HSBC Global Research

Free to View
Demographics - Multi-Asset

By: James Pomeroy, Davey Jose, Amy Tyler, Paul Bloxham and Jamie Culling

November 2023
www.research.hsbc.com

The Future of Food

Can we meet the needs of 9bn people?

As populations grow and many lower-income economies get richer, food demand should rise…

…and making sure there is enough food, and in the right places, looks set to be a challenge…

…with implications for poverty, inflation and growth across the world

This is a Free to View version of a report with the same title published on 12-Nov-23. Please contact your HSBC representative or email us at AskResearch@hsbc.com for more information.

Play video with James Pomeroy

Executive Summary

Food for thought

Food is not only essential for the future of mankind. It is fundamental to so much of the global economy.

It accounts for 10-50% of consumer spending in different parts of the world, 8% of global trade and surging food inflation has caused policymakers headaches with increased frequency in the past two decades. But, more importantly, it's crucial for our survival. As of 2023, roughly 10% (783m) of the world's population doesn't get enough food. With the world's population likely to add nearly another billion people over the next two decades and incomes rising, total food consumption will likely rise by more than 50%, and possibly by 70% by 2050.

For some products, demand will likely rise more quickly. Typically, as incomes rise, food spending pivots towards meat, protein, and fats, and away from carbohydrates like rice, although there will be regional divergences. Dietary changes may mean that western demand for plant-based proteins and pulses could rise quickly.

But what are the chances of us meeting these needs? Historically, global food supply has been able to keep up with demand, even if there have been challenges around making sure everyone has enough. Three channels are used: using more land for food production, shifting how we use these products (between say, food and feed for animals, or fuel) and increasing crop yields. With challenges in terms of climate change, devoting even more land to agricultural production may not be possible, while the ability to switch crops from being used for animal feed to food will depend on diets – and may be harder if meat consumption rises globally alongside incomes. More extreme and uncertain weather looks set to mean greater volatility in food production volumes across the world.

And so it may be that we're left with improving yields and cutting food waste at the heart of the solution. This could involve a range of technologies – from robot farmers to climate control and from blockchain to food sharing apps, technological improvements could help to substantially lift food production in a sustainable way. New technologies could mean greater output in all farms worldwide – from using better processes, tackling labour shortages, and controlling climate for crops to grow.

We also need to cut food waste. An eye-watering 14% of food produced is lost between harvest and retail, and on top of that, 17% of food products are wasted by consumers – reducing these numbers alone could help to mitigate any food supply challenges.

And even if we can tackle the global supply of food, we also need to make sure it can get to the right people. The role of global trade in making sure supply and demand are matched globally is key – and so any developments on export restrictions will play a role in determining whether we have enough food for all.

The world needs this to work. Without it, food poverty will only increase, keeping millions of people at risk of starvation. Food prices could keep rising or remain volatile (as we've seen in recent years), meaning more people who can afford to eat may not be able to afford a healthy, balanced diet. It may mean spending in other parts of the economy gets trimmed as food spending rises.

Whether we can produce enough food for all will depend on the trade-off improving technological solutions and the risks of climate change or export bans affecting food supply. While there is hope that this can be achieved, the path to food security is uncertain, and the future of food looks set to be one of the most important topics of our lifetimes.

Contents

The future of food demand

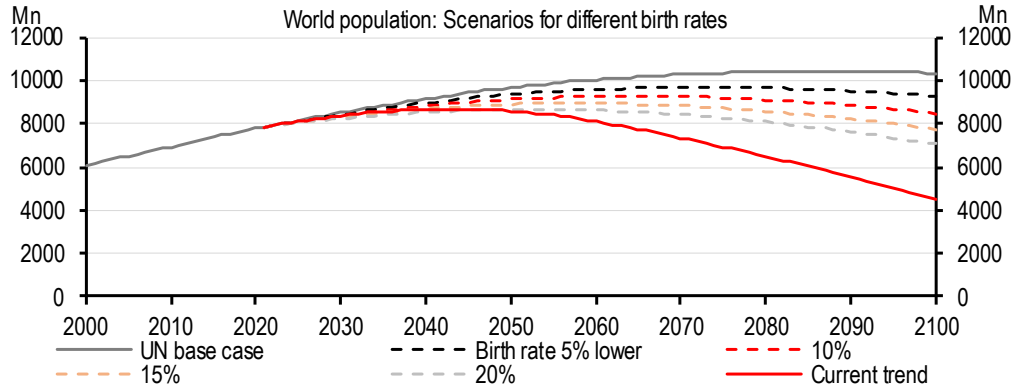
- More people and higher incomes should mean more global demand for food…
- …with income rises and social changes meaning stronger demand growth for some products rather than others…
- …while changing dietary habits could play a key role in some areas

More mouths to feed

Growing populations mean more food will be needed

As we wrote in *The big baby bust: Fewer babies, slower growth*, 22 August 2022, the outlook for the world's population is highly uncertain beyond 2040, as much depends on the birth rate assumptions we put into demographic models. Our estimate is that birth rates will trend lower from here, meaning that a global population peaking in the 2040s may be likely. However, over the course of the next 20 years, based on what's already baked in, we know there will be more people in the world – quite likely another 800m people as the world's population rises to just shy of 9bn. And with that, food demand will intensify, not only because the world is more populous, but also since as households get richer, spending on food rises.

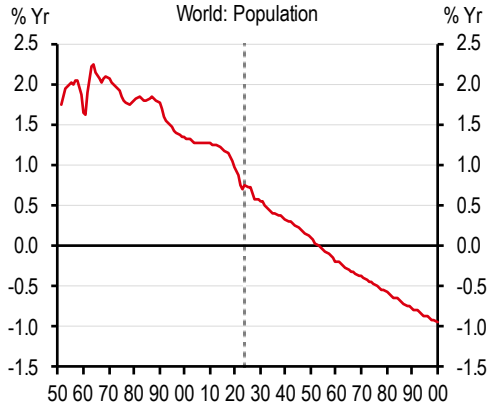
1. The world's population is likely to rise for the next 20 years, regardless of what happens after that



Source: HSBC estimates based on underlying UN assumptions. Current trend shows the trajectory of birth rates across the world continuing lower.

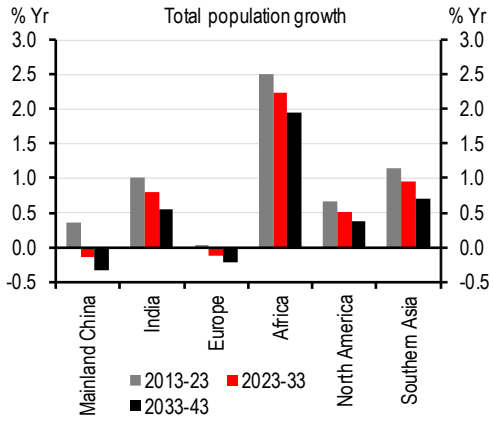
Despite a higher population in 20 or so years' time, the pace of the increase in population size is set to slow in the coming years, which should make managing the needs of the world's population slightly easier. Global population growth this decade is likely to be half of the speed in the next decade than in the first decade of this century – with the slowdown evident across all regions (chart 3).

2. Global populations will likely grow more slowly…



Source: UN Population Division

3. …in all regions



Source: UN Population Division

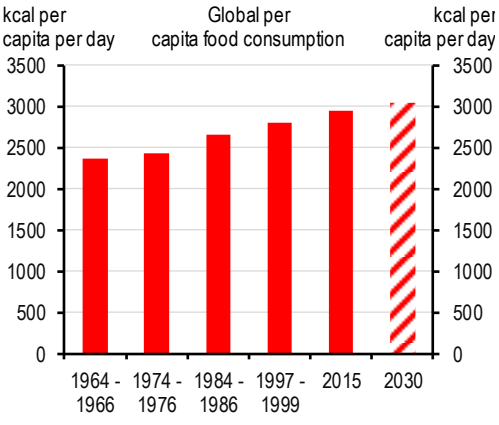
How much more food will we need?

Calorie intake looks set to keep rising

Data from FAOSTAT look at national food balance sheets to approximate "national average apparent food consumption" over time, and we can use that data to gauge how much total food consumption has changed in recent decades as a starting point for what might happen next. As depicted in chart 4, global food consumption per capita has been rising steadily since the 1960s and is expected by the FAO to keep on growing to just over 3,000kcal per day in 2030.

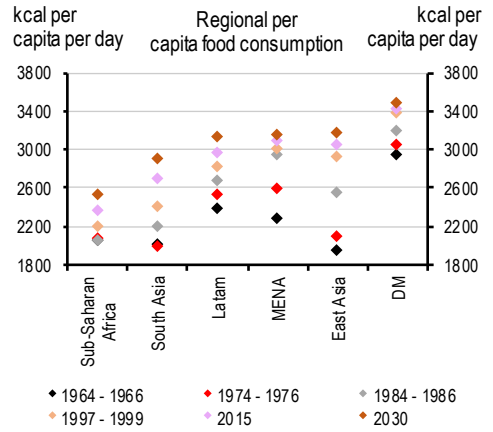
However, there have been divergences between regions as seen in chart 5. The growth in per capita food consumption since the 1960s has been much smaller in Sub-Saharan Africa compared to the rest of the world. On the flip side, East Asia has seen the biggest rise in per capita daily food consumption, by almost 1000kcal, mainly driven by mainland China. That said, in 2030, according to FAOSTAT's estimates, per capita food consumption across the emerging world is anticipated to be greatest in East Asia, closely followed by the Middle East and North Africa. Sub-Saharan Africa will likely still lag considerably behind the rest of the world.

4. Food consumption has kept rising…



Source: FAO Stat

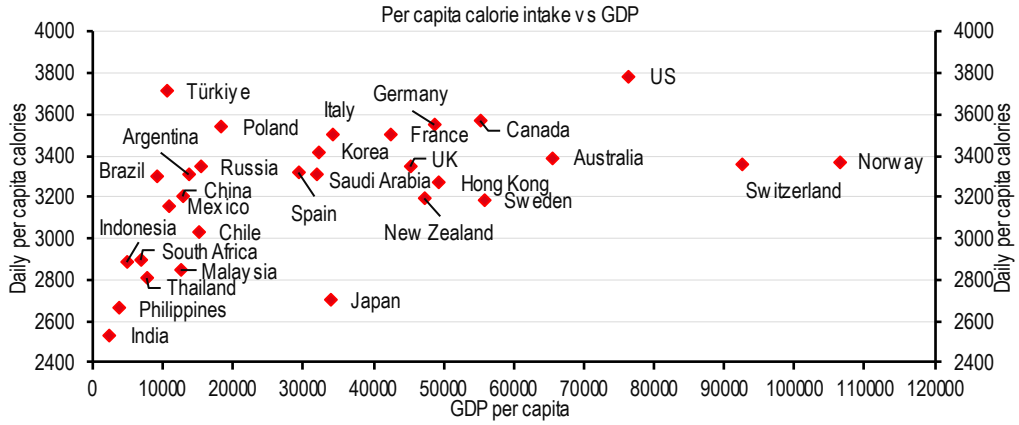
5. …at different speeds across regions



Source: FAO Stat

And if we couple up these per capita estimates with population growth, we can see how global food demand in terms of kcal has risen sharply. The world, in 2023, consumes 3x more food than in in the 1960s, and double that in the mid-1980s. The "good" news is that the pace of growth has slowed – from rising by ~2.5%pa in the 1960s and 70s, to now rising by ~1.5%pa, due to slower population growth and more people having escaped poverty in recent decades.

6. More calories per head, plus population growth = more demand for food

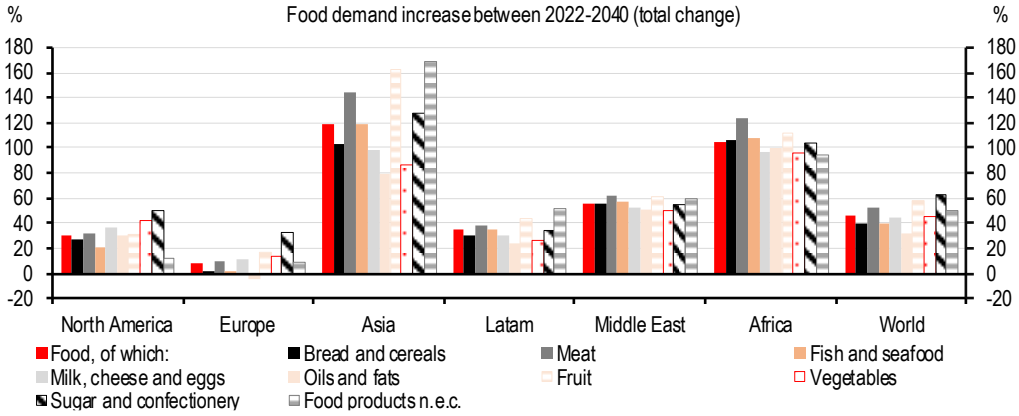


Source: HSBC estimates using FAO data and UN Population Data

Big increases in total food spend seem likely

So, since populations are consuming more food per capita and populations are expected to keep growing, global food demand is set to keep pushing higher, at least for the next couple of decades. Using a consumer spending model we published in *The next generation of spenders : The changing tastes of a billion new consumers*, 6 September 2023, we can estimate the likely growth in food consumption volumes using a mixture of income growth, population growth and how tastes change as households get richer. The outputs are in chart 7 and suggest that global food demand will rise by more than 40% between now and 2040 – although more quickly in some regions and for some types of products. That is what we look at next.

7. Food demand is set to rise quickly

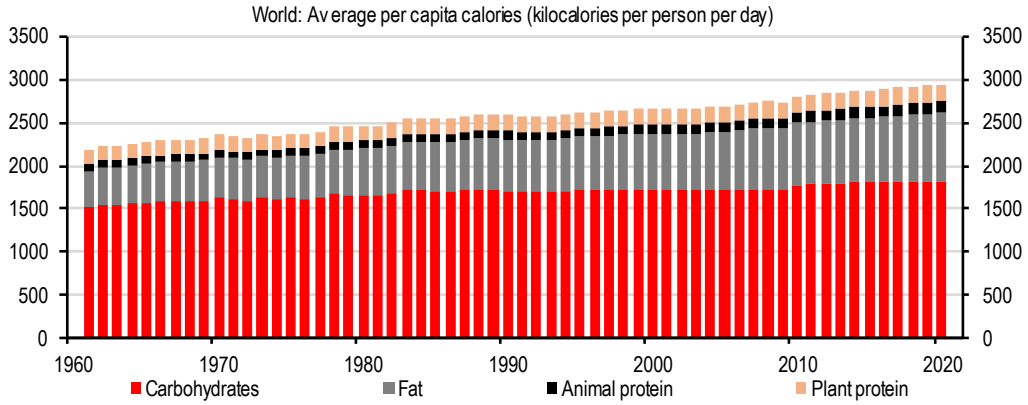


Source: HSBC estimates

What foods will we eat?

As well as aggregate food consumption rising, many important changes in diet happen over time. Firstly, typically as households get richer, their calorific intake rises. Secondly, the mix of that consumption changes, too. We can see how global consumption of different products has evolved, split by the number of calories from carbohydrates, animals, fats and plant proteins in chart 8.

8. As the world has gotten richer, diets have shifted, to bring in more fats and proteins

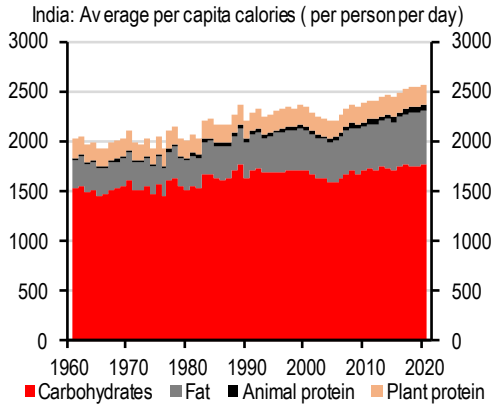


Source: FAO Stat

Diets will change, too

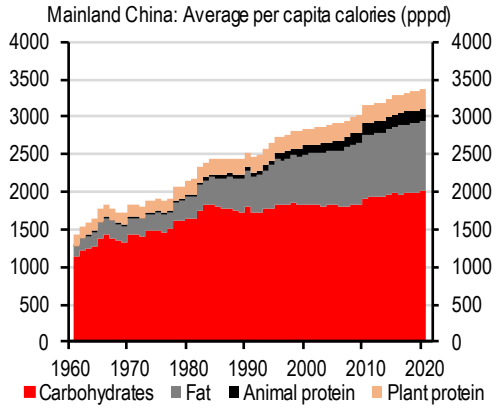
This is something seen in the dietary habits of the world's most populous economies. The changes in mainland China as households have gotten richer have seen a growing share of calories coming from fats – meat, oils and dairy, but calorific intake has risen across the board. In India, the same story may be emerging, but with animal proteins making up a much smaller share of diets.

9. Indian calorific intake could rise as incomes pick up…



Source: FAO Stat

10. …as we've seen in mainland China

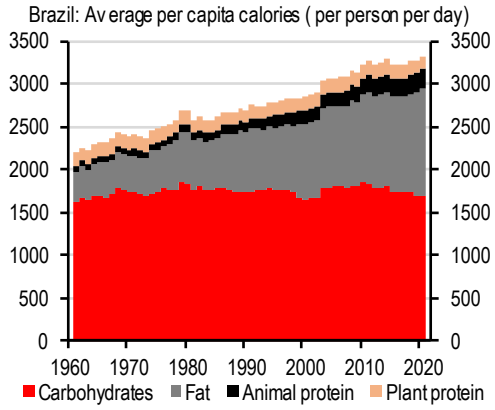


Source: FAO Stat

There will be differences between economies

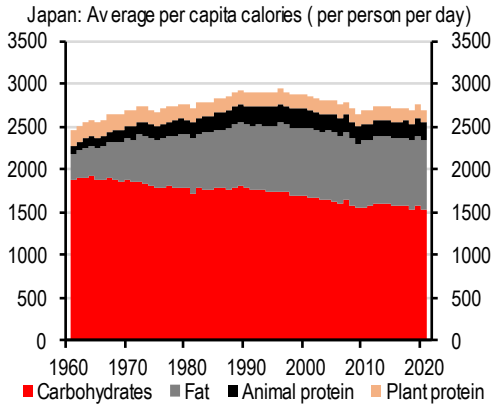
But, that said, it's not so straightforward. Some economies will consume different diets for cultural reasons – with historical trends as a good guide here. A great example is the contrast between Brazil and Japan (charts 11 and 12) where several things stand out. Firstly, as Brazil has gotten richer and calorific intake has risen, carbohydrate intake hasn't changed, but the growth has been in fats and animal proteins. While overall intake per capita is up 50% since 1960, the amount of these two groups has tripled. Comparing this to Japan is stark. Even though Japan is a wealthy economy, calorific intake on a per capita basis has actually fallen in recent decades – with carbohydrates taking up a smaller share of the total, too. Arguably a greater focus on diet in Japan has led to this change – and is a good reminder that rising incomes needn't just mean higher calorie intake everywhere in the years to come.

11. Brazilians have eaten more as they've gotten richer…



Source: FAO Stat

12. …but the same isn't true in Japan

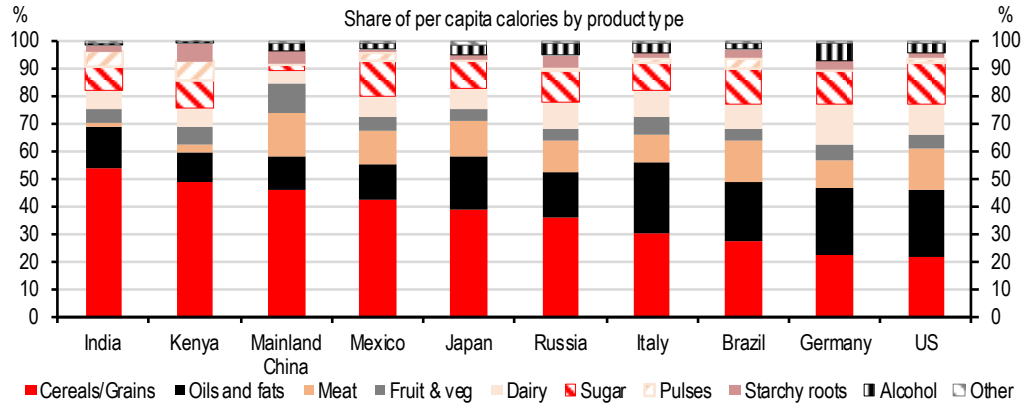


Source: FAO Stat

Types of food consumption vary, too

There is a clear diversity across the world in terms of the shape of diets today – evident when we look at calorific intake at a more granular level. Some of this is a function of wealth – with India and Kenya getting a bigger share of their calorific intake from cereals and grains, but even across countries with similar levels of wealth, there is still a notable difference in dietary tastes, as outlined above.

13. Diets vary greatly by region

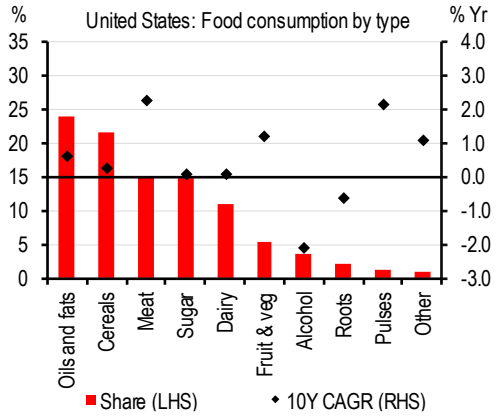


Source: FAO Stat, Our World in Data

What is clear, however, is that certain types of food will become more popular as the world's population continues to both grow and get richer. The past decade shows clearly where growth is most evident – with consumption of oils, dairy and pulses rising more quickly than cereals and sugars – likely an impact of both shifts in terms of wealth but also a focus on healthier diets in developed economies.

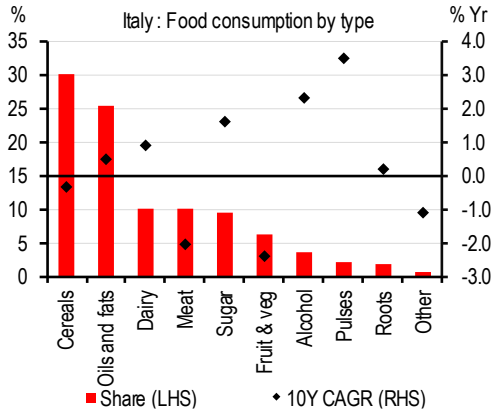
For example, in the US, alcohol consumption has dropped by roughly 2% per year over the past decade – while proteins – from meat and pulses – have risen quickly. In Italy it's striking how different the mix of calorific intake is from the US – but also how very different groups have seen growth – with fruit and vegetable and meat consumption falling over the past decade but alcohol consumption rising.

14. US food consumption looks quite different…



Source: FAO Stat, Our World in Data. Note: Data for 2020

15. …to Italy



Source: FAO Stat, Our World in Data. Note: Data for 2020

As a result, we must be careful with how different food groups' demand will change as economies get richer. In India, for example, where a greater share of households are vegetarian than the global average, we may see a greater rise in the consumption of vegetable proteins, pulses and cereals than meat products.

How else can diets change?

Within these broader trends looking at food demand, there are some more subtle changes in dietary habits, typically taking place within developed economies so far, that could become more widespread in the years to come, meaning we could see some divergent trends for different food groups.

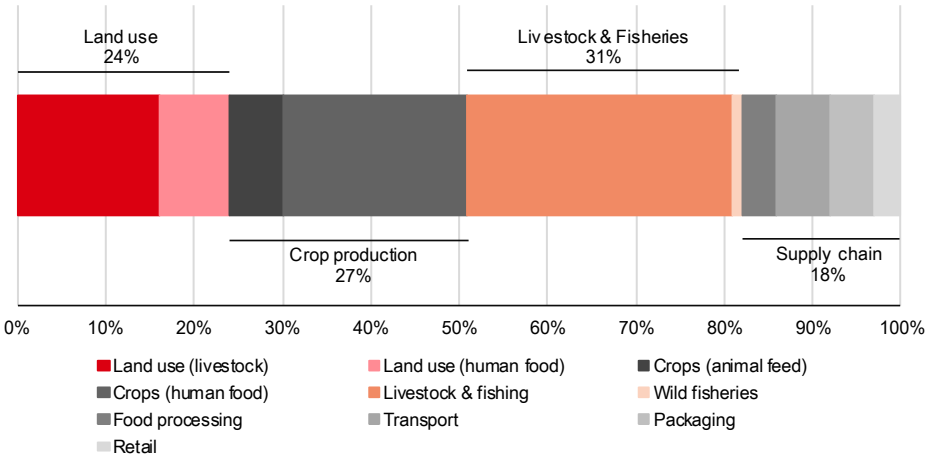
Dietary shifts – environmental and nutritional considerations

Awareness of food production impacts on the rise

Globally, food production represents approximately a quarter (26%) of global greenhouse gas (GHG) emissions, comprised of land use, crop production, livestock and fisheries and supply chains (chart 16). The majority of emissions are from livestock and fish farms, followed by crops from human food and land use for livestock.

As global focus intensifies on meeting emissions reduction targets and biodiversity impacts, consumers are increasingly aware of the environmental impact their products are having.

16. Sources of emissions from food production



Source: Our World in Data 2019, Poore & Nemecek, 2018

As more consumers demand lower-carbon and less environmentally harmful food, their changing preferences can play a significant role in shifting from diets with high environmental footprints to those with less impact on ecosystems. This is likely to involve a shift away from meat to more plant-based diets; looking across the food ecosystem, generally animal-based produce has a larger environmental footprint than plant-based produce. A kilogram of beef (beef herd) emits up to 99kg of CO_2eq GHG emissions, compared to a kilogram of peas which emits less than 1kg of emissions[1].

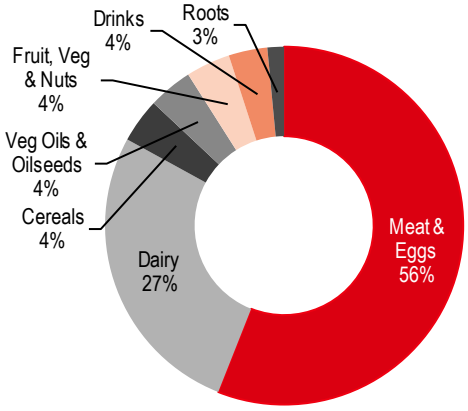
Is what you eat more important than eating locally?

A preference for locally produced food may not deliver the climate and environmental benefits consumers are demanding. The majority of emissions in the food ecosystem actually originate at the farm level. Combining farm and land use emissions makes up, on average, 80% of a food product's GHG emissions[2]. Eating local produce has the potential to reduce transport emissions, however, these represent a relatively small proportion of food production's overall emissions – 6%. Therefore, the greatest potential for emission reduction depends on what type of food produce is bought and opportunities for enhancing farm efficiency. Meat, eggs and dairy combined account for 83% of GHG emissions for diets in the European Union (chart 17). Therefore, the way meat, eggs and dairy are produced at the farm level is where consumers and policy makers need to focus.

Majority of food transported by sea

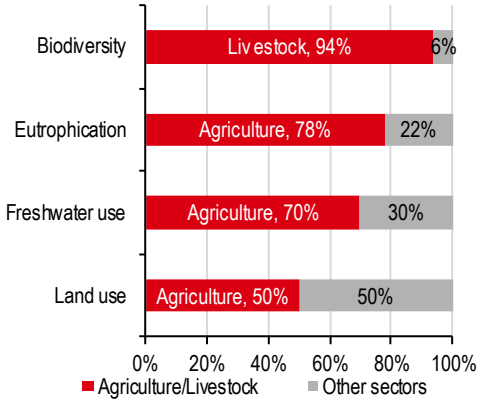
It is still important to consider food transport emissions for the small proportion of global food that is transported by air; this comes with a significant emissions contribution[3] compared to other forms of transport. However, in total, air food transport emissions are a minor part of all food transported globally. Nearly 60% of global food miles are accounted for by sea, followed by road at 30%, rail at 10% and air at 0.16%[4].

17. GHG emissions of diets in the European Union by food type



Source: 'The role of trade in the greenhouse gas footprints of EU diets', V. Sandström, et al., Global Food Security, 2018

18. Global environmental impacts of livestock and agriculture



Source: Our World in Data, Poore and Nemecek, 2018

UK consumers eating less meat

In our report *UK: Anatomy of the consumer 2023* (March 2023), the consumer survey found that over the past year (2022) the consumption of meat in the UK decreased by 33%. It is likely that this is due to a combination of consumers considering the impact of meat on the environment, focusing on health, and inflationary pressures resulting in consumers reducing consumption due to price.

Food demand is shifting…

As consumers switch their dietary habits, food demand changes and global food production must adapt. Factors driving the shift in food demand include inflationary pressures, consumers considering sustainability, health and nutritional value but also driven by food campaigns (eg, '5-a-day') and the increased availability of organic, vegetarian and vegan options in restaurants and supermarkets.

[1] Our World in Data, Poore and Nemecek, 2018
[2] Our World in Data, Poore and Nemecek, 2018
[3] 0.023 kilograms of carbon dioxide-equivalents (CO2eq) per tonne-kilometre by sea, versus 1.13 kilograms CO2eq by air
[4] Our World in Data, Poore and Nemecek, 2018

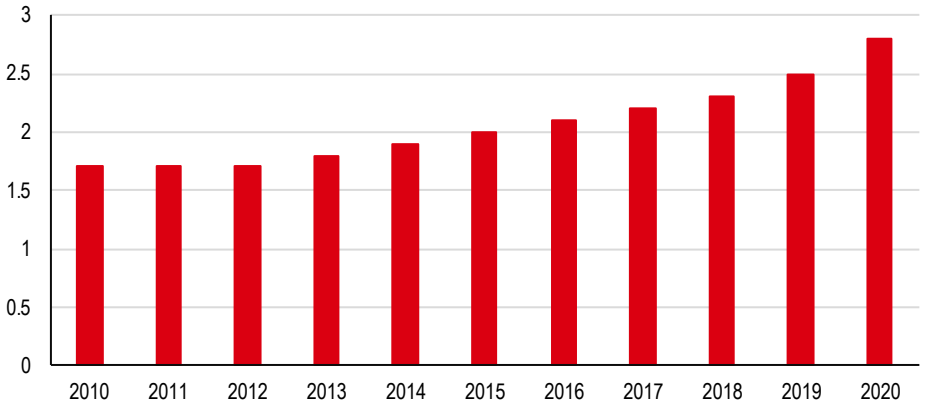
The rise of organic produce

Consumers are not only shifting their dietary habits, but are also demanding more organic produce. Organic produce is defined as food that is produced without the use of synthetic chemicals such as pesticides and fertilisers, as well as using organic farming practices such as recycling resources, utilising cover crops, composting and promoting biodiversity and soil health. 40-50% of the world's food production is supported by synthetic nitrogen fertilisers. Although this is important to keep food supply in line with the ever-increasing population growth and food demand, fertilisers have negative environmental impacts such as air and water pollution, damaging biodiversity.

Not only are considerations around the environmental benefits of organic produce on the rise, but also safety and human health. A growing number of findings have supported the health benefits of organic food consumption, particularly regarding fertility, birth defects and allergic sensitisation, due to differences in pesticide exposure or other indirect measures[5]. In the UK, the value of sales of organic produce nearly doubled between 2010 and 2020 (chart 19).

Environmental impacts of vegan & vegetarian diets

19. Value sales of organic food and drink in the United Kingdom (GBP billions)



Source: UK Government (2023)

While organic diets are on the rise, the story for vegan and vegetarian diets is a little more mixed. Vegan and vegetarian foods produce fewer emissions compared to meat diets, as well as reduced land use. For instance, exploring the environmental impact of dairy versus plant-based milks (specifically oat milk), per litre, dairy milk uses on average nearly 12x more land use, 13x more freshwater use and 3.5x more GHG emissions compared to oat milk[6]. However, although this is a seemingly intuitive reason to change eating habits, there are other factors at play that have slowed the shift to vegetarian or vegan diets including nutritional variations, personal preferences and additional environmental concerns with increased use of non-meat produce such as soy and its link to deforestation.

Any alternatives for the meat lover?

Plant-based meat alternatives have also sprung onto the market in recent years, providing a solution for meat lovers that want to better their environmental footprint, while also enjoying their taste preferences. Products such as the Beyond and Impossible Burgers offer almost the same taste and texture of meat but are entirely plant derived (our equity analyst colleagues looked at the sector in *Global Alternative Proteins: Big plate, small portion*, 29 November 2021).

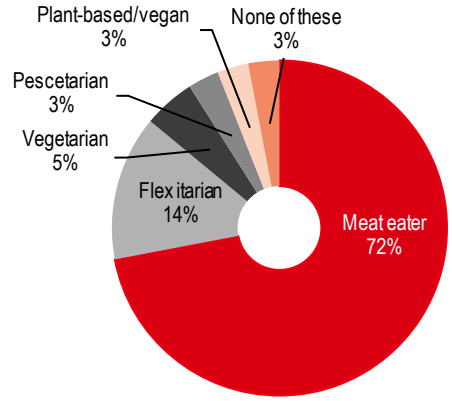
What do consumers consider healthy?

Although some meat products are often considered ultra-processed, the notion of 'single ingredient' is often seen as less processed than plant-based products with an extensive list of ingredients that are unrecognisable. With awareness growing of the risks of ultra-processed foods, focus turns to whether these plant-based alternatives are actually as good for you as the meat products

[5] 'A Systematic Review of Organic Versus Conventional Food Consumption: Is There a Measurable Benefit on Human Health?', V.Vigar, et al., Nutrients, 2020
[6] 'Dairy vs. plant-based milk: what are the environmental impacts?', Our World in Data, 19 January 2022

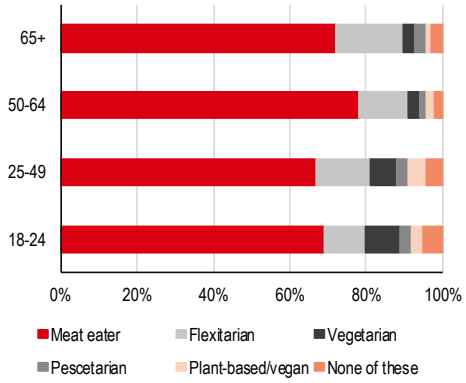
themselves. In 2020, 50% of US consumers believe plant-based meats were healthy, this fell to 38% in 2022[7]. In our view, the surge in uptake of plant-based meat alternatives can be considered to be originally fuelled by the significant environmental benefits of switching, yet more recently, consumers are increasingly analysing the health benefits and nutritional content of such products.

20. Reported dietary choices (United Kingdom, January 2023)



Source: Our World in Data (2023)

21. Reported dietary choices by age group (United Kingdom, January 2023)



Source: Our World in Data (2023)

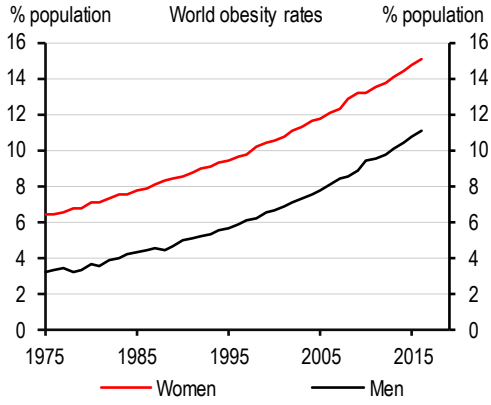
Sales of plant-based meat products in the US dropped 9% in Q1 of 2023, and have stagnated since their high in 2020. The UK has also seen a 'slump' in demand for meat free alternatives, and seen companies in this space struggle – UK vegan food company Meatless Farm stopped trading and let staff go this summer[8]. Changing consumer preferences around health benefits, sustainability and cost of living pressures are the reasons why the industry has seen such a dip in sales. Additionally, these imitation meats are often considered transitionary products for consumers that wish to become vegetarian, with people swapping processed meat alternatives for fully vegetarian products.

Though this shift in diets appears to be relatively small for now, it nonetheless could have enormous implications for the global food industry, which is currently structured around a diet with a much larger meat share. If consumers shun meat in favour of plants and carbs, factors of production currently purposed for rearing animals will have to be reallocated towards growing more crops. For example, large swathes of land currently used for grazing may have to be converted into crop fields, while the labour/capital involved in abattoirs may also be reallocated. Another interesting consideration is that 62% of all cereal crops are used to feed animals[9]. If falling demand for meat prompted even a 20% drop in animal feed demand – the newly-created grain surplus could have a big impact on supply, prices, or both. The same could be true for other foodstuffs, with 88% of soy and 53% of protein-rich pulses used for animal feed.

While one of the reasons for these dietary changes is health, it's striking that we're seeing a huge rise in obesity levels in much of the developed world. A UK poll of 2,000 people[10] found that adults spend an average of 61 minutes preparing food per day, 45 minutes less than their parents. The study signalled a growing preference for "ready meals" – typically pumped with fats salts and sugars, as well as lacking in macronutrients, though in recent years, greater awareness of this has improved ready meals and led to fewer people consuming them.

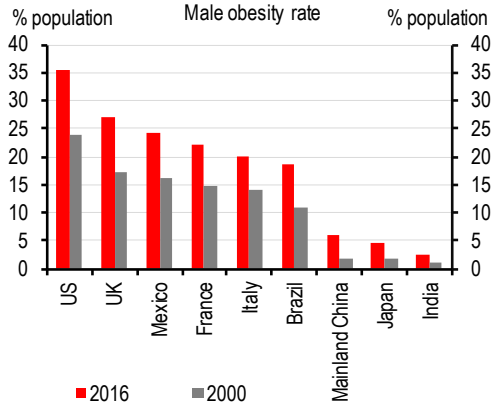
[7] 'Plant-based meat industry on a mission to rebrand itself as healthy option', Financial Times, 06 October 2023
[8] 'Meatless Farm: Vegan mince firm on brink of collapse', BBC, 12 June 2023
[9] Majority of European crops feeding animals and cars, not people, Greenpeace, 16 October 2020
[10] Average person spends 'half as much time' cooking as parents' generation, poll claims, The Independent, 26 February 2020

22. Obesity levels are on the rise…



Source: World Bank. Note: Prevalence of obesity adult is the percentage of adults ages 18 and over whose Body Mass Index (BMI) is 30 kg/m² or higher

23. …and are very high in some economies



Source: World Bank. Note: Prevalence of obesity adult is the percentage of adults ages 18 and over whose Body Mass Index (BMI) is 30 kg/m² or higher

This trend, towards more processed, convenience food is regularly cited as a reason for high levels of obesity in much of the developed world. The US often stands out in these sorts of comparisons, and according to CDC data, the high levels of obesity are evident across age groups, with 22% of those aged 12-19 being defined as obese. It says that the estimated annual medical cost of obesity in the US was nearly USD173 billion in 2019 dollars. Annual medical costs for adults who were obese were USD1,861 higher than medical costs for people with healthy weight. Of course, only part of this story is about food: exercise matters, too – with only 24.2% of American adults meeting the 2018 Physical Activity Guidelines for both aerobic and muscle-strengthening activities[11].

Obesity brings with it many other health challenges – the greater prevalence of disease and the associated healthcare costs are something that both society and governments would like to avoid. As a result, more programmes to encourage healthier eating habits may gain prevalence, with calorie counts not rising as quickly on a global basis if more individuals pull back in terms of what they're eating. The same may be true in terms of product demands – there may be more demand for fresh produce and lower-fat products. The same may be true for plant-based proteins, pulses, and dairy alternatives if these dietary changes become more popular.

One interesting side point here is the rising popularity of hunger-suppression drugs such as Ozempic and Wegovy, whose popularity has become so great that it's having a notable impact on the Danish economy[12]. The idea is that these pills reduce appetite and therefore users do not feel the need to eat as much. The impact may have been evident already in customer behaviour according to Walmart[13], who claim that basket sizes are lower amongst those shoppers who report to taking such products. This, of course, could play a big role in trimming the average calorie intake in many economies – with more corporates, particularly those who sell unhealthy foodstuffs, starting to worry about the impact that these could have on their bottom line. Although it's very early days, it's worth keeping in mind the role that a greater focus on diet and weight could have on trimming western food demand – with the example of Japan's lower calorie intake highlighted above possibly being replicated elsewhere. For now, the scale is unknown, depending on how widespread these products become.

[11] Physical Activity Among Adults Aged 18 and Over: United States, 2020, Centers for Disease Control and Prevention, August 2022
[12] How Ozempic and Weight Loss Drugs Are Reshaping Denmark's Economy, NY Times, 23 August 2023
[13] Ozempic Is Making People Buy Less Food, Walmart Says, Bloomberg, 4 October 2023

Nutritional inequality and food poverty

In the developed world, dietary outcomes have become increasingly polarised. This has become apparent during the very recent surge in food costs – where an ONS survey[14] for the UK highlighted that around 9% of adults in the lowest quintile of annual personal income reported running out of food and being unable to buy more, compared with 1% of those in the fifth and highest quintile.

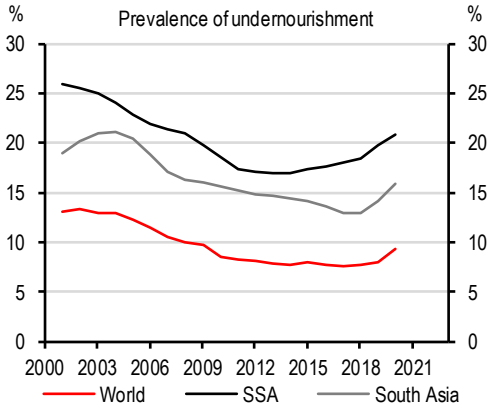
This fits with the fact that foodbanks are being used more than ever before in the developed world – with the Trussell Trust in the UK reporting that they saw more than 750k people using foodbanks for the first time between April 2022 and March 2023 (with the number of people receiving these parcels now close to 3m, up from 1m in 2014 and less than 100k in 2011). In the US, feedingamerica.org reported that 49m people turned to food banks and community programmes for help putting food on the table in 2022. And so even in economies where the average person can afford to feed themselves easily, millions of people are unable to.

Within developed economies, ensuring we have enough food to make sure that people don't go hungry is key. But just as importantly, across the world there are millions of people unable to afford a healthy diet - with the progress ahead of the pandemic being quickly undone in recent years.

Now, as many as 783m[15] people globally are unsure of where their next meal will come from and more than 345m people face high levels of food insecurity in 2023, up by 200m compared to before the pandemic. According to the UN, the challenge is even more acute in some economies such as Democratic Republic of Congo, while growing concerns have been in Afghanistan, Nigeria, Somalia, South Sudan, Yemen, for example, at the top of a list that is steadily getting longer.

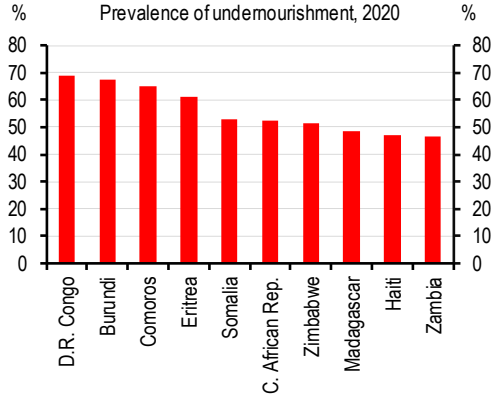
Globally in 2020, 149 million children under 5 were estimated to be stunted (too short for age), 45 million were estimated to be wasted (too thin for height), and 38.9 million were overweight or obese. Around 45% of deaths among children under 5 years of age are linked to undernutrition.

24. Food insecurity is rising again…



Source: World Bank

25. …and is very high in some economies



Source: World Bank. Note: Highest 10 readings from World Bank database shown.

This is the most concerning part of the food story. We already struggle to provide enough food to every corner of the globe, and food demand, globally, looks set to rise – potentially very quickly for some products. Having ample supply will be key to the survival of many, and the question of whether food supplies are able to rise quickly enough and be distributed adequately in the years to come will have huge, widespread impacts in terms of health, poverty and policy. In the next section we look at the future of food supply – and how likely it is that the world will be able to increase food production enough to tackle these growing challenges.

[14] Impact of increased cost of living on adults across Great Britain: February to May 2023, ONS, 14 July 2023
[15] Based on World Food Programme data

The future of food supply

- Generating enough food may be difficult…
- …with climate change likely to be at the heart of the challenges…
- …although technological solutions give cause for optimism

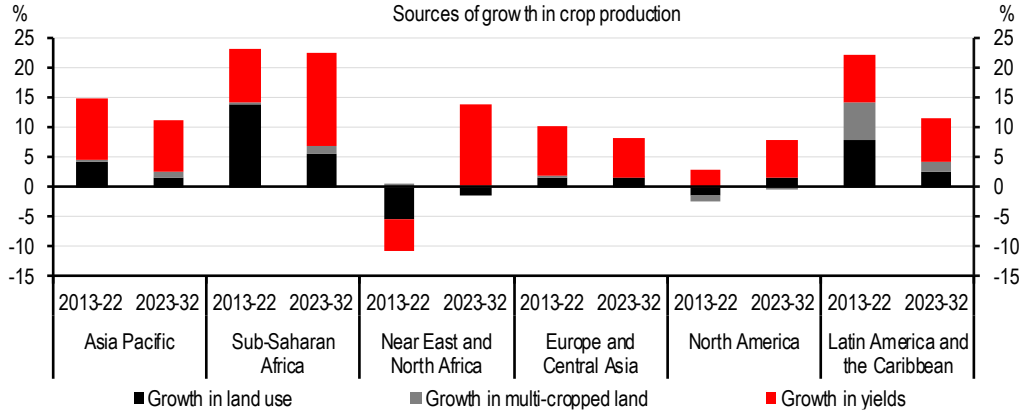
Can we yield enough?

So, with global food demand set to rise in the coming years, can supply keep up? Over recent decades, production hasn't been a problem – steadily rising, even on a per-capita basis – notably since the early 1990s.

What are the options to get more food for the world?

To date, this has been possible due to better crop yields – in many cases meaning less land is needed for the same amount of food. Some increase in crop production has come from more land use, but in much of Asia, Europe and North America, the increase in crop yields has been more important than land use over the past decade and is expected by OECD/FAO to be so in all geographies in the next decade (chart 26).

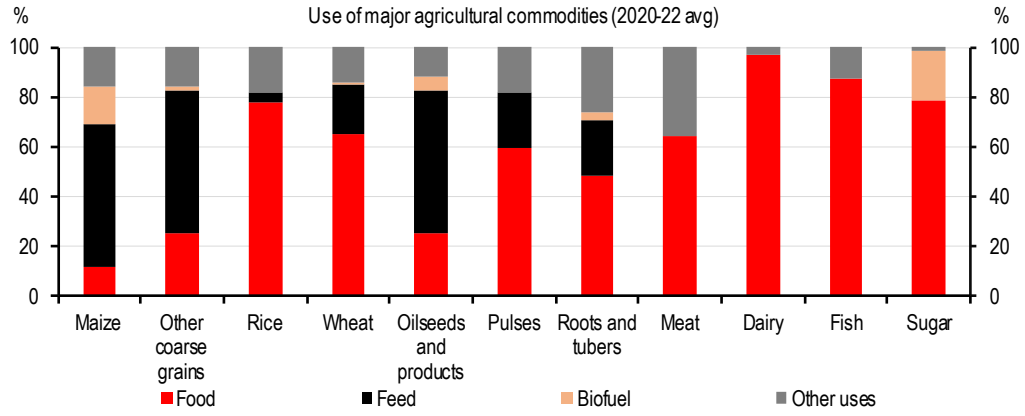
26. Rising crop yields are keeping the world fed for now



Source: OECD/FAO

But, not all this output is used for direct human consumption. For some commodities – notably maize and oilseeds, much of it is used for feed for animals. So, while production of these crops could keep rising, if diets evolve to desire more meat or animal products, then we may not see the same proportionate rise in the amount of available cereal foodstuffs for human consumption.

27. A lot of food products are used for feed and not for food



Source: OECD/FAO

So we have three ways of lifting food supply: changing the mix of how foods are used, using more land, and increasing yields. The first of these may not be possible for the aforementioned reasons. Increasing the number of farmers or devoting more land to farming isn't so simple, with society and investors wary of the downside externalities of food production such as GHG emissions, animal welfare, land and water constraints, the strains on labour practices/shortages and more.

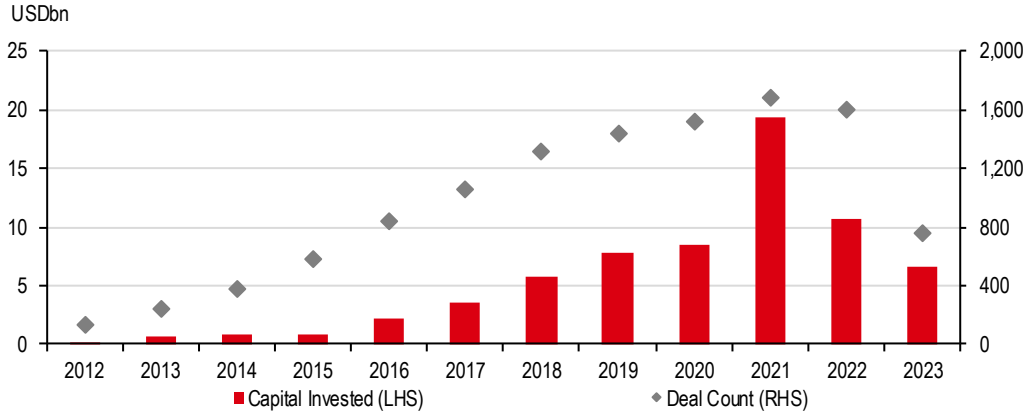
We need to increase food supplies but to do it sustainably and so much will come down to yields – and whether we can continue to see enough progress to lift food yields sufficiently.

Smarter farming to raise supply?

In this section of the report, we highlight some key technologies which are emerging within the smart farming space which not only helps boost food supplies but does it in a sustainable way.

Furthermore, not only does the farming process have an impact on climate change, but climate change has a knock-on impact on farming. For example, a recent Cornell University study found climate change has caused a 21% fall in farming productivity since the 1960's[16].

28. AgTech venture capital trends



Source: PitchBook Data, Inc, HSBC. Note: Global data that shows the investment into agricultural technology companies.

Davey Jose*
Thematic Analyst, Disruptive Tech Global Lead
HSBC Bank plc

Frank Lee*
Head of Technology Research, Asia
The Hongkong and Shanghai Banking Corporation Limited

Henry Ward*
Thematic Analyst, Disruptive Technologies
HSBC Bank plc

Shiva Joon
Data Scientist
HSBC Bank plc

Mark McDonald
Head of Data Science and Analytics
HSBC Bank plc

** Employed by a non-US affiliate of HSBC Securities (USA) Inc, and is not registered/ qualified pursuant to FINRA regulations*

[16] How Technology Can Help Restore Food and Agriculture Production, Forbes, 7 June 2021

Technology holds the key to boosting food production sustainably…

If only it were as simple as increasing the number of farmers or devoting more land to farming to solve any future food crisis. In our modern day, society and investors are also wary of the downside externalities of food production too. For example, GHG emissions, animal welfare, land and water constraints, the strains on labour practices/shortages and more. We need to increase food supplies but to do it sustainably. We took a deep dive into the role of technology to enable smart farming practices in our report called *Smart farming world (March 2022)*.

Smart farming tech to boost production:

- **Artificial intelligence: improving yield by optimising downstream process**

AI is aiding productivity growth across industries…

In our previous report *AI and the productivity paradox (August 2017)* we highlighted how the rise of artificial intelligence was helping to raise productivity in a range of sectors from the knowledge, service to manual labour economies.

In the 21st century, the agriculture process and its supply chain produces a lot of data. AI can be used to optimise and improve food production processes and thus boost productivity. Take as an illustration, a US listed AgTech company called AppHarvest, which uses AI to improve food production. The company grows fruits and vegetables through an indoor farming process.

AI enables real-time crop analysis to help predict yield and optimise operations

AppHarvest acquired a company called Root AI in 2019. This technology enables robots to use intelligent tools to make food sustainably. For example, robots collect data as they harvest, which enable it to evaluate crop health, precisely predict yield and optimise operations of the controlled environment agriculture (CEA) facility.

Real world applications are already underway

According to AppHarvest founder and CEO Jonathan Webb, a key challenge of agriculture is to improve yield prediction. This is because downstream decisions such as work schedules, transportation and retail planning are based on this output. The company believes AI together with big data can be used to solve this issue. The robot and AI system from Root AI have been taught over the last few years on tomato image data sets, so that it can identify more than 50 varieties in different growing environments and various stages of maturity.

- **Drones with AI: more than meets the eye**

Drones equipped with AI is important for productivity and saving costs…

In our recent report, *Drone Disruption: Transforming industries* we looked at how drones equipped with computer vision and tooled with AI as a brain would be able to carry out a whole host of new functions increasing productivity and saving costs for various sectors.

AI drones already identify weeds from crops with 96% accuracy

In the note, we highlighted a Canadian AI enabled farming company called Precision AI. It designs drones to identify and kill weeds without the need to blanket crops with chemicals. The AI identifies weeds with 96% accuracy. This permits targeted spaying that helps kill unwanted weeds in a more sustainable way, while also allowing farmers to spend less on herbicides.

And can reduce herbicide use by up to 90%

The AI is programmed and trained by feeding it images of 15,000 plant species and using unique algorithms to allow the AI to distinguish between staple crops and unwanted weeds. Precision AI said that the AI drones can reduce herbicide use by as much as 90% versus traditional methods. The drones can hold up to 20 litres of fluids per flight and can cover 80 acres in an hour, flying 1.2-1.8m above the surface[17].

[17] AI Weed-Killing Drones Are Coming for the Mega Farms, Bloomberg, 19 April 2023

29. Smart farming tech: which components tech optimises for the production and supply of food?

Technology	Animals	Crop yield	Emissions	Ethics/social	Labour	Land	Water
AI, big data, and data analytics	●	●	●	●	●	●	●
Alternative proteins	●		●	●		○	○
Blockchain	●		○	●	●	○	○
Business platforms and cloud		●	●	●		●	●
Consumer apps			○	●	○	○	○
Drones	●	●	●	●	●	●	○
Genome editing	●	●	●			○	○
Hydroponics/vertical farming		●	○	●	○	●	●
IoT connectivity	●	●	○		●	●	●
Real-time weather forecasting	●	●	○		○	○	○
Repurposing		●	●	●	○	○	○
Robotics and automation	●	●	○	●	●	●	●

Key: ● Direct impact ○ Indirect impact

Source: HSBC

- **Robotics: labour shortage could impact production of food - robots can help**

Robotics can either replace or augment agricultural workers

Farming is naturally a labour intensive process. Anything you can do to automate using modern robotics will naturally ease any risks from potential worker shortages (like we saw during the pandemic) and potentially protect against worker wage increases. Not only that, robotic automation on farms can help increase productivity and hence supply too.

Farming can have labour shortages…

This pressure on farming labour was highlighted by the UK's National Farmers Union calling on the government to offer more visas to farm workers in 2021[18]. In 2021, the Agriculture and Agri-Food Labour Task Force forecasted that by 2025 the labour shortage in Canada for farms could grow to 114k[19].

Robot fruit pickers are 300% more productive than their human counterparts

In order to combat food shortages, companies are turning to robots to pick fruit. Fieldwork Robotics Alpha robots have been used in Portugal to pick fruit, they move at a similar speed to human pickers and are capable of collecting 2kg of fruit per hour. These robots don't need breaks like their human counterparts. Fieldwork's CEO claims that what a human can do in an eight-hour shift, the robots can do 300% more. The robots use cameras and AI to identify the fruit's ripeness and pluck those suitable for picking[20]: indeed, recent advances in both of these technologies could be key to enabling robots to do everything from sorting tea leaves, to processing fish more efficiently.

- **Autonomous tractors: multi-tasking farmers**

Autonomous tractors can be operated using smartphones

Farmers can be out on their tractors for well over 12+ hours a day. Autonomous tractors can allow farmers to operate the tractors from their smartphones remotely and enable them to get on with other tasks in the meantime. This naturally increases productivity of farmers and food production.

If something goes wrong, farmer is alerted

In January 2022, John Deere launched its new autonomous tractor[21]. This technology allows farmers simply take the tractor to the field they wish to operate in and programme it, the rest is automatic. The John Deere Operations Mobile Centre monitors live video feeds and data from the tractor. In the event of any complications, farmers are notified via their phones immediately.

Autonomous tractors together with humans can double productivity…

However, this is not a new phenomenon; in Japan, Yanmar Agriculture has had a fleet of autonomous tractors since 2018[22]. Farmers can pre-set routes and settings. The company highlights a number of benefits: 1) reduced labour costs; 2) larger scale production; and 3) increased efficiency. The company outlines two use cases[23]: 1) the autonomous tractors

[18] 3 ways autonomous farming is driving a new era of agriculture, World Economic Forum, 20 January 2022
[19] Agricultural Worker Shortage Could Rise to 114,000, Immigration Canada, 16 May 2021
[20] Fieldwork Robotics unjams shortage of fruit pickers with AI raspberry harvester, The Times, 10 August 2023
[21] John Deere Reveals Fully Autonomous Tractor as CES 2022, John Deere, 4 January 2022
[22] Yanmar Launches New Autonomous Tractors – Easing the Farmer's Burden with Labor-saving ICT, Yanmar, 27 June 2018
[23] Self-Driving Robot Tractor: Yanmar Technology for Sustainable Agriculture, Yanmar, 3 April 2019

and human driven tractors operate at the same time for the same task, thus doubling the workload per hour; or 2) the human driven tractors follow the autonomous tractors (eg, autonomous tractors till the ground and the human driven tractors sows the seeds).

- **IoT connectivity: the internet of food**

At current rates of soil degradation topsoil will run out in 60yrs

Soil degradation is a threat to the global food supply chain. A Bournemouth University graduate invented a device in 2022 called Terra Nova, which now allows farmers to measure the nitrogen, potassium, phosphorous, and water content in topsoil. Given that 90% of food is grown in topsoil and that at current rates of soil degradation topsoil will run out in 60 years[24], technology that can monitor this can help secure food supplies.

IoT can help farmers make informed decisions over fertiliser usage

One of the important capabilities of the device is that it connects to an app using Long Range Networking, which means it can operate and feedback data even in areas with no Wi-Fi. Given that fertilisers can be expensive and scarce, devices like Terra Nova can help farmers make informed decisions on where and when to use precious resources like fertilisers and help boost the production of food.

- **Hydroponics and Vertical Farming: combating water shortages**

Water scarcity could impact food supply…

In the summer of 2022 the UK witnessed first-hand that water is becoming an increasingly scarce commodity. The same year saw the driest first 7 months of any year since 1976[25]; and this is certainly not a UK specific trend. As a result, farmers will have to start thinking about how they can produce large quantities of food using less water.

Vertical farming can boost productivity by square foot up to 10x

This is where vertical farming may become a potential solution. Vertical farming allows farmers to maximise their productivity by square foot and boost it by over 10x[26]. In the UAE, the world's largest vertical farm (330k square foot), Emirates Crop One, has announced it has the capacity to produce over 2m pounds of vegetables each year.

And save up to 95% on water usage

The farm uses hydroponic methods and requires 95% less water than traditional methods[27]. Similar technology is being used around the world; in the US, Upward Farms announced earlier this year that it will open a 250k square foot vertical farm[28].

- **Real-time weather forecasting: timing sowing and harvesting**

Real-time weather monitoring is being rolled out across Australia

In New South Wales, Australian farmers have access to real-time weather information from the Doppler radar[29]. The first of these went live in 2020 and 2021, in Brewarrina and Hillston-Ivanhoe, with the most recent Yeoval Doppler radar going live in May 2022.

And can help detect bushfires up to 200km away and protect food production

This technology is helping to provide farmers with instant data on rain and wind patterns and even bushfires up to 200km away. This will allow farmers to know the best times to sow and harvest their crops, hence increasing productivity.

- **Alternative proteins: easing strain on environment in production of food**

Demand for protein supply could be aided by alternative proteins

The demand for protein consumption is growing. In our report, *Global Alternative Proteins: Big plate, small portion*, 29 November 2021, we said that as of November 2021 the global alternative protein market was worth c.USD40bn which we estimate will rise to USD140bn by 2030, with c. USD76bn coming from meat alternatives and c. USD66bn from plant-based dairy. Alternative proteins can be easier on the environment than farming foods such as beef and other meats in terms of CO2 output; for more see *Smart farming world, 3 March 2022)*.

[24] Terra Nova soil monitor aims to avert future food crisis, Dezeen, 15 August 2022
[25] UK Heatwave: Official drought declared across large parts of England, BBC, 13 August 2022
[26] This Tech Will Solve the Biggest Food Crisis Since the Great Depression, Yahoo Finance, 27 July 2022
[27] Crop One, Emirate Opens 'world's largest vertical farm' in Dubai, TechCrunch, 19 July 2022
[28] Upward plans to open a 250,000-square-foot vertical farm in PA early next year, TechCrunch, 18 January 2022
[29] Real-time weather forecast at the fingertips of Central West farmers, NSW Government, 27 May 2022

Crops can be grown in harsher environments

An added benefit of methods such as biotechnology such as the above and vertical farming is they allow crops to be grown in previously unthinkable environments and encourage localised farming. This means crops and other food can grow in places closer to their end users, thus minimising fuel consumption, reducing waste, and allowing fresher produce for consumers.

It may also help countries develop their own domestic food sources

In general, the food crisis of the last few years has added to the increased scepticism about globalisation and concern over allowing nationally strategic products and services to be imported from abroad. For instance, we have seen the Indonesian government announce its intention to "reduce imports and substitute it with domestic products". The government has announced a target to reduce imports of wheat by 5% in 2022, 10% in 2023, and 20% by 2025[30].

A lot of money, infrastructure, and education is required to roll out the tech

Moreover, it is important to remember that some of these technologies are expensive and mostly suitable for large farming areas. Note that five out of six farms globally are less than two hectares and they are accountable for c. 1/3rd of the world's food[31]. It may be some time before these technologies can become widespread enough, globally, to impact yields due to costs.

Therefore, a lot of investment, education, and infrastructure (eg, connectivity) will need to be shared in order to have the most meaningful impact. Even in developed countries, there is a funding shortage. For example, in the US, for the past two decades, public funding of agricultural research has fallen by c. 1/3rd as policymakers often look for short-term solutions to immediate problems[32].

Lab-grown foods

Benefits and concerns…

To address the impact agriculture is having on the environment, lab-grown foods, including cultivated meat, is an emerging technology which combines biotechnology and the food industry. Developed in labs, animal cells are cultured to grow into food products for consumption. The benefit of such a product is that it eliminates the need for the suffering of animals, reduces land use and the emissions and environmental impacts that come with agricultural processes. However, the process has been criticised due to its energy intensity. Concerns regarding the lab purification processes have questioned whether the product actually produces more emissions and is more resource intensive than current meat production processes[33]. Nonetheless, if renewable energy sources are utilised, and the product is scaled efficiency, it has the potential to help address rising food demand sustainably.

Some consumers willing to try due to sustainability reasons

Producing an arguably more sustainable alternative to meat production is one thing, having consumers actually willing to try and integrate it into their diets is another. For cultural reasons, lab-grown meat may not make its way onto some consumers' plates, for others it's simply about protecting the demand of smallholder farms in developing regions and countries.

However, demand is likely to come from more developed countries initially. A Food Standards Agency survey in the United Kingdom found that around a third (34%) of respondents would be willing to try lab-grown meat with 40% of these citing environmental and sustainability reasons as to why they would be willing to try. Those unwilling to try the product cited "off-putting" as their biggest barrier[34].

Consumer attitudes and the efficiency and scalability of the process are challenges for the adoption of lab-grown meats. However, developments of these products have a role to play in supporting the transition towards sustainable food consumption – helping to reduce the environmental impacts of food production. Addressing concerns over safety and security in the agricultural supply chain are key to the adoption of such technologies to ensure risks to livelihoods and health are minimised. This includes supporting farmers in the technological shift and adaption strategies to adjust to changing food demands.

[30] Gov't boosts local food production as substitute for commodity imports, Antara, 13 August 2022
[31] How technology can help address challenges in agriculture, WEF, 22 March 2022
[32] The Global Food Crisis Shouldn't Have Come as a Surprise, Foreign Affairs, 25 July 2022
[33] 'Study: Lab-Grown Meat Potentially Worse for Environment than Retail Beef', The Food Institute, 26 May 2023
[34] 'Survey of consumer perceptions of alternative, or novel, sources of protein', Food Standards Agency, 10 January 2022

Additional technologies that are being implemented to reduce the environmental impact of agriculture in food production include: selective breeding, vaccine use, genetically modified crops/animals (including reducing GHG emissions via genetic selection for feed efficiency) and Climate-Smart Agriculture (CSA). CSA brings an integrated approach to managing landscapes and the interlinked challenges of food security and climate change – focusing on three outcomes: increased productivity, enhanced resilience and reduced emissions[35].

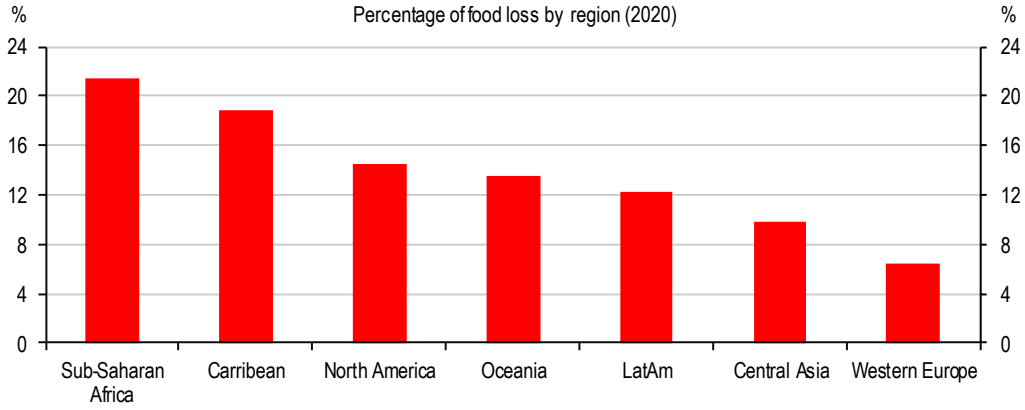
Food waste, boosting production and tech

Reducing food waste by just 25% by 2050 could have significant impacts – tech can help…

One area where supply has scope for improvements is by lowering the amount of food waste in the economy. According to the UN[36], an eye-watering 14% of food produced is lost between harvest and retail, and on top of that, 17% of food products are wasted - enough to feed the 828 million (and rising) people who are defined as hungry[37] Of this 17%, 11ppts comes from households, 5ppts from food services, and 2ppts from retail. Modern trends have led to this rise in waste; as food becomes more convenient to acquire, it becomes easier to throw it away.

On the loss side of the equation, so before food makes it from harvest to retail, we can see in chart 30 that - according to FAO - 21.4% of Sub-Saharan Africa food goes to waste, compared to just 6.5% in Western Europe. This disparity is due to better technologies within the supply chain – such as more refrigeration, tracking and management.

30. A higher proportion of food output is wasted in poorer regions – mainly between harvest and retail

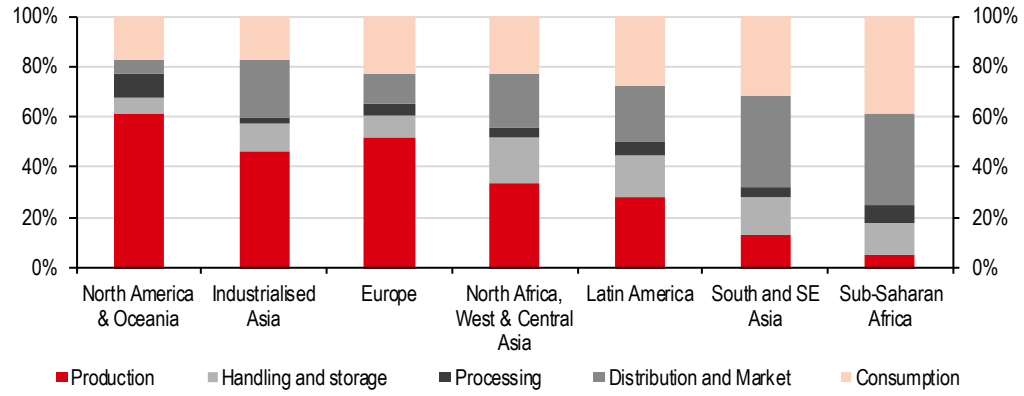


Source: FAO. Note: This is based on food loss within the supply chain, and any food wastage is on top of these figures.

Food waste exists at all stages of the agriculture supply chain. According to the World Resources Institute, reducing food loss and waste by 25% by 2050 would close the food gap (i.e. crop produced in 2050) by 12%, the amount of land required for agriculture by 27%, and expected annual agricultural emissions in 2050 by 15%.

[35] 'Climate-Smart Agriculture', World Bank
[36] UN: Stop Food Loss and waste, for the people, for the planet
[37] Action against hunger: Hunger Facts

31. Food waste occurs at all stages of the supply chain and varies drastically by region



Source: World Resources Institute

Some estimates put 40% of all food production going uneaten…

According to a report by the WWF and UK retailer Tesco, 1.2bn tonnes of food is lost on farms as well as 931m tonnes wasted at retail and consumption. This amounts to 40% of the food grown going uneaten. This is not just a waste of food which could go to the most vulnerable around the world, but it is also a massive waste of resources and a huge emitter of GHG emissions. The report estimates that about 10% of all GHG emissions worldwide are from food waste[38]. In China alone 35m tonnes of grain is lost each year before retail, amounting to nearly 5% of all grain produced globally[39].

As well as lifting production, technological developments can help to reduce waste, making supply chains more resilient, and generally mean that more production ends up being eaten.

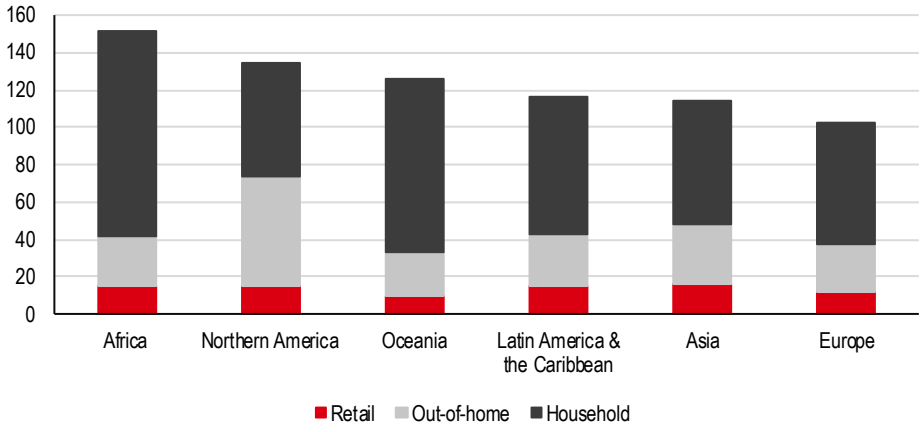
Reducing food waste from its majority source - households

'Best before' dates, loose produce and storage guidance

In 2022, the Waste and Resources Action Programme (WRAP) released a report outlining its recommendations to reduce the amount of fresh produce and single-use plastic packaging as waste. These include: selling loose produce, providing best practice guidance on storage and removing date labels ('best before' wording)[40]. It is estimated that more than 60% of global food waste is from households[41]. Therefore, changes in habits to buy more accurate quantities, storing produce correctly and using it right until it can no longer be consumed can help to reduce overall food waste.

[38] Over 1 Billion Tonnes More Food Being Wasted Than Previously Estimated, Contributing to 10% of All Greenhouse Gas Emissions, WWF, 21 July 2021
[39] How technology can help address challenges in agriculture, World Economic Forum, 22 March 2022
[40] 'Reducing household food waste and plastic packaging', Waste and Resources Action Programme (WRAP), 2022
[41] 'The world's food waste problem is bigger than we thought - here's what we can do about it', World Economic Forum, 26 March 2021

32. Food waste per capita (kilograms)



Source: Our World in Data (2019)

Behavioural changes

Influencing the behaviour of consumers in regards to food consumption can assist in reducing food demand and waste, ultimately, easing pressure on food production. Alongside the adaptions to food labelling and storage, campaigns are useful in prompting consumers to consume certain foods or reducing their food waste. For example, as a result of the Food Waste Action Week 2022, 4.4m citizens (55% of the 8.1m that heard/saw the campaign) in the United Kingdom claimed to have changed their behaviour towards food waste. The campaign included storage insights, demonstrated the value of food and the impact food production has on the planet[42]. Although a small piece of the puzzle towards sustainable food production, behavioural changes have a role to play in limiting demand and reducing the negative environmental impacts of waste.

In recent years, food subscription boxes or meal boxes have increased significantly in popularity due to their ease and convenience. Brands such as HelloFresh, Gousto, Mindful Chef and Able & Cole have packaged up produce and recipe instructions to be sent directly to the customer, eliminating the need to visit supermarkets.

Food waste reduction potential

A study in the Journal of Cleaner Production found that cooking food waste is reduced with meal boxes compared to traditional meals, due to the correct volume of produce being provided. However, meal boxes exhibit a higher chance of plate waste (where served portions aren't finished), due to portion sizing and taste preferences. Overall, the study finds that meal boxes reduce total meal waste by 38% in comparison to traditional cooked meals[43].

Technology to reduce waste and improve supply chains:

- **Blockchain: food transparency on the chain**

Blockchain helps keep an immutable record from ground to supermarket shelf

The blockchain technology is able to provide an immutable record of food products from the ground to the supermarket shelf. This will encourage farmers to adopt sustainable farming practices and to minimise food waste because increasingly environmentally conscious consumers will be able to look up exactly how the crops were grown and how much waste farmers are producing.

[42] ' The Courtauld Commitment 2030: Progress and Insights Report 2021/2022', Waste and Resources Action Programme (WRAP), 2022
[43] 'Do meal boxes reduce food waste from households?', S.Schuster, et al., Journal of Cleaner Production, 2022

Consumers can track their products across the supply chain with QR codes

One such example is Italian pesto sauce and pasta manufacturer Barilla, which has worked with IBM to improve traceability of its pesto sauces. The tracking begins at cultivation and harvesting, then up to transportation, storage, and eventually onto the supermarket shelf. Customers can then see the entire journey by scanning the QR code on the pesto[44]. One paper shows that Walmart's (in partnership with IBM) use of blockchain in its supply chains has reduced the time taken to track a mango's supply chain from seven days to 2.2 seconds[45].

- **AI and machine learning: animal care**

AI is being used to help detect animal health issues

Nxin, a Chinese company, is currently developing machine learning for pig farmers. It uses a set of cameras and voice recognition to alert farmers when piglets are showing signs of distress. The system also feeds data back into the company software systems to determine weight, pregnancy, or the prevalence of disease[46].

Could help save hundreds of thousands of cows each year

In the US, over 2.5m cows die each year from health issues, costing farmers GBP1.1bn. In 2018 the USDA National Institute of Food and Agriculture provided the University of Kentucky with funding to use drones to facially recognise cows to spot signs of illness (eg, weights or other visible ailments[47]).

- **Business platforms and clouds: digital farming**

Business platforms are available for farmers to learn about best practices

In August 2022, Bayer AG launched a new digital farming platform to marry farmers with sustainable practices and environmentally friendly companies[48]. The ForGround platform reviews soil, weather, and other relevant data and offers recommendations to farmers which can help with soil health, emissions, as well as the efficient use of water and fertilisers.

Farmers can become more sustainable with agri platforms…

The platform sends the data to an independent third-party for review and farmers can become certified as an ESG friendly provider, potentially allowing them to sell their produce at higher rates. It is currently a US programme, though Bayer has announced its intention to expand into other countries too.

Loading times have been reduced from 20 mins to 30 second at Zespri

Zespri International, the world's largest kiwifruit producer has been using the cloud since 2021 to optimise its supply chain. Zespri has been able to reduce the load time at ports from 20 minutes to 30 seconds. This means that products can get onto shelves quicker[49]. An Iowa State University professor developed a cloud solution, MyGeoHub, which models soil dynamics, crop growth, temperature, and sunlight to inform formers of the optimal time for fertilisation and irrigation[50]. This in turn allows farmers to use resources efficiency and to maximise yield.

- **Consumer apps: want not waste not through apps**

Unsold food is being advertised to consumers via apps

The pandemic made popular apps whose goals were to decrease food waste. One example is *Too Good To Go*, which allows consumers to buy unsold food from shops and restaurants which would otherwise be thrown away at the end of the day.

According to its website, 61.3m people use the app across Europe and North America, with 163,252 businesses signed up, which has helped to save 153m bags worth of food not going to waste[51].

[44] Blockchain for agriculture. Opportunities and challenges, UN FAO, 2019
[45] Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM, ResearchGate, July 2018
[46] Asia's new agricultural revolution: planting a high-tech future, Financial Times, 20 July 2022
[47] The drones watching over cattle where cowboys cannot reach, BBC
[48] Bayer launches sustainable ag hub to connect U.S. farmers, food and fuel makers, Nasdaq, 15 August 2022
[49] How Technology Can Help Restore Food And Agriculture Production, Forbes, 7 June 2021
[50] Can Cloud-Based Farming Make Agriculture More Sustainable?, Nutanix, 10 August 2021
[51] Let's start saving food, Too Good To Go, 10 July 2022

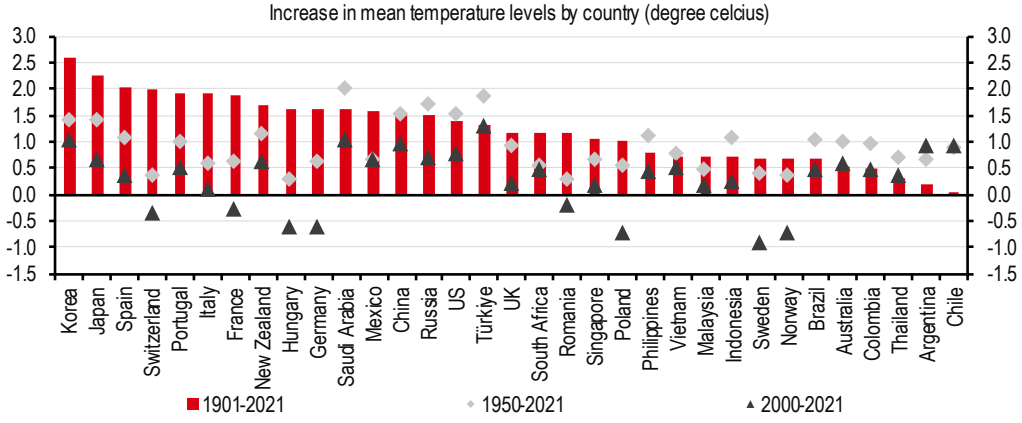
Climate change's role in supply

Not only does the farming process have an impact on climate change, but climate change has a knock-on impact on farming. For example, a recent Cornell University study found climate change has caused a 21% fall in farming productivity since the 1960s[52].

Climate change is driving structural changes that are likely to lead to much more volatility in wholesale food prices. With major weather events already becoming more frequent, and meteorologists expecting this trend to continue, there is little doubt that external supply shocks are likely to play a greater role in disrupting food production. A perfect example from this year is the failure of peaches to grow in the so-called 'Peach State' of Georgia for the first time since 1955[53]. An unusually warm winter caused the trees to blossom early before a late spring frost killed the flowers. While peaches do require unusually specific conditions to grow, this demonstrates how unseasonal weather and more extreme and erratic weather patterns associated with global warming are capable of bringing down an entire harvest.

As well as this, there are many cases where climate change will make existing agricultural land much less productive. More extreme rain patterns will reduce soil fertility[54]; too little rain will lead to drier topsoil and weaker soil structures, while too much rain will cause flooding and erosion, washing away the nutrients contained within the topsoil. Higher temperatures, meanwhile, can increase the virulence of pathogens that further threaten crop yields.

33. Temperatures have risen across the world



Source: Our World in Data, HSBC

In addition, the quality of produce can also be affected; some studies have found that increasing rainfall variations have been linked to greater variability in the protein content of wheat, for instance.

The areas likely to be hit hardest are in sub-Saharan Africa. The high temperatures and drought that already occur in such areas look set to increase in frequency and magnitude. Where there is limited global market access, environmental variability can translate more readily into local shortages. Disruptions in local food supply may also transmit down the supply chain, impacting even regions far removed from the extreme weather events. While developed markets may pay slightly higher prices and source their food elsewhere, in less developed regions that are more poorly integrated into supply chains, the consequences may be more severe.

[52] How Technology Can Help Restore Food and Agriculture Production, Forbes, 7 June 2021
[53] Georgia, the Peach State, has no peach crop this year, The Economist, 8 June 2023
[54] Climate change impacts on our soils, NSW Government

For example, in July India imposed a major rice export ban[55] after heavy monsoon rains damaged crops, halted shipments of non-basmati white rice of which India accounts for over 40% of worldwide exports. This caused world rice prices to increase to their highest in over a decade. In Sub-Saharan Africa local production covers only 60% of current rice demand; such price increases will hit hardest those who cannot afford the price rises in one of the already-cheapest categories of the grain.

Water scarcity and land use

Climate change is largely about water in some way: too much or too little. Flooding and drought are one of the clearest ways we notice the impacts of climate change on water, with intensified wet and dry conditions changing availability of water around the world (*The water crisis*, September 2021). This has a direct impact on agricultural production and therefore food supply.

Agriculture both exacerbates and falls victim to water scarcity

Alongside risks of increased floods and droughts impacting crop yields and quality, agriculture also contributes to water scarcity concerns. The industry withdraws 70% of global freshwater. In developing regions and countries this number increases to 95% - exacerbating already significant water security issues[56]. This has resulting knock-on risks to food security, which are then intensified further by climate change impacts and rising populations.

Large variations in water use across produce

Water use varies by type of produce. Producing 1kg of pulse crops requires between 1,000 to 4,000 litres of water compared to 13,000 to 15,000 litres for the same volume of beef/bovine meat[57]. For regions experiencing water scarcity concerns, studies have been conducted to calculate scarcity-weighted water use per kilogramme of food product. Nuts rank the highest followed by cheese and lamb/mutton. However, often these indicators provide unreliable scoring. Therefore, a focus on how sustainably the product is produced is a better indicator of sustainable food production. In addition, studies show that understanding water efficiency separately to water stress in a complementary way is a suggested procedure to evaluate the water footprint of food products[58].

Water supply and demand gap

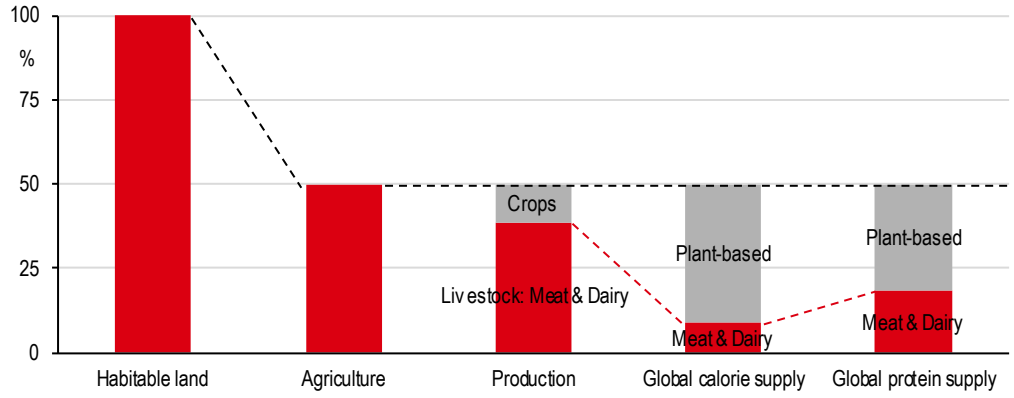
The global gap between water supply and demand is expected to reach 40% by 2030 on a business-as-usual path (current practises continuing)[59]. This risks a global food crisis as water insecurity increases, alongside damaged economic growth and worsened social conditions. Therefore, work to improve water efficiency, reuse water effectively and promote the safe use of wastewater are vital to mitigating potential risks from climate change impacts such as droughts and water scarcity concerns. Ultimately, the aim is to avoid negative environmental and social impacts arising from agricultural water use, to in turn limit the impacts on yields and food supply.

Land use on the rise…

As demand for food grows, so does the need for land use expansions. Currently, around 50% of habitable land is used for agriculture (chart 34), however, it is not used equally across the sector. Livestock use 77% of the land, while only generating 18% of the world's calories and 37% of its proteins today. Whereas crops (eg, plant-based) food, uses 23% of agricultural land but provides 82% of the global calories and 63% of its proteins. Between 1900 and 2016, land use for cropland increased by 88%, while land use for grazing almost doubled at 98%[60]. However, in 2015, 34% (1,660m hectares) of agricultural land was affected by human-induced degradation, including soil erosion, depletion of nutrients and increased intensification on existing cropland[61]. Therefore, the industry is experiencing the expansion of cropland with detrimental degradation alongside, reducing overall productive land and efficiency.

[55] India imposes major rice export ban, triggering inflation fears, Reuters, 20 July 2023
[56] 'Water Scarcity – One of the greatest challenges of our time', FAO, 2019 and the Water Footprint Network
[57] 'Water Scarcity – One of the greatest challenges of our time', FAO, 2019
[58] 'The scarcity-weighted water footprint provides unreliable water sustainability scoring', D.Vanham, M.M.Mekonnen, Science of The Total Environment, 2021
[59] 'Ensuring sustainable water management for all by 2030', World Economic Forum, 16 September 2022
[60] History Database of the Global Environment (HYDE)
[61] 'The state of the world's land and water resources for food and agriculture', FAO, 2021

34. Global land use for food production



Source: Our World in Data (2019)

Risks to biodiversity

The more degradation of land the greater demand for the expansion of land, this requires the clearance of forests and habitats to grow crops and provide grazing land. It's unsurprising that agriculture is the largest driver of deforestation globally, with products such as beef and soy leading tropical deforestation in regions such as South America[62]. Alongside the climate impacts of deforestation, the clearing of land threatens biodiversity. Currently, 42,108 species are recognised as threatened with extinction by the IUCN Red List, with agriculture and aquaculture practises listed as the top threat, impacting 23,000 of these species[63]. Land is often used inefficiently and the majority is used to feed livestock rather than people. Dietary changes and technological advances to increase efficiency (climate-smart agriculture) can allow us to provide a greater volume of food without damaging further ecosystems and degrading land.

Agricultural productivity has increased significantly, notably down to the importance of fertilisers, however, the negative environmental impacts of these risk sustainability into the future. Work is being done to develop solutions, such as developing drought resistant crops, as well as the adoption of regenerative agriculture, to help conserve and restore the environment while also meeting the needs of a growing population. Ultimately, enhancing natural resources, including water, is key for the agricultural sector to increase global food supplies.

Pests and diseases

Climate change enhancing the spread and emergence of disease

Crop disease outbreaks significantly risk food security and ecosystems, resulting in loss of biodiversity and socio-economic damage, which are often dependent on agriculture for livelihoods. Climate change risks these events becoming more common, as conditions change (ie, temperature and precipitation), pathogens evolve and this can facilitate the emergence of new strains, breaking down crop resistance and spreading to areas which formerly had less risk of such diseases/infections.

There is increasing evidence suggesting that climate change has a direct impact on disease development, via factors such as temperature increases, carbon dioxide levels, precipitation/water availability and biodiversity related factors such as soil health[64]. For example, warmer temperatures have created more favourable conditions for diseases in coffee plantations: coffee leaf rust, a devastating fungal disease, has already led to significant damage in Central and South America. The coffee rust epidemic in Colombia, from 2008 to 2011, reduced production by 31% on average, compared to 2007[65] (*How sustainable is your morning coffee?*, 26 July 2023).

[62] World Wildlife Fund, 2018
[63] International Union for Conservation of Nature and Natural Resources (IUCN), Red List of Threatened Species (2022), accessed October 2023
[64] 'Climate change impacts on plant pathogens, food security and paths forward', B.K.Singh, et al., Nature Reviews Microbiology, 2023
[65] 'The coffee rust crises in Colombia and Central America (2008–2013): impacts, plausible causes and proposed solutions', J. Avelino et al., Food Sec, 2015

Sustainable solutions to chemical pesticides

Overreliance of pesticides has been attributed to the emergence of new strains of pathogens, quicker than naturally would have occurred without use. Additionally, the deterioration of biodiversity due to the depletion of natural resources and intensive agricultural practices threaten the productivity of ecosystems, reducing resilience to disease. The use of pesticides is being increasingly controlled by regulators, such as the European Union implementing a target of 50% reduction in chemical pesticide use by 2030 – this aims to reduce pollution and risks to human health[66]. Therefore, the development of disease resistant crops, sustainable land management and synthetic biology solutions are key to managing the threat climate change poses on disease outbreaks, decreasing risks to global food supply.

But what if…

The impact of climate change on food supply chains may not be all bad though. Rising temperatures, particularly in the Northern hemisphere, will mean that some land which was previously unviable for farming will start to become suitable for growing certain types of crops on. The benefits of this are likely to accrue to regions such as Northern Europe, Canada and Russia. The sub-arctic conditions within these geographies may give way to something that is more temperate – unlocking new swathes of land which will be able to grow crops that today are only found in warmer climes.

Can climate change provide opportunities for food production?

This doubling up of land use is likely to be key to how the world can feed 9bn mouths in a sustainable way – providing renewable energy while also reducing the overall land footprint of agriculture. It also means that for farmers in poorer regions, who grow low-cost crops (such as rice, cocoa, tea), the solar energy produced could provide a vital income stream – as well as providing stability given the massive swings seen in wholesale food prices in recent years.

Incidentally, the regions with the highest solar potential are often some of the poorest – populated by smallholding farmers who often barely scrape by. There will be huge challenges involved in setting up and harmonising electricity grids between many small-scale farmers in hot, remote regions. But once the massive initial cost is overcome, the benefits could be enormous – solar is on track to become one of the most efficient and cheapest energy sources in the world (see *Global Solar*, 3 July 2023) – which could prove vital for an economy such as South Africa which is currently plagued with blackouts and electricity shortages.

Solar technology may have other benefits: For example, farmers' fields can now be covered with solar panels, while crops grow beside them – known as "agrivoltaic farming". This is used in South Korea, with broccoli growing underneath photovoltaic panels – a method which scientific studies suggest is much more productive[67], by assisting with moisture retention, convecting heat, and providing the crops some shelter from the elements and other animals.

A supply challenge

Clearly, the world is going need more food supply. Climate change threatens to derail our ability to do this, with greater uncertainty over whether land and temperatures will be suitable for various crops. But against that, the continued technological progress in the agricultural sector gives hope. These two forces will likely trade off against each other, and which one wins out will be crucial for determining whether the world has enough food or not.

Alongside this, though, we may see changes in where in the world food is produced, which is where the role of food trade becomes crucial for food to reach those who need it. We discuss that next.

[66] 'New pesticide rules to help achieve zero pollution targets', European Commission, 10 August 2022
[67] Can crops grow better under solar panels? Here's all you need to know about 'agrivoltaic farming', World Economic Forum, 26 July 2022

The future of food trade

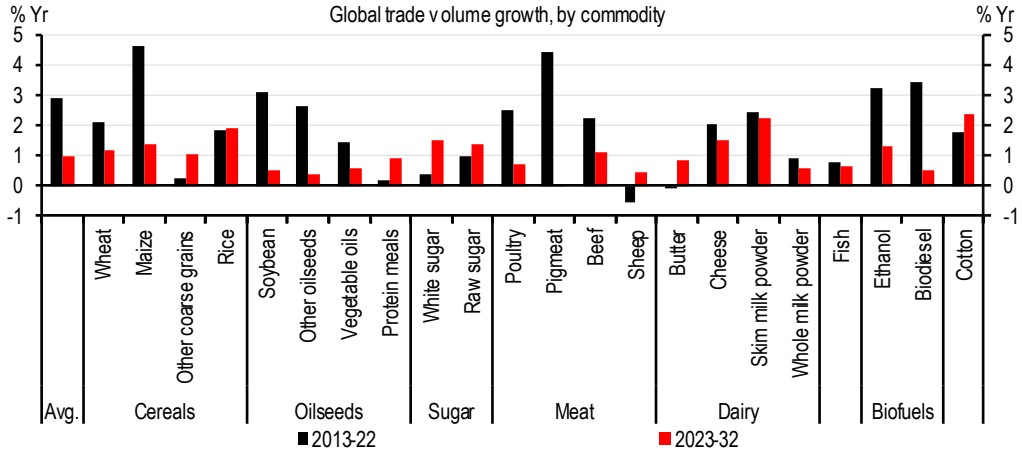
- Trade is already crucial to the global supply of food and is set to become even more important
- Geopolitics and supply uncertainty may create more trade barriers…
- …posing a risk to food supply for certain parts of the world

Food supply isn't just about how much is produced…

The future of food trade will depend on how food is supplied going forwards and whether trade restrictions in the space become more widespread and unpredictable. As the FAO highlights, there could be a growing need for food trade to tackle supply challenges, and as the significant adverse effects of climate change on food supply are expected to worsen, trade can also contribute to the stability of food security.

As a result, it expects food trade to keep growing in the years to come, but the pace of growth to slow due to slower demand growth from mainland China and other fast-growing emerging economies.

35. Trade in many foodstuffs is likely to slow



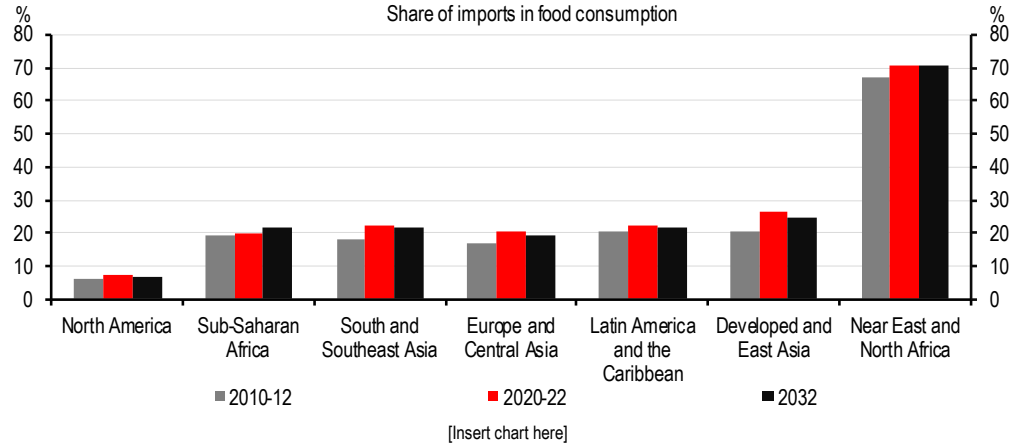
Source: OECD/FAO (2023), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database)

…it needs to distributed well, too

There are additional reasons why food trade could slow – including better local production methods (if yields rise fast enough), export restrictions, changing dietary habits or a greater focus on the source of food from an ESG perspective. Equally, due to the continued expectation of food consumption growth, we would expect food trade to keep rising, too, albeit at a slower pace.

The continuation of global food trade is crucial for some regions of the world – some rely on imports from elsewhere to feed their populations. While the Middle East stands out, across the rest of the world, roughly 20% of food consumption is imported, highlighting how important global food trade will be for keeping growing populations fed.

36. Some economies rely on imports for food consumption



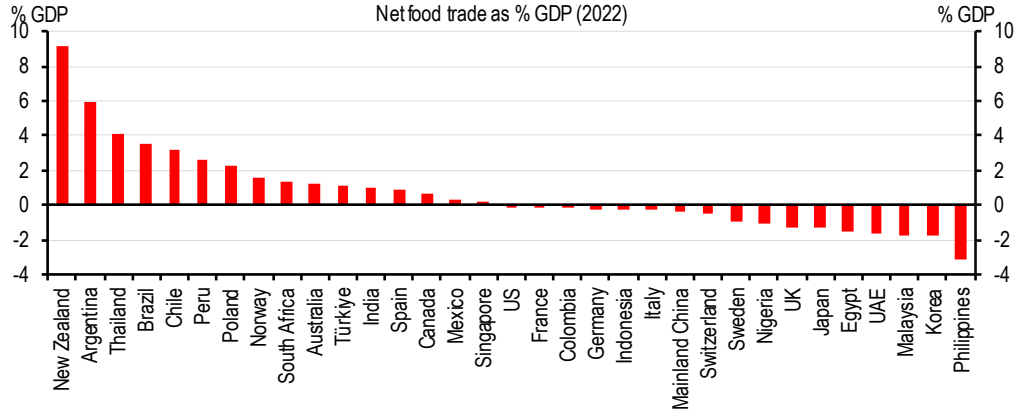
[Insert chart here]

Source: OECD/FAO (2023), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics. Note that includes feed, and availability includes processing of commodities which may be re-exported.

Some economies rely on food for output and jobs

For some, the impact may be more about economic performance. Some economies, such as New Zealand and Latam economies are big food exporters, with net exports of products amounting to more than 3% of GDP. If global trade in food does rise, then these economies could be beneficiaries. But, if improved localised production techniques, using new technologies, can mean reduced global food trade, we could see these economies being relative losers.

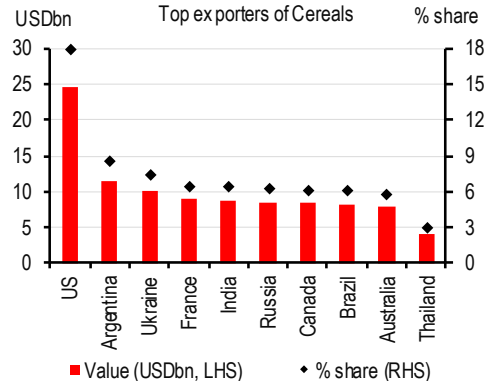
37. Some economies are big food exporters, some importers



Source: UN Comtrade, HSBC

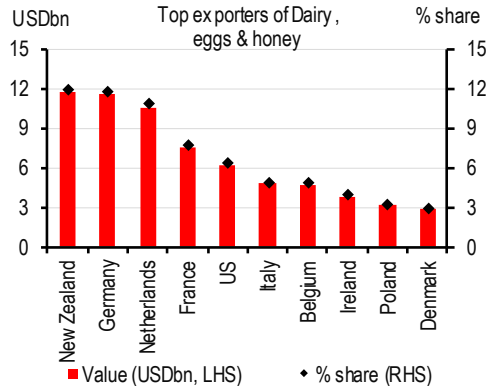
For some products, some economies stand out as key producers. New Zealand, as mentioned before, is a key producer of dairy and meat products, while on the cereals side – the US, Argentina, Ukraine, France and India are key for global consumption.

38. Some economies are key for certain food products…



Source: UNCTAD, HSBC

39. …such as cereals or dairy



Source: UNCTAD, HSBC

What about export restrictions?

Export bans are a concern in terms of getting food to all

Given the importance of global trade to food supply, the rise of food product export bans since the beginning of the war in Ukraine is concerning (food accounts for roughly 8% of global goods trade). The most high-profile bans in recent months have come from India, notably the export ban of non-basmati rice that led to a surge in some global rice prices, but these practices are becoming more commonplace, according to the World Bank. It highlights, that as of October 2023, 19 countries had implemented export bans and a further seven had export-limiting measures in place, some of which are highlighted in the table below.

40. Food export bans are now commonplace

Example food trade policies

Economy	Restriction	Product	Announced	Expected end date
Argentina	Export taxes	Soybean oil, soybean meal	19 March 2022	31 December 2023
Bangladesh	Export ban	Rice	29 June 2023	31 December 2023
Mainland China	Export ban	Corn starch	2 October 2022	31 December 2023
India	Export ban	Non-basmati rice	20 July 2023	31 December 2023
India	Export ban	Wheat	13 May 2022	31 December 2023
Morocco	Export ban	Tomatoes, Onions, Potatoes	8 February 2023	31 December 2023
Pakistan	Export ban	Sugar	15 April 2022	31 December 2023
Türkiye	Export ban	Beans, red lentils	27 February 2022	31 December 2023

Source: World Bank Food Security Update, 12 October 2023

This creates additional risks for global food supply. With more extreme weather events or heightened political risk, we could see more economies that are key producers of certain products opt to put these sorts of measures in place to protect domestic supply for their own population.

This further complicates the outlook for global food trade: we need more food to be traded to meet global food needs, particularly if we can't lift food yields across the world sufficiently. Geopolitics may make that increasingly difficult. Next, we look at what all of this means for food prices and policy.

What does this all mean?

- Global food prices may stay elevated and be volatile, offering little relief for consumers and challenges for policymakers
- But if technological solutions prevail, some prices could go lower…
- …while climate change may mean more uncertainty

Elevated prices and elevated volatility

James Pomeroy
Economist
HSBC Bank plc

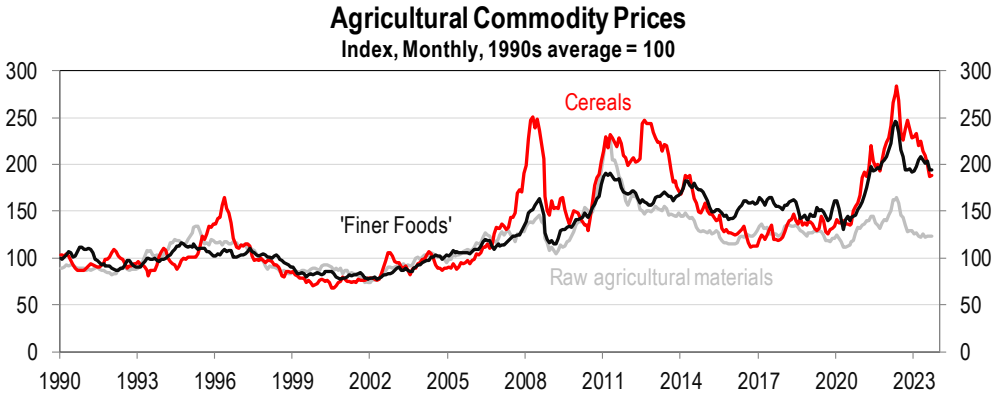
Paul Bloxham
Chief Economist, Australia,NZ & Global Commodities
HSBC Bank Australia Limited

Jamie Culling
Economist, Australia, NZ & Global Commodities
HSBC Bank Australia Limited

Global agricultural prices have remained high, by historical standards, through most of 2023, despite having fallen from their mid-2022 peak levels (Chart 41). Of course, the patterns of price movements in the next few years will depend a lot on the interaction between the numerous supply and demand factors outlined in the chapters above.

Continued high food prices have been largely in-line with HSBC's broader view on global commodity prices. A key theme that we have been describing is that commodity prices are set to stay elevated because of supply side constraints, including geopolitics, climate change and the energy transition (see *Global Commodities: The 'super-squeeze' and China's slowdown*, 14 September 2023). Food is a key part of this story.

41. Food prices are high by historical standards



Source: IMF; HSBC. Note: 'Finer foods' are: meat, dairy, sugar, seafood, and coffee, Cereals are: wheat, corn, barley, rice, and sorghum, Raw agricultural materials are: timber, cotton, wool, rubber, and hides

Our view largely aligns with the latest outlook for agricultural prices in the World Bank's latest Commodity Markets Outlook (October 2023). The World Bank forecasts suggest that agricultural commodity prices are likely to remain around current elevated levels in the years to come (Table 42 and chart 43): following a 7% fall in 2023, agriculture prices are expected to fall by only 2% in 2024 and 3% in 2025, partly reflecting some incremental positive supply developments for grains.

42. Selected World Bank commodity price forecasts

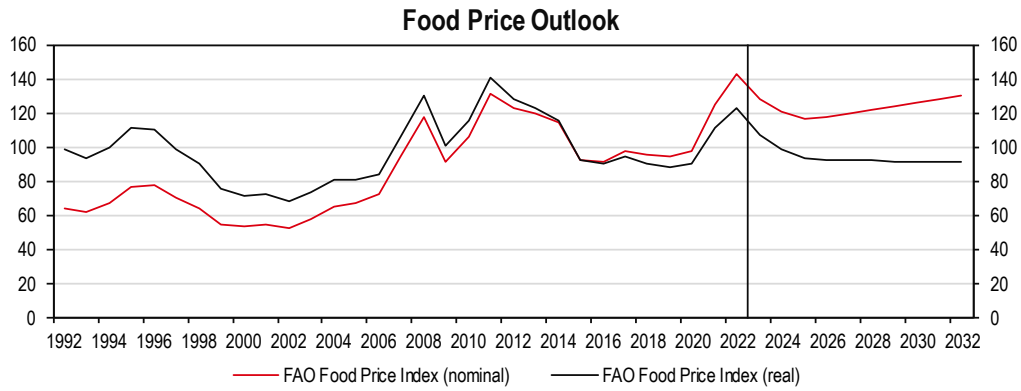
Commodity	Unit	2021	2022	Sept-2023	2023f	2024f	2025f
Agriculture	Index	108.3	122.7	112.74	113.9	112.2	109.7
Food	Index	121.8	143.7	129.24	131.1	129.1	124.7
Oils and Meals	Index	127.1	145.2	116.15	120.4	117.3	114.1
Grains	Index	123.8	150.4	127.78	133.4	129.6	122.9
Other food	Index	113.1	135.6	147.78	142.9	144.1	140.3
Maize	USD/mt	260	319	223.81	250	230	220
Wheat	USD/mt	315	430	231.06	345	335	320
Rice	USD/mt	458	437	620.00	560	595	550
Barley	USD/mt	…	…	...	210	190	189
Soybeans	USD/mt	583	675	619.04	615	585	560
Soybean oil	USD/mt	1,385	1,667	1111.63	1,120	1,105	1,095
Palm oil	USD/mt	1,131	1,276	829.60	920	900	850
Beef	USD/kg	5.39	5.78	5.17	5.15	5.30	5.36
Chicken	USD/kg	2.26	3.35	2.89	3.10	3.15	3.12
Sugar	USD/kg	0.39	0.41	0.58	0.52	0.49	0.45

Source: World Bank

Food prices may stay high, and likely volatile

Forecasts from the UN's Food and Agriculture Organisation (FAO) and the OECD paint a similar picture, falling slightly in the near term, before rising in-line with global inflation over the medium term. However, the OECD notes "an unavoidable degree of uncertainty attached to the projections and to the underlying assumptions" due to uncertainty over the war in Ukraine, high and volatile energy prices and the possible use of trade restrictions and subsidies by some countries to manage domestic inflation.

43. Food prices are likely to remain elevated



Source: UN FAO estimates; HSBC. Note: * Annual average forecast

Longer term, climate change and environmental policies are also expected to cause more uncertainty over food prices, and we could see greater volatility in prices depending on a range of the factors discussed in this report – from supply shocks and export bans to technological breakthroughs and reducing waste. In Asia, we've already seen the impact, clearly, as highlighted in *Food fragility: Climate change and food price stability in Asia*, 16 October 2023.

Resurgent volatility in commodity markets will likely pose economic challenges in coming years, even if prices decline. This is particularly the case as the recent volatility in global commodity prices has occurred at a time when price levels are high.

Higher and more volatile inflation … and a drag on GDP growth

Overall, the implications of the future of food span across the macro-economic and micro-economic landscape.

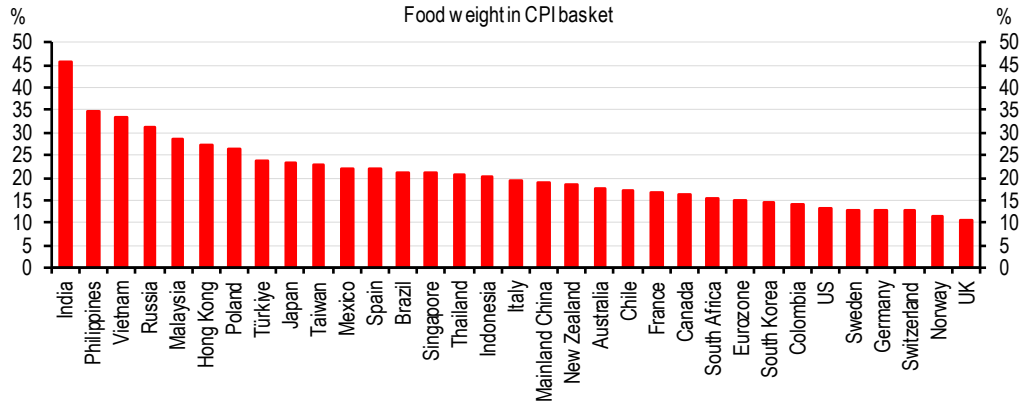
Greater uncertainty and volatility in inflation?

At a macroeconomic level, one of the most obvious implications is for inflation, real incomes and living standards across economies. A rise in global agricultural prices, to the extent it impacts local food prices directly, will place upwards pressure on headline consumer price inflation. As such, if commodity prices remain elevated, as we expect, then they are likely to contribute to stickier elevated global inflation – a risk we noted in our Q4 2023 Global Economics Quarterly – at least until demand for other goods and services falls sufficiently to exert downward pressure on other consumer prices.

However, the impact of elevated food prices is likely to be felt unevenly across economies. In general, the precise implication in a given region is likely to reflect a number of factors: 1) the outcome of global agricultural and energy commodity prices; 2) respective food import shares; 3) respective exchange rate dynamics; and 4) the respective consumption share of food.

Emerging markets, and developing and low-income economies, as well as those who rely more-heavily on food imports, are likely to be the most impacted by higher food prices. For instance, as chart 44 shows, in India, food accounts for roughly 45% of the CPI basket, whereas in the UK it is closer to 10%.

44. Food prices matter for inflation more in LICs and EMDEs



Source: OECD, National Sources

This fits with the conclusions drawn in previous work from international organisations, such as the World Bank and FAO. In empirically examining the transmission of global agricultural prices to local CPI inflation, broadly, emerging markets and low-income economies are more vulnerable to food price shocks. The transmission is generally incomplete and lagged. Africa is typically the region with the highest transmission, while the lowest transmission is found in North America and Europe.[68]

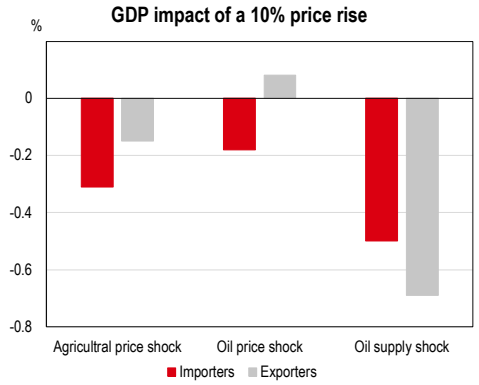
At a macro-economic scale, beyond inflation, there are also implications for global growth. Careful empirical studies that look at the supply-driven, rather than demand-driven, commodity price shocks show that these typically deliver a macro-economically significant negative effect on global growth.

68 For example, according to an FAO study, the US and Europe have the lowest long-run elasticities, around 0.30%, while elasticities in Asia and Africa are upwards of 0.80% (FAO, 2014). Likewise, a 10% shock to global food prices raises regional food prices by around 0.01% in the US and Europe, and up to 0.05% in Africa.

Higher food prices can hurt growth, too

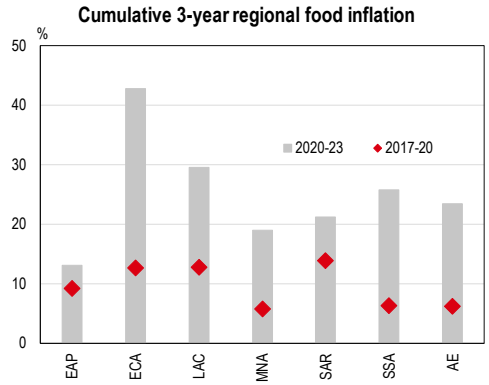
For instance, a recent study by the Bank of International Settlements (BIS) showed that a 30% sustained rise in oil prices and a 10% rise in agricultural prices would knock 0.7ppt off developed economy GDP growth (Chart 45). Again, as is the case for inflation, the precise impact on growth is likely to be unevenly felt across economies.

45. Growth is negatively affected by rising agricultural prices …



Source: BIS

46. … which would also support local CPI inflation rates

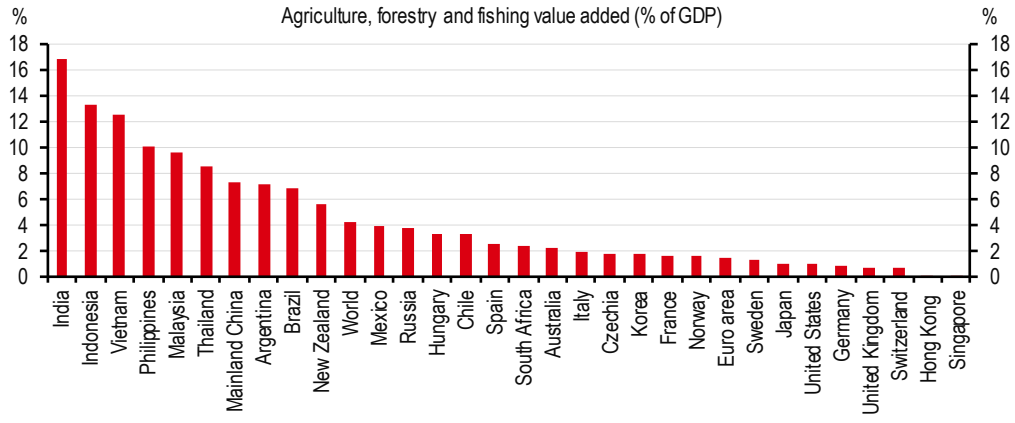


Source: World Bank. Note: Note: EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa; AE = Advanced Economies.

Volatility can affect output

Heightened volatility of food prices is also likely to play an important role here, particularly through the lens of a terms of trade shock. Volatility in the commodity terms of trade across economies has risen markedly in the past few years, which itself has likely weighed on growth in commodity-exporting countries. Recent IMF (2023) estimates point to a negative and significant association between higher commodity terms of trade volatility and per capita income growth among commodity exporting economies.

47. Economies reliant on agriculture could see slower economic growth or greater growth uncertainty



Source: World Bank

Cost-of-living challenges for households

At a micro-economic level, elevated food prices offer little relief for households, many of whom have experienced a cost-of-living challenge in recent years, reflecting the high-inflation environment.

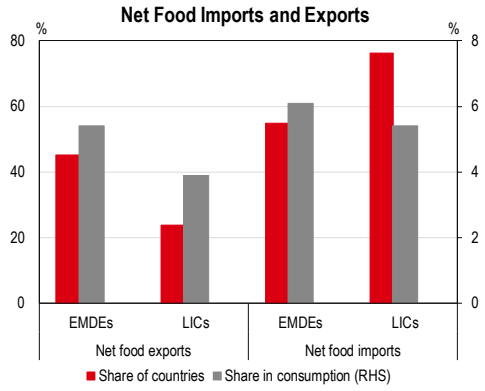
Potential for a cost-of-living shock

Lower-income households are particularly vulnerable (Charts 48 and 49). Lower-income households spend a greater share of their outlays and incomes on food, and so if we're heading into a period where food prices could be more volatile, the impact could be much greater on those at the lower end of the income spectrum. In the UK, ONS data found that adults with a personal income below GBP40k had between a 1.7 and 3.1 higher likelihood of experiencing some form of food insecurity than adults earning GBP40k or more.

48. Lower-income households spend more on food…

Source: US Survey of Consumer Expenditures

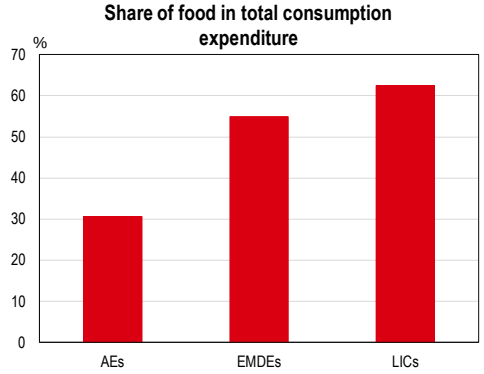
49. …making them more vulnerable to spikes in food prices



Source: World Bank

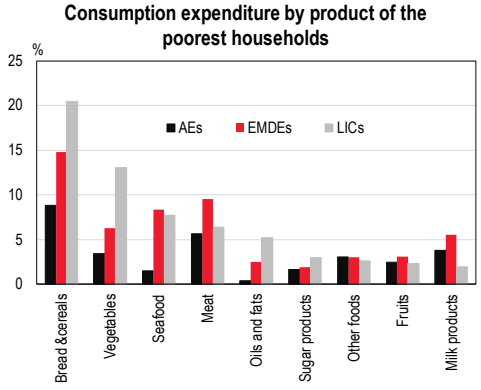
However, higher food prices could also support incomes for those involved in agricultural production, as higher prices are likely to raise incomes for those who work in the agricultural sector. In aggregate, though, because lower-income households spend a greater share of their income on food, there are adverse effects of food price spikes on poverty and income inequality.

50. Lower-income households spend more on food…



Source: World Bank

51. …making them more vulnerable to spikes in food prices



Source: World Bank

A risk to global food security

Huge risks for the most vulnerable across the world

Globally, food security has been an increasing challenge. While the latest UN FAO Statement of Food Insecurity (2023) noted that "hunger was no longer on the rise at the global level in 2022", it "was still far above pre-COVID-19-pandemic levels" and "food crises were still unfolding in many parts of the world". Unfortunately, this means the world is still far off track for achieving its Sustainable Development Goal targets: specifically, the goals to end hunger, food insecurity and all forms of malnutrition.

The prevalence of undernourishment increased from 7.9% in 2019 to be around 9.2% in 2022, with the UN (2023) estimating that between 691 and 783 million people in the world faced hunger in 2022 – around 122 million more people than in 2019. Likewise, the prevalence of moderate or severe food insecurity at the global level rose from 25.3% in 2019 to be 29.6% in 2022.

Food security is both a demand-side and the supply-side challenge. On the demand-side, higher agricultural prices have pushed up the cost of nutritious foods. High food prices also make it more difficult to address food security, as more and more low-income households become unable to afford sufficient food.

At the same time, on the supply-side, higher food prices can incentivise more and more farmers to increase production. However, producers that face higher input costs and are unable to pass them on may subsequently reduce production.

Beyond food prices themselves, a range of factors have a notable influence on food security:

- **Conflict**
- **Climate variability and extremes**
- **Economic slowdowns and downturns**
- **Internal (eg, higher prices, low productivity and inefficient food supply chains)**

According to the International Food Policy Research Institute (2018), around five countries (China, Korea, Japan, Russia and Saudi Arabia) are responsible for about 40% of food net imports and seven countries (Argentina, Australia, Brazil, Canada, New Zealand, Thailand and the US) account for about 55% of total food net exports.

On a more-positive note, the prominence of the challenges noted above in recent years, has motivated more action from policymakers. The first ever UN Food Systems Summit (2021) saw more than 150 countries make commitments to transform their food systems. The follow up, in 2023, saw the Secretary-General's Call to Action, urging greater investment and leadership. But, implementing the necessary changes is still a complex and longer-term challenge.

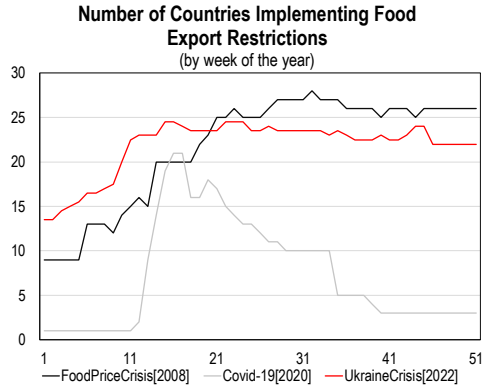
A challenge for policymakers

How to set policy on food?

Local policymakers are confronted with difficult choices in a world of high food prices. One option, though politically unfavourable, is simply to allow domestic prices to adjust to world food price changes, exposing domestic consumers and producers to changes in their real incomes. Alternatively, governments can spare consumers or producers from these losses by reducing the transmission of international food price shocks to domestic markets.

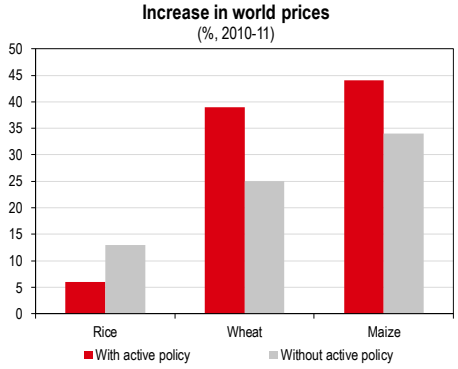
A range of policy interventions, impacting the trade of agricultural commodities, has been introduced, now covering more calories (as a percentage of global trade) than in the 2008 crisis (Chart 52). These policies could exacerbate the high prices, as work from the World Bank has shown is the case in previous crisis.

52. A large share of globally traded calories are impacted by restrictions…



Source: IFPRI

53. … and restrictions tend to place upwards pressure on prices



Source: World Bank; HSBC

Note: Estimates based on an error correction model described in Laborde, D., C. Lakatos, and W. Martin., 2019, "Poverty Impact of Food Price Shocks and Policies", Based on data for 82 countries, of which 26 are advanced economies, 44 are non-LIC EMDEs, and 12 are LICs for the period 2010-2011.

With supply concerns and high prices, a number of countries have introduced policies affecting food commodities. Although, according to the World Bank (Commodity Markets Outlook 2022), the trade restrictions imposed so far are not nearly as extensive as they were during the 2007-08 and 2011-12 commodity price spikes, they are likely to place further upwards pressure on prices at the margin.

For instance, during the 2007-08 food price spike, close to three-quarters of EMDEs undertook policy actions to insulate their economies from the sharp increase in international food prices, especially for rice. Similar policy actions were undertaken during the spike of 2010-11 (Implications of Domestic Price Insulation for Global Food Price Behavior, Ivanic, M., and W. Martin. 2014). Several studies have shown that the use of such trade policy interventions compounded the volatility of world prices (World Bank. 2019. Commodity Markets Outlook Report: Food Price Shocks: Channels and Implications).

Could policy also focus on promoting food production?

Given the enormous challenges that are present in terms of generating enough food, we could see more of a focus on policies to support food production. In some economies, agriculture is already a key part of the economy, but with a growing need for more home-produced foods, we may see more policies implemented.

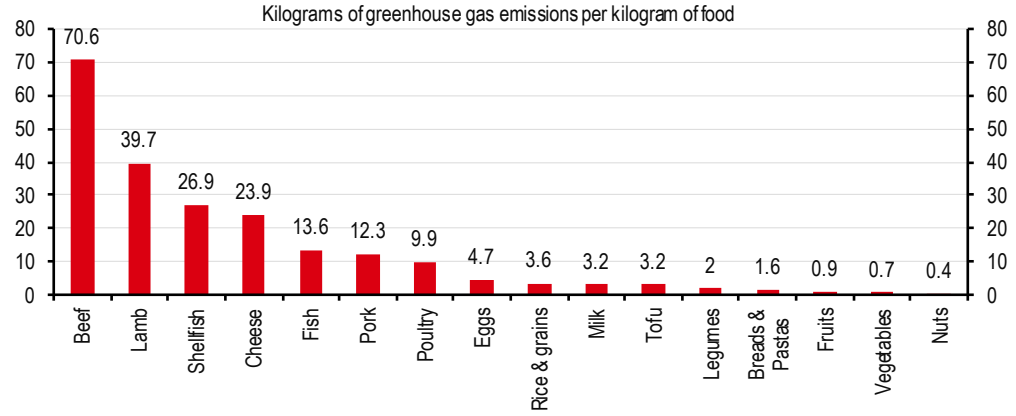
The FAO suggests that countries are starting to think more about how to control domestic food prices and supply, such as stock building, export restrictions, import barriers and increasing subsidies for producers and consumers, but putting these into force is often either expensive or logistically challenging.

One other move that we may see is a greater leaning towards foods which are better for the planet in terms of carbon emissions. This may involve prioritising more locally-produced food products, organic foods or a greater prevalence of vegan and vegetarian diets. Although 'meat taxes' are possible, and according to some academics, inevitable[69], such policies that restrict dietary choice may prove unpopular. Instead, we may see nudge approaches that encourage dietary changes, or subsidies to make healthier, lower-emission food choices cheaper.

[69] A meat tax is probably inevitable – here's how it could work, Smith School of Enterprise and the environment, 12 August 2022

New Zealand, for instance, while small in its global emission contribution, is a useful example, given the dominance of agriculture in its emissions profile. A variety of mitigation options already exist across the sector such as breeding low-emission animals, using feeds that produce fewer emissions, or the use of methane inhibitors.

54. In the fight against climate change, we could see policy aiming to change dietary habits



Source: UN

Finally, we may have to see more international collaboration, too, particularly when it comes to food poverty. International aid may have to increase, or countries may have to work much more closely when considering the global food situation. Without this, the challenges for global food supply may be even greater.

In summary…

All in all, the future of food is highly uncertain. Demand will rise, potentially enormously in the years to come. The challenge is going to be firstly making sure we have enough food, and then that it can get to all. The first part of that challenge depends on the trade-off between climate change and technology – if technological solutions can increase yields enough to compensate for land being unusable or unreliable due to climate change, then globally we should be able to get enough food. And then, beyond that, we need to make sure that food can get from where it's produced to where it's consumed. This may need more trade in food – and means that the geopolitical situation is likely to play an important role. Overall, getting enough food for all is possible – it's just unlikely to be an easy ride.

Disclosure appendix

The following analyst(s), who is(are) primarily responsible for this document, certifies(y) that the opinion(s), views or forecasts expressed herein accurately reflect their personal view(s) and that no part of their compensation was, is or will be directly or indirectly related to the specific recommendation(s) or views contained in this research report: James Pomeroy, Davey Jose, Amy Tyler, Paul Bloxham, Jamie Culling, Maitreyi Das, Frank Lee, Mark McDonald, Shiva Joon and Henry Ward

This document has been issued by the Research Department of HSBC.

HSBC and its affiliates will from time to time sell to and buy from customers the securities/instruments, both equity and debt (including derivatives) of companies covered in HSBC Research on a principal or agency basis or act as a market maker or liquidity provider in the securities/instruments mentioned in this report.

Analysts, economists, and strategists are paid in part by reference to the profitability of HSBC which includes investment banking, sales & trading, and principal trading revenues.

Whether, or in what time frame, an update of this analysis will be published is not determined in advance.

For disclosures in respect of any company mentioned in this report, please see the most recently published report on that company available at *www.hsbcnet.com/research*.

Additional disclosures

1 This report is dated as at 12 November 2023.

2 All market data included in this report are dated as at close 03 November 2023, unless a different date and/or a specific time of day is indicated in the report.

3 HSBC has procedures in place to identify and manage any potential conflicts of interest that arise in connection with its Research business. HSBC's analysts and its other staff who are involved in the preparation and dissemination of Research operate and have a management reporting line independent of HSBC's Investment Banking business. Information Barrier procedures are in place between the Investment Banking, Principal Trading, and Research businesses to ensure that any confidential and/or price sensitive information is handled in an appropriate manner.

4 You are not permitted to use, for reference, any data in this document for the purpose of (i) determining the interest payable, or other sums due, under loan agreements or under other financial contracts or instruments, (ii) determining the price at which a financial instrument may be bought or sold or traded or redeemed, or the value of a financial instrument, and/or (iii) measuring the performance of a financial instrument or of an investment fund.

Disclaimer

Issuer of report
HSBC Bank plc

This document has been issued by HSBC Bank plc, which has based this document on information obtained from sources it believes to be reliable but which it has not independently verified. Neither HSBC Bank plc nor any member of its group companies ("HSBC") make any guarantee, representation or warranty nor accept any responsibility or liability as to the accuracy or completeness of this document and is not responsible for errors of transmission of factual or analytical data, nor is HSBC liable for damages arising out of any person's reliance on this information. The information and opinions contained within the report are based upon publicly available information at the time of publication, represent the present judgment of HSBC and are subject to change without notice.

This document is not and should not be construed as an offer to sell or solicitation of an offer to purchase or subscribe for any investment or other investment products mentioned in it and/or to participate in any trading strategy. It does not constitute a prospectus or other offering document. Information in this document is general and should not be construed as personal advice, given it has been prepared without taking account of the objectives, financial situation or needs of any particular investor. Accordingly, investors should, before acting on it, consider the appropriateness of the information, having regard to their objectives, financial situation and needs. If necessary, seek professional investment and tax advice.

The decision and responsibility on whether or not to purchase, subscribe or sell (as applicable) must be taken by the investor. In no event will any member of the HSBC group be liable to the recipient for any direct or indirect or any other damages of any kind arising from or in connection with reliance on any information and materials herein.

Past performance is not necessarily a guide to future performance. The value of any investment or income may go down as well as up and you may not get back the full amount invested. Where an investment is denominated in a currency other than the local currency of the recipient of the research report, changes in the exchange rates may have an adverse effect on the value, price or income of that investment. In case of investments for which there is no recognised market it may be difficult for investors to sell their investments or to obtain reliable information about its value or the extent of the risk to which it is exposed. Some of the statements contained in this document may be considered forward looking statements which provide current expectations or forecasts of future events. Such forward looking statements are not guarantees of future performance or events and involve risks and uncertainties. Actual results may differ materially from those described in such forward-looking statements as a result of various factors.

This document is for information purposes only and may not be redistributed or passed on, directly or indirectly, to any other person, in whole or in part, for any purpose. The distribution of this document in other jurisdictions may be restricted by law, and persons into whose possession this document comes should inform themselves about, and observe, any such restrictions. By accepting this report, you agree to be bound by the foregoing instructions. If this report is received by a customer of an affiliate of HSBC, its provision to the recipient is subject to the terms of business in place between the recipient and such affiliate. The document is intended to be distributed in its entirety. Unless governing law permits otherwise, you must contact a HSBC Group member in your home jurisdiction if you wish to use HSBC Group services in effecting a transaction in any investment mentioned in this document.

Certain investment products mentioned in this document may not be eligible for sale in some states or countries, and they may not be suitable for all types of investors. Investors should consult with their HSBC representative regarding the suitability of the investment products mentioned in this document.

HSBC and/or its officers, directors and employees may have positions in any securities in companies mentioned in this document. HSBC may act as market maker or may have assumed an underwriting commitment in the securities of companies discussed in this document (or in related investments), may sell or buy securities and may also perform or seek to perform investment banking or underwriting services for or relating to those companies and may also be represented on the supervisory board or any other committee of those companies.

From time to time research analysts conduct site visits of covered issuers. HSBC policies prohibit research analysts from accepting payment or reimbursement for travel expenses from the issuer for such visits.

HSBC Bank plc is registered in England No 14259, is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority and is a member of the London Stock Exchange. (070905)

[1224386]