are enough fruits and vegetables produced globally to meet recommended guidance, its availability is unevenly distributed.

Supporting evidence

The shorter shelf life of fruits and vegetables means the supply chain tends to be more localised and dynamic, although this can be extended by canning, drying and freezing. This means that fruits and vegetables are not globally traded to the same extent as other commodities. The effect of global fruit and vegetable production on UK food security is discussed in Indicator 2.1.4 in Theme 2, which tracks the production of fruits and vegetables in countries from which the UK imports its food.

Accessibility to fruits and vegetables varies around the world varies. The 2023 assessment of progress towards health and sustainable development goals (SDGs) by the Food Systems Countdown Initiative found inequalities across countries, with low- and middle-income countries finding the availability and affordability of fruits and vegetables a challenge, compared to high income countries.

Forward look

On the supply side, challenges with the availability of sufficient fruits and vegetables are expected to ease with economic growth but are unlikely to be eliminated entirely (Mason-D'Croz and others, 2019). The amount of supply will also be affected by rates of food loss and waste, which is covered in further detail in Indicator 1.1.2 Global food loss and waste.

Climate change may present a challenge to the continued production of certain fruits and vegetables in regions where they have been traditionally grown. The effect of climate change on regions of the world where the UK predominately sources its fruits and vegetables is covered in Theme 2 Indicator 2.1.4. Analysis on the impact of climate change and plant disease on bananas and international trade is covered in Indicator 1.5.2 Global One Health.

On the consumer side, there is expected to be an increase in the demand for fruits and vegetables with the increasing adult population in developing countries.

1.1.6 Global seafood production

Rationale

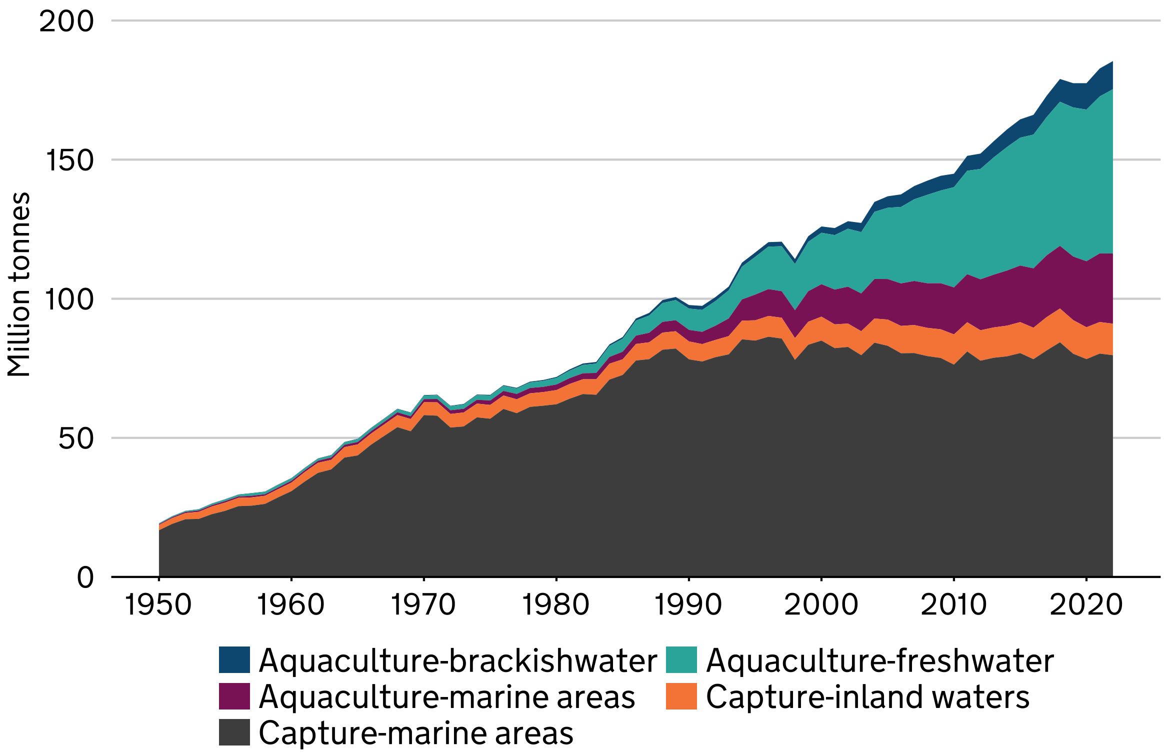
Fish and seafood, especially oily fish, play an important role in the diet of many people across the world. It is a major source of protein and of nutrients and vitamins that are important for overall health, such as vitamin A, iron, and omega-3 fatty acids. NHS dietary guidelines suggest aiming for at least two portions (each around 140g) of fish every week, one of which should be oily, such as salmon, sardines or mackerel. Fish and seafood provide 6.1% of total protein and 1.2% of total calories for human consumption across the world (FAOSTAT, 2024).

This statistic (Figure 1.1.6a) shows the raw numbers for production of capture fisheries and aquaculture in million tonnes to monitor trends in this important food group. 'Biologically sustainable levels' refers to whether fish stocks are at a level where there are enough fish to maintain the current stock with the present level of fishing.

Headline evidence

Figure 1.1.6a: World capture fisheries and aquaculture production, tonnes, 1950 to 2022

Source: The State of World Fisheries and Aquaculture 2022 (fao.org)



In 2022, 185.4 million tonnes of fish were produced, an increase of 4.5% or 8.0 million tonnes since 2019. This increase has been largely driven by increased aquaculture production which increased by 10.9% or 9.3 million tonnes between 2019 and 2022, as opposed to fish landings which marginally decreased by 1.4% or 1.3 million tonnes. These short-term trends mirror longer-term trends; since the early 1990s, fish capture has stagnated while aquaculture production has risen substantially, and in 2023 aquaculture production overtook fish capture for the first time (FishSTAT, 2024).

The percentage of marine fishery stocks within biologically sustainable levels continues a downward trend, having decreased to 62.3% in 2021, 2.3% lower than in 2019 (FAO, 2024). This fraction was 90% in 1974.

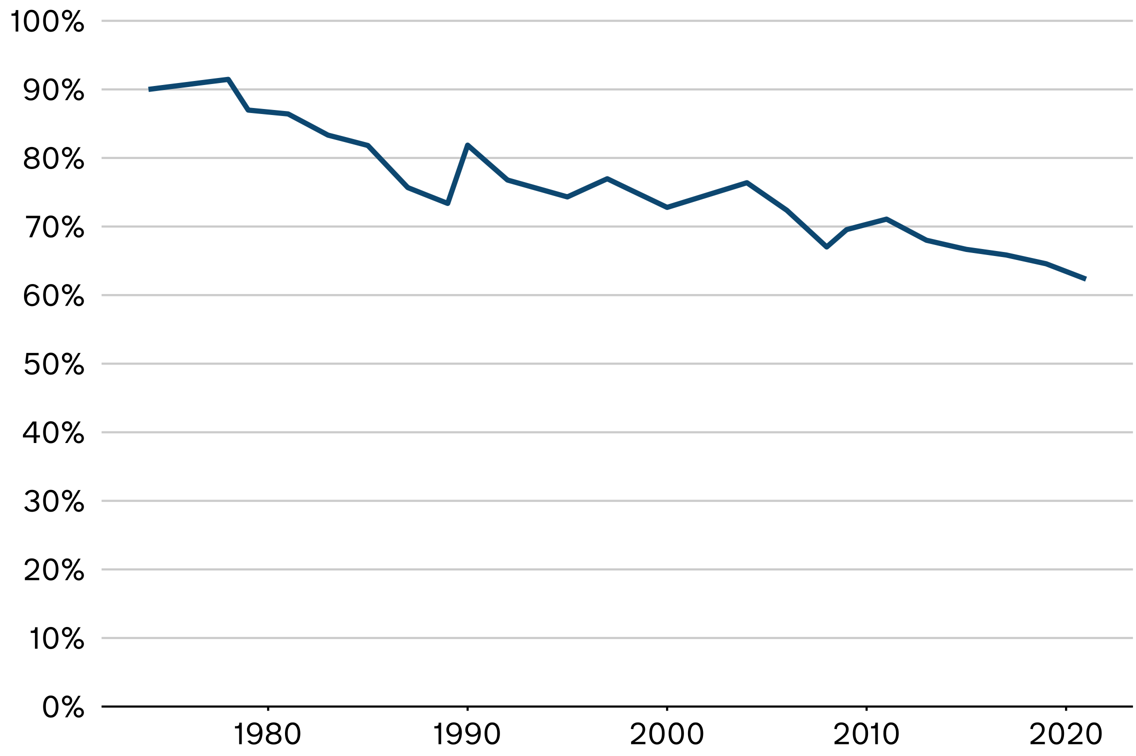
Supporting evidence

It is estimated that 19% of protein and 10% of calories in feed inputs to aquaculture species are part of human food supply, with significant variation between species (Fry and others, 2018). Fish is a more important part of the diet in some regions of the world. In Micronesia, for example, fish accounts for 4.2% of the food supply in calories and 21.6% of the protein supply in grams as opposed to 0.2% and 0.3% respectively in Central Asia. It is also an important source of protein in Southeast Asia (15.1%) and Polynesia (12.0%) (FAOSTAT, 2024).

Sustainability

Figure 1.1.6b: Proportion of fish stocks within biologically sustainable levels globally, 1974 to 2021

Source: FAO FAOSTAT SDG Indicators 14.4.1



The proportion of fish stocks within biologically sustainable levels has been on a downward trend since before the turn of the century (Figure 1.1.6b) but the distribution of biologically sustainable fish stocks is uneven. In 2021, the lowest levels of sustainable fish stocks were in the Southeastern Pacific (33.3%) and Mediterranean and Black Sea (37.5%), which were well below the global average of 62.3%. The highest, covering the Northeast Atlantic, and Southwest, Northeast and Eastern Central Pacific, were all over 70% (FAO, 2024). Information on where the UK sources its fish and seafood is covered in Theme 2 Indicator 2.1.5.

Carbon footprint

Fish and seafood have a much smaller carbon footprint than other sources of animal protein. Marine fisheries are typically not included in estimates of GHG emissions from food production. Data from 2011 shows that fishing vessels contribute to between 0.1 and 0.5 % of global CO_2 emissions and represent approximately 4 % of the carbon emissions generated by global food production (Parker and Others, 2018). Aquaculture production was estimated to account for 263 $MtCO_2e$ (covering catch, not population), equivalent to 0.49% of anthropogenic GHG emissions in 2017, the latest estimate available. This is lower than emissions produced by terrestrial animal protein largely due to the absence of enteric CH_4, which is a major factor in the production of beef and lamb. This is aided by high fertility (the ability to reproduce easily) and low feed conversion ratios (using less feed to produce more animal protein) (MacLeod and others, 2020).

Harmful algal blooms

A notable risk to fish stocks is harmful algal blooms. They can be harmful to fish and shellfish, as well as people, marine mammals and birds, making them a threat to productivity. The Harmful Algal Event Database (HAEDAT) is a meta database containing records of harmful algal events. It is difficult to say conclusively if and at what rate harmful algal blooms are increasing as better reporting may be a driver in the increase in reports (Hallegraeff and others, 2021).

Forward look

Aquaculture is expected to drive production growth in fisheries while capture fisheries production remains stable, declining in some regions and recovering in others. Global fish production is expected to rise, reaching 206 Mt by 2033, an increase of 22 Mt from the base period of 2021 to 2023 (OECD-FAO, 2024). This is expected to be driven by the ongoing expansion of aquaculture, particularly in Asia, with global aquaculture production increasing by 17.4% from 96.4kt (2023) to

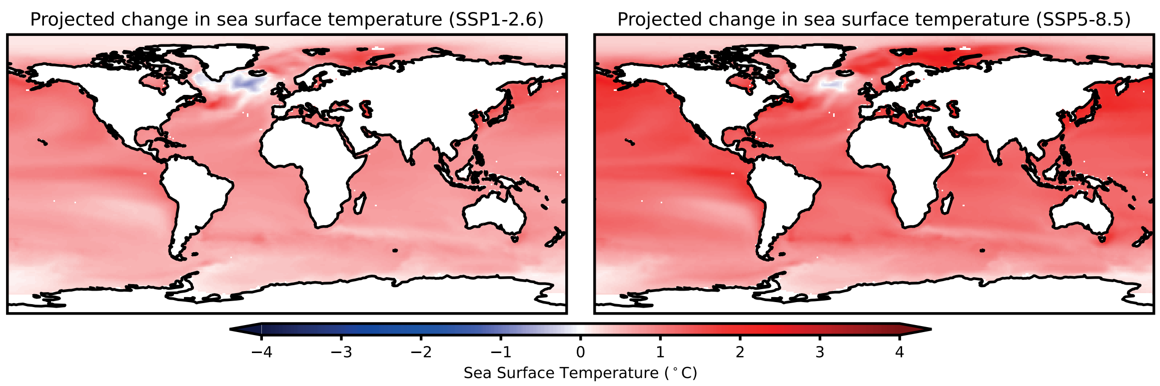
112.4kt (2033) and capture fisheries increasing 89.3kt (2023) to 93.8 kt (2033) (OECD-FAO, 2024).

Climate impacts

Making robust assessments of the impacts of climate change on the marine environment is challenging because of scarce data availability for complex biological interactions and model limitations at scales incompatible for resolving shelf sea processes, which are the habitats for 99% of the world's fish (Holmes and others, 2023). In addition, most scientific studies of tolerances have been conducted in a laboratory or modelled rather than within the open marine environment. Therefore, the implications of climate change for global fish stocks remain difficult to quantify. The impacts of climate change alone are projected to result in a 5% loss of mean global marine animal biomass for every 1°C of warming (Lotze and others, 2019).

Figure 1.1.6c: Two maps showing projected multi-model mean changes in sea surface temperature for 2041 to 2060, relative to 1995 to 2014, under the SSP1-2.6 and SSP5-8.5 climate change scenarios.

Source: Iturbide and others, IPCC



Globally, there is medium confidence that climate change will adversely affect fisheries' yields and aquaculture production (Cooley and others, 2022) but regionally, in the tropics and the higher northern latitudes, impacts are likely to be greater than the global average (Barange and others, 2018). It is almost certain that ocean temperatures will continue to increase out to 2050 (Figure1.1.6c), with medium confidence that these increases will be associated with further acidification, upper ocean stratification, deoxygenation and marine heatwaves (Bindoff and others, 2019).

Rising sea surface temperatures are an important factor in driving more, long-lasting, and intense marine heatwaves which are very likely to continue to increase in frequency, magnitude, duration and spatial extent and cause more mass mortality events (IPCC, 2019). Such events are projected to result in biomass decreases in more than 75% of fish and invertebrate species by the 2050s (Cheung and others, 2021) and mass mortality events through coral bleaching, particularly in the Indo-Pacific, Caribbean and the Gulf of Mexico (Holmes and others, 2023).

As well as risks from temperature increases over long and short timescales, most coral reefs, mangroves and salt marshes will be unable to keep up with projected sea level rise by 2050, even under the lowest SSP1-2.6 climate change scenario (IPCC, 2022). Ocean acidification is projected to worsen across all ocean basins, with the largest projected decreases in pH found in the Arctic and the smallest at the Equator (IPCC, 2023).

More than 90% of global aquaculture production originates in Asia and fish consumption per capita is highest in the Maldives, Seychelles, South-east and Eastern Asia and the Pacific Islands. Current aquaculture losses attributed to climate change have been caused by temperature increases, sea-level rise and associated saltwater intrusion, and from infrastructure damage, droughts and freshwater shortages arising during extreme weather events (Naylor and others, 2021). These are all expected to worsen as the climate continues to change, with additional uncertain indirect effects from pests, predators and pathogens and from harmful algal blooms.

Sub-theme 2: Productivity and inputs

1.2.1 Global agricultural total factor productivity

Rationale

This indicator measures the agricultural productivity of different countries based on TFP data from the USDA Economic Research Service (ERS).

TFP is defined as the amount of agricultural output produced from the combination of land, labour, capital, and material resources employed in farm production and encompasses the average productivity of all of these inputs in the production of agricultural commodities (USDA, 2024).

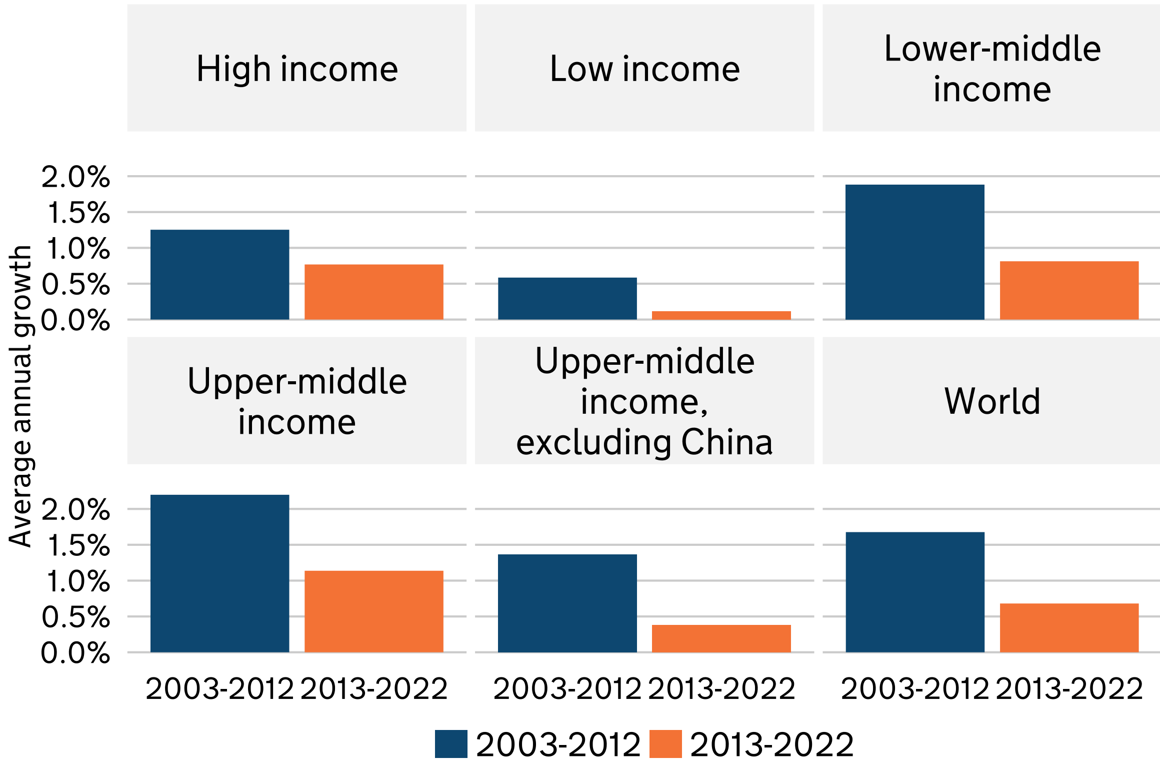
TFP is an indicator of how efficiently agricultural inputs are converted into food. The more that producers can do with less, the more productive they are and the more they can produce with limited resource. This is critical to increasing production levels to meet growing global population demand. Productivity growth is especially important in a context of increasing competition for resources.

TFP is one key measure of productivity. Other crucial measures of agricultural productivity, such as land productivity (output per unit of land) and labour productivity (output generated by a unit of labour) are briefly discussed in the supporting evidence section below.

Headline evidence

Figure 1.2.1a: TFP growth by country income group, 2003 to 2022

Source: ERS USDA International Agricultural Productivity



While global TFP grew at an average annual rate of 1.11% from 2001 to 2010, this figure fell to 0.74% for the period between 2011 and 2022 (Figure 1.2.1a). TFP growth has fallen across all income groups. Low-income countries, in particular, have experienced a reduction of 0.47 percentage points (pp) in average annual TFP growth between 2003-2012 and 2013-2022, and continue to lag in TFP growth with 0.12% annual growth in the period 2013-2022 (USDA, 2024). While TFP is not currently stagnating or decreasing, low TFP growth suggests that both the rate of adoption of new technology and innovation has declined globally (Agnew and Hendery, 2023).

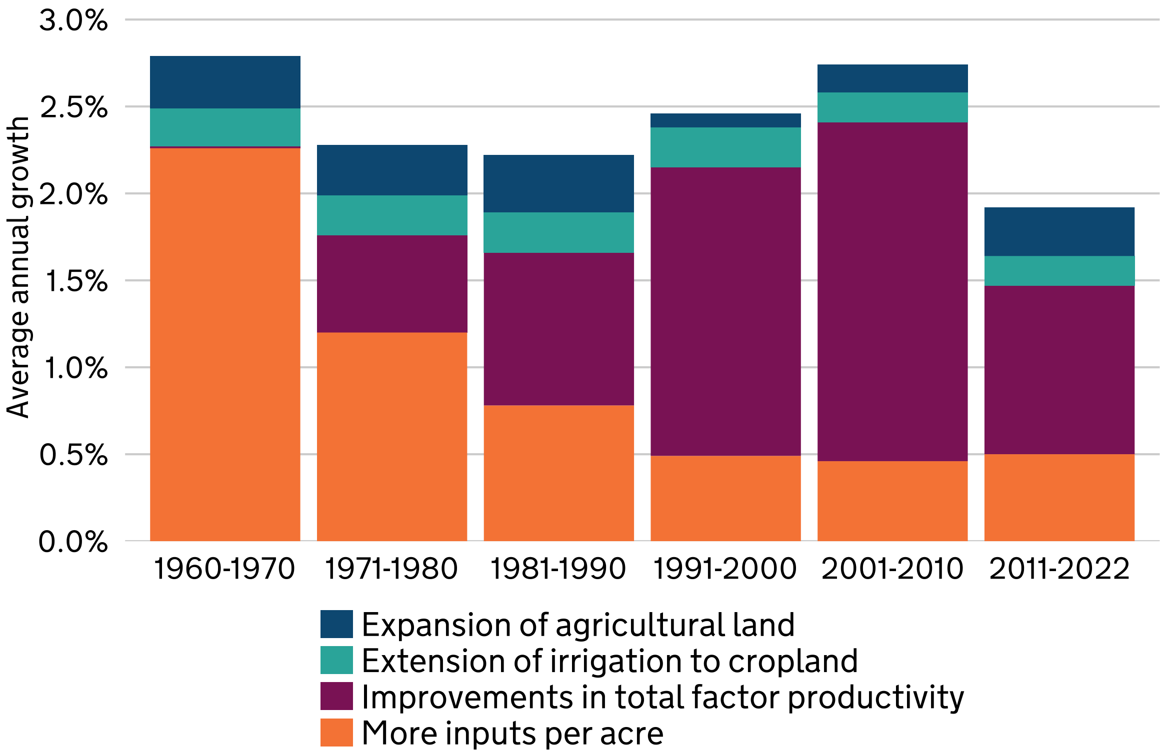
Supporting evidence

TFP data for this indicator comes from the Global Agricultural Productivity (GAP) Index, which was established in 2010 to track the growth needed in TFP to sustainably double global agricultural production by 2050. Under the assumption that the world population reaches 10 billion by 2050 (a figure which is slightly higher than the United Nations (UN, 2022) projection of 9.7 billion) and that all other inputs (including land, labour, machinery, materials, feed and livestock) remain static, the index suggests that TFP would need to increase at an average annual rate of 2.03% to reach this goal (2024 GAP Report). Some studies suggest a lower annual rate could be required (van Dijk and others, 2021).

Drivers of agricultural productivity

Figure 1.2.1b: Causes of growth in agricultural output, 1960-1970 to 2011-2022

Source: ERS USDA International Agricultural Productivity, 2024



In the 1960s and 1970s, agricultural production was largely driven by input intensification which involved an increased use of pesticides and fertilisers, mechanisation as well as planting improved crop varieties. TFP growth became a more important driver in the 1980s until the turn of the 21st century, after which both TFP and agricultural growth have been slowly falling (Figure 1.2.1b). TFP growth remains the largest contributor to agricultural output growth, and historically has been driven by technological innovations. These innovations include: improved genetics; precision agriculture; soil health management; integrated production systems; pest and disease control; mechanisation and automation; and learning and development. Despite this, both TFP growth *and* annual agriculture growth have slowed in the last decade (Figures 1.2.1a, 1.2.1b). This trend poses potential risk to food availability in the context of the rising global population.

Productivity by region

Trends vary widely by region. Productivity gains remain high in South Asia and China with average annual TFP growth at 1.44% and 1.78% respectively between 2013 and 2022. In South Asia these gains have been driven by technological change, increased mechanisation and labour reallocation. In China TFP growth has been driven by mechanisation and the adoption of policies aimed at reversing unsustainable growth from input intensification (Agnew and Hendery, 2023).

However, gains remain much lower in other areas. Productivity gains have been particularly low in the USA with annual TFP growth at -0.23)%and Sub-Saharan Africa with annual TFP growth at 0.37% (USDA, 2024), which has been driven by a range of different factors. In the USA, investment in public agriculture and food research and development in 2019 was at its lowest levels since the 1970s. This may be a contributory factor to the reduction in growth in TFP. In Sub-Saharan Africa, a lack of investment in agriculture overall, including agricultural research and development, access to improved seed varieties and mechanisation, have all contributed to a lack of growth in TFP (Agnew and Hendery, 2023). Indicator 1.2.3 Global fertiliser production explores this issue in further detail.

Further information on TFP in the UK is covered in Theme 2 Indicator 2.2.3. Productivity of the UK food chain is also covered in Theme 3 Indicator 3.3.3.

Land productivity

Land productivity is a key measure of agricultural productivity. Unlike TFP, land productivity is a partial factor productivity measure that is computed by dividing agricultural output by a single factor of production, land. When expressed in terms of physical output per unit of land, such as kilogrammes or tonnes per hectare, land productivity is typically referred to as 'yields' (FAO, 2017). Future trajectories of food security are closely linked to future average crop yields in the major agricultural regions of the world (Lobell, Cassman and Field, 2009). Halting agricultural expansion, closing 'yield gaps' on underperforming lands, and increasing cropping efficiency could enable environmentally sustainable increases in food production (Foley and others, 2011).

Regional variation, trends, volatility and projected changes in cereal yields are covered in further detail in Indicator 1.1.3 Global cereals production. The yields of other livestock products are covered in Indicator 1.1.4 Production of global livestock products. More information on trends in land use change are covered in Indicator 1.2.2 Global land use change.

There are indications that climate change may result in substantial changes to yield variability (Liu and others, 2021), with projections of cereal yield responses to modelled climate scenarios revealing a mixed picture. Global mean yield projections between 1983-2013 and 2041-2070 indicate decreases for maize and increases for wheat and rice (see Indicator 1.1.3 Global cereals production for more detail). The impact of climate change on yields is also covered in Indicator 1.1.6 Global seafood production and Indicator 1.5.2 Global One Health. This is expected to affect levels of agricultural productivity and is an important area to monitor for further developments.

Labour productivity

Labour productivity is another partial factor productivity measure commonly employed in agriculture (FAO, 2017). It can be computed by dividing agricultural value added by the number employed in the sector (World Bank Group (WBG)). In 2022, agricultural value added per worker at the global level was estimated to be $4,042 (in constant $2015), an increase of close to $200 compared to 2019 (WBG). This global value masks substantial differences across countries, with over 30 times higher labour productivity in high income countries compared to low income countries (2022 estimates for these two income groups were $26,547 and $840, respectively) (WBG). Indeed, there is a strong correlation between a country's income and the value added per agricultural worker. Countries with higher incomes tend to have greater access to technology and a more mechanised agriculture, which allows for an increase in output while reducing in the amount of labour required as an input, resulting in higher labour productivity.

There is high confidence that, without adaptation, the impacts of heat stress on the capacity of the agricultural labour force will increase with climate change (IPCC, 2022). Regions projected to experience the largest reductions in outdoor labour capacity are predominantly at low latitudes: much of South and Southeast Asia, tropical Sub-Saharan Africa and parts of Central and South America (IPCC, 2022; Masuda and others, 2024; De Lima and others, 2021). Impacts are expected to be worst in low- and middle-income countries.

1.2.2 Global land use change

Rationale

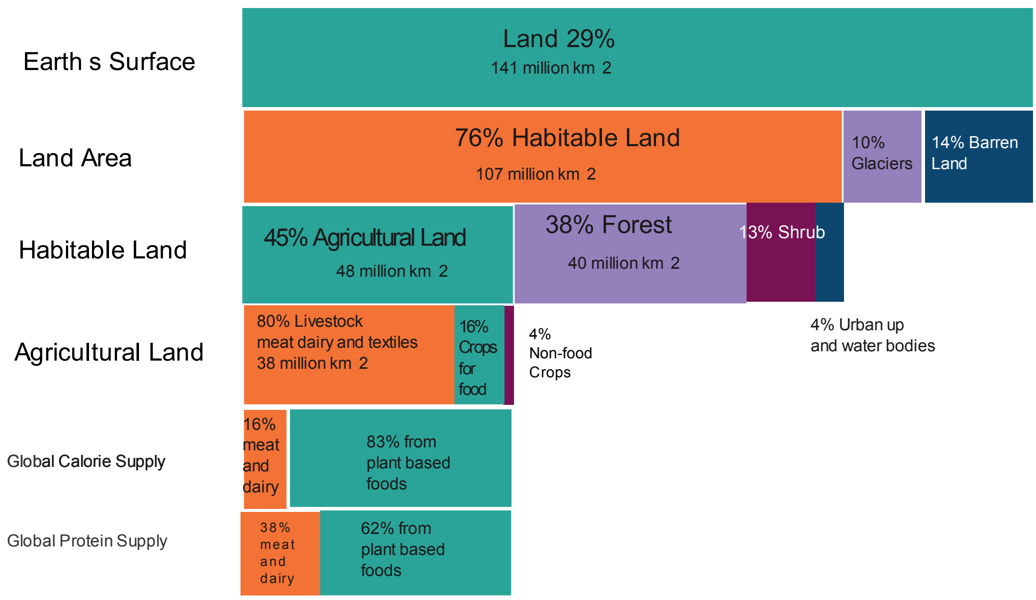
This breakdown of global land area summarises the amount of land used for agricultural production and different kinds of production within that. As land is an essential resource for food production (excluding seafood), it is useful to track trends in the total area of land used for agricultural production, and particularly how that land is being used. While the area of land used for agriculture is an important indicator of food production or supply, it should be considered in tandem with an understanding of current land productivity and management practices.

Agricultural land can be used to grow crops used for non-food uses such as cotton and fibre crops such as sisal.

Headline evidence

Figure 1.2.2a: Global land use for food production

Source: [Ritchie and Roser (2019)](), [FAO](), and Poore and Nemecek (2018)

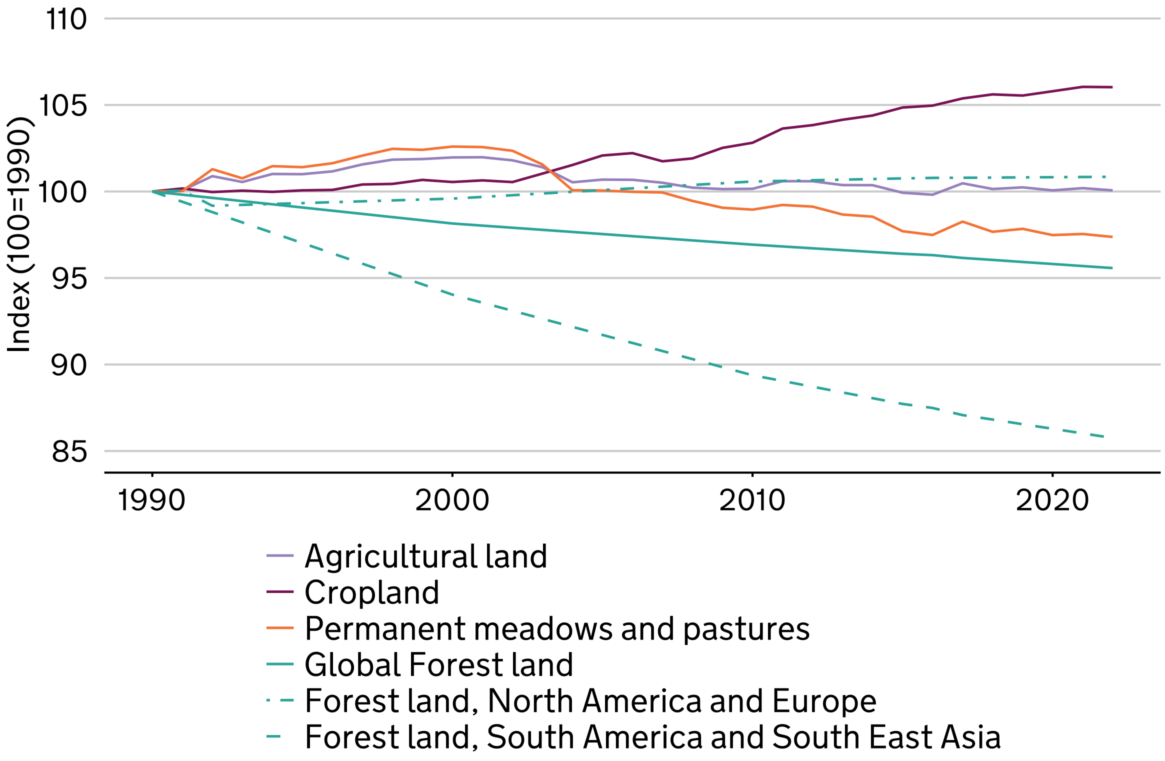


Competition for the world's finite land resources is intensifying. Around 85% of the world's usable land — ice-free and non-desert — has already been harvested for wood or converted to agriculture. This has contributed to about a quarter of human-induced (anthropogenic) carbon emissions and is the primary driver of global biodiversity loss (WRI, 2023). Land use change is continuing, and between 2000 and 2018, 88% of forest conversion was for agriculture purposes (50% for crop expansion including palm oil and 38% for livestock grazing. (FAO Remote Sensing Survey, 2020).Globally, around half of the worlds land is used for agriculture (see figure 1.2.2a above), and of that the majority of land is used to raise livestock, although the majority of our calorie supply is from plant-based foods, for example Rice, Maize and Wheat . Some land used for livestock grazing is not suitable for growing crops; this amounted to 40% global of cropland.

Changes in global agricultural land area generally happen over decades (see figure 1.2.2b below). Since the turn of the century, agricultural land area has been on a downward trend, decreasing by 1.8% between 1999 and 2022. This has been caused by a fall in permanent meadows and pastures of 4.9%. This is despite meat consumption dramatically rising in middle income countries in recent years (see Indicator 1.1.4 Global livestock production), driven by intensively farmed pigs and poultry, which do not require permanent meadows and pastures. Despite the downward trend in agricultural land, cropland has shown an accelerated trajectory of expansion since the early 2000s. In the last two years the expansion has flattened.

Figure 1.2.2b: Global agricultural land by area, 1990 to 2022

Source: FAOSTAT Land Use



As the world population grows, demand for food is expected to rise (see Indicator 1.1.1 Global food production). A combination of global population growth and income growth in the world's developing economies is expected to increase total demand for crops by 56% and for animal-source foods by 70% by 2050 (WRI, 2023). This will require an increase in both food production and food availability (see Indicator 1.1.1 Global food production). Historically food production has been increased by agricultural land expansion or by increasing output on existing agricultural land through input intensification or productivity gains through such measures as sustainable intensification (SI) and technological innovation. There are strong limits to the option of land expansion as further land expansion diminishes the world's natural capital on which food production is dependent (Zabel and Others, 2019). There is also limited land for what would be required: agricultural land would need to expand by over 600 million hectares, equivalent to an area of land nearly twice the size of India, to produce enough food for 2050 based on current dietary trends and at current productivity levels (WRI, 2023).

The long-term trend of decreasing total agricultural use is alongside a long-term trend of increasing food production (see indicator 1.1.1 Global food production), which points to the productivity gains since the 1980s (see indicator 1.2.1 Global agricultural total factor productivity). However, the accelerated trajectory of cropland expansion since early 2000 reflects a mixed picture of food production growth by productivity and land use expansion (see Indicator 1.2.1 Global agricultural total factor productivity). The cropland expansion is in part driven by the need for feed for increased intensive livestock and biofuel production, with the majority of the expanded cropland being maize and soya beans and driving the above-mentioned conversion of forest in regions such as South East Asia and South America.

Additionally, working towards redistributing food and reducing food loss and waste (see Indicator 1.1.2 Global food loss and waste), could also help meet future demand for food. Other approaches to improving output are covered in indicator 1.2.1 Global agricultural total factor productivity.

Supporting evidence

Changes in agricultural land

Globally there has been less available agricultural land overall, driven by increases in land productivity which has increased consistently since the 1960s, rising by 20% between 2012 and 2022 (FAOSTAT, 2024). Equally, in the next decade the overall area of land used for agriculture is not anticipated to increase, as increases in cropland will be offset by decreases in pasture. However, there is some variance at a regional level. For example, cropland expansion is projected to occur in the global South (primarily Asia and the Pacific, Latin America and Sub-Saharan Africa). Pasture land in Asia and the Pacific will likely be converted into cropland, in contrast in Latin America and Sub-Saharan Africa non-agricultural land will likely be converted. Whereas, in the global North (North America and Western Europe) cropland is anticipated to decrease due strict regulations and governance regarding sustainability (OECD, 2024).

Additionally, there is more competition for land to be used for purposes other than primary food production. The increase in intensive livestock production (see Indicator 1.1.4 Global livestock production) has increased the demand for crops for livestock feed. The advent of biofuels around the turn of the 21st century has also led to between 16% and 23% of maize, vegetable oils and sugar cane production being used for fuel. In overall area terms, since 1999 there has been a small increase in the crop area of wheat and rice and a fall in the crop area of barley, while there have been large increases in the crop area of soybeans, maize and sugar cane. Sugar cane now accounts for 86% of crop area of sugar crops, up from 75% in 1999.

The versatility of land means factors such as the price and availability of some raw ingredients and changes to market conditions can lead to substitutions in food production and changes to global food security. For example, when the supply of sunflower oil was affected by the Ukraine war, rapeseed oil was substituted but could not then be used for biofuels.

Environmental impacts associated with land use change

Previous methods of land conversion to accommodate competing demands, including food production, has had a negative effect on the global environment. Data from the FAO shows global agrifood systems (both pre and post farmgate) emissions were 16 billion tonnes of carbon dioxide equivalent (Gt CO2eq) in 2021, an increase of 14% since 2001, and equivalent to 30% of total anthropogenic emissions. The primary environmental impacts linked to land use change include land degradation, deforestation, biodiversity loss and production of GHG emissions. All of these impacts are direct or indirect drivers of the depletion of natural capital and ecosystem services on which agriculture itself relies. Agriculture is the main driver for deforestation with over 75% of land converted to cropland in Africa and Asia and around 75% to livestock grazing in South America (FAO, 2020). Increases in agricultural land use are typically associated with the destruction of biodiverse habitats with rates of deforestation highest in Africa, South East Asia and Latin America at 10.6%, 7.8% and 7.8% between 2002 and 2022 respectively (FAOSTAT, 2024). These changes make the environment less resilient to increasing extreme weather events which in turn further damage natural capital. For example, degraded lands are also often less able to hold onto water, which can worsen flooding.

While land use change makes up 19% of agri-food system emissions (FAOSTAT, 2024), there has been a reduction in GHG emissions from land use change over the last 20 years: GHG emissions were 3.1 Gt CO2e in 2021, marking a decrease of 5.7% over the last 3 years, 15.7% over the last 10 years and 19% over the last 20 years. South America, Africa and South East Asia continue to be the regions of the world with the highest GHG emissions due to land use change accounting for 90% of all global emissions. These have roughly halved in South America and South East Asia but increased by over a fifth in Africa in the last 20 years. While land use change makes up 19% of agri-food system emissions (FAOSTAT, 2024). There is a high degree of uncertainty in GHG emissions from land use change with

FAOSTAT and national GHG inventories returning lower estimates of GHG emissions from land use change than modelled estimates (IPCC, 2023).

1.2.3 Global fertiliser production

Rationale

Fertilisers typically consist of 3 main types of nutrients: nitrogen (N), phosphorus (P) and potassium (K). N, P and K represent the 3 primary nutrients plants need to grow. These nutrients occur naturally in the soil but can also be added in the form of fertilisers, to boost growth rates. In 2022, N fertilisers accounted for 57% of total global consumption, while phosphate (the plant available oxide form of P) and potash (the plant available oxide form of K) fertilisers accounted for 22.3% and 20.7% respectively (FAOSTAT, 2024). The FAOSTAT dataset contains information on the totals in nutrients for production, tracking the changes of each nutrient. These are important chemical fertilisers and inputs for agriculture and any price rise in fertilisers is likely to feed through to food prices.

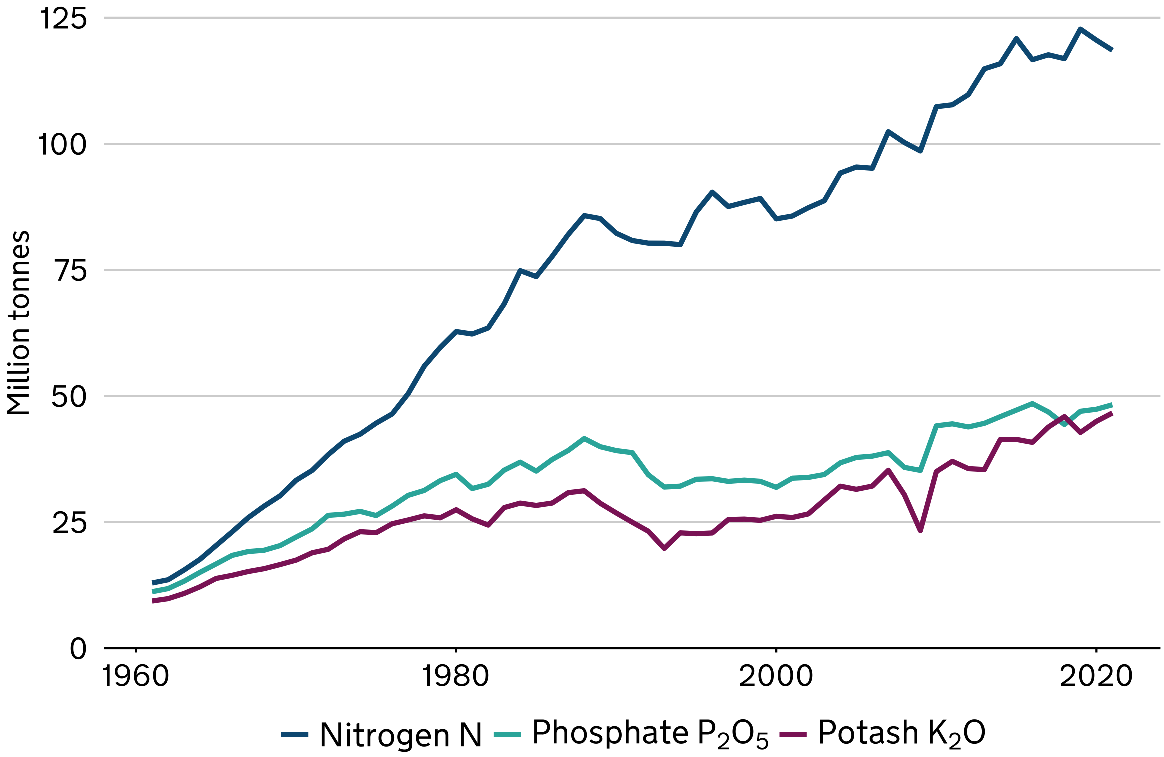
This indicator focuses on sources of phosphate and potash, which are mined and have experienced disruptions to supply as a result of geopolitical tensions and conflict. In addition to nitrogen, the production of these involve large amounts of energy and has implications for the sustainability of current fertiliser practices.

For countries without domestic production of these nutrients, global availability of these inputs is particularly important for food production and food security. The availability of phosphate and nitrogen plays an especially important role in the UK food security given that the UK has no P rock reserves (main raw material in the production of phosphate fertiliser) and import ammonia (which is the basic source for nitrogen fertiliser). The UK relies on imports to meet its demands, typically importing fertiliser products from more than 60 countries. The UK has one domestic producer of ammonium nitrate (AN), which is produced using imported ammonia. UK fertiliser use and supply is covered in further detail in Theme 3 Indicator 3.1.1 Agricultural inputs.

Headline evidence

Figure 1.2.3a: World fertiliser production, 1961 to 2021

Source: [FAOSTAT Land Inputs and Sustainability Inputs Fertilisers by Nutrient, 2024]



Note: Totals in nutrients for Production, Trade and Agriculture Use of inorganic (chemical or mineral) fertilizers, over the time series from 1961 to 2021. The data are provided for the 3 primary plant nutrients: nitrogen (N), phosphorus (expressed as P_2O_5) and potassium (expressed as K_2O). Both straight and compound fertilizers are included.

Phosphate production

Plants cannot absorb elemental phosphorus, so phosphorus fertilisers are usually produced in the oxide form (phosphate or P_2O_5). Typically phosphorus is mined in mineral form from igneous and sedimentary geological deposits. This crushed rock is then combined with sulfuric or phosphoric acids (depending on the type of phosphate fertiliser being produced) to produce fertilisers with higher phosphate contents ready for plant uptake.

While phosphate fertiliser production fell slightly by 1.9% to 46.1 million tonnes between 2019 and 2022, longer-term trends show overall growth. P rock production fell by 20 million tonnes between 2020 and 2023, equivalent to a decrease of 8.3%. China, Morocco and the USA remain the largest producers of P rock, however high rates of growth in production were seen across Togo (87.5%), Senegal (62.5%), Algeria (50%) and Saudi Arabia (45.2%) over the period. P rock production has risen by 36.1% since 2002 (FAOSTAT, 2024). According to the United States Geological Survey (USGS), global P rock economic resources amount to more than 300 billion tonnes and there are no imminent shortages of P rock.

Potash production

Plants cannot absorb elemental potassium, so potassium fertilisers are usually produced in the oxide form (potash or K_2O). Typically potassium is mined in mineral form from certain geological deposits (typically potassium salts found in sea beds) and then refined by crushing, resizing or chemical alteration to produce fertilisers ready for plant uptake.

Potash production similarly shows a recovery from any effects following the coronavirus (COVID-19) pandemic and longer-term trends show overall growth. Potash production rose by 2.4% to 42.9 million tonnes between 2019 and 2022 and has risen by 61.2% since 2002 (FAOSTAT, 2024). Potash production increases have been driven by Asia since the 1990s when there was a marked decrease in potash production in Europe.

Known economic reserves of potassium-based minerals have remained reasonably steady between 2019 and 2022, except in Brazil, China and Russia where reserves have decreased by over 90%, 50% and 33% respectively. Overall global production has fallen by 1 million tonnes or 2.4%. This has been driven by the effect of import quotas and economic sanctions on Russia and Belarus (USGA, 2024).

Nitrogen production

While there was a minor reduction in nitrogen (N) production over the last 3 years, longer-term trends show overall production continues to rise. Between 2019 and 2022 N production fell by 3.7% to 118.1 million tonnes (FAOSTAT, 2024). Production of N has risen by 35.2% since 2002 (FAOSTAT, 2024). N production increases have been driven by Asia since the 1990s when there was a marked decrease in N production in Europe.

Supporting evidence

UK dependence on global imports of nitrogen fertiliser

The UK is totally dependent on imports for N fertiliser; while AN is produced domestically, structural change to the domestic production base, with domestic gas no longer being used as feedstock and imported ammonia being used in the production of AN, means the UK now imports around 60% of N fertiliser as has been subject to structural changes. Since 2022, Lithuania and Poland have become large suppliers of Ammonium Nitrate (AN) (Agriculture and Horticulture Development Board (AHDB), 2024). The UK's production and consumption of N is covered in further detail in Theme 3 Indicator 3.1.1.

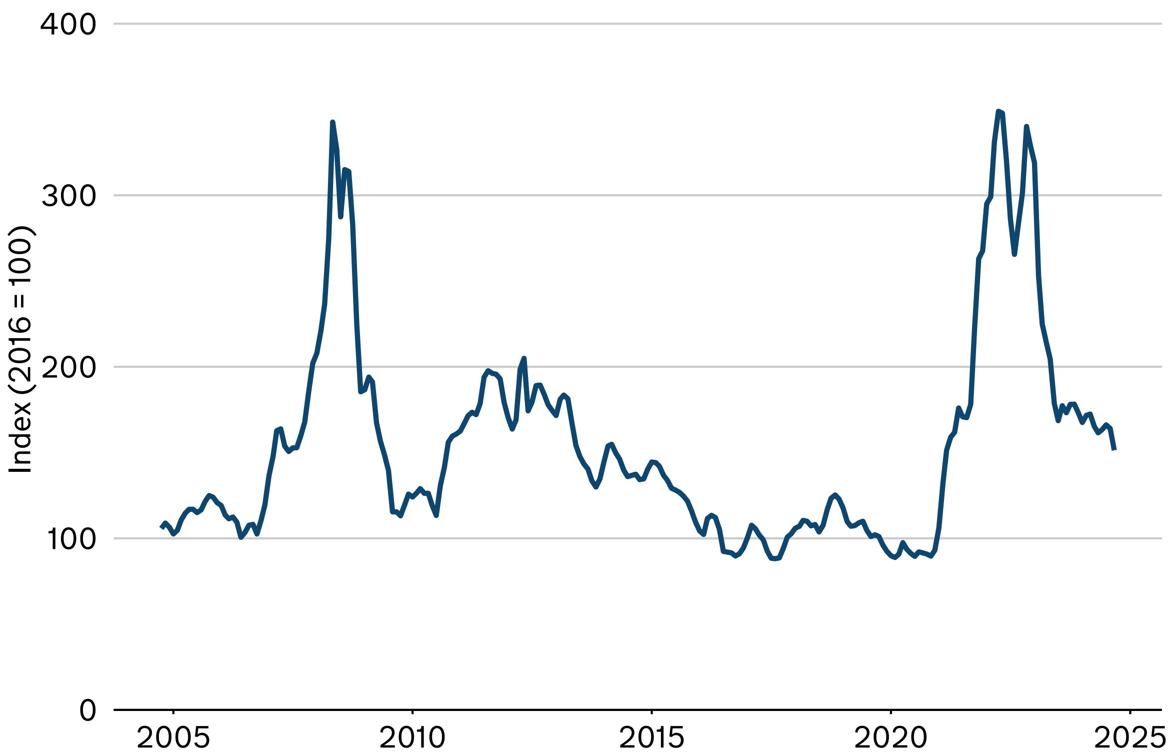
Geopolitical tensions

There have been some disruptions to global fertiliser production because of geopolitical tensions and conflict. Despite fertiliser materials being exempt from sanctions, the Russia-Ukraine war led to the European Union imposing import quotas on Belarus, which had been the third largest producer of K after Canada and Russia. Belarus has managed to export some supply via rail and Russian ports (USGS, no date). The war also prompted some countries to not allow Russian vessels in their ports which has further affected the availability of fertiliser. K has been much more severely affected than P in this regard as Russia responded to these measures by suspending the export of fertiliser products including K on countries it deemed unfriendly. The most significant disruption to P fertilisers followed an export ban from China for diammonium phosphate and monoammonium phosphate to control the domestic fertiliser prices. This removed 5 million tonnes of fertilisers from the global market, equivalent to approximately 10.9% of global supply in 2022, which was not entirely compensated for by other suppliers (USGS, 2023).

Global fertiliser prices

Figure 1.2.3b: IMF Fertiliser Price Index, October 2004 to September 2024

Source: [IMF]



While fertiliser prices have stabilised, they remain higher than before the start of the energy crisis in 2021 (Figure1.2.3b). Fertiliser prices rose dramatically between January 2021 and June 2023 following the energy crisis which led to a rise in gas price, peaking in April 2022 with prices 3.6 times higher than in April 2020. Prices have stabilised since July 2023 but remain 42% higher than prices in January 2021 before the start of the crisis. Fertiliser prices tend to follow energy prices closely as energy (in the form of natural gas) is the key ingredient in producing ammonia, and in a competitive market (see section below) changes in price tend to track production cost. Other factors, such as farmer demand, availability, tariffs and quotas, can also lead to changes in fertiliser prices (Fertilizer Europe, 2018)

Concentration of global fertiliser market

Among the 3 main nutrients, N has persistently been the nutrient with the most diverse sources of supply (in terms of exporters) and its market can thus be considered as relatively less concentrated (FAOSTAT, 2024). Instead, the markets for P and K can be considered as more concentrated. Recent data shows that between 2018 and 2021 the supply of N and P has become more concentrated, while K has become marginally more diverse in supply.

Risks associated with underuse and overuse of fertiliser

There is currently heterogeneity in fertiliser use globally with many countries using too little fertiliser and many countries using too much fertiliser (FAO, 2022).

Underusing fertiliser, linked with insufficient access to fertilisers, is associated with nutrient deficits in croplands and limits food production (Penuelas, Coello and Sardans, 2023). Lack of access to nitrogen and phosphate fertilisers is especially acute in low-income countries (Rockström and others, 2023; Cordell and White, 2014).

Overusing fertiliser can lead to nutrient imbalances in the soil, with wider implications for soil degradation and fertility as well as an overall loss of organic soil matter. The continued intensification of inputs, such as fertiliser, may result in problems with sustaining production at current levels in the medium term. Fertiliser use is also linked to environmental pollution and groundwater leaching (Singh and Craswell, 2021) as well as significant GHG emissions. 0.47 Gt CO_2-eq were emitted from fertiliser production in 2021 (FAOSTAT, 2024), of which NO_2 made up a large proportion: 0.6 Gt NO_2 were emitted from synthetic fertilisers in 2021, which constitutes 26% of all NO_2 emissions and 3.6% of all CO_2-eq emissions from the agri-food system (FAOSTAT, 2024).

Forward look

Global production of fertilisers is predicted to increase. According to a USGS report on P rock, the global capacity of P rock mines is projected to increase from 238 million tonnes in 2020 to 261 million tonnes in 2024. The greatest increases in planned capacity are predicted to be in Africa and the Middle East. Capacity expansion projects are ongoing in Brazil, Kazakhstan, Mexico, Russia, and South Africa but none are due to completed by 2024. Global consumption of P_2O_5 is also projected to increase from 47 million tonnes in 2020 to 49 million tonnes in 2024.

Similarly world annual K production capacity is projected to increase from 64 million tonnes in 2022 to about 66 million tonnes in 2025 (USGS, no date).

The International Fertilizer Association predicts that nitrogen capacity will increase from 192 million tonnes in 2023 to 207 million tonnes in 2028, with increases in capacity across all global regions except Central Europe (International Fertilizer Association, 2024).

1.2.4 Water availability, usage and quality for global agriculture

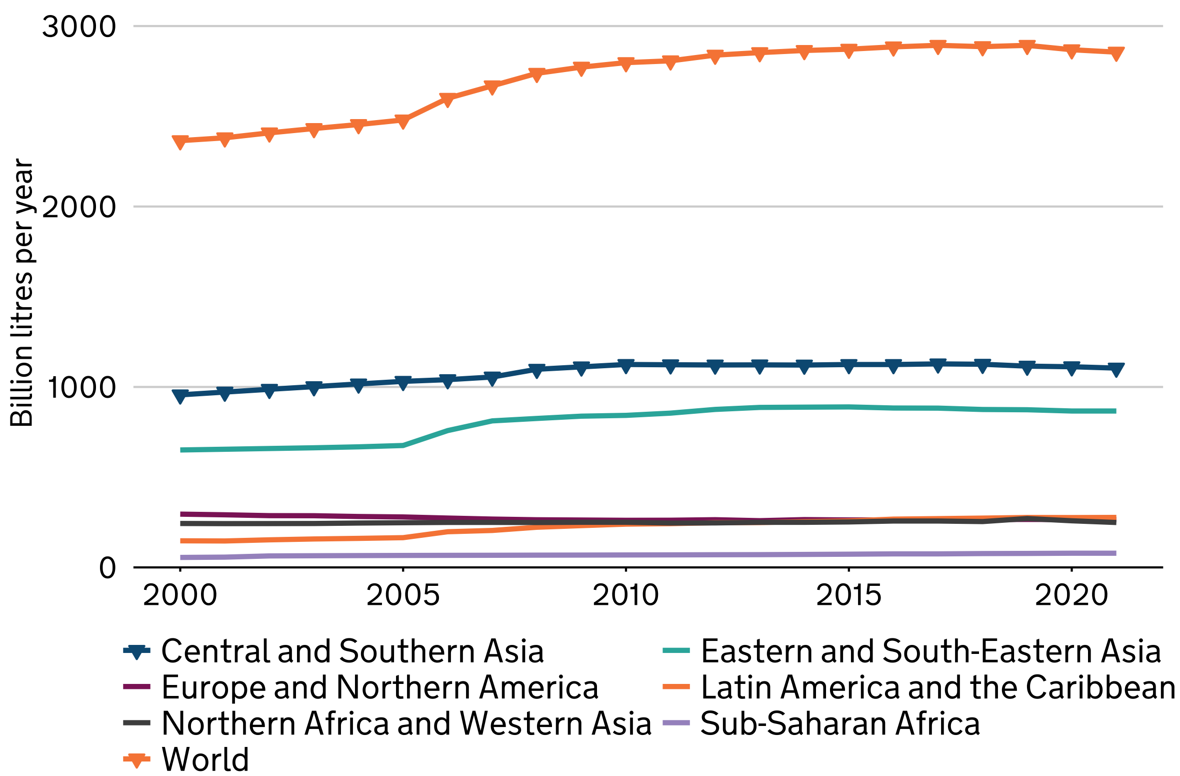
Rationale

Water is essential to food production. Agriculture accounts for around 70% of fresh water withdrawn (from rivers, reservoirs, or groundwater extraction) globally (UNESCO, 2024). This indicator measures how rates of agricultural water withdrawal vary by region and have changed over time. The majority of world agriculture currently relies on rainfall; however, irrigated agriculture plays a crucial role in global agricultural output growth and global food production.

Headline evidence

Figure 1.2.4a: World agricultural water withdrawal, by region, 2000 to 2021

Source: FAO AQUASTAT Pressure on Water resources



The amount of agricultural water withdrawn at the global level has risen noticeably since 2005 from 2,479 billion litres to high points in 2017 and 2019 of 2,893 billion litres, an increase of 16.7%, although the rate of growth has been slowing (AQUASTAT, 2024). Although there has been a small fall in global agricultural water withdrawals from that peak, by 1.3% in 2021 to 2855 trillion litres, it is too early to say if this is the start of a sustained fall in agricultural water use globally.

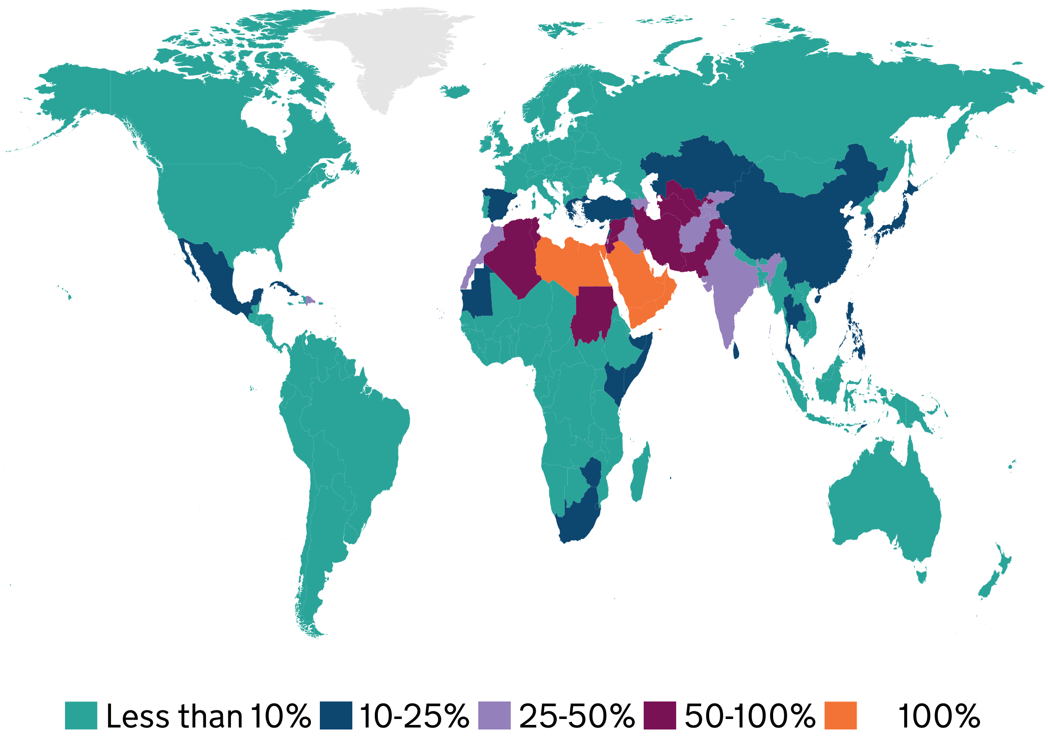
Important risks to food availability over the longer term are increasing water stress around the globe, catalysed by climate change, combined with increasing demand for fresh water from a range of uses which is projected to outstrip supply by 40% by the end of the decade. The global water withdrawals that UK food relies on through imports are therefore increasingly unsustainable, especially where imports come from countries with lower water security than the UK. See supporting evidence.

Supporting evidence

Water availability

Figure 1.2.4b: Agricultural water withdrawn as a percentage of total internal renewable water resources, 2021

Source: FAO AQUASTAT



'Total freshwater renewable water resources' covers the flow of rivers and recharge of aquifers from annual precipitation over land. Figure 1.2.4b above shows the global average percentage of agricultural water withdrawn as a percentage of total internal renewable water resources varies significantly globally, with Northern Africa and most of Asia above the global average

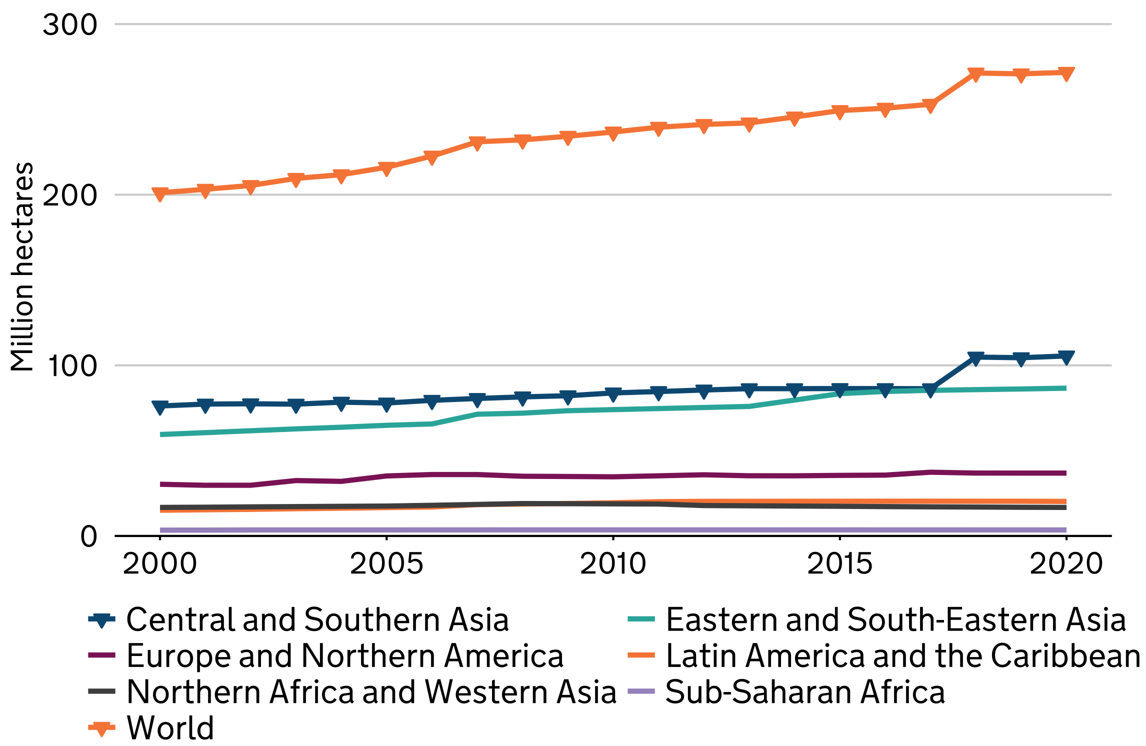
Increasing populations mean reduced natural resources available per capita. The amount of total renewable water resources per capita has fallen between 2018 and 2021 by 158.5 m^3 per capita per year to 5,401.7 m^3 per capita per year

(AQUASTAT, 2024). In sub-Saharan Africa, water availability per capita declined by 40% over the past decade, and agricultural land declined from 0.80 to 0.64 ha/capita between 2000 and 2017. Northern Africa, Southern Africa and Western Africa each have less than 1 700 m^3/capita, which is considered to be a level at which a nation's ability to meet water demand for food and from other sectors is compromised. (SOLAW, 2021)

While over 78% of agricultural land is rainfed and the remaining 22% is irrigated (FAO, 2021), food produced on irrigated land makes up roughly 40% of all food produced globally (World Bank, 2022). Irrigated land is roughly twice as productive per land unit than rainfed land which allows for more intensive production and crop diversification (World Bank, 2022).

Figure 1.2.4c: Area equipped for irrigation: actually irrigated, 2000 to 2021

Source: FAO AQUASTAT



The percentage of cultivated land that is irrigated was 21.18% on average globally in 2021. On a regional basis generally Asia had higher percentages, with Southern and Eastern Asia highest (46% and 59% respectively). Between 2018 and 2021 the largest decrease in percentage of cultivated land that is irrigated was found in Australia and New Zealand. The largest growth was found in Eastern and South Eastern Asia. (AQUASTAT, 2024).

Water quality

While agriculture is the greatest user of freshwater resources (70%), it is also the leading contributor to water pollution, with chemical and organic pollutants contaminating surface water and groundwater resources, with wide scale effects on people and planet (FAO and International Water Management Institute (IWMI), 2023). An estimated 1260 km³ of agricultural drainage effluent is released each year untreated into the environment (Mateo-Sagasta, Zadeh and Turral, 2018), with downstream impacts for irrigated farmland, animal husbandry and aquaculture production. Salinity pollution also plays a critical role, with almost 34 million hectares of irrigated land worldwide affected by salinization resulting in significant yield losses and poorer quality produce (World Water Quality Alliance, 2021).

Water demand

Global water demand is projected to increase significantly over the coming decades as an increasing global population (forecasted to reach 9.7 billion before 2050 (UN DESA, 2024) and increasing global wealth are expected to increase pressure on agricultural food systems. Global demand for freshwater is expected to outstrip available supply by 40% in 2030 (2030 Water Resources Group, 2009), with demand from all sectors increasing by between 25% to 40% and possibly being reallocated from lower to higher productivity activities, particularly in water stressed areas. This is expected to affect agriculture due to its high consumption of water.

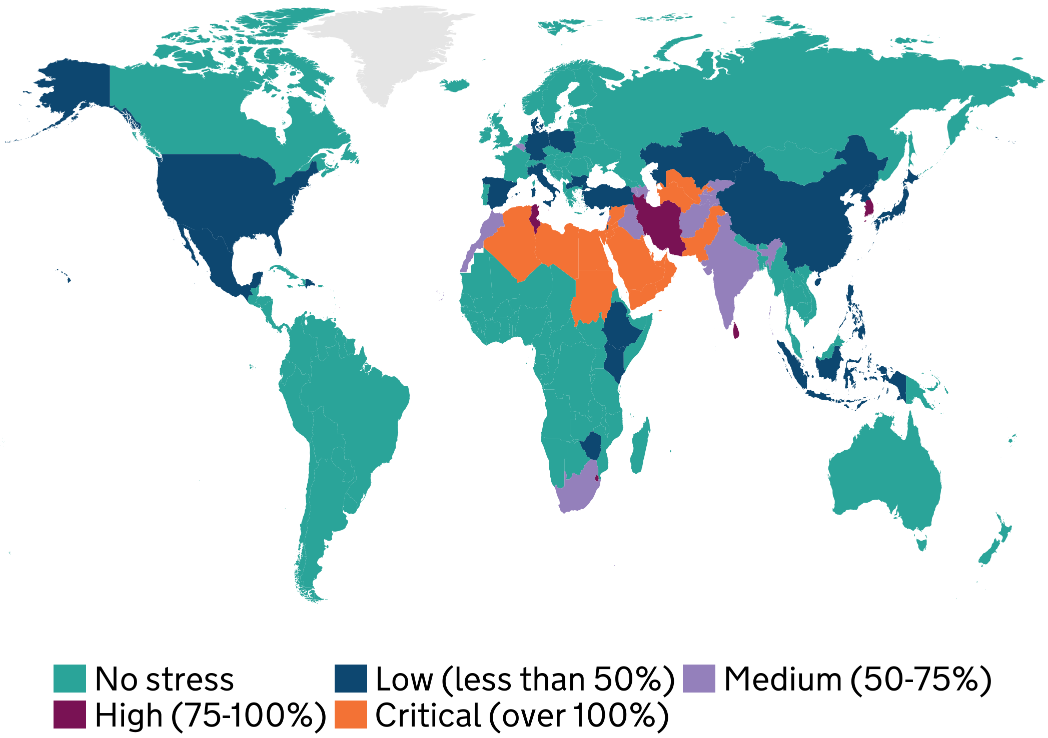
It is within this constraint that ever more difficult decisions will be made about where and to whom water should be prioritised with risks for development, geopolitical tensions, conflict, and progress towards the SDGs. The Water, Energy and Food Nexus is a useful framework that highlights the risks, trade-offs and opportunities that will arise because of the excess demand for freshwater resource.

Water stress

Water stress is the ratio between total freshwater withdrawn by all sectors and total renewable freshwater resources, after taking into account environmental flow requirements. Globally water stress has been steadily rising since records began in 2000, only falling significantly between 2007 and 2010. Since 2010 water stress has risen by 0.74 pp from 17.81% to 18.55% in 2021, 0.21 pp of which have been since 2018.

Figure 1.2.4d: Water stress, 2021

Source: FAO AQUASTAT



Water stress varies significantly globally (see figure 1.2.4c above). It is highest in Central and Southern Asia, Northern Africa and Western Asia. The agricultural sector contribution to water stress globally has risen consistently by 1.6 pp from 11.7% in 2000 to 13.3% in 2021 (AQUASTAT, 2024). Although UK water stress levels remain low at 14% in 2021, UK food supplies rely on food imports from countries with higher water stress and therefore is affected by increasing water stress around the world. This includes a large amount of fruit and vegetables from Spain and Morocco (AQUASTAT, 2024) where water stress levels are at around 40 to 50%. This is covered in further detail in Theme 2 Indicator 2.14 on Fruit and Vegetables.

A report from the Global Commission on the Economics of Water suggests that half the world's population already faces water scarcity. The number is set to rise with impacts of climate change and nature loss on the global water cycle including on 'atmospheric water exchange' dependent on declining vegetation. The global water cycle connects countries, regions and localities through both visible water and atmospheric moisture flows. It is deeply interconnected with climate change and the loss of biodiversity with each effecting on the other; and it underpins virtually all the Sustainable Development Goals.

Water volatility

Water volatility refers to variability in the levels and spatial distribution of precipitation This variability is expected to increase globally with climate change Droughts and flood conditions will increasingly affect rain fed agriculture, which produces 60% of the world's food on 80% of the world's cultivated land (FAO, 2021). The nature and magnitude of impact depends largely on the area or region with the risk of flooding likely to increase in wet tropical regions while semi-arid areas are likely to receive even less precipitation, with droughts becoming longer and more pronounced (IPCC, 2018). The effect of climate on global food production is explored further in Indicator 1.3.3.

Sub-theme 3: Stocks, prices and trade

1.3.1 Global stock to consumption ratios

Rationale

This indicator measures changes in the stock to consumption ratios of maize, soybeans, rice and wheat across different groupings of countries. The stock to consumption ratio is a measure for the relative tightness of stocks which is calculated by dividing the ending stocks of a commodity by the corresponding domestic consumption. A stock to consumption ratio of 100% means that total stocks held are equal to one year's worth of consumption. The stocks data in this section combines publicly and privately held stocks into one national figure; it not only includes government held stocks, but also stocks held by farmers, households, enterprises, or any other agents.

Stock to consumption ratios serve as an indicator of food availability and as an early warning for food security risks including possible shortages and price spikes, which can be indicative of global resilience to such shocks. Major price spikes can be detrimental to global food security, poverty and nutrition levels, particularly in lower income countries (World Bank, 2019). A key characteristic of the staple foods covered here, which makes them particularly important from a food security perspective, is that it is possible and less costly to store them than other food products such as meats and dairy products (AMIS, 2021). During periods of instability, which could be due to geopolitical, weather, or supply-chain disruptions, domestic stocks can ensure the availability of these products at a low and stable price. Crop markets are particularly susceptible to supply shocks, which is why this indicator focusses on cereals and oilseeds (in this instance soybeans).

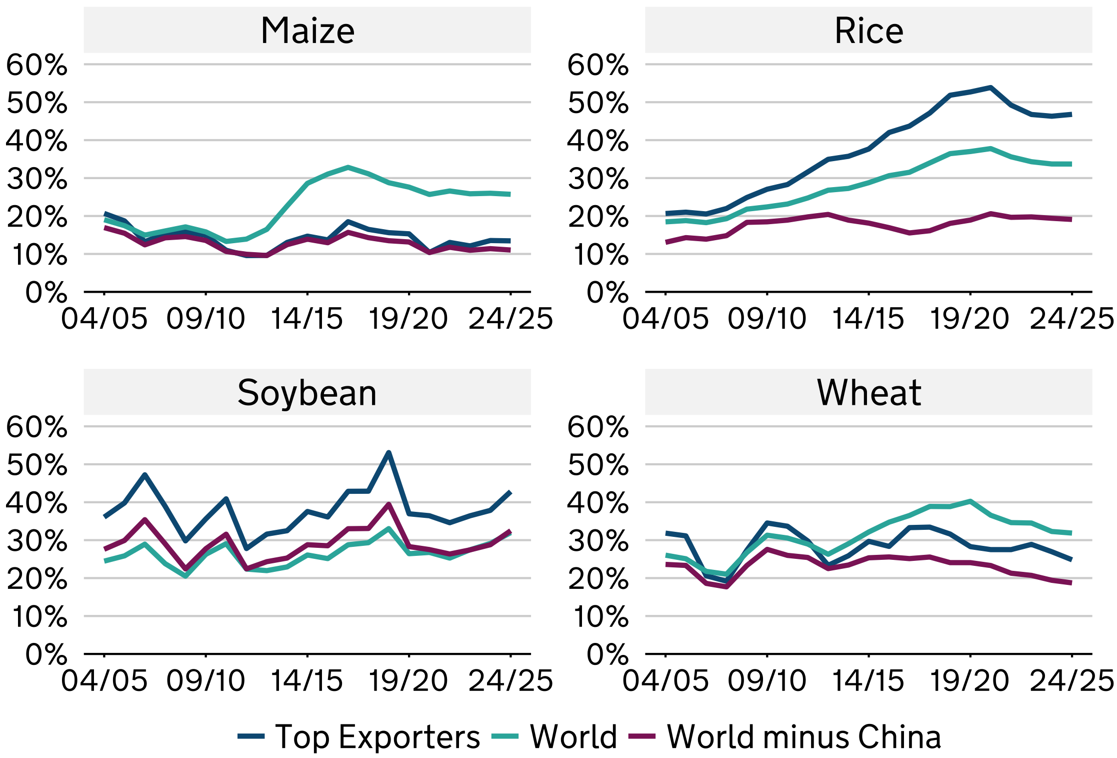
The ratio can aid in assessing the extent to which there is a 'buffer' against supply and demand shocks in the market; however, it is difficult to establish an ideal ratio. Commodities with higher ratios, such as soybeans (see Headline evidence), may be more insulated from potential price spikes and exert more resilience than commodities with lower ratios. Any changes in the ratio require careful interpretation to fully understand the root causes and possible implications.

A benchmark ratio of stock-to-consumption is used to indicate global food security and to interpret this indicator. In the 1970s, a ratio above 17 to 18% was considered sufficient to stabilise global markets. When the ratio fell below this threshold, it indicated a higher risk to the global market. However, this benchmark should be interpreted with caution today, as increased trade liberalisation since then may affect its relevance (AMIS). Over time, there have been shifts in the incentive structure for governments and private agents to hold stocks (USDA, 2008).

Headline evidence

Figure 1.3.1a: Annual stock to consumption ratio, 2004/05 to 2024/25: soybeans, rice, maize, wheat

Source: USDA Production, Supply and Distribution , 2024



Note: ‘Top exporters’ refers to the eight largest exporters based on a 3-year average between 2021/22 and 2023/24

Global stock to consumption ratios declined over the last 3 years (between 2020/2021 and 2023/24) with the exception of soybeans. While global maize stocks have increased by c17.9 million tonnes over this period, the pace of growth in consumption has been slower than the expansion of production, leading to a very slight increase of 0.1 pp in the stock to consumption ratio which is pegged at 25.8%. Rice stocks have decreased by 0.6% between 2022/23 and 2023/24 with the stock to consumption ratio remaining stable at 34.5% over the same period. Global wheat stocks have declined by 6% over the last 3 years (2022/23 to 2024/25) to c253 million tonnes with the stock to consumption ratio at 32.2% in the 2024/25 marketing year. This contraction has been driven by lower stocks in major exporters, especially the EU, Kazakhstan and Ukraine. Soybean stocks have grown by 30.4% since 2022/23 and reached c132 million tonnes in 2024/25. The stock to consumption ratios have been calculated by dividing annual ending stocks by annual consumption.

Supporting evidence

China

The divergence in recent years between 'World' and 'World minus China' ratios, particularly for maize, rice, and even wheat is substantial. The USDA reports that more than half of wheat stocks are estimated to be held by China, with other major exporters accounting for a further 20% (USDA, 2024). Between 2012 and 2020, China's wheat stocks increased by over 160% while wheat stocks held by the rest of the world declined by 12% (International Food Policy Research Institute (IFPRI), 2023). This difference is likely due to extensive Chinese stockholding programmes, though the actual volume of stocks held is uncertain. These are unreported by the Chinese government and mostly isolated from the global market. The uncertainty around Chinese stocks can have food security implications because data can be skewed or incomplete, so any narrative drawn via this data is caveated by such limitations.

On the other hand, the developments of stocks in India, another major staple exporter where public stockholding for rice has increased in recent years (Institute for Agriculture and Trade Policy, 2024), have implications for food security given the integration of the country to the world rice market. However, given its limited export for other staples, India has not been excluded from the 'World' total for this indicator.

Soybeans

In addition to cereals, the importance of which is covered in Indicator 1.1.3 Global cereals production, this indicator tracks changes in soybeans given their crucial role in achieving international food security. Soybeans and their by-products are regarded as one of the most important crop types in the world (Abiodun and Olufunmilola, 2017). A very large proportion of soybeans are processed into animal feed, used to rear animals (OECD-FAO, 2021); they are significant inputs to the meat and dairy sector. Technological advances have unlocked double-cropping practices in Brazil, meaning farmers can grow and harvest both soybeans and maize in one growing season, increasing the total annual yield (DePaula, 2019). This spreads the risk of disruptions across a longer growing period and reduces monoculture farming practices. These practices can cause soil erosion, jeopardising land's future nutrients and ability to cultivate crops, implicating future food security.

Trends by commodity

The pattern in stock to consumption ratios over the last 20 years varies by staple food commodity:

Maize – In the last 3 years, the maize stock to consumption ratio has remained fairly stable after a decline from the peak in the 2016/17 ratio. When China is excluded, the major divergence from the world ratio that first materialised in 2010 remains apparent and a similar size divergence has been maintained since 2016/17. Stock to consumption ratios for both 'world excluding China' and 'top exporters' is lower than 20 years ago, though the 'world' stock is much greater, suggesting that growth has been driven by growing Chinese stocks.

Soybeans – The 20-year trend of stock to consumption ratio is volatile and the ratio has consistently remained higher for top exporting countries than that of the world. This may have positive implications for international food security, as the soybeans are more likely to enter the global supply, maintaining the availability of this staple at a low price. The last 3 years seemingly feed into a successive peak in ratio, though this is difficult to predict.

Rice – There has been an upward trend in rice stock to consumption ratios in the last 20 years. This is a stronger trend for the 'world' and 'top exporting countries' than the 'world excluding China.' Despite this, the last 3 years have seen a slight decline in ratios for all 3 lines which could be driven by a fall in stock levels, or an increase in consumption.

Wheat – Prior to the 2012/13 season, the stock to consumption ratios for wheat were volatile. Low stocks during the 2007 to 2008 price spike stimulated a reactive increase in stock levels following this. The price spike caused by Russian wheat export ban in 2010, combined with other countries' protectionist policies, was met with low levels of global stocks, stimulating another increase in the stock to consumption ratio. 'World' ratio rose steadily until 2020/21 but has since declined, although the less volatile 'world excluding China' ratio suggests that this major, more volatile increase has been driven by China. 'Top exporters' have followed a similar trend as the other categories, but with a greater degree of volatility.

Data limitations

The data on stocks suffers from a number of limitations. The low accuracy of stocks data means future forecasts tend to project ahead for only one marketing year. This is partially due to a lack of consistent, government-reported stocks data which causes low reliability across data sources for global stocks.

Stocks are rarely measured by countries themselves, instead, they are calculated based on estimates from one period to the next. It is possible that inconsistencies are carried over from the past, leading to a further source of unreliability (AMIS, 2017). Therefore, while this indicator is crucial for assessing the resilience of agricultural markets, it should not be treated as the sole measure for food security and agricultural market dynamics.

Forward look

The USDA (2024) projected the combined world ending stocks (products wheat, milled rice, and soybean for close of seasons in 2025 to come to 572 million tonnes. This is a 2.5% increase from the predicted ending stocks for 2024 of the same product group. Global wheat ending stocks are projected to decline by 3.3% compared to 2023/24 and world rice ending stocks to grow by 1.9% across the same period (USDA, 2024). A 17.2% increase in world soybean ending stocks is forecasted between the 2023/24 and 2024/25 seasons. Some countries have expressed their intent to build up cereal stocks, and wheat stocks are increasing. However, this is not the same for all staple cereals and unreliable data discourages long-term projections of global stocks (OECD-FAO, 2023).

1.3.2 Global real prices

Rationale

This indicator tracks changes in the real commodity prices for rice, soybeans, wheat, maize, beef and chicken, which represent a considerable proportion of global energy consumption across the world. It shows the real price trends, recent and historic, of these agricultural commodities and how they are driven by market fundamentals of supply and demand, and exchange rate dynamics.

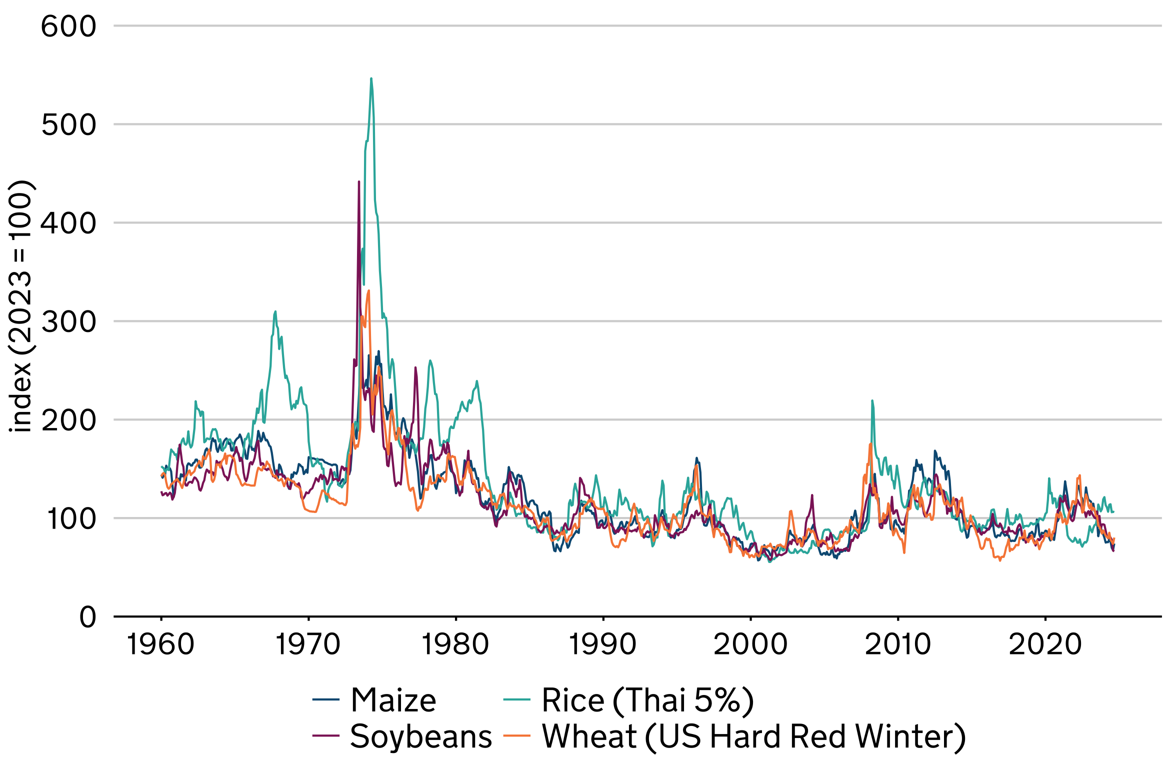
This indicator broadly reflects the global availability of agricultural commodities and signals whether the global market is over or undersupplied. Falling prices signal improved supply, while higher prices indicate relative shortages.

Prices also represent a crucial measure of food security as higher prices can support the sustainability of agricultural production for producers. At the same time, the higher prices are, the less affordable food becomes for consumers, directly affecting the accessibility of a secure supply of food. The effect of changing food prices in the UK for consumers is covered in Theme 4 Indicator 4.1.3 Price changes of main food groups. Where people are both producers and consumers, which is more common in low-income countries, the effect of prices on food security is less clear (FAO, 2014).

Headline evidence

Figure 1.3.2a: World Bank monthly real commodity prices for palm oil, soybeans, maize, rice and wheat 1960 to 2024, (2023=100)

Source: World Bank Pink Sheet and deflated by US Producer Price Index (PPI)



Since the 1970s, real agricultural commodity prices have trended downwards as global supply capacity has outpaced global demand, but since 2000 the downward trend has somewhat levelled off. Please see the real prices explainer at the end of this section for the rationale for using real prices.

Real commodity prices for cereals have experienced large fluctuations between 2021 and 2024. Increased uncertainty, higher energy prices and the imposition of export restrictions in response to Russia's invasion of Ukraine contributed to increased levels of price volatility, particularly for wheat which reached a decade-long peak in May 2022. These price spikes remain smaller in magnitude compared to historic episodes of elevated prices during the food crises of the 1970s, 2007 to 2008 and 2010 to 2012 (Figure 1.3.2a).

Since 2021, the price of wheat, maize and soybeans increased as a result of higher demand for livestock feed as well as a strong cycle of stocking which boosted Chinese imports. On the supply side, wheat production was hit by droughts in the USA, Canada, the EU and Turkey, leading to lower output levels (IFPRI, 2019). Meanwhile, droughts in Brazil in 2021 affected maize crops leading to a rise in maize futures prices to their highest in several years by mid-May (United States International Trade Commission, 2021). Export restrictions such as those imposed by Russia on limiting wheat exports, further contributed to the shrinking of the global supply of commodities, and therefore, price increases.

More widely, rising agricultural commodity prices from mid-2020 were part of a rebound in prices from the multi-year low seen during Spring 2020. Numerous factors contributed to the upward pressure on prices in 2021, including a recovery in global demand, elevated input and transportation costs, the depreciation of the US dollar, and adverse weather conditions affecting supply (United States International Trade Commission, 2021).

Overall, however, agricultural markets for staple foods have been resilient, global supplies remained adequate, and logistical challenges proved short-lived (IFPRI, 2022).

Real prices explainer

Real prices account for changes in the price level over time, which means changes in commodity prices can be evaluated at constant prices and they more accurately represent purchasing power at any point in time.

Prices are deflated using the US Producer Price Index (PPI) series, which, unlike other deflators, measures the prices received by producers and represents a reliable measure of wholesale inflation.

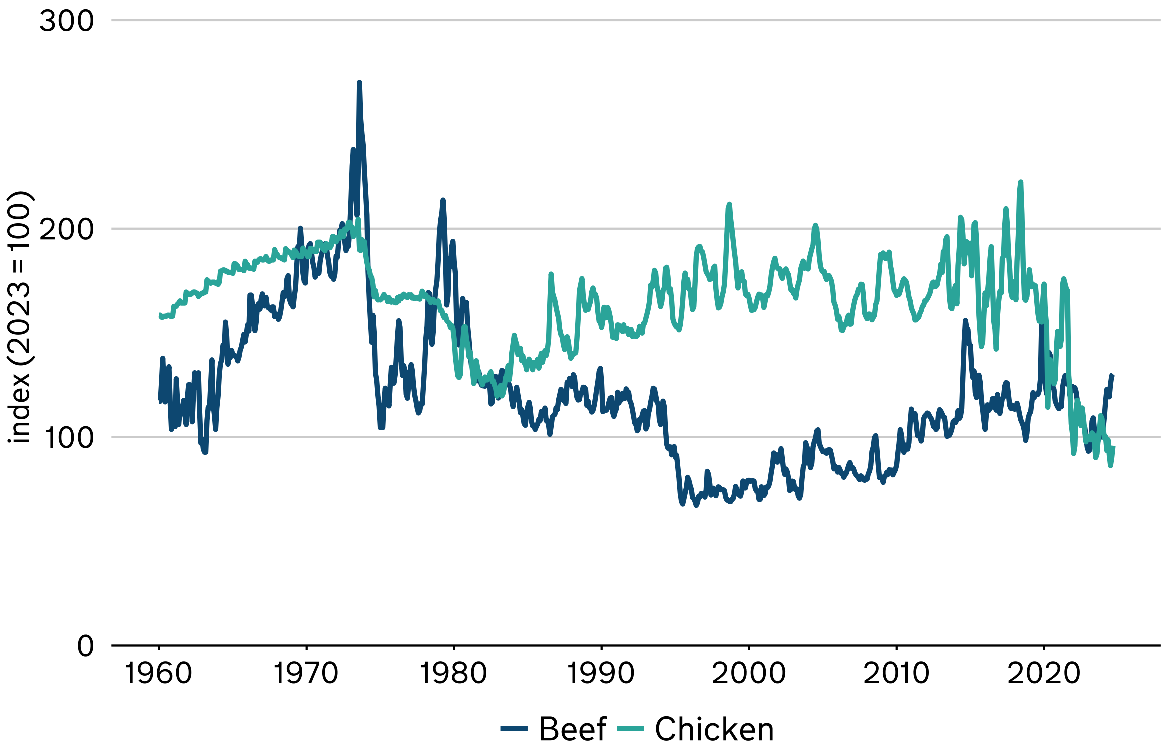
The base year for deflating prices that all subsequent calculations are based on is the most recent full year of data, i.e., 2023.

Supporting evidence

Prices for chicken and beef

Figure 1.3.2b: World Bank monthly real commodity prices for chicken and beef, 1960 to 2024

Source: World Bank Pink Sheet and deflated by US Producer Price Index (PPI)



Between 2021 and 2024 there have been spikes in the real prices of beef and chicken due to factors such as high feed costs and growing consumer demand (Figure 1.3.2b). Beef prices have trended downward over the past few years but increased by 16% between January and May 2024. This is due to supply pressures arising from shrinking herd numbers across Europe and North America.

Longer-term trends

Between 2021 and 2024 real commodity prices experienced some level of volatility and, as briefly discussed under 'headline evidence,' these fluctuations are not without historical precedent. From 2007 to 2008, commodity prices (such as wheat, rice and soybeans) increased sharply followed by sizeable falls in the second half of 2008. However, even at their 2008 peak, prices in real terms stayed well below their peaks during the 1970s food crisis.

Moreover, the combination of inelastic supply and demand, in the short term, means that the global agricultural market is inherently vulnerable to price volatility (Institute for Agriculture and Trade Policy, 2012). Higher agricultural commodity prices, however, pose risks to food security, particularly in low-income food deficit countries whose means to cope with high global agricultural commodity prices are more constrained.

Many factors can affect commodity prices, including favourable or poor harvests, input costs, the market structure, and external factors, such as macroeconomic conditions and population growth. While temporary supply shocks, such as harvest failures, can lead to a short-term spike in prices, a permanent increase in input costs, such as energy and fertilisers, can cause a medium-term increase in price levels. Historically, stocks have been an important tool in managing food price volatility and spikes, private stocks in particular. They also act well in absorbing unexpected variation in supply and demand (AMIS, 2021). This topic is covered in more detail in Indicator 1.3.1 Global stock to consumption ratios.

The impact of global prices on country-level food security across countries

Global agricultural commodity prices are transmitted to domestic markets through trade; however, the effect of increases on domestic food prices, energy and fertiliser prices and, in turn, food security is heterogeneous across countries. The speed and level of passthrough (price transmission) and a country's capacity to respond to worsening conditions are influenced by multiple factors including underlying vulnerabilities and socio-economic conditions. In the current context, factors such as dependency on the Black Sea region and domestic stock levels determine countries' ability to absorb trade shocks. Moreover, worsening financial conditions including the depletion of foreign exchange reserves and high debt levels may limit countries' room for manoeuvre when faced with shocks. Acute food insecurity, therefore, tends to be accompanied by causes other than elevated global food prices, with conflict and economic instability such as income and exchange rate shocks being important contributors in many countries (World Bank, 2024).

From a UK food security perspective, assuming international price shocks are transitory, UK consumer food prices could rise depending on the size, breadth and the duration of the shock in international food prices. However, a permanent increase in international food prices could see more substantial increases in consumer prices. Illustratively, previous evidence based on modelling commissioned by Defra shows that a permanent 10% increase in international food prices will eventually lead to an approximate 2.5% increase in the UK food Consumer Prices Index (CPI). This will have a greater impact on the poorest in the

UK who spend a greater proportion of their income on food, resulting in poorer dietary quality rather than insufficient energy (Defra, 2016).

Price volatility

Real commodity prices have exhibited volatility over the past few years but overall, there has been no systemic or general rise in international price volatility between 2021 and 2024 relative to the past 60 years. Some degree of agricultural price volatility is an entirely normal characteristic of the market, with sharp spikes in volatility seen during the food crisis of the 1970s, and periods from 2007 to 2008 and from 2010 to 2011. While grain price volatility recently is slightly higher than in the 1980s and 1990s, it is lower than in some decades of the past, such as the 1970s. This holds for the majority of commodities considered.

Low-income countries are hit harder by price volatility due to diets of people being more dependent on staple commodities and the associated difficulties in substitution to meet nutrition and energy needs. This is primarily due to low incomes and concentrated import sources which leaves these countries more exposed to sudden price fluctuations. Equally, periods of volatility and high prices are of a lower concern for countries such as the UK. Food expenditure represents a smaller proportion of household spending in advanced economies and consumers can substitute food more easily, leaving them less exposed to supply-chain disruptions and price spikes.

As well as the staple commodities discussed, prices of soft commodities have seen sharp rises over the past few years. For instance, the real price of cocoa peaked at a 45 year high in April 2024 at $295 per kg, equivalent to 116% growth in the first 5 months of 2024 from January. The real price of olive oil grew by 124% between January 2021 and December 2023, while year on year growth in Arabica coffee prices has been fluctuating between 2021 and 2024, growing at 15% during 2021 but decreasing by 17% in 2023.

The role of exchange rates

Most agri-food products are quoted in US dollars as it is the world's preeminent currency of international trade. The value of the US dollar has an impact via the prices paid by importers, and the international prices of agricultural commodities. The import price paid by countries is dependent on the domestic exchange rate, meaning depreciation in the domestic currency drives up the import price and vice versa (Davies, 2023).

Following Russia's invasion of Ukraine, a strong dollar coupled with high commodity prices prevailed throughout 2022. This differs relative to the exchange rate relationship of the food price crises from 2007 to 2008 and from 2010 to 2012 during which the US dollar and international commodity prices were characterised by an inverse relationship. The current dollar-commodity price relationship implies that net food-importing developing countries were faced with the double burden of higher import bills and additional price hikes driven by the depreciation of their domestic currencies. Countries such as Thailand, Ethiopia, and Egypt were hardest hit due to their heavily depreciating domestic currencies. The case of Egypt is explored further in the case study on the role of exchange rates on food prices in Egypt.

Impacts of changes in freight prices

Increases in freight prices can raise food prices for consumers who pay more for their imports as costs such as higher insurance premiums and shipping rates are passed onto them. Countries that are net food importers are hardest hit, particularly net food-importing developing countries that are dependent on container shipping to support food supply. Higher food prices driven by increased import bills coupled with other economic concerns such as exchange rate fluctuations put pressure on food security. Investment in infrastructure and logistics to better integrate countries into the global shipping network could help reduce the burden on food import bills (FAO Food Outlook, 2024).

Forward look

In the medium-term, international prices of agricultural commodities will depend on the balance between supply and demand; primarily whether productivity growth keeps pace with the growth in demand. The OECD-FAO Agricultural Outlook projects that over the next few years prices will reflect the lingering effects of the COVID-19 pandemic, Russia’s invasion of Ukraine and weather conditions in key producing regions. However, the Outlook projects that these factors underpinning elevated prices will subside and prices of agricultural commodities will resume to their long-term trend over the next decade. It is important to note that these price projections are sensitive to deviations in the difference between productivity and demand growth.

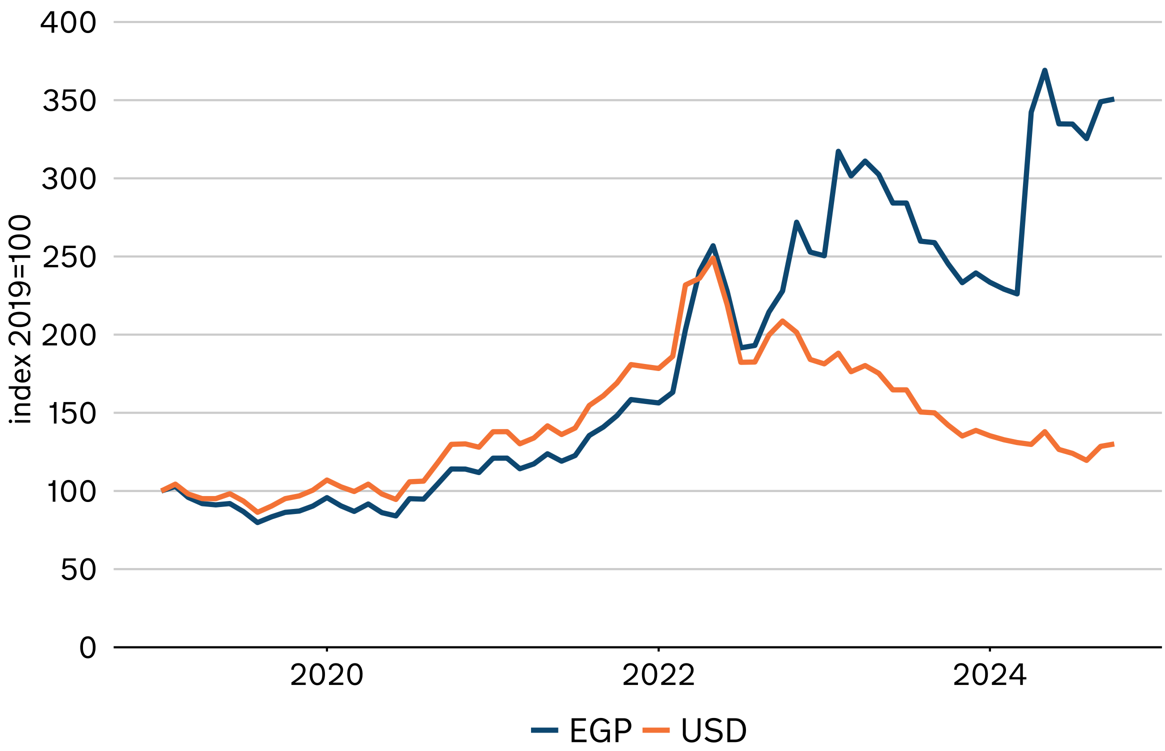
Moreover, the Outlook assumes normal weather, macroeconomic and policy conditions. However, there is an inherent risk that the uncertainties faced by agricultural production systems, such as weather events, animal diseases and further macroeconomic shocks, will lead to deviations from the medium-term projections. Projected lower international real prices are expected to put pressure on farmers’ incomes but will be beneficial to consumers. However, since the reference prices used in the Outlook reflect global markets, domestic impacts are dependent on trade policies, exchange rate fluctuations, transport costs and integration of domestic markets into the global trading system. These factors can all influence whether and to what extent international price signals are transmitted to domestic markets.

Case study 1: The role of exchange rates on food prices in Egypt

Egypt is one of the largest importers of wheat and has experienced a sharp currency depreciation, affecting the price of wheat paid by consumers. Figure 1.3.2c depicts the changes in international wheat prices in US dollars and Egyptian pounds over time. Prices increased by around 40% from January to May 2022 but have been decreasing since. Yet given the devaluation in the Egyptian pound, this decline is not reflected in domestic wheat prices. The effect on wheat prices in Egypt since August 2022 following its currency devaluation has been larger than price changes following Russia's invasion of Ukraine which began in February 2022.

Figure 1.3.2c: Changes in the price of wheat in US Dollar and Egyptian Pound terms relative to 2019 to 2024

Source: World Bank Pink Sheet and Bank of Egypt, 2024



These factors mean Egypt has seen an increase of over 100% in wheat prices between 2020 and 2022. Around 87% of this came from changes in international prices and 16% from the devaluation in the Egyptian pound relative to the dollar. Egypt imported approximately 12.1 million tonnes of wheat in 2020, equivalent to around one-fifth of the country's food import bill. To import the same amount in

2022, Egypt would have had to pay an additional $2.5 billion given the changes in international prices.

1.3.3 Global production internationally traded

Rationale

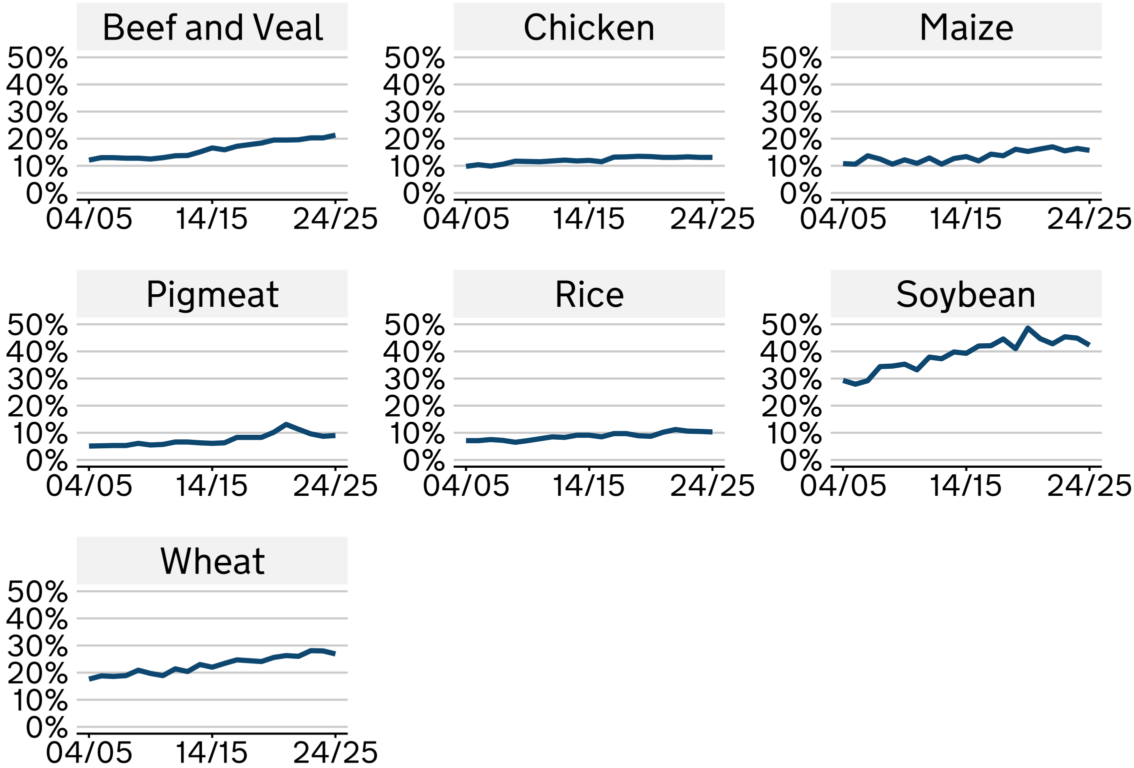
A well-functioning trading system insulates markets from vulnerability caused by supply-chain disruptions as domestic shortages can be supplemented with imports (FAO, 2023). International trade is crucial to food security and nutrition as it allows countries to meet food requirements above what domestic production could independently sustain. Without trade, food availability would be more inconsistent across regions, diets would be less diverse, and food would cost more (OECD-FAO, 2023). Overall, approximately one quarter of the world's food supply is internationally traded (FAO, 2022).

This indicator assesses, first, the aggregate extent of trade, measured by the traded share of global production of major food groups. Evidence is then presented on recent events that have caused disruptions to trade, which can pose a risk to global food security given the global reliance on imports, and the concentration of exports in world agricultural commodity markets. Global reliance on imports is measured by countries' food import dependency ratio and the concentration of exports is tracked by the export shares of leading agricultural commodity supplying countries.

Headline evidence

Figure 1.3.3a: Share of production internationally traded (by volume), Market Year (MYE) 2004/5 to Market Year 2024/25

Source: [USDA Production, Supply and Distribution]



Notes: Data for the year 2024 to 2025 represent estimated projections. Cereals are covered due to the importance of traded cereals for world food supply and soybeans represent an important source of animal feed. Meats are primary agricultural commodities which represent an important source of nutrition, providing 21% of total protein and 7% of total calories in 2022 ([FAOSTAT]).

The percentage of key global cereals, soybeans and meats traded by volume has increased steadily over the last two decades (Figure 1.3.3a) and has remained broadly stable with minimal fluctuations across these commodities (excluding wheat and soybeans) between 2021/22 and 2024/25 (Figure 1.3.3b). Over the last 4 years, the largest changes in share of production internationally traded were a 2.4 pp decrease in pigmeat and 1.4pp decrease in maize production traded across this period. There was a 1.7pp increase in the share of beef and veal production internationally traded over the same period. For the other commodities presented above, there were no difference exceeding 1.0pp between 2021/22 and 2024/25.

Considerable proportions of maize, wheat and soybeans are traded internationally and the share of traded production has increased steadily over the last two decades (Figure 1.3.3a). The international rice market is thin and therefore more vulnerable to disruptions in individual exporting countries. The share of primary meat products traded is lower than cereals but is increasing. Beef and veal saw the largest changes during this period with the traded share of production roughly doubling. For meats, however, a considerable proportion of trade is in semi-processed and processed goods, which makes it more difficult to construct a robust indicator than it is for cereals. These increases in the proportion of food traded internationally have been driven by better international integration and increased exports from low- and middle-income countries (World Trade Organization (WTO), 2021). Overall, approximately one quarter of the world's food supply is internationally traded (FAO, 2022).

Figure 1.3.3b: Share of production internationally traded (by volume), 2021/22, 2024/25

Source: USDA Production, Supply and Distribution

Food Type	2021/22 (%)	2024/25 (%)	Percentage Difference 2021/2022 to 2024/2025 (pp)
Beef and veal	19.5	21.1	+1.7
Chicken	13.1	13.2	+0.1
Pigmeat	11.3	8.9	-2.4
Maize	16.9	15.7	-1.3
Rice	11.3	10.7	-0.6
Soybeans	42.9	42.7	-0.2
Wheat	26.1	27.0	+0.9

Note: Data points for the 2024/25 season are estimated and subject to change. This data has been used as it is the most up to date (estimated) data for this indicator. All figures are rounded to one decimal place which may affect the percentage point difference which has been calculated.

Supporting evidence

Trade disruptions

During times of uncertainty, international trade flows have been found to decrease (Matzner, 2023). Trade disruptions are more damaging when a commodity market is 'thin', that is, there are few major exporters, given trade shocks are less easily dissipated. A reliance on a small number of trading partners can lead to vulnerability to such shocks for all countries involved (OECD-FAO, 2023). Few countries source a large variety of commodities from a wide range of exporters, meaning lots of countries are at risk. There is a case for further trade liberalisation to 'thicken' international markets to ensure greater food security. The last couple of years has seen a number of major shocks which tested the resilience of the international trading system.

The COVID-19 pandemic and the resulting global recession were accompanied by reduced food trade flows, driven in part by labour market disruptions and exacerbated by 14 countries suspending or banning grain exports (Springmann et Al.(2021)) (although these were short lived and transitory (OECD-FAO, 2023)). The swift rebound of trade following the COVID-19 shock highlights the resilience of the global trading system.

Following this shock, increasing geopolitical instability due to the Russian invasion of Ukraine has caused supply-chain disruptions for some staple crops and cereals. Ukraine is a major producer of wheat and exported approximately 11% of global wheat exports in the 2019/2020 season. This has since fallen to 8% of global wheat exports for the 2023/2024 season (USDA). A reduction in Ukrainian exports of these staples has caused a global reduction in supply, which has put temporary upward pressure on global prices, reducing the affordability of these commodities. The impact of the war on food prices is covered in further detail in the case study on the role of maritime trade chokepoints in global food security.

India announced large-scale bans on rice exports in August 2022 in an attempt to shelter its domestic market from the increase in global rice prices. This is covered in greater detail in the case study on export restrictions.

Global reliance on imports

Figure 1.3.3c: IFPRI Food Import Dependence Ratio (%) for all 3 staple foods (Wheat, Rice, Maize), 2020

Source: IFPRI

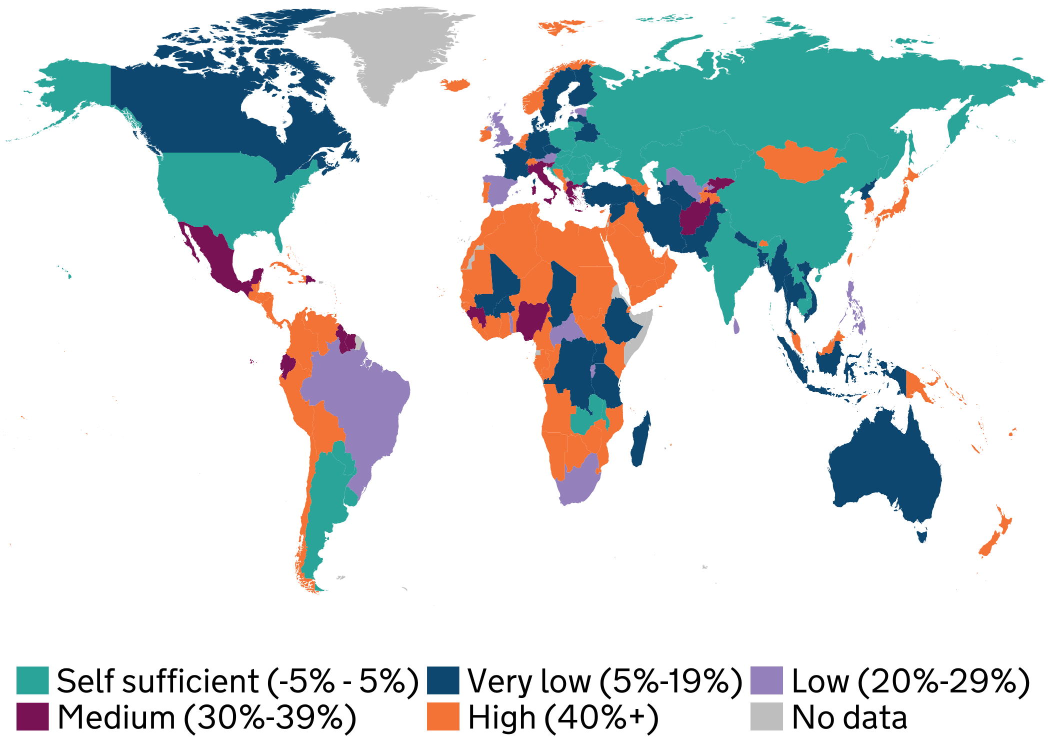


Figure 1.3.3c depicts countries' reliance on food imports. Globally, 44 countries have a food import dependence ratio above 80%, meaning their food supply is at least 80% reliant on food imports. This is much greater than the 50% threshold for 'Very High' import dependence. The countries are distributed unevenly across the world, with a larger proportion in Africa, Central America, and the Middle East. Conversely, countries in North America, Asia, and most of Europe tend to have 'Very Low' to 'Self-sufficient' statuses (5% to 19% and -5% to 5%, respectively) for their food import dependence, though this is not universal. The UK's net trade of wheat is covered in further detail in Theme 3 Indicator 3.1.2.

A large proportion of countries in Northern Africa, Southern Africa, the Middle East, Central and Southeast Asia source at least 40% of their calories from the three main staples (wheat, rice and maize). The United States, Canada, and much of Europe consume less than 30% of their calories from the main 3 staples (IFPRI). In lower-income countries, cereals account for a larger proportion of calories consumed because as income rises, people tend to substitute some of their cereal consumption for higher value food products (USDA). This suggests that trade in cereals is more significant for the food security of lower-income net food importing countries, because they make up a larger proportion of their calorie intake and they rely on cereal imports to meet domestic demand. It also means that shocks in the supply of these foods, for example from the Russian invasion of Ukraine on global wheat supply, and from export restrictions can have a disproportionate impact in these areas. During the peak of recent export restrictive measures, for instance, 100% of the calories consumed through food imports in the Western Sahara were subject to restrictions. Azerbaijan, Tajikistan, and Uzbekistan faced over 50% of their imported calorific intake under restriction, followed by Afghanistan, Kyrgyzstan, Georgia, and Egypt with restrictions imposed on over 40% of their imported calories. As of August 2024, 8% of globally traded supply of calories (excluding intra-EU trade) is subject to restrictions (IFPRI). The wider implications of export restrictions are explored further in the case study on export restrictions below which looks at the impact of India's export restrictions on rice.

Market concentration by exporting country

Market power in any market can have economically harmful effects on prices and supplies. If exports of agricultural commodities are heavily concentrated in one or two countries, overall market supplies could be vulnerable to country specific supply shocks. They are also vulnerable to economically or politically motivated national actions such as export restrictive measures, creating large price spikes or shortages.

Having a more diverse supply from a variety of countries is generally associated with higher levels of food security as diversity of supply spreads the risk of supply chain disruptions. However, factors such as changes to agricultural trade policy, regional weather events, and the political economic situation of leading suppliers also pose risks to supply.

Figure 1.3.3d illustrates the top three exporting countries by volume and export share for key agricultural commodities in selected time periods. These top 3 countries cumulatively made up 91% of soybean, 79% of pork, 70% of maize, 65% of rice, 48% wheat and 47% of beef exports between 2021 and 2023.

Figure 1.3.3d: Top 3 global export shares for selected commodities, MYE 2002-2004 and MYE 2021-2023

Source: [USDA PSD]

	2002 - 2004			2021 – 2023		
Commodity	**Country**	**Annual Average Exports (million tonnes)**	**Global Export Share**	**Country**	**Annual Average Exports (million tonnes)**	**Global Export Share**
Maize	United States	44.9	58.2%	United States	58.3	30.7%
	Argentina	12.2	15.9%	Brazil	41.2	21.7%
	China	10.1	13.1%	Argentina	33.6	17.7%
	Total	**67.3**	**87.2%**	**Total**	**133.1**	**70.0%**
Beef and veal	Australia	1.3	20.1%	Brazil	2.6	22.5%
	Brazil	1.2	18.5%	United States	1.5	13.1%
	United States	0.8	12.5%	India	1.4	12.0%
	Total	**3.4**	**51.1%**	**Total**	**5.5**	**47.5%**
Pigmeat	European Union	1.1	26.5%	European Union	4.8	40.1%
	Canada	0.9	22.4%	United States	3.1	26.2%
	United States	0.8	19.9%	Canada	1.5	12.4%
	Total	**2.9**	**68.7%**	**Total**	**9.4**	**78.8%**
Soybean	United States	27.5	45.3%	Brazil	85.4	52.1%
	Brazil	20.1	33.1%	United States	58.0	35.4%
	Argentina	8.3	13.7%	Paraguay	5.0	3.1%
	Total	**55.8**	**92.1%**	**Total**	**148.5**	**90.7%**
Milled rice	Thailand	8.3	29.5%	India	20.8	38.1%
	Vietnam	4.4	15.7%	Thailand	7.6	13.8%
	India	4.4	15.5%	Vietnam	7.2	13.2%
	Total	**17.1**	**60.7%**	**Total**	**35.6**	**64.8%**
Wheat	United States	27.9	25.7%	Russia	40.0	19.4%
	European Union	14.3	13.2%	European Union	32.2	15.4%
	Australia	14.0	12.9%	Australia	27.7	13.2%
	Total	**56.1**	**51.8%**	**Total**	**100.6**	**48.0%**

Note: MYE market(ing) years

Figure 1.3.3d above shows that soybean exports are more concentrated than other listed commodities, with the top 3 countries making up 91% of soybean exports on average over MYE 2021to2023. This is partly due to countries like Brazil and the US having a competitive advantage over other exporters. Higher concentration is generally viewed as presenting a greater risk to global food security, however, there are factors, such as the substitutability of the commodity which also impact the overall risk. For example, while soybeans have fewer exporters, soybean oil can be replaced by other alternatives, such as rapeseed and palm oil, which reduces the global food security risk of having a more concentrated market. Wheat on the other hand has a lower export concentration; however, it has limited alternatives, which makes its exports more sensitive to shocks as importers seek alternative suppliers, potentially resulting in sharper price increases. For other commodities the top 3 countries made up versus 79% for pork, 70% for maize, 65% for rice, 48% for wheat and 47% for beef. These percentages are generally similar to the situation twenty years earlier with the exception of maize where three countries accounted for 87%, and pork with 69%.

Over the last 20 years (MYE2002-2004 to MYE2021-2023), maize and soybeans have experienced the largest changes in export concentration between the six listed commodities. Maize exports have become more diverse due to changes in the USA's biofuels policy which was implemented in 2005 to increase energy security. While the USA continues to export maize, a significant amount is now used for domestic ethanol production. This created export opportunities for other countries, such as Brazil and Argentina. On the other hand, export shares of the two main soybean exporters, the USA and Brazil, have increased considerably. Other commodities have generally remained stable over the same period.

Given the concentration in the grain network, countries are least resilient to disruptions in such commodities (Krakoc and others, 2021). Historically, trade in grain was dominated by the USA, however, production has become more balanced, with growing exporting centres in Russia, India, France, and other countries (Wang and others, 2021). Export restrictions on grain, particularly when imposed by top exporting countries, can therefore be detrimental to food security, especially when imposed on 'thin' markets, which means there are few major exporters and trade shocks are less easily dissipated. Rice is relatively 'thin' when compared to other grains (IFPRI, 2023) with only around 10% of rice produced being traded internationally. Such restrictions limit the global supply, increasing the world price and price volatility, and reducing the affordability of these commodities. This jeopardises domestic food security, particularly for net food-importing countries. This is explored further in the case study on export restrictions below.

Forward look

Growth of agricultural trade is expected to slow down following major increase in the share of production globally traded across the last two decades. Although continued steady growth is anticipated, this may be at a lower rate than we have seen in recent decades due to the diminishing advances in trade liberalisation (OECD-FAO, 2024).

According to agricultural projections from the OECD-FAO for the period from 2023 to 2032, cereal trade (maize, wheat and rice) country shares are expected to change. Russia, a key wheat exporter, is estimated to account for 23% of global wheat exports (current average 19%) in 2032, with the EU accounting for 17% (currently 15%). Canada's share of global wheat exports is projected to increase to 13% over the same period. Maize exports are expected to grow, with the projected top five exporters in 2032 (US, Brazil, Argentina, Ukraine and Russia) estimated to account for 88% of the total trade. Asian countries will continue to dominate the rice markets, with India projected to have around 40% of the export share in 2032, Thailand 18% and Vietnam 12%.

As the world experiences the impacts of climate change, extreme weather events, such as extreme heat events, tropical storms, and wildfires, are growing in prevalence. The increased frequency of these events may, in turn, force up the world price of staples (Challinor and Benton, 2021). However, an operational global food trading system helps to maintain food security, mitigating price spikes caused by domestic weather shocks (OECD, 2023). International food security may be hindered because of increasing uncertainty which could reduce countries' willingness to export (Matzner, Meyer and Oberhofer, 2023). This has implications for countries that are heavily reliant on imports.

Case Study 2: Export restrictions

Introduction

In response to surges in global agricultural commodity prices, some countries may impose export restrictive measures (such as export bans, export quotas, export taxes) on agri-food products with the aim of insulating their respective domestic markets and consumers from the effects of international price spikes and supply-chain disruptions. Export restrictions are imposed in response to supply and price shocks, with recent years seeing the most measures imposed since the 2007 to 2008 food crisis, in response to events such as the COVID-19 pandemic and Russia's invasion of Ukraine (AMIS Policy Database, 2024). These measures exacerbate volatility in agricultural markets and drive higher global prices with the evidence on the effectiveness of domestic price stabilisation mixed. However, they do leave low-income net food importing developing countries particularly vulnerable to higher food prices (IFPRI, 2024). The restrictions imposed by India on rice exports in 2022 provide a useful case study of highlighting the implications of these measures for food security.

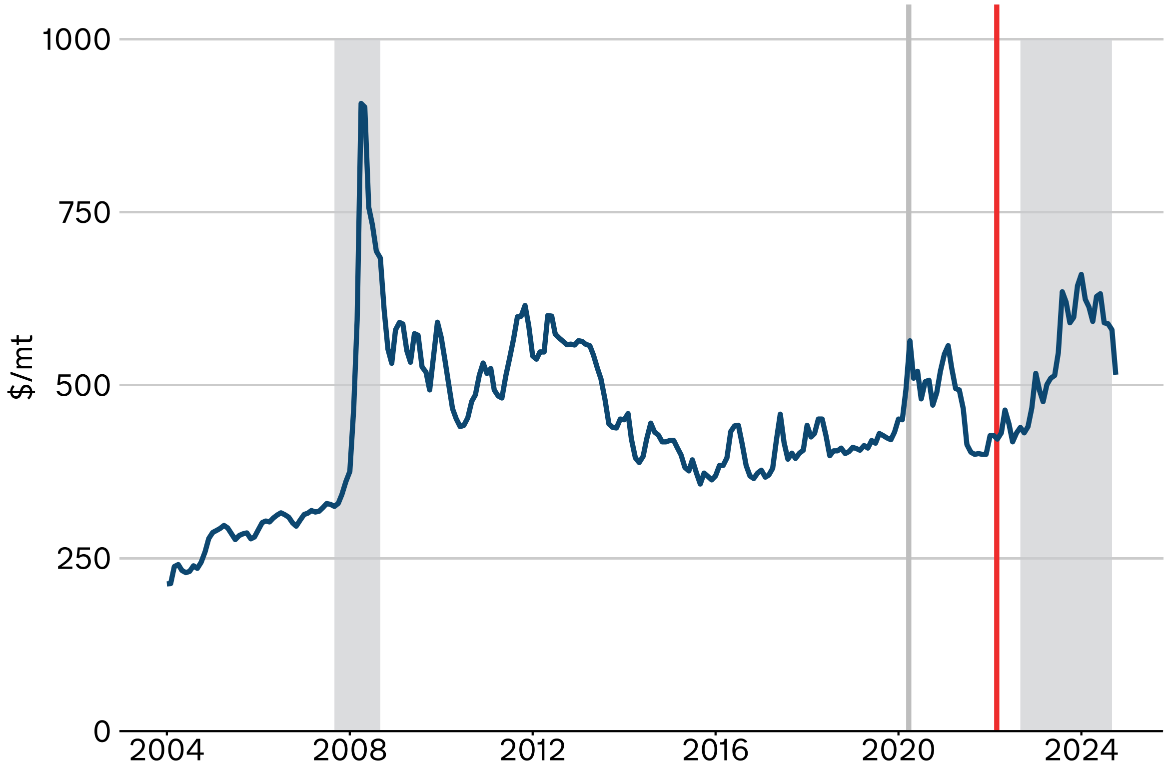
Description and analysis

Export restrictive measures are imposed to limit the volume of goods exported by a country to ensure there is sufficient supply for domestic consumption and to protect domestic markets, shielding consumers from global supply-chain disruptions and price spikes. As domestic production can no longer be exported, in theory, there should be more stable domestic supply, and consumers should benefit from lower prices relative to the global market. However, lower domestic prices can disincentivise production as gains from foreign exchange are no longer possible for domestic producers and millers, affecting their incomes and profitability (Akhter Ali and others, 2024). The WTO operates the global system of trade rules, whereby export restrictive measures are generally prohibited, except in certain circumstances for agri-food products, such as to respond to a critical food shortage (WTO, 2024).

India is among the most competitive white rice suppliers on the global market since 2020 and accounted for 40% of global rice trade in 2022, exporting more than the next four largest exporters combined (USDA, 2023). In August 2022, India banned exports of broken rice and imposed additional duties on the export of non-basmati white rice (excluding parboiled rice). This was followed by a ban on exports of non-basmati rice in July 2023 and further restrictions on basmati rice and parboiled rice in August 2023 (IFPRI, 2024). This was with the aim to stabilise domestic supply and prices but also to protect falling levels of closing public stock holdings, which fell by 8% and 5% in 2022 and 2023, respectively, from 2021 levels (USDA, 2024).

Figure 1.3.3e: Nominal monthly prices of Thai 5% white rice ($/mt), January 2004 to October 2024

Source: World Bank Pink Sheet (2024)



Note: Areas of grey indicate periods of export restrictions imposed by India. The grey line indicates the onset of the COVID-19 pandemic, and the red line marks the start of Russia's invasion of Ukraine.

India's export restrictions resulted in its rice exports falling sharply with export quotes rising significantly in response to tightened supply. Indian parboiled 5% rice quotes increased by 42% and 41% in 2022 and 2023 respectively (FAO, 2024). While in August 2023 the benchmark Thai 5% white rice price climbed to its highest level in 15 years ($635/tonne) (IFPRI, 2024) partly in response to the Indian export ban on-basmati white rice; this price level is 30% lower than its 2008 peak (Figure 1.3.3e) (World Bank, 2024).

In response to India's restrictions, importers responded by switching rice purchases to other large suppliers such as Pakistan, Vietnam, and Thailand. However, this further pushed up prices as demand outstripped the global supply of rice. Moreover, in some cases, other suppliers have struggled to sustain increased demand, putting pressure on production. This has led some smaller exporters, such as Myanmar and the Philippines, imposing their own restrictions on rice exports to mitigate against further price rises.

The sharp rises and variation in India's rice export quotes have disproportionately affected countries who are either import dependent or lower income. Of the 15 countries that imported more than 100,000 metric tonnes of rice from India in 2022, 7 were Least Developed Countries (IFPRI, 2023). Nepal and Bangladesh were hardest hit by price rises: between May 2023 and May 2024 the price of rice in Nepal rose 29% to 75 Nepalese rupees per kg, and by 10% in Sri Lanka to 210 Sri Lankan Rupees per kg (FAO, 2024). Both countries are heavily dependent on Indian rice imports with high proportions of daily calorie consumption coming from rice. In Sri Lanka, an average of 41% of per capita daily calories comes from rice (IFPRI, 2024).

Supply-side factors, particularly weather events, such as those associated with El Niño and La Niña, have also affected production and planting decisions, though exports from Pakistan, the USA and Myanmar have increased (by approximately 2 million metric tonnes) between June 2023 and May 2024 compared to the previous year over the same period (IFPRI, 2024).

Conclusion

Ensuring stable and predictable agri-food markets, and allowing agri-food trade to flow, plays an important role in global food security.

India's export restrictions on rice have contributed to a considerable disruption in global rice markets. The benchmark Thai 5% white rice price increased by over 20% by August 2023, in nominal terms, and has since remained at those elevated levels (around $600 per mt). As noted, this has caused particular food security challenges for low-income and import-dependent developing countries.

Following on from report of record-high stock levels, the Indian government lifted the export ban on non-basmati rice and imposed a minimum export price on 28 September 2024, which it subsequently removed (DGTF, 2024). Rice prices hit a one-year low with month-on-month prices in October falling by 11.2% due to limited buying interest ahead of upcoming harvests.

Given the importance of India as a rice producer and exporter, these changes are likely to help to reduce and stabilise global rice prices, in turn easing inflationary pressures on importing countries (IFPRI, 2024).

Case Study 3: The role of maritime trade chokepoints in global food security

Introduction

As around 80% of the volume of global trade is transported through oceans (UNCTAD, 2024), maritime chokepoints play an essential role in facilitating international trade by serving as critical waterways connecting larger areas. Geopolitical tensions and conflict have recently disrupted the flow of goods and services in some of these straits where high volumes of traffic converge, leading to shortages and increases in production costs. The recent events in the Black Sea and Red Sea present illustrative examples of how disruptions at strategic trade chokepoints can lead to different short-term and longer-term impacts on global trade and food security.

Description and Analysis

Black Sea: Restrictions imposed by Russian forces on the Ukrainian fleet from using the Black Sea when the war started in February 2022 led to a fall in traffic through the Turkish Straits and a subsequent rise in global commodity prices, particularly across grains. Before the start of the war, over 20% and 15% of global wheat and maize exports, respectively, used the Turkish Straits (Chatham House, 2024). By April 2022, two months into the war, wheat and maize prices rose by 58% and 38%, respectively (AMIS, 2022).

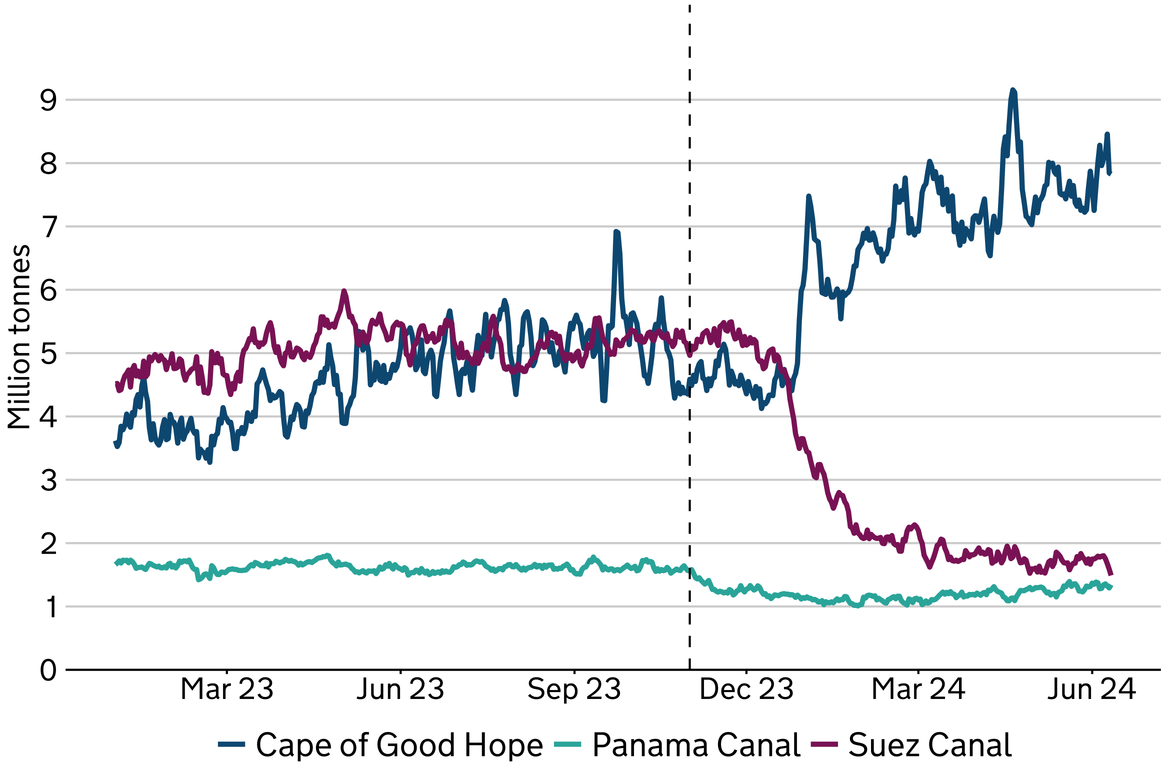
The significant rise in prices contributed to food inflation, particularly in developing countries which faced a 'double burden' after both the US dollar and price of grain rose sharply, leading to significant increases in import prices and inflationary pressure on importing economies (UNCTAD, 2022). The case of Egypt, a major wheat importer, is explored further in the case study on the role of exchange rates on food prices in Egypt. This situation was exacerbated by sharp increases in the price of gas in Europe, where prices reached around $70/ Million Metric British Thermal Units (mmbtu) while US gas prices remained under $10/mmbtu in August 2022 (IEA, 2022). This led to higher fertiliser prices (an 87.7% increase year on year) and overall increases to the cost of grain inputs (AMIS, 2022). Some of the global pressure on price was alleviated by the Black Sea Grain Initiative which allowed nearly 3 million tonnes of commodities, including grain and fertiliser, to be exported to other countries.

However, while restrictions in the Black Sea led to some disruptions to the price of grains, which affected some countries significantly, larger impacts on the price of grains were caused by the conflict between the two major wheat and maize exporters, which affected levels of Ukrainian production and exports. The harvested area in Ukraine for wheat, corn and barley declined by 32%, 23% and 37%, respectively between 2021 to 2022 and 2023 to 2024 (USDA, 2024).

Red Sea:

Figure 1.3.3f: Daily transit trade volume at selected chokepoints, tonnes, January 2023 to June 2024

Source: IMF Portmonitor (2024)



Note: Dashed line indicates start of Houthi attacks

Deliberate attacks by Houthis on shipping vessels in the Suez Canal in Egypt in November 2023 affected an area responsible for around 12% to 15% of global trade, leading to a number of significant supply-chain disruptions, particularly in the shipping industry (UNCTAD, 2024). Transits originally planned to pass through the conflict zone were diverted to the Cape of Good Hope, which led to higher transportation costs and delays of more than 10 days (Kamali and others, 2024). In the first two months of 2024, the volume of trade passing through the Suez Canal fell by 50%, leading to a 74% increase in the volume of trade passing through the Cape of Good Hope over the same period in comparison to the previous year (Figure 1.3.3f).

The attack and diversion of transits led to a wide range of price increases. Container prices were affected by the attack (see Figure 1.3.2a in Indicator 1.3.2), as were insurance premiums which rose sharply following the increase in risk. The expansion of the Houthi attacks to other areas, such as in the Indian ocean, created additional challenges for the shipping industry, with price implications for rice. As the quotations for Asia – Europe containerised shipping increased by up to six times, large rice exporters including India, Thailand and Vietnam, which use the Red Sea as their main route for exporters saw increases in rice prices, a commodity primarily shipped in containers (AMIS, 2024).

Conclusion

Recent events in the Black Sea and Red Sea show the role of maritime chokepoints in catalysing global supply chain disruptions. While these examples outline some of the short-term disruptions to global trade following these incidents, they also highlight the overall resilience of the global trading system, which has found alternatives. It is worth noting that these issues have been exacerbated by recent weather events and climate change, which have affected other important maritime chokepoints such as the Panama Canal and Rhine River. However, the UK is expected to only be significantly negatively affected by chokepoints where the disruption affects products where Europe is a net importer. The prospect of multiple chokepoints facing difficulties, remains a scenario to be monitored for its exact effect on food security.

Sub-theme 4: Global food and nutrition insecurity

1.4.1 Global food and nutrition insecurity

Rationale

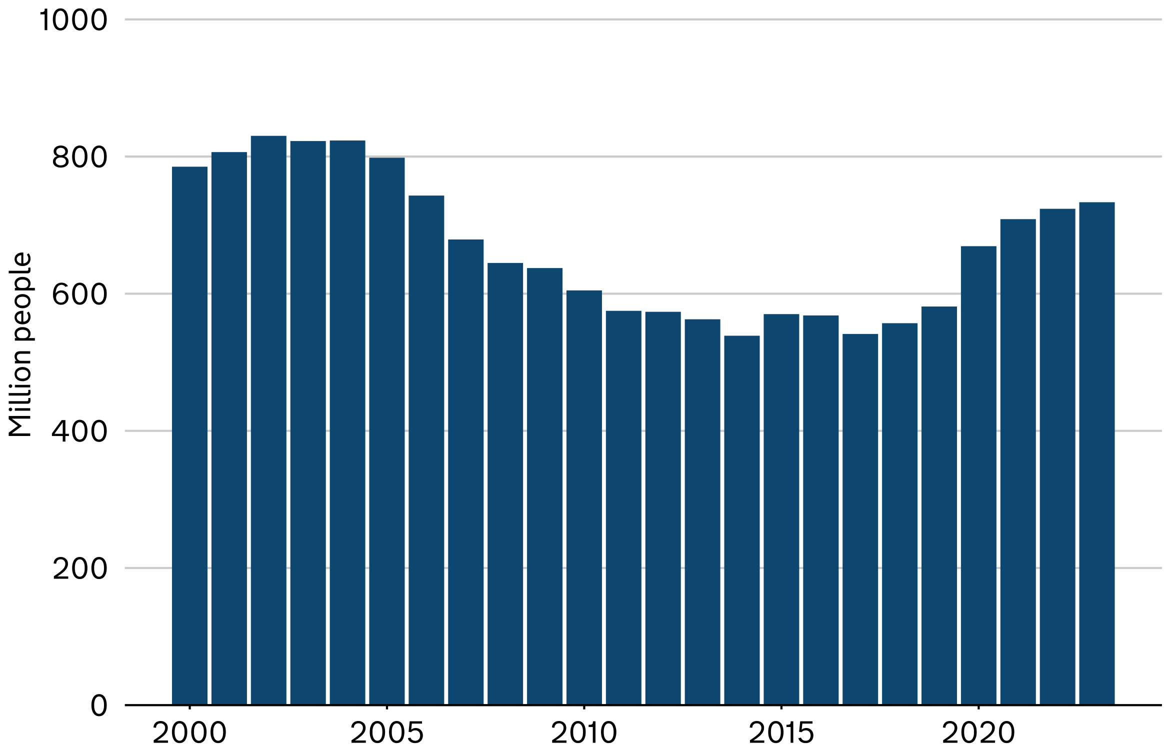
The following indicators provide some measure of the ‘access’ and ‘utilisation’ dimensions of global food security to complement the preceding analysis primarily focused on global food availability. By considering these in tandem with each other, and with the understanding that they only present part of global food accessibility and utilisation, they highlight ongoing issues in the distribution of global food production.

The headline data set shows the prevalence of undernourishment across the world, which is most prevalent in low-income countries, and is a useful indicator of global food insecurity. Here ‘undernourishment’ means that a person’s regular food consumption over a year was insufficient to maintain a normal, active and healthy life. It provides an indication of how global and national food production is distributed and the extent to which populations can access food.

Headline evidence

Figure 1.4.1a: Number of undernourished people, World, 2000 to 2023

Source: FAOSTAT, 2023 (SDG2.1.1)



It is estimated that there were 733 million people in the world living with undernourishment in 2023, equivalent to 152 million people more than in 2019. By region, Asia is home to more than half of the world's population with undernourishment (384.5 million). In Africa, 298.4 million people may have faced hunger in 2023.

The prevalence of undernourishment (PoU), a measure of hunger used to assess progress towards SDG Target 2.1, decreased between 2005 and 2017. However, since 2018 levels have been increasing. A substantial rise in global PoU occurred during the COVID-19 pandemic. The proportion of people with chronic undernourishment in the world rose from 7.5% in 2019 to an estimated 9% in 2021. Subsequently the global PoU has remained relatively static, with the most recent estimates showing a PoU of 9.1% in 2023, which is indicative of a lack of progress in recent years towards achieving SDG 2 'Zero Hunger'. Africa is the region with the largest PoU (20.4%). In comparison 8.1% in Asia, 6.2% in Latin America and the Caribbean, and 7.3% of people in Oceania were PoU (FAO; IFAD; The United Nations International Children's Emergency Fund (UNICEF); WFP ;WHO, 2024).

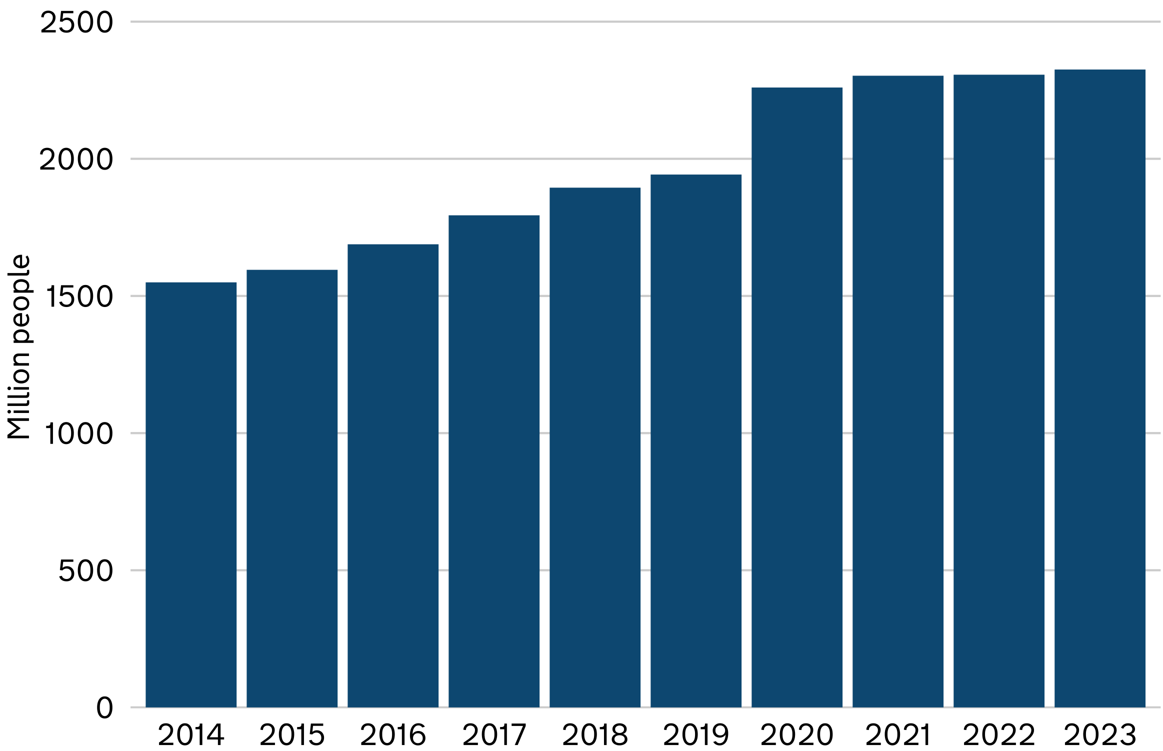
While there has been some progress, improvements have been uneven. From 2021 to 2023, progress was made towards reducing hunger in Latin America and the Caribbean and is relatively unchanged in Asia. However, hunger has been on the rise in Africa between 2015 and 2023. In all regions, the prevalence of undernourishment is still above pre-COVID-19 pandemic levels. High and persistent inequalities continue to drive hunger around the world.

Supporting evidence

Moderate or severe food insecurity

Figure 1.4.1b: Number of moderately or severely food insecure people, World, 2014 to 2023

Source: FAO, 2023 (SDG 2.1.2)



The prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES), is the second indicator of food access used to measure global food insecurity and track progress towards the realisation of SDG target 2.1. People experiencing moderate food insecurity have reduced the quality and/ or quantity of their food and are uncertain about their ability to obtain food due to lack of money or other resources. People experiencing severe food insecurity have run out of food and, at the most extreme, have gone days without eating (FAO).

In 2023, the prevalence of moderate or severe food insecurity in the population was estimated at 28.9% (FAO ; IFAD ; UNICEF ; WFP ; WHO, 2024). In other words, in 2023 there were an estimated 2.326 billion people in the world without access to adequate food (Figure 1.4.1b). The number of people experiencing moderate or severe food insecurity has been rising since 2014, with a notable rise occurring in 2020 due to the COVID-19 pandemic, when an additional 317 million were found to be facing moderate or severe food insecurity compared to 2019. Since then, the number of moderately or severely food insecure people in the world has increased by close to 66 million, while the prevalence has remained broadly stable owing to population growth (FAO ; IFAD ; UNICEF ; WFP ; WHO, 2024).

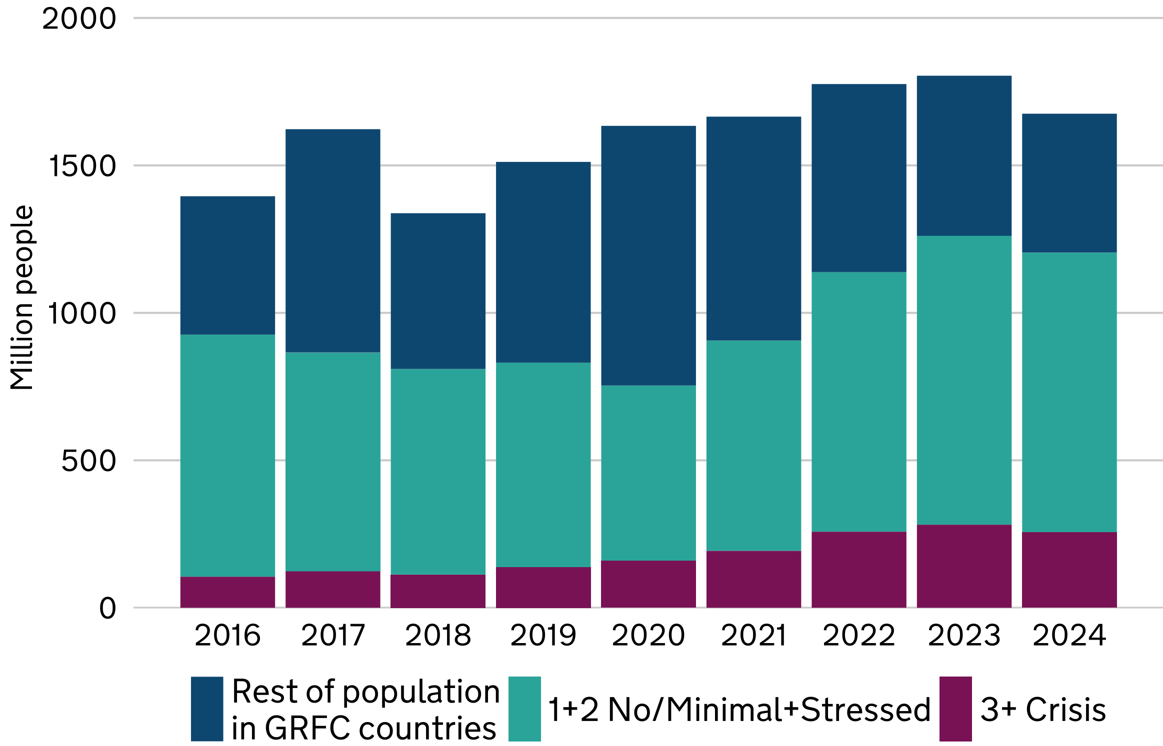
Breaking this down by region, the prevalence of moderate or severe food insecurity in Africa was 58.0%. This was nearly double the global average. In Asia, Latin America, the Caribbean, and Oceania, the prevalence is closer to the global average estimate. The prevalence remained virtually unchanged between 2022 and 2023 in Africa, Asia, and Northern America and Europe, and worsened in Oceania. However notable progress was made in Latin America.

Acute food insecurity

While the previous two indicators are considered as measures of chronic food insecurity, acute food insecurity can be regarded as a more transitory manifestation of food insecurity (that is reflecting a shorter-term or more temporary inability to meet dietary energy requirements), but that is of a severity that threatens lives, livelihoods or both (Global Network Against Food Crises, 2024; FAO ; IFAD ; UNICEF ; WFP ; WHO, 2023). While the indicators of chronic food insecurity described above are available at the global level, data on acute food insecurity reported in the Global Report on Food Crisis (GRFC) is only provided for a limited number of countries and territories that are identified as being in food crisis (Global Network Against Food Crises, 2024; see also FAO ; IFAD ; UNICEF ; WFP ; WHO, 2023: box 1. Also see boxes 2 and 8 for further details on conceptual, geographical and methodological differences between measures of chronic food insecurity and acute food insecurity as well as brief analyses).

Figure 1.4.1c: Number of people and share of analysed population in GRFC countries/territories facing high levels of acute food insecurity, 2016 to 2024

Source: IPC/CH, FEWSNET and WFP – Food Security Information Network



The Integrated Food Security Phase Classification provides a classification of 5 levels of food insecurity, where levels 3 and above ('3 Crisis,' '4 Emergency' and '5 Catastrophe/Famine') indicate a high level of acute food insecurity. 'Crisis' is defined as experiencing high levels of acute food insecurity requiring urgent food and livelihood assistance. The number of people facing high levels of acute food insecurity has steadily risen between 2018 and 2023 (Figure 1.4.1c). In 2023, 281.6 million people were facing high levels of acute food insecurity, close to 2.5 times more than in 2018 (Global Network Against Food Crises, 2024).

The 2024 GRFC identified 59 food-crisis countries and territories in 2023, of which 36 were classified as protracted food crises as they required emergency assistance and had evidence of populations facing acute food insecurity in all editions of the GRFC, which has been published since 2016 (Global Network Against Food Crises, 2024). In 2023, the prevalence of high acute food insecurity was 21.5% of the analysed population, representing a slight decrease compared to the peak of 22.7% recorded in 2022 (in 58 countries and territories). However, this was a 5 pp increase compared to pre-COVID- 19 pandemic levels and over 10 pp above the prevalence recorded in 2016 (when 48 countries were analysed).

The GRFC data and analysis highlights how economic shocks, conflict and weather extremes are the primary drivers of high acute food insecurity. In 2023, economic shocks were found to be the primary driver of high acute food insecurity for 21 of the 59 countries analysed (affecting 75.2 million people). Conflict and insecurity were the primary drivers identified for 20 countries (affecting 134.5 million people). Finally, weather and extreme events was the primary driver in 18 countries (affecting 71.9 million people). These events are driving an increase in the number of displaced people in countries experiencing food crises: 90.2 million people were displaced across the 59 countries covered by the GRFC in 2023, an increase of 13.6 million people since 2021.

Further information on the data underpinning the GRFC can be found here: GRFC Technical Notes.

Child malnutrition

Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/ or nutrients (WHO, 2024).The three main indicators of child malnutrition, tracked by the Joint Child Malnutrition Estimates, 2023, are stunting (too short for one's age), wasting (too thin for one's height) and living with overweight (too heavy for one's height). These remain an ongoing issue for children around the world.

The prevalence of children under 5 years of age affected by stunting has fallen since 2000 (from 33.0% to 22.3% in 2022), with a decrease of 0.4 pp between 2020 and 2022. However, there were still over 148 million children under 5 in the world that were affected by stunting in 2022. Stunting is regionally concentrated, with Asia (52%) and Africa (43%) making up 95% of total global cases.

The prevalence of children under 5 experiencing wasting has also fallen between 2000 and 2022, albeit at a slower pace (1.9 pp reduction over the period and virtually no change since 2020). In 2022, 45 million children under 5 were affected by wasting, corresponding to 6.8% of the under 5 population in the world. Most children under 5 who experience wasting live in either Asia (70%) or Africa (27%). Child malnutrition is directly affected by maternal nutrition, with long-term health consequences including higher risks of children being wasted, stunted, or both.

In addition, the number of children who are living with overweight under the age of 5 continues to increase. The prevalence of children under 5 who are living with overweight has increased by 0.3 pp to 5.6% between 2000 and 2022. While the large majority of the children under 5 affected by overweight live in Asia (48% of the global under 5 population living with overweight) and Africa (28%), the highest rates of prevalence are found in Australia and New Zealand at 19.3% in 2022.

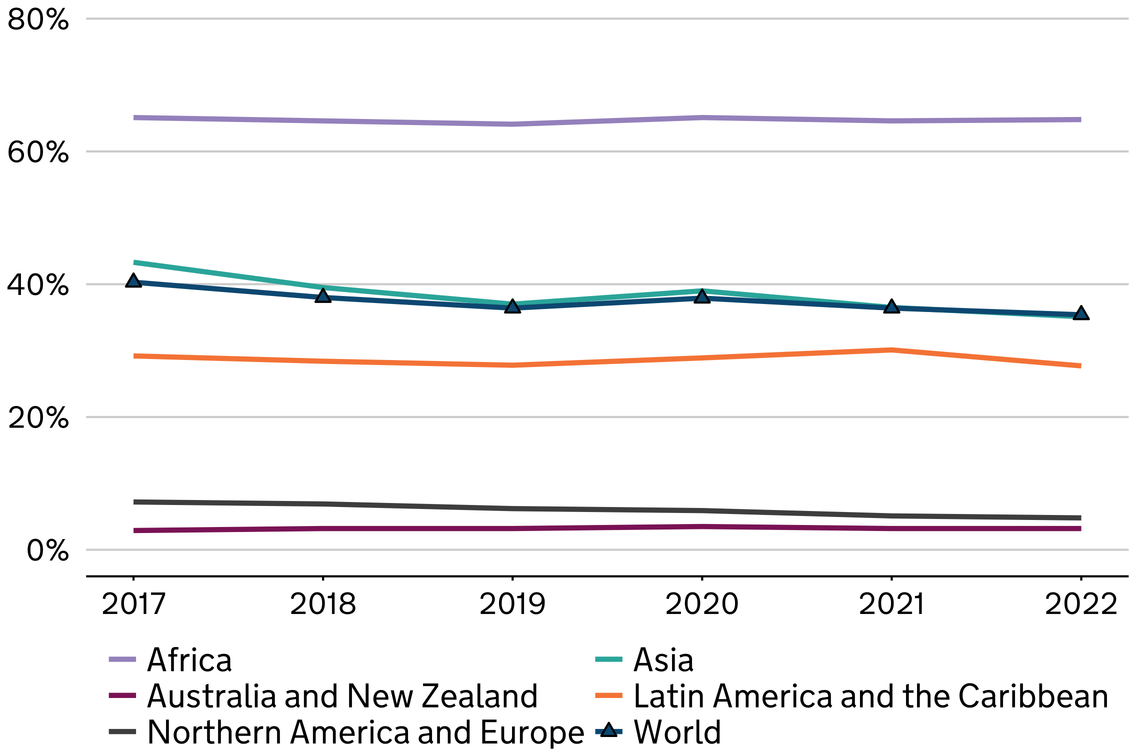
Adults and children living with obesity

Obesity is another component of malnutrition and can negatively affect a person's health. It is important to track given the continuation of a longer term rapidly rising trend in global rates of people living with obesity. Adult obesity rates more than doubled between 1990 and 2022 reaching around 16% of the adult world population. Over this period adolescent obesity quadrupled. In 1990, 2% of children and adolescents aged 5 – 19 were living with obesity. By 2022, 8% of children and adolescents were living with obesity (160 million). In most cases obesity is caused by environmental factors, such as limited availability of healthy sustainable food at locally affordable prices, lack of safe and easy physical mobility into daily life, and absence of adequate legal and regulatory environment. See Theme 4 (Indicator 4.3.2 Healthy diet) for analysis of the number of people who are living with obesity on the UK level. The global food system therefore exhibits negative trends on both ends of the spectrum, underconsumption and overconsumption.

Affordability of a healthy diet

Figure 1.4.1d: Percentage of the population unable to afford a healthy diet, 2017 to 2022

Source: CoAHD, FAO and World Bank, 2024



Between 2019 and 2022, the percentage of the global population that was unable to afford a healthy diet fell from 36.4% to 35.4% (Figure 1.4.1d), where 'healthy diet' is defined using a global standard Healthy Diet Basket (HDB). The HDB is based on 10 regional food based dietary guidelines (FBDG), in themselves summaries of national FBDGs that countries have developed to reflect their locally available foods and cultural context. The HDB is designed to meet a dietary intake of 2330 kcal per day (FAO ; IFAD ; UNICEF ; WFP ; WHO, 2024, annex 1B). In 2022, the highest proportions were found in Africa (64.8%), Asia (35.1%) and Latin America and the Caribbean (27.7%), The lowest proportions were found in the developed economies of North America and Europe (4.8%) and Australia and New Zealand (3.2%). It was 2.5% in the UK in 2022 (FAOSTAT, 2024).

Forward look

Projections from the 2024 SOFI report show that the global aim of eradicating hunger by 2030 is unlikely to be achieved (FAO ; IFAD ; UNICEF ; WFP ; WHO, 2024). By 2030, it is projected there will be 582 million people with chronic undernourishment (6.8% of the global population). Among regions with a PoU above 2.5%, Asia is projected to see a drop in the number of people with undernourishment during the second half of the decade, and in Latin America and the Caribbean the number of people with undernourishment are expected to continue to reduce but at a much slower pace. In Africa, the number of people living with undernourishment is projected to reach 308.1 million by 2030, rendering it the region with the highest number of people with undernourishment in the world.

In terms of the indicators used to track progress towards global nutrition targets for children under 5 years of age, stunting and wasting prevalence are projected to continue to decline, but at a pace insufficient to meet the 2030 targets, and the prevalence of overweight children under the age of 5 is projected to remain broadly stable reaching 5.7% by 2030, which is close to double the 3% target (Figure 10-SOFI, 2024). Underlying this, more countries are off-track than on-track to meet the 2030 stunting and overweight targets. For instance, according to the Joint Child Malnutrition Estimates, 2023, less than one-third of countries (29%) are on track to reach the SDG target of halving the rate of stunting. The annual average rate of reduction (AARR) would need to increase from the current 1.65% AARR (based on the 2012-2022 period) to 6.08% AARR between 2022 and 2030 to achieve the target of 13.5% of children under 5 affected by stunting. While a larger number of countries among those assessed are considered on-track (68 countries) than off-track (55 countries) to meet the wasting target, the majority of children under 5 years of age live in the latter group of countries (Figure 11-SOFI, 2024).

OECD-FAO project the daily per capita calorie intake (consumption net of household waste) to have the largest rise in developing and emerging economies between 2024 and 2033 (OECD-FAO, 2024 Figure 1.8). They correlate this with a modest increase in food intake in low-income countries (positive economic growth will be accompanied with ever growing population sizes). However, global diversification of diets remains slow due to income constraints and cultural preferences. In the same period, the share of dietary energy from nutrient-rich animal products, fruits and vegetables in middle-income countries is projected to increase by around 1%. This share is projected to be unchanged for low-income countries meaning the bulk of calories (71%) would continue to be provided through staple foods.

Sub-theme 5: Sustainability

1.5.1 Global land degradation

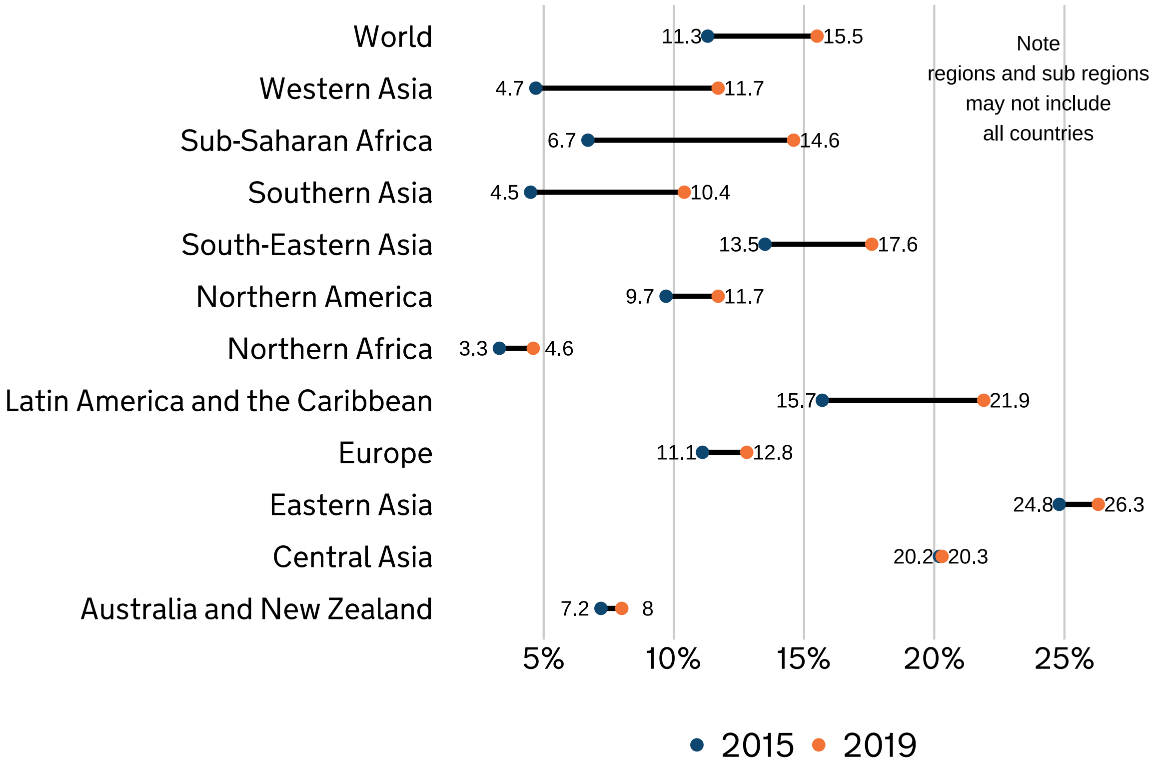
Rationale

This indicator shows the proportion of land which is degraded by region. Land degradation is defined as ‘the reduction or loss of the biological or economic productivity and complexity of rain fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from a combination of pressures, including land use and management practices’ (United Nations Convention to Combat Desertification (UNCCD, 1994). Given the dependence of food production and crop yield growth on productive land, land degradation has a direct implication for food security.

Headline evidence

Figure 1.5.1a: Proportion of land that is degraded over total land area in 2015 to 2019

Source: UN SDG 15.3.1



Note: based on 115 country-generated data values and 52 estimates generated by the United Nations Convention to Combat Desertification (UNCCD). Data is missing for some countries, including the United States of America and Russia.

Between 2015 and 2019 the amount of land globally which was reported as being degraded increased by 4.2 pp, from 11.3% to 15.5% (see Figure 1.5.1a). All regions saw an increase in land degradation between 2015 and 2019. In 2019, the region with the largest proportion of degraded land was Eastern Asia (26.3%), while Northern Africa remained the region with the lowest share of degraded land (4.6%). The biggest increases occurred in Sub-Saharan Africa (from 6.7% in 2015 to 14.6% in 2019), Western Asia (from 4.7% to 11.7%), and Latin America and the Caribbean (15.7% to 21.9%).

Supporting evidence

Figure 1.5.1b: Global area of agricultural land degraded, deteriorating and at risk, 2021

Source: FAO State of Land and Water report in 2021

Crop		Degraded		Deteriorated		At Risk	
	Total - Mha	Area - Mha	%	Area - Mha	%	Area - Mha	%
Cropland	1527	479	31%	268	18%	472	31%
of which:							
Rainfed	1212	340	28%	212	17%	322	27%
Irrigated	315	139	44%	57	18%	151	48%
Grassland	1910	246	13%	642	34%	660	35%

Available evidence suggests that land is currently degrading faster than it can be restored, and agriculture plays a disproportionate role as the largest single source of land and environmental degradation. Food systems are responsible for 80% of land conversion (UNCCD, 2022). The FAO State of Land and Water report (SOLAW) in 2021 assessed land degradation by combining data across four categories (soil, water, vegetation and demography) and found that 43% of land globally was affected by a deterioration of status and 13% of land degradation was human-induced based on a 2015 assessment. The report also found that almost all inhabited parts of the world were subject to some form of human-induced land degradation, with areas affected by human-induced land degradation covering 1,660 Mha (million hectares), of which 850 Mha was moderately to severely degraded and 810 Mha slightly degraded. Grazing occurred in 75% of the identified regions, followed by accessibility; where human-induced land degradation has occurred due to proximity to an urban area (71%) and agricultural expansion (64%) (Figure 7, FAO, 2021). Figure 1.5.1b (see above) shows that 80% of cropland and 82% of grassland was degraded, deteriorating or at risk of doing so. Across cropland, the percentage of irrigated cropland that is degraded was nearly 60% greater (44% or 57Mha) than that of rainfed cropland (28% or 212 Mha), generally due to good accessibility and high grazing density exerting significant pressures on irrigated fields.

Agricultural land degradation undermines global food security. Agriculture is the leading cause of soil degradation, which forms an important component of land degradation. Healthy soils are essential for long-term sustainable agricultural productivity, food and nutrition security, yet one third of soil globally is already degraded, reducing the quality and quantity of crops and food produced (FAO).The leading causes of soil degradation are agricultural intensification through excessive and mis-use of chemical inputs, such as fertilisers, pesticides, antibiotics and lime, the negative effects of which are discussed in Indicator 1.2.3 Global fertiliser production. Monoculture production systems, repeat soil disturbance, deforestation, of which agriculture is the leading driver, and climate change also drive soil degradation. Agricultural land degradation is also associated with pollinator decline (Dicks and others, 2021; Potts and others, 2010; UNEP, 2010) and water-related issues, which are covered in further detail in Indicators 1.2.4 Water availability, usage and quality for global agriculture and 1.5.2 Global One Health respectively. A further consideration regarding land degradation is the impact of land use change, covered in Indicator 1.2.2 Global land use change.

Land restoration

Restoring land is associated with greater food security, as land becomes more productive and able to provide for growth in global food demand, while reducing GHG emissions and environmental impacts, in addition to economic benefits (WRI, 2023; UNCCD, 2022). The United Nations SDG 15.3.1 tracks progress towards achieving land degradation neutrality (LDN), “a state whereby the amount and quality of land resources necessary to support ecosystem functions and services to enhance food security remain stable, or increase, within specified temporal and spatial scales and ecosystems.” 196 countries are aiming to achieve LDN by 2030 (UNCCD, 2024), which, if current trends continue, would require 1.5 billion hectares of degraded land to be restored by 2030 to achieve land degradation neutrality around the globe (UNCCD, 2024).

Some countries have had success in restoring their land. The Dominican Republic and Botswana saw the proportion of degraded land decrease from 49% to 31% and from 36% to 17%, respectively, between 2015 and 2019 (UNCCD,2024). Similarly, over the period from 2011 to 2020 Costa Rica made around 48% progress towards reaching its national goal of restoring 1 million hectares by 2030 (Nello, Rivera and Putzeys, 2023).

1.5.2 Global One Health

Rationale

This indicator tracks risks to global One Health. The One Health approach recognises that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent (WHO).

Traditionally, plant and animal health risks have been analysed in isolation. Taking a One Health approach means that animal or plant pests and diseases can be assessed holistically. For example, the 2014-2016 outbreak of Ebola in West Africa (CDC, 2024) would have had a higher effect on the overall food security in

West Africa (FAO, 2016) than Foot and Mouth Disease which is endemic in the region. Similarly, other risks such as natural hazards, and water supply and safety could affect the health of workers in the food supply chain which in turn could affect food security.

Common One Health issues threatening people, animal and the environment include endemic zoonotic diseases, vector-borne diseases, antimicrobial resistance, food safety, environmental contamination and climate change. This indicator focuses on animal and plant health, antimicrobial resistance, and the health of ecosystems (assessed through biodiversity) (CDC, 2024). The Global One Health Index Food Security (GOHI-FS) is then used to assess current global One Health status. Other aspects of One Health are covered elsewhere in this report, for instance in Indicator 1.2.4 Water availability, usage and quality for global agriculture, and Theme 5 Food Safety and Consumer Confidence.

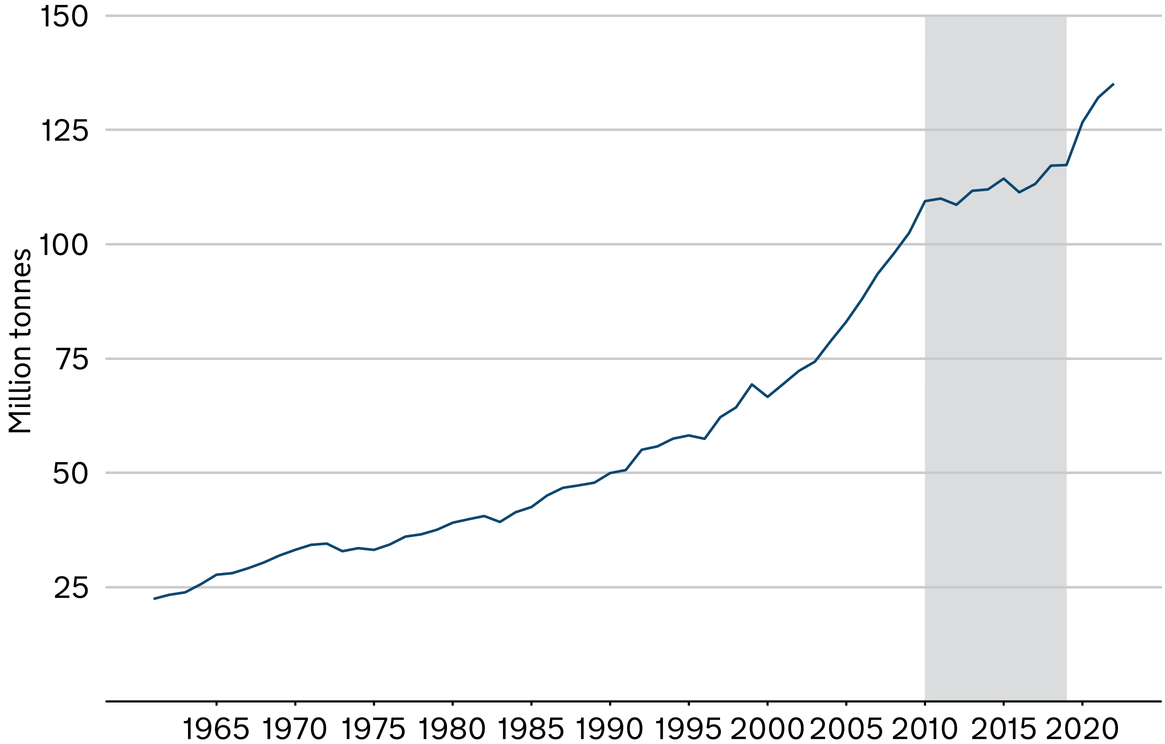
Pests and disease cause food production losses around the world, with potential for outbreaks to limit the availability of important crops. Measuring the global impact of crop disease is complex and beyond the scope of this report. However, the effect of individual pests and disease on crop production is well documented. This indicator covers two significant global plant pest and diseases threatening food security according to the International Plant Protection Convention (IPPC). Banana Fusarium Tropical Race 4 (TR4) threatens bananas while Fall Armyworm (FAW) threatens maize.

Headline evidence

Fusarium Wilt of Banana

Figure 1.5.2a: Global banana production, tonnes, 1961 to 2022

Source: [FAOSTAT Crops and livestock production, 2024]



Bananas are among the most produced, traded and consumed fruits in the world and are particularly important to some of the least developed, food deficit countries, where they contribute to both household food security and income generation (FAO, 2024). In the UK, households purchased more bananas than any other type of fresh fruit in 2021 and 2022 (Defra, 2024). Details of UK banana imports can be found in Theme 2 (Indicator 2.1.4 Fruits and vegetables).

Fusarium wilt of banana (FWB) is a disease that has previously posed a significant risk to banana production. FWB is very difficult to control and caused the collapse of the banana industry in the mid-twentieth century, when production was based on the Gros Michel cultivar. Gros Michel was replaced with a resistant cultivar, Cavendish, which is now the most prevalent commercial banana and commonly grown in large monocultures. However, a new strain of FWB called Tropical Race 4 (TR4) affects the Cavendish varieties and can result in the loss of the entire crop on plantations. Its effect on global banana production is visible in the limited growth in banana production between 2011 and 2019 (Figure 1.5.2a) (rising by only 6.8%). Growth in banana production has returned and increased by 15%

between 2017 and 2022. However, TR4 still represents a significant risk to food and income security in communities where bananas are grown. The IPPC Secretariat has been coordinating global efforts to prevent the spread and impact of TR4. The three main control strategies are to use varieties with disease resistance and consumer acceptance, maintain good soil health management practices, and use agronomic practices (CGIAR). Banana growers are increasingly managing TR4 by applying beneficial microorganisms and organic fertilisers in combination with resistant varieties.

Fall Armyworm (FAW)

FAW is a notable plant pest that feeds mainly on maize, as well as 80 other crops. FAW has the potential to spread rapidly worldwide and is a threat to global food security, affecting over 70 countries and regions. Based on FAO estimates from 12 African countries, up to 17.7 million tonnes of maize could be lost annually due to FAW, equivalent to USD 2.5 to 6.2 billion, and enough to feed tens of millions of people. Once established in a new territory, FAW is impossible to eradicate. The IPPC are coordinating global efforts to control its spread (IPCC). A map of the spread of FAW between 2016 and July 2024 can be found here (FAO).

Animal diseases

Animal diseases carry a potential threat to the supply of meat and livestock related foods. Several animal diseases directly result in the animal's death, or the animal being culled for the purpose of disease control. Moreover, animal diseases carry additional risks in terms of zoonotic diseases which have the potential to transmit to the human population.

Animal diseases are also associated with significant reduction in global livestock productivity. Industry groups estimate that in 2018 animal diseases caused global poultry production to fall by 2.8 million tonnes, and in low-income countries poultry production levels were likely reduced by up to 22%. Similarly, global egg production was likely reduced by 3 million tonnes, equivalent to losses worth 5.6 billion US dollars, a figure which is four times the size of the UK egg market in 2018 (Health for Animals, 2023).

Disease outbreaks can have a marked effect on the animal population of individual countries. For instance, an outbreak of African Swine Fever (ASF) in Southeast Asia and China between 2018 and 2020 resulted in a 238 million decrease in the pig population in China. Despite this the UK has not experienced significant effects on its meat supply in recent years (this is explored further in Theme 2 (Indicator 2.1.3 Livestock and poultry products (meat, eggs and dairy)). UK Government regularly monitors outbreaks of animal diseases internationally, to assess whether there is an increased risk to the UK. Risk assessments on the current disease risk can be found here (Health for Animals, 2023). Notable diseases of current interest to the UK include African Swine Fever, Avian Influenza and Bluetongue. The UK adopts a One Health approach to managing zoonotic disease through the Human Animal Infections and Risk Surveillance group (HAIRS).

Overall

Overall, this indicator shows ongoing One Health challenges. Notable cases of pests and diseases pose risks of food production losses on a large scale. The average global population of observed vertebrate species continues to decline, and climate change raises risks to animal and plant health (see supporting evidence).

Supporting evidence

Antimicrobial Usage

Antimicrobials (AMR) are key to treating diseases in food-producing animals and plants. The use of antimicrobials helps to maintain food production by limiting the spread of disease. However, an overuse of antimicrobials can lead to antimicrobial resistance, which is a growing issue. The recommended strategy by the World Organisation for Animal Health (WOAH) is to prevent disease and use antimicrobials responsibly.

WOAH estimates that AMR Usage could have been as high as 88,927 tonnes in 2021. It is estimated that there was an overall global increase of 2% in mg/kg, moving from 107.3 mg/kg in 2019 to 109.7 mg/kg in 2021. While a decreased usage was observed in the Americas (−9%), Europe (−6%) and Asia and the Pacific (−0.7%), there was a sharp rise in reported usage in Africa (+179%) (WOAH, 2024).

Some classes of antimicrobial reported larger rises than others. For instance, between 2019 and 2021 it was estimated there was a 10% increase in tetracyclines (the most used antimicrobial class in animal health), a 12% increase in penicillin, and a 19% increase in macrolides). Tetracyclines and penicillin are part of the Veterinary Critically Important Antimicrobial (VCIA) classes in WOAH's List of Antimicrobials of Veterinary Importance and represent 36% and13% of global antimicrobial use in animals respectively, but neither is listed among the highest priority critically important antimicrobial agents for human health, by WHO. Antibiotics on the WHO critically important list account for under 4% of antibiotic usage in animals (WOAH, 2024).

In the eighth round of WOAH Antimicrobial Usage Report (AMU), 24% of respondents said they were using antimicrobials for growth promotion. This does not represent responsible use. The highest proportion of participants using antimicrobials as growth promoters was in the Americas (WOAH, 2024). It is important to maintain antimicrobials as an effective disease control measure to maintain food security.

Fungicides and pesticides are widely used in crop production. These are applied directly to the environment and if overused can lead to the development of resistant microbes. Fungicide use has increased globally since 1990, rising by 75% between 1990 and 2022. The global estimate (self-reported by countries) of pesticides used in agriculture was 3,690,935 tonnes, of which 793,923 tonnes (21.5%) were fungicides and bactericides in 2022 (FAOSTAT, 2024).

The emergence of novel pathogens presents a challenge to food security. For instance, cultivars still have no natural immunity to a strain of stem rust that emerged in Uganda (Ug99) in 1998 (Lidwell-Durnin and Lapthorn, 2020). There will be further challenges should new strains of disease emerge faster than crops can be bred to develop immunity.

Health of the Ecosystem

Biodiversity is the range and variety of Earth's plants, animals and micro-organisms and is integral to the health of the ecosystem and to global food security. Forests, grasslands, inland wetlands, and marine and coastal ecosystems can all provide a range of services to food production and agriculture. Benefits include regulating the flow of water, improving air quality, binding carbon, and therefore helping to reduce the threat posed by climate change, and providing protection against extreme events, such as storms and floods. Equally, they provide a habitat for species that contribute to food supplies. Countless species of invertebrates and micro-organisms are essential to the fertility of soils upon which crops and livestock depend. Similarly, a variety of different species help to control pests and parasites that threaten food-producing plants and animals.

Pollinators support the yields of 75% of the world's food crops, and 35% of food production by weight (heavier staple crops such as cereals do not rely on pollinators to support yields). Most crops do not rely on pollinators but are aided by them, so the reduction in total food production is estimated to be around 5 to 10%, with cocoa beans, Brazil nuts and kiwi fruit among the crops most affected (Ritchie, 2021). However, the health of the ecosystem on which food production depends faces several threats. The three major causes of pollinator loss stem from agriculture, and include a loss of habitat, changes in land management practices (such as use of fertilisers and the increase in growing one type of crop) and pesticide use, notably neonicotinoids. Climate change is the fourth biggest cause, although there is limited data on its effect (Dicks and others, 2021).

Pollinators include vertebrate species such as birds, mammals, and reptiles, and invertebrate species such as bees, butterflies, flies, moths, beetles, ants and wasps. Most pollination is performed by invertebrates. More than 90% of the leading global crop types are visited by bees and around 30% by flies, according to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The Living Planet Report from the World Wildlife Fund for Nature highlights the average change in observed population sizes of 5,495 vertebrate species. It shows a decline of 73% between 1970 and 2020. The Red List Index of Species of Survival (a UN SDG 15 metric) shows a 12% deterioration between 1993 and 2024, and this was reported at 10% in 2020. Most invertebrate pollinators have not been assessed at a global level (IPBES, 2016). For analysis of the effect of UK consumption on global biodiversity, see Theme 4 (Indicator 4.3.3 Sustainable diet).

The Global One Health Index-Food Security (GOHI-FS)

The Global One Health Index-Food Security (GOHI-FS) examined the close links and inter-dependence of the health of humans, animals and the environment, particularly in the context of the sustainability of food systems. It gave a global overview of food systems from a One Health perspective based on 5 categories: food demand and supply, food safety, nutrition, natural and social circumstances, and government support and response.

GOHI-FS enabled comparisons to be made across countries. Lower scores indicate that food systems are weaker in these countries. It is also possible to consider the long-term effects of food system sustainability in countries that the UK relies on for food imports and consider learning from countries with more sustainable food systems.

There is no historic data available for GOHI-FS as currently it is a one-off piece of analysis, so it does not consider any long-term trends. Most of the data used was from international authoritative agencies but the missing data rate was 19.4%, which may pose a challenge to precisely evaluating the performance of food security in those countries or territories.

The score of GOHI-FS showed high correlations with economic indicators such as Gross Domestic Product (GDP) per capita, social development indicators such as the Social Development Index and health indictors, such as health expenditure and life expectancy. North America showed on average better performance than other regions across all five dimensions of the GOHI-FS, while sub-Saharan Africa had a low overall performance across these dimensions. Europe and North America performed better in food supply and demand than other regions. Sub-Saharan Africa and South Asia had low scores on food safety with a high burden of foodborne illness. Whereas Europe, Central Asia, East Asia and the Pacific had higher scores, which could be related to more effective surveillance systems in these regions. However, all regions performed poorly on government support and response relative to the other categories and only 29 out of 147 countries received scores in the top 3 quintiles (index score higher than 40) across all 5 categories.

Climate impacts on animal and plant health

Assessing the impact of climate change on global animal and plant health is challenging because of complex interactions between the pests or diseases and their hosts, predators and environmental conditions. For the UK, the potential climate change-related risks from pests, pathogens and diseases to animal and plant health are high and increasing overall. The risk to agriculture is currently assessed as medium, increasing to high in the future, and scaling with the degree of climate change (Berry and others, 2021).

The lifecycles of most pests, pathogens, and diseases are temperature-dependant. Rising temperatures are expected to lead to earlier and faster development times, more generations per year, and changes in the interactions between hosts and pathogens, likely increasing pressures on the host species. For example, the abundance of fungal soil-borne plant pathogens is likely to increase in most natural ecosystems worldwide (Delgado-Baquerizo and others, 2020), and potential yield gains under future climate change may be offset by increases in disease pressure (Chaloner and others, 2021). For example, *Culicoides* (biting midges) are a vector for many livestock viruses such as bluetongue (BTV) and epizootic haemorrhagic disease. Their abundance is highly correlated with temperature and the emergence of the BTV in northern Europe has been attributed to climate changes, particularly increasing temperatures (Guis and others, 2012). For England and Wales, continued warming is expected to extend the BTV risk further north, lengthen the transmission season and result in larger outbreaks (Berry and others, 2021). Warmer temperatures are also expected to increase the potential for genetic mutations and increased virulence of pests and pathogens (Berry and others, 2021).

One of the major impacts of projected climate changes is to increase overwintering potential for many pests, pathogens, and diseases, facilitating range expansions, more frequent establishment, and spread into new areas (Szyniszewska and others, 2024). Conversely, for some regions of existing establishment, the temperatures will become so high as to be limiting for the pest, pathogen, or disease (Bradshaw and others, 2019).

Changes in extreme weather events can also affect a species' ability to thrive. For example, heavy rainfall events have been found to lengthen development times and reduce survival of some caterpillar species (Chen and others, 2019). Heatwave events have also been shown to impact the lifespan, fecundity and oviposition (egg laying) of insects (Sales and others, 2021). Where increases in average wind speed and extreme wind events are projected, the transport of pathogens and infected vectors may increase in frequency (Hroššo and others, 2020) and may cover increasingly large distances (Hudson and others, 2023).

Theme 2: UK Food Supply Sources

Introduction

Theme definition

Having covered the global system in Theme 1 the focus now shifts in Theme 2 to the UK food system itself. This theme covers where the UK gets its food from across domestic production, imports and the sustainability of those sources.

In Theme 2, food security means a diversity of supply sources avoiding single points of failure, and a high degree of sustainability within those sources. Maintaining a balance of strong and consistent domestic production of food and strong trading relations supports this security. This theme focuses on the food availability and sustainability dimensions of food security, while commenting on impacts on other dimensions like accessibility and stability.

Theme 2 tracks the sources of UK food taken as a whole and then tracks sources by different groups (arable crops, fruit and vegetables, livestock produce, and seafood) (Sub-theme 1). The theme then looks at the state of domestic production by measuring its productivity and sustainability (Sub-theme 2). Productivity and sustainability on the international level were covered in Theme 1. This edition includes new indicators looking at agricultural productivity, animal and plant health, and a wider range of measures of natural capital.

All food production in the UK should be viewed not only in the context of global food security but in the context of the environment it sits within. Food production is reliant on the natural environment, good quality soil and water, and available pollinators. Agricultural and climatic changes have been driving shifts in the natural environment. These shifts can build up over time to have a significant impact on UK food security by degrading essential ecosystem services and thereby undermining fertility and yield. The UKFSR measures both this slow onset change alongside rapid shocks to production such as weather volatility and price shocks.

Overall findings

- **The UK's overall balance of trade and domestic production remains broadly stable.** The UK continues to source food from domestic production and trade at around an overall 60:40 ratio.
  Key statistic: The production-to-supply ratio was at 62% for all food and 75% for indigenous foods (meaning those that can be grown in the UK) in 2023, showing a small increase from 61% and 74% in 2021. This is a

continuation of the broadly stable trend seen in recent years (see Indicator 2.1.1 Overall sources of UK food).

- **Extreme weather events continue to have a significant effect on domestic production,** particularly arable crops, fruits and vegetables. Production levels fluctuate each year due to changes in both planted areas and yields, with weather conditions having a significant influence among other factors. Supply has also been affected by geopolitical volatility. As arable commodities are internationally traded, the disruption to the supply of oilseeds and cereals resulting from Russia's invasion of Ukraine caused prices to rise rapidly in spring 2022.
  Key statistic: In 2019 UK cereal production (25.5mt) was the highest this century, whereas in 2020 production (19.0mt) was the second lowest largely due to bad weather. The published first estimate of the 2024 English cereal and oilseed harvest shows a 22% decrease (around 2.8mt) in harvested wheat from 2023 (see Indicator 2.1.2 Arable products (grain, oilseed and potatoes)).

- **The UK continues to be highly dependent on imports to meet consumer demand for fruits, vegetables and seafood, which are significant sources of micronutrients for consumers.** Many of the countries the UK imports these foods from are subject to their own climate-related challenges and sustainability risks. Further research is required to understand the impact of climate change on the global production of fruits and vegetables.
  Key statistic: domestic production of fresh fruit increased slightly from 15% of total UK supply in 2021 to 16% in 2023. While this is a continuation of the long-term upward trend from 8% in 2003 it shows ongoing consumer demand for non-indigenous produce (see Indicator 2.1.4 Fruits and vegetables).

- **While there has been a small reduction over the long term, the UK is broadly maintaining its level of agricultural land area (UAA).** Greater fluctuation happens in terms of uses within UAA, although that is also quite stable. The major use of agricultural land continues to be land for animal feed.
  Key statistic: Between 2021 and 2023 UAA decreased by 1.2%, this is consistent with a longer-term gradual decrease (see Indicator 2.2.4 Land use).

- **A small reduction in the Total Factor Productivity (TFP) of agriculture between 2021 and 2023 contrasts to a longer trend of slow but positive productivity growth since 1985.** The reduction since 2021 was

caused by decreases in the total outputs of both crops and livestock, and rising input costs, which peaked in 2022.
Key statistic: TFP has increased by 9.1% overall over the last decade but is estimated to have decreased by 1.2% between 2021 and 2023 (see Indicator 2.2.3 Agricultural productivity).

- **There has been a long-term decline in key indicators of natural capital and ecosystem services on farmland due in large part to farmland management practices. The decline, however, is slowing.**
  Key statistic: The all-species indicator in England shows a decline in abundance to just under 70% of the 1970 value. This trend levels around the year 2000 and over the past 5 years, fluctuations in the all-species indicator are not considered to represent meaningful change (see Indicator 2.2.5 Biodiversity).

- **New government subsidy schemes designed to support sustainable farming and renew nature are underway, but it is too early to assess the impacts.**
  Key statistic: Across the UK, the area of land in agri-environmental schemes increased from 4,922 thousand hectares in 2021 to 5,872 thousand hectares in 2023 (see Indicator 2.2.9 Sustainable farming).

- **Food waste continues to represent a significant economic and environmental loss in the UK food system**. The majority of food waste is generated by UK households.
  Key statistic: Total food waste per capita in the UK amounted to around 115.7kg in 2021, representing a 5.6% increase compared to 2018, but a reduction of 18.3% compared to 2007 (see Indicator 2.2.2 Food waste).

Cross-theme links

The continued increase in production and levels of food traded internationally, covered in Theme 1, supports the security of UK imports in the immediate term. However, risks on the global level such as reduced productivity growth pose challenges over the longer term.

Price shocks to inputs covered in Theme 3 Food Supply Chain Resilience have driven an increase in agricultural production costs and food prices. The UK agri-food sector has needed to adapt to both a new business environment of high costs and changing subsidies and regulations after leaving the EU. Theme 3 looks at changing farmer incomes and confidence in this context, both of which have a bearing on farmers' choices of types of farming and food production, including sustainable practices covered in this theme.

Consumers continue to demand both domestically produced and imported food, supporting stable supply trends. Theme 4 Food Security at Household Level shows that there has been a return to pre-pandemic proportions of expenditure going on food and drink, although not a return to same levels of expenditure. Theme 5 Food Safety and Consumer Confidence shows that overall, levels of consumer trust in the food safety regulators to ensure food is safe to eat remains relatively high. Similarly, the market and consumer preference continue to drive purchasing of non-indigenous fruits and vegetables, which contributes to the relatively high reliance on fruit and vegetable Sub-theme 1: Food sources

2.1.1 Overall sources of UK food

Rationale

To ensure a consistent supply of food, the UK relies upon a combination of strong domestic production from the UK's agricultural and food manufacturing sectors, and a diverse range of overseas supply sources.

The production to supply ratio is generally understood to be a broad measure of national self-sufficiency. It is used in the UKFSR to show the relative contribution of UK domestic production and trade to UK supply. The ratio is calculated as the farmgate value of raw food production divided by the value of raw food for human consumption. It compares the value of what is produced in the UK with what is consumed. This indicator breaks down the overall ratio to show the balance of production and trade for some key commodities and food groups.

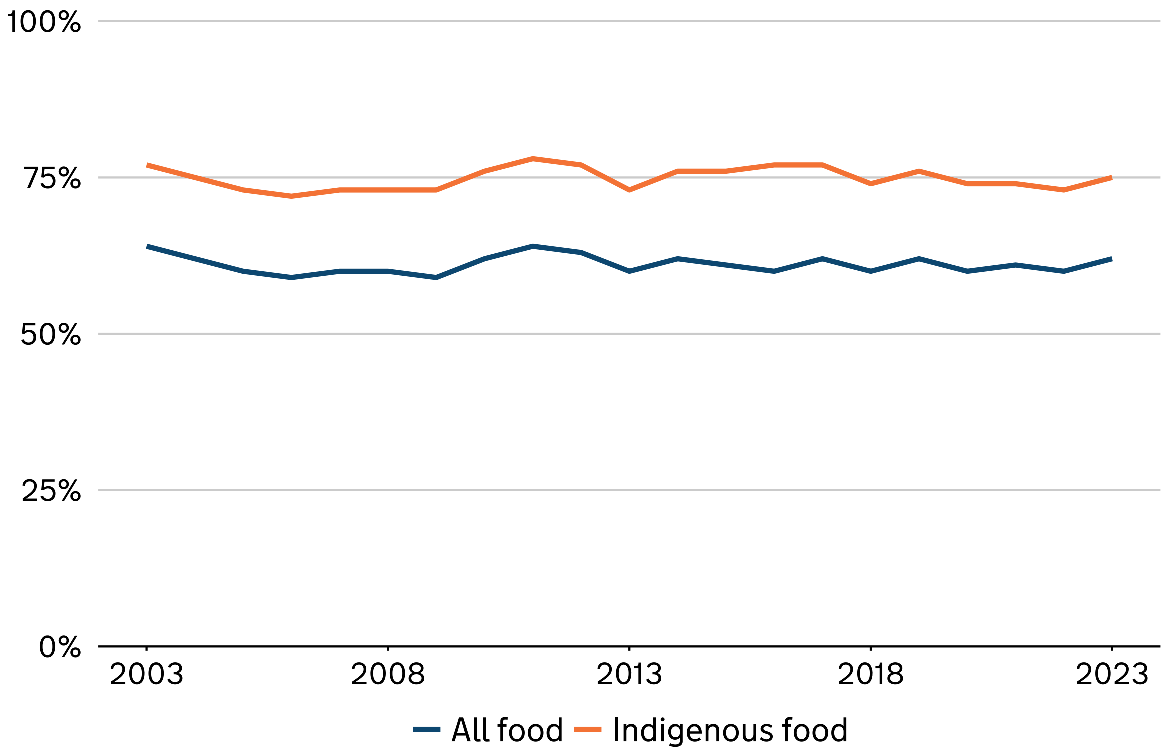
Importantly, the production to supply ratio is not a single measure of food security. A low or high ratio does not directly correlate to low or high national food security and the amounts and types of food produced are driven by market forces and consumer demands for goods. For instance, current UK consumer preference and diets include a range of non-indigenous products that cannot be produced domestically. Nevertheless, it is a starting point for conversations about UK food sources and the factors that contribute, both positively and negatively, to national food security.

The production to supply ratio is also considered in greater detail later in this theme within Indicator 2.1.2 Arable products (grain, oilseed and potatoes), Indicator 2.1.3 Livestock and poultry, and Indicator 2.1.4 Fruits and vegetables.

Headline evidence

Figure 2.1.1a: UK food production to supply ratio, 2003 to 2023

Source: Agriculture in the UK (Defra)



The production to supply ratio data for 2023 shows a broadly stable trend. Production was at 62% for all food and 75% for indigenous foods in 2023, compared to 61% and 74% in 2021. In 2023 the UK relied on imports for roughly 40% of its food (unchanged from 2021).

Indigenous foods are those that are commercially produced in the UK. These are products that suit the climate and conditions of the UK. Viewing the indigenous production to supply ratio alongside the ratio for all foods is important as it strips away the food that cannot be grown commercially in the UK. This includes citrus fruits, bananas and other products that rely on a tropical climate.

Note that the production to supply ratio does not include crops produced for animal feed so does not capture full UK productive capacity. It also does not include some meat imports (see Indicator 2.1.3 Livestock and poultry products (meat, eggs and dairy) for further details).

The production to supply ratio reflects what is available in the UK rather than production to supply of the recommended diet. For example, it does not factor in that the average adult consumes more calories than they need (PHE), nor does it factor in the amount of food wasted. To complete the picture from a food security perspective, it is therefore important to consider this indicator alongside Theme 4 Food Security at Household Level to understand how the food available is being accessed and utilised.

A secure food supply provides enough nutrients as well as calories. To understand the nutritional component of supply, analysis is needed on what aspects of diet current supply is providing. Both research and consumer trends for the different food groups suggest the UK has high import dependency for its supply of micronutrients (like vitamins and minerals) from goods such as fruits and vegetables and fish, compared to its supply of macronutrients (like carbohydrates and proteins), and this dependency has increased over the last 50 years.

Supporting evidence

Variation across the production to supply ratio

The UK produces most of the cereals, meat, dairy and eggs that it consumes (see Figure 2.1.1b). This figure is lower for vegetables (53% in 2023) and fruits (16% in 2023) due to UK climate suitability, seasonality and consumer and producer choices. Production to supply ratio data is not available for seafood. (Information on seafood can be found in Indicator 2.1.5 Seafood).

Figure 2.1.1b: UK production to supply ratio by food type, 2021 to 2023

Source: Agriculture in the UK (Defra), Horticultural statistics (Defra)

Food type	2021	2022	2023
All cereals	86%	92%	93%
Wheat	89%	95%	96%
Barley	110%	112%	113%
Oats	101%	121%	120%
Fresh vegetables	57%	54%	53%
Fresh fruits	15%	17%	16%
Beef	83%	87%	85%
Pork	71%	69%	64%
Lamb	108%	107%	114%
Poultry	93%	84%	82%
Milk	105%	105%	105%
Eggs	92%	90%	87%

Domestic production

Domestically produced food is not without its risks. Many factors affect the output of domestic production, including:

- climate and environmental factors such as soil health and rainfall
- the availability and suitability of land for particular forms of production
- inputs such as labour, water, fertiliser, pesticides and seeds

Weather conditions in recent years have been some of the most extreme on record and have affected domestic production. Following the driest UK summer since 1995 in 2022 (Kendon and others, 2023), England had its wettest 18 month period on record between October 2022 to March 2024. For several of the months between October 2023 and March 2024, parts of the UK had monthly rainfall totals that were double the 1991 to 2020 monthly averages (Met Office, 2024) resulting in the submersion of fields affecting livestock and reduced winter cropping for the 2024 harvest. Publication of the first estimate of the 2024 English cereal and oilseed harvest shows a decrease in overall cereal production in comparison to 2023, driven by the smallest wheat harvest since 2020. Overall yields were also down on the 5-year average. See Indicator 2.1.2 Arable products (grain, oilseed and potatoes) for more details. UK harvest data for 2024 will be published in December 2024.

Strong domestic production is dependent on sustainability of the whole food system, particularly healthy biodiversity, soil and water, which are explored later in this theme. Overproduction can lead to inefficient use of resource which in turn has a negative effect on natural capital by placing unnecessary pressures on the environment. Intensification of farming contributes to soil degradation, and food waste contributes to unnecessary greenhouse gas emission. This is covered in more detail later in this theme.

Domestically produced food may be less directly affected by international variables than imports. Such variables include international conflicts, extreme weather events outside of the UK, and export bans. However, the last 3 years have demonstrated that a stable production to supply ratio does not translate to stability of access. Domestic food production is not independent of global supply chains since production can be reliant on global inputs at the farming (for example, fertiliser) and the processing stages (for example, packaging and critical dependencies like CO_2). Theme 3 Indicator 3.1.1 Agricultural inputs, Indicator 3.1.2 Supply chain inputs, Indicator 3.1.3 Labour and skills, and Indicator 3.1.5 Energy explores the effect that Russia's invasion of Ukraine had on the price of inputs and the supply of some cereals and oilseeds. Furthermore, the increased cost of inputs led to food becoming more expensive and less accessible as a result. Theme 4 Indicator 4.1.3 Price changes of main food groups, covers the effect that supply-side shocks had on food prices.

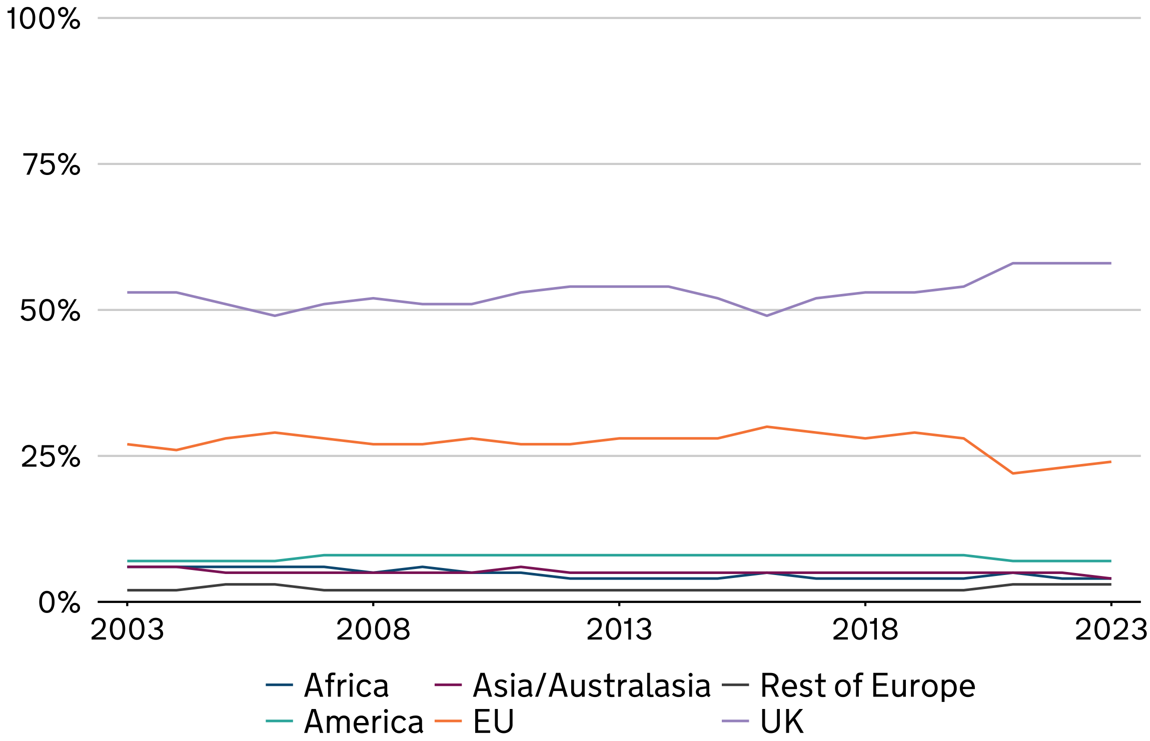
Despite the challenges posed by extreme weather events, geopolitics and a long-term decline in natural capital, domestic production has been able to keep up with population growth. In 2022 the UK produced £570 per capita, this is an increase from £502 in 2011.

Diversity of sources

Trade supports UK food supply resilience. This is due to the UK having diverse trade routes, strong international supply and purchasing power. Being a part of a global food system enables the UK to spread risk. As Theme 1 Global Food Availability explains in more detail, the global trading system remains a stable and reliable avenue for UK food security but faces challenges in both the short and longer term. Imports may be subject to shocks and disruptions and so overreliance on one geographical area makes food supply more vulnerable, while diversity of sources makes it more resilient. The diversity of UK sources can be assessed by looking at the 'origins of consumption'. While the production to supply ratio is calculated using farmgate value of raw materials and includes both imports and exports, 'origins of consumption' excludes exports from the calculation, so provides a slightly different view on where the UK gets its food from (see Figure 2.1.1c).

Figure 2.1.1c: Origins of food consumed in the UK, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



Domestic production provides the main source of food and drink in the UK. Proportionally, the UK consumed more domestically produced food by value in 2023 (58%) compared to 2020 (54%). Indicator 2.1.2 Arable products (grain, oilseed and potatoes), Indicator 2.1.3 Livestock and poultry, Indicator 2.1.4 Fruits and vegetables, and Indicator 2.1.5 Seafood explore at a commodity level whether this increase is a result of a rise in domestic production or a decrease in imports.

The EU continues to be the main source of food and drink imports and is therefore essential to the UK's food security. However, data on the sources of UK food and drink imports shows that the proportion supplied from the EU decreased from 28.4% in 2018 to 22.5% in 2021 following the UK's departure from the EU Customs Union on 1 January 2021. The proportion sourced from the EU partially recovered to 24.2% in 2023. The fall in imports from the EU has largely been replaced by an increase in domestically produced food and drink. Full EU import checks are yet to be implemented in the UK. Theme 3 Indicator 3.2.3 Import flows explores border changes since the UK left the EU. Note that some of the reduction in recorded EU imports since January 2021 might be due to changes in the methodology for data collection by HMRC as a result of leaving the EU. The retention of a reduced Intrastat survey and staged customs controls in 2021 and changes to Customs Declarations in 2022 where some food is recorded as being sourced from, mean that comparisons pre-and post-2021 need to be made with care.

In 2023 the 10 largest exporting countries to the UK provided 69% of all food and drink imports by value (65% by volume). While this was an increase from 2021 (64% by value and 62% by volume) it shows a continued diversity of supply. However, the UK depends on certain countries and regions for specific key products which creates a risk should supply be disrupted by trading barriers, geopolitics or extreme weather. For instance, 3 of the UK's largest suppliers of fresh fruit, Brazil, South Africa and Colombia, are all classified as low-medium climate readiness countries. For each of these countries agricultural capacity has been highlighted as a particular vulnerability. Further research is needed to understand the effect that climate change will have on horticulture in each of these countries. Rice, fruits, vegetables and fish are all important components of the UK consumer diet and each face climate related changes (see relevant indicators for further details).

In recent years the UK has demonstrated resilience to global shocks such as extreme weather and geopolitical stress. The UK's economic strength and purchasing power provides resilience by enabling the UK to utilise different trading partners. For instance, unusually hot climatic conditions in Morocco led to lower levels of tomato production and retailers setting limits on consumer purchasing of tomatoes at the start of 2023. The UK was able to ease pressure on supply by increasing imports from other major trading partners like Spain and the Netherlands. In addition, despite several economic shocks the Pound Sterling exchange rate has been stable since mid to late 2016 (using a constructed 'effective exchange rate' which weights a basket of foreign currencies in accordance with their influence on the UK's food import mix). A weak exchange rate would mean that imports become more expensive. Recent stability is particularly positive for household food security as importers are likely to pass some of the costs of a weak exchange rate to consumers.

Nevertheless, while the availability of food has remained stable, Russia's invasion of Ukraine had a significant effect on input costs which consequently led to a sharp increase in food prices. This is explored further in Theme 3 Food Supply Chain Resilience and Theme 4 Food Security at Household Level.

2.1.2 Arable products (grain, oilseeds and potatoes)

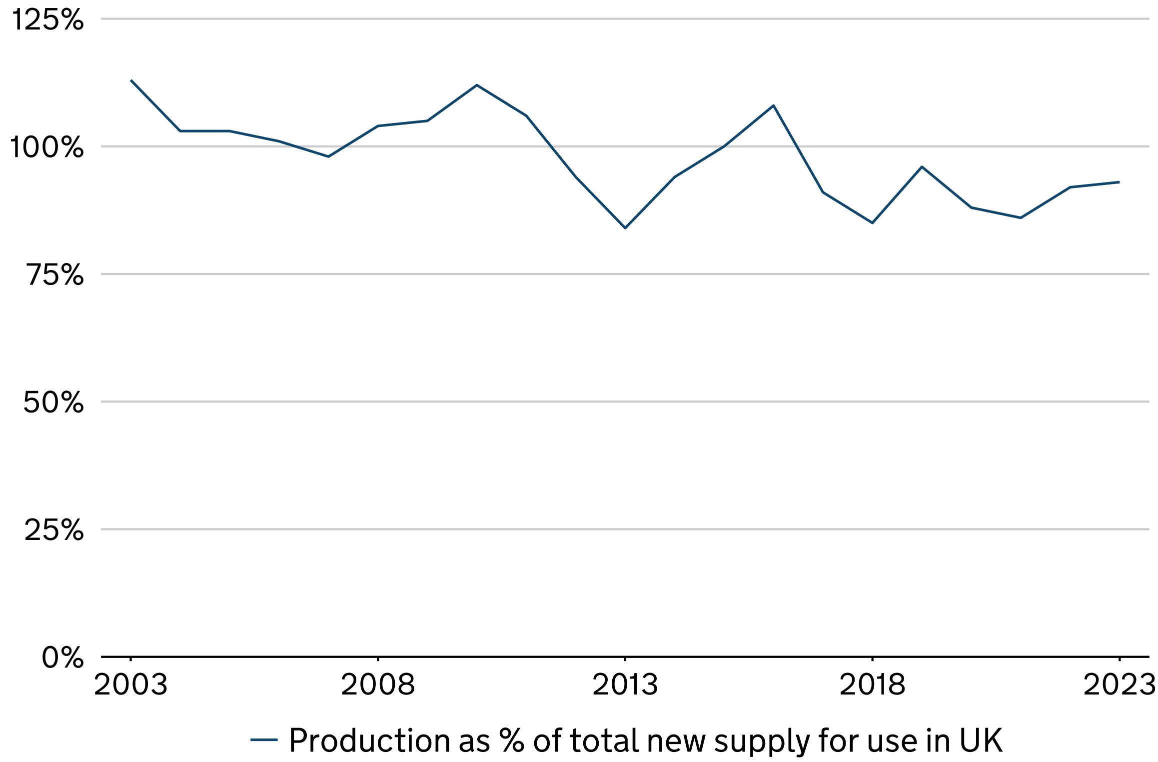
Rationale

This indicator tracks our supply of arable commodities from both production and trade. Grain, including wheat, barley and oats, are staple crops in the UK with wheat representing 31% of daily energy intake for the UK population between 2008 and 2012. In addition, cereals contribute significantly to the daily intake of protein, B vitamins and iron. The UK gets a significant amount of its micronutrients from fortified cereals (breakfast cereals and bread). UK government dietary recommendations are illustrated by The Eatwell Guide. It recommends that higher fibre and wholegrain starchy foods, such as wholegrain pasta and brown rice, should make up just over a third of the food we eat. Grain is an efficient form of production in terms of calories per hectare. The arable sector also provides products for animal feed.

Headline evidence

Figure 2.1.2a: Domestic UK cereal production as percentage of consumption (production to supply ratio), 2003 to 2023

Source: Agriculture in the UK (Defra)

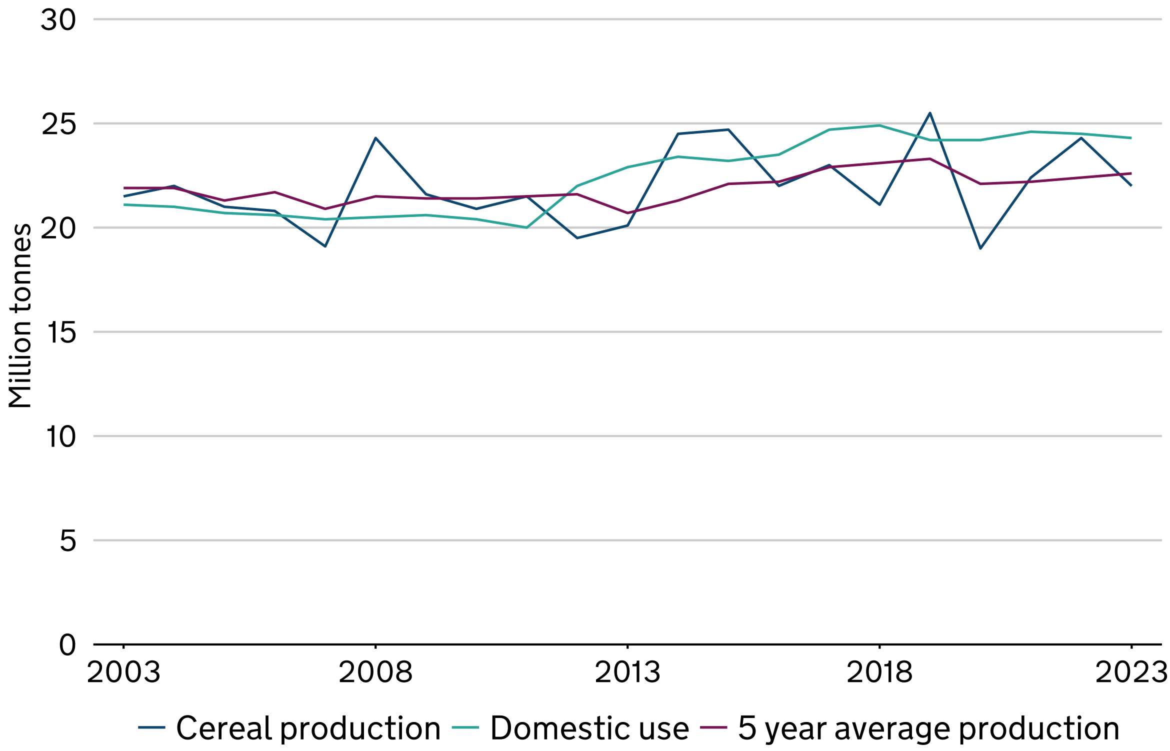


The UK produces most of its own cereals (wheat, oats, barley, rye, triticale and mixed corn). The production to supply ratio has continuously been over 80% for the last 20 years and increased from 86% in 2021 to 93% in 2023. This shows that the UK continues to produce most of the cereals it consumes. Despite this increase, the total volume of domestic harvested production decreased by 1.8% in 2023 compared to 2021. Cereal production continues to show year-on-year variability.

Supporting evidence

Figure 2.1.2b: Annual and 5-year average domestic production and usage of cereals, 2003 to 2023

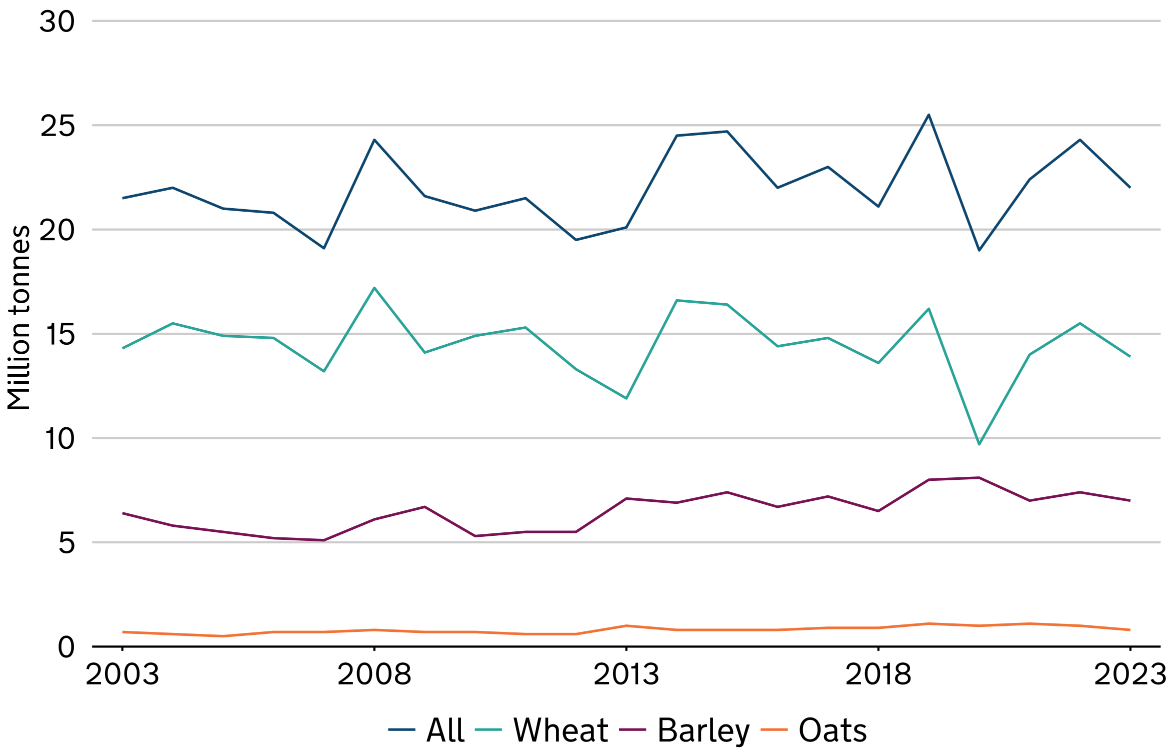
Source: Agriculture in the UK (Defra)



Extreme weather events and market fluctuations have had a significant effect on production. For example, in 2019 UK cereal production (25.5mt) was the highest this century, whereas the following year production (19.0mt) was the second lowest. While individual years may vary greatly, production remains relatively constant over time, usually within the range of 20 to 25 million tonnes per year (see Figure 2.1.2b). To meet the demands of the domestic market, trade and stocks are used to balance the peaks and troughs in domestic production. In 2021 and 2022 production was above the 5-year rolling average and more grain was stored as stocks. In 2023 production was below the 5-year rolling average and stocks were used to meet domestic demand.

Figure 2.1.2c: Time series of UK cereal production, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



Production of **wheat**, **barley** and **oats** have all been volatile over the last 20 years, with wheat more so in recent years. Weather during planting led to growers switching from winter to spring planting (particularly barley). From 2022 to 2023 harvested production of wheat decreased by 11% to just under 13.9 million tonnes due to decreased area and yields. Yields of barley and oats were also lower in 2023 compared to 2022, and generally closer to or just below the 5-year average. The published first estimate of the 2024 English cereal and oilseed harvest shows a 22% decrease of harvested wheat from 2023 because of decreases in both yield and area. In contrast the provisional estimate of the English barley harvest is an increase of 2.7% on 2023. This comprises a 26% decrease in winter barley production offset by a 41% increase in spring barley. Oat production is estimated to increase by 20% in 2024 due to an increase in both area and yield. UK harvest data for 2024 will be published in December 2024.

Cereals alone do not provide a healthy, sustainable diet that meets all our nutritional needs. However, in a worst-case scenario, the grain production in 2023 of just under 22 million tonnes would nearly sustain the population from a purely calorific perspective if it was consumed directly by humans. Significantly however, the majority of domestically produced arable crops are not used for direct consumption. Rather, as explored further in Indicator 2.2.4 Land use, a significant proportion goes into animal feed. In 2023, 51.8% (11.4 million tonnes) of wheat, barley and oats were used as animal feed.

2023 saw the production volume of **potatoes** decrease for a fourth consecutive year. Production fell by 8.3% between 2021 and 2023 from 5.1 million tonnes to 4.7 million tonnes. Wet weather led to around 20% of the potato crop being unharvested by the end of September 2023, however harvest continued through into November by which time approximately 5% was left unharvested. Reduced domestic supply drove price increases and the annual price index for potatoes increased by 52% in 2023 compared to 2022. In turn, potato prices increased for consumers. The Consumer Price Index including Owner Occupier Housing costs (CPIH) for potatoes between March 2022 and March 2023 rose by 20.4, which was greater than CPIH for all food and non- alcoholic beverages (19.2) and CPIH for all items (8.9). Prices continued to rise in 2024, although there was a decrease in the rate of inflation between August 2024 and September 2024.

Imports

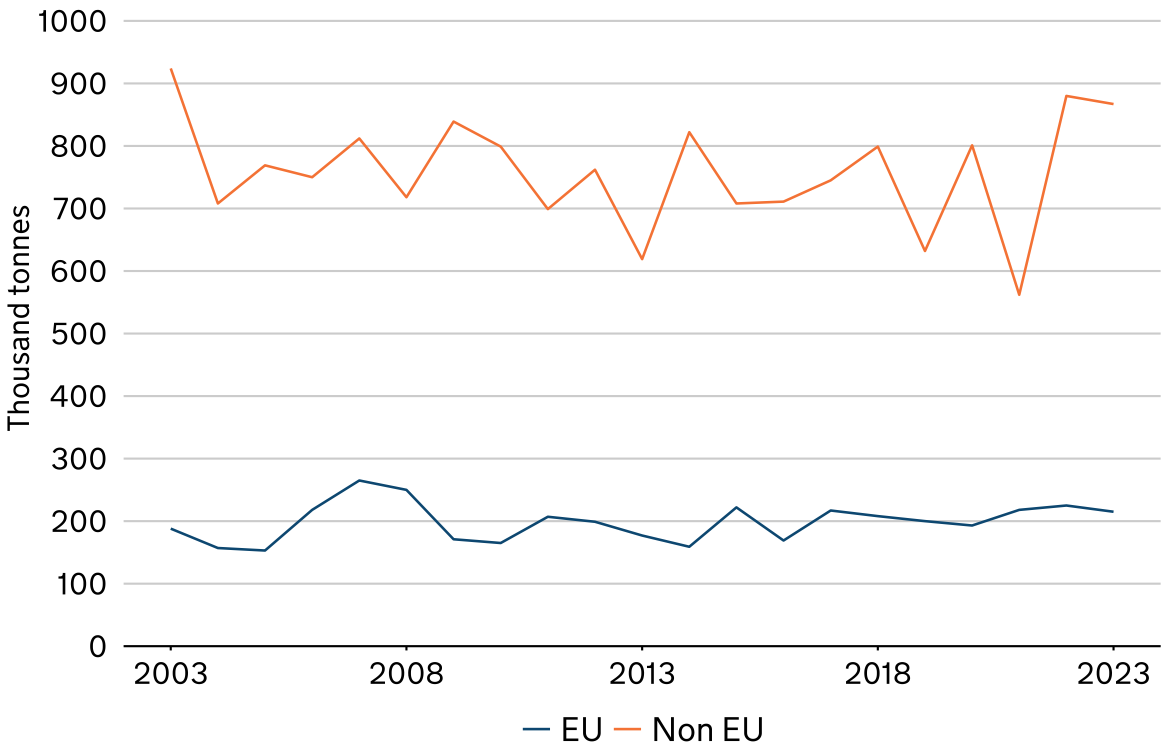
Import volumes of cereals such as wheat, oats and barley are much lower than domestic production volumes and see a less variable trend over the last 10-year period. The volume of imports is driven by the level of domestic production, market conditions such as the price, existing stock levels, and customer demand.

Due to environmental and climate conditions, the UK is consistently reliant on imports to meet demand for some arable crops. For instance, imports of **wheat for flour milling** account for around 15% of overall supply. Even if the UK had a top-quality harvest in terms of both quantity and quality, the milling industry would still require imports. These would come (predominantly) from Canada and Germany for milling wheats the UK does not grow due to differences in climate and soil. For the crop year 2023 to 2024, 1.1 million tonnes of imported wheat were used by UK millers, equating to 15% of the millers' wheat usage. This is explored further in Theme 3 Indicator 3.1.2 Supply chain inputs.

The UK is entirely dependent on imports to meet consumer demand for **rice**, largely from India and Pakistan. International factors such as the uncertainty on the impact of El Niño on production and trade restrictions threaten UK supply. India in particular is a climate-vulnerable country that has experienced extreme heat and flooding in recent years. In 2022, India also imposed export restrictions on rice in response to surges in global agricultural commodity prices; this is explored further in Theme 1 Case Study 2 Export restrictions. Consequently, in 2022 India provided only 22% of UK rice supplies. In comparison, India supplied 27% in 2021 and 26% in 2023. However, UK supplies were maintained with additional rice sourced from other countries.

Figure 2.1.2d: UK imports of soya bean, 2003 to 2023

Source: HMRC Monthly Overseas Trade Statistics



The UK does not grow sufficient protein crops to sustain its livestock sector. Theme 3 Indicator 3.1.1 Agricultural inputs explores UK demand for imported soya bean meal. Soya bean imports have shown year-on-year fluctuation but have remained relatively stable over the long term (the last 20 years). In recent years, Brazil has been the largest exporter of soya beans to the UK. In 2023 over half (54%) of all soya bean imports into the UK came from Brazil. As is explored further in Theme 1 Indicator 1.1.3 Global cereal production, the effects of climate change are projected to largely increase global mean soya bean yields by the 2050s. This increase will predominantly be found at higher latitudes, while reductions are projected for some major producing regions including the USA, parts of Brazil and Southeast Asia.

As arable commodities, both for food and animal feed, are internationally traded, the disruption to the supply of oilseeds and cereals resulting from Russia's invasion of Ukraine caused global prices to rise in spring 2022. Prices came down in 2023 but remain higher than pre-2021 with effects on access at household level (see Theme 4 Sub-theme 1: Affordability). Ukraine is a major supplier of sunflower oil and so the disruption to supply chains led to sunflower oil imports to the UK falling significantly and consequent increase in demand for rapeseed oil (see Theme 3 Indicator 3.1.2 Supply chain inputs).

Environmental impact of the arable sector

The high yield of UK cereal production relies on intensive farming practices which pose risks to sustainability of production. For example, pesticides, used to regulate growth and manage pests, weeds and disease, have detrimental environmental impacts, in particular terrestrial and aquatic biodiversity. See sustainability indicators in this theme and Theme 3 (Indicator 3.1.1 Agricultural inputs) for analysis of impacts and usage.

Climate impacts

Comprehensive, detailed projected of yield changes across crop types for the UK based on projected climate change are currently unavailable. Severe cases of heat stress or prolonged drought can lead to a total crop failure. However, rising average temperatures are also anticipated to provide opportunities, for example, by lengthening growing seasons.

The impact of increased frequency of adverse weather events may pose more of an immediate risk to food production, in comparison to changes in mean climate, since farmers have less time to adapt (Harkness and others, 2020). This has been evident by domestic production volatility over the last 20 years. Looking ahead, the probability of wetter springs is estimated to increase across the UK in the future, and, with less certainty, so too is the probability of wetter winters (UKCP18). This could increase the risk of waterlogging (Harkness and others, 2020). However, it is important to reflect that the degree to which winters in the UK may be wetter is noted as being particularly uncertain.

Studies suggest that the UK climate is expected to remain favourable for wheat production as many adverse weather indicators are projected to reduce in magnitude by mid-century (Harkness and others, 2020). Favourable changes include reductions in frost days, an earlier start to the growing season, lengthening growing season, faster crop growth, and field operations beginning earlier in the year. Additionally, hotter, drier summers and warmer, wetter winters are expected to improve sowing and harvesting conditions (Harkness and others, 2020). However, some changes that may be favourable overall may also be detrimental to certain crops, such as the reduction in vernalisation opportunities for winter-wheat. Furthermore, some of the favourable changes for crop yields will also be favourable for crop pests and diseases.

The potential impacts of climate change may be regional. Future climate projections suggest that the north and south-west may become more suitable for higher quality wheat in the future, while the east may suffer (Fradley and others, 2023). This may have an impact on the volume of bread-making wheat imported. Additionally, 2050 projections show time spent in drought is set to be similar to present-day for Scotland, Wales, and Northern Ireland, while increases are expected in England (Arnell and Freeman, 2021). Another study focusing on wheat found that prolonged water stress is not likely to increase significantly in the UK by 2050, and that the severity of drought stress during reproduction is projected to be lower in the 2050s for sites across the UK, except 2 sites in south-east England that are projected to experience increased drought stress severity (Harkness and others, 2020). Heat stress during wheat reproductive and grain filling periods is projected to remain a low probability in the 2050s (Harkness and others, 2020), however an increasing probability of at least one wheat heat stress day per year is projected for England (Arnell and Freeman, 2021Arnell and Freeman, 2021). . This may have an impact on the volume of bread-making wheat imported. Additionally, 2050 projections show time spent in drought is set to be similar to present-day for Scotland, Wales, and Northern Ireland, while increases are expected in England (Arnell and Freeman, 2021). Another study focusing on wheat found that prolonged water stress is not likely to increase significantly in the UK by 2050, and that the severity of drought stress during reproduction is projected to be lower in the 2050s for sites across the UK, except two sites in south-east England that are projected to experience increased drought stress severity (Harkness and others, 2020). Heat stress during wheat reproductive and grain filling periods is projected to remain a low probability in the 2050s (Harkness and others, 2020), however an increasing probability of at least one wheat heat stress day per year is projected for England (Arnell and Freeman, 2021Arnell and Freeman, 2021).

2.1.3 Livestock and poultry products (meat, eggs and dairy)

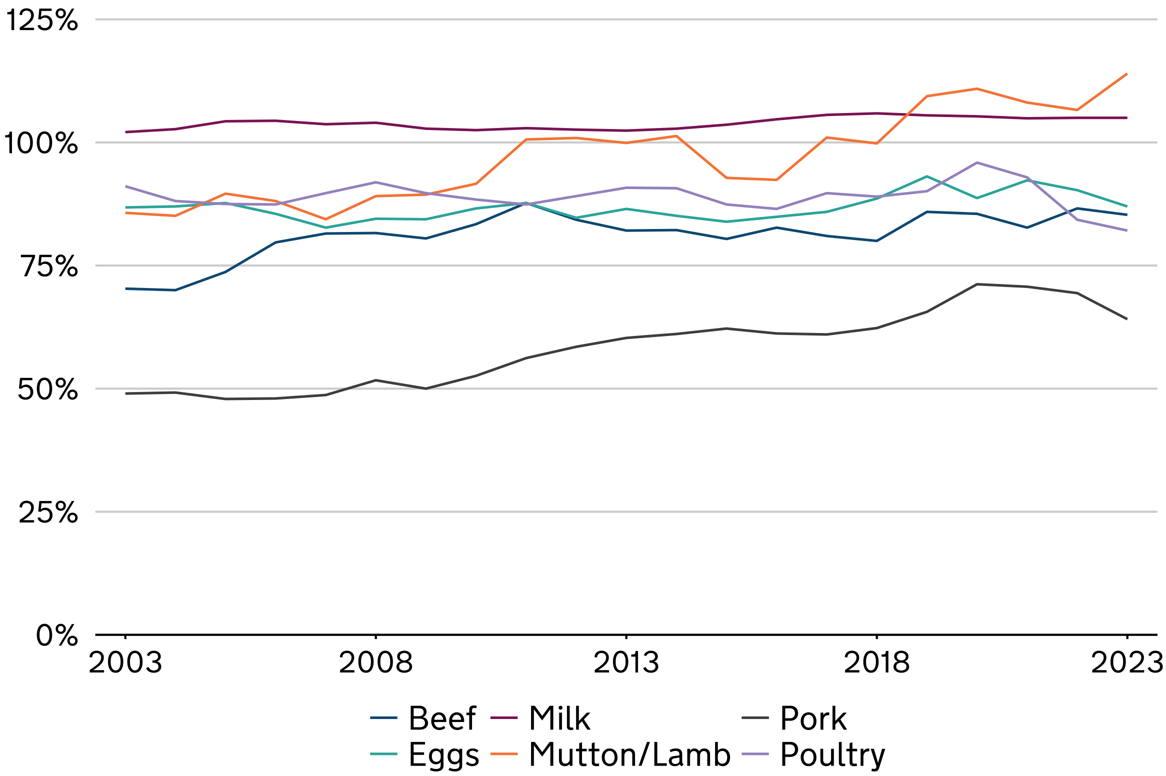
Rationale

This indicator breaks down supply to livestock elements. Animal products provide a range of important macronutrients, such as protein, fats and carbohydrates, and micronutrients, such as iron, B12, calcium and vitamin A, and can contribute to a healthy diet for a large part of the population (Public Health England).

Headline evidence

Figure 2.1.3a: UK production to supply ratios for livestock sector (meat, dairy and eggs), 2003 to 2023

Source: Agriculture in the UK (Defra)



Over the long term the production to supply ratio for all livestock sectors has remained relatively stable. However, there was a decrease in the production to supply ratio of pig meat from 71% in 2021 to 64% in 2023. Similarly, the production to supply ratio has decreased from 93% to 82% for poultry meat, and from 92% to 87% for eggs. For both sheep meat and milk the UK continues to produce more than it consumes.

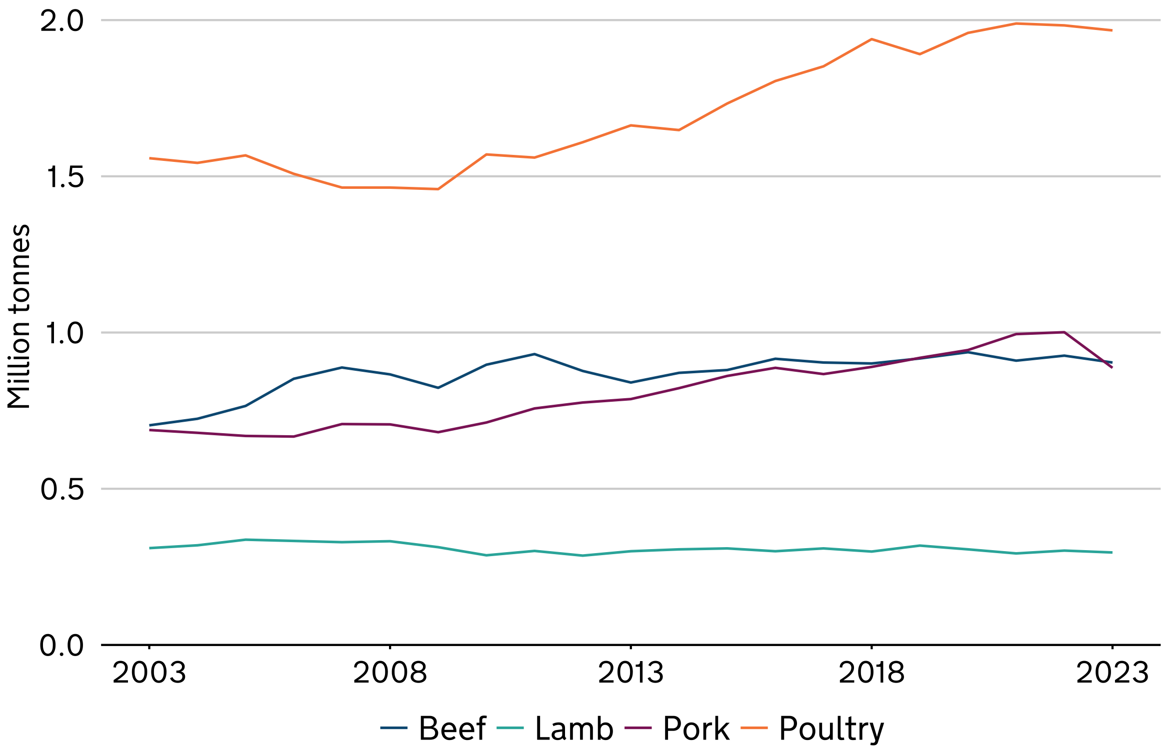
It is important to note that some meat imports and exports, such as meat-based ready-meals are not included in the production to supply ratio, therefore the figures do not provide a full picture, particularly for pig and poultry meat. Additionally, the production to supply ratio does not equate to self-sufficiency because the UK exports a high quantity of domestically produced meat and imports a high quantity of the meat consumed to meet consumer preference. For instance, the UK tends to export brown poultry meat and to import white poultry meat. This is discussed further under ‘carcase balance’ below.

Supporting evidence

Meat production

Figure 2.1.3b: Domestic UK meat production, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



A decrease in the domestic production of pig meat and poultry meat between 2021 and 2023 led to a decrease in production to supply ratio for each of these meats. While the production to supply ratio of beef increased, this was caused by a decrease in imports which experienced a greater decline than the fall in domestic production over this period. An increase in the domestic production of sheep meat led to the increase in production to supply ratio for this meat.

Over the long term, there has been a gradual increase in the production of **beef**. However, between 2021 to 2023 beef and veal production decreased by 0.6%. Over recent years, demand has been influenced by many factors, for instance, coronavirus (COVID-19) contributed to a decrease in demand at the beginning of 2021. The period of high inflation between 2021 and 2023 reduced the demand for beef as the price of beef is high compared to other meats. Similarly, **pig meat** has also seen a gradual increase in production over the long term. However, production decreased by 10.9% between 2021 and 2023. A fall in demand caused by the pandemic, a loss of exports to the Chinese market, supply chain issues from a disruption to carbon dioxide (CO_2), and a temporary shortage of labour in pork processing plants led to an oversupply of pigs and negative margins for producers. There has been a long-term increase in UK **poultry meat** production, largely driven by the relative affordability of poultry meat compared to red meat, and a general view that poultry meat is a healthier source of protein than red meat. However, there was also a 1.1% decrease in production for this meat commodity between 2021 and 2023 driven by high input costs, such as the 31% increase in poultry feed prices.

Over the long term the domestic production of **mutton and lamb** has remained largely stable. Between 2021 and 2023 there was a 2.8% increase in domestic production of mutton and lamb. While the input costs for sheep farmers have seen record high levels, sheep are less reliant on supplementary feed compared with other areas of meat production, so the industry was less affected by the 29% increase in compound sheep feed prices during 2022. UK supply and demand for mutton lamb is seasonal. While there is year-round demand, consumer demand peaks twice a year during the festive periods in spring and winter. The overall demand for lamb in the UK is lower compared to beef, poultry or pork.

Abattoir capacity and resilience

The numbers of UK abattoirs have declined in recent years (particularly smaller abattoirs), due to several factors including a lack of skilled labour, succession planning, and economies of scale. For example, 21% of smaller abattoirs in England closed between the period 2018 and 2022 (although throughputs increased by 2%). While these closures are unlikely to have a big impact on food security directly, it does increase the reliance on a small number of the bigger processors in the sector which in turn could affect the availability of meat in the future. Four processors account for approximately 90% of UK poultry production – 2 Sisters, Avara Foods, Moy Park and Cranswick. Smaller independent businesses account for the remainder of UK poultry production.

Abattoirs and the meat processing industry in general have been challenged with labour shortages over the last 3 years. A Food Standards Agency (FSA) commissioned research report published in 2022 found labour shortages in the meat processing industry (specifically, shortages of abattoir workers) and reduced slaughter rates, which in the short term resulted in periods of less meat entering the food supply chain. Labour is discussed in greater detail throughout Theme 3 Indicator 3.1.3 Labour and skills.

Imports and exports of meat

Difficult domestic production conditions over the last few years led to increased imports from both EU and non-EU countries. However domestic production continues to be the largest supplier to the UK market (82%). Imports of beef and veal from the EU decreased slightly between 2021 and 2023 while imports of pig meat from the EU increased slightly in this period. Imports from non-EU countries of poultry, beef and pig meat remain only a small proportion of total supply (AUK).

Animal feed

While the UK has a high domestic production to supply ratio for animal products, importing animal feed continues to be an essential component of the production process. As mentioned in Indicator 2.1.2 Arable products (grain, oilseed and potatoes), UK agriculture does not produce sufficient protein crops, for example peas, field beans, and sweet lupins, to support the livestock industry. Grass-based livestock production is therefore often augmented by the feeding of both domestic and imported grain and soymeal, particularly in intensive systems. See Indicator 2.1.2 Arable products (grain, oilseed and potatoes) for more details on soybean imports. Between 2019 to 2023 the volume of animal feed imported decreased by 6%. This was caused by the huge inflation in grain prices through 2022 which quickly fed into compound feed prices and created significant affordability problems for animal sectors. As such, livestock numbers were reduced and so demand for feed reduced. This is explored further in Theme 3 Indicator 3.1.1 Agricultural inputs.

The role of carcase balance on UK meat supply

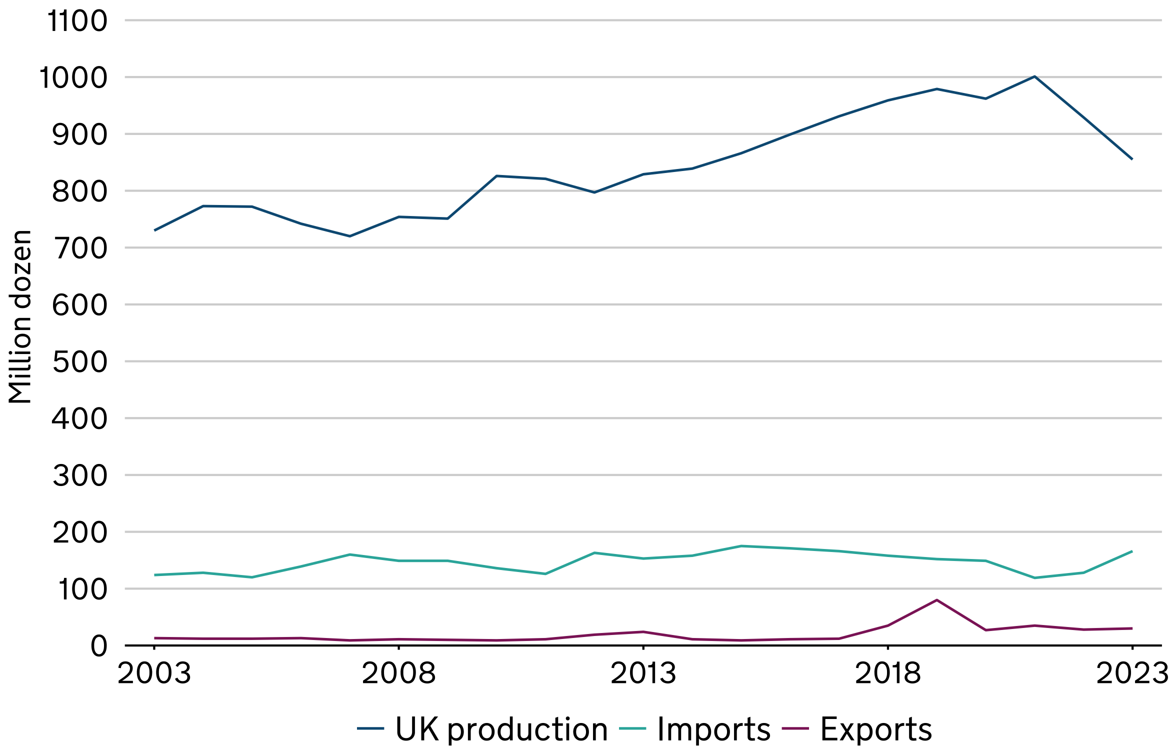
In value terms, the UK remains a net importer of beef and pigmeat, reflecting consumer preferences for eating higher value products and exporting lower value products. The meat sector is unique in that it disassembles its product and therefore needs to find a market for all cuts. A range of export markets facilitates the 'carcase balance' and are important for the viability of production. Carcase balance supports the viability of production and a reduction in food waste, ensuring that meat processors are able to sell the whole carcase of the animals they slaughter. Cuts that have little demand in the UK or would have to be destroyed at a cost such as low value bone-in cuts and offal can be exported to countries where they are more desirable. This increases overall returns from the animal to the processor. At the same time the UK tends to import high value steaks and boneless cuts of meat to meet UK consumer demand. In 2022, the UK imported around 243,000 tonnes of chilled and frozen beef, and a further 52,000 tonnes of processed beef, and exported around 125,000 tonnes of chilled and frozen beef, and 29,000 tonnes of beef offal. Based on average chilled and frozen beef imports from 2020 to 2022, with knowledge of the types of cuts imported to into the UK, the International Meat Trade Association (IMTA) have estimated that to replace these supplies with British product would require UK supplies of cattle for slaughter to almost double (IMTA, 2023).

Similarly, in the pig sector the UK prefers loin, while there is limited demand for trotters and offal. There is a strong market for trotters and offal in Asia, with China being our largest export market (approximately 40% of export volume). The carcase balance is also relevant to the poultry meat and sheep meat sectors.

Eggs

Figure 2.1.3c: UK production, import and exports of eggs, 2003 to 2023

Source: [Agriculture in the UK (Defra)]

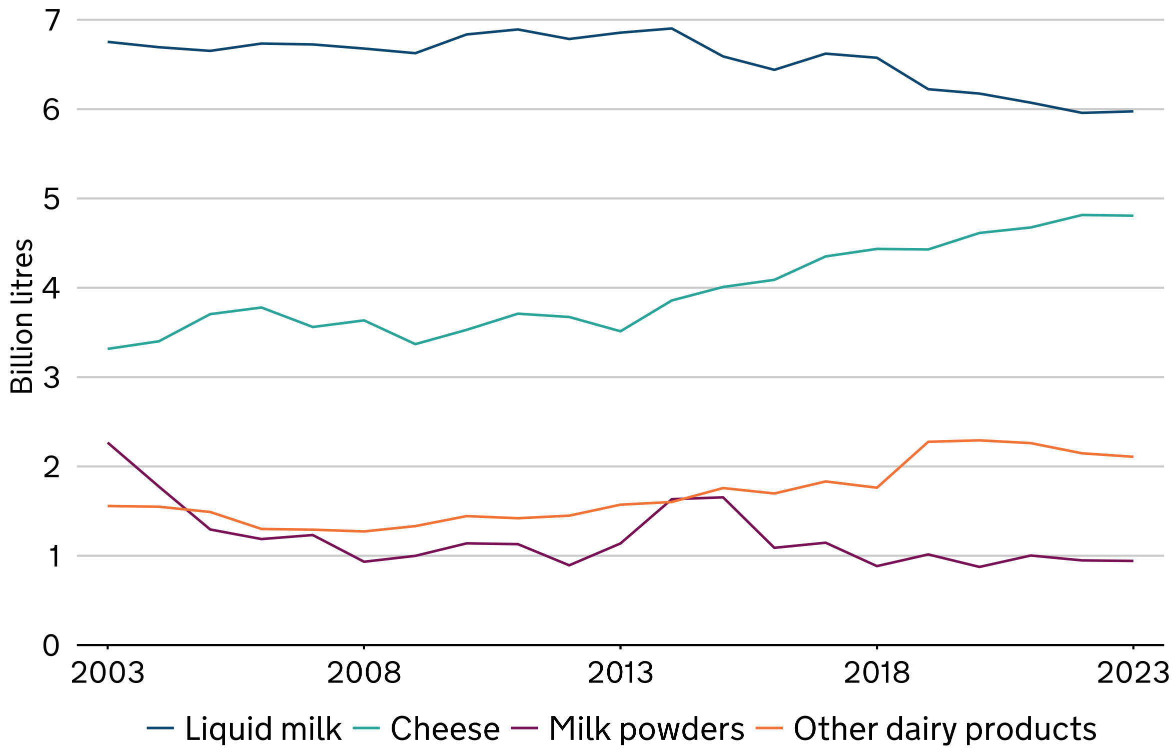


Between 2021 and 2023 the production of eggs for human consumption decreased by 14.6% to 855 million dozen. There had been a tightening of the egg market since April 2022 as a result of rising input costs for feed and energy. These were partly caused by Russia's invasion of Ukraine, along with the impact of Avian Influenza outbreaks in 2021 to 2023. As these increased costs were being borne primarily by the producers and not being passed fairly along the supply chain, a number of egg producers took the decision to stop egg production either temporarily, or in some cases permanently. During 2023 the supply chain adjusted with the increased costs being more fairly distributed and this led to a gradual increase in egg prices. The value of egg production for human consumption increased by 30% between 2022 and 2023; this is the 6th consecutive year-on-year increase. This large value increase was driven by an increase in the price of eggs. Egg imports increased by 39% from 2021 to 2023 and are now similar to pre-2020 levels. The UK remains a net importer of eggs, although the overall volumes are relatively low due to our high domestic production making up 87% of supply.

Milk

Figure 2.1.3d: UK milk usage by type, 2003 to 2023

Source: [Statistics on milk utilisation by dairies (Defra)]



Between 2021 and 2023 both the dairy herd and volume of milk produced has remained fairly stable. The size of the dairy herd fell by 0.9% to 1,837 thousand head, and the volume of milk produced from the dairy herd decreased by 0.8%. Across the 2023 calendar year, the average milk price decreased by 10% from a historic high in 2022, which was an increase of 42% from the 2021 price. The price decreases have meant the total value of milk production has decreased by 10% from 2022, but this value is still the second highest on record. Input costs began easing in late 2023. Approximately 45% of UK milk produced currently goes to liquid consumption and 55% to manufacturing, primarily into cheese, butter and milk powders. Trade is important to meet UK consumer demand for non-indigenous dairy products. For instance, in 2023 the UK imported 434 thousand tonnes and exported 180 thousand tonnes of cheese.

Animal disease

The presence and monitoring of Bovine Tuberculosis, Bluetongue and Avian Influenza is explored in Indicator 2.2.1 Animal and plant health.

Climate impacts

The extent to which projected climate change will impact UK livestock is currently uncertain. Heat stress is a likely effect of climate change. It can result in negative impacts on livestock productivity, fertility and reproduction, welfare and health. The average number of days per year that heat stress thresholds for various livestock types will be reached are projected to increase UK-wide between the period 1998 to 2017 and 2051 to 2070. These are based on projected changes in temperature and relative humidity from the UKCP18 regional climate model projections under the RCP8.5 scenario (Davie, Garry and Pope, 2021). Some places that did not experience heat stress conditions in 1998 to 2017 are projected to exceed heat stress thresholds for, on average, several days per year in the period 2051 to 2070. Studies have not yet explored the full range of uncertainty that may arise from using different climate models or scenarios. Heat stress could also lead to annual milk loss in some UK regions. For example, 17% of current annual milk yield could be lost in extreme years in the 2090s under the moderate emission A1B scenario, with south-west England identified as being most vulnerable (Fodor and others, 2018). Additionally, heat stress has been associated with reductions in egg production and quality of laying hens (Kim and others, 2024). Furthermore, lower farrowing rate of sows, negative impacts on pig foetal development, and slowed growth of grower and finisher pigs have also been highlighted as implications of heat stress (Liu and others, 2022).

Livestock may also be exposed to indirect effects of climate change such as changes to pests and disease. The number of days with temperatures suitable for sheep parasites is projected to increase across the UK by up to 35 days by the 2050s, under RCP8.5. The greatest increase is projected to be in Wales and southern and western England (Arnell and Freeman, 2021).

2.1.4 Fruits and vegetables

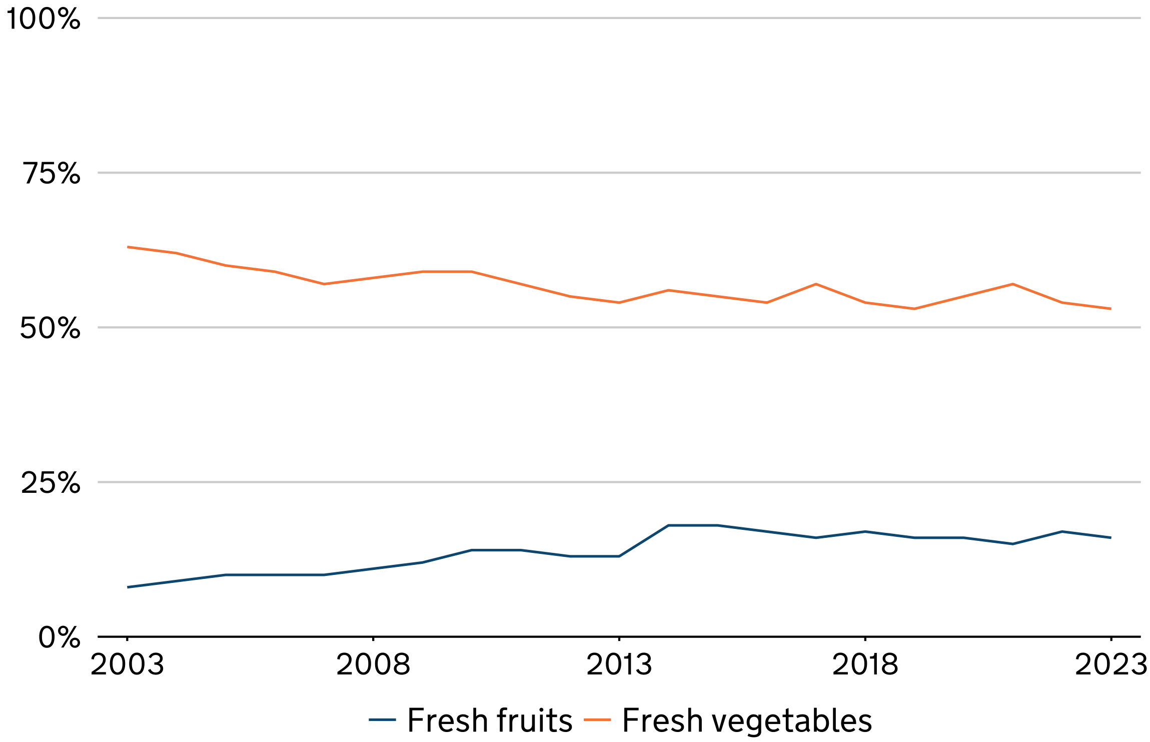
Rationale

Availability of fresh produce in the UK is an important part of food security and the health of the population. The Eatwell Guide indicates that just over a third of all food consumed in a day should be a variety of fruits and vegetables, with a minimum of 5 portions.

Headline evidence

Figure 2.1.4a: Domestic UK production of fresh fruits and fresh vegetables as percentage of overall supply (production to supply ratio), 2003 to 2023

Source: Agriculture in the UK (Defra)



In 2023 the production to supply ratio of fresh vegetables was 53%, down slightly from 57% in 2021. This is a continuation of the long-term gradual downward trend with the production to supply ratio having been 63% in 2003. The UK production to supply ratio for fruit increased from 15% in 2021 to 16% in 2023. Again, this continues a long-term trend, having increased gradually from 8% in 2003.

The relatively low production to supply ratios shows that the UK is more reliant on imports of fruits and vegetables than for other components of the UK diet. This is due to climate, seasonality, and consumer and producer choices. For example, in 2023 the UK imported 2,490 thousand tonnes of exotic and citrus fruits. Significantly, the UK is largely dependent on a few key countries for its imports of fresh fruits and vegetables, creating regional supply risks such as extreme weather events associated with climate change. The UK imported far less indigenous fruits (585 thousand tonnes). The production to supply ratio for many indigenous fresh vegetables such as cabbages, and some fruits such as strawberries, is far greater than the collective ratio (see Figure 2.1.4b for details). Supply sources of fresh fruits and vegetables are shaped by the seasonality of production, this is explored further later in this indicator.

Figure 2.1.4b: Examples of the production to supply ratio for indigenous fruits and vegetables

Source: Latest horticulture statistics (Defra)

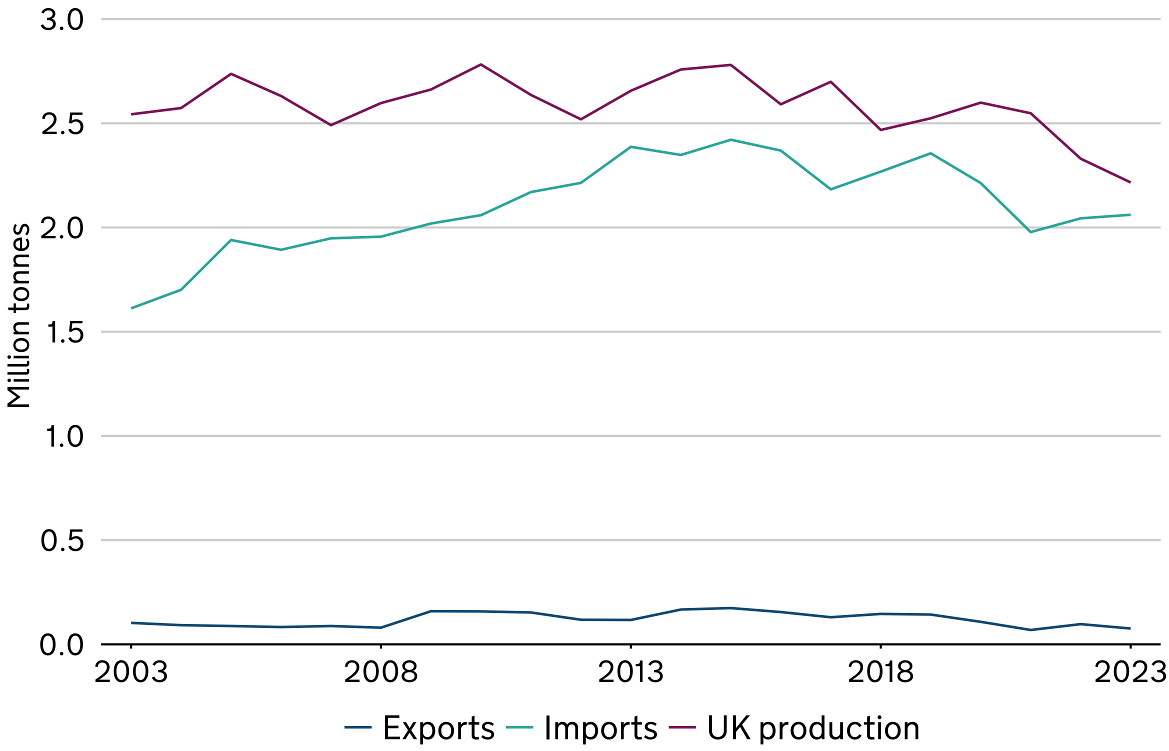
Food type	2021	2022	2023
Apples	37%	41%	38%
Pears	16%	14%	13%
Plums	9%	14%	13%
Strawberries	64%	67%	66%
Raspberries	30%	38%	38%
Cabbages	90%	85%	81%
Cauliflower and Broccoli	64%	54%	49%
Carrot, Turnip and Swede	95%	98%	96%
Mushrooms	47%	49%	48%
Lettuce	34%	43%	44%
Tomatoes	17%	15%	15%

Supporting evidence

UK consumers would need to eat at least 30% more of a variety of fruits and vegetables by weight to meet UK government dietary recommendations (NHS England, 2022). This would represent a significant increase in demand and supply. However, both domestic production and imports of fruits and vegetables face a number of challenges such as extreme weather events, climate change, disease, and high input costs.

Figure 2.1.4c: UK sources of fresh vegetables, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



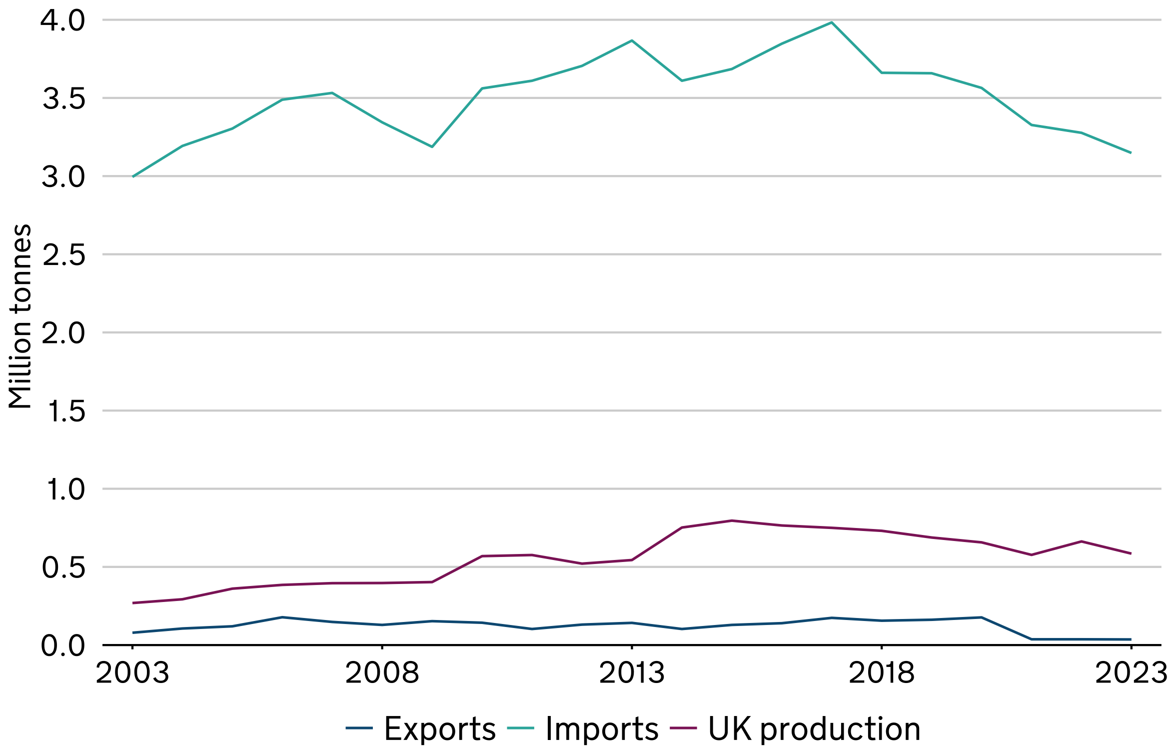
Domestic production of vegetables

Between 2021 and 2023 the volume of domestic production of vegetables decreased by 13% to 2.2 million tonnes. Over this period the price of vegetables increased (see Theme 4 Indicator 4.1.3 Price changes of main food groups for further detail). The decrease in production was primarily caused by extreme weather conditions, when a wet spring affected planting and harvesting, significantly delaying the start of the season for most crops. In early summer the weather turned hot and dry, so that any crops established in this period favoured farmers with access to irrigation and those without struggled to get crops to germinate or grow. In July, the weather turned wet, and this persisted until the end of the year, causing harvesting and disease issues (Horticulture statistics, 2023). Further still, production of protected vegetables (vegetables grown in a protected environment such as a glasshouse or polytunnel; including tomatoes and lettuce) has fallen each of the previous 8 years since peak production in 2015.

Increased energy costs due to Russia's invasion of Ukraine has also impacted production in recent years, particularly Controlled Environmental Horticulture (CEH) production of tomatoes, cucumbers and peppers. Faced with soaring heating bills many growers chose to delay or reduce planting. This decision, driven by economic necessity, led to a significant shortfall in domestically produced vegetables, adding pressure to imports from regions like Spain and North Africa that were already grappling with their own weather-related challenges (see below). This resulted in a temporary reduction of availability of tomatoes and peppers in early 2023, leading to higher prices from strained supplies.

Figure 2.1.4d: UK sources of fresh fruits, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



Domestic production of fruits

Between 2021 and 2023, the volume of fruit production increased by 1.3% to 585 thousand tonnes. The value of fruit production increased by 14%, driven by increased output prices particularly for raspberries and strawberries. However, between 2022 and 2023, fruit production fell by 12% from 663 thousand tonnes because like vegetables, fresh fruit production was impacted by extreme weather conditions. For instance, from 2022 to 2023 the total production of culinary apples decreased by 30% to 59 thousand tonnes, the lowest it has been over the last 10 years. This was due to both reductions in the planted area (down 1.2% to 2.3 thousand hectares), and yields (down 29% to 26 tonnes per hectare). Trees that had suffered from drought stress in 2022 had significantly less blossom in 2023. Cold winds during flowering in May adversely affected pollination and reduced crop potential.

There is currently a research gap exploring the projected effects of climate change on domestic fruit and vegetable production.

Imports

Consumers in the UK demand access to fresh produce all year round, including tropical and out-of-season produce. This is particularly true of fresh fruits and means that it must be sourced overseas from countries with more suitable climates. As a result, the UK is highly reliant on trade for its fresh fruits and vegetables. From a nutritional perspective, research shows that in 2010, imports of fruits were the greatest source of vitamin C in the UK while imports of vegetables were the greatest source of vitamin A.

There is a highly seasonal element to the supply of fresh fruits and vegetables, meaning that supply sources vary according to the time of year. For instance, tomatoes are seasonal both domestically and abroad. In 2023, the Netherlands was the largest exporter of fresh tomatoes to the UK during the summer months, when domestic production is also at its greatest. However, during the winter months both domestic production and imports from the Netherlands decreased and were replaced by southern European and North African countries, primarily Spain and Morrocco. The UK's economic strength and diversity of supply sources therefore provides consumers with year-round availability.

Significantly however, some fruits and vegetables such as bananas can only grow in certain overseas regions due to climate suitability. This concentration of production may create a supply risk which is considered later in this indicator.

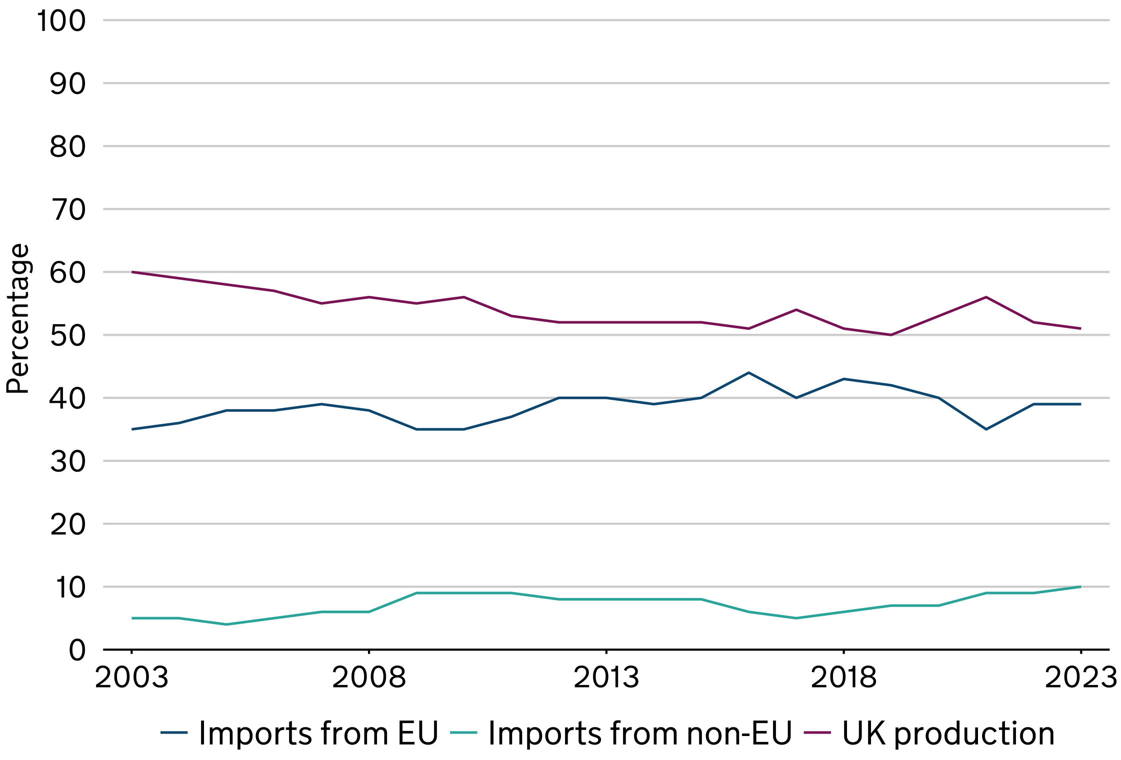
It is also important to consider the sustainability of exports in terms of resource use and environmental impacts on the exporting country. The capacity to meaningfully substitute imports with domestic production depends on the seasonal timing of the domestic and international supply. While field crop systems demonstrate a significantly lower Global Warming Potential (GWP) than heated greenhouse alternatives, the impact of domestic products can only fairly be compared with the impact of international products that are imported during the UK harvest season. Comparing glasshouse and open fields cultivation systems also demonstrates some trade-offs between energy and non-energy related environmental impact categories, for instance, water scarcity.

Ongoing research by Wrap for Defra shows that country origin where food is produced matters, as some regions are more productive than others. Importing from such regions may have lower environmental impact than domestic production, though this must be balanced against economic and food security objectives. However, there may be trade-offs between different environmental metrics – notably land use and water use – with one origin country or production method being favourable for some criteria but unfavourable in others. In addition, producing food out-of-season can substantially increase the GHG footprint, and importing from countries where it is in season (‘global seasonal’ food) is often preferable. ‘Seasonal’ is therefore a more important criteria than ‘local’ for environmental impact, except for air freighting food, as this adds considerably to its carbon footprint. Novel production methods may alter these conclusions in future, but only if they are guaranteed as using very low-carbon energy. The conclusions should be periodically reviewed as these technologies develop, though at present, field-grown appears preferable in most cases.

Sustainability of UK imports is explored in more detail elsewhere in the report (see Theme 1 Indicator 1.2.4 Water availability, usage and quality for global agriculture and Theme 4 Indicator 4.3.3 Sustainable diet).

Figure 2.1.4e: Origins of fresh vegetables in UK domestic consumption, 2003 to 2023

Source: Agriculture in the UK (Defra)



The shorter shelf life of fresh fruits and vegetables means the supply chain tends to be localised although this can be extended by canning, drying and freezing.

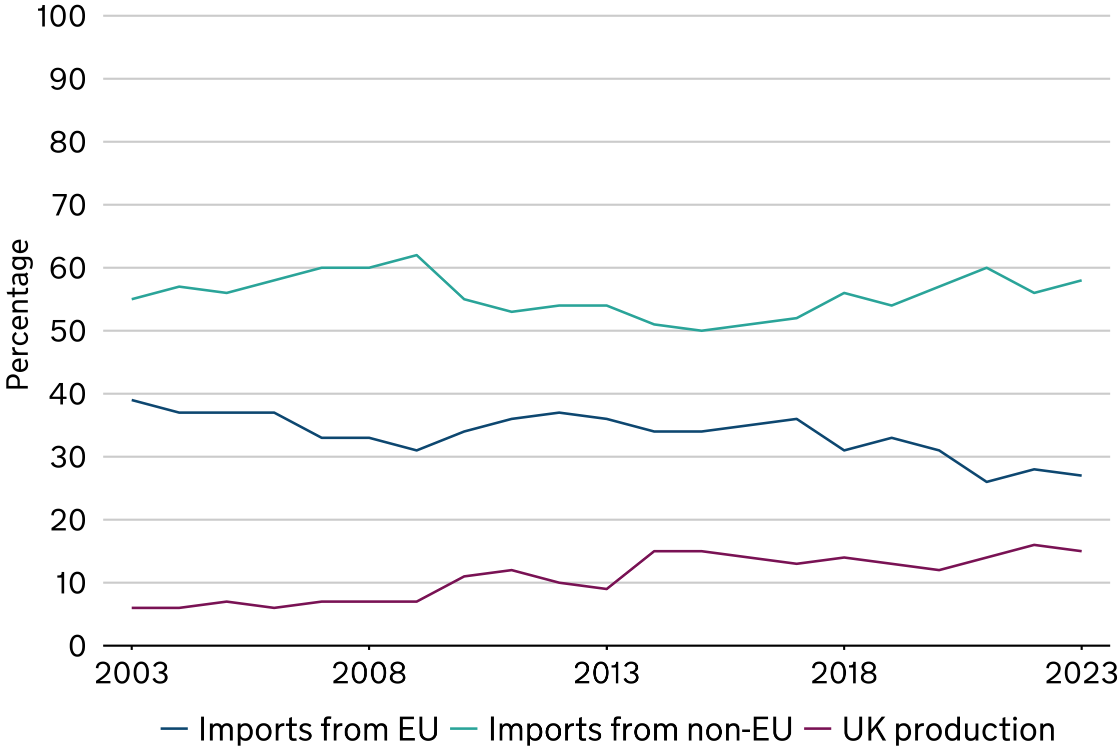
The EU remains a significant source of fresh vegetables for the UK. In 2023, 39% of fresh vegetables for UK domestic consumption were imported from the EU, down from 43% in 2018. Supplies of fresh vegetables from the EU have stabilised following the initial supply chain disruption after 1 January 2021 (note the changes in the methodology for data collection by HMRC as mentioned in Indicator 2.1.1 Overall sources of UK food). Overall, 92% of domestic consumption of fresh vegetables in 2023 was met by domestic and EU production. While this is a decrease from 97% in 2018 it reflects the continuing importance of geographical proximity for importing fresh produce.

Geographical proximity is also evident at a country level. In 2023 the largest exporters of fresh vegetables to the UK were Spain (32%) and the Netherlands (25%), this hasn't changed since 2018. However the proportion of imports arriving from Spain decreased from 39%. During this time there was an increase in imports from Morrocco (predominantly tomatoes). After Spain and the Netherlands, the largest exporters of fresh vegetables to the UK in 2023 were France (8.0%), Morocco (7.5%), and Poland (4.8%).

The importance of Spain and Morrocco as suppliers of fresh fruits and vegetables to the UK was demonstrated in 2023. Some domestic shortages of tomato, pepper and other fresh salad shortages were attributed to drought and heat in North Africa and southern Europe (Energy & Climate Intelligence Unit, 2023). The impact of drought and water stress on horticulture in Spain is explored further in the case study below. Theme 1 Indicator 1.2.4 Water availability, usage and quality for global agriculture provides a map of the levels of water stress globally, with North Africa showing highest levels. Further research is needed to understand the wider impact on fruits and vegetables from climate change.

Figure 2.1.4f: Origins of fresh fruits in UK domestic consumption, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



The EU also remains an important supplier of fresh fruits, providing the UK with 27% of fresh fruits consumed in 2023, compared to 31% in 2018. Overall, the origins of fresh fruits for domestic consumption is more diverse than vegetables, with 58% by volume from non-EU markets in 2023, a small increase from 56% in 2018. This reflects continued UK consumer demand for tropical and out-of-season fruit which cannot be sourced domestically or from Europe. The more diverse nature of supply can be seen when reviewing the UK's largest suppliers. In 2023, the UK's largest supplier of fresh fruit was Spain (16%), followed by South Africa (13%), Costa Rica (10%), Colombia (8.9%), and Brazil (5.5%). This has changed very little since 2018.

Although the supply of fruits and vegetables is diverse, this varies for specific commodities. While food security implications are unclear, regional concentrations of production could result in greater risk of supply disruption from regional impacts. Melons are only cultivated in warm regions, and they are highly susceptible to frost (Energy & Climate Intelligence Unit, 2023) so can only be sourced from certain regions. In 2023, the UK imported 118,311 tonnes of melons (excluding watermelons), 49% of which were from Brazil and 25% from Spain. Similarly, bananas grow best in tropical areas, or hot areas with good irrigation and most can be found within 30 degrees of the equator (Energy & Climate Intelligence Unit, 2023). In 2023, the largest 5 exporters to the UK, each located in either South or

Central America (Columbia, Costa Rica, Ecuador, Dominican Republic and Nicaragua), supplied 77% of all bananas coming into the UK. This has changed very little since 2018 (74%). As mentioned in Theme 1 Indicator 1.5.2 Global One Health, bananas have become the most purchased fresh fruit in the UK and are therefore an important source of micronutrients (particularly vitamin B6 and vitamin C) to the UK population. While there are other available sources of micronutrients, potential risks to the production of bananas such as the threat of pests (see Theme 1 Indicator 1.5.2 Global One Health) may create a risk to this consumer choice.

Case Study 1: Impact of drought and water stress on horticulture production in Spain

This case study illustrates some of the changing climate risks to agricultural production in Spain, a key region for UK imports of fruits and vegetables, with risks associated with water availability and heat stress. In 2023, Spain supplied 84% of total imports of lettuce, 37% of lemons and limes, 33% of oranges, and 30% of total fresh or chilled vegetables.

Drought and water stress already challenge agriculture in Spain, leading to reductions in fruit and vegetable production. For example, in 2022, “a long-lasting winter drought impacted exports to Northern Europe”, with exports of both fruits and vegetables 40% lower in 2022 compared to the previous year (Cooke, 2023). Irrigation is particularly important for agriculture in south-east Spain. For example, since its introduction in 1979, the Tagus–Segura Transfer (which channels water from the Tagus river to the Segura river in Spain) “has contributed a significant amount of water resources for both urban supply and for agriculture (irrigation) in south-east Spain”. Drought events affect rain-fed crops directly, and can also affect irrigated crops, through restrictions to irrigation (Pullman, 2022). For example, the transfer of water to south-east Spain via the Tagus–Segura Transfer is vulnerable to droughts around the Tagus headwaters (in central Spain, east of Madrid). This can limit the water available for transfer to the agricultural regions in south-east Spain (Cañizares and others, 2022). Climate projections indicate reduced rainfall in Spain, with an increase in temperatures leading to more evapotranspiration (water transfer to the atmosphere from the land by evaporation and by transpiration from plants), exacerbating the drying signal. Periods with low rainfall and high evapotranspiration (potentially limiting the availability of water for irrigation), are projected to become substantially more frequent by 2050, compared to what has been observed to date. However, changes to infrastructure or agricultural production systems, for example, improved irrigation techniques and water storage, may mitigate the impact of the changing risks of drought.

Temperature-related risks are specific to each agricultural product. Even for a particular crop, different varieties may have different tolerances and vulnerabilities to heat stress risks, as well as at different stages of crop growth. Climate projections indicate increases in average temperatures across Spain in all seasons. Such projected temperature increases are associated with an increasing frequency of high heat events, which can adversely affect the agricultural production of crops such as tomatoes, sweet peppers and grapes. Fresh grapes are primarily imported from Spain to the UK in August to October, with berry ripening occurring 1 to 2 months prior to harvest. Analysis exploring the changing risks of heat stress during berry ripening shows that days with maximum daily temperature above 40°C (an important threshold for grapes (Venios and others, 2020)) during July to October have historically occurred relatively infrequently (fewer than 5 days per year). This has occurred primarily in southern Spain, and in Aragon and Catalonia around the Ebro River Valley. By the 2050s, such events are projected to occur across most of Spain, with some regions (including parts of Andalusia and Extremadura) projected to experience more than 20 days per year.

Another notable example is that top fruit crops (including apples, cherries, peaches) require a cold period (vernalisation) to emerge from dormancy and produce fruit. Projected higher temperatures put this vernalisation event at risk, affecting viability and yields of these crops (Rodríguez and others, 2021). From the perspective of UK food security, climate risks to production in one international location may be mitigated by production elsewhere, either through imports from alternative international locations or increased domestic production. The degree to which local adaptations may be delivered should be considered when assessing overall risks to the UK's international sources of food.

2.1.5 Seafood

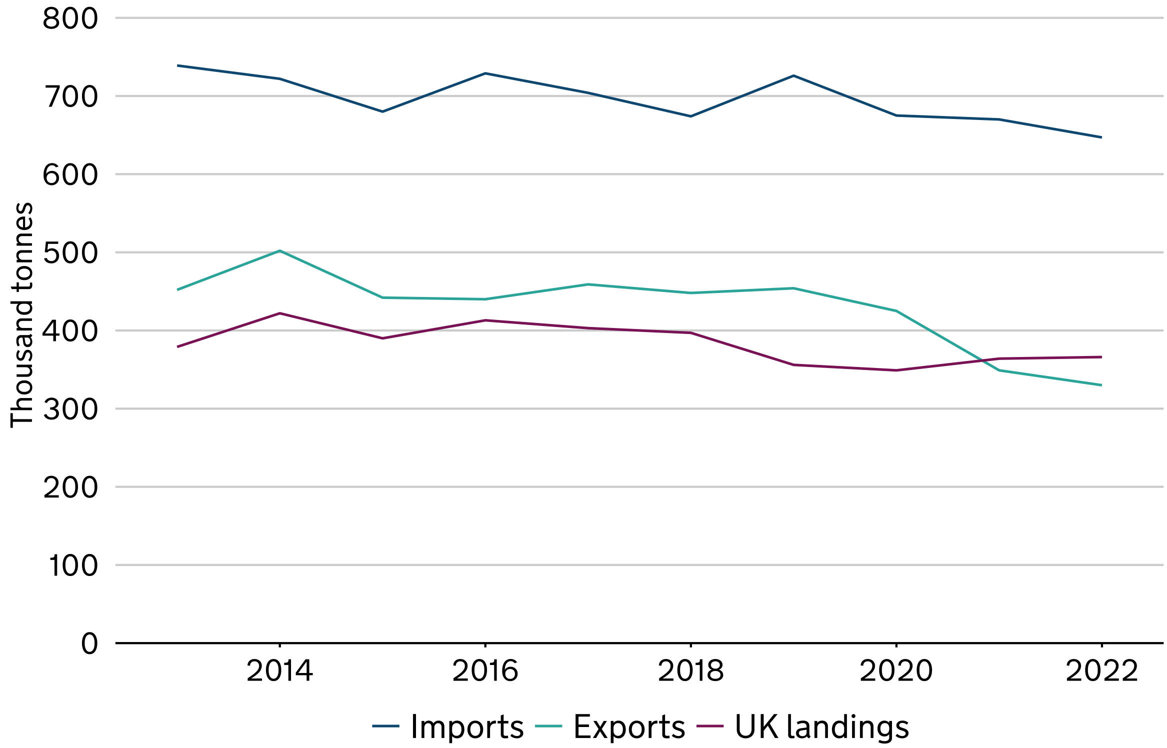
Rationale

The UK Eatwell Guide recommends consuming two portions of fish every week, including one of oily fish. As with livestock products, while not everyone in the UK eats fish it is a key source of protein and nutrients. Oily fish is also a source of omega-3 fatty acids.

Headline evidence

Figure 2.1.5a: UK landings by UK vessels, imports and exports of fish and shellfish, 2013 to 2022

Source: Marine Management Organisation (MMO), UK sea fisheries annual statistics report 2022: Section 4 – Trade - GOV.UK (www.gov.uk) and Section 2 - Landings - GOV.UK



Due to data collection methods and multiple sources of fish, a production to supply ratio is not possible for seafood in the way it is for other commodity groups. However, reviewing the volumes of UK landings from UK waters alongside import and export volumes can provide an overall picture of where fish consumed in the UK is sourced from.

The UK is a net importer of fish. Between 2018 and 2022 total fish imports decreased from 674,000 tonnes to 647,000 tonnes, while exports decreased from 448,000 tonnes to 330,000 tonnes. By comparison, between 2012 and 2018 the volume of fish both imported and exported was largely stable (accounting for annual fluctuations). These trends reflect a decrease in the trade of fish with the EU after 1 January 2021. From 2018 to 2022 the total volume of landings by UK vessels into UK ports fell by 7.7%. Climate change and overfishing remain a risk to fishing and marine sustainability.

Supporting evidence

Imports and consumer demand

The UK imports 90% of the seafood consumed, relying on imports to meet domestic demand, especially for cod, haddock, tuna, shrimp and prawns. Salmon is the only species which is both imported and exported in significant quantities.

In 2022, the top 5 imported species by volume were:

1. Tuna (106,300 tonnes) a 3% decrease from 2018 (109,500 tonnes)
2. Freshwater salmon (95,800 tonnes) a 20% increase from 2018 (80,100 tonnes)
3. Cod (84,800 tonnes) a 18% decrease from 2018 (102,900 tonnes)
4. Shrimp and prawn (77,700 tonnes) a 3% decrease from 2018 (80,200 tonnes)
5. Haddock (54,800 tonnes) a 10% increase from 2018 (49,800 tonnes)

In 2022 the 10 largest suppliers to the UK provided 64% of total imports of seafood. By comparison, in 2018 the 10 largest suppliers provided 59% of total imports of seafood. The 3 largest exporters to the UK in 2022, Norway, China and Iceland, accounted for 33% of all seafood imported by volume. Whereas the top 3 suppliers in 2018, China, Iceland and Germany, accounted for 26% of total seafood imported. This suggests that overall, UK imports have become more concentrated amongst its largest suppliers, while remaining reasonably diverse.

In 2022, Norway was the largest exporter to the UK supplying 17% of total imports (112,000 tonnes), mainly salmon and haddock. While this data suggests that imports from Norway have seen a huge increase since 2018 when exports to the UK were only 34,500 tonnes, there have been changes for some products in how the data is recorded by HMRC. As a result, some fish that were previously declared as coming to the UK via Sweden are now declared as coming directly from Norway. China was the second largest exporter to the UK supplying 9.4% of total imports (60,500 tonnes), mainly cod and 'other fish' (haddock, mackerel, salmon, sardines and tuna). China acts as a processing hub for import-originating seafood which is re-exported to other markets such as the UK. Iceland was the third largest exporter to the UK supplying 6.5% of total imports (42,000 tonnes), mostly cod and haddock.

Total imports of seafood to the UK from the EU decreased from 228,700 tonnes in 2018 (34% of total imports) to 159,300 tonnes in 2022 (25% of total imports), primarily from Germany, Denmark, Spain and Sweden. Approaching and following 31 December 2020, additional administrative costs associated with documentation requirements and new border processes contributed to cost-burdens on imports.

Theme 1 Indicator 1.1.6 Global seafood production explores the proportion of global fish stock within biologically sustainable levels globally. With regards to the largest exporters to the UK, only 50% (2021 figures) of fish stocks in Norway are biologically sustainable, which is well below the global average of 62.3%. Sustainability therefore remains a concern for UK supply. However, 76.9% of fish stocks in Iceland are biologically sustainable. There is no data available for China. Overexploitation varies significantly by country within the EU. For instance, 70.6% of fish stock are within biologically sustainable levels in Germany (2021), whereas only 41.4% are in Spain (2021).

Consumer demand

A decrease in consumer demand for fish correlated to higher prices. As explored in Theme 4 Indicator 4.3.1 Consumption patterns, between FYE 2020 and FYE 2023 the purchases of fish decreased by 15.1% (in grams per person per week) (Family Food Report, 2023). Simultaneously, the Consumer Price Index (CPIH) increased from 113.6 in 2020 to 136.2 in 2023. The impact that rising food prices has on household food security is explored in Theme 4 (Sub-theme 1: Affordability).

Landings (UK vessels into the UK):

In 2022, UK vessels landed 395,800 tonnes of seafood into the UK, the majority of which is exported. This was a 7.6% decrease from 2018. The vast majority of landings into the UK are by UK vessels. Multiple factors impact fishing, and landings tend to fluctuate considerably over time. The biggest impact on sea fisheries in recent years has been the UK's departure from the EU. This had an impact on the stocks and species the UK fleet had access to fish in subsequent years. Between 2018 and 2022 the volume of demersal fish (including cod, haddock, sole and monk) landed in the UK by UK vessels decreased by 19%. There was also a 7.1% decrease in shellfish landed. However, the volume of pelagic fish (including herring, mackerel and sardines) landed in the UK by UK vessels increased by 1.6%. UK landing of cod and haddock account for a small share of supply to UK consumers. A reduction in landings of cod and haddock, all other things being equal, would likely be offset by an increase in imports from key import partners. The effect on food security would therefore likely be minimal. For species such as Nephrops (scampi), where the UK accounts for a significant share of global production (58%), a reduction of landings may be more difficult to substitute. However, domestic consumption is a very small share of landings, and the redirection of exports to satisfy consumption may occur.

It is important to monitor population status and the proportion of fish stock being exploited as indicators of marine biodiversity and the sustainability of the UK seafood industry. The population status of some sensitive fish and shellfish stocks in the Celtic Seas and Greater North Sea shows a mixed picture. Some species have declined in both the short and long term while the status of others has improved. On balance, a greater number of species are recovering. Between 1999 and 2019 the proportion of fish stocks within biologically sustainable levels in seas around the UK increased from 42.1% to 57.9%. Figures for fish stocks within biologically sustainable levels have plateaued, having remained the same from 2015 to 2019.

Similarly, while there has been some annual deviation, the proportion of fish stocks that are being overexploited in seas around the UK has decreased over the last 20 years from 63.2% in 1999 to 26.3% in 2019 (the most recent year that data is available). Note that measures are based on a group of 20 species in 57 stocks for which there are reliable estimates. The indicator stocks include a range of local and widely distributed species of major importance to the UK fishing industry. The statistics show promising progress towards halting the decline in species population status and overexploitation. The indicator is not available for reporting in 2024 in a finalised form.

For 2024, 36 of the 79 baseline Total Allowable Catch (TAC) were consistent with ICES advice (46%). This is an increase of 6% compared to 2023 where 32 TACs (40%) were consistent.

Exports

The UK is a net exporter of herring, mackerel, salmon, nephrops (langoustines) and scallops. Between 2018 and 2022 the EU remained the largest export market for UK seafood. However, exports decreased to many of the UK's biggest market countries both within and outside the EU. The main outlier was exports to France which increased from 78,400 tonnes in 2018 to 115,300 tonnes in 2022. Variations are driven by UK landings (which reduced by 7.7% between 2018 and 2022), and aquaculture production (see below for details).

Domestic Aquaculture

Aquaculture in the UK is a growing industry. In 2021, the UK produced 240,000 tonnes of fish and shellfish with a value of £1.17 billion. This was a volume increase of 9% and value increase of 15% from 2020. However, there remains year-on-year variability. In 2022 overall domestic production decreased to 201,355 tonnes, although nominal value increased to £1.32 billion.

The top 5 specifies by volume in 2022 were:

1. Atlantic salmon (169,194 tonnes)
2. Rainbow trout (14,091 tonnes)
3. Sea mussels not elsewhere included (12,510 tonnes)
4. Pacific cupped oysters (2,564 tonnes)
5. Salmonoids not elsewhere included (1,476 tonnes)

Salmon produced in Scotland dominates the sector and in 2022 Scottish salmon represented around 93% of the value of UK aquaculture production. Over the longer term the production of Atlantic salmon produced in Scottish fish farms has increased. Production increased by 17% from 2002 (144,589 tonnes) to 2022 (169,194 tonnes). However, production remains variable year-on-year and 2022 saw an 18% fall from 2021 by volume, although the value of production increased. 2022 levels by volume were also a 17% decrease from 2019. An increase in the population of micro-jellyfish which led to gill health issues was identified as a contributing factor behind this decrease. The UK aquaculture sector may have some capacity to scale up production, to meet demand should salmon imports fall, but there will be a time lag associated with increase production and potential constraints on expansion.

The mortality rate on Scottish salmon farms is explored in Indicator 2.2.1 Animal and plant health.

Climate impacts

Sea surface temperatures in UK shelf seas are projected to continue to increase by between 0.25°C and 0.4°C per decade. Although remaining within thermal limits for many species, this could see increased competition from warmer-water species and northward shifts in plankton production. This is likely to continue to shift the distribution of fish and shellfish species commercially important to the UK northwards. As a result, north-west European waters are likely to see a change in species composition from traditional species such as cod, haddock and saithe, to those currently more widespread in southern Europe such as black seabream, European seabass, sardine, blue fin tuna and anchovy (Townhill and others, 2023). These potential changes in fish distribution may misalign with fishing quota allocations in the UK Exclusive Economic Zone and set by the European Common Fisheries Policy (Baudron and others, 2020).

Warmer waters are also likely to result in increased pressure from marine pests and pathogens such as parasitic copepods (sea lice) that infect salmon and trout and pathogenic bacteria like *Vibrio* species that accumulate in fish, shellfish and crustaceans (Trinanes and others, 2021). (See Theme 5 Case Study 2: Determining increased risk of Vibrio in seafood linked to climate change). Despite this, sea lice incidence could decline due to reduced dissolved oxygen availability at the surface, and vertical separation if fish inhabit deeper waters in response to future warming. This is because the main sea lice species, *Lepeophtheirus salmonis*, affecting salmon are found near the surface.

Sub-theme 2: Sustainability and productivity

2.2.1 Animal and plant health

Rationale

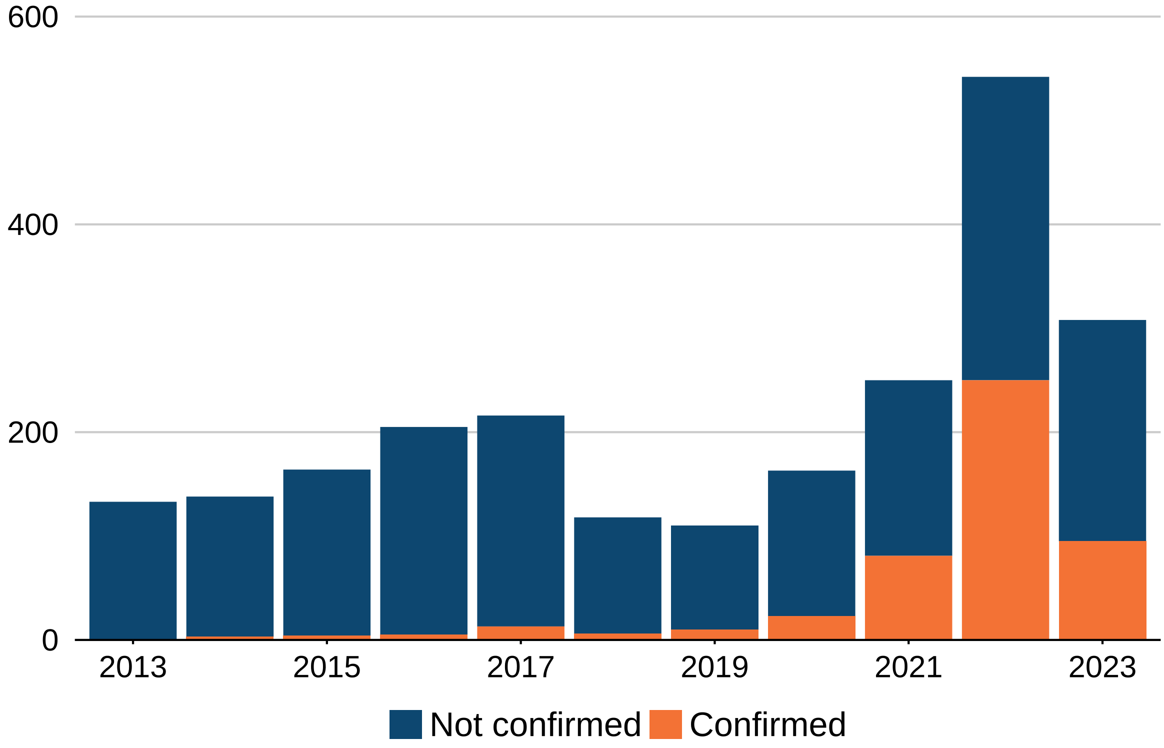
UK food security is dependent on the UK's management of risks to animal and plant health from pests and diseases. Pests and diseases can affect food availability by causing production losses. They can be either endemic, exotic or new and emerging. Endemic means they are already present in the UK and their distribution and presence changes little from one year to the next. Exotic means they are not normally present in the UK. New and emerging means it is too early to determine whether government intervention is needed. Biosecurity measures, such as border controls and testing are used to manage the risk of exotic diseases becoming established in the UK. Managing the integration between people and animals on farm or at the wildlife interface is also important to prevent disease spill-over.

Notifiable diseases are diseases that must be reported to governmental authorities by law, even in suspected cases. These diseases could present a risk to animal or human health. Reporting suspected cases of zoonotic disease allows health protection teams to manage potential outbreaks and prevent further infection in humans. Avian Influenza, which affects poultry, and Bluetongue, which affects cattle, sheep, and other ruminants, are 2 of the diseases that are controlled in this way.

Headline evidence

Figure 2.2.1a: Notifiable animal disease investigations in Great Britain, 2013 to 2023

Source: Animal and Plant Health Agency (APHA)



Reports of exotic animal notifiable diseases have risen with heightened disease risk. From 2020 to 2023, the total number of report cases in Great Britain increased from 163 to 308. In particular, the reports of Avian Notifiable Disease rose from 71 in 2020 to 157 in 2023. In 2023 there were 62 confirmed cases of Avian Influenza in Great Britain. Reports of Bluetongue also increased, from 13 in 2020 to 48 reports in 2023, of which 17 were confirmed cases.

Significantly, between 2020 and 2023 the ratio of reports to confirmed cases of Avian Influenza remained broadly stable, decreasing slightly as reports increased. This means that government veterinary services are continuing to detect disease early and livestock keepers are remaining vigilant to emerging disease risks. Data for Great Britain is broadly consistent with Northern Ireland [risk assessment.]

The average number of report cases of exotic notifiable diseases per year between 2013 and 2023 has been 223. Where the number of report cases per year has exceeded this, it has been in years where there has been a confirmed outbreak of Avian Influenza and the increased number of report cases are a result of greater vigilance by animal keepers. Similarly, an increased awareness of the risk posed by Bluetongue also increased report cases in 2016.

The Animal and Plant Health Agency (APHA) publish a monthly animal disease surveillance report which monitors new and existing diseases in cattle, sheep, pigs and poultry across England and Wales. Details on how the disease risk is assessed and how risk incursion levels in the disease surveillance report are calculated are available following the links. A similar report is produced for Scotland by the Scottish Agricultural Colleges Veterinary Services Division (SACVSD).

Plant pest outbreak data

While some UK pest and diseases have affected domestic production (see further analysis below), ascertaining the overall effect these diseases have had on food security is complex and beyond the scope of this report. The risk from climate change to animal and plant health is discussed in Theme 1 Indicator 1.5.2 Global One Health.

Supporting evidence

Biosecurity and exotic pest and disease risk

The UK Plant Health Risk Register (UKPHRR) provides information on more than 1,400 plant pests and diseases, including their presence or absence in the UK and the pathways by which they can be spread. One measure that can be tracked using the UKPHRR data is the number of GB quarantine (notifiable) pests moving from being absent to present in the UK. No quarantine pest and disease moved from being absent to present from 2022 to 2023. There is no historical data available for this measure. Further information on the UKPHRR and trade in plants is available.

Over the period 1969 to 2022, invasive non-native species have become more prevalent in the countryside. Since 1969, the number of these species established in or along 10% or more of Great Britain’s land area or coastline has increased in the freshwater, marine (coastal) and terrestrial environments. This has likely increased the pressure on native biodiversity. Comparing the latest data point from 2022 with the previous one, 2019, the number of invasive non-native species established in or along 10% or more of Great Britain’s land area or coastline has increased in terrestrial environments (from 60 to 61 species). It has also increased in freshwater environments (from 13 to 14 species) and remained the same in marine environments (29 species).

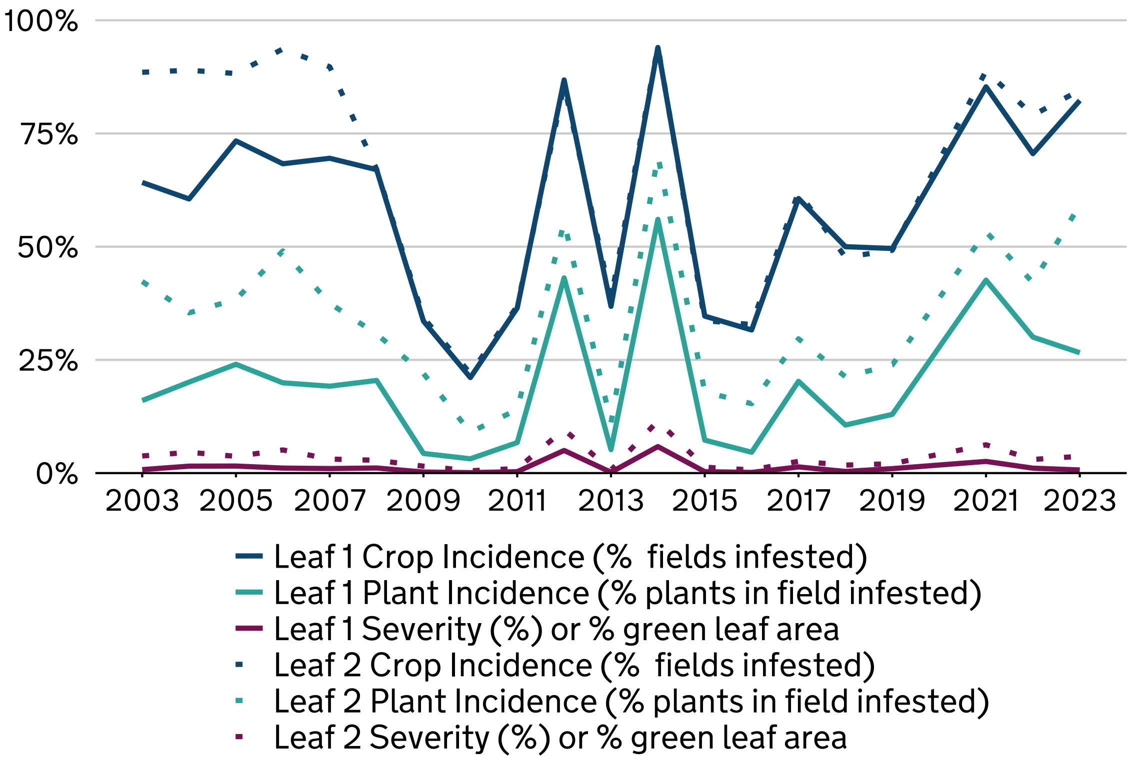
A case study on the outbreak of the Colorado beetle (Leptinotarsa decemlineata) in 2023 can be found at the end of this indicator.

Endemic pest and disease risk

Wheat

Figure 2.2.1b: Septoria tritici plant crop incidence and severity, July 2024.

Source: [Crop Pest and Disease Survey]



The Crop Pest and Disease Survey looks at the major disease and pests affecting wheat and oilseed rape. For wheat, this indicator tracks Septoria tritici as it's the most important and damaging foliar disease on winter wheat in the UK. The pathogen reduces green leaf area for photosynthesis. It causes significant yield loss every year. It also affects grain quality. Losses of 50% may occur in severely affected crops. Unusually dry weather throughout May and June may reduce losses, but heavy dews can still allow infection. Higher rainfall areas, in the south and west, are most at risk (AHDB).

Although wheat is the main host, the disease occasionally affects rye, triticale and some grass species (AHDB).

The first two leaves are the biggest contributors to wheat yields. Between 2003 and 2023, the percentage of plants whose first leaf was affected by Septoria tritici fell by 66% percent to 26.6 points at the national level. Crop incidence (number of fields affected) rose by 18.2% percent to 82.3 points and the severity of infection (percentage of each plant affected) fell by 1% to 0.7% (Crop Pest and Disease Survey).

The percentage of plants whose second leaf was affected by Septoria tritici rose by 23.4% to 59.2% at the national level. Crop incidence (number of fields affected) rose by 32.9% to 84.5% and the severity of infection (percentage of each plant affected) fell by 2% or 3.7%. This means that in 2023 less plants in more fields were getting affected by Septoria tritici than in 2003 (Crop Pest and Disease Survey). The severity of the disease has not increased in line with the rise in crop and plant incidence over the last 20 years.

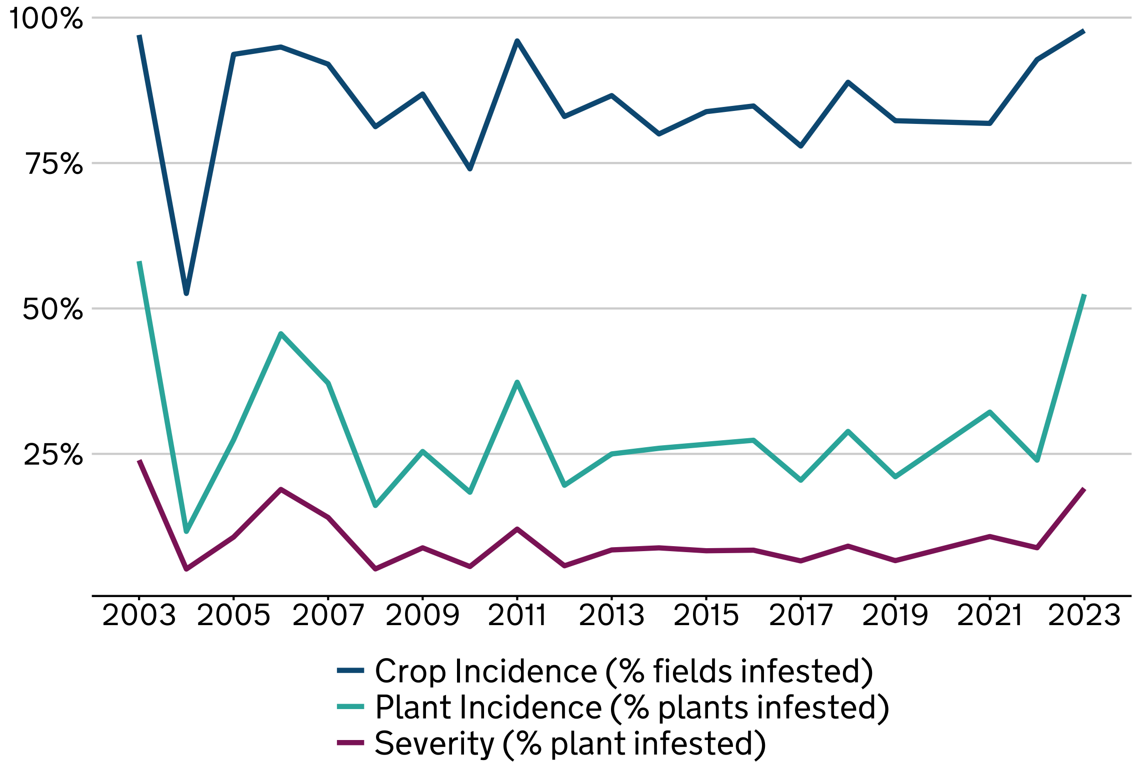
Fungicides can either be protective, eradicative or a mixture of the two. AHDB data shows that while protection from Septoria tritici has increased between 2018 and 2020, protection from mixed operation fungicides has reduced since 2020. Maintaining fungicide efficacy is important to being able to effectively manage fungal disease.

Oilseed rape

Cabbage Stem Flea Beetle (CSFB), a major pest of winter oilseed rape which can destroy a plant's growing point and cause crop failure (AHDB) has spread in recent years (John Innes Centre, 2019). CSFB in the UK continues to display resistance development to pyrethroids which has led to control failures (Wills and others, 2020). Climate risk modelling has shown that high CSFB pressure is associated with hot and dry summers, warm autumns and mild winters (AHDB). AHDB are monitoring CSFB at several winter oilseed rape sites across England during autumn 2024. The monitoring data will strengthen a long-term data set that shows how CSFB migration varies annually and regionally in response to local conditions. In addition, the ongoing annual (for the past 40+ years) Defra Crop Pest and Disease survey monitors larval populations of the beetle at specific crop growth stages across England and Wales. The survey assesses how risk is influenced by changes in weather, agronomic practice, crop protection and economic considerations.

Figure 2.2.1c: Phoma Canker plant crop incidence and severity, July 2024.

Source: Crop Pest and Disease Survey



Phoma canker was selected as it is a significant disease affecting oilseed rape. It is used in vegetable oils as biofuel and can be used as an animal feed. Oil has become an important substitute to sunflower oil since Russia's invasion of Ukraine. Other significant diseases of oilseed rape include light leaf spot, sclerootinia and clubroot.

Yield-reducing cankers make Phoma one of the most serious diseases of winter oilseed rape in the UK, especially in central, southern and eastern England. Despite fungicide treatment, infection is estimated to cause economic losses of about 20-78 million each season based on disease prevalence data, yield loss estimates, production data and average price 2012-2021. Early Phoma epidemics on small plants are associated with the greatest yield losses, with typical reductions of 0.5 tonnes per hectare in susceptible varieties.

Between 2003 and 2023, the percentage of plants in the Crop Pest and Disease Survey affected by Phoma Canker fell by 9.8% to 52.4% at the national level. Crop incidence (number of fields affected) rose by 0.8% to 97.8% and the severity of infection (percentage of each plant affected) fell by 20.3% to 19.1%. This means that in 2023 less plants in a similar number of fields were getting less severely affected by Phoma Canker than in 2003. From 2003 to 2023, the severity of infection and plant incidence both decreased and crop incidence slightly increased.

The effect of pest and diseases on crop yield varies significantly year-on-year and is highly weather dependant. For example, Phoma leaf spot generally starts to show on infected leaves after at least 20 days of rainfall (AHDB). The relationship between disease incidence and food security is complicated and a rise in disease incidence in the UK does not necessarily translate into an increased food security risk.

Bovine Tuberculosis

Bovine Tuberculosis (TB) is a chronic bacterial disease of cattle and can have a significant impact on the work of farms. Cattle which are found (or are highly likely) to have TB are slaughtered. Additionally, when an animal in a herd tests positive for the disease, the whole herd is put under movement restrictions until all the remaining animals are tested repeatedly with negative results.

Milk from TB test reactor cows cannot enter the human food chain. Milk from non-reactor cows in TB-restricted herds can be used for human consumption subject to pasteurisation. Meat from cattle that are slaughtered for TB control reasons can enter the human food chain subject to veterinary public health inspection.

In Great Britain statistics are presented every quarter at country, regional and county level. In Northern Ireland, the Department of Agriculture, Environment and Rural Affairs (DAERA) collates and publishes separate official statistics on TB in cattle, the latest report is available. Although the incidence and prevalence rates have shown fluctuation over the last 3 years, it has remained largely stable with no sharp rises and improvements in some places. In addition, Scotland has had official TB free status since 2009. In the north and east of England, bovine TB herd incidence and prevalence remain very low.

Scottish salmon mortality and sea lice

Monthly mortality as a percentage of biomass on Scottish salmon farms (and across other countries) has generally been increasing since 2011 due to various health issues and warmer winters. The mortality rate reported in 2023 peaked at 4.82% in October 2023. This is an increase from the peak in 2020, which was recorded at 2.64% in August 2020. However, mortality as a percentage of fish over a production cycle (numbers input minus output market) has remained steady since the 1990s when bacterial vaccines were introduced. Mortality is a limiting factor in maximum production potential (Moriarty and others, 2020).

Sea lice are an issue on salmon farms. Fish infected with lice cannot be sold to market due to damage from the lice. Even at low levels, sea lice can represent a threat to wild fish populations when farm infestations are not contained. In extreme cases, sea lice infestations can also increase salmon mortality on salmon farms. Sea lice counts are managed between 2 lice per fish (where increased surveillance is required) and 6 lice per fish (the threshold at which action is required). The upper threshold is rarely exceeded. However, sea lice treatment can itself be associated with significant mortalities if the treatment goes wrong, especially mechanical methods (hydrolicer, thermolicer) that can stress the fish. Between 2021 and 2024 the upper quartile of the average number of sea lice per fish across all farms peaked in January 2022 at 1.5 sea lice per fish. The highest average sea lice count in 2024 (up to 13 May 2024) was recorded in February at 0.67 lice per fish. Overall, average sea lice count has reduced since 2022 (Rabe and others, 2024).

Antimicrobial resistance (AMR)

Sales of veterinary antibiotics for use in food-producing animals, adjusted for animal population, decreased to 25.7 mg/kg in 2022. This is a 9% (2.6mg/kg) decrease since 2021 and an overall 59% (36.6mg/kg) decrease since 2014. This represents the lowest sales ever recorded and a positive trend in terms of reducing AMR on the farm to support animal health in the long term.

Case Study 2: Colorado beetle (Leptinotarsa decemlineata) outbreak

In July 2023, the Animal and Plant Health Agency (APHA) confirmed findings of single Colorado beetle colony in a single potato field in Kent, UK. This represented a risk from an exotic pest.

This beetle first became established in Europe in France in 1921, before establishing in most other European countries. The beetles are occasionally imported into the UK from continental Europe as ‘hitchhikers’ on non-host plant material, such as leafy vegetables, salad leaves, fresh herbs and grain. However, the beetle has yet to establish in the UK and the outbreak in 2023 was the first since outbreaks in 1977.

If not eradicated, Colorado beetle is a significant threat to potato crops for domestic consumption and export prohibitions. The adult beetles and larvae feed on the foliage of potato and several other plants in the nightshade family and can completely strip them of their leaves if they are left uncontrolled.

Official surveillance was carried out to 5 km in potato fields, allotments and private gardens to detect the presence of other Colorado beetles in 2023 and 2024. These actions are in line with Defra's contingency plan for the beetle. No Colorado beetles were found in 2024. Further surveillance will be carried out in 2025 to confirm eradication of Colorado beetle.

Through the official national surveillance programme and stakeholder vigilance, with officials responding to reports from growers, farmers, processors, agronomists, and members of the public, the UK can detect findings of the beetle early. It can then eradicate it before it is able to establish and spread.

2.2.2 Food waste

Rationale

Food waste represents a significant economic and environmental loss within the food system due to unnecessary land and resource use, excess carbon emissions and avoidable soil degradation. High levels of food waste across agriculture and industry are also a negative factor in productivity, as excess effort has been applied to produce food that holds little financial value. Levels of household food waste are a measure of the sustainability of UK diets (FAO,2019) (see Theme 4 Indicator 4.3.3 Sustainable diet).

Headline evidence

Figure 2.2.2a: Total food waste arising in the UK, by sector and including household waste, 2021

Source: WRAP: UK Food Waste and Food Surplus

Sector	2021 Waste volume (million tonnes)	% share
Household	6.4mt	60%
On-farm	1.6mt	15%
Manufacture	1.4mt	13%
Hospitality & Food Service	1.1mt	10%
Retail	0.2mt	2%
Total	10.7mt	100%

The definition of 'food waste' covers both edible parts (wasted food) and inedible parts (including eggshells, animal bones and inedible fruit peel). In 2021 the Global Environmental Action NGO Waste and Resources Action Programme (WRAP), estimated that 10.7 million tonnes of food went to waste in the UK. Total food waste in the UK is equivalent to 25% of all food purchased. Household food waste represented the biggest share at 60% (6.4 million tonnes). Note that there is significant uncertainty around the amount of on-farm waste, with WRAP estimating this to be between 0.9 and 3.5mt. This report uses WRAP's central estimate of 1.6mt. In 2021, 71% of food waste was edible parts and the remaining 29% was inedible parts (this excludes on-farm waste).

Supporting evidence

Total food waste per capita in the UK amounted to 115.7kg in 2021, representing a 5.6% increase compared to 2018, but a reduction of 18.3% compared to 2007. Breaking this down, food waste collected from UK households by UK authorities (not including food waste going down the sewer and home composted) amounted to 75.5kg per person in 2021. This represents a 13.5% increase compared to 2018 yet is still a 17% reduction compared to 2007. Retail food waste per capita reduced by 8.5% between 2018 and 2021, and by 26.0% from 2007. Similarly, manufacturing food waste per capita reduced by 9.2% between 2018 and 2021, and by 33.6% from 2007. How these trends relate to targets on food waste is discussed in The Courtauld Commitment 2030 Milestone Report 2023.

Household waste

The relationship between food prices and household earnings contributes to the levels of household food waste; lower prices in relation to household earnings are associated with more food purchased and subsequently more food wasted. In 2021 food prices relative to earnings were lower compared to previous years, with a 9.2% decrease from January 2018 to January 2021. Additionally, the coronavirus (COVID-19) pandemic may have contributed to increased levels of household food waste in 2021 as more food was consumed in the home during this year compared to pre-pandemic years.

Of the total 6.4 million tonnes generated by UK households, (based on data collected in 2021/22, 74% (4.7 million) was classified as edible parts. Fresh fruits and vegetables saw the highest wastage rate of all groups, with potatoes being the most wasted food overall. The cost to households of purchasing food and drink that was subsequently wasted was £17 billion. This figure is for edible parts only and does not include other costs associated with this food such as cooking, storage, and transport from the shop to the home. This equated to an estimated £250 per person each year, £600 per household, or £1000 for a household of 4. Meat and fish made up 19% of the total food waste by financial cost to householders despite making up only 6% of food waste by weight.

Household food waste greenhouse gas emissions

Waste further diminishes sustainability in the food system by generating greenhouse gas (GHG) emissions. Data collected in 2021/22 showed that wasted food and drink in the UK accounted for approximately 18 million tonnes of CO_2 equivalent, which is around 3% of total GHG emissions relating to consumption in the UK. This figure included contributions from relevant components of the food and drink system including land-use change, agriculture, manufacture, packaging, distribution, retail, transport to the home, storage and preparation in the home, and waste treatment and disposal. Broken down by food group, despite making up only 6% of food waste, meat and fish contributed the largest proportion of GHG emissions of wasted food (26%). Further information on the environmental impact of UK diets is covered in Theme 4 Indicator 4.3.3 Sustainable Diet.

Food waste and surplus on farms

In 2019 WRAP estimated food surplus and food waste levels from primary production, based on the best available data from the UK taken from around the world. Food surplus is material that was at risk of becoming food waste, but went instead for redistribution, animal feed, or to become bio-based materials. This typically happens with grains, root vegetables, brassicas and top fruit such as apples. The estimated 3.6 million tonnes of combined food waste and food surplus equated to 7.2% of all food harvested (2019). This would have had market value of £1.2 billion at farm gate prices, although a small part of this value is recovered through sales for animal feed and bio-based materials. Food surplus was estimated at 2 million tonnes per annum (4% of all food harvested), while food waste was estimated at 1.6 million tonnes (3.2% of all food harvested). Breaking the food waste down by food groups, horticultural crops made up 54% of the total, cereals 30%, livestock 8% and milk 8%. Causes of waste in primary production may include weather, pest and disease occurrence, supply and demand and storage conditions.

Redistribution

Around 2.8 million tonnes of food surplus from farms, manufacturing, retail and hospitality, and food service is either being distributed via charitable and commercial routes or being diverted to produce animal feed. Both are classed as waste prevention according to the food and drink waste hierarchy. The amount of surplus food being redistributed by charitable and commercial routes in the UK is steadily increasing. Figures published by WRAP show that in 2023 organisations (which had been included in the WRAP survey) reported receiving around 191,000 tonnes of redistributed food. This equates to food worth approximately £764 million and corresponds to nearly 456 million meals. This is an increase of 15% from 2022. While tonnes of surplus food redistributed by charitable and commercial channels have both continued to rise, charitable channels remain far more dominant accounting for 65% surplus redistributed.

Data limitations

The WRAP data relied upon for this report is from 2021 and is not yet updated for 2024. It should be noted that while the UK evidence base on food waste has been recognised as one of the strongest in the world, there remain significant uncertainties associated with the data. The quality of data varies by sector, from households and retail (both relatively accurate), to manufacture and hospitality and food service (relatively weak) and primary production (weak, and partly modelled using non-UK data).

2.2.3 Agricultural productivity

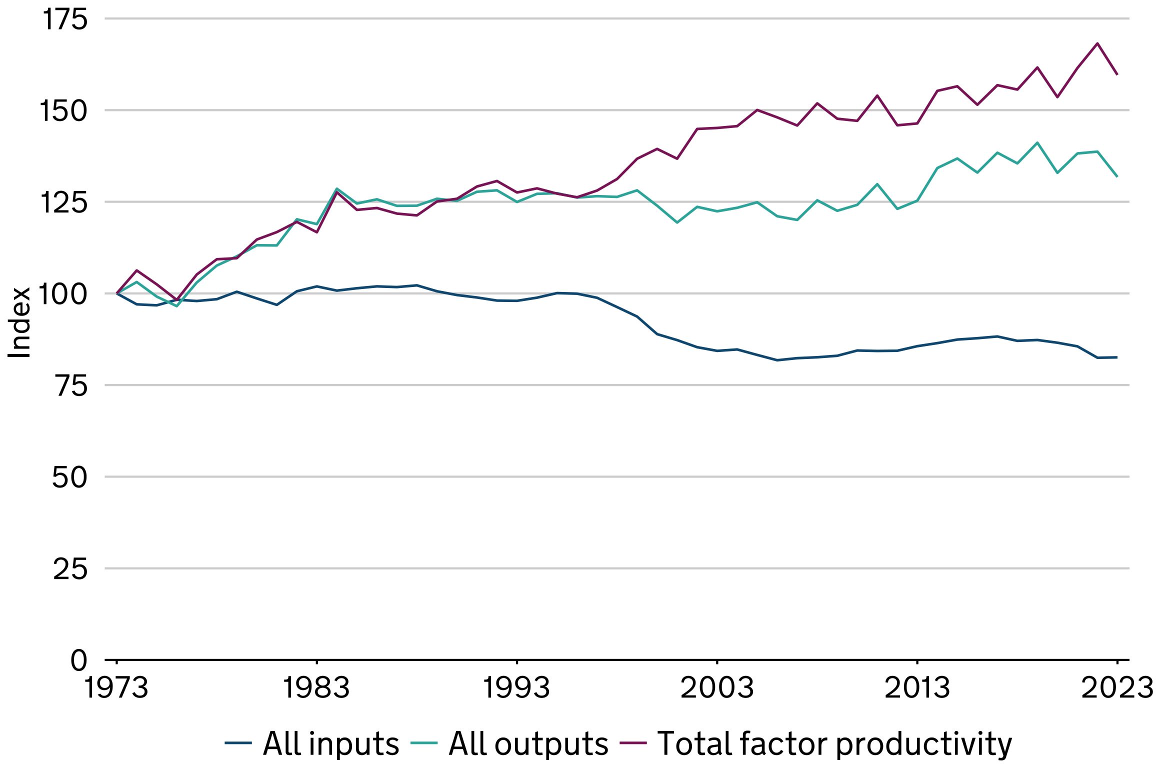
Rationale

This indicator uses Total factor productivity (TFP) to assess agricultural productivity. TFP is the ratio of agricultural outputs over agricultural inputs, giving a measure of efficiency of production. More efficient production supports UK food security by allowing the UK to produce at least the same amount of food with less inputs, or higher output for the same input. This reduces dependencies on finite resources like land and fertiliser. Increased agricultural productivity can be either damaging or conducive to environmental sustainability depending on the nature of the change. Inputs included in agricultural TFP are purchases (for example seeds and fertilisers), consumption of fixed capital, all labour, and land. Output is the volume of sales.

Headline evidence

Figure 2.2.3a: Total factor productivity of the agricultural industry, 1973 to 2023

Source: [Total factor productivity of the agricultural industry - GOV.UK (www.gov.uk)]



In recent years TFP has been volatile. TFP is estimated to have decreased by 1.2% between 2021 and 2023. This was driven by a decrease in the volume of outputs that more than offset a fall in inputs. The volume of all outputs decreased by 4.6% which included decreases across the majority of crop and livestock volumes.

The volume of all inputs decreased by 3.5% between 2021 and 2023. The majority of inputs decreased, with energy use decreasing by 9.0% and fertilisers decreasing by 25%. The decrease in fertiliser use was largely driven by rising energy prices starting in 2021, a phenomenon exacerbated by Russia's invasion of Ukraine, with gas being a key input to fertiliser production. See Theme 3 (Indicator 3.1.1 Agricultural inputs) for further details. TFP itself has not been affected substantially by this, as output prices were high and output itself remained stable in 2022 compared to 2021 (and indeed up on 2020 levels).

Supporting evidence

Since the series began in 1973, agricultural TFP has increased by 60%, driven by an increase in the volume of all outputs by 32% and a decrease in the volume of all inputs by 17%. TFP has grown at an annual average rate of 1% between 1973 and 2023, although this growth has not been constant over this time. From approximately the year 2000, agricultural output has been volatile, whereas the input series shows a smoother trend despite a sustained decline in the early 2000s. The TFP series tracks more closely to the output series volatility than the smoother input series.

Between 1984 and roughly 2000, TFP growth was on average 0 in the UK. Barriers to achieving consistent positive agricultural TFP include the slow adoption of new on-farm technology and practices due to farmers' risk aversion, and lack of access to accurate information regarding the benefits of adoption. New technology can in most cases be costly. Thirtle suggests the main reason for the stagnation during this period was the sharp decline in publicly funded agricultural research and development (agri-R&D) in the early 1980s (Thirtle and others, 2004). In 2022, the UK government spent roughly 2% (£300m) of R&D expenditure on agriculture, down from 4% in 2012.

Since 2000, TFP has increased by an average of 1% per year due to a reduction in inputs for a stable output, however it is documented that TFP in the UK remains behind our international competitors. International comparisons of TFP are difficult due to data limitations and differing methodologies.

Although external factors such as prices, weather conditions and disease outbreaks may have a short-term impact on productivity, it is technological development and innovation that is expected to improve productivity over a longer period. The overall upward trend in the UK is therefore an indicator of recent innovation in the sector (for example the Agritech strategy in 2013 and Transforming Food Production Challenge which ran 2019 to 2024). A specific example of innovation is where yields of wheat increased by 5 to 10% with the introduction of the Reduced Height genes during the Green Revolution. Further research is underway helping semi-dwarf wheat grow in water-limited environments, mitigating potential impacts of climate change. Another example is the collaboration between Cranfield University and the European Space Agency in 2014 to create 'FarmingTruth', a precision agriculture service which combines soil data with satellite images to improve crop yields. This led to a reduction in nitrogen fertiliser.

The impacts of climate change on agricultural production will vary across the UK. It will affect the range and quality of ecosystem services that agricultural production relies upon, including climate control, flood regulation, biodiversity and nutrient cycling. Agriculture has already invested in new R&D introducing new genotypes, varieties, breeds and management practices. However, there will be a need for further anticipatory adaption measures as the climate continues to change.

2.2.4 Land use

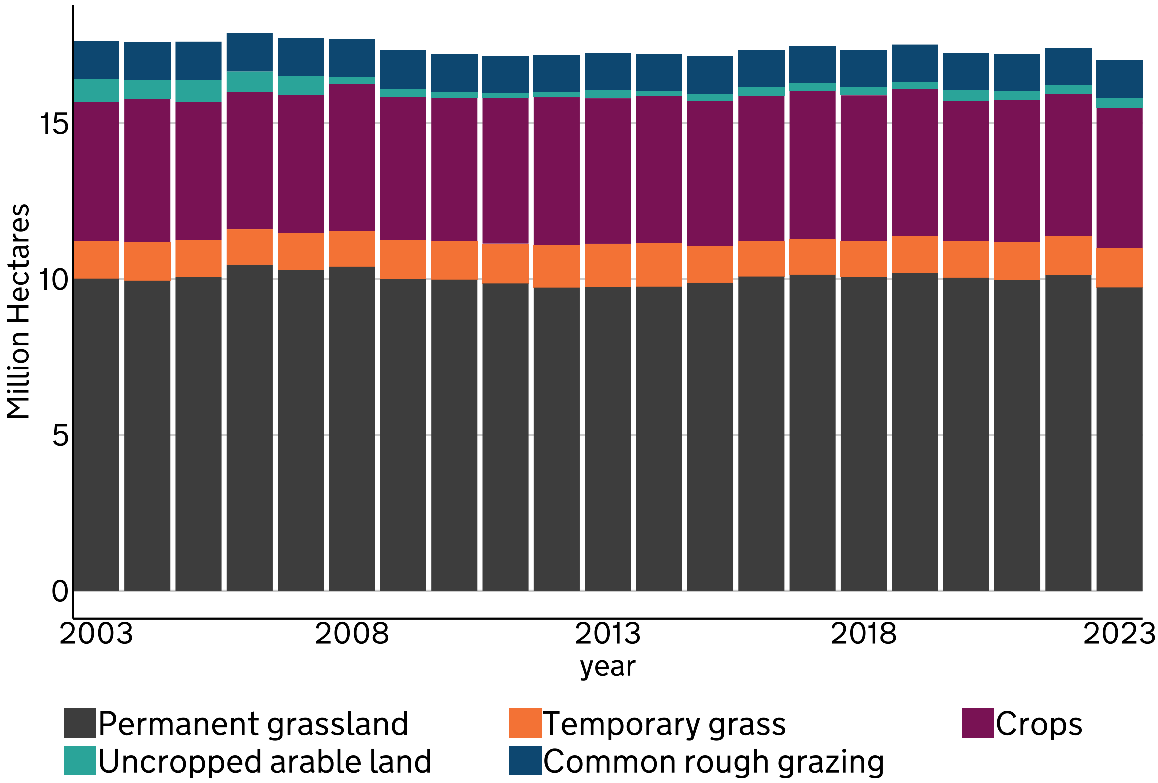
Rationale

Measuring utilised agricultural area (UAA) gives a high-level view of how the UK is using the agricultural land available to produce the UK's food. Land available for food production gives an indication of the long-term sustainability of our domestic production. This is because it is unusual for land to enter agricultural use, so it is necessary to monitor UAA levels for any trends towards a decline. However, there is not a direct link between UAA and food production and indeed a decline in UAA with increased efficiencies can still produce an increase in food production. It is productivity with respect to land that is significant when seeing how production responds to land use changes.

Headline evidence

Figure 2.2.4a: Total utilised agricultural area (UAA) by type, 2003 to 2023

Source: [Agricultural Land Use in the UK (Defra)]



The total UAA has seen a gradual but small decrease over the long term. In 2023 there were 17.0 million hectares of UAA covering 70% of land in the UK. This represents a 3.5% decrease from 2003 and a 1.4% decrease from 2020. The distribution of area for different types of land has remained broadly the same. UAA is made up of arable, horticultural, uncroppable arable, common rough grazing, grassland (temporary and permanent), and land for outdoor pigs. It does not include woodland or other non-agricultural land. Not all land is equal; gradient, soil quality, rainfall, water levels and other factors make much of the UK's agricultural area unsuitable for crops, while other parts are suitable only for specific crops. The high proportion of grassland primarily reflects the unsuitability of much of the UK's land for growing crops, and the relative suitability of those areas for grazing.

Supporting evidence

Change from UAA to other uses

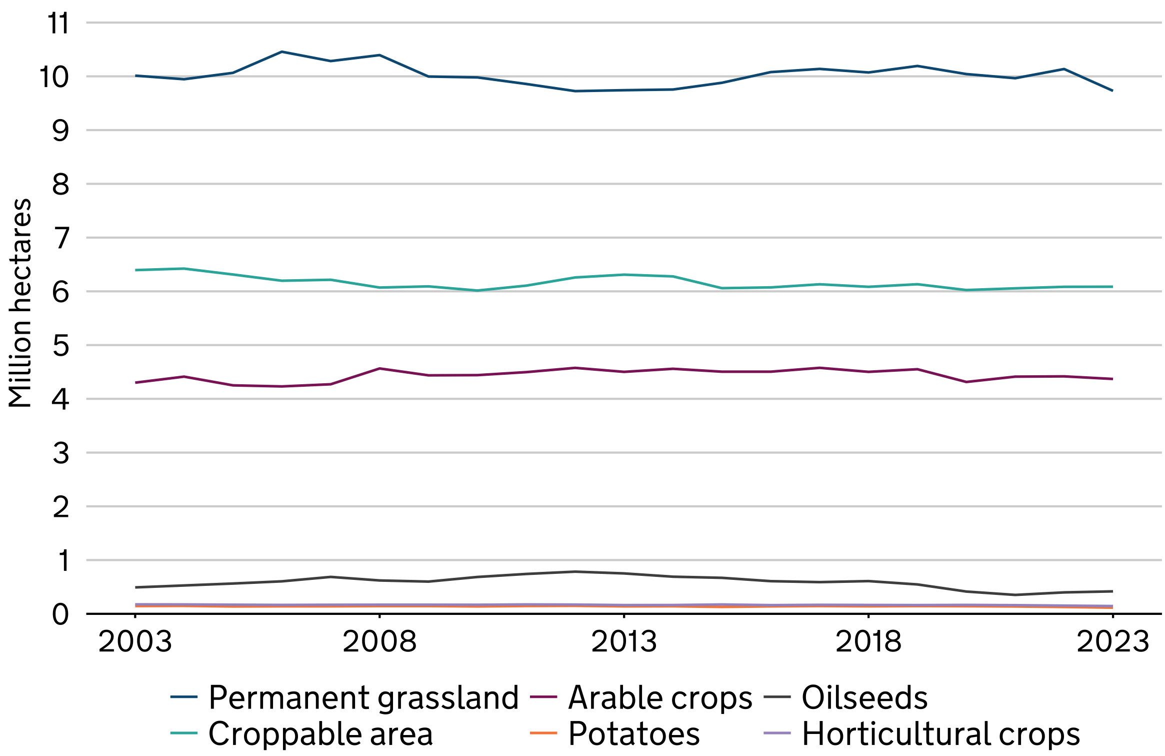
While there has been a small reduction over the long term, the UK is broadly maintaining its level of total UAA at around 70%, with some year-on-year variation. Greater fluctuation happens in terms of uses within UAA (see below) although that is also quite stable. Defra will be publishing the UK wide agricultural land use figures for 2024 on 12 December 2024. Looking ahead, based on current government policy framework for incentivising types of land use, it is expected that there will be increases in land use change from agricultural land to other uses. These uses include woodlands, grasslands, and restored peatland, as well as some being devoted to economic infrastructure like energy and housing. The impact this will have on food production will be affected by the kind of land being taken out of production. For instance, the impact is negligible if it is unproductive land which is taken. It is plausible that with continued growth in output and conducive market conditions, that food production levels could be maintained or moderately increased alongside the land use change required to meet our Net Zero and Environment Act targets and commitments. However, analysis projecting decades into the future involves significant uncertainties. The government is due to publish a land use framework to guide land managers on the balance of opportunities and risks.

Climate changes mean that types and quality of land are a moving picture (for which there is a data gap). Land classification data is being reviewed so it is challenging to map in the UK where losses and gains are for production.

Change and uses within UAA

Figure 2.2.4b: UK croppable area by area type, 2003 to 2023

Source: [Agriculture in the UK (Defra)]



Changes in how UAA is used has been a much more important variable affecting food production than changes in total UAA available. How UAA is used is largely determined by land type and factors such as weather. The majority of UAA (57%) is permanent grassland. Permanent grassland is land used for at least 5 consecutive years to grow grasses, legumes, herbs and wildflowers. It is land which is not included in the crop rotation and is typically land unsuitable for cultivation. Permanent grassland is often part of a livestock farming system, as it can be used to provide forage. The area of permanent grassland has remained relatively stable but did decrease by 3.1% between 2020 to 2023.

The croppable area consists of cereals, oilseed, potatoes, other arable crops, horticultural crops, uncropped arable land, and temporary grass. The total croppable area in the UK was just over 6.0 million hectares in 2023 and accounted for just over a third (36%) of UAA. This remained broadly unchanged between 2020 and 2023, increasing by 1%. Within this, some crops had greater changes than others. Much of the annual variation between specific crops is due to factors such as the weather and prices rather than any long-term and more systematic variation. Year-on-year land use change is typically in the range of 0% to 5%. The scale of change over the last 3 years is largely within or close to this typical range, although there have been noticeable declines in areas of both potatoes and horticulture.

The total area of **arable** crops increased by 1.3% between 2020 and 2023 and stands at just under 4.4 million hectares. Published figures for England at 1 June indicate that overall areas of arable crops declined from 2023 to 2024, largely due to flooding and difficult weather conditions. This resulted in failed crops and a partial switch to spring plantings. **Cereal** crops accounted for 71% of the total area of arable crops across the UK. The total area of cereal crops in the UK increased by 1.0% between 2020 and 2023 to almost 3.1 million hectares. This also represents a 2.0% increase in area of cereals from 2013. The total area of **oilseeds** (oilseed rape, linseed and borage) increased by 0.6% between 2020 and 2023 (418 thousand hectares). However, this is a 44% decrease from 2013.

The area of land sown in the UK for **potatoes** decreased by 19% between 2020 and 2023 (to 115 thousand hectares), which continues the decline in this area since 2019. It is also a 17.5% decrease in the area of potatoes since 2013. The area of **horticultural** crops (of which 91% is used to grow fruits and vegetables), decreased by 12.6% between 2020 and 2023 (to 145 thousand hectares). Indicator 2.1.2 Arable products (grain, oilseed and potatoes) and Indicator 2.1.4 Fruits and vegetables explore production volumes.

Use of produce

The majority of crops are used for **animal feed** rather than direct human consumption, with some crops also being used for bioenergy. Cutting across both grassland and croppable land, in 2023 85% of the total UAA was used for animal feed or animal production. This proportion has remained fairly stable since 2020. In these estimates all grassland has been assumed to be used for animal feed and 58% of the total croppable area. Animal feed is therefore a major use of UK agricultural land. Livestock, which consumes animal feed offer a much less efficient calorie conversion than crops for direct human consumption. The dominant use of land for animal feed in the UK is therefore an important consideration for questions around the sustainability and productive capacity of UK food production. Further research is needed to understand the full implications for food security. It is generally not practical to convert non-croppable UAA to crops for human consumption due to economic viability, environmental issues, soil types, weather and other factors, whereas all croppable land has the potential to be used for human consumption.

In 2023, 133 thousand hectares of agricultural land in the UK were used to grow crops for **bioenergy**, this is a 9% increase on total area in 2020. In 2023 crops grown for bioenergy represented 2.2% of the arable land in the UK. 36% of land used for bioenergy was for biofuel (biodiesel and bioethanol) in the UK road transport market, with the remainder mostly used for heat and power production. Maize used for anaerobic digestion was the largest contributor, with 73 thousand hectares (England only) being used for bioenergy. This was a slight decrease from 2020 (75 thousand hectares). In 2023, 45 thousand hectares of wheat was also used for bioenergy, this is a substantial increase from 2020 (30 hectares).

Some agri-environmental schemes (AES) have led to land being taken out of food and other crop production to support long-term biodiversity and sustainable production. AES such as the Sustainable Farming Incentive (SFI) may temporarily take land out of production but will not reduce the total UAA. As of July 2024, around 250,000 hectares of land have been entered into SFI options that temporarily restrict food from being produced on that land. For context, this is the equivalent of around 3% of England's UAA (9 million hectares). Other AES, for instance some forms of habitat creation, may lead to a reduction in UAA. The amount of food produced on land varies, so setting aside lower productivity land does not have a proportional impact on food production.

Data caveat

The drop in land area in 2009 is attributable to changes in the English coverage of the farming population and a register cleaning exercise. England figures prior to 2009 cover all farm holdings, whereas figures from 2009 onwards only relate to holdings with significant levels of farming activity (for example, holdings with over 5 hectares, or holdings with over 10 cattle). Full details of the thresholds are available. In addition, a register cleaning exercise in 2009 resulted in a drop in overall land area but had very little impact on levels of farming activity.

It's important to note that while UAA data is estimated annually, this is only done on a sample of farms. A full census is conducted every 10 years, 2010 and 2021 being the most recent, when all active commercial farms in England are asked to complete the surveys. This may account for some small year-on-year fluctuations in accuracy.

Land use is reported by farms based on the most predominant crop in a field. Any farm with silvo-pasture or grazed woodland is asked to record the land under grassland (not woodland) so it is still captured within the UAA. Areas under silvo-arable management are requested to be split so any non-fruit trees would fall within woodland and be excluded from UAA. This may cause small discrepancies in recording.

2.2.5 Biodiversity

Rationale

Biodiversity is the variety of all life on Earth. It includes species of animals, plants, bacteria and fungi, and the natural systems that support them. Agriculture is reliant on healthy biodiversity and can contribute towards it. For example, farmland provides semi-natural habitats, such as hedgerows and field margins, that provide food and shelter. Monitoring the abundance of species is essential for our understanding of the state of the wider environment, particularly as measures of species abundance are more sensitive to change than other aspects of species' populations. It should be noted that for a more comprehensive indication of the state of the wider environment, indicators of species abundance should be reviewed alongside species distribution and extinction risk indicators.

The headline evidence is the 'relative abundance of all species' and the 'relative abundance of priority species' in England only. This is because data for the 'all-species' indicator at the UK level is still in development, and the UK indicator of priority species abundance only covers to 2021 and relies upon an older methodology. Defra are looking to update the data and methodology at UK level.

Headline evidence

Figure 2.2.5a: Change in relative abundance of species in England, 1970 to 2022

Source: [Indicators of species abundance in England (Defra)]

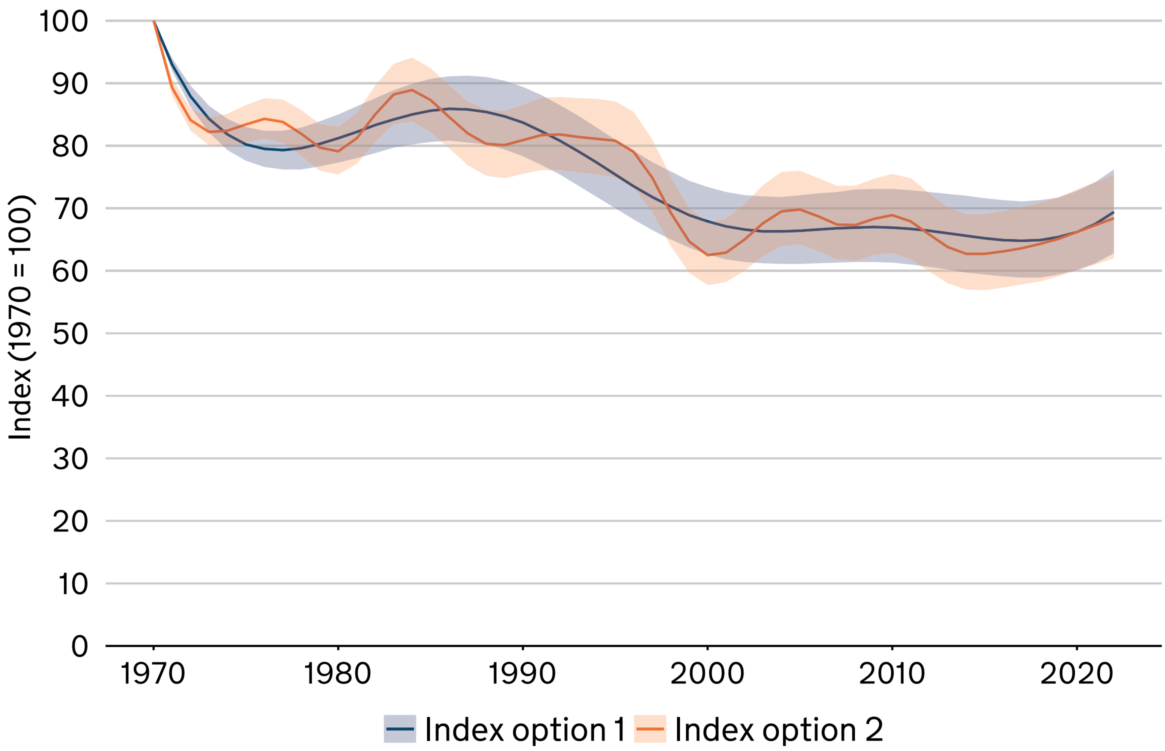
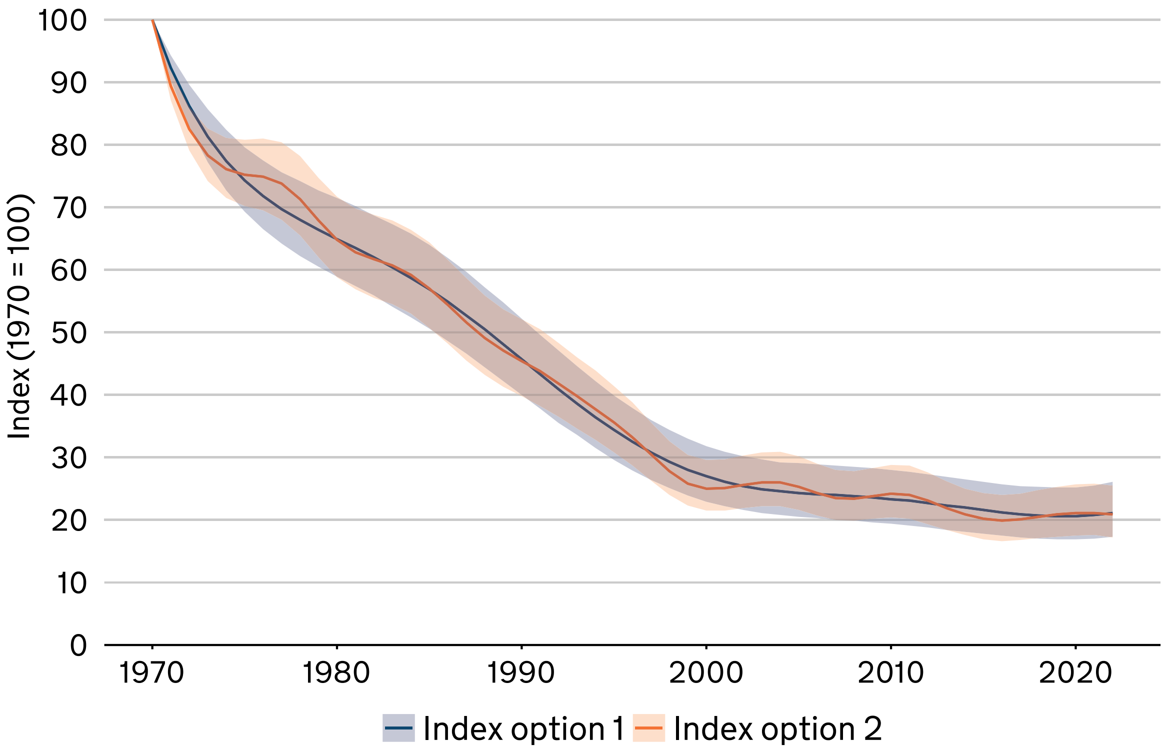


Figure 2.2.5b: Change in the relative abundance of 149 priority species in England, 1970 to 2022

Source: [Indicators of species abundance in England (Defra)]



The all-species indicator draws on data for 1,177 species for which there is suitable data, which mainly represents species found in terrestrial and freshwater environments. It includes wild birds, bees, butterflied fish, freshwater invertebrates, mammals, moths and vascular plants. Priority species are defined as those appearing on the priority species list for England. Currently this measure includes data on 149 of the 940 priority species in England including birds, butterflies, mammals and moths.

For both the all-species and priority species indicators 2 possible versions of the indicator are presented, option 1 being smoothed on a 10-year timescale and option 2 being smoothed on a 3-year timescale. Smoothing is applied to the species abundance indicators to reveal long-term trends in the otherwise noisy data. A greater degree of smoothing may provide a clearer view of the underlying long-term trends while a lesser degree of smoothing preserves the short-term patterns in the data. The shaded area of both options represents a 95% credible interval. Index values represent change from the baseline value in 1970. The credible interval widens as the index gets further from the 1970 value and confidence in the estimate of change relative to the baseline falls. Future development of this indicator includes working towards an indicator for the abundance of all-species at the UK scale. This will help to strengthen Defra’s understanding of the health of the UK-wide ecosystem, upon which agriculture depends.

Both indicators capture a decline in species abundance across England since 1970. For the all-species indicator, this trend appears to level around the year 2000 to just under 70% of the 1970 value. Over the past 5 years, fluctuations in the all-species indicator have been within the 95% credible intervals and therefore are not considered to represent meaningful change (credible intervals capture uncertainty in the trends of individual species that contribute to the index). The priority species indicator has declined much further than the all-species indicator, to just over 20% of the 1970 value, but with a similar levelling off period from 2000. The statistics show promising progress towards halting the decline in species abundance.

Supporting evidence

Farmland birds

Farmland bird populations have long been considered a good indicator of the broad state of wildlife and the environment in the UK on which agriculture relies on. This is because they occupy a wide range of habitats and respond to environmental pressures that also operate on other groups of wildlife. In addition, there is considerable long-term data on trends in bird populations, allowing for comparisons between trends in the short term and long term. They also occupy levels in food webs that help give an indication of ecosystem health. In 2023 the UK farmland bird index was 61% below its 1970 value. The majority of this decline occurred between the late 1970s and the 1980s largely due to the negative impact of rapid changes in farmland management during this period. The decline has continued at a slower rate in the short term, showing a decline of 9%. The long-term decline has been driven mainly by the decline of those species that are restricted to, or highly dependent on, farmland habitats, such as starlings and tree sparrow. The short-term decline is seen across both specialist and generalist species of farmland bird.

Farming practices such as the loss of mixed farming, a move from spring to autumn sowing of arable crops, and a change in grassland management all contributed to this decline. While some farming practices continue to have negative impacts on bird populations, most farmers do take positive steps to conserve birds. Several incentive schemes encourage improved environmental stewardship in farming, for instance uncropped margins on arable fields, and sympathetic management of hedgerows are designed to stabilise and recover farmland bird populations.

Insects

Insects including Butterflies are considered to provide a good indication of the broad state of the environment. This is because they respond rapidly to changes in environmental conditions and habitat management, occur in a wide range of habitats, and are representative of many other insects in utilising areas with abundant plant food resources. The abundance of butterflies on farmland has declined from the start of the time series in 1990. Specialist farmland species in particular have shown strong declines.

Pollination is an important ecosystem service that benefits agricultural and horticultural production and is essential for sustaining wildflowers. Many insect species are involved in pollination. Bees and hoverflies are some of the most important and are presented here as indicators of trends in the distribution of all pollinators. Insect pollination depends on the abundance, distribution and diversity of pollinators. Knowledge of the population dynamics and distribution of those species that provide the service, the pollinators, helps us assess the risk to these values. There was an overall decrease in the pollinator indicator, which is made up of wild bee and hoverfly species, from 1987 onwards. In 2022, the indicator showed a decrease of 24% compared to its value in 1980. Between 2017 and 2022, the indicator showed little or no change.

Many wild bees and other insect pollinators species that have become less widespread can be associated with semi-natural habitats. At the same time, a smaller number of pollinating insects have become more widespread. Loss of foraging habitat is understood to be a major driver of change in bee distribution, and pesticide use has been shown to have an effect on bee behaviour and survival. It has been particularly challenging for hoverflies to recover population. It is unclear whey hoverflies show a different trend to bees, although difference in the life cycle will mean they respond differently to weather events and habitat change. Weather effects, particularly wet periods in the spring and summer, are also likely to have had an impact. New seasonal patterns driven by climate change are increasingly disrupting the ecosystem services provided by pollinators, with impacts of reductions in food production. For instance, global analysis indicates that pollinators are increasingly losing their synchronization with timing of key crops dependent on pollination such as apples. Further research is needed to understand the relative importance of these potential drivers of change.

Animal Genetic Resources

Genetic diversity of animals is an import component of biological diversity. Rare and native breeds of farm animals are often associated with traditional land management required to conserve important habitats and may have genetic traits of value to future agriculture. Between 2000 and 2022 the average effective population size of the native species at risk deteriorated for pigs and horses but improved for sheep and cattle. However, since 2017, the average effective population size has been assessed as deteriorating for all species.

2.2.6 Soil health

Rationale

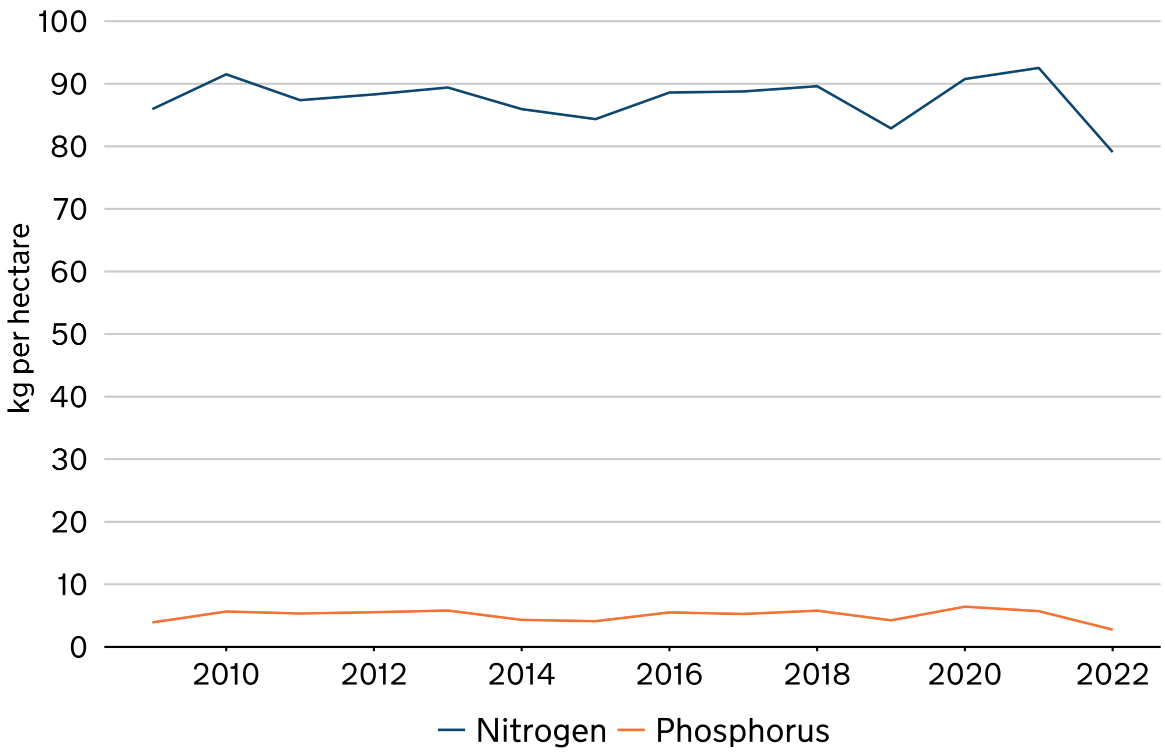
In the context of the UKFSR, soil health means the physical, chemical and biological condition of the soil determining its capacity to provide ecosystem services; in this case, the production of food. Soil health is essential to the long-term security of food and feed production. Healthy soils produce higher agricultural yields and more nutrient rich crops. 95% of food is directly or indirectly produced on soil. The Climate Change Committee identified soil health as one of the key concerns for climate change. Healthy, resilient soil is vital for producing food, improving water quality, increasing biodiversity, storing carbon, and helping to mitigate climate change impacts such as flooding and drought.

More data to inform soil health assessments will be available in the future through the Natural Capital and Ecosystem Assessment (NCEA) Programme but not in time for the UKFSR 2024. Moving forwards this will help measure the long-term sustainability of the food system. For now, the Soil Nutrient Balances report can be used as a proxy to show us what changes are occurring in UK agricultural soil. The Soil Nutrient Balance data is part of the best data available for understanding certain aspects of soil health, but it does not provide a holistic overview. Soil health encompasses a range of physical, chemical, and biological factors, and nutrient balance alone cannot fully represent these dimensions.

Headline evidence

Figure 2.2.6a: UK soil nutrient balances (nitrogen and phosphorous Levels), 2009 to 2022

Source: [UK and England soil nutrient balances, 2022 (Defra)]



Soil nutrient balances provide an indication of the overall environmental pressure from nitrogen and phosphorus in agricultural soils. They give an indication of the potential risk associated with losses of nutrients to the environment, which can impact on soil health, air and water quality, and climate change.

The overall UK nitrogen balance of management agricultural land in 2022 was a surplus of 79.1 kg/ha, which represented a decrease of 11.7 kg/ha (-12.9%) compared to 2020. This was driven by a decrease in Total Inputs of 6.0 kg/ha (-3.2%) coupled with an increase in Total Offtake of 5.6 kg/ha (+5.8%) over the same period. Levels in 2022 were also a decrease of 29.3kg/ha (-27%) compared to 2000.

The overall UK phosphorus balance in 2022 was a surplus of 2.8 kg/ha, which represented a decrease of 3.7 kg/ha (-51.1%) compared to 2020. This was driven by a decrease in Total Inputs of phosphorus of 2.0 kg/ha (-9.0%) coupled with an increase in Total Offtake of 1.6 kg/ha (+10.0%) over the same period. 2022 levels were also at a decrease of 6.8kg/ha (-71%) compared to 2000.

The 2022 estimates for both the UK nitrogen and phosphorus balances were the lowest since the annual time series began in 2000. This was caused by record low inputs from inorganic fertilisers, likely to be a response to high purchase prices (prices of inorganic fertiliser are explored in Theme 3 (Indicator 3.1.1 Agricultural inputs)).

Supporting evidence

The nutrient balances are used as a high-level indicator of farming's pressure on the environment and of how that pressure is changing over time. The balances do not estimate the actual losses of nutrients to the environment, but significant nutrient surpluses are directly linked with losses to the environment. Soils require a minimum level of plant-available nitrogen and phosphorus and other essential nutrients to fulfil the soil functions of food, feed and fibre production. An excess of nitrogen and phosphorous affects soil health through the potential declines to soil organic matter, and over-application of fertilisers have been shown to increase the decomposition of soil organic matter in some soils (Treseder, 2008; Condron and others, 2010). Ensuring food security and soil health requires a balanced approach to nutrient management with enough to meet the need of the crop but avoiding excess to reduce environmental harm. The reduction of both the nitrogen and phosphorus balances indicates a fall in excess nutrients which is positive for the wider environment.

Despite this positive trend, soil health remains at high risk from climate change and intensive farming. The Environment Agency's (EA) State of the Environment report estimated that, in England and Wales, soil degradation was putting 4 million hectares of soil at risk of compaction as well as over 2 million hectares at risk of erosion. The EA concluded that soil degradation is leading to flooding risks and is threatening biodiversity, water resources and soil fertility. For example, a review of 24 studies in the UK found that for every 10cm depth of topsoil loss, yields decreased by 4%.

There are signs that farming practices are changing to become more environmentally friendly; between 2021 and 2023 there has been an increase in the uptake of Agri-Environmental Schemes (AES) (see Indicator 2.2.9 Sustainable farming for further details). One of the options for sustainable farming is to incorporate vegetation and residue covers. Studies have shown that vegetation and residue covers of 30 to 40% in autumn can have a significant impact in reducing soil erosion rates by 20 to 80% (Chambers and Garwood, 2000), while higher covers of 60 to 70% can reduce the erosion rate by 50 to 90% (Niziolomski, 2014). It is however, too early to assess the impacts of these new AES on soil health.

Climate impacts

An increase in the frequency of extreme weather is a threat to soil health, particularly high rainfall and drought. Hotter, drier conditions make soils more susceptible to wind erosion, and high rain which can wash soil away. The UKFSR 2021 included a study carried out by the Met Office which explored the potential future impacts of climate change on UK soil erosions risks through changes to rainfall erosivity.

Peat

The long-term viability of domestic farming will rely upon changing land management practices. Carbon-rich, lowland peat soils provide some of the UK's most productive farmland. It is estimated that approximately 12% of all lettuce and 10% of all available onions in the UK are produced on UK peat as modelled using the Crop Map of England 2020 and the England Peat Statis GHG and C storage data layer. However, lowland peat soils are rapidly degrading due to historic drainage for agriculture and food production. In parts of the lowlands, such as the Fens, it is estimated that there could only be enough soil left to continue farming using current practices for another 20 years. Indicator 2.2.8 Greenhouse gas emissions explores the importance of protecting soil health to reduce emissions.

2.2.7 Water quality

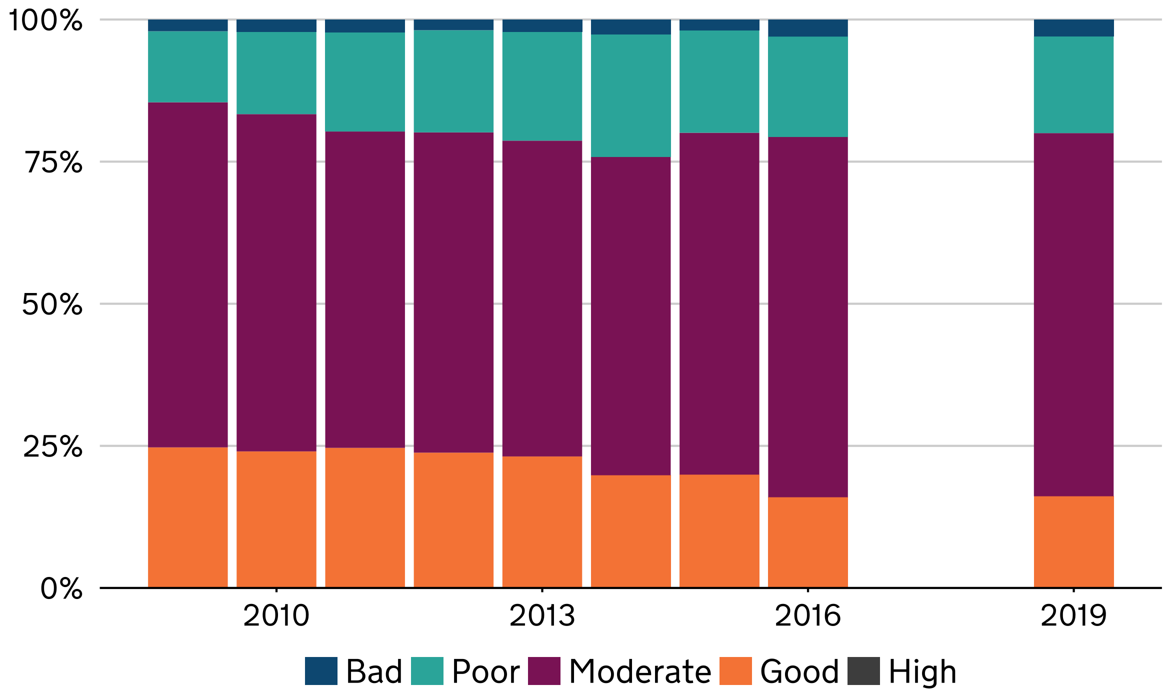
Rationale

Water is essential to agriculture, with vast quantities used for both irrigation and livestock. Good quality water is part of a sustainable future for agriculture and long-term food security in the UK. There are wider implications of water quality including biodiversity and public health. Reviewing the ecological and chemical status of UK surface waters can provide an insight into UK water quality. Agriculture is one of the main drivers of lower quality water, so this indicator is relevant to both the availability of quality water for agriculture and the impacts of agriculture on water. This indicator is assessed based on the most recent available data. In England this is to 2019 and the next classification update is due in 2025. The headline evidence focuses on data for England where there is the majority of UAA. Annual data for 2017 and 2018 were not collected and appear blank on the indicator. Data for Northern Ireland, Scotland and Wales are covered in the supporting evidence.

Headline evidence

Figure 2.2.7a: Status classifications of surface water bodies in England under the Water Framework Directive, 2009 to 2019

Source: England biodiversity indicators: 21. Surface water status (Defra)



In 2019 16% of all surface waters in England were classified as having a good ecological status. This has remained fairly stable since 2016. Less than 1% of surface waters were classified as high in 2019, while 63% were classified as moderate. 17% were classified as poor and 3% were classified as bad. Ecological status is assigned using various water, habitat and biological quality tests. Failure of any one individual test means that the whole water body fails to achieve good or better ecological status or potential (the 'one out all out' rule). Of the underlying tests for all 4,658 surface water bodies, 79% met the requirement for good ecological status. Only 14% of rivers achieved good ecological status, and only 43% of tests for fish living in rivers were classified at good ecological status in 2019.

While the proportion of all surface waters in England classified as having a good ecological status remains relatively low, significant progress has been made to improve water quality over the long term. However, in recent years improvements have plateaued.

Supporting evidence

Alongside the ecological status, the chemical status of surface water bodies is also assessed. Chemical status is calculated by assessing 52 different chemical elements and water bodies are classified as either good or failing. England adopted advanced monitoring for persistent chemicals in 2019 and consequentially no surface water bodies in England attained good chemical status in 2019. This was due to the presence of 3 ubiquitous, persistent, bioaccumulative, toxic (uPBT) pollutants. Significantly, these pollutants need to break down or disperse naturally so while these substances are now banned or restricted in the UK, they can remain in the environment for decades. Had new advanced monitoring not been used to detect these uPBT pollutants then 93.8% of surface water bodies would have reached good chemical status, compared to 97% in 2016. This shows a slight decline in the chemical status of surface water bodies in England.

However, over the long term there has been improvement in water quality in England. Between 1990 and 2023 there has been an 80% reduction in phosphorus concentrations. Excessive phosphorus in the water environment causes eutrophication. Similarly, levels of ammonia, which is toxic to aquatic life including fish, have reduced to 15% of their levels in 1990. Species such as seahorses, seals and salmon have returned to rivers and estuaries. However, as research shows, improvements have plateaued. This can be attributed to an increasing population, ageing infrastructure, increased pollution risks, and the pressure on our drainage system.

Groundwater

In England, 73% of groundwater bodies met good quantitative status in 2022, this remained stable from 2019 and is an increase from 60% in 2009. However, in 2019 (the latest available data) 45% of groundwater bodies were classified as good, this is a decrease from 53% in 2015 and 58% in 2009. Nitrate is the most common cause of groundwater test failure. The percentage of tests which failed due to nitrate increased between 2015 and 2019.

Northern Ireland

Water body status has stagnated in Northern Ireland during the past few years. In 2015, 32% of Northern Ireland's surface waters were at 'good or better' ecological status compared to 31 % in 2021. Some water bodies improved in ecological status, but this was offset by deteriorations in others. Further information on chemical status for surface water bodies as well as chemical and quantitative status for groundwater bodies is available in the Water Framework Directive

Statistics Report 2021. An update for surface water classification is planned for later in 2024.

Scotland

Scotland's water is famed worldwide and is critical in the production and branding of some of its biggest exports, and a big draw for tourists. The water environment in Scotland is generally in good condition. Overall, 65%% of surface waters were classified at good or high status and 85% of groundwaters were classified as good in 2022. As part of this assessment, 54% of surface waters achieve a good or high ecological status. However, there are environmental pressures on waterbodies, including diffuse pollution, discharges of waste water, abstractions and historic physical alterations (SEPA).

Wales

In 2021, 40% of surface water bodies in Wales had an overall ecological status of 'good or better' under the Water Framework Directive (WFD). This rises to 44% when looking just at Wales' rivers. These latest results are 8% higher than the first classification in 2009. Overall, 91.4% of surface waters were chemically classified as 'good'. Within this, 99.1% of lakes were classified as 'good' but only 60.9% of costal water bodies had good chemical status. Each of the 39 groundwaters assessed achieved a 'good' quantitative status. However, 17 of those were downgraded due to 'poor/chemical status. This suggests that pollution is a greater threat to Welsh groundwater than over-abstraction. Pollution in Welsh waterways comes from a wide range of sources. The most prominent known reasons for failing to achieve 'good' status under WFD are agriculture and rural land use, followed by water industry, mining and quarrying.

Impacts of water quality on agriculture

Water quality affects farming, food production and food safety. The agricultural sector is the largest consumer of water. Water quality is a vitally important pre-harvest factor for preventing foodborne contamination during food production. For example, irrigation water quality can affect food safety and health, and has been identified as a possible source of microbiological contaminants in produce linked to disease outbreaks. Although the impact of irrigation water quality on agriculture has been a longstanding topic of study, limited evidence on the impact of the use of polluted water in the food supply system and implications for food security and human health.

Factors impacting water quality

Agriculture has been identified as one of the leading sectors affecting water quality, with pollution from agriculture and rural land affecting 40% of water bodies. Farming contributes to poor water quality through excess nutrients such as phosphorus and nitrogen (see Indicator 2.2.6 Soil health for further details). It also contributes through other chemicals including veterinary medicines, pesticides and ‘emerging chemicals’, faecal bacteria and pathogens (predominantly from livestock), soil sediment (from both arable and livestock farming), and micro-plastics (present in sewage sludge, compost and other organic manures). Addressing pollution and improving water quality is a policy objective. See Indicator 2.2.9 Sustainable farming for further details.

Climate impacts

Climate change may bring new weather patterns such as extreme droughts that cause unpredictable issues for water sources that have previously been reliable. Wetter winters and more frequent, heavier storms are leading to more flooding and more pollutants being washed off fields and urban areas. Projections show rivers could have 50 to 80% less water in summertime by 2050 from drier summers. Drought could harm ecology and reduce the natural resilience of our rivers, wetlands and aquifers. This has the potential to damage water supply infrastructure and lead to interruptions in supply(Environment Agency, 2020).

2.2.8 Greenhouse gas emissions

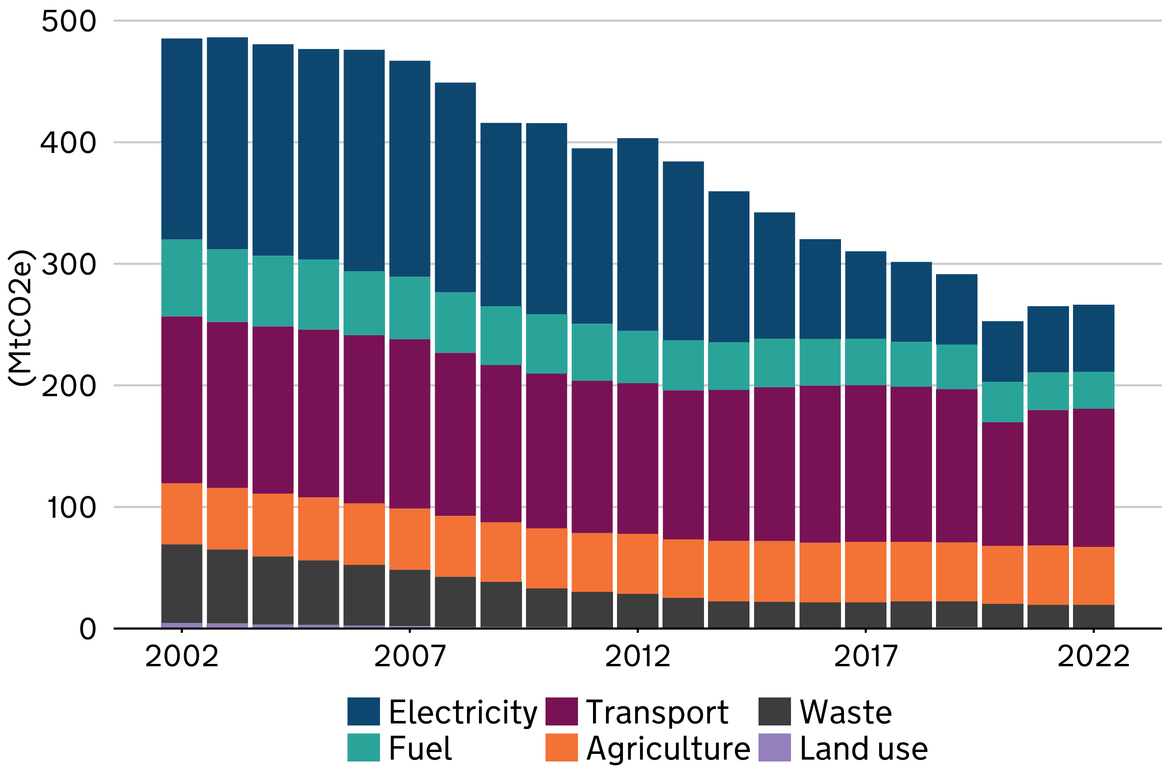
Rationale

Agriculture is a significant source of the UK’s total greenhouse gas (GHG) emissions, comprising of nitrous oxide, methane, carbon dioxide. Agriculture is also responsible for a large proportion of the UK’s ammonia emissions, which impact on air quality and subsequently human and animal health (AUK). GHG reductions are essential in the fight to mitigate climate change. Reducing agriculture's contribution to GHG emissions is a key part in ensuring the long-term sustainability of UK farming. The UK is already experiencing extreme weather events associated with climate change that are posing a threat to food production both domestically and abroad. This is explored further in Indicator 2.1.2 Arable products (grain, oilseed and potatoes), Indicator 2.1.3 Livestock and poultry products (meat, eggs and dairy), and Indicator 2.1.4 Fruits and vegetables.

Headline evidence

Figure 2.2.8a: Territorial greenhouse gas emissions by selected source category, UK 2002 to 2022

Source: [UK territorial greenhouse gas emissions national statistics (DESNZ/DBEIS)]



The indicator shown above relates to a subset of 6 sectors, rather than GHG emissions from all sectors. Between 2020 and 2022 overall GHG emissions fell by 0.5% to 406.2 million tonnes carbon dioxide equivalent ($MtCO_2e$). Emissions from agriculture and net removals by the forestry sector have fluctuated but show little overall change between 2002 and 2022. Between 2020 and 2022 GHG emissions from agriculture fell by 0.6%, while emissions from land use and forestry decreased by 0.3% or 0.002 $MtCO_2e$. In comparison, emissions from waste fell by 3.3% over the same period. This assessment does not consider whether any improvement is on a sufficient scale for meeting targets.

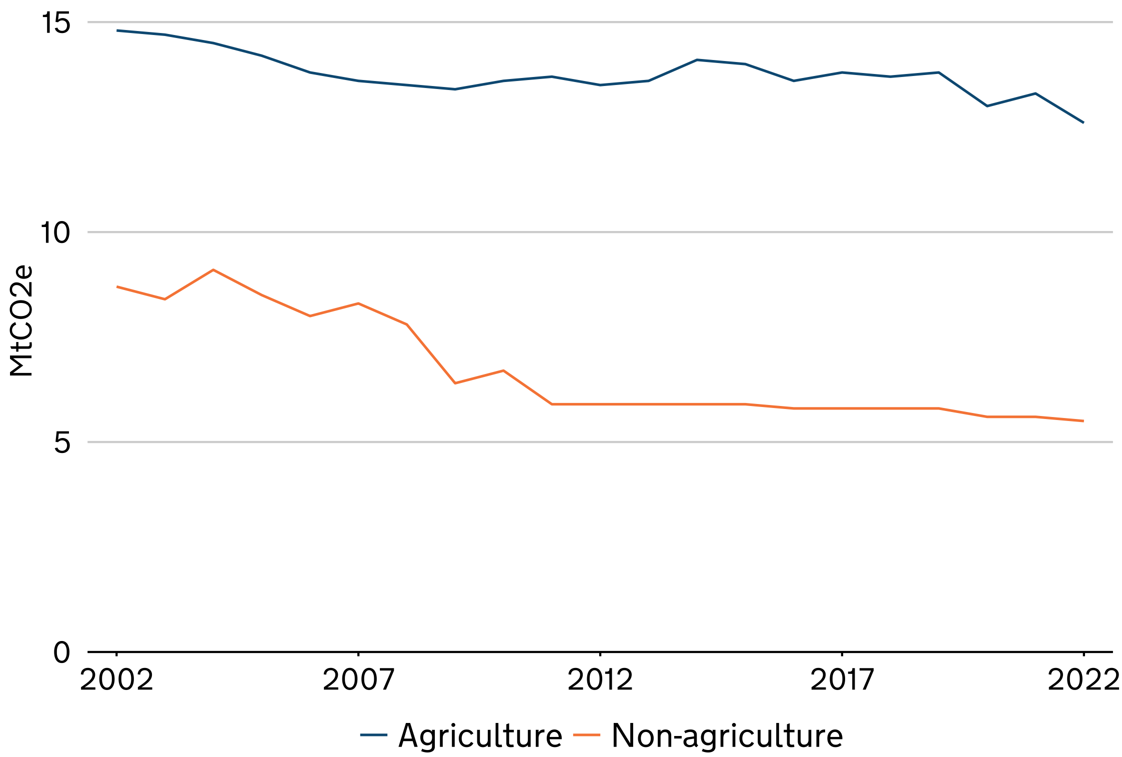
In 2022 agriculture accounted for around 12% of total GHG emissions in the UK, this is an increase from approximately 10% in 2020. In 2022 domestic transport was responsible for 28% (113.2 $MtCO_2e$) of overall GHG emissions, while buildings and product uses were responsible for 20% (82.8 $MtCO_2e$) emissions. Industry (57.3 $MtCO_2e$) and electricity supply (54.9 $MtCO_2e$) were each responsible for 14% of overall GHG emissions in 2022.

Supporting evidence

Agriculture is a major source of nitrous oxide, methane and ammonia in the UK. In 2022 it accounted for 70% of nitrous oxide emissions, 49% of methane emissions and 87% of ammonia emissions. In contrast, agriculture only accounted for <2% of carbon dioxide emissions in 2022. While total amounts of nitrous oxide, methane and carbon dioxide have reduced since 1990, this is mainly due to reductions in non-agricultural sources. Therefore, while agriculture has seen reductions in the emissions of nitrous oxide and methane, it now accounts for a larger proportion of total emissions.

Figure 2.2.8b: Territorial emissions of nitrous oxide (N_2O), UK 2002 to 2022

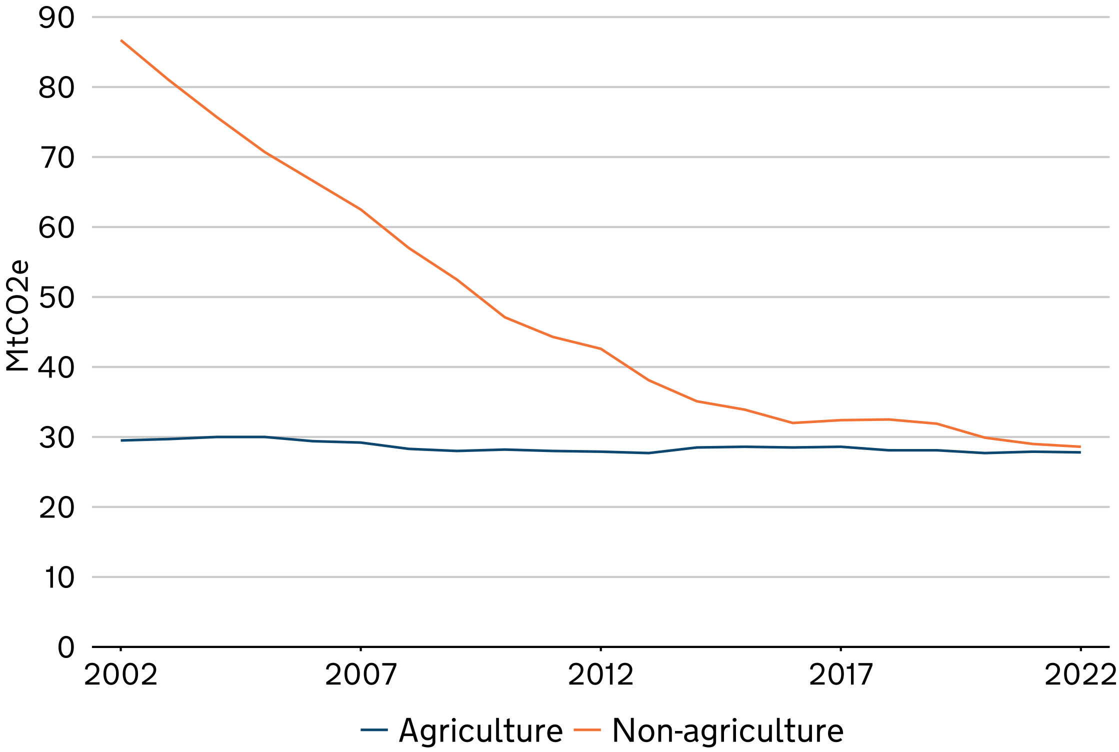
Source: [Final UK greenhouse gas emissions national statistics: 1990 to 2022 (DESNZ)]



The majority of agricultural nitrous oxide emissions are sourced from soils, particularly as a result of nitrogen fertiliser application, manure (both applied and excreted on pasture), leaching and run-off. In 2022, nitrous oxide emissions from agriculture are estimated to have fallen by 15% since 2002 and by 23% since 1990. This is consistent with trends in fertiliser usage. Since 2020, nitrous oxide emissions from agriculture fell by 3.1% from 13MtCO_2e to 12.6MtCO_2e in 2022.

Figure 2.2.8c: Territorial emissions of methane (CH_4), UK 2002 to 2022

Source: [Final UK greenhouse gas emissions national statistics: 1990 to 2022 (DESNZ)]



The majority of agricultural methane emissions come from enteric ruminant digestion in livestock, with manure management practices accounting for the remainder. Methane emissions from agriculture have fallen by 5.7% since 2002. Over the long term these emissions have fallen by 15% since 1990, mainly as a result of decreasing livestock numbers, particularly in cattle.

Agriculture's emissions of carbon dioxide are largely caused by farm vehicles and machinery and can also result from poor soil management. Agricultural emissions of carbon dioxide have remained low since 1990 and accounted for less than 2% of total emissions in 2022. While the proportion of carbon dioxide emissions related to agriculture are low, levels increased in 2004, where they have since fluctuated but remained at similar levels.

In 2022, agriculture accounted for 87% of the UK's ammonia emissions. The main sources of ammonia emissions in the UK are agricultural soils and livestock, in particular cattle. In 2022, ammonia emissions from agriculture are estimated to have fallen by 18% since 1990 due to long-term reductions in cattle numbers and more efficient fertiliser use. Emissions have generally fluctuated since 2010, in part driven by annual variations in weather conditions affecting crop planting and fertiliser use, as well as energy prices affecting the use of fertilisers.

Sustainable farming

Sustainable farming practices that protect soil health are an import part of reducing agricultural GHG emissions. Soil degradation is associated with increased carbon emission as it is estimated that UK soils currently hold around 9.8 billion tonnes of carbon. See Indicator 2.2.9 Sustainable farming for examples of agri-environmental schemes which help to protect soil health. The process of peat degradation places England's lowland peat soils among the largest sources of GHG emissions in the land use sector. This accounts for over 2% of England's overall GHG emissions and approximately 88% of all emissions from peat in England. Taking action to protect peat soils, including raising water levels where appropriate, will help achieve legally-binding net zero targets, while preserving some of the most productive agricultural land.

2.2.9 Sustainable farming

Rationale

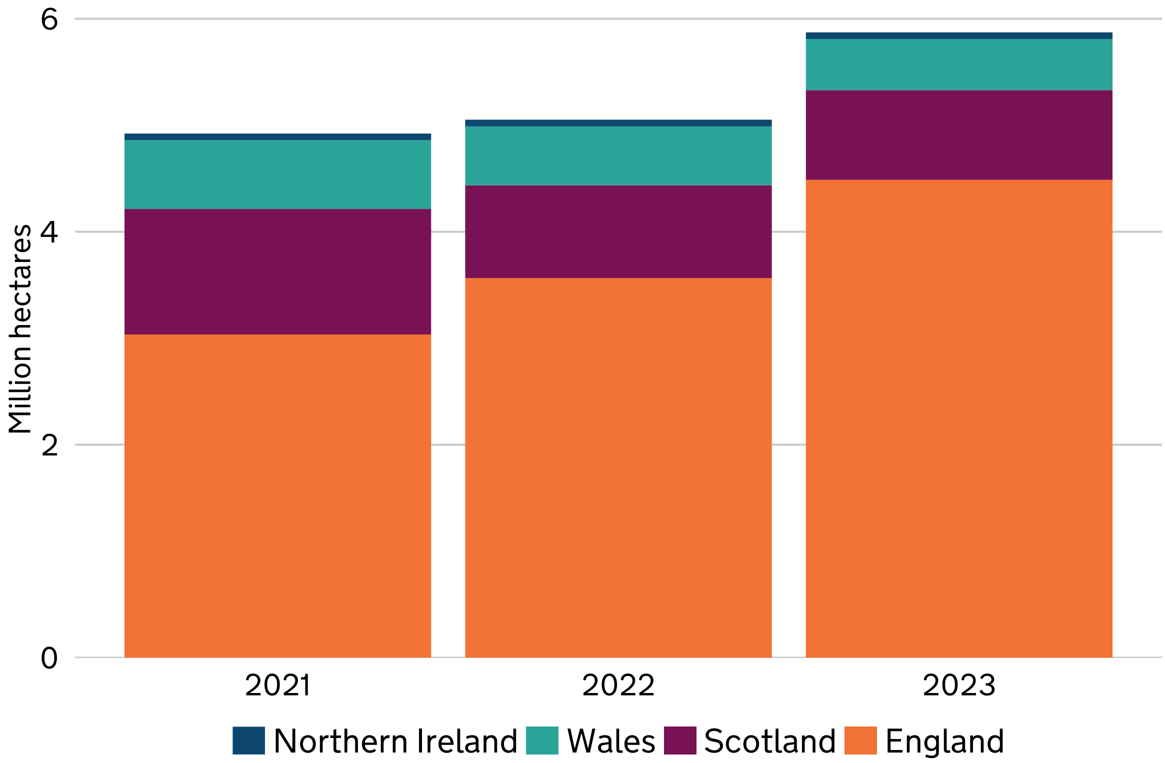
Intensive farming has dominated since the mid-20th century. Its effects on the natural world are becoming apparent through its impact on soil degradation, water quality, greenhouse gases, and biodiversity, and therefore food security itself. Sustainable farming practices can reduce or reverse these harms, encourage biodiversity, and capture carbon, all while producing food that contributes to healthy, sustainable diets and is essential to maintaining domestic production levels and quality in the long term.

There is no single measure of sustainable farming practices. Many producers choose to use sustainable farming techniques within one or more areas of their holding, and this is not compiled in a single national statistic. Data on land entered in agri-environment schemes (AES) across the UK and land entered in the organic farming programme is used as a proxy representation for the uptake of sustainable farming techniques. For both, upward or downward trends do not necessarily correlate with more or less sustainable farming in the UK, but they do allow the UKFSR to track trends across 2 significant areas that shape the sustainable farming landscape.

Headline evidence

Figure 2.2.9a: Area under agri-environment schemes by country, 2021 to 2023

Source: [Take-up of agri-environment schemes, (Defra)]



Note:

1. These numbers are based on the total area per land parcel for each option. Options may not cover the total area of the land parcel. However, the whole parcel is not always under management, so this method can inflate the area under management. For example, if a parcel just has a hedgerow option on it, the whole parcel area is still reported, despite the hedgerow being the only area under management.
2. Rotational options are excluded for Environmental Stewardship as the information on these options is not stored electronically. This means that the area under Environmental Stewardship could be higher.
3. For England (pre-2023), Wales, Scotland and Northern Ireland, the total area covered by AES is presented as a sum of the individual scheme areas. This may include a small amount of double counting as different schemes can cover the same land areas. From 2023 onwards the English total is based on a new methodology that removes any overlap, so the total area for England will be smaller than the sum of the individual scheme areas.

For the UK overall, the area in AES increased from 4,922 thousand hectares in 2021 to 5,872 thousand hectares in 2023. To put this into context, this is around one-quarter of total land area in the UK and around one-third of total utilised agricultural area (UAA). There was only a small increase between 2021 and 2022 but a much larger increase of 820 thousand hectares between 2022 and 2023. Note that not all AES is on UAA (see Indicator 2.2.4 Land use for further detail).

In England in particular the amount of land in AES has been increasing since 2021 due to the increased uptake of Countryside Stewardship (CS) and the launch of the Sustainable Farming Incentive (SFI). The range of options that can comprise a CS agreement, for example, can be seen here. While this can be considered a positive trend it should be noted that it was from a low baseline position. Between 2013 and 2018 there was a decline in the area of land in AES from 6,783 thousand hectares to 2,781 thousand hectares. This was due to the closure of Environmental Stewardship (ES) in December 2014.

In January 2024 the Office for Environmental Protection (OEP) published analysis of the uptake of 'nature friendly farming' which noted the increased uptake in 2022 to 2023, but assessed that rollout of the schemes needed to be accelerated if the UK is to achieve government targets in the Environmental Improvement Plan.

Supporting evidence

Agri- environmental schemes

Further research is needed to understand the different effects of the schemes on food production. The options which comprise a specific agreement vary. Some schemes will have a direct impact through direct measures supporting sustainable food production such as cover crops. Improving soil health will build resilience to flooding and droughts, therefore helping to protect domestic food production during periods of extreme weather. Other schemes will have an indirect impact through improving the resilience of nature. AES are helping farmers and land managers to deliver for the environment as well as produce food, by allowing farmers to generate income on less productive areas. This includes the creation of wildflower meadows, which help support species and pollinators. In some cases, there will be trade-offs between environmental use of land and using land for production. Land type will be a factor in this decision.

Agricultural policy is devolved across the four UK nations. Following 31 December 2020, the UK government has set its own agricultural support schemes.

England

Environmental Land Management schemes (ELMs) have a large-scale ongoing monitoring programme which collects both field samples and earth observation data, both pre- and post-scheme launch, to capture environmental change over time. Environmental outcomes can take considerable time to show change, so impact models are used to assess outcomes in the short term. The most recent ELMS monitoring assessment is available. Alongside the launch of the Sustainable Farming Incentive and growth in Countryside Stewardship, additional actions have launched in 2024 as part of the expanded SFI offer that will contribute to key outcomes.

Wales

The Welsh Government has now set out Sustainable Land Management Objectives in legislation, which all future agricultural support will need to contribute to. The Sustainable Farming Scheme, due to be launched in 2026, will reward farmers for carrying out actions that contribute to sustainable food production. This will be the Welsh Government's main mechanism for supporting farmers financially, so there will no longer be the distinction between a main subsidy and agri-environmental support as there has been previously.

Between 2013 and 2016, the Welsh Government ran the Glastir Monitoring and Evaluation Programme (GMEP). This evaluated the environmental effects of the Glastir agri-environment scheme at a national scale, as well as monitored the wider countryside of Wales in the longer term. This work has been continued through the Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP). A key strand of ERAMMP is to undertake a National Field Survey in Wales to provide information for the evaluation of Glastir and ongoing Sustainable Land Management. Reports and articles produced through the ERAMMP are available.

Scotland

The Agri-Environment Climate Scheme (AECS) is the Scottish Government's single largest funding mechanism for environmental and sustainable land management. It supports actions spanning habitat creation and restoration and measures to improve water quality and water resource management.

AECS supports the Scottish Government's Programme for Government 2021 to 2022 commitment to seek to double the amount of land used for organic farming by 2026 through the funding of conversion to and maintenance of organic land. This is in recognition of how organic farming practices seek to work with natural processes, using methods that are designed to achieve a sustainable production system with limited use of external inputs.

While AECS does not have independent targets or specific Key Performance Indicators, the scheme supports existing programmes and frameworks such as:

- Support for the appropriate management of national and international sites designated for nature (SSSI and European nature sites)
- the Climate Change Plan
- Scotland's Biodiversity Framework 2022 to 2045, including strategy and supporting delivery plan

In 2021 NatureScot, the Scottish Government's nature agency, commissioned the Evaluation of the biodiversity outcomes of the 2014 to 2020 report. This was supported by the accompanying Agri-Environment Climate Scheme heat maps report 2015 to 2018 which illustrates the geographic distribution of scheme uptake.

Northern Ireland

Since 2018, Environmental Farming Scheme (EFS) participants have managed over 58,000 hectares of priority habitat, planted or enhanced 1000 kilometres of hedgerows, protected 2,700 kilometres of waterway and planted half a million trees. The Department of Agriculture, Environment and Rural Affairs (DAERA) is developing a Farming with Nature (FwN) Package that will replace EFS in due course.

The FwN Package aims to assist farm businesses and land managers across all land types to make substantial contributions to environmental improvements and sustainability. It will focus initially on reversing the trends in nature decline through maintaining, restoring, and creating habitats that are important for species diversity and improving connectivity between habitat areas. Environmental payments will, as far as possible, seek to recognise and reward the public goods provided by farm businesses and land managers who improve environmental performance through the delivery of identified outcomes. This approach aims to encourage the environment to be seen as another on-farm enterprise and has the potential to become a profit centre within an overall sustainable farming model. It will also assist farm businesses and land managers to make an economic return on the environmental assets that they create and manage appropriately.

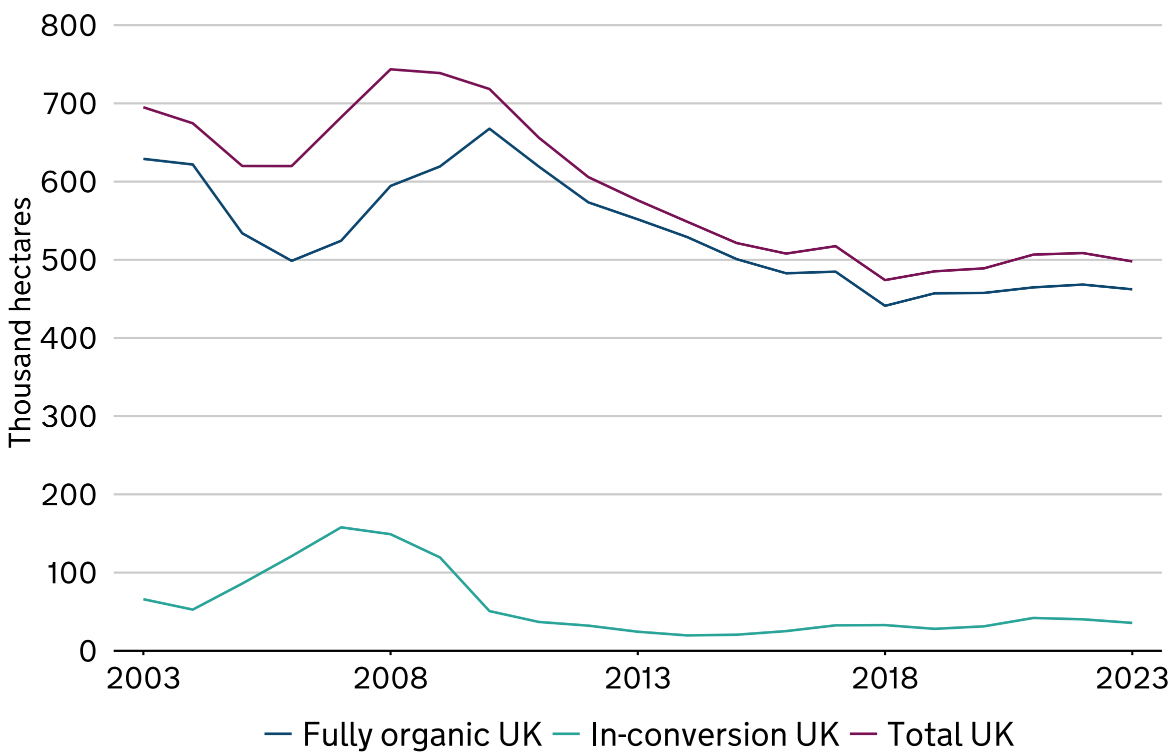
A new programme of Farm Support and Development, designed in consultation with the Northern Ireland agricultural industry and other key stakeholders, is being developed. It will be introduced on a phased basis over the coming years. The schemes and measures to be introduced will provide levers to contribute to statutory obligations under the Climate Change Act (NI) 2022, with a firm focus on just transition. The vision for Farm Support and Development in Northern Ireland is defined around 4 outcomes for the agricultural industry as one that is productive and profitable, sustainable, resilient and integrated.

Organic Farming

Organic farming is another proxy for sustainable farming practices. Other systems such as no- and low-till farming, agroecology, and agroforestry also contribute towards balancing sustainability and food production. Organic farming practices do not allow the application of chemical fertilisers or pesticides, or the routine feeding of antibiotics to animals, and they also have high standards for animal welfare. Consequently, productivity tends to be lower than in conventional systems. One of the core principles of organic farming is that by good land management, such as crop rotation, environmental harms can be reduced and soil health improved, offering greater sustainability in the long term.

Figure 2.2.9b: UK organic farming land area, 2003 to 2023

Source: [Organic farming statistics 2023 (Defra](#))



In 2023, organically farmed land represented 2.9% of total UK farmed area, and the total area of fully converted and in-conversion farmland was 498,000 hectares. The total area of UK organic farmland peaked in 2008 and then decreased to a low in 2018. The overall reduction in area was 36% (270,000 hectares) over that period. This was caused by a combination of factors. The economic recession of 2008 to 2009 impacted demand for organic produce, particularly from the large multiple retailers who cut back on their ‘premium’ lines including organic. During this period farmers were also experiencing uncertainty over the future of the organic support schemes under the EU Common Agricultural Policy (EU CAP). Scotland accounted for approximately 50% of total reduction in UK organic land.

Between 2020 and 2023 the total organic area in the UK has remained largely static at around 500,000 hectares. Long term lack of growth also reflects ongoing economic uncertainty and pressures on farm gate prices, as well as a lack of confidence among farmers and growers to invest in organic enterprises.

Theme 3: Food supply chain resilience

Introduction

Theme definition

Theme 3 measures the stability and resilience of the UK's food supply chain from production to consumption. This includes the physical, human, and economic infrastructure underlying the food supply chain. Food security requires stability, yet the interconnectedness of the global economy requires flexibility in the face of unexpected global challenges. Without the necessary stability, both the physical availability and accessibility of food becomes less certain. Stability is considered in terms of the shocks and stresses that key sectors within and outside the food sector are subject to. Resilience is considered by assessing the ability of the food supply chain to respond to and withstand those shocks and stresses, including key strengths like robustness (ability to recover), diversity and adaptability of the supply chain. Shocks often come from outside the food supply chain and cause immediate disruption, such as Russia's invasion of Ukraine, whereas stresses such as the effect of climate change, strain the food supply chain over the longer term, and exacerbate the effect of shocks. Theme 2 UK Food Supply Sources looked at shocks specifically to food production like weather and disease.

The UK food supply chain is built on a set of interdependent sectors working together. This theme looks at the risks and resilience across these sectors in three areas: input dependencies such as agricultural inputs, broader supply chain inputs, labour, water and energy (Sub-theme 1); movement of goods including the stability of import flows into the UK and travel within the UK (Sub-theme 2); and finally food businesses including cyber security of businesses, UK food retailers and their diversity, and broader economic and business stability throughout the supply chain (Sub-theme 3). This edition includes new indicators tracking water dependency and import flows.

Food, along with water, energy and transport are recognised as critical national infrastructure sectors. Changes and disruption to sectors outside of food can have a direct effect on food. Given the wide range of potential shocks and stresses that could affect the food supply chain, contingency planning is in place to mitigate against these risks. Defra, other UK government departments and the devolved governments routinely anticipate, prepare, mitigate, and respond to risks of national significance. This includes contributing to and monitoring the National Risk Register which provides public information on the most significant risks that could occur in the next two years, and which could have a wide range of effects on the UK. While the UKFSR tracks risks and broad attributes of the UK related to supply chain resilience, it does not include data on contingency planning for these risks.

Overall findings

- **Russia's invasion of Ukraine caused a spike in input costs such as energy and fertiliser.** This was a major development of the period between 2021 and 2024, having an effect across the food supply chain. The shock led to business uncertainty and the highest food inflation spike for consumers in 45 years. Despite global food commodity prices falling at the end of 2022, high food price inflation persisted through 2023, but falling steeply in the second half of the year. While the impacts were global, it showed the UK's and the rest of Europe's vulnerability to food inflation from high energy prices and the effect of other cost pressures in the system. UK food inflation was among the highest of the G7 countries in 2023. At no point in the last three years has the UK population faced shortages of food items for a sustained period, demonstrating a continued resilience in providing food availability through shocks.
  Key statistic: Fertiliser costs for UK farms rose from £1.5 billion in 2021 to £2 billion in 2022, before dropping to £1.4 billion in 2023. These changes contrast with a stable level of cost in the decade up to 2020. Similarly, electricity and gas prices climbed far surpassing prices in the period 2014 to 2020, doubling for electricity and nearly tripling for gas (electricity 100%, gas 187%) significantly from mid-2022 (see Indicator 3.1.1. Agricultural Inputs and Indicator 3.1.5 Energy).

- **Single points of failure in food supply chains pose resilience risks** with evidence of reliance on regionally concentrated suppliers of supply chain inputs making the UK vulnerable to supplier failure (such as sunflower oil from Ukraine and inputs to flour fortification from specific regions). This risk is compounded by a prevailing 'Just in Time' (JIT) model and low stock approach for many businesses and by a more volatile international context.
  Key statistic: From 2007 to 2021 UK imports of sunflower oil were broadly stable at around 300,000 tonnes. Following the Russian invasion of Ukraine, total UK imports of sunflower oil fell to 224,000 in 2023, a 25.3% decrease, creating temporary shortfalls for key processors while driving substitution of other oils, such as rapeseed (see Indicator 3.1.2 Supply chain inputs).

- **While there was a sharp fall in volume of imports of Food Feed and Drink to the UK in 2021, imports have increased slightly since then** and the EU remains the UK's largest external supplier.
  Key statistic: The EU accounted for 64% of the volume of UK imports of food, feed and drink in 2023. The volume imported from both the EU and

Non-EU countries was 6% lower in 2023 compared to 2018 (see Indicator 3.2.3 Import Flows).

- **Agri-food sector labour shortages continue and are compounded by significantly more restrictive access to EU labour.** Although overall employment in the food sector has increased, there have been long term perceptual challenges in attracting labour to certain sectors such as horticulture and seafood, causing a reliance on migrant workers. These challenges have been exacerbated following the UK leaving the European Union causing increased strain on the UK labour market due to difficulty in workers entering the UK to work.
  Key statistic: Between 2021 and 2023, the workforce in the food sector in Great Britain increased from 4.04 million to 4.38 million, showing a steady upward trend. However, this does not show shortages in skills in key areas of the UK's food supply chain such as the seafood sector and the veterinary profession (see Indicator 3.1.3 Labour and Skills).

- **UK agricultural water availability is at risk from increased extreme weather events** driven by climate change, but adaptation measures through storage of water are underway.
  Key statistic: Between 2010 and 2024 England saw a significant increase in water licensed for abstraction for both direct irrigation (up 16%) and reservoir storage for irrigation (up 15%). The abstraction of water can be disrupted by the activation of hands of flow measures in response to extremely dry weather. This was demonstrated during drought conditions in 2022 across the UK, with abstraction licenses suspended in Scotland for the first time (see Indicator 3.1.4 Water).

- **Many food businesses have shown resilience and recovery** in response to shocks, but investment levels are not back to levels before the price shock in 2022.
  Key statistic: Average total quarterly investment increased by 5.7% in 2023 compared to 2022 but was 21% lower than 2021 levels (see Indicator 3.3.3 Business resilience).

Cross-theme links

The UK food supply chain has been affected by geopolitical and climate volatility on a global level, covered substantially in Theme 1 Global Food Availability. Theme 3 looks at the resulting effect of increased costs in the UK supply chain. These have raised costs of production and created a challenging business environment, affecting the production of food un the UK covered in Theme 2 UK Food Supply Sources.

Labour shortages continue throughout different sections of the food supply chain, having different influences. For food standards to be enforced effectively, sufficient qualified local authority staff are needed to conduct inspections, and to ensure good hygiene practices within food businesses are maintained. Food business compliance with hygiene regulation is covered in Theme 5 (food safety and consumer confidence).

Since 2021 input price increases, extreme weather and shortages of skilled workers have had a cumulative effect on food businesses. This has all fed into food price increases which have contributed to complex decisions on purchasing food on the household level, which is considered in Theme 4 Food Security at Household Level.

Use of inputs such as fertiliser and pesticides, covered in this theme, directly affect the measures of environmental sustainability of food production in Theme 2.

Sub-theme 1: Input dependencies

3.1.1 Agricultural inputs

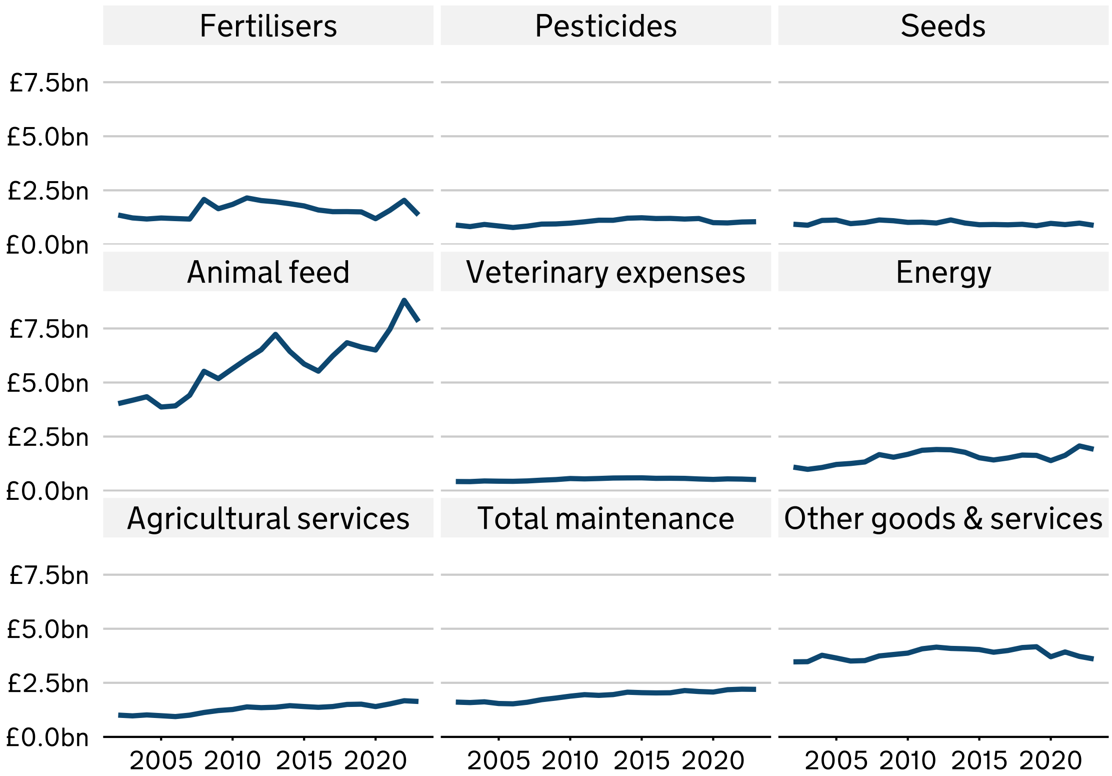
Rationale

The production of crops, livestock and aquaculture in the UK is reliant on a range of agricultural inputs such as fertiliser, pesticides, feed (terrestrial animal and fish). Prices of inputs can vary from year to year depending on the level of supply domestically and on international markets. Factors such as weather, geo-political conflict and competition can tighten supply of inputs, causing price spikes that affect the overall use of key inputs. Longer-term trends such as the removal of products from the market, further affect demand for these inputs and the sustainability of farming practices. This indicator looks at usage, price, and supply of inputs to surface these trends. Other critical inputs to food production, such as water (Indicator 3.1.4), energy (Indicator 3.1.5) and labour (Indicator 3.1.3), are discussed elsewhere in Theme 3.

Headline evidence

Figure 3.1.1a: Principal farm costs (real terms), 2003 to 2023

Source: [Agriculture in the United Kingdom 2023, Defra, Total income from farming data]



Agricultural costs in real terms in the UK have fluctuated, in the last three years. Costs are driven by input unit prices and the volume of inputs consumed. As shown in figure 3.1.1a above, most input costs increased from 2021 to 2022, before decreasing in 2023. The majority of input costs remain higher than before 2021, placing increased pressure on farm businesses and driving up food prices. Notable changes were seen in animal feed, fertiliser, and energy costs. Animal feed costs show a steep increase, climbing from £7.5 billion in 2021 to a high of £8.8 billion in 2022, before decreasing to £7.8 billion in 2023. Fertiliser costs also saw a volatile pattern, rising from £1.5 billion in 2021 to £2.0 billion in 2022, before dropping to £1.4 billion in 2023. Energy costs rose sharply from £1.6 billion in 2021 to £2.1 billion in 2022, and then decreased to £1.9 billion in 2023. Other inputs costs, for example seeds, remained much more stable. However, for some costs such as maintenance and agricultural services there is an increasing price trend over a longer term which may pose a future risk to food prices.

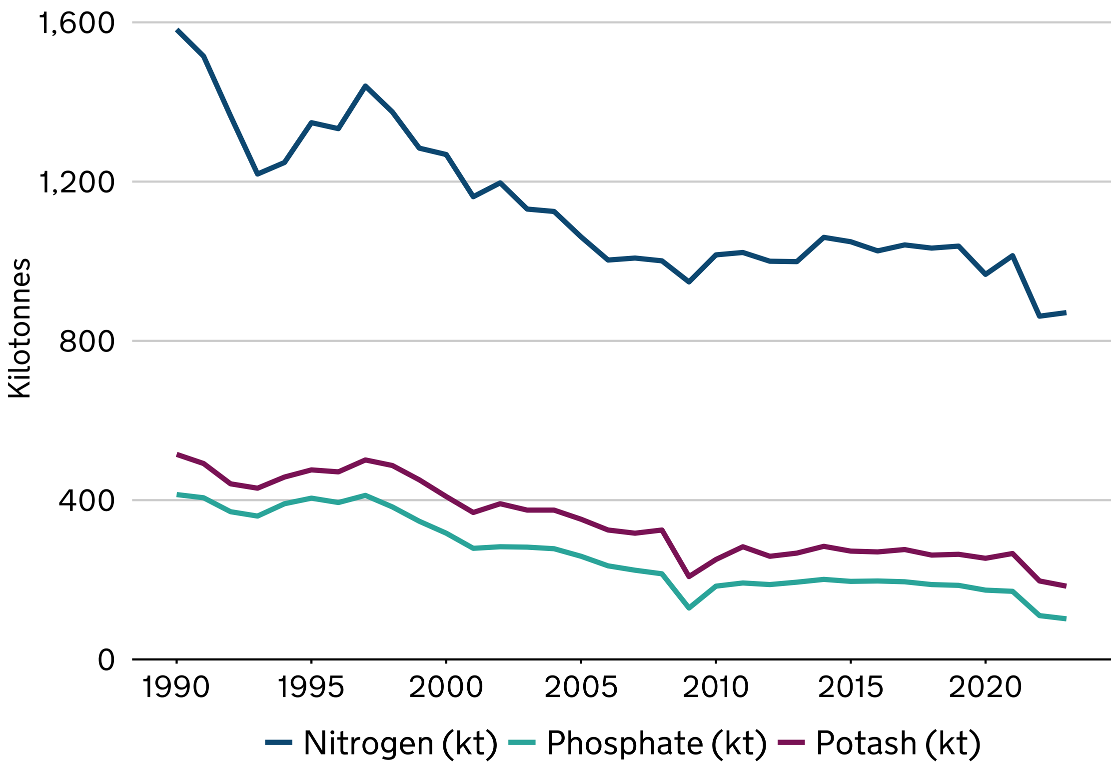
Notable changes were driven by global price shocks related to Russia's invasion of Ukraine and the resulting spike in energy prices covered in Indicator 3.1.5 Energy. The effect can be seen in the cost difference between imported and domestic inputs. From 2022 to 2023 producer input prices for home-produced food materials rose by 15.1% from 2022 to 2023, while for imported food materials the increase was 29.1% (ONS, 2023). See supporting evidence.

Supporting evidence

Fertiliser use and supply

Figure 3.1.1b: Fertiliser use in the UK, kilotonnes, 1990 to 2023.

Source: British Survey of Fertiliser Practice, Defra, Figure ES1



The UK demand for nitrogen is approximately 2 million tonnes and for phosphorus is 250,000 tonnes per annum. Approximately 50% of nitrogen is imported as inorganic fertilisers (or raw materials), and 50% of this is domestically produced via livestock manures. For phosphorus approximately 20% is imported inorganic fertiliser and 70% comes from livestock manures (Defra, 2022).The UK imports both finished fertiliser products and raw materials to satisfy the inorganic fertiliser demand. While the UK has a diverse supply sourcing from 60 countries, it imports certain products which are concentrated to a small number of countries due to geological reserves. Notable cases include dependence on Israel for 62.8% of phosphatic fertilisers and on Spain for 31.2% of potassic fertilisers in 2023. Diversity of supply is important to security of supply as it spreads risks from disruption from shocks such as conflicts, high prices or other barriers to trade, as discussed in Theme 1 (see Indicator 1.2.3 Global fertiliser production).

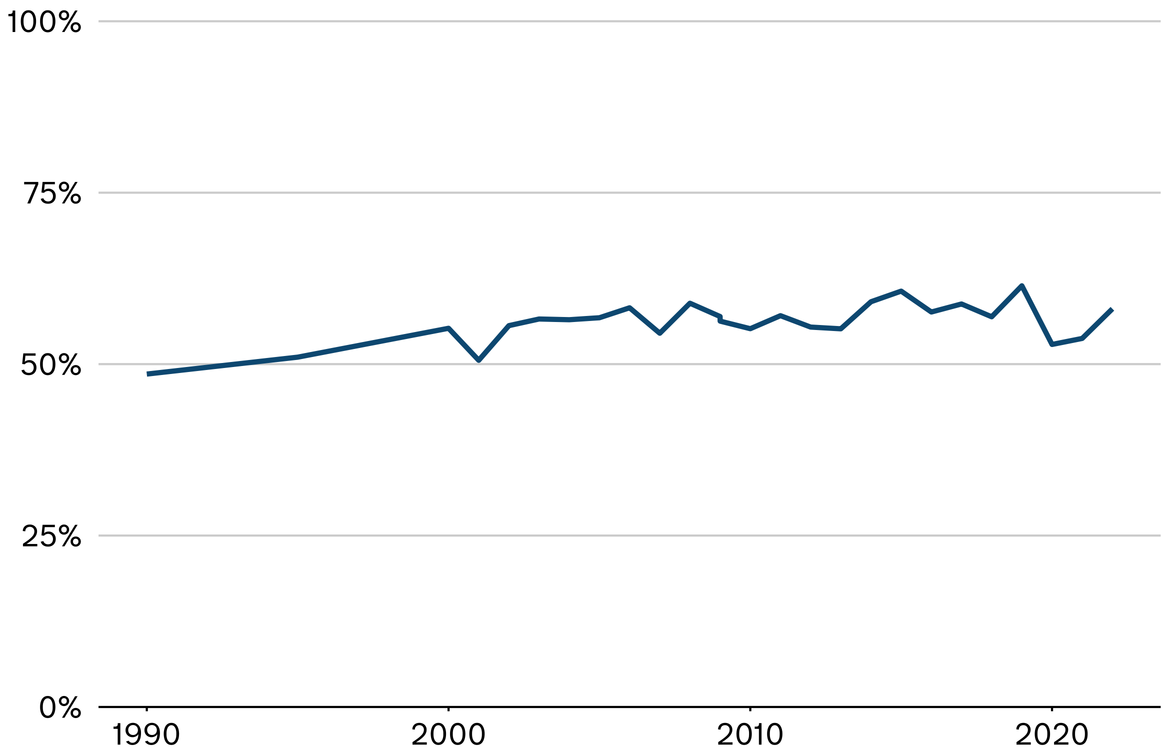
In August 2022, the only UK producer of ammonium nitrate moved to an import-only model for ammonia and has now permanently closed their ammonia production. While this is a change in the supply chain for ammonium nitrate, the product lines remain the same and it has not impacted ammonium nitrate availability in the UK. The UK imports both finished fertiliser products and raw materials to satisfy the inorganic fertiliser demand.

In Great Britain, the British Survey of Fertiliser Practice annually records the main trends in fertiliser usage. The long-term trend in fertiliser use is broadly downward. As shown above in figure 3.1.1b usage from 2003 decreased continuously before a substantial drop in the period 2008 to 2009. From the period 2008 to 2009, usage for nitrogen, phosphate and potash fertilisers plateaued. The overall downward trend is mostly due to a reduction in grazing livestock herd size reducing herbage production requirements. By contrast, overall nitrogen application rates for main arable crops have seen only marginal reductions over the last 30 years.

Long-term downward trends in fertiliser use need to be compared to the harvested outputs for a more useful comparison of how efficiently the UK uses nutrients. The Defra soil nutrient balance statistics (figure 3.1.1c below) show that since 2000 there has been no substantial change in nitrogen use efficiency, despite a reduction in overall fertiliser use in that time.

Figure 3.1.1c: Nitrogen use efficiency (NUE) for England,1990 to 2022.

Source: UK and England soil nutrient balance 2022, Defra



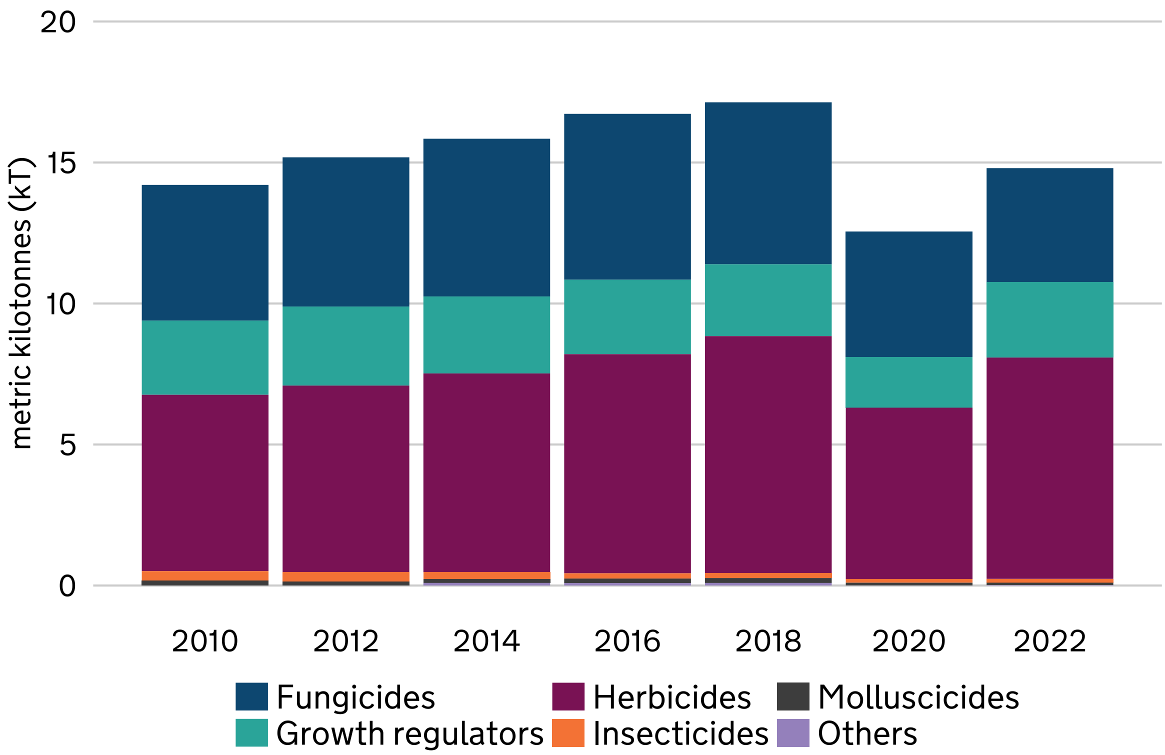
Fertiliser prices

Changing fertiliser prices as a result of international markets have affected usage. Usage continually decreased from 2003 with the exception of periods during two major events: the financial crisis in 2008 and the 2021 gas price hike as a result of increased oil demand following the COVID-19 pandemic. Oil and gas price rises were further exacerbated by Russia's invasion of Ukraine in 2022 (AHDB, 2024). Natural gas is a key component in fertiliser production and so the 2021-2022 events resulted in increased fertiliser prices. The price rises prompted a modest reduction in usage, which may have been in part due to farmers' expectation of enduring high market prices for agricultural commodities. Fertiliser prices decreased in the latter part of 2022 and in 2023 but remain above 2020 levels. This reduction was driven by falls in the price of natural gas.

Pesticide use and supply

Figure 3.1.1d: Pesticide use, UK 2010 to 2022

Source: [Pesticide Usage Survey Report 2022, Defra]



Plant protection products (PPPs) are pesticides that are used to regulate growth and to manage pests, weeds, and diseases in plants and plant products. They play an important role in maintaining high crop yields. However, they can have detrimental effects on the environment, particularly on terrestrial and aquatic biodiversity. In the UK, pesticide usage is reported through the Pesticide Usage Survey Report, which consists of surveys for a range of crop groups and produces estimates from representative samples of growers. Pesticides applied to arable crops make up around 85 to 90% of all pesticides applied to agricultural land in the UK.

Between 2010 and 2018 there was a gradual increase in the weight of pesticides applied to arable land. There was a subsequent drop in usage in 2020, which was partly due to a switch from winter cropping to spring cropping due to challenging weather conditions in the autumn of 2019. In 2022, pesticide use rebounded but fell below the levels seen in 2018. However, the amount of data available makes it difficult to assess or establish trends. Changes to future farming practices such as use of Integrated Pest Management (IPM) may mean that growers become less reliant on chemical pesticides over time.

UK imports and exports for PPPs exceed the UK's usage, suggesting that the UK plays a significant role in manufacturing or processing of PPPs for other markets. Currently there is a data gap on what proportion of PPPs used in the UK are imported. The UK's exit from the EU could lead to increased frictions associated with bringing PPPs to the GB market, although anecdotal evidence suggests that these have not yet led to significant impacts on GB PPP availability. Manufacturers of PPPs now must incur the costs of authorising and renewing PPPs in GB and the EU, which could affect availability of products in GB for access to a relatively small market. In addition, existing transitional arrangements with the EU to enable free movement of seed treatment products and 'parallel' products into the GB market will end in 2028. This could further affect GB product availability as PPPs that were previously imported through this route but do not have GB authorisation could lose access to the GB market.

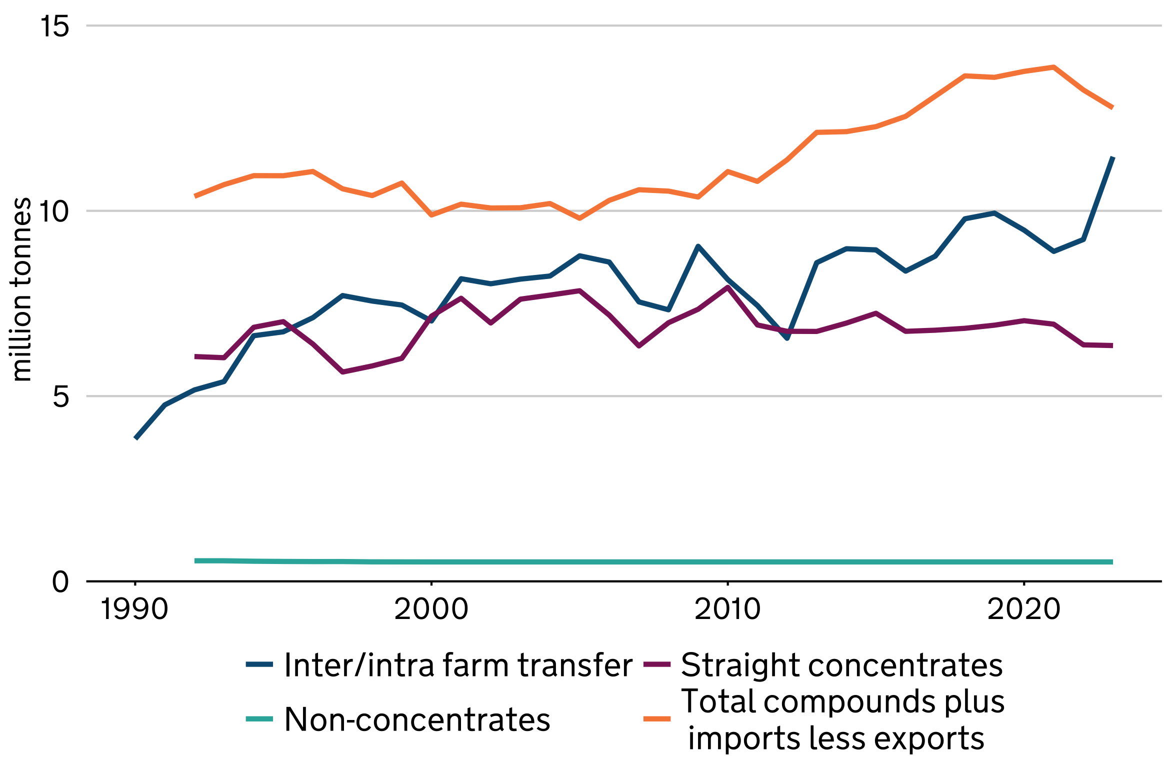
Pesticide prices

Pesticide prices remained relatively constant (in real terms) from 2004 to 2021, with only moderate fluctuations. This consistency is likely due to the absence of significant supply shocks during that period and the broadly competitive global market for pesticide products keeping prices stable over the long-term. The recent increase therefore represents an anomaly due to unprecedented global disruptions rather than a regular fluctuation pattern. Latest agricultural price indices show a 25% increase in prices for plant protection products between July 2021 and July 2023. This was driven primarily by a significant rise in prices starting in early 2021 and peaking in June 2022 before stabilising just below the peak. Pesticides are formulated using a variety of key raw materials, including petrochemicals, ammonia, phosphorus, sulphur, and chlorine. These materials are essential for creating the active ingredients and inert components that make pesticides effective. The increase in prices between July 2021 and July 2023 arose primarily due to the shocks to energy supply and supply logistics mentioned above.

Animal feed use, supply, and price

Figure 3.1.1e: Animal feed use, tonnes, UK 1990 to 2023

Source: [Agriculture in the United Kingdom 2023, Defra]



Note:

1. Straight concentrates are cereals, cereal offals, proteins and other high energy feeds.
2. Non-concentrates are low-energy bulk feeds expressed as concentrate equivalent. Includes Brewers and distillers' grains (e.g. barley), hay, milk by-products and other low-energy bulk feeds.
3. Inter/intra farm transfer is feed produced and used on farm or purchased from other farms.
4. Compound feed is a mixture of at least two feed materials.

Demand for animal feed as an input to the UK supply chain is driven by increases to livestock used in domestic production of animal products. Production of UK livestock is covered in Theme 2 (see Indicator 2.1.3 Livestock and poultry products). The cost of animal feed is the largest item of expenditure recorded in agricultural accounts. Usage of animal feed remained broadly level from 1993 to 2009 (around 25 million tonnes) before rising steadily since then to reach a peak of 30.8 million tonnes in 2018 before falling to 28.5 million tonnes in 2022. In 2023 the total volume increased to 31.1 million due to a 24% increase in inter/intra farm sales. However, total compound feed (see data note for definition) volume decreased by 3.6%, with decreases in **pigs** (-8.9%), **sheep** (-9.4%), **poultry** (-3.3%) and **cattle** (-0.3%). Compound feed for calves showed a small increase of 1.3%.

To meet these volume demands the UK imports commodities such as soybean meal and maize (AHDB,2024). Soybean meal is used to feed all livestock but is particularly important in the pig and poultry sectors. Soybean meal is favoured due to its low-cost, year-round availability and nutritional value, particularly its high protein content and few anti-nutritional factors post-processing. The UK is not an ideal growing environment for soybeans. The estimated area of soybeans in the UK is around 2000ha, but plant breeding work continues to develop varieties more suited to UK conditions. Despite a relatively satisfactory level of fodder maize production in the UK (mainly used for on farm feed of dairy cattle or for bioenergy), there is little grain maize production in the UK meaning that almost all is imported, mostly for human and industrial usage and poultry feed. However, cereals (maize, wheat, and barley) can generally be used interchangeably following reformulation of the feed product. The UK continues to import soybean and maize from a wide variety of countries in recent years, showing a diversity of supply. Some of the environmental impacts estimated to be associated with UK consumption of cattle related products, such as maize and soy, are covered in Theme 4 (see Indicator 4.3.3 Sustainable diet). There is significant variation from year to year based on availability and price. The total import volume of maize (excluding seed for sowing) in 2023 amounted to 2.1 million tonnes, a decrease of 12% compared to 2022, when imports stood at 2.4 million tonnes. UK imports of soybeans are covered in Theme 2 (see Indicator 2.1.2 Arable products). The UK is dependent on imports of feed additives (such as amino acids, enzymes, vitamins, minerals, phosphates) where supply is limited to a small number of countries and important to animal health and welfare (Environment, Food and Rural Affairs Committee, 2022).

Higher feed costs from 2022 to 2023 were driven by higher international prices in feed due to the global price shocks. This particularly challenged the pig and poultry sectors which have faced other challenges from butcher shortages capacity and increasing disease risks. This is explored further in Theme 2 (Indicator 2.1.3 Livestock and poultry products). Sufficient grass growth in the latter half of 2023 reduced the need for extra supplementary compound feed for cattle and sheep. Additionally, the volume of straight concentrates (see data note for definition) decreased by 0.3% in 2023 (AUK, 2023).

Fish feed use, supply, and price

UK production of seafood is discussed in Theme 2 (see Indicator 2.1.5 Seafood). Unlike terrestrial animal feeds, there are no equivalent public statistics on usage and prices for fish feed within UK aquaculture. Various diets are used for different species at various stages of production. Fish feeds are formulated from a range of ingredients, sourced from marine and terrestrial origins, from domestic and international suppliers. Fish feed therefore has a complex supply landscape, giving it similar strengths and risks to other animal feeds (see animal feed section above). In recent years prices for certain fish feed ingredients have surged. For instance, fish meal (ground-up fish) rose from 1,900 USD per tonne in October 2022 to 2,200 USD in October 2023. This is due to limited global supply availability as a result of reduced production from Peru, the main global supplier of fishmeal and fish oil (FAO, 2024). Increases in production of fish meal may lead to sustainability issues, because of overfishing to meet the demands of fish feed in aquaculture (Nagappan and others, 2021).

Land use

A final consideration for both feed types is land use and environmental sustainability of supply. Although animal feed and livestock contribute to 80% of agriculture land use, from a food availability and nutrition perspective meat, dairy, and farmed fish provide just 17% of the world's calories and 38% of its protein (FAOSTAT, 2024). Consideration of this statistic needs to factor in that type of land use is limited by type and quality of land. This is discussed in more detail in Theme 1 (see Indicator 1.2.2 Global land use change). Theme 1, Indicator 1.2.2 Global land use change, also discusses that soybean and maize have historically driven crop expansion resulting in deforestation in regions such as South America, an important supplier region of animal feed to the UK.

Semi-conductors

Agricultural production relies on broader inputs to the UK economy that are subject to a range of variables. Important examples are water and energy, which are considered as separate indicators in this sub-theme. Another important consideration is technological innovation, which continued growth in agri-productivity is dependent on (discussed in Theme 2 (see Indicator 2.2.3 Agricultural productivity). Technological innovation relies on resilient supply of key technological inputs, the majority of which are not specific to agri-sector uses only. Semi-conductors are a ubiquitous technological input, required for technological innovation of existing production efficiencies and new components and techniques. Global production of the highest-grade processing chips is limited to specific suppliers in specific regions. Notably 75% of the manufacturing capacity and required materials are located in China and East Asia (Mohammad, Elomri and Kerbache, 2022). There is therefore a global dependency on these specific regions for both supply and further development of semi-conductors. Recent international volatility and geopolitical contestation such as Russia's invasion of Ukraine highlights the risk of being dependent on narrow supply chains.

3.1.2 Supply chain inputs

Rationale

The food consumers purchase depends on a complex set of inputs at the processing stage (post-farmgate). This indicator tracks a select number of post-farmgate inputs to represent this complexity and to surface key trends affecting resilience of their supply over time. As with agricultural inputs, broader supply chain inputs are affected by domestic and international disruption. Import reliance and general supply landscape are considered for each input.

CO_2: CO_2 is an example of a chemical that is used across the food supply chain. CO_2 is used for animal stunning, for refrigeration, as a packaging gas and in carbonated drinks.

Sunflower oil: Edible oils are used in food manufacturing for a range of uses cooking, emulsifying, as a stabilizer. Sunflower oil has been selected to represent the wider edible oils category.

Wheat: Wheat, used to produce flour, is a staple ingredient of the UK diet not just in bread but in wider food manufacturing of other baked goods, as an ingredient in sauces and dressings, and the production of bioethanol.

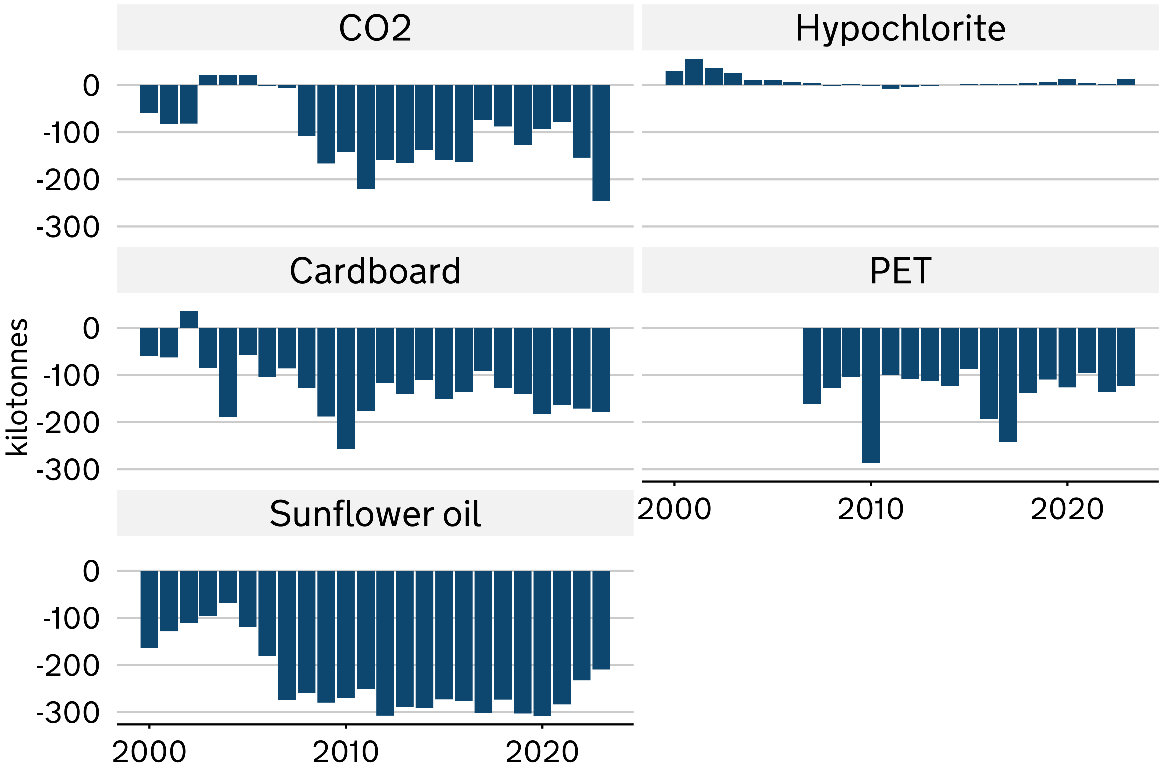
Cardboard and Polyethylene Terephthalate (PET): Packaging is an important part of the food manufacturing process. Both Cardboard and PET are prevalent packaging inputs. Paper based packaging can be both carton board (or solid board) for sandwich packs, food trays, breakfast cereal, confectionery and others or it can be corrugated for fruit and vegetable trays and pizza boxes, e-commerce/home delivery. In both carton and solid board, packaging starts as reels of paper before conversion into its final form. PET is a type of plastic that is used to produce beverage bottles and packaging for food products.

Sodium hypochlorite: Cleaning agents are vital across the supply chain for food hygiene and in the processing of horticulture and agricultural inputs. Sodium hypochlorite has been chosen as an example of a cleaning agent for this indicator as it is widely used in the food industry as a disinfectant, primarily for fresh fruit and vegetables and bagged salads.

Headline evidence

Figure 3.1.2a: Net trade of key supply chain inputs, kilotonnes UK 2000 to 2023

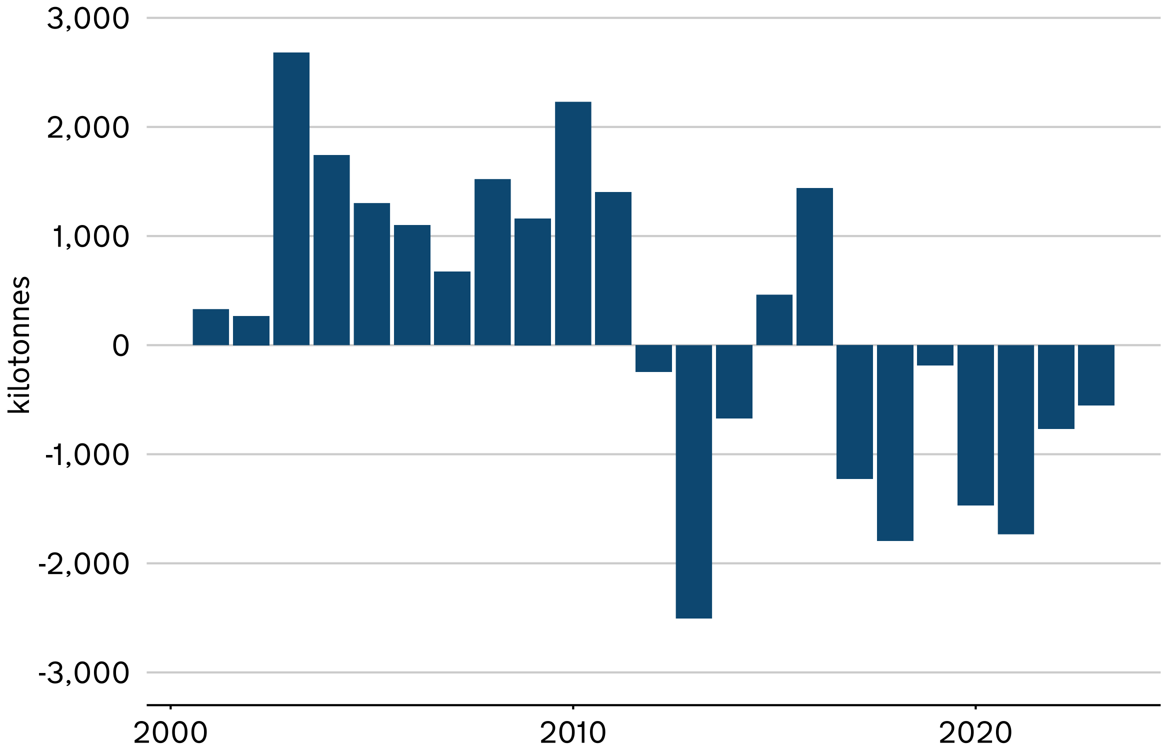
Source: HMRC



Note: Net trade is exports minus imports. Thus, a negative value of net trade indicates that a country is a net importer of that product.

Figure 3.1.2b: Net trade of wheat, kilotonnes UK 2000 to 2023

Source: [HMRC]



Note: Net trade is exports minus imports. Thus, a negative value of net trade indicates that a country is a net importer of that product.

CO_2

Figure 3.1.2a above shows that the UK has been a consistent net importer of CO_2 over the last 15 years, with a steep rise in the last 3 years. From 2021 to 2023, The Netherlands was the largest supplier of CO_2 imports to the UK, accounting for 70 to 90% of imports. Much of UK CO_2 is supplied by companies that import to the UK from the EU either by origin or dispatch and therefore the supply landscape is interlinked with the EU market for CO_2. There is some domestic production of CO_2 as a co-product in the production of bioethanol and through anaerobic digestion. As a byproduct of fertiliser production (energy intensive), CO_2 production is also affected by energy price increase. Detailed CO_2 price data is not currently available. Indefinite shelf life gives some stability to supply in an event of supply disruption, but storing CO_2 can be costly. The recent notable increase in imports is likely related to domestic production gap left by closure of one of CF Fertilisers' company assets in 2022, and another in 2023, where CO_2 was a co-product of processes at these assets. A CO_2 shortage in 2022 affected the meat industry (animal slaughter) for months, causing animal welfare issues, as well as affecting large parts of the food and drinks sector (brewers, soft drinks producers, some packaging processors) (Food Standard Agency, 2023). There are a relatively small number of companies supplying CO_2 in the UK and infrastructure enabling deliveries is often owned by the supplier, so it is difficult for food businesses to divert to alternative suppliers when disruptions occur. Finding alternatives to CO_2 is difficult, with limited uses of alternative gases across the food industry.

Sunflower oil

Sunflower oil is a component in a wide range of processed foods. Therefore, any disruption in supply will impact a wide range of food manufactures. As shown in figure 3.1.2a above, the UK has a high import reliance on sunflower oil. In the mid-2000s, after implementation of export tariffs for unprocessed sunflower seed, Ukraine developed a leading sunflower oil industry and became the leading exporter of sunflower oil in the world, accounting for 50% of the global export market (Food Standards Agency, 2022). While there are several refineries in the UK which can crush oilseeds and produce oil, they could not crush sunflower seeds competitively and instead concentrated their activity on processing domestically grown or imported rapeseed, to produce bulk vegetable oil for retail bottles or use in food manufacturing. This model worked well for several years, with UK oil processors meeting demand by importing sunflower oil that had already been through primary processing. Following Russia's invasion of Ukraine in 2022, sunflower supplies from Ukraine were suddenly withdrawn from the market. As a result, total UK imports of sunflower oil fell to 241,000 tonnes in 2022 and 224,000 in 2023 from an average of around 300,000 tonnes per year since 2007. Many food manufacturers showed resilience in response to the tightening of supply by adapting their recipes to use alternative oil supplies, which was supported by rapid assessment of risks of allergic reactions by the Food Standards Agency and Food Standards Scotland (Food Standards Agency, 2022). Since the initial disruption, Ukraine has been able to export sunflower oil again by road and sea. On a country-of-origin basis Ukraine and France accounted for 73% of the total volume imported to the UK in 2023. However, import volumes have not returned to pre-war levels. This in part due to weather patterns in both Ukraine and France reducing the seed available for crushing. After adjusting recipes to be more flexible following the initial disruption, food manufacturers are now able to place orders according to price point by switching from sunflower oil to rapeseed oil or using a blend of both when setting contracts. This could be interpreted as an example of re-orientation that helps mitigate the effect from future disruptions.

Wheat

Wheat is used in a number of inputs throughout the supply chain and is the UK's largest food import. Figure 3.1.2b above shows that the UK was consistent net exporter of wheat from 2000 to 2011. Since 2011, the UK's net trade in wheat has fluctuated between being a net importer and net exporter. 2013 was a peak year for imports due to an exceptionally wet autumn leading to much reduced area of winter crops, followed by a particularly cold spring with unseasonably late snowfalls in the last three years. Production of UK wheat is covered in Theme 2 (see Indicator 2.1.2 Arable). Depending on the quality of domestically produced wheat, UK flour millers will need to import some of the required wheat. From 2021 to 2023, Canada and Germany were the top two importers of wheat to the UK with around 40 to 60% of imports in total. North American wheat has good characteristics (high protein and gluten strength) to work well with a blend of UK wheats and import levels are relatively consistent. As discussed in Theme 1 (see Indicator 1.3.2 Global real prices), there have recently been several disrupting factors affecting the supply and price of wheat on international markets. Wheat is substitutable by a range of alternatives including barley, buckwheat, corn, maize/polenta, millet, oats, quinoa, rice, rye, and sorghum, but application of these options varies across a range of food products.

Cardboard and Polyethylene terephthalate (PET)

The UK is currently a net importer of both PET and cardboard, both of which are used in the food and drink manufacturing process as packaging. From 2021 to 2023, the UK imported cardboard from a number of sources, with the Netherlands and Türkiye the principal suppliers accounting for around 30%. Similarly, the UK imported PET from a number of importers, with China the primary supplier accounting for around a third of imports. Over the last three years the UK's net trade balance has remained broadly stable for PET and cardboard. Substitution depends on the product contained within the cardboard or PET packaging. For example, during shortages of pulp for egg cartons, single-use plastic cartons have been temporarily used. There is currently limited data available to adequately disaggregate how much of the total volume of PET and cardboard is used in the food and drink supply chain.

Sodium hypochlorite

Over the last 20 years the UK has been primarily a net exporter of sodium hypochlorite, this trend has continued over the last 3 years. Not all sodium hypochlorite is used domestically and therefore despite being a net exporter, the UK still imports sodium hypochlorite. From 2021 to 2023, Ireland and Italy were the top two suppliers to the UK, accounting for around 40 to 60% of imports in total. Sodium hypochlorite is used in a wide range of applications as a disinfectant. Examples include preventing algae or shellfish from growing in stored water, washing fruit and vegetables and the preparation of meat and fish for consumer consumption. Due to commercial sensitivities, there is limited data available on the UK's supplier landscape for sodium hypochlorite. Reports from industry body Eurochlor (Chlor-Alkali Industry Review, 2023) show UK domestic production of chlorine (an input in the production sodium hypochlorite) stood at 440 (total kt Cl2), for the period between 2021 and 2023. It is expected that the UK's domestic production of chlorine will decline because of plant closures. Due to the wide-ranging uses any possible disruption of supply would affect several actors within the food supply chain. Chlorine dioxide has been used as an alternative to hypochlorite solutions in cleaning applications with high organic loads such as poultry or fruit processing. It has much more oxidizing power than bleach, is less corrosive to equipment, and is less harmful to the environment.

Supporting evidence

Over the last three years, across the inputs within this indicator, except for sodium hypochlorite, the UK has continued to be a net importer. Broadly across the inputs, the UK's domestic production has fluctuated due to varying factors such as extreme weather and energy prices. Inputs such as wheat and sunflower oil have a number of substitutions, if their availability were to be disrupted. In contrast, CO_2 is more difficult to replace. While both domestic production and trade carry risks, risks to trade are made more acute where inputs have limited numbers of suppliers or concentrated supply, and this risk becomes stronger in conditions of volatility as seen in the years 2021 to 2023. Sunflower oil and CO_2 both show high import reliance on one or two countries. The risk for sunflower oil was demonstrated in 2022. Inputs to mandatory flour fortification of bread such as calcium carbonate also have a concentrated reliance on imports that was affected by recent volatility, this is discussed further in the case study below. A 2023 strategic assessment of the food system, commissioned by the Food Standards Agency, summarised that supply chain volatility can affect the food system mainly in two ways: through sudden unavailability of goods with systemic effect, and the increased risk of unexpected contaminants and food quality issues when sourcing from new suppliers and using new trade channels.

This indicator has not considered sustainability of these post-farmgate inputs. As an indicator of the challenges, recyclable inputs for plastics continue to be less accessible than non-recyclable inputs (IGD, 2024). Plastics and packaging broadly offer a range of benefits for food manufacturers, as discussed above. However, the effect of plastic and plastic pollution to the environment, ocean and human health, has led to increased scrutiny on the use of plastics in the food sector and over the longer term can feed into the depletion of the world's natural capital on which food production and productivity is dependent.

Case Study 1: Flour fortification and calcium carbonate

The Bread and Flour Regulations 1998 mandate the compulsory addition of calcium carbonate, iron, niacin, and thiamin to non-wholemeal wheat flour to help protect against nutrient deficiencies within the population. Previously, the supply of calcium used for flour fortification in the UK was sourced from a quarry in England, Steeple Morden. While this met the purity criteria for calcium carbonate in the Bread and Flour Regulations 1998, it was not compliant with the criteria set out for calcium carbonate in EU food law. Hence, industry has moved to a new calcium carbonate source which is compliant with both domestic laws and EU laws enabling single lines of production and giving the ability to serve both domestic and export markets. Calcium carbonate composition is determined by the natural geological makeup and is therefore unvarying and very difficult to change, meaning that existing UK quarried supply of calcium carbonate cannot meet EU criteria as they stand. Additionally, calcium carbonate used in flour has other requirements such as particle size which is needed to be suitable for purpose. The multinational supplier of calcium carbonate has since decided to rationalise their business model which has led to a reliance on a single quarry site in France to source all calcium carbonate for UK flour. Since this shift, the quarry in England has ceased production of food-grade calcium carbonate, meaning that domestic production is no longer a contingency option should supply of calcium carbonate from France be disrupted. Even if this were a contingency option, there could be significant challenges around supplying flour fortified with calcium carbonate that is not compliant with EU food additive requirements. Events such as the widespread protest in France in early 2024 have demonstrated knock-on effect to supply chains, pointing to the potential vulnerabilities of reliance on this single source.

Due to the scale of flour production in the UK and restrictions of storage space, frequent deliveries of calcium carbonate are required with some larger mills receiving tanker load deliveries 1 to 2 times per week. This is the JIT model whereby raw materials are purchased to align with production schedules and large stockpiles are not held. While enabling efficiencies in supply, it means that a disruption in the supply of calcium carbonate could lead to the depletion of stocks quickly with immediate effects on UK millers' ability to produce flour complaint with UK law. While there has been no break in the supply of compliant flour in the UK, this example highlights that there are areas where highly specialised ingredients and inputs are required by the UK food system, and limited suppliers producing to this specification. This, combined with an industry model that does not encourage stockpiling beyond immediate needs, presents a risk to the UK food system. Bread is a staple food for the UK population with a short shelf life and any disruption would be felt immediately by the population and would likely affect public confidence in the UK food system.

This issue is not exclusive to calcium carbonate and could also be true for most of the mandatory nutrients required to be added to flour. Thiamin and niacin are obtained exclusively from China due to difficult synthesis and low profit margins. A short-term issue with thiamin supplies was seen at the beginning of the COVID-19 pandemic but the effects were minimised, and stocks of worldwide supplies were redirected to the UK in time.

3.1.3 Labour and skills

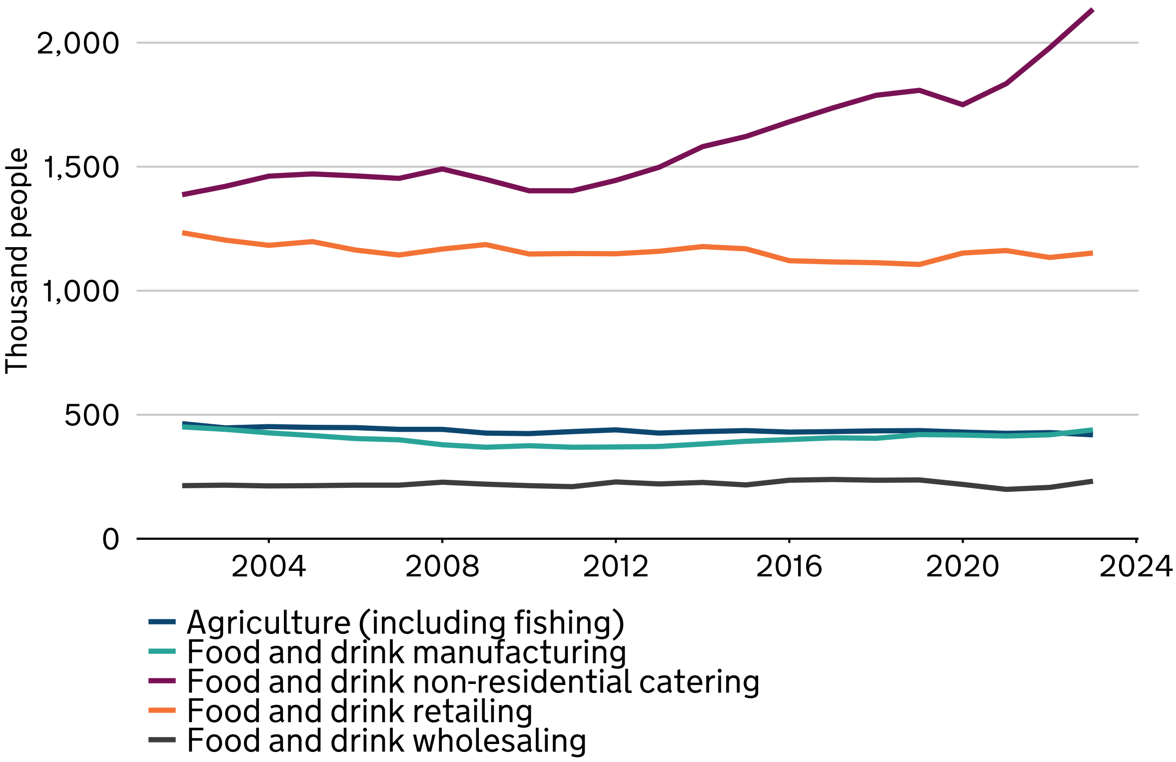
Rationale

Labour is a critical dependency within the food system which requires specific roles be filled to avoid risks and shocks to the supply chain. This indicator tracks overall numbers to quantify UK dependency on labour and surface trends, before highlighting specific types of roles to track pressure points, where labour supply is failing to meet demand and posing risks to the supply chain.

Headline evidence

Figure 3.1.3a: Employment levels of people in agri-food sector, Great Britain, 2002 to 2023

Source: [Agriculture in the United Kingdom 2023, Defra, Table 14.1]



Between 2021 and 2023, the workforce in the food sector in Great Britain increased from 4.04 million to 4.38 million, showing a steady upward trend. In line with the longer-term trend this was driven by the food and drink non-residential catering sector, which added 300,000 workers, rising from 1.84 million in 2021 to 2.14 million in 2023. The food and drink manufacturing sector also saw a small increase, from 414,000 in 2021 to 439,000 in 2023. The food and drink retailing sector fluctuated slightly but ended the same period broadly where it started, at 1.15 million workers. Meanwhile, the food and drink wholesaling sector showed an increase from 199,000 to 232,000 workers. In the last decade, the percentage of the total Great Britain workforce employed in the food sector has remained stable around 13.4%, but this increased in 2023 to 13.9%.

Agri-food employment data is GB only. In Northern Ireland specifically, the latest data shows that in 2021, 32,000 people were employed in the agriculture, forestry and fishing, and food and drink processing sectors, which is down from 35,000 in 2020 and 40,000 in 2019. This constituted 3.7% of total employment in Northern Ireland. Comparably these sectors made up 2% of total employment across the whole of the UK in the same period (Northern Ireland Agri-Food Sector Key Statistics).

Although the overall number of people employed in the agri-food sector is stable, it does not show the variance at a sectoral level. There are persisting labour shortages, resulting in a high reliance on migrant labour over recent decades in a range of roles. These include shortages in skilled and highly skilled roles throughout the supply chain, for example butchers and veterinary nurses, as well as manual labour roles such as deck hands on fishing boats and fruit and vegetable pickers. Many roles are permanent, but some are shorter term or seasonal. While many jobs still require manual tasks, automation is increasing across the supply chain, bringing new opportunities and new skill requirements. However, a combination of changing job preferences in UK society, broader sectoral image issues, the timeframe to train skilled workers and challenges with retention all contribute to the current high reliance on migrant workers to fill vacancies. These challenges have been exacerbated following the UK leaving the European Union causing increased strain on the UK labour market due to short term difficulty in workers entering the UK to work long-term dependants (Migrant Advisory Committee, 2024).

Migrant workers have helped some agri-food sectors to grow rapidly to meet demand and to keep production costs down, helping increase UK domestic food production. For example, the meat processing sector expanded rapidly in the early 2000s as EU freedom of movement brought easier access to Eastern European workers with butchery skills. The UK leaving the EU has increased the cost and complexity of accessing migrant workers who now tend to come from non-EU countries.

Similarly, the manufacturing, poultry and horticulture sectors also employ a high proportion of temporary and seasonal workers work during certain times of the year to meet peaks in workforce demand. These sectors have always relied on seasonal migrants for short term harvesting tasks that are difficult to automate.

Larger companies may have more flexibility to manage higher absence rates due to their ability to move staff around, whereas small and medium-sized enterprises (SMEs) may have limited capacity to develop contingency plans for sudden increases in absence rates. SMEs may also struggle to compete with the wages and hours that large manufacturers can offer.

Supporting evidence

Notable pressures and shortages across the sector are set out below, as well developments and opportunities such as automation. The section starts with lower skilled and temporary roles (e.g. seasonal labour) and moves to higher skilled roles (e.g. Farmers and vets). Both have issues with sector attraction that have led to high reliance on migrants. For lower skilled roles, there is a greater challenge of attracting workers. For higher-skilled roles, there is the additional challenge of shortage of skills.

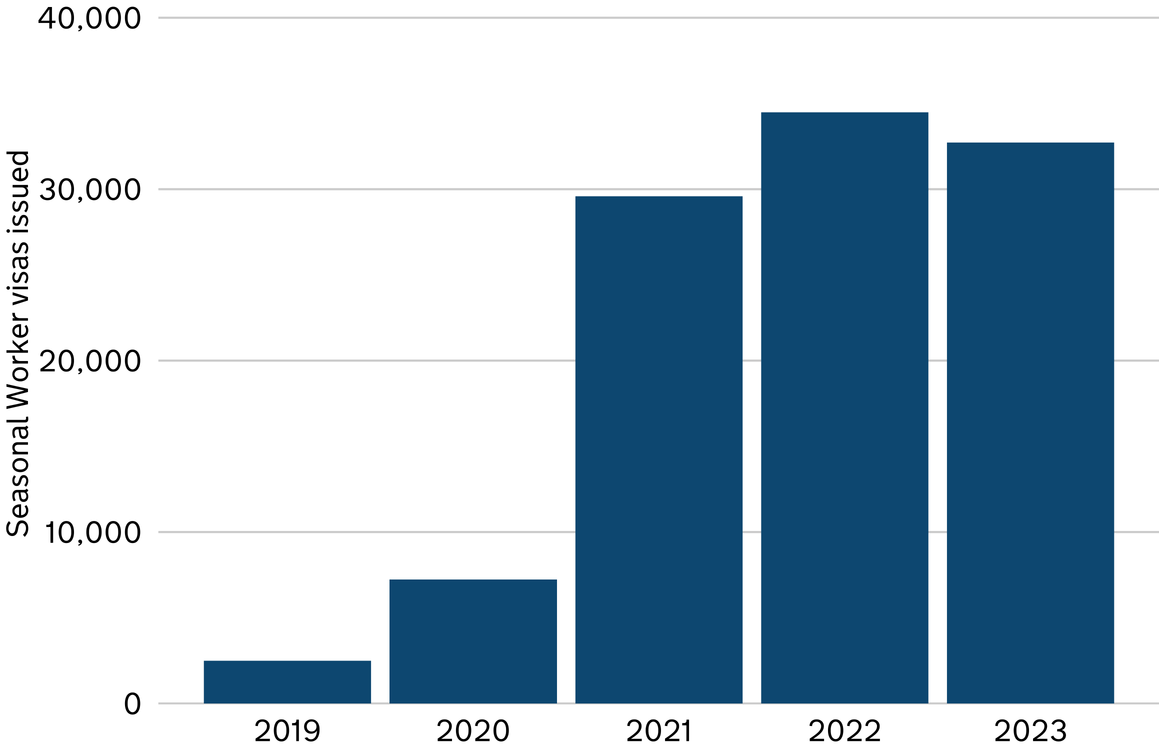
Seasonal Labour

The Seasonal Worker visa (Temporary Work) allows workers to come to the UK to work in horticulture (both ornamental and edible) or pre-Christmas poultry processing. The visa is delivered through the Seasonal Worker Scheme (SWS), which the Home Office and Defra are jointly responsible for. The government sets a quota for the number of visas to be allocated through the SWS, divided between several scheme operators. In 2019 the quota (including extension) was 2,500. For 2024, the Seasonal Worker visa quota was 47,000 (45,000 for horticulture and 2,000 for poultry, with an additional 10,000 available as a contingency if needed). In 2025, this quota will be 45,000, with 2,000 for poultry. Horticulture workers will be able to come to the UK for a maximum of 6 months in any 12-month period, and poultry workers will be able to come for the period between 2 October and 31 December inclusive. The route does not allow settlement, switching or dependants (Migrant Advisory Committee, 2024).

While Defra estimates the overall seasonal workforce for horticulture and Christmas poultry remains in the region of 50,000 to 60,000 annually (it fluctuates in response to weather and supply chain factors), the demand for workers recruited through the SWS has increased rapidly since the scheme was re-introduced in 2019 (see figure 3.1.3b below). This is because fewer EU workers with Settled Status (the main alternative source) are returning to horticulture work each year. EU workers provided over 95% of the seasonal horticulture workforce before EU Exit. Recruitment is now centred on central Asian nations through the visa scheme. Fewer than 5% of seasonal workers in horticulture are UK nationals (Defra, 2024)

Figure 3.1.3b: Seasonal Worker visas issued, UK, 2019 to 2023

Source: [Home Office immigration statistics, 2019 to 2023 and ONS UK payrolled employments by nationality, region and industry, 2023]



From the inception of the visa in 2019 through to 2022 the quota of visas available was below sector demand. This was compounded in 2022 by Russia's invasion of Ukraine , which disrupted recruitment plans. Some crops were left unharvested in fields and there were threats of production going offshore. In late 2022, the government announced that the visa scheme would continue to the end of 2024 and increased the visa quota considerably to ensure it met the sectors' demand. In 2023, visa demand dropped slightly but the SWS still supplied around 60% of overall seasonal worker demand. The land area of vegetable production fell compared to 2022 (mainly due to weather) and the sector was able to utilise several thousand Ukrainian workers still in the UK with extended visas.

Horticulture

Horticulture is the most labour-intensive UK farming sector, employing the highest proportion of casual staff, while relying on additional seasonal workers from overseas. Over three hundred horticulture crops are grown in the UK, using a variety of growing methods from fields: polytunnels, traditional orchards, glasshouses, and vertical farms. Each crop and each growing method come with its own unique labour needs for establishment, husbandry, handling and harvesting. Labour costs have been rising steadily in recent years, adding pressure on growers in a sector with tight profit margins and at a time when other costs such as energy have risen. The minimum hourly rate for migrant workers under the Seasonal Worker visa is linked to the national living wage and over recent years that rate has increased significantly to £11.44 per hour in 2024 (Migrant Advisory Committee, 2024). Labour accounts on average for over 40% of overall production costs, and is increasing at a two-year compound figure of 24.3% (NFU and Promar, 2023). The horticulture sector continues to struggle to attract British workers due to the short term, physical, repetitive, and outdoor nature of the work, but also its rural location which brings challenges of poor public transport and lack of affordable housing. Without the necessary labour to pick horticulture produce, there is a heightened risk that food will be wasted, rather than entering the supply chain, or that production moves overseas (Environment, Food and Rural Affairs Committee, 2022).

Seafood

Seafood sector jobs are perceived as difficult and poorly-paid, while offering unattractive working conditions (Seafish, 2023). These factors alongside low unemployment rates, particularly outside the main urban centres, and competition for labour with other sectors make for difficult business conditions and highlight the critical dependence on non-UK labour in the sector. Following changes to the immigration system in April 2023, the only route available to recruit non-UK workers in both seafood processing and catching sectors is the Skilled Worker Visa. The recent increase to the Skilled Worker Visa salary threshold (from £26,200 to £38,700, a 48% rise) has made it harder to recruit non-UK workers. Consequently, labour shortages in the catching and seafood processing sectors are causing closure of fishing vessels and reduced productivity in processing businesses.

Skills and training challenges across the food supply chain

The Independent Review into Labour Shortages in the Food Supply Chain identified a number of factors behind the sector's workforce recruitment and retention challenges. These include a negative perception of the industry, the rural location of many jobs and a lack of investment in relevant skills and training. Additionally, a lack of engagement with the current recruitment methods of advertising vacancies through online job sites and through social media, results in the sector having a low online profile. Inadvertently, this absence leads to a lack of pertinent data for government to analyse vacancies and skills needs. The agri-food sector lacks an effective relationship with the domestic workforce and the jobcentres in their locality as well as with national teams and central Department of Work and Pensions services.

The increasing use of digitisation, robotics and automation requires highly qualified staff to maintain and operate such technologies and the specialised skills required for these roles, which often require degrees and postgraduate qualifications, can make recruitment of staff more difficult. The Food and Drink Federation (FDF) has stated that apprenticeships and non-apprenticeship training courses allow businesses throughout the supply chain to upskill new and existing employees (Food and Drink Federation, 2024).

Average farmer age

42% of farmers in the UK were 60 years old or older at the time of the 2021 Census, with 29% being over 65 years old. This contrasts with the wider population of workers of whom 11% are over 60 years and 4.3% are over 65. The current state pension age in the UK is 66 years old. Less than 11% of farmers are under 30 years old. There is a risk to the agricultural sector if it cannot attract younger farmers to take on roles from the older generation of experienced farmers when they retire.

HGV drivers

In 2023 GB-registered HGVs lifted 219 million tonnes of food products, 14% of all goods lifted in the UK. HGV drivers ensure that these goods are transported smoothly throughout the food supply chain. In 2023 the number of HGV drivers in the UK was 271,800, the lowest in the last 19 years and down 5% from 2022 (286,500) (ONS, 2024). There were acute shortages of HGV drivers during COVID-19 due partly to the unavailability of HGV driver tests preventing new entrants to the sector. However, between Q1 2022 to Q1 2024, the number of HGV businesses reporting missing deliveries due to HGV drivers not being available decreased by 55% (Department for Transport, 2024). The current risks to the sector are the ageing workforce (ONS, 2021) and lower median salary compared to the UK average.

Butchers

The UK's meat processing industry relies heavily on overseas skilled labour for butchers, partly due to the lack of suitably trained domestic workers butchers. Higher salary requirements for skilled migrant butchers could have knock-on effects on the wider labour market for butchers. Equality law requires workers to receive similar wages for performing the same work. There are potential risks to remaining competitive internationally and to the cost and availability of butchered meat.

Veterinary professionals

Around 1,000 vets are employed in government roles, including 'Official Veterinarians' (OVs). Food safety and animal welfare legislation requires OVs to be present in approved meat establishments to oversee the delivery of official controls. OVs play a key role in ensuring UK food security verifying compliance with regulatory requirements and working with businesses to provide assurance over food safety. These duties enable continued trade in animal products, and the management of risk to human health from zoonotic diseases. Veterinary services underpin the £10.9bn domestic meat industry and the £2.1bn meat export trade (FSA, 2024).

Although numbers have been broadly increasing, demand has also expanded. Reasons include the need for increased veterinary public health expertise to support trade-related work including veterinary certification and attestation requirements resulting from the UK leaving the EU. Demand is also due to increased levels of animal ownership.

In 2019, there was an estimated 11.5% shortage in the profession as a whole (RCVS, 2024). There are several potential reasons for these shortages. A survey conducted by the Institute for Employment Studies in 2019 found poor work-life balance (60%), not feeling valued (55%) and chronic stress (49%) as the top three reasons for why individuals were intending to leave the veterinary profession (RCVS, 2019). Additionally, retention is low; in 2021, 45% of vets leaving the workforce had been in the profession for four years or less, including 21% who had less than one year of experience. There has also been a decrease in new UK-practising registrants from overseas, particularly from the EU; in 2018, 53% of new registrants were EU-qualified, compared to 23% in 2021 (RCVS, 2021). This has been driven by changes following the UK leaving the EU. For example, vets now need to meet specific criteria, as well as obtain a work visa, to practice in the UK, whereas previously EU veterinary school qualifications were recognised in the UK through mutual recognition of professional qualifications (FSA, 2024).

Ensuring sufficient OV levels is essential for upholding public health and animal welfare standards and ensuring the UK's meat supply chain operates smoothly. While FSA and FSS differ in how they recruit OVs, both organisations continue to face difficulties from supply challenges. In England and Wales, FSA OVs overseeing official controls in approved meat establishments are recruited and employed through a delivery partner. FSA also directly employs 77 vets who complete assurance visits and carry out approvals and audits of slaughterhouses and cutting plants.

COVID-19, EU Exit and increased demand across the wider veterinary profession contributed to a drop in the number of FSA's delivery partner OVs in 2021. Use of the RCVS Temporary Registration (TR) scheme allowed FSA to increase OV numbers and avoid risks to service delivery in meat establishments. In preparation for the scheme ending in December 2024, FSA reduced its reliance on TRNOVs from 38% in December 2022 (103 TRNOVs of 272 total OVs) to 17% in December 2023 (57 TRNOVs of 340 total OVs).

In Scotland, FSS employs OVs directly and uses temporary agency staff as needed. As of December 2023, FSS figures showed that the number of OVs in post was running at 82% of the capacity required for service delivery, causing some limited delays in meat production on some sites while OV cover was arranged. This is based on an estimated requirement of 29.8 FTE vs 24.4 FTE that were employed and deployable as of December 2023 (Our Food 2023). In the UK, local authorities are responsible for monitoring hygiene controls in food businesses. Food businesses include restaurants, cafés, pubs, supermarkets, and other places where food is supplied, sold, or consumed, such as hospitals, schools, and care homes. The professionals involved in the inspection process are food safety officers, environmental health officers (EHOs) and additionally in Scotland, food law officers.

Approved meat establishments include abattoirs, cutting plants, game-handling establishments, and meat markets. Responsibility for monitoring hygiene controls of those establishments lies with the FSA and local authorities in England and Wales, with FSS in Scotland, and with the FSA and the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northen Ireland. The professionals involved in the inspection processes are official veterinarians (OVs), meat hygiene inspectors (MHIs) and food safety officers/food law officers including EHOs.

Food Safety and Standards

Local authorities play an important role in protecting public health by verifying and validating food businesses' compliance with food law, and by taking enforcement action where necessary. Access to safe food is integral to a secure food system. The section below looks at trends in LA food safety and standards resourcing. It also reviews LA sampling activity from 2013/14 to 2023/24:

Local Authority Food Safety Resourcing

The food chain relies on qualified and experienced local authority staff to conduct inspections and work with businesses to ensure that they are operating in accordance with the law and that the food they are placing on the market is safe and meets legal requirements with regard to compositional standards, nutritional content, and labelling. Local authorities provide a critical line of defence in enforcing safety and standards regulations, and in identifying and tackling food crime. These activities help to keep consumers safe and maintain their confidence in our food system. The FSA and FSS have highlighted concerns about shortages of local authority food hygiene and food standards officers.

Figure 3.1.3c: Number of allocated food hygiene and food standards full time equivalent posts in local authorities across England, Wales, and Northern Ireland FYE 2011 to FYE 2024

Source: Food Standards Agency

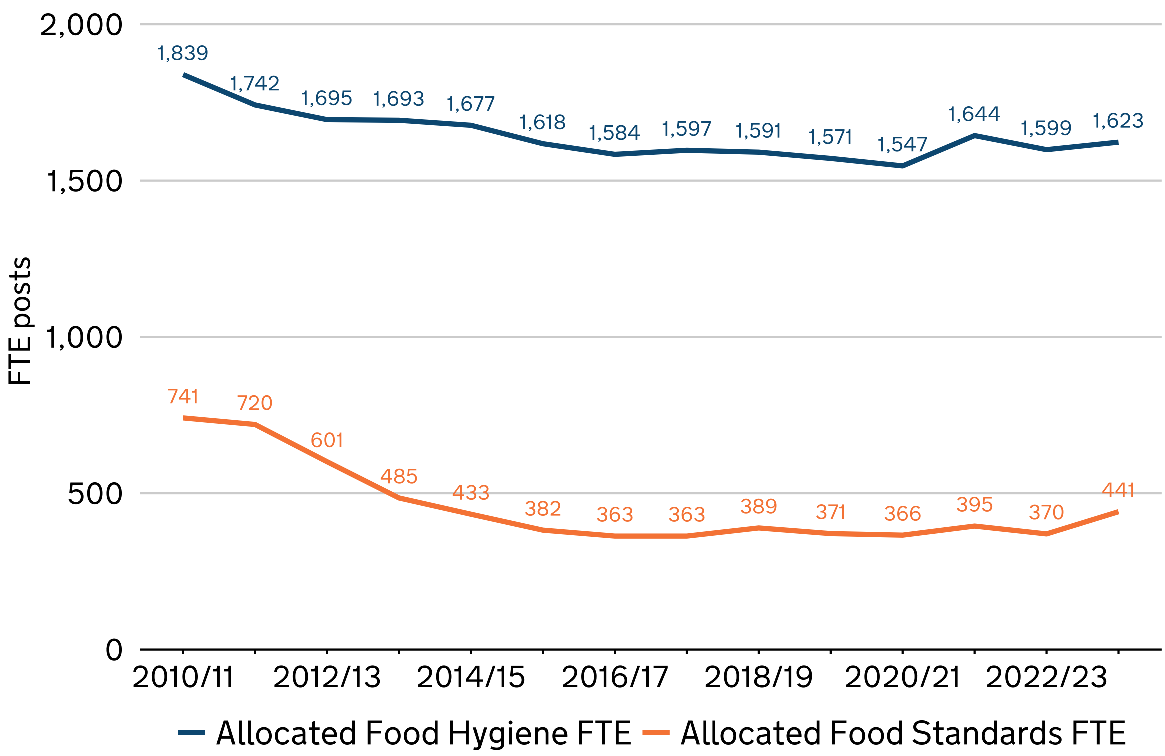
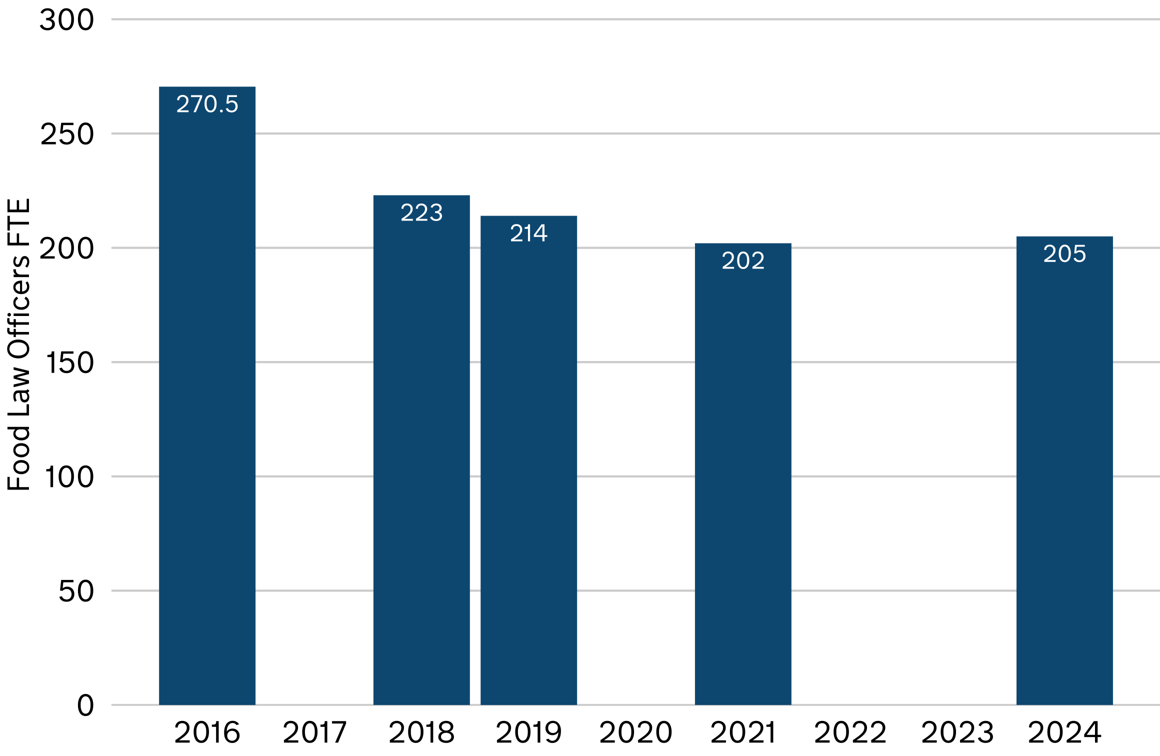


Figure 3.13c shows a decline of approximately 11.7% for allocated (the total number of positions available) food hygiene FTEs in England, Wales, and Northern Ireland between 2010/2011 and 2023/24, and a 40.5% decline in allocated food standards FTEs between 2011/12 and 2023/24. For England, Wales and Northern Ireland, resourcing data provides a snapshot of numbers at the time of the survey and does not represent average workforce estimates across the year. Additionally, a change in methodology, implemented in 2020/21, rephrased the question of incorporating COVID-related working conditions, which may have influenced how local authorities responded.

Figure 3.1.3d: Number of allocated Food Law Officers Full Time Equivalent posts in Scotland 2016 - 2024

Source: Food Standards Agency



In Scotland (see figure 3.1.3d) where food officers cover both food hygiene and food standards, food officer FTEs decreased from 270.5 in 2016 to 205 in 2024, a 24% reduction.

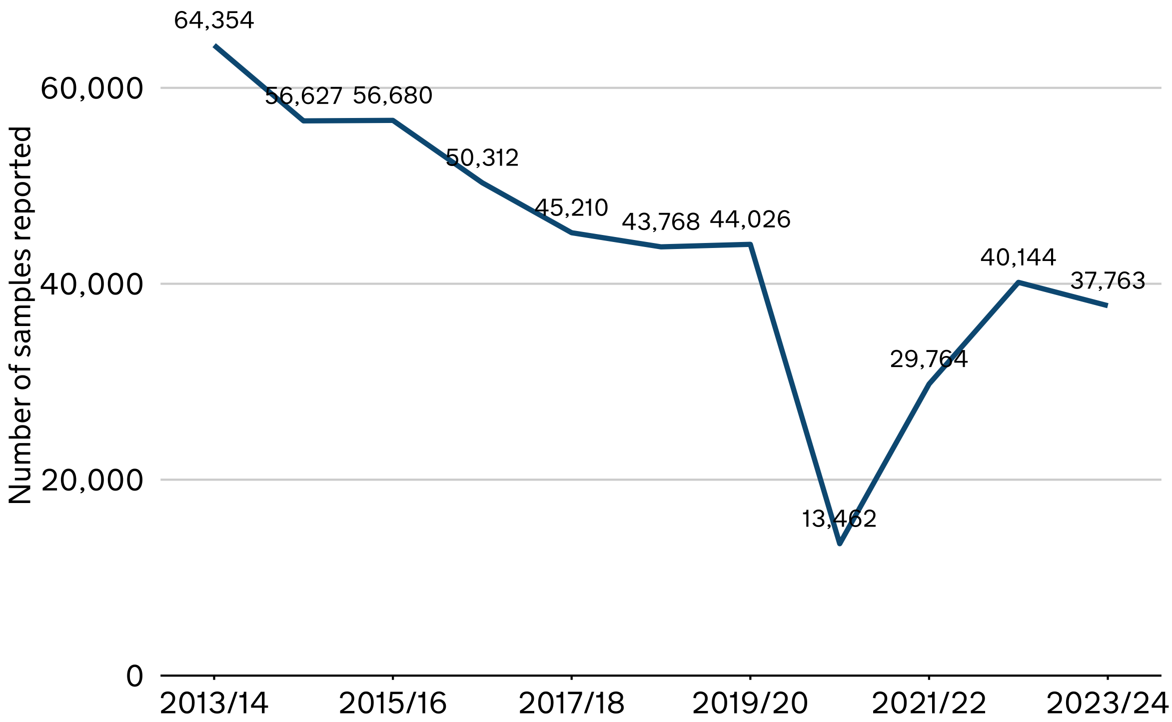
The FSA and FSS have highlighted that the ongoing decline in the number of vacant local authority food hygiene and food standards officer posts has resulted in a significant backlog in the number of food businesses awaiting inspection (Our Food 2023 | Food Standards Agency), and there are concerns that this problem could worsen over the next 5-10 years, when a proportion of the existing workforce reaches retirement age. As a result, the FSA and FSS are working closely with the relevant professional bodies to review competency requirements against the range of food law activities and identify strategies for attracting new entrants into the profession.

Local authority sampling

Food samples collected by local authority environmental health and trading standards teams are tested at designated Official Laboratories (OL) for safety and authenticity issues, including substitution and adulteration. Figures 3.1.3e and 3.1.3f show that the number of food samples taken by local authorities has declined over the past ten years. This is in part due to local authority resourcing shortages as well as overall financial constraints. The FSA and FSS also coordinate national surveillance programmes, which are referenced in Theme 5.

Figure 3.1.3e: Number of samples reported by local authorities in England, Wales, and Northern Ireland 2013/14 - 2023/24

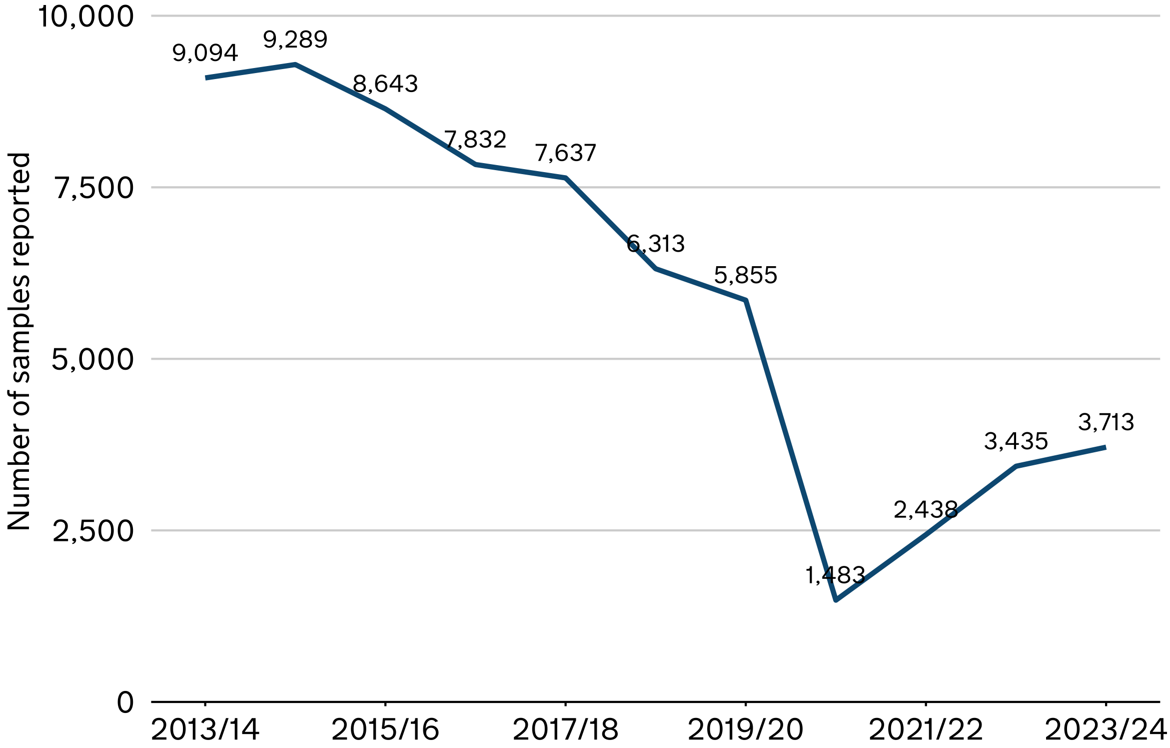
Source: Food Standards Agency



Samples taken by local authorities in England, Wales and Northern Ireland reduced by 41.3% between 2013/14 and 2023/24. Two anomalous data points (2020/21 and 2021/22) show a marked reduction in the number of samples when many local authority officers were diverted to the pandemic response.

Figure 3.1.3f: Number of samples reported by local authorities in Scotland 2013/14 to 2023/24

Source: Food Standards Scotland



Similar to the pattern seen in England, Wales and Northern Ireland, the number of samples taken by local authorities in Scotland reduced by 59% between 2013/14 and 2023/24. An anomalous data point in 2020/21 shows a sharp decline in Scottish samples due to the pandemic response when many local authority officers were diverted to other work.

3.1.4 Water

Rationale

Water is essential to food production. Access to water presents increasing challenges due to increased extreme weather events and increasing competition for use of water. This indicator focuses on agriculture water demand rather than covering the whole food supply chain. Although, the supporting evidence includes some analysis of Food and Drink Manufacturing water usage.

On the farming level, having sufficient access to water for irrigation affects agricultural production and yields; dry conditions produce smaller and fewer fruit and vegetables. Farms access water for irrigation via abstraction, from both ground and surface water, which is then either directly applied to the land or held in reservoirs for use during dry periods.

This indicator tracks volume of water abstracted to show the level of water required for irrigation including during times of water shortages, when conditions have been drier. The Environment Agency (EA) is responsible for regulating the abstraction of water from river, lakes, and groundwater across England on behalf of the government. Extracting water from these natural sources is known as abstraction and is subject to licensing conditions. An abstraction licence stipulates location, volume and use of the water extracted from natural resources, whether it is ground or surface water. These conditions are determined on a case-by-case basis, allowing the EA to tailor water usage to local environmental and catchment conditions, ensuring sustainable water management. This helps protect the environment during low flows (reduced water flow in a river or stream during a prolonged dry period or drought) and prevents over-abstraction. It also safeguards the water rights of other abstractors and improves drought resilience. All of these are increasingly important as population growth and climate change lead to an increased frequency of drought incidents (Rey and others, 2016).

The amount of abstracted water required for irrigation will vary by year and region depending on how wet or dry climate conditions have been, as well as factors such as soil type and the crops being produced. The volume of water licensed for spray irrigation can indicate the level of water dependency in agriculture. Higher volumes of water licensed for spray irrigation in any given region suggests a higher dependence on abstracted water. The risk of high dependence on abstraction can be mitigated if abstracted water is stored, and then used in the following irrigation season, providing resilience when water restrictions are in place. Storage is therefore tracked in supporting evidence.

Data for England is the focus in this indicator The other UK nations also face challenges from water shortages related to climate change. Notably, abstraction licences in Scotland were suspended for the first time in 2022.

Headline evidence

Figure 3.1.4a: Water licensed for irrigation, England, 2023

Source: National Abstraction Licensing Database Reports, 2024

Former EA Region	Number of licences for spray irrigation - storage	Indicative total volume licensed for spray irrigation - storage ('000m3)	Indicative total volume licensed for all spray irrigation ('000m3)	Indicative proportion of spray irrigation volume licensed for storage (%)	% change in storage since 2010	% change in spray irrigation since 2010
Anglian	1,075	90,502	222,909	41%	21%	40%
Midlands	372	17,166	81,759	21%	0%	-1%
North East	94	3,727	28,614	13%	-1%	-5%
North West	15	406	5,439	7%	82%	-15%
South West	35	778	4,861	16%	-9%	-31%
Southern	153	6,538	18,312	36%	2%	-16%
Thames	87	3,660	9,121	40%	-10%	-29%
EA Wales	81	2,174	5,317	41%	-35%	-31%
Total		**124,949**	**376,332**	**33%**	**13%**	**15%**
Total for England	1,831	122,777	371,015	33%	15%	16%

Figure 3.1.4b: Spray irrigation licences by region (million m^3), England, 2023

Source: Environment Agency

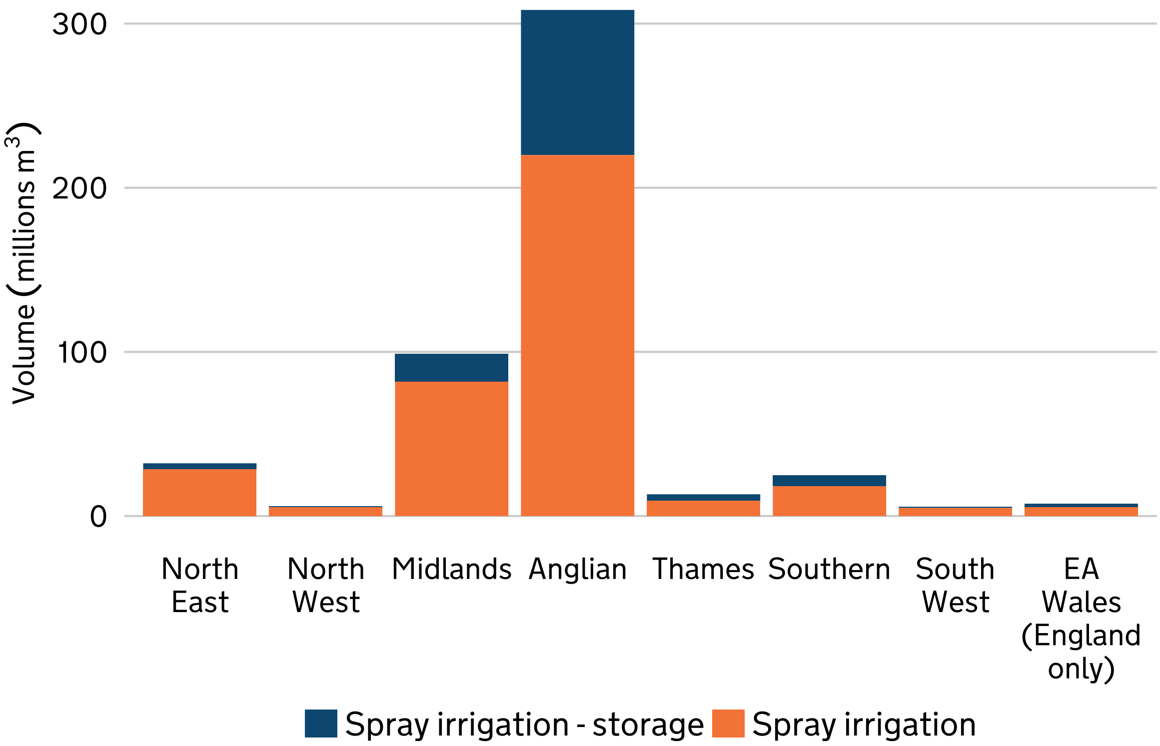


Figure 3.1.4a shows the volume of water licensed for spray irrigation and storage across different regions in England between 2010 and 2024. England saw a significant increase in water licensed for abstraction for both direct irrigation (16%) and reservoir storage for irrigation (15%). This growth is likely to be a response to the higher quality and production demands from supermarkets and decisions by farmers to protect themselves against the financial effect of crop losses resulting from water shortages and possible irrigation restrictions.

Regional variation of rainfall across the England means that there is varying level of need to supplement natural rainfall with irrigation from abstraction across the country. Some areas are already experiencing stress from high irrigation intensity, most notably in the east of England (UK Irrigation Association, 2020). In 2022, East Anglia was the largest area of the country where water was not available for licensing, because there was limited water available for abstraction (see map). In the last 14 years East Anglia experienced the most substantial increase in volume water licensed for spray irrigation and storage, with the area now accounting for 63% of all water licensed for direct irrigation in England and 74% of all reservoir-stored water (see figure 3.1.4b above). Reasons for the higher water dependency are the use of land for field-scale vegetable production due to the region's climactic and topographical suitability and high number of large-scale farms suited to irrigation. Most of the water is used to irrigate field-scale vegetables such as potatoes, onions, and carrots.

One data limitation is that abstraction licences are not required for those abstracting less than 20 cubic metres (approximately 4,400 gallons) per day. This means that small agricultural businesses using low volumes of water on land are not captured in the data. However, commercial enterprises will be abstracting far more than this limit so most agricultural water usage will be captured here. It is also worth noting that glasshouses and vertical farming systems tend to use public water supply for their crops rather than abstracted water, meaning that their water usage volumes are not captured here either.

Climate projections point to increasing severity and frequency of drought (UKCP18). Consequently, water abstraction for direct irrigation and storage is likely to increase. Farmers are finding solutions through water management such storing water and building infrastructure to provide resilience to droughts, for example, the Felixstowe Hydrocycle. These are considered further in supporting evidence and the case study below.

Supporting evidence

Hands-Off Flows

Water abstraction is subject to disruption from low availability in the source and to demand spikes due to increased need. There is also activation of Hands-off Flow which alerts licence holders to stop abstraction to protect the environment. Hands-off Flow data therefore provides an indicator of risk to supply, reflecting cases where farmers may need to stop irrigating during the irrigation season, potentially affecting food production. Hands-Off Flow thresholds are determined on a case-by-case basis. However, restrictions are strongly driven by climatic conditions when water levels are either too low to abstract (low rainfall) and/or there is high demand (periods of drought or high temperatures). In July 2022 the temperature exceeded 40 degrees in some parts of the UK for the first time on record, and the period of January to August 2022 was the driest across England and Wales since 1976, with drought status declared across parts of England and all of Wales (Met Office, 2023). Between April and October, there were 49,678 (2022) and 7,993 (2023) instances where Hands-off Flow measures were in activation for spray and trickle irrigation, meaning that no water could be abstracted for direct irrigation. The effects of the water shortages during the drought were shown by reduced yields for some commodities such as potato and onion crop (Barker and others, 2024).

Reservoir storage

The drought events of 2010 to 2012, 2018, and 2022 show the importance of abstracted water storage. Abstracted water can be drawn during the winter months or periods of high flow for storage into reservoirs held on farm. The water can then be used during times of drought or when access to abstraction sources is restricted. UK farmers are being encouraged to aim for sustainable abstraction and preparing for water storage is one way to mitigate the risks of low flow, low rainfall, and activation of Hands-off Flow. The storage volumes of these reservoirs can be used as a measure of resilience; they reflect the national planning for shocks and disruptions to water supply. The reported 15% growth in abstracted water licensed for storage (see figure 3.1.4a) may underestimate the actual demand. There was a hiatus in reservoir construction between 2022 and 2023 while farmers awaited grants under Defra's Farming Transformation Fund Water Management program. The Environment Agency has also seen a strong recent interest in new reservoir licence applications, which was likely driven by the availability of grants and by farmers seeking to find alternatives to their existing direct irrigation abstractions.

Climate change impacts

Climate projections indicate that, on average, UK winters will become wetter, and summers drier, with the frequency and intensity of heavy summer rainfall events also projected to increase. Natural variability means that years with wetter summers or drier winters will still occur. The seasonality of extremes will also change. Increases in heavy hourly rainfall intensity in autumn indicates that the convective season is extending from summer to autumn (Met Office, 2022). Heavy rainfall and related flooding can increase the risk of food contamination and water-borne diseases. Flooding may also damage infrastructure, potentially affecting safe storage and disrupting the transportation of food. Abstracting water for agricultural use compounds water-stressed catchments especially, as the timing is during hot and dry weather when abstraction will have the greatest effect on the environment. The UK generally abstracts more water from surface water than from ground water. Increased drought events will mean lower availability of ground water, leading to a higher dependence on surface water/storage from rainfall, which may also carry a higher risk of contamination.

Drought severity, frequency, duration and spatial extent are projected to increase for the UK (Hanlon and others, 2021; Reyniers and others, 2023; Parry and others, 2024). Droughts covering larger areas will become more common. Small (<10%) reductions in groundwater levels are projected for many UK boreholes by 2080 under RCP8.5 (Parry and others, 2024). The increase in droughts is expected to increase the risk of aflatoxin contamination of food crops, which could increase post-harvest losses (Bezner Kerr and others, 2022).

Food and Drink Manufacturing water usage

The Food and Drink manufacturing sector is a large consumer of water. Although the industry has grown since 1990, overall water consumption (both public water supply and non-public water supply) has reduced. This is because of economic conditions and a commitment by the industry to cut its water consumption. The latest published data shows that possible changes in demand for direct abstraction by the food and drink industry could range from the baseline of 20.8 million cubic metres per year (56.9 Ml/day) to 33.4 million cubic metres per year (91.6 Ml/day). The latest direct abstraction National Framework 2 data for Food & Drink Manufacturing recent revised actual baseline is 19.6 million cubic metres per year (53.6 Ml/day) (Environment Agency).

Case study 2: Felixstowe Hydrocycle

Some farmers are investigating innovative solutions to water management. The Felixstowe Hydrocycle project is one example of a farmer-led initiative to develop a sustainable water supply to farmers in the area. The project involves the Environment Agency, Suffolk County Council, Felixstowe Hydrocycle Ltd, the University of East Anglia and five local farmers.

The Felixstowe Peninsula, in the East of England, has been subject to increasingly dry conditions in recent years with abstraction becoming an unsustainable option for agriculture in the area. There is an estimated 1 million cubic meter shortfall in water, and abstraction poses a risk to the unique wetlands in the area. Conversely, up to 1 million tonnes of water is drained from fields in the Kings fleet catchment every year, to prevent flooding, and pumped into the River Deben estuary (Environment Agency, 2021).

In 2018, the project secured funding to build an 11km pipeline to divert drainage water away from the River Deben back inland for use. Rerouting the drainage water aims divert the usable ‘grey’ water back inland to a managed aquifer recharge system for irrigation while also preventing further erosion of the biodiverse saltmarsh and mudflat habitats of the area. Felixstowe Hydrocycle is now in its third year, with permits in place to deliver up to 600Ml of new water and store and recover up to 40Ml each year using managed aquifer recharge.

3.1.5 Energy

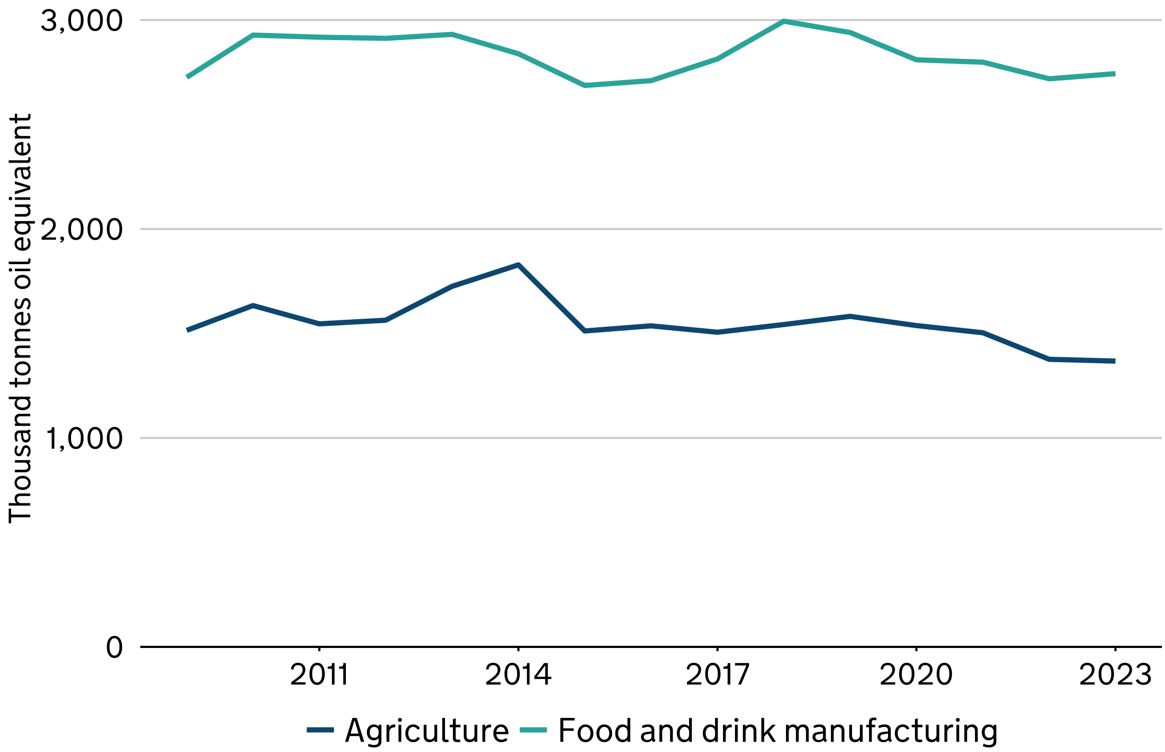
Rationale

Energy dependency exists throughout the food supply chain and capturing the energy intensity of the food supply chain is complex. From farmers to consumers, energy is needed to grow, transport and process food and other critical inputs such as fertiliser. Disruptions in supply or changes in energy price can have significant implications for food security, particularly with regard to stability and access. This indicator tracks both energy demand and prices in the food sector. Energy price data focuses on non-domestic energy prices as they are the prices paid by food businesses for electricity and gas.

Headline evidence

Figure 3.1.5a: Aggregate energy demand (Thousand Tonnes Oil Equivalent (ktoe) for agriculture and food and drink manufacturing in the UK, 2009 to 2023

Source: Digest of UK Energy Statistics, Table 1.1



In absolute terms, energy used in the Food and Drink Manufacturing sector has generally declined over the last 14 years (more significantly on a per capita basis), reflecting increased energy efficiency. From 2021 to 2023 specifically demand has continued to decline, but at a slower rate of approximately 2%. Notably, there was a decline of around 2.8% from 2021 to 2022, reducing from 2798 (ktoe) to 2719 (ktoe), which was likely related to the price spikes in 2022 following Russia's invasion of Ukraine. In contrast, from 2022 to 2023, there was a modest increase of about 0.9% in energy consumption, indicating a slight recovery in this sector.

For agriculture, total energy use increased between 2009 and 2014 before then declining between 2014 and 2021. Since 2021 energy consumption has decreased, with consumption dropping approximately 9% over the three-year period from 1503 (ktoe) in 2021 to 1367 (ktoe) in 2023. The drop occurred between 2021 and 2022, where energy usage fell by about 8.5%, from 1503 (ktoe) to 1376 (ktoe). This drop was notable in demand for electricity and gas following the price spikes during 2022. The reduction slowed from 2022 to 2023, with overall total usage remaining above 2002 to 2008 levels.

While there has been decline in energy use, energy will continue to remain a significant input for both agriculture and food manufacturing. As set out in the supporting evidence, the complex supply landscape means that there is a significant risk to stability of supply from price fluctuations caused by international disruption, as demonstrated over the last three years. The UK and continental Europe were particularly exposed by recent geopolitical disruption and limited in their ability to mitigate high prices due to their reliance on gas imports. This was demonstrated by UK annual energy price inflation being the highest among G7 economies in March 2023 reaching 40.5%.

The reduction of dependence on energy, particularly the reduced use of non-renewable sources, could be interpreted as an example of re-orientation that helps mitigate effects from future disruptions. It is difficult to establish from the data the extent to which the sector is re-orientating by reducing its dependence on energy or, by contrast, making short term business decisions.

Supporting evidence

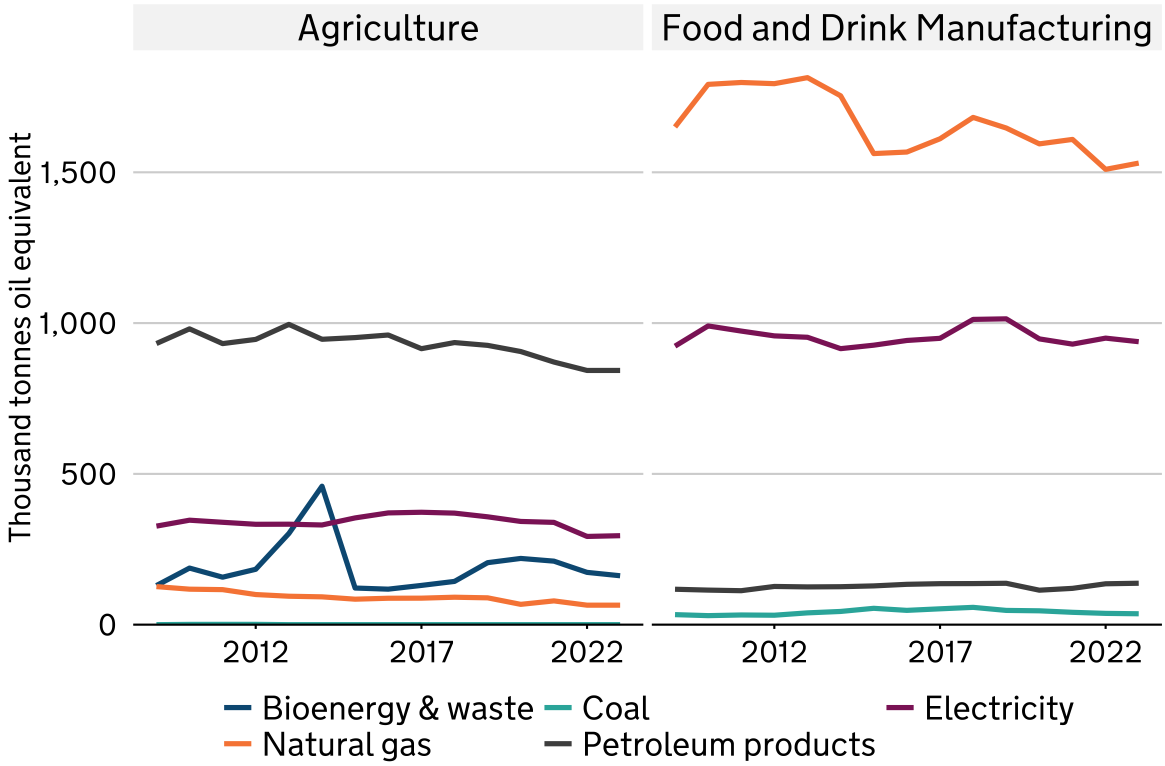
Energy supply landscape

The UK meets its energy demand through domestic production and trade. In 2023, overall energy demand in the UK dropped to levels last seen in the 1950s due to elevated temperatures and high energy prices. UK energy production in 2023 dropped to a new record low, down 8% in 2022, with non-renewable energy such as oil, gas and nuclear production all dropping. In contrast, output from renewable energy such as wind, solar and hydro reached record highs in 2023 but combined formed under 10% of UK production. Overall, energy imports in 2023 stood at 137.4 million tonnes of oil equivalent (mtoe), 6.5% lower than in 2022, and 24% lower than the peak in 2013. Over 90% of the UK’s energy imports comprise of oil and gas. Norway and the US together supplied more than 80% of gas imports in 2023. Each supplied more than 2.5 times the amount of oil as the Netherlands, which was the third largest UK oil supplier in 2023. This continues a ten-year trend of Norway being the UK's principal supplier of energy. The US has become a larger supplier following the closure of energy trade with Russia and decrease in supply from Qatar. Despite not being directly reliant on Russian energy (6% of gas and 13% of oil in 2021), UK energy prices rose following Russia's invasion of Ukraine in 2022 and subsequent rise in international gas and oil prices.

Energy consumption by energy type

Figure 3.1.5b: Energy consumption by energy type in Agriculture and Food and Drink Manufacturing in oil equivalent values, UK, 2009 to 2023

Source: [Digest of UK Energy Statistics, Table 1.1]

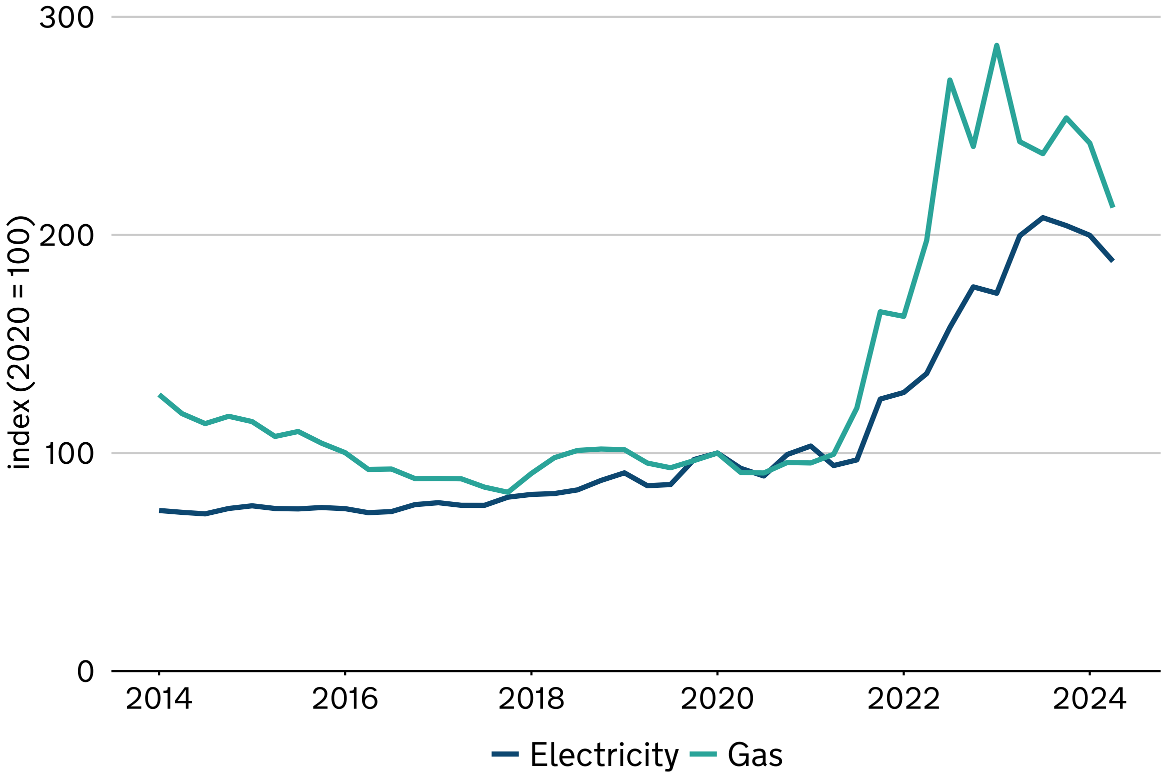


Energy demand in agriculture remains heavily reliant on non-renewables. Fuel types such as petroleum products continue to meet the majority of energy needs. Petroleum products consist of burning oil used for drying of crops and heating and gas oil (commonly known as red diesel) used to power non-road machinery. A small amount of propane is used mainly for heating (most commonly on poultry farms). In the Food and Drink Manufacturing sector, demand changes have varied across different energy sources. Natural gas remains the main energy source for food and drink manufacturing. Usage declined from 2017 to 2022 and increased in 2023.

Energy prices

Figure 3.1.5c: Non-domestic energy prices, UK, Q1 2014 to Q2 2024.

Source: Prices of fuels purchased by non-domestic consumers in the United Kingdom (excluding the Climate Change Levy) (DESNZ Quarterly Energy Prices table 3.4.1)



Note: DESNZ Quarterly data was first collected in 2004.

Non-domestic energy prices are the prices paid by businesses for electricity and gas. In recent years energy prices have reflected geopolitical shocks to energy supply, such as Russia's invasion of Ukraine. Figure 3.1.5.c above shows that both electricity and gas prices climbed significantly from mid-2022 onwards, well surpassing prices in the period 2014 to 2020. The price doubled for electricity and nearly tripled for gas compared to the 2020 baseline (electricity 100%, gas 187%) significantly from mid-2022. Following the price shock in 2022 energy prices stopped rising in 2024 but remain around double the pre-2022 levels. Non-domestic electricity prices remain high in comparison to the rest of the world, but gas prices are relatively low compared to EU and G7 prices.

It is difficult to isolate the effect of the recent energy price spike on businesses and where these may have contributed to business failures. The rise in energy prices affect some food sub-sectors more acutely than others and some inputs have cross-sectoral demand beyond the food supply chain which further tightens supply to the food sector. As a short term response to price rises in 2022, businesses that were eligible accessed support through the Energy Bill Relief Scheme and Energy

Bills Discount Scheme. Some food businesses responded to price rises by trying to reduce energy costs by making efficiencies and adapting their production methods, in both the short and long term. Where possible some businesses made applications to the Industrial Energy Transformation Fund (IETF). The IETF is designed to help businesses with high energy use to cut their energy bills and carbon emissions through investing in energy efficiency and low carbon technologies. In some cases, adaptation has had knock-on consequences in different sectors. For example, in horticulture (excluded from energy bill schemes) many growers faced with rising heating bills chose to delay or reduce planting altogether. This led to a significant shortfall in domestically produced vegetables adding pressure on imports from regions such as Spain and North Africa that already faced weather-related challenges, as discussed in Theme 2 (see Indicator 2.1.4 Fruit and Vegetables). The confluence of these factors (adverse weather and geopolitical disruption) resulted in a reduction of fresh produce availability (tomatoes, peppers, cucumbers, lettuce, salad bags, broccoli, cauliflower, and raspberries) in the spring of 2023, which led to higher prices and reduced supplies.

Energy as a proportion of overall business costs will differ from sector to sector. Energy costs are intricately linked to other inputs such as fertiliser and CO_2. This has meant that the energy price rises have had a cumulative effect, making it difficult for businesses to bring down prices. Since 2021 food input prices have outpaced food output prices, which in turn have outpaced consumer price. This was one of the principal drivers of the 2022 to 2023 food price inflation spike that was significantly higher than general inflation, as discussed in Theme 4 (see Indicator 4.1.3 Price changes of main food groups). Despite a fall in global food commodity prices from the end of 2022 (see Theme 1 Indicator 1.3.2 Global Real Prices Indicator), high food price inflation persisted through 2023, but falling steeply in the second half of the year. In the UK food price inflation was among the highest across G7 economies, second only to Germany. This may be because energy price inflation coincided with a range of factors such as increased labour costs, increased costs of imports, and delayed price transition due to fixed term contracts (ONS, 2023; Commons Library Research Briefing, 2024).

As an example of the impact of the inflation spike on food prices and consumers, in the out of home sector the average price of takeaway has risen from £13.50 in 2021 to £23.60 in 2024. Fish and chip shops have seen the largest increase in price, increasing by 19% from March 2022 to March 2023 (ONS, 2023).

Sub-theme 2: Movement of goods

3.2.1 Transport

Rationale

Transport is a critical national infrastructure sector. A functioning road, sea and rail network is an essential part of the supply chain, ensuring movement of goods into, out of and around the UK in a timely manner to meet demand. As all food is transported at least part of the way via road, this indicator looks at the Road Congestion and Travel Time Statistics which cover the Strategic Road Network (SRN) in England. The SRN is comprised of 4,500 miles of motorways and major A roads in England, connecting the large towns and cities. It is the most heavily used set of roads in the country carrying roughly a third of all freight traffic (National Highways Agency, 2024). Delay indicators are only available for the SRN in England. Road traffic statistics are published for Scotland, Wales and Northern Ireland but are not comparable.

The JIT inventory management model, used by the food industry, means very low stockpiles (if any) are held at any point, reducing the cost of holding stock on business premises. The system needs to be kept moving to function effectively. JIT supply chains are sensitive to transport disruption, particularly in road freight as it is the most used mode of transport. International Freight statistics for the UK show that in 2023, 0.88 million tonnes of food products were imported into the UK by UK-registered heavy goods vehicles. Food was the second most common commodity imported accounting for 27% of tonnage.

Headline evidence

Figure 3.2.1a: Average delay on the Strategic Road Network in England (seconds per vehicle per mile), 2015 to 2024

Source: [Travel time measures for the Strategic Road Network, Department for Transport]()