Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2013

Environmental Studies ENVS4

Unit 4 Biological Resources and Sustainability

Friday 21 June 2013 1.30 pm to 3.30 pm

You will need no other materials.
You may use a calculator.

Time allowed
- 2 hours

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
  Two of these marks are for the Quality of Written Communication.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.
- Question 7 should be answered in continuous prose.
  Quality of Written Communication will be assessed in this answer.

A

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Answer **all** questions in the spaces provided.

1 The table shows definitions of some terms connected with food production.

Complete the table.

Technical Term	Definition
Carrying capacity	
	Genetic modification by the transfer of genes into a different species
Heterotrophic nutrition	Gaining food energy from other living organisms
	The control of weeds by adding shredded vegetable matter to the soil surface
Polyculture	
Steroid hormones	Agrochemicals used to increase the Gross Growth Efficiency of livestock
Productivity	Yield per unit area
	Changes in society that meet the needs of the current generation without reducing the ability of future generations to meet their needs
Efficiency	Yield per unit input

(5 marks)

5

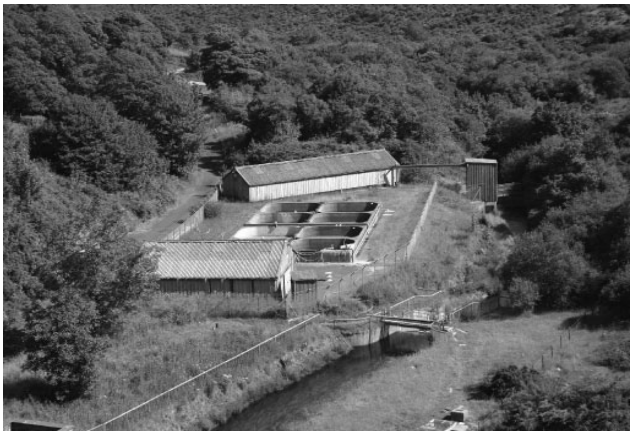
Turn over for the next question

2 The photographs show two fish farms and the fish produced in them.

Tilapia fish farm

Tilapia

Trout fish farm



Rainbow trout

2 (a) Outline the advantages of farming herbivorous fish, such as *Tilapia*, rather than carnivorous fish.

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(2 marks)

2 (b) Describe how abiotic factors may be controlled in an intensive fish farm.

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(4 marks)

2 (c) Outline the possible impacts, on the river downstream, of untreated organic waste effluent released from a fish farm.

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(4 marks)

10

Turn over for the next question

3 The photographs show some laboratory equipment and a field test site, which were both designed to study soil erosion.

Laboratory equipment

Field test site

Source: Keith Weller USDA/ARS

3 (a) Compare the advantages of carrying out such tests in the laboratory compared with field tests.

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(4 marks)

3 (b) Describe **one** method that may be used to investigate the effect of vegetation density on soil erosion.

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(4 marks)

Question 3 continues on the next page

3 (c) A field study was undertaken to investigate whether contour ploughing caused lower erosion rates than ploughing up and down slopes.

Table 1 shows the data collected.

Table 1

Annual erosion rates / t Ha^{-1}	
Fields ploughed along the contours n_1	**Fields ploughed up and down the slopes** n_2
2.9	3.7
2.8	3.5
3.4	4.1
3.2	4.1
3.7	3.2
3.5	3.4
3.2	3.7
3.3	4.0
3.1	3.5
3.5	4.0
3.2	3.2
3.0	3.1

The statistical significance of the study was assessed with a t-test, using the following formula.

$$t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

Where:
$\overline{x}$ = mean
s = standard deviation
n = sample size
Degrees of freedom = total number of samples – 2

Table 2 shows critical values of t.

Table 2

Degrees of freedom (df)	p values			
	0.10	**0.05**	**0.01**	**0.001**
1	6.31	12.71	63.66	636.00
2	2.92	4.30	9.92	31.60
3	2.35	3.18	5.84	12.92
4	2.13	2.78	4.60	8.61
5	2.02	2.57	4.03	6.37
6	1.94	2.45	3.71	5.96
7	1.89	2.36	3.50	5.41
8	1.86	2.31	3.36	5.04
9	1.83	2.26	3.25	4.78
10	1.81	2.23	3.17	4.59
12	1.78	2.18	3.05	4.32
14	1.76	2.15	2.98	4.14
16	1.75	2.12	2.92	4.02
18	1.73	2.10	2.88	3.92
20	1.72	2.09	2.85	3.85
22	1.72	2.08	2.82	3.79
24	1.71	2.06	2.80	3.74
26	1.71	2.06	2.78	3.71
28	1.70	2.05	2.76	3.67
30	1.70	2.04	2.75	3.65
40	1.68	2.02	2.70	3.55
60	1.67	2.00	2.66	3.46
120	1.66	1.98	2.62	3.37
∞	1.64	1.98	2.58	3.29

3 (c) (i) How many degrees of freedom are there for the data in **Table 1**?

Degrees of freedom .....

(1 mark)

3 (c) (ii) A t value of 3.01 was calculated.

Use **Table 2** to find the level of significance of this t value.

Level of significance .....

(1 mark)

10

Turn over ▶

4 The photograph shows a mixed forestry plantation of indigenous species.

4 (a) (i) Explain why there is a greater wildlife biodiversity in this type of forest compared with a monoculture of non-indigenous trees.

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(2 marks)

4 (a) (ii) Explain why mixed species plantations are often less profitable than monocultural plantations.

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(2 marks)

4 (b) Describe **one** method that may be used to compare the biodiversity of ground vegetation in two forest areas.

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(6 marks)

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Turn over for the next question

5 Increased farm harvests, since the 1980s, have encouraged the diversification of crops, livestock and farm products for non-food purposes.

Since 2009, wheat has been used in the UK to make ethanol as a biofuel replacement for petrol.

The table shows information about farmland and wheat production in the UK in 2010.

Feature	Quantity
Total area of arable farmland	4 900 000 Ha
Percentage of arable farmland used to grow wheat	39 %
Area of wheat grown	1 920 000 Ha
Total wheat harvest	1 370 000 t
Percentage of harvest exported	15 %
Area of arable farmland not cultivated	200 000 Ha
Wheat yield	7.6 t Ha^{-1}
Ethanol yield from 1 t of wheat	375 l
Volume of ethanol needed to replace 1 litre(l) of petrol	1.5 l
Annual consumption of petrol	28×10^9 l
Energy content of ethanol	21.0 MJ l^{-1}
Energy content of petrol	31.5 MJ l^{-1}

5 (a) Use the information in the table to calculate:

5 (a) (i) the volume of ethanol needed to replace 10% of UK annual petrol consumption

……l

(1 mark)

5 (a) (ii) the percentage of UK petrol consumption that could be replaced if the uncultivated arable land were to be used to grow wheat for ethanol production.

……*%*

(2 marks)

5 (b) Outline the ways in which energy inputs into agroecosystems are used to increase crop yields.

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(4 marks)

Question 5 continues on the next page

5 (c) Use examples to outline the advantages **and** disadvantages of using Genetically Modified (GM) crops.

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(8 marks)

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Turn over for the next question

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6 Read the article and answer the questions that follow.

Global food production and the Green Revolution

The term 'Green Revolution' was first used in the 1960s to describe the increases in food production in Less Economically Developed Countries (LEDCs) made possible by the introduction of new crop varieties and production methods.

During the 1960s, India was threatened by famine due to poor harvests, especially of rice and wheat. The government began a programme of plant breeding, irrigation development, and financing the use of pesticides and fertilisers.

Many LEDCs, including India, started to use new selectively bred varieties of maize, wheat and rice that have higher nitrogen-absorbing potential than other varieties and produce bigger harvests. Many new varieties had short stalks, which could support the higher seed yields that were produced when the crops were grown with high fertiliser inputs and irrigation.

IR8 rice yielded about 5 tonnes per hectare with no fertiliser, and almost 10 tonnes per hectare under optimum conditions, compared with 1 tonne per hectare for traditional rice varieties.

In India, wheat production was 10 million tonnes in the 1960s but reached 75 million tonnes by 2010.

Since the 1960s, the human population has risen from 3 billion to over 7 billion. If food production had not risen, there would have been famine in many countries.

While agricultural output increased, energy inputs increased faster, so that the ratio of crop yield to energy input decreased over time. The agrochemical inputs also required energy inputs, mainly from fossil fuels. Some scientists think that a future decline in the availability of fossil fuels may lead to a decline in food production.

The Green Revolution varieties significantly outperform traditional varieties in the presence of adequate irrigation, pesticides and fertilisers but, in the absence of these inputs, traditional varieties may outperform Green Revolution varieties as they are more resistant to pests, diseases, drought and infertile soil. Yields are lower but more reliable.

The genetically uniform new varieties had the ability to produce high yields but were susceptible to many pests and diseases, so high pesticide inputs were necessary, especially when the new crops were grown in monocultures. This reduced the populations of fish and frogs found in rice padi fields which were a traditional food for poor farm workers. They also killed many biological pest control species such as spiders. Some pesticides are also toxic to people: in 1989, the World Heath Organisation estimated that around 1 million people were poisoned by pesticides, with 20 000 deaths, mainly in LEDCs.

The increased crop yields made farming more profitable. Land rents rose and the poor tenant farmers who could not afford the new seeds or inputs became landless and often migrated to cities in search of work. Some of the profits were spent on machinery, which reduced the need for farm labourers and further increased rural depopulation.

The increased yields of Green Revolution varieties caused prices to fall. In 1970, rice cost $550 a tonne. In 2000, the price had fallen to $200 per tonne and surpluses were being exported. This drop in food price allowed richer countries to buy more food and to use it in inefficient systems such as meat production or for non-food products such as vehicle biofuels. Meat consumption in China has nearly trebled since 1980 while bioethanol production in the USA increased tenfold between 2000 and 2010.

The spread of Green Revolution agriculture has affected both agricultural and wild biodiversity. The spread of a small number of Green Revolution varieties has swept away large numbers of traditional varieties with their own unique gene pools. In some areas, wild biodiversity has been reduced by the clearance of uncultivated areas because the increased income from farming made it profitable to do so. However, it can also be argued that higher yields have restricted the expansion of farmland, thereby protecting wild habitats.

Therefore, although the Green Revolution has undoubtedly increased global food production, whether or not all the methods involved are sustainable is still open to scientific debate.

6 (a) Suggest why the increased food production of the Green Revolution has made life more difficult for some people.

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(2 marks)

6 (b) Outline **one** advantage and **one** disadvantage of growing genetically uniform crops.

6 (b) (i) Advantage.....

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(1 mark)

6 (b) (ii) Disadvantage.....

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(1 mark)

Turn over ▶

6 (c) Explain why, although the Green Revolution has increased food production, it may not be '*environmentally sustainable*'.

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(6 marks)

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7 Write an essay on **one** of the following topics. Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling. You should answer this question in continuous prose.

EITHER

7 (a) Discuss how the quality of life for humans may be improved by the better conservation of forests. *(20 marks)*

OR

7 (b) Discuss the advantages **and** disadvantages of methods that may be used to make fishing more sustainable. *(20 marks)*

OR

7 (c) Discuss the ways in which governments have attempted to achieve sustainable development using legislation and agreements. *(20 marks)*

Write the number of the question you have chosen in the box below.

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(20 marks)

Extra space for Question 7.....

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END OF QUESTIONS

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