

Prospects for feeding the world

Tim Dyson

Department of
Social Policy,
London School of
Economics, London
WC2A 2AE

Tim Dyson
*professor of
population studies*

t.dyson@lse.ac.uk

BMJ 1999;319:988–91

In 1950 the world's population numbered 2.5 billion. In 1999 it is around 6 billion. It will be roughly 8 billion by 2025. And it could reach between 9 and 10 billion by the middle of the coming century. Arguably this is the most important development of our time, with immense implications for the global environment and the prospects for feeding the world.

Methods

This paper addresses the prospects for feeding the world to the year 2025. It builds on the results of a two year research fellowship funded by the UK Economic and Social Research Council.¹ The data used throughout were those provided by the United Nations Food and Agriculture Organisation and the UN Population Fund. As well as analysing statistical data, the research involved talking to technical specialists and farmers throughout the world.

Population and food estimates

In the early 1990s the UN Food and Agriculture Organisation estimated that there were roughly 800 million undernourished people in the world.² Most of these people live in the developing world, mainly in the Indian subcontinent and sub-Saharan Africa. However, the organisation's estimate may be too high. The number was obtained through a tortuous statistical exercise which was loaded with assumptions. Also, an organisation concerned with food production may have a tendency to err on the side of overestimation. Certainly, in the past the organisation changed its criteria for estimating the number of people who were undernourished so that the number was increased.¹

Several considerations are worth noting. One is that obesity is rapidly becoming a problem in parts of the developing world, especially in major cities, where some people eat too much and exercise too little. Amid all the concern about world hunger, this increasingly important fact should not be lost. Also, nutritional status is more than just a matter of food consumption. In particular, with the exception of parts of sub-Saharan Africa, rates of infectious disease are generally thought to be declining throughout much of the developing world because, for example, of increasing immunisation coverage. Such positive developments in health should improve the average nutritional state. However, despite these considerations, it can safely be concluded that there are several hundred million people who do not have enough food to eat.

It is sometimes said that the world's farmers produce enough food for everyone and that the problem of hunger is mainly one of distribution. It is also said that the problem is largely one of poverty—that is, the hundreds of millions of people who do not have enough food have insufficient "purchasing power" or "food entitlements." Although true, these remarks are also potentially misleading. It is unrealistic to suggest that people in the developed world should eat less so that poorer people in the developing world will have

Summary points

Population growth is the most important factor fuelling the global demand for more food to be produced

The population of sub-Saharan Africa probably faces the grimmest prospects for receiving adequate nutrition

The world trade in cereals must increase substantially to meet projected increases in demand

The pace of increase in cereal yields is continuing with no signs of a slowdown

The outlook for feeding the world would be improved if the growth in population decreased

adequate food. It is fanciful to consider this a practical solution to the problem of world hunger. To say that the problem is one of poverty is to state the obvious.

Such statements are misleading because they distract attention from the central problem of food production. A sizeable proportion of the world's poor are undernourished because they cannot grow enough food. In many, although by no means all, situations people are poor because their crop yields are meagre and their agricultural output is low. Moreover, attributing world hunger to the inadequate distribution of food and to poverty turns attention away from the fact that the world's population is continuously increasing. Population growth will be the most important factor influencing the global increase in food production and forcing the world's farmers to produce more food in the coming years.

What of the future? There are several fairly detailed analyses of world food prospects.^{1–8} The subject is complex and involves many topics, such as land degradation, climate change, water scarcity, fertiliser use, political and economic policies, etc. However, in general terms, these studies all agree that, although there will be significant problems, a global malthusian crisis is unlikely to occur during the next few decades.

Over the next 25 years the largest increase in population will occur on the Indian subcontinent. There will also be considerable demographic growth in sub-Saharan Africa even if the impact of AIDS is considered. Additionally, China's population may rise by over 200 million, and smaller but significant population increases will occur in Latin America and the Middle East.

Prospects

Africa

Food prospects look bleakest for sub-Saharan Africa. Agricultural yields in this region are extremely low and

have changed little during the past 50 years. Sub-Saharan Africa has distinct methods of agricultural production. One unfortunate consequence of this has been that the technical agricultural developments which together constitute the “green revolution” in the developing world have not been of much benefit.

This region’s population will roughly double by 2025. Since the growth in crop yields has been dismal, it seems probable that much of the extra food that will be required will have to come from bringing more land into cultivation, and this will involve environmental damage, such as widespread land degradation and the continued destruction of forests. Since most African countries are extremely poor, they will have difficulty importing sufficient food to cope with the growth in demand that will be generated by the growth in population.

However, it is important not to be overly pessimistic. There are positive trends. Birth rates are dropping in most countries and, even more importantly, there have been positive political developments in recent years, notably—but not exclusively—in South Africa. However, average per capita food consumption in this region may be no better in 2025 than it is today, and it could be worse. Also, because of population growth, there could be a much larger number of undernourished people in 2025. More agricultural research is required to help African farmers. And much more attention is needed to make modern family planning methods accessible to African couples.

Indian subcontinent

The food outlook for the Indian subcontinent is significantly better than in Africa despite the fact that India, Bangladesh, and Pakistan are together projected to experience a net addition of nearly 500 million people during the next 25 years. Several reasons account for the subcontinent’s better prospects. Firstly, the region’s strong vegetarian tradition should moderate any growth in demand for cereals (large quantities of which are required for meat production). Secondly, the quantities of synthetic nitrogen fertilisers used in these countries are still comparatively low, although they are rising. This holds out the prospect that crop yields can be raised by increasing the use of fertilisers. Certainly, crop yields must rise considerably since there is little spare land available for agriculture. Thirdly, the administrative and scientific resources available in these countries are considerable. India has quite a good record of improving the amount of cereals produced during recent decades. The economy of Bangladesh has performed better than expected. If there is political stability, major famines in these countries will be things of the past. This is not to say that hunger will be banished by 2025, but there is a reasonable chance that the region’s food situation will improve.

East and South East Asia

It is hard to generalise about east and South East Asia because it is such a populous and diverse region. The populations of richer countries like Japan and South Korea will be well fed in 2025, but poorer countries like Indonesia and Cambodia will still contain many hungry people. China, however, with about 21% of the world’s population, dominates the region. Despite

some sensational claims about China’s ability to feed its people⁹ there is agreement that China’s food outlook offers no cause for alarm.^{1, 3, 4, 10} During the past 20 years few countries have matched China’s record of increasing its food supply. There have been important increases in the per capita production of cereals, meat, vegetables, and fruit. Moreover, recent research indicates that China has considerable agricultural potential; there is more agricultural land and greater room for increases in yields than had been hitherto supposed.¹⁰ China will probably be a modest net importer of cereals by 2025 but this should not place any unmanageable stress on world cereal production.³

Latin America and the Middle East

Both Latin America and the Middle East have seen some general improvement in the availability of food during recent decades. Latin America has tremendous agricultural resources, and it is conceivable that Argentina and Brazil will supply China with cereals, if demand there rises faster than is generally anticipated.

The food supply in the Middle East has improved because imports have increased. Indeed, roughly a third of all cereals consumed in the region are now imported, and this fraction will probably increase in the future. In part these cereal imports reflect the Middle East’s tight constraints on water, and the cereals imported have mostly been used to increase per capita consumption of meat. However, the cereal imports also reflect the ability of most countries to pay for these imports, for example from oil or tourism revenues. None of this should obscure the fact that some countries in both regions will continue to face considerable food problems.

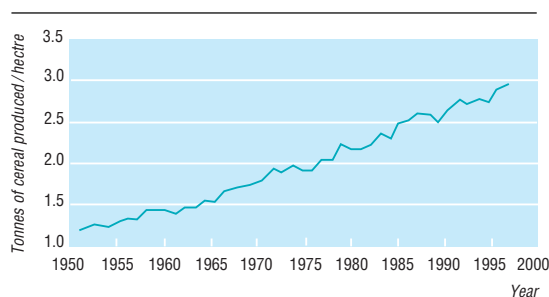
In general both Latin America and the Middle East have a record of progress in feeding their people and this is likely to continue.

North America and Europe

Finally we come to the two most agriculturally advanced regions in the world: North America and Europe, which here includes the former Soviet Union. Since 1945 the United States and Canada (with Australia) have been the world’s most important



Cereals growing in Washington state. The average growth of yields in the United States remains strong



Worldwide trend in cereal yields, 1951-97. Data from Food and Agricultural Organisation¹²

exporters of cereals. The average growth of yields in these countries has been and remains strong. For example, in the United States the average cereal yield rose from 4.58 tonnes per hectare in 1989-91 to 5.04 tonnes per hectare in 1995-7. There is no reason to believe that average yields will not continue to rise at a reasonable absolute rate, although a worrying recent development is the increasing volatility of harvests in North America, which is possibly caused by climate change occurring as a result of carbon dioxide emissions.

In western Europe the growth in yields is just as strong. For example, between 1989-91 and 1995-97 the average cereal yield in France rose from 6.24 tonnes per hectare to 6.81 tonnes per hectare.

The collapse of communism in the early 1990s led to major agricultural dislocation in eastern Europe and the former Soviet Union. Recovery is now under way in most of eastern Europe, and the prospect of eventual membership in the European Union augurs well for food production in countries like Poland. The food production and export potential of Ukraine, much of western Russia, and Kazakhstan is considerable but it will require political stability, institutional reorganisation, investment, and not a little time to be realised.

The future

Food production should be able to keep up with the growth in world population that is projected to occur over the next 25 years. An important reason for this is that the worldwide growth in cereal yield shows no sign of slowing down.¹¹ The figure uses data from the UN Food and Agricultural Organisation to plot the trend in cereal yields since 1951. Of course, because it is a linear trend it is inevitable that the annual percentage yield increase is declining. However, measured in absolute terms, which are what really matter, there is no real sign of any slackening. In some regions yields are already insufficient to meet the regional demand for cereals and this will become even more of a problem in future. Cereal exports from North America and perhaps Europe (and places like Australia and Argentina) will have to rise to meet the increased demand that will occur in many developing countries, mainly because of population growth. Most developing countries will be able to afford increased imports but some, especially in sub-Saharan Africa, will not.

There will be other challenges too. The trend towards increasing variability in harvests in North

America could have serious implications for the stability of world food prices. Worryingly, sub-Saharan Africa is experiencing a similar trend.

Nevertheless, other regions may benefit from climate change, and this may help explain the recent series of good monsoons in the Indian subcontinent.¹¹ Although rapid climate change would clearly be disastrous, the slower changes generally projected may have only a modest effect on aggregate food production worldwide.¹³

Water for agriculture will certainly be a major problem in some areas. Without doubt, water is a resource which must be used much more carefully and priced more fairly in future. No doubt poor farmers in many locations, such as hill areas in South East Asia and parts of the Sahel desert in Africa, are over-exploiting the soil and contributing to the degradation of the land because they need to grow more food. This trend too seems set to continue. Political stability everywhere will be absolutely essential to ensure that there is enough food available in future. The necessary worldwide increase in food production cannot be achieved without a considerable increase in the global use of nitrogen fertilisers. The world has already become accustomed to using large quantities of synthetic nitrogen, and population growth will inevitably increase this dependence. Opinions vary as to the implications of this development but there is general agreement that for environmental reasons, synthetic nitrogen must be used much more efficiently in future.¹⁴

Despite continued progress, there will still be many hungry people in 2025. It's a mixed and complex picture, which supports neither complacency nor alarmist pessimism. Both the provision of family planning services and the development of agricultural research should be given priority by governments and international organisations. The world's food prospects would be better if the population's size and growth rate were less.

Competing interests: None declared.

- 1 Dyson T. *Population and food*. London: Routledge, 1996.
- 2 Food and Agriculture Organisation. *World food supplies and prevalence of chronic under-nutrition in developing regions as assessed in 1992*. Rome: Food and Agriculture Organisation, 1992. (Document ESS/Misc/1/92.)
- 3 Alexandratos N, ed. *World agriculture towards 2010*. Chichester: Wiley, 1995.
- 4 Mitchell DO, Ingco MD, Duncan RC. *The world food outlook*. Cambridge: Cambridge University Press, 1997.
- 5 International Food Policy Research Institute. *A 2020 vision for food, agriculture and the environment*. Washington, DC: IFPRI, 1995.
- 6 Reeves G, Quirke D. *Food security—a future perspective*. Canberra: Australian Department of Foreign Affairs and Trade, 1996.
- 7 Bongaarts J. Population pressure and food supply in the developing world. *Popul Dev Rev* 1996;22:483-503.
- 8 Alexandratos N. World food and agriculture: outlook for the medium and longer term. *Proc Natl Acad Sci USA* 1999;96:5908-14.
- 9 Brown LR. *Who will feed China: wake-up call for a small planet*. New York: Norton, 1995.
- 10 Crosson P. *Perspectives on the long-term global food situation*. Washington, DC: Federation of American Scientists Fund, 1996.
- 11 Dyson T. World food trends and prospects to 2025. *Proc Natl Acad Sci USA* 1999;96:5929-36.
- 12 Food and Agriculture Organisation. *Production yearbook*. Rome: United Nations, 1952-98.
- 13 Rosenzweig C, Parry M. Potential impact of climate change on world food supply. *Nature* 1994;367:133-8.
- 14 Waggoner P. Is nitrogen fertilizer use nearing a balance [with reply by AP Kinzig and RH Socolow]? *Physics Today* 1995;48(8):74-5.

Commentary: Bread for the world—another view

Maurice King

Dyson fails to discuss the recent steep decline in the annual percentage rate of increase of global grain yields (percentage increase in kg of grain per hectare of farmland per year) and its relation to the annual percentage increase in population. Yields are not actually declining, but they are not increasing as fast as they were and, in particular, are not now increasing as fast as population. Dyson argues that “the pace of increase [shows] no signs of a slowdown” in terms of the steady annual increase of about 40 kg of grain per hectare. However, I argue that

• Relating yield and population increase in percentage terms is the most meaningful way of comparing

them, particularly since changes in the difference between them is reflected in changes in the amount of grain per person (the area of farmland being roughly constant)

• The now tiny percentage increases in yields suggest that the limit for further increase is not far away—which is worrying since demand could nearly double.

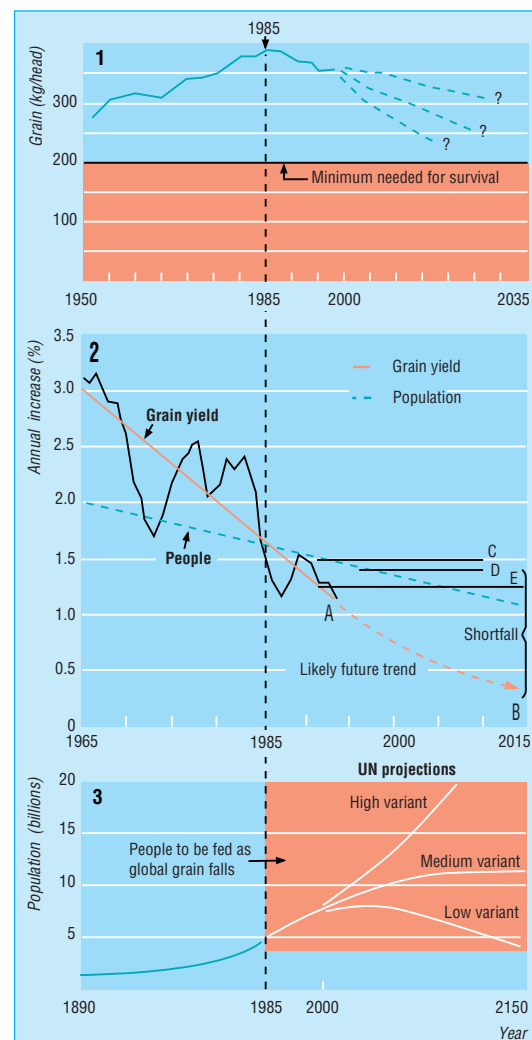
Graph 1 of the figure shows that per capita production of grain increased until about 1985 and has been falling since. A minimum of about 200 kg of grain per person annually is needed for survival, so there is still room for a further fall if grain was shared more equally throughout the world. Since 1985 was “humanity’s best fed year”—the one with the highest grain per person—the other graphs with their different time scales are centred on it.

Graph 2 shows why per capita grain (graph 1) started falling in 1985. It was the year in which the percentage rate of increase of grain yields, which had been over 3% in the 1960s, fell to below the rate of the increase in population.³ The world’s population is now increasing at 1.3% per year. The most recent years for which there are adequate data on the annual increase in grain yields are 1992, when the increase was 1.18%; 1993, when it was 0.99%; and 1994, when it was 1.07%. In view of the declining trend, the present increase in yields is likely to be under 1% per year, and it is likely to continue to fall along the line A-B on graph 2. Lines C at 1.5% (1990-2010),⁴ D at 1.4% (1995-2010),⁵ and E at 1.25% (1990-2025) are the increases in yields that three experts estimate are required to feed the world in the near future. All of these increases are well over 1%. Line E is Dyson’s estimate (from a paper presented at the British Society for Population Studies, Cambridge, 1998). Where will the declining trend in yield increases end? Where is line A-B going? How much shortfall will there be?

Graph 3 shows three population projections made by the United Nations,² illustrating the large proportion of the world’s future population increase that will need to be fed under conditions of declining per capita grain—even in the low variant. This figure provides an additional reason for the need for “A UN programme for a 1-child world”—the most powerful case being the local one, as argued elsewhere in this issue.

Competing interests: None declared.

- 1 Dyson T. *Population and food*. London: Routledge, 1996.
- 2 United Nations Population Fund. *State of the world population*. New York: UNFPA, 1994.
- 3 UN Food and Agriculture Organisation. *Faostat data*. Rome: FAO, 1998.
- 4 Alexandratos N, ed. *World agriculture towards 2010*. Chichester: Wiley, 1995.
- 5 Mitchell DO, Ingco MD, Duncan RC. *The world food outlook*. Cambridge: Cambridge University Press, 1997.



People and grain. (1) Worldwide grain production per capita (adapted from Dyson¹ and used with permission of Routledge). (2) Annual percentage increase in grain yield and population. (3) Worldwide population and projections made by United Nations²

Department of Public Health, University of Leeds, Leeds LS2 9PL

Maurice King
senior research fellow

Correspondence to: M King, 1 bis Rue du Tir, Geneva 1204, Switzerland
mhking@prolink.ch