

Unit 3 Sustainability & Interdependence

Key Area 3.2 Plant & Animal Breeding

1.

Holstein, Normande and Scandinavian Red are breeds of dairy cattle.

An investigation was carried out to compare average milk yield, the average fat content and the average protein contents of milk from pure bred Holstein, Holstein \times Normande F_1 hybrid and Holstein \times Scandinavian Red F_1 hybrid cattle.

The results are shown in the table.

<i>Breed</i>	<i>Average milk yield per cow (kg per day)</i>	<i>Average fat content of milk (%)</i>	<i>Average protein content of milk (%)</i>
Pure bred Holstein	44.80	4.15	3.25
F_1 Hybrid Holstein \times Normande	48.64	4.25	3.10
F_1 Hybrid Holstein \times Scandinavian Red	51.52	4.25	3.15

- (a) Calculate the percentage increase in average milk yield per day from the Holstein \times Scandinavian Red F_1 hybrid compared to pure bred Holstein.

Space for calculation

_____ % **1**

- (b) In milk for butter production, the fat content is important.

Calculate the total fat production in a day which would be expected from a herd of 200 Holstein \times Normande F_1 hybrids.

Space for calculation

_____ kg per day **1**

- (c) Summarise the effects of crossbreeding on the three characteristics shown in the table.

1

- (d) The development of pure breeds such as Holsteins has led to accumulation of deleterious recessive alleles.

Give the term which describes this.

1

- (e) **Some** F_2 offspring from crosses of F_1 Holstein \times Scandinavian Red hybrid cattle will have less desirable milk-producing characteristics compared to their parents.

- (i) Give a reason for this.

1

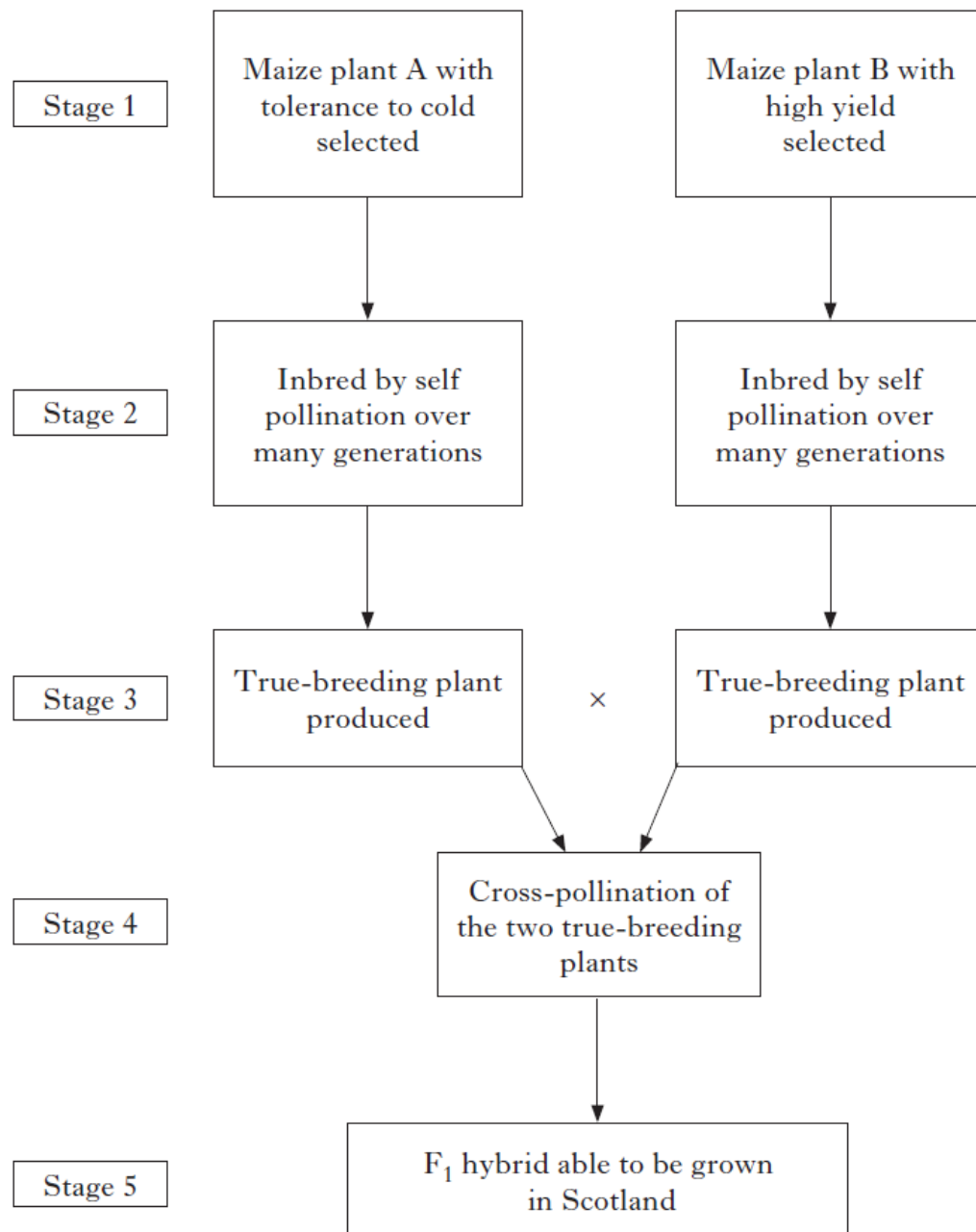
2. Which line in the table below correctly describes the type of variation and inheritance pattern normally involved in growth rate in pigs?

	<i>Type of variation</i>	<i>Inheritance pattern</i>
A	continuous	polygenic
B	discrete	polygenic
C	continuous	single gene
D	discrete	single gene

3.

Maize is a naturally self-pollinating crop plant native to the warmer areas of the USA.

An outline of the stages in the breeding of a hybrid plant with high yield which can be grown in the colder environment of Scotland is shown below.



- (a) State **two** characteristics of the F_1 hybrid at Stage 5 that would be beneficial to the breeder.

1 _____

2 _____

1

- (b) The F_1 hybrids can be grown in Scotland and can be crossed with each other to produce an F_2 generation.

- (i) Describe why some F_2 plants produced from this cross may not grow successfully in Scotland.

1

- (ii) Give an advantage to breeders of producing an F_2 generation in this case.

1

4. Many varieties of garden plants grown by breeders are F_1 hybrids which often show increased vigour and yield.

Further generations are not usually produced from these F_1 plants because the F_2 generation would be

- A heterozygous
- B homozygous
- C genetically variable
- D genetically uniform.

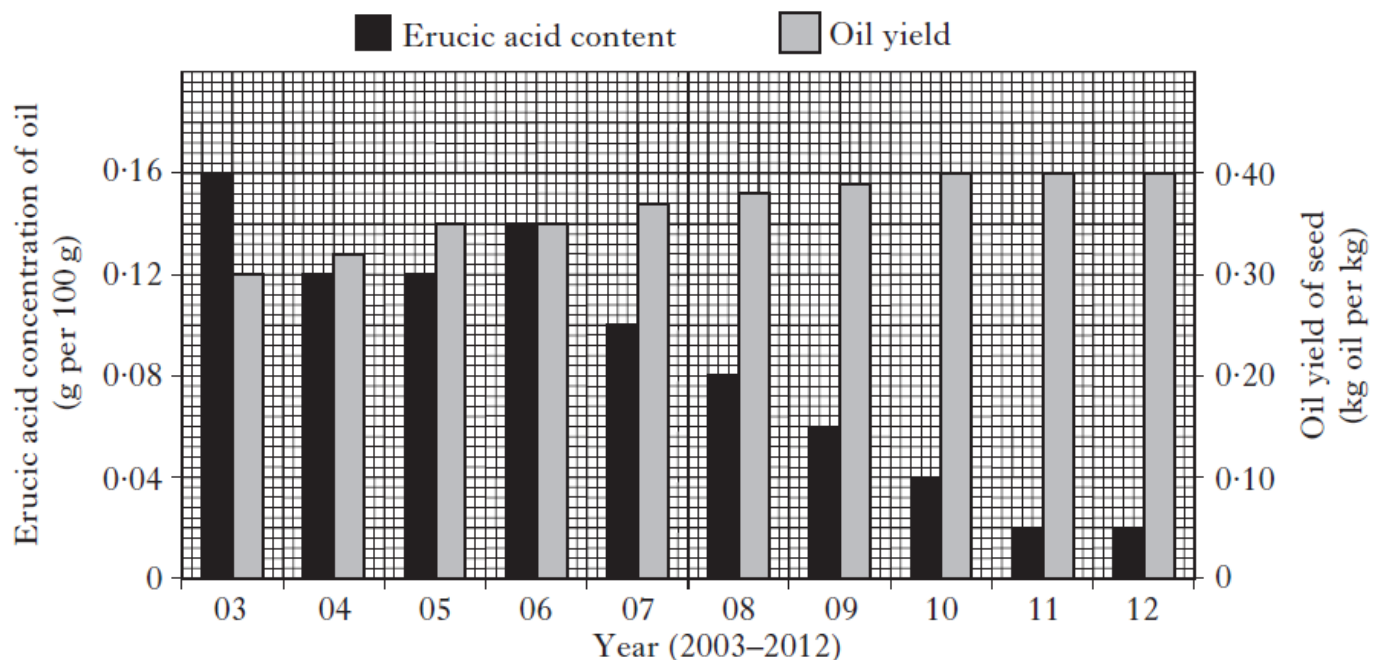
5.

Oil from wild varieties of oilseed rape plants contains a high concentration of erucic acid which makes the oil unsuitable for human consumption.

Selective breeding programmes have produced modern varieties of oilseed rape plants with oil of low erucic acid concentration which is suitable for human consumption.

In 2003 a new selective breeding programme was started which aimed to further reduce the erucic acid concentration of the oil and to increase oil content of seeds.

The **bar chart** below shows the results of the new selective breeding programme over a 10 year period.



- (a) (i) Use values from the **bar chart** to describe the changes in erucic acid concentration of the oil from 2005 until 2012.

- (ii) Calculate the simplest whole number ratio of the erucic acid concentration of the 2003 harvest compared with that of the 2011 harvest.

Space for calculation

_____ in 2003 : _____ in 2011 **1**

- (iii) Calculate the average increase per year in oil yield from 2003 to 2011.

Space for calculation

_____ kg oil per kg seed per year **1**

- (iv) Calculate the mass of seed from 2012 which would be needed to produce one kilogram of oil.

Space for calculation

_____ kg **1**

- (b) The bacterium *Bacillus thuringiensis* produces Bt-toxin, a substance harmful to leaf-eating insects. Some oilseed rape plants were genetically engineered so that they contained the gene for Bt-toxin.

A field trial was set up to compare seed yields in genetically engineered plants with the Bt-toxin gene and control plants without the Bt-toxin gene. Equal numbers of the two types of plant were grown under identical conditions in the presence of leaf-eating insects and their seed yields per hectare compared.

The results of the trial are shown in the **table** below.

<i>Plants</i>	<i>Seed yield (kg per hectare)</i>
Genetically engineered (with the Bt-toxin gene)	144
Control (without the Bt-toxin gene)	80

- (i) Calculate the percentage increase in the seed yield per hectare from plants with the Bt-toxin gene compared with the control plants.

Space for calculation

_____ % **1**

- (ii) Explain why the genetically engineered plants produce a higher yield of seed per hectare compared with the control plants.

2

- (iii) The selectively bred plants which produced the 2012 harvest were affected by leaf-eating insects.

Using information from the **table** and the **bar chart**, predict the increase in **oil yield** per hectare which could have been achieved, if these plants had been:

- genetically engineered to contain the Bt-toxin gene
- grown under identical conditions to those in the field trial.

Space for calculation

Increase in oil yield: _____ kg oil per hectare **1**

6.

The average yield, fat and protein content of the milk from each of three breeds of dairy cattle were determined.

The results are shown in the table below.

<i>Breed</i>	<i>Average milk yield per cow</i> (kg per day)	<i>Average fat content of milk</i> (%)	<i>Average protein content of milk</i> (%)
Pure bred Holstein	44.80	4.15	3.25
F ₁ hybrid Holstein × Normande	48.64	4.25	3.10
F ₁ hybrid Holstein × Scandinavian Red	51.52	4.25	3.15

- (a) Calculate the percentage increase in average milk yield per cow from the F₁ hybrid Holstein × Scandinavian Red compared to pure bred Holstein cattle.

1

Space for calculation

_____ %

- (b) The fat content of milk is important for butter production.

Calculate the total fat content in the milk produced in a day from a herd of 200 F₁ hybrid Holstein × Normande cattle.

1

Space for calculation

_____ kg per day

- (c) Select one from: average milk yield per cow; average fat content of milk; or average protein content of milk.

For your choice, draw a conclusion about the effects of crossbreeding.

1

Choice _____

Conclusion _____

- (d) The development of pure breeds such as Holsteins has led to an accumulation of deleterious recessive alleles.

State the term that describes this.

1

- (e) Some F₂ offspring from crosses of F₁ hybrid Holstein × Scandinavian Red cattle will have less desirable milk-producing characteristics than their parents.

- (i) Give one reason for this.

1

7.

Inbreeding depression is a result of

- A an increase in heterozygotes
- B a genetically variable population
- C crossbreeding for improved characteristics
- D an accumulation of recessive deleterious alleles.

8.

Gluten is a protein found in crops that can cause human health problems. Scientists are breeding barley cultivars to produce ultra low gluten levels.

A commercially produced barley (Sloop) and a low gluten cultivar (LG) were crossed to produce two different cultivars with ultra low gluten levels (ULG 1 and ULG 2).

The gluten content of each cultivar is shown in the table.

<i>Barley cultivar</i>	<i>Gluten content (mg/g)</i>
Sloop	57.0
LG	5.1
ULG 1	1.7
ULG 2	0.004

- (a) Calculate how many times greater the gluten content of Sloop is compared to that of ULG 2.

1

Space for calculation

_____ times greater

- (b) Barley grains contain the enzyme amylase which breaks down starch in the grain to sugar used in brewing beer.

Average grain mass, starch content and amylase activity for three barley cultivars are shown in the table.

<i>Barley cultivar</i>	<i>Average mass of a single grain (mg)</i>	<i>Starch content of grains (%)</i>	<i>Amylase activity (units/mg)</i>
Sloop	53.6	70	0.6
ULG1	33.5	65	1.0
ULG2	39.2	64	1.4

- (i) As well as total mass of all the grains, state the information required in order to calculate the average mass of a single grain.

1

- (ii) Select a cultivar from the table that would be best to use in beer production and justify your selection.

1

Cultivar _____

Justification _____
