11 Production, location and change

11.1 Agricultural systems and food production

Factors affecting agricultural land use and practices

A wide range of factors combine to influence agricultural land use and practices on farms. These can be placed under the general headings of physical, economic, political and social/cultural factors.

Physical factors

North America, for example, has many different physical environments. This allows a wide variety of crops to be grown and livestock kept. New technology and high levels of investment have steadily extended farming into more difficult environments. Irrigation has enabled farming to flourish in the arid west, while new varieties of wheat have pushed production northward in Canada. However, the physical environment remains a big influence on farming. There are certain factors that technology and investment can do little to alter. So relief, climate and soils set broad limits as to what can be produced. This leaves the farmer with some choices, even in difficult environments. The farmer's decisions are then influenced by economic, political and social/cultural factors.

Figure 11.1 shows the agricultural regions of the USA. Look at relief and climate maps of the USA in an atlas and see how the agricultural regions vary according to different physical conditions. Temperature is a critical factor in crop growth as each type of crop requires a minimum growing temperature and a minimum length of growing season. Latitude, altitude and distance from the

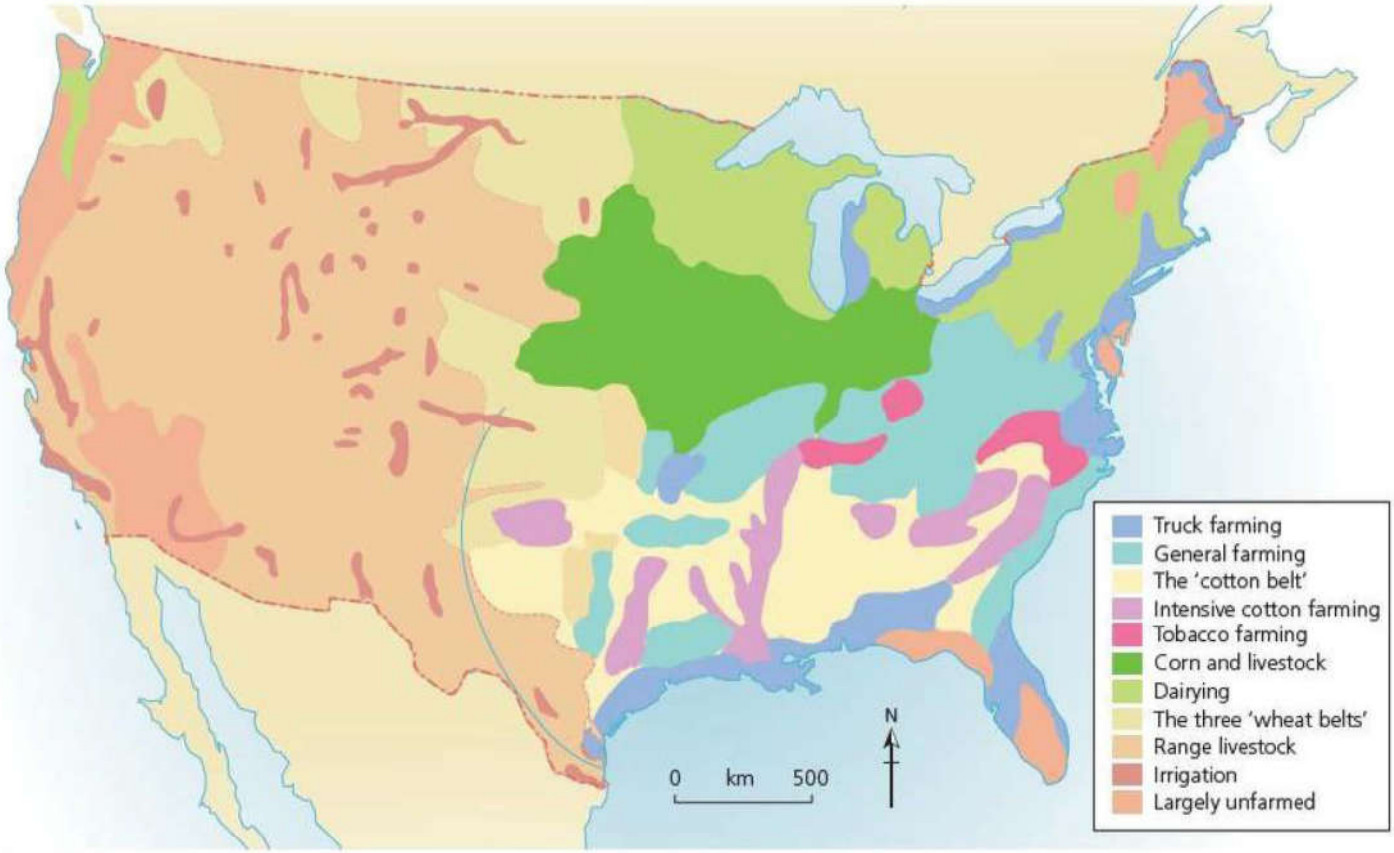


Figure 11.1 Agricultural regions of the USA

sea are the major influences on temperature. Precipitation is equally important – not just the annual total, but also the way it is distributed throughout the year. Long, steady periods of rainfall to infiltrate into the soil are best, making water available for crop growth. In contrast, short heavy downpours can result in rapid surface runoff, leaving less water available for crop growth and soil erosion.

Soil type and fertility have a huge impact on **agricultural productivity**. Often, areas that have never been cleared for farming were ignored because soil fertility was poor or was perceived to be poor. In some regions, wind can have a serious impact on farming, for example causing bush fires in some states such as California. Locally, aspect and the angle of slope may also be important factors in deciding how the land is used.

Cotton, for example, needs a frost-free period of at least 200 days. Rainfall should be over 625 millimetres a year, with not more than 250 millimetres in the autumn harvest season. Cotton production is now highly mechanised. Irrigation has allowed cotton to flourish in the drier western states of California, New Mexico and Texas. In contrast, the area under cotton has fallen considerably in the south. A crop pest called the cotton boll weevil, which caused great destruction to cotton crops in the past, has been a big factor in the diversification of agriculture in the southern states.

In contrast, corn is grown further north than cotton. Corn needs a growing season of at least 130 days. For the crop to ripen properly, summer temperatures of 21 °C are needed, with warm nights. Precipitation should be over 500 millimetres, with at least 200 millimetres in the three summer months.

In Canada, the USA's northern neighbour, farming is severely restricted by climate. Less than 8 per cent of the total area of the country is farmed; 70 per cent of Canada lies north of the **thermal limit for crop growth** and most farms are within 500 kilometres of the main border (apart from Alaska) with the USA. Other high-latitude countries such as Russia also suffer considerable climatic restrictions on agriculture.

Water is vital for agriculture. **Irrigation** is an important factor in farming, not just in North America but in many other parts of the world as well. Figure 11.2 shows the divide by world region between **rainfed water** for crop use and irrigation water. The figures in the circles refer to the total amount of rainfed water used. Here, the highest totals are for East Asia, South Asia and Sub-Saharan Africa. The highest proportion of irrigation water use is in the Middle East and North Africa, and South Asia. Irrigated farming accounts for 70 per cent of global annual water consumption. This rises to over 90 per cent in some countries such as India. Table 11.1 compares the main types of irrigation (Figures 11.3 and 11.4). This is an example of the **ladder of agricultural technology**, with surface irrigation being the most traditional method and sub-surface (drip) irrigation the most advanced technique.

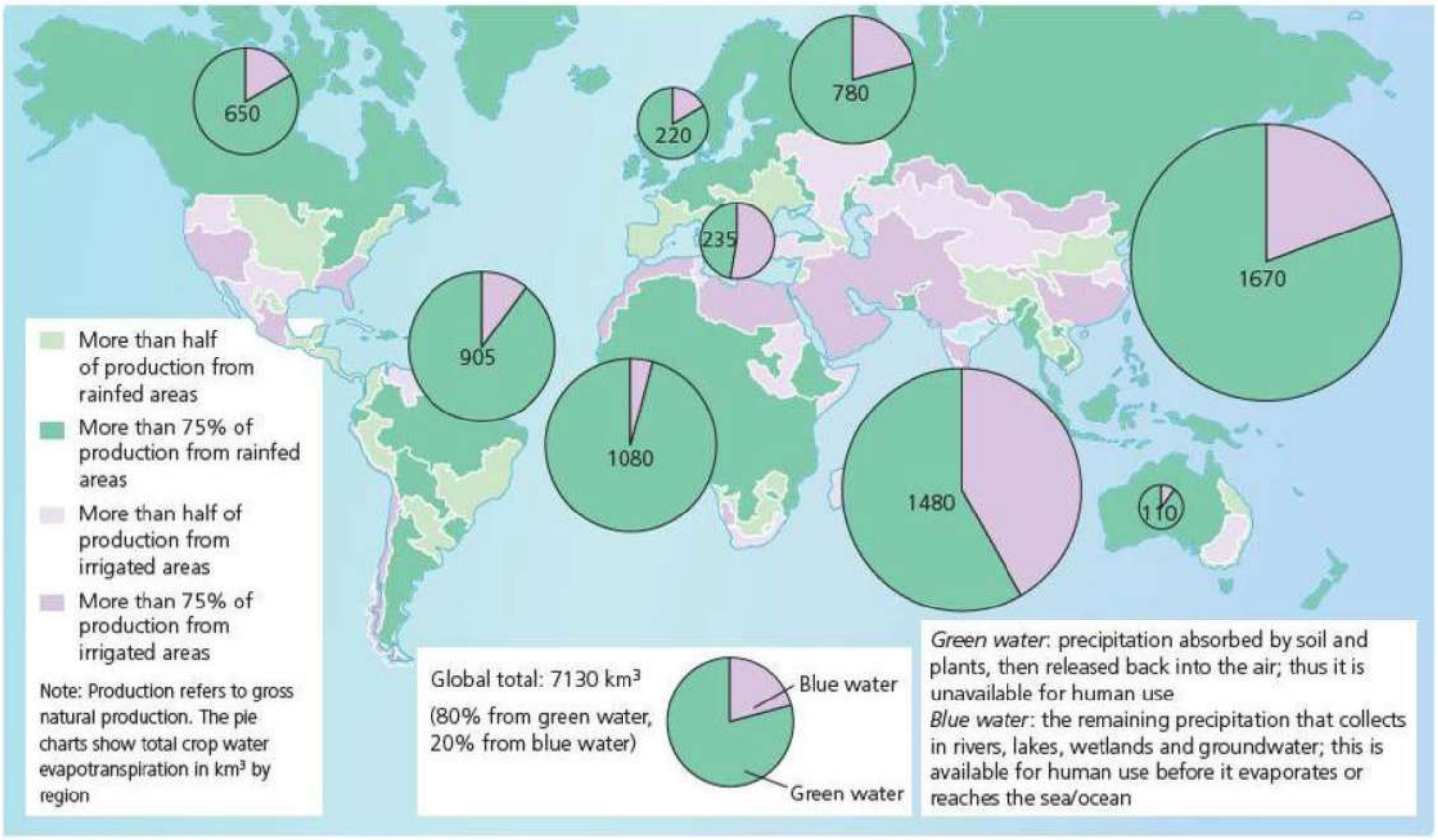


Figure 11.2 World distribution of rainfed and irrigation water for crop use

Table 11.1 Main types of irrigation

Method of irrigation	Efficiency (%)
Surface – used in over 80 % of irrigated fields worldwide	
Furrow: Traditional method; cheap to install; labour-intensive; high water losses; susceptible to erosion and salinisation	20–60
Basin: Cheap to install and run; needs a lot of water; susceptible to salinisation and waterlogging	50–75
Aerial (using sprinklers) – used in 10–15 % of irrigation worldwide	
Costly to install and run; low-pressure sprinklers preferable	60–80
Sub-surface ('drip') – used in 1 % of irrigation worldwide	
High capital costs; sophisticated monitoring; very efficient	75–95

Source: 'The Water Crisis: A Matter of Life and Death', Understanding Global Issues, *p7*

Figure 11.3 An irrigation canal in northern Spain

Economic factors and agricultural technology

Economic factors include transport, markets, capital and technology. The role of government is a factor here too, but this is considered in the next section, 'Political factors'.

The costs of growing different crops and keeping different livestock vary. The market prices for agricultural products also vary and can change from year to year. The necessary investment in buildings and machinery can mean that some changes in farming activities are very expensive. These will be more difficult to achieve than other, cheaper changes. Thus it is not always easy for farmers to react quickly to changes in consumer demand.

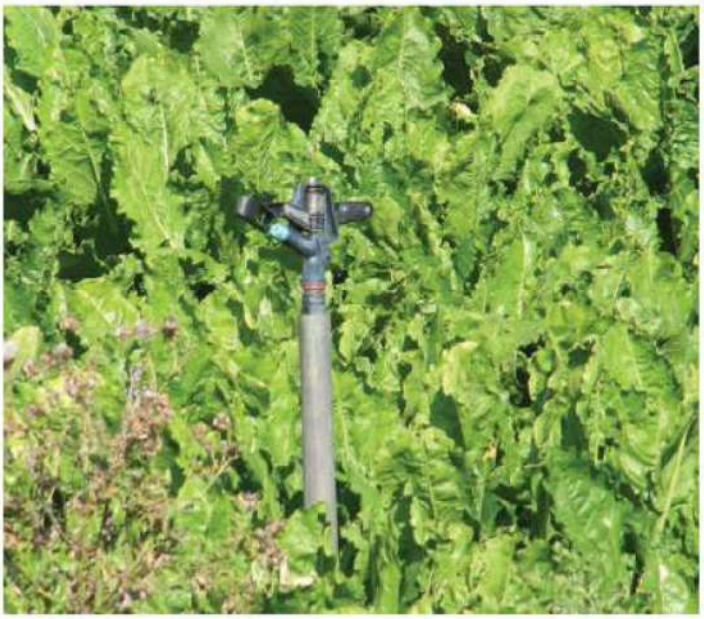


Figure 11.4 A sprinkler system irrigating crops in northern Spain

Figure 11.5 Goats feeding from a bowl because the ground is frozen, in cold central Asia

In most countries, there has been a trend towards fewer but larger farms. Large farms allow **economies of scale** to operate, which reduce the unit costs of production. As more large farms are created, small farms find it increasingly difficult to compete and make a profit. Selling to a larger neighbouring farm may be the only economic solution. The EU is an example of a region where average farm size varies significantly. Those countries with a large average farm size have more efficient agricultural sectors than countries with a small average farm size.

Distance from markets has always been an important influence on agricultural practices. Heinrich von Thünen published a major theoretical work on this topic in 1826. He was mainly concerned with the relationships between three variables:

Figure 11.6 A food market in Morocco

- the distance of farms from the market
- the price received by farmers for their products
- the economic rent (the profit from a unit of land).

Von Thünen argued that the return a farmer obtained for a unit of his product was equal to its price at market less the cost of transporting it to the market. Thus the nearer a farmer was to the market, the greater his returns from the sale of his produce (Figure 11.7). The logic of this is that land closest to the market would be the most intensively farmed land, with farming intensity decreasing with increasing distance from the market. At a certain distance from the market, transport costs would be so high that they would equal the profit from farming and therefore make cultivation illogical (Figure 11.7). Farmers setting out to maximise their profits would choose that activity or combination of farming activities that would give the best economic rent (profit). Although this theory is almost two centuries old, it still holds a basic logic.

Agricultural technology is the application of techniques to control the growth and harvesting of animal and vegetable products. The development and application of agricultural technology requires investment and thus it is an economic factor. Advances in agricultural technology can be traced back to the Neolithic Revolution. Table 11.2 shows the last two sections of a timeline of agricultural advance published in Wikipedia (the table only shows major and selected advances and thus omits a whole range of smaller improvements).

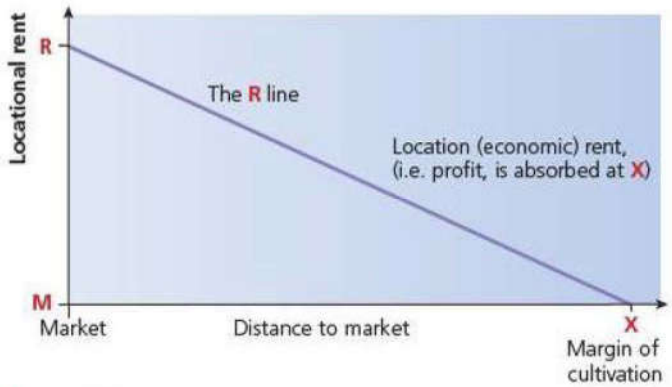


Figure 11.7 The relationship between economic rent and distance from the market

Table 11.2 Timeline of agricultural technology

Year	Event
Agricultural Revolution	
1700	Agricultural Revolution begins in the UK
1809	French confectioner Nicolas Appert invents canning
1837	John Deere invents steel plough
1863	International 'Corn Show' in Paris, with corn varieties from different countries
1866	George Mendel publishes his paper describing Mendelian inheritance
1871	Louis Pasteur invents pasteurisation
1895	Refrigeration introduced in the USA for domestic food preservation, and in the UK for commercial food preservation
1930	First use of aerial photos in earth sciences and agriculture
Green Revolution	
1944	Green Revolution begins in Mexico
2000	Genetically modified plants cultivated around the world
2005	Lasers used to replace stickers by writing on food to 'track and trace' and identify individual pieces of fresh fruit

Source: Wikipedia

The status of a country's agricultural technology is vital for its food security and other aspects of quality of life. An important form of aid is the transfer of agricultural technology from more advanced to less advanced nations (Figure 11.8). China is now playing a major role in this process. Eighty per cent of the population in rural Sub-Saharan Africa is reliant on agriculture as a source of income and employment. Yet agricultural productivity has stagnated. The agricultural sector is mostly made up of small-scale farms. But small farmers face serious barriers to their development:

- They have limited access to new technologies, such as new crop varieties and better methods of storage.
- They have difficulty accessing finance and suffer from a lack of investment in areas such as roads, agricultural equipment and silos.
- They lack support from areas such as market boards and advisory services.

CHINA AGREES TO HELP IMPROVE AFRICAN FOOD PRODUCTION – KENYA

First published Thursday 12 August 2010, 03:10pm ©2010 Dow Jones

Nairobi – (Dow Jones) – China has agreed to transfer agricultural technology to Africa to enable the continent to boost production and thereby guarantee world food security, the Kenyan vice president press office said in a statement Thursday. The Beijing declaration for the massive agricultural technology transfer came as the China-Africa Agricultural Forum, in which vice president Kalonzo Musyoka represented Kenya, drew to a close Thursday.

Reading the declaration, the Chinese deputy Prime Minister Hui Liangyu said global food security should be the number one priority of governments, given that acute food shortages were bound to lead to food crises and hence social and political instability. 'China is the largest developing economy able to feed 20% of the world's population on the proceeds of 9% of the planet's arable land. If we partner with Africa with a much higher percentage of arable land yet contains most of the developing countries we should be able to guarantee international food security,' the statement quoted Hui as saying.

The declaration called for a leap in Africa's agricultural output by transforming its rural agriculture through an infusion of Chinese agricultural characteristics, the statement said.

This will involve educating rural farmers, setting up modern farming demonstration centers, using better quality seeds, and new technology in appropriate faming machinery as well as soil improvement techniques, said the statement.

– By George Mwangi, contributing to Dow Jones Newswires; +254 735 781853; gmwangio@gmail.com

Fig: Agricultural Technology

Figure 11.8 China agrees to help improve African food production

- They contend with market constraints such as an inability to produce the right amount or quality for customers, price variations and inadequate storage systems.

Small farmers in other parts of the world such as India face similar problems (Figure 11.9).

TECA is an FAO (Food and Agriculture Organization of the United Nations) initiative that aims at improving access to information and knowledge-sharing about proven technologies in order to enhance their adoption in agriculture, livestock, fisheries and forestry, thus addressing food security, climate change, poverty alleviation and sustainable development.

Figure 11.9 A smallholding in northern India

Agro-industrialisation, or 'industrial agriculture', is the form of modern farming that refers to the industrialised production of livestock, poultry, fish and crops. This type of large-scale, **capital-intensive farming** originally developed in Europe and North America and then spread to other HICs. It has been spreading rapidly in many MICs and LICs since the beginning of the **Green Revolution**. Industrial agriculture is heavily dependent on oil for every stage of its operation. The most obvious examples are fuelling farm machinery, transporting produce and producing fertilisers and other farm inputs. Table 11.3 shows the general characteristics of agro-industrialisation. Not all farms and regions involved in agro-industrialisation will display all these characteristics. For example, intensive market gardening units may be relatively small but the capital inputs are extremely high.

Table 11.3 The characteristics of agro-industrialisation

Very large farms
Concentration on one (monoculture) or a small number of farm products
A high level of mechanisation
Low labour input per unit of production
Heavy usage of fertilisers, pesticides and herbicides
Sophisticated ICT management systems
Highly qualified managers
Often owned by large agribusiness companies
Often vertically integrated with food processing and retailing

Regions where agro-industrialisation is clearly evident on a large scale include:

- the Canadian Prairies
- the corn and wheat belts in the USA

Figure 11.10 Industrial agriculture on the Canadian Prairies

- the Paris basin (Figure 11.10)
- East Anglia in the UK
- the Russian steppes
- the Pampas in Argentina
- Mato Grosso in Brazil
- the Murray–Darling basin in Australia.

Agro-industrialisation is a consequence of the globalisation of agriculture, profit ambitions of large agribusiness companies and the push for cheaper food production. Over the last half-century, every stage in the food industry has changed in the attempt to make it more efficient (in an economic sense). Vertical integration has become an increasingly important process, with extended linkages between the different stages of the food industry (Figure 11.11).

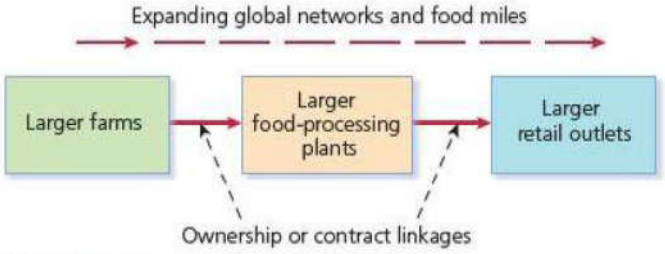


Figure 11.11 Agro-industrialisation – increasing vertical integration

Political factors

The influence of government on farming has steadily increased in many countries. For example, in the USA the main sectors of federal farm policy over the last half-century have been the following:

- **Price support loans** – loans that tide farmers over until they sell their produce; the government sets a price for each farm product it is willing to support, and if the farmer cannot sell the product for at least this price, they can keep the loan and let the government keep the crop that secured it.
- **Production controls** – these limit how much a farmer can produce of surplus crops; farmers lose price-support loans and other benefits if they don't comply.
- **Income supplements** – these are cash payments to farmers for major crops in years when market prices fail to reach certain levels.

The decisions made by individual farmers are therefore heavily influenced by government policies such as those listed above. However, in centrally planned economies the state has far more control. This was the case for many years in the former Soviet Union and China. Although much has changed in both of these countries in recent decades, the influence of government on farming still remains stronger than in most other parts of the world.

An agricultural policy can cover more than one country, as evidenced by the EU's Common Agricultural Policy (CAP). The CAP is a set of rules and regulations governing agricultural activities in the EU. The need for Europe to ensure a reliable and adequate supply of food in the post-Second World War period was one of the main reasons for its introduction in 1960. It is expensive to run: each year, every EU taxpayer contributes about £80 to the CAP.

Social/cultural factors

What a particular farm and neighbouring farms have produced in the past can be a significant influence on current farming practices. There is a tendency for farmers to stay with what they know best, and often a sense of responsibility from one generation to the next to maintain a family farming tradition. Tradition matters more in some farming regions than others.

A traditional rainforest system

Shifting cultivation is a traditional farming system that developed a long time ago in tropical rainforests. An area of forest is cleared to create a small plot of land that is cultivated until the soil becomes exhausted. The plot is then abandoned and a new area cleared. Frequently, the cultivators work in a circular pattern, returning to previously used land once the natural fertility of the soil has been renewed. Shifting cultivation is also known as 'slash and burn' and by various local names such as *chitimene* in Central Africa.

In the Amazon rainforest, shifting cultivation has been practised for thousands of years by groups of Amerindians who initially had no contact with the outside world. It is likely that there are some isolated groups where this situation still exists, but for most Amerindians there are now varying degrees of contact with mainstream Brazilian society. As a result, there has been a gradual blending of modern ideas with traditional practices.

Legal rights and land tenure

Land tenure refers to the way in which land is or can be owned. In the past, inheritance laws had a huge impact on the average size of farms. In some countries, it has been the custom on the death of a farmer to divide the land equally between all his sons, but rarely between daughters. Also, dowry customs may include the giving of land with a daughter on marriage. The reduction in the size of farms by these processes often reduced them to operating at only a subsistence level.

Women face widespread discrimination around the world with regard to land and property. The agrarian reforms implemented in many countries from the 1950s and through the 1970s were 'gender blind'. They were often based on the assumption that all household members would benefit equally, when this was simply not the case. For example, many women in LICs lose their homes, inheritance and possessions, and sometimes even their children when their partners die. This may force women to adopt employment practices that increase their chances of contracting HIV.

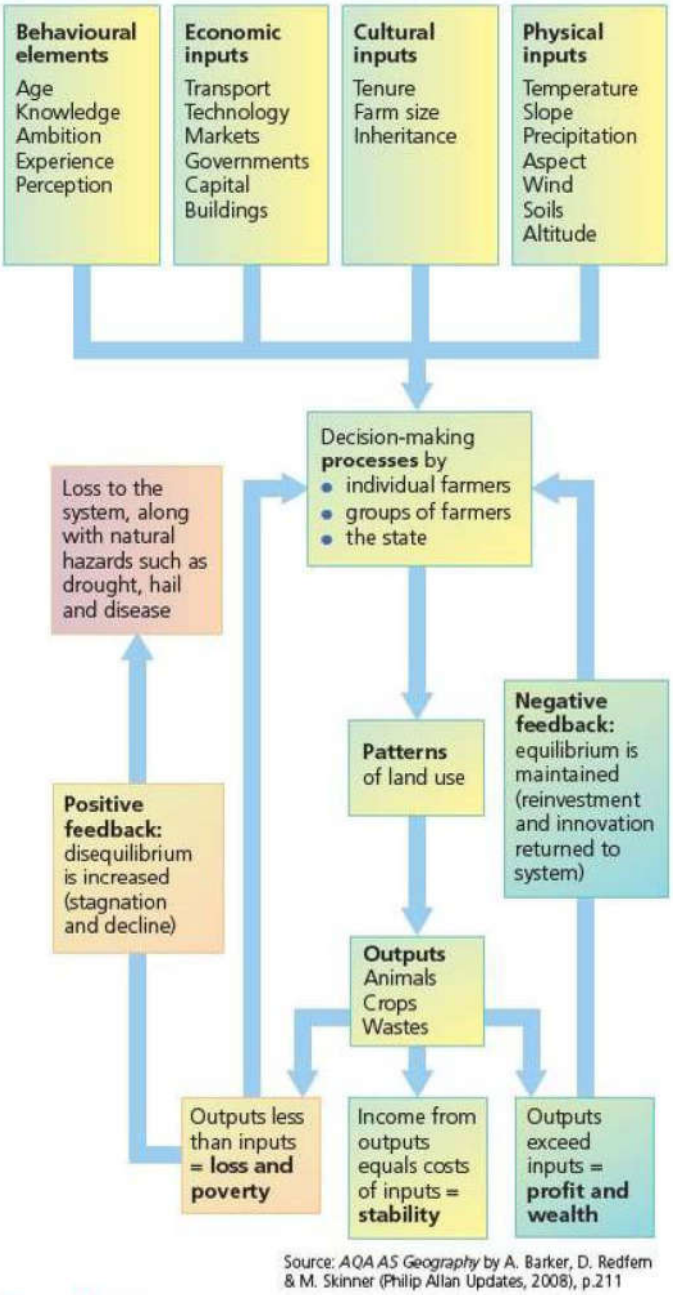
In many societies, women have very unequal access to, and control over, rural land and associated resources. The UN's Food and Agriculture Organization has stated that 'denying large segments of rural society equitable access to land and to the benefits of land tenure regularisation creates unanticipated costs and is a major contributing factor to extreme poverty, dependence and rural migration leading to land abandonment, social instability and many other negative conditions because of the unforeseen externalities that arise.' It is now generally accepted that societies with well-recognised property rights are also the ones that thrive best economically and socially.

Section 11.1 Activities

1 List the main physical factors that can influence farming.
2 Look at Figure 11.1. Suggest why almost all of the USA's range livestock and irrigated farming is in the west.
3 Summarise the information presented in Table 11.1.
4 Describe and explain the relationship shown in Figure 11.7.
5 Discuss the characteristics of agro-industrialisation.
6 Briefly state the importance of advances in agricultural technology.
7 Give an example of how one social/cultural factor can affect farming.

Agricultural systems

Individual farms and general types of farming can be seen to operate as a system. A farm requires a range of inputs, such as labour and energy, so that the processes (throughputs) that take place on the farm can be carried out. The aim is to produce the best possible outputs, such as milk, eggs, meat and crops. A profit will only be made if the income from selling the outputs is greater than expenditure on the inputs and processes. Figure 11.12 illustrates the agricultural system. It shows how physical, cultural, economic and behavioural factors form the inputs. Decision-making at different scales, from the individual farmer to governments and international organisations such as the EU, influence the processes. The nature and efficiency of the processes dictate the range, scale and quality of the outputs. Agricultural systems are dynamic human systems that change as farmers attempt to react to a range of physical and human factors.



Source: *AQA AS Geography* by A. Barker, D. Redfern & M. Skinner (Philip Allan Updates, 2008), p.211

Figure 11.12 The agricultural system

Different types of agricultural system can be found within individual countries and around the world. The most basic distinctions are between:

- arable, pastoral and mixed farming
- subsistence and commercial farming
- extensive and intensive farming
- organic and non-organic farming.

Arable farms cultivate crops and are not involved with livestock. An arable farm may concentrate on one crop such as wheat or may grow a range of different crops. The crops grown on an arable farm may change over time. For example, if the market price of potatoes increases, more farmers will be attracted to grow this crop. **Pastoral farming** involves keeping livestock such as dairy cattle, beef cattle and sheep. **Mixed farming** involves cultivating crops and keeping livestock together on a farm.

Subsistence and commercial farming

Subsistence farming is the most basic form of agriculture, where the produce is consumed entirely or mainly by the family who work the land or tend the livestock. If a small surplus is produced, it may be sold or traded. Examples of subsistence farming are shifting cultivation and nomadic pastoralism. Subsistence farming is generally small-scale and labour-intensive, with little or no technological input.

In contrast, the objective of **commercial farming** is to sell everything that the farm produces. The aim is to maximise yields in order to achieve the highest profits possible. Commercial farming can vary from small-scale to very large-scale (Figure 11.13).

Figure 11.13 Much farmland in Nepal is terraced to counteract the steep slopes

Extensive and intensive farming

Extensive farming is where a relatively small amount of agricultural produce is obtained per hectare of land, so such farms tend to cover large areas. Inputs per unit of land are low. Extensive farming can be both arable and pastoral in nature. Examples include wheat farming in the Canadian Prairies and sheep farming in Australia. In contrast, **intensive farming** is characterised by high inputs per unit of land to achieve high yields per hectare. Examples of intensive farming include market gardening, dairy farming and horticulture. Intensive farms tend to be relatively small in terms of land area.

Organic farming

Organic farming has become increasingly popular in recent decades as people seek a healthier lifestyle. In 2010, 37 million hectares of land were organically farmed worldwide – three times more than in 1999.

Organic farmers do not use manufactured chemicals, and so this type of farming is practised without chemical fertilisers, pesticides, insecticides or herbicides. Instead, animal and green manures are used, along with mineral fertilisers such as fish and bone meal. Organic farming therefore requires a higher input of labour than mainstream farming. Weeding is a major task with this type of farming. Organic farming is less likely to result in soil erosion and is less harmful to the environment in general. For example, there will be no nitrate runoff into streams and much less harm to wildlife.

Organic farming tends not to produce the 'perfect' potato, tomato or carrot. However, because of the increasing popularity of organic produce it commands a substantially higher price than mainstream farm produce.

Section 11.1 Activities

1 Describe the inputs, processes and outputs for the agricultural system shown in Figure 11.12.
2 How can the increase in a country's wealth influence its demand for energy?
3 Examine the differences between **a** commercial and subsistence farming and **b** intensive and extensive farming.
4 Describe the characteristics of organic farming.

Case Study: A pastoral system – sheep farming in Australia

Characteristics and location

Sheep farming in Australia occupies an area of about 85 million hectares, making it one of Australia's major land uses. It is a classic example of extensive farming, which can be seen to operate clearly as a system. The main physical input is the extensive use of natural open ranges, which are often fragile in nature. Australia's sheep farms are located predominantly in inland and semi-arid areas. Human inputs are low compared with most other types of agriculture, with very low use of labour and capital per hectare. The main processes are grazing, lambing, dipping and shearing. The outputs are lambs, sheep, wool and sheep skins.

Australia is the world's leading sheep-producing country, with a total of about 120 million sheep. As well as being the largest wool producer and exporter, Australia is also the largest exporter of live sheep and a major exporter of lamb and mutton. The sheep and wool industry is an important sector of Australia's economy.

Sheep are raised throughout southern Australia in areas of moderate to high rainfall and in the drier areas of New South Wales and Queensland. Merinos, which produce very high-quality wool for clothing, make up 75 per cent of the country's sheep. Merino sheep are able to survive in harsh environments and yet produce heavy fleeces. Sixteen per cent of Australia's sheep are bred for meat production and are a mixture of breeds such as Border Leicester and Dorset. The remaining 9 per cent are a mixture of Merino and cross-bred sheep used for wool and meat production. There are about 60 000 sheep farms in Australia overall, carrying from a few hundred sheep to over 100 000 animals.

Sheep and wool production occurs in three geographical zones (Figure 11.14):

- high rainfall coastal zone
- wheat/sheep intermediate zone
- pastoral interior zone.

About a quarter of all sheep are farmed in the pastoral zone (Figure 11.15). Sheep farming in Australia in general is extensive in nature but this type of agriculture is at its most extensive in the pastoral zone, which is the arid and semi-arid inland area. Here, summer temperatures are high, rainfall is low and the area is prone to drought. Because of the lack of grass in this inhospitable environment, sheep are often left to eat saltbush and bluebush. In the pastoral zone, the density of sheep per hectare is extremely low due to the poor quality of forage. The overall farming input in terms of labour, capital, energy and other inputs is also very low – it is in fact the lowest input per hectare of farmland in the country. Not surprisingly, farms can be extremely large.

Figure 11.14 Australia's three 'sheep' geographical zones

Figure 11.15 Sheep farm in Australia's pastoral zone

In the coastal and intermediate zones, the best land is reserved for arable farming, dairy and beef cattle and market gardening. Sheep are frequently kept on the more marginal areas, for example on higher and colder land in the New South Wales highlands where more profitable types of farming are not viable.

About two-thirds of Australia's sheep are on farms that support more than 2000 animals. The smallest sheep farms are generally those on the better-quality land, where it is possible to keep many more animals per hectare than in the pastoral zone.

Farming issues

The main issues in Australian sheep farming areas are:

- weed infestation, which is difficult to control on very large extensive farms that yield relatively small profits per hectare
- destruction of wildlife habitats due to sheep grazing, particularly in marginal areas
- the occurrence of periodic droughts that make farming even more difficult in low-rainfall areas
- soil loss from wind erosion and loss of soil structure – in some areas, this is transforming traditional 'mainstream' farming areas into marginal lands
- animal welfare, particularly in the most inhospitable environments where the low human input means that individual animals may not be seen for long periods
- increasing concern about the shortage of experienced sheep shearers.

Regarding the last point, many shearers have left the industry because of poor working conditions and the attraction of better-paid jobs in the mining industry and elsewhere. The number of experienced shearers fell by about a quarter

between 2003 and 2006. A good shearer can shear up to 200 sheep in one day.

Sheep farming in Australia is a major user of land resources in a generally fragile landscape. Changes in farming systems are required in some locations to address the issues facing the industry. Failure to do so will result in the progressive decline in utility of the resource base for the sheep and wool industry.

Section 11.1 Activities

1 Why is sheep farming in Australia considered to be 'extensive farming'?
2 Describe the three geographical zones in which sheep are kept.
3 Briefly discuss the main issues affecting sheep farming in Australia today.

Case Study: An arable system – intensive rice production in the Lower Ganges valley

Location

An important area of intensive subsistence rice cultivation is the Lower Ganges valley (Figures 11.16 and 11.17) in India and Bangladesh. The Ganges basin is India's most extensive and productive agricultural area and its most densely populated. The delta region of the Ganges occupies a large part of Bangladesh, one of the most densely populated countries in the world. Rice contributes over 75 per cent of the diet in many parts of the region. The physical conditions in the Lower Ganges valley and delta are very suitable for rice cultivation:

- Temperatures of 21 °C and over throughout the year allow two crops to be grown annually. Rice needs a growing season of only 100 days.
- Monsoon rainfall over 2000 millimetres provides sufficient water for the fields to flood, which is necessary for wet rice cultivation.
- Rich alluvial soils have built up through regular flooding over a long time period during the monsoon season.
- There is a seasonal dry period, which is important for harvesting the rice.

Figure 11.16 The Lower Ganges valley

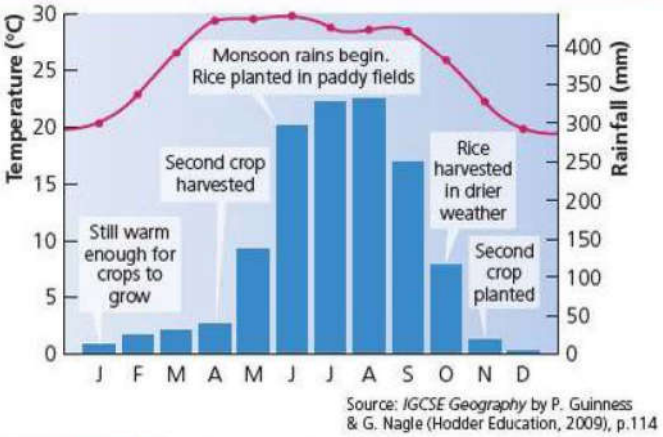


Figure 11.17 Climate graph for Kolkata

A water-intensive staple crop

Rice is the staple or main food crop in many parts of Asia. This is not surprising considering its high nutritional value. Current rice production systems are extremely water-intensive; 90 per cent of agricultural water in Asia is used for rice production. The International Rice Research Institute estimates that it takes 5000 litres of water to produce 1 kilogram of rice. Much of Asia's rice production can be classed as intensive subsistence cultivation where the crop is grown on very small plots of land using a very high input of labour. Rice cultivation by small farmers is sometimes referred to as 'pre-modern intensive farming' because of the traditional techniques used, in contrast to intensive farming systems in HICs such as market gardening, which are very capital intensive.

'Wet' rice is grown in the fertile silt and flooded areas of the lowlands, while 'dry' rice is cultivated on terraces on the hillsides. A **terrace** is a levelled section of a hilly cultivated area. Terracing is a method of soil conservation. It also prevents the rapid runoff of irrigated water. Dry rice is easier to grow but provides lower yields than wet rice.

The farming system

Paddy fields (flooded parcels of land) characterise lowland rice production (Figure 11.18). Water for irrigation is provided either when the Ganges floods or by means of gravity canals. At first, rice is grown in nurseries. It is then transplanted when the monsoon rains flood the paddy fields. The flooded paddy fields may be stocked with fish for an additional source of food. The main rice crop is harvested when the drier season begins in late October. The rice crop gives high yields per hectare. A second rice crop can then be planted in November, but water supply can be a problem in some areas for the second crop.

Water buffalo are used for work. This is the only draft animal adapted for life in wetlands. The water buffalo provide an important source of manure in the fields. However, the manure is also used as domestic fuel. The labour-intensive nature of rice cultivation provides work for large numbers of people. This is important in areas of very dense population where there are limited alternative employment opportunities. The low incomes and lack of capital of these subsistence farmers mean that hand labour still dominates in the region. It takes an average of 2000 hours a year to farm 1 hectare of land. A high labour input is needed to:

- build the embankments (bunds) that surround the fields – these are stabilised by tree crops such as coconut and banana
- construct irrigation canals where they are required for adequate water supply to the fields
- plant nursery rice, plough the paddy field, transplant the rice from the nursery to the paddy field, weed and harvest the mature rice crop
- cultivate other crops in the dry season and possibly tend a few chickens or other livestock.

Rice seeds are stored from one year to provide the next year's crop. During the dry season when there may be insufficient water for rice cultivation, other crops such as cereals and vegetables are grown. Farms are generally small, often no more than 1 hectare. Many farmers are tenants and pay for use of the land by giving a share of their crop to the landlord.

Figure 11.18 Rice paddy field, Lower Ganges valley

Section 11.1 Activities

1. Describe the location of the Lower Ganges valley.
2. Why is rice cultivation in the area considered to be an intensive form of agriculture?
3. Explain why the physical environment provides good conditions for rice cultivation.
4. Describe the inputs, processes and outputs of this type of agriculture.

☐ Issues in the intensification of agriculture and the extension of cultivation

Agricultural production can be achieved in two ways, by:

- increasing the land under cultivation through, for example, irrigation, or extending farming onto marginal land
- increasing the yield per hectare when scientific advance allows such changes to occur.

The **intensification of agriculture** has occurred through the use of high-yielding crop varieties, fertilisers, herbicides and pesticides and irrigation. The result has been a substantial increase in global food production over the last 60 years. However, increasing agricultural production has not just been achieved by the more intensive farming of long-established agricultural land, but also by the **extension of cultivation** into previously unfarmed areas. This has occurred with varying degrees of success.

The industrialised farmlands of today all too frequently lack the wildflowers, birds and insects that lived there in the past. These sterilised landscapes provide relatively cheap food, but at high environmental cost. These costs are typically borne by the citizens of the countries concerned rather than by the producers. Land conversion and intensification can alter ecosystems to such an extent that serious local, regional and global consequences result:

- **local** – increased soil erosion, lower soil fertility, reduced biodiversity
- **regional** – pollution of groundwater, eutrophication of rivers and lakes
- **global** – impacts on global atmospheric conditions.

The intensification of agriculture can result in **soil degradation**. Soil degradation is a global process. It involves both the physical loss (erosion) and the reduction in quality of topsoil associated with nutrient decline and contamination. It has a significant impact on agriculture and also has implications for the urban

environment, pollution and flooding. The loss of the upper soil horizons containing organic matter and nutrients and the thinning of **soil profiles** reduces crop yields on degraded soils. Soil degradation can cancel out gains from improved crop yields. The statistics on soil degradation make worrying reading:

- Globally, it is estimated that 2 billion hectares of soil resources have been degraded. This is equivalent to about 15 per cent of the Earth's land area. Such a scale of soil degradation has resulted in the loss of 15 per cent of world agricultural supply in the last 50 years.
- For three centuries ending in 2000, topsoil had been lost at the rate of 300 million tonnes a year. Between 1950 and 2000, topsoil was lost at the much higher rate of 760 million tonnes a year.
- During the last 40 years, nearly one-third of the world's cropland has been abandoned because of soil erosion and degradation.
- In Sub-Saharan Africa, nearly 2.6 million km^2 of cropland has shown a 'consistent significant decline' according to a March 2008 report by a consortium of agricultural institutions. Some scientists consider this to be a 'slow-motion disaster'.
- In the UK, 2.2 million tonnes of topsoil is eroded annually and over 17 per cent of arable land shows signs of erosion.
- It takes natural processes about 500 years to replace 25 millimetres of topsoil lost to erosion. The minimum soil depth for agricultural production is 150 millimetres. From this perspective, therefore, productive fertile soil can be considered a non-renewable, endangered ecosystem.

The Global Assessment of Human-induced Soil Degradation (GLASOD) is the only global survey of soil degradation to have been undertaken. Figure 11.19 is a generalised map of the findings of this survey. It shows that substantial parts of all continents have been affected by various types of soil degradation. The GLASOD calculation is that damage has occurred on 15 per cent of the world's total land area – 13 per cent light and moderate, with 2 per cent severe and very severe (Figure 11.20).

The International Forum of Soils, Society and Global Change in September 2007 referred to 'the massive degradation of land and soil around the world which is contributing to climate change and threatening food security'. The Forum noted that:

- At least a quarter of the excess carbon dioxide in the atmosphere has come from changes in land use, such as deforestation, in the last century.
- Without the cover of vegetation, land becomes more reflective. It also loses fertility and the capacity to support vegetation and agricultural crops.
- The Intergovernmental Panel on Climate Change should develop a special report on the link between land

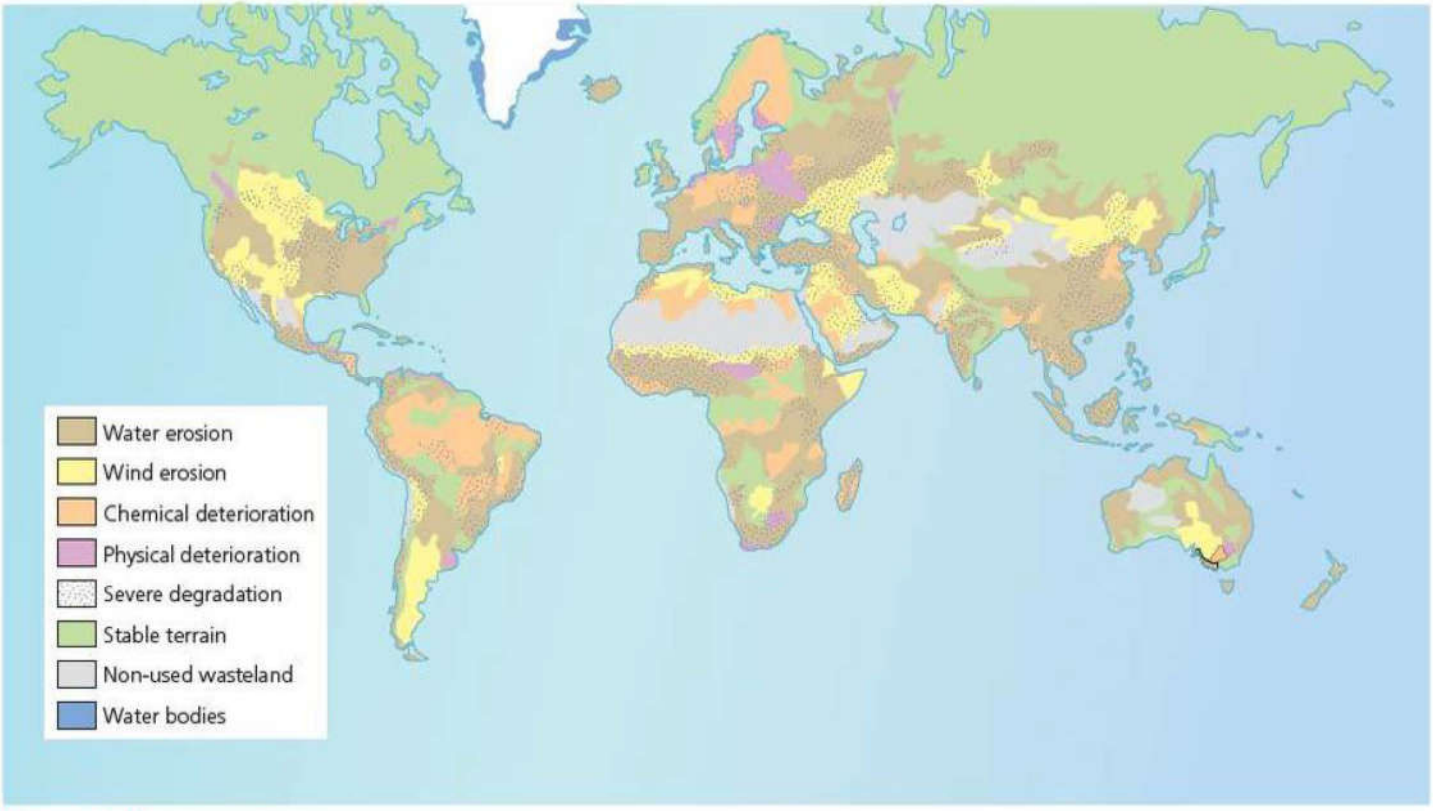


Figure 11.19 Worldwide soil degradation types

Figure 11.20 Infertile saline soil in the south of France

degradation and climate change. By addressing soils and protecting the land cover and vegetation, it is possible to obtain high value in terms of mitigating climate change.

- A better understanding of the capacity for carbon sequestration in soil is needed.
- Degradation of soil and land in already marginally productive land is a significant issue for many LICs, particularly in northern Africa, the Sahara region and parts of Asia, including China. Many of these regions have fragile ecosystems where any human interventions can lead to serious degradation.

Research has shown that the heavy and sustained use of artificial fertiliser can result in serious soil degradation. In Figure 11.21, soil profile **a** illustrates the problems that can result. In contrast, soil profile **b** shows a much healthier soil treated with organic fertiliser. In the artificially fertilised soil, the ability of the soil to infiltrate water has been compromised by the breakdown of **soil aggregates** to fine particles that have sealed the surface. Pore spaces have been filled up by the fine soil material from the broken crumbs. This can result in ponding in surface depressions, followed by soil erosion.

It has been estimated that food production and consumption accounts for up to twice as many greenhouse emissions as driving vehicles. Figure 11.22 shows US data published in the *New Scientist*. The average US household's footprint for food consumption is 8.1 tonnes of carbon dioxide equivalent, compared with 4.4 tonnes from driving.

The environmental impact of the Green Revolution

Much of the global increase in food production in the last 50 years can be attributed to the Green Revolution, which took agro-industrialisation to LICs on a large scale. India was one of the first countries to benefit when a high-yielding variety seed programme (HVP) commenced in 1966–67. In terms of production, it was a turning point for Indian agriculture, which had virtually reached stagnation. The HVP introduced new hybrid varieties of five cereals: wheat, rice, maize, sorghum and millet. All were drought-resistant with the exception of rice, were

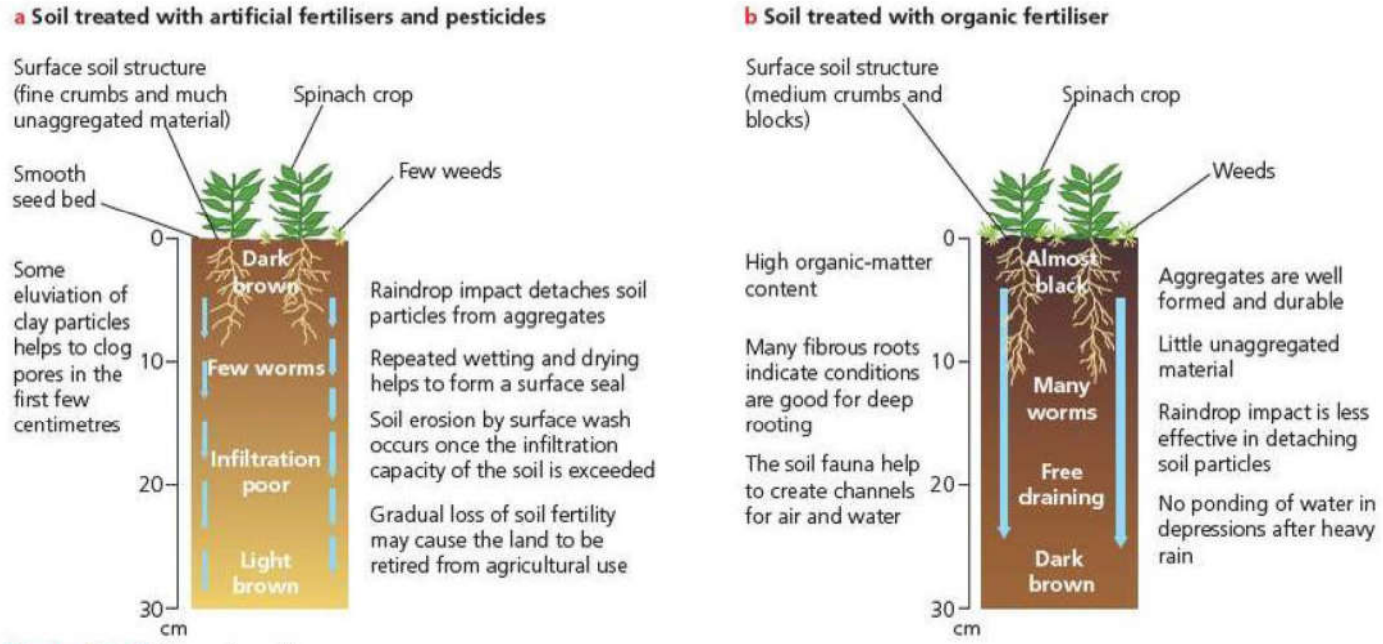


Figure 11.21 Two soil profiles

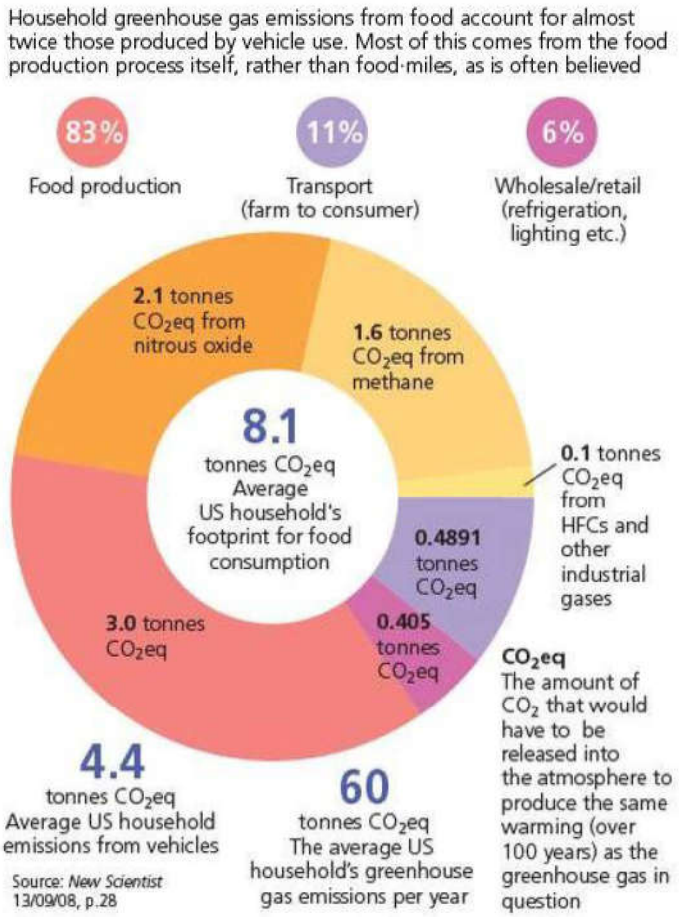


Figure 11.22 Comparison of household greenhouse-gas emissions from food and vehicle use

very responsive to the application of fertilisers and had a shorter growing season than the traditional varieties they replaced. Although the benefits of the Green Revolution are clear, serious criticisms have also been made, many linked to the impact on the environment:

- High inputs of fertiliser and pesticide have been required to optimise production – this is costly in both economic and environmental terms.
- The problems of salinisation and waterlogged soils have increased, along with the expansion of the irrigated area, leading to the abandonment of significant areas of land.
- High chemical inputs have had a considerable negative effect on biodiversity.
- People have suffered ill-health due to contaminated water and other forms of agricultural pollution.

In the early 1990s, nutritionists noticed that even in countries where average food intake had risen, incapacitating diseases associated with mineral and vitamin deficiencies remained commonplace and in some instances had actually increased. The problem is that the high-yielding varieties introduced during the Green Revolution are usually low in minerals and vitamins. Because the new crops have displaced the local fruits, vegetables and legumes that traditionally supplied important vitamins and minerals, the diet of many people in LICs is now extremely low in zinc, iron, vitamin A and some other micronutrients.

In India's Punjab, yield growth has flattened since the mid-1990s. Over-irrigation has resulted in a steep fall in the water table, now tapped by 1.3 million tube wells. Since the beginning of the Green Revolution in Asia, the amount of land under irrigation has tripled.

The Green Revolution has been a major factor in enabling global food supply to keep pace with population growth, but with growing concerns about a new food crisis, new technological advances may well be required to improve the global food-security situation.

Section 11.1 Activities

1 Describe the distribution of soil degradation types shown in Figure 11.19. Refer to all elements of the key and make reference to all continental areas.
2 Describe and explain the differences shown in the soil profiles illustrated in Figure 11.21.
3 Summarise the data presented in Figure 11.22.
4 Discuss the environmental impact of the Green Revolution.

11.2 The management of agricultural change

Agriculture remains vital to the lives of many individual people and communities, and to the economies of many countries, particularly in LICs. Jamaica is an example of a country where the management of agricultural change can be observed at both the level of the individual farm and the country a whole (Figure 11.23).

Physical background

Jamaica has considerable variety of topography and geology (Figure 11.24). Approximately half of the island lies above 1000 metres, which has a significant influence on its various microclimates. The country has a highland interior formed by a series of mountain ranges along the major west-north-west to east-south-east axis of the island. The central mountain ranges form the main watershed for rivers, which drain either to the north or the south, except for the Plantain Garden River, which drains to the east. Flat coastal plains surround the central mountain ridge. The climate of Jamaica is mainly subtropical or tropical maritime.

The importance of agriculture

Agriculture in Jamaica is dominated by the production of traditional crops such as sugar, bananas, coffee, cocoa

Figure 11.23 Large plantation of bananas in Jamaica

Figure 11.24 Jamaica – relief and drainage

and spices. In addition, a number of **non-traditional crops** including sweet potatoes, yams and hot peppers are cultivated for both domestic and international markets. In terms of livestock, Jamaica has well-developed beef, dairy and poultry sectors. The products of these, together with those of the pork and small ruminant industries, are mainly for domestic consumption. The maritime and inland fish sectors serve both domestic and export markets. Over the last two decades, the major export earner, sugar, has experienced a considerable decline. Both sugar and bananas in particular have had to contend with price and market insecurity as a result of

preference erosion in the EU market. Additional problems for Jamaican agriculture have arisen in relation to non-traditional products such as milk, food aid and the dumping of surpluses on the local markets.

Although it has faced significant challenges, the agricultural sector continues to play an important role in terms of:

- food security
- employment
- income
- rural livelihoods (Figure 11.25).

Agriculture contributes 7 per cent to Jamaica's GDP and employs about 20 per cent of the workforce.

Figure 11.25 Jamaican farming scene – a smallholding

Recent changes in Jamaican farming

Table 11.4 shows that the total amount of land in farming fell by almost 23 per cent between 1996 and 2007 as significant areas of marginal land were abandoned. Land devoted to crops declined by 13 per cent during this period, while land given over to pasture fell by a massive 49.6 per cent. The difficulties of making a living on marginal land were the main reason, as people sought other means of employment, particularly in urban areas.

A significant problem has been the removal of preferential treatment for bananas on the European market, which is creating greater competition and lowering prices. Some farmers no longer consider bananas a profitable venture and have stopped farming. This is particularly true of small farmers who are unable to achieve the economies of scale of their larger competitors. However, farmers have had to face other problems such as 'praedial larceny', by which farmers are robbed of their produce, in some cases even before the crops are mature. For small farmers, such theft can turn a modest profit into a loss, with resultant rural–urban migration. Disease is another problem. For example, Moko disease, which affects bananas and similar species such as plantains, has infected some farms and resulted in losses to farmers.

Table 11.4 Area in farming in Jamaica, 1996 and 2007

Items	2007		1996		Change 1996–2007	
	Area in ha	% of total	Area in ha	% of total	Absolute change	% change
Total land in farming	**325810**	**100.0**	**421550**	**100.0**	**–95740**	**–22.7**
Active farmland	202727	62.2	273229	64.8	–70502	–25.8
Crops	154524	47.4	177580	42.1	–23056	–13.0
Pasture	48203	13.8	95649	22.7	–47446	–49.6
Inactive farmland	114048	35.0	134204	31.8	–20157	–15.0
Fulnate and fallow	80560	24.7	87300	20.7	–6740	–7.7
Woodland and other land on farm	33488	10.3	46905	11.1	–13417	–28.6
Land identified to be in farming but no information reported	9035	2.8	14116	3.2		

Source: www.statinja.gov.jm

Climatic hazards often have a substantial impact on farming in Jamaica. In 2005, for example, agricultural GDP fell by 7.3 per cent. The reasons for this decline included:

- the long-term effects of Hurricane Ivan
- the drought that occurred between January and April 2005
- the impacts of Hurricanes Dennis and Emily and tropical storm Wilma in 2005, which caused combined losses of $994 million.

In addition, there have been economic and political difficulties. The European Commission proposed a 36 per cent cut in the price paid for raw sugar exports from African, Caribbean and Pacific countries, starting in 2006. In the 1950s, Jamaica had 20 working sugar factories, but by 2005 this number had fallen to eight.

Policy responses

In response, the Jamaican government announced a new policy for a sustainable local sugar industry. The main elements of the policy were:

- to centre the industry around three products – raw sugar for export and domestic markets; molasses for the manufacture of rum; and ethanol for fuel
- to set a production target of 200000 tonnes of raw sugar per year.

Commodity-specific policies for bananas included rationalisation of areas under production; provision of technical support for irrigation and extension; and the restructuring of the banana insurance scheme. For the cocoa industry, expansion in production, increased efficiencies and identification of more lucrative markets were the main strategies.

Jamaica has also produced a New Agricultural Development Plan, which aims to transform the farming sector by 2020. The main objectives of the Plan are to halt the decline of the agricultural sector, to restore productivity to agricultural resources and to ensure that farming communities provide meaningful livelihoods and living environments for those who depend on the agricultural sector. The New Agricultural Development Plan aims to increase production in eight key areas, through:

- The Small Ruminant Industry Development Project
- The National Organic Agriculture Project
- Protected Cultivation (Hydroponics)
- The Beekeeping Enhancement Project
- Marketing (Agribusiness Enhancement Project)
- The Fruit Tree Crop Development Project
- Ornamental Horticulture
- The Fisheries Development Project.

As exports of some traditional farm products have declined, the Jamaican government has tried to encourage **agricultural diversification**. This is exemplified by Table 11.5, which divides exports into 'traditional' and 'non-traditional'. Look at the agricultural products under these headings. Also take note of the manufacture of agricultural products.

Table 11.5 Exports of traditional and non-traditional commodities, January–December 2009

Commodities	Jan–Dec 2009
Total traditional exports	**55 026 594**
Agriculture	**3 440 439**
Banana	559
Citrus	149 080
Coffee	2 978 540
Cocoa	157 750
Pimento	154 509
Mining and quarrying	**40 645 392**
Bauxite	8 326 228
Alumina	32 302 855
Gypsum	16 309
Manufacture	**10 940 763**
Sugar	6 405 019
Rum	4 296 721
Citrus products	46 208
Coffee products	133 061
Cocoa products	59 753
Total non-traditional exports	**55 465 717**
Food	**10 538 829**
Pumpkins	31 319
Other vegetables and preparations thereof	210 663
Dasheen	122 669
Yams	1 650 806
Papayas	253 032
Ackee	1 199 038
Other fruits and fruit preparations	553 278
Meat and meat preparations	249 329
Dairy products and birds' eggs	568 153
Fish, crustaceans and molluscs	418 816
Baked products	951 342
Juices excluding citrus	604 530
Animal feed	459 184
Sauces	935 614
Malt extract and preparations thereof	333 266
Other food exports	1 776 465
Beverages and tobacco (excl. rum)	**4 672 930**
Non-alcoholic beverages	755 157
Alcoholic beverages (excl. rum)	3 912 774
Tobacco	4 999
Crude materials	**1 476 079**
Limestone	95 439
Waste and scrap metals	1 115 360
Other	265 280
Other	**38 777 879**
Mineral fuels, etc.	18 887 511
Animal and vegetable oils & fats	16 432
Chemicals (excl. ethanol)	2 546 690
Ethanol	15 151 290
Manufactured goods	1 401 815
Machinery and transport equipment	155 332
Wearing apparel	129 250
Furniture	63 388
Other domestic exports	421 261

Source: Statistical Institute of Jamaica

Poultry is an example of a farming sector in which significant benefits have accrued through:

- internal structural changes
- reorganisation of the production system
- the introduction of higher levels of technology.

The spice industry is another example. This traditionally operated at the cottage level, but with government encouragement the industry has been restructured and modernised to increase its share of international markets. The exploitation of **niche markets** has been a major aspect of the modernisation of Jamaican agriculture.

In March 2010, Jamaica's Minister of Agriculture, the Honourable Dr Christopher Tufton, announced that the government was working to prepare a new agriculture land-use policy for the island, with the aim of getting fallow fields back into production. Dr Tufton made this statement at a meeting held to discuss the Arable Lands Irrigated and Growing for the Nation (ALIGN) project. The ALIGN programme is intended to boost agricultural production in Jamaica by providing irrigation on arable land.

Land degradation

Jamaica is having to address the issue of land degradation. A report published in the early 2000s stated: 'While land degradation in Jamaica is not as serious as in some parts of Africa or even like that in its Caribbean neighbour Haiti, it is a problem that must be confronted.' Some of the most seriously degraded areas of the island are in the southern coastal sections of the parishes of Clarendon, Manchester and St Catherine and particularly on the southern coastal border areas of Manchester and St Elizabeth.

ICT and agriculture

The government has recognised the contribution ICT can make to enhancing the sector's efficiency and productivity. Current initiatives include:

- **Agri-Business Information System (ABIS)** – Recently developed, this computer-based information system collects and disseminates to interested parties information on crops, marketing, agricultural stakeholders and agricultural production.
- **Geographical Information Systems (GIS)** – The Forest Department and the Rural Physical Planning Division are currently using GIS as a tool in the mapping and management of Jamaica's forest and land resources. The private sector, in turn, is using GIS for the purpose of advertising and marketing agricultural products via the internet.

Evaluation

The range of policies introduced by the government in recent years has undoubtedly helped to bring about beneficial changes in Jamaican agriculture. More efficient management and new agricultural technology have been introduced into both the traditional and non-traditional farming sectors. The product range has been broadened and more attention has been placed on marketing. ICT systems have played an increasing role in this push for modernisation. However, limited funding has meant that progress has not always been as rapid as hoped and climatic hazards have at times proved costly. The erosion of preferential treatment in EU markets has been a significant setback, although Jamaica did have advance warning this was going to happen. There is little that small countries like Jamaica can do in terms of world trade agreements and fluctuating international demand and prices. Nevertheless, this should not deter governments from making the best policy provisions they can.

Section 11.2 Activities

1. With reference to Figure 11.24, describe the relief and drainage of Jamaica.
2. In what ways is the agricultural sector important to Jamaica?
3. Discuss the differences between Jamaica's traditional and non-traditional farm products.
4. How has the government tried to improve the fortunes of the country's agricultural sector?

Case Study: Kew Park farm, Jamaica

Kew Park farm is a mixed commercial farm in the west of Jamaica. It is located high in the hills of the parish of Westmoreland, overlooking the Great River valley that forms the border between Westmoreland and St James (Figures 11.26 and 11.27). Kew Park covers an area of about 385 hectares and is run along with Copse Mountain farm (about 425 hectaresa). The two farms together form one unit: Kew Park. This is a very hilly part of Jamaica. About 30 per cent of Kew Park can only be accessed on foot and about 15 per cent of the total area is not farmed at all. Good management has been essential for the farm's survival as an economic entity because of the physical hazards and economic obstacles the farm has had to face.

Most of the farmed area is allocated to beef cattle; much of the breeding research for the Jamaican Red Poll was conducted here. At present, there are five pedigree Jamaica Red Poll herds and two commercial herds on the farm – a total of about 700 animals. The cattle are raised extensively, but are confined in grass pastures by either barbed-wire fences or dry-stone walls. Other parts of the farm support a variety of agricultural activities:

- Above about 400 metres, an area of 16 hectares is planted with arabica coffee, producing the 'Estate' brand. Much of the primary processing of the coffee is done on the farm, but it is then sent to Kingston to be graded, roasted and packed. Kew Park has a licence to export the processed coffee, although much of it is sold locally. Kew Park has worked hard for 20 years to develop the quality of its coffee and its reputation. Decisions such as this can take many years really to pay off. The high quality of Kew Park coffee has resulted in the farm being one of a relatively

small number being granted a licence to export. The farm's website states: 'Kew Park Estate Coffee has been carefully expanded over the past 20 years to fit the coffee in to the land; working always for the long term sustainability of the farm, the people who work here, and the environment on which it depends.'

- 2 hectares are given over to citrus fruits (ortaniques). However, the fruit are not of prime quality as the climate is too wet and the trees are not well maintained.
- There are 2 hectares of lychees, which is a difficult crop to grow, but there is a good local market for the fruit.
- The farm supports some 2000 free-range chickens. The eggs are washed and packed on the farm and sold locally.

Figure 11.26 The location of Kew Park farm

Figure 11.27 Kew Park farm

Life in rural Jamaica is not easy and Kew Park provides the only full-time employment in the area. Wages are low. Some staff live in houses owned by the estate but most travel from their own homes nearby.

Farm managers have had to be constantly aware of the costs of all their inputs, such as labour, animal stock, seeds and machinery. The costs of the processing that is carried out on the farm also have to be calculated. Knowledge of local and more distant markets in terms of both access and price are important. Because Kew Park produces a number of farm products, the allocation of resources for different purposes must be done carefully. A more favourable price for one particular farm product may justify a larger share of farm resources if it is felt that the increase in price is not just a temporary upturn.

The farm also has to be aware of government agricultural policies and incentives. Often the balance between costs and revenue is marginal, which makes correct decision-making crucial.

The damage caused by a pest known as the coffee berry borer can eliminate the profit expected from a coffee crop in Jamaica. The female borer, which is a tiny beetle just 1.5 millimetres long, drills into coffee berries and lays its eggs inside. There can be up to 50 per berry. Once hatched, the young borers eat the beans from within, leaving them worthless. Combating the borer is an expensive task. Existing methods include traps, parasitic insects and insecticides. The most effective insecticide is endosulfan, which is highly toxic. Jamaica's Coffee Industry Board phased out its use in 2010.

However, a more natural solution may be at hand. Migratory warblers (birds) spend winter in Jamaica and like to feast on the coffee berry borers. Research has estimated that growers who enlist these birds to control berry borers could save as much as $96/hectare every year. This should create an economic incentive for coffee producers to manage their farms in ways that aid bird conservation. In particular, this means planting or maintaining pockets of trees instead of clear cutting, which has been the traditional method. Kew Park farm is looking at ways to attract more birds to the coffee fields, including preserving more woodland.

Figure 11.28 shows the section of the farm's website devoted to 'Kew Park Essentials'. Many of the traditional herbal remedies, spicy foods and refreshers date back to the indigenous Tainos (Arawaks); others were introduced by African slaves, indentured labourers from China and India and other migrants to the island. Even though conventional medicine is well established in Jamaica, folk medicine is still widely practised, particularly in the rural areas. Popular remedies include some of the herbs and spices grown at Kew Park. Although production of these products is not new, the marketing of them has changed considerably in recent years, reaching an international audience through the farm's website and other channels. This aspect of the farm's production has accounted for an increasing proportion of its income in recent years.

Figure 11.28 Website advert for 'Kew Park Essentials'

Evaluation

The relief and location of the farm have always presented certain challenges to Kew Park. The farm is in a hilly part of the country, some distance from Kingston, the capital city. However, careful locational choices within the farm and management of the farm's product range, along with incisive marketing, have built a good reputation for the farm. The farm has responded to international markets by extending the range of its non-traditional products in particular. Its use of ICT has been an important part of this process. However, individual farms have no influence on national and international policies and thus they must be able to react to policy changes at both these levels, as well as dealing with the challenges presented by the physical environment.

Section 11.2 Activities

1 Describe the location of Kew Park farm.
2 Discuss the farm's product range.
3 What are the main problems the farm has had to contend with?

11.3 Manufacturing and related service industry

☐ Industrial location: influential factors

Every day, decisions are made about where to locate industrial premises, ranging from small workshops to huge industrial complexes. In general, the larger the company, the greater the number of real alternative locations available. For each possible location, a wide range of factors can affect total costs and thus influence the decision-making process. The factors involved in industrial location differ from industry to industry and their relative importance is subject to change over time. These factors can be broadly subdivided into physical and human. Table 11.6 provides a brief summary and introduction to this topic.

Table 11.6 Factors of industrial location

Physical factors	Human factors
Site – the availability and cost of land: large factories in particular need flat, well-drained land on solid bedrock; an adjacent water supply may be essential **Raw materials** – industries requiring heavy and bulky raw materials that are expensive to transport generally locate as close to these raw materials as possible **Energy** – at times in the past, industry needed to be located near fast-flowing rivers or coal mines; today, electricity can be transmitted to most locations – however, energy-hungry industries, such as metal smelting, may be drawn to countries with relatively cheap hydro-electricity **Natural routeways and harbours** – these were essential in the past and are still important today as many modern roads and railways still follow natural routeways; natural harbours provide good locations for ports, and industrial complexes are often found at ports **Climate** – some industries such as the aerospace and film industries benefit directly from a sunny climate; indirect benefits, such as lower heating bills and a more favourable quality of life, may also be apparent	**Capital (money)** – business people, banks and governments are more likely to invest money in some areas than others **Labour** – increasingly, it is the quality and cost of labour rather than the quantity that are the key factors; the reputation, turnover and mobility of labour can also be important **Transport and communications** – transport costs are lower in real terms than ever before but remain important for heavy, bulky items; accessibility to airports, ports, motorways and key railway terminals may be crucial factors for some industries **Markets** – the location and size of markets is a major influence for some industries **Government influence** – government policies and decisions can have a big direct and indirect impact; governments can encourage industries to locate in certain areas and deny them planning permission in others **Quality of life** – highly skilled personnel who have a choice about where they work will favour areas where the quality of life is high

Raw materials

Industries that use raw materials directly, such as oil refining and metal smelting, are known as **processing industries**. Once the dominant type of manufacturing, processing industries are in a minority today as most industries now use components and parts made by other firms.

The processes involved in turning a raw material into a manufactured product usually result in **weight loss**, so that the transport costs incurred in bringing the raw materials to the factory will be greater than the cost of transporting the finished product to market. If weight loss is substantial, the location of the factory will be drawn towards its most costly-to-transport raw material(s). Figure 11.29 shows a simple example of weight loss, where 2 tonnes each of two raw materials are required to manufacture 1 tonne of the finished product.

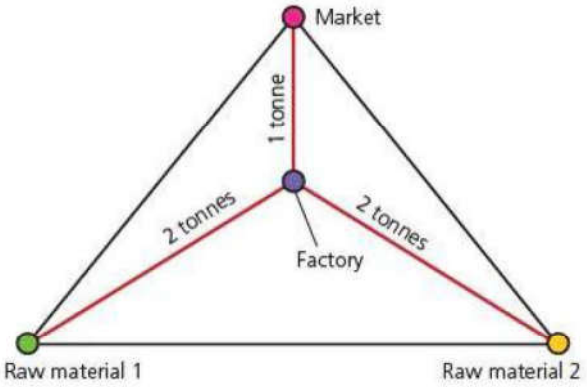


Figure 11.29 Weight-loss diagram

The clearest examples of this influence are where one raw material only is used. In the UK, sugar beet refineries are centrally located in crop-growing areas because there is a 90 per cent weight loss in manufacture (Figure 11.30). Frozen pea factories are also strategically located in the growing areas. Here, the weight loss is much less, but to achieve prime quality the peas must be processed very quickly after picking.

Figure 11.30 Sugar refinery in France

In many processing industries, technological advance has reduced the amount of raw material required per finished product and in some cases less bulky and cheaper substitutes have been found. Thus, across the industrial board as a whole, the raw material requirement per unit of finished product has been reduced.

Tidewater locations are particularly popular with industries that use significant quantities of imported raw materials, for example flour milling, food processing, chemicals and oil refining. Tidewater locations are **break-of-bulk** points where cargo is unloaded from bulk carriers and transferred to smaller units of transport for further movement. However, if raw materials are processed at the break-of-bulk point, significant savings in transport costs can be made.

Markets

Where a firm sells its products may well have a considerable influence on where the factory is located. Where the cost of distributing the finished product is a significant part of total cost and the greater part of total transport costs, a market location is logical. A small number of industries, including soft drinks and brewing, are **weight gaining** and are thus market-oriented in terms of location. The heavy weight gain for both of these industries comes from the addition of water, a ubiquitous resource. The baking industry is also cited frequently as an example of weight gain, but here it is largely a case of increase in volume rather than weight, although the impact on transport costs is similar.

However, there are other reasons for market location. Industries where fashion and taste are variable need to be able to react quickly to changes demanded by their customers. Clear examples of this can be seen on both the national and international scales. In terms of the latter, one of the reasons that the global car giants spread themselves around the world is to ensure that they can produce vehicles that customers will buy in the different world regions. Ford, for example, recognised a long time ago that Europeans prefer smaller cars than Americans do.

Energy

The **Industrial Revolution** in many countries was based on the use of coal as a fuel, which was usually much more costly to transport than the raw materials required for processing. It is therefore not surprising that outside of London most of Britain's industrial towns and cities developed on coalfields or at ports nearby. The coalfields became focal points for the developing transport networks – first canals, then rail, and finally road. The investment in both **hard** and **soft infrastructure** was massive, so even when new forms of energy were substituted for coal, many industries remained at their coalfield locations, a phenomenon known as **industrial inertia**. Apart from the advantages of the infrastructure being in place, the cost of relocating might be prohibitive.

Also, a certain number of new industries have been attracted to urban areas on coalfields because of the acquired advantages available, such as a pool of skilled labour and the existing network of linkages between firms. However, overall the coalfields have suffered considerable economic distress due to the decline of coal and the traditional industries associated with it. In many HICs, these areas are now the main 'problem' regions.

During the twentieth century, the construction of national electricity grids and gas pipeline systems made energy virtually a ubiquitous resource in HICs (Figure 11.31). As a result, most modern industry is described as **footloose**, meaning that it is not tied to certain areas because of its energy requirement or other factors. However, there are some industries that are constrained in terms of location because of an extremely high energy requirement. For example, the lure of low-cost hydro-electric power has resulted in a huge concentration of electro-metallurgical and electro-chemical industries in southern Norway.

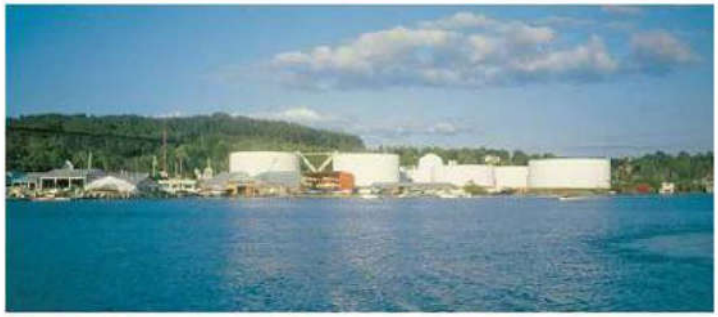


Figure 11.31 Oil storage, Parry Sound, Ontario, Canada

Section 11.3 Activities

1 a What are raw materials?
  b How can raw materials influence industrial location?
2 For what reasons are companies likely to choose a market location?
3 Explain the importance of break-of-bulk points.
4 Discuss industrial inertia as a factor in industrial location.
5 What are footloose industries?

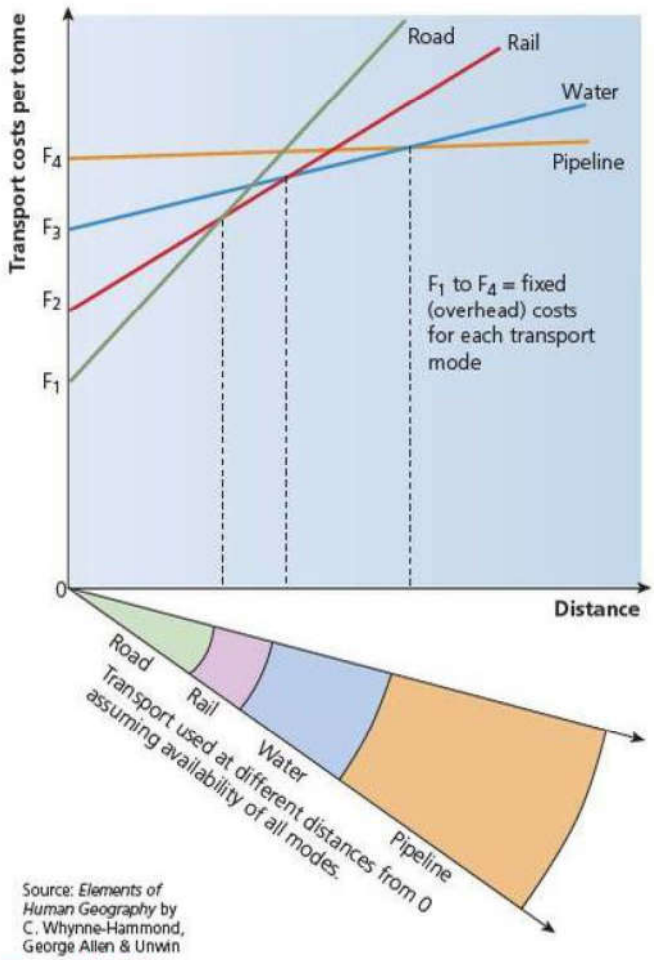
Transport

Although it was once a major locational factor, the share of industry's total costs accounted for by transportation has fallen steadily over time. For example, for most manufacturing firms in the UK, transportation now accounts for less than 4 per cent of total costs. The main reasons for this reduction are:

- major advances in all modes of transport
- great improvements in the efficiency of transport networks
- technological developments moving industry to the increasing production of higher value/lower bulk goods.

The cost of transport has two components: fixed costs and line-haul costs. **Fixed (terminal) costs** are accrued by the equipment used to handle and store goods, and the costs of providing the transport system. **Line-haul costs** refer to the cost of actually moving the goods and are largely composed of fuel costs and wages. In Figure 11.32, the costs of the main methods of freight transport are compared. While water and pipeline transport have higher fixed costs than rail (Figure 11.33) and road, their line-haul costs are significantly lower. Air transport, which suffers from both high fixed and line-haul costs, is only used for high-value freight or for goods such as flowers that are extremely perishable. Other factors affecting the cost of transport are:

- **the type of load carried** – perishable and breakable commodities that require careful handling are more costly to move than robust goods such as iron ore and coal
- **the type of journey** – those that involve transferring cargo from one mode of transport to another are more costly than those using the same mode of transport throughout
- **the degree of competition** within and between the competing modes of transport.



Source: *Elements of Human Geography* by C. Whynne-Hammond, George Allen & Unwin

Figure 11.32 Transport costs and distance

Figure 11.33 Timber being transported on the Trans-Siberian railway, Russia

Land

The space requirements of different industries, and also of firms within the same industry, vary enormously. Technological advance has made modern industry much more space-efficient than in the past. However, modern industry is horizontally structured (on one floor) as opposed to, for example, the textile mills of the nineteenth century, which had four or five floors. In the modern factory, transportation takes up much more space than it used to – for example, consider the area required to park cars for a firm employing 300 people.

During the Industrial Revolution, entrepreneurs had a relatively free choice of where to locate in terms of planning restrictions, providing of course that they could afford to purchase the site they wanted. However, with the passage of time more and more areas have become unavailable to industry, mainly in an effort to conserve the environment. Areas such as National Parks, Country Parks and Areas of Special Scientific Interest now occupy a significant part of most countries. In urban areas, land-use zoning places a considerable restriction on where industry may locate, and green belts often prohibit location at the edge of urban areas.

Capital

Capital represents the finance invested to start up a business and to keep it in production. That part of capital invested in plant and machinery is known as 'fixed capital' as it is not mobile, compared with 'working capital' (money). Capital is obtained either from shareholders (share capital) or from banks or other lenders (loan capital). Some geographers also use the term 'social capital', which is the investment in housing, schools, hospitals and other amenities valued by the community, which may attract a firm to a particular location.

Figure 11.34 A large capital input was required to build this container port in Indonesia

In the early days of the Industrial Revolution in present-day HICs, the availability of capital was geographically constrained by the location of the major capital-raising centres and by limited knowledge – and thus confidence – about untested locations. It was thus one of the factors that led to the clustering of industry. In the modern world, the rapid diffusion of information and the ability to raise and move capital quickly within and across international borders means that this factor has a minimal constraining influence in HICs today. However, in less developed economies the constraints of capital are usually greater, depending on the level of economic development. It is the perceived risk that is the vital factor. The political unrest that has affected so many African countries in recent decades has made it very difficult for these nations to raise the amount of capital desired.

Virtually all industries have over time substituted capital for labour in an attempt to reduce costs and improve quality. Thus in a competitive environment, capital has become a more important factor in industry. In some industries, the level of capital required to enter the market with a reasonable chance of success is so high that just a few companies monopolise the market. This has a major influence on the geography of manufacturing. The aircraft industry, for instance, has a massive barrier to entry in terms of the capital required to compete successfully.

The issue of foreign direct investment (FDI) is considered in detail in Section 14.2, pages 466–68.

Section 11.3 Activities

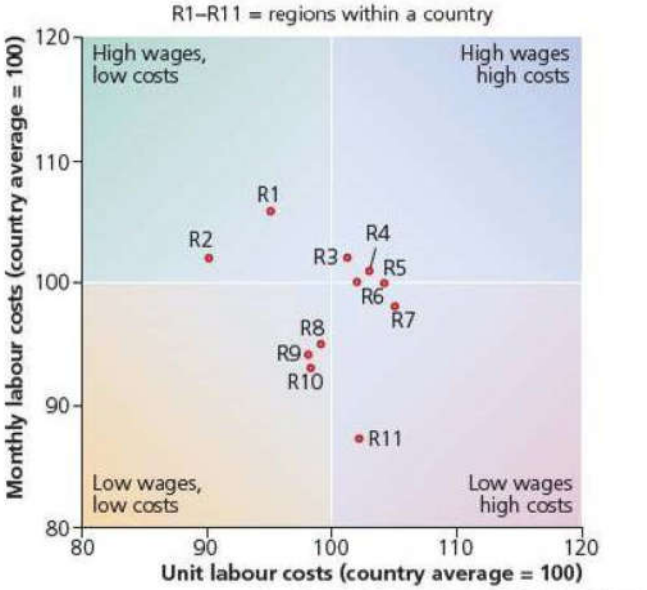
1 Why has the relative cost of transport declined significantly over time for most industries?
2 Distinguish between fixed transport costs and line-haul costs.
3 Discuss 'land' as a factor in industrial location.
4 How does capital influence industrial location?

Labour

The interlinked attributes of labour that influence locational decision-making are cost, quality, availability and reputation.

Although all industries have become more capital-intensive over time, labour still accounts for over 20 per cent of total costs in manufacturing industry. The cost of labour can be measured in two ways: as wage rates and as unit costs (Figure 11.35). The former is simply the hourly or weekly amount paid to employees, while the latter is a measure of productivity, relating wage rates to output. Industrialists are mainly influenced by unit costs, which explains why industry often clusters where wages are higher rather than in areas where wage rates are low. It is frequently, although not always, the high quality and productivity of labour that pushes up wages in an area. In such an area, unit costs may well be considerably lower than in an economically depressed area with poor-quality labour and lower wage rates. Certain skills sometimes become concentrated in particular areas, a phenomenon known as the **sectoral spatial division of labour**. As the reputation of a region for a particular skill or set of skills grows, more firms in that particular economic sector will be attracted to the area.

Variation in wage rates can be identified at different scales. By far the greatest disparity is at the global scale. The low wages of LICs with reasonable enough levels of skill to interest foreign companies has been a major reason for transnational investment in regions such as South East Asia and Latin America. A filter-down of industry to lower and lower wage economies can be recognised in particular in Asia –this topic is examined in more detail in Section 14.2, pages 470–71.



Source: *Advanced Geography: Concepts & Cases* by P. Guinness & G. Nagle (Hodder Education, 1999), p.147

Figure 11.35 Regional variations in labour costs

Recent analyses of labour costs in manufacturing have highlighted the wide variations in non-wage labour costs, which include employer social security contributions, payroll taxes, holiday pay, sick leave and other benefits.

The availability of labour as measured by high rates of unemployment is not an important location factor for most industries. The regions of the UK that have struggled most to attract new industry are the traditional industrial areas, which have consistently recorded the highest unemployment rates in the country. In such regions, although there are many people available for work, they frequently lack the skills required by modern industry. The physical dereliction and the social problems generated by unemployment also act to deter new investment. Where availability really has an impact is in sparsely populated areas because large prospective employers know that they will struggle to assemble enough workers with the skills demanded. Such regions are therefore often ruled out at the beginning of the locational search.

Figure 11.36 Factory producing tapestries in Vietnam – this is a labour-intensive process

That there have always been considerable regional differences in unemployment in the UK, a relatively small country, indicates that the **geographical mobility of labour** is limited. A major factor impeding the movement of labour from region to region is the huge differential in the cost of housing between the South East and the traditional industrial areas. In general, the degree of geographical mobility increases with skill levels and qualifications. It is the most able and financially secure that can best overcome the obstacles to mobility.

People can of course move from one type of job to another within the same town or region. Such

movement is referred to as occupational mobility. However, like geographical mobility, it is limited in extent. People who have been employed in heavy industry in particular often find it very difficult to adjust to a working environment that is less physically demanding but requires much more in terms of concentration.

The reputation of a region's labour force can influence inward investment. Regions with militant trade unions and a record of work stoppages are frequently avoided in the locational search. In the USA, manufacturing firms often avoid states in the north-east where trade union membership is high, favouring instead the south and the west where union influence is minimal. Trade union membership in most countries has weakened in recent decades for two main reasons:

- Many governments have passed legislation to restrict the power of unions.
- The decline in employment in manufacturing, the historic nucleus of trade unionism, has had severe implications for membership; unions are particularly unpopular in Asia.

Economies of scale: internal and external

Both internal and external economies of scale can be recognised. Internal economies of scale occur when an increase in production results in a lowering of unit costs. This is a major reason why firms want to increase in size. The reduced costs of production can be passed on to customers and in this way a company can increase its market share. Alternatively, it can increase its profits. Economists recognise five types of internal economies of scale:

- **Bulk-buying economies** – as businesses grow, their bargaining power with suppliers increases.
- **Technical economies** – businesses with large-scale production can use more advanced machinery or use existing machinery more efficiently. A larger firm can also afford to invest more in research and development (R&D) and in ICT.
- **Financial economies** – larger firms find it easier to find potential lenders and to raise money at lower interest rates.
- **Marketing economies** – as a business gets larger, it is able to spread the cost of marketing over a wider range of products and sales, thus cutting the average marketing cost per unit.
- **Managerial economies** – as a company grows, there is more potential for managers to specialise in particular tasks and thus become more efficient.

However, it is possible that an increase in production at some stage might lead to rising unit costs. If this happens, diseconomies of scale are said to exist. In Figure 11.37, the average cost of production at output Q is C_2. Increasing output beyond this point reduces unit costs and thus economies of scale are achieved. This continues until output Q_2 is reached, when the lowest unit costs of production are achieved (C). Beyond this point, unit costs rise and diseconomies of scale are occurring.

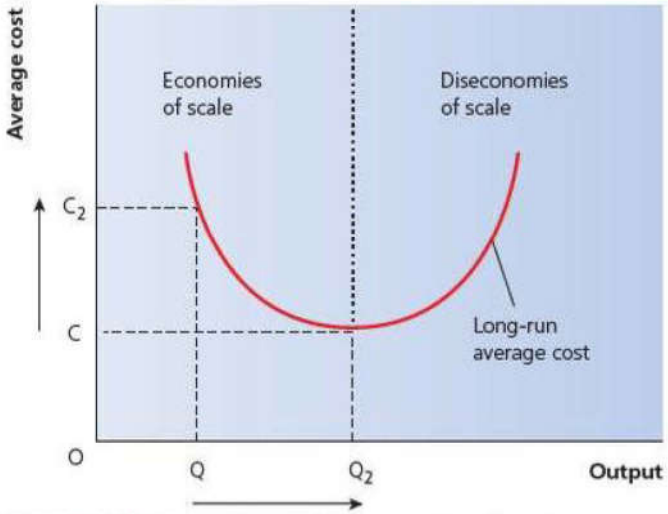


Figure 11.37 Economies and diseconomies of scale

External economies of scale (agglomeration economies) are the benefits that accrue to a firm by locating in an established industrial area. External economies of scale can be subdivided into:

- **urbanisation economies**, which are the cost savings resulting from urban location due to factors such as the range of producer services available and the investment in infrastructure already in place, and
- **localisation economies**, which occur when a firm locates close to suppliers (backward linkages) or to firms that it supplies (forward linkages) – this reduces transport costs, allows for faster delivery and facilitates a high level of personal communication between firms.

However, when an urban-industrial area reaches a certain size, urbanisation diseconomies may come into play. High levels of traffic congestion may push up transport costs. Intense competition for land will increase land prices and rents. If the demand for labour exceeds the supply, wages will rise. So locating in such a region may no longer be advantageous, with fewer new firms arriving and some existing firms relocating elsewhere. In the USA, such a process has occurred in the Santa Clara valley (Silicon Valley), with entrepreneurs looking in particular at the less crowded mountain states such as Arizona and Colorado (Figure 11.38).

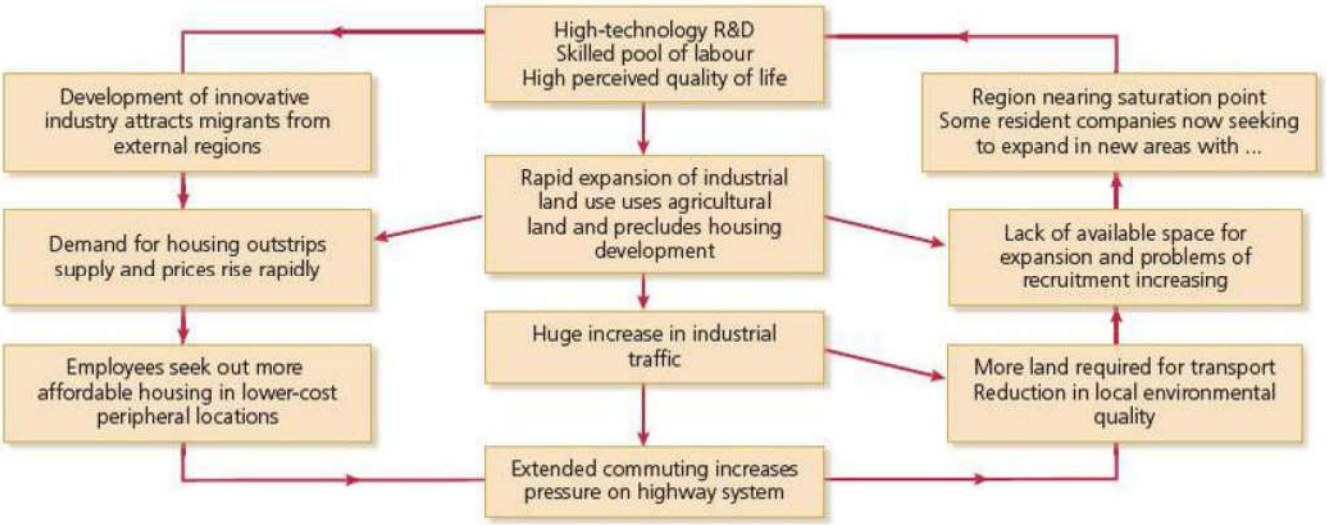


Figure 11.38 Model illustrating the problems of rapid growth in the Santa Clara valley (Silicon Valley)

Government policies

In the old-style centrally planned economies of the communist countries or former communist countries, the influence of government on industry was absolute. In other countries, the significance of government intervention has depended on:

- the degree of public ownership
- the strength of regional policy in terms of restrictions and incentives.

Governments influence industrial location for economic, social and political reasons. Regional economic policy largely developed after the Second World War, although examples of legislation with a regional element can be found before this time. There is a high level of competition both between countries and between regions in the same country to attract FDI.

Technology

Technology can influence industrial location in two main ways:

- The level of technological development in a country or region in terms of infrastructure and human skills has a major impact on the type of industry that can be attracted.
- Technological advance may induce a company or industry to move to alternative locations that have now become more suitable due to the new developments in technology.

Figure 11.39 is a useful summary of the different stages of technological development. Advances in technology can stimulate new industrial clusters, as has happened with biotechnology in a number of countries.

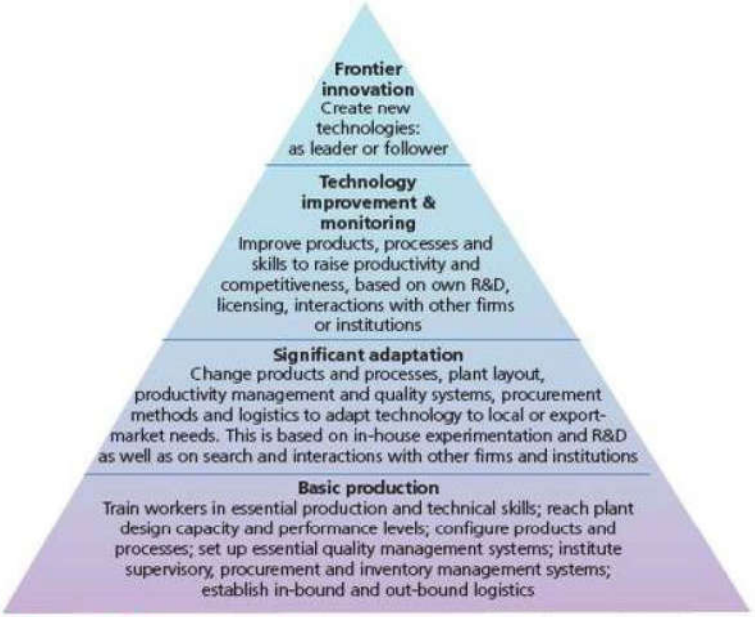


Figure 11.39 Stages of technology development by innovation effort

Industrial inertia

The importance of the factors responsible for the location of a particular industry may diminish over time. What was once a profitable location may become less so. However, many factories remain in locations that are no longer the best places to be because of the cost of moving and for other reasons such as tradition. This phenomenon is known as industrial inertia. Examples of industrial inertia are often found in industrial towns that developed on coalfields that no longer produce coal. Although coal as a source of energy was often the initial reason for factories locating in a coalfield town, the investment in hard and soft infrastructure over a long period of time has brought new advantages to such settlements. These might include improved accessibility, purpose-built industrial estates and modern hospitals and schools.

However, some industries are affected by changes of such magnitude that they have no option but to close down (Figure 11.40).

Figure 11.40 Abandoned whaling station, island of South Georgia, South Atlantic Ocean

Section 11.3 Activities

1 Distinguish between wage rates and unit costs.
2 Define the sectoral spatial division of labour.
3 With regard to labour, briefly discuss the impact on industrial location of cost, quality, availability and reputation.
4 Explain internal economies of scale.
5 How can diseconomies of scale occur?
5 What are external economies of scale?
6 Briefly review the impact of **a** government policies and **b** technology on industrial location.

Case Study: Slovakia – the changing location of EU car manufacturing

Car manufacturing is one of the world's largest industries. Within the EU, investment in car manufacturing has shifted from western to eastern Europe in recent years as countries like Slovakia have joined the EU (Figure 11.41). This is because eastern EU countries like Slovakia can manufacture cars at a lower cost than western EU countries.

Figure 11.41 Slovakia

The location factors that have attracted the car industry to Slovakia are:

- relatively low labour costs
- low company taxation rates
- a highly skilled workforce, particularly in areas that were once important for heavy industry
- a strong work ethic, resulting in high levels of productivity
- low transport costs because of proximity to western European markets
- very low political risk because of the stable nature of the country
- attractive government incentives due to competition between Slovakia and other potential receiving countries
- good infrastructure in and around Bratislava and other selected locations
- an expanding regional market for cars as per person incomes increase.

Volkswagen expands

Prior to EU membership, Slovakia already boasted a Volkswagen (VW) plant with an output of 250000 cars a year. The Bratislava plant is one of the top three Volkswagen factories in the world, producing the Polo, the Touareg and the SEAT Ibiza.

In addition to its car manufacturing plant in Bratislava, which was founded in 1991, VW also has a plant manufacturing components in Martin, which opened in 2000. Between the two plants, VW employs 8700 workers. A number of companies supplying parts to VW have also opened up in Slovakia.

Other recent investment

In 2006, Hyundai–Kia opened a major car factory in Slovakia. The location of the factory is near Žilina, 200 kilometres north-east of Bratislava. As with other large car plants, it is attracting some of its main suppliers to locate nearby. With its seven suppliers, the total investment is estimated to be $1.4 billion.

In 2006, Peugeot opened a large new car plant in Trnava, 50 kilometres from Bratislava. When it reaches maximum production, this state-of-the-art plant will export 300000 cars a year to western Europe and to other parts of the world. Production reached 248000 in 2013.

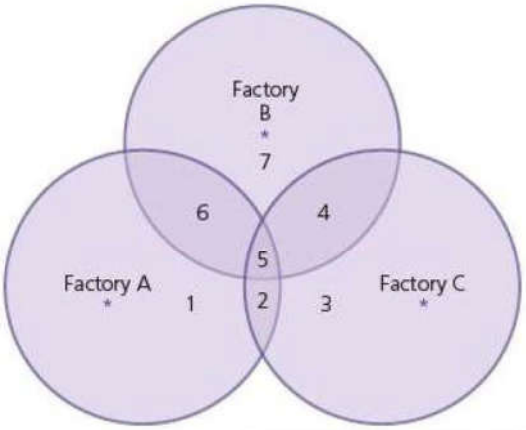
Slovakia produced a record 980000 cars in 2013. This accounted for just over 40 per cent of Slovakia's industrial output. The car industry in Slovakia now employs more than 60000 people.

Section 11.3 Activities

1 Why have Slovakia and other eastern EU countries been so keen to attract foreign car manufacturers?
2 Discuss the reasons for such a high level of investment in car manufacturing in Slovakia by foreign TNCs.

Industrial agglomeration and functional (industrial) linkages

Industrial agglomeration is the clustering together and association of economic activities in close proximity to one another. Agglomeration can result in companies enjoying the benefits of external economies of scale (Figure 11.42). This means the lowering of a firm's costs due to external factors. For example, the grouping together of a number of companies may encourage local government to upgrade the transport infrastructure and attract bus companies to run new services. Companies may be able to share certain costs, such as security and catering. Such benefits are greatly increased if they actually do business together.



Source: *Advanced Geography: Concepts & Cases* by P. Guinness & G. Nagle (Hodder Education, 1999), p.152

Figure 11.42 Agglomeration economies

Alfred Weber published his *Theory of the Location of Industries* in 1909. At that turn of the century, transportation was a much greater element of total industrial costs than it is today, and for many industries it was the major cost. Thus it is not surprising that Weber developed his theory around the cost of transportation. However, he did recognise that other elements of total cost could also vary, particularly labour and the savings associated with agglomeration. Containerisation (Figure 11.43) has been a major factor in reducing transport costs.

Figure 11.43 A container ship, Seattle dockside

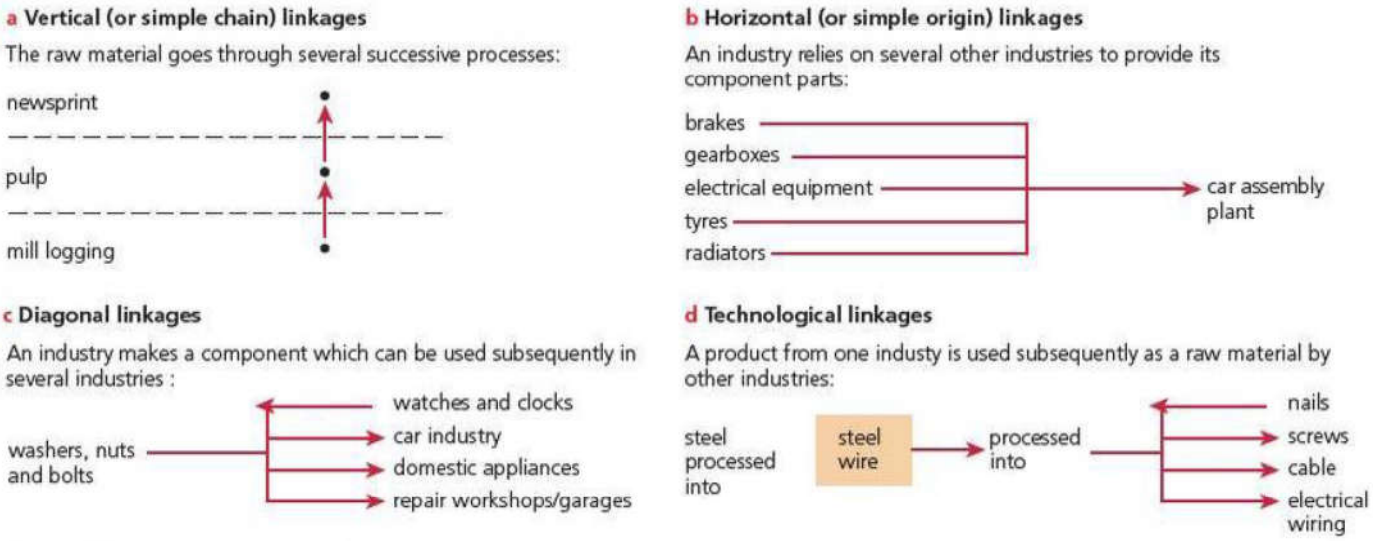


Figure 11.44 Types of industrial linkage

Weber referred to the savings that could be made when firms located together as 'agglomeration economies'. In Figure 11.42, the least transport cost location and the critical isodapanes for agglomeration for three factories are shown. Only in area 5 will all three factories benefit from agglomerating there.

The success of one company may attract other companies from the same or industry groups. Alternatively, a number of smaller firms may combine to produce components for a larger product.

Industrial (functional) linkages are the contacts and flows of information between companies that can happen more cheaply and easily when companies locate in close proximity. Three types of linkage are generally recognised:

- **backward linkages** – to firms providing raw materials, components and services needed in its production processes and activities
- **forward linkages** – to firms further processing the product or using it as a component part
- **horizontal linkages** – with other companies involved in the same processes or production, for example collaboration in research or marketing.

Figure 11.44 shows examples of the linkages that can induce companies to locate together.

Industrial estates

An industrial estate is an area zoned and planned for the purpose of industrial development. Industrial estates are also known as industrial parks and trading estates. A more 'lightweight' version is the business park or office park, which has offices and light industry, rather than larger-scale industry.

Industrial estates can be found in a range of locations, from inner cities to rural areas. In inner cities, they tend to be relatively small, but nevertheless important to local employment. Industrial estates are usually located close to transport infrastructure, especially where more than one transport mode meet. The logic behind industrial estates includes:

- concentrating dedicated infrastructure in a delimited area to reduce the per-business expense of that infrastructure
- attracting new business by providing an integrated infrastructure in one location
- separating industrial uses from residential areas to try to reduce the environmental and social impact of the industrial uses
- providing for localised environmental controls that are specific to the needs of an industrial area
- eligibility of industrial estates for grants and loans under regional economic development policies.

Export processing zones

There are a number of different types of export processing zones (EPZs), including free trade zones, special economic zones, bonded warehouses and free ports. The International Labour Organization (ILO) has defined EPZs as 'industrial zones with special incentives set up to attract foreign investors, in which imported materials undergo some degree of processing before being re-exported'. This can also include electronic data. EPZs have evolved from initial assembly and simple processing activities to include high-tech and science parks, finance zones, logistics centres and even tourist resorts. Table 11.7 summarises the different types of EPZ.

Table 11.7 Export processing zones – types of zones

	Trade	Manufacturing			Services		
	Free port	Special economic zone	Industrial free zone/EPZ	Enterprise zone	Information processing zone	Financial services zone	Commercial free zone
Physical characteristics	Entire city or jurisdiction	Entire province, region or municipality	Enclave or industrial park	Part of city or entire city	Part of city or 'zone within zone'	Entire city or 'zone within zone'	Warehouse area, often adjacent to port or airport
Economic objectives	Development of trading centre and diversified economic base	Deregulation; private sector investment in restricted area	Development of export industry	Development of SMEs in depressed areas	Development of information processing centre	Development of offshore banking, insurance, securities hub	Facilitation of trade and imports
Duty-free goods allowed	All goods for use in trade, industry, consumption	Selective basis	Capital equipment and production inputs	No	Capital equipment	Varies	All goods for storage and re-export of imports
Typical activities	Trade, service, industry, banking, etc.	All types of industry and services	Light industry and manufacturing	All	Data processing, software development, computer graphics	Financial services	Warehousing, packaging, distribution, trans-shipment
Incentives: **Taxation** **Customs duties** **Labour laws** **Other**	Simple business start-up; minimal tax and regulatory restraints; waivers with regard to termination of employment and overtime; free repatriation of capital, profits and dividends; preferential interest rates	Reduced business taxes; liberalised labour codes; reduced foreign exchange controls; no specific advantages – trade unions are discouraged within the SEZ	Profits tax abatement and regulatory relief; exemption from foreign exchange controls; free repatriation of profits; trade union freedom restricted despite EPZs being required to respect national employment regulation; 15 years' exemptions on all taxes (maximum)	Zoning relief; simplified business registration; local tax abatement; reduction of licensing requirement; trade unions are prohibited; government mandated liberal policies on hiring and firing of workers	De-monopolisation and deregulation of telecoms; access to market-priced INTELSAT services; a specific authority manages labour relations; trade union freedom restricted	Tax relief, strict confidentiality; deregulation of currency exchange and capital movements; free repatriation of profits	Exemption from import quotas; reinvested profits wholly tax-free
Domestic sales	Unrestricted within free port; outside free port, upon payment of full duty	Highly restricted	Limited to small portion of production			Limited to small portion of production	Unlimited, upon payment of full duty
Other features	Additional incentives and streamlined procedures	Developed by socialist countries	May be extended to single-factory sites				
Typical examples	Hong Kong (China), Singapore, Bahamas free port, Batam Labuan, Macao	China (southern provinces incl. Hainan and Shenzhen)	Ireland, Taiwan (China), Malaysia, Dominican Republic, Mauritius, Kenya, Hungary	Indonesia, Senegal	India (Bangalore), Caribbean	Bahrain, Dubai, Caribbean, Turkey, Cayman Islands	Jebel Ali, Colon Miami (US FTZ), Mauritius, Iran

Source: www.ilo.org

Table 11.8 shows the considerable global increase in number of EPZs, rising from 79 in 1975 to 3500 in 2006. Asia and Central America have the largest share of employment in EPZs. Apart from China, which has 40 million people working in EPZs, the rest of Asia has 15 million people employed in EPZs. In Central America, 5 million workers come into this category.

Table 11.8 The development of export processing zones

Year	1975	1986	1997	2002	2006
Number of countries with EPZs	25	47	93	116	130
Number of EPZs or similar types of zone	79	176	845	3000	3500
Employment (millions)	n.a.	n.a.	22.5	43	66
– of which China	n.a.	n.a.	18	30	40
– of which other countries with figures available	0.8	1.9	4.5	13	26

The formal and informal sectors of employment

The concept of the informal sector was introduced into international usage in 1972 by the ILO. Jobs in the formal sector will be known to the government department responsible for taxation and to other government offices. Such jobs generally provide better pay and much greater security than jobs in the informal sector (Figure 11.45). Fringe benefits such as holiday and sick pay may also be available. Formal sector employment includes health and education service workers, government workers and people working in established manufacturing and retail companies.

In contrast, the informal sector is that part of the economy operating outside official government recognition. Employment is generally low-paid and often temporary and/or part-time in nature. While such employment is outside the tax system, job security will be poor with an absence of fringe benefits. About three-quarters of those working in the informal sector are employed in services. Typical jobs are shoe-shiners, street food stalls, messengers, repair shops and market traders. Informal manufacturing tends to include both the workshop sector, making for example cheap furniture, and the traditional craft sector. Many of these goods are sold in bazaars and street markets.

Figure 11.45 Informal sector – selling cigarettes on the street in Ulaanbaatar

The government estimates that about 5 per cent of all employment in the UK is in the informal sector. This usually occurs when people insist on being paid in cash and do not declare this to the Inland Revenue. Examples may be window cleaners, part-time bar staff, cleaners and builders. In LICs, the informal sector may account for up to 40 per cent of the total economy.

A World Bank report recognises two types of informal sector activities:

- **coping strategies** (survival activities) – casual jobs, temporary jobs, unpaid jobs, subsistence agriculture, multiple job holding
- **unofficial earning strategies** (illegality in business) – unofficial business activities (tax evasion, avoidance of labour regulation and other government or institutional regulations – no registration of the company) and underground activities (crime, corruption – activities not registered by statistical offices).

The advantages of the informal sector are that it:

- provides jobs and reduces unemployment and underemployment
- alleviates poverty
- bolsters entrepreneurial activity
- facilitates community cohesion and solidarity.

Activities in the informal sector have to contend with a significant number of obstacles, for example:

- There is little access to credit for workers in the informal sector to finance their activities, although in some countries microcredit is being used to fill this gap.
- The World Bank estimates that the size of the informal labour market varies from the estimated 4–6 per cent in HICs to over 50 per cent in LICs. Its size and role in the economy increases during economic downturns and periods of economic adjustment and transition.
- Women in Informal Employment: Globalizing and Organizing (WIEGO) is a global research-policy network that seeks to improve the status of the working poor, especially women, in the informal economy. It does so by highlighting the size, composition, characteristics and contribution of the informal economy through improved statistics and research.

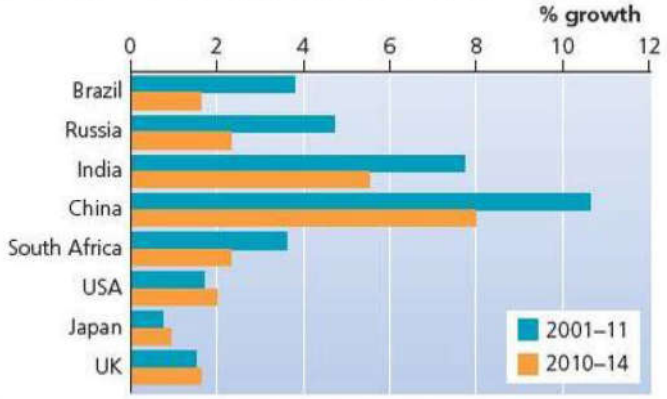
Informal sector employment can be found in all parts of urban areas but is particularly concentrated in and around the CBD where potential demand for such services is at its highest. It is also often concentrated at key tourism locations where the informal crafts sector is in clear evidence. Informal sector employment is also attracted to industrial areas offering food and other services to industrial workers.

11.4 The management of change in manufacturing industry

Case Study: India

With approximately 1.3 billion people, India has the second largest population in the world. India is the 'I' in **BRIC**, the new buzzword for the economies tipped for rapid growth: Brazil, Russia, India and China. Because of its recent rapid economic growth (Figure 11.46), India is classed as a NIC. However, unlike other Asian economies such as South Korea, Taiwan, Thailand and Malaysia, which all became NICs at an earlier date, the recent transformation of the Indian economy has been based more on the service sector than on manufacturing. This has been at least partly due to a low level of **foreign direct investment (FDI)** in manufacturing, a situation that began to change in the early 1990s with the introduction of a number of important economic reforms.

The service sector accounts for 57 per cent of India's GDP, with industry responsible for 26 per cent and agriculture for 17 per cent (Figure 11.47). The situation with regard to employment is very different. Agriculture leads with 52 per cent of the workforce. Services account for 26 per cent and industry 22 per cent.



Source: Calculated from World Economic Outlook Database October 2014

Figure 11.46 Annual growth rates of the BRIC countries and three major developed economies

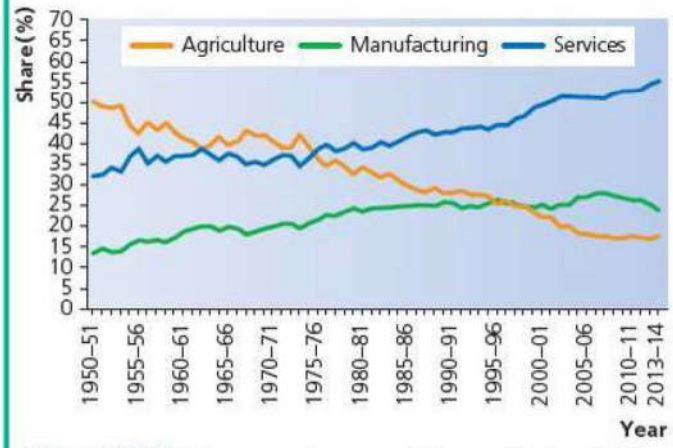


Figure 11.47 Main economic sectors' share of Indian GDP

Textiles is the largest industry in the country, employing about 45 million people and accounting for 27 per cent of India's exports. India is the second largest producer of textiles and garments in the world. The car industry has expanded significantly in recent times and is now the seventh largest in the world, with a production of 3.2 million cars in 2013. However, it is in the field of software and ICT in general that India has built a global reputation. Figure 11.48 shows the major manufacturing hubs in India for automobiles (Figure 11.49), machine tools, textiles and pharmaceuticals.

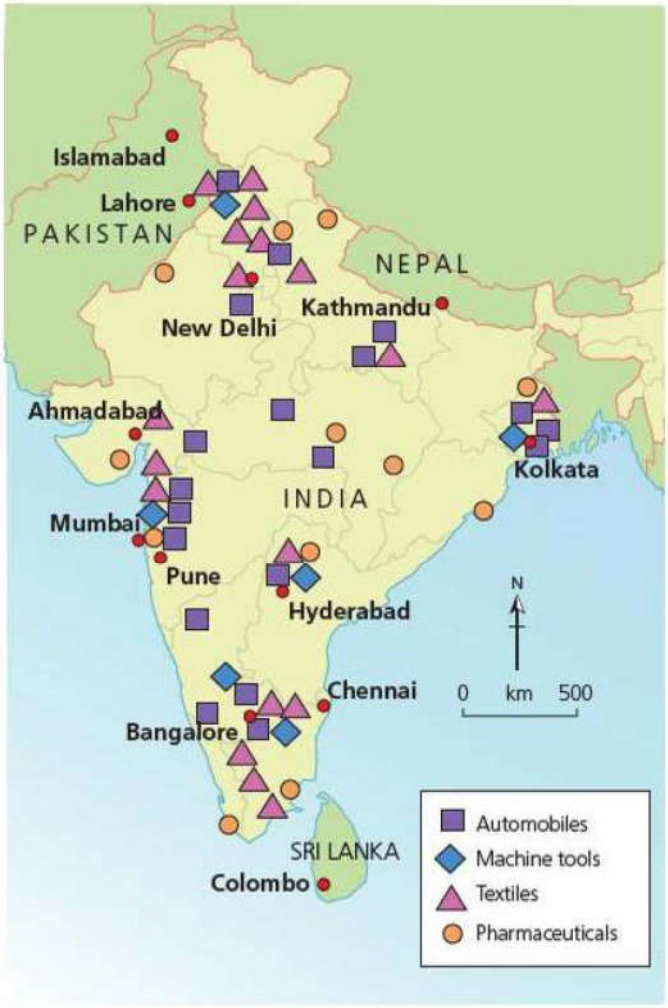


Figure 11.48 Major manufacturing hubs in India

Figure 11.49 Car manufacturing in India

Traditional industrial policy

In 1950, India was arguably the first non-communist LIC to institute a fully-fledged industrial policy. The objective of India's policy was to co-ordinate investment decisions in both the public and private sectors and to bring certain strategic industries and companies under public ownership. Following the example of the former Soviet Union, five-year plans were set up and this state-directed industrialisation model was followed from 1950 to 1980. The five-year plans were designed to bring about economic and social development within a 'socialist' framework. The main objectives of the plans were to:

- industrialise
- raise per person incomes
- achieve equity in the distribution of gains from economic development
- reduce the existing concentration of economic power
- achieve a more even regional distribution of industrial development.

The role of **heavy industry**, particularly of iron and steel, was emphasised, with the public sector playing a major role in the structural transformation of the economy from what was primarily an agricultural society. Investment in the private sector would be based not on the issue of profitability, but according to the requirements of the overall national plan. Technological self-reliance became an important element of industrial policy. Here, the objective was to produce as much as possible inside India itself and keep imports to a minimum. This would be important for India's trade balance and also advance technical knowledge in the country.

Industrial policy measures under the five-year plans included:

- industrial licensing – a firm that wanted to manufacture a new product or sought a substantial expansion of its existing capacity had to obtain a government licence
- strict import controls
- subsidising exports
- strict controls on investment by TNCs.

The range of controls made India one of the most protected economies in the world. High tariffs made imports very expensive and thus controlled their volume. The Indian model was not just influenced by the Soviet Union but also by Fabian socialism and UK labour party thinkers like Harold Laski. In the 1980s, the model began to erode (as some liberalisation measures were introduced) and it was virtually abandoned after a serious external liquidity crisis in 1991.

The Planning Commission has taken the major role in formulating industrial policy and in guiding India's ongoing industrial revolution. It is still widely accepted by the country's mainstream political parties.

Many economists argue that India made a serious error from 1950 in taking on so many aspects of socialist central planning. The main criticisms were that there were far too many rules and regulations, which proved to be a major hindrance in the successful development of private sector industry. There was widespread corruption and massive inefficiency. Considerable aid from the West seemed to have very little impact on the industrial sector. However, opinion does differ widely on this subject.

Economic reform

The currency crisis of 1991 proved to be a major turning point, instigating bold economic reforms that resulted in rapid economic growth that is likely to double average productivity levels and living standards in India every 16 years. The economic reforms were based on:

- **liberalisation** – fewer government regulations and restrictions in the economy
- **deregulation** – changing regulatory policies and laws to increase competition among suppliers of commodities and services
- **market orientation** – more careful analysis of demand in domestic and global markets.

Tariffs on imports were significantly reduced along with other non-tariff trade barriers as a result of India's membership of the World Trade Organization (WTO). The essence was greater freedom from government control. This 'unshackling' of the economy is credited with increasing the growth rate of GDP from 3 to 3.5 per cent during the period 1950–80 and to 6–7 per cent in recent decades. The international financial institutions (IFIs) regard India as a major beneficiary of globalisation and are urging India to undertake even more reforms to open up its economy even further.

Instead of planning inputs and outputs for each company and each industry, the government adopted indicative planning. However, it maintained high tariffs by international standards and restrictions on portfolio and FDI. India has been determined to be master of its own policies and not blindly to copy the 'Western model'.

India's technological success has not been confined to the ICT industry. The country's corporations have achieved significant growth in a number of industries including, in particular, pharmaceuticals and auto components. It is one of only three countries in the world to build super-computers on its own, and one of only six countries in the world to launch satellites.

The relationship between growth of manufacturing and that of services is an issue of considerable significance for the economic development of the country.

Regional policy

Like many other countries, India adopted regional economic planning and tried to encourage a better spread of industry around the country. In the early 1970s, backward states and districts were identified and a scheme of incentives for industry to locate in these regions was introduced. This included:

- a grant of 15 per cent of fixed capital investment
- transport subsidies
- income tax concessions.

In 1977, central government decided that no more industrial licences would be granted in and around metropolitan cities and urban areas with a population of 500 000 and more. In 1980, new initiatives confirmed the government's commitment to correcting regional imbalance. The number of industrial concentrations has risen from about half a dozen in 1965 to more than 40 today, indicating a significant spatial expansion. In terms of international comparison, India has achieved a reasonable degree of success in its attempts to narrow regional imbalance.

Industrial policy and ICT

In the last two decades, India has spawned a modern, highly export-oriented ICT industry. The export intensity of Indian software is more than 70 per cent, compared with an overall export intensity of 10 per cent for the economy as a whole. The country's comparative advantage lies largely in the availability of low-cost skilled labour. The background to the success of the software industry was established in the era of traditional industrial policy, which more recent reforms have magnified. In the pre-1980 era:

- a large number of engineering colleges were established, particularly in the south of India under entrepreneurial state governments; these colleges were subsidised to a considerable degree by state and central government
- the government's philosophy in this period was to create a broad science and technology base to transform the Indian economy by stimulating domestic innovation; the benefits of this process were particularly felt by the ICT, biotechnology and pharmaceutical industries
- the government's role in the establishment of Bangalore as a hub attracting the bulk of the country's technological and scientific activity was fundamental to the development of the city as a global centre of ICT; Bangalore was favoured partly because of its distance from Pakistan and China, countries with which India has had difficult relations in the past.

NASSCOM, the Indian software association, has stated: 'The software and services industry has received immense support from the government both at the central and state level. This support in the form of tax incentives and other benefits has been instrumental in the growth of software and services exports.'

With the background set in the traditional industrial policy era, the age of reform has seen the ICT industry flourish, attracting high levels of FDI.

Future industrial policy

The direction taken by the Planning Commission in the future will have a major impact on India's economic performance (Figure 11.50). Many Indian economists stress the importance of achieving the best possible balance between the manufacturing and the service sectors. The general feeling is that India should take advantage of its strength in ICT and use it extensively in all areas of the economy to upgrade agriculture, industry and services in order to compete more effectively in the global economy. A major issue is the distribution of the gains and losses from globalisation. It seems that most gains have accrued to the Indian urban middle-class of around 100 million people, which amounts to less than 10 per cent of the country's population.

Some Japanese scholars have used a picturesque analogy to describe the gradual spread of development in Asia, with countries escaping mass poverty in a V-shaped formation that resembles a flock of flying geese.

Japan led the way after World War II, till rising wage costs in the 1960s led to the shift of low-value manufacturing to other regional economies in decadal waves that pulled millions off the farm and into the factory.

Most Asian countries that prospered used explicit industrial policies – and a rigged exchange rate – to build manufacturing prowess. Such policies went out of fashion in recent decades, but seem to have made a comeback in the entire ideological churn in the wake of the Western financial crisis.

World Bank chief economist Justin Lin says it is time to rethink development policy, with the state playing an important role even though 'the market is the basic mechanism for effective resource allocation'. There are clear signs that there has been a change in the attitude of the Indian government as well: industrial policy is making a quiet comeback in India.

The contours of the new industrial policy seem quite different from the sort of policies followed by Nehruvian India and other Asian countries in their early stages of development. 'The needs of building competitive enterprises and meeting WTO requirements need to be taken into account,' Planning Commission member Arun Maira told me during a telephonic chat. This means the new industrial policy that is emerging will not have much of the old statist and protectionist policy mix: protection through high import tariffs, preferential access to bank funds, promotion of national champions and resource allocation by a government agency.

Yet, there is a clear belief that the country needs an explicit industrial strategy. The government will choose which industries need encouragement and design suitable policies. Physical and social infrastructure will also be developed, a process that should lower transaction costs and raise the rates of return on investment.

Maira gave me three key policy parameters that will be kept in mind in designing the new economic strategy – there should be a growth in quality jobs, the Indian economy should get strategic depth in capital goods such as power and telecom equipment, and defence and security issues should be kept in mind.

There will be both technical and political economy challenges here. The technical challenge is to identify industries that need a helping hand, and one assumes that government agencies have an understanding of India's factor endowments and comparative advantages. The political economy challenge is perhaps even more complex. Comparative advantage rapidly changes in the modern economy and technology cycles are getting shorter. Policy will have to be flexible if India is not to stagnate.

A market economy has immense flexibility. Japan was a pioneer of successful industrial policy, but it lost the flexibility that it needed to fight its long economic stagnation. South Korea provides another lesson. Industrial policy there led to the formation of industrial conglomerates – the chaebol – and the gradual decline into crony capitalism.

What the Planning Commission has now set out to do is thus interesting but fraught with risks of regulatory capture and rent-seeking by favoured industrial groups. Maira says it is important that the focus of industrial policy remains on sectors rather than companies, in the attempts to forge closer collaboration between 'productive sectors and policymakers'.

By Niranjan Rajadhyaksha

Figure 11.50 India's new industrial policy

The state of India's infrastructure is also an important issue. Infrastructure in India is at a lower level than that in China and other NICs in the region. Current spending on the elements of infrastructure such as railways, roads, seaports and airports is about 6 per cent of GDP. This is about 50 per cent below what the government itself thinks needs to be spent. Because of the huge sums of money involved, the Planning Commission suggests that it can only be done by creating a partnership with the private sector.

Bangalore: India's high-tech city

Bangalore, Hyderabad and Chennai, in the south, along with the western city of Pune and the capital city Delhi, have emerged as the centres of India's high-technology industry.

Bangalore is the most important individual centre in India for high-tech industry. The city's pleasant climate, moderated by its location on the Deccan Plateau over 900 metres above sea level, is a significant attraction to foreign and domestic companies alike (Figures 11.51 and 11.52). Known as 'the Garden City', Bangalore claims to have the highest quality of life in the country. Because of its dust-free environment, large public-sector undertakings such as Hindustan Aeronautics Ltd and the Indian Space Research Organisation were established in Bangalore by the Indian government. The state government also has a long history of support for science and technology. The city prides itself on a 'culture of learning', which gives it an innovative leadership within India.

Figure 11.51 Location of Bangalore

In the 1980s, Bangalore became the location for the first large-scale foreign investment in high-technology in India when Texas Instruments selected the city above a number of other contenders. Other multinationals soon followed as the reputation of the city grew. Important backward and forward linkages were steadily established over time. Apart from ICT industries, Bangalore is also India's most important centre for aerospace and biotechnology.

India's ICT sector has benefited from the filter-down of business from HICs. Many European and North American companies that previously outsourced their ICT requirements to local companies are now using Indian companies because:

- labour costs are considerably lower
- a number of HICs have significant ICT skills shortages
- India has a large and able English-speaking workforce (there are about 80 million English-speakers in India).

Since 1981, the city's population has grown rapidly, from 2.4 million 9.6 million in 2011, while the number of vehicles has grown even faster, from fewer than 200 000 cars and scooters to over 2 million. The city's landscape has changed dramatically, with many new glass-and-steel skyscrapers and numerous cybercafés. The city has grown into a major international hub for ICT companies. Bangalore has the nickname of 'the Silicon Valley of India'.

BANGALORE

- Bangalore is the location of 925 software companies employing more than 80 000 IT workers. Bangalore accounts for nearly 40 per cent of India's software exports.
- The city has 46 integrated circuit design companies, 166 systems software companies and 108 communications software companies. Over 40 per cent of Bangalore's software exports are in these high-technology areas.
- Major companies include Tata Consulting Services (TCS), Infosys Technologies, Wipro and Kshema Technologies.
- The 170 000 m² International Tech Park was set up as a joint venture between the government of Karnataka state, the government of Singapore, and the House of TATA. The Electronic City is an industrial area with over 100 electronics companies including Infosys, Wipro, Siemens, Motorola and TI.
- The city has attracted outsourcing right across the IT spectrum from software development to IT-enabled services.
- The city boasts 21 engineering colleges.
- NASDAQ, the world's biggest stock exchange, with a turnover of over $20 trillion, opened its third international office in Bangalore in 2001.

Figure 11.52 Bangalore factfile

Section 11.4 Activities

1 Describe the trends shown in Figure 11.46.
2 Describe and explain the changing share of India's GDP by the three main economic sectors.
3 Discuss the development of traditional industrial policy in India.
4 Comment on the changes in industrial policy that began in the early 1990s.
5 How has the Indian government tried to narrow regional industrial imbalance?
6 In terms of future industrial policy, produce a 100-word summary of Figure 11.50.
7 How has government policy helped to build India's ICT industry into one of global prominence?