11 Production, location and change

In this chapter you will learn about:

- The factors affecting agricultural land-use and practices on farms; the concept of an agricultural system with inputs, throughputs, subsystems and output; how food production might be increased by the intensification of agriculture and the extension of cultivation.
- A case study of the management of agricultural change – Kazakhstan.
- The factors affecting the location of manufacturing and related service industry including economies and diseconomies of scale, the effect of government policies on industry; industrial agglomeration, industrial estates, export processing zones and the informal sector of manufacturing and services.
- A case study of the management of change in manufacturing industry – Taiwan.

Agricultural systems and food production

This section looks at the factors affecting agricultural land use and practices.

Physical factors

Physical factors are important in the broad world patterns of agriculture. Different crops grow best under different physical conditions and yields of crops will differ. At a local level, or on an individual farm, physical factors may still be important in controlling differences in the pattern of land use and the farming practices, but less so.

Climate

Climate is the main factor in controlling the broad world distribution of crops. We think of certain crops such as palm oil or rubber as associated with humid tropical lands and others such as potatoes or oats as associated with colder climates. The real position is more complicated because crops are grown outside the areas where they originated and selective breeding has altered the climatic tolerances of crops.

The influence of climate on crop growth is illustrated by the world's three principal grain crops, wheat, maize and rice.

Wheat originated in the Middle East and Ethiopian Highlands. As Fig. 11.1 shows, today it is mainly a temperate crop but widely adapted to varying climate conditions. It needs a cool, dry climate for better growth and yield. A hot and humid climate is harmful because it encourages diseases such as rust. All crops have different climatic requirements at different stages of their growth but the optimum temperature range for wheat growth is between 21 °C and 24 °C. Without irrigation it needs 310–380 millimetres of rainfall in the growing season. The wide range of conditions in which wheat is grown is possible due to the complex nature of the plant's genome, which allows adaptation to a variety of conditions. Wheat also needs a lot of sunshine, especially when the grains are filling. In the temperate lands of western Europe and the areas bordering the Mediterranean it is the norm to grow 'winter wheat'. This is planted and goes through germination and early growth in the autumn. The crop ripens and is harvested in the following summer. In the extreme climates of the temperate continental interiors such as the Canadian prairies or the steppes of Russia, Ukraine and Kazakhstan this would be impossible and 'spring wheat' is grown. It is planted in the spring and harvested in the autumn. Here, a critical factor is the number of frost-free days with approximately 130 needed for high yields.

Fig. 11.1 A simplified map showing some of the world's main wheat growing areas

Rice originates from the Pearl River valley region of China (The People's Republic of China or PRC). Today it is principally a tropical and sub-tropical plant, as Fig. 11.2 shows. Rice growing is controlled by temperatures at the different phases of growth. The best mean temperature for flowering and

fertilisation ranges from 16 to 20 °C. During ripening the range is from 18 to 32 °C. Temperatures above 35 °C prevent the grain from swelling. The yield of rice is influenced by the amount of sunshine, particularly during the last 35 to 45 days of its ripening period. If the mean temperature is favourable for rice cultivation throughout the year then, unlike other grains, two or three crops can be grown. Where winter temperature is fairly low, only one crop of rice is grown.

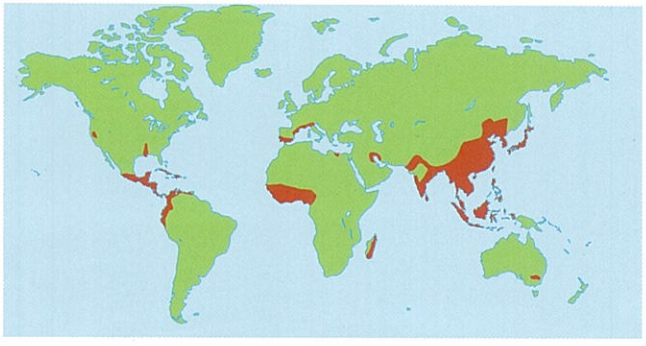


Fig. 11.2 A simplified map showing some of the world's main rice growing areas

Maize (also known as corn or mealie in different parts of the world) originates from Central America. Optimum temperatures for maize are 12 °C or more for germination and 18–32 °C for growth. The optimal amount of rainfall is 500–1200 millimetres, although maize is grown with less rainfall if dry farming methods are practised. Maize is a short-day crop and grows best nearer to the equator. However, as Fig. 11.3 shows, it is grown in a wide range of latitudes.

Fig. 11.3 A simplified map showing some of the world's main maize growing areas

1. Using Figs 11.1, 11.2 and 11.3, describe the world distribution of the growth of wheat, rice and maize.

We have looked at the effects of temperatures, rainfall totals and sunshine hours on grain crops; however, it is the variability of the climate from year to year which is a critical factor for many farmers – particularly rainfall variability and **drought**. Drought occurs in many climates but is a particular feature of dry savanna and semi-arid areas where failure of the summer rains can lead to famine. The links with desertification and the problems of sustainable management in a semi-arid environment in an LIC have already been discussed in Chapter 10, with reference to the Sahel in West Africa.

Soil

The soil factors which affect crop growth are drainage and water retention capacity, acidity and soil structure. Soils with a good structure formed by a high humus content and a good range of particle sizes not only have a good balance of water retention and drainage but they also retain fertilisers and are not prone to excessive leaching of nutrients. Such soils are referred to as **loams** and are favoured by most crops. The structure binds the particles together so that the soil is less prone to erosion.

Although wheat is grown in different types of soils ranging from desert soil to heavy clay, it has been grown particularly successfully on the black **chernozem** soils of the prairies of North America and the steppes of Eurasia. These soils have been formed by the decay of temperate grasslands which has built up a very high humus content. The potential evapotranspiration exceeds precipitation which means that there is limited leaching of the soluble nutrients, particularly nitrates, phosphates and potassium salts.

Where the climate is too arid there may be excessive accumulation of salts (salinisation) and high pH values which inhibit crop growth. Salinity reduces the uptake of water and minerals and decreases dry matter production. Some ions such as sodium may be toxic to certain plants. This problem is sometimes made worse by irrigation with saline water or by failing to drain during irrigation. The level of salt tolerance of different plants is often much less than the salt tolerance of animals in their drinking water. Humans can drink saline water that would kill many plants. The UN Food and Agriculture Organization (FAO) has classified plants by their salt tolerance.

Level of salt tolerance	Examples
Tolerant	Barley, rape seed, cotton, sugar beet, durum wheat
Moderately tolerant	Soya, sorghum, sunflower, wheat
Moderately sensitive	Maize, groundnuts, many vegetable crops
Sensitive	Carrots, padi rice, onions

Table 11.1 Levels of salt tolerance of crops

Land and its relief

In the world's temperate lands, the most favourable agricultural land is often at low altitudes. This is for a variety of reasons:

- → The land is generally flatter and allows easier mechanisation.
- → Soils are thicker.

- Higher altitudes have colder temperatures and more snow.
- The areas are more remote from markets.

In Europe and North America upland areas have tended to have pastoral systems such as dairying in the Alps and ranching on the High Plains of the USA. In these areas aspect is an important factor with the sunny slopes being favoured for cultivation. In the northern hemisphere this is south facing and in the southern hemisphere north facing. This is seen in the adret (sunny) and ubac (shaded) slopes in the Alps or the south-facing Norwegian fiord slopes which are favoured for fruit production.

An exception to this rule is where river flood plains are used for pasture (and not cultivation) because animals can be moved more easily in times of flooding. Alternatively, they are used for fodder crops such as hay which can recover more easily after flooding.

In the tropics, this situation is often reversed. The lower areas may be unfavourable for these reasons:

- They are more prone to malaria.
- The tsetse fly carrying the disease nagana (trypanosomiasis or sleeping sickness in humans) prevents cattle-keeping.
- Flooding can cause crop failure.

Nevertheless, the flood plains of Bangladesh, Pakistan and Egypt are intensively cultivated because of naturally fertile alluvial soils and supplies of irrigation water. In contrast, some higher areas have the advantages of:

- cooler, more comfortable temperatures
- naturally fertile volcanic soils in areas such as the Andes or Kenyan Highlands.

Where highlands are cultivated, the steeper slopes often require more intensive methods such as terracing.

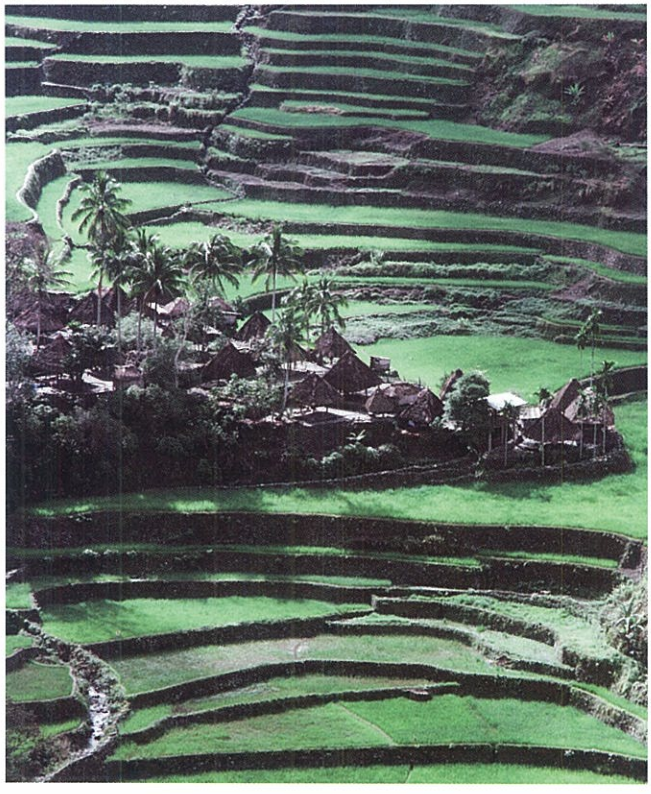


Fig. 11.4 Rice cultivation on terraces in Thailand

Human (social, economic and political) factors

Irrigation

Much of the world's agriculture uses a supplementary water supply, either from rivers or groundwater. It has been estimated that irrigated cropland provides as much as 40 per cent of the world's food supply. This includes

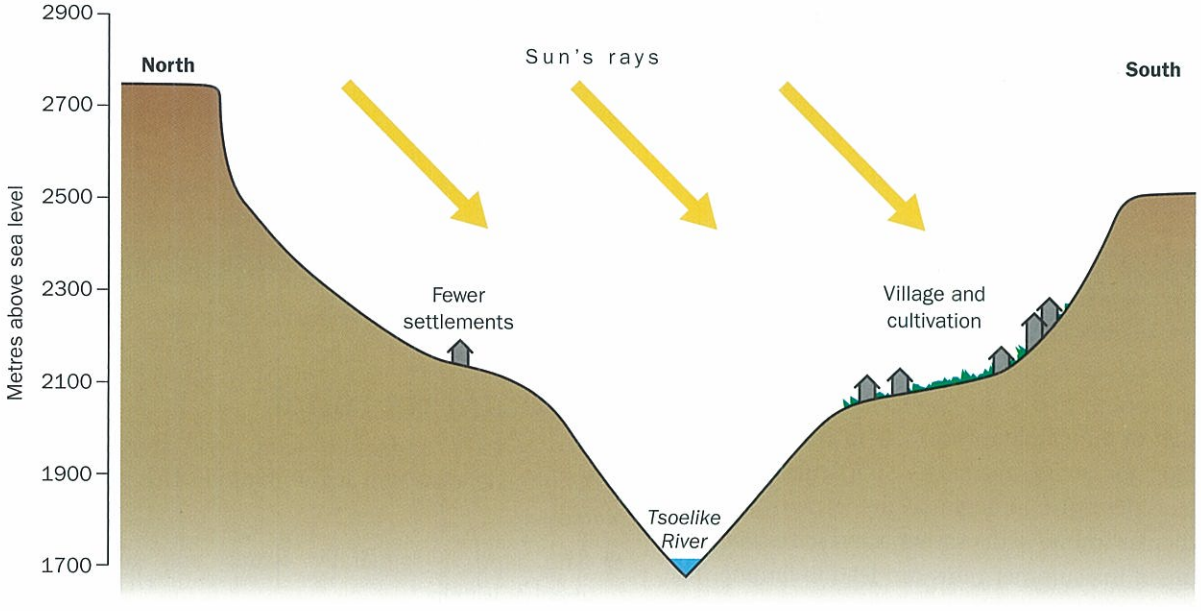


Fig. 11.5 A cross section through the Tsoelike valley in Lesotho, southern Africa

highly sophisticated systems used on commercial farms and more basic methods used on subsistence farms. In some of these areas, such as the Nile valley, cultivation would be impossible without irrigation and in others it is used to boost yields. Water is drained from rivers, or from dams, or pumped from the ground and then applied to the land by a variety of methods. The names used for these methods vary, which can be confusing, but they include:

- channels or furrows between the rows of crops
- pipes with holes in them running between rows of crops
- overhead sprays
- booms which move over the crop, either rotating (using a centre pivot) or moving to and fro over the field.

Fig. 11.6 Boom irrigation has produced the circular patterns of green cultivation in the brown land seen in this aerial photograph of Free State, South Africa

Fig. 11.7 Overhead spray irrigation of an alfafa fodder crop. The fruit trees in the background are irrigated by pipes

Fig. 11.8 An overhead irrigation boom moving along a field

As well as the irrigation needs of arable crops, water needs of pastoral farming should not be overlooked. For example, a dairy cow producing milk in a modern system will need 95–115 litres of water a day. In dry lands pastoral farmers use groundwater or build small dams which trap water in the wet season.

It is estimated that water **abstraction** for agriculture far exceeds that for industrial or domestic use. This is a particular issue if irrigation is to be used to extend agricultural land. The UNESCO World Water Assessment Program forecasts a 40 per cent increase in global freshwater demand and a corresponding 35 per cent decrease in per person supply by the year 2025.

In the section above about soil, reference was made to the salt tolerance of different plants. This is an issue in irrigated agriculture because much irrigated land is affected by salinity. Salts are introduced to the soil in the irrigation water. This water evaporates and salts accumulate in the soil. The capillary rise of soil moisture also draws salts to the surface. Continued irrigation often leads to increasing salinisation. Of the world's 1.5 billion hectares of dryland agriculture, 32 million hectares are affected by salinity. Much of the land which has been used for maize, rice and soya produces lower yields or is out of production. Commercial companies are attempting to breed crop varieties that are more salt-tolerant.

2. Explain how irrigation can lead to the salinisation of crop land.

Land tenure and social structures

The way land is owned and managed varies greatly and affects how land is developed. Existing systems are:

- individual ownership

- communal ownership
- state ownership
- ownership by companies, including trans-national corporations (TNCs).

In Eastern Nigeria land tenure systems in the densely populated rural areas are affected by population pressure, leading to communal land coming under individual ownership under the government's Land Use Decree (LUD). Large-scale capital-intensive agricultural production is usually restricted to communal tenure because of the difficulties of acquiring a sufficiently large area under private ownership. **Communal land tenure** is based on the inalienable and equal rights of joint ownership of land by every member of the community, with some appointed members, usually elders and titled men, given the responsibility to act on behalf of others as custodians of the land.

In many rural areas in eastern Nigeria, outright purchase of such land is difficult; in a few, it is even prohibited by the lineage or clan. In spite of these restrictions, the outright sale of land to individuals by either family members or even whole communities is becoming a lucrative business in some rural communities in eastern Nigeria. This has resulted in a class of well-to-do landed gentry, members of which have bought out the rural poor.

In a few cases, individual landowners with enough capital have been able to establish agriculturally-based industries in rural areas, but most owners have not been able to do so because of lack of capital. Landowners have the advantage of almost complete security of tenure, no rent exploitation, the freedom to farm as they want, the ability to mortgage their land for capital, and the knowledge that improvements are for their own benefit. When established, such farming enterprises generate employment opportunities and enhance the economic and social well-being of people in the community.

There are some state-owned projects which are usually large since the state is able to allocate sufficient land. This enables investors to embark on large-scale production on secure tenure terms. Employment opportunities are created in such communities and, by using local raw materials, the inhabitants enjoy increased income and improved welfare. However, the area of state-held land in rural areas is small, hence the small number of projects located on such lands.

In the rural areas of Swaziland, most of the population are subsistence farmers. Many of them live on Swazi National Land. This makes up over 60 per cent of the total land area of the country. It is held in trust by the king for the Swazi people and supports about 70 per cent of the population. Under the traditional land system, farmers cultivate small plots, averaging less than 3 hectares, and have no right to sell this land. The main crop is maize and farmers keep a few cattle. The system of Swazi National Lands has sometimes led to fragmentation - fields being separated from each other and from the household - so that farmers might have to walk for up to 3 kilometres to reach their fields.

The effects of the land tenure system on agriculture in Zimbabwe have been particularly contentious. The country became legally independent in 1980 following a civil war. In 1979 Zimbabwean whites made up 5 per cent of the population of whom 4 500 were farmers who owned 70 per cent of the most fertile land. The reform of land tenure to achieve a more equitable distribution has been in two phases. From 1979 to 2000 white farmers were allowed to sell land with economic help from the former colonial power, the UK. A second phase began in 2000 - the fast-track land reform programme involved the forcible removal of white farmers and re-allocation of land. Opinions on the success of the programme have been divided. In 2010 the Institute of Development Studies of the University of Sussex published a report which gave a favourable view of the reforms.

Whatever the truth the production of export crops has decreased greatly. About 45 per cent of the population is now considered malnourished and production of the staple food crop, maize, has decreased. The small plots of ordinary black farmers are now producing quite well but productivity is still somewhat lower than before land reform, with 2012 tobacco production of US$ 400 million compared to peak production of US$ 800 million. Profits are much more widely distributed. As a reaction to the fast-track land reform, the US government put the Zimbabwean government on a credit freeze in 2001 which affected the economy.

Between 1917 and 1990 all agricultural land in the then Soviet Union was in state ownership and governed by a '**command economy**', in other words farms had to respond only to production targets set by the government and a market controlled by the government. Land was organised in large collective farms. When the Soviet Union broke up, the land and farm assets were privatised and had to respond to a market economy. The share of state-owned agricultural land decreased from 100 per cent in 1990 to less than 40 per cent in 2000.

Agriculture in what is now Russia survived a severe transition decline in the early years because of the loss of state-guaranteed marketing and supply of materials. In less than 10 years, livestock numbers decreased by about 50 per cent, reducing demand for feed grains, and the area planted to grains dropped by 25 per cent. Farm inputs decreased because most farms lacked the capital to invest. Improvement is now taking place, there are more small farms which are operating with greater efficiency.

Russian agriculture today is characterized by three main types of farms, corporate farms and household plots which existed all through the Soviet period and the new peasant farms.

Farm type	1990 (% of total output)	2005 (% of total output)
Corporate farms	74	41
Household plots	26	53
Peasant farms	0	6

Table 11.2 How agricultural production has changed in Russia

Initially peasants had no experience of management and there was uncertainty about the new systems such as marketing so few were interested in establishing individual farms. Large farms remained largely unchanged. The corporate farms continued to operate largely as they had done under the Soviet system.

Privatisation of land ownership so far has resulted in limited transfer of control to individuals and most land privatised by the state is managed by large-scale corporate successors of former collective farms.

The role of multinational corporations is discussed in the case study of Kenya later in this chapter.

3. List the advantages and disadvantages of different systems of land tenure.

Capital

In large-scale commercial farming, the large capital input is a key feature. The capital could be raised through bank loans or provided directly by a multinational corporation owner. The capital input allows for the purchase of the land, a paid labour force (often skilled), research and development, modern mechanisation, improved crop varieties and hybrids, inputs of fertiliser, pesticide, herbicide and, where necessary, drainage and irrigation. On smaller commercial farms the smaller profit margins mean that it is more difficult to find capital to invest, including through bank loans. This applies in HICs, MICs and LICs.

Lack of capital input is an issue which prevents many subsistence farmers from increasing their output. Poverty means that farmers lack capital and do not have money to buy improved seeds and fertiliser. Those who do not have teams of oxen for ploughing find it difficult to rent tractors. In some countries subsidised farming inputs such as seeds and fertiliser, especially for farmers of small areas, can help overcome the lack of capital. One scheme would require farmers to pay for one-third of the cost of the inputs. Farm mechanisation is a major issue where farmers lack capital and can be helped by equipment hire schemes. In some areas the formation of cooperatives is important in getting bank credit.

In the previous state capital systems of the former Soviet Union and China, the command economy meant that central planning decided on production targets and all capital came from central government.

In the capitalist countries of western Europe farmers raise capital through bank loans. However, capital can also be raised through grants from the EU for specific projects. This is dealt with in the following section on government influence.

Government influence and political factors

Agricultural subsidies from governments are common in the developed world. The aim has been to encourage increased production and to ensure a basic level of income to farmers. Farmers' decision making is heavily influenced by this. For example, a 2007 study by the Organisation for Economic Co-operation and Development (OECD) found that farms in countries in Europe could get between 30 per cent and 70 per cent of their income through subsidies.

Fig. 11.9 Autumn ploughing on a farm in Devon, UK

Agriculture in the **EU** is controlled by a system of subsidies and programmes called the **Common Agricultural Policy** (CAP). It was introduced in 1962 and has undergone many changes since then. The CAP is highly complex and constantly changing but it is a critical factor in the decision making of farmers within the EU. Look at Fig. 11.9. The land-use on this farm in any year will depend on the subsidised prices for wheat, the quota the farmer has for milk production, the environmental grants available for woodlands and hedgerows and 'set-aside' grants not to produce certain commodities.

The CAP is a system of measures which works by maintaining agricultural commodity prices within the EU and by subsidising production. The detail of the CAP is beyond the scope of this book but the measures which have been applied are subject to constant change. However they have included the following:

- Import levies were placed on specified goods imported into the EU which raises the prices of these goods to the 'target price'.

- Import quotas were set to restrict the amount of food being imported into the EU. Countries which had a traditional trade link with a member country may be exempt.
- An internal intervention price can be set. If the internal market price falls below the intervention level then the EU will buy up goods to raise the price to the intervention level, guaranteeing the price to farmers.
- Direct subsidies were paid to farmers. This was originally intended to encourage farmers to choose to grow those crops attracting subsidies and maintain home-grown supplies. Subsidies were generally paid on the area of land growing a particular crop, rather than on the total amount of crop produced.
- Production quotas and set-aside payments (paying farmers not to use land) were introduced in an effort to prevent overproduction of some foods (e.g. milk, grain, wine) that attracted subsidies well in excess of market prices. The excess produce needed storing and was heavily criticised.

From 2015 two key production quotas are to be abolished. There are concerns that the abolition of the sugar quota (after lobbying from international sugar producers such as the drinks companies) will flood the world market with cheaper sugar produced from sugar beet grown in the EU. This would adversely affect sugar cane producers in countries such as Jamaica. Sugar beet grown in the EU is subsidised at around US$27 per tonne. The abolition of milk quotas may allow EU milk producers to increase production and exports to growing markets such as China but lower prices could adversely affect other producers.

In 2000 the Rural Development Policy, known as the 'second pillar' of the CAP, was introduced. This policy aims to encourage the economic, social and environmental development in the countryside. Its budget is allocated along three 'axes'.

- The first axis aims to improve the competitiveness of the farm and forestry sector through support for restructuring, development and innovation.
- The second axis aims to improve the environment and the countryside through support for land management as well as helping to fight climate change. Such projects could, for example, concern preserving water quality, sustainable land management, planting trees to prevent erosion and floods.
- The third axis aims to improve the quality of life in rural areas and encouraging diversification of economic activity into activities such as tourism.

Achievements of the CAP

- It has protected the 'rural way of life', for example helping small farms to remain in existence.
- The policy has achieved its goal in increasing agricultural production and improving Europe's ability to feed itself as it emerged from the Second World War. The average EU household today spends 15 per cent of its budget on food, compared to 30 per cent in 1960.
- Consumer prices have been stabilised. For example in 2010, the EU announced its intention to sell some of its cereal stocks when a Russian grain export ban caused world wheat prices to rise to a two-year high.
- Since 2010 large amounts of money have been spent on environmental challenges in agriculture such as protecting and promoting biodiversity in the countryside.

Criticisms often heard about the CAP

- Urbanised member states where agriculture comprises only a small part of the economy, such as the Netherlands and the UK, are much smaller beneficiaries and the CAP is less popular in these countries. Countries with larger agricultural sectors including France and Spain receive more money under the CAP. Other countries receive more benefit from different areas of the EU budget. Most Europeans live in towns and cities and only 5.4 per cent of the EU's population works on farms, and the farming sector is responsible for 1.6 per cent of the GDP of the EU (2005). This is decreasing each year.
- It is highly bureaucratic and costly to administer.
- The CAP rewards larger producers disproportionately. The CAP has usually rewarded farmers who produce more, so larger farms have benefited much more from subsidies than smaller farms. As a result, most CAP subsidies have made their way to large-scale farmers. Some large landowners can receive extremely large subsidies in excess of €5 000 000 per year.
- Subsidies mean unfair competition with LICs and MICs which are highly dependent on agriculture. The UN Food and Agriculture Organization (FAO) has estimated that agriculture provides for the livelihood of 70 per cent of the world's poorest people. It is claimed that the subsidies of the CAP are preventing LICs and MICs from exporting agricultural produce to the EU fairly. However, the EU is the world's biggest importer of farm products from developing countries and under the Economic Partnership Agreements some LICs and MICs have had full duty-free and quota free access for certain commodities.
- The system has encouraged overproduction. The EU purchases millions of tonnes of surplus output every year at a guaranteed market price and stores this produce in large quantities (leading to what critics have called 'butter mountains' and 'milk lakes'), before selling the produce wholesale to developing nations.
- Parts of the EU stocks are exported with the use of export subsidies. It is argued that many African and Asian

dairy, tomato and poultry farmers cannot keep up with cheap competition from Europe. At the same time, many urbanised families in the developing world benefit from the cheaper products from Europe.

- CAP price intervention has been criticised for creating artificially high food prices throughout the EU. High import tariffs (estimated at 18–28 per cent) have the effect of keeping prices high by restricting competition by non-EU producers.
- It is sometimes claimed that the CAP has allowed farmers to employ unecological ways of increasing production, such as the indiscriminate use of fertilisers and pesticides, with serious environmental consequences. The CAP has been criticised because of its impact on bird populations. Between 1980 and 2009, the farmland bird population has decreased dramatically partly due to the removal of hedgerows and ploughing over permanent grassland. In more recent years environmental considerations have strengthened and farmers will have to face cuts in their subsidy levels if they do not meet the strict environmental requirements. The 2000 Rural Development Policy aims to address these claims.

Market influence, demand and distance from markets

The previous section showed how government intervention can control markets. However, one of the earliest attempts to explain the effects of markets was by the German geographer Von Thünen in his model of agricultural land use in *Der Isolierte Staat in Beziehung auf Landwirtschaft* (*The Isolated State*) which he began to develop in 1826. This was one of the earliest uses of models (theories) in geography and assumed a state without external links, a single city, farmers operating at maximum efficiency, a flat uniform plain and equal availability of transport.

With these assumptions, Von Thünen produced a land-use pattern of concentric rings around the single city.

In the model, the relative costs of transporting different agricultural commodities to the central market determine the land use. The different land uses compete for the closest land to the market. The model compares the relationships between production cost, the market price and the transport cost of an agricultural commodity. Profit is the market price minus the transport and production costs. The most productive activities (gardening or milk production) or activities having high transport costs (firewood) locate nearby the market.

Von Thünen then introduced differences in soil, markets and transport which distorted the concentric pattern.

Although it is difficult to identify concentric land-use zones today, some of the effects that Von Thünen identified can be seen. For example, in the UK many major cities have market-gardening zones in close proximity (for London this zone is Kent, for Birmingham it is the Vale of Evesham, and Liverpool and Manchester have the Ormskirk area). In the past, perishable produce such as vegetables and milk needed to be produced close to markets with appropriate transport systems. Modern refrigeration has made this obsolete but many of the traditional areas have remained.

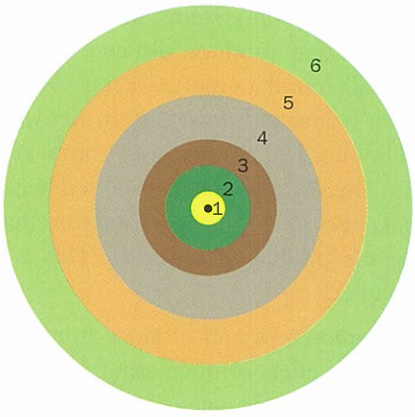


Fig. 11.10 Von Thünen's concentric land-use pattern

4. Study Fig. 11.11 and suggest how it shows the effects of physical and economic factors.

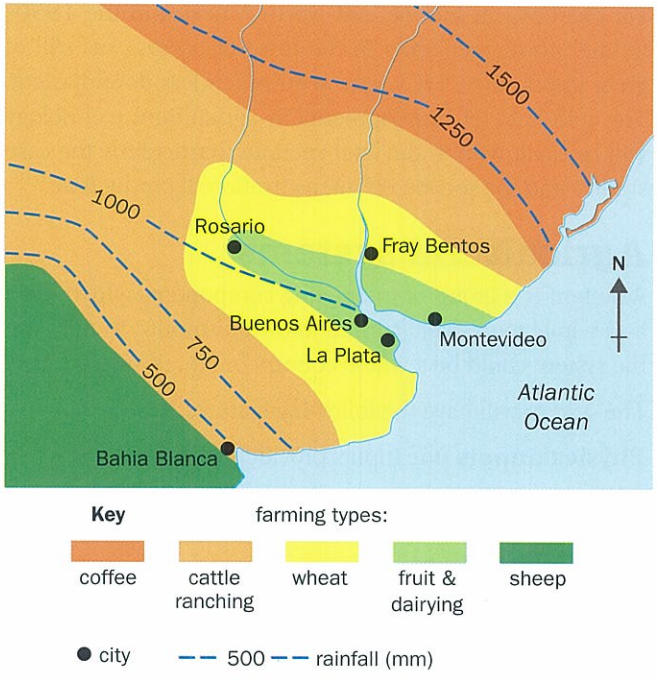


Fig. 11.11 Agricultural land-use zones in part of Argentina and Uruguay

Some modern production systems seem to indicate that, for relatively high-value produce, distance from markets is not a factor. A walk round a supermarket in western Europe will show green beans and flowers from Kenya and other similar commodities. The market price can bear the heavy transport costs. This trade has been criticised because of the environmental effects of air transport and the effect on food production in the producing countries. This is discussed later in this chapter.

In many LICs remoteness and distance from markets has a serious inhibiting effect on increasing the production of commercial crops. In areas connected only by long gravel roads, small farmers cannot get crops to market easily and are trapped in a subsistence way of life.

5. Explain why perfect concentric zones of land-use do not occur.

Agricultural technology

This includes developments in:

- machinery
- plant breeding such as hybridisation and genetic modification
- animal breeding
- drainage systems
- irrigation systems
- pest control
- soil improvement.

Great advances have been made in HICs in all these areas. For example, in Europe and North America in the 1950s animal power, generally in the form of horses, was still of great importance. LICs have seen much less development. The influence of developments in agricultural technology will be dealt with in the later sections, particularly the case studies and the section on intensification of production.

Agricultural systems

A system is a group of interacting components which react as a whole to external stimuli known as inputs. In this case the system could be a whole country or an individual farm.

The system will have the following features.

Physical inputs (the inputs provided by nature) are:

- temperatures
- rainfall
- sunshine
- soil
- land
- fodder.

Human inputs (the inputs provided by people) are:

- capital
- labour
- machinery and tools
- seeds
- government influence
- market influence
- fertilisers, pesticides and herbicides
- irrigation.

The inputs are transformed into outputs by the processes taking place.

Outputs are:

- crops
- meat
- milk
- industrial products such as cotton, rubber or leather.

Processes (the methods people use to produce the outputs) are:

- preparation of the land: clearing vegetation, providing terracing, drainage and irrigation systems
- ploughing
- sowing
- weeding
- application of fertilisers, pesticides, herbicides and irrigation
- harvesting
- storage and transporting to market
- milking.

Throughputs are things which are transferred through a system. In the case of agriculture it could be physical features such as water or plant nutrients or human attributes such as information or knowledge.

Systems have boundaries, in this case capital, amount of available land, topography, technology and the skill of the farm manager.

The farming system may be regarded as being made up of a series of interacting **subsystems**. Each of these will have its own inputs and outputs. These could include:

- animals
- plants
- soil
- human features.

This is illustrated in Fig.. 11.12.

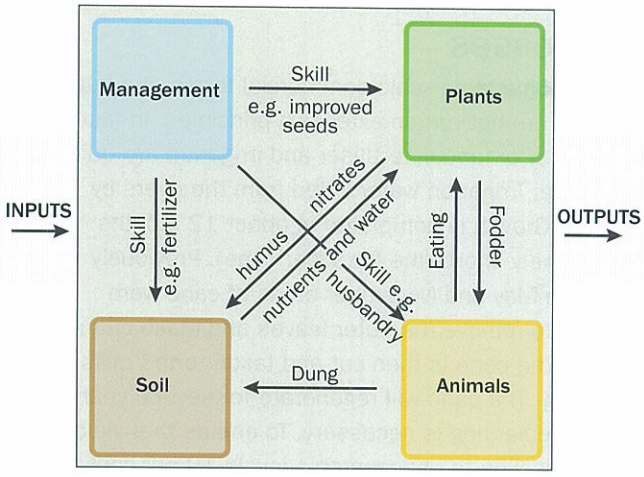


Fig. 11.12 Interacting subsystems within a farming system. Note that the subsystems for management, plants, soil and animals all have their own inputs and outputs

Case study: An arable system: sugar cane in Swaziland, in southern Africa

Sugar growing in Swaziland is in the Low Veld area of the east of the country around three sugar mills at Ubombo (opened 1958), Mhlume (opened 1960) and Simunye (opened 1980). The operations of the Swaziland sugar industry are regulated by a national body, the Swaziland Sugar Association (SSA). Mhlume and Simunye are operated by the Royal Swaziland Sugar Corporation (RSSC) and Umbomo is a subsidiary of the Durban South Africa based Illovo Sugar Limited.

As well as the sugar grown on large estates, there is also production by smallholders (referred to by the large estates as 'outgrowers'), mostly on Swazi Nation Land (communal land). The smallholders account for about a quarter of the production and this has grown considerably in recent years, particularly since the 1990s. The smallholders often also grow subsistence crops.

Since 2010 sugar has been the biggest foreign exchange earner in Swaziland. The total annual sugar production stands at approximately 640000 tons. The total area under sugar cane is approximately 52000 hectares.

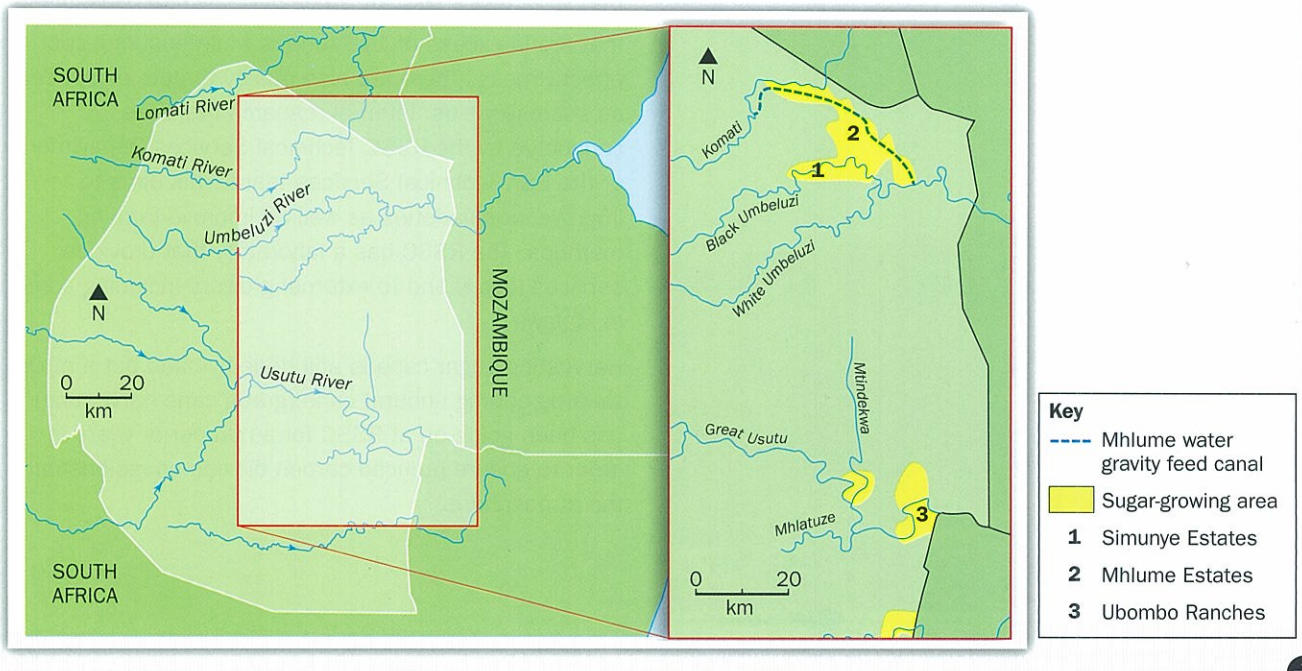


Fig. 11.13 The irrigated sugar areas in Swaziland

Natural inputs

Average annual rainfall ranges between 600 and 700 millimetres and is received mainly from November to March. The rainfall is normally in high intensity, short duration storms that produce a lot of surface run-off, so that less than half of the rainfall contributes to crop growth. The crop water requirement of sugar in this area is 1450 millimetres per year so the balance of the water required is supplied through irrigation. The Low Veld of Swaziland has an average monthly temperature of 29°C in summer and temperatures rarely fall below 15°C, which fulfils the requirement for sugar to have high temperatures. There is a high number of sunshine hours per day and flat land allows large-scale mechanisation. Alluvial soils in the river valleys are rich in nutrients and retain moisture.

Human inputs

Significant financial investment was needed to buy the land, build the irrigation canals (the Mhlume Water gravity feed canal shown on Fig. 11.13 was opened in 1958), build the sugar mills (processing close to the fields is necessary) and buy machinery. Updating plan and irrigation systems (see below) is also costly.

Trade agreements allow the entry of the products into international markets. The most important of these are to other countries in southern Africa and to the EU. Changing policies in the EU have a significant impact on the industry (see CAP earlier in this chapter).

As mentioned below, a mixture of hand labour and machinery is used.

Fig. 11.14 Hand labour being used in the sugar fields on a smallholding in Swaziland

Processes

Unlike some large-scale commercial farms, the sugar estates are not run on extensive principles. In fact, the inputs of labour, fertiliser and irrigation are quite intensive. Irrigation water is led from the rivers by canals. Growth is completed in about 12 months (a relatively short time for sugar cane). Previously between May and November areas of cane were burned to remove the outer leaves and make cutting easier. The cane is then cut and taken to the mills for crushing. The cane will regenerate for several years before replanting is necessary. To ensure that yields do not decline to unacceptable levels 10 per cent of the big estate area is replanted annually. Replanting is carried out ensuring that soil compaction is minimised. New plants are raised in a nursery for replanting in the fields.

By the end of 2011, 47 per cent of the area of the Royal Swaziland Sugar Corporation estates was under sub-surface drip irrigation while 2.4 per cent was under surface drip. The balance of the area is under furrow, sprinkler and centre pivot systems. The drip system uses water more efficiently and allows for a measured and precise application of fertiliser to the roots, thus minimising leaching and washing off of fertiliser into nearby rivers and streams. The area has seen drastic improvements in efficiency through drip installation which has increased yields over the same areas through the introduction of high-yielding varieties and improved machinery.

The industry constantly attempts to improve yields. The RSSC average yield per hectare was 106.2 tonnes in 2011. The objective is to achieve yields that are in excess of 113 tonnes while ensuring cost effectiveness. There are also quality targets expressed as sucrose yields. Internal research trials are conducted by the RSSC Technical Services Department or the SSA Technical Services team. This aims to improve crop varieties as well as improve farming methods. The RSSC has a laboratory that provides services locally and to external growers including some in Malawi.

Harvesting sugar cane is still done by hand but a move towards cutting unburnt cane (green cane harvesting) has been going on at RSSC for a number of years in order to ensure reduced carbon dioxide emissions into the atmosphere.

The RSSC has a responsibility to make assistance available to outgrowers in areas such as farm management, sugar cane growing, irrigation system maintenance and repairs, land preparation and harvesting. The Swaziland Government has also passed on to RSSC the management of a fund for the farmers that would ensure sustainability of the projects. This programme has also enabled indigenous Swazis to participate more effectively in the sugar cane growing industry and to benefit communities through poverty alleviation. While accounting for a smaller volume of total production, the largest number of growers falls under the category of medium and small growers. This sector is currently undergoing a process of rapid expansion through the implementation of two major irrigation schemes: the Swaziland Komati Downstream Development Project and the Lower Usuthu Smallholder Irrigation Project.

The big sugar companies also offer their employees benefits such as pre-primary, primary and high schools on the estates, scholarships to colleges, free medical services, free or subsidised housing, electricity and water for employees, security services, an orphan programme and sporting and recreational facilities.

Fig. 11.15 Burning sugar cane in Swaziland

Fig. 11.16 Harvesting biomass fuel on a sugar estate in Swaziland

Outputs

The primary outputs are:

- raw sugar
- refined sugar (Mhlume and Ubombo only)
- brown sugar
- molasses (this has a rich potassium content and is blended with nitrogen and phosphoric acid to make liquid fertiliser)bagasse (waste fibre used as animal feed)
- biomass fuel (from waste leaves).

RSSC has an ethanol plant with a capacity of 32 million litres which is situated adjacent to the Simunye mill (the distillery is strategically located next to the source of raw material). The distillery produces:

- biofuel
- high-grade ethanol for the drinks and pharmaceutical industries
- white rum
- 'feints' which is used in the manufacturing of methylated spirit, bio-gels and mine water treatment.

The industry has embarked on a carbon reduction programmme, which involves harvesting carbon dioxide, green harvesting (see above) and substituting coal with wood chips.

Mill	2008/09	2009/10	2010/11	2011/12	2012/13
Simunye	233557	210659	222608	234637	261695
Mhlume	183843	181875	161651	187996	229540
Ubombo	209584	213123	197760	224148	286915
Total	**626984**	**605657**	**582019**	**646781**	**658137**

Table 11.3 Sugar output of Swaziland (tons of sugar)

6. List the environmental impacts of sugar farming in Swaziland.

Case study: A pastoral system: sheep farming in New Zealand

New Zealand is one of the world's major producers of sheep. For many years sheep farming was the country's major industry and it played an important part in the development of the country. New Zealand remains the world's largest exporter of sheep meat and wool. It is a good example of how market factors provide the overall context of production but local physical factors influence the methods of production. The move to cross-breeding and the intensification in farming methods encouraged farmers to find breeds that suited their local environments. However, regardless of the type of country, New Zealand breeders wanted a dual-purpose sheep which would provide good yields of meat and wool.

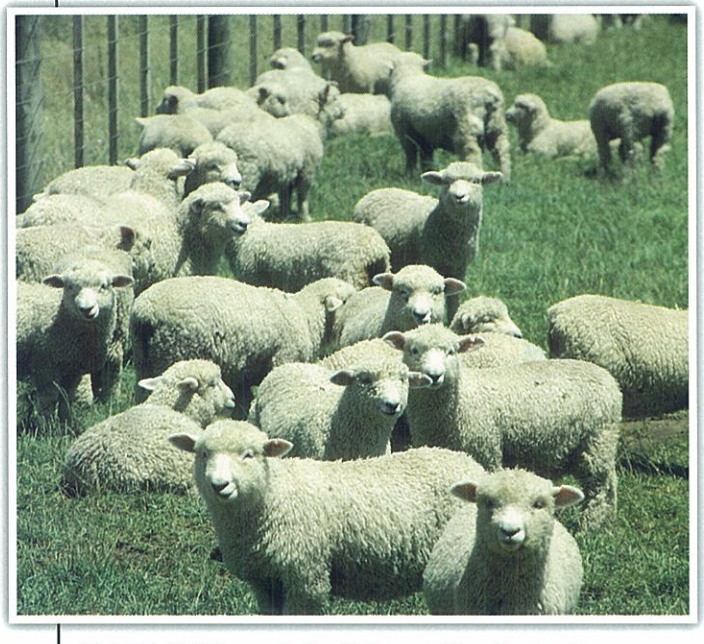


Fig. 11.17 Sheep in North Island, New Zealand

Physical factors

The lowlands

The dry, rainshadow, eastern side of the South Island was the area first developed. In the 19th century extensive pastoralism developed here and in the North Island at Wairarapa and Hawke's Bay. Colonists from Europe leased land from the government and Merino sheep were imported. Sheep farming expanded more slowly in the North Island. The indigenous Māori people owned much of the land and the wetter climate did not suit Merinos. In the 2000s, this land has been increasingly given over to dairy farming and horticulture, and in some areas vineyards. Lowland farmers generally fatten stock brought off the hill and high country.

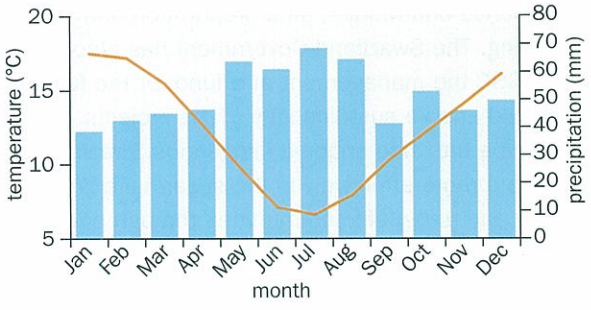


Fig. 11.18 The climate of Christchurch

The highlands

The highlands of South Island have cold winters and higher rainfall. They also experience snowfalls, which in some years cause stock losses. Pastures are mostly unimproved grasses (grasses that are not deliberately planted). Flatter areas may be cultivated to grow feed crops, hay and silage. Fine wool from Merino or cross-bred sheep is the main source of income although lambs may be sold for meat. Perendale sheep are good for meat and wool and are farmed in cold, wet areas. Surplus sheep are sold to farmers on rolling hill country and lowlands to breed cross-bred lambs, or for fattening. Animals are often shifted seasonally to the high mountains in summer and down to the valleys before winter – a system known as transhumance.

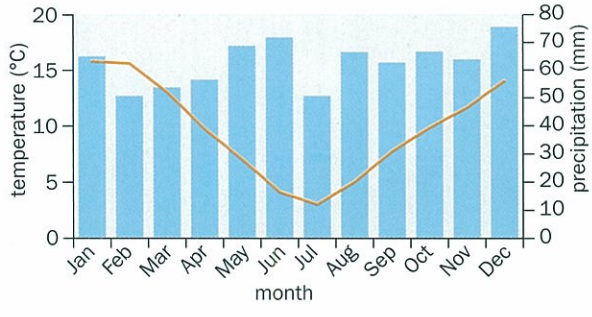


Fig. 11.19 The climate of Queenstown

The rolling 'hill country'

This forms much of the pastoral land in both North and South islands. These areas are the main stock-rearing area of the country. Pastures have been improved by aerial topdressing with fertiliser and aerial oversowing with grasses and clovers. On the higher areas, income is from wool and the sale of store sheep (sheep to be fattened for slaughter) and cattle to be finished on the easier hills and lowlands. In lower areas, as well as wool, fattening goes on and there are sheep-studs.

Sheep breeds

The **Merino**, a Spanish breed, was brought to New Zealand in large numbers and was the first breed to be introduced. Merinos produce fine wool, but not such good meat, and they get footrot in damp conditions. There are about 3 million Merinos in the country today. In the early 20th century a new fashion for worsted cloth in Britain, Europe and America led to a move to different varieties of sheep. The process for making the fabric required long wool with good tensile strength which was not found in Merino wool.

The **Corriedale** is a cross between the Merino and several English breeds. It was bred for both wool and meat, particularly for the plains and gentle hills of the drier eastern districts of both the North and South islands. The wool is sold for the worsted trade. The Corriedale breeds more easily than the Merino, and its lambs mature early to produce a well-muscled carcass.

The **New Zealand Romney** was bred from the English Romney Marsh. It is favoured in the wetter areas of Southland and Otago because of its resistance to footrot. It grows a heavy fleece used in carpets, furnishings and knitting yarns. The New Zealand Romney makes up around two-thirds of the national flock.

The **Coopworth** has replaced the Romney on wetter lowlands and easy hill country because of its improved productivity. The national Coopworth flock is around 7 million.

In the early 2000s, just over 80 per cent of New Zealand wool was from cross-bred animals. Merino wool accounted for 5–7 per cent and Corriedale/halfbred types about 10–12 per cent. Wool purchased by European, North American and Australian buyers was usually shipped to China, where it was spun into yarn – lower labour costs have made China the world's centre for wool spinning.

Fig. 11.20 Sheep farming in the Southern Alps, Wanaka, South Island, New Zealand

Markets and outputs

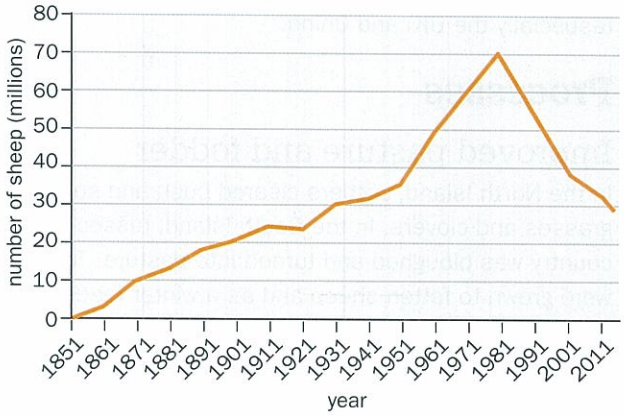


Fig. 11.21 The changes in number of sheep in New Zealand (Source: data from http://beeflambnz.com/industry-production-trends/)

Initially exports of fine wool grown on the open grasslands of the South Island provided the main income. The woollen textile industry in Yorkshire, UK was the main market. 1882 was a key date in the development of the industry because frozen meat was sent to Britain for the first time which triggered an expansion of sheep farming and meat production. Initially the trade was dominated by South Island farmers. However, as land in the North Island was transferred from Māori to European settlers and the bush was cleared, sheep rearing spread to the north. Wool was the country's single most valuable export for 89 of the 112 years between 1856 and 1967.

The Second World War changed the UK economy and food was rationed. In the post-war period the UK took all the meat and wool New Zealand could produce. As a result, sheep numbers increased by 40 per cent between 1951 and 1961.

In 1973 the UK joined the EU (then the European Economic Community – EEC) which meant that import tariffs raised the cost of New Zealand products. At the same time an oil crisis raised the costs of transport and production. Wool prices fell because of competition from synthetic fibres and changes in fashion – the start of a decline from which the prices have never recovered.

Nevertheless, government subsidies kept farming buoyant despite the falling prices and increasing costs. In 1982 sheep numbers peaked at over 70 million. In 1985–86 the government removed all subsidies for farmers, and sheep numbers dropped drastically. Since 1992, earnings from the dairy industry have exceeded those of sheep production.

Today, farmers have placed increased emphasis on breeding sheep for improved meat or wool production, to keep farms profitable. The main markets for meat

are the EU, North America, North Asia, the Middle East and Africa. The main markets for wool are the EU (especially the UK) and China.

Processes

Improved pasture and fodder

In the North Island, settlers cleared bush and sowed grasses and clovers. In the South Island, tussock country was ploughed and turned into pasture. Turnips were grown to fatten sheep and as a winter feed. In Southland, wetlands were drained, cultivated and sown in pasture. Blood and bone manure, a by-product of the meat industry, and superphosphate became more widely used to fertilise pastures. Aerial topdressing of fertiliser began in 1949, increasing the productivity of hill country.

Performance-based selection

Reference has already been made to improving productivity by developing local breeds suited to local conditions. Today this has been taken a stage further by performance-based selection, which focuses on features such as wool weight, fertility and lamb growth rates. A National Flock Recording Scheme started 1967, administered by the Department of Agriculture. By the early 1980s half a million ewes and 1 300 ram-breeding flocks were having their performance recorded annually. Since 2002 the scheme has been run by Sheep Improvement Ltd, a division of Meat and Wool New Zealand. A genetic database provides breeding values and other genetic information, helping breeders and ram buyers to select more productive sheep.

Artificial breeding

Artificial insemination and ova transplants have improved the genetic bases of sheep breeds. Between 1992 and 2002 the number of breeding ewes and hoggets in New Zealand fell by 24 per cent, yet between 1993 and 2003 the tonnage of lamb meat processed increased by 22.4 per cent. The number of lambs per ewe has increased, as have growth rates.

Composite breeds

In the early 2000s many sheep farmers moved away from individual breeds to take advantage of the various traits of different breeds. Cross-breeding has always been important in New Zealand, and this has been taken further to develop composite breeds, e.g. the Kelso.

The farming processes are governed by the seasons as follows.

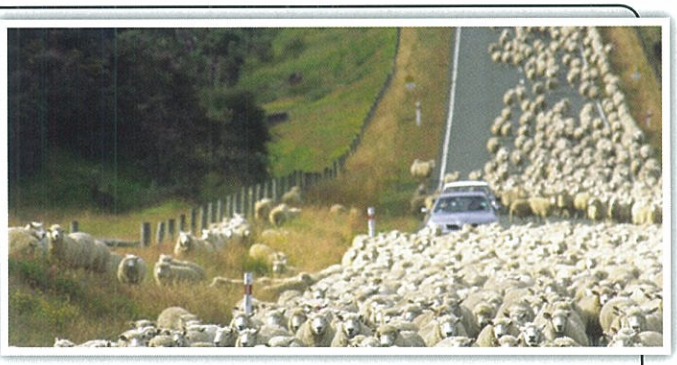


Fig. 11.22 Sheep mustering along a remote highway in New Zealand

Winter

- Most sheep farms carry their lowest number of stock.
- In the high country and harder hills, farmers feed hay and silage.
- In lowlands sheep are fed in paddocks.
- Ewes are scanned to check for pregnancy. Barren ewes are culled, while those carrying twins or triplets are given preferential feeding.

Spring

- Ewes are sheared before lambing.
- Farmers try to time lambing to match the first flush of grass growth.
- Farmers allocate a certain number of ewes to each paddock or block and leave them to lamb unattended.
- Ewes are drenched to kill intestinal worms.
- Lambs are vaccinated against clostridial diseases and sprayed with a chemical to prevent flies laying their eggs on a living animal.
- Tails are docked and ram lambs are castrated.

Summer

- Lambs are weaned off their mothers at about three months of age.
- In lowlands some of the lambs will be ready to be slaughtered for meat.
- Highland lambs not required to maintain the flock are sold to be fattened on lowland farms.
- Ewes are culled or sold to farmers in lowlands.

Autumn

- Ewes are mated in autumn.
- Before mating they are 'flushed' – given better feeding to lift their body weight – to increase their fertility.

7. List the physical and human factors affecting sheep farming in New Zealand. Refer to Figs 11.18 and 11.19 in your answer.

Intensive and extensive production

Commercial farms may be intensive or extensive, as may subsistence farms, although the latter tend to be intensive.

	An intensive commercial farming system	An extensive commercial farming system
Capital input per hectare	High	Low
Labour input per hectare	High	Low
Fertiliser input per hectare	High	Low
Output per hectare	High	Low

Table 11.4 The differences between intensive and extensive production

As Table 11.4 shows, on an extensive farm the inputs per hectare are low and the outputs per hectare are low but this is overcome by using a large area of land. Extensive farming can be highly profitable. In large-scale commercial farming, some farms cover hundreds of square kilometres. The large area compensates for a low level of human inputs.

In large-scale commercial farming the capital input may be from a trans-national corporation. This can allow intensification of large areas. The capital input allows for the purchase of the land, a paid labour force, research and development, mechanisation, improved crop varieties and hybrids, inputs of fertiliser, pesticide, herbicide and, where necessary, irrigation. Complex systems ensure that production is linked to current market demands, prices and government policies.

In small-scale subsistence arable **intensive** farming the small units of land are cultivated. However, in the case of subsistence pastoral farming, areas of land can be much larger, especially in the case of pastoral nomadism, where people move from place to place with their animals. The only fertiliser used might be animal manure. Where irrigation is used, very low technology systems are often used, usually draining water in channels from a nearby river. The lack of capital prevents many subsistence farmers from increasing their output. Family labour is generally used, relying on traditional methods. There are few machines – these farmers use hand tools such as hoes, and draught animals such as oxen or water buffalo pull ploughs. Seeds left over from the previous year's crop are used for the next year which prevents the use of improved varieties.

Fig. 11.23 Spraying a wheat crop with liquid fertiliser to increase yields

Fig. 11.24 Intensive farming in Japan

Agricultural productivity

Global food security is now an international concern with the converging impacts on human welfare of increasing population size, shortages of natural resources and climate change.

Attempts to increase agricultural productivity usually involve either **intensification** or increasing the area under cultivation (**extension of cultivation**). This section explores these methods.

The previous case studies of agricultural systems in Swaziland and New Zealand illustrate various ways of increasing agricultural productivity. They included:

- → extension of irrigation
- → improved crop varieties
- → improved cultivation and harvesting practices
- → selective animal breeding
- → improved pastures.

This section looks at other methods.

Greater inputs

One of the main ways of increasing agricultural production is to increase yields per hectare by increased inputs of:

- fertiliser
- mechanisation
- pesticides and herbicides.

There is no doubt that increasing these inputs has improved agricultural productivity and made a major contribution to increasing the world's food supplies. However, there are conflicts involved in this approach. Kenya illustrates this well. The agriculture sector accounts for about 25 per cent of this East African nation's GDP and at least 60 per cent of exports. Government statistics further show that small-scale production accounts for at least 75 per cent of the total agricultural output and 70 per cent of marketed agricultural produce.

According to the Kenya Agricultural Research Institute (KARI), more than 10 million out of Kenya's total population of 40 million is food insecure, with the majority of people living on food relief. According to the Ministry of Agriculture, an estimated five million out of about eight million Kenyan households depend directly on agriculture for their livelihoods. Climate change, and particularly drought, is placing addition stress on farming. The country's main sources of water are producing less than they did in the past. The rivers flowing from Mount Kenya, Mau Complex, Aberdares, Cherangani Hills and Mount Elgon are now producing less water, or drying up completely during the dry season. Tea, one the country's leading exports, is among the crops at greatest risk.

Some people argue against the use of chemical fertilisers and suggest that it would be better to concentrate on traditional methods of using animal manure and the remains of previous crops. It has been claimed that to become dependent on chemical fertilisers means that multinational companies would exploit peasant farmers who lack capital to invest in expensive products.

The use of nitrate fertiliser boosts the growth of green vegetation such as grass (nitrates are the basis of products sold as domestic lawn fertiliser). Nitrates are used by dairy farmers to increase grass yields and by grain farmers. They are highly soluble and are soon leached out of the soil into groundwater, lakes, rivers and water supplies. In China it has been claimed that increasing the use of chemical fertiliser in an effort to improve yield has make some arable land unusable, making the quality of China's fruit and vegetables decline, killing lakes and streams, and introducing pollutants into the air. Where soil lacks nutrients adding inorganic fertiliser is an obvious answer. However, if not used carefully it can lead to a decline in the organic content of the soil and, in some climates, desertification. The chemicals are eventually leached into the ground water and find their way into rivers and water supplies. The answer is to use artificial fertiliser in carefully calculated quantities and to add organic matter such as animal manure or crop waste.

Eutrophication is the accumulation of excess nitrate and phosphate fertilisers in lakes and rivers. This can lead to an excessive growth of algae. As the algae die out and decompose, water is depleted of oxygen, which causes the death of other organisms, such as fish. Ammonia discharges cause air pollution and the nitrous oxide released is a major greenhouse gas. Ammonia - classed as 'reactive nitrogen' as opposed to inert nitrogen gas - is claimed to threaten biodiversity as it falls out from the air. A team led by Dr Albert Bleeker, from the Energy Research Centre of the Netherlands, identify the Himalayan and south east China forests as being especially at risk and receiving more than their sustainable levels of reactive nitrogen.

In the USA, EU and other areas, there are safety limits for the amount of nitrates in drinking water. Water supply companies are not allowed to supply water which exceeds these levels.

In the UK the Royal Society for the Protection of Birds (RSPB) has reported that many species of farmland birds have shown huge declines in numbers and range over the past four decades. These have been linked to agricultural intensification, which has taken the form of a suite of changes in farming practice, one of which is increased pesticide use. Concern has switched from the direct poisonous effects of pesticides to indirect effects. Indirect effects of pesticides act predominantly via reduction in food supplies because of fewer insects and grubs.

There is also concern about the effects of pesticides on pollenating insects. A two-year EU ban of three neonicotinoids, the most widely used insecticides in the world, began in December 2013, following research that showed harm to honeybees and bumblebees. The neonicotinoids are 'systemic' pesticides, being applied to seeds so that the chemical spreads within the plants. Over three-quarters of the world's food crops require insect pollination, but bees have declined in recent decades due to loss of flower-rich habitat, disease and pesticide use.

Mechanisation, larger units and removal of field boundaries

On commercial farms there has been a move to increase farm size, increase field size, have larger machines and reduce the size of the agricultural labour force. In southern England ancient hedgerows were being removed at a great rate but this has now been reduced. Hedgerows help to prevent soil erosion by stopping run-off and acting as wind breaks. They are an important habitat for wildlife and their removal was a factor in decreasing biodiversity. They are often seen as a defining feature of the English landscape. Under the Hedgerows Regulations of 1997 it is against

the law to remove or destroy certain hedgerows without permission from the local planning authority. Local planning authority permission is normally required before removing hedges that are at least 20 metres in length, more than 30 years old and contain certain plant species. The authority will assess the importance of the hedgerow using criteria set out in the regulations.

Improved varieties

Over time wild plant varieties have been improved by **selective breeding** to produce higher yields. This has been taken a stage further by the use of **hybrids**. These are selectively bred varieties of crops and animals which are noted for their consistency. A more recent innovation has been the use of **genetically modified (GM)** varieties where the DNA has been altered by laboratory means.

Tea production in Kenya is an interesting example. The Tea Research Foundation of Kenya has developed 45 varieties of tea, some of which are adapted to the changing climatic conditions. However, farmers are yet to adopt them because they do not even know they exist. Dissemination of this type of information is hampered by the lack of extension workers. Where the FAO recommends that there should be one extension officer to serve 400 farmers, currently Kenya has just one extension officer for every 1 500 farmers, according to the Association for International Agriculture and Rural Development.

A highly successful new variety is the wheat variety HD 2967 in the Punjab. It now occupies around 70 per cent of Punjab's total wheat production area. The advantages of the variety are its ability to withstand a wider temperature range, and its resistance to yellow rust disease. The variety gives a slightly higher yield than other varieties. It is shorter and less prone to falling during strong winds which makes harvesting difficult.

The University of Liverpool, UK, is home to the Centre for Genomic Research, which is a leading facility for genome sequencing with client researchers from major companies and research institutions worldwide. The university has established an inter-disciplinary Food Security Network to address concerns over increasing food shortages worldwide. The Food Security Network will investigate many of these challenges, which span all aspects of animal and crop production, disease control, nutrition and food quality, as well as land use and biofuels, and food processing. In 2010 scientists at the university, in collaboration with the University of Bristol and the John Innes Centre, decoded the genome of wheat, the largest genome to be sequenced to date, to help increase the yield of wheat varieties in the UK.

Dr Anthony Hall said: 'Wheat production is already under pressure with failures in the Russian harvest driving up world wheat prices. It is predicted that within the next 40 years world food production will need to be increased by 50 per cent. Developing new, low-input, high-yielding varieties of wheat will be fundamental to meeting these goals. Using this new DNA data we will identify variation in gene networks involved in important agricultural traits such as disease resistance, drought tolerance and yield.'

Criticism of genetically modified crops has focused on three aspects:

- It will increase the influence of 'big business' on food production as research and production will be controlled by trans-national corporations.
- There are claims that the products will be hazardous to the health of consumers.
- There are claims that genetically modified species will disturb natural ecosystems and damage existing plants and animals.

In Europe the Soil Association has been important in promoting the **organic** range of environmentally friendly products. Organic standards are the rules and regulations that define how an organic product must be made. Organic standards for food are laid down in EU law. Anything labelled 'organic' that is for human consumption must meet these standards as a minimum. The standards cover all aspects of food production, from animal welfare and wildlife conservation, to food processing, to packaging.

In organic farming, artificial chemical fertilisers are prohibited and pesticides are severely restricted. A free-range life for farm animals is guaranteed. Fallow periods and crop rotation is used to help break cycles of pests and disease and builds fertility in the soil. The routine use of drugs, antibiotics and genetically modified crops are banned. Organic products are labelled as such on supermarket shelves and are often more expensive, which has limited their attractiveness to consumers.

Extension of cultivation

If agricultural yields per hectare are not to be increased by intensification, then the other way of doing so is to increase the area under cultivation. Figures from the World Bank show that in the period from 2000–02 to 2009–11 the percentage of the world's land area remained the same at 38 per cent. When continents are examined there are small differences, as Table 11.5 shows.

The area under cultivation has been increased by 5 per cent or more in 11 countries, as shown in Table 11.6.

As Tables 11.5 and 11.6 show, currently there are only a few countries where the area under cultivation is being extended. This is being achieved through:

- bringing areas which are currently unused bushland and other natural vegetation into cultivation
- deforestation
- reclamation of marsh

	Percentage of land area under cultivation	
	2000–02	2009–11
Low-income countries	37	39
Middle-income countries	45	44
High-income countries	30	29
East Asia and Pacific	49	48
Europe and Central Asia	67	66
Latin America and Caribbean	35	37
Middle East and North Africa	25	23
South Asia	55	55
Sub-Saharan Africa	44	44
Euro area	47	45

Table 11.5 Global changes in the area under cultivation

	Percentage of land area under cultivation	
	2000–02	2009–11
Argentina	47	54
Armenia	49	60
Channel Islands	38	51
Dominica	29	35
Ethiopia	30	36
The Gambia	51	61
Ghana	64	70
Malawi	51	59
Niger	30	35
Uganda	64	70
Vietnam	30	35

Table 11.6 Countries which have extended cultivation by 5 per cent or more

- development of terracing on hillsides
- extending the area of irrigation.

There are environmental consequences of extending cultivation and the systems employed may not be sustainable. Desertification, land degradation, salinisation of soils and sustainable farming have already been discussed in Chapter 10. In areas such as the UK, the reclamation of marshland has removed habitats and resulted in a loss of biodiversity. The former Soviet Union's Virgin Lands programme pushed cultivation into areas of dry steppe and some of this has not been sustainable. The Soviet Union also developed lands on the Amu Darya and Syr Darya rivers for the irrigated farming of cotton. This led to the shrinkage of the inland Aral Sea (now on the borders of Kazakhstan and Uzbekistan) which is one of the world's great environmental catastrophes. This is referred to later in this chapter. CareEarth, a Chennai India-based biodiversity research organisation, has identified 474 wetlands in greater Chennai of which 43 are in need of immediate attention. The ones in Ambattur, Korattur, Madhavaram, Narayanapuram, Pallavaram Periya Eri, Velacherry and Porur are on this list.

	Percentage of land area	
	2000–02	2009–11
Australia	58	53
Austria	41	35
Barbados	40	35
Bermuda	20	15
Burundi	91	86
Georgia	43	36
Grenada	38	32
Hungary	65	59
Iran, Islamic Rep.	39	30
Italy	52	47
Macedonia, FYR	52	44
Maldives	40	23
Mauritius	49	44
Mongolia	83	73
Poland	55	49
Samoa	17	12
Slovak Republic	47	40
St. Kitts and Nevis	31	23
Sudan	56	46
Virgin Islands (US)	17	11
West Bank and Gaza	61	43

Table 11.7 Countries which show a decrease in the area of cultivation by 5 per cent or more

However, there are many countries that have decreases in the area under cultivation, as Table 11.7 shows. Fig. 11.25 shows an area where cultivated land has been abandoned.

8. Describe and suggest reasons for the changes shown in Tables 11.5, 11.6 and 11.7.
9. Produce a list of advantages and disadvantages for intensification or extension of cultivation to increase agricultural output.

Fig. 11.25 An abandoned field in Eastern Cape, South Africa. The area was used to grow alfalfa but is beginning to return to scrubland. It will eventually look like the natural scrub in the background

Case study: The management of agricultural change in Kazakhstan

Kazakhstan is the world's ninth largest country by land area. It is sparsely populated and only Australia has fewer people per square kilometre. In 2011–12 it was the sixth largest wheat exporter in the world. It illustrates how agricultural change has been constrained by physical and politico-economic factors.

Physical factors

Physical factors present opportunities and great challenges to agriculture in Kazakhstan. There is an abundance of flat, steppe lands and only in the extreme south-east does altitude present a challenge to agriculture. There is a high annual range of temperature and long, cold winters limit the growing season.

Water supply is a key limiting factor and much of the country is arid or semi-arid, with less than 350 millimetres of precipitation a year. Fortunately, the bulk of this falls in the summer months. Rainfall is somewhat unreliable and this is partly reflected in the fluctuations of wheat production from year to year described later.

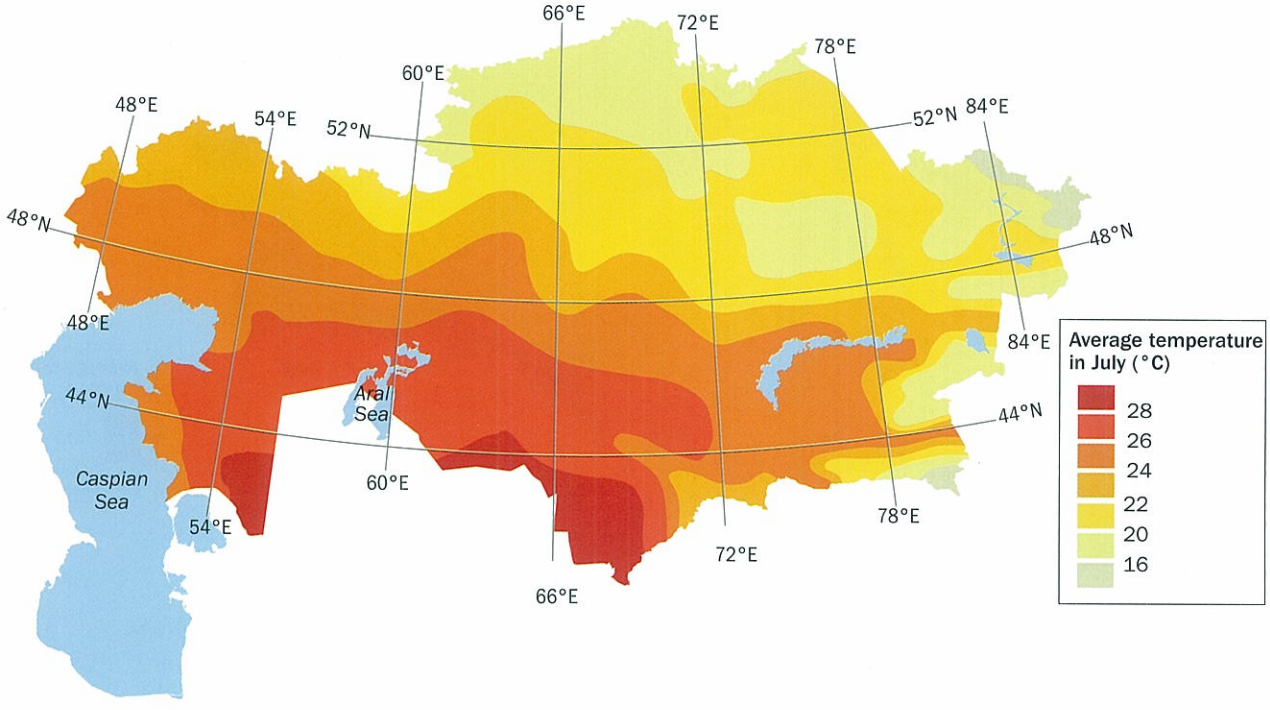


Fig. 11.26 July temperatures in Kazakhstan

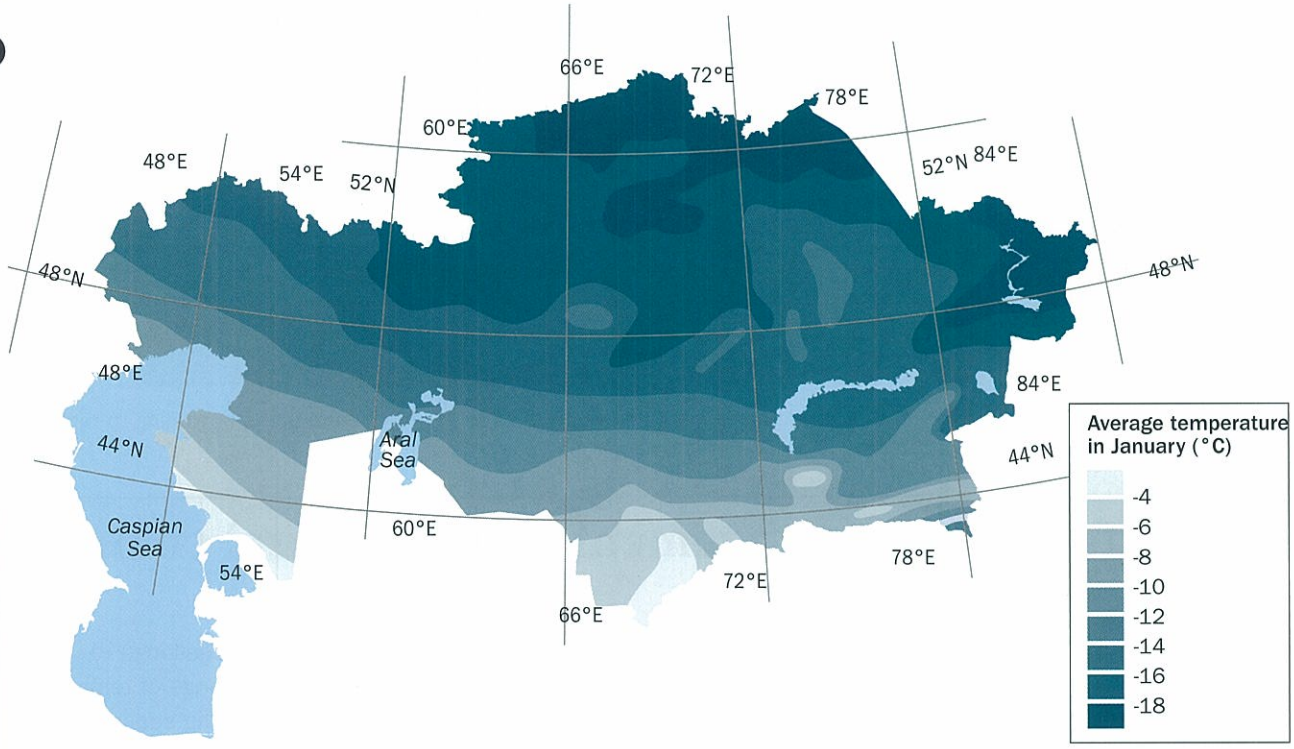


Fig. 11.27 January temperatures in Kazakhstan

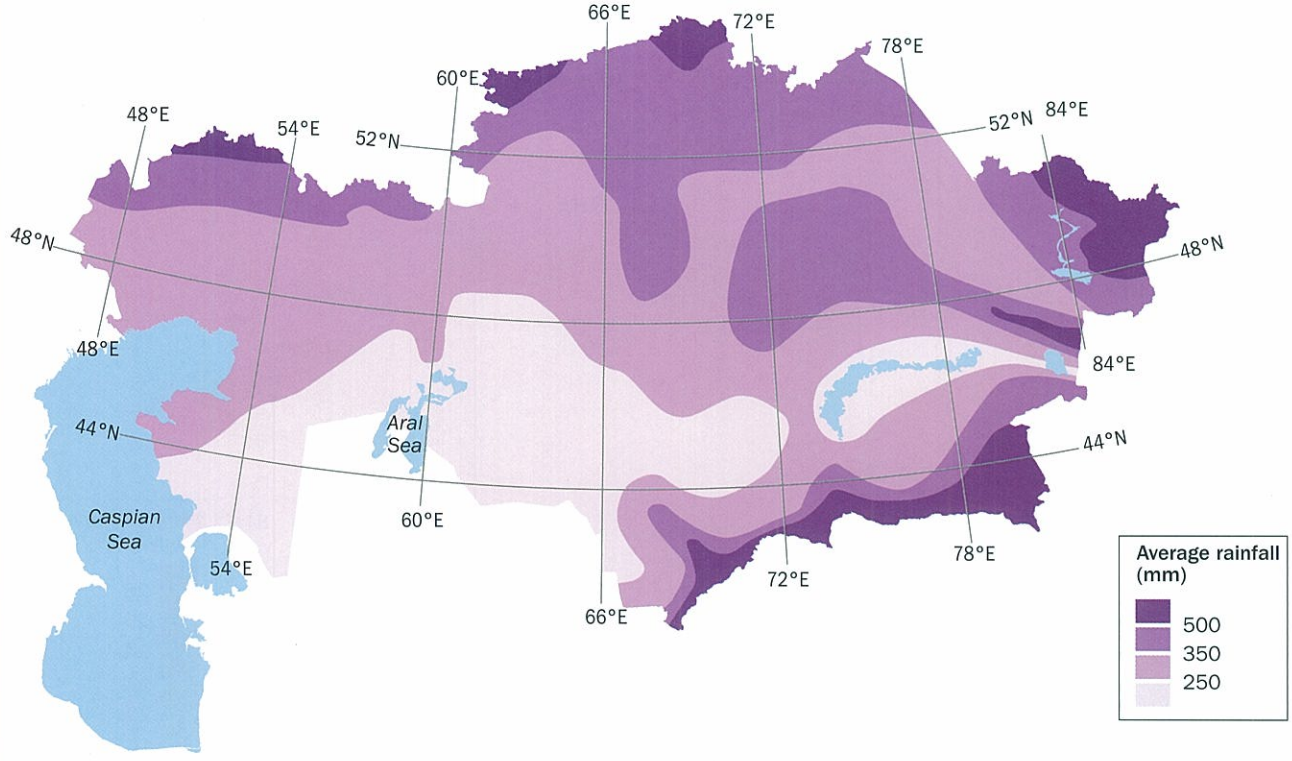


Fig. 11.28 A simplified map of annual precipitation in Kazakhstan. Mountains in the south and east make the pattern complex

Strong winds blowing across the steppes have a desiccating effect and cause soil erosion. Irrigation water is in short supply and farming is the main user of water in the country.

Physical factors account for the broad patterns of agricultural land use. In the north and north-east, particularly in Kostanai, North Kazakhstan and Akmola oblasts (regions), large-scale grain and oil seed cultivation occurs on the better-watered steppes. Farming here is capital intensive, with grain silos and well-developed marketing systems. In the wetter regions in the south and south-east such as Almaty, Zhanbyl and South Kazakhstan oblasts there is small-scale mixed farming, including horticulture, cotton and rice growing. In 2010 sequencing of the genome demonstrated that the apple originates from this region of Kazakhstan. The old name for Almaty, the former capital of Kazakhstan, is Alma Ata, meaning 'father of apples'.

In the dry east of the country, livestock farming is dominant.

The wetter areas are also the most productive, as Fig. 11.29 shows.

Human effects on the environment

Between 1954 and 1960, the Soviet Union (of which Kazakhstan was then a part) implemented its Virgin Lands programme, involving the cultivation of the dry steppes of southern Kazakhstan to increase food production. This programme was abandoned in the 1990s because it led to salinisation of soils (see Chapter 10), wind erosion and humus losses.

This dry region has also seen one of the world's environmental catastrophes. In the 1960s, the Soviet Union implemented a major water diversion project on the arid steppes of Kazakhstan, Uzbekistan, and Turkmenistan. The region's two major rivers, the Syr Darya and the Amu Darya, are fed by precipitation in mountains to the south, and were used to transform the land into farms for cotton and other crops. These rivers ended in an inland basin of drainage at the Aral Sea, once the fourth-largest lake in the world. Although irrigation made the desert bloom, it devastated the Aral Sea. In 2000, the lake was already a fraction of its 1960 extent. The eastern part of the Southern Aral Sea shrank greatly between 2005 and 2009, when drought cut off the flow

Fig. 11.29 The main types of farming in the oblasts (regions) of Kazakhstan

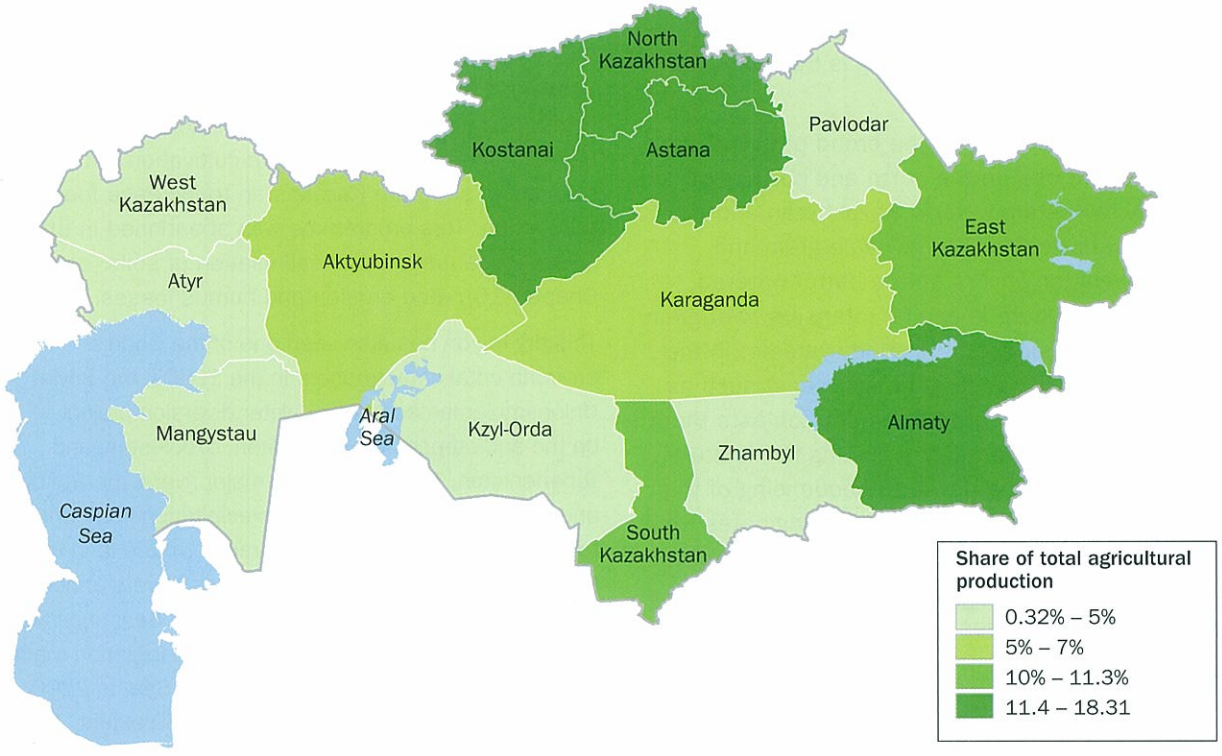


Fig. 11.30 Contribution to total agricultural output of the oblasts (regions) of Kazakhstan 2009–2011

of the Amu Darya. Water levels then fluctuated annually between 2009 and 2013 in alternately dry and wet years. As the lake dried up, fisheries and the communities that depended on them collapsed. The increasingly salty water became polluted with fertiliser and pesticides. The blowing dust from the exposed lakebed, contaminated with agricultural chemicals, became a public health hazard. The salty dust blew off the lakebed and settled onto fields, degrading the soil. Croplands had to be flushed with larger and larger volumes of river water. The loss of the moderating influence of such a large body of water made winters colder and summers hotter and drier. In an attempt to save some of the lake, Kazakhstan built a dam between the northern and southern parts of the Aral Sea. Completed in 2005, the dam was basically a death sentence for the southern Aral Sea, which was judged to be beyond saving. All of the water flowing into the desert basin from the Syr Darya now stays in the Northern Aral Sea.

Economic and political factors

Kazakhstan became an independent country in 1991 on the break-up of the Soviet Union. This marked the change from a government controlled 'command economy' to a market economy. The previous price support systems were no longer in place and this, plus hyper-inflation in the 1990s, led to a decline in production. A total of 19 million hectares were

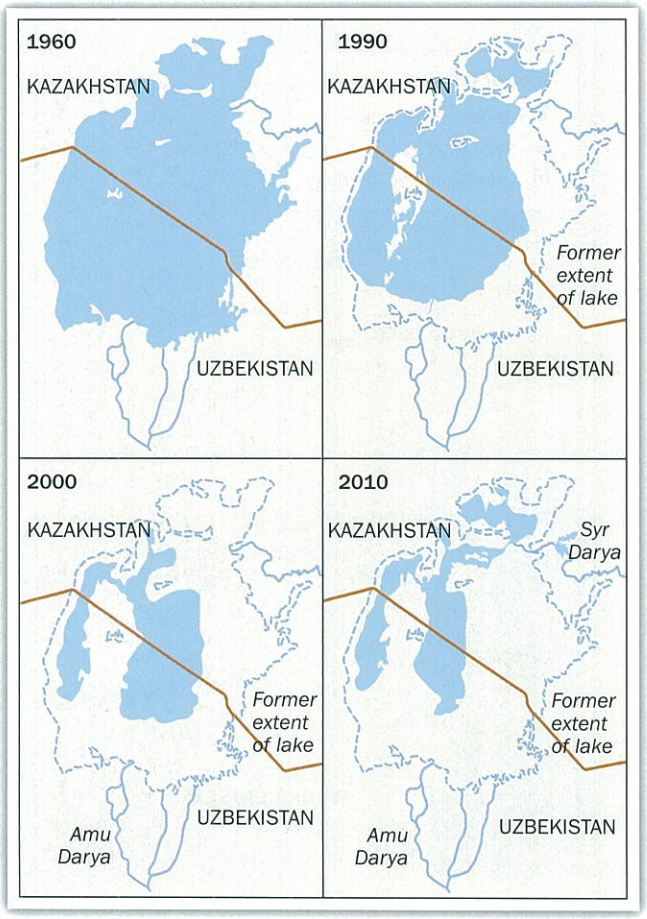


Fig. 11.31 How the Aral Sea shrank between 1960 and 2010

withdrawn from crop production. Livestock numbers on the collective farms (the Soviet system of a farm, organised as a unit, worked by a community under the supervision of the state) fell to 20 per cent of their previous levels, leading to hardship.

Fig. 11.32 Working in the potato fields in Kazakhstan. Notice the workers' houses

Kazakhstan is now an oil-rich state and the government has used its oil revenues to invest in agriculture and change the system. The period from 2000–07 was a period of growth. This slowed in 2008–09 because of the global financial crisis and a local banking crisis. Since then production has increased again.

Land reform has led to privatisation of many farms, a re-allocation of land, as well as a great increase in the numbers of farms. In 1990 there were under 5000 farms, but by 2012 this had increased to 188 616. There are now three types of farm:

- agricultural enterprises with an average size of 8000 hectares, including farms which maintain collective organisation
- individual farms with an average size of 270 hectares
- private (household) farms with an average size of just 0.13 hectares.

In 1990, the large-scale units accounted for over two-thirds of production. By 2011 it had fallen to less than one-third. Although much privatisation has occurred, it is common for land to be held on a 49-year lease from the state.

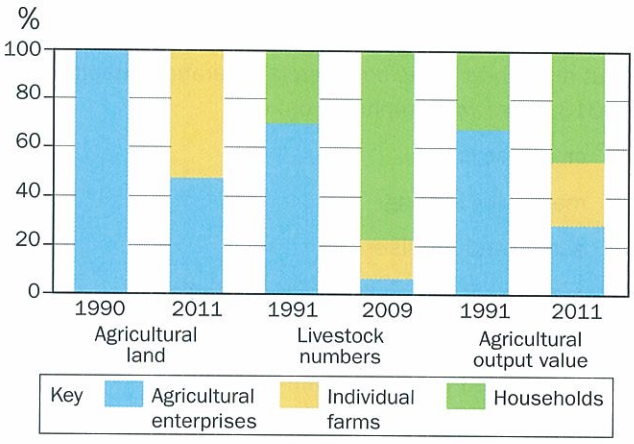


Fig. 11.33 The changes in the share of agricultural land, livestock numbers and agricultural output of the three different types of farm. In 2011 the household farms accounted for only 0.33 per cent of agricultural land

Despite rural–urban migration since 1991, agriculture still employs 26 per cent of the workforce. In 2013, an OECD report identified problems such as the following:

- Certain sectors were dominated by subsistence-oriented producers.
- Domestic supply chains were poorly organised. This is a result of poor rural roads, shortage of grain elevator space and poor organisation of marketing. The collapse of livestock production on large farming enterprises indicates weaknesses in refrigerated meat supply.
- Farmers had difficulty accessing external markets. However, exports have become less focused on Russia with more being exported to areas such as Azerbaijan, Turkey, Iran and north Africa.
- There was a shortage of farmers with modern skills.
- Credit was heavily dependent on state provision.

Fig. 11.34 Farm in the steppe, Tamagaly Das, Kazakhstan

Since 2003 agriculture is seen as part of economic diversification. This is delivered through centralised

policy making as part of the President's national development strategy. KazAgoHolding provides support but also undertakes commercial operations itself. In 2013, there was emphasis on:

- credit facilities
- machinery leasing
- subsidised fertilisers
- a greater focus on livestock production
- information, marketing and consultancy
- guaranteed prices for grain and cotton
- import tariffs.

In 2013, the OECD report on agriculture in Kazakhstan made recommendations including the following:

- Improve transport in rural areas.
- Improve plant and animal health and food safety systems.
- Increase agricultural education and research and development.
- Increase private investment in agriculture.
- Integrate small-scale farmers more fully through credit facilities and assisted marketing.
- Improve incentives for sustainable resource management on leased land.

Fig. 11.35 Harvesting grain at the 40 Years of October Collective Farm in the Taldu Kurgansk Region in Kazakhstan

Kazakhstan is one of the world's major producers and exporters of wheat, and this dominates the output of its large-scale commercial farms (agricultural enterprises). However, production is highly variable. It also has an important milling industry and has been the world's greatest wheat flour exporter.

Fluctuations in production are common, as Fig. 11.35 shows.

After peaking in 1969, the area under wheat cultivation began to decrease as areas of marginal productivity were taken out of production. Following the break-up of the Soviet Union and the loss of government subsidies, productivity thresholds were set for individual fields. Fields that consistently failed to meet the threshold were taken out of grain production and converted to permanent pasture. The decline in grain area accelerated in the mid-1990s when a reduction in livestock numbers caused feed-grain demand to fall. From 2005 onwards production has generally increased but there are fluctuations due to the state of the world market and local weather conditions.

Kazakhstan was facing a fall in production in 2012–13 because important northern wheat-growing areas, especially the Kostanay oblast, were experiencing continued dry weather and high temperatures throughout the growing season. The average yield was reported at 0.97 tonnes per hectare compared with 1.76 the previous year. The bumper harvest of 2011 and high prices for farmers have helped to somewhat mitigate the negative impact on farmers compared to previous years of drought. Flour exports to traditional customers such as Uzbekistan were expected to fall.

The Kazakhstan government grain operator is developing a better supply chain infrastructure including the construction of several grain terminals in various regions of Kazakhstan such as the South Kazakhstan, North Kazakhstan, Akmola and Mangystau oblasts. The ministry of agriculture is trying to encourage diversification into crops other than wheat, as in many

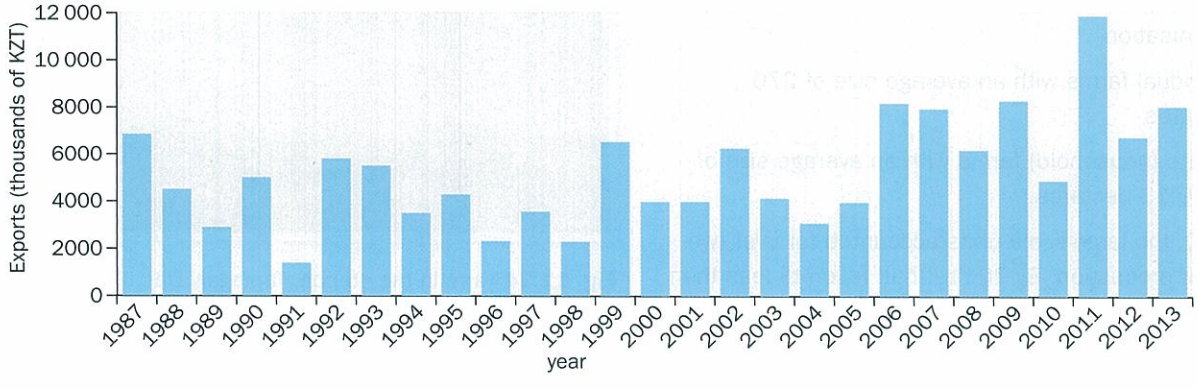
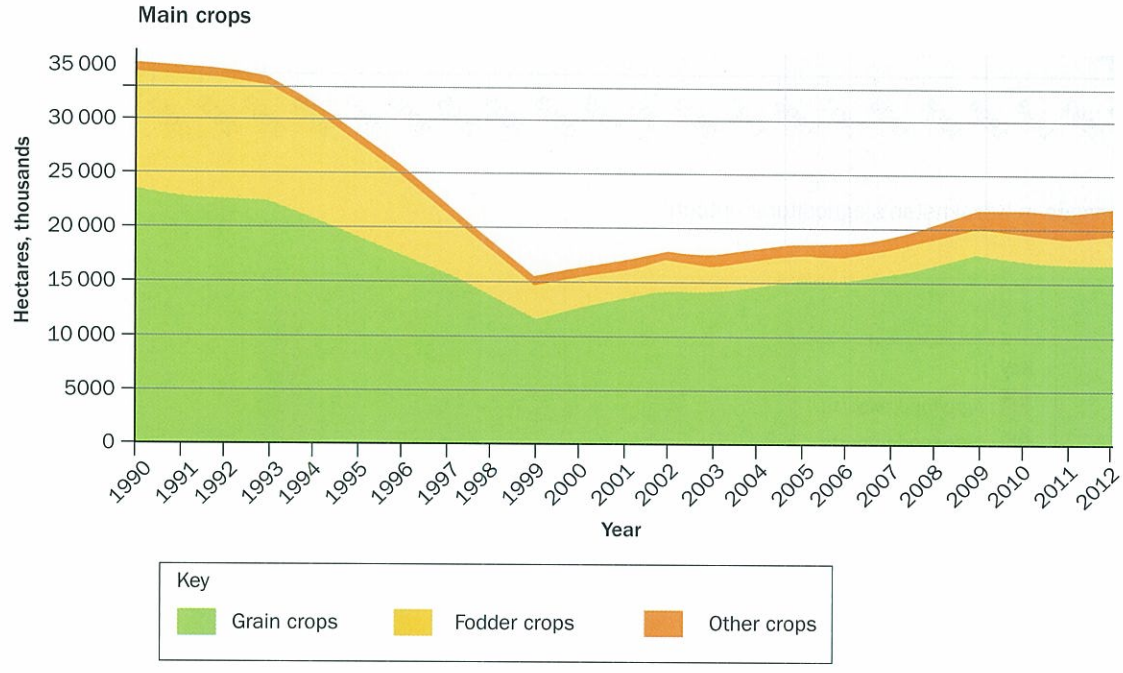


Fig. 11.36 Changes in Kazakhstan's wheat exports (Source: United States Department of Agriculture)

places wheat is planted as a monoculture. This is to encourage crop rotation and provide more feed grains and oilseeds (sunflower seed and rape seed) to the expanding livestock and poultry industries. This is mainly occurring in the larger agricultural enterprises which have the financial means to pay for the improved seeds and machinery that are needed to switch into other crops.

Evaluation

There is no doubt that agriculture in Kazakhstan has undergone a dramatic transformation. It is a major player in world food markets and wheat from Kazakhstan is used in bread making in countries such as the UK. This section and the statistics in Figs 11.37, 11.38 and 11.39 illustrate some of the difficulties in managing this change, both for the individual farmer and the government. What has been achieved is illustrated as well as what still needs to be done.



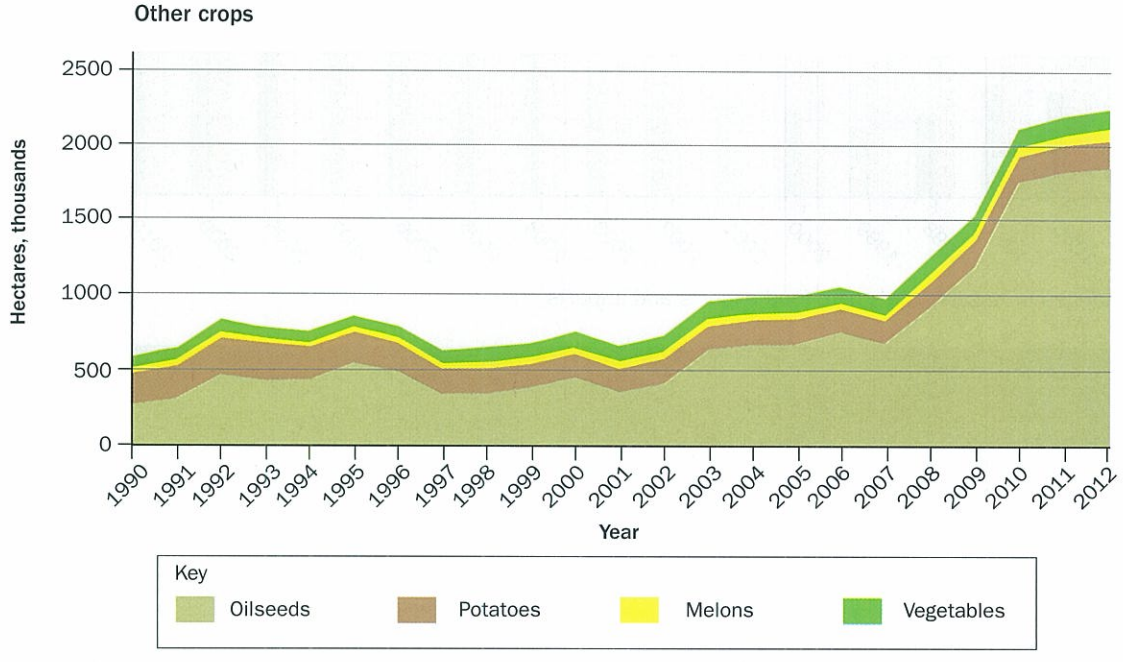


Fig. 11.37 Changes in the area planted with agricultural crops in Kazakhstan

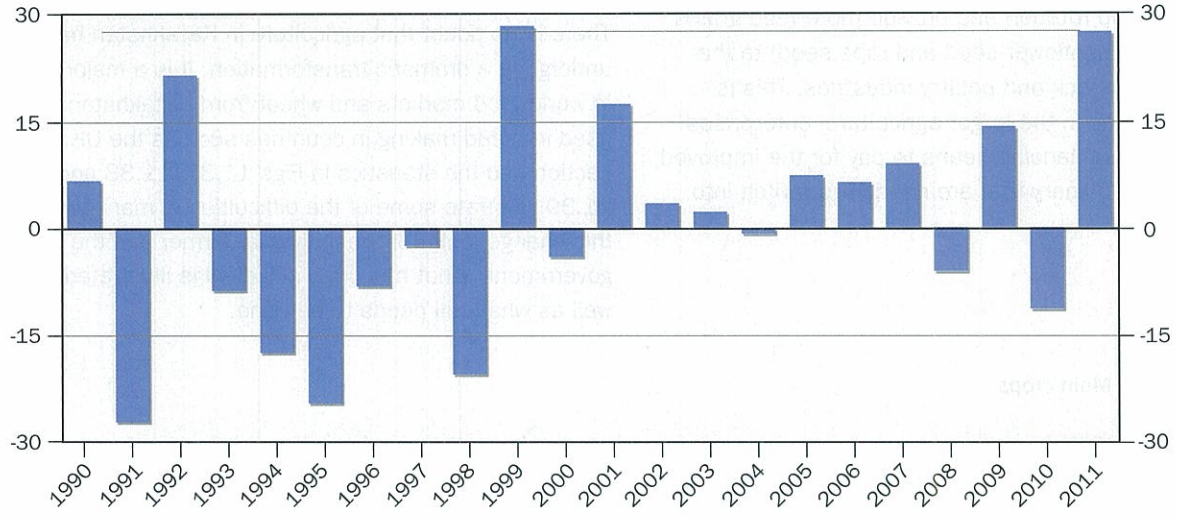


Fig. 11.38 Changes in Kazakhstan's agricultural outputs

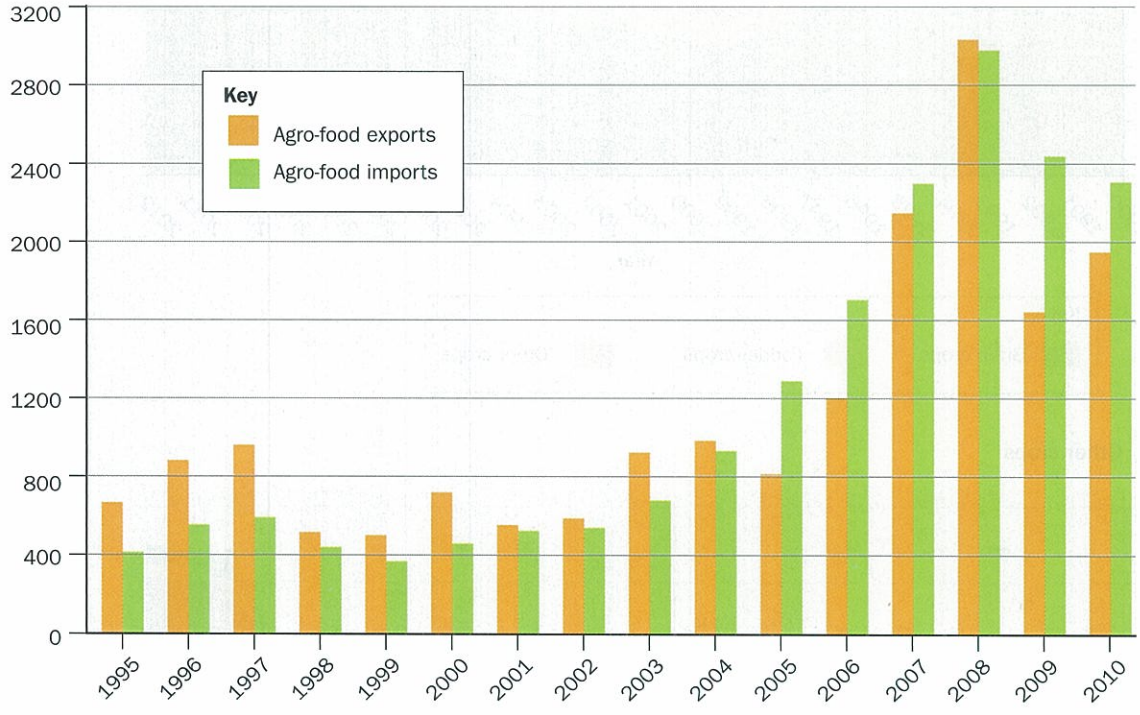


Fig. 11.39 Changes in Kazakhstan's agro-food exports and imports

10. List the difficulties facing individual farmers in Kazakhstan.

11. List the achievements of agricultural reform in Kazakhstan.

12. List the challenges still facing the Kazakhstan government in its management of agricultural change.

Manufacturing and related service industry

Factors affecting the location of manufacturing and related service industry

Some of the factors described below affect the global distribution of industry while others affect the location of industry within a country. Some factors which were previously very important are now much less so.

Site

Many industries demand space and need large, reasonably flat sites for large factories and warehousing. In Europe during the Industrial Revolution and into the early 20th century many industries grew up close to city centres and the houses of the workers who had to walk to work. This applies to the textile industry (e.g. Lille, Roubaix and Tourcoing in France), the iron and steel industry (e.g. Workington and Barrow in the UK) and shipbuilding (e.g. Glasgow and Belfast, UK). As public transport systems developed, the need to be close to workers declined and the old sites were often cramped and difficult to develop and expand. For these reasons heavy industry today tends to be located away from city centres where large, flat, well-drained sites are available. Power stations and chemical plants which are regarded as being visually unattractive are also found on the outskirts or outside cities. Where the heavy industry uses imported raw materials, nearness to a deep-water port is important, as illustrated below.

Fig. 11.40 Buna chemical plant, Schkopau, Saxony-Anhalt, Germany

Distribution and warehousing also tends to be located on the edge or away from settlements where transport links are good.

This trend also applies to the quaternary section where rapid development means that sites should be adaptable and able to expand. These sites sometimes have attractive, rural surroundings. Examples of this include the Cambridge Science Park and Aztec West industrial park in Bristol, UK. As well as the site, accessibility is an important factor and this is described below.

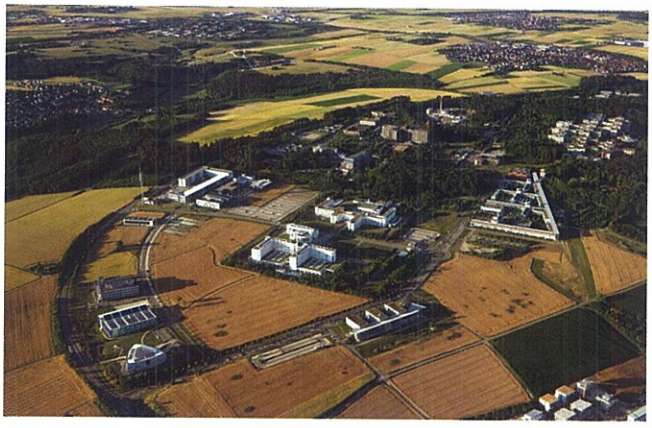


Fig. 11.41 A science park at the University of Ulm, Baden-Württemberg, Germany

Labour

In industries with large workforces, companies try to reduce costs by seeking the cheapest labour. This has led to the decline of the textile industry in many HICs and relocation to countries such as China, India and Bangladesh. An examination of the labels on your clothing will demonstrate this point.

Other industrial sectors have small workforces and skill is a more important factor. In Chapter 6 it was noted that many trans-national corporations have their management functions in 'world cities' such as New York, London, Hong Kong, Paris, Singapore, Tokyo, Shanghai, Chicago, Dubai or Sydney but their manufacturing is in LICs or lower MICs.

Skilled labour is also sought by these industries. However, the reputation and adaptability of the workforce is a significant factor. A good example of this is motor vehicle assembly where global giants such as Toyota or VW are able to locate in every continent and train a local workforce.

Capital

To establish an industry an initial capital input is required and it may be some time before sufficient profits are made to recoup this. In LICs, getting credit is more difficult and this impedes industrial development. This is why LICs and lower MICs welcome investment from trans-nationals or state enterprises from China. Trans-nationals have larger capital resources and can get credit more easily which allows them

to expand globally. Smaller enterprises find it more difficult to get credit to start businesses.

Markets

The market is the people who buy the goods. In manufacturing a large, affluent population is needed to sell goods to. However, many commodities can bear the costs of transport, e.g. electrical and electronic goods which are shipped from China or Japan to Europe. The market factor is also affected by trade agreements and import tariffs. A country may only allow a certain quantity of a commodity to enter its borders. In the motor vehicle industry, import tariffs encourage the industry to locate assembly plants in the market country or continent, often importing the parts.

Market is an important factor for service industries. Although some services can be conducted at a distance, e.g. via call centres in another continent, industries such as accountancy often require more direct contact with the customer. Head offices tend to remain close to those of other similar firms. Banking is an example of this, where headquarters will be located in financial centres such as London, New York, Hong Kong or Shanghai, but other functions may be dealt with by thousands of local branches close to the customer, or by distant call centres.

Raw materials

The availability of raw materials was previously the single most important factor in the location of heavy industries such as iron and steel and chemicals. It was for this reason that the coalfields became the location of heavy industry during the Industrial Revolution. Coal was required as a raw material or as a source of power in steam-driven machinery. All across Europe and North America the coalfields became the industrial centres, as they did in Australia and South Africa.

Where raw materials were imported, e.g. imported iron ore in steel making, the industry located near to deep-water ports to avoid higher costs of transport on land. The advent of bulk carriers has meant that it is now possible to transport comparatively low value and high bulk commodities such as iron ore, coal and crude oil around the world. Industry is now not so tied to its raw materials and other factors, such as nearness to markets, have become more significant.

In the case of industries with high value and low bulk goods, such as the high technology industries, the supply of raw materials is not a factor in their location.

Technology

Today areas which have specialist technologies tend to continue to forge ahead in their specialist areas. This is part of inertia, described below. Areas develop specialist technologies and skills and become centres of research and development in those industries and this leads to the development of linked industries. For example Seattle, USA and Toulouse, France are centres of aeroplane manufacture and linked aerospace industries; Bangalore, India and Toronto, Canada are centres of high technology industries. Other areas find it more difficult to break into these industries. Major industries develop specialist supply chains in their areas.

Fig. 11.42 An aerial view of the steel industry complex at Pohang, South Korea. This illustrates the importance of site and imported raw materials

A linked factor is the basic infrastructure of an area. In the remoter areas of LICs and some lower MICs, a lack of tarred roads, financial institutions and social facilities (e.g. schools, hospitals and leisure facilities) inhibits industrial development.

Economies and diseconomies of scale

Economies of scale are the cost advantages resulting from the large size of a business. Economies of scale work in the manufacturing, retail and service sectors. The cost per unit of output generally decreases with increasing scale because fixed costs are spread out over more units of output and therefore greater income. This idea is also linked to the division of labour where individual production units concentrate on one aspect of production. The motor vehicle industry is an excellent example. Economies of scale can be gained as follows:

- A business can spread the capital cost of buildings.
- Bulk buying of materials will be possible.
- The specialisation of managers can be increased.
- Lower interest charges can be negotiated when borrowing from banks.
- The cost of advertising will be spread over a greater range of output.
- Expensive machinery may be used 24 hours a day.
- The physical fact that making buildings, pipelines, aircraft and ships slightly longer and wider increases the volume greatly. This is the 'square-cube law'. It is more efficient to heat these buildings.

→ Many manufacturing industries, e.g. chemicals, refined petroleum products, cement and paper, have labour requirements that are not greatly influenced by changes in factory capacity.

Large producers produce a standard commodity very efficiently. Smaller producers can remain viable by concentrating on speciality products. The difference between a hypermarket and a small highly specialist shop is an example.

Economies of scale may require a larger market. For example, it would not be efficient for a single country to have its own car maker if that company only sold within the country. This leads to a smaller number of larger trans-national producers.

Diseconomies of scale are when economies of scale have reached their limits and costs per additional unit begin to increase. Examples might be when the local raw material supply, such as wood in the pulp and paper industry is exceeded or when the local market is saturated and goods have to be transported longer distances.

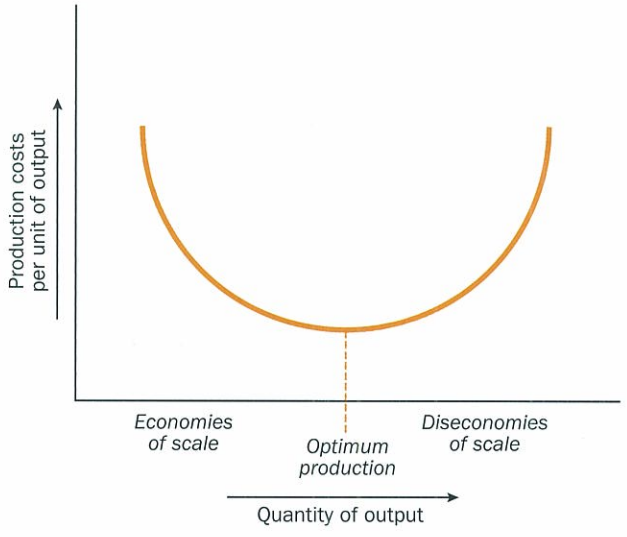


Fig. 11.43 Economies and diseconomies of scale

Economies of scale affect industrial location by concentrating production, retail and service functions in large units in central locations.

Inertia

A map of the coalfields of Europe is quite similar to a map of population density. As mentioned earlier, the Industrial Revolution in Europe led to the concentration of heavy industries on the coalfields. Many of these areas remain as centres of industry, even though the initial reasons for their establishment have disappeared. The areas developed expertise and reputation for certain products and have remained centres of production.

Fig. 11.44 The coalfields of northern France, Belgium, the Netherlands and the western part of Germany

Transport

As mentioned above, raw materials and the heavy cost of transport was previously the single most important factor in the location of heavy manufacturing industry. The advent of more efficient forms of transport such as the bulk ocean carrier has changed this. Steel producers reliant on imported raw materials will tend to locate at deep water ports such as Rotterdam and Ijmuiden in the Netherlands. However, car assembly plants using imported components have not found it necessary to find a port location. There are examples of this in the UK.

In the retail and service sectors transport has become an important factor, in this case related to the market. Scale economies have led to larger units. At the same time city centres have become more congested and these functions have increasingly located in out-of-town localities often close to ring roads where supplies can be brought in easily and there is access to a large market travelling by private car. Access to an airport is an important factor for high technology industries and some tertiary activities such as company head offices.

In many LICs weak transport infrastructure impedes industrial development as there is poor access to materials and market.

Government policies

Even in the market economies of the western nations, government policies have been very important in the development and location of industry. In the UK, one of the

earliest examples of this was the development of industrial estates (see later in this chapter) in the 1930s in areas of very high unemployment. Government intervention takes place in the following ways:

- A government may offer direct financial incentives to companies, e.g. to develop a major factory such as the Toyota cars factory in Derby, UK.
- A favourable tax system can attract trans-nationals. This also affects head office and other tertiary and quaternary functions where low-tax countries such as the Channel Islands and the Isle of Man have an advantage.
- The effect of trade agreements and import tariffs on markets has already been referred to.

In the command economy of the USSR government influence was direct. All industrial location was controlled by the government.

13. For the country where you live, or another country, find the location(s) of the steel industry. Has this changed in the past and how?

Industrial agglomeration and functional linkages

The concept of agglomeration may apply to:

- firms of similar types of business – this leads to areas or parts of towns and cities specialising in certain industries
- different types of business – this leads to the growth and predominance of large cities and is linked to the concept of the world city, described in Chapter 6.

Agglomerations of similar businesses

Most larger towns and cities will have examples of agglomerations, e.g. streets or areas where there are concentrations of particular types of service such as banks or shoe shops, or areas where there are concentrations of particular types of manufacturing. Close to the centre of Birmingham, UK, there is a jewellery quarter with over 800 jewellery businesses, 100 specialist retailers and 50 jewellery designers. There is also a gun quarter which was for many years the centre of world's gun-manufacturing industry, specialising in the production of military firearms and sporting guns, although this area has gone into decline. Agglomerations also occur in services.

14. Think of your own local area. What evidence can you see for agglomeration?

These agglomerations develop for the following reasons:

- **Shared labour skills**
  Large populations of specialist, skilled workers enter the area making it easier for companies to recruit here.
- **Supply chain factors**
  In manufacturing, component industries spring up around large manufacturers, e.g. car assembly plants. It is easier for firms to source components when they are located in a specialist area.
- **Shared innovations**
  Clustering of similar industries leads to quicker diffusion and adoption of new ideas. This factor is often quoted in relation to high technology industries.
- **Market and reputation**
  The area develops a reputation for the product or service and customers are attracted by the quality or choice available.

This factor applies partly because locating near other similar businesses gives each business a larger market share, as in the ice cream exercise. It applies particularly for goods and services where people shop around, e.g. for shoes or jewellery.

Agglomerations of different types of business

It may be better for businesses to locate near other businesses which are completely unrelated. This could be because of the existence of a larger, more wealthy market from the population in the area and the existence of better infrastructure such as roads, banks, schools, police or fire services. This is the basic reason for the growth of cities and the predominance of **world cities** such as London and New York (see Chapter 6). These cities develop a better educated workforce with a higher number of graduates and more skills, which in turn attracts more industry. Wealth becomes concentrated in these cities and there is greater investment in transport infrastructure and social facilities such as theatres and restaurants. Upmarket retailing also develops. In the period after the world economic recession of 2008–12, major cities grew much faster and recovered faster than provincial areas.

This is the reason for the regional economic policies of many governments as they invest in poorer areas in order to help them achieve economic take-off and attract industry. Achieving economies of agglomeration is the reason many state governments in the USA redistribute income from their affluent suburbs to poorer urban localities. This is often achieved through grants to local governments according to criteria that favour low-income communities.

Industrial estates

Industrial estates are areas set aside for industry and usually have a variety of industries on site. They tend to deal with light industries but not always. They have often been established by local or national governments to stimulate economic development or to provide employment. However, they have also been established by entrepreneurs. Industrial estates have the advantage that the sites chosen are usually flat and spacious. They are usually, but not always, in suburban locations with good road access. Free trade zones and export processing zones (see below) may be considered as industrial estates, although the latter may not be on a single site.

In the UK industry was badly affected by the First World War (1914–18) and then by the economic depression of 1929–33. In 1934 the UK government passed the Special Areas Act. This was the first of a long series of measures which aimed to bring regeneration to severely depressed areas through strategies of financial aid to new firms willing to relocate to them. Eligible districts were those with unemployment figures above the national average, designated as 'special areas'. These were often areas of declining coal mining, iron and steel and shipbuilding. They included much of South Wales, Tyneside, West Cumberland and Central Scotland. In 1931, in the small town of Maryport, West Cumberland, unemployment reached 76.7 per cent. The Special Areas Act led to the development, in Maryport, of what is thought to be the UK's first industrial estate to be established as part of government regional policy.

A contrasting example is provided by another early industrial estate, Trafford Park, Manchester, UK. This was developed by a private entrepreneur and throughout its history has had much heavy industry. It was developed by the financier Ernest Terah Hooley in 1896. It is one of Europe's largest industrial estates and claims to be the first planned industrial estate in the world. It is located on the Manchester Ship Canal, linking Manchester with Liverpool and the sea. The changing fortunes of Trafford Park is shown by the numbers employed (see Table 11.8).

Year	Number of employees
1903	12 000
1945	75 000
1967	50 000
1976	15 000
2008	35 000

Table 11.8 Numbers of employees at Trafford Park industrial estate

The industries located at Trafford Park have varied but have included:

- engineering (British Westinghouse, Rolls-Royce, Ford Motor Company)
- brick making
- timber merchants
- electric cable manufacturers (W. T. Glovers)
- food packing and flour milling (Cooperative Wholesale Society, Kellogg's, Rank Hovis).

The new generation of container ships is too large for the Manchester Ship Canal and so it is no longer significant to the estate. The Trafford Park Urban Development Corporation, formed in 1987, reversed the estate's decline and, in 2008, there were 1 400 companies present.

Science parks are another category of industrial estate. As discussed earlier in this chapter, rapid development means that the sites of science parks should be adaptable and able to expand, and be accessible to national transport routes. They often have attractive, rural surroundings. Examples of this include the Cambridge Science Park and Aztec West industrial park in Bristol, UK.

Case study: Industrial estates in Maseru, Lesotho

Lesotho is a small, landlocked lower MIC in southern Africa. Industrial estates have been a significant factor in the development of the country, as they provide basic infrastructure such as tarred roads, water and electricity supplies, which might be otherwise lacking. Landownership in the country is controlled by the Government which has allocated land for industrial estates.

Industrial estates can be found both in the capital Maseru and in other parts of Lesotho. They are administered through the Lesotho National Development Corporation (LNDC), an organisation which also offers investment and after-care services including assistance with licenses, permits and company registration.

Clothing and textiles are the main industries on all the industrial estates in Maseru. They are predominantly owned by foreign companies, especially from China and Taiwan. This industry has developed rapidly since the 1990s, taking advantage of preferable trade agreements, including duty-free access to the EU market. Lesotho is sub-Saharan Africa's biggest

Fig 11.45 The location of Maseru in Lesotho

exporter of textiles and clothing to the USA. The industry has been an important job creator for low-skilled women who were previously excluded from the formal sector of the labour market. The industry reached a peak in 2008 when there were 70 factories on industrial estates in the country. Since then and the ending of quota systems, Lesotho has faced strong competition from low cost producers in China and the Far East. However, South African firms are re-locating to Lesotho to take advantage of the labour market conditions in the country.

Foreign Direct Investment (FDI) in Lesotho is estimated at 2.7 per cent of GDP with most of this from textile firms. FDI provides 45 400 jobs (LNDC 2014), a significant number in a small country.

The oldest industrial area is Maseru West. This is linked by a 2.5 km narrow gauge railway to the border post with South Africa and the Bloemfontein to Bethlehem line. The line carries about a third of Lesotho's trade in bulk goods. These include imports of cement, maize and fuel. There is also container trade serving the textile and clothing industry via the Maseru Container Terminal (MASCON). It is hoped that it will develop into a dry port operated by a semi-autonomous government agency; in addition to being a transshipment point for goods, the dry port would also be a customs clearance point. Expansion of the site is limited by the Mohokare River (and the border with South Africa) to the north west, and the residential area to the south east. In addition to textiles, industries include the Maluti Mountain Brewery and maize milling.

A more recent LNDC industrial estate is at Thetsane, once a separate village but now part of the built-up area. This site is restricted by neighbouring residential areas and steep high ground. In addition to textiles, industries include manufacturing of TVs, bags, tents and bricks.

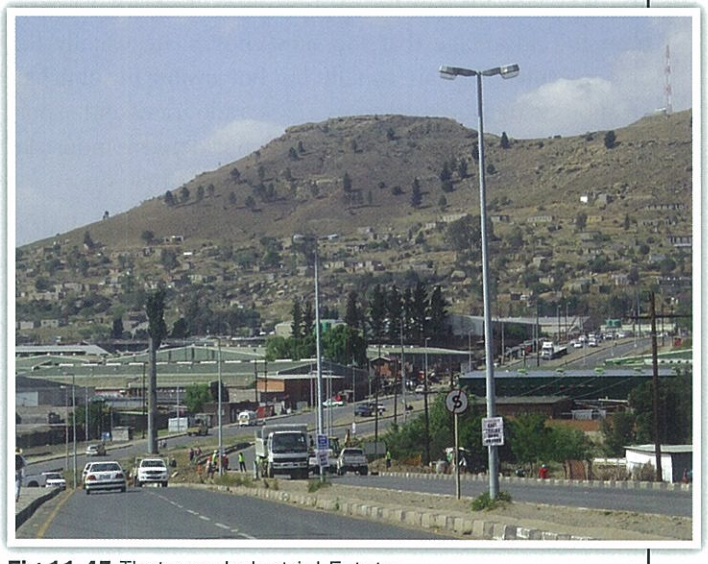


Fig 11.45 Thetsane Industrial Estate

The LNDC's most recent industrial estate is a 40 acre site at Ha Tikoe, 7 km south of the city centre. Infrastructure development at this site has been financed by the Lesotho Government, the Arab Bank for Economic Development in Africa and the OPEC Fund for International Development. The site includes water, electricity, 2 km of tarred roads and 30 000 m^2 of factory space. The LNDC has completed 11 factory shells; six smaller shells are reserved for local entrepreneurs. An injection moulding factory has been established in addition to textiles.

Fig 11.46 Ha Tikoe Industrial Estate

Free trade zones

Free trade zones (FTZs) were formerly called **free ports**. They are areas where goods may be imported, handled, manufactured and re-exported without going through customs. Only when the goods are moved to consumers within the country in which the zone is located do they become subject to customs duties.

FTZs are often found around major seaports and international airports. An early FTZ was established in 1959 in Shannon, Ireland, by the Irish government to promote employment in a rural area. It is a 2.43 km^2 site next to Shannon Airport. Businesses based on the site enjoy special tax incentives. There are over 100 multi-national firms and 6500 people employed. Companies include DeBeers Industrial Diamonds (now Element Six) Kraus & Naimer, GE Capital, Precision Castparts Corp., Genworth, Ingersoll Rand, Intel, Lufthansa Technik, Mentor Graphics, Molex, Illinois Tool Works, Transaero, RSA Security, Ohshima, Schwarz Pharma and Zimmer.

Export processing zones (EPZs)

Export processing zones (EPZs) are a type of FTZ set up generally by governments in LICs and MICs to promote industrial and commercial exports. They aim to attract foreign investment and to create employment. Incentives to companies choosing to operate within such zones include duty free imports of raw materials, flexibility of labour laws (including in some zones exemption from labour laws) and tax concessions. EPZs are known as Special Economic Zones in China and Maquiladoras in Mexico. These zones are often used by multinational corporations to set up factories to produce goods such as clothing or shoes where production is labour intensive. Brazil, Colombia, India, Indonesia, El Salvador, China, the Philippines, Malaysia, Bangladesh, Pakistan, Mexico, Costa Rica, Honduras, Guatemala, Kenya, Sri Lanka, Mauritius and Madagascar have EPZ programmes. In 2003 it was estimated that EPZs in 116 countries employed 43 million people.

Companies locating in EPZs benefit from low wages and low taxation.

Advantages for the host country may include the following:

- Host governments may invest in infrastructure such as electricity or water supplies.
- Workers in the EPZ may get higher pay than those outside.

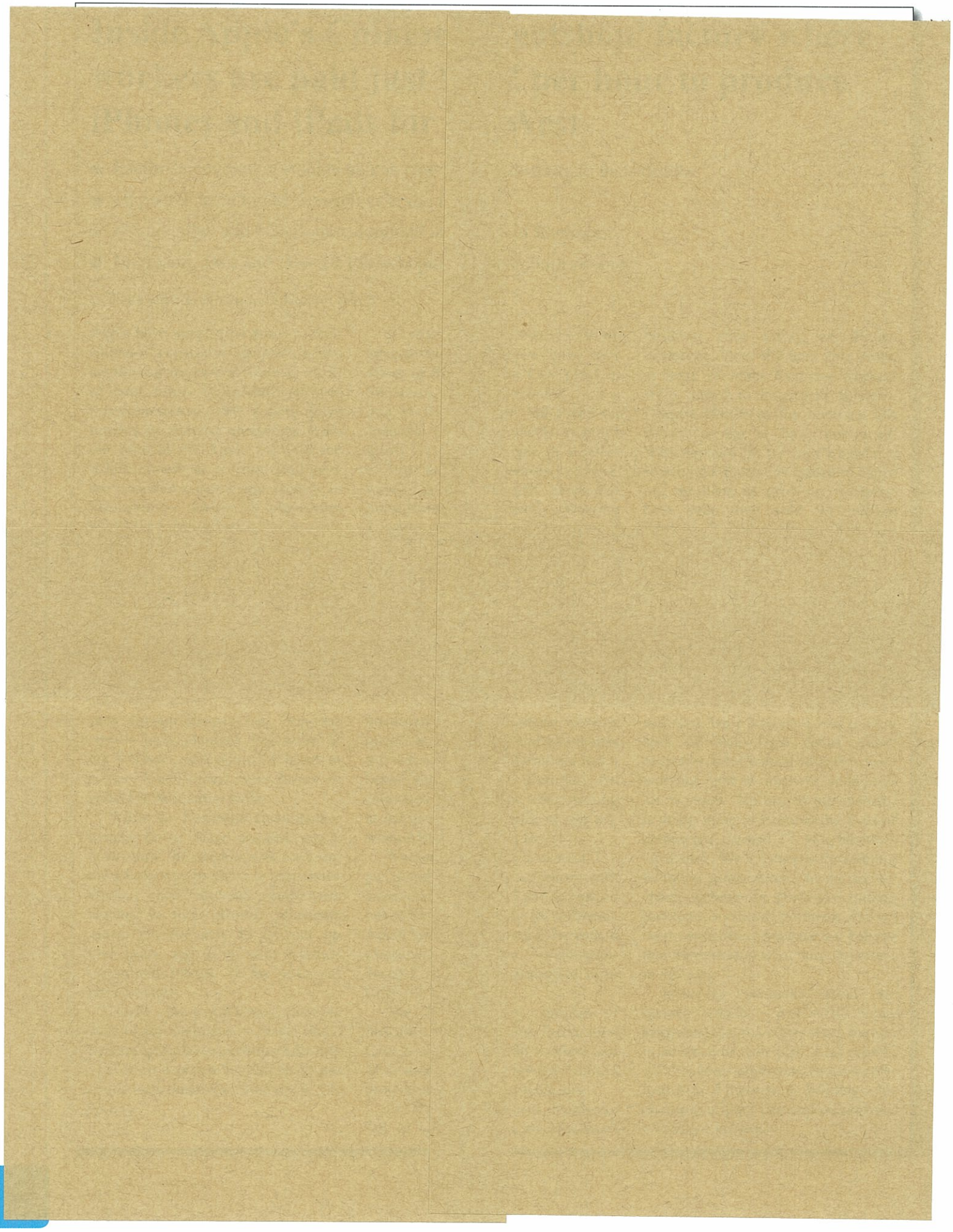
Fig. 11.47 A woman works in a garments factory in Ashulia Savar in Dhaka, Bangladesh

Disadvantages for the host country may include:

- low wages
- long working hours
- little regard for health and safety
- no organised trade unions
- little impact on the overall economic development of the host country.

The use of EPZs is contentious as the following article from the UK *Daily Mail* (Mail Online, 25 January 2013) shows. Shenzhen is one of China's Special Economic Zones.

15. Assess the contribution of different types of industrial estate to economic development.



pharmaceuticals. Taiwanese companies have invested heavily in other Asian countries such as Thailand, Indonesia, the Philippines, Malaysia, and Vietnam. Economic ties between Taiwan and mainland China have always been strong with Taiwanese companies investing in China and about 10 per cent of the Taiwanese labour force working there, often running their own businesses. Taiwan's main export partners are: China 27.1 per cent, Hong Kong 13.2 per cent, USA 10.3 per cent, Japan 6.4 per cent, Singapore 4.4 per cent. The heavy dependence on exports exposes the economy to fluctuations in world demand.

Another development of this period has been the development of high technology industrial parks all over Taiwan. The workforce which was an asset because it was cheap is now an asset because it is well-educated and adaptable. Sony, Sharp and IBM have research and development centres in Taiwan. Acer inc is a Taiwanese TNC dealing in electronics.

Relationships between the Taiwan (ROC) and China (PRC) are complex. The ROC sometimes joins international organisations under a politically neutral name. The ROC is a member of the World Trade Organization under the name 'Separate Customs Territory of Taiwan, Penghu, Kinmen and Matsu (Chinese Taipei)'.

Taiwan's low birth rate could mean future labour shortages, falling domestic demand, and declining tax revenues. Taiwan's population is aging quickly, with the number of people over 65 accounting for 11.2 per cent of the population in 2012.

Fig. 11.49 Tatung TV factory, Taipei

Industrialisation and a rapid increase in population have led to damage to the ecology, natural environment and human health of Taiwan by various pollution problems including land, water air and noise.

- **Waste disposal** – the government has been disposing of garbage through sanitary burial and incineration while promoting the sorting out of different kinds of garbage to facilitate disposal. The government constructed 75 hygienic waste burial sites and 16 garbage incinerators between 1991 and 1996. Research has been carried out into the feasibility of using compressed garbage to reclaim coastal land.
- **Water pollution** – local governments are responsible for promoting river pollution clean-up plans along rivers, such as the Kaoping River and Tungkang River. There is also a problem of effluent from livestock farms which is being addressed.
- **Air pollution** – measures include introducing control permits for utilisation and sale of high-polluting fuels; implementing control permits for sale of special chemicals and promoting a unified system of vehicle emission standards, inspection and maintenance. There are free motorcycle exhaust-testing centres.
- **Noise** – the government has set standards for noise levels in different types of urban zone and established a noise monitoring system.
- **Soil pollution** – controls over the transportation, storage and use of toxic materials and soil pollution monitoring have been introduced.
- **Environmental beautification** – the government has attempted to promote the beautification of residential communities, campuses, and government offices.
- **Ecological protection** – 25 forest conservation zones (including Mount Takuan and Mount Hsuehpa), 18 nature conservation zones (including Mount Yon and Mount Tawu), 3 wild animal protection zones (Mao Islet, Nantzuhsien River and Wuwei Harbor) have been designated and 11 rare plant species (including Cycas taiwaniana and Amentotaxus formosana) have been listed under cultural heritage protection laws. The government is also attempting to stamp out the hunting and illicit sale of wild animals. Education and publicity drives are also aimed at ensuring the continued survival of wild animals.

17. Explain how the statistics shown in Table 11.9 show the phases of industrial change in Taiwan.

18. Explain how this change has been managed.

Key concepts

The key concepts listed in the syllabus are set out below. For each one a summary of how it applies to this chapter is included.

Space: different types of agriculture and industry occupy different spaces on the Earth's surface. Some types of space are appropriate for the development of different types of activity. For example, large areas of flat land in temperate climates allow the development of extensive wheat cultivation. A space on a river estuary close to a large city might be the location for an industrial estate or export processing zone. Small spaces in an industrial town may be occupied by industries with functional linkages.

Scale: the spatial scale of agriculture and industry is illustrated by the global scale of the distributions of major crops or the activities of trans-national corporations. The local scale is shown by the activities of individual farms and factories which may be very small. Time scale is also important as these patterns change. The end of the Soviet Union in 1991 led to profound agricultural changes in Kazakhstan and these changes are still going on today as the system evolves. In other cases, such as the closure of a factory, change may be very quick. Both industrial and agricultural systems are influenced by economies of scale. Industrial inertia also shows that time sometimes stands still!

Place: the broad patterns of agricultural production are the result of the climate of different places, so that different places have very different practices. Local relief, drainage, soils and market conditions then influence the local pattern so that places are different within the broad zones. Different industries seek different types of places with appropriate supplies of labour, land, materials, transport and technology.

Environment: agriculture and industry illustrate the need for environmental management and sustainability. Examples such as the Dust Bowl in the 1930s in the USA or the USSR's Virgin Lands programme show how poor practices can lead to environmental disasters. (A further example is that of the Sahel in Chapter 10.) Where industries develop rapidly and there is rapid population growth the environment can be affected. The case study of Taiwan shows the damage to the ecology, natural environment and human health by various pollution problems including land, water, air and noise, and how they are being managed.

Interdependence: agriculture illustrates the complex nature of interacting physical and human systems where the different physical and political factors shape agricultural patterns. Agriculture in Europe is dependent on the physical environment but also by the political decisions made by the European Union. Few communities or countries are completely self-sufficient in food and most are, wholly or partially, dependent on producers elsewhere in the world. Conversely, food producers are often highly dependent on overseas markets. For example, a change in European Union import policy can affect farmers in Africa or the Caribbean.

Diversity: the global pattern of agriculture is highly diverse, with climate providing the broad pattern but local physical and economic factors providing the detail. However, there are large areas like the grain belts of North America which lack diversity. Some major industries such as motor vehicle assembly can operate almost anywhere in the world that there is a market and lack diversity. Industrial estates and export processing zones are similar wherever they are in the world.

Change: the dynamic nature of industrial location and agricultural production is stressed throughout this chapter. The main change to industrial location in recent years has been the relocation of manufacturing from HICs to LICs and lower MICs, with tertiary and quaternary activities being concentrated in HICs. However, there are examples where industrial inertia occurs. The case study of Taiwan shows the changes within one country. Agricultural change is largely the result of population growth, and political and market factors. The case study of Kazakhstan shows the changes within one country.

Exam-style questions

1 Study Fig. 11.50 which shows a farming area.

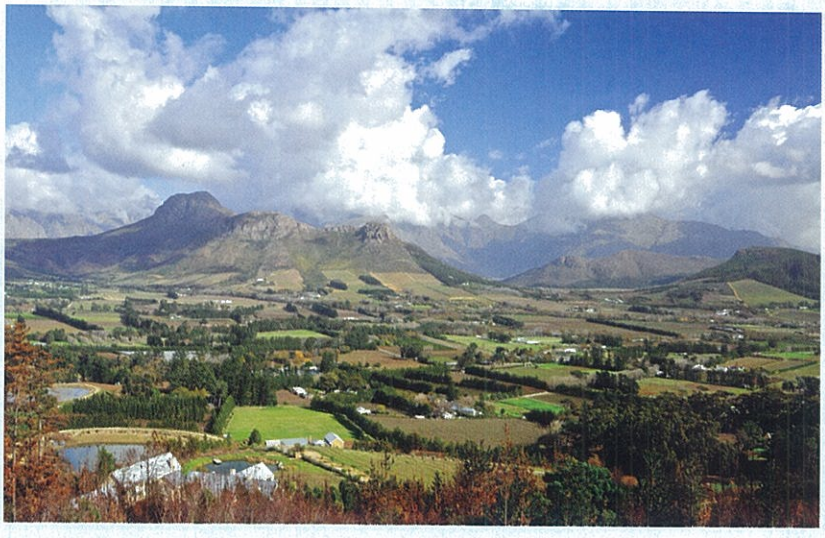


Fig. 11.50

(a) Describe the pattern of agriculture shown in the photograph. [4]

(b) Explain what might be done to increase agricultural output in this area. [6]

2 Explain the term agglomeration economies and assess their importance to manufacturing and related service industries. [20]