INTRODUCTION

FOOD PRODUCTION AND SECURITY – CHALLENGES AND SOLUTIONS

To meet the needs of the world's ever growing population, food output will have to increase by 70–100 per cent in the coming decades.

A worryingly rapid game of leapfrog is taking place on a global scale. The world's population, currently more than 7 billion, is predicted to reach 9 billion by 2050. Already, one in every eight people on our planet goes to bed hungry. So, in order to close this pressing resource gap, food output will have to increase in the coming decades by at least 70–100 per cent. How can production keep pace with this tug of war between supply and demand?

There is no simple answer, as analysts ranging from Thomas Malthus in 1798 with *An Essay on the Principle of Population* to Paul Ehrlich with *The Population Bomb* in 1968 have amply demonstrated. The much-discussed 1972 book *The Limits to Growth*, commissioned by the Club of Rome, used computer modelling to explore the tension between unchecked population growth and the capacity for technology to increase the availability of resources, which is relatively limited.

A complex problem

Clearly, improved crop technologies and farming practices are crucial to securing adequate food production. But it is not simply a matter of encouraging or empowering farmers to generate more calories from their land. Other considerations come into play alongside simple yield.

Aspects of sustainability including greenhouse gas emissions, soil erosion, water availability and depletion together with deleterious impacts on other aspects of the Earth system, especially biodiversity, all have to be taken into account when computing the arithmetic of supply and demand. And, of course, any new technologies must deliver a discernible benefit to the farmer: without prospects for improvement there can be no investment in sustainability.

A further complication is the geographical location of the growing population. Eighty per cent of the increase to 9 billion people in 2050 will take place in the developing and transition countries of China, India, Africa, Southeast Asia and South America, with the majority living in cities. The next 40 years will see the population of Africa double, placing immense strains on arable land, so that each hectare will need to feed five people compared to just two in 1960.

Looking long term

In the face of climate change through fossil-fuel use and the intensification of agriculture, which further drives up greenhouse gas emissions and atmospheric carbon dioxide (CO_2) levels, food producers will be hard-pressed to keep abreast of their targets. Water availability is expected to decline and pests and pathogens to increase, with an impact on both food production and post-harvest losses, but urbanisation will pursue its course and dietary requirements will continue to rise, with a concomitant demand for meat.

Today, all these factors can, more or less, be coped with, particularly if efforts are made to reduce food waste on both the supply and the demand sides of the equation. Existing food stocks are also adequate to respond to the acute hunger associated with civil unrest or adverse climatic influences. In the long term, however, these chronic problems will need to be overcome by measures designed to promote so-called sustainable intensification. This means growing more from less in order both to meet current needs and to improve the ability of future generations to meet their own dietary requirements while looking after the planet on which they live.

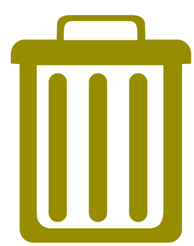
Revolutionary science

A crucial factor in meeting these goals will undoubtedly lie in maintaining what has been a genuine revolution in plant science. Humankind has been breeding crops for about 10,000 years by selecting seeds or cuttings from plants with desirable characteristics. More recently, scientists have accumulated an ever deepening understanding of the information encoded within the genes of plants, as well as those of the pests and pathogens that attack them.

We have entered the era of "-omics" technologies – such as genomics (the study of genomes) and proteomics (the study of proteins) – which are revealing the intricacies of genetic structures and their relationship with how plants function. Researchers are drawing on bioinformatics and computer modelling to integrate this knowledge, supported by the use of appropriate chemicals and farming practices.

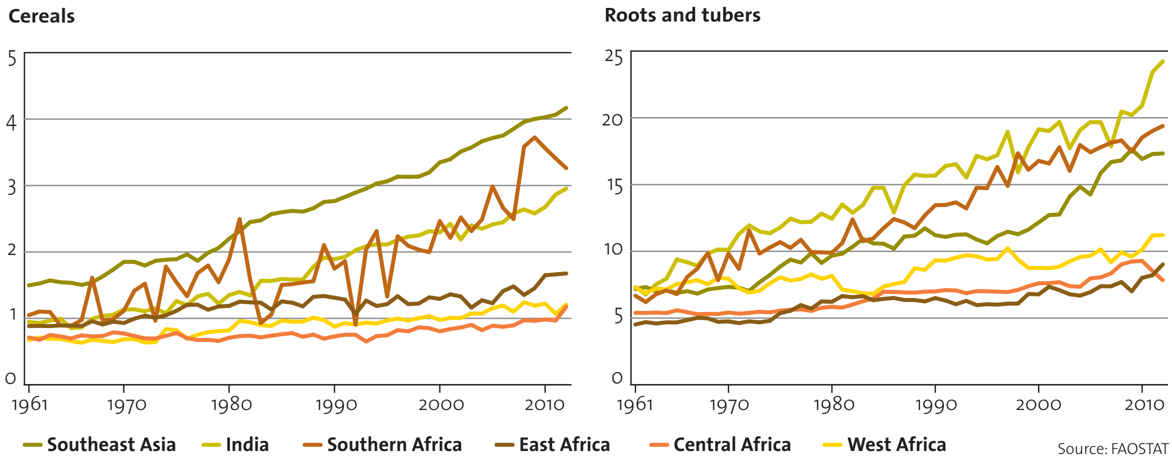
We now have an unprecedented ability to produce more robust and productive crops, either through sophisticated molecular breeding methods based on our new powers of observation and selection, or by directly and specifically changing a plant's genetic composition and function.

Around 1.3 billion tonnes of food, about a third of all production, is wasted every year – at a cost of US$ 750 billion.



Crop yields in selected regions, 1961–2012

Tonnes per hectare



Southern Africa was the only part of the continent to enjoy the benefits of the Green Revolution during the second half of the 20th century.

Through all these techniques and technologies we can be reasonably confident of meeting the food production challenge. That, at least, is the hope, provided that a number of other important components fall into place. What are these?

Policy matters

Science and technological innovation cannot operate in a vacuum. Their implementation takes us into tricky areas of policy. Take Africa, where the population is expected to double, from 1 billion to 2 billion, by 2050. Unlike other developing regions such as Asia and Latin America, Africa has failed to enjoy significant uplifts in food security and productivity: indeed, with the exception of Southern Africa, crop yields in Sub-Saharan Africa have largely stood still over the past 50 years or so when compared with the impact of the Green Revolution in India and Southeast Asia.

Expanding production by increasing the land available would be costly in both environmental and economic terms, so the continent is likely to suffer ever more intense pressure to produce more food from the same – or even less – agricultural land. Nor will improved farming technologies – such as irrigation systems or mechanisation – be sufficient to meet such huge demands.

Even in those regions where pressures are fewer than in Africa, and scientific innovations are more likely to make an impact, there are political hurdles to overcome. Genetically modified (GM) foods have been eaten for many years in the USA, yet in Europe they are persistently regarded by many people as unsafe, unnatural and not particularly beneficial. The public remains so sceptical about them that politicians have been reluctant to press their case until recently, in spite of the scientific and economic arguments in their favour. They see no advantage in adopting policies that will attract more votes “against” than “for”.

There is a tangle of social, political, industrial and scientific complexities here that needs to be unravelled if decision makers, within and outside government, are to convert our new knowledge in plant science into widely acceptable practice.

Socio-political, legal and ethical issues

Major technological changes have, throughout history, met with opposition, debate and downright hostility, not necessarily on rational grounds but because they tug firmly at people’s hearts and minds. In truth, scientific and technological innovations can often be judged quite irrationally: historically, there are many examples of this – famously, the 1865 Red Flag Act in England, which stipulated that a person with a red flag had to walk in front of railway engines.

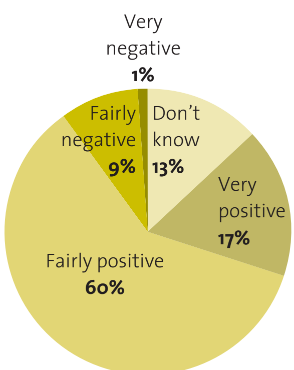
Nonetheless, surveys of public opinion such as the European Commission’s Eurobarometer suggest that, in general, public attitudes to science and its offerings are positive and that scientists are trusted to explain the impacts on society of what they are doing in the laboratory. So far so good. On the other hand, when it comes to the acceptability or otherwise of novel scientific enterprises such as GM foods, it is not a simple cost/benefit equation with perceived advantages being weighed against perceived disadvantages. Viewpoints vary. What may be seen as an advantage to one individual or nation may be regarded as the complete opposite by other people living in quite different circumstances in different parts of the world.

When evaluating GM, in particular, a bewildering number of players have points to make: the environmentalists, the biotechnology – or biotech – sciences and industry, the media, philosophers and ethicists, and economists. Each group has its well-argued position, its passionate advocacy, its prejudices and weaknesses. At no point is it easy to take a black and white stand for or against such subtleties.

One key aim of this book is to present the range of available technologies, the arguments and counterarguments, so that we can all make up our own minds. But this must surely build upon sound evidence-based science.

Public confidence in science and technology

Responses to the question *“Do you think that the overall influence of science and technology on society is positive or negative?”*



Source: European Commission, 2013