

Can we feed the world without wrecking the environment?

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Abstract

It is now over 200 years since Malthus pessimistically predicted demand for food would inevitably outpace our capacity to produce it. Over these two centuries the goal of feeding the world sustainably has seemed elusive and even receding as we understand the threats posed by global warming and other types of environmental challenge that John Beddington so memorably called the 'Perfect Storm'. But there are grounds for hope. Population growth rates are decelerating as more countries go through the demographic transition. We can now imagine a future where humanity's demands of the Earth plateau or even decrease. But at that plateau there will be billions more people needing to be fed than exist today. This talk argues that it is possible to feed this number of people without despoiling the environment, but only if we make hard decisions today. We require a new revolution in agriculture, of the same magnitude as the Industrial and Green Revolutions, that not only boosts productivity but also radically improves resource-use efficiency and sustainability. We need to reduce waste across the food system. We need to make hard decisions about diets and consumption patterns. And we need to accept globalisation and refashion a globalised food system that provides public as well as private benefits. These ambitious goals are attainable – it's 'game on' – but only if we understand the risks and the challenges and build the political will to act.

Malthus, famously, at the end of the 18th century wrote in his essay on populations about the inevitability at some time, as he saw it, of population outgrowing food supply. Malthus predicted that during the early decades of the 19th century there would be widespread famine. That famine did not happen, because of the Industrial Revolution, which was a technological and a social and economic advance, also associated with new methods of rural production, sometimes called an agricultural revolution.

The next wave of Malthusian pessimism was in the 1960s and 1970s, associated with movements such as 'Limits to Growth', 'the Club of Rome', and Paul Ehrlich's very influential book *The Population Bomb*. Rereading that recently, with modern eyes, I found it an extraordinary book in its pessimism that democracy would disappear in Europe by the end of the 20th century. That did not happen either, largely because of the Green Revolution, the advances in the technology around plant genetics and food production.

At the moment I think we are going through a third wave of Malthusian pessimism, which my friend John Beddington memorably called the 'Perfect Storm'. It differs from previous episodes of Malthusian pessimism, especially in its global scope.

This paper has been prepared from a transcript and the illustrative slides of the presentation.

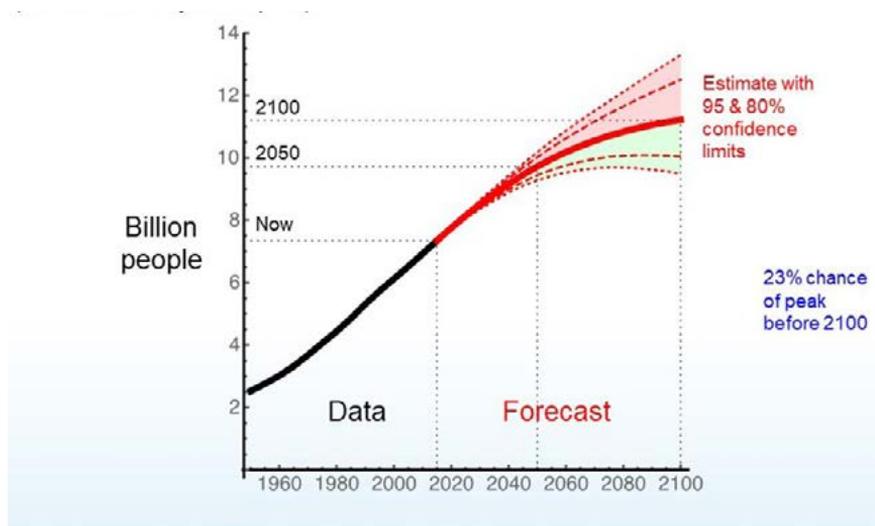


Figure 1. Estimated future population growth assuming medium fecundity.
 Source: *World Population Prospects, 2015 Revision*. UN Population Division.

I like to tell my students that at age 60 I am more positive about the future than when I was in my 20s. That is largely because we know that human population increase can be slowed, if we eliminate poverty, provide access to reproductive healthcare, and educate children – especially girls. It is intellectually possible today to say that there is a counter argument to Malthus which didn't exist when I was a student, 35 years ago.

It will be a challenge to feed a global population of 10 billion or 11 billion (Figure 1), but at least we can conceive of a time when the demands of humanity on the planet to produce food will plateau, or even decrease.

However, the pressures on food supply do not come just from population increases but also from demand for more varied and acceptable food. Figure 2 shows increases in meat consumption up to now, and projected global increase in meat consumption into the future. As people come out of poverty they will demand, understandably, a richer and better diet. These types of diet typically have a greater environmental footprint.

Thus we will face for at least the next 30–40 years the challenge of continuing demand growth. This demand growth will be increasingly urban with the challenge of feeding an increasing number of mega-cities in the global south. Though progress has been made on hunger, numbers are increasing again, largely because of civil strife and low-level wars – new types of conflict that we have not seen before. Progress has not been as fast as hoped on ending micronutrient deficiencies, and we face a rising epidemic of the diseases of over-consumption – the obesity crisis.

There are challenges on the supply side too. Agriculture faces increasing competition for water and land, and from soil degradation due to unsustainable production methods. And we will see an increasing frequency of shocks; some

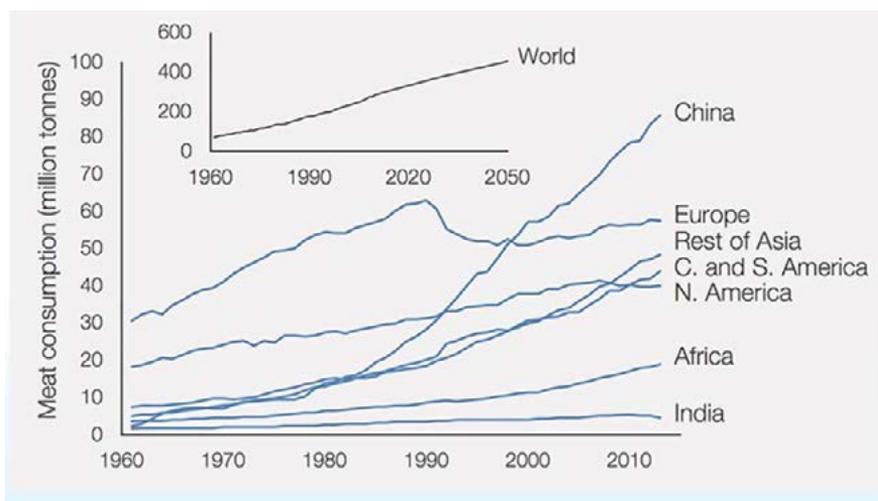


Figure 2. Current regional and projected global meat consumption.
Source: Godfray et al. 2018. Data from www.fao.org/faostat/en/?#data.

associated with climate change and some geopolitically, such as the challenges to global trade systems we are seeing at the moment.

What if we eat healthily?

‘Win–wins’ are often scarce, but healthy eating is one approach that I think offers some genuine ‘win–wins’.

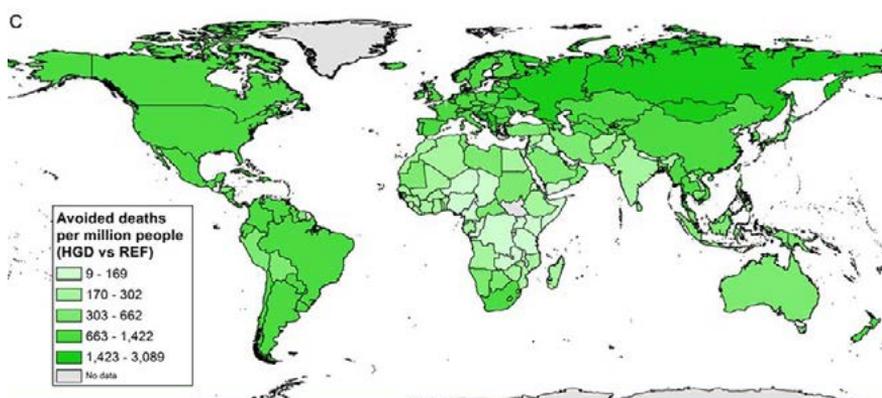
What if we were to assume that by the year 2050 the world’s population will have adopted regionally appropriate diets as recommended by the World Health Organization’s nutrition guidelines? This is a hypothetical question, but useful for exploring the scale of potential gains if the world were to change in this way.

I am part of a team led by Marco Springmann that has modelled this transformation and calculated its effect on the numbers of diet-related deaths and on greenhouse gas emissions, and we have begun to explore the associated economics (Springmann et al. 2016).

The first result is that if globally everyone were to transition to healthy diets by 2050, there would be 5.1 million fewer avoidable deaths per year (Figure 3, top). On the map the darker colours are where there are more avoided deaths per capita. There tend to be more in high-income countries reflecting the fact that today many diet-related diseases are problems of over-nutrition – of being overweight or obese.

As well as the clear global health advantage of switching diets, Figure 3 shows a significant environmental benefit in reduced greenhouse gas (GHG) emissions. On our current path we expect GHG emissions from the food system to increase by about 50% by mid-century, but in our hypothetical dietary shift for purely health reasons, the associated food-system emissions would increase by only 7%. We need to do much better than this but it shows the potential there is, just through dietary change, for helping maintain this planet within stable climate limits.

Compared to FAO diet predictions, adoption of a diet meeting nutritional guidelines would in 2050 result in 5.1M avoided deaths per year



Adoption of a diet meeting nutritional guidelines would in 2050 reduce the increase in food-system associated GHG emissions from 51% to 7%

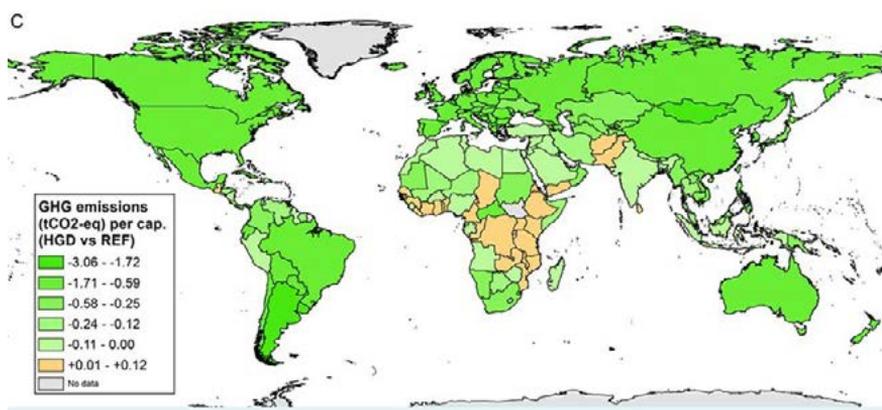


Figure 3. Global healthy eating effects (modelled and calculated) on deaths (top map) and greenhouse gas emissions (lower map).

We also found economic benefit during our analyses. Part of that came from the significant direct benefits of fewer diet-related deaths, in term of healthcare costs and time off work. Overall, hypothetically, there is a clear argument for multiple wins (health, climatic, economic) from healthy eating.

Can we feed the world within planetary boundaries?

Marco Springmann, at Oxford, has also led a team examining options for keeping the global food system within planetary boundaries (Springmann et al. 2018). What sets of solutions maintain a safe operating space, and what does that space look like? What are the contributions of different types of agriculture

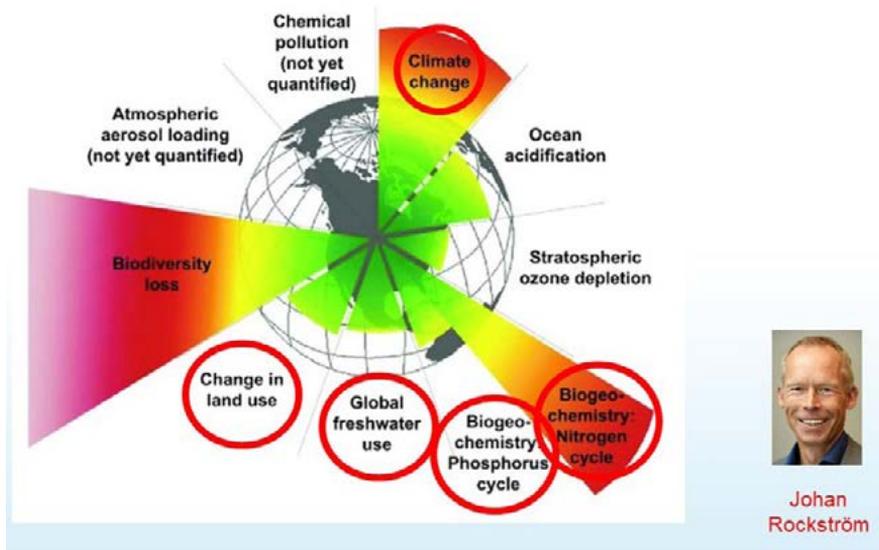


Figure 4. Planetary boundaries.

to breaching these planetary boundaries and what might be possible to do about that?

Planetary boundaries (red circles in Figure 4) were proposed by a team led by Johan Rockström, now at Potsdam, and Will Steffen (ANU). They are notional safe limits, safe boundaries, that would prevent really serious environmental catastrophes in the future. The Springmann team looked at the threats to the climate change boundary (represented by extent of GHG emissions) from various types of agricultural production: staple crops, legumes, and animal products. For GHG emissions using 2010 data, animal products contributed the greatest threat or pressure, with staple crops coming second (Figure 5).

We then repeated that analysis for all five planetary boundaries using the most recent available data (for 2010) and projecting for the year 2050. Figure 6 shows the sectors of agriculture that are having the greatest effect on each boundary.

The analysis also shows tensions. The green bar represents fruit and vegetable production. Eating more fruit and vegetables is good for health but is the second largest pressure (after staple crops) on freshwater use.

Can we lessen the effects of food production on planetary boundaries?

Can we help reduce the environmental impacts through increased investment in technology such as agronomic practice, and food processing research; or through increased investment in preventing food-loss and waste; or through diets or through socio-economic measures? We tested this using econometric analysis and Figure 7 shows again the large potential to reduce GHG emissions through dietary change (FLX stands for 'flexitarian'). For the other planetary boundaries, most opportunities come from a combination of investment in technology and waste/food-loss management, as well as changing diets.

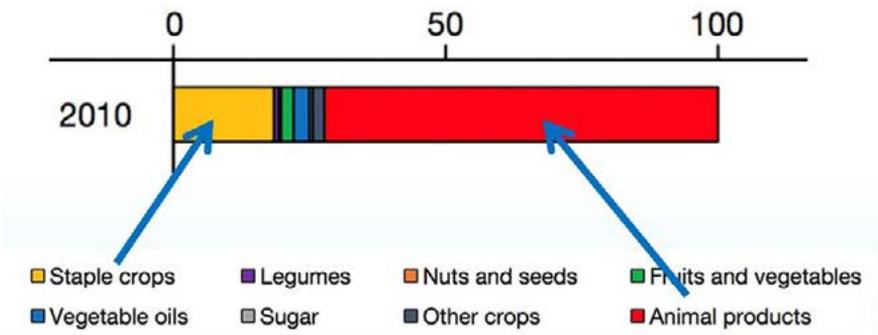


Figure 5. Percentage contributions of different sectors to total agricultural greenhouse gas emissions.

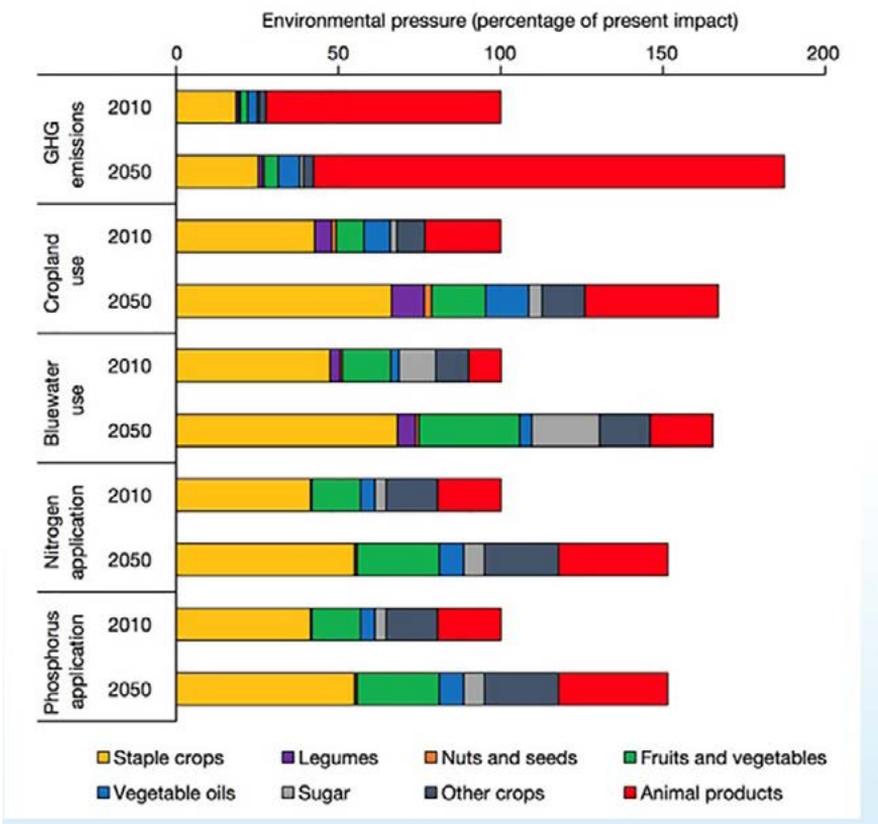


Figure 6. Comparison of environmental pressure on planetary boundaries (as a percentage of present impact) contributed by various agricultural sectors: data from 2010 and modelled for 2050.

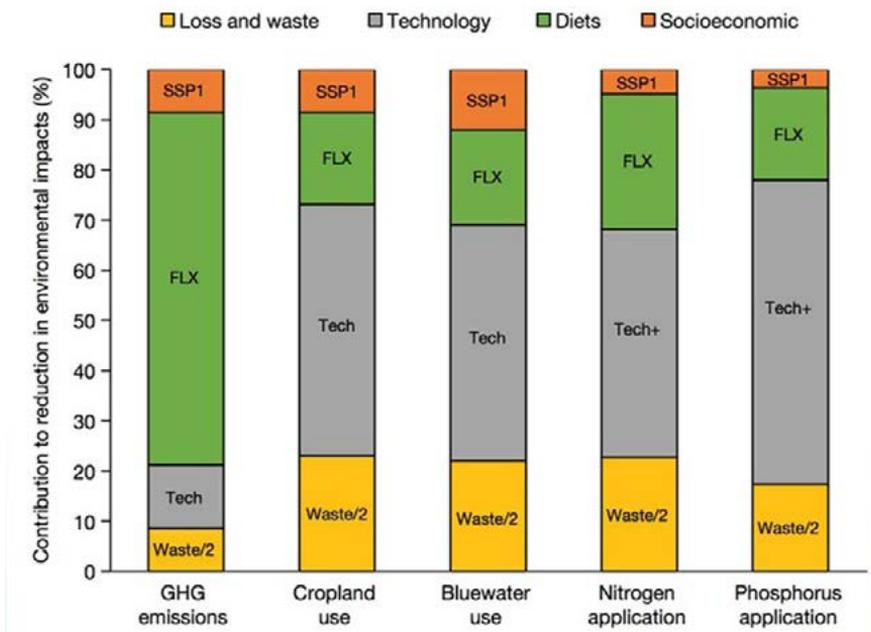


Figure 7. Potential avenues (dietary, technological, waste/loss management, socioeconomic) for reducing the environmental impacts of food production on planetary boundaries.

Near-term governance challenges

There are some near-term challenges I find particularly worrying.

Figure 8 shows the percentage income spent on food for a selection of countries. In low-income countries such as Cameroon, Belarus, Egypt, a major part of family income is still spent on food. For countries such as UK and USA, families typically spend about 10% of their income on food.

More and more people are living in cities. Over half the world's population lives in a city and many of the fastest-growing cities are in sub-Saharan Africa, India, China and SE Asia, and South America (Figure 9). I do not think this fact gets sufficient policy attention. Figure 10 shows developing-country cereal trade: the amounts that the sector exports are dwarfed by the amounts of imports. Feeding the urban mega-cities of the global south requires a well-functioning global commodity sector that can transfer food from countries with a surplus to those with a deficit. If we get this wrong then we will see movements of people and forced migration that will dwarf what we have seen recently with huge humanitarian consequences.

Global commodity markets are largely run by the private sector, and may have the flexibility and adaptability to cope with future shocks. But I think they need stress-testing – we thought we had a very well-functioning global banking system in the years up to 2008 and now rue the fact we had failed to do insufficient stress-testing. This call shouldn't be seen as criticism of the major

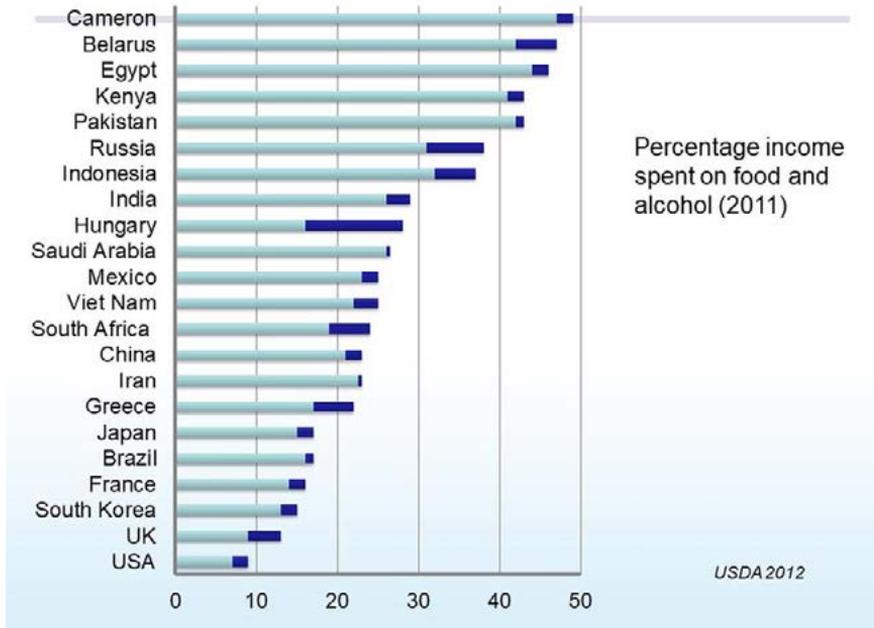


Figure 8. Greatly varying family-expenditures on food. Source: USDA 2012.

companies that run the trade in global food, but as a plea to build resilience into global food systems.

I began by saying how first the Industrial and then the Green Revolution brought to an end the first two episodes of what I have called Malthusian pessimism. I think we now need a new revolution. I very much like the narrative of my friend Sir Gordon Conway, of Imperial College London, who has argued for a Double Green Revolution: yes, increasing productivity, but also increasing the efficiency of resource input use and dramatically reducing the environmental footprint of

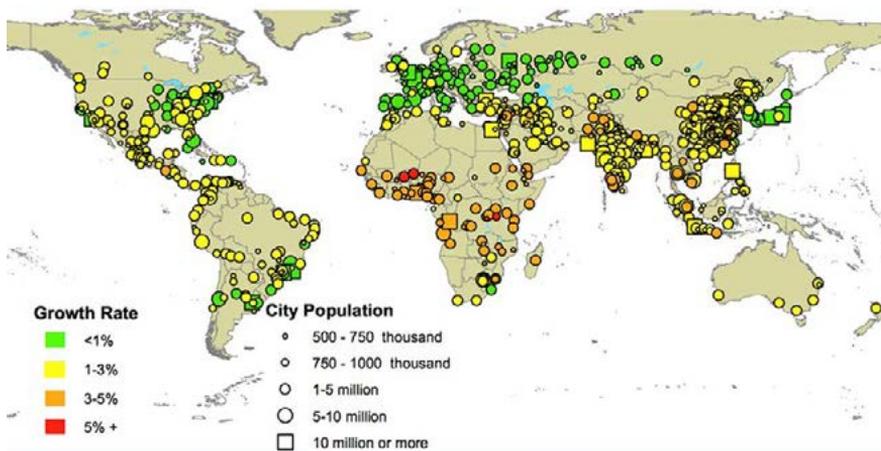


Figure 9. Distribution of large global cities and their growth rates. Source: *World Urbanisation Prospects*. UN Population Division.

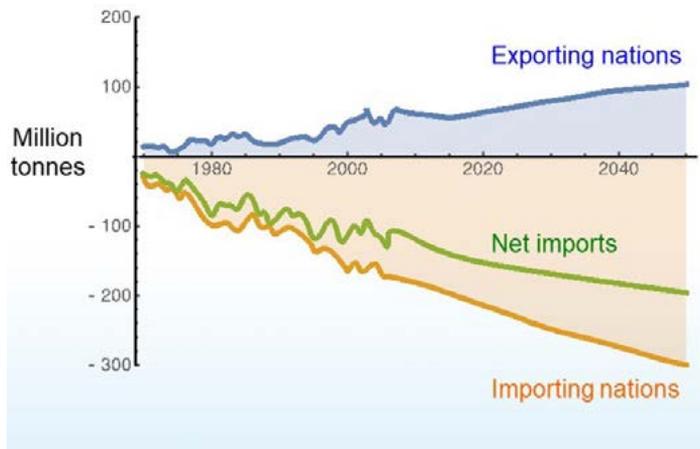


Figure 10. Cereal trade in developing countries: imports and exports.
Source: FAO (Alexandratos & Bruinsma 2012, Figure 1.5).

food production. And unlike the Industrial Revolution and the Green Revolution, this revolution also requires radical changes on the demand-side of the food system, the way we invest and retail food, and the diets we choose to eat.

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Charles Godfray is a population biologist with broad interests in science and the interplay of science and policy. He has spent his career at the University of Oxford and Imperial College and is currently Director of the Oxford Martin School and Professor of Population Biology at Oxford. His research has involved experimental and theoretical studies in population and community ecology, epidemiology and evolutionary biology. He is particularly interested in food security and chaired the UK Government Office of Science’s Foresight project on the Future of Food and Farming and is currently chair of the UK’s agricultural and environment (DEFRA) ministry’s Science Advisory Council.