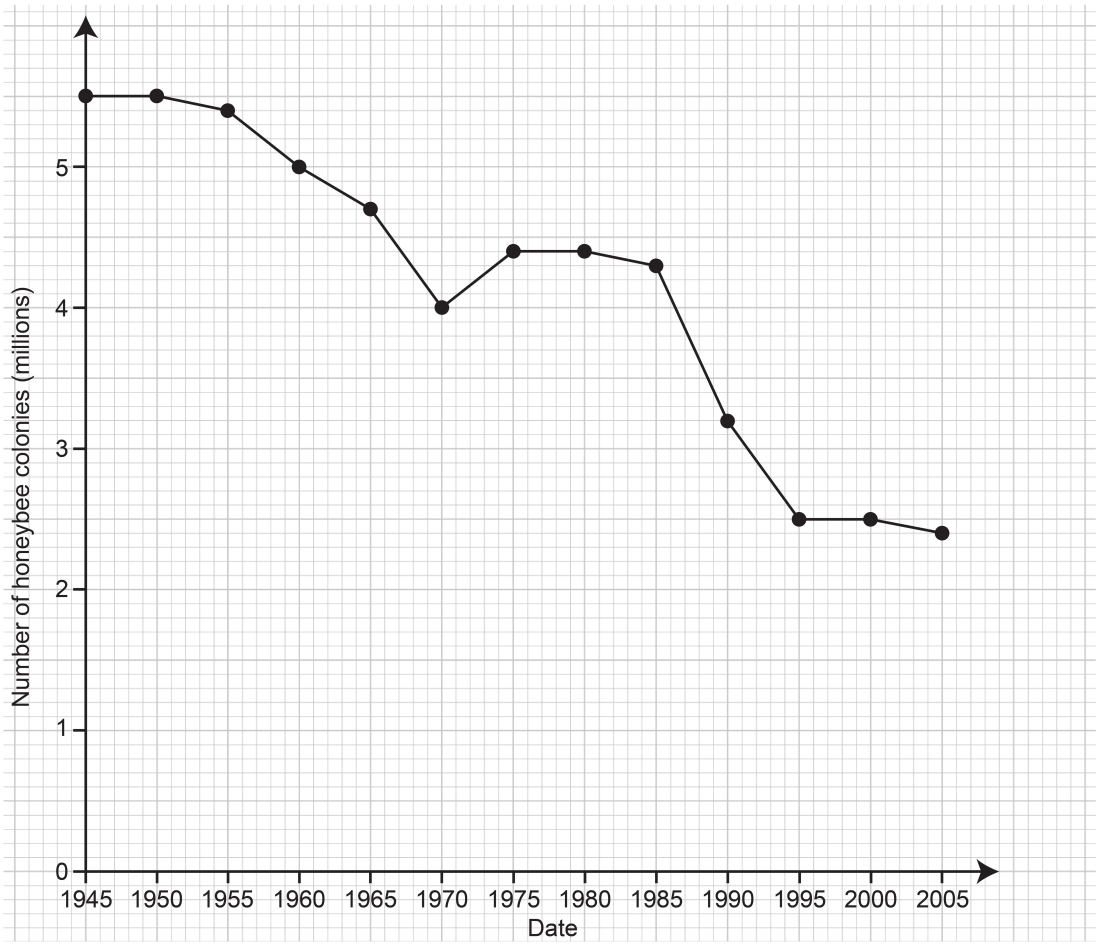
Answers to data response and decision making exercises

1. The data in the table below shows changes in managed honeybee colonies in the United States between 1945 and 2005.

Year	Number of honeybee colonies (millions)	Year	Number of honeybee colonies (millions)
1945	5.5	1980	4.4
1950	5.5	1985	4.3
1955	5.4	1990	3.2
1960	5.0	1995	2.5
1965	4.7	2000	2.5
1970	4.0	2005	2.4
1975	4.4		

Table 3.2 Changes in managed honeybee colonies in the US between 1945 and 2005.

a) Plot this data as a line graph on the grid below.



b) By how many millions did the number of colonies fall between 1945 and 2005?
3.1 million

c) Which five-year period recorded the largest single fall in colony numbers?
1985-1990

d) At the current rate of decline from 2000 to 2005, in which survey year will researchers record less than two million bee colonies for the first time?
2030

2. Throughout North America, Europe and many parts of Asia and Oceania, wild bee populations (as well as managed bee colonies) are facing a very serious decline.

Fig. 3.8 European honeybee *Apis mellifera*.

Ecologists place much of the blame for this on intensive commercial farming practices. Explain how each of the following practices can threaten wild bee numbers.

a) Misuse of chemical pesticides
Pesticides are used by commercial farmers to boost agricultural yields by killing harmful fungi (fungicides), weeds (herbicides) and insects (insecticides). Serious ecological effects can occur when broad spectrum insecticides (those which do not discriminate between pest insects such as aphids and ecologically and economically valuable insects such as ladybirds and honeybees) are sprayed indiscriminately over fields of growing cereal crops.

b) Loss of habitats such as wildflower meadows, scrubland and forests
Honeybees require a habitat which contains sources of nectar, such as flowering plants, trees with cavities in which to build their nests, and loose soil that is rich in vegetation in order to hibernate. Many commercial farmers plough up wildflower meadows and areas of scrub as well as felling woodland in order to create more farmland to boost agricultural yields. When this happens, fewer honeybees are able to survive on the remaining suitable habitat.

c) Air pollution

Honeybees depend on their sense of smell to find flowers from which they extract the nectar they require to survive and bring food to their nests. Air pollution such as petrochemical smog from car exhausts and sulphur dioxide from industries burning fossil fuels reduces the strength of the scent of flowers in the atmosphere. This is most serious in towns and cities and means that some bees do not find sufficient flowers and extract enough nectar to survive.

d) Use of genetically modified (GM) crops

GM involves artificially changing the genetic structure of the cells of farm crops or animals by swapping genes within and across species to improve yields. Some cereal crops are genetically changed to produce proteins which they didn't before and are poisonous to pests such as beetles and caterpillars when they plant tissue containing them. Many ecologists believe that these proteins can seep into nectar and pollen and poison honeybees as well when they come to feed.

3. Wild bees and other invertebrate creatures such as butterflies and midges, together with vertebrate organisms like bats, are vitally important crop pollinators. Pollination involves the transport of male gametes or sperm cells to the female reproductive organs of seed plants. It is an example of one kind of interaction between species in a habitat.

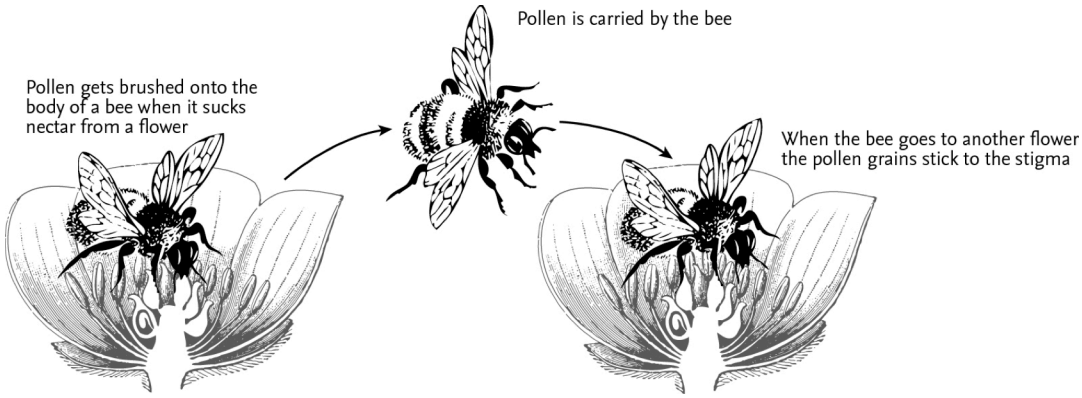


Fig. 3.9 Pollination by bees.

Explain what these three other types of interaction involve.

a) Competition

This occurs when there is a shortage of resources required by a number of living things such as food or suitable mates. It can cause aggression both within and between species, for example, the annual rut of red deer stags to achieve dominance and exclusive mating with female hinds.

b) Predation

This is a biological interaction involving one species preying on another as a source of food such as a cheetah eating a Thompson gazelle. Most organisms eat other living things and are, in turn, eaten themselves. Only apex consumers such as cheetahs have no predators apart from humans.

c) Mutualism
This involves two organisms benefiting from the activity of another through symbiosis. For example, red billed oxpeckers perch on buffalos from which they extract insects and ticks. The buffalo has parasites removed and is alerted to nearby potential predators by the bird's alarm call.

4. It is estimated that pollinators are worth at least US$5 billion a year to European commercial farmers. This is because 80 per cent of all crops grown on farms in Europe depend directly on wild insects, bats and birds for their pollination. If there were no wild pollinators then farmers would have to pay to hire captive honeybee hives that would then be transported to their farms to do the job instead.

a) If this situation were to occur in the future, describe and explain one very likely effect it would have on food shoppers around the world.
The cost of hiring captive hive bees will be added to the price that farmers charge food processing companies for their crops. In turn food processors will increase the price of products for retailers who will then pass it on to the consumer. Food shoppers will be faced with increased prices for basic foods which will impact on the poorest in societies the most.

b) If the pollination of food crops in the future came to rely on a single species of captive bee, why could this be a serious risk to the security of global food supplies?
The bee would be vulnerable to being wiped out by the occurrence of a natural disease, a new predator or the impact of human activity such as 'broad spectrum' spraying of insecticides. Plant crops would not then reproduce and food supplies would be decimated around the world.

5. In July 2009 the global agribusiness company, Syngenta, launched a five year programme called Operation Pollinator to provide essential habitat and food sources for pollinating insects across Europe. The project aims to boost the numbers of pollinating insects on commercial farms and protect biodiversity, which in turn increases crop yields and farmers' incomes.

a) What does biodiversity mean?
Biodiversity refers to the range of living things or plant and animal species to be found within the variety of different habitats in an ecosystem such as a tropical rainforest or hot desert.

b) What does it mean when a farmer improves crop yields?
This is when a farmer increases the amount of grain or fruit they produce each year per unit of land, often through the application of intensive methods such as the application of fertilisers.

c) An important element of the Operation Pollinator programme is to create new areas of habitat for pollinators such as planting field margins around crops with wild flowers.

Fig. 3.10 A rapeseed field margin sown with pollen and nectar rich wildflowers for bees and insects in Northamptonshire, England.

As well as creating new habitat for pollinating insects, explain why wildflower margins will also boost the numbers of a variety of birds and mammals living on farmland.
Creating habitat for producers such as species of flowers will also have the effect of increasing the general biodiversity of habitats. For example, flowers which attract primary consumers like butterflies will also increase the number of secondary consumers such as flycatchers which feed on the insects. In turn, predatory sparrowhawks (tertiary or apex consumers) will feed on the flycatchers. Biodiversity increases through the development of food chains such as this.

6. Operation Pollinator is considered to be a good example of sustainable agriculture because it seeks to improve yields on commercial farms in a way that conserves and improves the natural ecosystems on which all farming depends. Describe and explain how each of the following strategies are also good examples of sustainable farming practices.

a) Organic fertilisers
This is enriching soils to replace lost nutrients using naturally occurring materials such as decomposed plant and animal waste. There is no risk of the environment being polluted with chemical nutrients which can have devastating impacts such as eutrophication in rivers.

b) Livestock and crop rotation
Regularly altering the crops grown in particular fields allows the soil to replace lost nutrients without the use of chemical fertilisers. Similarly, rotating grazing fields enables the forage crops to restore lost energy reserves and deepen their root systems naturally over time through 'fallow' periods.

c) Biocontrol of pests and diseases
Farmers may plant crops selectively bred to be resistant to particular diseases or encourage natural predators such as ladybirds to prey on crop pests like aphids. This approach relies much more on what the environment can provide naturally rather than chemical alternatives.

d) Weeding by hand

Hand weeding is more sustainable than using chemical insecticides as it only targets specific species of plant and does not damage the soil or lead on to bioaccumulation within food chains. It also provides work for local people and maintains a sustainable rural community.

e) Trickle drip irrigation and rainwater harvesting

Most water taken from freshwater sources every year is used in farming. Sustainable methods like trickle drip irrigation minimise waste and evapotranspiration losses, and rainwater harvesting uses 'grey' water for things like yard cleaning for which fresh water is not required.

7. Creating new land for both subsistence and commercial agriculture is the single most important cause of deforestation in the world. Define the following terms.

a) Deforestation

Deforestation is the clear cutting or permanent destruction of forests and woodlands. The United Nations estimates that 73 000 square kilometres of forest are destroyed each year. This is equivalent to an area the size of twenty soccer pitches a minute, or the size of the country of Panama a year.

b) Subsistence agriculture

This is self-sufficiency where farmers concentrate on growing or rearing enough food for themselves and their families with a little surplus generated occasionally. Such farms are found mostly in LEDCs and use practices such as 'slash and burn' and shifting cultivation.

c) Commercial agriculture

These farms comprise over 80% of the world's agricultural land. This is farming for a profit – growing crops or rearing animals to sell at market. Almost all commercial farms are in MEDCs and either arable (crop growing), pastoral (livestock) or mixed (both arable and livestock).

8. The central African country of Cameroon has a population of 20 million and is one of the poorest countries in the world. It is similar in area to Sweden and is ranked 147th out of 183 counties by the World Bank when measuring Gross Domestic Product at purchasing power parity per person. Life expectancy at birth is 55 years (South Korea: 81 years), infant mortality is 56 per 1000 live births (South Korea: 4 per 1000) and access to improved water supplies stands at 76 per cent (South Korea: 100 per cent). Just under half of the country is covered by tropical rain forest.

Fig. 3.11 Location of Cameroon.

Fig. 3.12 Cameroon.

In 2015, Cameroon produced 300 000 tonnes of the agro-industrial crop palm oil. By 2020, the government intends to increase production by 50 per cent to 450 000 tonnes. This expansion in palm oil production will almost certainly bring both benefits and negative impacts.

Consider some benefits that might arise under the following headings.

a) Employment and living standards

The new plantations will require large numbers of workers to manage the trees and collect and process the palm oil. Job opportunities and living standards will increase for local people as they are likely to have more expendable income to spend locally improving their quality of life.

b) Income to the government

The government will tax both the profits of the plantation companies and the earnings of the workers. This will mean that the government will have more money available to spend on improving living conditions for the people such as building and staffing schools and hospitals.

c) Development of new road and railway infrastructure

New plantations will need roads and railways to supply them with goods and services like food and power and also to export the palm oil to processing factories. These will also benefit local people allowing them to travel to new opportunities such as universities outside of the area.

Now consider some negative impacts under the following headings.

d) Deforestation and biodiversity

Every year tens of thousands of square kilometres of biodiversity-rich tropical rainforest are cleared and replaced with monoculture palm oil plantations consisting of just one species of tree. The resulting biodiversity loss is catastrophic particularly for top primates such as orang-utans in Borneo.

e) Impact on indigenous peoples

Tropical forests are the home of tribes such as the Penang in Borneo. As forests are felled they are pushed into ever smaller areas and their cultural traditions and subsistence lifestyles disappear. Sometimes they may be violently removed from homelands they seek to protect.

f) Greenhouse gas emissions

Forests are felled and burned to make way for the plantations. This releases huge quantities of greenhouse gases like carbon dioxide into the atmosphere. This adds to global warming and climate change such as the predicted 3 °C increase in atmospheric temperature by 2100.