Geo Factsheet

Number 64

World Food Outlook

Can food supply keep up with population?

World population is increasing rapidly - by about 1.7% annually. Growth rates are highest in the developing world. Whilst, in 1990, it was estimated that 77% of the worlds' population lived in developing countries, by 2025 this is expected to have risen to about 84%. Although crude annual birth rates (the number of births per thousand of the population) are declining (Fig 1) so too are crude death rates (Fig 2). Thus, overall population and life expectancy are increasing and therefore so too must food production.

Fig 1. World crude birth rates, 1950 to 2020

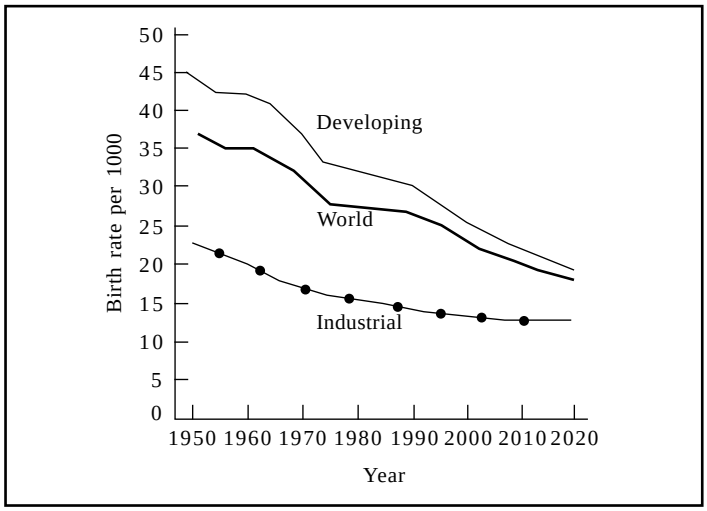
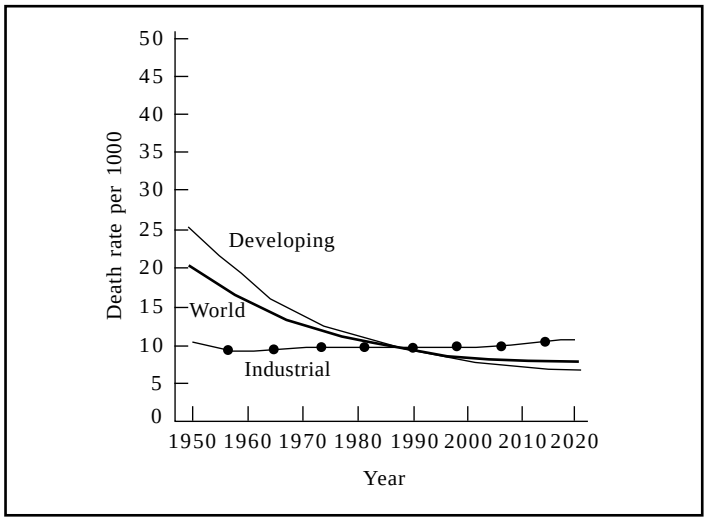


Fig 2. World crude death rates, 1950 to 2020



Increasing population inevitably means demand for food will increase but unfortunately the increase is not proportional. This is because an increasing percentage of the world's population are eating meat (Fig 3). This meat is obtained from animals fed on grain (cereals), therefore demand for grain increases disproportionately quickly as population increases (Fig 4). Because developing countries use much of their grain to feed animals instead of humans, eating meat is an inherently inefficient way of supplying the world's energy requirements.

Fig 3. World meat production per person, 1950 to 1999

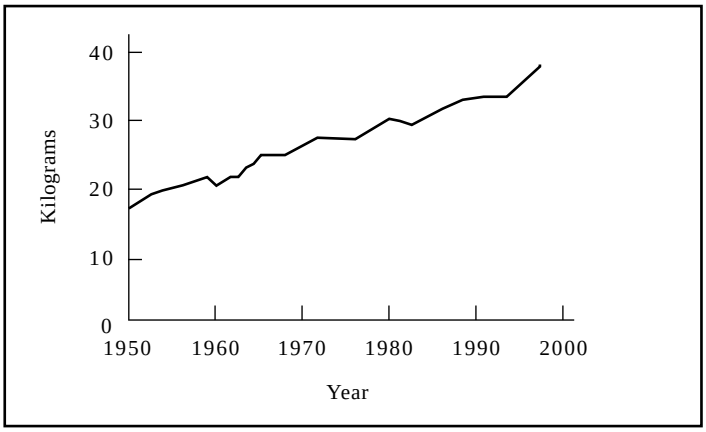
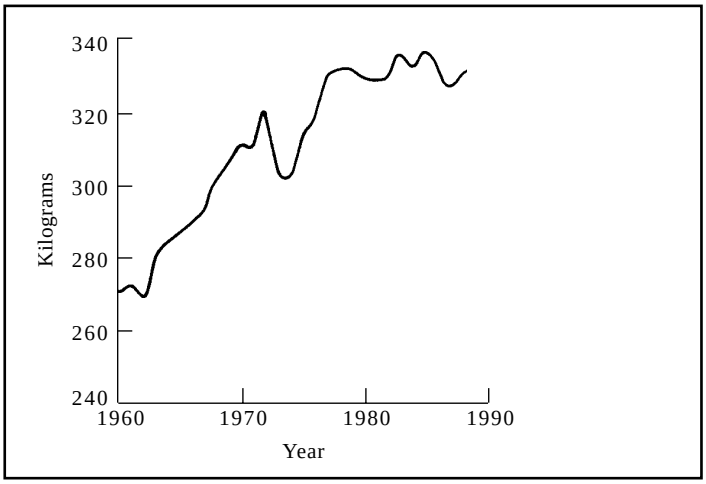
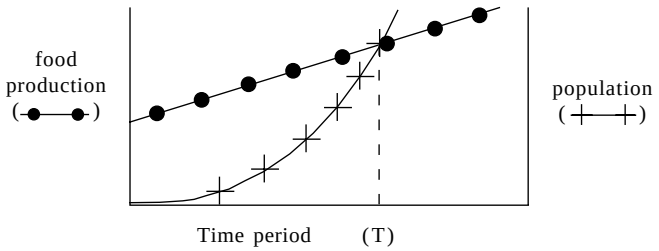


Fig 4. World per capita cereals consumption, 1960 to1990



A note on Malthus

Malthus noted that population increases geometrically (1, 2, 4, 8, 16, 32 etc.) whilst food production increases arithmetically (1, 2, 3, 4, 5, 6 etc.). Thus, inevitably, at some point (T) population will outstrip food supply (see diagram).



Thus, famine would halt population growth. Malthus could not predict the roles of technology (HYVs, fertilisers, pesticides, irrigation etc.), trade and population mobility but there are dozens of countries where lack of food clearly limits population growth. In this respect Malthus' views are still relevant.

Increasing food production

There are two basic ways to increase food production;
1. Increase the area of cultivated land.
2. Increase productivity of any area of land.

For thousands of years – up until about 1945 – farmers relied upon the first method. Between 1950 and 1990 farmers were incredibly successful at increasing the productivity of their land - as shown by wheat yields (Fig 5) and Table 1.

Fig 5. Wheat yields in France, China & United States, 1950-97

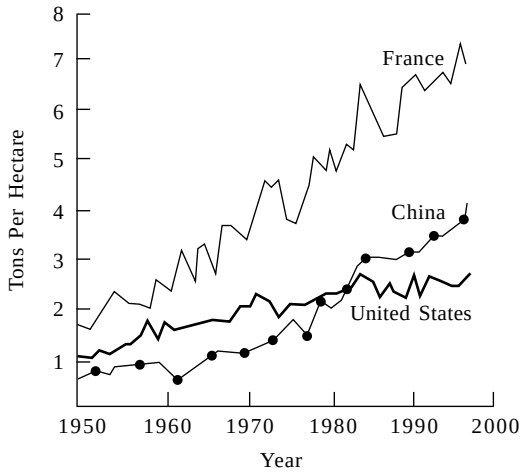


Table 1. How has productivity been increased?

Genetic Improvement	- Fast growing varieties - Disease resistance - Dwarf varieties, less likely to fall over and puts more end products of photosynthesis to seed.
Increase Inputs	↑ fertilisers ↑ irrigation ↑ pesticides
Mechanisation	Mechanisation made it possible to plant, weed and harvest crops throughout the year and in a matter of days.
Irrigation	36% of world food production comes from the 16% of the total land area which is irrigated.

In fact, intensive agriculture was so successful in increasing yields that the USA and many countries in Europe were forced to take huge areas of land out of production to avoid the huge surpluses which were accumulating. Such surpluses, if released on to the open market, would have decreased food prices. Thus, in simple terms, food production was deliberately slowed down to protect profits and farmers incomes.

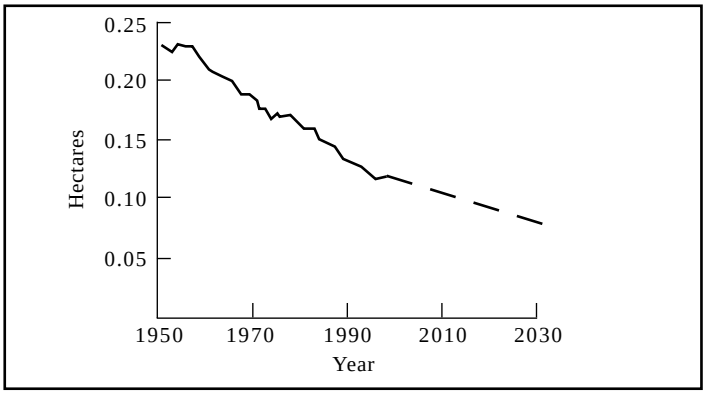
Since 1990, productivity per hectare has began to level off – there are clear signs that it is not going to be possible to increase yields much more. As population grows, there will be little alternative but to bring all available land back into production. Whether there is sufficient land to feed the population predicted for the next century is a highly controversial question. Some land economists claim there is more than sufficient land available, whilst others claim that it will be the supply of land which becomes the overall limiting factor to food production. **Pessimists** point to the huge areas of land which are no longer available for agriculture (Table 2).

Table 2. Losses of cropland

New housing	Population of India now 960 million. Expected population in 2030 1,500 million Number of new homes required = 58 million (assumes 10 people / home)
Recreation	As income increases in Asia, the number of golf courses has rocketed e.g. Japan, the Philippines and Indonesia. Vietnam has now banned the development of golf courses on rice paddies.
Soil erosion (wind + water)	Kazakhstan, the largest wheat producer in Central Asia, has lost 30% of its land to erosion since 1980.
Soil degradation	Loss of nutrients, salinisation, acidification and water loss.

To some extent, such losses may be offset by gains through land reclamation etc. but many scientists believe that the clear trend is that, per capita, crop land area will continue to decrease (Fig 6).

Fig 6. Per capita grain area 1950-2030



Although yields have increased, yields of the world's two most important staple crops - wheat and rice - vary enormously between countries (see Tables 3 and 4).

Table 3. Annual rice yield per hectare in key producing countries, 1994-96

Country	Yield (tons)
Japan	4.8
China	4.2
Indonesia	2.9
India	1.9
Pakistan	1.8
Bangladesh	1.8

Table 4. Annual wheat yield per hectare, 1994-96

Country	Yield (tons)
United Kingdom	7.7
Egypt	5.6
China	3.6
India	2.5
United States	2.5
Pakistan	2.0

However, this is not always because some countries do not possess the high yield varieties. In countries within Africa, a lack of soil moisture means that farmers are unable to exploit the genetic potential of their crops. Much of Table 3 and 4 is explained by differences in soil moisture – China and Egypt rely upon extensive irrigation.

The fundamental importance of irrigation to food production is illustrated in Table 5.

Table 5. Importance of irrigation to food production

Country	% of land which is irrigated	% of food production which comes from irrigated land
India	35	59
Pakistan	65	80
China	45	65
Indonesia	45	55
Mexico	30	35

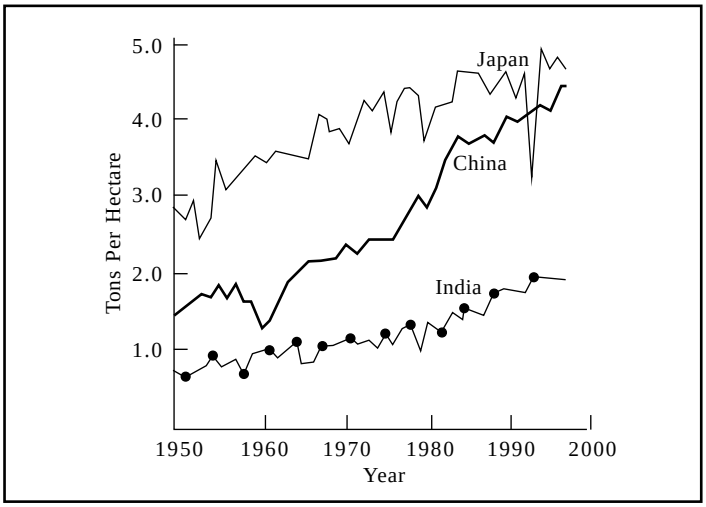
Two other environmental factors – the average length of the day and the solar intensity – are also important in determining crop productivity. Thus, although crop yields can and have been increased hugely by genetic improvement, there comes a point when it is environmental factors which become limiting. This is sometimes put forward as an explanation as to why, in the US, although wheat yields tripled between 1959 and 1983 – yields have hardly increased since.

When soil moisture is a limiting factor, irrigation may do more harm than good. In China, huge irrigation projects have caused environmental problems such as depletion of aquifers and drying up of rivers – The Huang He (Yellow River) now runs dry for several weeks each spring, and for progressively longer periods each year - and this in turn, means less irrigation waters for domestic downstream farmers.

Farmers in countries such as Bangladesh, which rely upon the monsoon to provide moisture, have to use that moisture extremely efficiently and this is difficult. Thus, yields of rice are dramatically less than yields from the same variety grown in countries which have sufficient irrigation. In Asia, the potential for countries such as Japan, China and Indonesia to continue to increase rice yields looks pessimistic.

The length of the summer day in India is less than that in Japan and China unless artificial light is employed, it is difficult to see how yields can be increased to those levels in China (Fig 7).

Fig 7. Rice yields in Japan, China, and India, 1950-97



However, yields in Pakistan, the Philippines and Vietnam are expected to increase as more efficient irrigation and fertilizers are developed. Furthermore, the Philippines will soon release a new rice variety which is expected to dramatically increase rice yields again.

Finally, it should be noted that fertilizer manufacture depends upon petroleum and, as happened during the 1970s, if fuel prices rise, then so too does the cost of fertilizer. Although oil prices are very low now, they will inevitably rise as reserves deplete and it may not be sensible to base agricultural improvement on such a variable resource.

Thus, although the yields of all of the world's most important cereals have tripled or quadrupled in the last 50 years, it is by no means certain that such improvements can be maintained. Once farmers have exploited the high yielding varieties in the best agronomic conditions – optimum soils, plant spacing, irrigation, use of fertilizer etc. the yield potential of any particular crop is limited by the physical environment and this is extremely difficult to change.

Optimists

Not all agricultural economists believe that soil erosion, water scarcity or the price of oil (hence fertilizer) are serious threats to global food production. Such economists argue that, on a global scale, soil erosion has an almost negligible effect on crop yields. This is either because the effects have been exaggerated or because the ability of soils to regenerate themselves has been underestimated.

They also argue that water scarcity is really a problem of water pricing. In the past it has been priced - because of subsidies from governments - at less than its true cost, hence farmers have over used it. Priced correctly, they argue, there will be plenty of water to go round and optimists believe that the dramatic improvements of the last 40 years will be maintained into the next century. Similarly, they argue that land supply is not a major limiting factor to agricultural production. They point out that the land area of pastures and meadows is huge and suggest that much of this can be put to cereal production (Table 6).

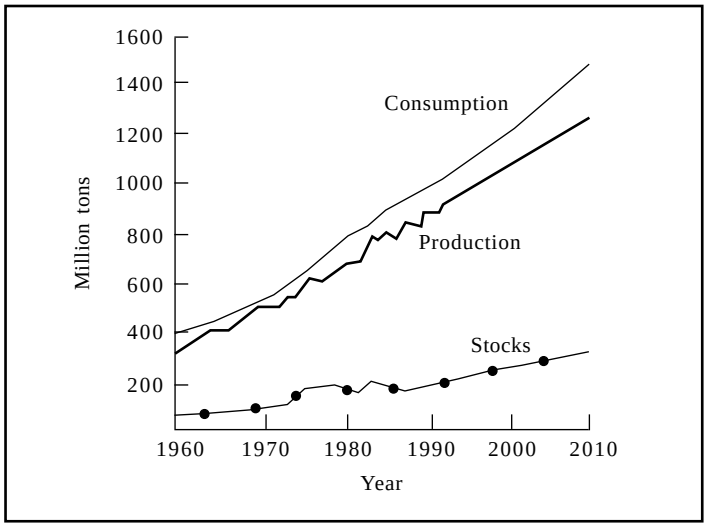
Table 6. Land use by region, 1989 (million hectares)

	Total land	Crops	Pastures and meadows	Forests and woodlands	Other
World	13,076	1,477	3,304	4,087	4,208
Africa	2,964	187	891	684	1,203
North & Central America	2,138	274	369	716	778
South America	1,753	142	479	891	240
Asia	2,678	453	678	535	1,012
Europe	473	140	83	157	93
Oceania	843	51	432	157	203
Fmr Soviet Union	2,227	231	371	946	679

Again, however, such global statistics can hide important regional differences and technical problems. Whilst Europe uses 29% of its total land area for crops, India already uses 56%. Much of the unused land in the former Soviet Union is remote and is difficult to access or farm. Thus, crude estimates of land availability may perhaps best be treated with caution.

It seems certain that many developing countries will require food aid over the next 30 years, others will have to devote a large percent of the GNP to pay for the imports from countries with surpluses. The gap between consumption and production will continue to increase (Fig 8). As incomes rise in such developing countries, imports will also have to be more varied – increased income is almost always associated with increased dietary diversity.

Fig 8. Grain balance for developing economies, 1960-2010

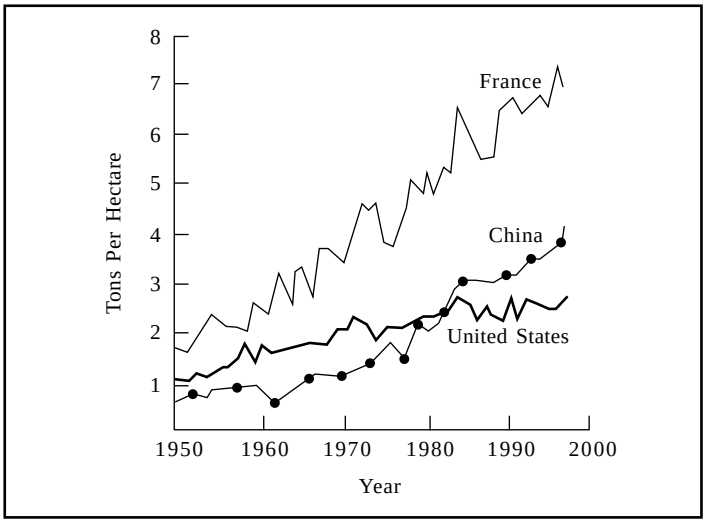


In the 1990s, world wild grain stocks have fallen to their lowest level ever. As a result, the United States has restored all of its set-aside land to production. Despite this, present stocks would only supply 80 days of world consumption. This is near the minimum which is considered necessary for world food security. If supplies fall below this, one poor harvest can result in a rapid price increase. When stocks dropped to 56 days of consumption in 1973 world grain prices doubled. In such circumstances, developing countries are simply unable to pay for imports.

The situation is made worse for developing countries because just one country supplies 48% of all cereal to them - the US. In practical terms then the US controls a greater percentage of cereal exports than Saudi Arabia does of oil. In years of poor harvests, the US - or any other developed nation - may be unwilling to supply cereal aid since that would inevitably cause political unpopularity as domestic food prices rise. Developing countries such as South Korea and Taiwan that import 70% of their grains, and to a lesser extent Egypt, Iran and Saudi Arabia which import 30 - 60 % are therefore in a very difficult position. Faced with such food insecurity many commentators believe that stricter population policies are required. In regions such as North Africa and the Middle East, populations are expected to double within the next 30 years but these regions already have acute water and, in some cases, food shortages.

Practice questions

The diagram below shows wheat yields in France, China & United States, 1950-97.



(a) Suggest reasons for:

(i) the increase in wheat yields in the three countries between 1950 and 1980 (3 marks)

(ii) the differences in yields between the three countries (3 marks)

Answers

Semicolons indicate marking points

(a) (i) Genetic improvement;
Increased inputs;
Mechanisation;
Irrigation;

(ii) Greater inputs e.g. fertilisers, pesticides, HYVs;
Climatic factors e.g. more reliable rainfall in France;
Soil factors;

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