FEEDING A TEEMING PLANET
Global population growth, food security and future farming

2

The broad sweep of history

What are the trends in population growth – past, present and future – and how do these interact with agricultural production and food security? What factors influence these trends?

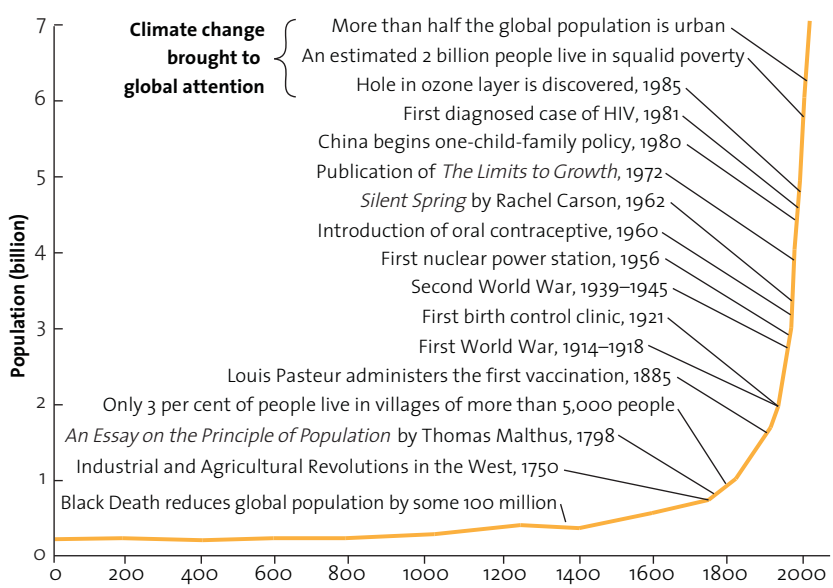
The broad picture shows a world population of between 1 million and 10 million people at the dawn of agriculture some 10,000–15,000 years ago, growing to 300 million about 2,000 years ago (Figure 2.1), thence doubling to 600 million in the early part of the 17th century. As the 20th century opened, the total had reached 1.5 billion, climbing rapidly to today's 7 billion or thereabouts.

A key take-off point (Figure 2.2) came in around 1950 when the curve turned dramatically upwards as less developed regions began to enjoy marked reductions in death rates: within 50 years there were to be two and a half times as many people on the planet.

KEY THEMES

- Past, present and future links between population and production.
- Measuring hunger.
- Constraints on agricultural output.
- Production improvement strategies.

Figure 2.1 Global human population growth over the last 2,000 years

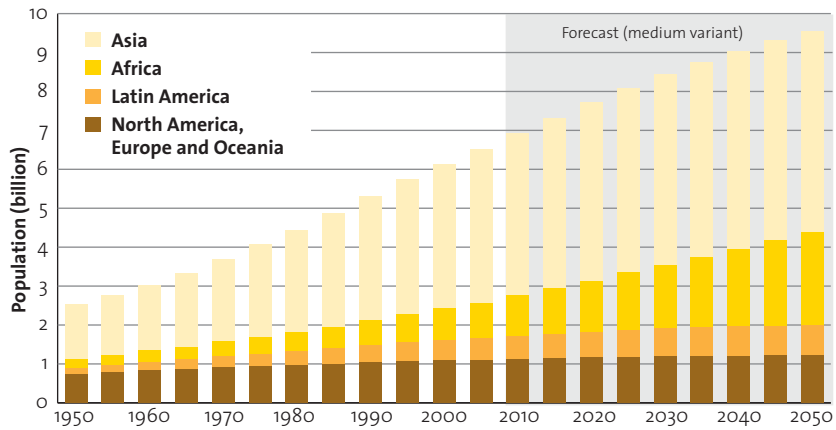


The plague that swept along the Silk Route and reached its peak in Europe in the mid-14th century, killing some 30–60 per cent of the region's population, was the last major event to cause a drop in global human numbers. No further population checks have affected the upward trend of the graph.

Source: Wordpress, 2011

While the population of Europe, North America and Oceania is expected to remain largely stable, significant growth is forecast for both Africa and Asia.

Figure 2.2 Population growth by region, 1950–2050



Source: UN Department of Economic and Social Affairs Population Division

The rapid uplift in the population after 1950 was, in many countries, accompanied by a corresponding increase in agricultural production, with more land being given over to crops which, themselves, were being improved through better farming practices and genetic enhancement. The Food and Agriculture Organization of the United Nations (FAO) recorded a rise in production of around 150 per cent over the last five decades.

Not all regions enjoyed such increases, though. While China and India saw grain production surging upwards – not only in terms of total production but also per head of their populations, particularly so in China – no such progress occurred elsewhere, notably Sub-Saharan Africa.

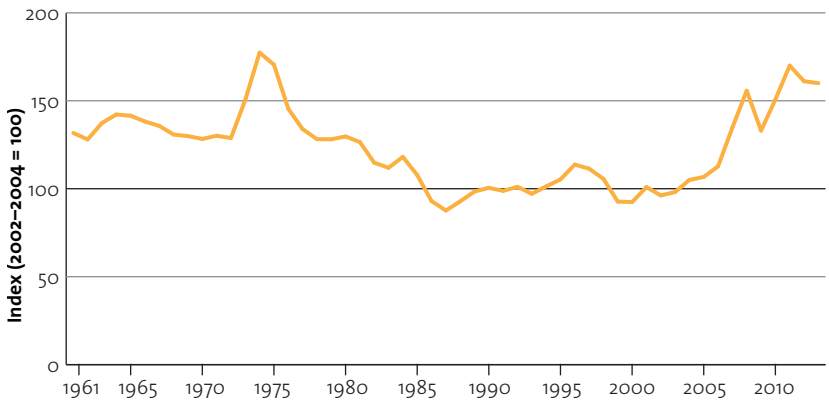
The Global Hunger Index

The unequal distribution of improvements in agricultural production means that, today, three-quarters of the world's population live in the developing world where poverty is concentrated: 1 billion people have to live on less than US$ 2 a day, some 827 million of whom are hungry. In fact, every hour of every day, more than 1,000 people die from hunger-related causes.

What do we mean by hunger? The best-known measure is the Global Hunger Index (GHI), which combines three equally weighted indicators:

- undernourishment – that is, insufficient calorie intake to meet dietary energy requirements;

Figure 2.3 Food Price Index, 1961–2013



Source: FAO

Recent spikes in world food prices highlighted the vulnerability of those living with food insecurity.

- underweight – low weight for age, wasting and stunted growth in children under five years;
- child mortality – death rates in children under five, reflecting inadequate diet in terms of both calories and micronutrients such as vitamins, iron and iodine, and unhealthy living conditions for mothers and children.

Although the GHI shows some recent progress in reducing hunger, the number of hungry people remains high. One factor contributing to this is the volatility and sudden rapid surges – spikes – of global food prices (Figure 2.3).

Population in the 22nd century

Looking to the long term, the United Nations Department of Economic and Social Affairs foresees a global population of around 9 billion in 2050, veering to anything between the current 7 billion and more than 25 billion by 2100, depending on fertility rates – the numbers of children born per woman of reproductive age. Figure 2.4 shows the link between projected fertility rates and population size in the decades ahead.

The role of urbanisation

In 2010, the numbers of people living in towns and cities across the world overtook those in the countryside for the first time in history. This dramatic shift has been speeding up over the past 40 years, partly due to agricultural mechanisation, with the result that the proportion of people employed in agriculture has fallen severely, despite the overall growth in population.

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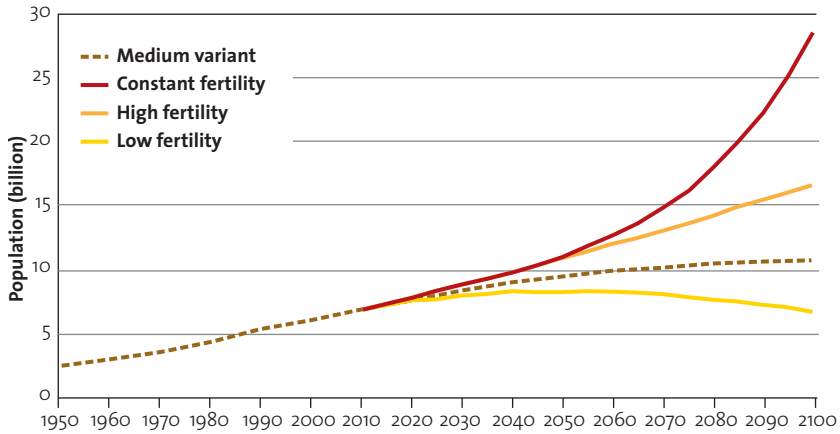
The United Nations projects a world population of 9.3 billion in 2050, a 27.5 per cent increase from today. Forecasts for 2100 vary widely, from 7 billion to more than 25 billion.

Figure 2.4 Projected world population based on variable fertility rates



Source: UN Department of Economic and Social Affairs Population Division

Currently, about 3.2 billion of us are urban and require 2.4 billion tonnes of food each year. In addition, an important consequence of economic development and urbanisation is that consumption patterns change towards higher-value foods: sugar, vegetable oil and livestock products (dairy, meat and eggs), and fish. As far as livestock products are concerned, milk consumption has almost doubled since the 1960s, meat consumption has tripled and that of eggs has risen fivefold.

Factors that limit agricultural production

Access to appropriate land

This is the most fundamental constraint on production and has, in recent years, been influenced a good deal by various global crises: in finance, the environment, energy and food. This in turn has driven land deals made by a number of Middle Eastern and Asian governments – which are finance-rich and resource-poor – in areas of the world that are resource-rich and finance-poor, such as Africa and South America. These transactions, aimed at securing the future food and energy requirements of one group of countries, but often to the detriment of another, has led to a move by organisations such as the World Bank, the United Nations – including the FAO – and other socially aware bodies to regulate such land deals.

Water

If enough farming land is available, water becomes the next most important limiting factor on output. Some 70 per cent of all water use on the planet is in agriculture. Here, the future is both bright and bleak, depending on which regions we consider.

As a consequence of climate change, water availability – in rivers, lakes, reservoirs and aquifers as well as in soils – is predicted to decline in Africa, the Near and Middle East and northeastern China, which are already water-scarce and experiencing increasing desertification. Australia and most countries in the Americas, however, are forecast to have enough water to generate the calories needed by their populations. Understandably, regional conflicts and increased economic and environmental migration are also predicted as these disparities in access to water become more acute and obvious.

Climate change

Global warming and the related phenomenon of increased carbon dioxide (CO_2) levels and other greenhouse gases in the atmosphere – such as methane from agriculture – will have a number of effects on agriculture: some problematic, some not.

For example, 95 per cent of all plant species are so-called C3 plants (relating to how they fix carbon during photosynthesis), and these will probably enjoy increased yields. On the other hand, some specific crops such as wheat and rice will be adversely affected by the forecast temperature rises of 1–3 °C and will give lower yields. Another impact with potentially negative consequences will be a proliferation of soil-borne pathogen populations in warmer weather.

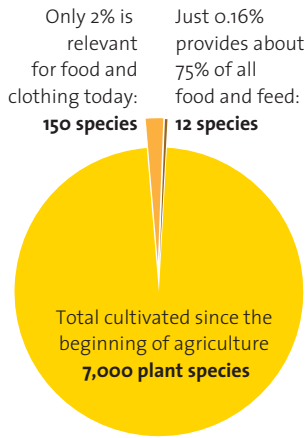
Strategies for enhancing production

Novel crops

Historically, agricultural development has turned on increasing the output of a relatively small number of crops, particularly cereals. This has undoubtedly been beneficial, saving countless lives in Asia, for example, during the Green Revolution of the 20th century. However, some experts argue that there has been too much emphasis on grain production at the expense of valuable but underused crops such as nutrient-rich pulses, fruits and vegetables. The Crops for the Future initiative is an attempt to redress this imbalance by giving underused crops their own organisation to drive research and development.

It is a sobering thought that, today, just 12 species of plant – barley, maize, millet, rice, rye, sorghum, sugarcane and wheat, all from the grass family, and the tubers cassava, potato, sweet potato and yam – provide around three-quarters of global food (Figure 2.5). Yet our planet supports no fewer than 7,000 partly domesticated edible species and an estimated 30,000–75,000 wild species that could also provide us with food.

Figure 2.5 Plants under cultivation



There are genetically modified varieties of a number of important human food crops, but few have been commercialised.

Table 2.1 Twelve crops that feed the world, 2012

	Annual production Million tonnes	Yield Tonnes per hectare	GM status	Commercial GM product
Sugarcane	1,832.54	70.24	Yes	No
Maize	872.07	4.92	Yes	Yes
Rice	719.74	4.41	Yes	Yes(?)
Wheat	670.88	3.11	Yes	No
Potato	364.81	19.00	Yes	No
Cassava	262.59	12.88	Yes	No
Barley	132.89	2.68	?	No
Sweet potato	103.15	12.75	Yes	No
Yam	58.75	11.66	Yes	No
Sorghum	57.00	1.49	Yes	No
Millet	29.87	0.94	?	No
Rye	14.56	2.62	?	No

Data source: FAOSTAT

Trade and research

World trade and support for fundamental and applied research are also important influences on agricultural production. Mathematical modelling suggests that increased liberalisation of trade could lower food production costs across the world by as much as 10 per cent, as well as reduce food scarcity. Investment in agricultural research and development (R&D) would also be highly beneficial, particularly as R&D expenditure in many countries has tended to decline or stagnate in recent decades, reducing growth in agricultural production. Many – if not most – experts recommend a global expansion in R&D investment, with more support for national research programmes. This would be of particular benefit to food security where land degradation, water scarcity and climate change are serious obstacles.

New genetics has been applied to some orphan crops – including cowpea and cassava – to help address food security and nutrition, and should be applied to others, but progress in Africa is hindered by lack of public acceptance and an unfavourable policy and regulatory climate.

The role of biotechnology

Biotechnology opens up many avenues for crop improvement, both in enhancing plants' responses to their environment and in improving their inbuilt genetic and physiological potential. Yields can be driven up, for example, by increased insect resistance or by modifying a crop's internal processes, as has been illustrated before in this section.

But there is a potential problem here. In North and South America, genetically modified (GM) crops with improved traits such as insect resistance have been extensively cultivated. Other countries, however, have objected to their use

because they fear that they would be unable to export their crops to Europe where the cultivation of GM crops has encountered considerable public and government opposition.

Whatever the benefits of the new genetic technologies, then, there has to be a favourable policy and regulatory climate, as well as broad public acceptance, if they are to be realised.

Incentives for farmers

Growers already have considerable knowledge and skills that can help increase crop yields in an environmentally sustainable manner. But they need encouragement to adopt best practices through incentives, especially economic ones. For example, they have at their disposal a variety of methods for improving environmental sustainability, such as increasing the nitrogen efficiency of their crop and livestock production systems or reducing methane emissions. And they could readily sequester more carbon on their farmland by improving soil management. But it has to be worth their while to do what is necessary to achieve this. Farmers need help from the public sector to exploit the most effective combinations of traditional and innovative methods if they are to rise to the challenge.

Food uses up a much smaller proportion of household incomes in developed countries than in those still developing – representing about 10 per cent of take-home pay in the USA and Europe versus 80–100 per cent in some developing countries.