

## Unit 1 Biomes and food security

# Food security

Compared to most people around the world, Australians have very reliable access to a wide variety of different foods. High wages and a strong economy mean that many Australians can afford to buy and prepare the food they need and rarely worry about where their next meal is coming from.

Unlike people in Australia, these Somali women are waiting in line to receive food from an aid organisation in the capital city, Mogadishu. They are victims of a food shortage that affected 10 million people in African nations in 2011–2012. A widespread shortage of food is known as a famine. Famine can be caused by many factors including drought and war. Food experts are warning that famines are likely to become more severe and widespread as the Earth's climate changes and the human population continues to grow. Some argue that food security is the greatest single issue facing the world today.



## chapter 3

**Source 1** These people are victims of the famine in the Horn of Africa. Drought, conflict and restrictions on delivery of food aid caused the famine (one of the world's biggest humanitarian emergencies) in 2011–2012.

### 3A

What is food security?

- 1 Make a list of the different things you have eaten in the last 24 hours.
- 2 How different do you think your list would look compared with one of the women shown in Source 1?

### 3B

What are the main threats to food security?

- 1 Brainstorm some of the ways in which food security is threatened around the world, including in Australia.
- 2 Some areas of the world, such as the Horn of Africa, are more at risk of famine than other places. Why do you think this is the case?

### 3C

How can we improve food security?

- 1 What is being done in Somalia to improve the food security of people affected by famine?
- 2 The United Nations set the target of halving hunger by 2015. Do you think this was possible? Give some reasons for your answer.

## 3.1 Food security

**Food security** is a state where all people at all times have access to enough safe, nutritious food to sustain a healthy life. For a person, community or country to have a secure food supply they must have three things:

- food availability
- food accessibility
- knowledge and resources to use food appropriately.

People who do not have food security suffer from hunger and illnesses related to lack of food, such as malnutrition. About 870 million people around the world do not have food security – the majority of them live in developing countries.

### Food availability

Food availability means people have enough food of appropriate quality available on a consistent basis. This may include production, storage, distribution and exchange of foodstuffs, provided reliably and regularly. People whose food availability relies solely on the production of a single crop, for example, may find themselves at great risk of food insecurity if that crop fails.

Many countries have strategies in place, such as growing a variety of crops, to maximise their food availability and ensure food security. Management of fishing and fishing industries is also used by some communities to ensure a constant supply of fish is available to sustain them. Food availability alone, however, does not guarantee food security.

### Food accessibility

Food accessibility means physical and economic access to food. That is, there needs to be enough food available and it must be in reach of those who need it. Many food researchers believe that the world's farmers produce more than enough food to meet the needs of every person on Earth. However, the food is not distributed evenly. **Developed countries** have more food than they need and high levels of wastage, while many people in **developing countries** struggle to access enough food to meet their daily needs. The reasons for this uneven distribution are many and complex. They include social, political and economic factors, such as rising prices, trade agreements and quotas set up between countries.



**Source 1** In many coastal communities in Arnhem Land, the ocean provides food security. Local knowledge ensures the catch will be prepared in a safe and appropriate way.



**Source 2** Australia is a country that has a high level of food accessibility – many people enjoy good access to a wide variety of food.

### Knowledge and resources to use food appropriately

Appropriate use of food means using food safely and applying knowledge about nutrition, clean water and sanitation when preparing food.

What is appropriate use of food varies between different places and cultures. What is appropriate and usual to eat in one part of the world might be viewed as unusual somewhere else. In many Asian countries,

for example, insects and other invertebrates such as scorpions and spiders are regularly eaten as part of a balanced diet (see Source 3). Local cultural knowledge means these insects are prepared properly, making them safe to eat and nutritious. This is an example of appropriate use of food. Knowing how to use such foods appropriately could potentially stave off the incidence of food insecurity. In fact, the United Nations has identified insects as the 'forgotten food crop' as they could help alleviate food insecurity, particularly in developing countries.



**Source 3** Deep fried scorpions ready for sale at a Beijing street market.

### Check your learning 3.1

Remember and understand

- 1 What are the three factors that contribute to food security?
- 2 Describe and explain food security in Australia with reference to these three factors.

Apply and analyse

- 3 Where does most of your food come from? How would your answer differ if you lived in another country, for example, Vietnam? Explain the reasons for your answer.
- 4 Quentin, the boy in Source 1, shows that he has food availability and food accessibility. To have food security he now has to use the food appropriately

and prepare it ready for eating. Do you know how to prepare his food? Do you think that he does? What does this tell you about food security?

Evaluate and create

- 5 Find images of foods from around the world and display them on your classroom wall. Use your examples to explain why food preferences and food security differ between places and cultures.
- 6 It is estimated that about 870 million people suffer from hunger due to poor food security. Of the three factors that contribute to food security which do you believe is most important? Discuss your thoughts with a partner and then share your thoughts with the class.

# 3.2 Levels of food security in different places

People living in different parts of the world experience different levels of food security. People in developed countries including North America, Western Europe and Australia, for example, generally have very high levels of food security. Food is available, accessible and appropriate to a high proportion of the population in these places. At the other end of the scale, many people in developing countries, particularly throughout Asia and Sub-Saharan Africa, do not have food security.

## Forces impacting on food security

Poverty and food insecurity are closely linked. Individuals who suffer from poverty struggle to meet their basic daily food needs and spend a greater percentage of their income on food than those in wealthier countries. This makes them highly vulnerable to forces that change the availability and accessibility of food. If the price of food suddenly increases, for example, food which they could previously afford becomes unaffordable.

Other forces that can impact severely on those who do not have food security include natural disasters, such as drought or flood. Many people in poor areas rely



**Source 2** One of the most food-secure nations in the world is the United States, where the majority of people have access to a reliable, safe and nutritious food supply.

on local agriculture for food, so food sources can be left damaged or destroyed following natural disasters. Human activities can also affect food security in many places. Armed conflicts may interrupt usual markets and food supply lines, or land used for growing crops may be repurposed for other uses, which results in local food supplies being affected. Those without food security are much more vulnerable to change that is caused by outside forces.

## Global patterns of food security

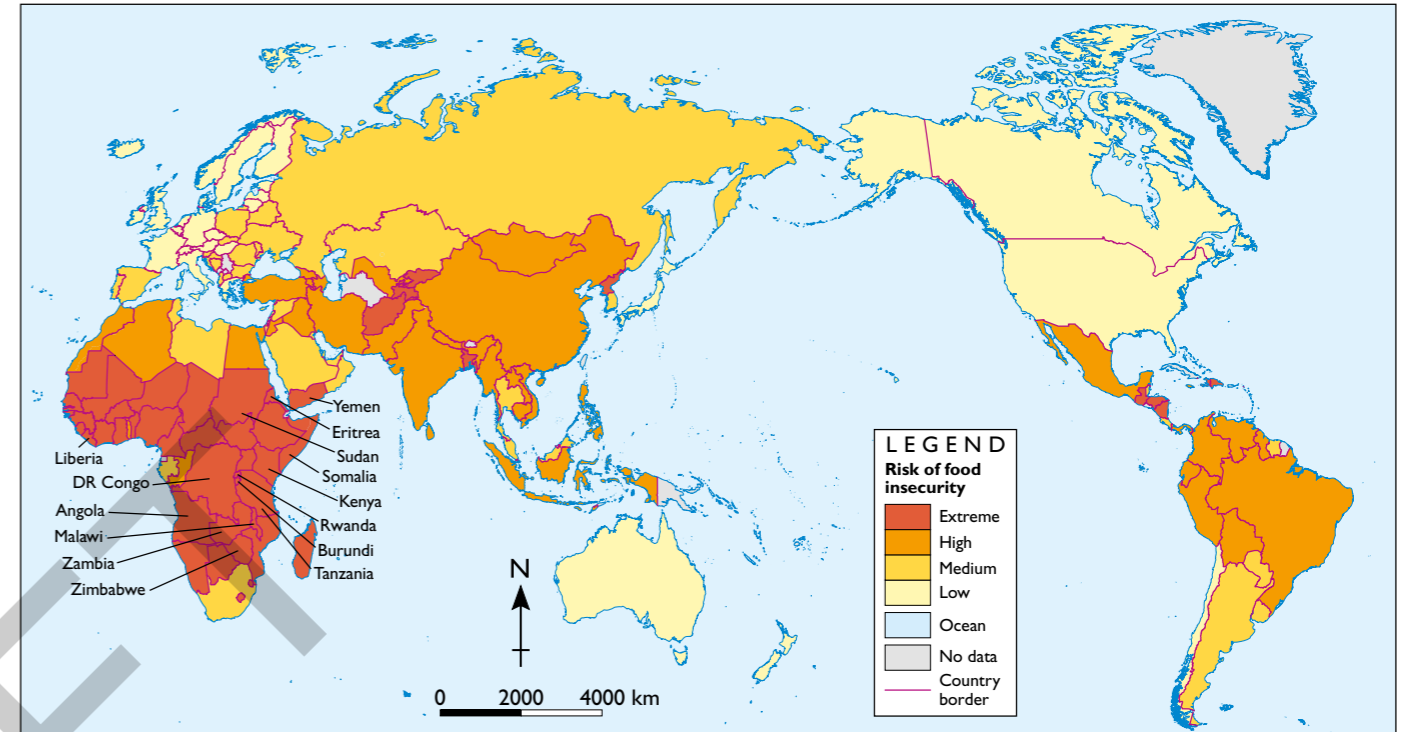
Source 3 shows the global pattern of food security and insecurity. Scores for each country were calculated using 18 different indicators, including the nutrition and health status of the population, the availability of food staples such as rice, wheat and corn, and access to these foods. Countries were then grouped into four categories according to their risk of experiencing widespread food insecurity.

The global distribution of food security is not static. The number of **undernourished** people in the world, for example, has fallen by more than 130 million in the last 20 years, despite the world's population growing by more than 1.5 billion in the same period. The distribution of undernourished people in the world has also changed (see Source 4).

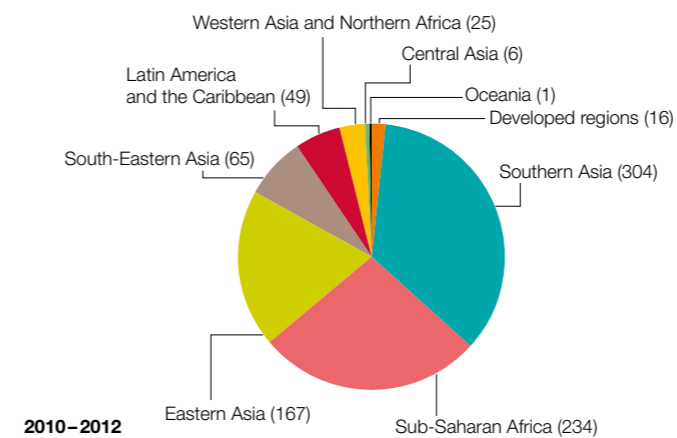
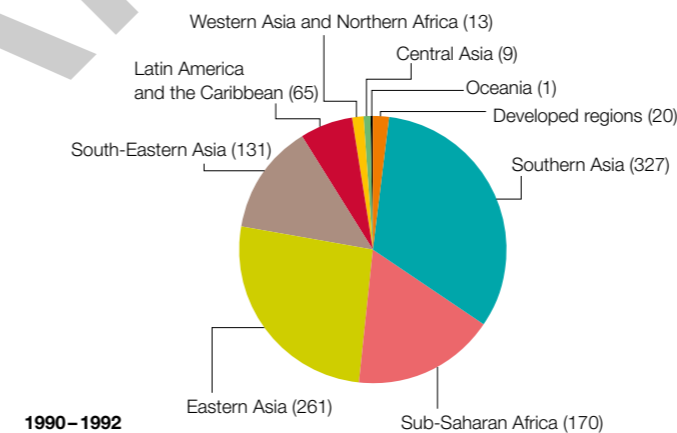


**Source 1** The people of Zimbabwe in Southern Africa have one of the lowest levels of food security. This girl is scavenging for food in a rubbish dump near the capital, Harare.

WORLD: FOOD INSECURITY LEVELS



**Source 3** Source: Oxford University Press



**Source 4** The distribution of hunger in the world is changing. These charts show the number of undernourished by region, 1990-1992 and 2010-2012, in millions.

## Check your learning 3.2

### Remember and understand

- 1 How are poverty and food insecurity linked?
- 2 Compare the food security of the two individuals shown in Sources 1 and 2. Comment on the food availability, accessibility and appropriateness for each of these people.

### Apply and analyse

- 3 Examine Source 4 which shows the 1990-1992 distribution of undernourished people in various parts of the world compared with the 2010-2012 distribution.
  - a What has happened to the overall number of undernourished people over the past 20 years?
  - b Which regions have seen an overall increase of undernourished people?
  - c Is this change reflected in Source 3?
- 4 Describe the distribution of global food insecurity using the PQE method (for more information on the PQE method, refer to page XX of 'The geography toolkit').
- 5 Discuss the factors that may be responsible for the pattern you have described.
- 6 Australia is described as having a low risk of experiencing food insecurity. Why do you think this is the case?

## 3.3 Food security into the future

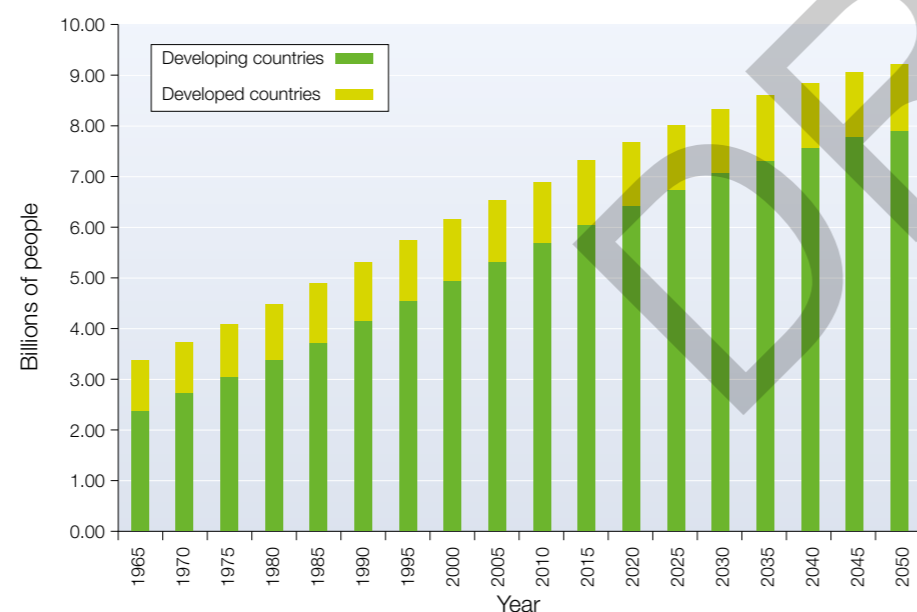
The world's population increases by about 200 000 people per day. At this rate, food will need to be grown to feed an extra 2.5 billion people by 2050. Virtually all of this population growth will occur in developing countries (see Source 2) where much of the population already struggles to meet their daily food requirements. Asia's population will increase by more than 1 billion by 2050 and Africa's population is projected to increase by 1.3 billion. Food experts estimate that global food production will need to increase by about 70 per cent by 2050 to meet the food requirements of the growing population.

There are two schools of thought regarding the impacts of population growth on food security:

- 1 Some researchers believe that the world's population is growing faster than the world's farmers are able to feed it. The result will be widespread food insecurity, starvation and famine. Those who support this scenario point to the degradation of existing agricultural resources such as fresh water and soil. They also point out that most of the population growth is occurring in areas already at risk of food insecurity, such as parts of Africa.
- 2 Other researchers are more optimistic. They point out that food production over the last few centuries has largely kept pace with (and even exceeded) population growth. This has been largely due to the use of new technologies, referred to as the Green Revolution (see Source 3). They also focus on the slight slowing of the world's population growth rate in the last few years and the ability of humans to adapt to changing situations through research and innovation.



**Source 1** Will the world's growing population mean there will be less food security in the future?



**Source 2** Population growth in developing and developed countries, 1965–2050.

Many believe that new developments in **genetic modification** of plants, for example, hold the key to increasing farming productivity and crop yields in the future.

### keyconcept: Environment

#### The Green Revolution

The Green Revolution refers to sweeping and widespread changes that occurred in farming regions across the world over the period 1950 to 1979. Beginning in Mexico and spreading through North America and much of Asia, these changes brought food security to hundreds of millions of people. The key changes were:

- the development and planting of new and improved varieties of grains, including wheat and rice, that produced much higher yields
- the widespread use of fertilisers and pesticides to increase farm productivity
- the adoption of mechanical vehicles and systems, such as tractors, pumps, sprays and irrigation systems.

As these and other related changes swept through countries such as India and China, many farming practices changed from small, **subsistence farms** to larger, more efficient farms. Although the Green Revolution has its critics, it is important to note that many of the African countries most at risk of food insecurity have yet to adopt many aspects of the revolution.

For more information on the key concept of environment refer to page XX of 'The geography toolkit'.



**Source 3** Farm workers in the Punjab region of India use a tractor to pull a load of grain. Part of the Green Revolution in India has been the introduction of high-yielding seed varieties, such as wheat, to encourage self-sufficient farming.

### Check your learning 3.3

#### Remember and understand

- 1 What was the Green Revolution? What were the key changes it introduced?
- 2 How could the Green Revolution help to increase food security in Africa?
- 3 By what number is the world's population increasing each day?
- 4 By the year 2050, by how much do food experts estimate food production will need to increase to feed the world's population?

#### Apply and analyse

- 5 Examine Source 2 and answer these questions.
  - a What evidence is there that the most population growth is occurring in developing countries?
  - b Why is this important when considering global food security in the future?
- 6 List the arguments for and against the theory that there will be increasing food insecurity due to

population growth. Which arguments and evidence do you believe have the most solid basis? Give some reasons for your response.

#### Evaluate and create

- 7 While there are many supporters of the Green Revolution there are also many critics. As a class, brainstorm what these criticisms might be. Use this brainstorming session to develop some inquiry questions and use these to research this issue further.
- 8 Conduct research on the Internet into the genetic modification of plants.
  - a In your own words, explain what is meant by genetic modification.
  - b Outline three main arguments in favour of genetic modification of foods.
  - c Outline three main arguments against the use of genetically modified foods.

### 3A rich task

# Food insecurity in the Horn of Africa

The Horn of Africa refers to the countries in the north-east of the African continent. Ethiopia, Eritrea, Somalia and Djibouti are the four countries that officially make up the Horn, but Kenya, South Sudan, Sudan, Uganda and even Tanzania are sometimes considered to be part of the Horn of Africa. It covers an area of approximately 2 million km<sup>2</sup> and is home to around 100 million people.

People who live in countries on and around the Horn of Africa often experience food insecurity. This is mainly due to a combination of natural processes and human activities. In 2011–2012, the area experienced the worst drought in decades. It caused the widespread devastation of millions of hectares of vital food crops and led to the deaths of hundreds of thousands of people by starvation and malnutrition. The United Nations declared the area to be in the grip of a famine, the first announcement of its type in nearly 30 years.

At its most severe, the drought and subsequent famine brought food insecurity to more than 13 million people in the Horn of Africa as well as in neighbouring countries, including Kenya, Uganda and South Sudan. The situation was worsened by an ongoing conflict in southern Somalia that made it difficult for aid agencies to deliver food to the communities in need. As many as one million people fled the affected areas causing a further humanitarian crisis as refugee camps struggled to accommodate the flood of new arrivals.

#### Local people in need of assistance as at 5 September 2011

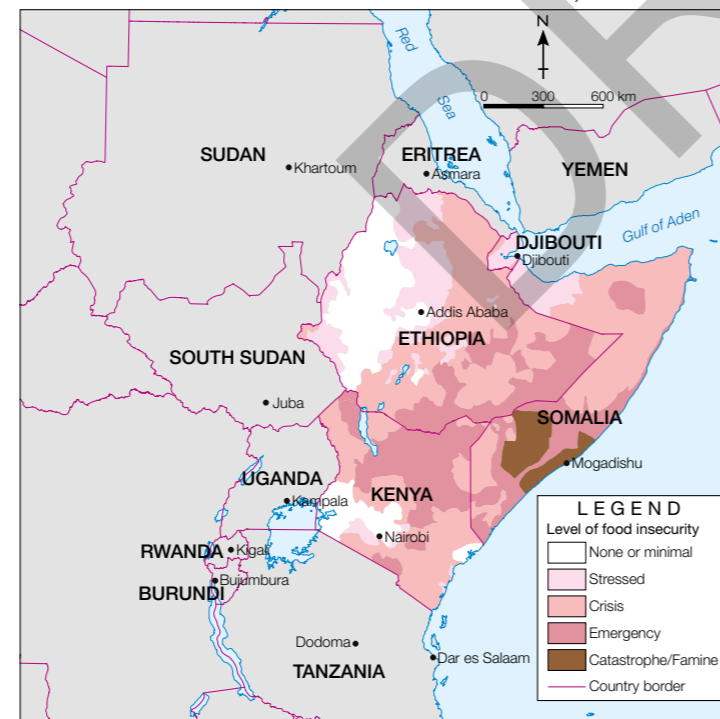
Ethiopia	4.6 million
Djibouti	146 600
Somalia	4 million
Kenya	3.8 million

THE HORN OF AFRICA: VARIATIONS FROM AVERAGE RAINFALL, 2011

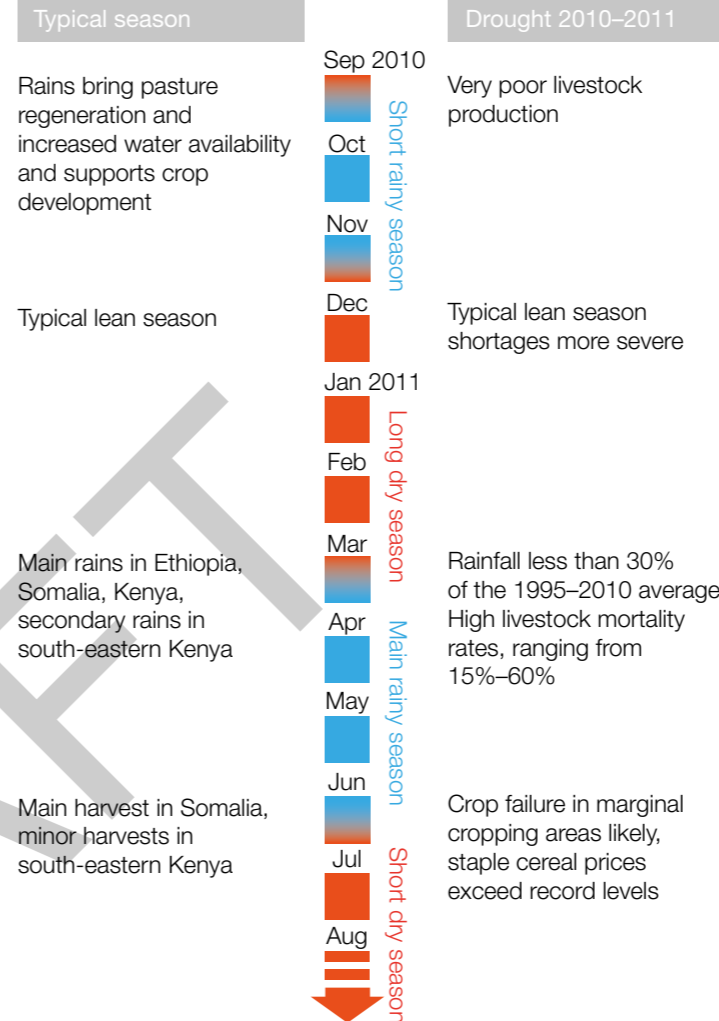


Source 1 Source: Oxford University Press

THE HORN OF AFRICA: FOOD INSECURITY SNAPSHOT, 2011–2012



Source 2 Source: Oxford University Press



Source 3 This timeline shows the rainy season failure of 2010–2011, compared to a typical season.

### skilldrill: Place, space and interconnection

#### Developing geographical questions

It is important that geographers ask lots of questions. These questions can be simple or complex, and can guide understanding of places, events, and the causes and effects that various factors have on an environment.

For example, in the case of an event such as a famine, a geographer may start the process of understanding the situation by asking a simple question such as, 'How many people died in the famine?' Often a simple question will look at the more quantitative aspects of a situation (i.e. facts that can be expressed in numbers).

Then, to investigate further and deepen their understanding, a geographer may ask a more complex question, such as, 'Was there a change in climate that caused food crops to fail?' Often, a complex question will look at the more qualitative

aspects of a situation (i.e. things that can be expressed in words not numbers). The best complex questions can open up a whole new area to explore and result in an in-depth understanding of the situation.

The following steps will help you generate a range of simple and complex questions.

- Step 1** Select an event that you would like to investigate.
- Step 2** Construct some simple questions to guide your initial investigation. The key words 'who', 'where', 'when', and 'what' should help you get started.
- Step 3** Investigate the questions you have listed and note down your answers.
- Step 4** Expand your investigation by forming some more complex questions. Words such as 'why', 'what caused', 'who interacts' and 'what impact' will help you to construct these types of questions.
- Step 5** You may also develop some of the questions from Step 2 into more complex ones. For example, you could develop 'What?' into 'What will the effect of ... have in the future?' to allow for further discussion.

#### Apply the skill

Use Sources 1, 2 and 3 together with the information provided to complete the following tasks.

- 1 Develop a set of five simple questions about the famine in the Horn of Africa in 2011–2012. Use your answers to list some main facts about the situation.
- 2 Now investigate the famine more deeply by constructing three complex questions which focus on its causes. You may want to develop a complex question that focuses on the political situation in the region and the effects this had on the countries that suffered.
- 3 Prepare a brief report explaining the famine based on your answers. Check that you have included causes as well as effects in your report to give a well-rounded viewpoint.

### Extend your understanding

Conduct some further research and then complete the following tasks.

- 1 How did the ongoing conflict in southern Somalia contribute to the famine?
- 2 Research the ways in which organisations such as Caritas, UNICEF, AusAID, Mercy Corps, World Vision and Oxfam helped bring food security to this region during 2011 and 2012.
- 3 What means do you think can be adopted to establish long-term food security in a region that experiences famines?

## 3.4 Threats to food security: an overview

As we have learned, food security (the consistent access and availability of an adequately nutritious food supply) depends on a number of factors. In some places, these factors are in a state of flux, and food security is under constant threat.

There are six main threats to food security which are outlined here, and which will be explored in more depth in this section of the chapter. The main factors that come into play and put food security at risk are: water scarcity; climate change; threats from non-native plants, animals and insects; competition for land; the use of land for fuel instead of food; and armed conflict.

### Water scarcity

Water scarcity is the lack of access to enough safe water. The supply of clean, safe water is important not only for people to drink, but for the safe growing of crops for food. As the world's population continues to grow, water becomes an even more important resource, and its management becomes more crucial. Water is needed for people to drink, wash and cook with on a household level; however, massive amounts of water are also needed for agriculture, industry, manufacturing and leisure activities. This competition for water can lead to shortages, and when there is not adequate water, food security is put at risk.

### Climate change

The term 'climate change' refers to long-term changes in weather events and patterns worldwide. The effects of climate change include rising global temperatures and changes in levels of rainfall. Such changes impact on the environment and the sustainability of agricultural production. Places that are able to grow certain crops because of the reliable rainfall, for example, may find that increases or decreases in rainfall affect the viability of that crop. Climate change may also cause more frequent droughts or floods in some regions, both disastrous to crops. The effect on crop growing is just one example of the way climate change can directly impact on food security.



**Source 1** The melting of glaciers and icebergs is a well-known example of climate change. Another effect of climate change is the threat to food security in many parts of the world.



**Source 2** Swarms of locusts, which will eat any plant material in their path, are another pest that can quickly destroy crops, resulting in food insecurity.

### Threats from non-native plants, animals and insects

The introduction of non-native plants, animals or insects into an area can have devastating effects on the natural environment. This, in turn, can develop into a situation where food security is put at risk. Pests such as the Khapra beetle that live and breed in stores of grain, can destroy up to 70 per cent of a store and make it inedible. A native of South Asia, the Khapra beetle is now one of the top invasive species globally. In countries where rice is a food staple, the damage caused by this beetle puts food security at risk.

### Competition for land

In many places around the world, agriculture is being threatened by competition for land. Food security may come under threat by people or corporations who want to use land for purposes other than growing food crops. Land that was once productive farmland is being converted into housing, mines, golf courses, shopping complexes and factories (see Source 3). This competition for land, partly to service and house growing populations, means that there is less land available to grow food.

### The use of land for fuel instead of food

One of the biggest emerging threats to food security in recent years has come from the growth in the amount of land being used to produce crops used to feed cars, not people. These crops are used in biofuels – fuels that are produced, or partly produced, by some types of plants. Researchers, trying to reduce carbon emission caused by traditional fuels, developed biofuels. This has meant that land previously used to grow food crops has been taken over in order to supply the produce for biofuel (see Source 4).

### Armed conflict

Armed conflict is another complex and severe threat to food security. Armed conflicts have the potential to affect the food security of entire regions and may even result in famine. In cases of armed conflict, the food security of a population can be affected in various ways. Food may be stolen from the local people by armed forces, land used for growing food crops may be destroyed, or the young men – even children – who would normally tend fields may instead go off to fight. The effect of armed conflict on food security, and how to deal with it, is a major global concern to organisations such as the United Nations and UNICEF.



**Source 3** Increasing competition for land to use for purposes other than growing food poses a threat to food security in some regions of the world.



**Source 4** The practice of using land to grow crops for fuel, not food, puts food security at risk for many people.

### Check your learning 3.4

Remember and understand

- 1 Why is there growing competition for water and land resources?
- 2 Name some of the competing uses for land around the world.

Apply and analyse

- 3 The use of biofuels can help reduce the carbon emissions that cause climate change, but growing crops for fuel can also increase food insecurity.
  - a In this instance, do you think it is more important to provide enough food for people or to help stop climate change?
  - b How would you suggest balancing the potential risks of climate change against people's need for food?

# 3.5 Water scarcity

Agriculture uses about 70 per cent of all fresh water taken from rivers every year. From the rice terraces of China to the orchards of Australia's Murray–Darling Basin, river water is used to irrigate farms and feed billions of people around the world.

River systems and the water they capture, store and distribute are among the most threatened natural environments on Earth. The level of threat to the ongoing supply of fresh water available for agriculture varies from place to place, but an increasing demand for water is by far the most common threat to food security around the globe. In many places, population growth – particularly in cities – puts increased demand on nearby rivers and lakes. This increased demand and usage then threatens the water supplies that farmers rely on.

## Economic factors

Greater prosperity and socioeconomic development also places greater demands on water supplies. Industrial development and an increase in the number of individual households means increased water consumption. At current usage rates water needed for industry around the world is predicted to at least double by 2025.

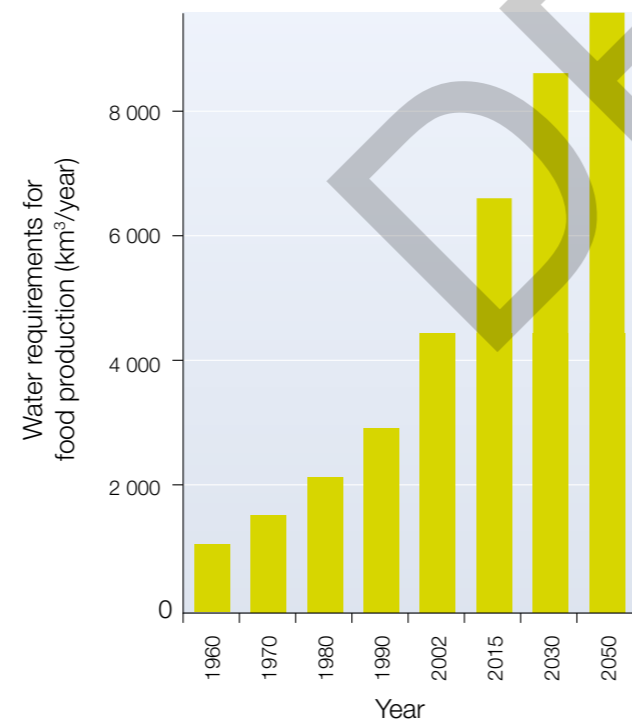
Rapid economic growth and Westernisation in countries such as China and India is also affecting water usage. According to environmentalists and academics, water scarcity and quality is the most pressing environmental issue facing China today. Currently water is being used at an unsustainable rate. Changing tastes in places like China are also increasing the demand for certain foods, such as meat, which requires more water to produce than traditional rain-fed crops. This is putting an added strain on water resources.

## Environmental factors

Environmental factors also affect the amounts of water used for growing food (see Source 2). Changing rainfall patterns and warmer temperatures as a result of climate change are seriously affecting water supply in some regions of the world. The rapid melting of glaciers in places such as South America and Central Asia is of particular concern.



Source 1 A farmer searches for water in the Mekong river basin.



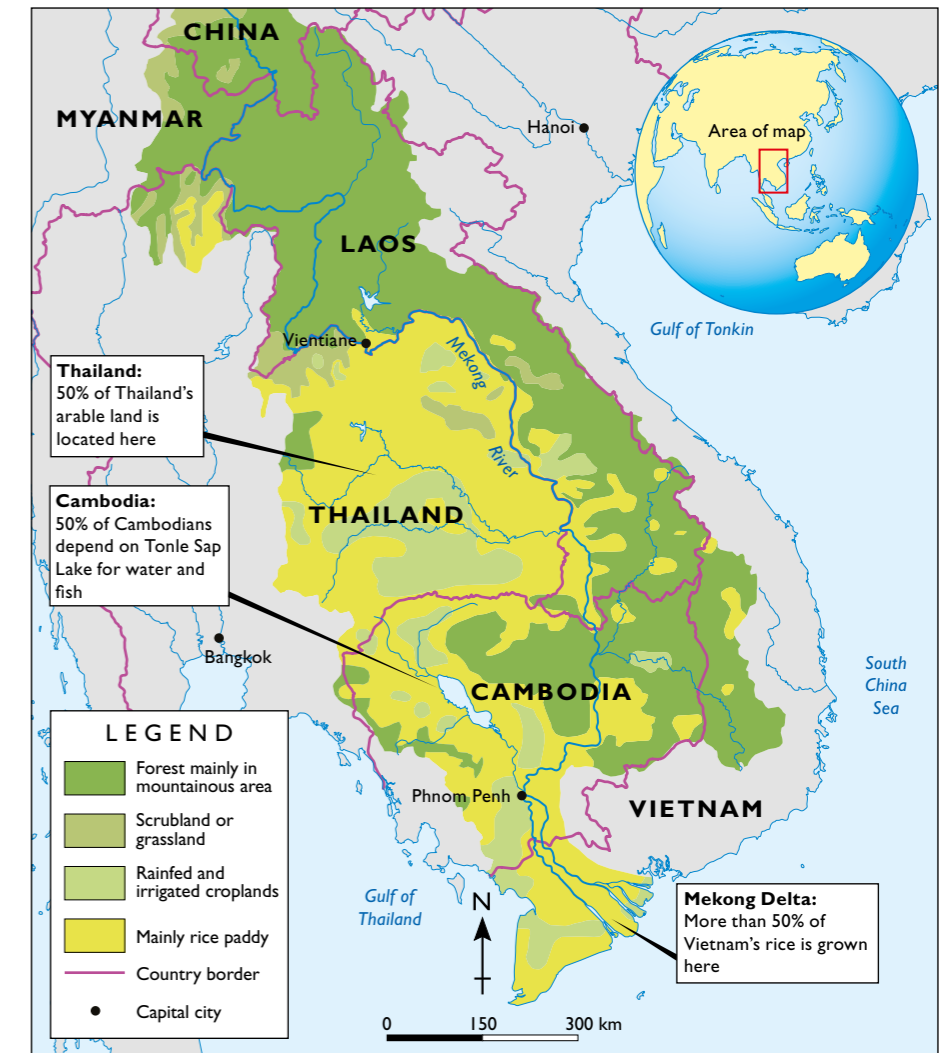
Source 2 The historic and projected changes in water consumption needed for agriculture, 1960–2050.

Glaciers have historically acted like reservoirs. As the glaciers have slowly melted, water has flowed down the mountains into the rivers, providing water to millions of people. This water has been used to grow a significant amount of the food to meet the requirements of 2.5 billion people in Asia, and 53 million people in Peru, Bolivia and Ecuador. As the glaciers shrink, however, this water flow is declining. A lack of water to grow crucial crops is predicted to have a severe impact on food security for people in these regions.

## Case study: The Mekong Basin

The Mekong River begins on the northern slopes of the Himalayas and crosses six countries before reaching the South China Sea. On its journey it is dammed for electricity and diverted for irrigation, providing water to meet the needs of more than 60 million people. Forty-eight million people rely directly on the Mekong River basin for their food supply (see Source 3).

THE MEKONG BASIN: LAND USE



Source 3

Source: Oxford University Press

## Check your learning 3.5

### Remember and understand

- 1 List the ways in which the supply of river water for farming is threatened. Highlight those that apply to rivers in Australia.
- 2 Explain how water scarcity and food security are linked.

### Apply and analyse

- 3 Use an atlas and Source 3 to describe the route taken by the Mekong River from its source to the mouth. Explain how changes near the source could bring about food insecurity for communities near to the mouth.

- 4 Estimate the area of rice paddy cultivation in the region shown in Source 3. Describe the spatial association between the river and the rice paddies.
- 5 Describe the changes in the amount of water used, and projected to be used for food production from 1960 to 2050.

### Evaluate and create

- 6 The Mekong River crosses six countries. How might this cause problems and conflicts between countries who rely on it? In particular, how might downstream users such as the rice farmers of Vietnam be affected?

# 3.6 Climate change

Much debate surrounds the subject of climate change, but there is now considerable evidence and consensus that the main cause of global warming is the rising carbon dioxide levels in our atmosphere from burning **fossil fuels**. Gases produced by human activities are being added to the atmosphere at such a rate that they are changing the Earth's climate. The most obvious change is a rise in global temperatures but there are other changes too. Some places are becoming wetter, while others are becoming drier. Glaciers and ice caps are melting, causing sea levels to rise. Extreme weather events such as droughts, floods and cyclones are becoming more serious and frequent. These and other changes are already impacting on food production, and climate scientists warn that these impacts will become more severe in the future depending on global temperature increases (see Source 1).

Changes in the atmosphere affect water and land that is used for growing crops. Droughts mean there is not enough water for successful crop growing, while a drastic

increase in the amount of rain falling on a region means crops may be flooded and destroyed. These changes in climate pose a significant threat to food security.

## Impacts on Sub-Saharan Africa and Asia

The impacts of climate change on food production are likely to be greatest in Sub-Saharan Africa and Asia. Many farming areas in Africa are expected to become drier. As the soil dries, causing plants such as trees and shrubs to die, the possibility of Africa's deserts spreading into areas currently being farmed is expected to increase. Infestations from plants and animal pests such as locusts are also expected to become more severe, as are droughts.

Asia's river deltas, such as the Mekong, Ganges, Indus and Yangtze, are sometimes referred to as the world's rice bowl. Due to farming improvements introduced during the Green Revolution, these river deltas now help provide food security to over one billion people. This food security, however, is under threat from several impacts of climate change. Changes in rainfall patterns are making it difficult for farmers to know when to plant their crops. Severe rainfall variability is damaging crops and affecting food security.

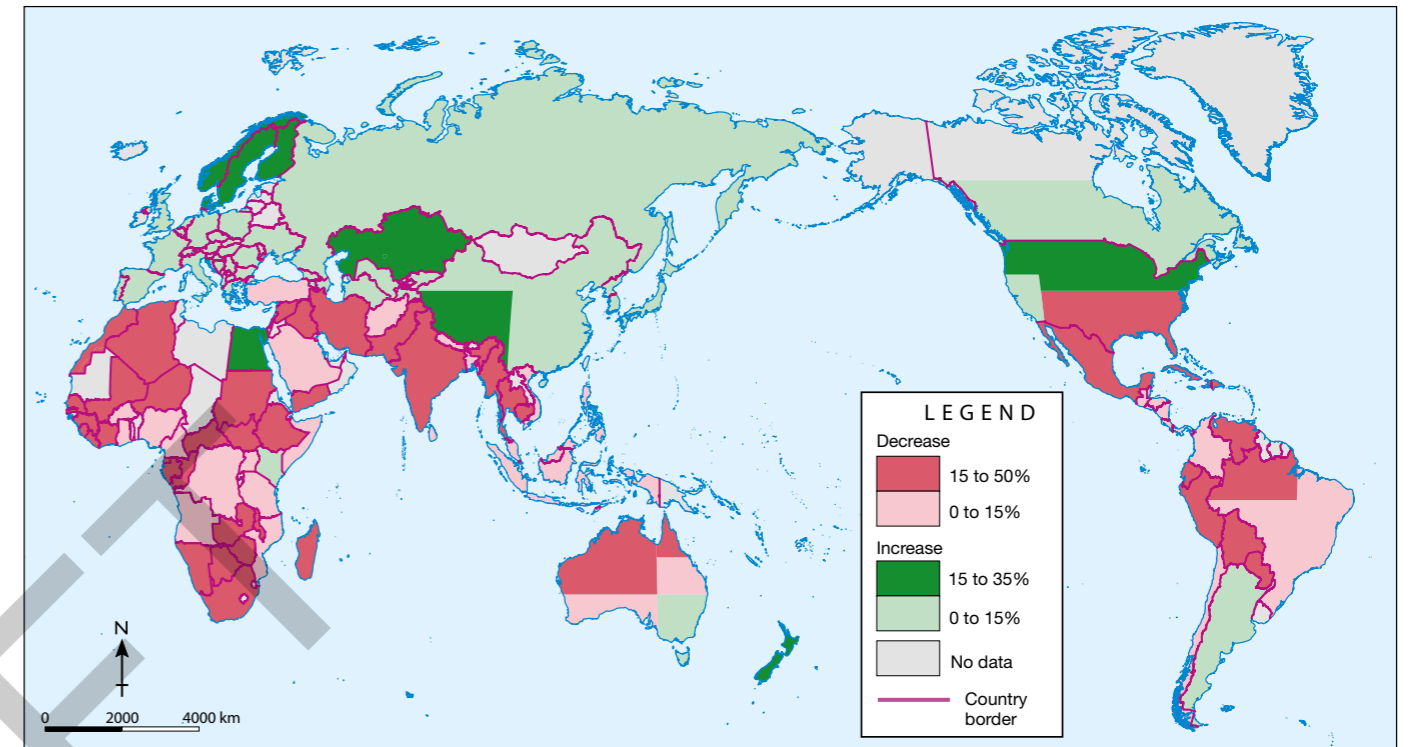


**Source 2** This rice field sits on a low island near the mouth of the Ganges River in Bangladesh. A sea level rise of a few centimetres would cover the crop in salty water, destroying it.

**Source 1** Climate change is projected to impact significantly on food, water and ecosystems.

Global temperature increase	Projected effect
0°–1°	<ul style="list-style-type: none"> <li>Small mountain glaciers disappearing, impacting on water supplies</li> <li>Extensive bleaching and damage to coral reefs leading to widespread death of coral and attached species</li> <li>Risk to some ecosystems</li> <li>Increase in extreme weather events – increased damage from floods and storms</li> </ul>
1°–2°	<ul style="list-style-type: none"> <li>Up to 30% of species at increasing risk of extinction</li> <li>Falling crop yields in many areas, particularly developing regions</li> <li>Cereal-growing productivity to decrease in some regions</li> <li>Risk to some ecosystems increases</li> </ul>
2°–4°	<ul style="list-style-type: none"> <li>Significant decrease in water availability in many areas, including the Mediterranean and southern Africa</li> <li>Increasing level of extreme weather events – increased number of human deaths due to floods, heatwaves, droughts, etc.</li> <li>Many ecosystems now at risk</li> <li>About 30% of global coastal wetlands to be lost</li> </ul>
4°+	<ul style="list-style-type: none"> <li>Very high risk of irreversible environmental damage</li> <li>Very high risk of abrupt changes to global environments</li> <li>Sea level rise threatens major cities</li> <li>Falling crop yields in many developed regions</li> <li>Significant number of extinct species around the globe</li> <li>Increasing levels of malnutrition, diarrhoea and infectious disease</li> </ul>

WORLD: PREDICTED CHANGES IN FOOD PRODUCTION BY 2080



**Source 3**

Source: Oxford University Press

Thailand, for example, suffered a severe drought in 2010 that damaged crops across the country. A year later, devastating floods swept through Thailand leaving behind a \$40 billion damage bill.

It is the impact of rising sea levels, however, that has the greatest potential to damage food security in these river delta regions. Rice is grown in the fertile soil of low-lying river deltas. As sea levels rise, ground and river water become saltier, killing rice crops and depositing more salt in the soil.

## Predicted changes in food production

The effects of climate change on food production will vary across the world. Some regions may even be able to increase food production with the changes in climate. However, for most parts of the world, and most significantly, for the most populated parts of the world, climate change will cause a decrease in potential food production (see Source 3).

### Check your learning 3.6

Remember and understand

- 1 Why are many rice paddies in river delta regions at risk from climate change?
- 2 Explain the link between human activities and climate change.

Apply and analyse

- 3 Examine Source 1 showing some predicted effects of climate change. Select five of the effects listed and describe how they may threaten food security.
- 4 Examine Source 3. Which regions of the world are predicted to lose between 15 per cent and 50 per cent of their food production by 2080?
- 5 Compare Source 3 with Source 3 on page 93 and complete the following tasks.
  - a Which regions that currently have stable food security are predicted to experience significant change by 2080?
  - b Which regions currently at risk of extreme food insecurity are predicted to lose more than 15 per cent of their food production by 2080?

Evaluate and create

- 6 Compare the predicted changes in food production for Australia and New Zealand. Which impact of climate change do you think will most affect their food security in the future? Give some reasons for your answer.



## 3.7 Threats from non-native plants, animals and insects

One of the greatest threats to natural ecosystems and to food security is the arrival or introduction of non-native plants, animals or insects into an area. Known as **invasive alien species (IAS)**, they cause billions of dollars of crop loss and damage throughout the world every year. Vast sums of money are spent trying to control and contain these invaders.

Virtually all farming communities are under threat from invasion. In Australia, for example, it is estimated that about 15 per cent of all plants growing throughout the country are weeds. Weeds affect food security as they compete with crops for water, sunlight and soil nutrients. The number of invading plant species in Australia is also growing by about 10 new species per year. These new species are spreading faster than they can be controlled.

Invading plants and animals are mainly spread through human activities. In some cases, the spread is accidental. The most successful invader in the world,

for example, is the black rat. Native to north-east China and India, rats were carried around the world as stowaways on ships. Most modern invaders, however, now hitch rides on planes rather than ships. Seeds carried accidentally on shoes, or insects in clothing can now travel from place to place across the world in a matter of days, even hours.

In other cases, alien invaders are introduced to native environments deliberately. Humans have, at different times, purposely brought non-native species into an environment, usually to tackle an existing problem with another species. Unfortunately, in the past there has been a failure to predict the level of negative consequences that the introduction might have on the local ecosystem as a whole. The cane toad and Indian Myna bird were both introduced to Australia to control pests. They have, however, now caused massive destruction to the natural ecosystem, native species and the food chain.

### Case study: Desert locusts

Desert locusts are usually solitary insects causing no great harm to farmers' crops. When conditions are right for them, however, they become one of the world's most destructive pests, bringing widespread food insecurity to communities in Africa, Asia and the Middle East. Drought conditions in their usual recession area (the area where they normally withdraw and are not active) combined with good rains in their breeding area cause the locusts to form vast swarms that invade surrounding areas (see Source 1). A swarm may cover 1000 square kilometres, with up to 80 million locusts per square kilometre. Travelling up to 100 kilometres per day, they devour entire crops in minutes. One swarm in Ethiopia, for example, is believed to have consumed enough grain to feed a million people for a year.

### Case study: The larger grain borer

Two of the most important food crops in Sub-Saharan Africa are maize (a type of corn) and cassava (a root plant). **Subsistence farmers** – those who grow only enough for their household needs – grow small fields of maize and cassava and pick and store them during harvest time, providing some food security throughout the year. However, their stored crops are under attack from an unwelcome invader, the larger grain borer.

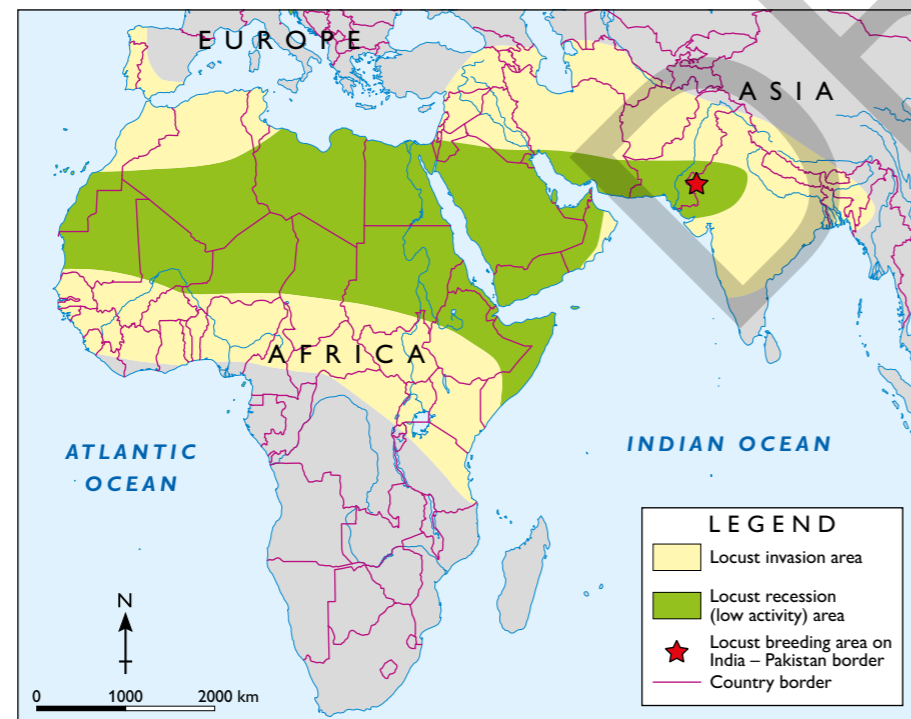
Accidentally introduced into Tanzania from its native Central America in the late 1970s, the larger grain borer

has now spread throughout West and East Africa. Feeding on the stored maize and cassava, it can quickly reduce stores to piles of dust unfit for human consumption. Farming families are then forced to try and buy food from other farmers. In many cases, however, all the stored crops in a region have been destroyed.



**Source 3** Maize is the staple food of millions of people. An invasive alien species such as the larger grain borer can pose a very serious threat to the food security of people who rely on a maize crop for food every day.

AFRICA AND SURROUNDS: LOCUST AREAS



**Source 2**

Source: Oxford University Press



**Source 1** A swarm of locusts can devour a vast area of crops in a stunningly short period of time.

### Check your learning 3.7

Remember and understand

- 1 How do weeds impact on food security?
- 2 How are invasive alien species spread?

Apply and analyse

- 3 Examine Source 2. Describe the spread of desert locusts from recession areas into invasion areas. Use the names of regions, countries and compass directions in your description.
- 4 Why are desert locusts a threat to food security in some regions?

Evaluate and create

- 5 From its discovery in Tanzania in the late 1970s, the larger grain borer has spread throughout much of the African continent. Here is a list of countries where the larger grain borer has been found with the year of its detection:

Kenya (1983); Togo, Benin and Burundi (1984); Guinea (1987); Ghana (1989); Burkina Faso (1991); Malawi and Nigeria (1992); Rwanda and Zambia (1993); Niger (1994); Namibia (1998); Mozambique (1999).

- a Using the list of the countries above, as well as the years of detection, map the spread of the larger grain borer from its discovery in Tanzania in the late 1970s on an outline map of Africa. Use labelled arrows to show the progression of the spread.
- b Describe the movement of the borer as shown on your map.
- c Which countries do you believe are most at risk from the future spread of this invader? Why do you think this would be the case?

# 3.8 Competition for land

In addition to environmental factors, food security can also be threatened by individuals or corporations taking over productive land and using it for purposes other than growing food. In many places around the world, land that was once farmland is being converted for housing, mines, golf courses, factories and other uses. This competition for land is being driven partly by the increase in the world's population and partly by the desire to make more money from the land.



**Source 1** New suburbs sprawl into existing farmland north of Asmara, the capital of Eritrea, in Africa.

## Land for housing

The development of rural areas for housing is one example of competition for land use. Urban areas cover only about two per cent of the world's total land area. They are often built, however, on the best land – flat, fertile and well watered. Farming areas on the edges of cities provide food to the city dwellers. As cities grow in population, however, they also grow in size, and farmland and rural spaces are taken over and developed into new suburbs for the growing population. The spread of a city outwards is known as **urban sprawl**. In this process, farmland is taken over for housing, and farmers are pushed further out onto land that may not be as suitable for growing crops. Their ability to produce

food may fall, putting at risk the food security of the people in the city.

The city of Asmara in Eritrea, for example, has tripled in size in the last 20 years and now sprawls across land that was previously prime farmland. Source 2 maps the rapid growth of Asmara. This growth is expected to continue at its current rate, and may even accelerate in the next few decades, absorbing more productive farmland. This same process has been experienced by many places around the world, including in Australia, where urban sprawl has seen productive farmland converted to suburban living spaces.

## Land for tourism and recreation

In some places, productive farmland is also being converted into tourism and recreation facilities. Many developing countries, for example, recognise that attracting tourists provides them with a reliable source of income. These tourists, most of them from developed countries such as Australia and the USA, are drawn to these countries for a range of factors including climate, stunning scenery and unique cultures. But tourists often also want a high standard of accommodation and recreation facilities like hotels, pools and golf courses (see Source 3).

A study of the impact of golf course development in Thailand found that 250 courses in the country

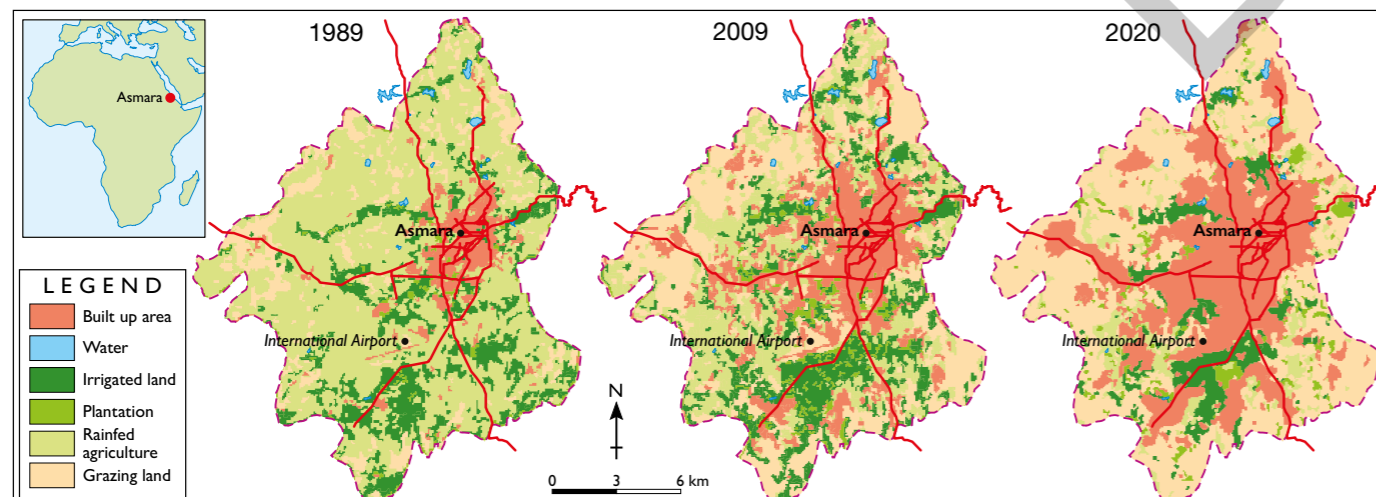
together consume about 200 square kilometres of land. About three-quarters of these courses were built on existing farmland, the rest on land that was previously forested. This area represents a loss of about 89 000 tonnes of rice every year. Furthermore, golf courses put great pressure on the freshwater resources of the local area. Each Thai golf course consumes the same amount of water as 60 000 Thai villagers would.

This trend is not confined to Thailand. In other Asian countries such as Indonesia, Cambodia and Vietnam, as well as in island nations throughout the Caribbean, productive farmland and scarce fresh water resources are being consumed by golf courses and other recreation facilities.



**Source 3** A rice field has been converted into a golf course to attract tourists, an increasingly common use of agricultural land in many places in Asia. This poses a significant threat to food security – not only is the land for crop growth taken away but golf courses consume massive amounts of water.

ASMARA: URBAN GROWTH 1989–2020



**Source 2**

Source: Oxford University Press

## Check your learning 3.8

### Remember and understand

- 1 What is urban sprawl and why is it a threat to food security?
- 2 How does the growth in global tourism impact on food security?

### Apply and analyse

- 3 Use Source 2 to describe the growth of Asmara from 1989 to 2009. Which type of farming was most affected by this growth? What is predicted to happen by 2020?
- 4 If golf courses threaten food security, why do many countries around the world build them on productive

farmland? Explain the underlying causes of this problem.

- 5 The golf course shown in Source 3 has caused the loss of productive farmland and created other problems. It has also brought some benefits. Brainstorm the potential costs and benefits of this golf course to the local region and community.

### Evaluate and create

- 6 Research the growth of a large Australian city. Find out if its development has resulted in urban sprawl and the loss of productive farmland. If so, explain what the impacts of this have been for food production in the region.

## 3.9 The use of land for fuel instead of food

Brazil is one country where the use of land for growing fuel rather than food has increased dramatically. Despite offering many advantages, this change has the potential to put future food security in Brazil at risk.

### Case study: Brazil's biofuel

Biofuels are fuels made from organic matter rather than fossil matter. They are often made from biomass (i.e. plant materials high in sugar, starch or oil) such as sugarcane, corn, soya beans or sunflowers.

Brazil has gradually developed a booming biofuel industry. Biofuels such as ethanol and biodiesel are an example of how countries can develop 'home-grown' renewable energy sectors. The establishment of a biofuel industry has been part of wider long-term initiatives

to change the way Brazilians produce and use energy, including adopting integrated food–energy systems (IFES). IFES combine the production of food and energy into one system. Other measures include:

- the introduction of new 'flex-fuel' vehicles which run on any blend of petrol and ethanol
- new land zoning laws that identify suitable areas for biofuel production (avoiding using land with high biodiversity, such as rainforests)
- efficiency improvements to increase the productivity of biofuels
- social and environmental safeguards to address any concerns.

Around 15 per cent of Brazil's total domestic energy supply now comes from biofuels made from sugarcane.

### skilldrill: Data and information

#### Analysing complex maps

**Complex maps** contain more than one set of information. Geographers use complex maps to analyse different features, reveal patterns and explain links between features in a given area. You can analyse a complex map by following these steps.

**Step 1** Look carefully at the map and read its title to make sure you understand what is being shown.

**Step 2** Examine the map's legend. Complex maps can have more than one part to a legend, and these parts will be represented on the map in different ways. For example, in Source 3.31 areas of colour are used to show the location of soya bean and sugar cane crops. Different coloured symbols are also used, to show biodiesel and ethanol plants.

**Step 3** Train your eyes to look for one set of information at a time. For example, look at solid blocks of colour on the map and work out what they tell you.

**Step 4** Look for concentrations of the same symbol in areas to see if patterns exist.

**Step 5** Note any patterns you can find on the map between different features and locations.

**Step 6** Describe the degree to which patterns are connected.

**Step 7** Try to suggest reasons for the connection between the two patterns.

#### Apply the skill

Look at the map of South America (Source 1) showing biofuel infrastructure.

- 1 Find the symbol for ethanol and biodiesel plants in the legend then locate these on the map. Describe the concentration of these.
- 2 What relationship is there between the concentration of ethanol plants and the location of sugar cane crops?
- 3 What does the location of the ethanol pipelines tell you about the production and consumption of biofuels?

BRAZIL: BIOFUEL INFRASTRUCTURE



Source 1

Source: Oxford University Press

## Biofuels as a threat to food security

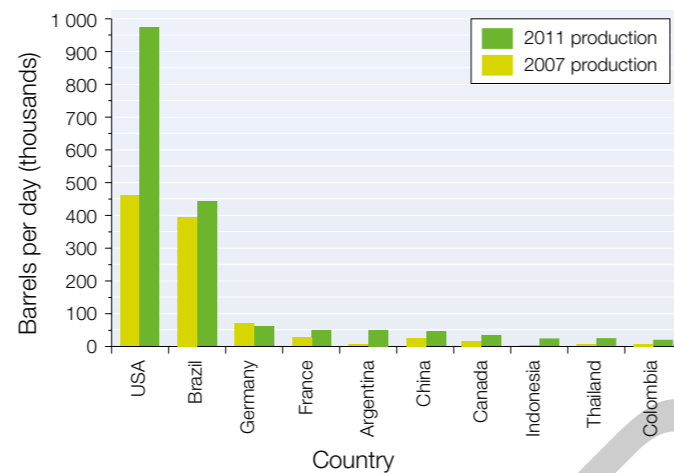
Although waste products of food crops such as corn and sugarcane can be used to provide some of the raw material for the production of biofuels, greater production of biofuel needs bigger crops. In some places, fuel crops are replacing food crops and this has raised concerns about food security in these countries.

While the amount of biofuel produced and used has grown rapidly in recent years, it still provides only three per cent of the total energy used to power vehicles worldwide. Despite this, biofuel production threatens the food security of many communities, particularly in South American countries such as Brazil, Argentina and Colombia, that are boosting their biofuel production.

Biofuel production poses a threat to food security in two main ways. Firstly, marginal farming land (land that is situated on edges of arable land) is the land most likely to be converted for growing biofuel crops. This is often the land that poorer farmers use to grow the food needed to feed their families. Secondly, growing crops for fuel rather than food pushes up the price of food, making it less accessible. As people on lower incomes spend a much greater proportion of their income on food than wealthy people do, it is the poor who suffer most when food prices increase.



**Source 2** Political cartoonists often rely on simple images to convey a complex message – this cartoon comments on the competition between using land for food and using land for fuel.



**Source 3** The top ten biofuel producers in the world, 2007 and 2011

### Check your learning 3.9

Remember and understand

- 1 What are biofuels? What are they produced from?

Apply and analyse

- 2 Examine Source 2.
  - a What point is the cartoonist making about biofuels?
  - b How effective is this cartoon in communicating this point?
- 3 Examine Source 1.
  - a Compare Source 1 with Source 4 on page 45 (World biomes). Which biomes are most threatened by the expansion of Brazil's biofuels industry?
  - b Some new ethanol plants are planned for construction across Brazil (shown as 'Proposed ethanol plant'). Describe the distribution of these new plants. How might the construction

of these new plants lead to land use changes in the near future?

- 4 Who benefits from the growth in biofuel production? Who loses?

Evaluate and create

- 5 Use the data in Source 3 to construct a proportional circles map of the world's major biofuel producers in 2011.
- 6 One type of plant being used for biofuel production is jatropha. Jatropha is a flowering plant whose seeds are high in oil. In India, there are more than one million hectares of jatropha plantations. Research this plant and list the advantages and disadvantages of using it as a biofuel to replace fossil fuels. When finished, state your opinion on this use of farming land in India.

## 3.10 Armed conflict

Armed conflict – war between different countries, or civil war between groups within a single country – also has the potential to affect the food security of millions of people. It can result in widespread food shortages, and even long-lasting famines. While armed conflict results in deaths from battle, in some conflicts many people also die from a lack of access to food. Food insecurity caused by an armed conflict can kill more people than are killed by the fighting itself. Most at risk are people in developing countries, where many people rely on their own small farms to provide their family's food.

Several countries in Africa have experienced the devastating effects that armed conflict can have on the food security of the population. In an area where food security is already a serious concern – currently 75 per cent of the continent's countries are considered at high or extreme risk of food insecurity – the added turmoil of armed conflict brings an extra threat to a situation which is already critical. Many African countries, including Somalia, have endured decades of armed conflict and the resulting decrease in food security.

### International aid

While international aid agencies such as the Red Cross and United Nations work hard to address the lack of food security in these war-torn areas, the environment can be very dangerous. In Somalia alone, 14 employees of the United Nations World Food Program were killed while distributing aid between 2008 and 2011 (see Source 2). Corruption, theft and a lack of law enforcement all contributed to the terrible situation.

Transporting food and farming supplies by road in these countries is risky, with aid often being seized by fighters for their own use. In Somalia, sacks of grain, peanut butter and other foodstuffs meant for starving Somali people were often stolen. Some families receiving aid were even forced to give it back after journalists taking photos of them with the food had left. With local food supply markets disrupted, food aid that has been stolen is often sold on in markets, taking relief efforts away from the starving and needy (see Source 2).

Distributing food aid is also often complicated by difficulties in reaching war-torn areas. Groups in remote areas can be difficult to locate and delivery of food aid to these places may be slow.

In such situations, hunger can be used as a weapon. The government can deliberately keep food away from opposition fighters and the local people who support them.



**Source 1** Western armed forces distributing food aid in Somalia



**Source 2** Food supply is affected as local markets are targeted. In Mogadishu, the capital of Somalia, relief aid was commonly looted at the distribution points and then sold at the markets.

## Impact on local farmers

During times of war, such as those experienced by Somalia, food shortages are common. There are many reasons for this. Some food shortages are caused by the disruption of food markets and food aid. Land mines are planted, causing lasting danger (see Source 6). Some are caused by the fact that apart from the conflict that is happening, there are ongoing harsh climate conditions to deal with. The effects of war combined with climate can go on for years (see Source 7).

Crops cannot be planted, weeded or harvested. Farmers cannot plant new crops, which extends food insecurity even when the conflict is finished (see Source 7). Irrigation systems are destroyed and other water resources, such as wells, are sometimes poisoned as an act of war.

Animals are killed and taken for food by armies and rebel fighters. As well as a food supply, farmers lose manure for their crops as well as animal power to work their fields. Crop stores are often raided by rebel fighters as well.

Young men are often forced to fight. This seriously affects the agricultural output by reducing the available hands to work on farms. The amount of food and income for the family is diminished.

Farms may also be completely destroyed by the armed forces. Native scrub is burnt, and wild sources of food, such as wild fruits and honey, are destroyed. Many farmers abandon their farms.

In the Democratic Republic of the Congo in Africa, at least 400 000 people were displaced from their fields during the harvest period. This affected not only their short-term food security, but their long-term food security as well.

Particularly for countries that already experience other threats to their food security, such as weathering the effects of climate change or battling plagues of locusts, the effects of an armed conflict on their food security can result in life-or-death situations.



**Source 3** Somali children waiting in line for food aid.



**Source 4** In war-torn areas, water is a precious resource. These women wait at a water distribution area for their empty containers to be filled.



**Source 5** Amnesty International reported that in Somalia, children as young as eight years old were recruited to take up weapons and fight in the conflict.



**Source 6** Due to landmines, land previously used to grow food becomes inaccessible for years. Harvests are destroyed and fields cannot be cultivated.



**Source 7** Food security can be threatened for years, as the land bears the ravages of war.

### Check your learning 3.10

#### Remember and understand

- 1 Why is there often a shortage of farm labour during armed conflicts?
- 2 How can hunger be used as a weapon during times of war?

#### Apply and analyse

- 3 Why are subsistence farmers – farmers who grow just enough to feed their own family – most at risk of food insecurity during armed conflict?
- 4 Describe three ways in which food security for local people would improve if peace was reached in an area that had been experiencing armed conflict.

#### Evaluate and create

- 5 List the effects of armed conflict mentioned here. Rank them in order from the one that you think will have the most severe lasting impact on food security to the one you think will have the least serious lasting impact. Explain the reasons for ranking them in the order you chose.
- 6 How would the conflict in Somalia impact on the food security of people in other areas of the country or in neighbouring countries? Discuss this with a partner and then with your class.

### 3B rich task

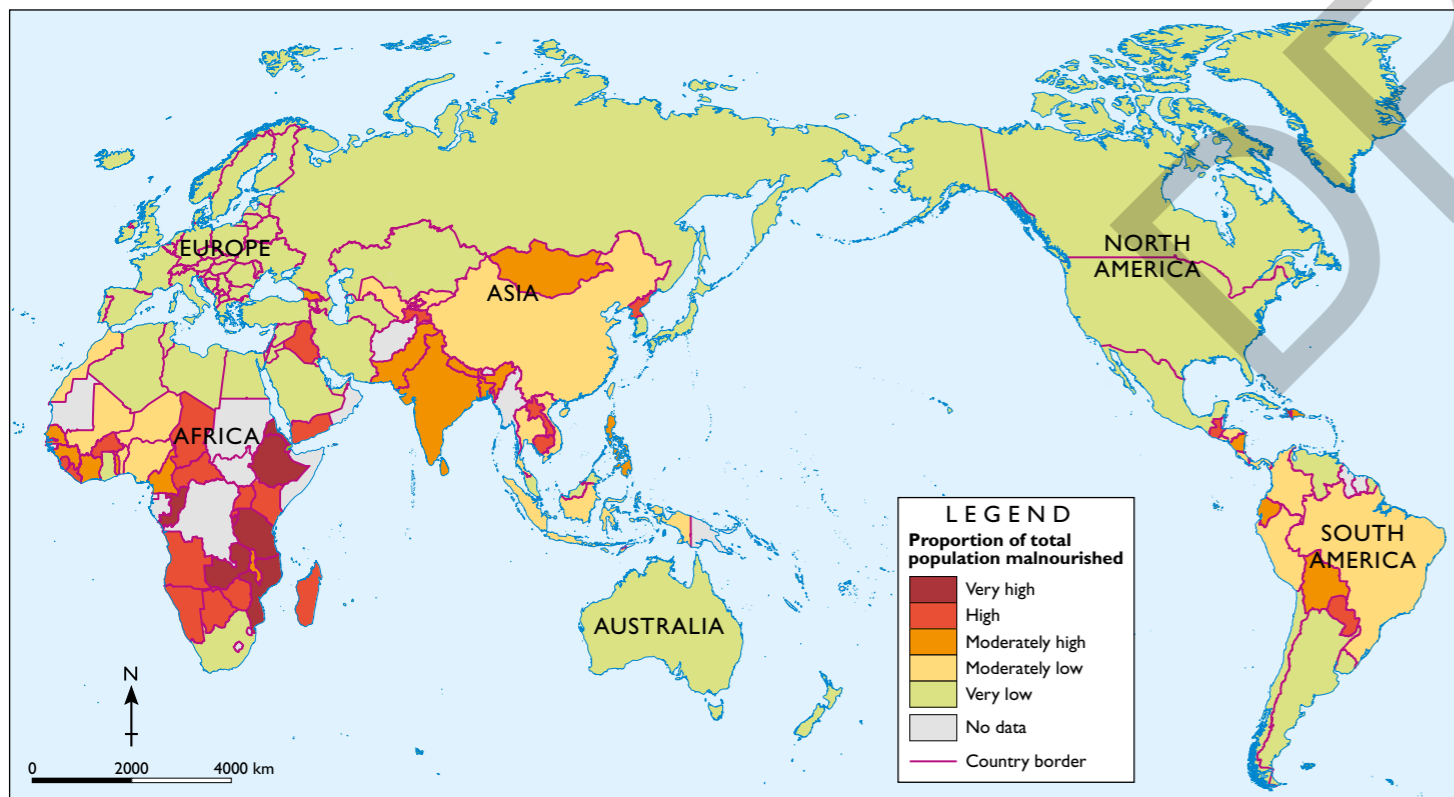
## Zero hunger by 2030?

At a meeting of the United Nations in 2000, 189 member countries agreed on a set of goals designed to improve the living conditions of people in developing countries. Eight goals, known as the Millennium Development Goals (MDGs), were developed. One of these goals was to halve the proportion of people suffering from hunger by 2015. This goal was almost achieved, but there is still a lot of work to be done. On 1 January 2016, the UN launched a new Agenda to replace the MDGs. It calls on member countries to begin efforts to achieve 17 Sustainable Development Goals (SDGs) by 2030. One goal is to 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture'.



**Source 1** In 2016, the United Nations officially launched the 17 Sustainable Development Goals to be achieved by 2030. Goal 2 is to achieve zero hunger.

WORLD: HUNGER LEVELS 2016



Source 2

Source: wfp.org

### skilldrill: Data and information

#### Presenting an oral report to an audience

Geographers often present their findings to an audience by giving an oral presentation. You may find giving an oral presentation a little scary at first, but if you follow these steps you will be able to confidently deliver a successful report.

- Step 1** Decide on a topic that will interest both you and your audience. Consider your audience and think about what they already know about the topic. What would you like them to understand by listening to your presentation?
- Step 2** Research your topic. Geographers start with inquiry questions and then seek to answer them. Collect information from a wide variety of sources and keep a bibliography of these sources.
- Step 3** Organise your findings into a draft report. It should have a clear introduction and conclusion. In your introduction it is often a good idea to use something to 'hook' your audience. It may be a question, a personal story or a challenging image. After your introduction, develop your report in a series of clearly defined sections (like paragraphs in a written report). Your conclusion usually summarises your key points. If your report is going to be assessed, make sure you have fulfilled the criteria for assessment.
- Step 4** Support your report with clear visual material. This may be a set of graphs, maps or images. Do not just read your report to your audience.
- Step 5** Practise your presentation. Make sure that you do not exceed the time limit and that you know your information well enough to avoid having to read it. It may be a good idea to have some memory cards with key words or ideas written on them.



**Source 3** Try to find relevant images and visual materials (such as maps and graphs) to add variety and interest to your oral report.

- Step 6** Deliver your presentation. Make sure that you speak clearly and vary pitch and tone. Stand up straight, keep your hands out of your pockets and don't lean on a desk. Take a few deep breaths to calm yourself and then pretend that you are speaking to only one person.
- Step 7** Invite your audience to ask questions and do your best to answer them. If you are unsure of an answer don't make something up, just do your best.

#### Apply the skill

- 1** Prepare and deliver an oral report on an aspect of the Millennium Development Goal target to halve hunger by 2015. Your report must be supported by visual material and include responses to questions asked by the audience. Here are some possible topics to choose from, or you may like to develop your own.
  - There will always be hungry people in the world.
  - It is possible to halve hunger in some places but not others.
  - The solution to halving hunger is to ...
  - If we address the causes of poverty we will meet the goal of halving hunger.
  - The proportion of hungry people in the world is more likely to rise than to fall.

### Extend your understanding

Visit [www.un.org/millenniumgoals/](http://www.un.org/millenniumgoals/) to complete the following questions.

- 1** According to the UN, the Millennium Development Goal of halving hunger in developing nations was almost achieved. What were the rates of hunger in 1990 compared to 2015?

- 2** In 2015, how many people globally are estimated to be undernourished? How many of these people are children?

Gather some more information about the Sustainable Development Goal to achieve zero hunger by 2030. How does the UN plan to achieve this goal? Do you think they will be successful? Answer in a paragraph of 200 words.

# 3.11 Looking for answers

Over the course of human history, the world has seen dramatic and far-reaching changes. Humans have adapted to changes in the natural environment as well as building and changing the environment themselves. People have changed from being hunters and gatherers living in small communities to living as farmers and city dwellers. We have also improved our way of life through a series of remarkable revolutions: the **Agricultural Revolution**, the **Industrial Revolution** and the **Green Revolution**. These revolutions have allowed our populations to grow at an astonishing rate. In the rush to provide enough food and other raw materials to support our way of life, however, we are in danger of causing permanent damage to the very systems that support us – the soil, water and climate.

There are solutions, however, and some of them can be found in unusual places. Some solutions are based on developments at the forefront of technology, such as manipulating the genes of living organisms. Others come from the distant past; techniques used by Indigenous people who worked more closely with the natural systems of the Earth.

## Looking after the soil

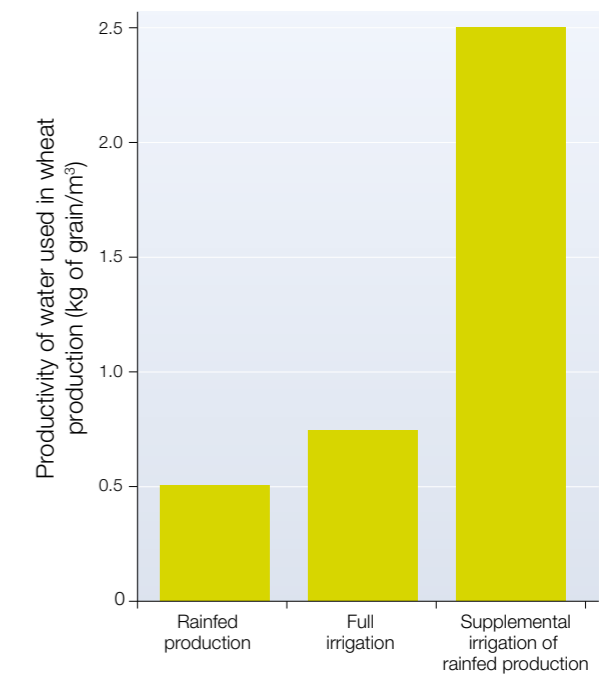
Soil is perhaps the farmer's most important resource. Many farming practices, however, such as ploughing, fertilising, clearing natural vegetation, irrigating and draining have degraded soil to such an extent that the soil can no longer support the same growth of crops as it did in the past. Many farmers are now changing their techniques to minimise their impact on the soil structure and nutrients by reducing ploughing, adding protective layers of organic material (mulch) and growing plants that help return nutrients to the soil.

## Water management

Modern techniques of measuring soil moisture and delivering water to plants and animals are helping to reduce poor water management techniques and improve results in yields. Measuring distribution of water not only conserves the resource, but avoids over-watering, which can lead to salty soils. Storing rainwater in dams and adding it to crops during critical growing times,



**Source 2** These Cambodian schoolgirls are learning how some insects can be used to control pest species in their rice crops.



**Source 3** Productivity of wheat production under various irrigation techniques, including supplemental irrigation.

for example, can triple the amount of wheat grown compared to irrigation systems that water the crops all year round (see Source 3).

## Pest control

The Green Revolution promoted the use of pesticides such as chemical sprays that helped to increase the amount of food grown in many places. Some of the

side-effects of using these pesticides, however – such as build-up of chemicals in the soil, loss of biodiversity and an immunity of some pests to the chemicals – have damaged some of the natural processes on which farmers depend. A range of techniques are now being developed and put into place around the world to reduce reliance on pesticides. Using natural pest controls such as ladybirds to reduce numbers of aphids on crops, for example, has been highly successful in many places (see Source 2).



**Source 1** Maize crops planted beneath Acacia trees in Africa are three times more productive than others nearby as the shade reduces evaporation and the falling leaves provide a natural fertiliser and mulch.

### Check your learning 3.11

#### Remember and understand

- 1 What are the advantages of growing crops in fields where trees are present? What might be some disadvantages?
- 2 List the ways in which using chemical pesticides may be harmful to the environment.

#### Apply and analyse

- 3 In Australia, adding mulch to the soil is a common practice for gardeners and farmers alike. What is mulch and how does it help look after soil and water?

- 4 Using Source 3, describe the advantages of adding water to wheat crops at the right time of the year.

#### Evaluate and create

- 5 Find an example of an animal species that has been successfully introduced to control another species.
- 6 Cane toads were brought to Australia to control pests but now cause more problems than the pests they were supposed to control. Research the introduction and spread of the cane toad. What lessons can be learnt from these experiences?

## 3.12 Indigenous land and resource management strategies

Aboriginal and Torres Strait Islander peoples have lived in Australia for at least 60 000 years, making them one of the world's oldest living cultures. Over this huge span of time, Indigenous Australians learned a great deal about the natural environment and developed many approaches and systems to help ensure food security. These systems varied from place to place depending on the food resources available.

Most Indigenous cultural groups were hunter-gatherers that moved around with the seasons. In fact, Indigenous peoples planned their annual migrations to coincide with the seasonal changes that influenced food availability. For example:

- In coastal regions, movements were timed with the springtime arrival of migratory birds such as the short-tailed shearwater.
- In rainforest regions, movements were timed with the fruiting of the bunya nuts.
- In mountain areas, movements were timed with the summer nesting of the bogong moth.

### Using fire to improve food security

From ancient times, Indigenous peoples in Australia have used fire as a hunting and land management tool. This practice continues to this day in some regions. Fires are usually lit in the cooler months so they can be more easily controlled. Many Europeans, such as Joseph Lycett (see Source 1), believed these fires were lit to make the hunting of large game such as kangaroos easier as animals were flushed out from their hiding places beneath shrubs and trees towards the waiting hunting party.

There is increasing evidence that deliberately-lit fires were also used to modify the landscape and to increase food security. The low-intensity fires favoured certain

plants such as orchids, grass and lilies. The fresh new grass growth would not only attract large herbivores such as wombats and wallabies (that could be hunted), but also provide food and store water in their roots.



**Source 1** This artwork, *Aborigines using fire to hunt kangaroos*, was painted by Joseph Lycett in the 1820s. Lycett was transported to Australia from England as a convict but, once released, painted many scenes of early colonial Australia.

In some places, fires were deliberately used over many years to change the vegetation. This created a mosaic of grasses and other plants of varying ages. This, in turn, attracted a range of bird and animal species including bilbies and emus. The ash left by the fires also contained minerals that helped plants to grow, thereby increasing the productivity of the land. The term firestick farming has been coined to describe this deliberate use of fire to manage the landscape.

The controlled burning of the land is also recognised as an important tool in reducing the threat of disaster fires as it removes much of the dry fuel from the landscape. Landscape managers in many parts of Australia are now using the same techniques used by Indigenous Australians for thousands of years to reduce the risk of bushfires.

### Fish traps

Freshwater fish were one of the most important food sources for thousands of Indigenous Australians. In many places, elaborate stone walls and channels were constructed to make the fish easier to catch. In the Darling River of inland New South Wales, large circular stone walls were made to take advantage of the rise and fall of the river throughout the year. When the river was full fish swam harmlessly above the traps, but as the level fell, many were trapped within the walls. In other places, walls across the rivers made of reeds and branches funnelled fish towards a gap in the middle. Using spears or specially woven baskets, the fish could be easily caught.

In south-western Victoria, the Gunditjmarra people constructed an intricate system of canals and dams that could be used to control the level of a swampy lake in the area known as Lake Condah (see Source 2) and to capture water in small ponds. These ponds were used to farm and harvest eels, providing food security over many generations.

Like most of Australia's early fish traps, those at Lake Condah now lie idle but provide proof of some of mankind's earliest attempts to harness the natural environment to provide a secure supply of food. In mid-2015 the Victorian Government put forward a proposal that the remaining traps should be listed as a World Heritage site, a status that would bring renewed interest and the promise of protection.



**Source 2** The stone walls and channels at Lake Condah are older than England's Stonehenge and the pyramids of Egypt.

### Check your learning 3.12

#### Remember and understand

- 1 How was fire used to help improve food security?
- 2 What lessons are modern land managers taking from the fire practices of Indigenous Australians in the past?

#### Apply and analyse

- 3 How would the seasonal movements of people help to ensure food security?
- 4 Look closely at Source 1.
  - a How are the Indigenous hunters using fire to help them hunt kangaroos?
  - b This painting has often been used to show that Aborigines used fire not only to change and

manage the landscape, but also as a hunting tool. Provide three pieces of evidence from the painting to support this theory.

#### Evaluate and create

- 5 Construct a sketch map of Source 1 to show the main ways in which fire is being used by the Indigenous people in this region. Use arrows and a legend to show wind direction and the movement of the kangaroos.
- 6 Research the criteria used to decide if a place is put on the World Heritage list. Do you think the Lake Condah fish traps meet any of these criteria?



# 3.13 Genetically modified food

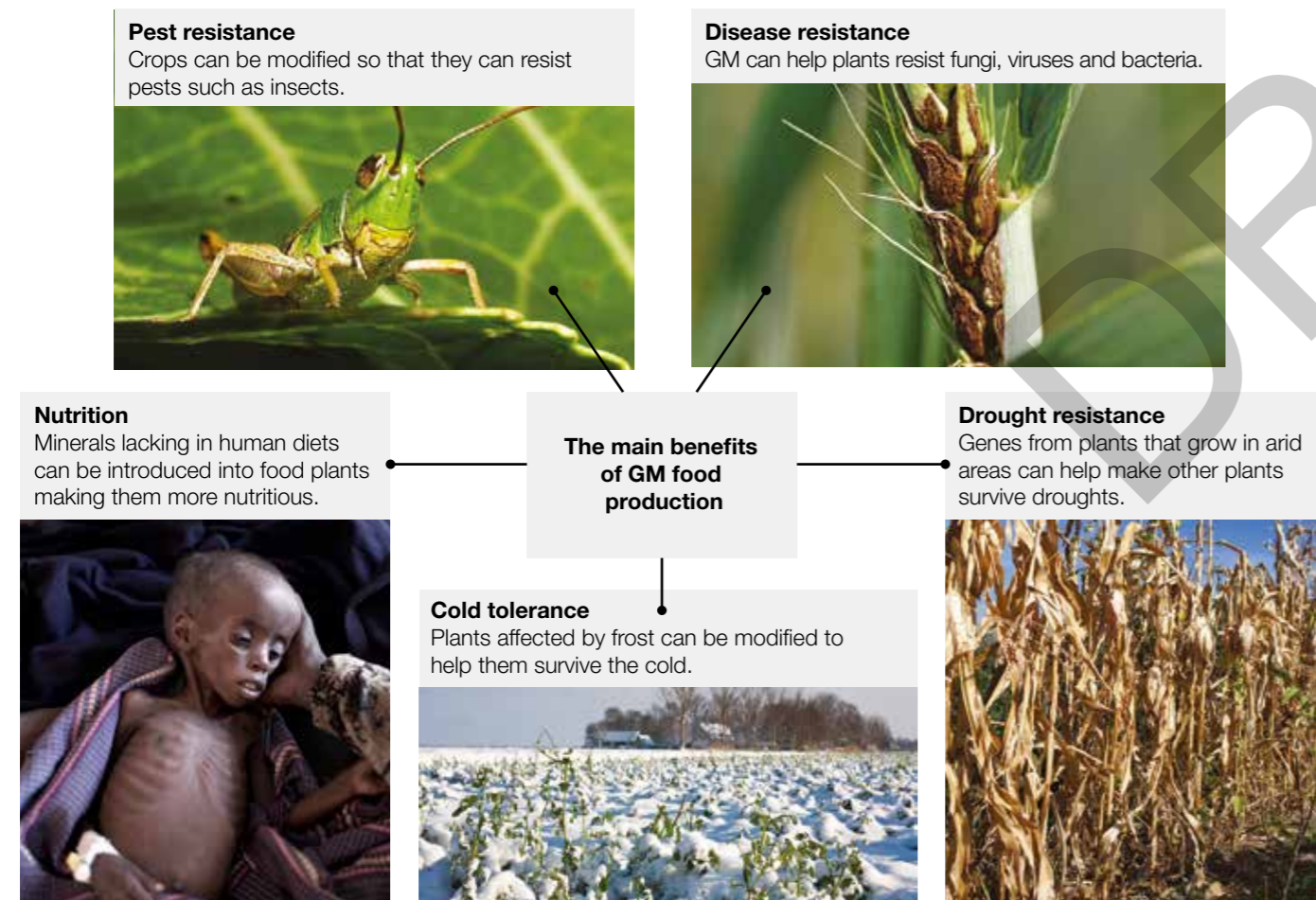
Farmers have taken advantage of natural genetic processes in their farming for generations. Dairy farmers, for example, will choose the most productive cows to breed with carefully selected bulls in order to produce offspring who produce the most milk. This is known as selective breeding.

Some farmers, using modern scientific discoveries and techniques, have taken this selection process a step further. All living things are made up of cells containing genes. These genes determine how each organism grows, acts and looks. Scientists are able to change the genes of plants and animals to give them certain desirable qualities known as traits. This is known as **genetic modification (GM)**. In one example of genetic modification, scientists developed a cotton plant that produced a natural insecticide. This has resulted in a 90 per cent decrease in the amount of chemicals used to control insect pests on many Australian cotton farms since 1996.



**Source 1** Some canola crops in Australia are genetically modified to produce larger yields and require fewer sprayings of herbicide. Canola is present in many foods such as margarine, bread, mayonnaise and potato chips.

## The main benefits of GM food production



**Source 2** The five main benefits of producing genetically modified food

## Opposition to GM foods

Many people are opposed to the genetic modification of food. They are concerned that GM foods are gradually becoming a part of our everyday diet without us knowing very much about the long-term effects. They are also concerned about the possible impacts of GM crops on other organisms such as the animals that eat the crops, which are then used for human consumption.

Environmentalists are worried about the impacts of GM crops on the environment and on the balance of ecosystems. They believe that some characteristics from GM plants, such as a resistance to herbicides (weed killers), may be passed onto other plants within the environment and even the weeds themselves.

## GM foods in Australia

In Australia, many foods containing GM plants are already available on our supermarket shelves. You have probably eaten some GM foods today. These foods are checked for their safety and must be labelled as being genetically modified (see Source 4).

**Source 3** Genetically modified foods that are available in Australia. The name of the GM crop (see column 1) differs from the way it appears on food labels (listed in column 2).

GM crop	The way it appears on ingredients lists	Examples of foods in which it may be used
Canola	<ul style="list-style-type: none"> <li>Vegetable oil, canola oil</li> </ul>	Cooking oil, margarine-type spreads, mayonnaise, bread, cakes, biscuits, snacks (such as potato chips)
Corn	<ul style="list-style-type: none"> <li>Glucose/glucose syrup/dextrose</li> </ul>	Cakes, biscuits, muffins, muesli bars, breakfast cereals
	<ul style="list-style-type: none"> <li>Fructose</li> </ul>	Cakes, muesli bars
	<ul style="list-style-type: none"> <li>Maltodextrin</li> </ul>	Simmer sauces, cake mixes, snacks, breakfast cereals, peanut butter
	<ul style="list-style-type: none"> <li>Modified starch/thickener</li> </ul>	Cakes, biscuits, muffins, muesli bars, sauces, breakfast cereals
Cotton	<ul style="list-style-type: none"> <li>Vegetable oil/cottonseed oil</li> </ul>	Cooking oil, margarine-type spreads, mayonnaise, snacks (such as potato chips), simmer sauces
Soya bean	<ul style="list-style-type: none"> <li>Soy oil/vegetable oil</li> </ul>	Mayonnaise
	<ul style="list-style-type: none"> <li>Soy protein/vegetable protein</li> </ul>	Breads, cakes, biscuits, snack foods
	<ul style="list-style-type: none"> <li>Soy lecithin/emulsifier (322)</li> </ul>	Breads, cakes, biscuits, chocolate, margarine-type spreads, sauces



**Source 4** In Australia, foods with genetically modified ingredients must disclose this on the label.

## Check your learning 3.13

Remember and understand

- 1 What are the main benefits of genetically modified foods?
- 2 Examine Source 3. Did you know that so many foods in Australia contain GM ingredients? Do you eat any of these foods regularly?

Apply and analyse

- 3 Check the food labels of five foods you eat often. How many of them contain GM ingredients? Compare this to your classmates' results and work out a percentage of these foods that are partially GM.
- 4 Why is it beneficial for farmers to reduce their use of chemicals such as pesticides and herbicides?

Evaluate and create

- 5 How do you feel about GM foods? Write a 250–300 word piece explaining your point of view and the reasons behind it.
- 6 Which of the benefits of GM food production do you think has the greatest potential to increase global food production? Give some reasons for your answer and discuss them with the class.
- 7 Research one of these GM crops: Golden rice, Bt cotton, Fortuna potatoes, Flavr Savr tomatoes or GM bananas. How, why and where have these crops been modified?

## 3.14 Conservation agriculture

Geographers and environmental scientists classify different farming and agricultural practices in terms of the impact they have on the environment. At one end of the scale is the type of farming that relies heavily on human intervention with nature, using technology. Turning over the soil with machinery (tilling), and adding chemical fertilisers and pesticides are characteristics of this type of farming.

At the other end of the scale is the type of farming that requires only minimal human interaction with nature and disturbance of the natural environment. Known as 'minimum impact farming' or '**conservation agriculture**', this type of farming is seen by many experts and farmers as the best way to increase food production while protecting and restoring the natural environment.

Conservation agriculture is the practice of adopting resource-saving production methods – adding elements such as water, seed and fertiliser that complement natural processes. This aims to achieve high and consistent levels of production, while conserving the environment at the same time. Australian farmers are leading the world in the adoption of this type of farming. A 2008 survey of Australian grain farmers found that about 80 per cent were using conservation agriculture techniques compared with less than 5 per cent in 1980.

The three key principles of conservation agriculture are:

- Principle 1 – Do not disturb the soil by tilling (see Source 1).
- Principle 2 – Keep the soil covered with organic material (see Source 2).
- Principle 3 – Grow a range of plants, not a single crop (see Source 3).



**Source 2** Principle 2: Keep the soil covered with organic material such as stalks from the previous harvest as mulch.



**Source 1** Principle 1: do not disturb the soil by tilling (turning it over). Plant crops by drilling seeds instead. Tilling leads to soil erosion and disturbs the microorganisms in the soil that are crucial for fertility.



**Source 3** Principle 3: Grow a range of plants including trees, shrubs, crops and pastures. This encourages natural biodiversity and crop nutrition and aids resilience to pests.

### keyconcept: Sustainability

#### Farmer-managed natural regeneration

A well-known form of conservation farming is called **permaculture**. This type of farming brings together the resources of the natural environment and the people who use those resources for their food, energy, shelter and other needs. The emphasis is on the careful and thoughtful use of nature to ensure the sustainability of Earth's ecosystems – using nature to support the farming rather than working against nature.

Farmer-managed **natural regeneration** is a form of permaculture used to combat poverty and hunger among poor subsistence farmers in developing countries. It uses old methods of management to encourage continuous growth of trees on farmland. When woodland management techniques are followed, trees are integrated into crops and grazing pastures. As a result

there is an increase in crop yields and soil fertility and a decrease in wind and heat damage, and soil erosion.

For more information on the key concept of sustainability refer to page XX of 'The geography toolkit'.



**Source 4** This area of Jordan is a garden developed by an Australian permaculture expert, which uses natural regeneration techniques.

## Case study: Regreening the desert in Niger

The country of Niger in Western Africa lies in the Sahel, a vast arid belt of savanna that crosses Africa, south of the Sahara Desert (see Source 5). This zone is considered to have the highest levels of food insecurity in the world. A combination of poor rains and overuse of the land and water mean that crops regularly fail there. In the last 25 years, however, there has been a remarkable transformation across much of Niger.

Five million hectares of degraded land have become productive again, increasing the amount of food grown in some areas fivefold. This produces an extra 500 000 tonnes of grain each year, feeding an extra 2.5 million people. Vast areas that were once infertile dust bowls incapable of supporting any farming are now green croplands, returning food security to one of the world's poorest nations.

This dramatic change is due largely to the work of an Australian, Tony Rinaudo, and a simple discovery he made in Niger. For generations Niger's farmers had seen trees in their fields as a source of wood for fuel and a nuisance to farming. Millions of trees had been cleared from the landscape to make way for small farms.

### 'An underground forest'

When Rinaudo arrived in Niger in 1981 he began planting new trees but they kept dying. He noticed, however, that the roots of the trees that had already been cleared still lay in the ground and were soon sending up new growth in the form of saplings. He called these roots an 'underground forest.'

He convinced a few farmers to carefully prune this new growth rather than clear it completely. The trees soon returned to the landscape bringing shade and wind protection to crops and animals, preventing erosion, providing firewood for the farmers and adding organic matter and nutrients to the soil. The crop yields of those farmers who pruned and protected their trees increased dramatically. Other farmers soon followed their example. It is estimated that around 200 million trees have been protected in Niger and the technique is now being used across the Sahel to help increase food security for millions of people.

## skilldrill: Data and information

### Analysing satellite images

A satellite image is a photograph taken from space. Satellite images have become one of the most useful tools for geographers, as they provide a snapshot in time of a large area of the Earth's surface. This allows us to identify patterns and changes over time, and to better understand the causes and effects of these patterns and changes.

When analysing a satellite image or set of images follow these simple steps.

**Step 1** Identify the exact area shown in the image or images. Use an atlas to verify where they were taken.

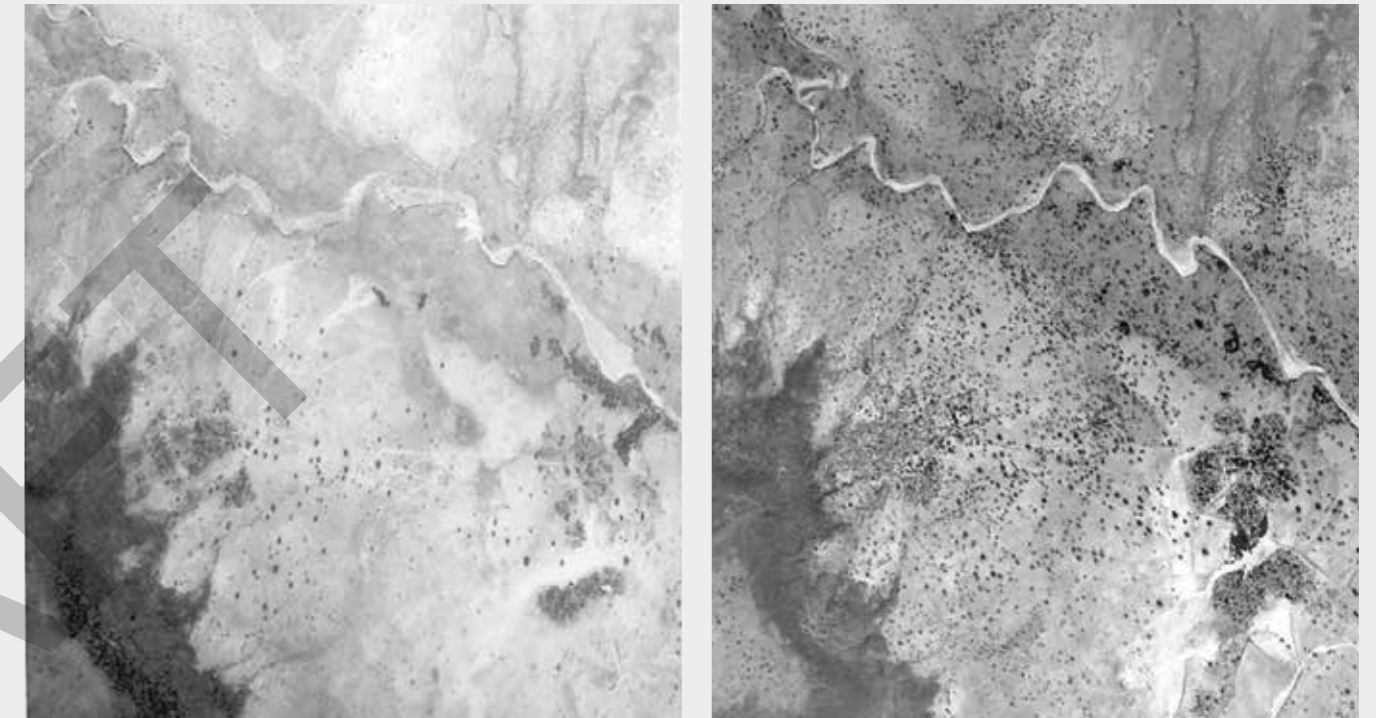
Take note of other features in the region such as international borders, mountains and cities.

**Step 2** Look closely at the image for features you can identify. A satellite image is taken from directly above (**plan view**) so objects appear in their correct location and size relative to each other.

**Step 3** When comparing two satellite images of the same places taken at different times note the dates when the images were taken. Look for changes that have occurred between these two dates.

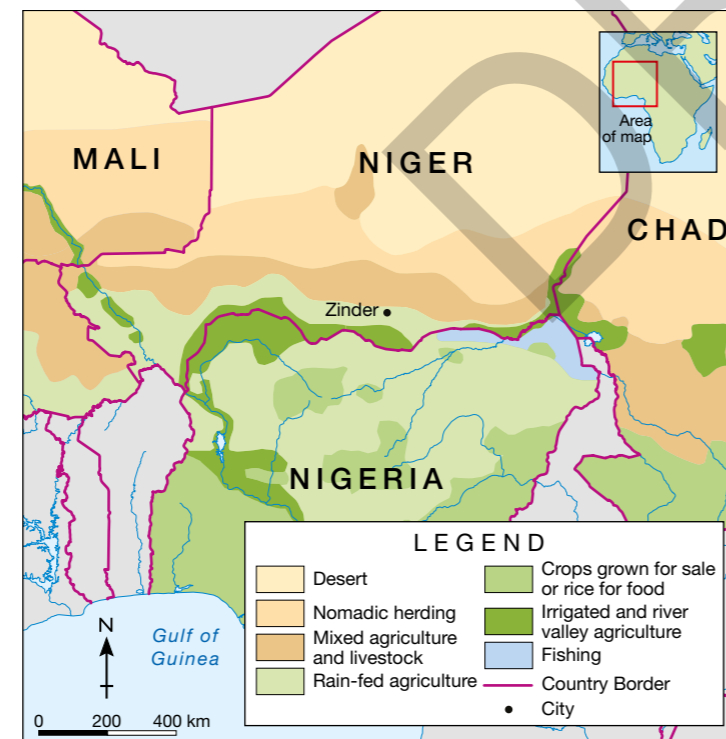
### Apply the skill

- Describe the landscape in the 1975 satellite image in Source 6. Each dark grey dot is a tree. Estimate the number of trees.
- Describe the changes between 1975 and 2005 in Source 6. Include an estimate of the number of trees and also their distribution.



Source 6 Dual satellite images of the Zinder area of southern Niger in 1975 (left) and 2005 (right).

AFRICA, NIGER: LAND USE IN THE SAHEL REGION



Source 5

Source: Oxford University Press

## Check your learning 3.14

### Remember and understand

- What is tilling?
- What are the three key principles of conservation agriculture?
- What is permaculture?
- Describe the method of revegetation developed by Tony Rinaudo.

### Apply and analyse

- Why is drilling seed directly into the soil better than tilling the ground and then planting seed?
- How does using a variety of plants (principle 3) help to reduce pests such as weeds and invasive insects?
- How does covering the soil with organic material (principle 2) help to conserve water? How would it benefit the soil?
- Examine Source 5. Describe the location of the Sahel.

- Describe land use patterns in Niger from north to south. Why do these variations in land use occur in this country?

### Evaluate and create

- The permaculture garden shown in Source 4 shows what is possible on a local scale. Do you think permaculture principles could be applied on a national or global scale? Discuss this with a partner and then with your class.
- Permaculturalists limit their use of chemical fertilisers and pesticides. How do you think they achieve this?
- You can use the historic imagery feature on Google Earth to explore satellite images and aerial photographs of Niger. Find a region that has changes similar to those in Source 6.
- What lessons from the experience in Niger could be applied to other places struggling to maintain food security?

3C rich task

# Food waste and food loss

It has been estimated that around one-third of all food is lost or wasted around the world every year. **Food loss** refers to the amount of food lost during the growing or production process. In developing countries, most food tends to be lost during production because of problems in harvesting, storing, cooling, packaging and marketing by producers. This equates to around 1.3 billion tonnes.

**Food waste** refers to the amount of food thrown away during the consumption process. In developed countries most food waste is carried out by consumers and retailers rather than food suppliers. Consumers tend to reject food that is not perfect in appearance. They also tend to buy too much food which spoils or passes its 'best-before' date. Reducing food waste and food loss would help increase food security in many places.



**Source 1** Australians tend to buy more food than they need, leading to a high level of food waste.



**Source 2** This Mongolian boy is transporting milk without refrigeration, which could lead to a high level of food loss.

**skilldrill:** Data and information

## Preparing an infographic

An increasingly popular way for geographers to present their findings and data is to prepare an infographic. Infographics use pictures and symbols to represent complex ideas and data so that information is clear and quickly accessible. Follow these steps to produce your own infographic.

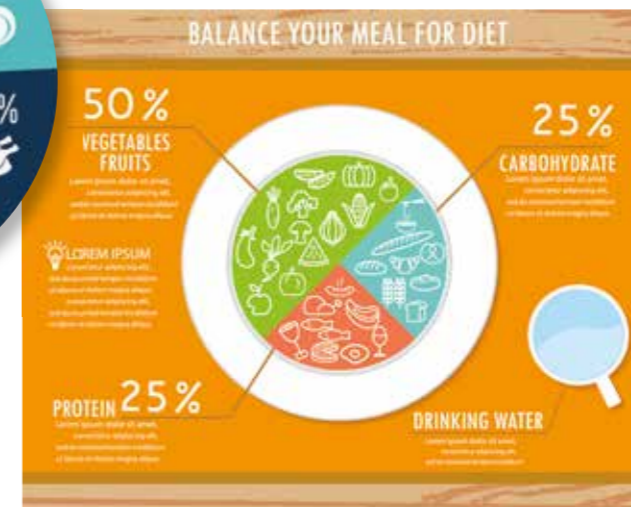
- Step 1** Decide on a topic and the message that you want to communicate to your audience. In the infographic in Source 4, for example, the key message is that people waste a huge quantity of food.
- Step 2** Research your topic and collect data that helps to communicate your key idea. Try not to have too much data; don't include more than 10 key facts or numbers.
- Step 3** Use a simple picture to communicate each of your key facts. The digger and hole in Source 5, for example, communicates that food is being dumped in landfill.
- Step 4** Lay your graphics out in a logical way that links together the key ideas. Make sure your infographic is not too cluttered. Give your infographic a catchy title that communicates your message – something like, 'From Farm to Plate', 'Waste not, want not' or 'Starve the landfill'.

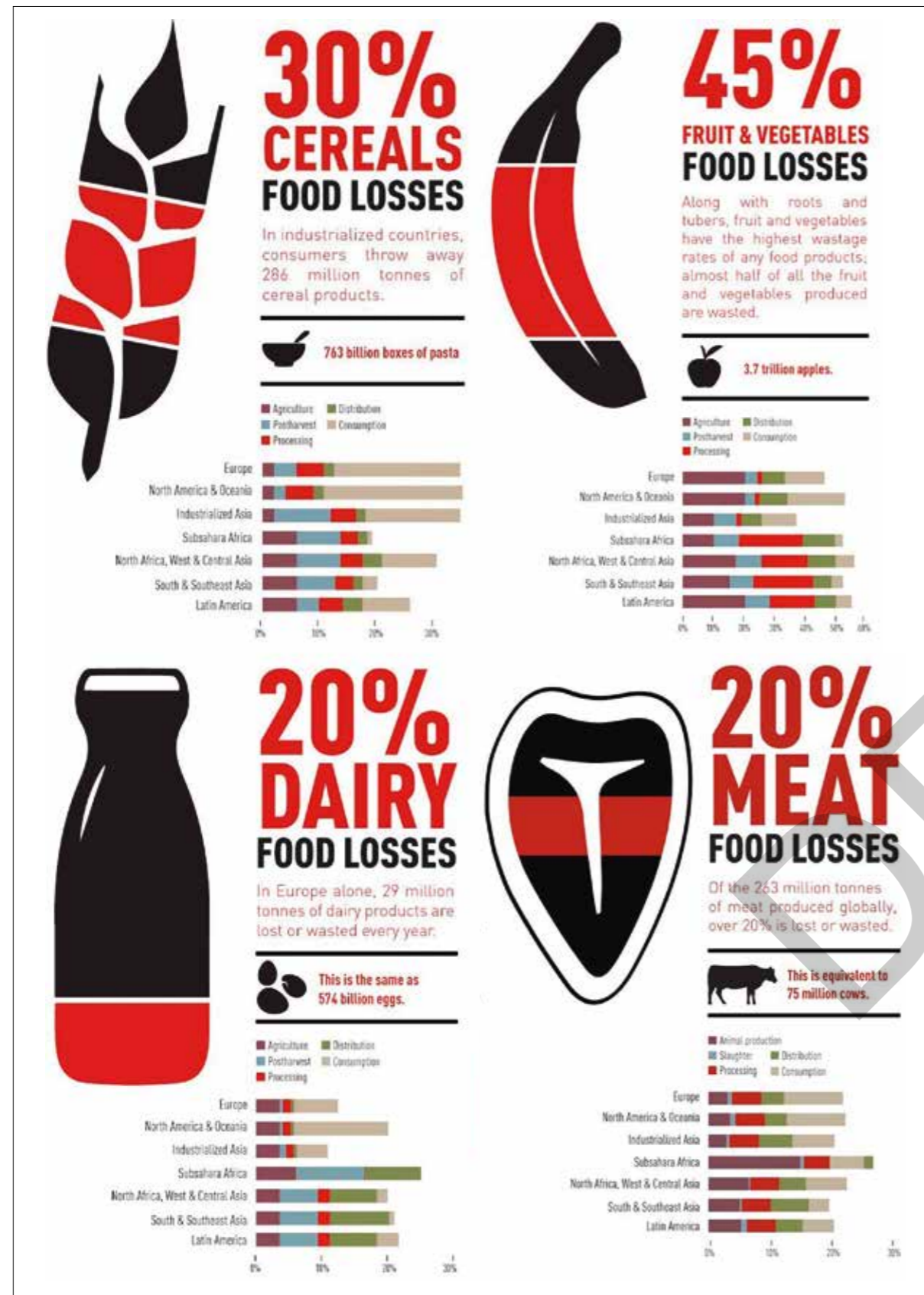
## Apply the skill

- 1** Design and present an infographic on an aspect of food waste. Here are some facts that you can use to help you get started. Many of these come from a UN report, *Global Food Losses and Food Waste*.
  - One-third of all food is wasted or lost.
  - Up to 50 per cent of fruits and vegetables are wasted every year.
  - Total food wasted and lost in North America, Oceania and Europe is 280–300 kilograms per person per year. The amount of this that is food wasted by consumers is 95–115 kilograms.
  - In Sub-Saharan Africa 120–170 kilograms is wasted or lost, about six kilograms of it by consumers.
  - In developing countries more than 40 per cent of food loss occurs in harvesting, transporting and processing. In developed countries more than 40 per cent of losses occur at the retailing and consuming stages.
  - The total amount of food wasted every year in developed countries is about the same as the total amount of food produced in Sub-Saharan Africa, which supports close to 900 million people.
  - One-third of all fish and seafood produced in North America and Oceania is wasted by consumers.
  - The cost of wasted food in Australia is about \$239 per person per year, or \$5.2 billion as a nation.



**Source 3** Infographics use pictures and symbols to represent complex ideas and data.





Source 4 Food waste is a serious issue for many countries around the world. This infographic shows the percentage of waste worldwide each year for different food groups.

**Extend** your understanding

- 1 Keep track of your household's food waste for a week. This means taking note of all edible food that is not eaten, and includes food that is wasted during meal preparation (such as peelings), food served but not eaten, or food that is spoiled and discarded. This could be placed into a bucket and weighed every day. Multiply the total amount by 52 to find out the amount of food wasted per year at your house. Compare this result to those of your classmates.
- 2 One of the main reasons why food is wasted in Australia is linked to consumer demand for fruit and vegetables that are pleasing in shape and appearance. Blemished items such as curved carrots or spotted apples are often taken out by the food producer, discarded by the retailer or not chosen by the consumer. Design an advertising campaign to reduce this aspect of food waste. Your campaign may take the form of a television, newspaper or social media advertisement, or a combination of these.



Source 5 Infographics are a good way to convey a lot of information in a simple, visual way so that it can be quickly understood.