



# Our Planet's Food and Health



**E-BOOK**

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**Stephen Codrington**



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# Our Planet's Food and Health

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Cover photos show rice cultivation in Bali, Indonesia.



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BBC: 3.27. CDC (Centers for Disease Control and Prevention): 2.73. Daan Luining: 4.35. Dipartimento della Protezione Civile, Italy: 4.68. James Foley: 4.30. Kevin Hicks: 4.27. Mark Post: 4.36. Pixabay: 4.31. Sky Greens: 4.33. Suncore: 4.34. Vincent Callebant Architects: 4.32. Vlad Karavaev/Shutterstock: 3.25.

# Preface

*Our Planet's Food and Health* is one of seven monographs written to support the options for the International Baccalaureate Diploma Geography (IBDP) course. These seven monographs complement three larger books that span the entire content of the IBDP Geography Program. *Our Changing Planet* covers the SL and HL Core (Paper 2), *Our Connected Planet* covers the Higher Level Core Extension (Paper 3), and *Our Dynamic Planet* includes material on all seven options in the SL and HL themes (Paper 1).

As with all the books in the *Planet Geography* series, my aspiration is that every reader of this book will acquire knowledge and wisdom to become an effective steward of our planet, committed to ensuring its healthy survival and vibrant flourishing.

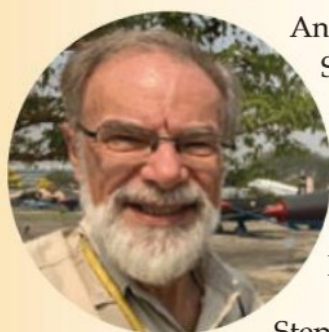
Any comments or suggestions to improve future editions of this book are always welcome. I hope you, the reader, will enjoy learning more about the geography of our fascinating planet as I have over the years.

Stephen Codrington.

## The Author

Dr Stephen Codrington has a Ph.D. in Geography, and has taught the subject in several countries at both the high school and university level. He is the author or co-author of 69 books, mainly books that focus on his life-long passion for Geography.

Following his highly successful career as a teacher of Geography and Theory of Knowledge, including serving as the Head of five International Baccalaureate (IB) schools in four countries, he now works with school boards and leaders through Optimal School Governance, educates trainee teachers at Alphacrucis College, and is Chair of the Board at Djarragun College.



An Australian by birth, Stephen is a former President of both the Geographical Society of New South Wales and the Geography Teachers' Association of New South Wales (twice). He edited *Geography Bulletin*, the journal of the Geography Teachers' Association of New South Wales for seven years, and is now a Councillor and Treasurer of the Geographical Society of New South Wales. He has taught in schools in Australia, the United Kingdom, New Zealand, Hong Kong and the United States.

Stephen has been honoured with election as a Fellow of the Australian College of Education, the Royal Geographical Society (UK), and the Geographical Society of NSW. He was appointed to the role of IB Ambassador in 2014 and honoured with life membership of the Geographical Society of New South Wales in 2018. He is a former Chairman of HICES (Heads of Independent Co-educational Schools). Stephen's work has taken him to 161 countries, and he has been listed in *Who's Who* in Australia every year since 2003.

From 1996 to 2001 he served as Deputy Chief Examiner in IB Diploma Geography, setting and marking examination papers, assisting with curriculum development, and leading many teachers' workshops.

He maintains a personal website at [www.stephencodrington.com](http://www.stephencodrington.com) that contains links to travel diaries and other items of geographical interest.





1.1 A good supply of fresh, locally grown food is available for sale in this market in Thimphu, Bhutan's capital city.

## Global patterns in food and nutrition indicators

### The global availability of food

Why do farmers produce food? If your answer was 'to eat', you would only be half right. Food is grown by **subsistence farmers** to eat, but in the case of **commercial farmers**, food is grown to sell, usually for the highest price that can be found. Perhaps that is why we now have a situation in the world where we produce enough grain (mainly wheat and rice) to feed every man, woman and child in the world more than 3,000 calories every

day. This is **more than enough food** to feed everyone adequately, indeed more than adequately, even without allowing for any other food production such as vegetables, fruit, fish and meat.

Indeed, the world has never before produced so much **food per person** than is happening now. In Europe and North America there are huge **surplus** stocks of wheat, butter, wine and other foods that simply cannot be sold for a price that would cover the cost of production. Farmers would often prefer to **dump** food into the ground or into the ocean than sell it for a price that is too low. In the United States, the government tries to reduce farming production by paying farmers not to produce a



## Chapter 1 - Measuring food and health

certain crop and take their land out of farming production. This is because the government believes that a surplus of food on world markets will **lower prices** to farmers and **reduce their incomes** to an unacceptable level. In other words, the interests of the farmers in the wealthier countries are being put before the interests of hungry people overseas.

The **growth** in world food production has not been consistent in all parts of the world, however. Table 1.1 shows the trends in **world food production**, both in terms of **absolute** production levels and **food per capita** (per person). Although the quantity of food production has grown in most parts of the world, production per capita was



1.2 A weight loss centre does brisk business in New York, USA, surrounded by fast food outlets.

Table 1.1

Average annual rate of growth of food production, and per capita food production, 1970 to 2015

World / Region	Total Food Production					Per Capita Food Production				
	1970 to 1980	1980 to 1990	1990 to 2000	2000 to 2010	2010 to 2015	1970 to 1980	1980 to 1990	1990 to 2000	2000 to 2010	2010 to 2015
<b>WORLD</b>	<b>2.5</b>	<b>2.4</b>	<b>2.5</b>	<b>2.5</b>	<b>2.6</b>	<b>0.6</b>	<b>0.6</b>	<b>1.2</b>	<b>1.2</b>	<b>1.3</b>
<b>Industrialised countries</b>	<b>2.0</b>	<b>1.0</b>	<b>1.3</b>	<b>0.6</b>	<b>1.1</b>	<b>1.2</b>	<b>0.3</b>	<b>1.0</b>	<b>0.2</b>	<b>0.7</b>
North America MEDCs	n.a.	n.a.	2.6	1.0	1.6	n.a.	n.a.	1.3	0.0	0.6
Asia MEDCs	n.a.	n.a.	-1.1	-0.5	-0.3	n.a.	n.a.	-1.3	-0.6	-0.2
Europe	n.a.	n.a.	0.4	0.4	1.1	n.a.	n.a.	0.4	0.3	1.0
Oceania MEDCs	n.a.	n.a.	3.7	0.7	-1.9	n.a.	n.a.	2.5	-0.5	-3.0
<b>Developing countries</b>	<b>3.0</b>	<b>3.6</b>	<b>3.3</b>	<b>3.4</b>	<b>3.2</b>	<b>0.7</b>	<b>1.5</b>	<b>1.7</b>	<b>1.9</b>	<b>1.8</b>
Latin America & Caribbean	3.6	2.5	3.1	3.8	3.8	1.1	0.4	1.5	2.5	2.6
Middle East & North Africa	3.1	3.5	3.1	3.0	0.4	0.3	0.7	1.0	1.1	-1.4
Sub-Saharan Africa	1.1	2.9	3.2	3.4	2.5	-1.7	-0.1	0.5	0.8	-0.1
East and South-east Asia	3.3	4.4	2.0	3.3	3.4	1.4	2.7	0.8	2.2	2.4
South Asia	2.7	3.8	2.6	2.4	3.8	0.4	1.5	0.7	0.7	2.2
Oceania LEDCs	2.2	1.7	1.2	2.0	1.2	-0.1	-0.6	0.3	-0.8	0.0
North America LEDCs	-2.3	1.2	2.1	2.5	2.6	-3.5	0.3	1.5	2.5	2.6
<b>Continental groupings</b>										
Africa	1.4	3.0	3.7	3.4	2.8	-1.4	0.1	1.2	1.0	0.4
Asia	n.a.	n.a.	3.3	3.2	3.1	n.a.	n.a.	1.8	1.8	1.9
North America	2.8	0.6	2.8	2.4	2.7	1.8	-0.4	1.4	1.2	1.6
Oceania	2.2	1.4	3.6	0.8	-1.7	0.6	-0.2	2.2	-0.7	-3.0
Europe	n.a.	n.a.	0.4	0.4	1.1	n.a.	n.a.	0.4	0.3	1.0

Source: FAO (Food and Agricultural Organisation) and World Bank





**1.3** A young child in Bobo Diasoulou, Burkina Faso, has a swollen belly that is a symptom of malnutrition.

declining in some regions, with the **largest declines** occurring in the developing countries of Oceania, the Middle East, North Africa, Sub-Saharan Africa, and industrialised countries in Oceania and Asia. On the other hand, the **largest increases** in food production per capita have been occurring in the developing economies of North America, Latin America, the Caribbean, East Asia, South-east Asia and South Asia.

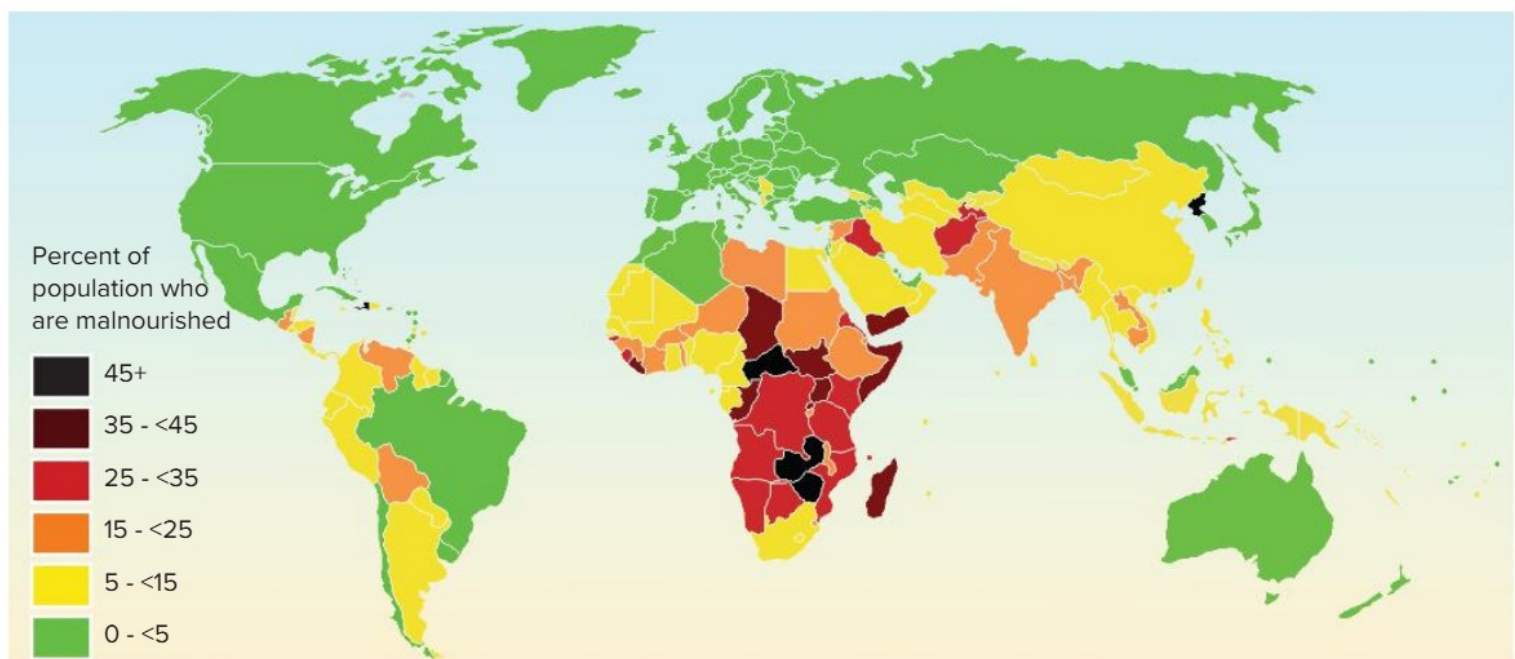
In spite of the overall glut of food on world markets, there have never been so many people suffering from starvation or malnutrition than now. To be **malnourished**, a person consumes fewer calories and less protein than they need to maintain health. **Chronic hunger** is long-term, whereas periodic hunger is short-term, caused by factors

such as drought, famine, war, conflict or political upheavals. It has been estimated that about 800 million of the world's people suffer from chronic malnutrition, which is about one in nine of the world's population.

The overwhelming majority of malnourished people live in world's **poorer countries**, especially in Africa. According to the World Food Program (WFP), about 13% of people in developing countries are malnourished, a figure that rises to 25% in Sub-Saharan Africa, which has the highest prevalence (percentage of the population) of hunger in the world.

Poor nutrition causes about 45% of the **deaths of children under five** in the world annually, which represents more than three million children each year. Because of malnutrition among young mothers, many babies in poorer countries are born with very low birth weights, defined as below 2,500 grams. Children with low birth weights often have shortened life expectancies, greater risk of disease and sometimes retarded brain development.

Fortunately, the **trend** in world hunger is **downwards**, although like the trends in food production per capita, the trend is not uniform in all parts of the world (table 1.2, and figures 1.7 to 1.9). In spite of the improvements, Africa remains the continent where malnutrition is highest, although it is also a significant problem in the developing nations of Oceania.



**1.4** Percentage of the population who are malnourished. The world average level of national malnutrition is 11%.



Table 1.2

Prevalence of malnutrition, 1990-92 to 2016-18  
(all figures are percentages)

Region	1990-92	2014-16
The World	18.6	10.8
Industrialised countries	<5.0	<5.0
Developing countries	23.3	12.9
Africa	27.6	19.8
Asia	23.6	12.1
Latin America and the Caribbean	14.7	5.5
Oceania	15.7	14.2

Source: FAO (Food and Agricultural Organisation)

At the same time as people in developing countries are suffering from malnutrition, millions of people in more **affluent societies** are dying with **diseases** that are caused by **over-consumption** of food, or diseases that are aggravated by over-eating the wrong types of food. Examples of such conditions include heart disease, strokes and some types of cancer. Airline manufacturers in the United States have found that the average width of American bottoms has increased by almost 10 centimetres during the past half century, and that seats in aircraft must be widened accordingly if comfort is to be maintained. This is an enormous change in human evolutionary terms in a very short space of time, and it reflects the consequences of over-consumption of food combined with lack of exercise in that society.

Overall, the problem is not that the world is producing insufficient food. The underlying problem lies in the **distribution** of the food that is produced. Commercial farmers (perhaps reasonably) will usually sell their produce to the person (or company) that will **pay the highest price**. Unfortunately, for many poor people in developing nations, they are usually the ones who cannot afford to pay the top prices. As a result, the quantities of food available to humans (as measured by calorie intake) vary considerably from one part of the world to another.

**Wheat** is an important staple food for much of the world's population. However, wheat is also in demand by **beef farmers** in developed nations who



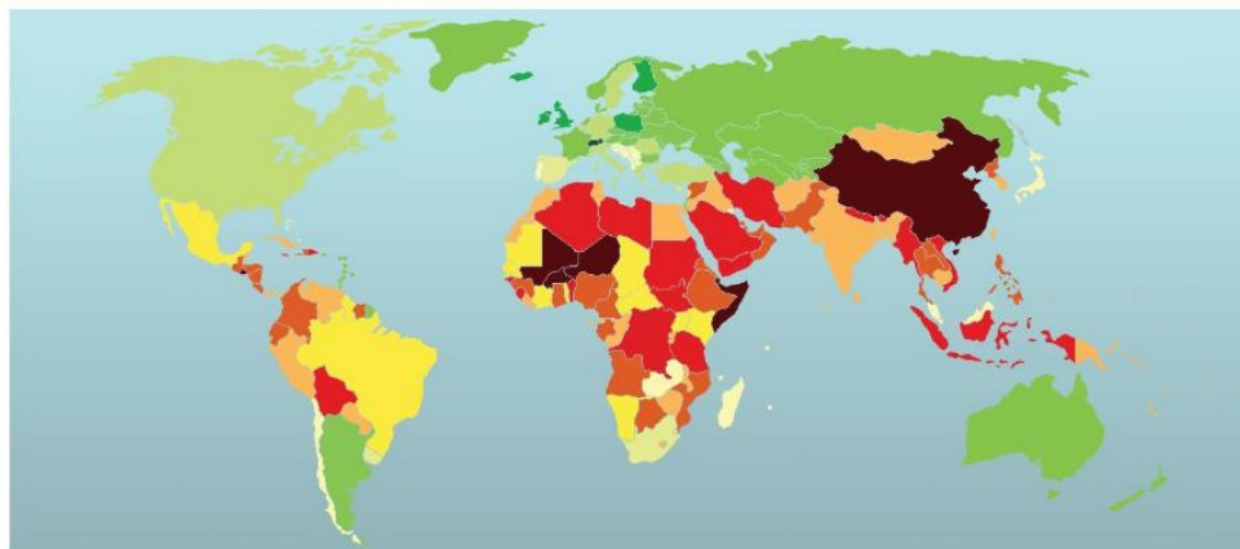
1.5 A food stall in the central markets of Niamey, Niger. In the global food market, food tends to be sold to the highest bidders. In such a situation, children — and especially girls — will almost always be at the bottom of the customer priority list.



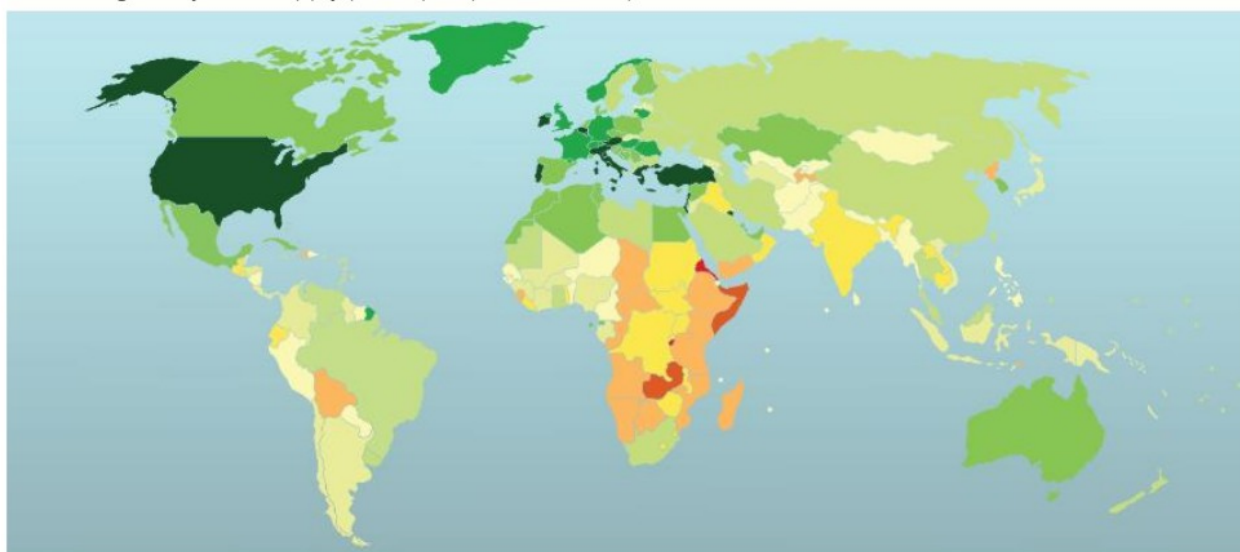
1.6 In contrast to the food stall shown in figure 1.5, this food store in Moscow, Russia, carries a vast range of high quality food for consumers who are capable of out-bidding most people in the world to acquire whatever quantity and quality of food they desire.

feed it to their cattle to produce high quality, lean meat. A beef farmer in the United States will always be able to afford to pay a higher price for wheat than a hungry peasant in Mali, which means that the peasant in Mali will usually miss out. The problem is made worse when we realise that the food energy a person would get from a tonne of wheat is reduced by 90% if it is eaten in the form of wheat-fattened beef rather than as bread. Put another way, **economic factors** work to reduce the **food energy** available to people from wheat by 90% when the wheat is fed to cattle, and it is not even the people who most need the food energy that will be able to afford the lean beef.





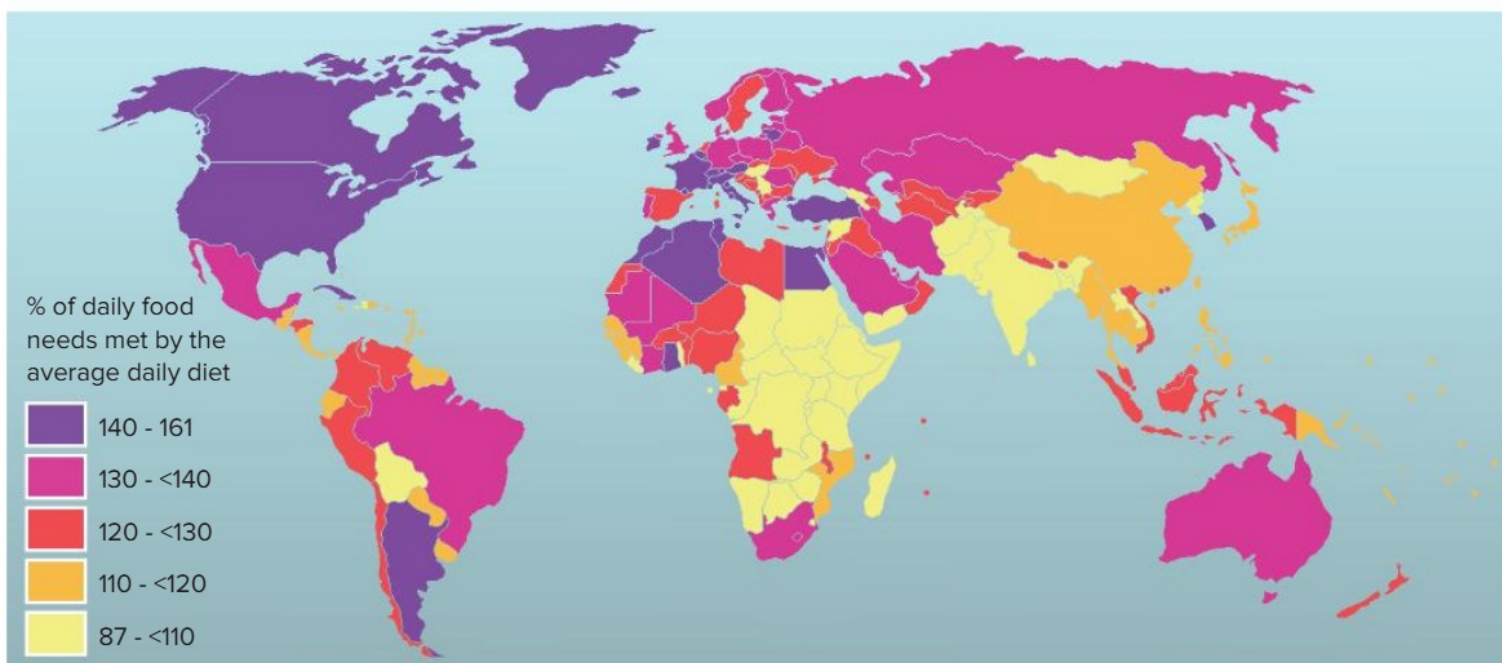
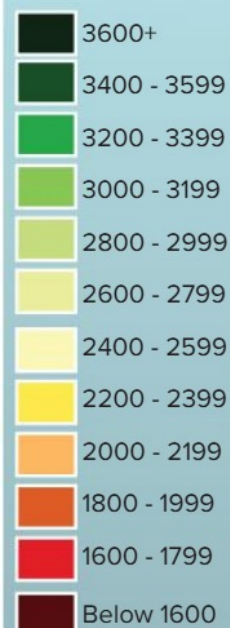
1.7 Average daily food supply per capita (in kilocalories), 1961



1.8 Average daily food supply per capita (in kilocalories), 2018

Key to figures  
1.7 and 1.8:

Calories per  
capita per day



1.9 Average dietary energy supply adequacy, as a percentage of daily needs, 2018.



Another problem concerns the role of **agribusiness**, or **large corporations** that are involved in farming. With the backing of organisations such as the World Bank, large profit-driven corporations have persuaded many subsistence farmers in poorer countries to **abandon food production** and switch to commercial production of **non-food crops** — a program known as **crop substitution**.

The **argument** put to farmers is that they could sell their cotton or rubber or coffee on the world market, and use the money earned to buy the food they used to grow, having a handsome surplus of money left over for other purposes. On the basis of such arguments, large numbers of farmers in poorer countries began producing cocoa, cotton, cut flowers, tobacco, asparagus, strawberries, grapes and other crops for **export**. This also helped farmers in Europe and North America to sell some of their surplus production as new markets opened up in the poorer countries.



**1.10** Crop substitution in Latin America. Farmers near the Cuban town of Viñales have abandoned their food crops to grow tobacco for the manufacture of cigars for export.

Unfortunately, crop substitution has not worked well for many farmers in poorer countries. **Prices** for the export crops have often failed to meet expectations, so farmers have not even been able to buy the amounts of food they had previously grown for themselves. The farmers are **trapped** because of their contracts, obligations and commitments to the large corporations and the loans they have received from these corporations. Crop substitution schemes were very popular in African nations such as Sudan and Ethiopia — countries that used to be self-sufficient in food production but now experience widespread **malnutrition**.



**1.11** Mechanical harvesting of tea on a plantation in the Wahgi Valley, east of Mount Hagen, Papua New Guinea. Cultivation of tea and coffee on foreign-owned plantations for export has replaced food cultivation in many parts of the Wahgi Valley.

## Food and nutrition indicators

The picture we have developed of hunger and malnutrition so far has been based on **simple ratios**, such as **average calories per day per person** (figures 1.7 and 1.8), **dietary energy supply as a percentage of daily needs** (figure 1.9), and most straightforward of all, the **percentage of people who are malnourished** (figure 1.4). As the study of hunger and malnutrition has progressed, researchers, aid workers and health professionals have sought to understand the nature, the causes and the distribution of malnutrition more fully. That has led to the development of more complex, composite measures of malnutrition.

**Composite measures** (which are sometimes called composite variables or composite indicators) combine multiple data items into a single score. This contrasts with **simple variables** (or single factor measures), which examine one factor (such as total population size) or a single ratio (such as calories consumed per person). The two most commonly used composite measures for malnutrition are the Global Hunger Index and the Global Food Security Index.

### Global Hunger Index

The **Global Hunger Index** (GHI) is a composite indicator developed by the International Food Policy Research Institute (IFPRI). The GHI measures hunger on a 100 point scale, with 0 representing no hunger and 100 representing an extreme degree of hunger in the nation being measured. GHI scores are interpreted as follows:



- below 10: a low degree of hunger
- 10 to 20: moderate hunger
- 20 to 35: serious hunger
- 35 to 50: alarming hunger
- above 50: extremely alarming hunger

The GHI is calculated by combining **four components** that focus on the effects of hunger among young children:

- the proportion of **undernourished** children in the population
- the proportion of children under five years old who suffer from **wasting** (a debilitating disease that causes muscle and fat to waste away)
- the proportion of children under five years old who suffer from **stunting** (reduced height for the age as a result of malnutrition)
- the **mortality rate** of children who under five years old.

The GHIs for a sample of selected countries are shown in table 1.3.

One of the **problems** faced by statisticians who try and assemble composite measures such as the GHI is that many poorer countries **do not collect** the basic information required to calculate the data. For example, the GHI cannot be calculated in Burundi, Comoros, Congo, Eritrea, Papua New Guinea, South Sudan, Sudan, and Syria because the raw data required has never been collected, even though it is known that these countries experience significant rates of malnutrition.

## Global Food Security Index

The **Global Food Security Index (FSI)** was developed by *The Economist*, a weekly British news magazine, designed to be a comprehensive composite measure of food security. For the purposes of the FSI, **food security** is defined as “the state in which people at all times have physical, social and economic access to sufficient and nutritious food that meets their dietary needs for a healthy and active life”.

The FSI is a relatively complex measure that is based upon **three dimensions** — affordability, availability, and quality and safety — each of which is made up of several facets:



**1.12** Food affordability is one of the three components of the Global Food Security Index. This view shows food being sold in Sigatoka, a town in Fiji. The sellers are the farmers who grew the food, helping to keep prices low by eliminating intermediate sellers.



**1.13** Fruit is being sold from the back of a small truck in Santo Domingo in the Dominican Republic. The cost of the food is lowered when the seller does not have to pay for a premises, making the food more affordable to low income earners.

- **Affordability** measures the ability of consumers to purchase food, their vulnerability to price shocks and the presence of programs and policies to support customers when shocks occur. It comprises six facets:
  - **Food consumption as a share of household expenditure**, which measures the average percentage of household expenditure that is spent on food.
  - **Proportion of population under global poverty line**, which measures the percentage of the population living under US\$3.10 per day in purchasing power parity.
  - **Gross domestic product per capita**, which measures individual income and, therefore, the



# Chapter 1 - Measuring food and health

Table 1.3

Indicators of malnutrition in 30 selected countries (arranged in descending order of FSI), 2019

	Average daily energy consumption (calories)	Global Hunger Index, 2019 (GHI)	Global Food Security Index, Affordability component, 2019	Global Food Security Index, Availability component, 2019	Global Food Security Index, Quality and Service component, 2019	Global Food Security Index 2019 (FSI)	Global Food Security Index category
Singapore	3,770	n.c.	95.4	83.0	79.4	87.4	Best environment
United States	3,800	n.c.	87.4	78.3	89.1	83.7	
Switzerland	3,190	n.c.	83.8	84.3	78.2	83.1	
Norway	3,530	n.c.	81.9	81.0	90.5	82.9	
Canada	3,530	n.c.	83.3	80.0	86.7	82.4	
Germany	3,440	n.c.	84.9	79.1	79.8	81.5	
Australia	3,460	n.c.	86.6	77.1	79.9	81.4	
United Kingdom	3,450	n.c.	83.6	74.4	80.9	79.1	
Japan	2,810	n.c.	82.4	71.0	76.7	76.5	
Malaysia	2,910	13.1	81.7	67.7	70.6	73.8	Good environment
China	2,970	6.5	74.8	66.9	72.6	71.0	
Russia	3,480	5.8	79.8	60.1	70.9	69.7	
Mexico	3,270	6.2	74.9	62.3	75.2	69.4	
Indonesia	2,660	20.1	70.4	61.3	47.1	62.6	
India	3,160	30.3	64.2	58.4	47.0	58.9	Moderate environment
Myanmar	2,770	19.8	59.1	57.2	51.3	57.0	
Mali	3,110	24.1	45.9	60.1	59.9	54.4	
Bangladesh	2,540	25.8	60.4	54.8	30.6	53.2	
Cambodia	2,300	22.8	56.7	48.1	34.6	49.4	
Ethiopia	2,850	28.9	49.7	52.6	39.0	49.2	
Uganda	2,440	30.6	45.8	45.5	49.1	46.2	
Zambia	2,250	38.1	41.8	50.7	33.6	44.4	Needs improvement
Haiti	2,580	34.7	50.3	39.6	35.9	43.3	
Mozambique	n.a.	28.8	42.5	47.9	20.6	41.4	
Syria	3,050	n.a.	34.6	38.9	46.4	38.4	
Madagascar	1,950	41.5	35.7	45.7	22.1	37.9	
Chad	2,030	44.2	40.3	34.9	33.5	36.9	
Yemen	2,670	45.9	45.5	28.6	30.2	35.6	
Burundi	2,310	n.a.	36.6	32.2	34.5	34.3	
Venezuela	2,040	16.9	15.8	32.2	66.9	31.2	

n.a. = not available; n.c. = not calculated. Sources: FAO, International Food Policy Research Unit, The Economist Intelligence Unit.





**1.14** Lack of transport infrastructure in many poorer countries makes food distribution difficult, increasing the potential for malnutrition. This photo shows transport of rice by animate power from a storage area near Paungde, Myanmar.

ability to afford food in \$US purchasing power parity terms.

- ▶ **Agricultural import tariffs**, which measures the average applied most favoured nation (MFN) tariffs on agricultural imports.
- ▶ **Access to financing for farmers**, which is a qualitative indicator that measures the availability of financing to farmers from the government, multilateral, and private sectors.
- ▶ **Presence of food safety net programs**, which is a qualitative indicator that measures public initiatives to protect the poor from food-related shocks. This indicator considers food safety net programs, including in-kind food transfers, conditional cash transfers (such as food vouchers), and the existence of school feeding programs by the governments, NGOs, or the multilateral sector.
- **Availability** measures the sufficiency of the national food supply, the risk of supply disruption, national capacity to disseminate food and research efforts to expand agricultural output. It comprises eight facets:
  - ▶ **Sufficiency of supply**, which is a composite indicator that measures the food availability through the supply of calories per capita per day, and levels of food aid.
  - ▶ **Public expenditure on agricultural research and development**, which is measured as a percentage of agricultural GDP. It is a proxy



**1.15** Transport infrastructure is often poorly developed in developing countries. This decrepit vehicle is transporting bananas to the market in Allada, Benin.

for agricultural innovation and technology that increases market efficiency and access.

- ▶ **Agricultural infrastructure**, which is a composite indicator that measures the ability to store and transport crops to market. Sub-indicators include: existence of adequate crop storage facilities; extent and quality of road infrastructure; and quality of the infrastructure in ports.
- ▶ **Volatility of agricultural production**, which is measured as the standard deviation of the annual growth in agricultural production over the most recent twenty year period for which data is available.
- ▶ **Political instability**, which is a qualitative indicator that measures the presence of general political instability. Political instability has the potential to disrupt access to food through such avenues as transportation blocks or reduced food aid commitments.
- ▶ **Corruption**, which is a measure of the extent of corruption in a country, calculated by measuring the risk of corruption. Corruption can impact food availability through distortions and inefficiencies in the uses of natural resources, as well as bottlenecks and inefficiencies in food distribution.
- ▶ **Urban absorption capacity**, which is a measure of a country's capacity to absorb the stresses placed by urbanisation and still ensure food security.





**1.16** Countries where fish consumption supplies protein score better on 'diet diversification' than countries with little protein intake. This fish market is in Kumasi, Ghana.



**1.17** A large supply of dried fish in the market beside the River Niger in Mopti, Mali.



**1.18** This market in Madang, Papua New Guinea, sells little more than starchy root crops (such as sweet potato), bananas and peanuts. This market indicates a poorly diversified diet.

dietary guidelines, existence of national nutrition plan or strategy, and existence of regular nutrition monitoring and surveillance.

- ▶ **Micronutrient availability**, which is a composite indicator that measures the availability of iron and vitamin A in the food supply. Sub-indicators include: dietary availability of vitamin A, dietary availability of animal iron, dietary availability of vegetal iron.
- ▶ **Protein quality**, which measures the grams of quality protein consumed using the methodology of the Protein Digestibility Corrected Amino Acid Score (PDCAAS). This methodology assesses the presence of nine essential amino acids in the average national diet. The inputs of this calculation include: the amino acid profile, protein digestibility value, and the average grams consumed of each food item that contributes a minimum of 2% to protein consumption.
- ▶ **Food safety**, which is a composite indicator that measures the enabling environment for food safety. Sub-indicators include: existence of agency to ensure health/safety of food; access to potable water; presence of formal grocery sector.

The FSIs for a sample of selected countries are shown in table 1.3, together with their constituent components.

In addition to the problem faced by the GHI (lack of data in some countries), the FSI faces the problem of **complexity**. The amount of data required to

- ▶ **Food loss**, which is a measure of post-harvest and pre-consumer food loss as a ratio of the total domestic supply (production, net imports and stock changes) of crops, livestock and fish commodities.
- **Quality and safety** measures the variety and nutritional quality of average diets, as well as the safety of food. It comprises five facets:
  - ▶ **Diet diversification**, which measures the share of non-starchy foods (all foods except cereals, roots, and tubers) in total dietary energy consumption. A larger share of non-starchy foods signifies a greater diversity of food groups in the diet.
  - ▶ **Nutritional standards**, which is a composite indicator that measures nutrition governance. It is composed of a three binary ('yes-or-no') sub-indicators that are: existence of national



compile the statistics is huge, and therefore costly to undertake. To address this problem, The Economist has received **financial support** from DuPont that covers the cost of the project. DuPont is a US-based TNC with a broad range of activities including chemicals, energy, and agriculture (including hybrid and genetically modified seeds).

## Disparities in access to food

There are millions of people in the world who are malnourished, and whose main priority is securing an adequate food supply. Although most of these people live in poorer countries, it would be wrong to think that the typical person in developing countries is malnourished. Certainly average daily food intake in poorer countries is less than that of people in richer countries, and this is shown in figure 1.4, and in figures 1.7 to 1.9.

**The world has never produced so much food.** We now have a situation in the world where **enough grain** (mainly wheat and rice) is produced to feed every man, woman and child in the world more than 3,000 calories every day. This is more than enough food to feed everyone adequately – indeed more than adequately – even without allowing for any other food production such as vegetables, fruit, fish and meat.

In the economically developed nations of Europe and North America, there are huge **surplus stocks** of wheat, butter, wine and other foods that simply cannot be sold for a price that would cover the cost of production. Farmers would often prefer to **dump food** into the ground or into the ocean than sell it for a price that is too low. And yet in spite of this **glut** of food on world markets, there have never been so many people suffering from starvation or **malnutrition** than now. It has been estimated that about seven million people are **dying** of hunger or hunger-related disease each year, the equivalent of 21,000 people per day.

**Food production** is increasing in most parts of the world, and as table 1.1 showed, it is even increasing on a **per capita basis** in most parts of the world. In other words, food production is increasing more rapidly than population growth.

Despite this rosy outlook, world food production is constrained because farmers in poorer countries

generally produce **less food per capita** than farmers in industrialised countries. There are many reasons for the difference, including the following:

- In most developing countries, and especially the economically poorest countries, most farming is done on a **subsistence basis**. This means that most of the food grown is consumed by the farmer's immediate family, leaving only a small surplus for commercial sale. Subsistence farmers have neither the incentive nor the means to increase production in order to produce a surplus.



1.19 Traditional farming methods — using animal power to pull a wooden plough near Sodo, Ethiopia.

- **Traditional farming methods** that do not optimise productivity are still used by many farmers. Examples of such methods include broadcasting seeds rather than sowing them in rows and using traditional implements such as wooden ploughs and animal power.
- Because of **poor storage facilities**, there is a large loss of production due to **insect pests**. It is estimated that about 30% of the world's food production is destroyed by rats, grasshoppers and other pests.
- When plots of farming land are divided among the children of a farmer who has died, **small divided landholdings** often result. This is to ensure that each of the children has an equal share of land with different qualities, but it makes the use of machinery impractical and means that valuable time must be spent walking from one small plot to another. On the other hand, the practice does often provide some protection from natural disasters by providing each family with



some land in the valley floor as well as on the slopes and ridges.

- In many poorer countries, **absentee landlords** control much of the farming land. These landlords often charge excessive rental to the farmers, such as a large percentage of the crop grown. The farmers are therefore forced to continue working to pay off their debts to the landlord. This provides little incentive to the farmers to boost production more than is necessary.
- Farmers in poorer countries often do not specialise in one specific crop, but cultivate **many crops**. This is sensible for a subsistence farmer whose diet depends on what is grown, but it means that farmers seldom become experts in growing one particular crop.



**1.20** A farmer cultivates ten different crops on this small plot west of Mount Hagen in the Highlands of Papua New Guinea.

- **Agribusiness** companies often convince farmers to abandon growing food, and switch instead to growing commercial crops such as cotton, rubber, tobacco or tea for export. Because the prices of such crops have fallen in real terms over recent decades, farmers who accepted this option may now find themselves not earning enough money to buy the food they once grew themselves.

**Food security** for people in developing countries has improved greatly in recent decades. This has occurred for four main reasons:

- Many farmers adopted new **high yielding varieties** (HYVs) of crops, especially rice and wheat. These are crops that have been **genetically engineered** to shorten the growing

cycle, enabling double cropping and even triple cropping of farmland. Many of these high yielding varieties were also more resistant to diseases that affected traditional species of crops.



**1.21** Irrigation at Kokolo in the Sahel Desert of Mali uses a labour intensive system of carrying buckets of water from the nearby river.

- **Irrigation** systems became more widespread.
- There was a big increase in the use of **chemical pesticides** and **fertilisers** on farms. Although there can be undesirable side effects on the biophysical environment from the widespread use of chemicals, they also increase farm productivity, at least in the short-term.
- **Mechanical technology** has become much more widespread on the world's farms, enabling a small number of people to achieve tasks that used to require a huge work force.



**1.22** Originally developed from mechanised ploughs, the simple Chinese-made walking tractor is an example of low cost technology used on many farms in East, North-east and South-east Asia. This example is on a collective farm near Sariwon, North Korea.



## QUESTION BANK 1A

1. What is the difference between subsistence and commercial agriculture?
2. Why do farmers in some industrialised countries dump food rather than sell it when there are so many hungry people in the world?
3. With reference to table 1.1, describe the pattern and the trend of world food production.
4. 'The problem with food today is not that we can't grow enough. The problem is that we grow too much but we can't seem to distribute it appropriately'. Critically evaluate this statement.
5. With reference to figures 1.4 and 1.9, describe the pattern of malnutrition in the world.
6. With reference to figures 1.7 and 1.8, describe the trend of malnutrition in the world.
7. With reference to two composite measures of malnutrition, outline the advantages and disadvantages of using composite indicators to analyse malnutrition.
8. Why are farmers in many developing countries less productive than farmers in industrialised countries when measured by the amount of food each farmer produces?
9. What measures are being taken to improve food security in less economically developed countries?

## The nutrition transition

As countries develop economically, **three related transitions** typically occur. One is the **demographic transition**, in which the fertility of the population declines as birth rates decrease, slowing the rate of population growth. As the demographic transition continues, a population shifts from high fertility and high mortality to low fertility and low mortality.

The second transition is the **epidemiological transition**, in which the pattern of diseases shifts away from infectious diseases that are caused by malnutrition and poor sanitation to degenerative, non-infectious diseases that are associated with old age and sedentary urban-industrial lifestyles.

The third transition is the **nutrition transition**. This occurs when a society changes its patterns of food consumption and activity. These changes lead in turn to changes in the types of nutrition-based diseases and conditions experienced by the people

in that society. The nutrition transition is usually thought to pass through five sequential stages, as shown in figure 1.24.

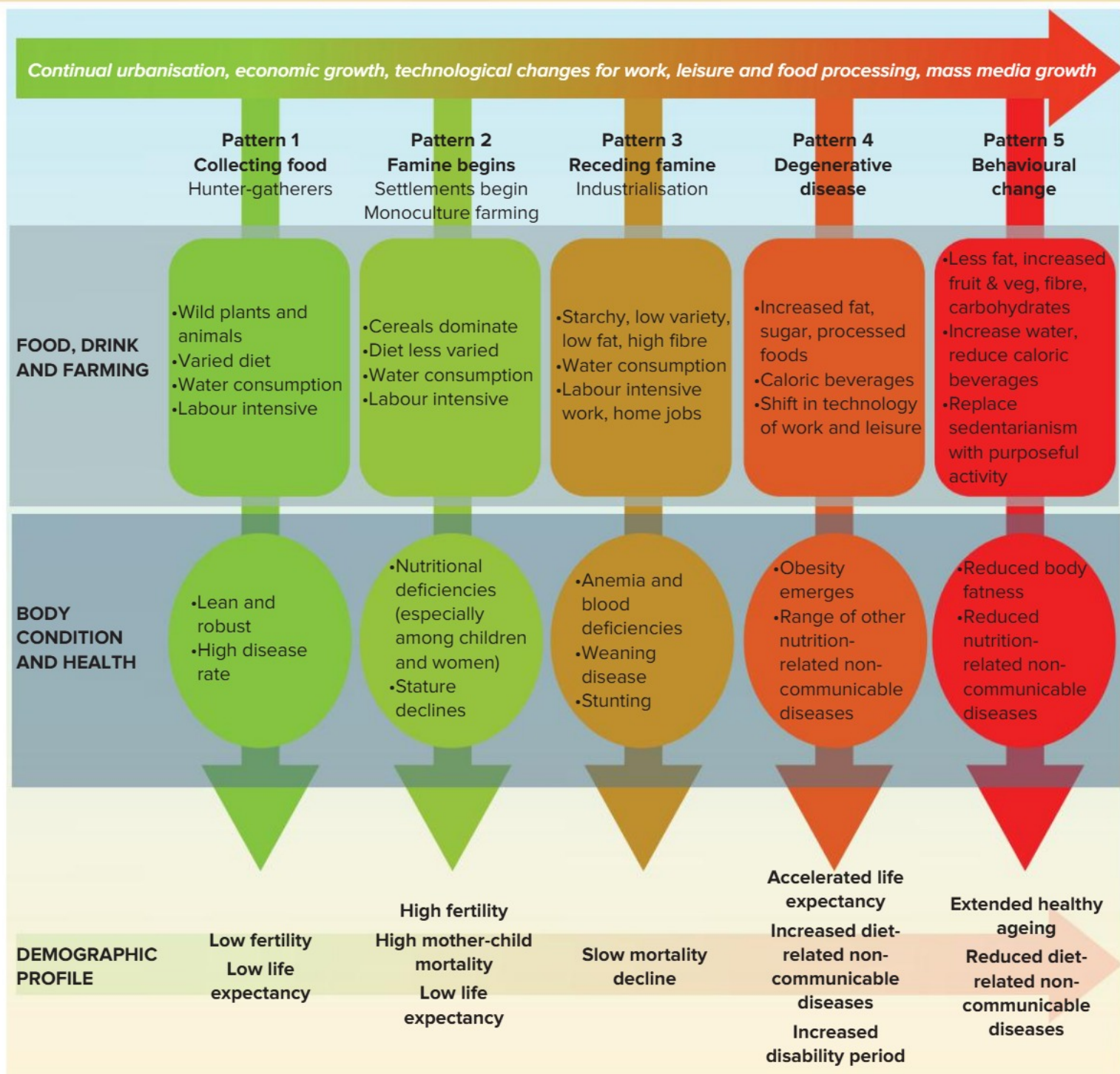
**Pattern 1: Collecting Food.** This first stage of the nutrition transition applies to traditional hunter-gathering societies. There are very few pure hunter-gather societies left in the world today, and so pattern 1 is largely historical, extending right back to paleolithic (old stone age) communities. Although the pattern 1 diet is fairly varied, it is high in carbohydrates and fibre, but low in fats, and especially saturated fats because wild animals tend to have less saturated fats than domesticated animals. In order to survive, people living in a pattern 1 society need to spend a great deal of time and a lot of energy finding food, and so obesity is almost unknown.



**1.23** There are very few pure pattern 1 societies left in the world today, but some traditional societies still show several characteristics of pattern 1, such as a carbohydrate-heavy vegetable-rich diet with little animal fat. This example shows children of the Dani people of West Papua, Indonesia, preparing for a rare celebratory meal in which pig meat has been added to the usual diet of sweet potatoes as a special extra element.

**Pattern 2: Famine Begins.** As settlements are established and food cultivation begins, people abandon nomadism and settle in a fixed location. Once people have more control over their diet by growing their own food, diet becomes less diverse, resulting in a shortening of adults' height by about seven centimetres. As pattern 2 develops, inequalities between genders and social standing often develop, resulting in malnutrition among the disempowered and less empowered members of society. Famines become more common in some societies where the climate varies or where the





**1.24** Stages of the nutrition transition. Source: adapted from BM Popkin (2006) Global Nutrition Dynamics, *American Journal of Clinical Nutrition*, 84(2): p.290

environment is not fully understood, although the more privileged citizens tend to be unaffected by such famines.

**Pattern 3: Receding Famine.** In societies that industrialise, employment becomes more specialised, and an agricultural surplus becomes necessary to feed workers living in the growing cities and towns. Many people therefore gain access to a wider range of types of food than they could ever get if they had to grow all their own produce. Consequently, as the consumption of

vegetables, fruits and animal meat increases, the importance of starchy foods starts to decrease (while still remaining quite important). As a result of a more diversified diet and the beginnings of commercial agriculture, famines become rarer, but because inactivity increases as leisure time grows, people become less lean and muscular.

**Pattern 4: Degenerative Disease.** As countries become more economically developed, there is usually a trend towards greater consumption of convenience foods that are high in fat, cholesterol,





**1.25** Typical food found in a pattern 4 diet — pizzas that have been delivered to a family home in Houston, USA.



**1.26** As more people in wealthy societies adopt pattern 5 diets, fruit and vegetable consumption increases, as indicated by this large area devoted to fresh food in a supermarket in Seattle, USA.

sugar and other refined carbohydrates, but low in both unsaturated fats and fibre. In most wealthy societies, this shift is often accompanied by more sedentary lifestyles. The result of this combination of diet and lifestyle is increased prevalence of obesity and degenerative diseases such as diabetes (type II), atherosclerosis, cancer and heart disease.

**Pattern 5: Behavioural Change.** Pattern 5 is an emerging trend found in some economically wealthy societies where people consciously change their diets in an effort to reduce obesity and postpone the onset of degenerative diseases. The diets in pattern 5 emphasise unprocessed foods that are low in fat, low in carbohydrates (especially sugar), high in fibre, and they tend to increase the intake of fruits and vegetables while decreasing meat consumption. Evidence suggest that people

who adopt pattern 5 nutrition tend to postpone infirmities and prolong disability-free lifespans.

Although progression through each stage of the nutrition transition is closely related to the process of economic development, **globalisation** is spreading energy-dense but nutrient-deficient pattern 4 diets to less economically developed countries, leading to a more rapid shift from pattern 2 and pattern 3 diets. This is especially so for residents in large cities and towns that have relatively open access to world food markets, and to people living where transport links are good.

As diets change in poorer countries, obesity is posing health problems and some local farmers are even changing their production to emphasise foods that fit more within pattern 4 diets than patterns 2 or 3. The increase in degenerative diseases caused by obesity is placing growing pressure on the health systems of many countries, increasing costs and imposing a growing economic burden. It is expected that by 2030, diseases of overnutrition will overtake diseases of undernutrition in the world's economically poorer countries.



**1.27** A supermarket in Mount Hagen, a town in the central Highlands of Papua New Guinea, features sugar-based soft drinks, carbohydrate-heavy cakes and bread, and imported foods such as grains, reflecting the impact of globalisation on the nutrition transition in this economically poor country.

## QUESTION BANK 1B

1. Explain how the demographic transition, the nutrition transition and the epidemiological transition are related.
2. What differences would you expect in food consumption and nutrition choices in different parts of the world that are at different stages in the nutrition transition?



## Global patterns in health indicators

### Variations in health

Most societies regard people as their most precious resource. Few things matter more to people than their good health. **Good health** affects the way people feel and ultimately the length of their lives. Even in economic terms, a healthy population is important. A population that is weakened by sickness and disease will not work well and will cost the society large sums of money in health care.

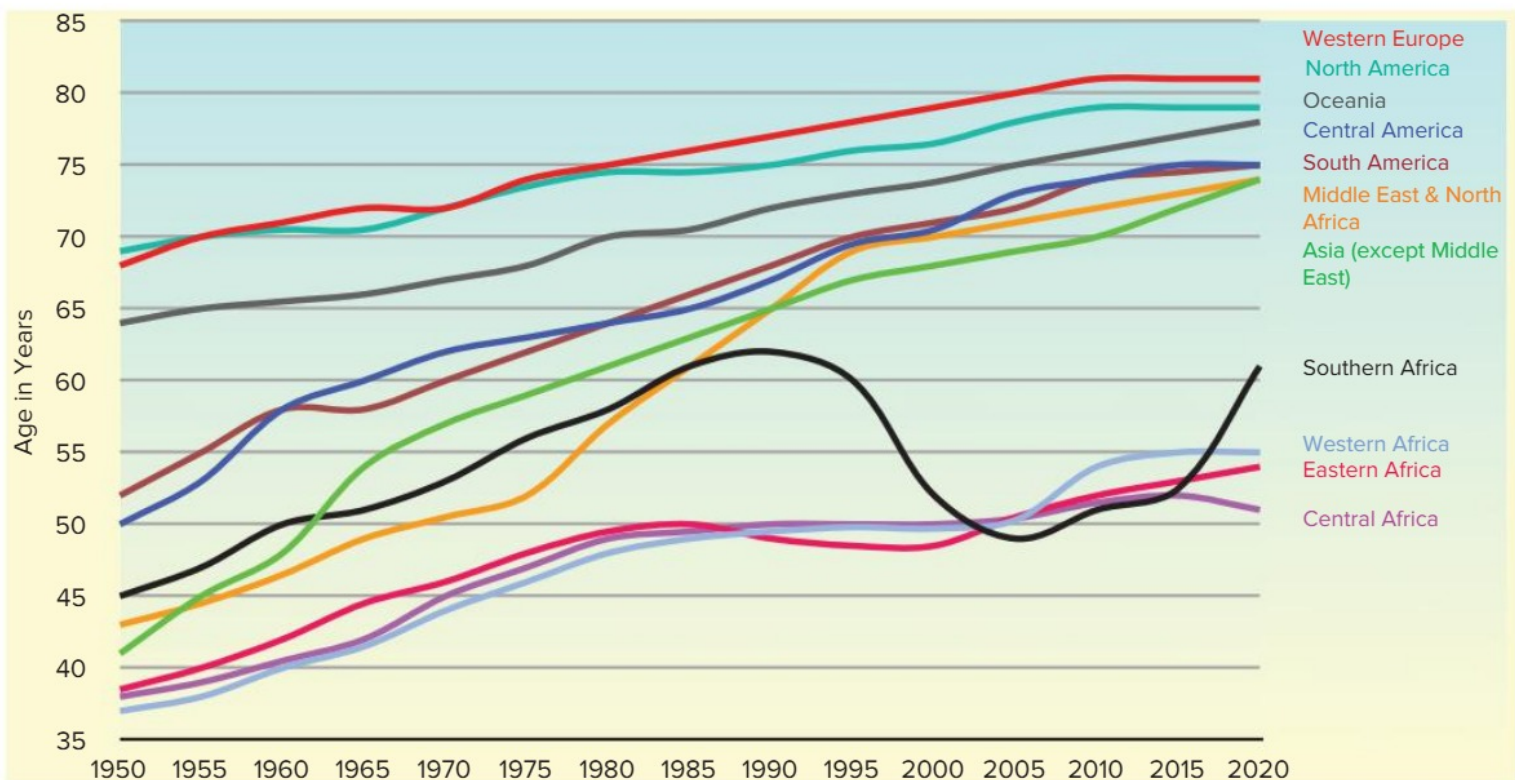
Like many features in the world, **health is distributed unevenly**. Many different indicators are used to measure the quality of health, but perhaps the most basic is **life expectancy**, which is defined as the average number of years that a person may expect to live at the time of their birth. There has been a long-term trend for average life expectancies to increase in most parts of the world, and this has been very evident in the period from 1950 to the present day (figure 1.28). Nonetheless, there are significant differences, as can be seen by looking at the present world pattern of life expectancy (figure 1.30).

Despite the overall improvements in health standards, even today Africans can expect to live an

average of only 55 years, compared with Asians 72 years and South Americans 74 years. The average life expectancy in Sierra Leone (West Africa) is 54 years, while half of all Zambians die before reaching 41. The average life expectancy in Eswatini is 58, up from 45 years in 2004, but still worse than 30 years earlier. In 1990 it was 59 years, the difference being due to the **impact of AIDS**. Indeed, figure 1.28 shows a large dip in the trend of life expectancies in southern Africa from 1990 to 2020, and this is largely the results of AIDS.

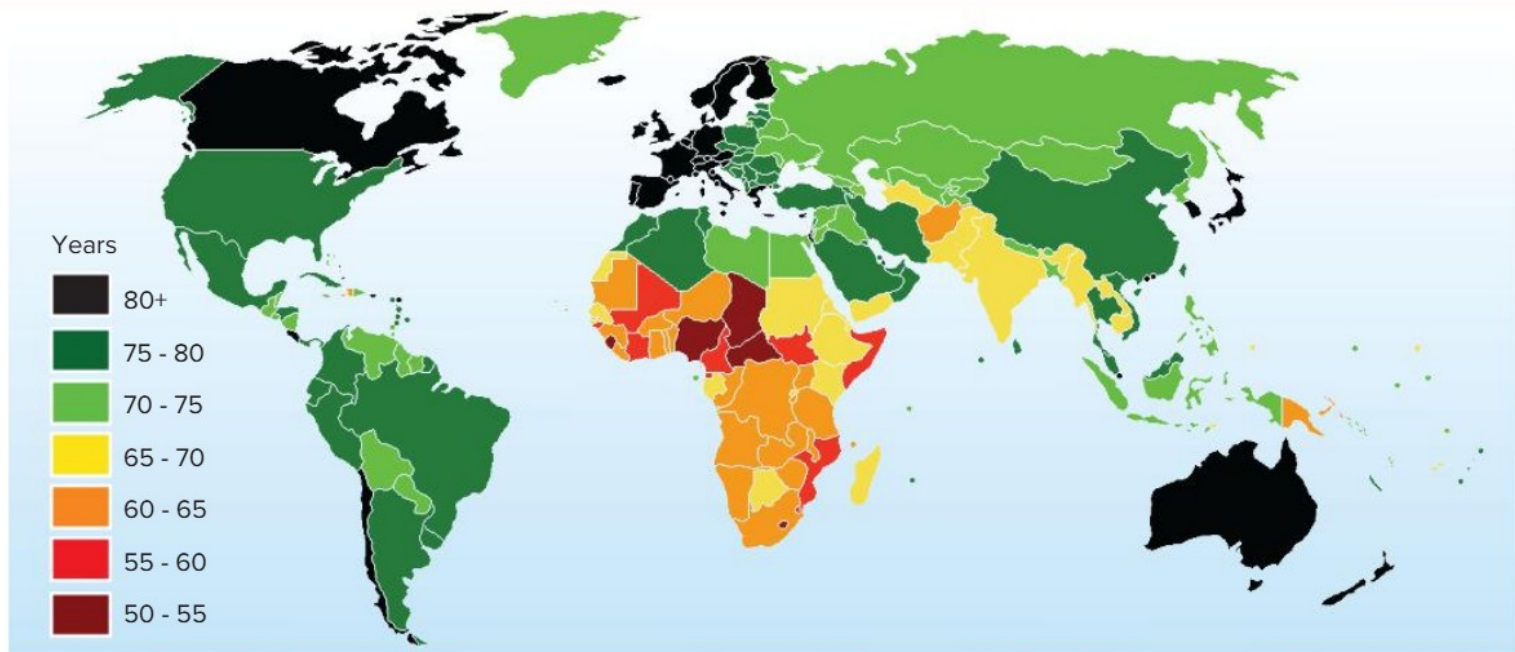


**1.29** AIDS continues to reduce life expectancies in several less economically developed countries with poorly developed health care systems. This AIDS warning sign is in Andranomaintso, Madagascar. The message in Malagasy reads "Let's take action to overcome AIDS. Let's get HIV testing for protection and treatment".



**1.28** Life expectancy at birth, selected regions, 1950 to 2020. Source: UNAIDS, United Nations Population Division. World Population Prospects, Census reports and other statistical publications from national statistical offices



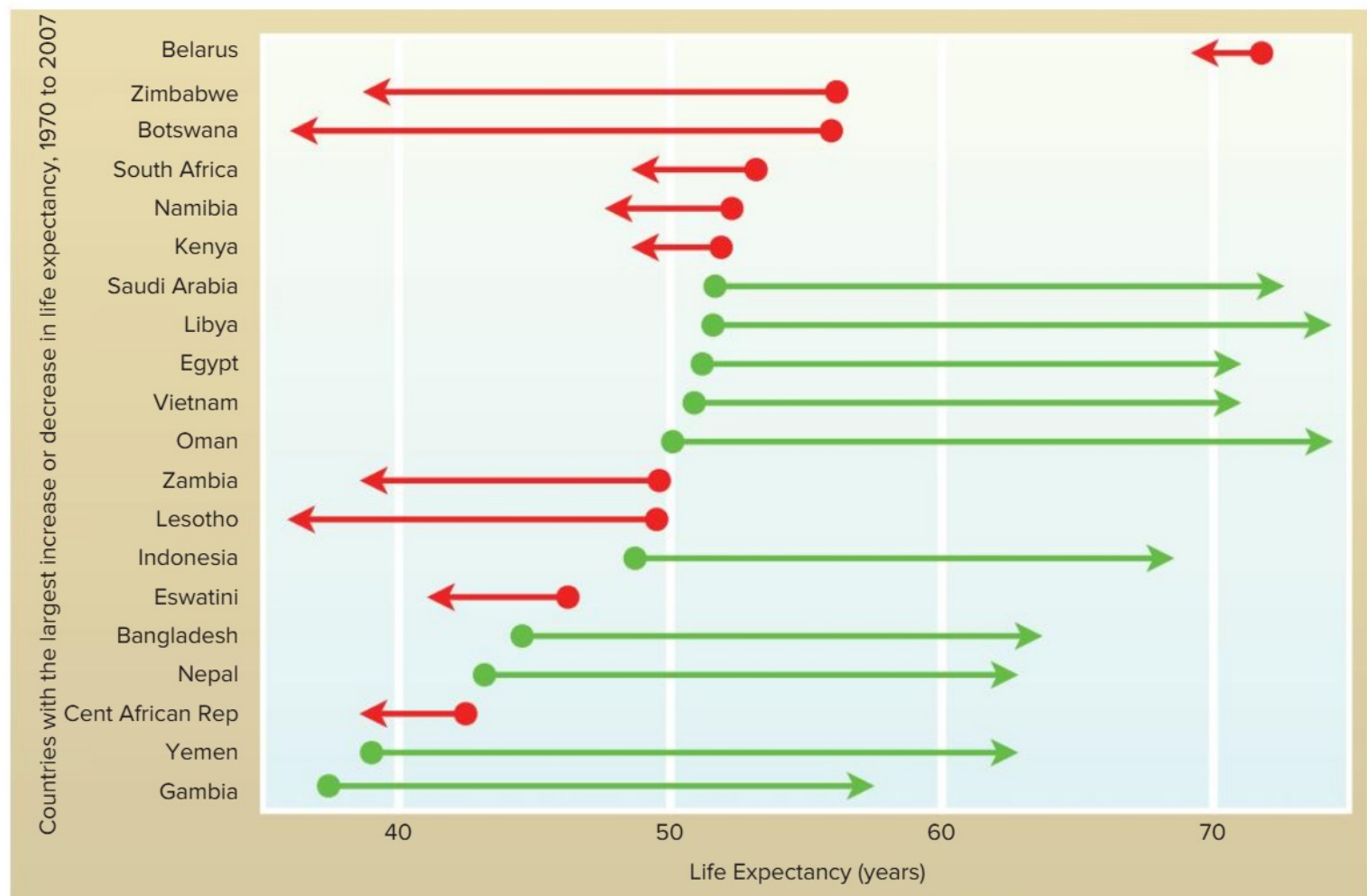


1.30 Life expectancy at birth, 2020.

Further evidence of this pattern is provided in figure 1.31, which shows the twenty countries with the largest **changes in average life expectancies** between 1970 and 2007, the period in which AIDS had its maximum impact. This graph shows an overall trend towards longer life expectancies (in

green), the exceptions being several African countries (nine of the ten countries shown in red) where life expectancies decreased markedly because of the impact of AIDS.

On the other hand, medical advances have improved the health of Europeans, who live to an



1.31 Changes in life expectancy during the period when AIDS affected demographics in selected countries, 1950-2007. Source: United Nations Population Division. World Population Prospects



average age of 81 years, as well as Americans (79 years), Canadians (82 years) and Japanese, who have the world's longest average life expectancy (apart from the micro-states of San Marino and Hong Kong) — 84 years.

## QUESTION BANK 1C

1. Describe the pattern shown in figure 1.30.
2. Describe and account for the contrast in life expectancies between industrialised and developing countries.
3. Describe the overall trend shown in figure 1.28, noting and explaining any exceptions.
4. Suggest reasons for each the 20 trends in life expectancy shown in figure 1.31.

## Measuring health

Life expectancy, as discussed in the previous section, is a somewhat **crude measure** of health standards as it fails to consider the negative impact that poor health can have on quality of life. For this reason, several other indicators are used to measure global health.

Table 1.4 shows data for four of these alternative measures of health, with figures for the same 30 countries shown in table 1.3. Like life expectancy, two of the indicators in table 1.4 are **outcomes** of health – infant mortality rate and maternal mortality rate. The remaining two factors – access to improved sanitation facilities and physicians per person – are factors that **contribute** to health. All four indicators are **single factor** measures, or simple measures, of health.

The **infant mortality rate** measures the number of children who die before reaching the age of five, and it is usually expressed as a number per 1,000 live births to enable comparisons between countries with different population sizes to be made. Infant mortality rate directly reflects the quality of health care in a country, and less directly, a country's socio-cultural, economic and environmental conditions including income levels, nutritional quality, and quality of sanitation. In 2019, the average infant mortality rate for the world as a whole was 29 per 1,000. Figures ranged from a low of 1 per 1,000 in Finland, and 2 per 1,000 in Cyprus, Estonia, Iceland, Japan, Luxembourg, Montenegro, Norway, San Marino, Singapore, Slovenia and Sweden, up to 76 per 1,000 in Nigeria, 77 per 1,000

Table 1.4  
Global health indicators, 2019

	Infant mortality rate (per 1,000 live births)	Maternal mortality rate (per 100,000 live births)	Population with access to improved sanitation facilities (%)	Physicians per 1,000 people (2015 figures)
Singapore	2	6	100	2.3
United States	6	28	90	2.6
Switzerland	4	5	100	4.2
Norway	2	6	76	4.6
Canada	4	11	82	2.6
Germany	3	8	97	4.2
Australia	3	5	96	3.6
UK	4	7	98	2.8
Japan	2	8	99	2.4
Malaysia	7	25	89	1.5
China	7	23	72	1.8
Russia	6	12	61	4.0
Mexico	11	38	50	2.2
Indonesia	21	313	61	0.38
India	30	170	40	0.78
Myanmar	37	320	55	0.86
Mali	62	368	19	0.139
Bangladesh	25	210	33	0.527
Cambodia	24	170	42	0.168
Ethiopia	39	676	28	0.100
Uganda	34	432	18	0.091
Zambia	40	398	16	0.090
Haiti	50	630	24	0.235
Mozambique	54	443	16	0.074
Syria	14	65	42	1.220
Madagascar	38	480	12	0.181
Chad	71	860	8	0.048
Yemen	43	150	17	0.310
Burundi	41	500	8	0.050
Venezuela	21	72	24	1.924

Countries arranged in same order as table 1.3. Source: World Bank data.

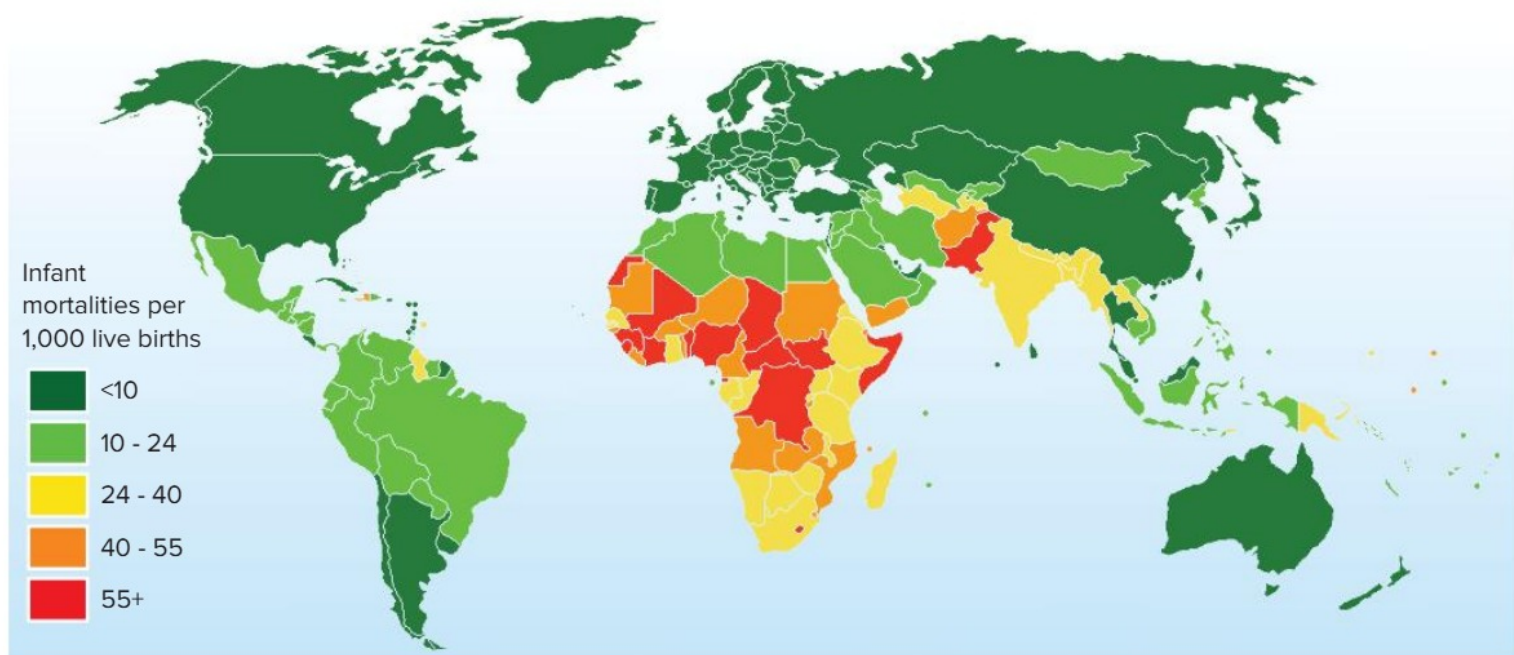


in Somalia, 79 per 1,000 in Sierra Leone and 85 per 1,000 in the Central African Republic.

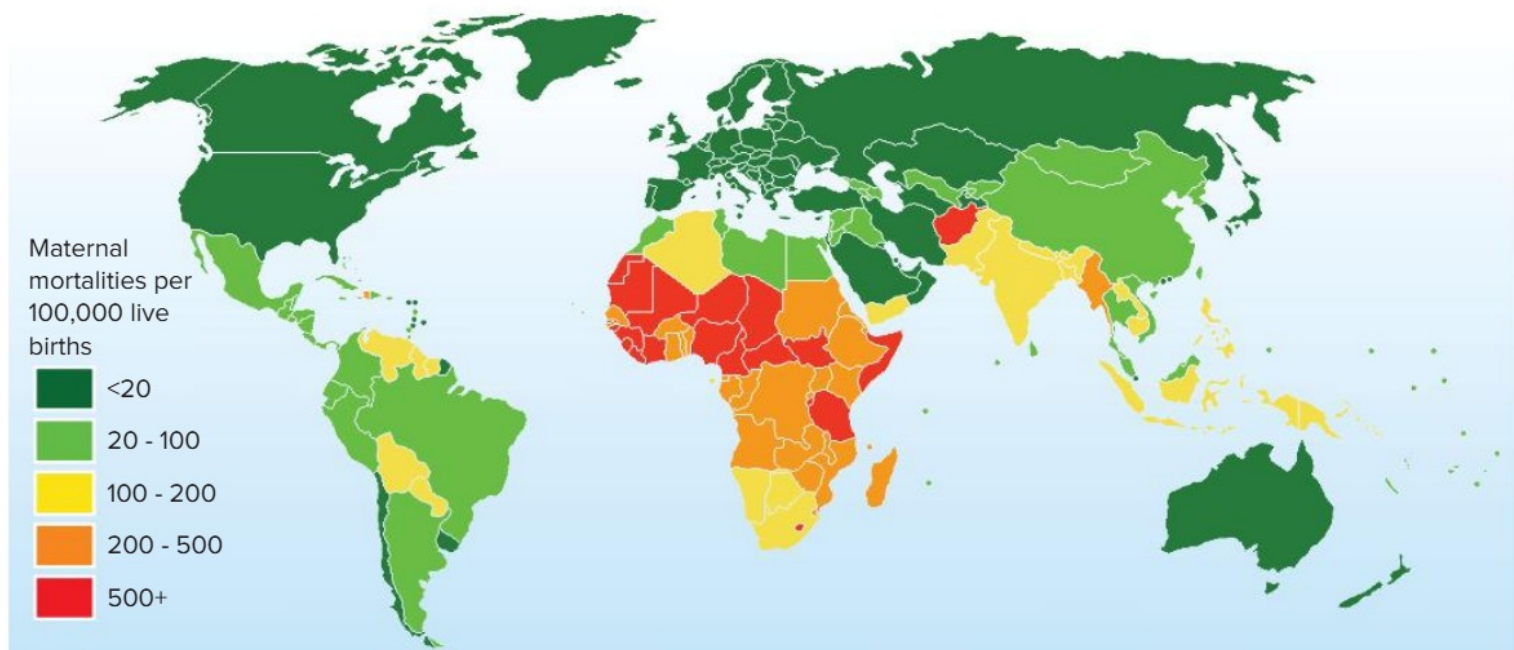
**Maternal mortality rate** measures the number of women who die during childbirth, expressed as the number of deaths per 100,000 live births. Like infant mortality rate, the maternal mortality rate reflects the quality of health care in a country. In 2019, the average world-wide maternal mortality rate was 210 deaths per 100,000 live births. Countries with low rates of maternal mortality included Belarus, Italy, Norway, Poland, (2 per 100,000), and Czechia, Finland, Greece, Israel and the United Arab Emirates (3 per 100,000). At the other end of the scale, the six countries with the

highest rates of maternal mortality were Somalia and the Central African Republic (both 829 per 100,000), Nigeria (917 per 100,000), Sierra Leone (1,120 per 100,000), Chad (1,140 per 100,000), and South Sudan (1,150 per 100,000).

**Access to improved sanitation** measures the proportion of a country's population that has access to flush toilets, piped sewerage systems or a septic toilet, or a composting toilet. Better sanitation improves hygiene, which reduces the prevalence of disease and thus improves health. In 2019, the average world-wide level of access to safely managed sanitation was 45% of the population. Only seven countries reported 100% access, these

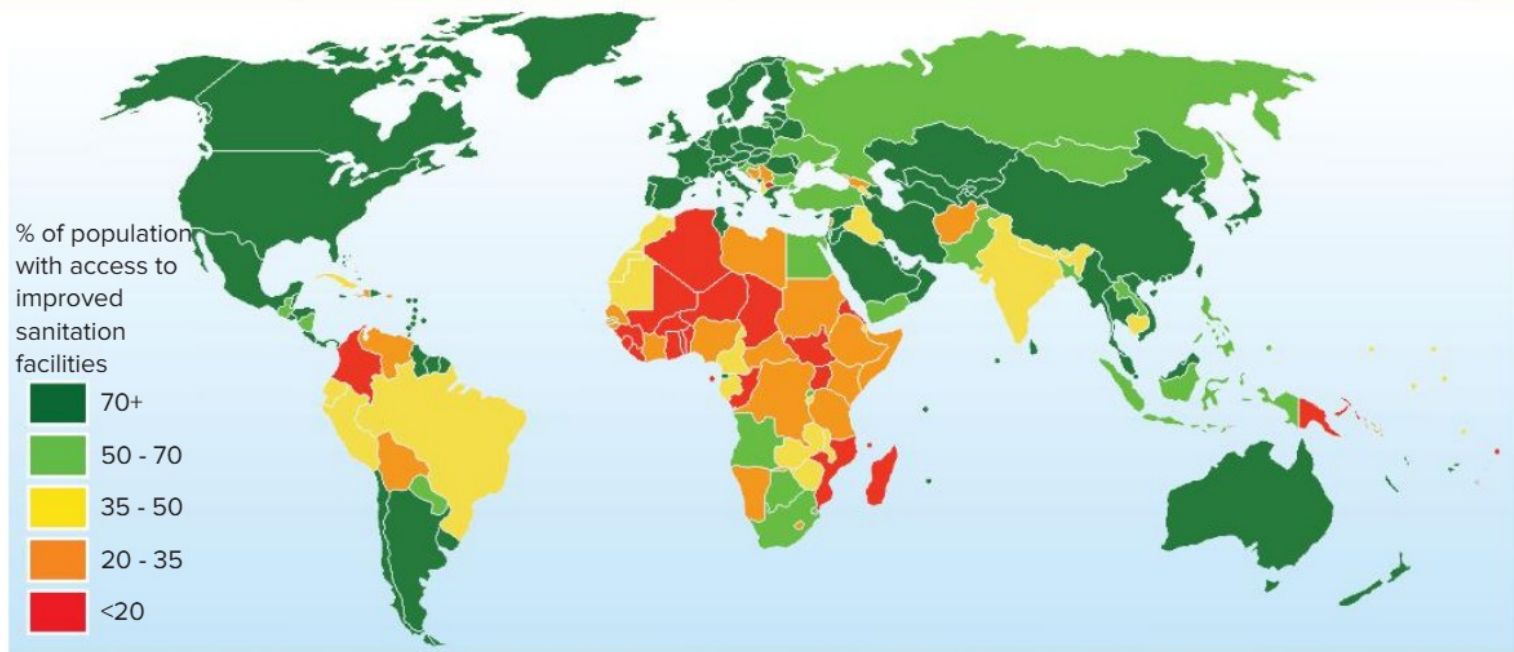


1.32 Infant mortality rate per 1,000 live births, 2019.

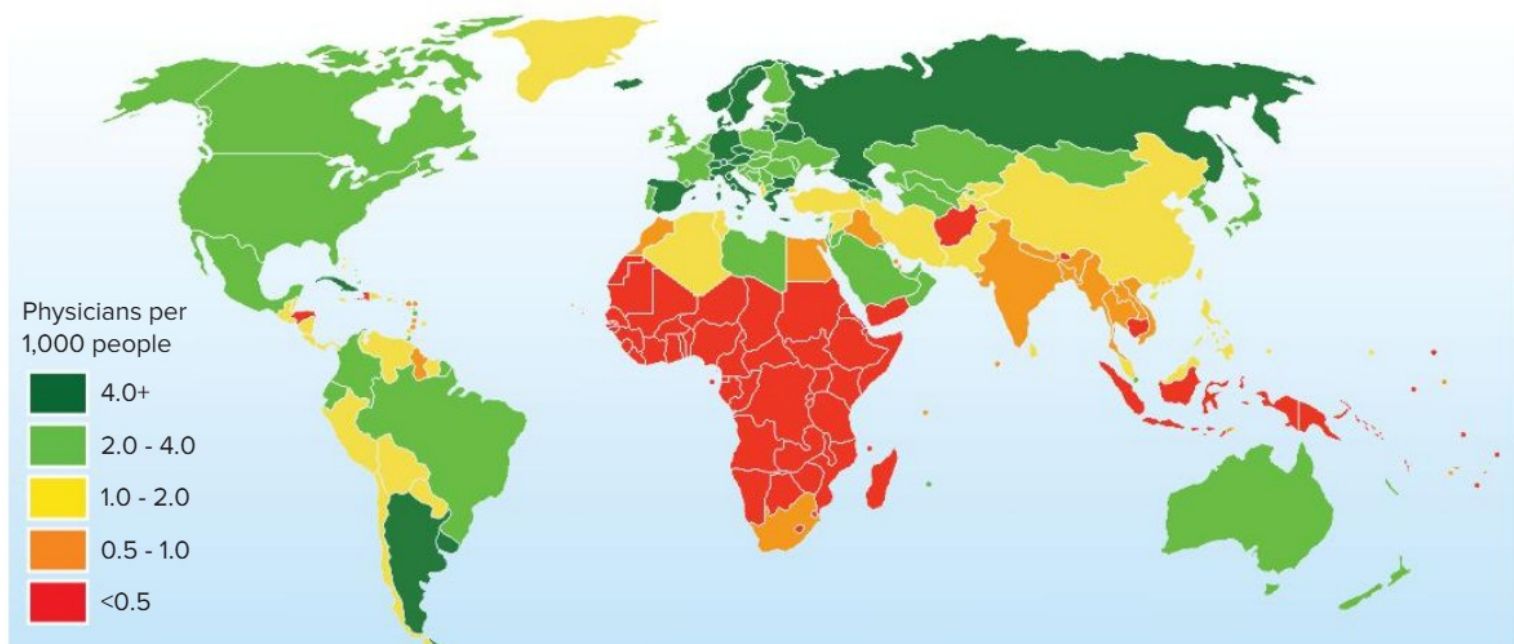


1.33 Maternal mortality ratio, expressed as maternal deaths per 100,000 live births, 2019.





1.34 Percentage of the population with access to safely managed sanitation facilities, 2019.



1.35 Physicians (doctors) per 1,000 people, 2019.

being Andorra, Kuwait, Liechtenstein, Monaco, Singapore, South Korea and Switzerland. The eight countries with the lowest levels of access to improved sanitation were Senegal (21%) Mali (19%), Algeria (18%), Colombia and North Macedonia (17%), Sierra Leone (13%), Niger (10%) and Tuvalu (6%).

The number of **physicians (or doctors) per 1,000 people** is a direct measure of the quality of health care in a country, assuming equal productivity of all doctors. In 2018, there was a world-wide average of 1.5 doctors per person. Among the countries that reported statistics on physician numbers, the most generous ratios were in Cuba (8.2 doctors per 1,000 people), Monaco (6.6 per 1,000), San Marino (6.1 per

1,000), Sweden (5.4 per 1,000), Austria (5.1 per 1,000), Georgia (5.1 per 1,000), and Uruguay (5.0 per 1,000). Countries with low ratios of doctors per person included Papua New Guinea (0.053 doctors per 1,000 people), Niger and Burundi (both with 0.050 doctors per 1,000 people), Togo (0.049 per 1,000), Chad (0.048 per 1,000), Tanzania (0.040 per 1,000), Liberia (0.037 per 1,000), Sierra Leone (0.025 per 1,000), Somalia (0.023 per 1,000) and Malawi (0.016 per 1,000).

**Composite indicators** of health attempt to produce less crude measures by combining several factors. For example, it would be possible to produce a composite measure of health by combining the five measures discussed so far into one figure.



## QUESTION BANK 1D

1. Produce a composite indicator of health by using the maps in figures 1.30, 1.32, 1.33, 1.34 and 1.35. For each map, you should allocate 5 points for a country if it is coloured dark green, 4 points for light green, 3 points for yellow, 2 points for orange, and 1 point for red. Using this framework, allocate and add the five numbers (one from each map) for each of the following countries: Australia, Brazil, Chad, China, Cuba, Ethiopia, Germany, India, Iran, Mali, Russia, United States and – if it is not listed already – the country where you live. Choose two more countries that interest you, add these to your list, and calculate their scores too.
2. Describe the types of countries with high scores, and those with low scores.
3. Rank the list of 14 or 15 numbers you have developed from the highest number to the lowest.
4. Using the ranking you developed in the previous question, describe the relationship between health and the level of economic development (or wealth) of a country.
5. Which is more useful to examine global patterns of health – precise statistics such as those in table 1.4, or banded data like the maps in figures 1.30, 1.32, 1.33, 1.34 and 1.35. Outline the advantages and disadvantages of each type of data.
6. Reflect on the composite indicator you have just calculated:
  - a. Should the five factors have equal weighting, or should one or more factors be weighted differently?
  - b. Should any of the factors be excluded or replaced by another factor (such as calorie intake, access to hospital beds, government expenditure on health care per person, etc)?
  - c. How would you suggest the composite indicator calculated in question 1 could be improved?

To overcome the shortcomings of single factor indicators, Canadian statisticians developed a more finely-tuned measure called the **HALE (health-adjusted life expectancy)** in the early 1990s. Whereas previous measures of life expectancy considered all years of life as being equal, the HALE weighted years of life according to health status, with healthy years being regarded as more valuable than years spent in poor health (due to disease or injury). In essence, the HALE is measured by calculating the number of years that a person can expect to live in full health, based on current rates of ill-health and mortality in that society. The gap between HALE and life expectancy represents society's **burden of ill health**.

The statisticians who developed HALE applied it to Canadian society at the time to ascertain the burden of ill health. The results of that initial study, which are shown in table 1.5, revealed that there is a greater gap between HALE and life expectancy for women than for men, and hence women have a greater burden of ill health. This suggests that although they live longer lives than men, women are more likely to be affected by the types of conditions that place a burden on the health care system than men.

As shown in table 1.5, the burden of ill health varied according to age group. At age 15, the difference between life expectancy and HALE in Canada was 14% for women and 11% for men, indicating a higher burden of ill health for women. One of the reasons for the **gender difference** is that

Table 1.5  
Life expectancy and HALE, Canada, 1990-92

BOTH SEXES					MEN					WOMEN				
Life Expectancy					HALE					Difference				
At Age...					At Age...					At Age...				
years	years	years	years	%	years	years	years	years	%	years	years	years	years	%
15	63.4	55.6	7.8	12	15	60.3	53.7	6.6	11	15	66.6	57.4	9.2	14
25	53.8	46.7	7.1	13	25	50.9	44.9	6.0	12	25	56.8	48.4	8.4	15
35	44.3	37.9	6.4	14	35	41.5	36.1	5.3	13	35	47.0	39.4	7.6	16
45	34.8	29.2	5.6	16	45	32.1	27.5	4.6	14	45	37.4	30.7	6.8	18
55	25.9	21.3	4.6	18	55	23.4	19.6	3.8	16	55	28.3	22.7	5.6	20
65	17.9	14.3	3.6	20	65	15.7	12.9	2.9	18	65	19.9	15.4	4.5	23
75	11.2	8.5	2.7	24	75	9.6	7.5	2.1	22	75	12.5	9.0	3.5	28
85	6.3	4.4	1.9	30	85	5.4	3.8	1.6	29	85	6.9	4.4	2.5	36

Source: Social and Economic Statistics Division, Statistics Canada.



on average, women live longer than men. As chronic health problems are more prevalent in old age, it follows that women tend to spend a longer period of life with chronic health problems than men. The Canadian research also showed that chronic health problems are less common among the **wealthier members** of society, who also tend to live longer than poorer people.



**1.36** HALE shows that on average, women have longer life expectancies than men. As a consequence of these longer life expectancies, women are more likely than men to suffer from chronic health problems associated with ageing, such as adult onset diabetes, arthritis, kidney and bladder problems, dementia, Parkinson's disease, glaucoma, lung disease, cataracts, osteoporosis, enlarged prostate, Alzheimer's disease, macular degeneration, depression, or cardiovascular disease, and may require ongoing care in health facilities.

A more complex way of measuring the cost burden on a society imposed by poor health is the **disability-adjusted life year (DALY)**. DALY was developed by the World Health Organisation and the World Bank in the mid-1990s to provide a single figure that measures the impact on a society of premature death and disability.

Disability-adjusted life years are calculated using the formula  $DALY = YLL + YLD$ , where YLL represents Years of Life Lost and YLD represents Years Lived with Disability. On this basis, one DALY represents one year of healthy life that is lost.

As a result of applying the DALY measure, the World Health Organisation announced that five of the ten main causes of disability in more economically developed countries were psychiatric conditions, and that psychiatric and neurological conditions accounted for 28% of all the years that are lived with disabilities.

The use of DALYs has been criticised by some researchers because of the **value judgements** said to be implicit in the measure. For example, because future years of life are discounted for disabilities, it has been calculated that 3,300 DALYs would equal 100 infant deaths or 5,500 people aged 50 living for one year with blindness. While such comparisons may be helpful for planners who are assessing priorities for health care, critics argue that the age-weighting and discounting are **discriminatory**, and may lead to a diversion of health care resources away from needy cases.

Another composite indicator that is related to both HALE and DALY is the **Potential Years of Life Lost (PYLL)**. This measure quantifies the potential years of life that are lost by examining the average age of death resulting from certain medical conditions, and comparing this with the average life expectancy. To calculate the PYLL, the number of deaths in a country that result from particular cause or condition (or set of related conditions) are added for each age group, and then multiplied by the number of remaining years to live up to a selected age limit. If the average life expectancy is not used, then an arbitrary age limit of 70 is usually selected, although some countries choose to use 65 instead.

There is no standard way of expressing PYLL, and it can be stated either in absolute years per disease or condition, or as a ratio comparing the years lost to the average life expectancy.

## QUESTION BANK 1E

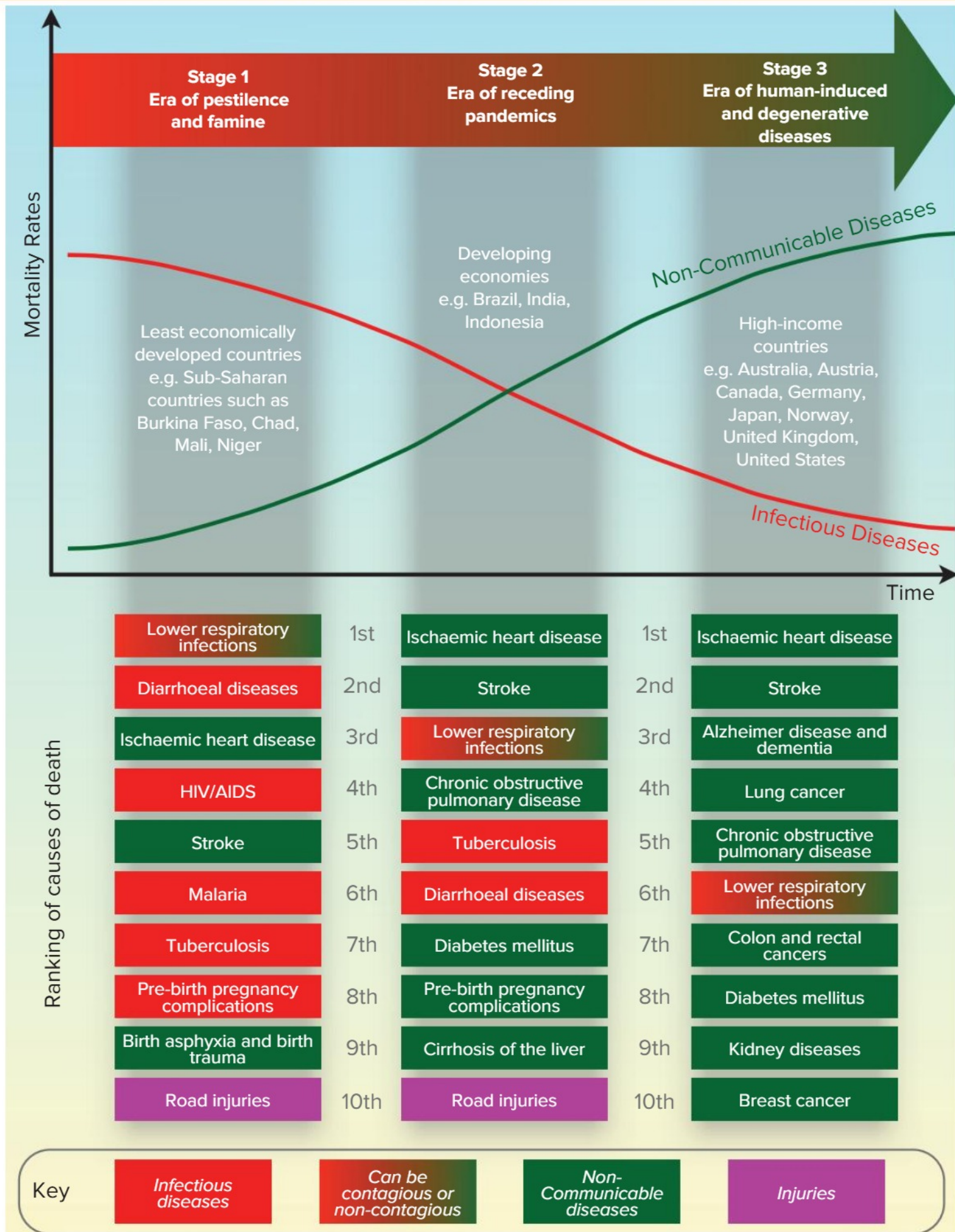
1. Explain the difference between life expectancy and HALE.
2. Explain what is meant by the term 'burden of ill health'.
3. Study the information in table 1.5. Describe the main patterns evident and suggest reasons for these patterns.
4. Discuss the arguments for and against the use of DALYs as a useful indicator of health.
5. Which is most useful to examine global patterns of health — HALE, DALY or PYLL? Give reasons for your answer.

## Trends in global health

### The epidemiological transition

Earlier in this chapter, the **epidemiological transition** was identified as the trend in which the pattern of diseases in a country shifts away from





1.37 Stages of the epidemiological transition, and leading causes of death, 2018. Source of causes of death data: WHO.



infectious diseases that are caused by malnutrition and poor sanitation to degenerative, non-infectious diseases that are associated with old age and sedentary urban-industrial lifestyles.

The epidemiological transition is usually divided into three stages, or eras. **Stage 1** is known as the **era of pestilence and famine**, and it is characterised by high death rates arising from the high incidence of contagious diseases such as diarrhoea, malaria, tuberculosis and HIV/AIDS. As a result of the high death rates, average life expectancy is typically in the high 40s or low 50s, as seen in several Sub-Saharan countries in Africa.



**1.38** Infectious diseases such as malaria are still significant causes of illness and death in many poorer countries, so governments conduct public awareness campaigns, such as this large sign in Kumasi, Ghana.

Countries enter **stage 2**, which is the **era of receding pandemics**, as a result of improvements in the quality of medical care, hygiene and diets. The rate of population growth increases as death rates decline and pandemics become less frequent. Average life expectancy rises to an average in the 60s, as seen today in rapidly industrialising countries such as India, Indonesia and Brazil.

As economic development progresses, medical care, hygiene and diets continue to improve, leading to the reduction or elimination of many infectious diseases. When this happens, a country enters **stage 3**, which is the **era of human-induced and degenerative diseases**. At this point, life expectancies rise into the 70s and 80s as non-communicable and degenerative diseases replace contagious diseases as the main cause of illness and death. This situation can be seen today in high income countries in North America, Europe, Australasia and parts of East Asia.



**1.39** As disposable incomes rise in poorer countries, people may become more vulnerable to human-induced diseases such as lung cancer, which increases when rates of smoking rise. This anti-smoking sign in Cotonou, Benin, urges residents (in French) to “demand an environment without tobacco”.

As a consequence of the processes evident in the epidemiological transition, there are significant differences between the **diseases** which affect people in traditional societies compared with the diseases that affect people in industrialised nations. Some of the diseases and health conditions that are found in poorer countries, such as malnutrition, malaria, river blindness and cholera, are sometimes referred to as **diseases of poverty**. On the other hand, health problems that become more common as a country industrialises and becomes wealthier, such as heart disease, obesity, strokes and cancers, are sometimes called **diseases of affluence**, or **diseases of over-development**.

## The diseases continuum

There is a **sharp difference** in the types of diseases found in different parts of the world. As a broad generalisation, the main medical problems found in poorer countries are diseases of poverty, whereas the main medical issues found in wealthier countries are increasingly diseases of affluence.

**Diseases of poverty** are medical conditions that are more commonly found among poorer people and in less economically developed countries. Poverty is often an important contributor to the causes of diseases in these areas, either directly or indirectly.

There are **five distinctive causes** of poor health in poorer countries. These causes are poor diet, poor hygiene, water-borne parasites and bacteria, other pests, and poor public health facilities combined

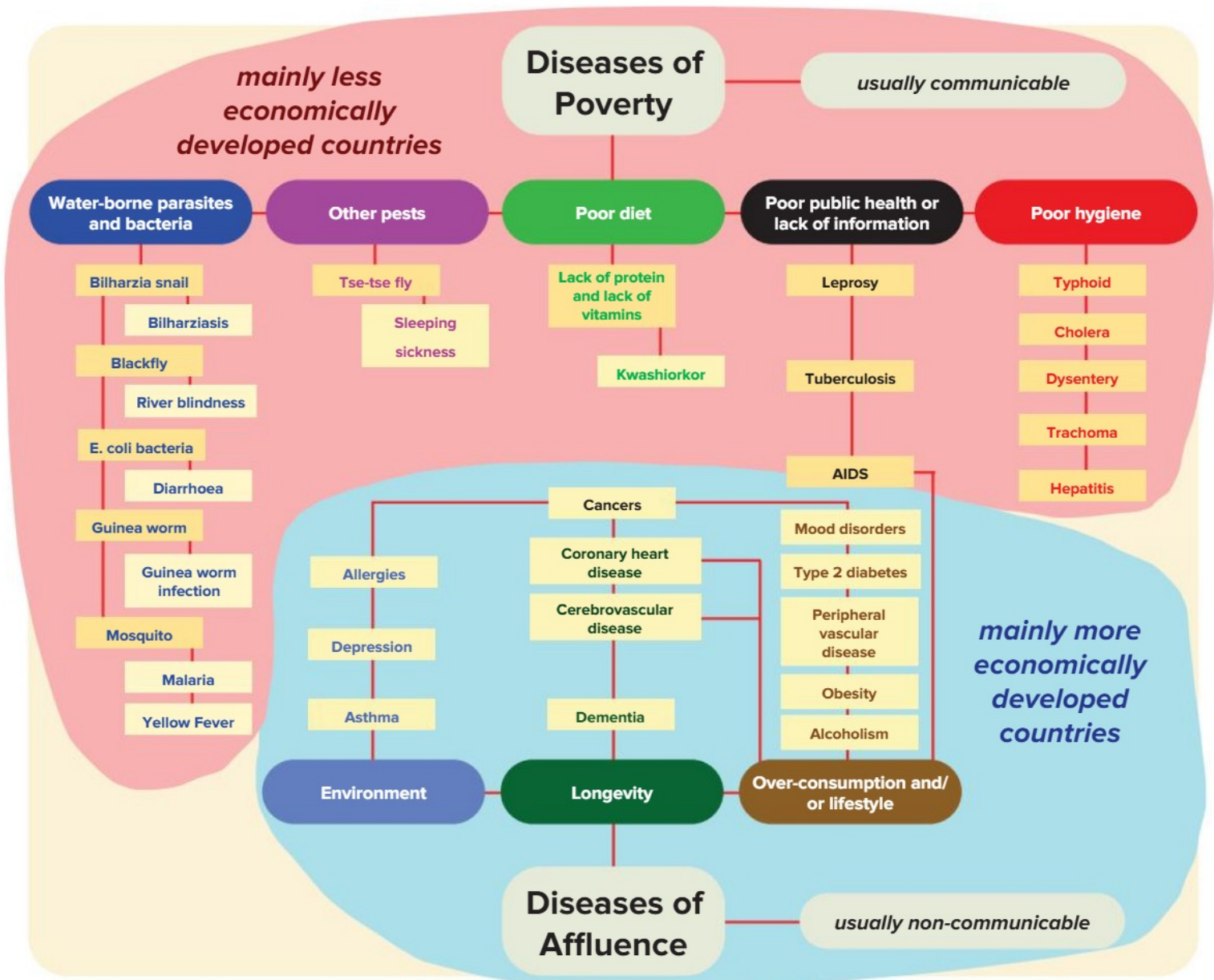


with lack of information or education. Each of these causes can lead to diseases of poverty, and some examples are shown in the pink sector of figure 1.40. In general diseases of poverty are **communicable**, which means they are **contagious** and can be passed from one person to another.

In contrast to the common medical problems in poorer countries, many of the significant diseases in more economically developed countries are **diseases of affluence**, which can be defined as medical conditions that are the consequence of increasing wealth in a country. There are **three main causes** of diseases of affluence (as shown in the blue sector of figure 1.40), these being increased longevity, environmental quality, and the combined impact of over-consumption and lifestyle. Diseases of affluence are mostly **non-communicable**.

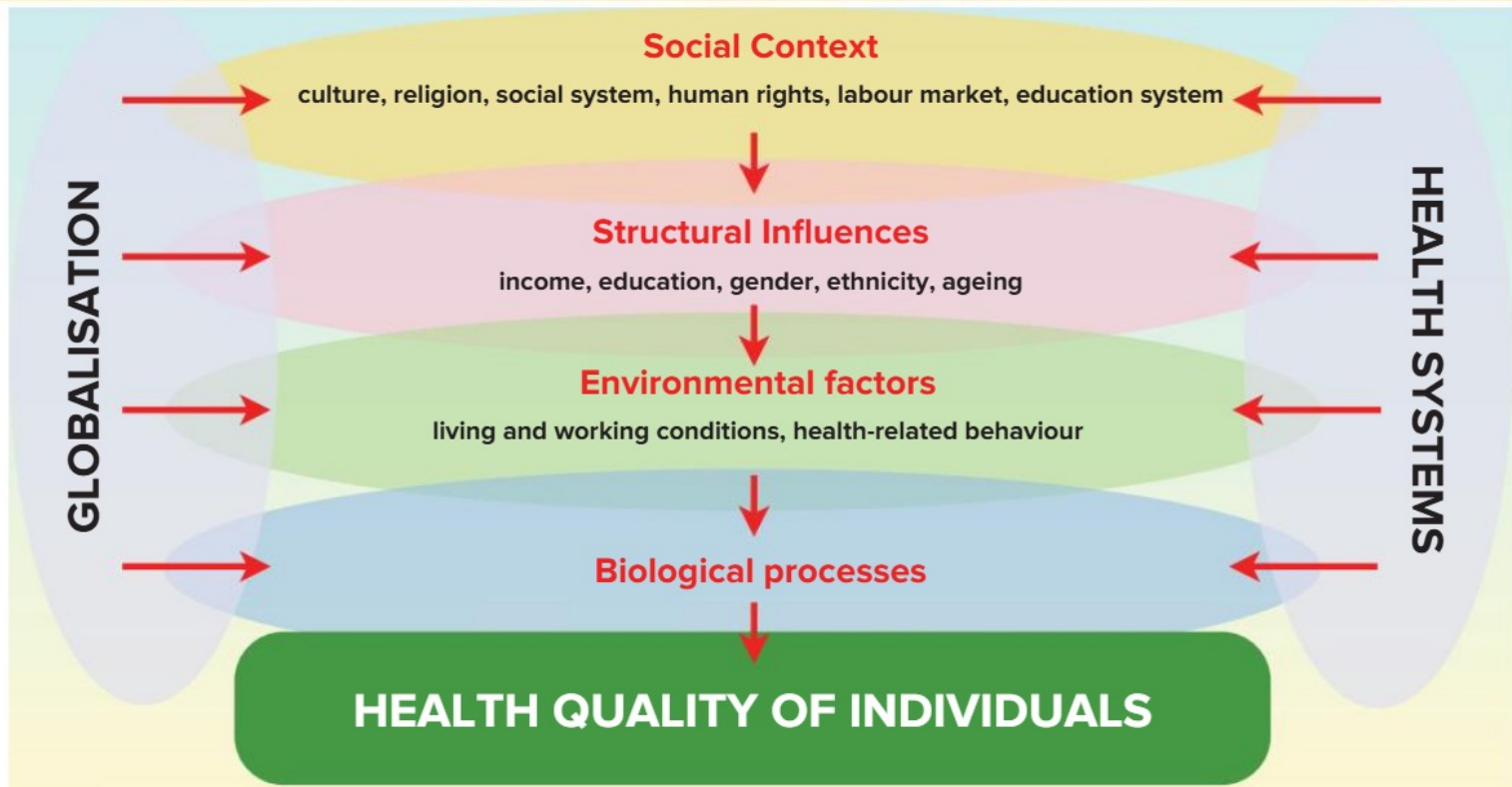
The **global distribution** of the diseases shown in figure 1.40 closely follows the broad world patterns shown in figures 1.32 and 1.33. It is important to remember, however, that there are significant variations in wealth within most countries as well as internationally, and **domestic disparities** in wealth also affect the patterns of health within countries.

Regardless of whether people live in poorer or wealthier countries, there are some common overlapping factors that help to explain the state of people's health. These are sometimes known as the **influences on the quality of people's health**. The influences, which are explained in figure 1.41, include several aspects of an individual's social context, which combine to affect the particular structures within their society. These in turn affect



1.40 Diseases of affluence and diseases of poverty.





1.41 Influences on the quality of people's health.

the environment in which a person lives, which then has an impact on their biological processes which finally determine the quality of their health. All these causes are in turn affected by wider external factors, including the country's health system and even the impact of globalisation as people become more internationally mobile and as transnational corporations become more and more involved in supplying medicines internationally.

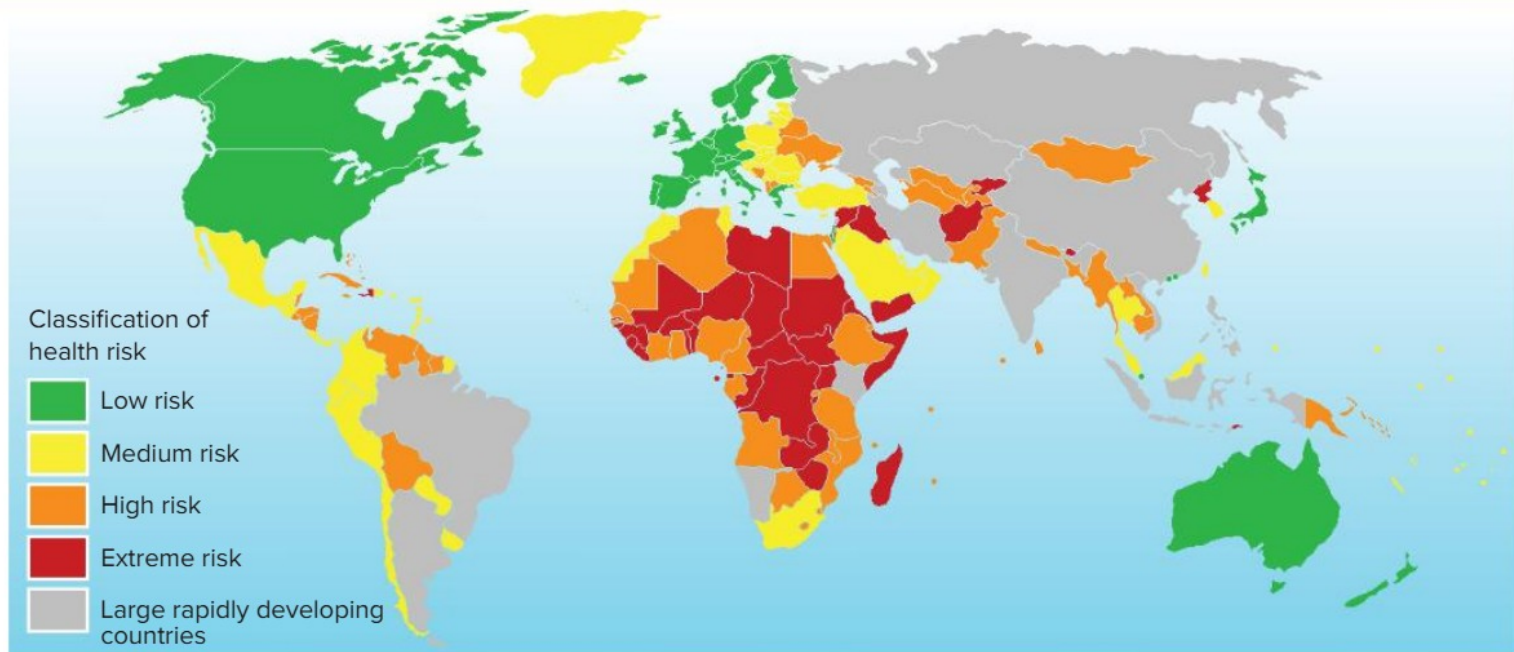
All these factors can be combined to generate maps showing the **global distribution of health risks**. Figure 1.42 shows one such distribution based on the standard of medical and dental care available, access to prescription medicines, the extent of infectious diseases, and cultural or administrative barriers that might impede health care. Five categories of countries result from this classification:

- **Low risk countries** have an international standard of health care available in all parts (or at least the populated parts) of the country. Specialist as well as general medical care is widely available, and there are high quality emergency and dental facilities. High quality prescription medicines are readily available, there is a low risk of infectious disease.
- **Medium risk countries** have high standard medical services available from some providers,

while other providers offer a lower standard of health care. Adequate emergency services and dental care are usually available. There is some risk of food-borne or water-borne diseases, and diseases such as malaria or dengue fever may be present.

- **High risk countries** have limited medical facilities, and basic emergency and dental services. Access to prescription medicines may be limited, and in some countries, problems arise from counterfeit medicines or improper storage of medicines. Serious infections such as cholera, typhoid, malaria or dengue fever may be present.
- **Extreme risk countries** experience almost non-existent or severely over-taxed health care, and there may be no generally available emergency or dental services. Quality prescription medicines are not usually available, and there is a high risk of food-borne or water-borne infections. Serious infections such as malaria, dengue, typhoid and cholera are common.
- **Large rapidly developing countries** often have great differences between the high quality health care available in major cities compared with the poor quality of health care in the rest of the country. In the major cities, health care may be of international or high standard, but in small towns and rural areas, medical and dental care may be





**1.42** World distribution of health risks. For explanation of terminology, see accompanying text. Source: International SOS.

very basic. Counterfeit medicines may be a problem, and serious illnesses such as dengue, malaria, typhoid and cholera may be present in some parts of the country.

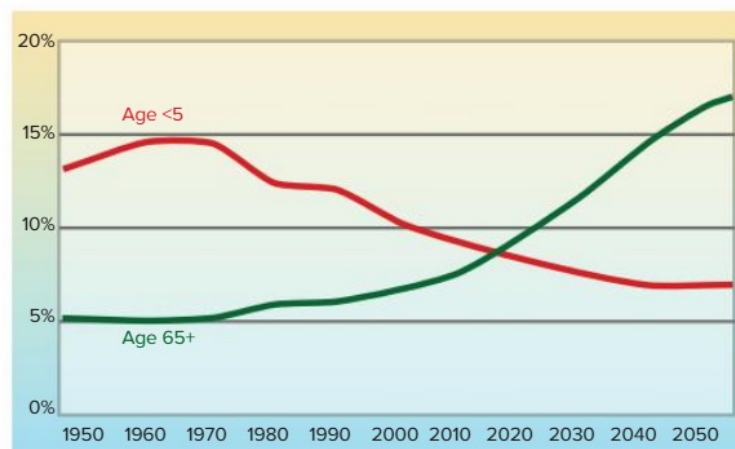
## QUESTION BANK 1F

- Using figure 1.37, count the number of top 10 causes of death that are infectious diseases in each of three macroregions. (Hint: if a disease can be either contagious or non-contagious, count it as 0.5). How do your counts relate to the graph in the top part of the figure?
- Define 'diseases of affluence' and 'diseases of poverty', and give five examples of each.
- Describe the global distribution of diseases of affluence.
- Suggest reasons that explain the distribution of diseases of affluence.
- Describe the global distribution of diseases of poverty.
- Suggest reasons that explain the distribution of diseases of poverty.
- Explain how differences in the distribution of wealth within countries might affect the standards of health within those countries.
- Conduct some research to compare the quality of health in one low income country and one high income country. Use the framework provided in figure 1.41 to explain the differences in standards of health in the two countries.
- Describe the world pattern of health risks shown in figure 1.42, and outline any differences between this distribution and those shown in figures 1.30 and 1.32 to 1.35.

## Global ageing and the disease burden

The **global population structure** is changing quite dramatically as a consequence of the epidemiological transition. Since the beginning of humanity, the number of children has outnumbered the number of elderly people. For the first time, in 2020, the number of people in the world aged 65 and over exceeded the number of children aged under 5. Today, it is not unusual to find substantial numbers of people in their 80s and 90s in industrialised high-income countries, and this situation is expected to spread to other countries as life expectancies continue to rise.

A significant consequence of this trend is a global rise in the incidence of non-communicable diseases associated with ageing such as cancer, diabetes,



**1.43** Young children and older people as a percentage of the global population, 1950 to 2050. Source: UN statistics.



heart disease and dementia. Associated with this shift is a decline in the incidence of communicable diseases. It is expected that this trend will continue in coming decades, when the shifts that have already occurred in high income countries will extend to middle and low income countries.

It is expected that by 2030, non-communicable diseases will represent over half the disease burden in low income countries, and more than three-quarters the disease burden in high income countries. The term **disease burden** refers to the impact of a health issue when measured by its financial cost, mortality, morbidity, or other indicators. It is often quantified in terms of disability-adjusted life years (DALYs) or Potential years of life lost (PYLLs).

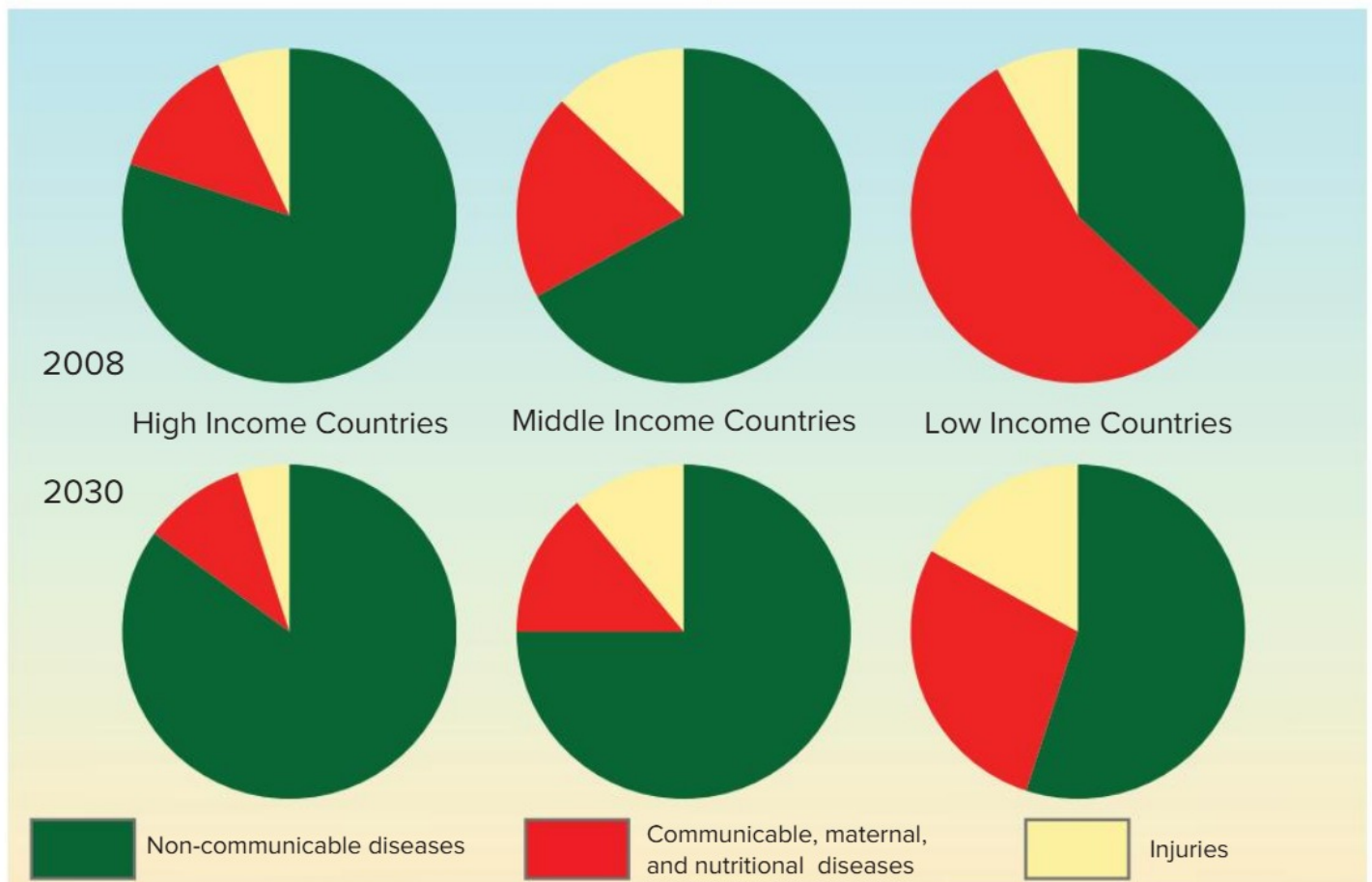
The rise of non-communicable and degenerative diseases poses a growing **economic burden** upon health systems that is additional to the **social burden** of the diseases themselves. In an attempt to control the escalating financial costs of treating the rising numbers of older people, some countries such as the United Kingdom and Australia are encouraging elderly people to remain at home rather than going into a nursing home for as long as

possible. Remaining in a person's own home reduces government expenditure on health care, even when daily support is provided by health care workers who provide daily home visits, and helps to prolong personal independence.

The shift from communicable to non-communicable diseases is not always as simple or straightforward as the epidemiological transition might suggest. In low income countries where communicable diseases still dominate, the growing number of old people means that they account for a growing share of the infectious disease burden. Furthermore, elderly people are more susceptible to infectious diseases than younger people because immune systems decline with age, so not all diseases of the elderly are non-communicative or degenerative diseases.

## QUESTION BANK 1G

1. For each pie chart shown in figure 1.44, estimate the percentage of each of the three sectors shown.
2. Quoting figures where possible from your answer to question 1, describe and account for the pattern (changes over space) and trend (changes over time) shown in figure 1.44.



1.44 The growing burden of chronic non-communicable diseases, 2008 to 2030. Source: World Health Organisation.





2.1 Research shows that shifting cultivation is the world's most energy efficient form of producing food. This mountainside is being cleared by shifting cultivators to grow sweet potatoes in the Baliem Valley of West Papua, Indonesia.

## Sustainability and food production

### Farming as a system

Farming can be viewed as a **system**, with certain **inputs** coming into a farm that undergo a series of **processes** to produce a set of **outputs**. In reality, farms are human-organised systems that are designed to manipulate the physical environment to produce provide desired products.

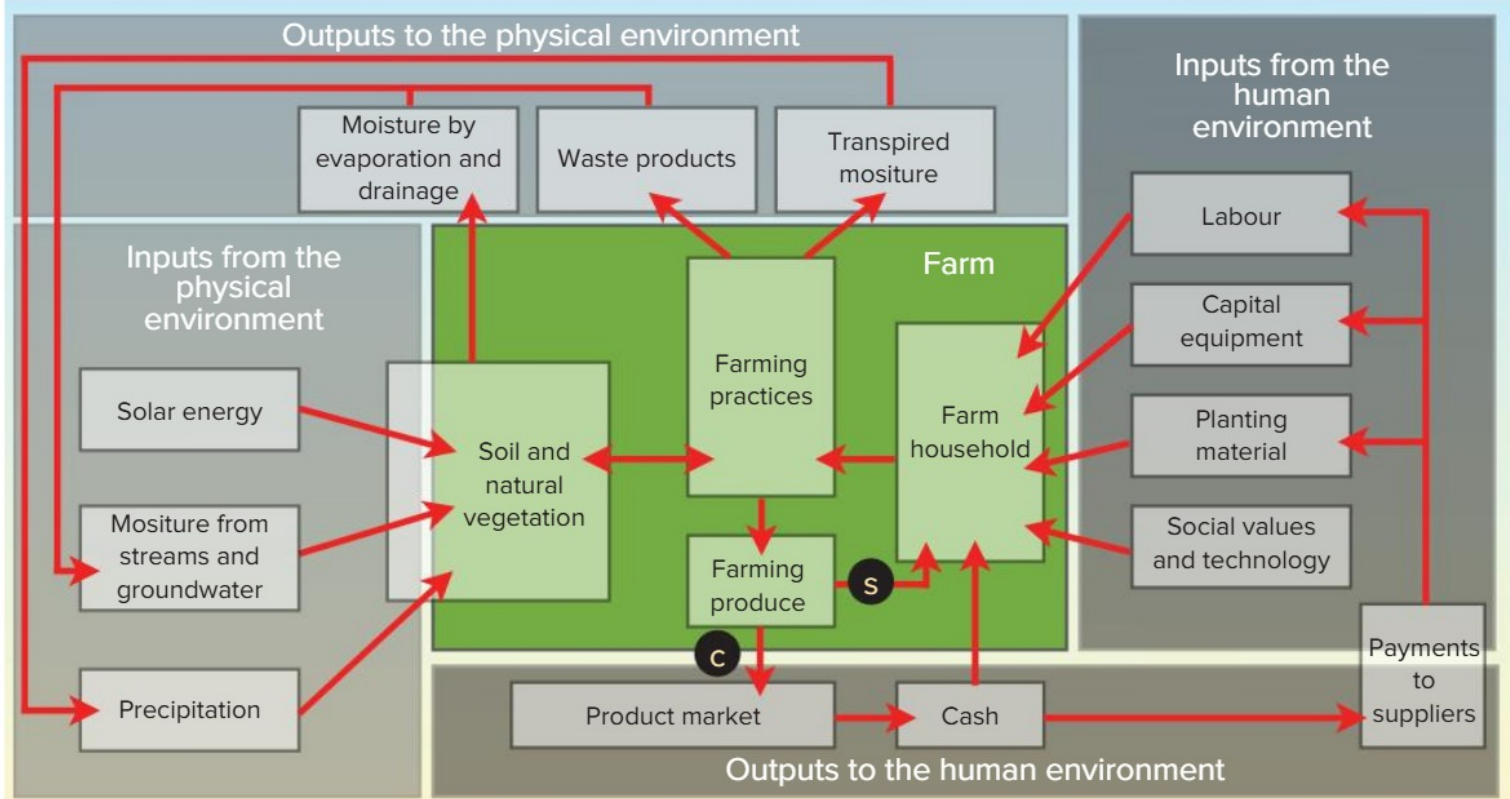
The farm system is designed by the farmer in order to achieve three **outcomes**:

- **establish** a desired ecosystem
- **manipulate** the ecosystem by controlling several of the processes operating within the ecosystem
- **harvest** the outputs of the ecosystem, either for consumption by the farm household (subsistence farming) or for sale in a market (commercial farming).

Farms take on **various forms** in different parts of the world depending upon three factors:

- the **site** characteristics of the farm, which means the nature of the **natural ecosystems** found within the farm





**2.2 Farming as a system.** A farm is a human system that is organised so that the farmer is able to obtain desired products as a result of the manipulation of one or more ecosystems. The “s” in a black circle represents subsistence farming, whereas the “c” in a black circle represents commercial farming.

- the **situation** of the farm, which means the **location** of the farm in relation to other places
- the **cultural characteristics** and **preferences** of the group to which the farmer belongs.

When viewed as a system, the farm can be thought of as a type of factory where the production techniques are mainly biological, and the processes revolve around the life cycles of plants and animals. In modifying the natural ecosystem, the farmer aims to **favour** certain plant and animal species while discouraging competitor species. The farmer thus becomes the **ecological dominant** in the modified ecosystem established on the farm.

Figure 2.2 shows a farm as a system that manipulates the natural ecosystem in intentional ways. The farm could be any type of farm in any part of the world. The farm receives **inputs** from the **physical environment** such as sunshine and moisture, as well as **inputs** from the **human environment** such as labour, machinery and cultural understandings. The farmer uses these inputs to create and then maintain a manipulated ecosystem through the processes of farm production.

The **inputs from the physical environment** vary season by season, and these variations affect the farming routines. Farming practices have to be adjusted to fit in with the time and nature of the physical inputs such as water and sunlight, and these will be affected in turn by the site characteristics of the farm and its situation.

The **inputs from the human environment** will vary according to the culture of the group living where the farm operates. Different cultural groups will have different food preferences, and this will affect crops that are grown or animals that are raised. For example, the Indonesian islands of Java, Bali and Sumatra are situated very close to the island of New Guinea. They have similar latitudes and the climates in their lower altitudes are very similar. However, the main crop grown in Java, Bali and Sumatra is rice, whereas in New Guinea the main crops are root crops such as taro, cacao and sweet potato. The reason for the difference is simply cultural; Javanese, Sumatran and Balinese people prefer to eat rice, whereas New Guineans prefer root crops. Similarly, pigs are found on most Chinese farms, where they are highly prized as they are scavengers that eat almost anything and





2.3 Irrigated rice cultivation near Ambalavao, Madagascar. Cultivation of rice is a cultural choice in Madagascar.



2.4 Irrigated cultivation of sweet potatoes in West Papua, Indonesia. Cultivation of root crops is a cultural choice in West Papua.

produce pork, which is very popular among Chinese people. However, pigs are almost never found in Muslim nations such as Indonesia and Malaysia where they are seen as unfit for human consumption for religious reasons.

The **culture** and level of **technology** available to a farmer will determine the foods that are produced and the extent to which purchased inputs such as machinery, fuel, labour and seeds might be needed.

The main **outputs** from farms are the products that are provided by the processes operating within the manipulated ecosystem. In a **subsistence** economy, these products are mostly consumed by the farmer and the farming family. In a **commercial** economy, the products are mostly sold in markets that are accessible to the farm. In addition to these intended outputs, there are often some **unintended outputs**, such as waste water.



2.5 These farms in Ollantaytambo, Peru, have sites that optimise **inputs** from the physical environment. They are in an elevated valley of the Andes Mountains where the air is thin and temperatures can be cool, so the farms are built on slopes that face the sun to maximise inputs of solar radiation. A river at the foot of the terrace supplies water, and this is supplemented by water flowing down the mountainside through a large gully.



2.6 Food is the intended **output** from farms, shown by the rice market in Djenné, Mali. Other outputs, such as moisture losses and polluted water, are usually less visible.



Farms that use **fertilisers** and **pesticides** often produce outputs of these substances which can cause environmental issues in nearby streams and groundwater. Irrigated farms in areas with salty soils may produce **saline water runoff** that pollutes rivers and streams. Farms where animals such as pigs or dairy cattle are raised may produce algal blooms in nearby streams and lakes as **excess nutrients** from manure enters the water, although this does not necessarily happen if the outputs are carefully managed.

Farms are said to be **sustainable** if they can operate in perpetuity using current farming practices, inputs and outputs. One way of measuring farming sustainability is to compare the inputs of energy used for ecosystem control and the outputs of energy obtained from the food produced. When arranged from least sustainable to most sustainable, typical **energy efficiency ratios** for different types of food production, are:

**10:1 – Deep sea fishing** (needs 10 times more energy to produce the food than is obtained from the food produced)

**10:1 – Feedlot beef raising** (also needs 10 times more energy to produce the food than is obtained from the food produced)

**2:1 – Intensive poultry farming** (consumes twice as much energy to produce the food than is obtained from the food produced)

**1:1 – Coastal fishing** (requires the same amount of energy to produce the food as is obtained from the food produced)

**1:1 – Dairy farming** (also requires the same amount of energy to produce the food as is obtained from the food produced)

**1:2 – Cattle grazing** (produces twice as much energy as food than it takes to produce the food)

**1:5 – Intensive rice cultivation** (produces five times more energy as food than it takes to produce the food)

**1:10 – Hunting and gathering** (produces 10 times more energy as food than it takes to produce the food)

**1:20 – Shifting cultivation** (produces 20 times more energy as food than it takes to produce the food)

When ecosystems are manipulated for farming, they are almost always **simplified**, which means



**2.7** A 'swidden', or burnt clearing, for shifting cultivators near Madang in Papua New Guinea. The ash produced acts as fertiliser for the crops. In terms of energy efficiency, and thus sustainability, shifting cultivation (or 'swiddening') is the world's most efficient form of food production.

they contain a reduced number of species. More diverse ecosystems are usually considered to be more stable, so simplified ecosystems are **less sustainable** in that they require constant intervention to maintain.

Large-scale 'factory farms' and plantations commonly have only a single crop species, and this is known as **monoculture**. Monocultures have a low level of stability, especially when all the crops are of the same age, as they extract the same minerals from the soil without any compensatory replacement of these minerals by other plant species.

Another way of describing monocultures is to say that manipulated ecosystems on farms have **low**



**2.8** This extensive area of rice cultivation near Sariwon, North Korea, illustrates the monoculture of the simplified ecosystem that typifies some types of farming. Monocultures are usually unsustainable in the long-term without human intervention.



**species diversity.** They also have a **narrow range of chemicals** within them, and the life cycles of the plants are also usually simplified. Although crops such as cereals are allowed to grow to maturity, many others (such as orchard trees and tree crops for timber) are cut short.

Monocultures and simplified ecosystems are inherently **unstable** and **unsustainable**, and natural processes will operate to compensate by attracting other plant and animal species to replace the simplified ecosystem with a more natural, diverse and stable ecosystem. Farmers therefore have to make some effort to resist these unwanted species, and the solution is often to use **chemical herbicides** (to kill 'weeds') and **pesticides** (to kill unwanted insects and birds). Despite these efforts, insects and plant diseases are estimated to destroy 20% to 25% of the world's farm crops each year. Monocultures are especially vulnerable to attack by diseases and pests that are specific to one crop type.



2.9 A farmer sprays pesticides on a tea plantation beside a sugar plantation near Kitega, Uganda, to eliminate competitor species threatening the simplified ecosystem's monoculture.

Farmers have been using **poisons** against ecosystem competitors, or pests, for well over two hundred years. Some of the substances that came into use, such as potassium cyanide and arsenic compounds, were very dangerous to humans and to the wider environment. In the 1950s and 1960s, pest control has become increasingly dependent on **synthetic compounds**, such as DDT. Widespread of these new 'wonder' pesticides in the period up to the mid-1960s allowed enormous gains in crop yields. However, these gains proved difficult to sustain as pests developed greater resistance, and in some cases, these chemicals were therefore applied at 20 to 40 times the original recommended rate.

There are three reasons why increasing inputs of **pesticides** proved **unsustainable**:

- Over time, pesticides develop **genetic resistance**. Chemical attacks on a particular pest may leave alive a small number of individuals that are genetically more resistant to the pesticide. These survivors can then inbreed and multiply into a population on which the pesticide has no effect at normal concentrations. These survivors then have the ecological niche to themselves, and they may even expand to fill some of the niches left vacant by other species that were killed unintentionally by the pesticide. Unless a given pest can be made extinct at a local scale, a resistant population would be expected to develop.
- Pesticides may **kill off desirable species** as well as the unwanted species. In some cases, the desirable species is a predator, competitor or parasite upon the 'pest'. When this happens, the survival and reproduction of resistant populations of the pest will not be kept in check by natural enemies, and an explosive increase in pest numbers might result.
- There is a tendency for non-biodegradable materials to become **concentrated up the food chain**. An example is DDT, a complex chemical compound developed in the 1940s and used widely as a pesticide until the 1980s. Although DDT was thought to have low toxicity for humans, it was toxic to a wide variety of pests, and was long-lasting when applied. Unfortunately, these same characteristics made DDT and similar products very dangerous to natural ecosystems because of **biological magnification** in the food chain. Because DDT is very soluble in fats and oils, it tends to be absorbed and stored within the fatty tissues of organisms rather than excreted. The organisms that were higher on the food chain therefore received lethal concentrations of DDT as part of their normal diet. Once this was understood, DDT was banned for agricultural use in the United States in 1972, and this was followed by bans in many other countries in the years and decades afterwards. Nonetheless, DDT continues to be used in a few countries such as India and North Korea.



In an attempt to make farming more sustainable, **biological control** of pests is becoming more popular. With biological control, certain parasites or predators are deliberately let loose to attack 'pests'. The results of biological control have been mixed. It works best where the predator or parasite cannot live on any organism apart from the one that the farmer wishes to control. Some early introductions were not of this type, such as the release of common sparrows into north-eastern USA to control caterpillars. The sparrows decided to include a large proportion of grain in their diets, which they obtained from the farmers' cereal crops.

### QUESTION BANK 2A

1. Figure 2.2 shows a general model of farms as a system. Think of a particular farm you may have visited. Apply the ideas of figure 2.2 to this farm:
  - a. Identify the main inputs into the farm system, giving them accurate values wherever possible.
  - b. What are the main outputs of this farm system?
  - c. Outline the significance of the site and situation of this particular farm.
2. What is meant by the term 'sustainability' when it is applied to farming?
3. There is a trend for farmers to move away from subsistence to commercial farming. With reference to energy efficiency ratios, what does this suggest about the efficiency and sustainability of world agriculture?
4. Explain why simplified ecosystems, especially monocultures, are unsustainable.
5. Pesticides are used on many farms to prolong the sustainability of their simplified ecosystems. Give three reasons why this is unlikely to work in the long term.

### Sustainable agriculture and the future of farming

As commercialisation of farming expands in developing economies and standards of living continue to rise, the risk of **unsustainable practices** in world food production increases.

For example, rapid increases in food production in China have resulted in big rises in income for Chinese people, about 70% of whom are farmers. As China becomes more affluent, its population will follow the trend which every other country becoming richer has shown – it will increase its consumption of meat. As this happens, the demand for grain to feed the cattle is expected to

skyrocket, and China will need to import grain from overseas because the country has very little capacity to increase its own grain production. Most of China's fertile land is already under cultivation, and existing vacant land is generally very unproductive. Moreover, rapid urbanisation and industrialisation in China is **reducing farmland** by about 1% per year, or about 350,000 hectares per annum. There is little capacity to increase irrigation because large volumes of water are being diverted to non-farm uses that make more money.

There is also little capacity to increase yields. In China, rice yields have stabilised at about 4 tonnes per hectare per year. Increased **fertiliser** use will do little as it has reached the point of diminishing returns. In other words, if more fertiliser were applied in many areas, it would actually reduce the crop yield. Fertiliser use in China increased from 7 million tonnes in 1977 to 30 million tonnes in 1995 and 4.4 billion tonnes in 2009, before falling to 3.95 billion tonnes in 2015.



**2.10** As affluence rises in developing countries, standards of living improve and meat consumption is expected to increase, placing stress on the sustainability of world food production. In this photo, meat is on sale in the markets in Bobo-Dioulasso, Burkina Faso.

**Environmental problems** such as soil erosion, air pollution, global warming, waterlogging of the soil and siltation of irrigation systems will also work against increasing Chinese farm yields. By the year 2030, it is estimated that China will need to import 216 million tonnes of grain, more than the world's entire grain exports of 200 million tonnes just three decades earlier.

The fear is that because China contains more than 20% of the world's population, this could create **global food shortages** and drive up the price of



food around the world, leaving millions of poorer people hungry. Furthermore, the trend of increasing affluence and rising meat consumption is not confined to China; it is occurring in many economically developing countries, exacerbating the potential problem of **unsustainable farming**.

Another factor affecting sustainability of agriculture is the increasing **distances** that food is **transported**. One way of measuring this is to use **food miles**, which measures the distance food is transported from the point of its production until it reaches the consumer. This measure was first developed in the United Kingdom (which may explain the use of 'miles' rather than 'kilometres'), but the measure can be expressed either in units of distance or as the amount of energy consumed during transport.

It has been estimated that the average distance travelled by food from farms to consumers in the wealthy industrialised countries has increased by about 30% since 1980, leading to significant increases in **greenhouse gases** that cause global warming. This has led to more frequent calls to buy locally produced food to reduce the distance that food is transported.

The concept of food miles serves as a useful reminder of the need to control the amount of energy used to move food from one location to another. However, the concept is somewhat **simplistic** and **difficult to apply** in a practical sense. For example, distance travelled is not necessarily the main determinant of the amount of energy used.

This can be seen by comparing **two hypothetical farms**. One is small in scale and produces just 10 tonnes of beans. The farmer has a small truck that can carry only one tonne at the time. If the farm is situated 100 miles (160 kilometres) from the market, each bean would travel 100 food miles, although the farmer would need to make ten return trips (2,000 miles) to deliver all his beans to the market.

The second hypothetical farm produces the same quantity of beans, but is located at a distance of 1,000 (1,600 kilometres) from the market. However, if that farmer has a larger truck that can carry 10 tonnes, the produce would travel 1,000 food miles, although the total distance travelled would be the



**2.11** Increasing meat consumption lowers food sustainability because food energy from crops is lost when fed to animals before being consumed as meat by humans. This view shows beef for sale in an open air market in Lomé, capital city of Togo.



**2.12** In poorer countries with limited electricity, refrigeration is usually unavailable in markets. One way to keep meat fresh is to keep the animals alive, as shown here where poultry is for sale in a streetside stall in Segou, Mali.

same. In fact, the amount of greenhouse gas produced may be slightly more because larger vehicles consume more fuel, but the difference is certainly not ten-fold as the measure of 'food miles' might suggest. The differences become greater when different forms of transport are considered. Trucks produce a different level of pollution when compared with an aircraft, a donkey cart or a train, but the measure of 'food miles' ignores such differences.

In many parts of the world, eating locally grown food may lead to an **increase** rather than a decrease in **energy use** and the **carbon footprint**. This is because certain areas are better suited physically for producing particular types of food than others, and thus eating locally produced food may increase





**2.13** Sheep grazing on grass fields near Te Anau on New Zealand's South Island.

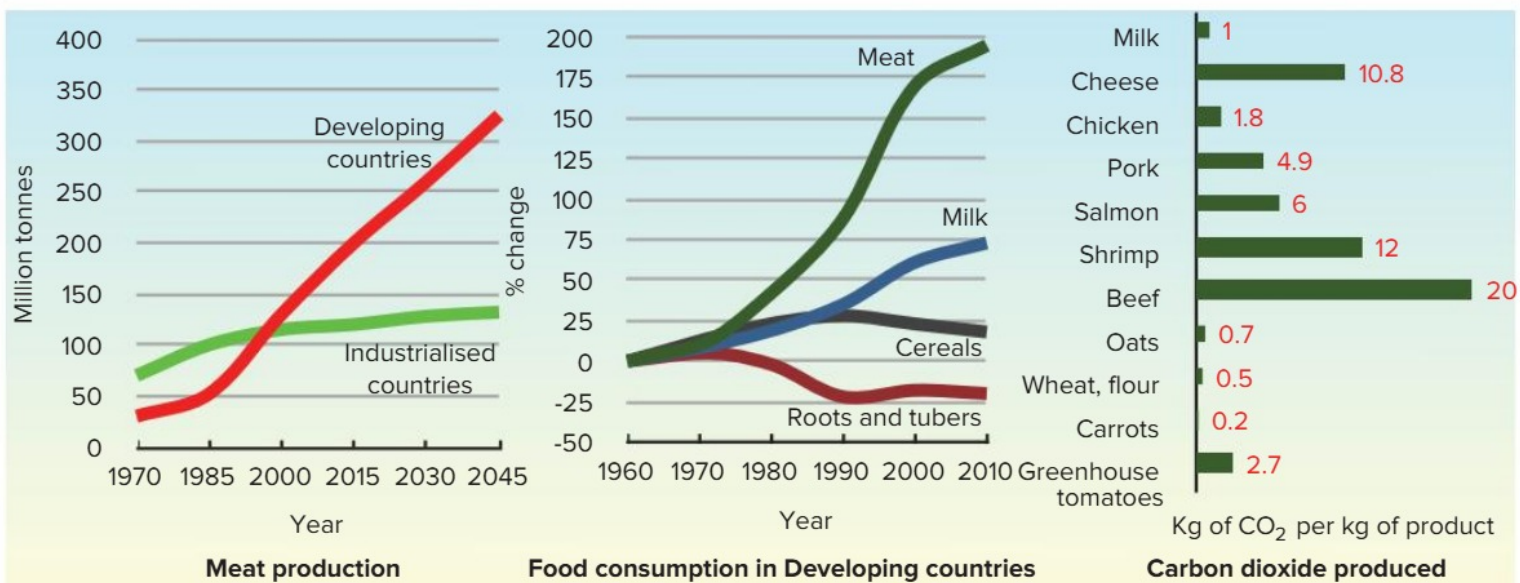


**2.14** Sheep in Lancashire (UK) depend on hand feeding during the cold winter months.

energy use because of the need to grow crops or raise animals in sub-optimal conditions.

For example, raising lamb on New Zealand's natural grassland pastures and transporting it 18,000 kilometres by ship to the United Kingdom would produce 626 kilograms of carbon dioxide emissions per tonne. This figure compares with lamb produced in the United Kingdom, which would produce 2,580 kilograms of carbon dioxide per tonne between the point of production and delivery to the consumer. A large part of this difference arises because the poorer British pastures and colder climate forces farmers to use stored feed in order to sustain their animals through the colder winter months. Contrary to the implications of the 'food miles' concept, it was therefore four times more energy-efficient for a person in London to buy lamb imported from the other side of the world than to buy it from a local farmer.

Globally, only about 4% of the **greenhouse gases** produced by the food industry are the result of transporting produce from farmers to retail outlets. Therefore, a more effective way to reduce greenhouse gas emissions than minimising food miles may be to adopt a **vegetarian diet**, even if the vegetarian food is transported over very long distances. The United Nations estimated that the world's trillions of farm animals generate 18% of the world's greenhouse emissions, which is more than the greenhouse gases produced by the world's cars, buses and aircraft. This figure is expected to increase as the consumption of meat increases in developing countries as they grow in affluence. The projected trends are shown in figure 2.15.



**2.15** Meat consumption and carbon dioxide emissions, past trends and future projections. Sources: FAO, Lantmannen (2006), New York Times (2009).



## QUESTION BANK 2B

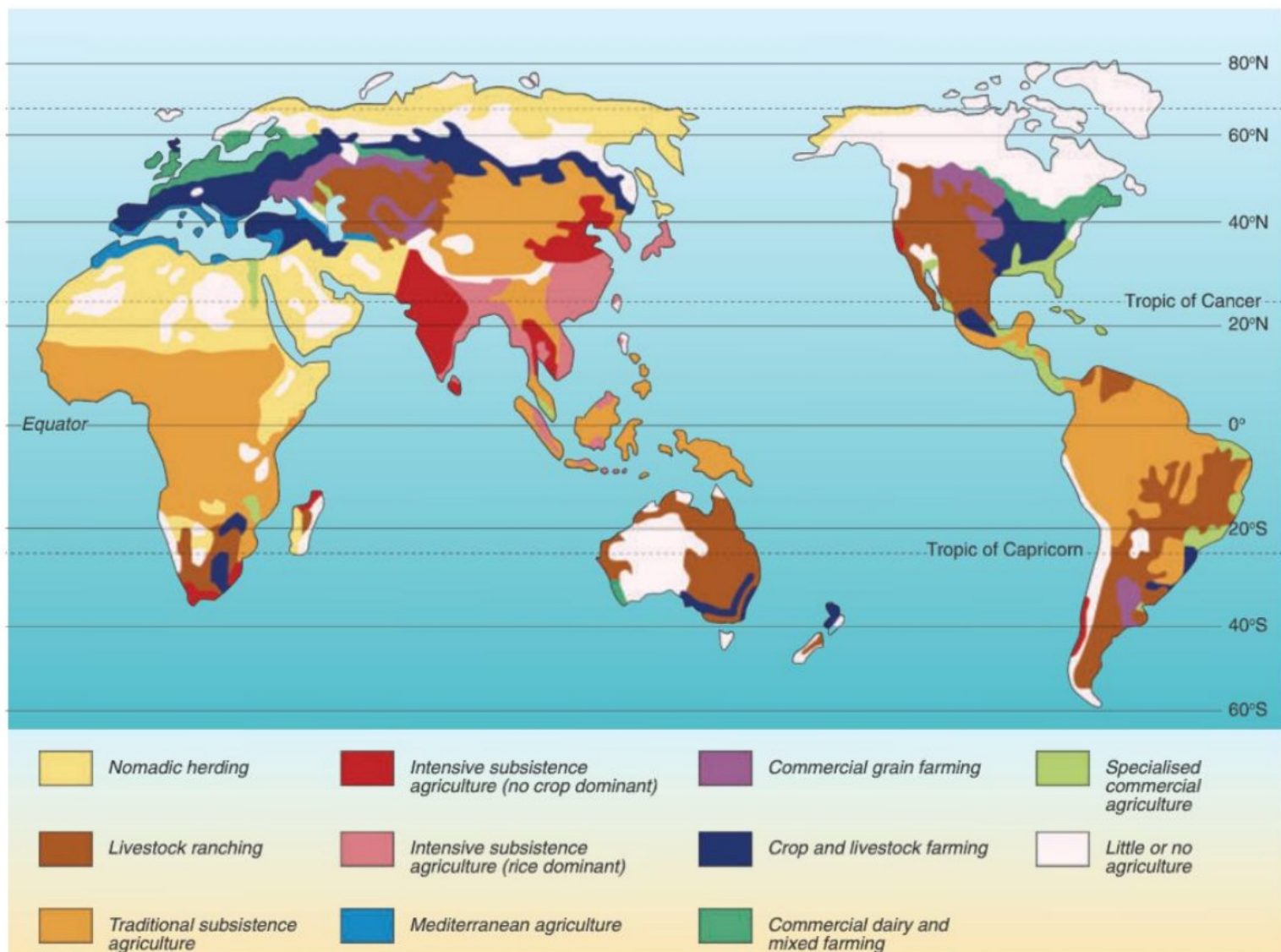
1. Explain why increasing affluence poses a potential threat to farming sustainability.
2. Describe the concept of 'food miles'.
3. Outline the shortcomings of 'food miles' as a measure of sustainability.
4. It has been claimed that the best way to promote sustainable agriculture is for the world's population to become vegetarian. What is the evidence for and against this claim?
5. Describe the trends or patterns shown in each of the three graphs in figure 2.15.

## Variations in food consumption

### Areas of food sufficiency and deficiency

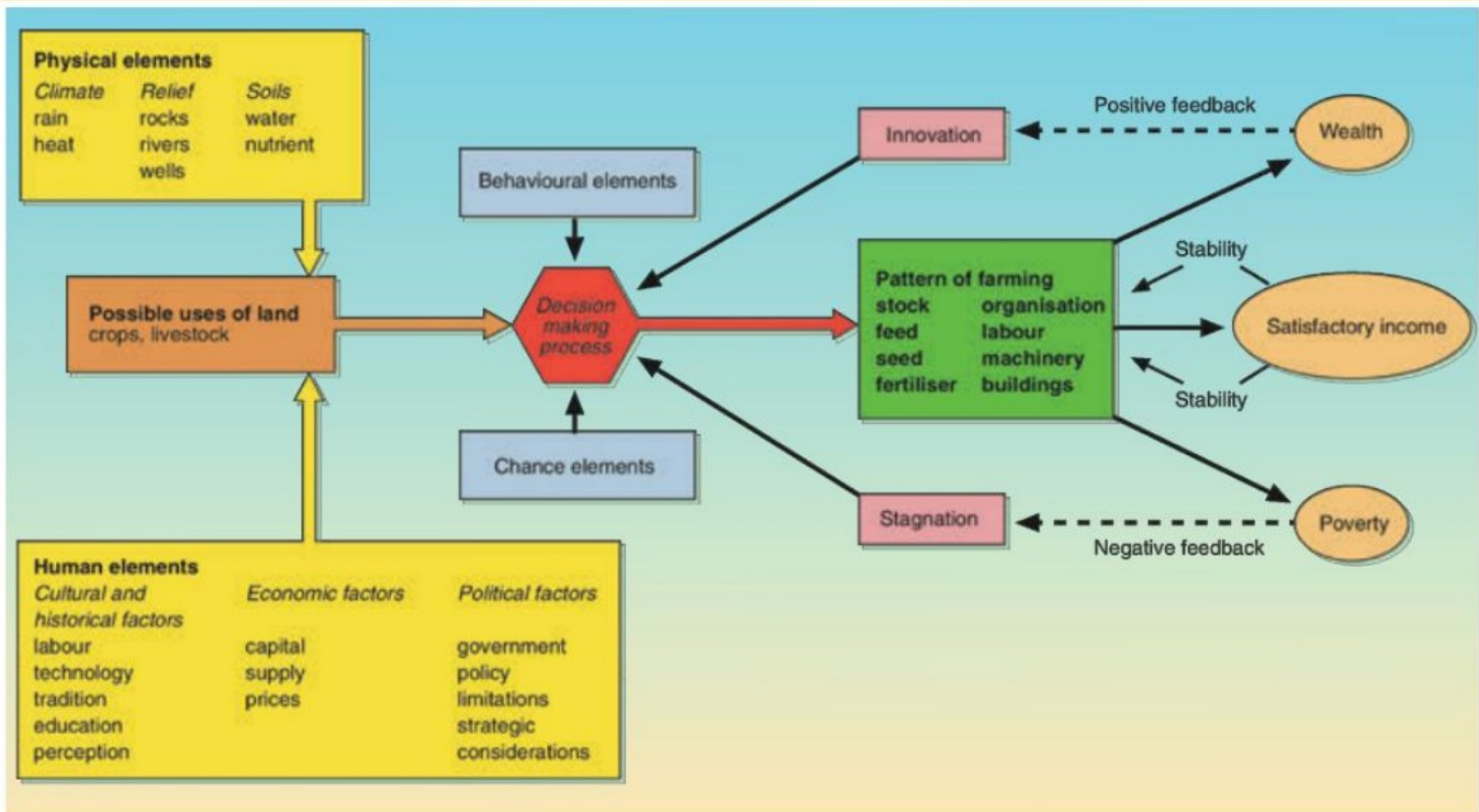
Figure 2.16 shows the **global pattern of farming** activities. Even though this map is a simplification of reality, the pattern shown is quite complex. The distribution shown in figure 2.16 is the result of an interconnected set of biophysical, economic and socio-political factors. Many of these factors are shown in figure 2.17, which shows the **decision making process** which farmers (consciously or unconsciously) go through in deciding what to produce and what methods to use.

One of the most important factors affecting the pattern of farming is **climate**. All plants need sunlight, water and warmth to survive. Heat is necessary for plant seeds to germinate, and although the figure varies a little, a minimum temperature of about 6°C is necessary for plant growth. That is why few crops are found in areas close to the poles or in alpine areas; temperature falls by about 1°C for every 200 metres rise in altitude. Different crops need varying amounts of warmth to survive. Thus, wheat cannot be grown



2.16 The global pattern of farming activity. For the sake of clarity and simplicity, minor variations are not shown.





2.17 Influences on farmers' decision making process.

beyond the latitudes 60°N and S of the equator, whereas the limits of maize are 50°N and S and cotton 35°N and S. In general, farmers in poorer countries are more dependent on the climate than farmers in more advanced economies, who have greater capacity to **change the climate**, or more accurately, the **microclimate** of their farms. Having said this, it is important to remember that farmers in traditional societies have made huge changes to their environment using irrigation, sometimes for thousands of years.

Similarly, plants require **water** to survive. Water can often be an important factor in deciding what

crop will be grown, or even if it is possible to farm an area at all. If the rainfall is inadequate, then either a different crop must be grown or water must be provided artificially by **irrigation**. This becomes especially important as plants need water in different amounts at different times of their growth cycles. Unless extra water is provided by irrigation, cotton must be grown where annual rainfall is at least 550 mm and not more than 1,150 mm. On the other hand, a crop like rubber needs at least 1700 mm of rain each year.

The **lithosphere** can impose additional biophysical limits. Areas with hard, igneous rocks such as granite are usually poor for farming because these rocks produce coarse soils with few nutrients that are easily eroded. In fact, soils that are too acidic, too alkaline (as in swamps) or too salty (as in coastal areas) result in reduced crop yields. Furthermore, in mountainous and cool areas, soil formation takes place more slowly than in warmer areas, and so soils tend to be quite thin, again reducing crop yields. That is why areas with poor soils and marginal climates often concentrate on livestock raising rather than crop growing.

On the other hand, the best soils for cropping are often the alluvial soils found near rivers, and volcanic soils that are found, not surprisingly, near



2.18 Greenhouses create a microclimate for the cultivation of tomatoes and flowers on the outskirts of Bogotá, Colombia.





**2.19** An oasis in the Asif Imini Valley of Morocco. Water seeps from the bottom of the slope to the dry river bed, providing just enough water for the crops to survive.



**2.20** The traditional technology of this well in a date palm plantation near Ghardaïa, Algeria, shows that irrigation has been practised here for many centuries.

active volcanoes. Alluvial and volcanic soils are normally only slightly acidic, with a friable texture and with a rich supply of minerals that make them very fertile.

Important though biophysical factors are in influencing the pattern of agriculture, **cultural factors** are also very important. Tradition can be particularly important; if farmers in an area have been producing a particular crop for generations, farmers will be most comfortable if they continue to grow that familiar crop, about which they will know a great deal.

The level of **economic development** of a particular society is another important influence on the type of agriculture practised. Countries that are largely pre-industrial tend to have large proportions of their populations involved in farming. For



**2.21** The cattle near Taungdwingyi in the dry, central area of Myanmar are causing erosion of the soil, and possibly contributing to desertification.



**2.22** The volcanic soils near Mount Hagen in the Highlands of Papua New Guinea are highly fertile, supporting a population of over a million people in the region.



**2.23** Cultural influences on agriculture can be expressed in many ways. The Intha people live on Inle Lake in Myanmar, and they have adapted so well to the water that they grow their crops on islands which they construct from dredged mud in tubular cane cages that float on the surface of the lake. The long poles visible in this photo anchor the floating islands to the bottom of the lake to stop them drifting or floating away.



example, the proportion of the work force employed in agriculture in Malawi is 91%. The equivalent figures for other less industrialised countries include Nepal (92%), Papua New Guinea (84%) and Tanzania (81%). On the other hand, the figures for more industrialised countries include the United Kingdom (1%), the United States (2%), Canada (2%), Germany (2%) and Australia (3%).

The reason for this difference can be explained by looking at the **types of farming** practised. A majority of farmers in pre-industrial economies are **subsistence farmers**, which means that the main intention in producing food is to feed the farmer's own family. This does not mean that nothing at all will be sold, only that the farmer's **intention** is to consume **most** of the crop produced.



**2.24** The woman who grew these beans is preparing them for consumption by her household in Konso, Ethiopia. She is thus a subsistence farmer.

In strong contrast to this, most farmers in industrialised countries are **commercial farmers**, who produce food with the **primary intention** of **selling** most of it, hopefully for a profit. There is little reason for subsistence farmers to produce a large surplus. Once the family is fed and a small surplus has been kept as insurance against disasters and for trading, there is little sense in working hard to produce more while only a few linkages with a commercial market exist. On the other hand, commercial farmers can use some of their profits to invest in technologies which will increase productivity, enabling one farmer to produce enough food to feed tens or perhaps hundreds of families.



**2.25** Using small wooden hand-held tools to cultivate vegetables — an example of traditional, labour-intensive farming techniques in the rugged mountains of the Haa Valley, Bhutan.



**2.26** Expensive machinery such as this harvester near Berat, Albania, are only possible (and useful) on commercial farms.

It follows, then, that **economic influences**, such as the cost of wages, equipment, transport, and the prices received, will have a much stronger impact on commercial farmers than on subsistence farmers. Similarly, **political influences** such as government policies, trading treaties, subsidies and taxes will affect commercial farmers much more strongly than subsistence producers. Commercial farmers can use money to overcome the **constraints** of the **biophysical environment** much more easily than subsistence farmers. A commercial farmer may be able to afford pesticides, fertilisers, machinery, irrigation systems and even climate modifying structures that would be an impossible dream for a subsistence farmer. Subsistence farmers must largely live **within the confines** of their biophysical environment, whereas many commercial farmers have the means to **change** their biophysical environment.





**2.27** Shifting cultivators in northern Thailand have burnt grass to create a clearing, or 'swidden', to grow crops. The ash made by the burning is being dug into the soil. This will be the only fertiliser added to the poor soils used for cultivation. These farmers are largely working within the confines of their environment.



**2.28** In contrast to the limited environmental manipulation shown in figure 2.27, this air conditioned greenhouse near Boulder, Colorado, USA, has been built to create an artificial environment to grow vegetables. The farmer controls every aspect of the growing environment, including the water, humidity, light and soil fertility.

### Addressing imbalances

In the late 1960s and early 1970s, there were many **predictions** of **famine** and **starvation** in the world. The opening words of one famous book at the time (1971), *The Population Bomb*, by Paul Ehrlich, stated boldly:

*"The battle to feed all of humanity is over. In the 1970s and 1980s hundreds of millions of people will starve to death in spite of any crash programmes embarked upon now. At this late date nothing can prevent a substantial increase in the world death rate."*

It was predicted that in the decades to come, the growth in world **food production** would fall behind the growth in **world population**. It was thought that most of the world's arable land was already being fully used, that crop yields in the developed nations were already high and had little potential for further increases, and that rises in yields in developing nations were unlikely because subsistence farmers could not afford the technology necessary.

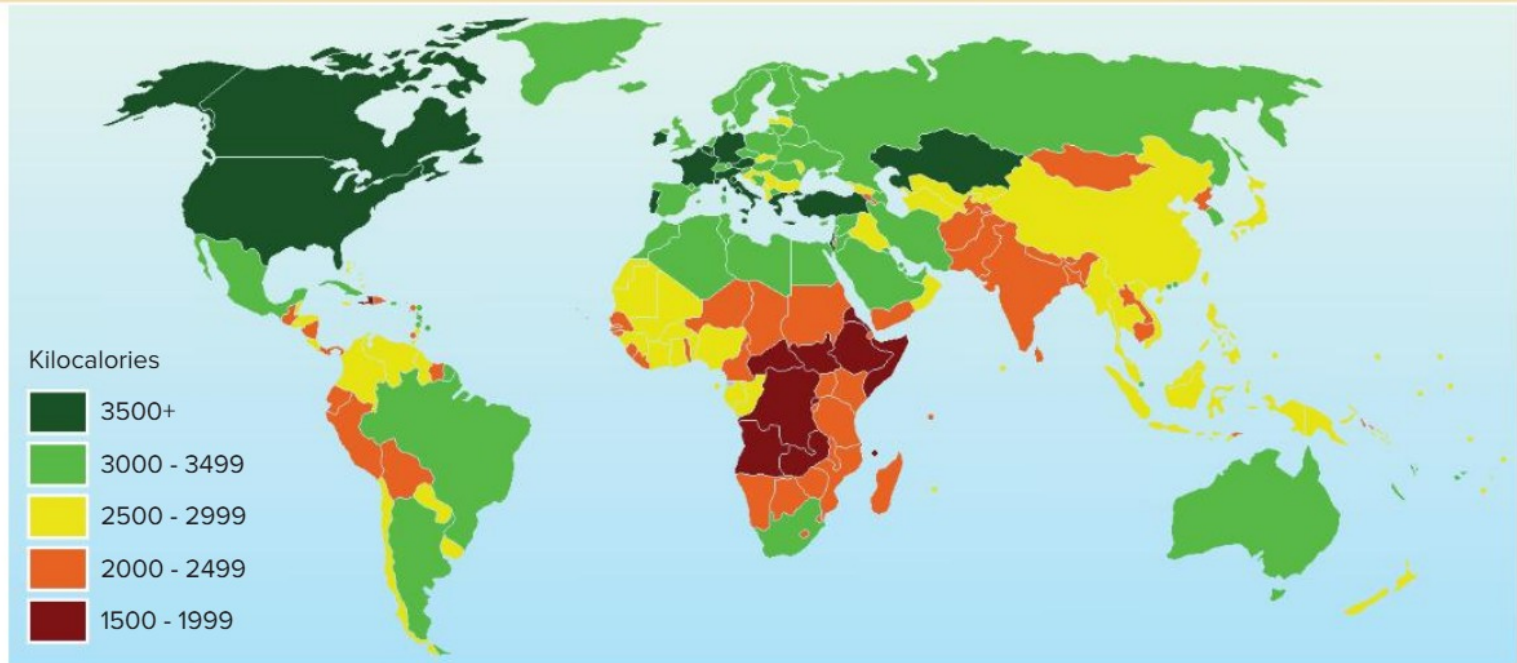
The predictions were **half right**. World **population** did increase rapidly. During the period 1950 to 2016, world population rose from 2.5 billion to 7.5 billion, an annual average increase of less than 2% per year over the whole period. Entering the 1980s and 1990s, the rate of growth slowed somewhat. Between 1980 and 1985, the average annual rate of growth of world population fell to 1.75%. It fell further to 1.70% between 1985 and 1990, to 1.68% between 1990 and 1995 and to 1.42% between 1995 and 2000. During the period 2000 to 2015, the average annual rate of growth of world population was 1.20%.

The widespread **famines** that Ehrlich and others forecast did not occur. The reason was that over the same period (1950 to 2015) world food production rose by an average of about 2.6% per year, a rate faster than world population growth. Indeed, in the ten-year period 1982 to 1992, world food production rose by 23%. Despite a slowing in the rate of increase in world food production, by 2015 the annual increase in food production (2.86% per year) was still more than double the annual increase in world population (1.18% per year). It is because food production has grown more rapidly than population that we find ourselves in the

### QUESTION BANK 2C

1. Describe the main features of the distribution of world agriculture shown in figure 2.16.
2. Account for (i.e. explain) the main features of the distribution of world agriculture shown in figure 2.16.
3. With reference to figure 2.17 and the text in this section, suggest the three main factors that affect a commercial farmer's decisions about farming methods and crops or animals to raise. Justify your selection of the three factors.
4. How would your answer to question 3 differ for a subsistence farmer? Explain why.





2.29 Average daily food intake per capita, 2019.

situation where there is (on average) **more than enough food** for every person in the world to be well nourished.

Although there is sufficient food to feed everyone in the world, it is **unevenly distributed**. The result of this uneven distribution of food is **uneven consumption** of food, as shown in figure 2.29. To place the statistics of figure 2.29 in perspective, the Food and Agriculture Organisation (FAO) of the United Nations states that the minimum daily energy requirement for the world as a whole is about 1,800 kilojoules per day. This is a simple average figure that neglects the different energy needs for people of various heights, weights, ages and genders. This average figure of 1,800 kilojoules per day is achieved in all countries except Burundi (1,680 kilojoules per person per day) and Eritrea (1,590 kilojoules per person per day).

The global **increase in food consumption per person** in recent decades became possible as food production per person rose, and this occurred for two main reasons. First, the **amount of land** used for cultivation has **increased** slowly but steadily. Between 1965 and 2020, the area of land used for growing crops almost doubled. This increase was not uniformly distributed around the world, however. In Sub-Saharan Africa the area under permanent cultivation more than doubled, and in East Asia and the Pacific it more than tripled. On the other hand, smaller increases in the area under crops were reported elsewhere, and in Europe and



2.30 Eritrea has the lowest average daily food intake per capita in the world. In this view of the capital city, Asmara, food is being sold from the back of a truck at a bus stop near the city centre.



2.31 When food is scarce in countries like Eritrea, it is usually women and children, like this girl in a camp on the outskirts of Dogali, who receive the least.





**2.32** One way that the area of land under cultivation can be expanded is by terracing hillsides, thus creating strips of flat or gently sloping land. These terraces are near Lake Titicaca, west of Tiquina in Bolivia.



**2.33** When land is scarce, even tiny parcels of sloping land are used for food production. These tiny plots of farming land are in a small village near Sukchon, North Korea.

North America, the area devoted to cropland halved between 1965 and 2020. Although the amount of land used world-wide for cultivation has increased, the amount of land per capita has decreased. In 1965, there were 0.44 hectares per capita used for growing crops in the world. By 1990 this figure had fallen to 0.24 hectares. By 2010 it had dropped to 0.20 hectares, and to 0.18 hectares per person in 2020. If less land per person is producing more food per person, it follows that the **productivity** of the land has **increased**. This is the second reason that the forecast widespread famines did not occur.

Raising farm productivity is important because finding **sustainable** ways to make less land produce more food can be an important means to avoid, or at least minimise, malnutrition in the



**2.34** The productivity of farmland can be increased when the microclimate is made more suitable for cultivation. This can be done by building greenhouses or, as shown here, by adding water using irrigation. This apple orchard is near Kozjak, Macedonia.

future. There are **six main reasons** that land productivity has been increasing in recent decades.

First, many farmers adopted new **high yielding varieties** of crops, especially rice and wheat, which were genetically engineered to shorten the growing cycle, enabling double cropping and even triple cropping of farmland. Many of these high yielding varieties (HYVs) are more resistant to diseases that affected traditional species of crops. Between 1955 and 2005, India more than quadrupled its food production and the main reason was said to be the adoption of HYVs.

Second, **irrigation systems** have become more widespread in many areas of the world. Between 1980 and 2015, the percentage of the world's croplands under irrigation increased from 16% to 22%, although in Asia the increase was



**2.35** Irrigated rice fields on the Jatiluwih terraces, Bali, Indonesia.



considerably greater – from 31% to 40%. Some nations saw quite spectacular increases in irrigated croplands, with examples including Bangladesh (17% to 39%), Nepal (22% to 35%) and North Korea (59% to 74%).

Third, there was a big increase in the use of **chemical pesticides** and **fertilisers** on farms. Although there can be undesirable side-effects on the biophysical environment from the widespread use of chemicals, there is no doubt that they can increase farm productivity, at least in the short-term. In 1964, an average of 29 kilograms of fertiliser were used on each hectare of the world's croplands. By 1981 this figure had increased to 87 kilograms, rising further to 99 kilograms by 1991, 101 kilograms by 2003 and 140 kilograms by 2017. In some countries, the amount of fertiliser being used by 2017 was vastly greater than the world average, with examples being Singapore (30,238 kg/ha), Qatar (6,755 kg/ha), Hong Kong (2,704 kg/ha), New Zealand (1,777 kg/ha), Malaysia (1,723 kg/ha), Ireland (1,248 kg/ha), Kuwait (751 kg/ha), Colombia (660 kg/ha), Egypt (649 kg/ha), Costa Rica (605 kg/ha), China (503 kg/ha), Vietnam (430 kg/ha) and South Korea (3870 kg/ha).

The fourth factor was **mechanical technology**, which has become much more widespread on the world's farms, enabling a small number of people to achieve tasks that used to require a huge work force. Between 1980 and 2015, there was a 1.6% increase in the number of tractors used on the world's farms and an 13.6% increase in the number of harvesters. Some countries have seen spectacular increases in mechanisation. The



**2.36** Mechanisation is now common on commercial farms in most parts of the world, including developing countries. This tractor is working on a farm near Huatajata, Bolivia.



**2.37** Even low cost, basic machinery can improve farm productivity, although it also binds the farmer to purchased inputs such as fuel and spare parts. In this view, wheat is being processed on the farm where it was grown in the Nile Valley near Cairo, Egypt.



**2.38** Increased mechanisation has raised farming productivity around the world. In this view, combine harvesters are being used to harvest wheat near Gyula, Hungary.

percentage increase in the number of tractors between 1980 and 2015 in South Korea was 2,913%, in Indonesia 353%, in Burkina Faso 230% and in India 205%.

Fifth, the changing nature of the **agricultural work force** has also affected productivity. The number of people engaged in agriculture around the world is declining. This decline is found in every part of the world, and is expected to continue into the future. The decline in agricultural labour force was made possible by farm amalgamations, where neighbours or corporations have bought farms and enlarged them to make the use of machinery easier. This has enabled an increase in the productivity of farmers so that each farmer is now capable of producing more food than was the case previously.





**2.39** In most parts of the world, farms are becoming more capital intensive as machines replace people. There are exceptions, such as Georgia, shown here, where many farms remain labour intensive. In this view, farmers are packing potatoes into bags for transport to market.

Finally, food shortages have been alleviated by the growth of **free trade** and fair trade. **Fair trade** refers to the organised social movement that promotes a market-based approach to empowering farmers in poorer countries to sustain their viability as farmers. The key to 'fair trade' is paying farmers in poorer countries a fair price for their produce, rather than exploiting them as some claim may be done by transnational corporations or corrupt government officials. Advocates of the 'fair trade' movement also emphasise the importance of requiring farmers in poorer countries to meet environmental and social standards in their farming practices. 'Fair trade' explicitly aims to help poor and marginalised farmers in developing

countries, and for this reason the products of 'fair trade' are often distributed by international development aid and religious organisations such as Oxfam, World Vision and Caritas International.

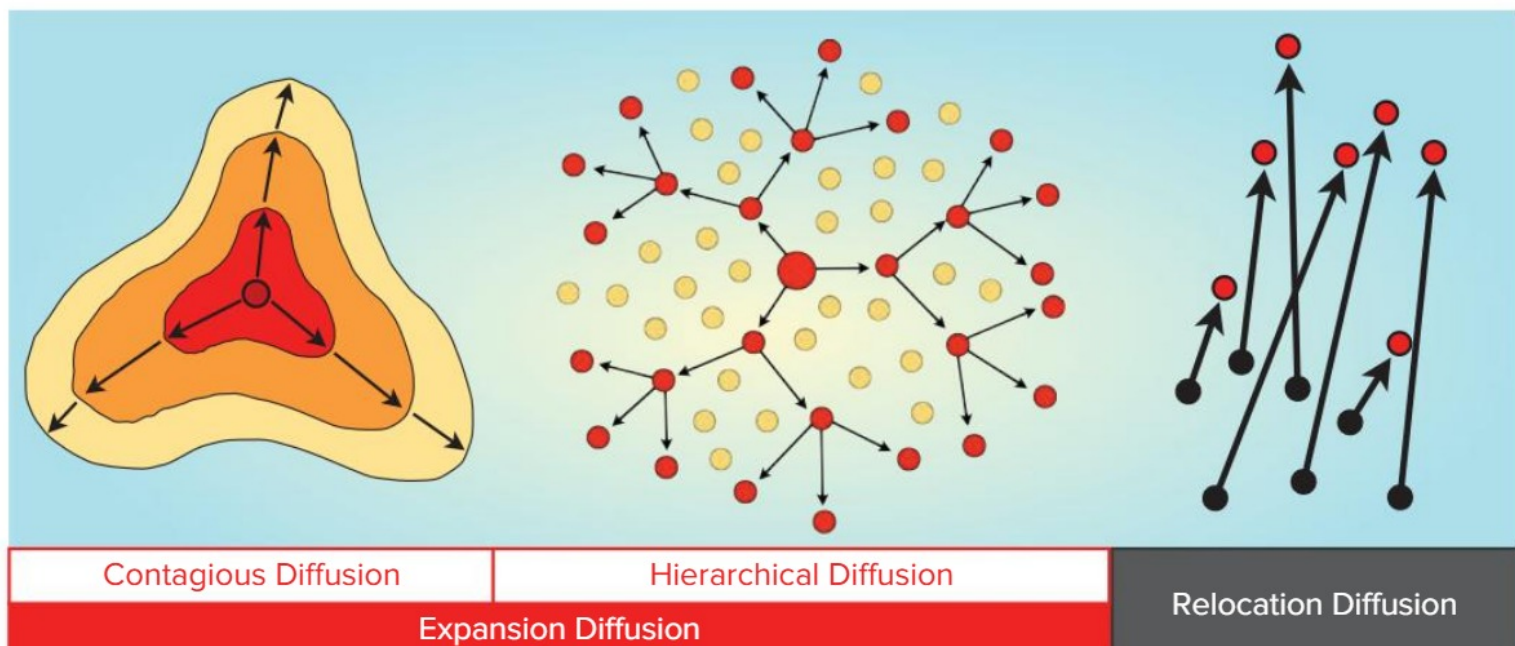
## QUESTION BANK 2D

1. 'The problem with food today is not that we can't grow enough. The problem is that we grow too much but we can't seem to distribute properly'. Critically evaluate this statement.
2. Why has food production risen more than expected in recent decades?
3. In 2015, the world population was about 7.347 billion people. Using this information, and the information contained in this section on the area per capita used for growing crops in the world, calculate the approximate area in the world used for crop production in 2015.
4. What is meant by the term 'productivity'?
5. Do you think physical or human factors are more important in explaining variations in food consumption in different parts of the world? Give reasons to explain your thoughts.

## Diffusion

The spread of something, such as new technology, an idea, a disease or a pollutant over space and through time is known as **diffusion**.

Figure 2.40 shows that there are two broad types of diffusion, **expansion diffusion** and **relocation diffusion**. In expansion diffusion, an innovation, an idea or a disease, develops in a source area and spreads out from there while also remaining strong in its source area. This can happen in two ways.



**2.40** Types of diffusion.



With **contagious diffusion**, the phenomenon spreads out in several directions from the source, affecting most individuals who come into contact with it (even if they do not show the symptoms).

**Expansion diffusion** takes place in populations whose locations are stable and fixed. It is the phenomenon (such as an idea or a disease) that moves, not the people. **Relocation diffusion**, on the other hand, involves the movement of individual people who carry the phenomenon to new locations. When expansion diffusion occurs, the phenomenon (such as the idea or the disease) remains at the source area, often becoming more intense. When relocation diffusion occurs, the phenomenon evacuates the source area along with the person who is the carrier of the idea or disease.

### The diffusion of agricultural innovations

**Agricultural innovations** spread as new ideas through the process of **diffusion**. A new idea that originates at a certain point will spread out from that point. If there is little or no communication by radio or television, the new idea will spread by word of mouth, either from one neighbour to the next or between family and friends at the markets in town. In general, ideas will spread fastest along lines of communication, while physical barriers such as rivers or mountains will slow the spread of ideas. As distance increases from the centre of the new idea, fewer and fewer farmers will have adopted the innovation.

At the present time, and over recent decades, there are several **key innovations** in food production that have been spreading in different countries, and even within countries.

#### Increasing commercialisation

An increasing proportion of the food grown by farmers is being sold and traded in **markets**, and this is perhaps the most marked trend today in global food production. Sometimes, food is simply sold in markets in nearby towns although in other cases the food finds its way to large companies and international trade. The idea of switching from subsistence to commercial farming usually begins to spread through the same markets where the food is sold, as subsistence farmers see the financial benefits that selling a small surplus can bring.



**2.41** This small market represents the first step towards commercialisation of farming. The market forms three days per week in Papua New Guinea, half way between the village of Yamok and the Sepik River. People living at the river bring fish, while people from Yamok sell vegetables, sugar cane and sago. Most trade is barter, but some is cash. The buying and selling is done by the farmers, all of whom are women.



**2.42** Farmers bring their food from dispersed areas to the markets in Djenné, Mali. The exchanges that occur when people meet from disparate areas is a key element of the process of diffusion of new ideas.



**2.43** Food is sold to the public by the farmers who grew the food in a market in Key Afar, Ethiopia.



Increasing commercialisation means that there is an increasing **flow of money** into farmers' households for the first time. This is resulting in improvements in the standards of living of farmers such as larger houses and even some consumer goods. On the other hand, one of the **problems** faced by farmers who sell food commercially is that prices are declining on a long-term basis.

**China** is a good example of an especially rapid diffusion of the idea to make farming more commercialised. In China, increasing commercialisation has been strongly encouraged by the government under a scheme known as the '**responsibility system**'. Under the responsibility system, farmers take out a contract with their township government to supply an agreed quantity of a crop such as rice or vegetables to the township government in exchange for the right to cultivate a particular parcel of land.



**2.44** Farmers in the inland Chinese town of Lijiang sell their surplus crops and livestock, encouraged by the Responsibility System, a government-supported policy that arrived in Lijiang by diffusion through Communist party officials, radio and television publicity, and the exchanges of ideas between farmers at markets such as this.

Once this agreed quantity is supplied, any excess produce from the land belongs to the farm household to use as it wishes. Households usually give the worst quality produce to the government, keeping the best produce for the next year's seed stock and to sell the remainder in the market for a premium price. The responsibility system was first introduced into coastal regions of China during the period 1978 to 1984, and since then it has expanded throughout the country, resulting in huge increases in both agricultural production and farmers' standards of living.

### Increasing specialisation

As farmers become more involved with commercial production, they are able to earn money which can be used to buy types of food which they previously had to grow themselves. Once a farming family does not have to grow all the food it will eat, it can afford to **specialise** in growing the crop that will bring the greatest economic profit. With the extra income earned, they can afford to purchase a variety of other foods rather than having to grow these crops themselves.



**2.45** This sugar plantation near Trois Mamelles mountain, Mauritius, is an example of specialised food production. The farming family that grows the sugar cane could not possibly consume all the crop itself, so the sugar is sold and the income earned is used to purchase food and other needs through commercial markets.

### Increasing spatial integration

With the increasing trend towards commercialisation, two-way links between farmers and markets must develop. First, **transport links** must develop for farmers to transport their produce to town markets. Second, other **supportive service industries** such as marketing, banking and insurance develop. The **links** that arise are two-way in that farmers sell their produce in the market towns, but then use their new earnings to purchase items from other businesses in the town. In this way, the economies of the towns and the countryside become much more **integrated** and **interdependent**.

Spatial integration extends beyond the nearest market town, of course. The prices received by farmers will be influenced by forces operating on a **global scale** – prices that reflect the demand for food in other countries and the availability of food





**2.46** When markets for farmers are poorly developed, transport links between farms and towns are also poorly developed. In North Korea, there is no commercial agriculture and the market system is almost non-existent, so transport often relies on ox-carts such as this one near Sinchon.



**2.47** As commercialisation becomes established, farmers improve their transport links with towns and cities. This farmer is selling produce from his own small truck directly to consumers in Santo Domingo, Dominican Republic.



**2.48** As farming becomes more commercialised, more efficient transport links become necessary, such as motor lorry transport as seen here near Zigon, Myanmar.

from competing producers. As a result of all this, the factors that can affect a farmer become much more complex with spatial integration.

Spatial integration affects **social** and **cultural** aspects of farmers' lives also. As farmers begin to earn extra cash income, one of their frequent purchases is often a television set. The purchase of a radio or television transforms farmers' **views of the world**. Traditionally, farmers in isolated areas relied upon word of mouth – conversations with other people at the markets – to learn about events outside the local area. With a television in the house, farmers and their families are in instant contact with the rest of the world through satellite news broadcasts — as well as dramas and comedies from Hollywood and Bollywood!

After the Communist Party came to power in China in 1949, one of their earliest policies was to bring **electricity** to the countryside, even to peasants in the most remote areas. This policy was considered important so that government propaganda could be instantly distributed to farmers (who made up 85% of the population) via the radio. Rural electrification throughout Asia and other developing parts of the world now puts even poor farmers in contact with global information, changing their world outlooks irreversibly.

Of course, new ideas can spread without the aid of electricity. When a new idea or technique is introduced, nearby farmers will often wait and see



**2.49** Chengzhong is a remote area of Guizhou province in China that is inhabited by people of the Miao nationality. The electricity lines that criss-cross these rice padis in Chengzhong provide of rural electrification that allows even very isolated farmers to become integrated with global information and communication networks.



how it works over time before rushing in and changing their familiar techniques, slowing the rate of diffusion. Subsistence farmers tend to be very conservative, preferring to continue with the proven techniques used by their parents and their parents before them. This is understandable as such farmers do not produce a large surplus and so they have little spare production with which to experiment. However, once farmers start commercialising their production, they are more likely to **innovate** and change in search of extra production and extra profits. Thus, change through diffusion becomes more rapid in an area of commercial food production.

### Increasing mechanisation

There is a very strong trend for farmers to replace people with **machines** as they become more involved with commercial production. The type of machinery used varies from place to place and is influenced by the profitability of the farmer. In many parts of Asia, small hand held tractors are replacing water buffaloes. The machines enable the farmer to perform tasks such as ploughing and puddling much more quickly than when they were done using water buffalo. Machines are also less temperamental than water buffalo, although they cost much more to buy and to operate. In some areas, these hand-held tractors are owned by a few operators who use them to do the work for local farmers under contract for payment.

In China, a unique type of **tractor** is found throughout the country in rural areas. These walking tractors have become a symbol of rural



2.51 A Chinese 'walking tractor' on a remote farm in the mountains north-east of Qiaotou, Yunnan province, China.

mechanisation in China. Originally introduced by Russian agricultural engineers in the 1950s as a small, hand-held plough, the Chinese adapted the design into a tractor, and then began producing them in small factories throughout the country. Today, millions of these slow-revving tractors are used to haul produce, transport equipment and even provide local bus services in isolated areas.

In industrialised countries, farming is heavily mechanised. In Japan, small machines have been developed to perform most of the unpleasant menial tasks of rice cultivation such as ploughing, planting, harvesting and winnowing. These machines enable many Japanese rice farmers to have regular paid employment through the week and carry out their rice farming only on weekends. On the other hand, the machines require that standard, uniform practices are adopted. For example, mechanised rice planters used in Japan and elsewhere can only operate if the rice seedlings have been planted in standard sized boxes that are fed automatically through the planter as it crosses the padi field (a padi is the field where rice is grown).

On the other hand, the farms of most subsistence rice farmers in developing countries remain largely non-mechanised, relying on **human power** and **animal power** provided by water buffalo, donkeys and horses. This is actually a very **efficient** use of the resources available to most rice cultivators. In most Asian nations, it is land that is a scarce commodity rather than labour. It is very doubtful that replacing large numbers of people who can farm the land intensively with machinery would



2.50 Small, hand-held tractors like this one in Bali, Indonesia, are used in several countries to perform the same tasks as water buffaloes used to do much more slowly.



increase the very high yields already being obtained. Using more machines would, however, create large-scale **unemployment** and **social problems** as (perhaps) millions of displaced farmers migrated to the cities in search of jobs for which they had no skills.



2.52 A farmer near Ambatolampy in Madagascar uses oxen to plough and pound the mud in a padi field into a thick, structureless mud.

It is likely that the increasing use of machinery is actually making food cultivation less and **less efficient**. As we saw earlier in this chapter, we can measure efficiency by comparing the input of energy used to produce a crop with the output of energy contained in the food. This efficiency can be measured as a ratio of energy inputs to energy outputs.

On this basis, intensive rice production is among the world's most efficient sources of food energy with a ratio of between 1:5 and 1:3, although this falls to about 1:1.5 for extensive commercial rice production. In other words, we obtain up to three times more food energy from growing rice in the traditional way than we put into producing it. This compares with ratios of 1:2 for cattle grazing, 1:1 for dairying, 2:1 for intensive poultry raising, and 10:1 for feedlot beef and deep-sea fishing. As farming becomes more mechanised, the **energy inputs** can become so great that we are spending more energy than we are obtaining from the food produced — in the case of feedlot beef 10 times more energy.

### Increasing purchased inputs

As soon as a farmer purchases machinery, an ongoing commitment to purchase other inputs is made. Machinery requires inputs of **petrochemicals**, and these can prove to be

expensive for a farmer. Machinery is also expensive to repair when it breaks down, and repairs must usually be paid for in cash. As a farmer becomes more oriented towards commercial production, greater priority is placed on maximising yields, and so **pesticides** and **chemical fertilisers** are more likely to be used. Once again, these must be paid for in cash. Even at a more simple level, many farmers want to replace simple wooden tools they can make themselves with **tools** made of steel because they are harder and will last longer. Such tools must be fabricated, either in a factory or by a craftsman in a nearby market town. Either way, such tools are usually a purchased input that must be paid for in cash, forcing the farmer to engage in more and more commercial farming activity.



2.53 Farmers (most of whom are women) in the Baliem Valley of West Papua, Indonesia, traditionally used wooden digging sticks to cultivate their sweet potato gardens. In recent years, those living near towns with markets have begun using metal digging sticks, an example of expansion diffusion.



### Increasing farm sizes

As farms become more commercialised and more machinery is used in an attempt to boost production, farmers feel the pressure to **increase the area** of their farms. More area means more production and, hopefully, more profits. Larger farm areas also make it easier to justify the use of machinery, and if a larger area also means the fields can be more rectangular, then it becomes easier to use machinery on a large scale.

The trend towards increasing farm sizes has occurred in some nations to a greater extent than in others. Following World War II, American forces occupying Japan forced **land reform** on the rural countryside, amalgamating farms and creating larger land units. Even after the Japanese land reform had occurred, however, average farm size had only increased up to about one hectare.

A more effective land reform program was imposed by the Chinese Communist Party after it came to power in 1949. Before the revolution in 1949, most of China's farmlands were owned by rich peasants or **landlords** who collected extremely high rents from the farmers who worked the land. There were instances in the late 1940s of rents as high as 120% of the annual crop being collected by landlords from their farmers. Between 1949 and 1952, land was confiscated from the landlords and redistributed to the peasants who had been farming the land.

In 1958, as part of a political campaign known as the Great Leap Forward, China's farmland was **collectivised** (brought into public ownership) and amalgamated into large communes. The area of communes varied somewhat, but in general they were between 40 and 120 square kilometres each. Each commune was divided into a number of production brigades, each of which roughly equated to a village. Each brigade was divided in turn into a number of production teams, each of which roughly corresponded to a neighbourhood. Finally, each production team was divided into households (extended families).

The formation of communes made enlarging and squaring off fields much easier. However, the commune system was abandoned in the early 1980s when the responsibility system was introduced.



2.54 Rice paddies near Yangshuo still show the small fields of irregular shapes that were common in China before land reform.



2.55 These large, rectangular fields near Kunming are typical of post land reform layout of farms in China.

Nonetheless, the trend towards larger farms has been retained, and the large rectangular fields that were introduced under the system continue today.

### Increasing control over the biophysical environment

**Environmental manipulation** occurs to some extent on any farm. When wet-rice is grown, a completely new wetland ecosystem is generated which relies on **water management** to maintain rice as the ecologically dominant species. However, commercialisation of rice production gives farmers the power to control or manipulate their biophysical environment to an even greater extent. Farmers with cash incomes may be able to afford to buy **mechanical pumps** to boost the irrigation capacity of their farms. Many farmers can use purchased inputs such as **chemical fertilisers** to boost yields and **pesticides** to control insect pests.





**2.56** The construction of rice terraces on hillsides replaces the natural ecosystem with a new human-controlled ecosystem. The manipulated ecosystem features artificial drainage that diverts, stores and drains water, a transformed soil structure, and the replacement of natural vegetation with an introduced monoculture species that is maintained by ploughing, puddling, seed selection and weed control. These rice terraces are at Tegalalang, Bali, Indonesia.

Farmers with increased power to control the biophysical environment must use this ability wisely or else unforeseen damage can occur. In 1954, the Chinese government launched a campaign around Beijing in northern China in 1954 to **eradicate birds**. It was thought that birds were eating much of the grain from the wheat and rice fields, and spreading encephalitis, a dangerous disease that causes swelling of the brain which can lead to death. The government decided to 'mobilise the masses', which meant involving the entire population in the campaign. Every person in every neighbourhood was placed on a 24-hour roster to stand outside and beat pots and pans together for a few days. The idea was that the birds would be so frightened that they would not come down to rest and they would die from heart failure while continuously flying. The campaign worked as planned, and after three days there were no birds remaining in Beijing.

Unfortunately, the absence of the birds meant that the biological control on insects and spiders was removed from the ecosystem. As a result, insect and spider numbers increased to plague proportions, and massive doses of **chemical pesticides** were needed. Indeed, a new pesticide factory had to be hurriedly built near Beijing simply to supply the chemicals needed to control the insect plague that resulted from eradication of the birds.

### Changing social structures

All the changes listed above have changed the lives of farmers enormously. Traditional **social structures** have been broken down and there have been upheavals in many societies as some people benefit but others lose as a result of the changes.

In China, farmers have experienced many social changes that have been enforced by government policy. The establishment of the communes in 1958 and their abolition in the early 1980s caused huge changes for farmers as they tried to adjust to reversals of economic policies and government priorities which even affected how families were structured and organised. The model of Chinese communes was adopted in other nations also, notably Tanzania and Cambodia, and in each case it resulted in a savage decline in rice production as farmers lost the incentive to work hard.



**2.57** A large, fading government-sponsored sign in Georgetown, Guyana, encourages commercial farmers to produce more food.

**Increasing commercialisation** is the main cause of changing social structures. Most traditional rice growing communities organise their society and festivals around the annual cycle of rice growing. Farmers who are growing rice for profit rather than for lifestyle are less inclined to spend resources such as time, money and rice to celebrate **traditional religious beliefs**. Traditional subsistence farmers see rice as a gift from the gods and the very sustenance of life. Commercialisation breaks down this traditional culture.

Eventually, farmers embrace the same attitude as many farmers in industrialised nations who see producing food simply as a means to make money,



devoid of any religious significance. They come to see a successful crop as being the result of spending money on fertilisers, pesticides, machinery or irrigation — manipulating and controlling the ecosystem rather than working within its confines. When this occurs internationally, the scale of diffusion has become global.

### QUESTION BANK 2E

1. What is the difference between relocation diffusion and expansion diffusion?
2. What is the difference between the two types of expansion diffusion (contagious diffusion and hierarchical diffusion)?
3. Suggest reasons why the trend towards commercialisation of food production is so strong in the world today.
4. Give examples of diffusion of ideas in China that have led to agricultural innovations.
5. What are the advantages and disadvantages of small tractors compared with water buffaloes for rice farmers when they are ploughing a padi field?
6. What are the social costs of replacing people and animals with machines?
7. When farmers exercise greater control over their biophysical environment, is this a good or a bad thing?
8. Give specific examples of the diffusion of ideas at different scales that have led to agricultural innovations.

### The spread of disease

Like agricultural innovations, diseases spread through diffusion. Both expansion diffusion and relocation diffusion can occur with diseases. When the mechanism is **contagious diffusion**, the disease spreads out in several directions from the source, affecting most individuals who come into contact with it (even if they do not show the symptoms).

Not all diseases spread through contagious diffusion. Some diseases, such as AIDS, spread through **hierarchical diffusion**. In hierarchical diffusion, there are channels of diffusion among people or groups that are more susceptible to the disease, and the disease by-passes individuals or groups that do not share this vulnerability.

The spread of disease through diffusion is a major issue confronting humanity. A proposed speaker at a TED conference commented that “the greatest threat to our species is not global warming, warfare, poverty, or environmental degradation – the greatest threat is **drug-resistant bacteria**. Should a flesh-eating

*streptococcal infection someday exchange the right genes with drug-resistant Staphylococcal infection, the resulting super-bug could conceivably melt the human race like a wax museum on fire”.*

Diseases do **mutate**, and this poses significant potential threats to humanity. If a catastrophic disease mutation were to happen, some people will survive, but who survives will have little to do with power, money or influence. Indeed, many medical experts warn that people in wealthier countries are likely to be at a significant disadvantage compared with people in poorer countries. This is because **diffusion** tends to work more quickly and efficiently in industrialised countries with fast transport networks, and because many people in richer countries have **compromised immune** systems due to the over-use of certain antibiotics, both in the community and the food chain.

Although the ‘causes of the causes’ of **health quality** shown in figure 1.41 can be identified using the same general headings for both low income and high income countries, the way they operate in poorer societies is very different from their operation in more affluent areas.

In low income countries, many factors combine to allow and even encourage the spread of **diseases of poverty**. **Environmental factors** include crowded working and living conditions, inadequate sanitation, and unclean water supplies. Social conditions include inadequate nutrition, low wages that make people reluctant to seek expensive medical help, long working hours, inaccessible health care, and exposure to health risks and injury in unsafe working conditions.



2.58 A poster in Singapore informing residents about ways to slow the diffusion of dengue, a vector-borne fever spread by mosquitoes.



The diffusion of disease can be thought of very simply as one person passing an infection to someone else, who in turn passes it on to others, and so on. However, this simple process applies only to directly **transmitted diseases**, which are diseases that are transferred from one human to another. The processes involved with **water-borne diseases** and **vector-borne diseases** are slightly different, and will be considered later in this section.

One example of a **directly transmitted disease** of poverty is **leprosy**. Leprosy has a long history, first being identified in about 600BC. It affects the nerves and skin of affected people, leading to permanent damage to the limbs, skin and eyes. Leprosy is not highly infectious, and 90% of the world's population have a natural **immunity** to it. It is spread via airborne droplets from the nose and



**2.60** An elderly leprosy sufferer in his home in Ma Chan village, Yunnan province, China.

mouth during close and frequent contacts with untreated cases. However, the bacteria multiply very slowly, and the incubation period is about five years; indeed, symptoms may not appear for 20 years after infection.

Leprosy is easily treated, and if treatment begins in the early stages of the disease, then long-term disabilities are unlikely. The fact that people still suffer from the disease highlights leprosy as a **disease of poverty**, caused largely by lack of information or poor public health facilities, as often occurs in isolated regions of low income countries.

The World Health Organisation is trying to eliminate leprosy. Since 1995, WHO has supplied free Multi Drug Treatment (MDT) to leprosy patients anywhere in the world where leprosy remains a problem. The MDT comprises a combination of medications, including rifampicin,



**2.59** This woman in Ma Chan, China, had one leg amputated when she was young due to the impact of leprosy.



**2.61** This young mother had leprosy, but it was cured before severe symptoms set in. The only visible damage from the leprosy is the sparse hair of her eyebrows.



clofazimine and dapsone (which has been readily available for treating leprosy since 1930). In this way, WHO hopes to erect what geographers call a **barrier to diffusion** for leprosy.

One of the challenges in stopping the spread of leprosy is that the disease carries a strong social stigma because of the deformities that can arise in advanced cases. The **discrimination** shown to leprosy sufferers is a major obstacle to self-reporting and early treatment as well as a major obstacle to former leprosy sufferers who have been cured returning to a normal life in wider society. As an example, none of the residents of a village populated with former leprosy sufferers where the author performed voluntary work over several years felt they would ever be able to return to their families because of the discrimination and ostracism they would face. Consequently, they expected to spend the rest of their lives in the village where they were sent when first diagnosed with leprosy, in some cases three or four decades previously.



**2.62** This man suffers discrimination because of the facial disfigurement caused by leprosy when he was younger.

## Vector-borne and water-borne diseases

### Water-borne diseases

One of the main ways in which diseases spread in poorer countries is through **dirty water (expansion diffusion)**, causing a variety of water-borne diseases. As recently as the early 1990s, 19% of people in urban areas and 42% of people in rural areas around the world did not have access to a safe supply of drinking water. As these figures were



**2.63** In places that lack piped water, water may be delivered from tanks, such as this donkey-drawn cart in Sehoul, Mali. This water is often polluted, spreading disease to those who drink it.



**2.64** Many houses may lack piped water, even in major cities such as Johannesburg, South Africa, shown here, where residents must collect water from communal taps or wells. This water is often dirty, leading to water-borne diseases such as diarrhoea.

world averages, the figures for many low income countries were much worse. Today, the situation is somewhat better, with 4% of people in urban areas and 15% of people in rural areas around the world lacking access to a safe supply of drinking water.

Some water-borne diseases are caused by **parasites** or **organisms** that live in the water. **Bilharzia** snails cause about 20 million deaths each year, and this is an example of disease that spreads by **expansion diffusion**. The snails live in warm, still waters of tropical areas. When people walk with bare feet in the water, the snails enter the body through the soles of the feet or through a body orifice. Once in the human body, the snails reproduce in the kidney or the bladder. The person becomes weak and suffers from anaemia and failure of the bladder or kidney. When infected people urinate or defecate





**2.65** People bathe, collect water for domestic use, wash clothes and wash dishes in the Hooghly River in central Kolkata (formerly Calcutta), India. The Hooghly River is notorious for its high levels of organic pollution.



**2.66** These metal sheds above the river in a shanty area of Dhaka, Bangladesh, are toilets. The toilets have no storage capacity, causing water pollution as the wastes drop straight into the river.

in a lake or river, the eggs of the bilharzia snail are released, starting the life cycle and the process of diffusion once again.

Other water-borne diseases include guinea worm disease and river blindness. **Guinea worm disease** is caught by drinking water which contains water fleas which in turn contain guinea worm larvae. These larvae are found in West Africa and on the west coast of India. The disease causes an open sore, through which a worm up to 30 cm in length protrudes. **River blindness** is caused when the blackfly bites a human and deposits parasitic worms in the blood. One worm produces about a million offspring in a year inside the human body, causing swelling and intense itching. If the worms get under the eyelid, then blindness results. Most river blindness is found in West Africa.

A problem in low income countries is that water is often used for many different purposes, and sometimes these uses are **not compatible**. For example, it is common to see people washing their clothes in the river even though the river bed might also be used to graze cattle and the water might be used as a toilet and garbage dump.

### CASE STUDY Diarrhoea

One of the main pollutants of water in low income countries is **human sewage**. Poorer people in low income countries often have difficulty in affording hygienic disposal of human wastes. In some countries, a toilet is simply a hole in the ground or a river bank set aside for toileting. Diseases can spread easily in these situations as flies and other vermin carry germs from the exposed excrement to people's food. It is hard for people to maintain personal hygiene under such conditions, and diseases such as **diarrhoea** can spread easily.

Diarrhoea is an **infectious disease** that leads to frequent, sometimes forceful expulsion of loose, watery faeces. It can be caused by a virus, bacteria or parasite that has been ingested in one of three ways: by eating food that is contaminated with the disease, by drinking water that has been contaminated by faeces, or through direct contact with an infected person.

In industrialised countries where hygiene is good and medicines are readily available, diarrhoea is seen as an **inconvenient** but relatively minor disease. However, in low income countries, diarrhoea is often a very **serious** disease that leads to severe **dehydration** and extensive **fluid loss**, and frequently to **death**. Each year, about two billion children under the age of five get diarrhoea, of whom about 1.5 million die. As shown in figure 2.68, these deaths are overwhelmingly in low income countries.

A common way of disposing of human wastes in poorer countries is to dump them in a river. Usually, this involves building toilets over the water of a river or, occasionally, piping the wastes to the river from elsewhere. When sewage is dumped in a river, **bacteria** such as **E. coli**, **shigella**, **campylobacter** and **salmonella** feed on it. If large amounts of sewage are dumped in a river, the





**2.67** The bank of the Bagmati River in Kathmandu, Nepal, is extensively used for open defecation. Open defecation is a major contributor to infectious diarrhoea, which can be fatal. In addition to human faeces, the river bank also has animal manure and garbage. The area is a point source for the diffusion of disease, carried by flies, rats and the river's water.

bacteria multiply greatly and can use up most of the oxygen in the water. When this happens, other forms of life may become starved of oxygen and die. When the oxygen in a body of water is used up, the process of **eutrophication** is said to occur. **Health problems** occur when people use water with sewage dumped in it for other purposes such as washing and drinking.

Diarrhoea is spread in three main ways. First, diarrhoea spreads in situations where **sanitation** is poor. When people share a dwelling with **domesticated animals**, when they **lack refrigeration** for food, or when housing is **overcrowded**, diarrhoea is likely to occur. In low

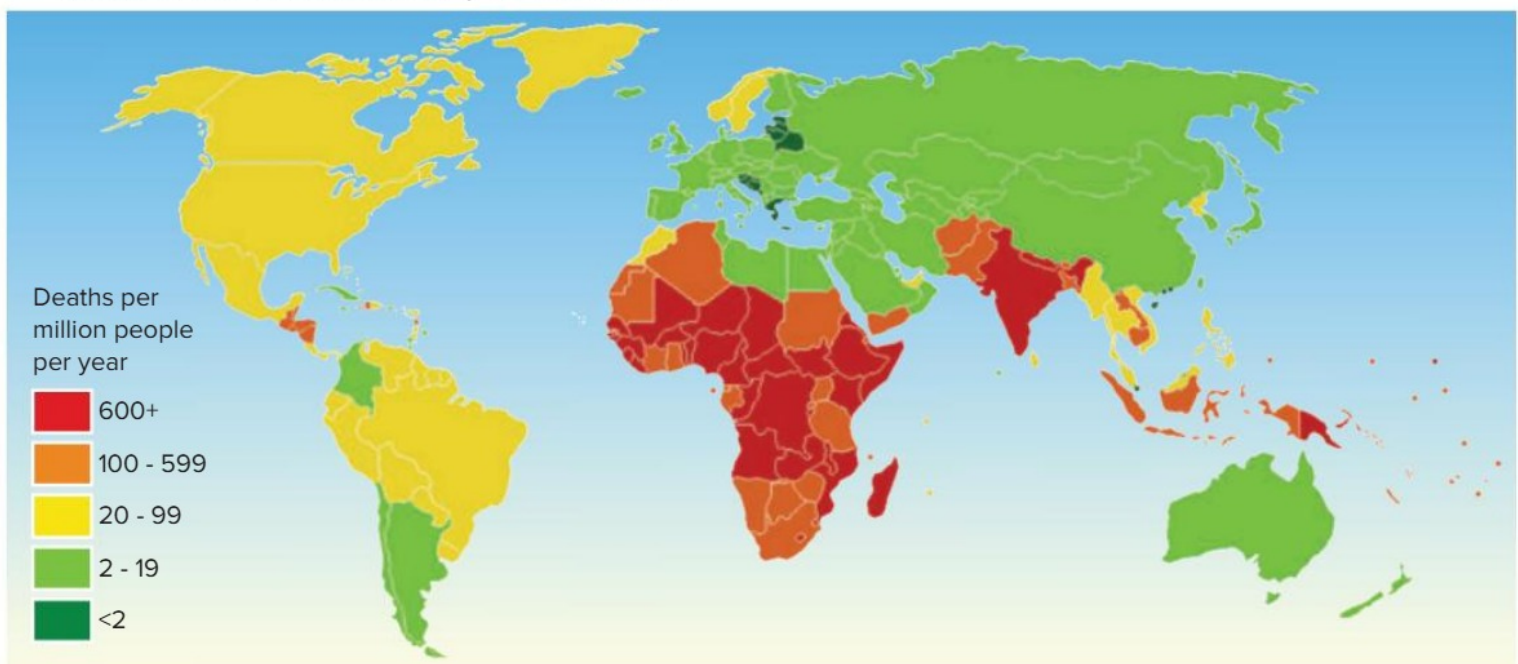


**2.69** Very few homes in Kiribati have running water or toilets. This beach on the southern shoreline of Tarawa reef is used for open defecation in the expectation that the ocean will wash away the deposits at high tide.

income countries, **open defecation** (excreting in the open, such as on a river bank or in a field, rather than in a designated toilet) is one of the main causes of infectious diarrhoea leading to death.

Second, diarrhoea occurs in places where people do not have access to **clean water**. This is associated with poor sanitation because lack of running water often leads to poor disposal of faeces, which in turn pollutes the groundwater.

Third, **poor nutrition** can lead to diarrhoea, especially in young children or adults with low immunity. A poor diet leads to a zinc deficiency and compromises natural immunity to diseases, both of which make a person more vulnerable to diarrhoea.



**2.68** Deaths due to diarrhoea, 2019.



All the causes of diarrhoea are related to **poverty**, as poverty frequently leads to poor sanitation, lack of access to clean water and poor nutrition. If sanitation and access to clean water are available, then diarrhoea is fairly easy to control, especially if hand washing is practised. Breastfeeding of babies has been shown to be effective in reducing diarrhoea, both because it builds up babies' antibodies and because it reduces the need for babies to ingest unclean water.

### Vector-borne diseases

A **vector** is a living organism such as an animal, insect, bird or micro-organism that carries and transmits a disease to another organism. Diseases that are spread by vectors are known as **vector-borne diseases**, and they account for 17% of the world's infectious diseases and more than one million deaths per year.

Most vectors are bloodsucking **insects** such as mosquitoes, sandflies and ticks. These insects become disease carriers when they take blood from an infected animal or person, and then inject the disease when they take blood from another organism. Common vector-borne diseases include:

#### Carried by mosquitoes

*Aedes mosquito*

- Chikungunya
- Dengue fever
- Rift Valley fever
- Yellow fever
- Zika

*Anopheles mosquito*

- Malaria

*Culex mosquito*

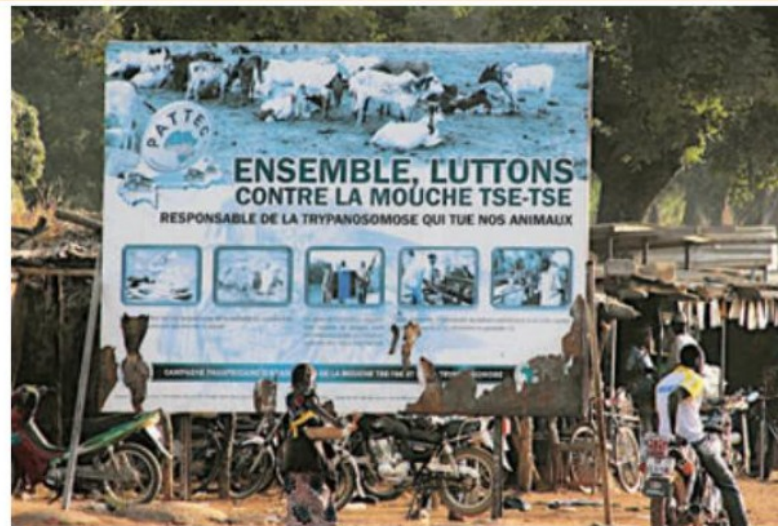
- Japanese encephalitis
- Lymphatic filariasis
- West Nile fever

#### Carried by sandflies

- Leishmaniasis
- Sandfly fever (phlebotomus fever)

#### Carried by ticks

- Crimean-Congo haemorrhagic fever
- Lyme disease
- Relapsing fever (borreliosis)
- Rickettsial diseases (spotted fever and Q fever)
- Tick-borne encephalitis
- Tularemia



**2.70** A large sign on the outskirts of Bobo-Dioulasso, Burkina Faso, encouraging residents to work against vector-borne diseases carried by the tse-tse fly. The message reads "Together, let's fight against the tse-tse fly, which is responsible for trypanosomiasis (sleeping sickness) that is killing our animals".

#### Carried by triatomine bugs

- Chagas disease (American trypanosomiasis)

#### Carried by tse-tse flies

- Sleeping sickness (African trypanosomiasis)

#### Carried by fleas

- Plague (transmitted by fleas from rats to humans)
- Rickettsiosis

#### Carried by black flies

- Onchocerciasis (river blindness)

#### Carried by aquatic snails

- Schistosomiasis (bilharziasis)



**2.71** Schistosomiasis is an acute parasitic disease carried by larvae released by aquatic snails, so it is both vector-borne and water-borne. Infection occurs through exposure to infested freshwater when larvae penetrate the skin. Symptoms include abdominal pain, diarrhoea and blood in the urine or faeces. It can lead to internal bleeding, bladder cancer and death. Women and children are especially vulnerable because they use the rivers for washing and playing, as shown here in the Niger River in Mopti, Mali.



As travel and trade has become more **globalised**, vector-borne diseases have spread more easily. It is now possible for a person to travel to the other side of the world before symptoms of infection appear, carrying a disease to countries where it was previously unknown. This has occurred with several vector-borne diseases such as dengue, chikungunya, zika and West Nile virus.

One of the possible consequences of **climate change** is that as some places become warmer, they may become more hospitable habitats for disease-bearing vectors. If this occurs, then diseases which are regarded as tropical today will expand in area.

### CASE STUDY Malaria

**Malaria** kills thousands of people each year in tropical areas of the world. Malaria is a **parasite** which is carried by one particular type of mosquito, the anopheles. The mosquitoes breed in stagnant water where the summer temperature is over 21°C. If an anopheles mosquito bites a person, the malaria parasite may be injected into the person's blood stream. Once in the blood, the parasite multiplies and can cause the person to suffer from the disease of malaria.

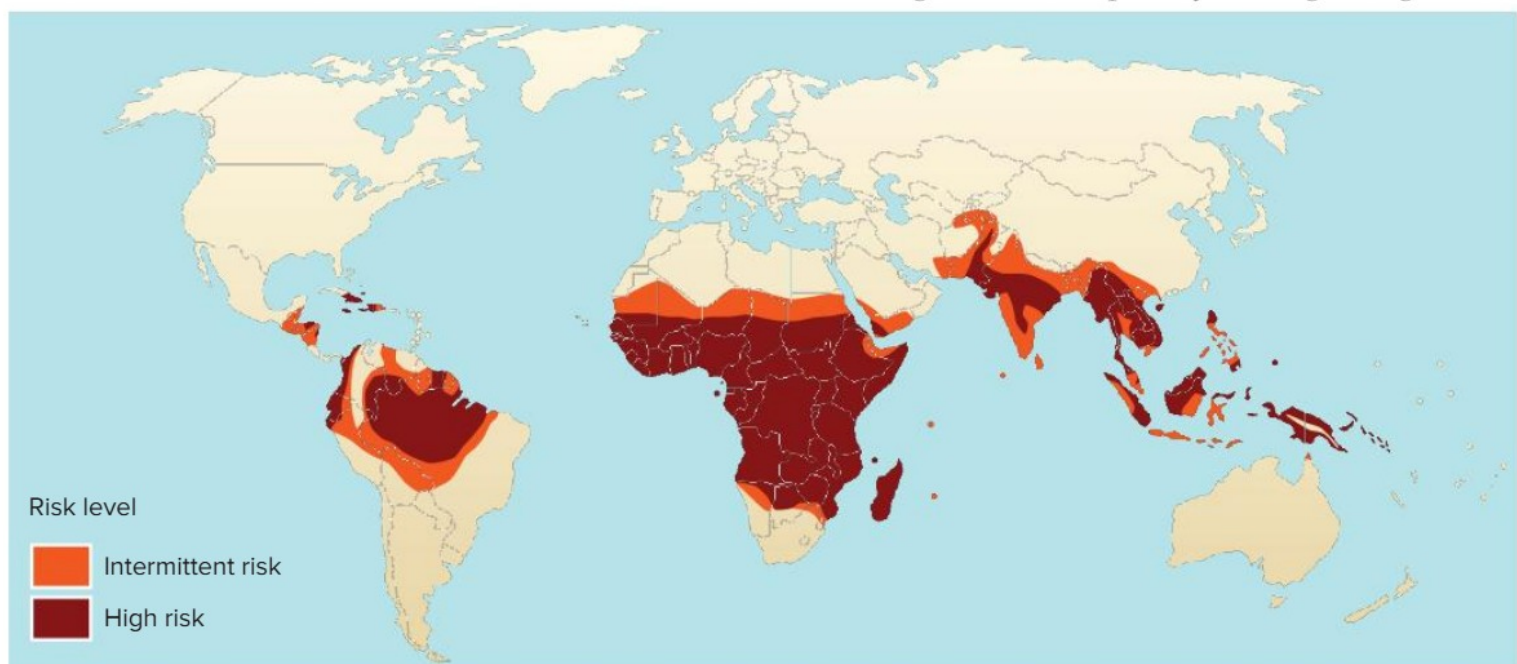
Malaria causes fever and fits of shivering. It can either kill a person directly, or else it can weaken a person so that they are unable to work properly. Sometimes, it weakens the immune system so that



**2.73** An anopheles mosquito is obtaining a blood meal from a human host through its pointed proboscis. Note the droplet of blood being expelled from the abdomen after having engorged itself on its host's blood.

other diseases can infect and perhaps kill the sufferer. Malaria is largely found in **tropical areas** of developing nations, and especially in **heavily populated areas** such as towns and agricultural areas where ponds, canals, irrigation channels and puddles of stagnant water are found. This is unfortunate as these areas have scarce medical facilities and limited resources to fight disease.

Contagious diseases spread when there are **triggers to diffusion**, or factors that initiate the process of diffusion. For malaria, triggers can be any factor that modifies the biophysical environment in a way that makes conditions more favourable for the anopheles mosquito. For example, **expanding irrigation** usually leads to an increase in the area of still or stagnant water, especially in rice growing



**2.72** Risk of malaria.





**2.74** Heavily polluted water in a poor residential district of Manila, Philippines, makes an ideal breeding environment for malarial mosquitoes.

areas where the rice padis are flooded for much of the year. **Logging tropical forests** also creates areas of stagnant water as the disturbed surface of the soil forms puddles after rainfall. Constructing **dams**, **mining** the surface of the ground, and **war and conflict** that create explosion craters are all triggers to diffusion for malaria.

Over time, some people who live in malarial areas can build up **resistance** to the parasite. When people who have no immunity move into a malarial area, perhaps to find work or perhaps because they are refugees fleeing conflict elsewhere, they can be especially **vulnerable** to succumbing to malaria. Other especially vulnerable sections of the population include children, as they have not developed any immunity to the parasite, and people who have compromised immune systems because of HIV.

The spread of contagious diseases can be arrested or slowed by erecting **barriers to diffusion**. In cooler parts of the world, malaria was eradicated by **draining** swamps and marshes, and this represented a barrier to further expansion of the disease. However, it is difficult to drain all the stagnant water in tropical areas — after all, the staple food of much of the world (rice) is grown in flooded padi fields. Therefore, eliminating the parasites would probably involve the use of **pesticides**. The sprays involved are expensive for poor nations and they can cause significant damage to the environment. They have long-lasting harmful effects on the environment, and some such as DDT build up in living organisms, causing



**2.75** An anti-malaria awareness sign erected in Accra, capital city of Ghana, by the Anglican Church informs residents about barriers to diffusion.

experts to fear that people may be poisoned by eating animals with pesticides in their systems.

Another barrier to the diffusion of diseases is **medication**. People suffering from malaria are treated with medications such as chloroquine. However, these medications have significant side-effects — they can destroy the functioning of the liver and can cause blindness if used for long periods of time. Moreover, the ongoing use of anti-malarial treatments over many decades has caused the disease to develop a **resistance** to chloroquine and to other more potent medications. Thus, malaria is spreading in tropical areas today.

An effective barrier to diffusion for malaria is the use of **bed nets**, also known as mosquito nets. The anopheles mosquito is most active at dawn and dusk, so humans are most vulnerable to attack at



**2.76** A large sign in Kumasi, Ghana, urges people to seek medical treatment quickly if they show symptoms of malaria. Prompt treatment not only saves lives, but it is a barrier to diffusion.



those times. Bed nets erect a physical barrier between the mosquito and the human, provided no part of the person is in contact with the net. Bed nets have been shown to reduce infant deaths from malaria by about 20%, and malarial infection by almost 50%. However, the cost of bed nets at US\$2 to US\$10 is beyond the reach of many people in low income countries.



**2.77** A mosquito net used by residents in Yamok, a village in the humid wetlands of the Sepik River in Papua New Guinea that has a high rate of malarial infection.

The ultimate barrier to diffusion would be to **eliminate malaria**. This may not be as unrealistic as it sounds at first. Malaria used to be prevalent in Europe and North America, but it was eliminated from most of Western Europe by the mid-1930s and from the United States in 1951.

One way to eliminate malaria is to **eliminate the anopheles mosquito**. Attempts to achieve this involve filling in disused irrigation channels, draining areas with stagnant water and covering water storage tanks. It is also possible to introduce fish that eat anopheles larvae into lakes and ponds.

In recent years, a new strategy to eliminate malaria has been adopted with almost US\$2 billion in grants provided by the Bill and Melinda Gates Foundation. The strategy is based on a new approach to treating malaria sufferers. At present, malaria medications cure the **symptoms** of malaria, but they do not eliminate the parasites that cause the infection. The Gates Foundation approach is to try and develop new medicines that not only cure the symptoms but completely **eradicate the parasites** from the infected person. The hope is that this will mean malaria sufferers will cease to be

carriers of the disease, as their blood will no longer carry the parasite for uptake by mosquitoes.

There are also **natural barriers to diffusion**. Apart from climate, **time** and **distance** are both factors that work against diffusion (whether it is disease, ideas or innovations). The further a disease (or an idea) moves from its source, the less likely it is to remain viable. Similarly, the passage of time reduces the effectiveness with which many diseases (and ideas) can spread. We refer to these natural barriers as **time-distance decay**.

Perhaps the most effective barrier to diffusion to reduce the impact of malaria would be to **educate** the local population in ways they can minimise the risks of catching the disease.



**2.78** Education can play an important part in changing traditional acceptance of disease as an inevitability, enabling young people to take measures that will erect barriers to diffusion to malaria. This classroom of primary school children is in Accra, Ghana, one of the countries with a high annual death rate from malaria.

Over 200 million suffer from malaria each year, and more than 600,000 people die annually from the disease. Of the deaths, 77% were children under 5 years old, and about 90% were in Sub-Saharan Africa. This places a huge **financial burden** upon the economies and health systems where malaria is found, not to mention the **social cost** and **personal tragedies** of the loss of life.

The dangers are especially high for pregnant women and children who are infected for the first time. Among the children who survive the disease, permanent **intellectual disabilities** can be a consequence, adding billions of dollars per year in lost productivity to the economic burden of





**2.79** Palimbe village on the Sepik River in Papua New Guinea. This is the stimulus photograph for question 14 below.

malaria. The economic costs are amplified when **tourists** are reluctant to visit malarial areas, businesses are reluctant to **invest** there, productivity is reduced by high levels of **absenteeism**, and **wages are lost** when people can't work due to illness. It is estimated that the economic cost of treating malaria absorbs almost half the government **health budgets** in some countries.

### QUESTION BANK 2F

1. Name a disease spread by each of the two types of expansion diffusion.
2. Define each of the terms (a) directly transmitted disease, (b) water-borne disease, and (c) vector-borne disease.
3. Why do we regard leprosy as a disease of poverty?
4. Why is diarrhoea regarded as a serious problem in low income countries?
5. How does diarrhoea spread in low income countries?
6. Describe and account for the world distribution of deaths due to diarrhoea as shown in figure 2.68.
7. Identify five vector-borne diseases that are carried by different vectors.
8. Why is schistosomiasis regarded as both water-borne and vector-borne?
9. How does malaria spread?
10. Describe and account for the world distribution of malaria as shown in figure 2.72.
11. Describe the barriers to diffusion that can contain the spread of malaria.
12. Why is malaria regarded as a serious problem in low income countries?
13. What is time-distance decay, and how does it affect the spread of malaria?
14. Residents of the village shown in figure 2.79 have a high incidence of both diarrhoea and malaria. Identify as many possible sources of each disease as you can from the photo, and then suggest strategies to lower the incidence of both diseases for the residents.
15. Compare the geographic factors that contribute to the incidence, diffusion and impact of diarrhoea (a water-borne disease) and malaria (a vector-borne disease).



## Diffusion of diseases of poverty and diseases of affluence

### Diseases of poverty

A common cause of diseases of poverty is **inadequate diet**. Most experts in the field estimate that an average adult person weighing 70 kilograms needs about 2,500 calories each day to maintain body weight (although the FAO suggests this figure could be as low as 1,800 calories per day). However, as we saw in figure 1.8, there are many parts of the world where people are not receiving an average of 2,500 calories per day. The areas where diets are deficient are mostly in Africa, western South America, south Asia and parts of south-east Asia. On the other hand, there are other parts of the world where the average person is eating much more than the amount of food needed to maintain body weight. These areas are mainly the developed nations of Europe, North America, Russia and Australasia.

It is estimated that over 20% of the world's population are **chronically hungry**. The problem is not simply the small amount of food that many people receive but that the diet may be **unbalanced**. If people eat mainly carbohydrates and have insufficient protein, then their bodies cannot metabolise the carbohydrates. They can suffer from malnutrition even though their stomachs are full.

The most serious diseases of malnutrition are kwashiorkor and marasmus. Both these diseases are caused by not eating enough **protein**, found in meat, fish and beans. **Marasmus** mainly affects children in their first year of life whereas kwashiorkor affects children from the age of two upwards. Children with marasmus are very underweight and are so thin that the shape of their bones protrudes through their skin. Muscles are undeveloped, there is no fat and the face looks like that of an old person. On the other hand, children with **kwashiorkor** have a swollen belly, are listless with blotches on the skin and have hair that has changed to a ginger colour. If young children have either of these diseases it may impede the development of the brain at a crucial stage of a child's life, causing mental retardation in adulthood — if the child survives to adulthood.



2.80 A food market selling local produce in Talatamaty, Madagascar. The range of food available is insufficient for a fully balanced diet.



2.81 Protein is available in this market in Lijiang, China, in the form of chicken, dog and pig meat.

Other diseases of malnutrition are caused by **insufficient vitamins**. Insufficient vitamin B causes **beri-beri**. People with beri-beri waste away, become paralysed and may have disorders of the nervous system. Another vitamin deficiency disease is **rickets**, which is caused by having insufficient vitamin D. Rickets causes deformities in bones, especially the spine and the legs.

Diseases can be caused by food-related problems other than the amount consumed. In many parts of the world, **storage of food** is difficult because of lack of refrigeration (or even lack of electricity). Where meat is stored in the open without refrigeration, flies can contaminate the food and spread disease. Furthermore, bacteria multiply in warm temperatures and diseases such as food poisoning and **salmonella** can result. That is why the markets in many places without refrigeration





2.82 Large flies cling to this meat on sale in an open air market in Chinsapo, Malawi.



2.83 Fast food is becoming increasingly popular in many developing countries. This Subway outlet is in Antigua, Guatemala.

sell live animals, it is the cheapest and most effective way of keeping the food fresh.

As nations develop economically, **food preferences change**. These changes in diet affect people's health. In general, people in wealthier societies tend to eat more red meat, more protein, more dairy foods, more sugar and less fibre than people in more traditional societies. People in wealthier societies are more likely to eat processed 'fast' foods. On the other hand, people in traditional societies are more likely to eat fresh, unprocessed foods. Some fast foods have been criticised as offering an unbalanced diet if eaten too frequently. Furthermore, low fibre and high fat foods have been linked to bowel cancer, strokes and heart disease — diseases of affluence.

In recent years, fast food has become very popular in many low income countries where economic

growth is occurring. This is an example of **expansion diffusion**, where a spread of new ideas and cultural values leads in turn to a spread of diseases of affluence into poorer countries. Since 1960, Japanese people have more than tripled their per capita consumption of beef. Many doctors believe that this is the cause of a large increase in rates of breast cancer among Japanese women during the same period of time.

Another example of the diffusion of Western ideas and cultural values is the widespread advertising of cow's milk, **baby formula** and foods. Thus, women may be persuaded by large companies to stop breast-feeding their babies and bottle feed instead. This has caused significant health problems, especially in low income areas where mothers have stopped breastfeeding. The best balanced and most appropriate food for any baby is the milk from the baby's own mother.



2.84 A huge sign promoting infant cereals as a substitute for breast milk at a bus station in Harare, Zimbabwe.



2.85 Milk powder for sale at the entrance to a maternity hospital in Tangshan, China.



Milk formula may cause problems for babies because it is often (of necessity) made in a **non-sterilised bottle** with **impure water**. Further problems can occur because uneducated mothers without literacy **cannot read** the instructions and may quite possibly mix the formula with the wrong concentration, leading either to **malnutrition** (if it is too weak) or **dehydration** (if it is too strong). Bottled baby's milk is made from cow's milk (to which many young babies are allergic). Moreover, milk formula costs money, but breastfeeding is free.

Severe illness and even death can result from babies being fed unhygienic milk formula instead of breastmilk. Most mothers in low income countries do not have access either to **pure water** or to the means of purifying contaminated water. This can also be a problem in industrialised countries.

In response to this problem, the World Health Organisation has called on all countries adopt a voluntary common code of conduct. Countries signing the code of conduct have agreed to halt to all advertising of powdered milk for babies and feeding bottles, to stop giving free samples of milk for babies, to ban milk company employees from acting as health educators and to require labels on baby milk which state the hazards of bottle feeding and the benefits of breastfeeding. Adopting the common code of conduct would be an example of a **regulatory barrier to the diffusion of diseases** related to unhygienic milk formula for babies.

Several countries now have policies which support breastfeeding. In Papua New Guinea, for example, a baby's feeding bottle may only be obtained with a doctor's prescription certifying that the mother is unable to breastfeed.

### Diseases of affluence

Some years ago, the-then Director of the World Health Organisation (WHO) stated:

*"Global standards of health and well-being are declining. Life expectancy, after reaching a peak, is now decreasing. Cancer rates are rising; heart diseases are rampant; drugs, alcohol, cigarettes and traffic accidents nowadays kill more people than did all the epidemics together in earlier centuries."*

He was referring mainly to **diseases of affluence** in that statement. Diffusion of diseases of affluence generally follows a different pattern from the

spread of diseases of poverty. Increases in the rates of diseases of affluence are caused, perhaps ironically, those things that many people would regard as improving their quality of life, such as more labour-saving devices, less need for physical exertion, over-consumption of food, tobacco and alcohol, more use of mechanised transport, easy access to cheap fast-food, less exposure to infections throughout life (which means immunity is likely to be less fully developed), and the consequences of longer life expectancies.

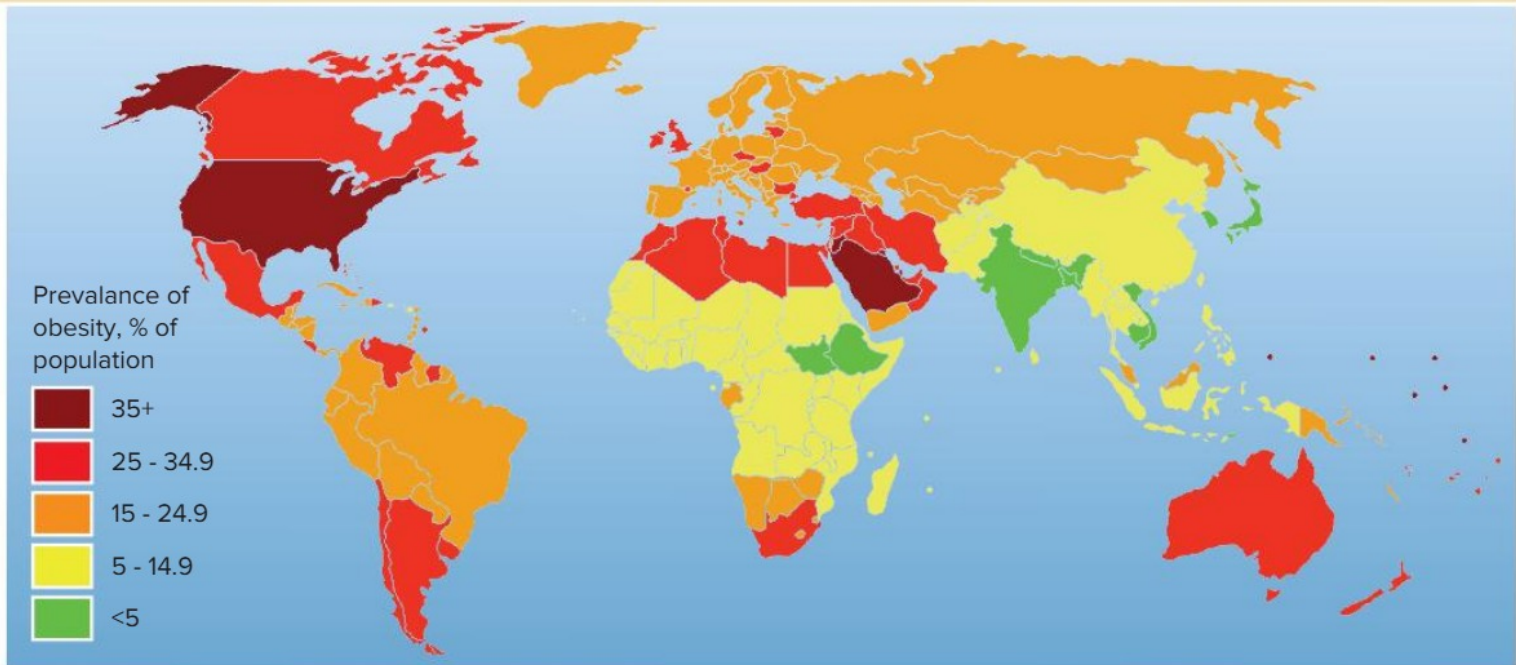
Examples of diseases of affluence were listed in figure 1.40. Many people regard obesity as a classic disease of affluence because it thought to be caused by a combination of factors such as over-consumption of highly processed foods, insufficient exercise, stress and lifestyle factors. **Obesity** can be defined as having such an excess of body fat that a person's health is adversely affected. Obesity is measured in terms of a person's BMI (body mass index), which relates a person's weight to height. According to the WHO (World Health Organisation), a normal BMI is defined as being within the range of 18.5 to 25 kg/m<sup>2</sup>. An overweight person has a BMI of 25 kg/m<sup>2</sup> or more, while obesity is indicated by a BMI of 30 kg/m<sup>2</sup> or more. By comparison, an underweight person has a BMI of less than 18.5 kg/m<sup>2</sup>, while a BMI of under 16.5 kg/m<sup>2</sup> indicates severe underweight.

The world distribution of obesity is shown in figure 2.87. Although the general pattern is broadly related to affluence and economic development, there are many significant exceptions to this pattern. The six countries with the highest



**2.86** The Pacific Ocean island of Nauru has the highest rate of obesity in the world, with over 90% of the adult population being overweight.





**2.87** Prevalence of obesity in adults (aged 18 and above), defined as a BMI of 30 kg/m<sup>2</sup> or more, 2018.

percentages of overweight adults are Nauru, Micronesia, Cook Islands and Tonga (with more than 90% of their adult populations being overweight), plus Niue and Samoa (with over 80% of adults overweight). All these countries are relatively poor Pacific Island nations, suggesting that diet or culture is an important factor in influencing weight. In fact, obesity is regarded in these societies as a positive attribute as it is thought to signify wealth and prestige.

Several affluent nations also have high rates of overweight people, such as the United States, with 74% of its adult population being overweight, Kuwait (74%), New Zealand (68%), Australia (67%), United Kingdom (68%) and Canada (61%). On the other hand, several other affluent nations have much lower rates of overweight people, such as Denmark (46%), Italy (45%), France (40%) and Japan (23%). At the other end of the scale, countries with low levels of obesity, such as Vietnam (6%), Bangladesh (6%), Ethiopia (5%) and Eritrea (4%) are less economically developed countries. Overall, the pattern shown in figure 2.87 suggests that while obesity is a disease of affluence, it does not affect all countries and all cultures to the same extent.

Of course, obesity is just one example of a disease of affluence. It has been said that in the coming decades, rising affluence will bring a global 'plague' of **neurological diseases**. The reason that affluence is increasing life expectancies and ageing brings neurological disorders. Figures 2.88 and 2.89

show the distribution of countries where 20% or more of the national populations are aged over 65 years today, and the projected pattern in 2050. This change is expected to arise because improved medical care will continue to lengthen average life expectancies around the world. At the present time, world-wide average life expectancies are increasing by about five hours per day.

As a consequence of increasing longevity, age-related diseases such as **Alzheimer's disease** (a type of **dementia**) and **Parkinson's disease** will



**2.88** Countries with 20% or more of the population aged 65 years and over in 2019, shown in red.



**2.89** Countries expected to have 20% or more of the population aged 65 years and over in 2050, shown in red.





**2.90** A family at Kitty Hawk, North Carolina, USA. The US has one of the world's highest rates of obesity.



**2.91** Most of the people in this street scene in Dhaka, Bangladesh, are underweight. Bangladesh has one of the world's lowest rates of obesity.

almost certainly increase. As people age beyond 65 years, the chances of getting either (or both) of these diseases increases exponentially. It is expected that by 2050, the United States alone will have about 32 million people over the age of 80, and unless there are significant medical breakthroughs before that time, about half of them can be expected to be affected by Alzheimer's disease, while an additional 10% are expected to have Parkinson's disease. On the brighter side, for reasons that are not yet understood, there is a significant negative correlation between the incidence of neurological diseases and most forms of **cancers**, meaning that those who get cancer are less likely to be also affected by dementia.

It can be seen from this discussion that the **concept of diffusion** relates somewhat differently to diseases of affluence than to diseases of poverty. Most diseases of affluence are to some extent 'lifestyle diseases', and thus they are generally non-communicable. Therefore, the spread of most diseases of affluence is the consequence of the **spread of affluence**, not a direct process of disease diffusion as occurs with infectious diseases. For that reason, the influence of **globalisation** is even more significant for understanding the spread of diseases of affluence than it is for understanding the diffusion of diseases of poverty.

Because diffusion of diseases of affluence is a **secondary process**, barriers to diffusion become more difficult to develop. Although some might

argue that wealthier countries ought to reduce their standards of wealth, this is usually argued on the grounds of environmental sustainability or global justice rather than as a strategy to reduce the incidence of diseases of affluence. Suggestions to reduce the rates of diseases caused by longevity by shortening people's lives are also unlikely to attract widespread support. Thus, the barriers to diffusion are more difficult to identify and define for diseases of affluence than they are for diseases of poverty.

### QUESTION BANK 2G

1. Give examples of some diseases of poverty that are diet-related.
2. With reference to types of diffusion, explain how these diseases spread.
3. Give examples of some effective barriers to diffusion of diet-related diseases of poverty.
4. Why are neurological diseases regarded as diseases of affluence?
5. Referring to data in figure 2.87, explain why obesity is (or is not) a disease of affluence.
6. Explain how the concept of diffusion relates to diseases of affluence.
7. It is claimed that "the barriers to diffusion are more difficult to identify and define for diseases of affluence than they are for diseases of poverty". Identify and describe (a) the factors that have led to reductions in the incidence of diseases of affluence, and (b) the factors that have the potential to reduce rates of diseases of affluence in the future.





3.1 A sign in Koutiala, Mali, promotes small manually-powered irrigation pumps financed by the United States Agency for International Development (USAID) as part of PRODEPAM (Program for the Development of Agricultural Production in Mali).

## The role of international organisations

**Food insecurity and disease** have always been **global issues**, but it is only in recent decades that a global approach has been taken to try and address these matters. Hundreds of organisations are working to advance food security and reduce the spread of disease, including the following:

### International organisations

**CARE (Co-operative for Assistance and Relief Everywhere):** Founded in Europe in the aftermath

of World War II, CARE delivers disaster emergency relief as well as engaging in long-term international development projects to improve food security, improve water and sanitation, and improve farming to relieve food insecurity.

**FAO (Food and Agricultural Organisation):** The FAO is the United Nations' international agency that oversees global food security and agriculture. In addition to its research work, the FAO encourages sharing of knowledge and information among member countries, it makes information and statistics about food and agriculture available to the general public, it supports policies to reduce malnutrition and other illnesses, it promotes



strategies for agricultural development, and it conducts research into various complex issues that face the global food system.

**IFAD (International Fund for Agricultural Development):** IFAD is a financial institution that is supported by the United Nations to eradicate rural poverty in developing countries. IFAD tries to empower poor people in rural areas by providing them with the resources they need to invest in their farms and increase incomes.



**3.2** A large poster has been erected by UNAIDS on the outskirts of Bamako, Mali, as part of a public education program about HIV/AIDS. The message (in French) reads: "Yes to testing for HIV/AIDS. Screening is voluntary, free and confidential."

### **UNAIDS (United Nations Program on HIV/AIDS):**

This United Nations agency is working in partnership with governments and NGOs in four policy-oriented areas, defined by UNAIDS as: (a) establishing and strengthening mechanisms that involve civil society including faith-based organisations, the private sector, and people living with HIV / AIDS at all levels; (b) encouraging and supporting local and national organisations to expand and strengthen regional partnerships, coalitions and networks; (c) providing encouragement for the full participation of people living with HIV / AIDS, those in vulnerable groups and people mostly at risk, particularly young people, and (d) addressing the issue of stigma and discrimination.

### **UNICEF (United Nations Childrens Fund):**

UNICEF is an agency of the United Nations that works internationally to provide humanitarian assistance to children and mothers, with a focus on low-income countries. UNICEF provides food, vaccines and medicines to poorly nourished and



**3.3** The headquarters of WAHO in Bobo-Bioulasso, Burkina Faso.

impoverished children and mothers, and currently works in 191 countries around the world.

### **WAHO (West African Health Organisation):**

WAHO, which is also known by its French name OOAS (Organisation Ouest Africain de la Santé), is a specialised institution of ECOWAS (the Economic Community of West African States). It supports and finances research into major endemic diseases and their eradication, it supports training of doctors and medical personnel, it distributes medical information to medical professionals and the general population, establishes technical information centres and research laboratories to produce vaccines, and encourages the exchange of health professionals throughout West Africa. WAHO also hosts medical conferences that encourage networking between scientists and health professionals.

**WFP (World Food Program):** WFP is an anti-hunger and anti-malnutrition organisation that is part of



**3.4** A road sign pointing to a WFP project to collect rainwater at Ouan, near Ségou in Mali.



the United Nations. It collects and distributes food aid to populations who are in need. It is the world's largest organisation that is working to fight hunger, and it distributes food to over 90 million people annually, mainly delivering assistance to children, refugees, people in emergency situations and the rural poor.

**WHO (World Health Organisation):** WHO is a specialised agency of the United Nations that focuses on public health. It is working to fight dangerous communicable diseases such as HIV / AIDS, malaria, tuberculosis and ebola, both through its own workers and in partnership with governments and NGOs in many countries. It is also working to mitigate the impact of non-communicative diseases by trying to improve sexual and reproductive health, ageing, nutrition, food security, occupational health, and substance abuse, and it supports these initiatives by undertaking research and publishing policy documents and statistics.

### Government organisations

**Saudi Fund for Development:** Saudi Arabia is second only to the United States in the amount of foreign aid it provides to developing countries, mainly those with a substantial Muslim population. Priority targets of Saudi government aid are water projects to address food insecurity, together with transport and power development.

**USAid (United States Agency for International Development):** USAid is the government agency that is responsible for administering the United States' non-military foreign aid. Money, technical

assistance and material aid is given to low income countries for a variety of purposes, including disaster relief, poverty relief, infrastructure development and investments that are seen to serve US interests abroad. USAid has special-purpose bureaus that administer aid relating to global health and food security.

### NGOs (Non-government organisations)

**Aga Khan Foundation:** Founded and financed by the Aga Khan, the Aga Khan Foundation makes funds available to volunteers who are keen to work in areas such as health, rural development, the environment and civil society. The Foundation focuses its efforts in countries with a substantial Muslim population.

**Amity Foundation:** This Christian-initiated NGO is the largest charity organisation in China, and provides money and voluntary labour to improve medical care in low-income rural areas, such as



3.6 A medical clinic provided by the Amity Foundation in Xiasi, a poor rural area in Guizhou province, China.



3.5 This water well near Tingole, Mali, has been provided to local farmers by the Saudi Fund for Development.



3.7 Patients recovering in another medical clinic provided by the Amity Foundation, located in Chengzhong village, China.



building medical clinics and training paramedical workers. Amity also addresses food insecurity and health care through disaster relief, support of churches that are involved in social work, HIV / AIDS awareness and prevention training, and upgrading water supplies in rural areas.

**Ashoka Innovators for the Public:** Ashoka is an international NGO that began in the United States to encourage social entrepreneurs in low income countries to transform the food chain, making crops more nutritious.

**Australian International Food Security Centre:** The AIFSC is a non-profit Australian NGO that works to promote agricultural innovation and attract investment to agricultural development projects around the world. Its specific aims are to improve nutrition, connect researchers with farmers, and enhance the supply chain systems to make it easier for farmers to bring their products to market.

**AVRDC (World Vegetable Centre):** This Taiwan-based international NGO seeks to reduce poverty and malnutrition in low-income countries by raising agricultural production and improving access to a variety of vegetables, which should provide essential nutrients for poorly nourished people. AVRDC also works with private and public sector partners to undertake research into new technologies and their effective implementation.

**Barilla Centre for Food and Nutrition:** An Italian NGO, the Barilla Centre for Food and Nutrition promotes science and research that is geared to fight hunger and malnutrition around the world. Barilla tries to take innovative ideas for tackling food insecurity and translate them into effective policy recommendations for governments around the world. The NGO has also released original research on issues food insecurity, global obesity and sustainable agriculture.

**Bill and Melinda Gates Foundation:** this NGO is the world's largest private foundation, and seeks to apply business techniques through venture philanthropy to enhance health care and reduce extreme poverty. Specific, well-funded programs are in place to control infectious diseases such as malaria, sexually transmitted diseases (including HIV / AIDS), and tuberculosis. The Gates



**3.8** The headquarters of the Bill and Melinda Gates Foundation in Seattle, USA.

Foundation works by funding other organisations that will implement the programs, and recipient organisations include GAVI (the Global Alliance for Vaccines and Immunisation), WHO (World Health Organisation), the Global Fund to Fight AIDS Tuberculosis and Malaria, PATH (the program for Appropriate Technology in Health), UNICEF and the Clinton Health Access Initiative.

**Biodiversity International:** Biodiversity International is a research and development organisation that supports small scale farmers in low income countries as they try to implement sustainable agricultural practices and conservation. It focuses on non-irrigated farming systems that are managed by smallholder farmers in places or communities where large scale agriculture is not possible.

**Caritas International:** This NGO is a confederation of 165 Catholic relief, development and social service organisations that operate in more than 200 countries to improve the lives of poor, oppressed, malnourished and sick people.

**CGIAR (Consultative Group on International Agricultural Research):** CGIAR is a network of research organisations that are trying to promote and support global food security by sharing information, knowledge and research on rural poverty, health, nutrition, and management of natural resources.

**ECOVA Mali:** ECOVA Mali works with Malian farmers to teach other farmers about sustainable agricultural methods, also offering micro-financing and small-scale grants so that farmers can invest in



the environmental and social sustainability of their operations.

**Feeding the 5000:** This UK-based international NGO is working to prevent mis-shapen and sub-optimal fruits, vegetables, and other food from being wasted by getting volunteers to collect unattractive produce that would otherwise be wasted for consumption.

**Heifer International:** This US-based, international NGO is a non-profit organisation that seeks to end hunger and poverty by providing needy communities with livestock and other animals that can help them to build local, self-sufficient agricultural systems. It also offers a range of resources that assist poor and struggling farmers to create more sustainable sources of income, providing them with information on effective grazing methods, optimal animal rearing, and ways of forming local networks in which farmers can share resources with one another.

**IATP (Institute for Agriculture and Trade Policy):** IATP is a research and advocacy NGO that is working to promote fair and sustainable food, farm, and trade systems around the world. IATP works with like-minded organisations around the world to analyse the impact of global trade agreements, develop clean energy models, and stop the excessive use of antibiotics in agriculture and aquaculture.

**MSF (Médecins Sans Frontières – Doctors Without Borders):** Founded in France and operating in more than 70 countries, MSF provides health care using voluntary doctors and health care workers in conflict zones and low income countries whose governments cannot afford to provide adequate health care for the population. In addition to primary health care, MSF also undertakes infrastructure projects to provide clean drinking water, nutritious foods (such as porridge and powdered milk) and education to help prevent the spread of water-borne diseases.

**One Acre Fund:** This NGO provides farmers in sub-Saharan Africa with the tools they need to successfully farm their plots, such as seeds and fertilisers, financial credit, access to markets, and educational programs on farming techniques. The

services are provided to participating farmers for a small fee.

**Oxfam International:** Oxfam works through a range of approaches, including long-term campaigns (such as the 'Behind the Brands Campaign' to secure rights for employees in the cocoa industry), and immediate emergency support to improve health care, improve food security and end global poverty.

**Project HOPE:** Founded in the US but operating internationally, Project HOPE implements health education programs in ten countries in Africa, ten countries in Latin America and the Caribbean, eleven countries in the Asia-Pacific region, and eight countries in former Communist countries in Europe and Asia.



**3.9** A sign erected by Save the Children Fund in association with UNICEF in Ouagadougou, Burkina Faso. In French, the sign reads: "Global movement for Children. Change the world! Burkina Faso commits (1) not to exclude any child, (2) to give priority to children, (3) to take care of each child, (4) to fight against HIV/AIDS, (5) to end the exploitation of children and the harm done to them, (6) to listen to children, (7) to educate all children, (8) to protect children from war, (9) to protect the earth for children, (10) to fight against poverty, investing in our children.

**Save the Children Fund:** Founded in the UK, Save the Children focuses on nutrition and health care for children in low income countries, and also provides advocacy support for children's rights globally. Although Save the Children is often involved in short-term disaster relief programs, it also focuses on countries where armed conflict or internal political instability threaten children's welfare, and is active today in 28 such countries



including Afghanistan, Congo, Haiti, Somalia, Sudan and Uganda.

**World Vision:** this non-denominational Christian NGO provides humanitarian aid, emergency relief, education, health care, development and advocacy services in more than 90 countries. It conducts programs in many countries that are designed to address specific issues, such as the anti-female-genital mutilation campaign in Mali, and it operates a global program of child sponsorship that aims to help needy children become educated, access clean drinking water, get improved sanitation, better nutrition and health care.



**3.10** A roadside sign near Koutiala, Mali, has been erected by World Vision to warn against female genital mutilation, which represents a significant health risk to many women in West Africa.

## The influence of transnational corporations

For much of human history, food production was seen as the job of the family or village. Towards the end of 20th century, **commercial farming** in many parts of the world was transformed into a **corporate enterprise** as large companies purchased and merged smaller farms. The aim of the corporations involved in farming, commonly known as **agribusinesses**, to achieve **economies of scale** by farming **large areas** of land using a high rate of **mechanisation** to **minimise labour** needs in an effort to **maximise profits**. Some agribusinesses are international in scale, in which case they are examples of **TNCs (transnational corporations)**.

The growth of TNCs in food production has been mirrored by the expansion of TNCs in **food retailing**, where they are having a significant impact on **food consumption** habits. Some **examples** of transnational corporations that are heavily involved in the global food industry include:

**Campbell's Soups:** a US-based TNC that sells packaged (mainly canned) soup, baked snacks and health beverages in 120 countries. Brand names used by the company include Arnott's, Blå Band, Campbell's, Plum Baby, Prego and V8.

**Cargill Inc:** a US-based TNC that operates across 66 countries in the areas of crop (especially grain) and livestock production in addition to several other industries such as energy, pharmaceuticals and risk management. Cargill specialises in commodity food production (growing, trading and shipping grains, beans and meat), and because of the huge scale of its operations, it is periodically accused of manipulating the prices of food commodities on the world market.

**Kraft Heinz:** a US-based TNC that processes food and manufactures food products in factories in six continents, and then markets these products in more than 200 countries and territories. Its brand names include Bagel Bites, Cadbury, Complian, Farex, Greenseas, Heinz, HP Sauce, Jell-O, Kool-Aid, Kraft, Lea & Perrins, Maxwell House, Planters, Vegemite, Wattie's, and Weight Watchers.

### QUESTION BANK 3A

1. Make a list showing each of the organisations listed in the section above, categorised according whether its primary focus is (a) combatting food insecurity, (b) combatting disease, or (c) combatting food insecurity and disease equally.
2. Undertake detailed research of one international organisation, government agency or NGO that is involved in combatting food insecurity to describe (a) its origins, (b) how it is financed, (c) its main aims and goals, (d) where it functions, (e) how it undertakes its work, (f) its significant achievements, and (g) any problems, shortcomings or controversies in which it has been involved.
3. Undertake detailed research one international organisation, government agency or NGO that is involved in combatting disease to describe (a) its origins, (b) how it is financed, (c) its main aims and goals, (d) where it functions, (e) how it undertakes its work, (f) its significant achievements, and (g) any problems, shortcomings or controversies in which it has been involved.



**Itochu Corporation:** a Japanese-based TNC that has many business interests, including the production, processing and distribution of various types of food under brand names such as Dole and FamilyMart.

**Kellogg's:** a US-based TNC that produces cereal and convenience foods such as breakfast cereals, biscuits, crackers, cereal bars, frozen waffles and frozen foods. In addition to marketing foods under the Kellogg's brand name, products are sold under other brands such as Bear Naked, Cheez-It, Krave, Mother's Cookies, Pop-Tarts, Pringles and Sunshine Biscuits.

**Mars:** a US-based TNC that manufactures food (mainly confectionery), chewing gum, drinks and pet food in the United States, Australia, Belgium, Canada, the Netherlands, and the United Kingdom. Mars uses about a hundred different brand names for its products, including Bounty, Dolmio, Extra, Freedent, Hubba Bubba, Juicy Fruit, Life Savers, M&Ms, Maltesers, Mars, MasterFoods, Milky Way, Skittles, Snickers, Twix, Uncle Ben's, and Wrigley's.



**3.11** A McDonalds outlet in Manama, Bahrain. The introduction of Westernised diets in Middle Eastern countries has been one factor in the region's growing problem with obesity.

**McDonalds:** a US-based TNC chain of more than 36,000 fast-food restaurants that operate in almost 120 countries and territories around the world. The main foods sold at McDonalds are hamburgers, fried potatoes, soft drinks, desserts, although in response to concerns about the poor nutritional quality of the food, additional products such as wraps, salads and fruit are now offered in many countries.

**Nestlé:** a Swiss-based TNC that is the world's largest food company when measured by revenue.

Nestlé has about 450 factories operating in 194 countries producing a vast range of products, including confectionery, baby food, medical foods, breakfast cereals, noodles, tea, coffee, dairy products, frozen foods, snacks and pet food. It sells food under more than 8,000 different brand names, some of which are Alfare, Carnation, Cérélac, Cheerios, Gerber, International Roast, Lactogen, Lean Cuisine, Maggi, Milo, Mövenpick, Nescafé, Nespresso, Nesquik, Nestlé, Oreo, Ovaltine, Rowntrees, Ski, and Smarties.

**PepsiCo:** a US-based TNC that sells foods, beverages and snacks in North and South America, Europe, Africa, the Middle East, Asia and Australasia. The main brand names used by include Pepsi, Mountain Dew, Lay's Potato Chips, Gatorade, 7 Up, Doritos, Quaker foods, Cheetos, Aquafina, and Walkers.

**Unilever:** a British-Dutch TNC that manufactures a wide range of consumer products, including food and beverages. It has manufacturing plants in all six inhabited continents, and it sells its products in 190 countries. It is the world's third largest consumer goods company, when measured by revenue, after Nestlé and Procter and Gamble. The brand names used by Unilever for its food products include Ben and Jerry's, Bovril, Bushell's, Continental, Flora, Heartbrand, Lipton, Marmite, Streets, T2, and Wall's.

The growth in size and influence of TNCs in the global food industry has had a significant **negative impact** on the **viability** of smaller, independent, national food companies who have often found they are unable to compete with TNCs' **economies of scale**, access to **raw materials** and ability to **shift profits** (and therefore taxes).

TNCs can operate very efficiently in the world food trade because they vertically integrate and horizontally integrate their operations. **Vertical integration** occurs when one firm controls most or all of the stages in the production process. For example, divisions of the one conglomerate can control the seeds, own the farm, do the initial processing, ship the produce, manufacture the final product and even do the final retail selling (in the case of fast-food chains). Controlling every step of the production process enables the TNC to declare its profits in the country with the lowest tax rate as



well as avoid large mark-ups that might be payable for services in an open, competitive environment.

**Horizontal integration** occurs when one corporation controls several firms within the same industry. For example, one TNC may sell food under many brand names, effectively controlling competition within the market and thus increasing profits by charging whatever the market will tolerate.

As a consequence of the financial efficiency of TNCs, there has been **consolidation** in food retailing where smaller companies have been acquired by larger TNCs, placing larger numbers of consumers under the influence of TNCs.

For many consumers, this has had some **positive outcomes**. Because of their large scale of operations, TNCs can often negotiate **preferential prices** for the raw materials and commodities they use. Although this can **threaten the viability** of commodity farmers, who are price-takers rather than price-setters, it does give TNCs a **cost advantage** over smaller food producers who do not have the same bargaining power. The lower costs of production can be passed on to consumers, who are able to obtain cheaper, **more affordable food** as a consequence. For the TNC food producer, these lower prices have the advantage of placing further pressures on smaller competitors, sometimes forcing them out of the market.

The cheaper food prices that are often offered by TNCs cause more consumers to switch their **consumption habits** towards food supplied by TNCs, and this trend is occurring in both low-income and high-income countries. The involvement of TNCs in the global food industry has made the **movement** of products, ideas and technology much easier, and it has provided opportunities for **food security** to improve as food has become cheaper and therefore more accessible to poorer people. On the other hand, this transition is causing **health problems** for a growing number of people, especially those in urban areas of low-income countries who struggle to find or afford nutritious food such as fruits and vegetables.

Traditional, fresh food diets emphasise plants such as fruits and vegetables, and whole coarse grains such as millet and barley that are high sources of dietary fibre. By contrast, the food supplied in supermarkets by TNCs is mostly **processed food**.



3.12 These breakfast cereals produced by a large US-based TNC are made in Thailand for sale in Taiwan and Hong Kong.

WHAT IS THE HEALTH STAR RATING?		WHAT IS THE HEALTH STAR RATING?	
The Health Star Rating is a government led initiative that provides an easy way to compare the nutritional profile of packaged foods so you can make informed choices. Put simply, the more stars the healthier the choice. Foods may rate from 1 to 5 stars. Together with other important nutrition information on this pack, like serve size and nutrients per serve, the Health Star Rating is another way for you to make the best choices for you and your family.		The Health Star Rating is a government led initiative that provides an easy way to compare the nutritional profile of packaged foods so you can make informed choices. Put simply, the more stars the healthier the choice. Foods may rate from 1 to 5 stars. Together with other important nutrition information on this pack, like serve size and nutrients per serve, the Health Star Rating is another way for you to make the best choices for you and your family.	
Nutrition Information (AVERAGE)		Nutrition Information (AVERAGE)	
servings per package - 9		servings per package - 9	
average serving size - 30g (1/4 metric cup)		average serving size - 30g (1/4 metric cup)	
quantity per serving	% daily intake per serving	quantity per serving	% daily intake per serving
ENERGY 490 kJ	9%	ENERGY 490 kJ	9%
PROTEIN 1.9 g	4%	PROTEIN 1.9 g	4%
FAT, TOTAL 0.4 g	0.8%	FAT, TOTAL 0.4 g	0.8%
- SATURATED 0.2 g	0.4%	- SATURATED 0.2 g	0.4%
CARBOHYDRATE 25.6 g	8%	CARBOHYDRATE 25.6 g	8%
- SUGARS 11.4 g	13%	- SUGARS 11.4 g	13%
DIETARY FIBRE 0.7 g	2%	DIETARY FIBRE 0.7 g	2%
SODIUM # 102 mg	4%	SODIUM # 102 mg	4%
THIAMIN (VIT B1) 0.28 mg	25%	THIAMIN (VIT B1) 0.28 mg	25%
RIBOFLAVIN (VIT B2) 0.42 mg	25%	RIBOFLAVIN (VIT B2) 0.42 mg	25%
NIACIN 2.5 mg	25%	NIACIN 2.5 mg	25%
VITAMIN C 10.0 mg	25%	VITAMIN C 10.0 mg	25%
FOLATE 50 µg	25%	FOLATE 50 µg	25%
IRON 3.0 mg	25%	IRON 3.0 mg	25%
ZINC 1.8 mg	15%	ZINC 1.8 mg	15%
† Cup measurement is approximate and is only to be used as a guide. If you have any specific dietary requirements please weigh your serving.		† Cup measurement is approximate and is only to be used as a guide. If you have any specific dietary requirements please weigh your serving.	
* % Daily Intakes are based on an average adult diet of 8700 kJ. Your daily intakes may be higher or lower depending on your energy needs.		* % Daily Intakes are based on an average adult diet of 8700 kJ. Your daily intakes may be higher or lower depending on your energy needs.	
# % Recommended Dietary Intake (RDI) per serving		# % Recommended Dietary Intake (RDI) per serving	
† 102mg of sodium per serve is equivalent to 0.3g of salt.		† 102mg of sodium per serve is equivalent to 0.3g of salt.	
Ingredients		Ingredients	
Cereals (80% cornmeal, wheat flour, oat flour), sugar, vegetable oil, salt, colours (carotene, paprika, caramel), tocopherol, copper chlorophyll, vegetable carbon, dextrose, vitamins (vitamin C, niacin, riboflavin, thiamin, folic acid, inositol), natural flavours (orange, lemon, raspberry, lime).		Cereals (80% cornmeal, wheat flour, oat flour), sugar, vegetable oil, salt, colours (carotene, paprika, caramel), tocopherol, copper chlorophyll, vegetable carbon, dextrose, vitamins (vitamin C, niacin, riboflavin, thiamin, folic acid, inositol), natural flavours (orange, lemon, raspberry, lime).	
CONTAINS GLUTEN CONTAINING CEREALS. MAY CONTAIN TRACES OF PEANUTS AND/OR TREE NUTS.		CONTAINS GLUTEN CONTAINING CEREALS. MAY CONTAIN TRACES OF PEANUTS AND/OR TREE NUTS.	
INGREDIENTS: Céréales (80% farine de maïs, farine de blé, farine d'avoine, sucre, huile végétale, sel, colorants (carotène, paprika, caramel), tocophérol, vitamines (vitamine C, niacine, riboflavine, thiamine, folate, inositol), saveurs naturelles (orange, citron, framboise, citron vert).		INGREDIENTS: Céréales (80% farine de maïs, farine de blé, farine d'avoine, sucre, huile végétale, sel, colorants (carotène, paprika, caramel), tocophérol, vitamines (vitamine C, niacine, riboflavine, thiamine, folate, inositol), saveurs naturelles (orange, citron, framboise, citron vert).	
CONTIENT DES CÉRÉALES CONTENANT DU GLUTEN. POUR CONTENIR DES TRACES DE CACAHOUËTES ET/OU DES NUTRIMENTS.		CONTIENT DES CÉRÉALES CONTENANT DU GLUTEN. POUR CONTENIR DES TRACES DE CACAHOUËTES ET/OU DES NUTRIMENTS.	

3.13 Concerns over the nutritional value of processed foods have led to mandatory display of dietary information on food products in some high income countries such as Australia, Canada, France, Germany, the United Kingdom and the United States. However, the dietary information has been widely criticised as being hard to read and difficult to interpret. These breakfast cereals produced by a large TNC score just 2 stars on the Australian government's mandated 5 point nutritional scale because of its high sugar content and low fibre content.



Processed foods contain **additives** such as **preservatives** that give them a long 'shelf life', which means the storage time for food before it deteriorates and becomes unfit for consumption. As TNC food sales increase, traditional dietary patterns that were based on fresh, unprocessed foods are being displaced, and there is a **decrease in consumption** of fruits, vegetables, coarse grains, legumes, fish and nuts.

**Processed foods** have lower fibre, more sugar, more salt, more carbohydrates, more saturated fats and more preservatives than fresh foods, and are thus **less nutritious** or sustainable for a healthy lifestyle. As the consumption of processed foods increases, **chronic diseases** such as obesity and bowel cancer become more widespread, placing greater pressure on health systems to cope with increased demands. In the case of many societies, the shift away from traditional unprocessed foods has a range of **additional impacts**, such as undermining the culture (which is often centred around traditional foods and eating patterns), fragmenting community life, disrupting local economies and diluting national identity.

The growing influence of TNCs in the global food industry therefore can be seen as a threat to food sovereignty. **Food sovereignty** is the right of people to have healthy and culturally appropriate food produced through their own sustainable, defined food and agriculture systems. As cheaper processed foods become more widely available, many people are choosing to surrender control over the type and quality of food they consume, especially when they are influenced by the extensive media advertising that TNCs often use to promote their products.

TNCs spend heavily on **advertising** to promote their products. Current annual advertising costs are in the order of US\$7.4 billion for Unilever, US\$3 billion for Nestlé, US\$3 billion for Coca-Cola, and US\$2.5 billion for PepsiCo. Advertising is done through many media formats, including television, websites, large signs, discount promotions, sporting sponsorships, product placements in television shows and movies, and marketing in schools. The aim of this advertising is to create demand and shift consumption patterns.

For people living in low income countries with televisions, the **media** plays a powerful role in



**3.14** Coca-Cola is one of the world's largest advertisers as it encourages people around the world to replace traditional drinks such as milk, water, tea, coffee and fruit juice with 'modern' sugar-heavy carbonated soft drinks. The slogan on this sign in Ségou, Mali, reads "Here, the taste of happiness".

shifting food consumption habits. Movies and other programs often portray relatively affluent families who have adopted Westernised lifestyles. The characters in these programs routinely consume processed foods, often as a result of **product placement** paid for by TNCs. This **normalises** the consumption of processed foods, and even **elevates its status** as many people see successful actors as role models for their own lives. Non-traditional foods found in fast food outlets come to be seen as modern, convenient, sophisticated alternatives to unprocessed foods found in traditional markets, so **food preferences** and tastes shift over time and become moulded without a full understanding of the negative nutritional implications.

In low-income countries, the presence of food produced by TNCs is having six significant effects:

- TNC **control** of domestic food systems is tightening, supported by many governments' granting of tax exemptions, policies that remove restrictions from imports and exports, legal protection within trade agreements, and unwillingness by governments to appear hostile towards powerful TNCs.
- Local food producers, production companies and distributors find they **cannot compete** with the cost advantages and the political influence that TNCs enjoy. There are 500 million small farms in developing countries that support about two billion people, which is more than a quarter of the world's population. Surviving on an income





**3.15** This supermarket in Mount Hagen, Papua New Guinea, shows the heavy influence of TNCs, both in the advertising that encourages local people to switch to an energy-dense Westernised diet, and in the TNC-sourced products available.



**3.16** In contrast with figure 3.15, this market in Wewak, Papua New Guinea, shows the traditional foods that dominate diets of local people when TNC influences are absent.

of about US\$2 per day, they cannot keep up with changing patterns of demand for food and cost pressures.

- Processed foods are more **available** and more **affordable** for a larger number of people, which encourages the purchase and consumption of nutrient-poor foods that are detrimental to long-term health.
- **Fast food chains**, restaurants and large supermarkets are expanding. While they offer greater diversity, convenience and quality of food, they compromise health and nutrition.
- There are simultaneous processes of dietary adaptation and dietary convergence. **Dietary adaptation** comprises changes in the diet towards more processed, refined and branded foods due

to easier availability, time constraints in preparing traditional foods, advertising, and cultural shifts. **Dietary convergence** means that diets are becoming more similar to diets elsewhere in the world due to greater use of grains such as wheat and rice, lower intake of fibre, and greater consumption of meat, edible oils, sugar and salt.

- Twin problems of **obesity** and **malnutrition** are emerging. On one hand, over-consumption of poor quality, cheap food that contains excessive, fats, oils, starch and sugars is leading to an increase in non-communicable diseases such as diabetes, cardiovascular disease and obesity. Forecasts suggest that the economic cost of non-communicable diseases will reach US\$30 trillion by 2035. At the same time, consuming food that is nutritionally poor leads to malnutrition in that people are not receiving the balance of minerals and nutrients that are needed to support a healthy lifestyle.

### QUESTION BANK 3B

1. Why are TNCs in the food industry often able to operate at lower costs than smaller producers?
2. How do TNCs influence food consumption habits? Are these changes advantageous or disadvantageous?
3. Why are processed foods often less nutritious than unprocessed foods?
4. How do TNCs threaten food sovereignty?
5. Explain how the media (including advertising) can amplify the impact of TNCs in shaping food consumption habits.
6. Undertake detailed research on one TNC mentioned in this section to describe (a) its origins, (b) its range of products (c) its financial turnover, (d) the countries where it operates, and (e) any problems, shortcomings or controversies in which it has been involved.

### Gender roles

In the previous section, the nutritional value of food was discussed. Among the factors affecting people's food choices are the **gender stereotypes** that are attached to various types of foods. There is a widespread stereotype that women are more interested than men in eating healthy foods than men, which is why **advertising** for fresh, healthy foods such as salads and yogurt invariably features





**3.17** Advertising for sushi in Kyiv, Ukraine, is geared towards females. Sushi is viewed as a healthy, low calorie food, and therefore its appeal to slim, successful women is emphasised.

women. Consequently, advertising for junk food, fried chicken and beer is usually oriented towards men, whereas advertising for low fat, low sugar foods are usually geared towards women. Food packaging generally appeals to the same gender stereotypes.

Food preferences are not the only ways that gender differences arise in food and health. In low-income countries in Africa, the Middle East and parts of Asia, **women** have **inferior** access to education, information, money and decision-making authority compared with men. World Bank statistics show that there is no part of the developing world where women have equal legal, social or economic rights as men. In such societies, women and children are thus **marginalised** members of society. The long-standing tradition in some countries is that women eat last, and only after the men and children have been fed. The consequence of this **food discrimination** is that many women suffer from **chronic malnutrition** and **poor health**.

Furthermore, when crises cause **shortages of food**, women are generally the first to **sacrifice consumption** of food so that the rest of the family can be fed. The **subordinate position** of women is often reflected in females' lack of access and control over household assets and decision-making. One example of this situation is illustrated in table 3.1, which compares men's and women's control over economic assets in Oeutufu (or Oetefu), a fishing and dry land farming village on Pulau Rote (Rote Island) of East Nusa Tenggara province, Indonesia.



**3.18** In contrast with figure 3.17, beer advertising in Koror, Palau, is designed to attract the attention of male customers. Beer is not regarded as a health drink, and although women do drink beer, advertising is geared mainly to a male audience.

The consequence of **female marginalisation** is that in many societies, women and children have less access to nutritious food than men, and therefore are more likely to be malnourished. This is ironic as common **socially constructed roles** dictate that women usually do most of the arable farming (crop growing) in these countries, although the raising of animals and commercial cropping are more likely to be done by the men, or men and women jointly.



**3.19** Women and children in Hukuluak, a remote village in the Highlands of West Papua, Indonesia, chew on some sweet potato for dinner while they wait for the men to finish eating some pig meat and bring them the leftovers.

Although women do the bulk of subsistence crop farming in many low income countries, the **yields** they produce are typically 20% to 30% lower than yields produced by male farmers. The reason for this discrepancy is that women have **less access** than men to improved seeds, fertilisers and capital equipment, all of which require money. It has been



Table 3.1

Gender differences in economic empowerment, Oeutufu village, Rote Barat Daya Sub-district, Indonesia

Resources	Access (Right to possess)		Control (Right to sell)		Holder of income		Right to determine the use of yields	
	Males	Females	Males	Females	Males	Females	Males	Females
Land	✓	✗	✓	✗	✓	✓	✓	✓
House	✓	✓	✓	✗	✓	✓	✓	✗
Chicken	✓	✗	✓	✗	✓	✓	✓	✗
Dog	✓	✗	✓	✗	✓	✓	✓	✗
Pig	✓	✗	✓	✗	✓	✓	✓	✗
Goat	✓	✗	✓	✗	✓	✓	✓	✗
Palmyra palm	✓	✗	✓	✗	✓	✓	✓	✗
Coconut palm	✓	✗	✓	✗	✓	✓	✓	✗
Onions	✓	✗	✓	✗	✓	✓	✓	✗
Palm sugar	✓	✗	✓	✗	✓	✓	✓	✗
Salt	✓	✓	✓	✗	✓	✓	✓	✗
Jewellery	✓	✗	✓	✗	✓	✓	✓	✗
Marine products	✓	✗	✓	✗	✓	✓	✓	✗

Source: Fangidae & Muslimatun (2009) *A Brief Review on The Persistence of Food Insecurity and Malnutrition Problems in East Nusa Tenggara Province*, Working Paper 12: Oxfam GB.



3.20 A scene that typifies many low income countries — a woman in Komon, Papua New Guinea, prepares her field with a digging stick to grow a subsistence crop to feed her family.

shown that in places where women have less secure access to land, the fallow periods that women farmers allow for farmland are shorter than the fallow periods allowed by male farmers, and this further reduces the yields, thus also lowering income and the supply of food for the household. The WFP estimates that if women had more **resources** for their farming, the number of hungry

people in the world could be reduced by 100 to 150 million people.

The WFP estimates that 85% to 90% of the time spent **preparing household food** is done by women. Women are also more likely than men to spend any income they receive on food and children's needs. FAO research suggests that children's chances of **survival** rise by about 20% when the mother controls the **household budget**.



3.21 A roadside sign in Dili, Timor-Leste, encourages better health and hygiene through regular hand washing.



Therefore, women play a vital role in improving **children's health**, **dietary diversity** and overall **food security** in low income countries.

Women have different **nutritional needs** to the rest of the population when they are **pregnant** or **breastfeeding**. The heavy nutrient demands that are made upon women's bodies at these times mean they are especially vulnerable to malnutrition and **nutrient deficiencies** when they most need an adequate diet. FAO statistics show that twice as many women suffer from **malnutrition** as men, while girls in low-income countries are twice as likely to die from malnutrition as boys.

Malnutrition means that a woman is less likely to give birth to a healthy baby, and babies with low birth weights are less likely to survive to the age of five than babies with normal birth weights.

Because women play such a significant role in food preparation, especially in low-income countries, they have a disproportionately **high influence** on the overall health and nutritional levels of all members of the family. Many diseases and health problems in low-income countries can be prevented with good **hygiene** and **sanitation** that is not always understood in traditional societies. Hygiene can be taught in schools, but the participation rate in **education** for girls is less than for boys in many low-income countries. Research shows that women are more likely than men to engage in healthy behaviours when they have been **empowered** with knowledge about health and hygiene. Therefore, until the **educational gender discrepancy** is



**3.22** Volunteer students from the Hong Kong-based Global Concerns Action Team perform public education songs in Chengzhong, a village of Miao nationality people in Guizhou province, China, to raise awareness of the importance of washing hands and hair regularly.

eliminated, **public education** and **training**, especially for women in rural villages, would help to improve community health.

A significant challenge to improving women's health in many low-income countries is that most **doctors** and **paramedics** are still men. In many traditional societies, it is considered **inappropriate** for an unrelated man to touch or examine a woman. This is especially a problem in rural areas where many of the health problems experienced by women are gynecological in nature. The solution to this challenge is to **train more women** as doctors and paramedics, and this is starting to happen, even in some conservative areas such as rural China.

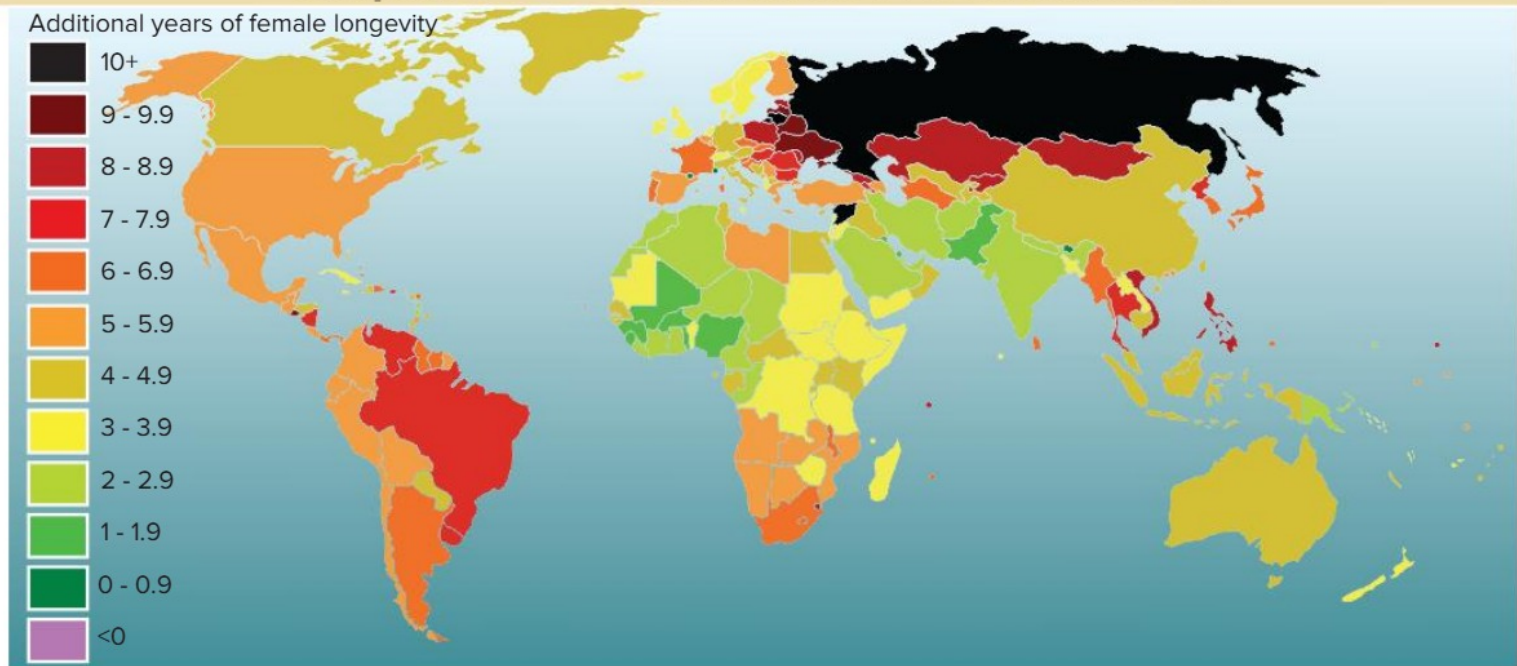


**3.23** This husband and wife team share the role of doctor in a small medical clinic in Dachong village, Majiang County, Guizhou province, China. All female patients are seen by the wife, while the husband attends to the men.

It has been shown that **risky health-related behaviours**, including poor food choices, are more commonly practiced by men than women. In all but two countries of the world (Mali and Swaziland), men have shorter average life expectancies than women. As figure 3.24 shows, the difference between male and female **life expectancies** varies globally. The largest **gaps** between male and female life expectancies are found in several former republics of the Soviet Union and in Syria. Syria has the world's largest difference, with men living an average of 12.5 years less than women. The smallest gaps between male and female life expectancies are found in Africa and some parts of Asia.

The **world-wide difference** between male and female life expectancies can be explained by a





**3.24** Difference between female and male average life expectancies, measured in years of average additional female longevity, 2018. No data is shown for Vatican City as there it has no permanent female population. No nation had a longer life expectancy for males than females in 2018, although fluctuations in life expectancies from year-to-year mean that this does sometime occur.

combination of factors, including higher infant mortality among boys, more accidental deaths during adolescence and young adulthood, and a higher incidence of risk-taking behaviours. In Russia and other former Soviet republics where the gap is very wide, an additional major factor is the long-term effect of excessive alcohol consumption among males, including binge drinking.

The gap between male and female life expectancies has **widened** in recent years as female deaths from pregnancy and childbirth have been reduced due to better health care, extending average life expectancies for females. While chronic diseases affect both genders, the female genome delays the development of many diseases in women, partly as a result of sex hormones.

A further reason that men generally have shorter life expectancies than women is that males are more prone than women to have an **excessive dietary intake** (i.e. they eat too much compared with their physical needs). Medical research shows that men are generally **less interested** than women in adjusting behaviours such as eating, exercising and practising good hygiene to improve their health, and men also show less interest in learning about foods, nutrition and health than women. Although **education** cannot address physiological differences between men and women, it could be useful in alerting men to the consequences of risk-taking and poor nutritional choices that are limiting their life expectancies unnecessarily.

## QUESTION BANK 3C

1. How is food advertising influenced by gender stereotyping? Provide some examples from your own experience.
2. Explain why many women in low-income countries suffer from poor nutrition and chronic ill-health.
3. How do socially constructed gender roles affect food production?
4. Why are women's farming yields in low-income countries often lower than the yields produced by men?
5. Why would boosting educational access for girls in low-income countries improve community health and hygiene?
6. Explain why it is important to train more female doctors and paramedics.
7. With reference to the map in figure 3.24, describe and suggest reasons for the world distribution of the gap in longevity between women and men.
8. In your opinion, is it a worthwhile objective to try and lengthen men's life expectancies to narrow the gap with women's life expectancies? If so, what strategies would you suggest to achieve it? If not, explain why not.

## Famine

A **famine** is a widespread, prolonged shortage of food that causes disease and death from starvation within a geographical area. There have been **major famines** in developing countries over recent decades, some notable examples being:



- **China 1958-1961:** about 30 million deaths due to failed agricultural policies during a political campaign known as the Great Leap Forward.
- **Biafra (south-eastern Nigeria) 1967-1970:** at least one million deaths in a famine that was due to blockades and disease, part of a civil war over Biafra's unsuccessful action to separate from Nigeria.
- **Sahel region of Africa 1968-1972:** one million deaths due to prolonged drought.
- **Ethiopia 1972-1973:** 60,000 deaths when a combination of drought and political instability stopped food supplies to large areas of the country.
- **Bangladesh 1974:** 27,000 deaths due to floods, inadequate infrastructure and poor governance in the years immediately following independence from Pakistan.
- **Cambodia 1975-1979:** two million deaths under the extremist Khmer Rouge regime due to a combination of forced labour, murder of intellectuals and political opponents, and food shortages due to inappropriate enforced collectivisation of farming.
- **Ethiopia 1984-1985:** 400,000 deaths in the north of the country due to a combination of drought and civil war.
- **Somalia 1991-1992:** 300,000 deaths due to drought and civil war.
- **North Korea 1995-1998:** 200,000 deaths during the Arduous March, a period of natural disasters (floods) immediately following the death of President Kim Il Sung and the breakup of the Soviet Union, which had subsidized North Korea's economy for several decades.
- **Sudan 1998:** 70,000 deaths due to drought and civil war.
- **Eritrea 1998-2000:** unknown number of deaths due to drought and separatist war with Ethiopia.
- **Congo 1998-2004:** 3.8 million deaths due to a combination of starvation and disease during a civil war.
- **Sahel 2005-2006:** 10 million deaths in West Africa, of which three million were in Niger, due to prolonged drought.
- **Somalia 2011-2012:** 200,000 deaths due to drought and political instability.

- **Sahel 2012:** unknown number of deaths, but an estimated 3.6 million suffering from malnutrition in Gambia, Senegal, Mali, Burkina Faso, Niger and Mauritania due to drought.
- **Yemen 2016 - present:** 85,000 children's deaths plus an unknown number of adults arising from Saudi Arabia's blockade of Yemen.
- **Horn of Africa, 2017 - present:** South Sudan, Somalia and parts of Nigeria due to drought.



3.25 Volunteers hand out food to people in Lalibela, Ethiopia.

Famines used to be much more common in previous centuries than they are today. Almost every continent in the world has experienced famine at some time in its history. **Europe** had a three year famine from 1315 to 1317 that killed millions of people in northern areas of the continent, including 10% of England's population (about half a million people). During the Little Ice Age in the 15th and 16th centuries, famines became more frequent in Europe, and famines continued in Europe subsequently and through the 20th century. **China** has experienced almost 2,000 famines over the past 2,000 years, with the last famine occurring there in the late 1950s and early 1960s. India, Iran, Vietnam, Brazil, and many other places have all known famines over the centuries.

Centuries ago, a **drought** was enough to cause a famine because **food reserves** were scant and **transport infrastructure** was not sufficiently developed to bring food from areas unaffected by the drought. Furthermore, **surpluses** were small because agricultural productivity was low, being geared primarily to subsistence farming with small additional production being needed to feed people living in towns and cities.

In recent decades, transport infrastructure has improved greatly in all but the poorest parts of the world. Therefore, a drought today is less likely to lead to famine except when **political unrest** or **conflict** disrupts movement. Most famines in





**3.26** As roads like this one near Abomey in northern Benin in the African Sahel are developed, the threat of famine recedes because freight trucks can bring emergency food supplies from less affected areas.

recent years have occurred in places where civil wars, inter-tribal rivalry or other disputes have disrupted distribution networks.

Although improved transport infrastructure in many parts of the world now reduces the potential impact of droughts, several factors work to perpetuate the **continuing risk** of famines:

- **Conflicts and wars** continue in some parts of the world, and these areas remain highly vulnerable to famines as one side or the other may decide to use food as a political weapon, withholding or blocking the supply of food to people or areas that are seen as hostile to their cause.
- Some semi-arid parts of the world, such as the Sahel in Africa, are especially vulnerable to the impact of **climate change**. It is believed that global warming is causing increased evaporation from the ocean off the coast of West Africa due to rising sea surface temperatures, and this is affecting the amounts of rain that fall in the Sahel.
- Changing **food preferences** in rapidly developing countries such as China and India are leading to a rise in meat production. This is forcing an increase in world grain prices, as it becomes more profitable for grain farmers to sell their produce to large beef producers for feeding to animals than to sell it for lower prices to hungry, but impoverished, people.
- The increase in land area used for cropping to produce **biofuels** as a form of renewable energy is reducing the overall supply of grain for human consumption.

Contrary to the picture that is often portrayed through news media, famines are as much an **economic phenomenon** as a physical shortage of food. In practice, the shortage of food forces prices to rise because the **demand** for food outstrips its **supply**. Food is still available in the markets, but because of the high prices it is out of reach of poorer people; wealthier people in famine-stricken areas can still obtain food because they can afford the higher prices. Scarce food tends to be distributed unevenly within most families in low-income societies as men and boys tend to receive more food than the women and girls.

### Food aid

A common response to famines in low-income countries is for governments and aid agencies in wealthier countries to send emergency **food aid**. It is argued that if people in poorer countries are short of food when farmers in wealthier countries have surplus stocks, the obvious solution must be to send food aid.

Perhaps surprisingly, food aid from wealthier countries can **make the situation worse**. When farmers in poorer countries are trying to establish a commercial food growing industry in their country, there could be no greater blow than to have to compete with free food or subsidised grain from the United States or Europe. Farmers in wealthier countries like the policy of sending food aid, because it gives them an additional market when the government or aid agencies purchase their production. Immediate and **short-term food aid** is important on humanitarian grounds when there is a natural disaster, but it severely hurts farmers in poorer countries when it continues for a long period of time. This issue must be considered carefully before food aid is sent to famine-stricken areas, as the motive for such aid is sometimes to assist farmers in wealthier countries rather than the needy in poorer countries.

### The influence of the media

The **media** is playing a growing role in forming **public perceptions** of famines. Media outlets know that they attract higher viewership numbers with stories about catastrophic events, especially when there are powerful visual images to accompany their reports. Famines lend themselves to



widespread media coverage provided they can get access to on-site video recordings.

The **pioneering media** coverage of a famine was in 1984 when the BBC reported on the famine in northern Ethiopia. The BBC reports described the famine as being of biblical proportions, and featured strong images provided a famous Kenyan photographer, Mohammed Amin. Community reaction, first in Britain and then throughout the world, was very strong, leading to widespread donations to charitable bodies committed to relieving the suffering in Ethiopia.



**3.27** A still from a BBC news report on famine in Ethiopia. Media reports often focus on the 'human interest' emotional impacts of a famine rather than analysing the underlying causes.

The BBC reports of the Ethiopian famine also led to another initiative, **celebrity fundraising**. Bob Geldof, an Irish musician and political activist, formed a musical group called Band Aid to raise funds for the Ethiopian famine. In July 1985, he organized a concert called Live Aid, attended by 172,000 people in two venues, Wembley Stadium in London (72,000 attendees) and the John F Kennedy Stadium in Philadelphia (100,000 attendees). Live Aid raised about US\$300 million through ticket sales, donations given during and after the concert, and subsequent sales of recordings of the event, becoming a model for future celebrity fundraising events to combat famines.

Although the media can be very effective in raising awareness of famines, the reporting often **over-simplifies** the causes and the consequences. Media outlets' preferences to make reports of famine simple enough for viewers to understand during a news item of a minute or two in duration means that the subtleties of political conflict, distribution

disruptions due to poor transport infrastructure and economic marginalisation tend to be under-reported. Media reports of famines instead tend to focus on whether or not rain is falling, which is not always the key factor in understanding the problems faced by local people.

As the influence of global news networks has expanded, the media is increasingly seen as a key element in influencing **government** and **public responses**. Known as the **CNN effect**, news networks make decisions about which events to cover, which events to emphasise and which events to neglect. This **selection bias** means that, for example, a humanitarian disaster in Haiti may get widespread coverage because it is geographically close to the United States, while a simultaneous disaster (such as famine in Somalia) is largely neglected because it is more remote from the viewers. Consequently, far more funds are raised for some catastrophes than others, simply as a consequence of media decisions about ratings.

Another aspect of media reporting on famines is the problem of compassion fatigue. **Compassion fatigue** is the attitude of indifference towards appeals to help people in distress as a result of a high frequency of such appeals. The 24-hour news cycle of global media means that catastrophic events such as famines feature fairly frequently, and for media consumers in wealthy countries, one famine starts to look like all the others after a while. For viewers who have given generously when they were first touched deeply by reports of a famine, it is difficult to sustain the emotional distress required to keep donating for more and more famines. Compassion fatigue may become more entrenched by media reports of charities that have mis-used or mis-appropriated funds donated for famines, as scepticism begins to over-ride compassion.

### QUESTION BANK 3D

1. Outline the factors that are working to make famines (a) less common, (b) more common.
2. Explain why famines are an economic phenomenon.
3. How can food aid aggravate the problem of food security?
4. On balance, do you think the media plays a positive or a negative role in addressing the problems of famines? Give reasons to support your answer.



## CASE STUDY

## Famine-related issues in the Sahel

The **Sahel region** is a broad band of semi-arid land that stretches east-west across the African continent south of the Sahara Desert. With an area of three million square kilometres, the Sahel includes parts of Mauritania, Mali, Burkina Faso, Niger, Chad, Sudan and Eritrea. It has experienced **periodic famines** over time and it is arguably the **most vulnerable** part of the world to famines today. In recent years, the Sahel has experienced famines in 1968-1972, 2005-2006, 2010 and 2012, which suggests famines in the Sahel are becoming more frequent — contrary to trends elsewhere in the world.

In the **2012 famine**, an estimated 15 million people were malnourished, mainly in Chad (where the famine affected 3.6 million people), Burkina Faso (2.8 million) and Senegal (800,000). The main **cause** of the famine was a **drought** that caused crops to fail, leading to a widespread shortage of food. Mauritania and Chad reported crop losses of 50% compared with the previous year. **Food reserves** are perpetually low in the Sahel as most farmers are subsistence producers who produce only a small annual surplus for commercial sale. Consequently, the shortage of food caused **prices to rise** in local markets, with corn prices rising between 60% and 85% above the average. Most of those who suffered malnutrition at this time were poor people who simply could not afford the inflated prices being charged for the scarce food in the markets.



**3.28** The food market in Djenné, Mali. During famines, food is available here, but the prices are too high for poorer people to afford.

The previous Sahel **famine in 2010** was also caused primarily by a **drought**. The most severe effects were felt in the western Sahel where heavy rains fell, followed by an extreme heat wave and dry conditions lasting six months. Food shortages occurred in Senegal, Mauritania, Mali, Burkina Faso, Niger, northern Nigeria, Chad and Sudan. The food shortages were exacerbated by the growing trend to replace food crops with commercial **produce for export**, such as peanuts, cotton, sesame and groundnuts.

## Why is the Sahel vulnerable to famine?

The Sahel is unusual in that famines seem to be becoming **more frequent** in the region, mainly because **droughts** are becoming more frequent. Research is still underway on the reasons that droughts may be increasing in frequency in the Sahel. One explanation is that **global warming** is changing the patterns of **ocean currents** and **sea surface temperatures** in the Atlantic Ocean (to the west of the Sahel) and the Gulf of Guinea (to the south). Changes in sea surface temperatures are known to affect rainfall in land masses around the Pacific Ocean through the El Niño and La Niña effects, and it is reasonable to think this may also be a factor in the Sahel.



**3.29** Much of the Sahel region has land of marginal quality that cannot withstand the impact of additional physical pressures such as drought. This area is near Djiliki in Niger.

**Population** is growing faster in the Sahel region than any other part of the world. Population pressures have placed pressure on farmers to engage in sub-optimal practices such as **over-grazing**, **deforestation** for fuelwood and **poor land management**, such as ignoring the need to let land rest for fallow periods. Much of the Sahel farmland





3.30 Over-grazing cattle near Kantchari, Burkina Faso.



3.31 This field near Ségou in Mali has been improved by irrigation to increase the yield of onions being grown for commercial sale.

is of **marginal quality**, as **soils** are often infertile and highly porous, **irrigation** is rare, **evapo-transpiration** rates are high, and **farm improvements** involving fertilizer, pesticides and machinery are almost unknown. Most farmers are very poor, and have **little capacity to invest** in farm improvements. In that context, pushing natural resources beyond their limits makes the land highly vulnerable when physical pressures such as droughts or floods are added.

Famines are more likely to occur in **politically unstable** areas and zones of **conflict**. By 2016, an estimated 1.8 million people had been **displaced** from their homes across the Sahel, many because of terrorist activity, civil wars and ethnic victimisation by government officials. Boko Haram insurgents have infiltrated the Sahel region from north-eastern Nigeria, while Tuareg rebels have engaged in armed conflict in northern Mali. In 2014, French



3.32 The construction of sealed roads like this highway between Ouagadougou and Bobo-Dioulasso, Burkina Faso, reduce the risk of famine because they enable food to be shipped into areas where it is scarce. However, the high cost of constructing these roads means there are still very few of them, and those that do exist are often poorly maintained with broken surfaces and potholes.

military forces staged a major operation to drive Islamic militants out of Mali, but **terrorist activity** continues with attacks on public places and hotels, both in Mali and Burkina Faso. Kidnappings and hostage taking have been underway in Niger and Chad for many years, and this has led to the **withdrawal** of many aid workers from the region.

When people **migrate** as a response to political instability and conflict, it can increase the pressure on food supply in their destination zones, increasing the threat of famine if a drought or disruptions to transport and distribution patterns should occur.

### What can be done to relieve the threat of famine in the Sahel?

Governments and residents of the Sahel region have **few financial resources** to build infrastructure such as roads, markets and irrigation schemes that might reduce the impact of droughts and famines. Political unrest exacerbates the problem of finding or raising money to fund **capital improvements**. Many **aid workers** have left the region due to fear of kidnapping or terrorism, and foreign governments (with the notable exception of France) are reluctant to **invest** or give aid to the region.

On the other hand, aid workers from several **United Nations** agencies are still present in large numbers, chiefly through UNOWAS (United Nations Office for West Africa and the Sahel) and



MINUSMA (United Nations Stabilisation Mission in Mali). MINUSMA is mainly a peace keeping force to establish **law and order** in Mali following the Tuareg uprising in 2012, which should reduce the risk of famine if successful. UNOWAS, on the other hand, operates throughout the Sahel to promote **sound governance** in post-conflict areas, and to resist **terrorism**, violent **extremism**, organized **crime** and **piracy** — all factors that can increase vulnerability to famine. Other UN agencies such as WHO, FAO and WFP are also present in the Sahel, providing **advice to farmers** on improving farming yields, introducing additional **irrigation** and expanding **commercial food production**.

The main focus of improvements that are underway involve **water management**. Advisors are encouraging farmers to introduce or expand **irrigation**, and many **wells** are being built to pump water from underground aquifers, often financed



3.33 A well that brings water from an underground aquifer for people and cattle near Kouré, Niger.



3.34 A well provided by a foreign aid NGO in Tiébélé village in Burkina Faso.



3.35 The Dogon people who live on Bandiagara Escarpment in Mali near the border with Burkina Faso have developed a resilient traditional system to withstand the impact of droughts. The dried mud buildings with the conical roofs are grain stores, and Dogon people use them to store surplus food for use in times of shortage. The floors are elevated so the stored food is not spoiled by moisture or attack by rats. Adopting a simple system such as this might help other communities in the Sahel to withstand the impact of famines.

by aid donors. When the financial aid is in the form of **loans**, it can create long-term problems for the recipient country as it incurs a debt to the lending authority (such as a bank, a government, an aid agency, or an NGO) that will need to be repaid.

Perhaps the most significant changes to reduce the threat of famine in the Sahel need to be undertaken by people **outside the region**. Presuming the increasing frequency and severity of droughts in the Sahel are at least partly the result of **global warming**, the pressures will only be relieved when climate change is brought under control. This will require a concerted **global effort** to reduce greenhouse gases and address other factors that contribute to global warming.

### QUESTION BANK 3E

1. Why is the Sahel region so vulnerable to famines? Mention examples of specific famines to illustrate your answer.
2. Why does the Sahel region experience frequent droughts?
3. What measures are being undertaken to relieve the impact of famines in the Sahel? How successful have these measures been?
4. Suggest additional strategies that might reduce the impact of famine in the Sahel region.
5. In what ways is the problem of famine in the Sahel region different in scale or nature from other parts of the world.





4.1 Food insecurity is a constant risk for people in semi-arid areas such as the Bandiagara Plateau in Mali, shown here.

## Possible solutions to food insecurity

Food insecurity arises from a **diverse range** of climatic, political, economic, technological and management reasons. The significance of each reason varies between countries. Solutions that are relevant to one area therefore may not be so critical in another area. It is important that the major **causes** of food insecurity in a particular area are identified so that **appropriate solutions** that target the causes can be implemented.

## Economic solutions

**Microfinance (or microcredit):** Small-scale farmers in low-income countries (and especially women) often find it difficult to get access to loans that would enable them to invest in their farms to improve efficiency and raise production. Farmers who can get access to microcredit, which may be as little as US\$50 to US\$100 with generous repayment periods, enable farmers to improve their farms and reduce the risk of food insecurity. At present, many farmers are reluctant to obtain microcredit because average annual interest rates range between 30% and 70%, reflecting the high-risk nature of these loans.





4.2 A Canadian-sponsored sign informing farmers who live near Parakou, Benin, about microcredit. The woman in the cartoon on the sign is thinking “the borrowed money is not a gift, it must be repaid”.

**Grow crops for human consumption:** Commercial farmers sell their crops to markets that will pay the highest prices. With rising affluence in many developing countries, farmers who raise livestock for **meat production** can usually pay higher prices than hungry, impoverished people. This creates a grain shortage, and thus higher prices, for poorer people who cannot readily afford alternative foods. There is a 90% **loss of food energy** when humans consume grain in the form of the meat of an animal that has eaten the grain compared with humans consuming the grain directly. This situation could be addressed if more people in affluent societies **reduced consumption** of meat, or if more meat production were to be based on **pasture feeding**, which has the added bonus of producing healthier meat for human consumption.



4.3 As standards of living rise, meat consumption also tends to increase, as indicated by the sign in Abomey, Benin, directing customers to the Divine Glory Delicatessen.

**Grow food crops:** In recent decades, commercial farmers in many low income countries have been encouraged to abandon growing food and switch to non-food crops such as biofuels, palm oil, cotton and flowers, which are said to bring higher prices. The idea is that farmers can earn a higher income, use some of it to buy the food they once grew for themselves, and have extra money available for other uses. As a result of this action, food security has deteriorated in many countries, especially in Africa, as the country has sacrificed its self-sufficiency in food production and commodity prices have fallen short of predictions. Food security could be improved if farmers were encouraged (or forced) to grow food crops rather than industrial raw materials, although the resulting lower profits that some farmers receive may need to be compensated.



4.4 Onions — a food crop — are grown on this farm in Bongo, Mali.

## Management solutions

**Crop substitution:** Water is scarce in many countries that experience food insecurity, especially in Sub-Saharan Africa, the Middle East and Central Asia. Therefore planting food crops that demand less water would help to make farms less vulnerable to droughts. This process is known as **crop substitution**. Crops such as rice and sugar cane require large quantities of water compared with peas, beans, tomatoes, melons and squash. The challenge is that most commercial farmers decide what to plant based on market values, so economic incentives such as subsidies may be required to encourage crop substitution.



**Raising farm productivity:** Farms in areas where food insecurity is experienced, such as in sub-Saharan Africa, have much lower productivity than farms anywhere else in the world. Improving farm productivity requires a combination of approaches, including:

- **educating** farmers through training programs and observing model demonstration farms
- providing **female farmers** with better resources that enable them to narrow their productivity gap with male farmers
- giving farmers access to improved **seeds and fertilisers**, perhaps through microcredit loans that can be re-paid when yields and profits improve
- making more widespread use of traditional, **low-technology techniques** such as terracing hillsides to expand the area of cultivable land



**4.5** An example of low-technology that can increase farm productivity — the low lines of raised stones are ‘diguettes’, placed along the contours of the slope to slow the flow of water, enabling it to soak into the soil and reducing soil erosion. These diguettes are in Songo, Mali, but diguettes are also found in Burkina Faso.

**Expand commercialisation:** Many farmers in low-income countries are subsistence farmers who have little interest in producing an agricultural **surplus** for sale in the market. Sometimes this reluctance arises because transport links to markets are so poorly developed that selling a surplus becomes impractical. For farmers who do have access to markets, encouraging them to produce a surplus (or increase their current surplus production) for commercial sale would increase food supply and help to relieve food insecurity. It is often difficult to persuade farmers to make this transformation, perhaps because they resent the extra work



**4.6** These roadside markets in Kondodimini, Mali, are evidence of commercialisation of farming in the area. The women selling the produce are the farmers who grew the food.

involved, or they lack any unused land that would be suitable for planting, or they understand that increasing the supply of food will lower prices for all farmers, themselves included.

**Reduce food waste:** Between 30% and 50% of the world’s food production goes to waste because of poor **storage facilities**, attacks by **vermin**, inefficient food **preparation** or poor **management** of food that allows it to spoil or become stale before it is used. In wealthy countries, huge quantities of food are thrown away by supermarkets and restaurants every day because its ‘use by’ date has expired or the food is not visually appealing. While food that is thrown away in a wealthy country cannot simply be shipped to hungry people in other countries, the high rate of food wastage suggests that excessive quantities of food are brought to markets in wealthy countries, which **raises global food prices** and places pressure on those who can least afford to pay for food. According to a refereed article in the respected journal *Science* in 2014, reducing food waste in the United States, China and India could feed an additional 413 million people annually.

### Technological solutions

**Expand irrigation:** Irrigation can cause environmental side-effects such as water-logging and salinisation of the soil and streams. Nonetheless, it is an effective way to increase **yields** in semi-arid areas when it is properly managed to supply water in a measured way at times the crop requires extra moisture.





**4.7** Residents of Tiébélé, Burkina Faso, store surplus food harvested during abundant years in grain stores made of dried mud, such as the one shown here in the courtyard of a housing compound. The grain store is elevated above the ground to protect it from dampness and rodents. The flat roofs of the houses are also used to store grains.



**4.8** Farmers carry basins of water to irrigate their crops in Bongo, Mali.

**Improve transport infrastructure:** One way to improve food security is to ensure it can be transported to areas where it is needed. For this to be achieved, investment is needed in **roads** and **railways**. In some countries this investment is undertaken by governments, but in many low-income countries it is done by agribusinesses to serve their own needs as the government does not have sufficient funds.



**4.9** The construction of major roads, like the international highway between Niger and Benin, shown here south of Dosso in Niger, provide protection against food insecurity by enabling transport of food and supplies in large trucks.

**Improve service infrastructure:** Providing **electricity** to farms gives farmers access to radio and television, and thus **information** about the wider world including farming **policies** and **techniques**. This can be a valuable aid to **decision-making**, enabling the farmer to make **informed choices** about crops and marketing. Enhancing **water services** to farms, such as by irrigation channels, also provides farmers with options to improve productivity through irrigation and appropriate water management.

**Expand mechanisation:** On all but very small farms, machinery can be an effective means to boost farming production. However, this involves a substantial **capital expenditure**, even when farmers share machinery in co-operatives. Mechanisation is therefore not a feasible strategy for small-scale commercial farmers or subsistence producers. Farmers who do invest in mechanisation are committed to being part of the **cash economy** because of the ongoing need to purchase fuel and maintenance items, and the risks involved in this commitment deter many farmers from the investment.





**4.10** A water well near Kouré, Niger. Wells are one of the most important service infrastructure improvements in drought-prone regions such as the Sahel.

## Political solutions

**Food aid:** Gifts of food from wealthy countries can reduce food insecurity in times of crisis. However, as we saw in the previous chapter, food aid can weaken long-term food security, food sovereignty and food self-sufficiency as local farmers cannot establish a viable farming industry when competing with free or heavily subsidised food from elsewhere.

**Free trade:** In some ways, free trade works against food self-sufficiency and food-sovereignty. The assumption that underpins free trade is that each country should produce the products in which it has a **comparative advantage** over other countries. Therefore, if a country can produce (say) cotton more efficiently and at a cheaper price than any other country, then it should devote as much land and effort as possible to producing the cotton, using the income earned to import whatever other products it needs (such as food). In free trade, all countries trade by exporting their efficiently produced products and importing their other needs without imposing **tariffs** or **taxes**, as that would **distort** the relative efficiencies of the trading countries. While free trade can undermine food security by threatening local food producers, it can improve food security by providing consumers with cheaper imported food. Whether a country supports free trade or prefers to impose tariffs is a political decision made by each sovereign government (sometimes under pressure from its larger, more powerful trading partners).

**Fair trade:** Sometimes called **ethical trade**, fair trade occurs when companies in economically developed countries pay 'fair' prices to producers who supply their products from economically developing countries. In this context, 'fair' price payments are amounts that are sufficient **not to exploit** workers or less empowered companies in low-income countries, and which are **socially, economically and environmentally** responsible and sustainable. Fair trade helps to improve food stability because it considers the ongoing viability of production units (such as farms) in low-income countries, protecting their interests from the savagery of uncontrolled markets.

**Land reform:** Many farms in low-income countries are **small** and **fragmented**, making economies of scale and even the use of machinery impossible. Farm fragmentation often occurs because of inheritance customs. In many societies in Africa and Asia, a farm is broken up and shared between the children as the **inheritance** of a farmer who dies. In some cases it is not simply a matter of splitting a farm by the number of children, as each descendent needs to get an even share of well-watered land near a stream, hilly land that doesn't flood, flat land and undulating land. When this process continues over many generations, extraordinarily small plots of land may result. Some countries, such as Japan and China, have imposed land reform to **amalgamate** tiny farms into larger, more viable farming units. In places where land reform has occurred, food security has invariably improved.

**Planning:** Many countries in Africa develop regular plans and strategies to improve the performance of their farming sectors. This enables governments to channel financial resources into areas that are judged as needing support, such as **reducing** regional **disparities**, improving the **quality of life** for rural impoverished people, raising the status and educational level of **women**, **diversifying** the types of farming in the country, reducing **soil erosion**, providing better **food and water storage** facilities, and strengthening **advisory services** to support farmers. When they are properly focussed and free of **corruption** (bribes), government plans can be a powerful tool to reduce food insecurity.

**Population control:** Many countries that suffer from food insecurity also have rapidly growing



populations, which place incessant pressure on limited food supplies. Population growth can be reduced in several ways, one of which is government policies that are implemented through **regulation, taxes or financial incentives**. As societies become wealthier, population growth slows, thus reducing pressure on food insecurity. This implies that government policies that **raise the incomes** of very poor people are likely to reduce population growth and hence reduce food insecurity.

**Establish peace:** Political instability and conflict are great threats for food security as they disrupt transport and distribution networks, discriminate against certain ethnic, tribal or political groups, and in extreme cases, destroy farmlands. Although it is often difficult to achieve, bringing a peaceful, stable political environment invariably improves food security.



**4.11** The large number of children in villages and towns throughout Papua New Guinea indicates a high rate of population growth. These children are in Hobe village.



**4.12** The large mural on the wall of a building in Tiébélé, Burkina Faso, promotes peace, development, solidarity and work, all defences against food insecurity.

## Climatic solutions

**Stop climate change:** Climate change is blamed for increasing the frequency of **extreme weather events** such as droughts, floods and storms. Longer-term environmental impacts such as rising sea levels and changing patterns of rainfall are also attributed to climate change. These changes all have the potential to affect food security adversely by threatening the availability of food, people's access to foods of certain types and the transportation of food. Some parts of the world are expected to receive more rainfall as global warming continues, but these are areas that already receive abundant rainfall and do not experience food insecurity; places such as northern Europe, eastern North and South America, and northern and central Asia. Semi-arid areas that suffer from food insecurity such as the Sahel and the Middle East are expected to become **drier** and experience more frequent and more severe **drought periods** as global warming continues. It follows from this that **global action** to arrest climate change should enhance food security, or at least prevent or slow its decline, especially for people who are vulnerable due to their geographical location or their financial disempowerment.

### CASE STUDY

#### Food insecurity in Yemen

**Yemen** is an Arab republic in the south-western corner of the Arabian Peninsula. With an area of almost 528,000 square kilometres, it is the second largest country on the Arabian peninsula after Saudi Arabia (figure 4.13). Most of the country is covered by rocky desert, and with a GNI (gross national income) per capita estimated at just US \$1,200, it is the poorest country in the Middle East. The population size is just over 25 million people, of whom 73% live in rural areas. Yemen's rural areas are poorer than the towns and cities, and 84% of Yemen's poor people live in rural areas.

Since 2011 Yemen has been embroiled in several simultaneous **political crises**. Within the country, al-Qaeda have been staging terrorist attacks and kidnappings, while an opposition group known as the Houthis (or Ansar Allah, or 'Supporters of God') were mounting an armed rebellion to take over the country.





4.13 The location of Yemen. Note that the locations of several boundaries are disputed.

The **Houthis** took over Yemen's capital city, Sana'a in late 2014, at which time the ousted government moved its operations to the southern port city of Aden. Following the Houthi seizure of Sana'a, Yemen's powerful northern neighbour, **Saudi Arabia**, began a **military campaign** against the Houthi government that involved a naval blockade and heavy aerial bombings that have caused large numbers of deaths and injuries in addition to destruction of buildings and infrastructure. The



4.14 In an attempt to improve food security, residents of Yemen's capital city, Sana'a, grow food on vacant land.

Saudi attacks have been supported by US drone strikes. At the time of writing, western Yemen was controlled by the Houthis, southern and eastern Yemen was controlled by the ousted Yemeni government, while central Yemen was controlled by Al-Qaeda with smaller pockets under the control of the Islamic State of Iraq and the Levant - Yemen Province.

Yemen is thus an **arid to semi-arid country** that is engaged in **civil war**, **terrorist attacks** and an **external war** with a powerful adversary. The internal and external conflicts have damaged **infrastructure** such as roads, storage facilities, homes and farms. The conflicts have also destabilised the **market system** and upset established price structures, caused large-scale

**unemployment**, halted all **foreign investment** and donor-supported development programs, caused about 2.5 million people to leave their homes and become **internally displaced** (refugees in their own country), thus devastating the livelihoods of much of Yemen's population. Not surprisingly, **food insecurity** has become a serious and growing concern for both rural and urban populations in Yemen. By 2016, 14.4 million



4.15 Yemen's markets often have short supplies of some types of food, as seen here in Manakhah, west of Sana'a.





**4.16** The traditional method used in mountainous areas of Yemen's west to improve security is to expand the cultivated area by terracing steep hillsides, as seen here near Yazel.



**4.17** The steep terrain in Yemen's food growing areas means that many fields are very small, making the use of machinery difficult, reducing productivity and contributing to food insecurity. These farms are at Al-Hudhaib.

Yemenis (more than half the population) were classified as food insecure, of whom 7.6 million were severely food insecure.

The internal and external conflicts have disrupted **government services** (by all the competing administrations), causing the closure of many farming activities, including government safety net programs that were in place to protect poorer people from the food insecurity imposed by aridity and periodic droughts. This has placed additional pressure on Yemen's food insecurity, placing many more people into a food insecure situation.

Coinciding with Yemen's political instability, the country experienced a prolonged period of **erratic weather conditions**. The country was hit by two hurricanes in late 2015 that brought flash floods, and by swarms of locusts in 2016.



**4.18** Old reservoirs such as this one in Hababah provide small reserves of water for irrigating crops during droughts. They are not really adequate to provide food security today.



**4.19** Shelters used by internally displaced people on the outskirts of Sana'a.

Most of Yemen's crops are grown in the west of the country because the eastern two-thirds is too arid. The **main crops** grown are millet, sorghum, vegetables and fruits. About half of Yemen's farmland is rain-fed, with the other 50% being irrigated from groundwater (31%), from floods (10%) and from dams, streams and water tanks (9%). As a result of the erratic rainfall, some **crops failed**, leading to a **shortage of supply and rising prices**, adding further pressure to the country's food security. By 2016, prices for wheat in Yemen had risen by 15% over pre-conflict prices, even though global wheat prices had fallen during the same period. Price rises for food were exacerbated as **diesel prices** rose due to the conflicts, affecting both food distribution and food production (because farm machinery such as tractors and irrigation pumps use diesel fuel).





**4.20** As conflicts in Yemen have escalated, fuel has become scarce and expensive, forcing many farmers to revert to less productive techniques such as using donkeys to pull ploughs.

Because of its aridity, Yemen was **not self-sufficient** in food, even before the conflicts began. The usual pattern is for Yemen to import 55% of the food consumed, including 90% of wheat, the main food staple in Yemen. As a consequence of armed conflict in their surrounding areas, three of Yemen's eight **ports** have been closed, increasing the strategic pressure on the remaining five ports to remain open to avoid a famine. Yemen has no **strategic food reserve** to protect its population in the event of a crisis.

UNICEF estimates that about three million children under the age of five require services to treat or prevent acute **malnutrition**, as do many pregnant and breast-feeding mothers. As the conflict continues, food insecurity worsens.

**Solutions** to food insecurity are difficult to implement in a conflict environment like Yemen. The obvious solution is to stop the fighting, but this is difficult to implement when four ambitious regimes are competing to control the country and when the nation is under attack by a more powerful neighbouring country with superpower support.

**Food aid** began trickling into Yemen in 2016, at which time about 3.6 million people started to receive emergency food supplies, shipped into the country through the port of Aden in ships chartered by **WFP** (the United Nations World Food Program). WFP's operations in Yemen have three **stated aims**:

- to deliver food to people affected by conflict, malnourished children, pregnant women and nursing mothers

- to provide emergency food assistance
- to help the humanitarian aid community by transporting fuel into the country.

WFP is working with local suppliers to introduce **commodity vouchers** that can be exchanged by vulnerable families in hard-hit parts of the country to obtain food. Each voucher is designed to provide a family of six people with a month's supply of wheat grain, pulses, vegetable oil, salt and sugar, as well as WSB (Wheat Soya Blend), which is a protein-rich blended food. One limitation of the voucher scheme is that the vouchers only work in those parts of Yemen where the market is still functioning. Nonetheless, it is an attempt by WFP to provide food for needy families while also supporting local food producers.



**4.21** A United Nations freight plane loads provisions at Addis Ababa Airport in Ethiopia to relieve food insecurity in Yemen.

One of the problems of addressing food insecurity in Yemen is that the **road networks** in the conflict areas have been closed, making it difficult for humanitarian workers to reach people in the hardest hit areas. To address this problem UNHAS (United Nations Humanitarian Air Service) operates three **flights** per week from Djibouti or Ethiopia to Sana'a to transport aid workers and cargo such as agricultural machinery and emergency food supplies. Food and equipment is also being sent to Yemen by other organisations such as IRC (the International Rescue Committee), USAid (United States Agency for International Development), and MSF (Médecins Sans Frontières).

Meanwhile, the internal and external conflicts continue despite protests, demonstrations and



international efforts to negotiate a cease-fire and an end to the fighting. Until peace is achieved, measures to solve Yemen's food insecurity will need to focus on the **symptoms** rather than the underlying **causes** of the problem.

## QUESTION BANK 4A

1. For each of the possible solutions to food insecurity discussed in the first six pages of this chapter, outline the barriers that must be overcome if the solutions are to be achieved.
2. Why does Yemen experience food insecurity?
3. List the characteristics of Yemen's situation that are shown in figures 4.15 to 4.20 contribute to the country's food insecurity.
4. Draw up a table with three columns to list the possible solutions to food insecurity that are discussed in the first six pages of this chapter. Categorise the possible solutions by listing them in one of the three columns using these column headings: (a) Solutions that are being implemented in Yemen, (b) Solutions that are not being implemented in Yemen and would be impossible, impractical, or of no use there, and (c) Solutions that are not being implemented in Yemen but which would help to address food insecurity there.
5. The food situation in Yemen is highly changeable. Do some online research to update the information in this section, and describe the changes that have taken place, either for the better or the worse.

## Contemporary approaches to food production

A number of **innovative techniques** are being used in different parts of the world in an effort to raise the yields of food production. These approaches fall into two groups, the Green Revolution, which is mainly applicable to farms in **developing countries**, and contemporary approaches in **high income countries**.

### The Green Revolution

In the 1960s, 1970s and 1980s, many **predictions** of widespread hunger and starvation were made. These predictions did not come true, largely due to the increase in yields in subsequent decades, especially in developing countries. Some people have described the increase in yields as nothing

short of a miracle. The terms '**Green Revolution**' and '**seed-fertiliser revolution**' have been used to label the package of measures introduced by farmers in developing countries to boost production. The measures included introducing new 'miracle' **high yielding varieties** (HYVs) of rice and wheat, expanding **irrigation**, and using larger amounts of **fertiliser**. The Green Revolution was so successful in boosting production that nations like India, Indonesia, Malaysia and the Philippines, which were rice importers, became rice exporters.

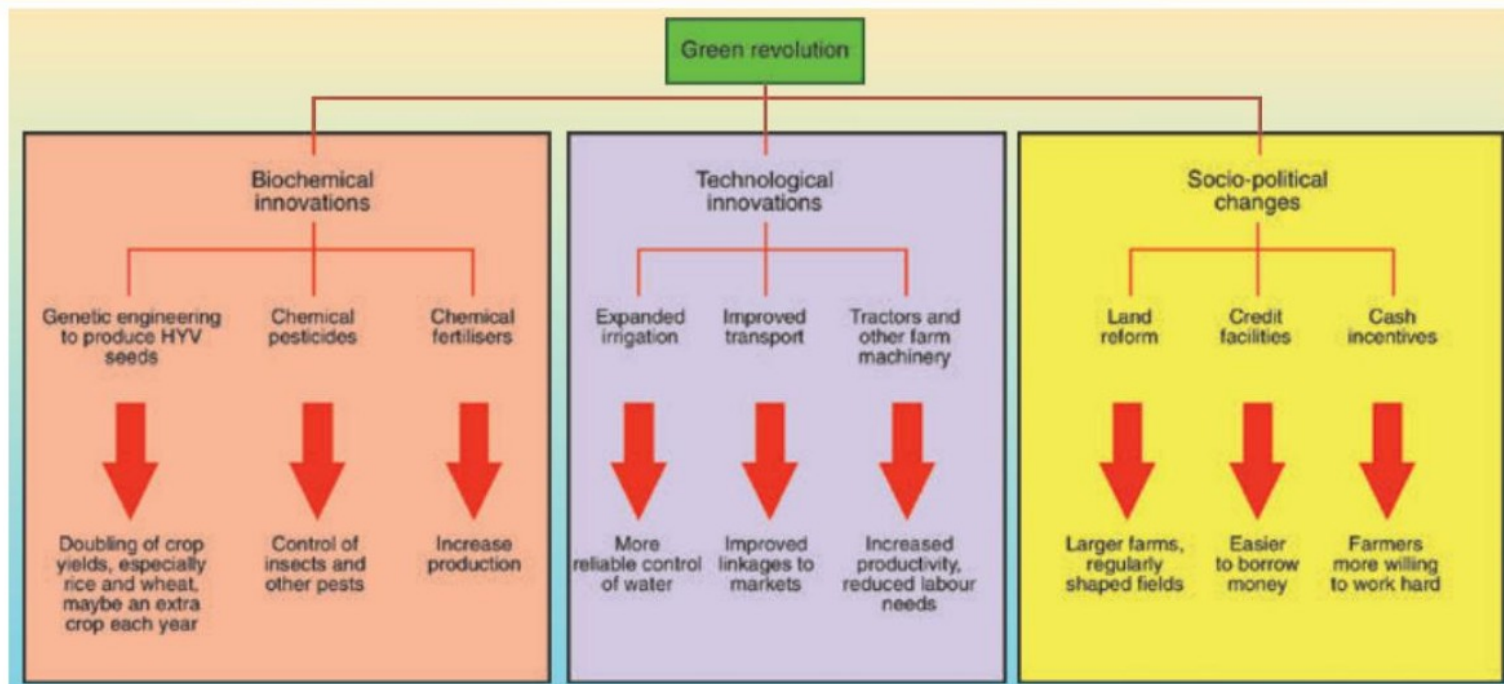
The key to the Green Revolution for rice cultivators has been the development of **hybrid** (or cross-pollinating) high yielding varieties of rice. Much of the work to develop new strains of rice was done at the **International Rice Research Institute (IRRI)** in the Philippines, which was established in 1960. IRRI was established specifically to modernise Asian rice production by helping farmers to introduce Western (or temperate climate) technology.



4.22 Rice cultivation near Antsirabe, Madagascar.

At first, only types of *japonica* rice were developed into HYVs, but later varieties of *indica* rice were also developed. The first of the 'miracle' HYVs was known as IR8 and it was released to farmers in 1962. In some places, the first crop of IR8 produced a yield 600% greater than the traditional varieties of rice grown the year before. IR8 was a low growing, short stemmed variety of rice, meaning that its growing season was shorter than traditional rice plants and it was less prone to damage by strong winds and heavy rains.





4.23 The Green Revolution 'package'.

In the early 1970s, large areas of IR8 were destroyed by tungro virus which was spread by green leaf hoppers. This showed both the danger to farmers of depending on one type of rice only, and the **vulnerability** of the new HYVs to **disease**. To overcome these problems, other varieties of HYV rice were developed in future years by the IRRI and other agencies. Among the new varieties are the following:

- IR17 and IR19 — developed for the flood plains of central Thailand where annual flood waters may be more than one metre deep;
- IR36 — a quick maturing variety of rice allowing three crops of rice to be gathered from each padi field each year, and high yields of over 30 tonnes per hectare;
- IR42 — a high yielding variety developed for areas with poor soils;
- IR48 — a variety of rice for farmers who cannot afford expensive fertilisers and which is adaptable to a wide range of temperatures and rainfalls;
- IR52 — a quick maturing variety that is resistant to drought and blight.

The HYV strains of rice brought both advantages and disadvantages for rice farmers. The obvious advantage was the **increased yields** and the **shorter growing season**, enabling the cultivation of an extra crop each year from many padi fields.

Furthermore, the low height of the HYVs made them more **resistant to damage** from monsoonal rains and high winds.

However, there were also problems. The new strains of rice were more **difficult to grow** than traditional types. Most of the HYVs required large amounts of **fertiliser** to produce their potential yields, and this proved very costly for all but the **wealthiest farmers**. The new strains of rice also needed more precise allocation of **water**, meaning that a great deal of work was needed in some areas to improve **irrigation** systems. The HYV plants were also more susceptible to attack by **disease** and so **chemical sprays** were often needed to ensure a successful crop. These sprays were expensive for smaller farmers and had some harmful effects on



4.24 Short-stemmed, quick growing rice that is suited to cooler climates is found near Sinchon, North Korea.



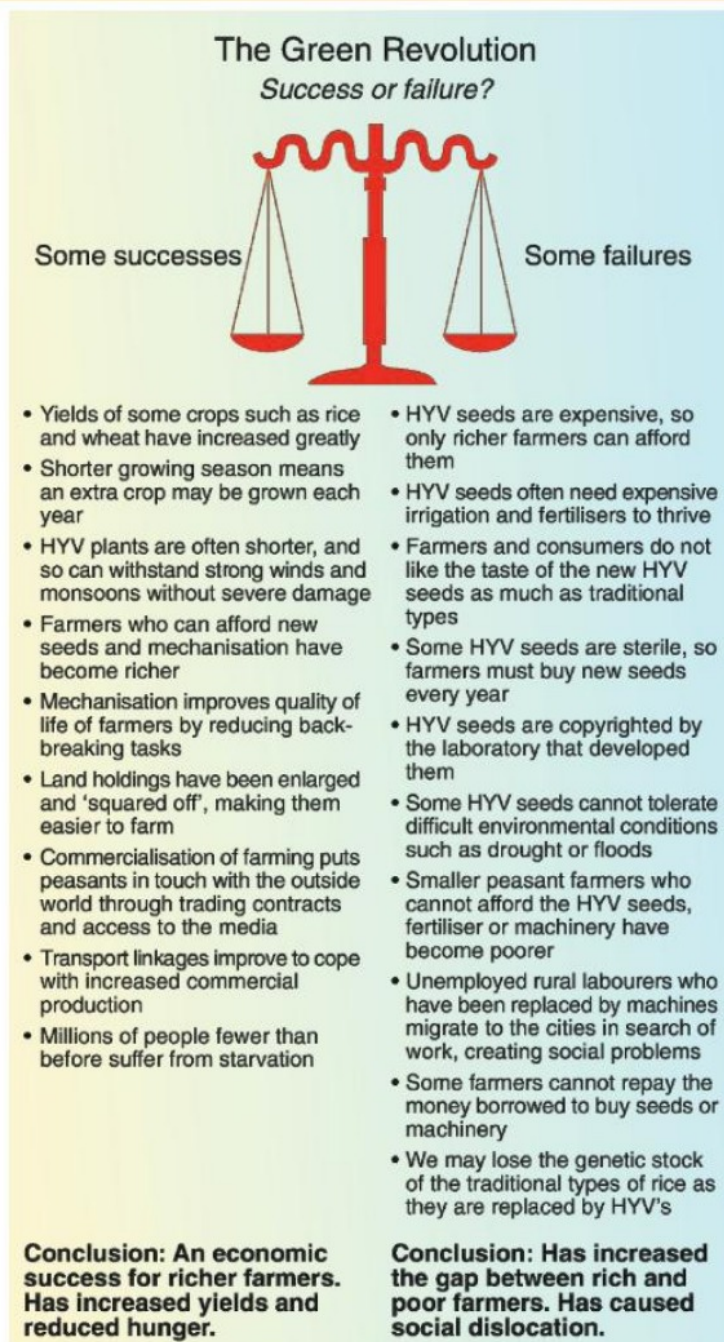
the biophysical environment. Moreover, the seeds were **expensive** to buy, and some of the genetically engineered types were **copyrighted** and **sterile**. This meant that the farmer had to buy new seed every year rather than just keeping some of the previous crop for the following year's planting.

Other problems were also encountered. For example, the increased yields of rice put a great deal of pressure on poorly developed **transport networks** and **storage facilities**. In the early years of HYV introduction, much of the crop was left to spoil because storage and transport could not cope with the huge volumes being produced. Because of the high cost of switching to HYVs, governments and banks established **credit facilities** for farmers to borrow money. Many farmers used these new facilities, only to find themselves heavily in **debt** and unable to repay their new debts. Finally, the new strains of rice were **unpopular** with many consumers because they did not like the taste of the rice produced. Many people found that the HYV rice lacked flavour and became sticky and mushy when cooked. For this reason, traditional varieties of rice often attract a higher price in the markets.

The Green Revolution is much more than the simple introduction of high yielding varieties of seed. It is a **package of measures** carried out in full or in part. A summary of the components of the Green Revolution is given in figure 4.23.

There is no doubt that the Green Revolution has brought many **benefits** and many **problems**. Figure 4.25 attempts to weigh up and balance some of the main points for and against the Green Revolution. Of course, the situation is not as simplistic as this diagram might suggest, as many of the problems faced by rice cultivators are consequences of **side-effects** of the Green Revolution. This particularly applies in the area of the biophysical environment.

For example, the high yielding varieties of rice have proved to be more **vulnerable** to attack by **pests** and **diseases** than traditional varieties. Farmers have been forced to use large quantities of toxic **chemicals** and **pesticides** to control these pests. These chemicals have been **expensive**, but even more importantly they have **destroyed wildlife** and other food resources such as fish and snails that were part of the padi field ecosystem.



4.25 Some benefits and problems of the Green Revolution.

Another effect of pesticide use has been the development of more **resistant pests**. The insect pests have become more and more resistant to the chemicals used against them through a process of **selective breeding**. Some insects always have greater immunity to the toxic effects of chemicals than others. These more resistant insects survive the pesticides and become the breeding stock of the next generation of insects. In this way, insects become more and more resistant to the pesticides over time, and so even more toxic chemicals must be used. Furthermore, as some insect species are reduced through toxic chemicals, other species (which may also be pests) will increase in number. This is because the insects destroyed will have been



the natural predators of other species. By largely removing one link from the food web, then other species can multiply without the normal biological controls. In this way, pests which were once a very minor problem can increase in numbers to plague proportions.

And yet, it seems beyond dispute that the Green Revolution has produced **more food**. However, this food has not always gone to the people who have needed it most. Much of the extra production went to the **wealthier people** who live in the towns, to other countries to earn **export income**, to fatten **cattle** and as ingredients to make **luxury food products**. Commercial farmers do not grow food to eat but to sell, and it will be sold to the highest bidder, and this person will almost always not be the hungriest person.



4.26 Rice cultivation near Tegallalang, Bali, Indonesia.

The development of HYV strains of rice was a conscious **choice**. In making this choice, some other choices were not made. For example, it was decided not to improve traditional seeds that were already well adapted to local conditions. It was decided not to improve long-established traditional methods of farming, but to replace them with an adaptation of high cost, high technology 'Western' techniques. Furthermore, it was decided not to develop a labour intensive technology that would create employment, but to replace people with machines.

Deciding whether or not the Green Revolution has been a good or a bad thing depends on one's individual **perspective**. If you were a poor peasant, displaced from your farm because a wealthy farmer had bought your farm and replaced you with

expensive machinery, forcing you to migrate to the city in search of work, you would probably be disappointed by the Green Revolution. On the other hand, if you were a fairly rich farmer whose income has been boosted by higher yields, you would appreciate the Green Revolution. Perhaps the most powerful argument in favour of the Green Revolution is that millions of people are alive today in developing nations who are adequately fed – people who may well have been malnourished if it had not been for the Green Revolution. Regrettably, these may not be the poorest people who most needed it.

## QUESTION BANK 4B

1. Why is the Green Revolution sometimes also called the 'seed-fertiliser revolution'?
2. What do the letters HYV stand for?
3. Why was IR8 known as the 'miracle rice'?
4. What have been the problems in growing the high yielding varieties of rice?
5. What measures have farmers had to implement to support the introduction of HYVs? Have these other measures created any problems?
6. Discuss the impact of the Green Revolution on the biophysical environment.
7. What social problems have resulted from the Green Revolution?
8. On balance, do you think the Green Revolution has brought more benefits or problems? Explain your answer fully.
9. Speaking of the Green Revolution, the geographer Philip Woodhouse wrote "It has demonstrated a capacity to produce enough food for a population believed to have grown perilously beyond the 'carrying capacity' of the fixed amount of land available. It has simultaneously demonstrated that this, though necessary, is not by itself sufficient to improve rural food security or living standards."

What do you think he means by this statement? Do you agree or disagree with it?

## GMOs

GMO is an increasingly common abbreviation for a **Genetically Modified Organism**. Unlike HYVs, which are hybrid varieties of rice and wheat, GMOs can be plants, animals or microorganisms whose DNA has been altered by human genetic



engineering techniques such as gene modification, gene splicing or transgenic technology. This enables new organisms to be developed using genetic combinations that do not occur in nature and which cannot be created using traditional cross-breeding techniques, such as those used to breed HYVs.

GMO foods have been developed to redress certain deficiencies that are seen in natural foods, such as improving **resistance to viruses and bacteria** that cause disease and herbicides, and **improving nutrient levels**. Developing genetically modified foods is a highly expensive business, so the work is generally undertaken by **large corporations** such as Monsanto, Del Monte, JR Simplot, Bayer and BASF on foods that return high profits such as canola, corn, tomatoes and soybeans.



**4.27** GMO foods are controversial. This anonymous demonstrator is protesting against Monsanto's practices in developing and controlling GMO foods.

The **first GMO food** to be sold openly was the **Flavr Savr tomato** (also known as CGN-89564-2), released by Calgene (later taken over by Monsanto) in the United States in 1994. The Flavr Savr was engineered to have a **slower ripening process** than conventional tomatoes, giving them a longer shelf life. In practice, Flavr Savr tomatoes did ripen more slowly, but unfortunately they did not remain firm any longer than conventional tomatoes. Therefore, their shelf life could not be extended beyond the shelf life of other tomatoes. Consequently, it was not a commercial success because no additional revenues were generated to repay the costs of genetic engineering.

The first genetically modified animal to be marketed was the **AquaAdvantage salmon**, released

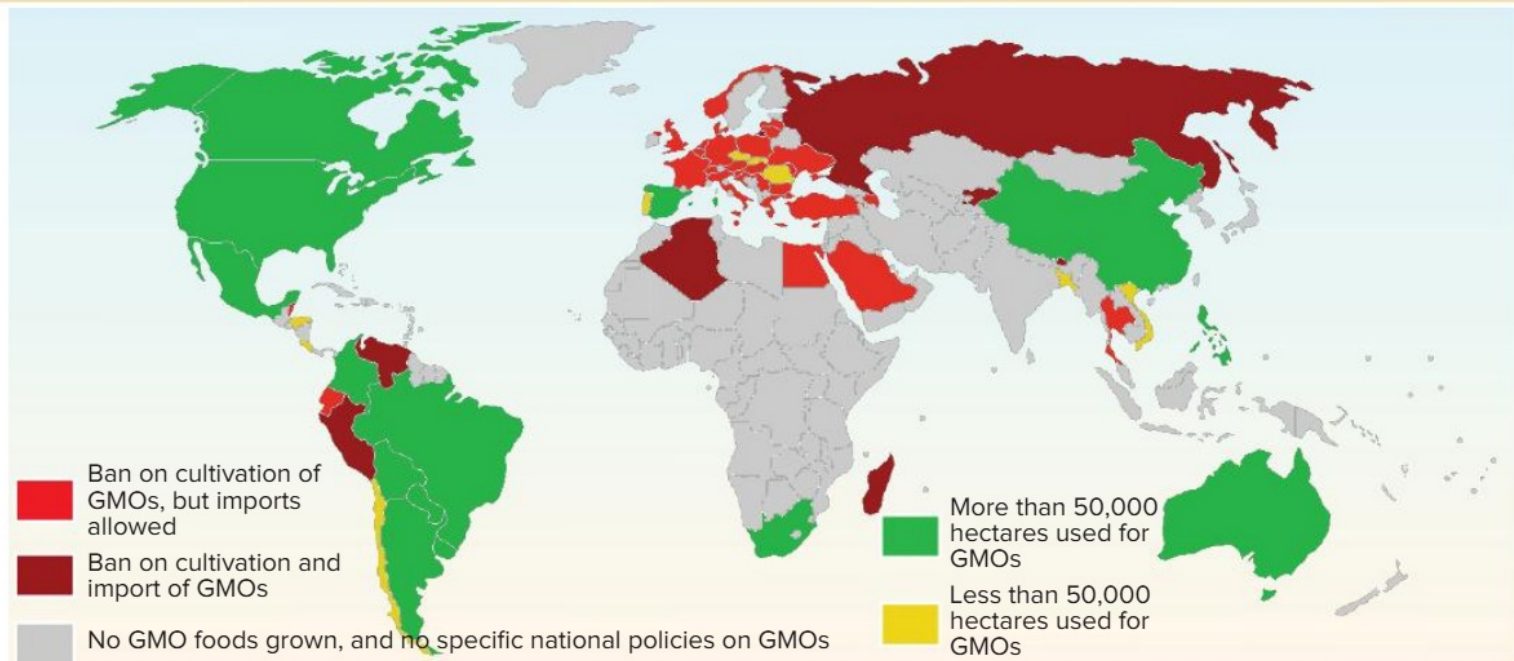
in 2015. Its genetics were engineered to allow it to grow throughout the year rather than being restricted to spring and summer growth, as is the case with natural salmon.

Work on GMO foods is accelerating, with corn, soy, canola, potatoes, tomatoes, zucchinis, papaya, pineapples, apples, wheat and other foods now released to consumer markets. The **United States** is the world's leading country producing GMO food, and by 2016, GMOs comprised 92% of US corn production and 94% of US soybean output. The main focus of efforts to develop GMO foods in the US has been developing foods that can **withstand powerful herbicides**. This is seen as necessary as many weeds have developed a resistance to commonly used herbicides, and farmers feel the need to use stronger chemicals to kill the resistant weeds. Some GMO foods are developed to **enhance nutrient levels**, a notable example being 'Golden Rice'. **Golden Rice** was developed with added beta-carotene (normally found in carrots) to boost the Vitamin-A content in order to address **vitamin deficiencies** in developing countries. GMO canola and soybean oils have been developed to have lower polyunsaturated fatty acid levels and higher monounsaturated fatty acid (oleic acid) content, which should make them healthier than natural oils.

GMO foods are **controversial**. On one hand, supporters of GMO foods point to widespread research that suggests a scientific consensus that GMO foods pose **no greater threat** to humans than conventional food. Countries with significant GMO food industries have established **regulatory processes** for the approval of GMO foods before they can be marketed, although the strictness of the regulations varies widely from country to country. However, many consumers are **wary** of GMO foods, being aware that humans metabolise the genetic material they consume, with concerns that are perhaps influenced by media articles that portray GMOs as 'frankensteins foods'.

Opponents of GMO foods worry that releasing genetically modified crops into natural environments is **freeing genetic material** that may cause permanent damage to natural varieties that are growing nearby, irreversibly altering the genetic composition of foods that are eaten by humans. At the very least, opponents argue that GMO foods





4.28 International support for or opposition to GMO foods as expressed through government policies.

should be more clearly **identified** and **labelled** so consumers can make informed choices about whether or not to purchase them.

In the United States, GMO foods are tested by three **regulatory authorities**, the FDA (Food and Drug Administration), the USDA (United States Department of Agriculture), and the EPA (Environmental Protection Agency). However, it is not compulsory to label GMO foods explicitly when they are sold in the US. As figure 4.27 shows, regulations are tighter in some areas away from the US. In Europe, any food that contains more than 0.9% of GMOs must be labelled as such, and cultivation of GMO foods is banned in many European countries. More than 60 countries require food containing GMO products to be labelled. Seven countries specifically **ban** the cultivation and import of GMO foods; Algeria, Bhutan, Kyrgyzstan, Madagascar, Peru, Russia and Venezuela.

There is **no consensus** on the role GMO foods will have in boosting food output and improving food security. The companies that develop GMO foods promote their potential strongly, but agricultural experts in United Nations agencies doubt their effectiveness in increasing yields. GMO foods have several impacts, as described below:

#### Impacts on the environment

- **Superweeds:** Many GMO foods have been engineered to tolerate strong herbicides. The expansion of GMO cropping has therefore

allowed farmers to use herbicides in much stronger concentrations than previous years. There have been reports that use of the toxic herbicide glyphosate (commonly known as Roundup) has increased 16 fold since GMO crops were introduced. As a result of its extensive use, some weeds have developed glyphosate resistance, leading farmers to use still stronger herbicides.

- **Power over patents:** The development of GMOs is done by a small number large corporations that invariably also develop pesticides and herbicides. The small number and large size of these companies gives them considerable power to control their markets, such as by raising prices and placing patents that restrict the use of their GMOs. These patents place stringent requirements on farmers producing GMOs, and the licence fees that arise from the patents add to farmers' financial pressures. The licenses typically prohibit farmers from saving the seeds from harvested crops to plant the next season, requiring farmers to purchase new seeds every year. The licences also specify certain farming practices that must be followed, specify which sales markets may and may not be used, and allow the corporation to inspect farmers' fields periodically. Furthermore, the companies that develop GMOs can sue farmers who use GMO seeds without permission, even if it results from seeds blowing in from neighbouring farms.





4.29 Organic foods are threatened by cross-pollination by GMO crops if they are grown in close proximity.

### Impacts on farmers

- **Liability:** Farmers who unintentionally grow or harvest crops that have been cross-pollinated with GMO crops face costly lawsuits from GMO companies for 'seed piracy'. GMO farms are not required to provide a buffer zone to prevent cross-pollination, and where buffer zones have been established, they have not been effective anyway.
- **Contamination:** In the United States and elsewhere, food products that are certified as being 'organic' may not contain any component from a GMO. Farmers who produce organic foods must therefore be very careful that no GMO seeds or livestock feeds contaminate their production, because this would make their produce impossible to sell. Contamination can occur when animal feed is transported in trucks



4.30 Opposition to GMO foods is strong in some areas, as shown by the graffiti added to this road sign in Bend, Oregon, USA.

that have previously carried GMO products, or when GMO crops cross-pollinate with non-GMO crops. Two-thirds of organic farmers report that they have had to deal with GMO contamination.

### Hydroponic farming

**Hydroponics** is the process of growing plants **without soil**, usually in **nutrient-loaded water**. The water may be static, as in a tank or basin, or it may be in a continuous flow past the roots of the plant. A variation of hydroponics is **aeroponics**, where a plant's roots hang in the air while being continually saturated with fine droplets of nutrient-enhanced water. Both hydroponics and aeroponics have been used on a **small scale** to grow tomatoes, lettuces, bean sprouts, cucumbers and peppers.

The **benefit** of using hydroponics to grow food is that more food can be grown on **less land** when no soil is required. This makes hydroponics suitable for growing food in an **urban environment**, as yields can be as much as ten times higher than traditional open field farming. The water can be **recycled**, thus reducing pressure on scarce water supplies in drier areas, **pollution** from herbicides and pesticides can be contained, and producing food in urban locations has the potential to reduce **transportation costs** and the **environmental impacts** of shipping food over long distances.

The main **shortcoming** of hydroponic food production at this time is that the range of crops that can be grown hydroponically is quite **limited**, and does not include food staples such as wheat, rice and potatoes. Until there is a significant



4.31 Lettuces being grown hydroponically in the United Kingdom.



technological breakthrough, hydroponics only lends itself to small-scale production of a limited range of foods.

### Vertical farming

**Vertical farming** means growing food in **vertically stacked layers**, usually in urban areas. Although they are still a concept rather than a reality, vertical farms are expected to take the form of urban food production centres where food is grown inside **tall buildings** or **stacked shipping containers**. Vertical farms are designed to use **less land area** at ground level to produce food in a **humidity, temperature and gas-controlled environment** within an urban location that reduces the distance needed to **transport** the food to its destination market. Because the transport distance is less, food can be **fresher** when it is sold to consumers. If vertical farming were to expand, it may even allow rural farmlands to be **returned to nature**, restoring degraded natural ecosystems.

Commercial vertical farms are in their infancy, and very few have been built. Supporters of the concept argue that vertical farms could relieve the threat of **climate change** by allowing farmlands in rural areas to revert to their natural state. On the other hand, critics argue that this effect would be more than offset by the **additional power** needed for the artificial light, heating, humidity control and movement of plants needed in a vertical farm. Supporters of vertical farms argue that they will **save resources** and **reduce transport costs** by locating food production near its markets. Critics dismiss this argument, arguing that transport costs are a very **minor component** of the selling price of food in urban areas, and in any case, the amount of energy needed to operate vertical farm would **exceed** the energy used for transporting food from traditional farms to urban areas.

**Supporters** of vertical farming claim **15 benefits**:

- Vertical farms can produce food **all year round**, rather than seasonally, because the growing conditions can be manipulated. Supporters of vertical farming argue that this additional production (perhaps four to six crops per year) would offset the higher costs of production, thus making vertical farming a profitable proposition.



4.32 An artist's impression of a future vertical farm.

- Vertical farms protect crops from **harmful weather events** such as floods, droughts, strong winds and excessive heat.
- Vertical farms reduce losses of food due to **damage and waste** because the food is transported much shorter distances to market.
- Vertical farms will allow large tracts of rural farming land to **revert** to the natural landscape, restoring ecosystem functions and services.
- Vertical farms should also be **safer** for farmers, reducing risks inherent in less controlled, traditional farming environments such as tractor accidents, being bitten by venomous snakes, catching diseases such as malaria and schistosomiasis, or being poisoned by pesticides or herbicides.
- Vertical farms should eliminate the need for large-scale use of **pesticides and herbicides**.
- Vertical farms do not release **polluted runoff** such as saline water or water containing toxic pesticides and herbicides into streams.
- Vertical farms can safely and efficiently use the organic portion of human and agricultural waste to **produce energy** through methane generation, and at the same time significantly reduce populations of vermin such as rats and cockroaches.
- Methane that is produced in vertical farms can add energy back to the **electricity grid**.
- Vertical farms can use, recycle and purify **sewage**, producing a clean supply of drinking water,



breaking the transmission cycle of harmful bacteria and viruses found in human sewage.

- Vertical farms reduce the use of **fossil fuels** by eliminating farm machines and reducing the transport of crops to market.
- Vertical farms can make productive use of abandoned and unused **urban spaces**.
- Depending upon the level of mechanisation used in vertical farms, they may create new **employment** opportunities for people in urban areas.
- Vertical farms can provide a major new role for **agrochemical industries** as they design and produce safe, nutrient-defined diets for a wide variety of commercially viable plant species.
- Vertical farms should create an environment that encourages **sustainable urban life**, promoting a state of good health for all those who choose to live in cities.



**4.33** Sky Greens in Singapore was the world's first commercial vertical farm. The shelves are moved hydraulically, and support various types of cabbages and spinach.

**Critics** of vertical farms argue that the benefits claimed remain unproven, adding several additional criticisms:

- Vertical farms are less efficient than conventional farms as they **use energy inefficiently**. Vertical farm supporters advocate using renewable energy sources such as solar arrays and wind farms to convert the sun's energy into electric current. This current would feed lamps which in turn would convert a portion of the electrical energy into artificial sunlight to shine on plants so they can convert that light energy into food. Critics argue this is very inefficient, as there are

large losses of energy at each of the conversion points. The critics argue that it is far more energy-efficient to let the crop plants simply capture the sunlight directly in the fields, cost-free and emissions-free.

- The additional year-round production that vertical farms will produce would require extra inputs of **carbon dioxide** amounting to perhaps three to four times the concentration needed on traditional farms. In the same way that some greenhouses supply extra carbon dioxide to plants by burning fossil fuels, this has the potential to increase greenhouse gas production. Even if the extra carbon dioxide is produced using renewable energy, more carbon dioxide will be ventilated into the surrounding urban environment.
- Replacing traditional farms with vertical farms would **reduce efficiency** of food production because (a) transporting food from rural areas to urban areas uses less energy than producing food in urban areas in artificially controlled vertical environments, and (b) the world is not running short of farming land.
- Vertical farming does not lend itself to cultivation of **food staples**, but is largely restricted to small-scale, intensive foods such as strawberries, lettuces and tomatoes.
- Urban areas have high land values, especially in their central areas. The market mechanism allocates land according to its potential to make a profit, so the most valuable land in central areas tends to be offices while less valuable land is



**4.34** Modular shelves produced in China are designed to help establish vertical farms in small buildings. The shelves include piping for water and nutrient circulation.



used for residential housing. Food production is a comparatively low value-adding economic activity, so it is **unlikely to be viable** within the boundaries of an urban area. The high costs of building vertical farms are therefore unlikely to be retrieved by selling the food produced, suggesting that vertical farms will not be economically viable.

### In-vitro meat

**In-vitro meat**, which is also called **cultured meat**, **cell-cultured meat**, **synthetic meat** and **clean meat**, is meat that is produced **outside animals** using tissue engineering technology. In-vitro meat is produced without directly using an animal. The process involves taking starter cells painlessly from a living animal, such as a pig, fish, sheep, chicken or turkey, and placing the cells in a protein-rich liquid that allows them to grow and multiply independently of a living animal. The process does not involve any genetic manipulation, and the process of growing meat outside animals offers huge potential to satisfy the world's growing demand for meat.

The process of growing meat in a fluid outside an animal is a comparatively straightforward process when growing **unstructured** meat for processed products such as sausages, burger patties or nuggets. The process works less well for heavily **structured** meat such as steaks because these comprise muscle tissues with long, fine blood capillaries.

In-vitro meat production is still in its **experimental stage**, and it was only in 2013 that the world's first in-vitro burger was cooked and eaten at a news conference in London. However, advocates of in-vitro meat estimate that ten pork muscle cells could ultimately produce up to 50,000 tonnes of meat over a two month period. They hope that **expanding the sources** supplying meat will **lower its price**, making meat available to people from a more diverse range of economic backgrounds.

**Benefits** of in-vitro meat include:

- In-vitro meat offers the possibility of an **unlimited supply** of meat protein at low cost, especially if growth hormones are added to the protein fluid that hosts the growing cells.



**4.35** Ten-layer tissue culture flasks used for making a piece of hamburger at the University of Maastricht, Netherlands. Making one entire hamburger requires many more culture flasks than the number shown here.

- The nutrition of in-vitro meat can be **enhanced** by adding additional vitamins or omega-3 fatty acids.
- In-vitro meat should have fewer **bacteria** and **diseases** than conventional meat because it is raised in sterile, laboratory-like conditions, and it should be pesticide-free.
- In-vitro meat is said to be less damaging to the **environment** than conventional meat. Supporters of in-vitro meat estimate that for every hectare used to produce in-vitro meat, between 10 and 20 hectares of pastures can be released and converted back to its natural state. Furthermore, it produces only 4% of the greenhouse gas emissions of conventional livestock raising, as cattle breaking wind represent a major source of greenhouse gases.
- In-vitro meat production does not consume **grain** as livestock raising does, releasing the grain for human consumption.
- In-vitro meat stops the **cruel practices** that are used in many abattoirs to kill animals, thus enhancing animal welfare.
- In-vitro meat production centres could convert organic wastes into **methane biogas** which could in turn be used to generate electricity that would supply a small of the facility's energy needs.

**Shortcomings** of in-vitro meat include:

- At this stage, in-vitro meat remains **expensive** to produce as no economies of scale have been established. Current costs are about US\$1 million





4.36 Muscle tissue being grown in a nutrient-rich fluid culture at the University of Maastricht, Netherlands.

for a 250 gram piece of steak, but future predictions are that with large-scale commercial production, the beef patty for a hamburger could be produced for about US\$9.

- Some of the people who have tried in-vitro meat don't like its texture and say it seems **unnatural** or **artificial**. Critics describe it as 'frankenmeat'. In-vitro meat's lack of bones limits some of its culinary uses.
- Critics argue that the **industrial energy** needed to produce in-vitro meat is greater than the energy needed to produce pasture-fed livestock-based meat. As this industrial energy may be produced by burning fossil fuels, in-vitro meat may result in more greenhouse gases than conventional meat production.
- Unlike natural meat, in-vitro meat contains **no antibodies** or **immunity** to diseases, so it must be sterilised to avoid contamination by harmful microbes.
- In-vitro meat production takes the power over meat production away from farmers and places it in the hands of **large corporations** that can afford to build the production facilities.

There are several **ethical** and **religious** questions that remain unanswered regarding in-vitro meat, such as:

- should **vegetarians** consume in-vitro meat, as it does not involve any cruelty to animals?
- does in-vitro meat satisfy the requirements to be accepted as **kosher** meat (for Jewish people) or **halal** (for Muslims)?

## QUESTION BANK 4C

1. How do GMOs differ from HYVs?
2. Why are GMO foods controversial?
3. Figure 4.28 suggests that Europeans are more wary of GMOs than people in North and South America? Can you suggest reasons why this might be so?
4. On balance, do you think GMO foods provide more benefits or more shortcomings for consumers? Give reasons for your answer.
5. Outline the advantages and disadvantages of hydroponic farming.
6. Describe the concept of vertical farming.
7. In the description of vertical farming, there are 15 advantages and 5 shortcomings listed. Does that necessarily mean that the advantages outweigh the disadvantages? Explain fully.
8. What do you think is the most persuasive argument (a) in favour of vertical farming, and (b) against vertical farming. Justify your choices.
9. On balance, do you think vertical farming provides more benefits or more shortcomings (a) for the environment, (b) for consumers, and (c) for the economy? Give reasons for your answers.
10. What is in-vitro meat, and why is the concept attractive?
11. Rank the advantages of in-vitro meat from the most important to the least important, and then in a separate list, rank the disadvantages of in-vitro meat from the most important to the least important. Justify your top choice in each list.
12. On balance, do you think in-vitro meat provides more benefits or more shortcomings (a) for the environment, (b) for consumers, and (c) for the economy? Give reasons for your answer.

## Prevention and treatment of disease

### Prevention vs treatment

Most countries in the world emphasise **curative health care**. In other words, governments spend money on hospitals and medical facilities which are designed to cure illnesses rather than prevent them. **Curative health care — treatment** — can be expensive, requiring hospitals, doctors, medicines and facilities. The results can be impressive where enough resources are allocated, with heart





4.37 The ward of a typical hospital that emphasises curative health care. This hospital is in Pyongyang, North Korea.

transplants, surgery and other techniques saving many lives. However, the sums of money involved are beyond the resources of many of the world's countries if curative health care is to be adequate.

**Primary health care** is different to curative health care in that it combines **prevention** with cure. Many nations are coming to realise that it is better to prevent diseases where possible than to wait for people to get sick because:

- preventing disease is usually **cheaper** for the health system than curing disease;
- preventing disease reduces economic losses due to **absenteeism** from work compared with periods of hospitalisation;
- preventing disease **contains** infections, or confines them to a smaller area, rather than allowing the spread of **infections** through a community; and
- preventing disease is much **less traumatic** for the human body than many cures.

Keeping people well enables them to work productively, feel better and not be a drain on government spending by being in hospital.

**Screening** for diabetes, doing Pap smears to detect cervical cancer in women, using sputum cytology to detect tuberculosis and mass inoculations for diseases such as polio and Hepatitis B are cheap and could save millions of lives in developing countries. It is estimated that providing all the primary health care needed in the world would cost an extra \$50 billion per year for the next 20 years. This sounds like a large sum of money, but it is only a small percentage of what is spent on cigarettes



4.38 Basic rural health clinics like this on the Altiplano of Bolivia provide essential health care for many people in poorer countries.



4.39 The Prince Sultan Military Hospital in Riyadh, Saudi Arabia, is one of the most advanced medical facilities in the Middle East, with specialist services in cardiology, pathology, psychiatry, endoscopy, radiology, ophthalmology and otorhinolaryngology.

around the world in a year, or  $\frac{1}{24}$  what is spent annually on arms and the military.

In the 1960s, China introduced widespread primary health care. Thousands of **paramedics**, called barefoot doctors, were trained in the basics of medicine and sent to work in rural areas to care for farmers and their families. Similar systems have since been established in many countries, including Iran, Sudan, Jamaica, Botswana, Tanzania and Sri Lanka. These initiatives have been important tools to reduce the **social marginalisation** that is often experienced by poor people, especially those living in rural areas. Many low income countries have realised that it is impossible, and inappropriate, to copy overseas health care systems without questioning their basic assumptions and financial demands. It is usually better to develop a system of





**4.40** The Centro Sanitário de Dili is the main hospital providing health and medical care to the entire population of the nation of Timor-Leste. It is located in Dili, the nation's capital city.

health care which is affordable and suited to the specific needs of the country concerned.

In most countries, one of the greatest differences in the provision of health care occurs between urban and rural areas, reflecting **government priorities** in health expenditure. Large cities usually have hospitals that are well equipped, clean and efficient. However, people living in rural areas in many countries lack access to the equivalent standards of health care.

## CASE STUDY

### Medical care in Majiang, China

Enlightened medical planners and policy-makers are increasingly emphasising **prevention**, as opposed to **treatment**, of disease. One example of a region where a focus on prevention is transforming the lives of poor, isolated farmers is **Majiang** county in China's Guizhou's province.

Because of its **isolation** and **difficult physical environment**, Guizhou is one of China's poorest provinces. According to a local saying, Guizhou is the province of "The Three Noes" — there are no three days without rain, no three kilometres without a mountain, and no three coins in anyone's pocket.

Majiang is a rural county that has been designated by China's government as a '**poverty county**' of national significance. It is situated near the centre of Guizhou province, about one and a half hour's drive east from the provincial capital of Guiyang. Situated beside the Qingshui (Clearwater) River,



**4.41** A small medical clinic in the village of Chengzhong (Guizhou province, China). The clinic provides basic health care for the poor rural farming community that lives in the surrounding area.



**4.42** Typical mountainous scenery in Majiang county, Guizhou province, China.

Majiang County has an **area** of 1,200 km<sup>2</sup> and a mild, wet, sub-tropical **climate**.

The area is populated by many minority ethnic groups, with the **Miao** group being the most populous. Most of the county's 220,000 people live in small farming villages, although there are also nine designated townships in the county. The main **farming products** are rice, corn, and vegetables. The town of Xiase in the east of Majiang county is famous for its dogs; its guard dogs are specially trained to maximise their aggression, which is perhaps easy to understand given the fact that they also are part of the local diet (dog meat).

Majiang is an area with **significant medical needs**. Of the county's 129 villages, only six had clinics of an acceptable standard by 2007. The clinic shown in figure 4.46 was fairly typical of the rural clinics





4.43 The location of Majiang county, Guizhou province, China.



4.44 Miao women in Majiang county.



4.45 Typical farmland in Majiang county.





4.46 A medical clinic in Chengzhong village, Majiang county.

available at that time, with leaking roofs, bare earth floors, open cabinets used for storing medical supplies, cardboard lining on the walls to keep out the wind, and damp, unhygienic conditions. Many of the clinics were so **small** that there was no room even for a bed to handle intravenous drips, which are the most common way of treating many conditions in the Chinese rural health care system. Consequently, the majority of rural doctors performed most of their work as **house calls**, carrying a heavy medical kit box long distances through the rice fields by foot. It was quite common for doctors' house calls to require a walk of up to five kilometres, which could take about three hours in the difficult terrain of Majiang.

In 2004, **concern** with the **low standards** of health care and the desire to develop better preventative health care led the officials from the Majiang County Health Bureau to form a partnership with the **Amity Foundation**, an independent Christian voluntary NGO based in Nanjing, China.

This led to the launch of a program by the Amity Foundation's Hong Kong bureau to raise the funds to **build 100 new medical clinics** in Majiang County. The aim was to provide well-built and well-equipped clinics built in highly accessible locations with sturdy concrete block construction that would be equipped with running water, electricity, a street-fronted medicine dispensary, several consultation rooms and a welcoming waiting area. Being a partnership, the government agreed to match the funds raised, and by 2012, all 100 rural clinics had been completed, with approximately equal funding being contributed by the government and the Amity Foundation.



4.47 A doctor makes an open-air house call near Gonghe village, Majiang county.



4.48 Some house calls are made inside patients' houses, as in this farmer's home in Gonghe village, Majiang county.



4.49 A doctor greets local people as he walks to make a house call to check on the health of some elderly residents in Miao Luo.

Significant geographical factors needed to be considered in **choosing locations** for the new clinics. According to Majiang County health officials, the **priorities** in deciding when and where



to build clinics are determined by factors such as (1) whether or not the existing clinic building was actually collapsing, (2) how far the village was from the county hospital, and (3) the density of the local population.

As part of the partnership between Majiang County and the Amity Foundation, Amity has begun a program to **upgrade the skills** of village health workers, providing professional development and ongoing training. Having seen the early improvements in health care that this training brought, the government followed Amity's lead and became involved in training village doctors.

Today, much of the doctors' work in Majiang county is **preventative**, such as checking babies' growth and elderly people's pulse and blood pressure. House calls are still made, but with better clinic buildings now in most small villages, more residents now make the trip to the clinic.

Many of the doctors are still poorly trained and are really **paramedics** rather than doctors, being equipped to handle only basic and routine medical issues. Many of the doctors are misinformed or lack basic medical knowledge. As an example, when asked by the author if he knew how AIDS is spread, one doctor in Majiang blushed heavily, and in a hesitating and embarrassed manner said "it depends on where you are sitting", adding that if you sit downwind of an AIDS-infected person you are more likely to become infected.

The rural doctors keep very **long hours**, working on a 24/7 basis. It is quite common that if patients come to the clinics at meal times, they join the doctor's family for lunch or dinner, as most rural doctors live in their clinics, sleeping on the beds at night that are used for intravenous drips during the day. The most **common problems** dealt with are arthritis, high blood pressure, hepatitis B, tuberculosis and gynaecological issues.

The doctors' monthly **incomes** vary, but typical figures are 400 Renminbi Yuan (US\$60) per month, comprising 120 RMB (US\$18) per month from the government, with the balance coming from profits made on medicines sold. All consultations for basic medical issues are free for the patients. Even so, many people in the villages cannot afford treatment (because of the cost of the medicine), so most of the rural clinics operate on an IOU system. Over the



**4.50** Selling medicines from the shop front that part of most new clinics in Majiang. Profits from the sale of medicines comprise a significant component of doctors' income. This clinic is in Gonghe village.



**4.51** A new medical clinic in Yang Qiao village.

course of a year, the IOUs can amount to about 5,000 RMB (US\$750), which is more than the doctor's annual income.

Another health-related issue facing medical policy-makers in Majiang is that like many rural areas of China, Majiang is **depopulating** as young men leave in search of work in the coastal cities of Guangzhou, Shenzhen and Xiamen. Most of the county's farming is subsistence cultivation, and thus the only way for the county's poorly educated population to make money is to send its young people to the coastal cities for work in construction and other labouring jobs. This has resulted in more and more women having to take on the farming work, and it also created fears that **AIDS** might spread when the men return.

An important aspect of preventative health care in rural areas is improving **hygiene**. To this end,



Amity began an innovative project in Majiang to promote the use of environmentally sustainable **biogas** energy. Centred on a Han nationality village called Nabai, Amity installed a total of 52 underground tanks in which a mixture of pig manure and human excrement is fermented to produce biogas, which is used to fuel small **gas stoves** and **household lights**. Although the tanks need cleaning out every two years or so, the sludge is a very useful fertiliser for the fields. Local officials have noted how the biogas project seems to have resulted in a much cleaner and tidier town than many of the others in the county, and Nabai seems likely to become a model for other villages to emulate.



**4.52** An elderly resident of Nabai stands beside her biogas-fuelled cooker. Biogas cookers promote preventative health because they do not produce the smoke that is common with the wood-burning stoves they replace, smoke that fills the rooms of the house and cause lung problems.

As a result of the improvement in Majiang's standards of preventative health care since the partnership between the county government and the Amity Foundation was established, Majiang now fulfils 95% of the government's health vaccination targets, which helps to explain why the county has experienced no serious epidemics since the partnership began. As a result of a vigorous **public health education** campaign, the percentage of pregnant woman delivering their babies in hospitals rose from just 2% in 2002 to over 80% by 2007.

Within China, Guizhou appears in the middle of provincial rankings of **AIDS**, but within Guizhou, Majiang has the lowest incidence of HIV / AIDS among all counties — no cases whatsoever. To some extent, this can be explained by Majiang's

high proportion of ethnic minorities, who tend to have more conservative attitudes towards sex than other groups. However, because of the fears of a possible epidemic when the county's migrant workers return, a large-scale preventative anti-AIDS campaign is underway throughout the county, even in the smallest and remote rural clinics.



**4.53** Anti-AIDS posters are prominently displayed in this old medical clinic in Xuetou village, Majiang county. The grey powder on the floor is ash from the open fire that the doctor burns in winter to keep warm.

Majiang is an example of how careful planning and adequate funding of preventative health care can bring huge improvements in medical standards very quickly. Nonetheless, many challenges remain in Majiang. Because of the **conservative attitudes** of the county's population, women refuse to be treated by male doctors for gynaecological problems, and even for routine pregnancy checks. This means that most young doctors entering the rural clinics tend to be female, although there are also some husband-and-wife teams.

## QUESTION BANK 4D

1. State the location of Majiang County, and describe its geography.
2. List the ways in which Majiang County and the Amity Foundation have co-operated to promote preventative health care in Majiang County.
3. Describe the geographical factors that influence the location of new medical clinics in Majiang.
4. How successful do you think the promotion of preventative health care in Majiang has been? In your answer, consider (a) social marginalisation issues, (b) government priorities, (c) impact on infections and (d) scientific interventions.



## Managing pandemics

A **pandemic** occurs when there is an outbreak of a serious infectious disease that spreads internationally, crossing national borders to cover a large region, or even the whole world to affect a large number of people. Milder diseases that recur regularly (such as seasonal flu) are called **endemic diseases**, and these are not regarded as pandemics.

Over the past 300 years, ten influenza pandemics have occurred. The influenza epidemic of 1918-1919 killed between 50 and 100 million people globally. With today's larger population sizes, higher urban population densities and increased global mobility, the risk of widespread deaths in the event of a pandemic are amplified, as we have seen during the COVID-19 pandemic that spread globally in 2020.

Pandemics can involve a **range of diseases** besides influenza. Over time, pandemics have also included the spread of typhoid, smallpox, tuberculosis, bubonic plague, cholera, typhoid fever, measles, yellow fever, SARS, HIV/AIDS, zika virus and ebola fever.

Medical researchers believe that pandemics are **inevitable**, and that **human intervention** can only attempt to **manage** or **control their spread** and **reduce** the number of **deaths**. The reason that pandemics are inevitable is that new viruses are constantly emerging. Viruses undergo continual evolution through two processes, antigenic drift and antigenic shift. **Antigenic drift** is the gradual change that occurs to a virus over time, and it is responsible for new types of seasonal influenza that emerge almost annually. **Antigenic shift** occurs when two virus strains combine and infect the same cell, creating an entirely new strain. Antigenic shift can occur in three ways:

- A virus is **transferred** from a bird or animal to humans, as seems to have occurred during an outbreak of SARS (Severe Acute Respiratory Syndrome) in southern China. The SARS virus was transmitted from either civets or bats to humans in rural China, and within 24 hours it had spread five countries. After several months, SARS had caused to a pandemic that infected more than 8,000 people, killing 774 people in 37 countries.

- **Genetic sorting** occurs when two different viruses simultaneously infect one host cell. When the two viruses meet, segments from each virus mix, leading to the emergence of a third viral strain.
- A virus may remain **dormant** for a long time and re-emerge as a pandemic when the immunity of a population has waned. This occurred with an outbreak of Russian Flu in 1977 that was genetically identical to the H1N1 virus that had caused a major epidemic in 1950.

Some parts of the world are more vulnerable to the risk of pandemics than others. There are three components to the risk of pandemics:

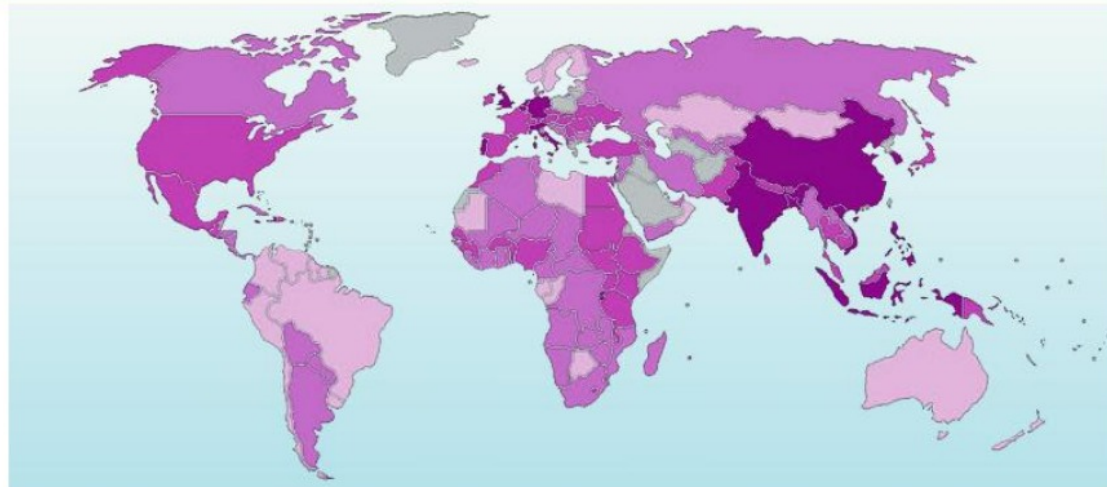


**4.54** Preventing pandemics requires quick action when problems emerge. This sign in Accra, Ghana, encourages residents to seek early treatment if they show symptoms of tuberculosis in an effort to prevent pandemics.

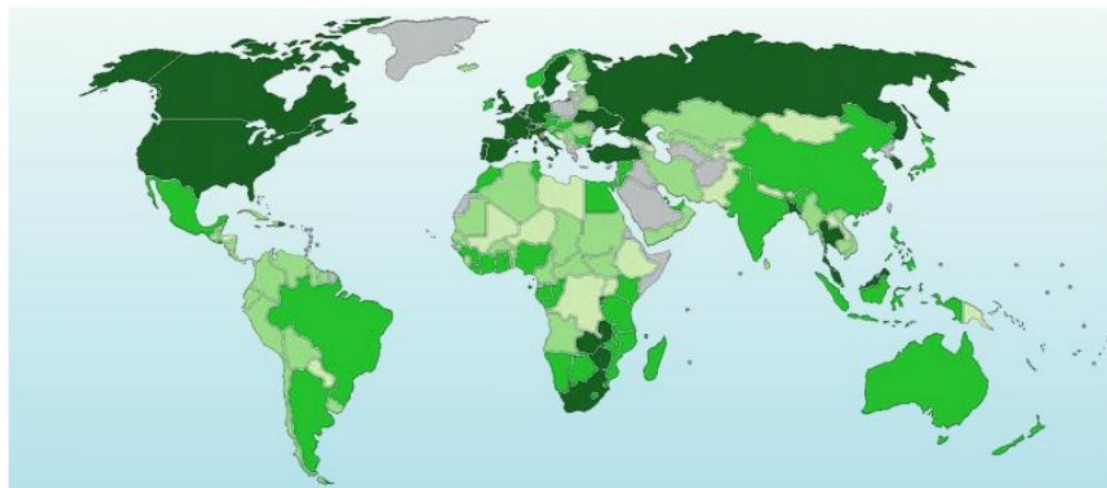


**4.55** Vaccinations are generally regarded as an important component of containing the spread of disease. This sign in the town of Malanville, on the Benin side of the border with Niger, encourages parents to vaccinate their children against poliomyelitis, tuberculosis, diphtheria, whooping cough, tetanus, and measles.

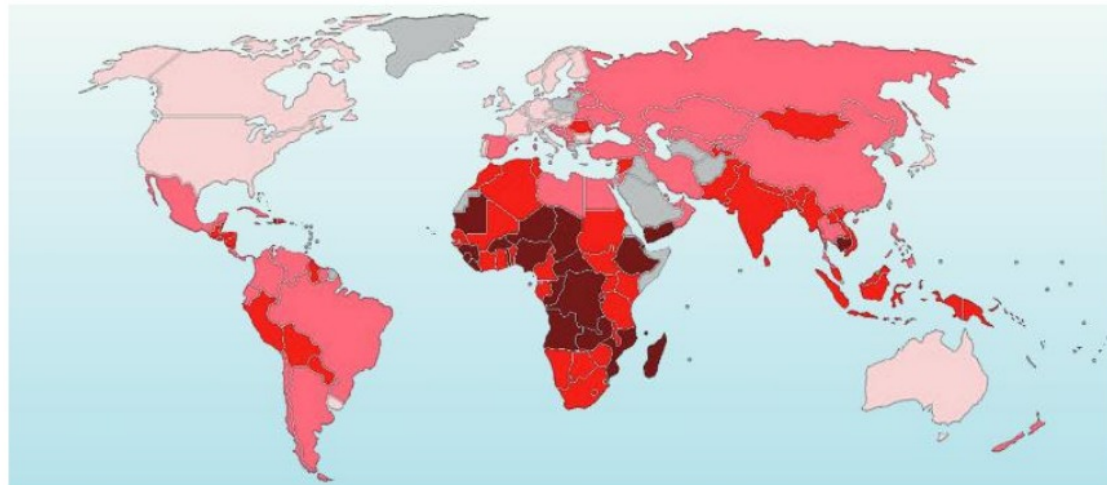




**4.56** The risk of emergence of a new disease in each country of the world. Darker shades of purple indicate higher degrees of risk. Countries in grey have insufficient data to assess the risk.



**4.57** The risk of spread of a disease to and within each country of the world. Darker shades of green indicate higher degrees of risk. Countries in grey have insufficient data to assess the risk.



**4.58** Capacity to contain outbreak of a disease in each country of the world. Darker shades of red indicate higher degrees of risk. Countries in grey have insufficient data to assess the risk.

The three components of pandemic risk are shown in figures 4.56 to 4.58. The risks are not confined to low-income or high-income countries. The **risk of emergence** is highest in countries with a high rural population density, where many people are in contact with livestock, where standards of hygiene are basic, where access to clean water and sanitation is limited, and where public health education is poor. The countries with the highest risk of emergence are Vietnam, China and Bangladesh.

The **risk of spread** is highest in countries with a high overall population density, with well-developed transport links (including busy airports), high rates of urbanisation, and where access to health care may be restricted for some parts of the population (usually poorer people). The United Kingdom has the world's highest risk of spread, closely followed by the Netherlands, Germany, Italy, Russia, Canada and Japan.

- the **risk of emergence** of a new disease in a country;
- the **risk of spread** of a disease to a country, and the risk of spread within the country;
- the **capacity to contain** a disease within the country.

The **capacity to contain** a disease outbreak is lowest in countries that are economically less developed, with poorly developed health care systems, poor transport infrastructure, low expenditure on education, poorly developed information and communication networks, and weak or corrupt governance. The





**4.59** Poor public sanitation raises the risk of emergence of disease in a country. This building shows the only improved public toilets in the town of Tiébélé, Burkina Faso.



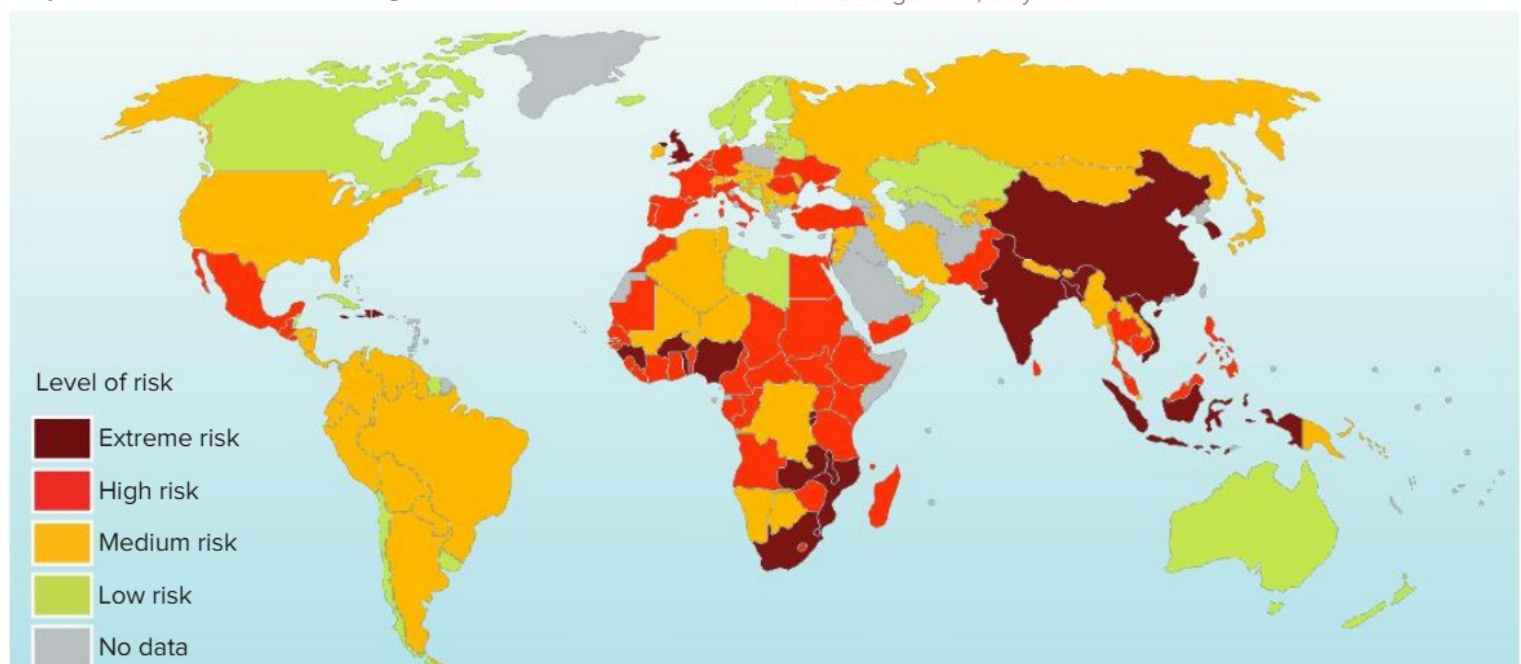
**4.61** Access to health care is an important factor in reducing the risk of spread of disease. Located on Betio atoll, this is the main hospital for the South Pacific nation of Kiribati.



**4.60** Public health education is a key factor in reducing the risk of emergence of disease. This sign in Bamako, Mali, urges parents to preserve their children's health by giving them oral rehydration solutions at the first signs of diarrhoea.



**4.62** The capacity to contain outbreaks of disease is enhanced when discrimination can be overcome, as this encourages people with symptoms of disease to seek treatment. This sign is in Georgetown, Guyana.



**4.63** The risk of a pandemic in each country of the world. Political factors, which can change very quickly, may affect the risk of pandemics in individual countries, as shown by the COVID-19 pandemic in the United States and Brazil in 2020.



risks of a pandemic due to poor capacity to contain a disease are highest in Sub-Saharan Africa, with 27 or the 30 highest-risk countries being located in that region.

When the three components of pandemic risk are combined, the overall risk of pandemic can be calculated, as shown in figure 4.63. This map shows that countries in East Asia, South-east Asia, South Asia, and significant parts of Africa and Western Europe are generally most at risk.

### CASE STUDY

#### The COVID-19 pandemic

### Overview of COVID-19

**COVID-19** is an infectious disease caused by a microscopically small crown-shaped (or corona-shaped) virus. It emerged suddenly in December 2019, quickly spreading in 2020 to cause the most severe global pandemic in over a century. The name of the disease is an abbreviation **CO** (corona) **VI** (virus) **D** (disease) that was identified in 2019, and the World Health Organisation (WHO) made this the official label in February 2020.

The virus that causes COVID-19 is related to another **coronavirus** – SARS – that caused an epidemic in Hong Kong and southern China in 2003. The 2003 SARS virus was officially known as SARS-CoV, so another name for the COVID-19 virus is **SARS-CoV2**. It is also referred to as the **novel coronavirus**, as the word novel means ‘new’ or ‘unusual’. The term novel coronavirus refers to the virus itself, while the term COVID-19 refers to the disease caused by it.

COVID-19 affects the people who catch it in different ways. The **most severe effects** are usually felt by the elderly, while children often have very mild or even no symptoms. It is thought that the age-related differences are due to changes in the body’s **immunity** system as it ages. This may also explain why people with compromised immunity or other health challenges such as obesity, diabetes, hypertension or smoking are more likely to suffer severe symptoms.

**Common symptoms** include difficulty in breathing, fever, tiredness, coughing and loss of the sense of smell and taste. In severe cases, these

symptoms can lead to pneumonia, heart failure and strokes, and even death.

The disease **spreads most effectively** when people are close to one another, especially indoors or in confined spaces. It spreads through the air in small droplets when people breathe, speak, sing, cough or sneeze. It also spreads when people touch surfaces where the virus has landed and then rub their eyes or mouth before washing their hands.

Once exposed to the coronavirus in sufficient quantity to cause COVID-19 (which varies from person to person), symptoms can emerge during the following 14 days, although in most cases, symptoms emerge within two to five days. One of the challenges of controlling COVID-19 is that an infected person may be contagious for several days before any symptoms are evident.



**4.64** Even though COVID-19 spreads through airborne droplets, medical officials in some countries initially discouraged the use of face masks, claiming they might actually increase the risk of infection because people might feel they were protected and therefore take fewer precautions. These medical officials emphasised instead the need for hand washing to slow the spread of the virus after touching contaminated surfaces. It later became clear that this message was an attempt to make sure panic buying didn’t exhaust the stocks of face masks that may be required by medical professionals working with infected patients. As the production of face masks increased, the advice shifted to encourage the wearing of face masks, which research had demonstrated was an effective way to reduce viral spread.

### The beginnings of COVID-19

Despite COVID-19’s recent origin, its beginnings are somewhat of a mystery. The WHO received reports on 31st December 2019 that an unusual, highly infectious pneumonia-like disease was spreading through **Wuhan**, a large city with 11



million people in central China. Efficient contact tracing by government authorities quickly found that two-thirds of the people originally infected by the novel coronavirus had either visited or worked at the **Huanan Seafood Wholesale Market** in the Jianghan district of Wuhan. Despite its name, the Huanan Seafood Wholesale Market sold much more than seafood; it was a wet market.

Chinese **wet markets** are places where fresh meat, fish, poultry, and sometimes exotic animals such as bats, pangolins, meerkats, tree bears, tortoises are sold, often while alive for freshness. They are often dank environments with poor sanitation and insufficient ventilation.



**4.65** Before it was demolished, the wet market in Wuhan where the spread of COVID-19 began looked similar to this wet market in another Chinese city.

Animals that are sold as delicacies are sometimes endangered species, having been captured in remote faraway forest locations and transported to the city wet market. When this happens, humans become exposed to hitherto unknown diseases that are carried by animals. **Zoonotic** (animal-to-human) transfer of these diseases can occur if humans are susceptible to the disease. The SARS-CoV-2 virus that causes COVID-19 is a zoonotic virus (or **zoonosis**) that is closely related to coronaviruses found in bats and, to a lesser extent, in pangolins.

The Huanan Seafood Wholesale Market covered an area of more than 50,000m<sup>2</sup> and had over 1,000 stalls, making it the largest wet market in central China. In response to the disease outbreak, the market was closed on 1st January 2020 and samples were taken to test for diseases and clean up the area. Although the test results concluded that the

market was almost certainly the venue of an early **superspreading event**, it was unlikely to have been the original source of the infection. That is because the novel coronavirus was found on surfaces in the market, but not in any animal tissues.

Nonetheless, government authorities acted decisively and announced the permanent closure and subsequent demolition of the market. On 22nd January 2020, the sale of all wild animal products was banned in Wuhan, and on 24th February 2020 the ban was extended to all of China in an effort to prevent the spread of zoonotic infections.

According to researchers at the Wuhan Institute of Virology, some unknown person (identified by the code name **Patient Zero**) became a superspreader at the Huanan Seafood Wholesale Market after having contracted the SARS-CoV-2 elsewhere. A **super-spreader** is an infected person (or any organism) that is so contagious that the individual infects far more people than most other infected people. Epidemiologists (people who study the spread of diseases) often speak about the “**80/20 rule**” where about 20% of infected people account for about 80% of infections, as an example of superspreading.

It is not known for sure where or how Patient Zero acquired the SARS-CoV-2 virus. Researchers have concluded that SARS-CoV-2 is a zoonotic disease, and was not genetically engineered by humans. Some US-based sources claim that the **Wuhan Institute of Virology** was conducting research into strains of coronavirus at the time of the outbreak.

The Institute is 14 kilometres from the wet market, and the suggestion is that one of the workers in the Institute may have become infected while conducting research and then travelled to the wet market. However, **no evidence** has emerged of any Institute staff being among the early cases of COVID-19, nor has any evidence surfaced to date of any deliberate or accidental leakages of viral material from the Institute. The US assertions remain unverified, and some commentators classify the claims as conspiracy theories.

The identity of Patient Zero, and thus the origin of COVID-19, remains a mystery.

### The spread of COVID-19

Within a month of its discovery in Wuhan, COVID-19 was **spreading globally**. As geograph-





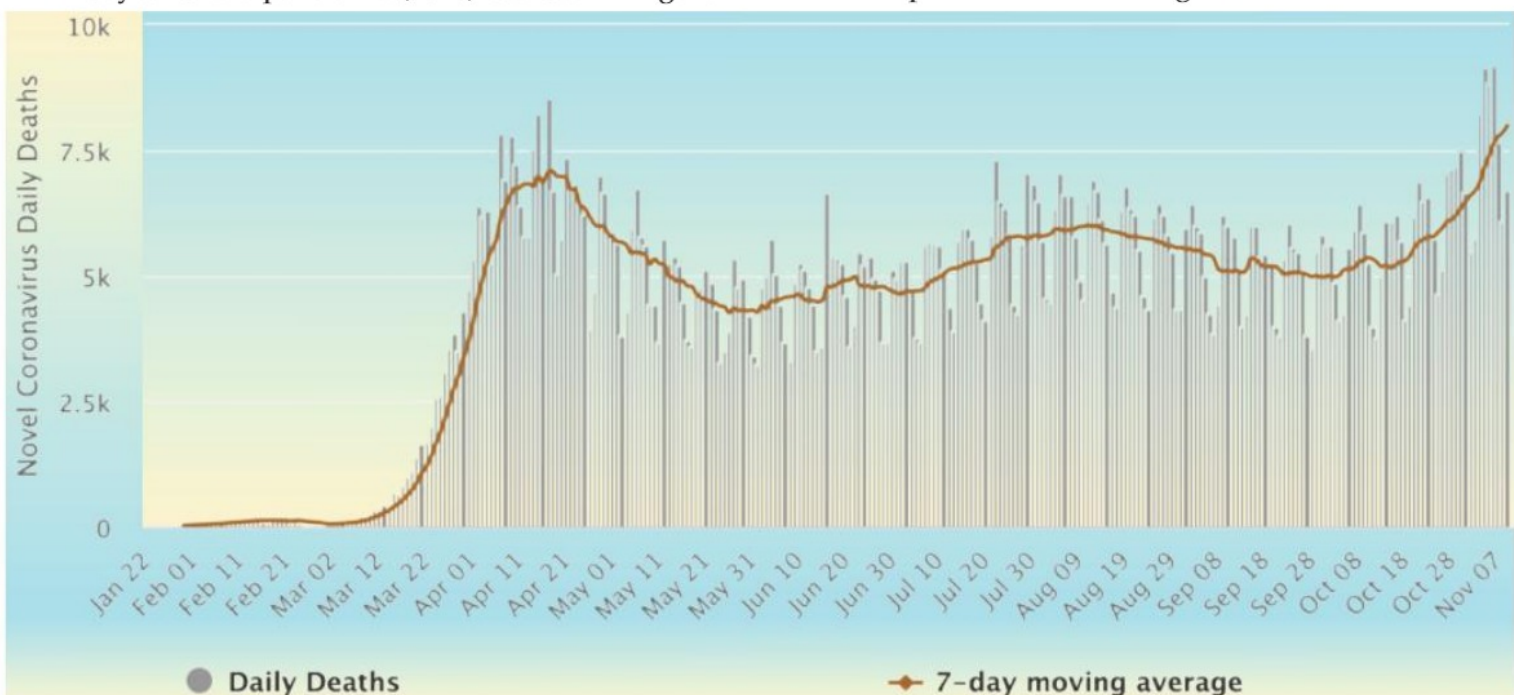
**4.66** Daily global new cases of COVID-19 in 2020. In order to smooth daily fluctuations that are caused by lower rates of testing on weekends, researchers often look at 7-day rolling averages. The graphs are based on official national statistics, which may be unreliable in some countries. Source: Johns Hopkins University and Worldometer ([www.worldometers.info/coronavirus](http://www.worldometers.info/coronavirus)).

ically dispersed countries such as Italy, South Korea, Iran and Japan began reporting significant numbers of cases, the WHO **declared** the spread to be a **pandemic** on 11th March 2020. By the end of March, the number of cases outside China exceeded the number of cases within China, and by October 2020 the pandemic had spread to more than 200 countries and territories.

The **daily number of new cases** globally during the first year of the pandemic (2020) is shown in figure

4.66. After an initial steep increase in the number of cases in March 2020 that peaked in mid-April, the rate of new infections declined through the northern hemisphere's summer as temperatures rose and people spent less time indoors. As temperatures fell as winter approached in the northern hemisphere, the number of infections rose again, reaching new record high numbers of cases.

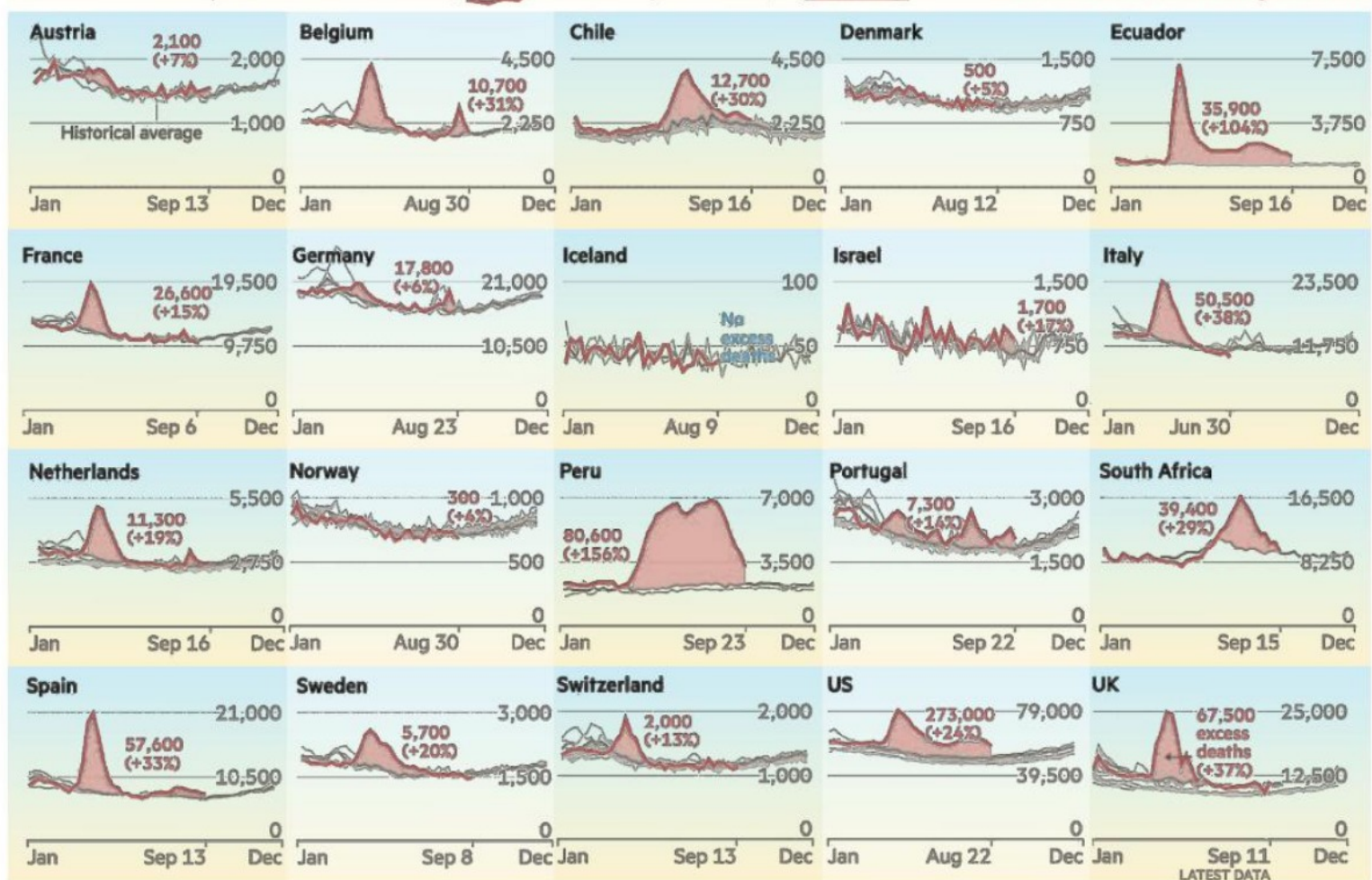
The **daily trend in deaths** due to COVID-19 during the same period is shown in figure 4.67. In the



**4.67** Daily global new deaths due primarily to COVID-19 in 2020. In order to smooth daily fluctuations that are caused by lower rates of testing on weekends, researchers often look at 7-day rolling averages. The graphs are based on official national statistics, which may be unreliable in some countries. Source: Johns Hopkins University and Worldometer ([www.worldometers.info/coronavirus](http://www.worldometers.info/coronavirus)).



Number of deaths per week from all causes, 2020 vs recent years: Shading indicates total excess deaths during outbreak



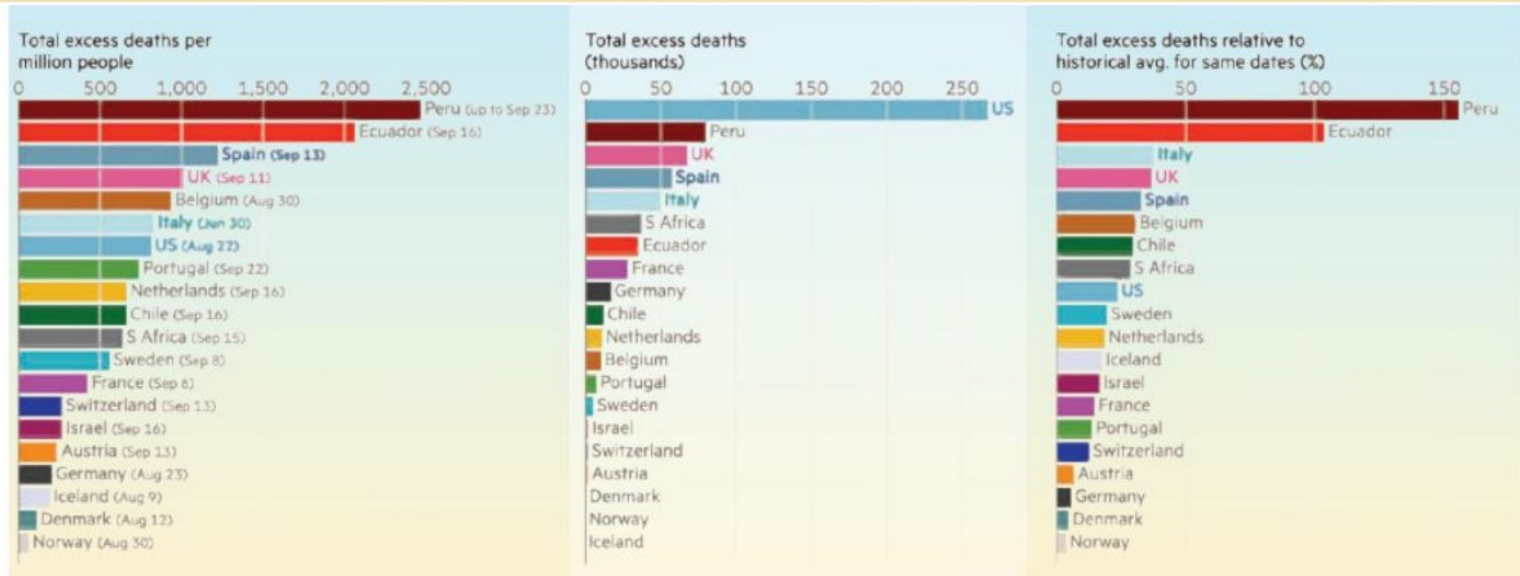
4.68 Deaths per week in selected countries in 2020 (red lines) compared with average death rates in recent years (dark grey lines show average death rates up to 2019, while light grey lines [where shown] indicate death rates for individual recent years). Red shading shows excess deaths in 2020 compared with average trends in recent years. Source: John Burn-Murdoch, Financial Times.

early phase of the pandemic in February 2020, the global death rate exceeded 25% of all cases, but this fell as the spread of the disease progressed. One reason for the drop was that many early cases were among **elderly people**, who were more prone to dying from COVID-19 than younger people. As the pandemic spread, larger numbers of **young people** began to catch the virus, and consequently the proportion of infected people who died from COVID-19 fell. This explains the flatter shape of the graph in figure 4.67 compared with figure 4.66.

The graphs shown in figures 4.66 and 4.67 are based on official national statistics supplied by the governments of each country. Although governments may at first appear to be sound sources for data, relying on official numbers has led to problems because different countries use **varying assumptions, methods and techniques** to gather their data.

In most countries, a case of infection is confirmed as being COVID-19 as a result of medical testing. In countries where **little testing** is done, rates of infection may appear artificially low. Furthermore, different **types of tests** are conducted in various parts of the world, with some tests being more reliable (but often more expensive) than others. Some countries count every death of a person who has COVID-19 in their COVID-19 statistics, even if the patient has co-morbidities (other contributing factors to the death) that may have been the primary cause of the death. On the other hand, other countries take the opposite approach, attributing deaths of people with COVID-19 to any co-morbidity that the person may have had at the time. Adding further to the confusion, several countries have **changed their assumptions** and procedures to record COVID-19 infections and deaths during the course of the pandemic. Statisticians at The Financial Times estimated that





**4.69** Excess deaths in selected countries from January to September, 2020, measured as the number of deaths in excess of historical averages for the same time of the year. Source: Financial Times analysis of official mortality data.

the real death toll due to COVID-19 in 2020 may have been about **60% higher** than the figures reported in official accounts.

Consequently, the official international statistics for COVID-19 infections should be regarded as **approximations** rather than precise figures. In an effort to overcome different countries' statistical assumptions, geographers have examined the excess mortality in countries affected by COVID-19 during the pandemic. **Excess mortality** is defined as the number of deaths that exceed the historical average number.

As figures 4.68 and 4.69 show, some countries had mortality rates in 2020 that were more than 50% higher than their historical average figures. Such **excess mortality rates** suggest that whatever causes of death were shown in various countries' official statistics, COVID-19 had a significant impact on their populations by increasing the numbers of deaths. Excess mortality rates were even higher in some **cities** that were particularly affected by COVID-19 such as Lima, Peru (+269%), Guayas, Ecuador (+171%), New York City, USA (+127%), Mexico City, Mexico (+118%), Madrid, Spain (+96%) and London, UK (+68%).

## The distribution of COVID-19

Pandemics spread geographically through contact between people who are travelling while infected. This process of **expansion diffusion** was explained in chapter 2 (pages 49 to 50, and 57). In past centuries, the movement of infected people was typically by foot, horseback or camel train.



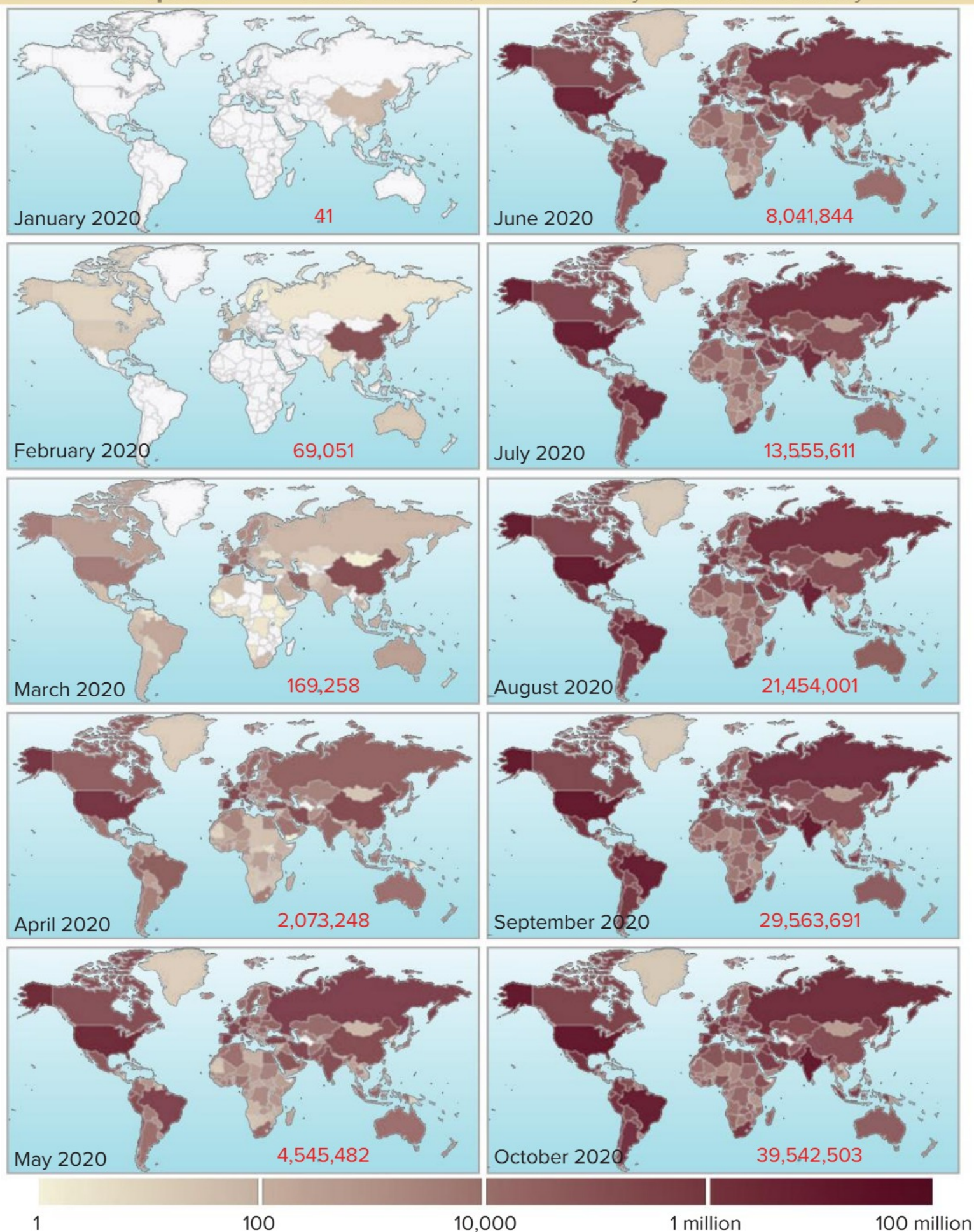
**4.70** Lima, Peru's capital city, became a COVID-19 hotspot early during the pandemic. From early April to late September 2020, Lima recorded 41,900 excess deaths, representing a 269% increase over its April-to-September historic average. Factors leading to Lima's high excess mortality included its high population density, the high rate of smoking, high obesity rates and inadequately funded hospitals and medical care.

The global spread of COVID-19 occurred much **faster and less evenly** than previous pandemics because many of the early carriers travelled by aircraft from Wuhan to cities in various parts of the world, including **intercontinental travel**. This explains the early outbreaks of COVID-19 in such dispersed countries as Italy, Thailand, Spain, Japan, Australia and the United States.

The subsequent movement of people by plane as well as cars and trains quickly spread the virus globally. The **spread of COVID-19** during the first ten months of transmission is shown in figure 4.71.

In the first month after the SARS-CoV-2 virus had been identified, the vast majority of COVID-19





**4.71** World distribution of the spread of COVID-19 cases, January to October 2020. Shading shows the total number of cases per country on the 15th day of each month. Figures in red show the official total numbers of COVID-19 cases world-wide at the time. Sources: Harvard Dataverse (2020) *China Data Lab Dataverse*.



cases (and therefore deaths) were in Asia, mainly in Wuhan and its surrounding area within Hubei province. Local authorities in Wuhan **acted swiftly and strongly** to stop the spread of the virus, placing Wuhan and its surrounds in a complete lockdown in which most shops were closed and people were confined to their residences. Consequently, there was **minimal spread** of the virus to other parts of China.

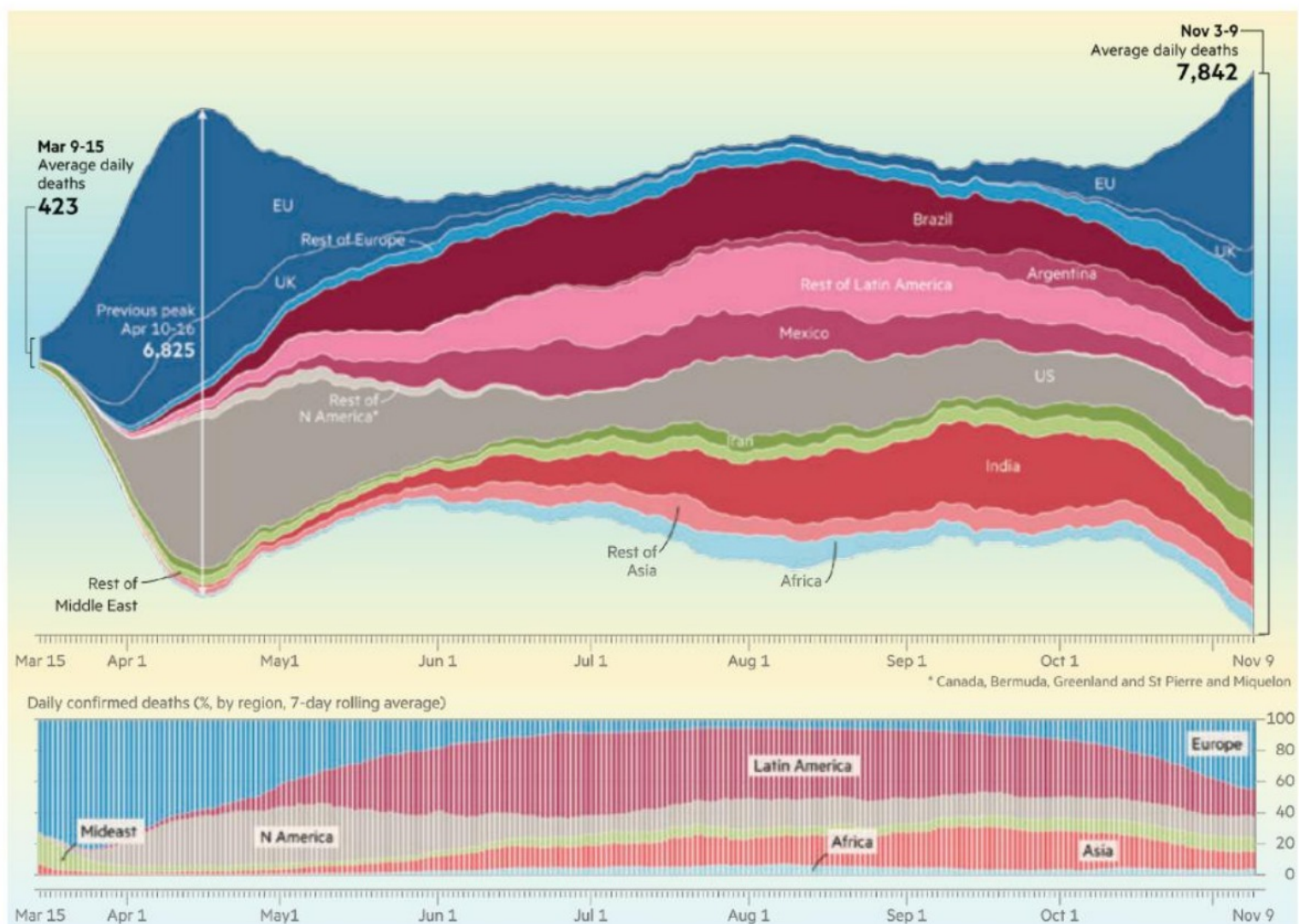
By late February, **Italy, Spain and Iran** had become hotspots for the virus as a result of the arrival of infected travellers from Wuhan, some of whom appeared to be superspreaders. The virus quickly spread across Europe as there were **no border controls** within the European Union at the time. By mid-March 2020, the vast majority of deaths due to COVID-19 were in **Europe** (figure 4.72).

Subsequent movement of people internationally soon brought COVID-19 to other parts of the world, resulting in a global spread. By May the **United**

**States** was reporting the largest number of deaths in any country due to COVID-19. By July, **Latin America** had become the main focus of deaths due to COVID-19, with the focus shifting in late 2020 back towards **Europe**, with the death toll rising sharply in France, Italy, Russia, Poland and the UK.

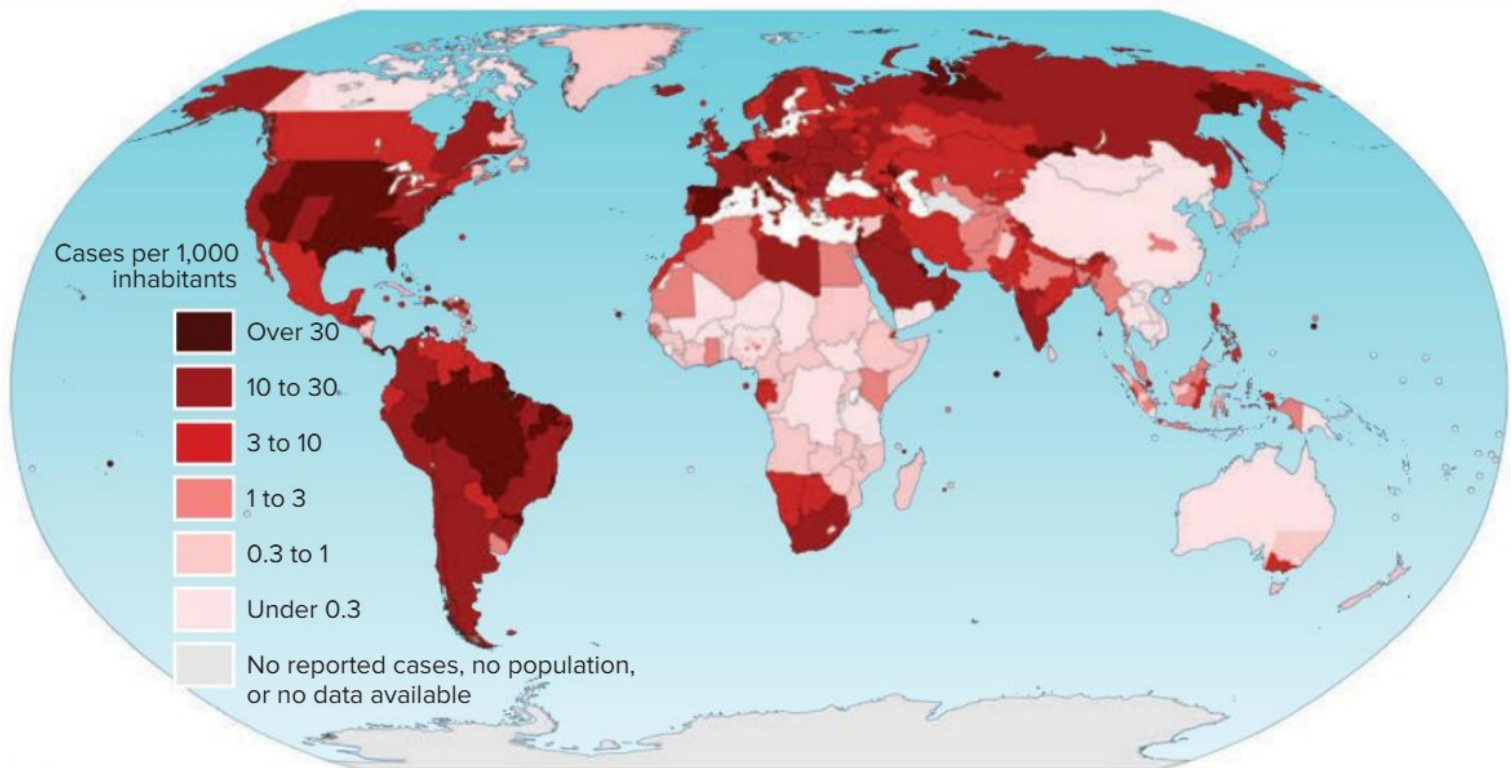
Simply looking at the **total numbers** of cases or deaths in different countries due to COVID-19 can be misleading. It is reasonable to expect that a country with a **large population** (such as China, the United States, India or Brazil) would have a **larger number of cases and deaths** than a country with fewer people (such as the Netherlands, Sweden, the United Arab Emirates or Armenia). Rather than looking at total numbers, therefore, it is more helpful to look at **per capita figures** if we wish to make international comparisons.

Figure 4.73 shows the world distribution of **COVID-19 cases per capita** in the tenth month of the spread of the virus outside China, while figure



**4.72** Daily deaths of patients diagnosed with COVID-19, March to October 2020, shown as raw numbers (top) and percentages (bottom). The statistics used in this graph are official government-supplied seven-day rolling averages. Source: Steven Bernard, Financial Times.



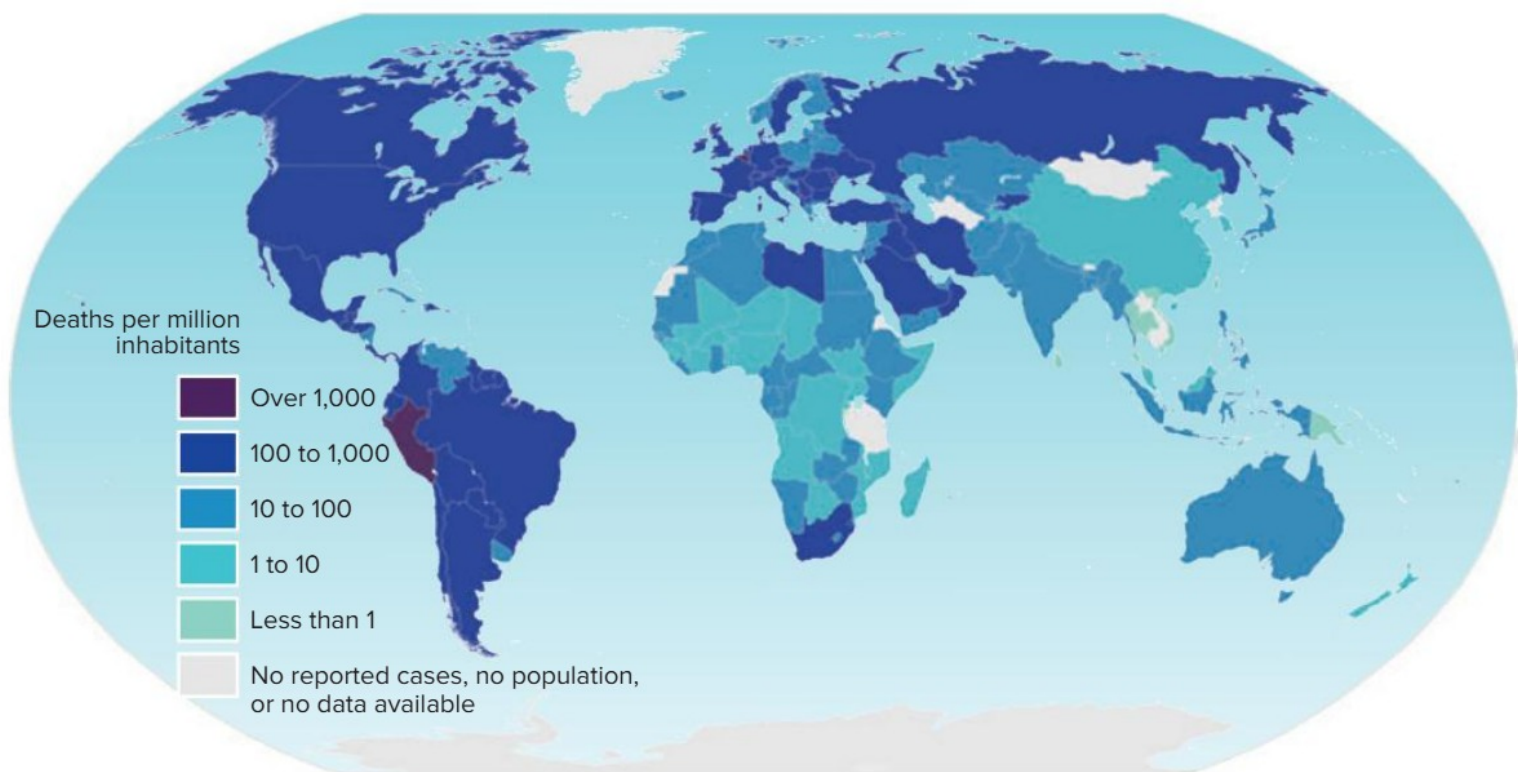


**4.73** World distribution of COVID-19 cases per capita, November 2020. The distribution shown is based on official government statistics issued by local authorities. Countries with populations exceeding 200 million people or having an area exceeding 3 million square kilometres have been split into first order administrative areas (provinces, states, etc) to show more precise distributions. Source: Raphaël Dunant.

4.74 shows the world distribution of COVID-19 **deaths per capita** at the same time. These maps suggest that the demographic impact of COVID-19 was heavier in North America, South America, Europe and the Middle East than in Asia, Africa or Australasia.

### Factors affecting the spread

The **reasons** that some countries and regions have been more affected by COVID-19 than others are only partially understood. Figure 4.63 showed the global variations in the overall risk of pandemics in



**4.74** World distribution of COVID-19 deaths per capita, November 2020. The distribution shown is based on official government statistics issued by local authorities. Source: Dan Polansky.



general. As the data in figure 4.63 would predict, several countries in the “high risk” and “extreme risk” categories have been **impacted severely** by COVID-19, examples being the United Kingdom, South Africa, France, Spain and India. On the other hand, many countries in the “high risk” and “extreme risk” categories such as China, Zimbabwe, Nigeria and South Korea experienced relatively **mild impact** from COVID-19.

Anomalies also occur in the opposite direction. **Unexpectedly severe impacts** were felt by several countries in the medium to low risk categories, examples being the United States, Brazil, Russia, Iran and Peru.

Researchers usually predict that the **severity of any pandemic** will tend to be greater in countries with high population densities, low economic development, poor health care, disorganised or corrupt governments and high mobility. The spread of the COVID-19 pandemic **challenges** several of these assumptions.

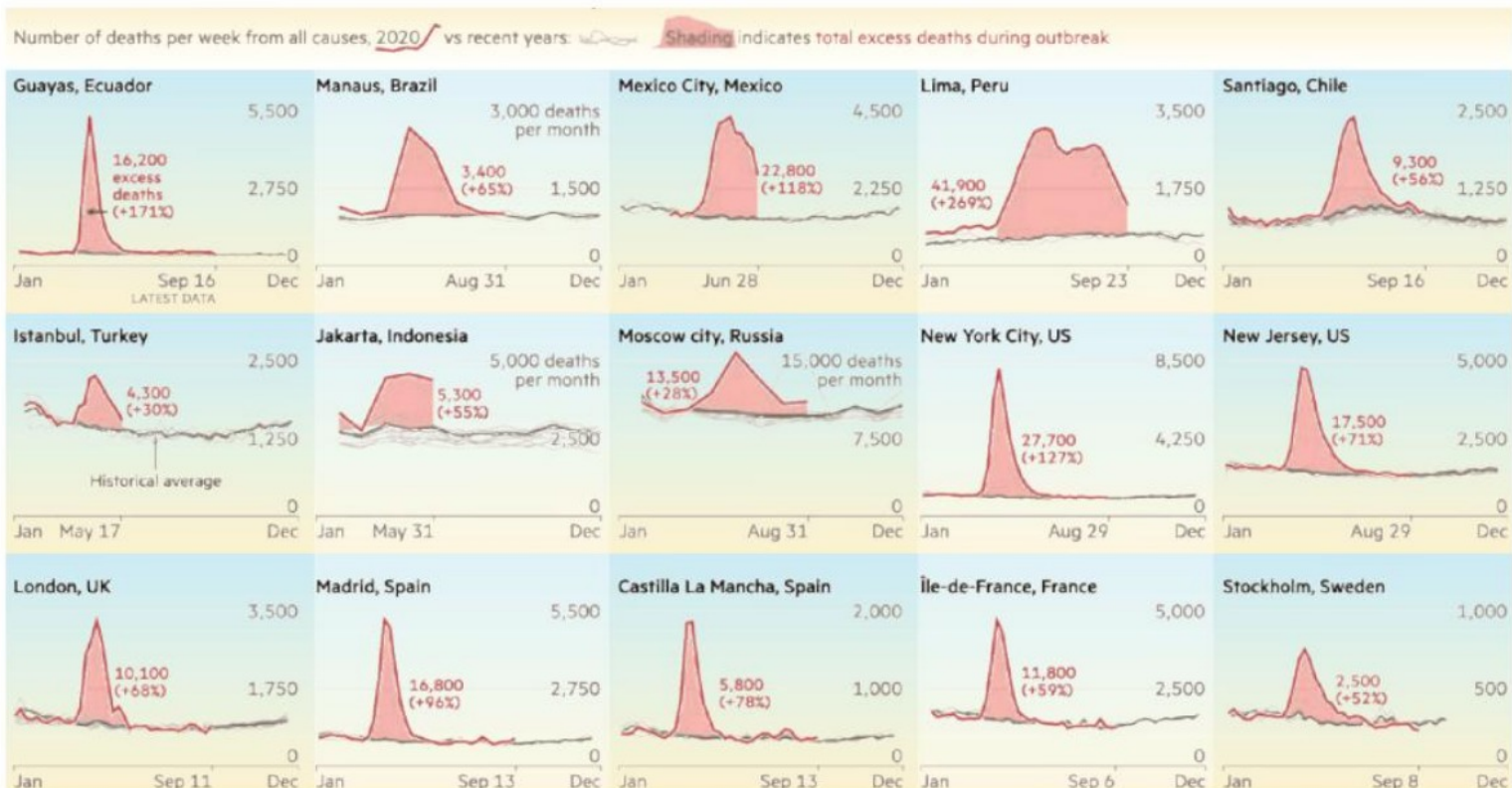
## Population Density

**High population densities**, especially in urban areas, aid the spread of contagious diseases. The main reason for the high positive correlation between population density and the spread of

disease is the difficulty of maintaining **sufficient personal space** to stay beyond the range of airborne droplets that are expelled when an infected person coughs, sneezes, speaks or sings.

COVID-19 spreads more quickly and more widely in **urban areas** than rural areas. This helps to explain why some cities in countries that were severely affected by COVID-19 showed very high excess mortality rates that were **greater than the national averages** for those countries (figure 4.75). Even countries that were more successful in controlling the spread of COVID-19 during the pandemic such as Australia experienced the majority of their cases in large cities such as Melbourne and Sydney rather than in smaller urban centres and rural areas.

Nonetheless, population density does not fully explain the world-wide distribution of the virus. While some countries with high population densities such as the Netherlands, India and the United Kingdom were severely affected, others such as Bangladesh, Japan and South Korea were not. Although some countries with low population densities such as Australia, Niger and Mongolia were not severely affected, others such as the United States, Brazil and Russia were affected quite severely.



**4.75** Deaths per week from all causes in selected cities in 2020 (red lines) compared with average death rates in recent years (dark grey lines show average death rates up to 2019, while light grey lines [where shown] indicate death rates for individual recent years). Red shading shows excess deaths in 2020 compared with average trends in recent years. Source: John Burn-Murdoch, Financial Times.



## Economic Development

Countries with lower levels of **economic development** are generally more prone to pandemics because of the poorer quality of health care provided to the bulk of the population. As shown in figure 4.63, the **greatest general risk** of pandemics occurs in parts of Africa and Asia where economic development lags, especially in countries that also have high population densities.

The spread of COVID-19 **did not reflect** this 'expected' pattern. Although COVID-19 first occurred in **China**, swift government action contained the spread and therefore had COVID-19 infection and death rates that were below the world average. Even though **Africa** contains many of the world's poorest countries, the spread of COVID-19 there has been minimal compared with other parts of the world. This trend was contrary to the predictions of many health experts in early 2020 who forecast widespread infections and deaths when COVID-19 reached Africa because of the poor quality of health care, under-resourced facilities and inadequately trained staff in many hospitals.

On the other hand, comparatively wealthy parts of the world including **North America, Europe, the Middle East and Latin America** suffered high rates of infection and high death rates from COVID-19. In general, levels of economic development were a **poor predictor** of the impact of the COVID-19 pandemic.

## Mobility

In January 2020, the SARS-CoV-2 virus spread internationally from China to Europe and the Middle East when a small number of infected people travelled on **flights** from Wuhan. These first people who spread the virus internationally did so unknowingly as they were asymptomatic (had no symptoms) at the time. They were certainly unaware of the existence of COVID-19, which was not identified by the WHO until February 2020. It is thought that just a few of these travellers were superspreaders.

Once it had been introduced into countries such as Italy and Iran, the disease spread rapidly as people travelled (mainly by **car, bus or train**) to nearby towns and cities, and further afield to other regions. COVID-19 spread quickly from Italy to Spain,



**4.76** Health checks were introduced at Milan Airport, Italy, in early 2020 in an attempt to slow the spread of COVID-19.

France, Germany and the United Kingdom, as well as other parts of Europe, because of the **lack of travel restrictions** at the time across much of Europe.

Throughout world history, **personal mobility** had never been as free, as fast or as affordable as it was in early 2020, both internationally and nationally within all but a very few countries. The **ease of movement** for tourists, business personnel, traders and others for reasons such as family events provided unprecedented potential for the **rapid spread** of a pandemic.

The world distribution of COVID-19 cases indicates the impact of **high mobility rates**. Many of the countries that experienced early high numbers of COVID-19 cases per capita also had relatively **open borders** with high numbers of arrivals and departures by air.

On the other hand, countries that were more closed, such as North Korea, Mongolia and Laos had very few cases despite their proximity to the original source of the virus in China. The low rate of COVID-19 spread in Africa can be partially explained by the relatively small number of international flights in that continent, while the small spread of COVID-19 in Australia and New Zealand is partly due to the early closure of international borders in those countries.

## Government policies and reactions

Governments across the world reacted quite differently to the COVID-19 pandemic. In general, COVID-19 was **controlled most effectively** in countries that **imposed strict measures swiftly**.



As the first country to experience COVID-19, **China** quickly adopted **strict policies** to control the spread of SARS-CoV-2. These policies included a strict lockdown in Wuhan, confining residents to their homes for several weeks, closing many shops and factories, and limiting travel between cities and provinces. As a consequence of these strict policies, China controlled the spread more effectively than most other countries. By mid-2020, many aspects of life had returned to the freedoms of pre-COVID-19 across most parts of China.

Although less strict than the measures imposed in China, **Australia** and **New Zealand** also imposed strict containment measures. In addition to closing international borders to all but a small number of arrivals who then had to go into two weeks' quarantine, most Australian states closed their borders to interstate travel. Depending upon the local spread of the virus, lockdowns and travel restrictions with mandatory wearing of face masks were imposed, effectively suppressing widespread movement of the virus. Furthermore, a generous wage-support scheme introduced by the Australian government with bi-partisan support subsidised many businesses to continue operating at a vastly reduced scale through the period when normal commercial pressures would have forced closure. This measure protected the economy from the damage felt in many other parts of the world when businesses were forced to close in order to slow the spread of the virus.

By contrast, many national governments in **South America** and **Europe**, as well as state authorities in the **United States**, either lacked the political will or the authority to impose such strict measures. In many cases, these governments allowed flights and other forms of transport to continue without even requiring the wearing of face masks. In those areas, control measures were generally imposed less severely and later than in most parts of Asia or Australasia.

Nonetheless, the United States eventually took large-scale action in areas such as developing vaccines, securing ventilator machines to assist breathing in severely affected patients, and providing additional temporary hospital facilities. On the other hand, a reluctance to restrict travel or interfere with personal liberties resulted in the United States having the largest number of



**4.77** Actions by governments played a significant role in controlling rates of spread of COVID-19 in many countries.

COVID-19 cases for much of 2020, with the number of new daily cases in the US rising to more than 100,000 in late 2020.

### Underlying fitness and health

It is known that COVID-19 spreads more easily and has more severe impact on **the elderly** and on people with other **medical conditions** such as obesity, cancer, asthma and other lung conditions, weakened immune system, hypertension and high blood pressure, diabetes and heart conditions.

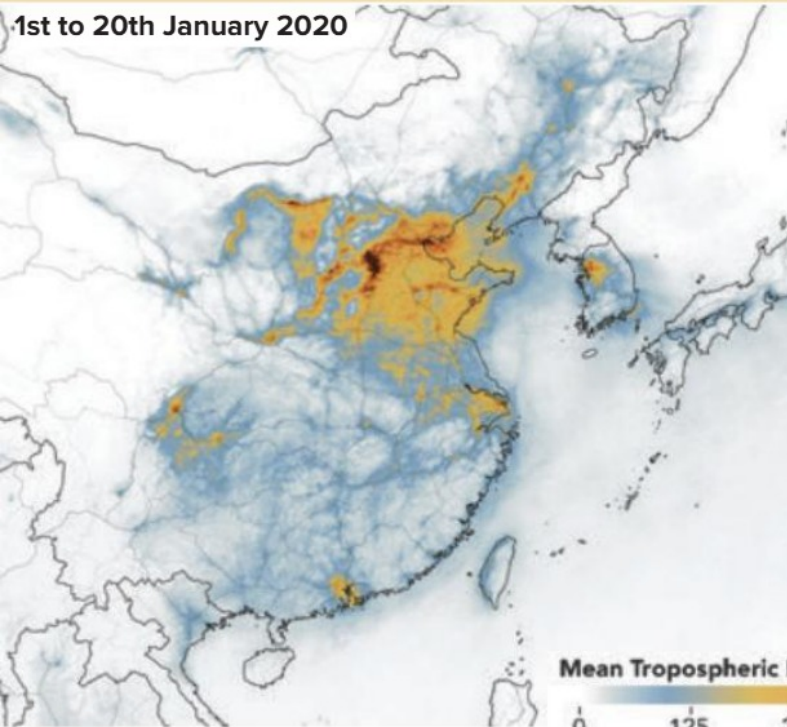
Many of the countries that experienced high death rates in the early phase of the COVID-19 pandemic such as Italy, Spain, France and Japan had high proportions of elderly people and high proportions of smokers. Subsequent spread of COVID-19 has been greater in countries where several of these conditions (sometimes referred to as **comorbidities**) are found. As many of these conditions are concentrated in wealthier countries, health factors explain why higher rates of COVID-19 were found in Europe, North America and South America than in Africa or many parts of Asia during 2020.

### The impact of COVID-19 and responses to the pandemic

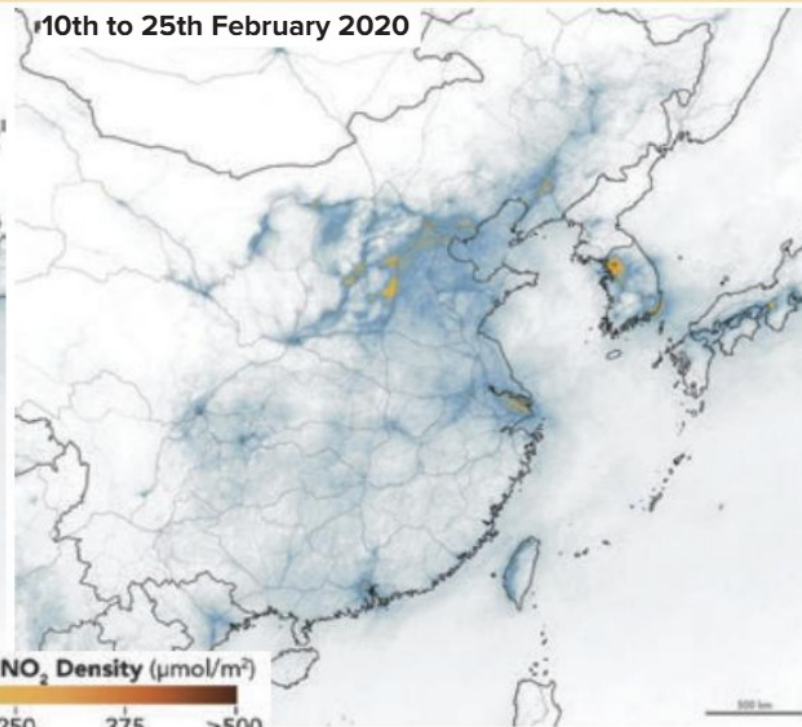
The most obvious impact of COVID-19 has been the impact on people's **health**. The worldwide number of cases reached 50 million in early November 2020, leading to about 1.3 million deaths plus many more cases of ongoing long-term health problems such as damage to the heart (heart attacks), brain (strokes) or lungs (pneumonia). The full range of side-effects of COVID-19 on health are still being researched.



1st to 20th January 2020



10th to 25th February 2020



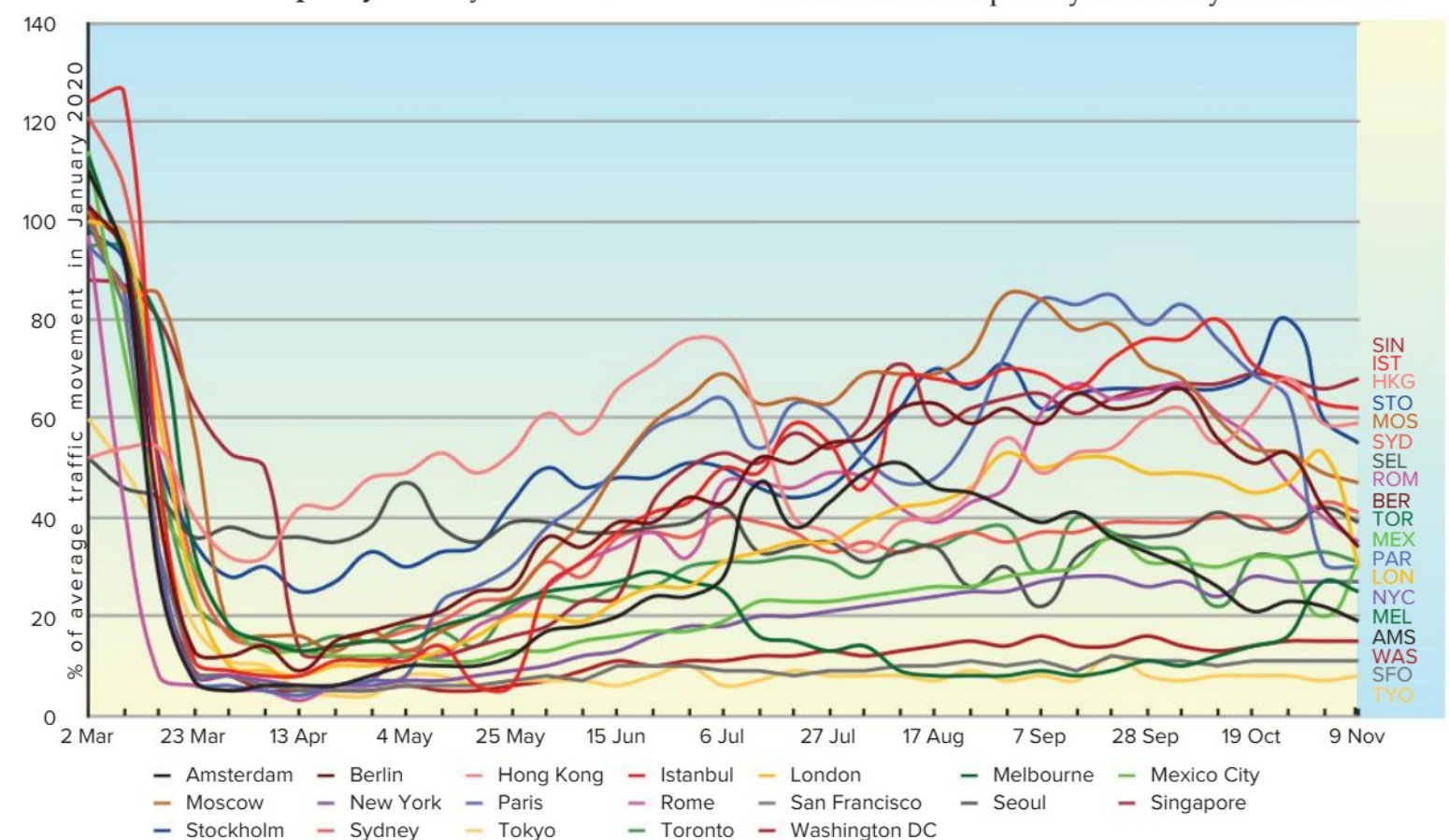
Mean Tropospheric NO<sub>2</sub> Density (μmol/m<sup>2</sup>)

0 125 250 375 ≥500

**4.78** Satellite images showed significant decreases in air pollution over China as factories and transport were shut down as an early response to the outbreak of COVID-19. Source: NASA.

As governments reacted to the health risks by imposing lockdowns and closing factories, schools and shops, there were immediate improvements in **environmental quality** in many countries,

especially lower rates of air pollution and clearer skies. Among widespread **economic recessions**, the travel, tourism, airline and cruise ship industries were especially affected by the economic



**4.79** Changes in traffic flow in selected cities on Mondays during the early phase of the COVID-19 pandemic, measured by the CMI (Citymapper Mobility Index). The CMI is calculated by comparing the number of trips measured per day as a percentage of typical travel, which is defined as the average traffic usage during the four weeks of 6th January to 2nd February, 2020. Statistics are calculated from data gathered by the Citymapper app, and includes trips taken by public transport, walking, cycling, taxis and some forms of micromobility. Source: Citymapper.com/CMI.





**4.80** Selected government responses to the COVID-19 pandemic in 2020, measured by the Oxford COVID-19 government response stringency index. The index is calculated by examining 17 variables in four categories:

**CONTAINMENT AND CLOSURE:** (1) school closing, (2) workplace closing, (3) cancel public events, (4) restrictions on gathering size, (5) close public transport, (6) stay at home requirements, (7) restrictions on internal movement, (8) restrictions on international travel.

**ECONOMIC RESPONSE:** (1) income support, (2) debt/contract relief for households, (3) fiscal measures, (4) giving international support.

**HEALTH SYSTEMS:** (1) public information campaign, (2) testing policy, (3) contact tracing, (4) emergency investment in healthcare, (5) investment in COVID-19 vaccines.

**MISCELLANEOUS:** (1) Other responses.

Source: Max Harlow, Caroline Nevitt and Aleksandra Wisniewska, Blavatnik School of Government, University of Oxford.

shutdowns, causing widespread bankruptcies and business closures. As air travel shut down because of the risks of carrying the virus internationally, the quality of **weather forecasts** in many countries deteriorated because the input received from pilots stopped abruptly.

The health and economic impacts of COVID-19 led to significant **social consequences**. In some countries, most people who remained employed suddenly had to shift to working from their homes, leading to a fall in **urban mobility** (figure 4.79) and a rapid rise in the demand for **internet services** such as video conferencing and online teaching. Significant numbers of people found that having to work from home led to **mental health issues** such as isolation, loneliness and anxiety that, in some more extreme cases, led to rising rates of suicide.

Figure 4.80 shows the 17 main **responses** to the COVID-19 pandemic adopted by government authorities, together with measures of the severity with which these measures were implemented in several countries.

## QUESTION BANK 4E

1. What is meant by the term 'pandemic'?

2. Why do health experts say that pandemics are inevitable?

3. Explain the difference between antigenic drift and antigenic shift. Which is the cause of pandemics?

4. Describe and account for the broad world pattern shown in each of figures 4.56, 4.57 and 4.58.

5. Suggest reasons why the countries shown as 'extreme risk' in figure 4.63 have such a high risk of pandemic.

6. Suggest reasons why the countries shown as 'low risk' in figure 4.63 should be relatively well protected from the risk of a pandemic.

7. What are the characteristics of COVID-19 that make it so dangerous for humans?

8. How did COVID-19 begin, and how did it initially spread during the first six months of the 2020 pandemic?

9. Why is it difficult to know the precise number of cases and the number of deaths due to COVID-19 during the global pandemic that began in 2020?

10. Describe the spread of COVID-19 as shown in figures 24.71 and 24.73.

11. With reference to figures 4.72 and 4.74, which parts of the world had the highest concentrations of deaths due to COVID-19?

12. With reference to figures 4.73 and 4.74 and the discussion on pages 128 to 131, describe the factors that make people in some parts of the world more vulnerable to COVID-19 than others.

13. Outline the consequences of the COVID-19 pandemic in different parts of the world, classifying the impacts as (a) demographic, (b) social, and (c) economic.

14. With reference to figure 4.80, classify the 17 actions to halt the COVID-19 pandemic that were, in your opinion, (a) effective, and (b) ineffective? Explain your reasons with evidence from your research and your personal experiences.

15. Considering your answers to questions 12, 13 and 14, what lessons can be learned from the COVID-19 pandemic for the management of this and other pandemics in the future?





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