14-16

# SATIS 12

## Science & Technology in Society

SATIS

## About SATIS

Science and Technology in Society (SATIS) is a project of the Association for Science Education, funded by charity and by industry.

This new publication forms part of the revision and extension of the SATIS project for students in the 14 to 16 age range. It is a set of ten resource units linking major science topics to important social and technological applications and issues. Each unit usually takes one to two hours to complete.

SATIS units are intended to support science courses. Many have found wider application within the school curriculum.

There are now twelve books of ten units. Each unit is numbered in a system giving the number of the book followed by the number of the unit within it. Thus the first unit in the first SATIS book is numbered 101 and the last in the twelfth book is 1210.

The revision and extension of the original SATIS Project has been made possible by a generous grant from the Gatsby Charitable Foundation and by the people from schools, universities, industry and the professions who volunteered to write, develop and trial it.

## SATIS 12

*List of activities in this book*






First Published 1991 by the Association for Science Education.





The Association for Science Education
College Lane, Hatfield, Herts AL10 9AA

ISBN 0 86357 141 7

Produced by Communications Management International

## *Material for students aged 14 to 16 (or 17)*

### SATIS units

*Copyright-waived material for photocopying*

| | |
|---|---|
| SATIS 1 to 7 | (published 1986) |
| SATIS 8 to 10 | (published 1988) |
| SATIS 11 and 12 | (published 1991) |
| General Guide for Teachers | (published 1986) |

### SATIS Audiovisual

Tape-slide programmes

1 *Acid from the air* – a programme about acid rain
2 *More wheat for better bread* – a programme about the impact of science and technology on agriculture
3 *More and more people* – a programme about human population growth
4 *Dams, people and the environment* – a programme about the environmental effects of dams
5 *Radiation around us* – a programme about low-level radiation
6 *Bridges* – a programme about the design and construction of bridges

### SATIS topics 14–16

Audio tapes

A series of 24 topics, each lasting 7 minutes or so, which were originally broadcast by BBC Schools Radio in 1989–90. They were devised to support and enhance SATIS printed material. These programmes are now available on C-60 audio cassettes from the ASE.

| | |
|---|---|
| 109 | Nuclear Power |
| 206 | Test-tube Babies |
| 207 | The Story of Fritz Haber |
| 302 | Living with Kidney Failure |
| 304 | A Medicine to Control Bilharzia |
| 307 | Chemicals from Salt |
| 309 | Microbes make Human Insulin |
| 402 | DDT and Malaria |
| 406 | Blindness |
| 407 | Noise |
| 409 | Dam Problems |
| 502 | The Coal Mine Project |
| 504 | How Safe is Your Car? |
| 601 | Electricity on Demand |
| 602 | The Limestone Inquiry |
| 603 | The Heart Pacemaker |
| 607 | Scale and Scum |
| 801 | The Water Pollution Mystery |
| 802 | Hypothermia |
| 806 | Stress |
| 807 | Radiation – how much do you get? |
| 903 | What are the Sounds of Music? |
| 907 | Your Stars – revelation or reassurance? |
| 1010 | Can it be done? Should it be done? |

Teachers' programme

### The SATIS Atlas *(publication 1992)*

The SATIS Atlas comprises a set of copyright-waived maps giving information and data linked to the science curriculum with associated questions for students to answer.

SATIS materials are available from

ASE Booksales,
The Association for Science Education,
College Lane, Hatfield, Herts AL10 9AA
Tel. 0707 267411 Fax 0707 266532

# List of units in the SATIS 14–16 series

**SATIS 1**

101 Sulphurcrete
102 Food from Fungus
103 Controlling Rust
104 What's in our Food? – a look at food labels
105 The Bigger the Better?
106 The Design Game
107 Ashton Island – a problem in renewable energy
108 Fibre in your Diet
109 Nuclear Power
110 Hilltop – an agricultural problem

**SATIS 2**

201 Energy from Biomass
202 Electric Vehicles
203 Drinking Alcohol
204 Using Radioactivity
205 Looking at Motor Oil
206 Test-tube Babies
207 The Story of Fritz Haber
208 The Price of Food
209 Spectacles and Contact Lenses
210 The Pesticide Problem

**SATIS 3**

301 Air Pollution – where does it come from?
302 Living with Kidney Failure
303 Physics and Cooking
304 A Medicine to Control Bilharzia – Part 1
305 A Medicine to Control Bilharzia – Part 2
306 Fibre Optics and Telecommunications
307 Chemicals from Salt
308 The Second Law of – What?
309 Microbes make Human Insulin
310 Recycling Aluminium

**SATIS 4**

401 Fluoridation of Water Supplies
402 DDT and Malaria
403 Britain's Energy Sources
404 How would you Survive? – an exercise in simple technology
405 The Label at the Back – a look at clothing fibres
406 Blindness
407 Noise
408 Industrial Gases
409 Dam Problems
410 Glass

**SATIS 5**

501 Bridges
502 The Coal Mine Project
503 Paying for National Health
504 How Safe is Your Car?
505 Making Fertilizers
506 Materials for Life
507 Computers and Jobs
508 Risks
509 Homoeopathy – an alternative kind of medicine
510 Perkin's Mauve

**SATIS 6**

601 Electricity on Demand
602 The Limestone Inquiry
603 The Heart Pacemaker
604 Metals as Resources
605 The Great Chunnel Debate
606 The Tristan da Cunha Dental Surveys
607 Scale and Scum
608 Should we Build a Fallout Shelter?
609 Hitting the Target – with monoclonal antibodies
610 Robots at Work

**SATIS 7**

701 Electricity in your Home
702 The Gas Supply Problem
703 Vegetarianism
704 Electric Lights
705 Physics in Playgrounds
706 Dry Cells
707 Artificial Limbs
708 Appropriate Pumps
709 Which Anti-acid?
710 What is Biotechnology?

**SATIS 8**

801 The Water Pollution Mystery
802 Hypothermia
803 The Technology of Toilets
804 Electrostatic Problems
805 The Search for the Magic Bullet
806 Stress
807 Radiation – how much do you get?
808 Nuclear Fusion
809 Ball Games
810 High Pressure Chemistry

**SATIS 9**

901 The Chinese Cancer Detectives
902 Acid Rain
903 What are the Sounds of Music?
904 Which Bleach?
905 The Impact of IT
906 IT in Greenhouses
907 Your Stars: Revelation or Reassurance?
908 Why not Combined Heat and Power?
909 AIDS
910 Disposable Nappies

**SATIS 10**

1001 Chocolate Chip Mining
1002 Quintonal: an industrial hazard
1003 A Big Bang
1004 Lavender
1005 Mental Illness
1006 As Safe As Houses
1007 240 Volts Can Kill
1008 Why 240 Volts?
1009 Trees as Structures
1010 Can it be done? Should it be done?
Index to SATIS 1 to 10

**SATIS 11**

1101 Breast or Bottle?
1102 A Special Type of Hearing Aid
1103 Save the Salmon!
1104 Materials to Repair Teeth
1105 Radon in Homes; Radon – an Investigation
1106 Tin Cans
1107 The Eruption of Mount St Helens
1108 Telephones
1109 Electricity Supply and Demand
1110 Project Management

**SATIS 12**

1201 Agrochemicals and the Environment
1202 Mapping the Human Genome
1203 Prospecting by Chemistry
1204 From Babylon to Biotechnology
1205 Earthquakes
1206 The Greenhouse Effect
1207 Radio Telescopes
1208 Are there Fairies at the Bottom of the Garden?
1209 Are you made of Stardust?
1210 Bottled Water

## Science National Curriculum attainment targets

The following list suggests how SATIS units may be linked with the attainment targets of the Science National Curriculum. Many units link with several attainment targets. The brackets indicate links with only a minor part of that unit.

| | | |
|---|---|---|
| *AT 1* | *Exploration of science* | 110 201 205 208 209 210 405 505 509 606 706 709 801 807 809 904 907 910 1001 1004 1007 1008 1009 1101 1103 1104 1105ab 1106 1110 1201 1203 1205 1208 |
| *AT 2* | *The variety of life* | 102 201 (208) 210 304 402 404 505 (703) 906 1004 1009 1201 |
| *AT 3* | *Processes of life* | 102 104 108 110 (201) 203 206 208 302 (304) 309 401 402 503 506 508 509 603 606 (608) (609) 703 707 802 (803) 805 806 901 909 1002 (1005) 1101 1204 1210 |
| *AT 4* | *Genetics and evolution* | 309 807 901 (1004) (1103) 1202 1204 |
| *AT 5* | *Human influences on the Earth* | 301 304 308 310 401 402 404 409 410 502 602 605 (607) 708 801 803 902 1001 1103 1106 1201 1203 1210 |
| *AT 6* | *Types and uses of materials* | 101 (405) 408 410 506 604 (910) 1104 1106 |
| *AT 7* | *Making new materials* | 102 103 105 207 (305) 307 310 405 502 505 510 604 (607) 709 810 (904) 1001 1003 1004 1103 1106 1204 |
| *AT 8* | *Explaining how materials behave* | (109) 204 205 (305) 608 807 808 (1004) 1105ab |
| *AT 9* | *Earth and atmosphere* | (602) 1107 1205 1206 |
| *AT 10* | *Forces* | 501 504 705 (708) 809 (1006) (1009) |
| *AT 11* | *Electricity and magnetism* | 701 704 804 908 1007 1008 (1101) 1108 1109 1208 |
| *AT 12* | *IT and microelectronics* | 306 507 (603) 610 905 906 (1101) 1102 1108 1109 1208 |
| *AT 13* | *Energy* | 106 107 109 201 202 303 308 403 409 502 504 508 702 704 705 (706) 802 807 808 809 908 (1006) (1101) 1109 |
| *AT 14* | *Sound and music* | 407 705 903 1102 |
| *AT 15* | *Using light and electromagnetic radiation* | 209 303 306 406 (704) 1207 |
| *AT 16* | *The Earth in space* | 1209 |
| *AT 17* | *The nature of science* | 207 305 (306) 309 509 510 609 805 (810) (901) 907 1108 1202 1204 1208 |

## Subject areas

The following are units with strong links to specific subject areas.

| | |
|---|---|
| *Biology* | 102 104 108 110 201 203 204 206 208 209 210 301 302 304 305 308 309 401 402 404 406 407 409 503 506 508 509 606 609 703 707 801 802 803 805 806 901 902 906 909 1002 1004 1005 1006 1009 1010 1101 1102 1103 1104 1105a 1201 1202 1204 |
| *Chemistry* | 101 103 105 110 203 204 205 207 210 301 305 307 308 310 401 402 404 405 408 410 502 505 506 510 602 604 607 702 706 709 801 810 902 904 910 1001 1002 1003 1004 1010 1103 1104 1106 1203 1204 1210 |
| *Physics* | 106 107 109 202 204 205 209 303 306 308 403 404 407 501 504 507 508 601 603 608 610 701 702 704 705 706 708 802 803 804 807 808 809 903 905 907 908 1006 1007 1008 1009 1010 1101 1102 1105ab 1106 1108 1109 1207 1208 1209 |
| *Geography* | 106 107 109 110 208 301 304 403 404 409 502 505 602 604 605 708 901 902 1001 1105a 1107 1109 1203 1205 1206 |
| *Sixth-form General Studies* | 102 104 105 106 107 108 109 110 203 204 206 207 208 301 302 308 309 404 405 407 409 502 503 507 508 509 605 607 608 610 703 802 803 806 807 808 901 902 905 906 907 908 909 910 1002 1003 1005 1010 1101 1105a 1109 1110 1202 |
| *Technology* | 102 103 104 106 107 108 201 202 205 208 303 305 306 308 404 405 407 410 501 503 506 507 603 605 610 707 708 802 803 905 906 1006 1010 1101 1103 1106 1110 |

## Cross-curricular themes

Many SATIS units include cross-curricular themes. This list is for general guidance only and was compiled before National Curriculum Council publications were available.

| | |
|---|---|
| *Health Education* | 102 104 108 203 204 206 208 209 302 304 305 309 401 402 404 406 407 503 506 508 509 603 606 608 609 703 707 708 709 802 803 805 806 807 901 904 909 910 1002 1005 1007 1010 1002 1005 1007 1010 1101 1102 1104 1105a 1202 1210 |
| *Environment* | 101 107 108 201 202 210 301 307 308 402 404 407 409 410 502 505 508 602 605 703 801 803 902 1001 1010 1103 1106 1201 1203 1205 1206 |
| *Careers* | 507 610 905 |
| *Citizenship* | 104 109 203 206 207 302 406 407 409 502 503 504 507 508 602 605 607 608 705 807 905 1002 1003 1005 1106 |
| *Economic and Industrial Understanding (listed as 'Economic Awareness' in the text)* | 102 103 105 106 202 208 210 302 307 310 403 408 503 604 605 610 701 703 704 709 904 905 908 1001 1004 1010 1001 1004 1010 1103 1106 1201 1204 1210 |

# AGROCHEMICALS and the ENVIRONMENT

**Science content**
**Agriculture, fertiliser, fungicide, organic farming.**

**Science curriculum links**
AT 1 Exploration of science
AT 2 The variety of life

**Syllabus links**
- GCSE Science, Biology

**Cross-curricular themes**
- Environment
- Economic Awareness

**Lesson time**
**1–2 hours**
(homework possible)

**Links with other SATIS materials**
110 Hilltop
210 The Pesticide Problem
505 Making Fertilizers
703 Vegetarianism

**SATIS Audiovisual**
More Wheat for Better Bread

**NERIS**
Search on
AGRICULTURAL CHEMICALS and AGRICULTURE
Or on
FERTILISERS and AGRICULTURE


## SUMMARY

A look at the economic and environmental implications of the use of fertilisers and fungicide for growing wheat and the possibilities of organic farming.


## STUDENT ACTIVITIES

- ☐ Information and questions about the benefits and problems caused by the use of nitrogen fertiliser and fungicide.
- ☐ Translation of data into graphical form: fertiliser application and yield.
- ☐ Data handling: profit and yield.
- ☐ Questions for small group discussion: organic farming.

## AIMS

- ☐ To link with work on environmental issues concerning agriculture
- ☐ To introduce students to the economics of intensive farming and to the balance of profit against environmental considerations

## USING AND ADAPTING THE UNIT

- ☐ Worksheets are provided for Q4, Q7 and Q8 (graphs 1 and 2 and table 3).
- ☐ Weaker students may need support with part B. The figures to complete table 3 may be given to students who find the mathematics a stumbling block.
- ☐ Parts A and B are suitable for independent work or for homework.
- ☐ Students could be asked to calculate the figures in tables 2 and 3 with a spreadsheet.
- ☐ For part C, groups of students could be asked to tackle different questions, reporting their answers to the class.
- ☐ Designing an advertisement (optional) may be a group or individual activity.

Author **Rachel Young**

First published 1991

## Teaching notes

The unit provides a range of activities from which teachers can select those most appropriate to their students. If all parts (A, B and C) are used, they should be done in sequence.

The SATIS Audiovisual (a tape-slide presentation), *More Wheat for Better Bread*, deals with intensive farming technology – plant breeding, fertilisers, pesticides, herbicides, fungicides, growth regulators and agricultural machinery. The sound commentary contains a great deal of information. Teachers may prefer to select slides from the pack and use the commentary script themselves, unless they have particularly able students. Alternatively, each group of students may be given a few slides and a copy of the printed commentary and asked to give their version of the commentary as the slides are shown.

## Discussion questions

1 Suggestions may include the ideas that organic crops are somehow better for your health, do not contain toxic residues of fungicides and insecticides, that organic farming practices help to conserve the environment, or ideas based on a romantic perception of the countryside.

2 Answer about £140 per tonne. (You might accept lower profits for environmental benefits.)

This figure assumes that the farmer would want the same profit margin as he gets for inorganic wheat (using agrochemicals), that is, **£194 per hectare**. (Graph 2 shows this is the maximum profit margin, obtained at a fertiliser rate of 200 kg / ha.)

The yield without fungicide and fertiliser is 4.6 tonnes per hectare. He spends nothing on agrochemicals, but his standing costs remain at £465 per hectare.

Substituting into the formula

£194 = ([4.6 tonne / ha] × price) – (£0 + £465)

Price = (£194 + £465) / 4.6 tonne

= £143 / tonne.

3 As a source of organic nitrogen the farmer could use farmyard manure, compost, sewage sludge, etc.

The problems with organic nitrogen sources include: transportation, higher cost, variable composition, storage and disease.

4 Fertilisers and agrochemicals linger in the soil. At present there is no legal definition of 'organically grown food', but food grown two years after the last application of agrochemicals is a definition that many accept. The United Kingdom Register of Organic Food Standards (UKROFS) defines a national set of organic standards, a code of production practice and a symbol.

Farmers tend to convert their farms a field at a time, continuing to sell inorganically grown crops from the rest of the farm.

5 There would need to be considerable improvement in organic farming yields to produce enough food at a reasonable price. Perhaps advances in organic farming may come through the genetic engineering of disease-resistant strains of wheat which need less fertiliser.

**Acknowledgements**

Dr Nigel Paul of the University of Lancaster assisted the author with the preparation of this unit.

C. E. Flint, Director of the Association for Agriculture, read and commented on the draft of this unit.

Figure 1 is reproduced by permission of Martin Dohrn, Science Photo Library.

## Answers to the questions

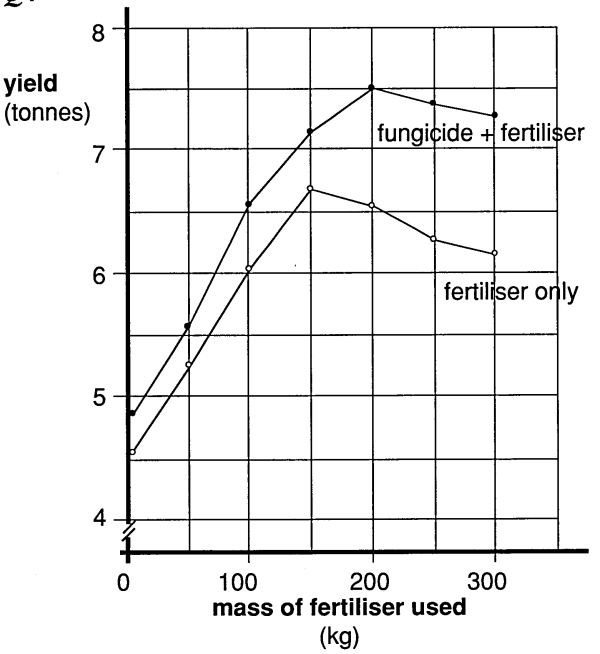
***Q1*** *Today's high yields are due to improved varieties of wheat which have the genetic potential to produce a high yield when combined with the use of agrochemicals and fertilisers.*

***Q2*** *Fertiliser promotes plant growth. Closer contact between plants facilitates the spread of disease.*

***Q3*** *(a) Nitrates can pollute ground water, rivers and streams.*

*(b) Fungicides can be toxic to wildlife and may have harmful effects on humans.*

***Q4***




*All figures given are per hectare. Teachers may prefer their students to draw smooth curves.*

*(a) 4.6 tonnes / hectare.*

*(b) The effect of disease can be measured from the difference between the two graph lines (assuming fungicides kill all disease).*

*(c) The mass of fertiliser needed to give the highest yield (i) is 150 up to 170kg / ha (ii) with fungicide is about 200 kg / ha.*

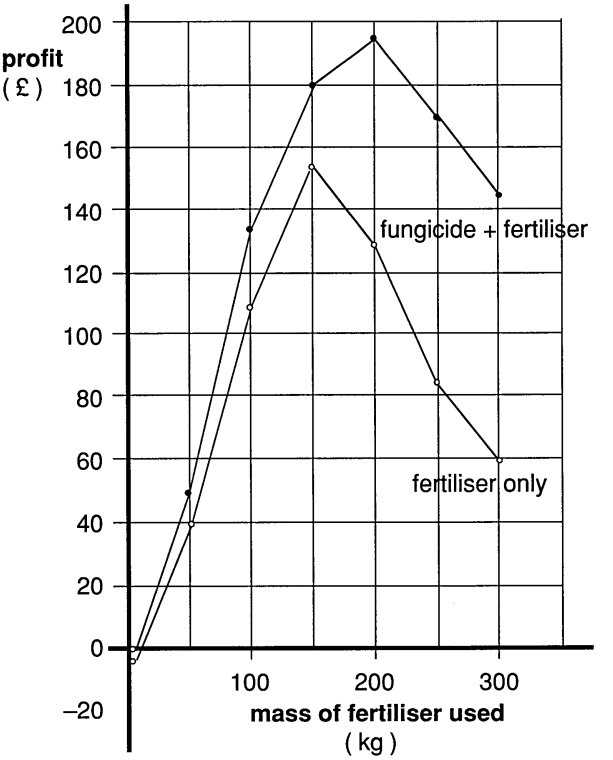
*(d) (i) (7.5 – 4.6) kg / ha = 2.9 kg / ha*

*(ii) (2.9/4.6 × 100)% = 63 %*

***Q5*** *A loss of £5 per hectare.*

***Q6*** *£59*

***Q7*** *About 150 kg / ha.*




*All figures given are per hectare.*

***Q8*** *Column 2 Total cost of applying fertiliser per hectare (at 30 p / kg and £6 / ha to apply) and fungicide (£25 / ha) is £25, £46, £61, £76, £91, £106, £121.*

*Column 4 The total costs are 490, 511, 526, 541, 556, 571, 586.*

*Column 6 The value of the wheat (income) in £ is 490, 560, 660, 720, 750, 740, 730.*

*Column 7 The farmer's profit per hectare when using both fertiliser and fungicide together is £0, £49, £134, £179, £194, £169, £144.*

*(a) Fertiliser with fungicide is more profitable.*

*(b) 170 kg/ha.*

***Q9*** *In a low disease year, the farmer would not have any fungicide costs. The lower graph line would move towards the upper graph line and give a similar profit margin to high disease years when fungicide is used. The farmer could avoid spraying with fungicide until a high disease year was predicted, but he is taking a risk.*

# AGROCHEMICALS and the ENVIRONMENT

## Part A – More and more wheat

Wheat harvests only dreamed of 25 years ago are now a regular event. New varieties of crops give high yields, especially when grown with the use of **fertilisers** and **agrochemicals**. Such farming is called **intensive farming.**

Farmers use fertilisers and agrochemicals like fungicides to improve the quality and quantity of their crops. But these chemicals have disadvantages – they are expensive to apply and can escape into the environment.

In this unit you will look at the effect of nitrogen fertiliser and fungicide on the yield of wheat and consider a few of the difficult decisions that farmers face.

*Figure 1 Modern arable farming produces high yields of wheat*

Image removed

**Part A** Information, questions and graphical work about agrochemicals.

**Part B** Data handling and graphical work about the economics of intensive farming.

**Part C** Discussion questions on organic farming. Designing an advertisement for an organic loaf.

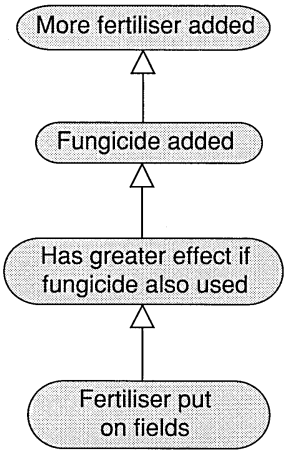



*Figure 2 High yields depend on the use of both nitrogen fertiliser and fungicide*

### Fertiliser and fungicide – the advantages

Plants need nitrogen to grow. Applying nitrogen fertiliser to a crop like wheat makes it grow more. The closer together plants grow, the greater is the contact between them. If disease is present, it is able to spread more quickly. In fact diseases may spread so much that yields of crops go down.

Fungicide kills the fungi that damage crops. Fungal diseases of cereal crops, such as yellow rust and powdery mildew, increase greatly when farmers apply nitrogen fertiliser. To protect their crops, farmers spray with fungicide and usually apply extra nitrogen fertiliser as well.

## Fertilisers and fungicides – the disadvantages

Both fertiliser and fungicide affect the environment. Ploughing the ground allows nitrates from nitrogen fertilisers and manure to drain away (leach) into the soil, polluting ground water, rivers and streams. In areas of intensive crop farming, water taken up for human use may have dangerously high levels of nitrates.

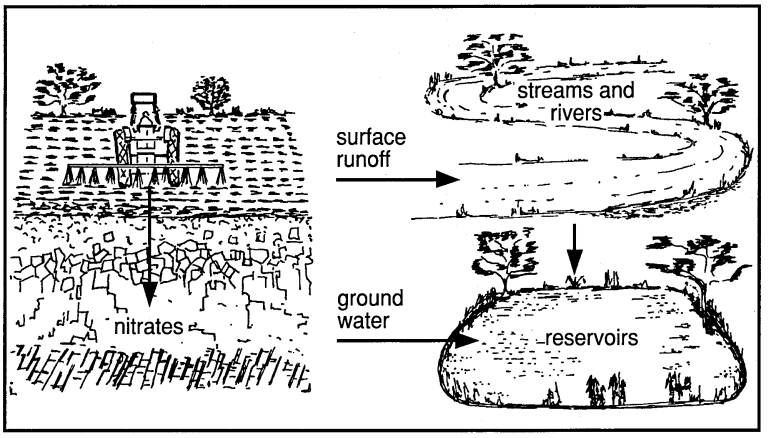



*Figure 3 How nitrates from fertilisers can enter the water supply*

***Q1*** *Why have yields of wheat increased in recent years?*

***Q2*** *Explain why fungal diseases in crops may increase when the farmer applies fertiliser.*

***Q3*** *What are the undesirable effects of using too much*
*(a) nitrogen fertiliser,*
*(b) fungicide?*

Agrochemicals, which include fungicides, insecticides, weed-killers and growth regulators, can be toxic to wildlife and pass into the food chain. There may be dangerous side-effects for humans as well.

Fertilisers and agrochemicals need to be applied correctly. There is concern that their over-use can change the structure of the soil and reduce its fertility.

## Making a living off the land

The yields of wheat the farmer can expect from applying fertiliser or both fertiliser and fungicide are shown in table 1.

*Table 1 How the yield of wheat per hectare varies with the use of fertiliser or fertiliser and fungicide. (These figures are for a year with high levels of fungal disease.)*

| **Mass of fertiliser used** ( kg ) | **Yield** ( tonnes ) | |
|---|---|---|
| | fertiliser only | fungicide + fertiliser |
| 0 | 4.6 | 4.9 |
| 50 | 5.25 | 5.6 |
| 100 | 6.1 | 6.6 |
| 150 | 6.7 | 7.2 |
| 200 | 6.6 | 7.5 |
| 250 | 6.3 | 7.4 |
| 300 | 6.2 | 7.3 |

***Q4*** *Plot graphs of the data in table 1, showing how the yield of wheat varies with the use of (i) fertiliser only and (ii) fertiliser with fungicide.*

*Label both graphs clearly.*

*The fertiliser graph is shown below.*

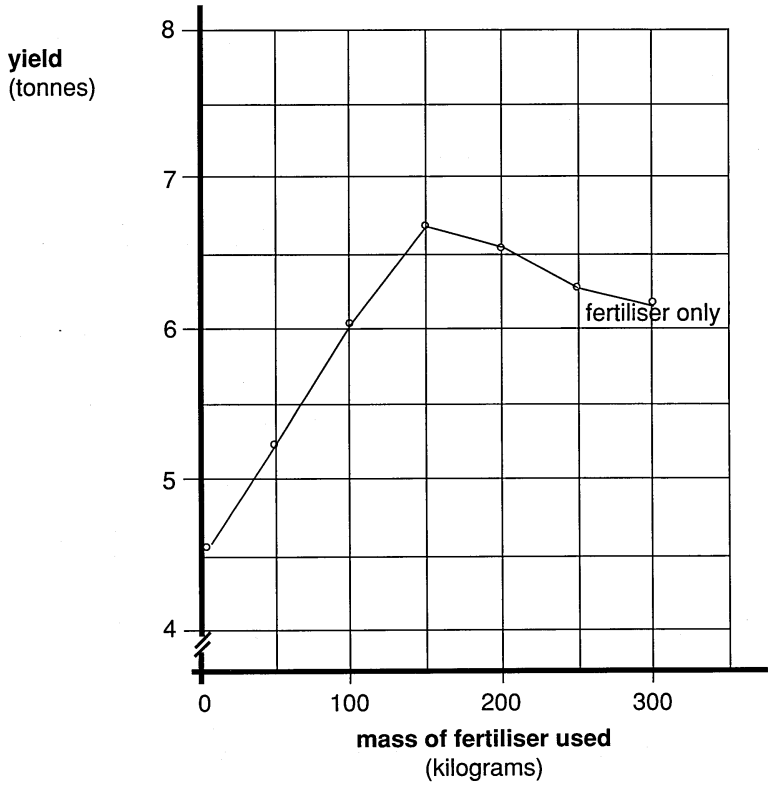
*(a) What yield can farmers expect if they use no fertiliser or fungicide?*

*(b) How does the effect of disease show up on the two curves?*

*(c) How much fertiliser must farmers use to get the highest yield, if they use (i) fertiliser only, (ii) fertiliser and fungicide together?*

*(d) (i) How many more tonnes per hectare can the farmer get by using fertiliser and fungicide compared with using neither? (ii) What percentage increase in yield is this?*

*Graph 1 How the yield of wheat per hectare varies with the mass of fertiliser used. (You may prefer to interpret it as a smooth curve.)*




An outline of this graph is available on a worksheet.

Fertilisers and fungicides are expensive. If farmers could make the same *profit* using less chemicals, they would be able to reduce the environmental problems caused by their use.

**Farming costs**

**INCOME**
**Selling price of wheat**
= **£100 per tonne.**

**EXPENDITURE**
**Fixed costs**
= **£465 per hectare**

**Variable costs:**
***Nitrogen fertiliser***
= **30p per kilogram** to buy
= **£6 per hectare** to apply

***Fungicide*** (including the cost of applying it)
= **£25 per hectare**

## Part B – High yields, high profits?

A wheat farmer's profit depends on

(a) **income** from selling the crop. This depends on the mass of wheat produced and its market price.

(b) **expenditure** which is of two types. The **fixed** costs include *labour, machinery, rent, rates, repairs, insurance etc.* The **variable** costs include the cost of *fertilisers and fungicides.*

$$\text{PROFIT} = \underbrace{(\text{yield} \times \text{wheat price})}_{\text{INCOME}} - \underbrace{(\text{variable costs} + \text{fixed costs})}_{\text{EXPENDITURE}}$$

*Table 2 How a farmer's profit varies with the mass of nitrogen fertiliser used. All figures are per hectare; no fungicide*

| Mass of fertiliser used (kg) | Variable costs (£) | Fixed costs (£) | Total costs (£) | Yield from table 1 (tonnes) | Value of wheat (£) | Profit (£) |
|---|---|---|---|---|---|---|
| 0 | 0 | 465 | 465 | 4.6 | 460 | –5 |
| 50 | 21 | 465 | 486 | 5.25 | 525 | 39 |
| 100 | 36 | 465 | 501 | 6.1 | 610 | 109 |
| 150 | 51 | 465 | 516 | 6.7 | 670 | 154 |
| 200 | 66 | 465 | 531 | 6.6 | 660 | 129 |
| 250 | 81 | 465 | 546 | 6.3 | 630 | 84 |
| 300 | 96 | 465 | 561 | 6.2 | 620 | ? |

**Example calculation**

When the farmer uses 250 kg fertiliser per hectare and no fungicide:

Fixed costs = £465

Variable costs (the cost of fertiliser and applying it)
= (£0.30 × 250) + £6
= £81

Total expenditure
= £465 + £81
= £546

His profit
= (6.3 tonne × £100) – (£81 + £465)
= £630 – £546
= £84

***Q5*** *What does a 'profit' of '–£5' mean to a farmer?*

***Q6*** *Work out the farmer's profit using 300 kg of fertiliser per hectare.*

***Q7*** *Plot a graph (graph 2) showing how the farmer's profit depends on the mass of fertiliser used.*

*Find from the graph how much fertiliser the farmer needs to use to get the highest profit margin.*

Using fungicide with fertiliser produces slightly higher yields of crop, but does it produce more profit for the farmer?

*Table 3 How the farmer's profit varies with the mass of fertiliser used with fungicide at £25 per hectare*

Outlines of table 3 and graph 2 are available on a worksheet.

| **Mass of fertiliser used with fungicide** ( kg ) | **Variable costs** ( £ ) | **Fixed costs** ( £ ) | **Total costs** ( £ ) | **Yield** from table 1 ( tonnes ) | **Value of wheat** ( £ ) | **Profit** ( £ ) |
|---|---|---|---|---|---|---|
| 0 | 25 | 465 | 490 | 4.9 | 490 | 0 |
| 50 | 46 | 465 | | 5.6 | 560 | 49 |
| 100 | | 465 | 526 | 6.6 | | |
| 150 | 76 | 465 | | 7.2 | | 179 |
| 200 | | 465 | | 7.5 | | |
| 250 | 106 | 465 | | 7.4 | | 169 |
| 300 | | 465 | | 7.3 | | |

***Q8*** *Calculate the figures missing from table 3.*

*Plot a graph to show how the profit varies when using fertiliser with fungicide. Plot it on the same graph as you used for Q7 so that you can compare both curves.*
*(a) Which is more profitable – using fertiliser alone, or using fertiliser with fungicide?*
*(b) Suppose fertiliser starts to leach into the ground when the farmer uses more than 170 kg per hectare. How much fertiliser would you recommend the farmer uses?*

***Q9*** *Mild winters and wet summers increase the amount of fungus like yellow rust in crops. The figures given are for a year in which disease levels were high.*
*(a) Could a farmer make more profit in low disease years? Explain how.*
*(b) It is difficult to forecast whether disease levels will be high in any year. Do you think a farmer should spray with fungicide regardless of whether it is likely to be a high disease year or not? Explain your answer.*

## Part C – Do we need agrochemicals?

'Organic farming' is the term now used to describe growing crops without manufactured fertilisers or agrochemicals. No weedkillers, fungicides, pesticides or growth regulators are used. Organic methods produce lower yields and crops may be blemished by insects or disease.

Organic fruit and vegetables sell at higher prices. At present, the market for organic food is small, but for the few farmers who practise it, organic farming can be a profitable business.

**Organising the discussion**

- Work in small groups.
- Appoint somebody to chair the group and to report back to the class if required.
- Note down the answers you decide on.

### Questions for discussion

1 Suggest why people are prepared to pay more for organically grown crops. Do you think they are better? Would your family pay more for an organic loaf of bread?

2 Organically grown wheat can be sold for a higher price than wheat grown with agrochemicals.

If inorganic wheat fetches £100 per tonne, what would be a reasonable price for organically grown wheat? Justify your answer.

3 Suggest what sources of organic nitrogen a farmer could use to increase his yield of organic wheat.

4 Suppose a farmer decides to change over to organic farming after using intensive farming methods for many years. How long after the last application of fertiliser and agrochemicals to a field, would you describe a crop grown on it as organic?

Suggest how farmers could try to stay in business while they convert to organic farming.

5 Do you think that farmers should change to organic farming methods?

6 Are there any organic farmers near you?

### Activity

Design an advertisement for an organic loaf of bread.

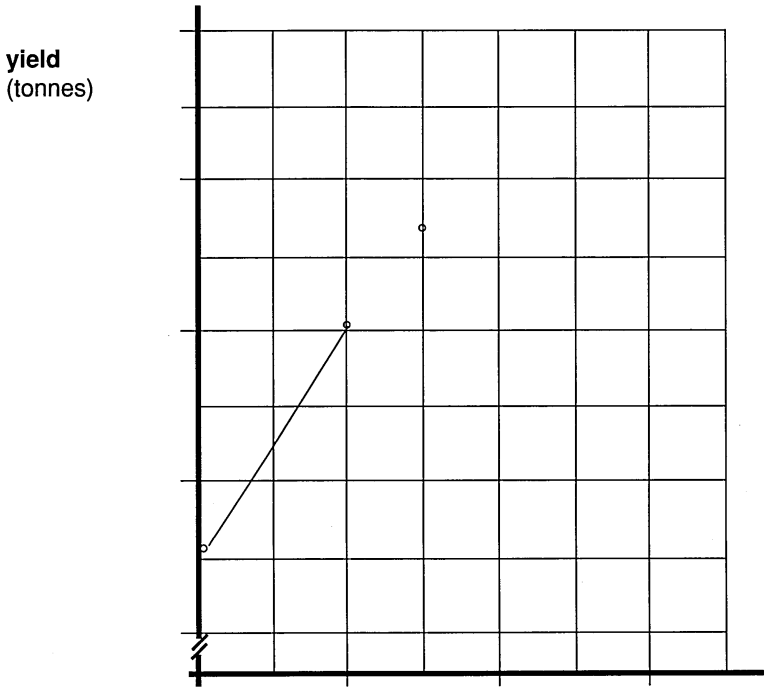
Answers to the questions are given in the *Teachers' Notes.*

*Name* _____

***Question Q4***

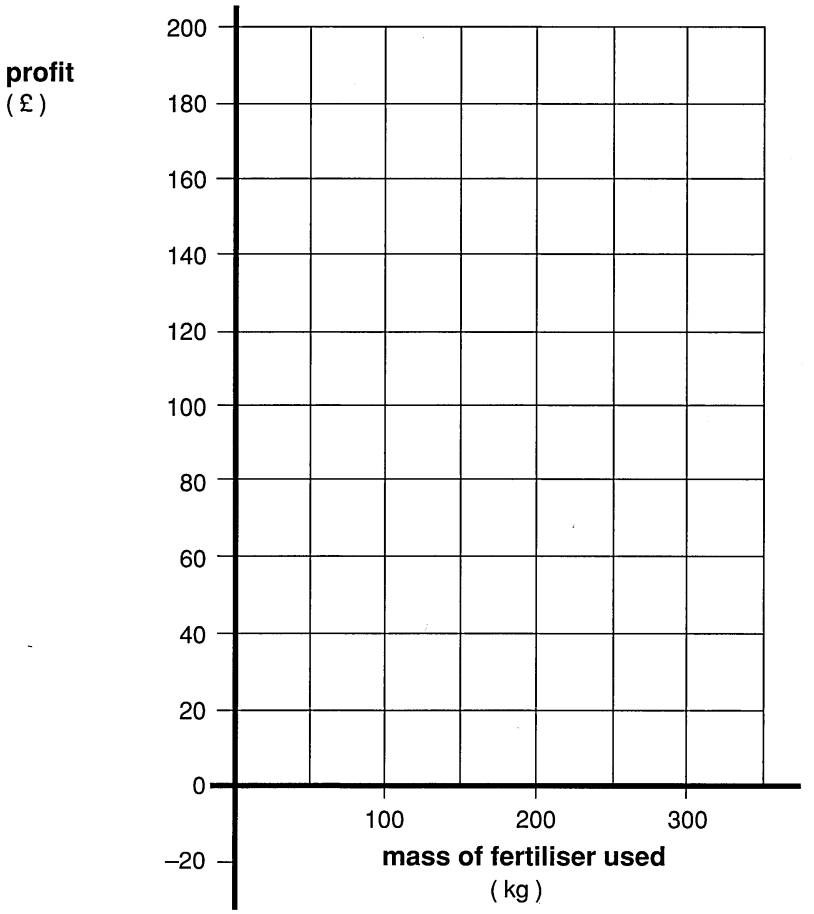
*Graph 1 How the yield of wheat per hectare*
(complete the title) _____

_____



***Question Q7 and Q8***

*Graph 2 How the farmer's profit margin per hectare depends on the mass of fertiliser used*




***Question Q8***

*Table 3 Fertiliser used with fungicide: how the farmer's profit varies with the mass of fertiliser*

| Mass of fertiliser used with fungicide (kg) | Variable costs (£) | Fixed costs (£) | Total costs (£) | Yield from table 1 (tonnes) | Value of wheat (£) | Profit (£) |
|---|---|---|---|---|---|---|
| 0 | 25 | 465 | 490 | 4.9 | 490 | 0 |
| 50 | 46 | 465 | ..... | 5.6 | 560 | 49 |
| 100 | ..... | 465 | 526 | 6.6 | ..... | ..... |
| 150 | 76 | 465 | ..... | 7.2 | ..... | 179 |
| 200 | ..... | 465 | ..... | 7.5 | ..... | ..... |
| 250 | 106 | 465 | ..... | 7.4 | ..... | 169 |
| 300 | ..... | 465 | ..... | 7.3 | ..... | ..... |