

## Unit 9D Plants for food

### About the unit

In this unit pupils:

- learn about humans as part of a complex food web
- learn about factors affecting plant growth
- learn how management of food production has many implications for other animal and plant populations in the environment
- consider some of the issues involved in sustainable development of the countryside

In scientific enquiry pupils:

- present information in tables and graphs
- investigate the effects of fertiliser on plant growth
- survey weeds growing in a habitat, using an appropriate sampling technique

This unit is expected to take approximately 7.5 hours.

### Where the unit fits in

The unit builds on unit 8D 'Ecological relationships' and unit 9C 'Plants and photosynthesis'.

It relates to unit 9A 'Inheritance and selection', which considers genetic approaches to improving productivity on farms, and to unit 9G 'Environmental chemistry', in which the importance of air and water quality is considered.

This unit provides opportunities to revisit and revise topics met in other units in years 7 and 8. With some pupils, teachers may wish to consolidate the earlier work, to concentrate on some of the new topics, extending activities, and with others, to spend more time on revision of previous work.

There are opportunities for links with citizenship in the teaching of food production issues. This unit relates to unit 8E(i) 'Producing batches (food)' and unit 9A(i) 'Selecting materials (food)' in the design and technology scheme of work, and to unit 14 'Can the earth cope? Ecosystems, population and resources' in the geography scheme of work.

This unit provides the foundation for work in key stage 4 on the impact of humans on the environment, the management of food-production systems and the importance of sustainable development.

### Expectations

#### At the end of this unit

##### in terms of scientific enquiry

**most pupils will:** decide on an appropriate approach to investigating a question about the effects of fertiliser, identifying relevant variables and choosing an appropriate sample size; present results in tables and graphs which show features effectively; draw conclusions that are consistent with the evidence, identifying shortcomings, where appropriate, and relate them to scientific knowledge and understanding

**some pupils will not have made so much progress and will:** suggest how to control variables identified for them; present results in tables and graphs and point out patterns in these; draw conclusions, relating these to scientific knowledge and understanding, and suggest some improvements to their work

**some pupils will have progressed further and will:** consider critically tables of results and graphs and explain how additional data would enable them to have more confidence in their conclusions

##### in terms of life processes and living things

**most pupils will:** name the products of photosynthesis and some of the nutrients supplied by fertilisers; identify conditions in which crops will grow well; describe how the abundance and distribution of organisms may be affected by pesticides or weedkillers, relating this to knowledge of food webs; describe how other plants compete with food crops, and other animals compete with humans for the food crops, and that there are ways of achieving a balance between communities

**some pupils will not have made so much progress and will:** name the products of photosynthesis and some of the nutrients provided by fertilisers; identify factors which affect the growth of crops and identify some organisms which compete for resources where crops are grown

**some pupils will have progressed further and will:** relate crop production to pyramids of numbers and explain some ways of achieving a balance between the demands of different communities within an environment; explain how toxic materials can accumulate in a food chain

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## Prior learning

It is helpful if pupils:

- know about some of the life processes common to living things, *eg movement, growth, reproduction, nutrition*

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## Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:

- use fertilisers which may contain hazardous substances
- plan and carry out their own investigation
- carry out work outside the school

Many employers have specific guidance on fieldwork. Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations.

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## Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:

- words relating to managing plant production, *eg herbivore, pesticide, weedkillers, nutrient, fertiliser, toxin*
- words with similar but distinct meanings, *eg insecticide, pesticide, fungicide, herbicide*
- words with different meanings in scientific and everyday contexts, *eg competition, balance, compete, yield*
- words relating to scientific enquiry, *eg bias, reliable evidence*

Through the activities pupils could:

- recognise the standpoint of the author of a text and how it affects the meaning
- evaluate how effectively information is presented in whole texts, web pages, databases, etc

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## Resources

Resources include:

- secondary sources to explore food production, farming and pests, *eg CD-ROMs, photographs, video clips, gardening reference books and other literature such as information leaflets produced by environmental, farming and government organisations*
- samples of a wide range of crops or plants
- microscope slides showing starch grains in plants, *eg potato*
- food webs showing animals and plants associated with a crop, *eg cereals*
- duckweed and/or wheat for growing
- examples of packaging or advertisements for fertilisers, weedkillers, pesticides
- data about crop yields with, and in the absence of, weeds
- case studies about the use of pesticides, *eg effect on bird populations, effect on locusts, malarial areas*
- texts about use of pesticides and insecticides from different perspectives, *eg 'Silent Spring' by Rachel Carson*


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## Out-of-school learning

Pupils could:

- read about issues relating to plant breeding in newspapers and periodicals
- watch television programmes which deal with issues relating to intensive crop production
- visit a rural or city farm to gain first-hand experience of farm practice
- go fruit picking to gain first-hand experience of harvesting crops
- grow and harvest fruit and vegetables, *eg tomatoes, capsicums*, to gain practical experience of food production

### Where does our food come from?

<ul style="list-style-type: none"> <li>to use ideas about feeding relationships in a new context</li> <li>to combine ideas from different sources</li> </ul>	<ul style="list-style-type: none"> <li>Review pupils' knowledge and understanding of feeding relationships by asking them to draw food chains representing a typical meal that they may have eaten. Help them to combine their responses to show the wide variety of foods that humans eat, and the complexity of the human food web.</li> <li>Ask pupils questions about why plants can be food sources and the importance of the Sun as an energy source for food chains. Check pupils' understanding and relate their ideas to the food web produced.</li> </ul>	<ul style="list-style-type: none"> <li>construct a food web showing feeding relationships of humans</li> <li>explain the meaning of terms, <i>eg producer, consumer, energy source, herbivore</i>, in relation to food chains</li> </ul>	<ul style="list-style-type: none"> <li>This activity is designed to elicit pupils' knowledge of feeding relationships. Teachers will need to bear this in mind in later work.</li> <li>For this activity, teachers may need to provide information about the foods that different animals are fed on farms.</li> <li>There is an opportunity here to revise the concept of a balanced diet, covered in unit 8A 'Food and digestion', and to consider cultural issues relating to food and diet, and the various diets that are typical of different parts of the world.</li> </ul>
<ul style="list-style-type: none"> <li>that different parts of plants are food sources of different kinds</li> <li>that some parts of plants are starch stores</li> <li>about the products of photosynthesis</li> <li>how plants respire</li> </ul>	<ul style="list-style-type: none"> <li>Provide examples of food from plants, <i>eg carrot, pea, potato, wheat, maize, lettuce, apple, rice, mango, soya bean, grape, radish, coconut, onion</i>. Ask pupils for further examples and to identify which parts of a plant each represents. Explain that each of these foods contains materials produced by the parent plant. Ask them how plants produce this material, and why plants keep large stores of starch in certain parts (roots, stems, seeds), emphasising that it was not produced for humans or animals to eat. Remind pupils about plant respiration.</li> <li>Ask pupils to test the samples for the presence of starch, and invite them to suggest why some parts do not give positive results. Explain how the products of photosynthesis may be converted into other substances by the plant.</li> <li>Provide microscope slides showing starch grains inside cells, <i>eg of a potato</i>, and help pupils to interpret what they see.</li> </ul>	<ul style="list-style-type: none"> <li>identify which part of a plant is food for humans</li> <li>identify, from experimental results, starch stores in some plants</li> <li>name some materials produced as a result of photosynthesis</li> <li>describe how plants respire</li> <li>relate knowledge of the products of photosynthesis to ideas about plants as sources of food for humans and other animals</li> </ul>	<ul style="list-style-type: none"> <li>Fruits contain sugars and are for animals to eat as an aid to seed dispersal.</li> <li>There is an opportunity here to revise the process of photosynthesis, covered in unit 9C 'Plants and photosynthesis', and adaptations for seasonal change, covered in unit 7C 'Environment and feeding relationships'.</li> <li>Pupils will have tested for starch in unit 8A 'Food and digestion' and unit 9C 'Plants and photosynthesis'.</li> <li>Extension: pupils could be asked to find out about the reasons why humans do not eat some parts of plants, <i>eg rhubarb leaves</i>.</li> </ul> <p> <b>Safety</b> – pupils should not eat the foods. Avoid the use of peanuts if any pupils are allergic to them</p>


### Checking progress

<ul style="list-style-type: none"> <li>to relate together ideas about feeding relationships and photosynthesis</li> </ul>	<ul style="list-style-type: none"> <li>Ask pupils to make a concept map using appropriate terms, <i>eg producer, consumer, food web, photosynthesis, energy, Sun, glucose, starch, root, leaf, stem</i>. Ask pupils to exchange maps and to suggest additional connections, explaining these.</li> </ul>	<ul style="list-style-type: none"> <li>make and explain connections between the use of plants for food and photosynthesis and its products</li> </ul>
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Pupils should learn:

Pupils:

### How do fertilisers affect plant growth?

<ul style="list-style-type: none"> <li>to identify relevant information and summarise it in a table</li> <li>that plants require a range of minerals for healthy growth</li> <li>that fertilisers supply these minerals to crop plants</li> </ul>	<ul style="list-style-type: none"> <li>Ask pupils to use samples of fertiliser packs of different types and other sources to find out about nutrients, <i>eg the range of nutrients that plants need, what role these nutrients play in the life of the plant, which nutrients each fertiliser provides, how much a plant requires</i>, and to summarise the information in a table. Tell pupils the cost of a pack of fertiliser, and the recommended application rate, and ask them to calculate the cost per 100 square metres of crop.</li> <li>Show images, <i>eg video clips, photographs</i>, of large-scale fertiliser application to farmland. Ask pupils to consider the great costs involved, and any other implications of this practice.</li> </ul>	<ul style="list-style-type: none"> <li>find information about fertilisers and plant nutrients and summarise it in a table</li> <li>identify a range of minerals that plants need for healthy growth</li> <li>describe how fertilisers supply these minerals to crop plants</li> </ul>	<ul style="list-style-type: none"> <li>A gardening reference CD-ROM, information from fertiliser packs and leaflets from garden centres could be used to find out about the roles of different chemical compounds in fertilisers.</li> <li>Pupils are not expected to learn details of plants' mineral needs, but to develop an understanding of the range of minerals required, and that plants require only small amounts of these minerals.</li> <li>Environmental effects of fertilisers are discussed later.</li> </ul>
<ul style="list-style-type: none"> <li>to decide which factors are relevant to a question</li> <li>how to deal with factors that cannot be controlled</li> <li>to decide which measurements/ observations to make</li> <li>to draw conclusions from results and explain the significance of these</li> <li>to evaluate the method in terms of the data obtained</li> </ul>	<ul style="list-style-type: none"> <li>Extend this work by asking pupils to plan and carry out an investigation into the effects of fertiliser, <i>eg of nitrate fertiliser concentration on duckweed growth, providing information about culturing the plant and a maximum concentration; the effect of different fertilisers on wheat growth</i>. Ask pupils to produce a report of their investigation and to contribute conclusions to a class summary, indicating whether they think they should have confidence in what they found out.</li> </ul>	<ul style="list-style-type: none"> <li>identify relevant factors, <i>eg concentration of nitrate, mass of fertiliser</i></li> <li>choose an adequate sample size to deal with variation between individual plants</li> <li>choose an appropriate timescale for measurements</li> <li>identify differences in growth and relate these to variables, <i>eg composition, mass, of fertiliser used</i></li> <li>give reasons why they have or do not have confidence in their conclusions</li> </ul>	<ul style="list-style-type: none"> <li>This investigation will need to run over 2–3 weeks.</li> <li>Duckweed is an excellent organism for this investigation, providing good results in the space of 2–3 weeks. Growth is measured by counting the number of leaves in the culture. Samples can be obtained from local ponds.</li> </ul> <p> <b>Safety</b> – some fertilisers will be oxidising and others may be harmful on contact. Eye protection should be worn. Pupils' plans must be checked for health and safety before practical work begins</p>

### How does competition with other plants affect plant growth?

<ul style="list-style-type: none"> <li>that the organisms living in a habitat compete with each other for resources from the environment</li> <li>how treating fields with selective weedkillers affects food webs</li> </ul>	<ul style="list-style-type: none"> <li>Ask pupils to suggest what the term 'weed' means, why weeds might affect yields from food crops, and ways in which weeds compete with crop plants for resources. If possible, provide pupils with data about the yields of crops with, and in the absence of, weeds, and ask them to explain whether the data supports their ideas. Ask pupils to suggest what the effects of killing the weeds might be on other living things on the farm.</li> <li>Provide pupils with examples, <i>eg specimens, photographs</i>, of weeds that often grow alongside food crops and show photographs or video clips of workers in protective gear spraying food crops with weedkiller. Ask pupils to find out about the chemicals used and their effects, <i>eg using information from packaging</i>, and to present this information as a table.</li> </ul>	<ul style="list-style-type: none"> <li>describe ways in which weeds compete with crop plants for resources from the environment</li> <li>describe how treating fields with selective weedkillers affects specific food webs</li> <li>explain how animals are affected by the removal of a particular food plant</li> <li>suggest how a high crop yield might be attained alongside preservation of animals' food supply</li> </ul>	<ul style="list-style-type: none"> <li>The information from packs of weedkiller could be photocopied for individuals or groups to use. This could be supplemented by further reference literature, such as leaflets and gardening books.</li> <li>Extension: pupils could read about the possible effects of weedkillers on an ecosystem and find out about specific examples and possible solutions, <i>eg through the internet</i>.</li> <li>Extension: pupils could be provided with a detailed food web found in the countryside, including many wild plants and a few crop plants. Ask them to erase some of the wild plants to show the effect of weedkiller, and to note how many animals have a reduced food supply because of this. Ask pupils to relate this to the work on yields from crops, and to suggest approaches that might combine efficient crop production with preservation of animals' food supply.</li> </ul>
<ul style="list-style-type: none"> <li>to plan and carry out an investigation involving sampling</li> <li>to present a report of their findings using tables and graphs</li> <li>to recognise and use scientific terminology effectively and accurately</li> </ul>	<ul style="list-style-type: none"> <li>Extend this work by asking pupils to carry out a survey of weeds growing, <i>eg in a lawn, allotment or crop field</i>. Provide a key for identifying weed plants and remind them how to use quadrats to sample a population.</li> <li>This could be set in the context of having to produce a report for the landowner about the types and numbers of weeds on the land. In the report, pupils could be asked to explain the problems that weeds present and to make suggestions about how to treat the land to remove them, and to identify possible consequences of the treatment.</li> </ul>	<ul style="list-style-type: none"> <li>follow their plan to collect data about the population and distribution of weeds</li> <li>produce appropriate tables and graphs to present data</li> <li>write a report for a third party in a suitable format, using scientific terminology effectively and accurately</li> </ul>	<ul style="list-style-type: none"> <li>Extension: pupils could compare the numbers of weed plants on a lawn with a similar area of wasteland or recently dug-over ground, simulating the invasion of weeds into arable land after ploughing.</li> </ul> <p> <b>Safety</b> – all off-site visits should be carried out in accordance with LEA/ school guidelines. Pupils' plans must be checked for health and safety before practical work begins</p>

Pupils should learn:

Pupils:

### How do pests affect plant growth?

<ul style="list-style-type: none"> <li>that the organisms living in a habitat compete with each other, <i>eg for food resources from the environment</i></li> <li>to represent feeding relationships using pyramids of numbers</li> <li>that the numbers of a population of predators influence the numbers of prey organisms</li> </ul>	<ul style="list-style-type: none"> <li>Ask pupils about the types of animals that might feed on the crops grown and establish that these are competing with humans for the crops. Ask pupils to find out what these animals, <i>eg fieldmouse, cabbage white butterfly, aphid, snail, slug</i>, feed on, and emphasise that, for these animals, the food crops are part of the food web. Help pupils construct pyramids of numbers for some of the feeding relationships identified.</li> <li>Ask pupils how farmers respond to pests, and consider methods of management, including the use of pesticides. Show packaging or advertisements, <i>eg for insecticides, snail and slug treatment</i>, and ask pupils to find out about what chemicals are used, how dangerous they are, and whether they are specific to one type of animal.</li> <li>Show a food web and identify a pest species that could be eliminated by a pesticide. Ask pupils to predict some effects of this on the pest species and on other populations, <i>eg fewer insect pests leads to a decrease in the bird population</i>, and to relate this to pyramids of numbers.</li> </ul>	<ul style="list-style-type: none"> <li>identify some common animals, including pests, which feed on crops and explain that they compete with humans for these resources</li> <li>explain how the elimination of pests will affect the populations of predator animals such as birds, relating explanations to pyramids of numbers</li> </ul>	<ul style="list-style-type: none"> <li>There is an opportunity here to revise animal classification, covered in unit 7C 'Environment and feeding relationships' and unit 8D 'Ecological relationships'. Pyramids of numbers are introduced in unit 8D 'Ecological relationships'.</li> <li>As an alternative, pupils could look for animals feeding on plants in the locality of the school or their home.</li> <li>Gardening reference books and CD-ROMs provide information on pests.</li> </ul>
<ul style="list-style-type: none"> <li>that toxins enter a food chain when plants take them in or are in contact with them</li> <li>that as animals feed on plants they may accumulate toxins taken in by the plant</li> <li>that at each step of the food chain persistent toxins are accumulated in the carnivores and that this process is bio-accumulation</li> <li>about advantages and disadvantages of using pesticides</li> </ul>	<ul style="list-style-type: none"> <li>Remind pupils how to select information from a text and ask them to suggest ways in which information about toxins in food chains might depend on the author of the text. Provide pupils with secondary sources of information, <i>eg textbooks, videos, environmental leaflets</i>, about the effects on the wild bird population of bio-accumulation of toxins in the food chain, <i>eg the effect of DDT used as a pesticide on the heron population, the osprey and other birds of prey such as sparrowhawks, and the decline in populations of some UK native birds as a result of pesticide use on farms</i>.</li> <li>Ask pupils to consider and evaluate the information provided, and to extract from it the key points to explain why the bird populations have declined.</li> <li>Provide pupils with secondary sources of information about the use of pesticides, <i>eg in controlling populations of locusts, malarial mosquitoes</i>. Ask pupils to consider and evaluate the information provided and to extract from it the key points about which pesticides were used and why they were used.</li> </ul>	<ul style="list-style-type: none"> <li>describe how a persistent toxic material passes up a food chain</li> <li>explain why pesticides and weedkillers are used, identifying the dangers</li> <li>evaluate the information provided, relating it to the standpoint of the author of the text</li> </ul>	<ul style="list-style-type: none"> <li>Not all toxins used as herbicides or pesticides will be passed on to animals that feed on them. Many biodegrade over very short periods; it is only those containing persistent substances that bio-accumulate.</li> <li>As an alternative, pupils working in groups could be given information, presented as single sentences on cards, about the effect of pesticides on the wild bird population. Ask pupils to put together the evidence to describe and explain what happened to the birds. A similar set of cards could be produced about the effect of a plague of locusts.</li> </ul>
<ul style="list-style-type: none"> <li>to recognise the standpoint of the author of a text</li> <li>to evaluate how effectively information is presented in whole texts</li> <li>to evaluate conflicting evidence to arrive at a considered viewpoint</li> </ul>	<ul style="list-style-type: none"> <li>Use the examples above to draw out issues and ask pupils to reflect on questions, <i>eg</i> <ul style="list-style-type: none"> <li><i>Why are pesticides used?</i></li> <li><i>Are there alternatives?</i></li> <li><i>Who develops alternative, less harmful pesticides?</i></li> <li><i>What could be done to protect vulnerable populations such as birds?</i></li> <li><i>Should pesticides be used to produce more food for humans at the expense of other animals?</i></li> <li><i>How are pests managed on organic farms?</i></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>describe the views of different people who write about pesticides</li> <li>identify advantages and disadvantages of pesticides, and people to whom each will be important</li> </ul>	<ul style="list-style-type: none"> <li>Teachers may wish to develop their own secondary sources or case studies based on local or current events.</li> <li>Development of pesticides links with making new materials in unit 9H 'Using chemistry'.</li> </ul>

Pupils should learn:

Pupils:

### What is the perfect environment for growing plants?

<ul style="list-style-type: none"> <li>about environmental factors that influence plant growth</li> <li>to consider the advantages and disadvantages of a controlled environment for growing crops</li> </ul>	<ul style="list-style-type: none"> <li>Ask pupils about the conditions that plants need for healthy growth, <i>eg light, water, minerals, warmth, carbon dioxide</i>. Reinforce by showing examples of plants that have been deprived of one of these, <i>eg grass seedlings grown in the dark, in the cold, in dry conditions, or with a mineral deficiency</i>, and ask pupils to suggest reasons for the plants' conditions.</li> <li>Show images of commercial greenhouses in operation. Supplement with information about smaller-scale greenhouses, <i>eg from a catalogue</i>. Discuss the advantages of growing crops this way, <i>eg control of climate, longer growing season, no weeds</i>, and consider and evaluate any problems associated with this type of production, <i>eg appearance in the environment, possible variation in taste</i>.</li> </ul>	<ul style="list-style-type: none"> <li>identify environmental factors which have influenced the growth of plants</li> <li>suggest some advantages and disadvantages of growing crops in a greenhouse</li> </ul>	<ul style="list-style-type: none"> <li>This activity could be enhanced by a visit to a commercial greenhouse. Alternatively, someone working in commercial food production could be invited to talk about what they do and help evaluate the pupils' designs in the next activity.</li> <li>Extension: pupils could be asked to find out about the seasonal nature of fruit crops and how some crops are now available most of the year.</li> </ul>
<ul style="list-style-type: none"> <li>to apply knowledge and understanding about plant growth to solve a problem</li> <li>that different approaches to crop production contribute to sustainable development</li> <li>to present ideas as drawings and diagrams</li> </ul>	<ul style="list-style-type: none"> <li>Ask pupils to use their knowledge of the needs of plants and of growers to design an ideal greenhouse environment for crop production on farms. They may include control-technology devices to monitor and control the internal environment. Their plans should be presented as annotated drawings that include the reasons for each design feature.</li> <li>Ask pupils why most food crops are not grown under protective cover.</li> </ul>	<ul style="list-style-type: none"> <li>present an annotated drawing of a design for a commercial greenhouse, relating this to knowledge and understanding of plant growth</li> <li>describe the benefits and drawbacks of greenhouse crop development</li> </ul>	<ul style="list-style-type: none"> <li>Genetically modified plants are considered briefly in unit 9A 'Inheritance and selection'.</li> </ul>

### Reviewing work

<ul style="list-style-type: none"> <li>to identify key points about a scientific issue</li> <li>that there is often a balance of advantage and disadvantage in development</li> </ul>	<ul style="list-style-type: none"> <li>Draw together the concepts and issues from the previous activities, <i>eg</i> <ul style="list-style-type: none"> <li><i>the need to provide food for humans and domestic animals</i></li> <li><i>the reasons for, and effect of, the removal of hedges and woodland</i></li> <li><i>why pesticides and weedkillers are used</i></li> </ul> and provide comparative information about alternatives, <i>eg organic farming</i>. </li> <li>Ask pupils to produce a piece of work that summarises the issues of plant production for food, based on their scientific knowledge of the problems, <i>eg</i> <ul style="list-style-type: none"> <li><i>a magazine article highlighting the main issues for the general public</i></li> <li><i>a script for a radio or TV documentary</i></li> <li><i>a classroom debate in which individuals or groups argue the case for and against intensive agriculture</i></li> <li><i>a carefully scripted role play where individuals act the parts of participants in a meeting to discuss the issues</i></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>summarise understanding of an issue, incorporating appropriate scientific knowledge and understanding, and explain with examples, <i>eg</i> <ul style="list-style-type: none"> <li><i>how a stable ecosystem is one in which there is a balance of organisms</i></li> <li><i>how human development can have a harmful effect on the living things in an area</i></li> <li><i>how sustainable development involves an approach which aims to have minimal impact on the environment and living things</i></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Further information on these issues can be obtained from environmental groups and agencies, farming and government organisations, large-scale food producers and the media.</li> </ul>
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