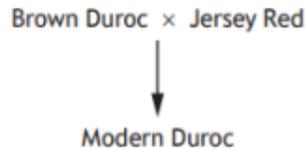


Breeding Programmes & Field Trials

1. The Brangus breed of cattle is an F_1 hybrid produced by crossing the Brahman and Aberdeen Angus cattle breeds.
Which of the following statements could apply to Brangus cattle?
1. They could show inbreeding depression.
 2. They could show improved characteristics.
 3. Breeding them together could produce a genetically variable F_2
- A 1 only
B 2 only
C 1 and 3 only
D 2 and 3 only
2. Breeding programmes can be used to increase starch levels in barley plants. This involves breeding closely related plants with high starch levels for several generations.
This is carried out in order to
- A increase the frequency of homozygous deleterious alleles
B reduce the frequency of homozygous deleterious alleles
C increase the frequency of heterozygotes
D reduce the frequency of heterozygotes.
3. The list describes features of a field trial designed to compare the yield of maize cultivars.
1. Treatments are allocated to plots randomly.
 2. Trial includes plots of four different maize cultivars.
 3. A sufficient number of replicates is used.
- Which of the features would take into account the variability of yield in each cultivar?
- A 2 only
B 3 only
C 1 and 2 only
D 1 and 3 only
4. 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.
5. 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.
6. In plant field trials, replicates are used to
- A take account of the variability within samples
B eliminate bias when measuring treatment effects
C ensure that comparisons are fair
D prevent weather conditions affecting results.

Breeding Programmes & Field Trials

7. The diagram shows the breeding of two parental pig breeds to produce the Modern Duroc pig.



The Modern Duroc pig has increased quality and quantity of meat compared to both parental breeds.

The development of the Modern Duroc pig breed is an example of

- A inbreeding
- B cross breeding
- C natural selection
- D genetic modification.

8. A field trial was set up to investigate the effect of mass of fertiliser applied and the application of fungicide on growth of barley.

The diagram shows the distribution of plots in the field and the treatments applied.

30	30	50
30	10	30
50	50	10
10	50	30
10	30	10
50	10	50

Key

Fungicide applied

No fungicide applied

10 10 kg fertiliser applied per hectare

30 30 kg fertiliser applied per hectare

50 50 kg fertiliser applied per hectare

Which design feature was included to eliminate bias?

- A Application of fungicide to half of the plots
- B Randomisation of treatments
- C Application of three different masses of fertiliser
- D Use of three replicates

9. The reason for replicating treatments during plant field trials is to

- A develop improved plant varieties
- B ensure fair comparisons between treatments
- C take into account variability within the plants being grown
- D eliminate bias when measuring the effects of treatments on growth.

Breeding Programmes & Field Trials

1. Commercial strawberry plants are F_1 hybrids, which often have improved resistance to *Botrytis*.

(i) Other than improved disease resistance, give one other advantage of F_1 hybrids.

(ii) State why F_1 hybrids are **not** usually bred together to produce more strawberry plants.

2. The development of pure breeds such as Holsteins has led to an accumulation of deleterious recessive alleles.

State the term that describes this.

Some F_2 offspring from crosses of F_1 hybrid Holstein \times Scandinavian Red cattle will have less desirable milk-producing characteristics than their parents.

Give **one** reason for this.

3. Spider lamb syndrome is a hereditary condition in sheep caused by a recessive deleterious allele which results in limb deformities.

State why inbreeding could cause an increase in the number of lambs born with this condition.

4. The diagram shows crosses in a breeding programme involving different breeds of sheep.

1

(P) Scottish Blackface female X Border Leicester male



1

Greyface female (F_1) X Suffolk male



(F_2)

Commercial lambs

(a) Suggest a reason why breeding programmes such as this include crossbreeding.

1

1

(b) Explain why Greyface sheep are produced by crossbreeding Scottish Blackfaces with Border Leicesters instead of breeding F_1 Greyface sheep together.

1

1

(c) To produce commercial lambs which show a desired dominant characteristic, Suffolk males homozygous for that characteristic are used. Explain the importance of selecting a Suffolk male homozygous for the desired dominant characteristic.

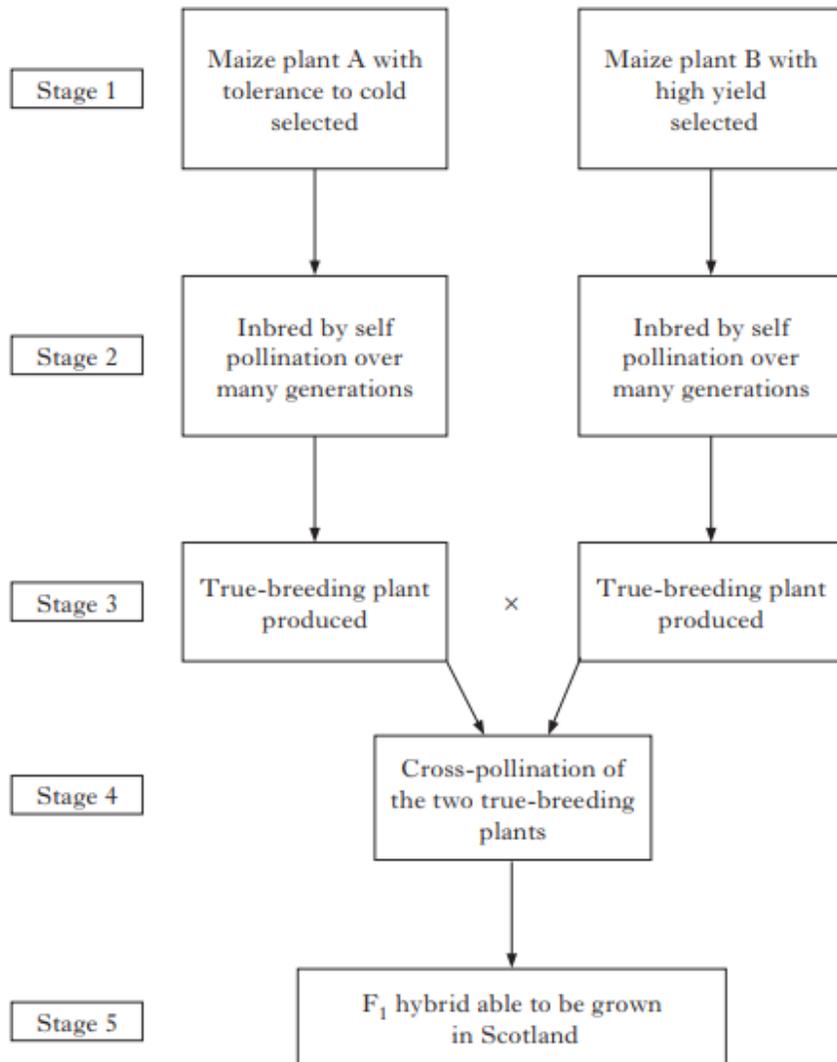
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1

Breeding Programmes & Field Trials

8. 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.

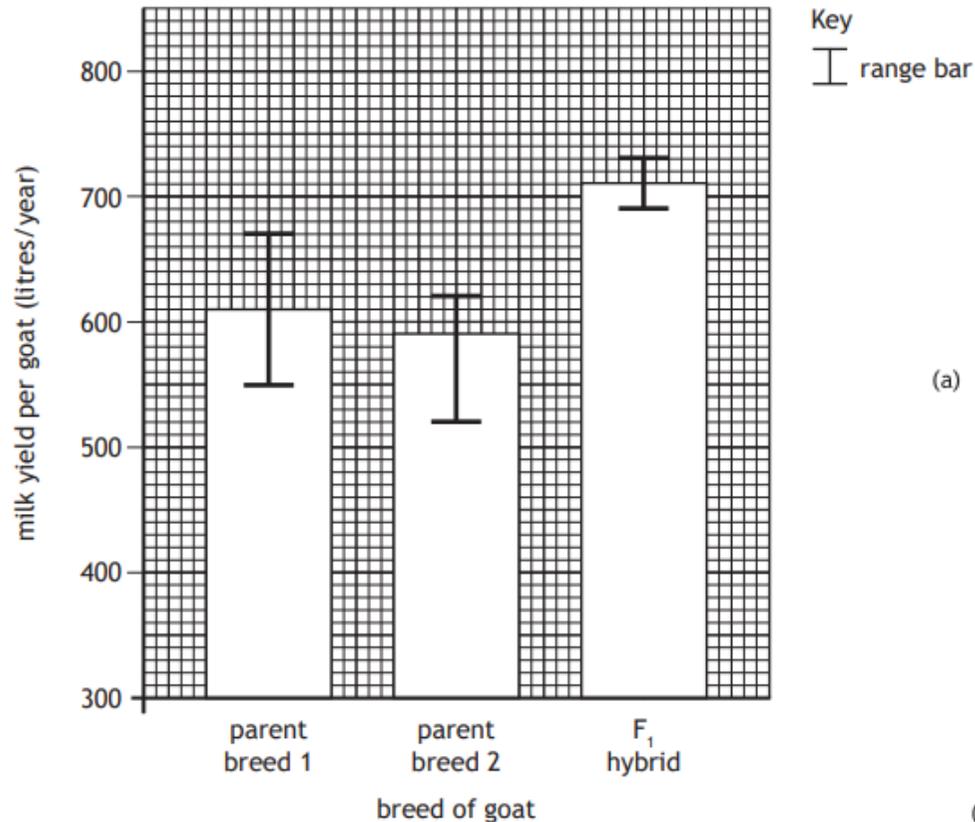
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Breeding Programmes & Field Trials

9. Different breeds of goat can be crossbred to produce F_1 hybrids that have increased milk production.

In an investigation, the milk yields from the two parent breeds of goat and the F_1 hybrid were measured.

The results are shown in the graph. The bars show the average milk yield of 10 goats per group. The range bars show the range of milk yields in each group.



An F_2 population was produced by breeding F_1 hybrids together. Some individual goats within this population showed a decrease in milk yield compared with the F_1 hybrid.

Suggest why this decrease occurred.

1

10. Crops such as buckwheat (*Fagopyrum esculentum*) grown in exposed regions can be damaged by the wind. Long roots help anchor crop plants in the soil, minimising damage in windy conditions.

A field trial was carried out to compare the mass of grain produced and root length of four cultivars of buckwheat, Q, R, S and T.

The plots in the trial were set up as shown in the diagram.

Q	R	S	T
S	T	Q	R
R	Q	S	T
T	S	R	Q

- (a) During the field trial one side of the field was more exposed to wind than the other side.

(i) Identify a design feature of the trial that eliminated this bias. 1

(ii) Describe how the investigation took into account any variability in the mass of grain and root length within plants of the same cultivar. 1

- (b) Explain why F_1 hybrids are not usually bred together in plant breeding programmes. 1

Breeding Programmes & Field Trials

11. Red Fife and Coteau are cultivars of wheat. Their grain is grown for bread-making. A field trial was carried out to compare their economic and biological yields. Equal numbers of plants of each cultivar were grown in 16 field plots for six months as shown in the **diagram** below.

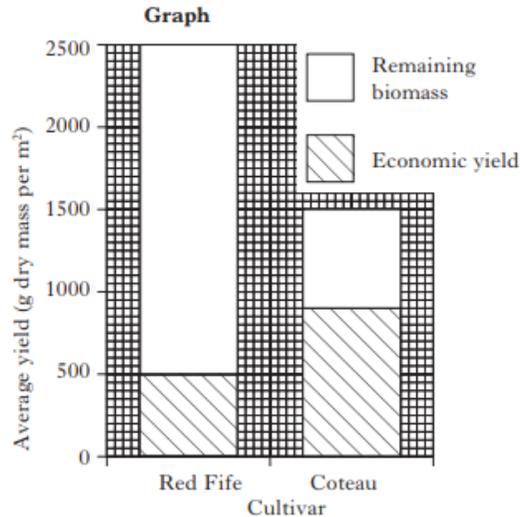
The **graph** below shows the average economic yield of grain and the average yield of the remaining plant biomass from samples of each cultivar.

Diagram

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Key

	Red Fife plot
	Coteau plot



- (a) In designing a field trial, account should be taken of the factors in the list below.

- A selection of treatments
- B number of replicates
- C randomisation of treatments

Complete the table below using letters from the list to match the reasons for taking the factors into account.

<i>Factor to be taken into account</i>	<i>Reason</i>
	To take account of the variability within samples.
	To ensure fair comparisons.
	To eliminate bias when measuring the treatment effects.

- (b) Give **one** precaution, not already mentioned, which would have to be taken so that the comparison of the yields from each cultivar was valid and explain the reason for it.

Precaution _____

Reason _____

2

12. Genetically modified (GM) crops are evaluated in field trials.

Certain experimental procedures are required when setting up field trials to compare GM and non GM crops.

Give **one** such procedure and explain how it allows valid conclusions to be drawn.

2

Procedure _____

Explanation _____

Breeding Programmes & Field Trials

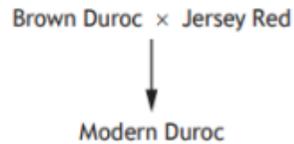
13. Write notes on plant and animal breeding under the following headings:
- (i) inbreeding 3
 - (ii) crossbreeding. 6

Breeding Programmes & Field Trials

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Breeding Programmes & Field Trials

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Breeding Programmes & Field Trials

1. Commercial strawberry plants are F_1 hybrids, which often have improved resistance to *Botrytis*.

(i) Other than improved disease resistance, give one other advantage of F_1 hybrids.

Increased growth/yield

(ii) State why F_1 hybrids are not usually bred together to produce more strawberry plants.

F_2 too genetically variable

2. The development of pure breeds such as Holsteins has led to an accumulation of deleterious recessive alleles.

State the term that describes this.

Inbreeding depression

Some F_2 offspring from crosses of F_1 hybrid Holstein \times Scandinavian Red cattle will have less desirable milk-producing characteristics than their parents.

Give one reason for this.

F_2 too genetically variable

3. Spider lamb syndrome is a hereditary condition in sheep caused by a recessive deleterious allele which results in limb deformities.

State why inbreeding could cause an increase in the number of lambs born with this condition.

Accumulation of homozygous recessive deleterious alleles

OR inbreeding depression,

4. The diagram shows crosses in a breeding programme involving different breeds of sheep.

(P) Scottish Blackface female X Border Leicester male



Greyface female (F_1) X Suffolk male



(F_2) Commercial lambs

(a) Suggest a reason why breeding programmes such as this include crossbreeding.

Improved characteristic/higher growth/yield in offspring OR

F_1 hybrid has hybrid vigour

(b) Explain why Greyface sheep are produced by crossbreeding Scottish Blackfaces with Border Leicesters instead of breeding F_1 Greyface sheep together.

F_2 too genetically variable

(c) To produce commercial lambs which show a desired dominant characteristic, Suffolk males homozygous for that characteristic are used.

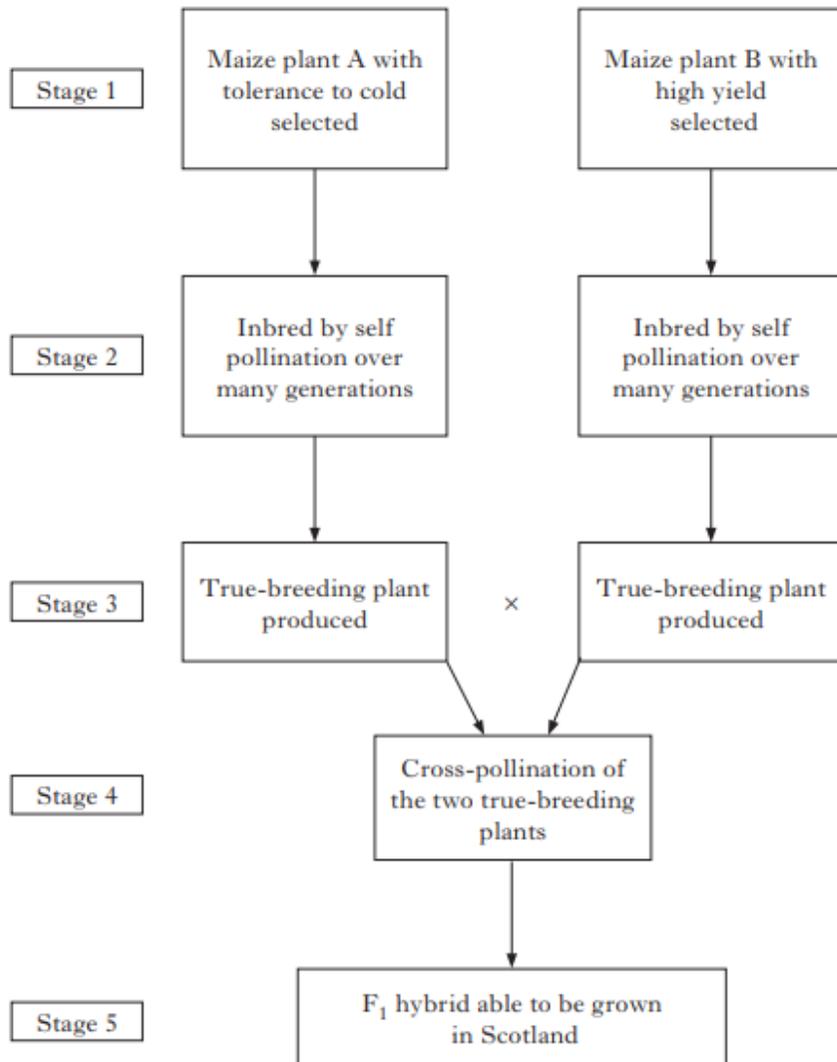
Explain the importance of selecting a Suffolk male homozygous for the desired dominant characteristic.

All offspring will contain a dominant allele.

Breeding Programmes & Field Trials

8. 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 F₁ hybrid at Stage 5 that would be beneficial to the breeder.

- 1 High yield
- 2 Tolerance to cold 1

- (b) The F₁ hybrids can be grown in Scotland and can be crossed with each other to produce an F₂ generation.

- (i) Describe why some F₂ plants produced from this cross may not grow successfully in Scotland.

- F2 too genetically variable
- _____ 1

- (ii) Give an advantage to breeders of producing an F₂ generation in this case.

- Some will have hybrid vigour like F1
- _____ 1

Breeding Programmes & Field Trials

5. 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.

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

- (a) Type of breeding programme.

Cross breeding

(1)

- (b) The allele for ultra low gluten is recessive. To investigate if the cultivar LG was heterozygous for gluten, it was crossed with the cultivar ULG1 which was homozygous for this recessive allele.



Describe the expected phenotypes of the offspring if LG was heterozygous.

Half low gluten & half ultra low gluten

1

6. A field trial was carried out to investigate the effectiveness of a selective herbicide to control dandelions in eight grass plots as shown.



Key A – untreated
 B – treated with herbicide spray

Suggest an improvement to the design of this field trial and justify your answer.

2

Improvement Randomise plots

Justification Eliminates bias

7

It was suggested that each large field could have been separated into many small plots and the treatments randomised.

State why this would be considered as good experimental design.

1

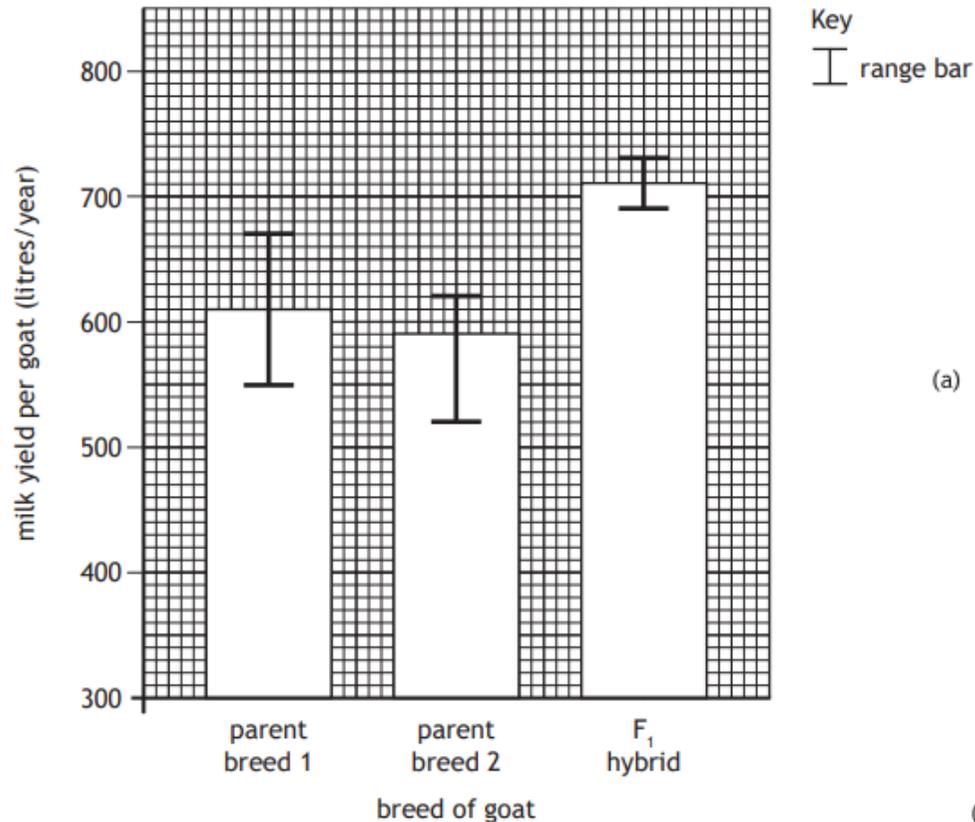
Eliminates bias

Breeding Programmes & Field Trials

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An F_2 population was produced by breeding F_1 hybrids together. Some individual goats within this population showed a decrease in milk yield compared with the F_1 hybrid.

Suggest why this decrease occurred.

F2 too genetically varied

10. Crops such as buckwheat (*Fagopyrum esculentum*) grown in exposed regions can be damaged by the wind. Long roots help anchor crop plants in the soil, minimising damage in windy conditions.

A field trial was carried out to compare the mass of grain produced and root length of four cultivars of buckwheat, Q, R, S and T.

The plots in the trial were set up as shown in the diagram.

Q	R	S	T
S	T	Q	R
R	Q	S	T
T	S	R	Q

- (a) During the field trial one side of the field was more exposed to wind than the other side.

- (i) Identify a design feature of the trial that eliminated this bias. 1

Randomisation of treatment

- (ii) Describe how the investigation took into account any variability in the mass of grain and root length within plants of the same cultivar. 1

Four/several replicates per cultivar

- (b) Explain why F_1 hybrids are not usually bred together in plant breeding programmes. 1

F2 too genetically varied

1

Breeding Programmes & Field Trials

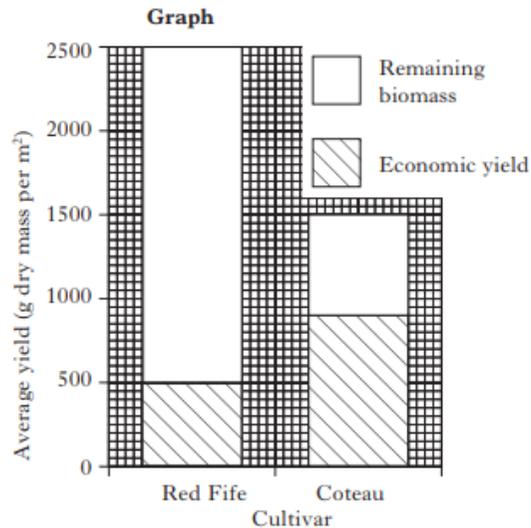
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Diagram

1	2	3	4
5	6	7	8
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Key

	Red Fife plot
	Coteau plot



- (a) In designing a field trial, account should be taken of the factors in the list below.

- A selection of treatments
- B number of replicates
- C randomisation of treatments

Complete the table below using letters from the list to match the reasons for taking the factors into account.

<i>Factor to be taken into account</i>	<i>Reason</i>
Take several replicates	To take account of the variability within samples.
Select fair treatments	To ensure fair comparisons.
Randomisation of treatments	To eliminate bias when measuring the treatment effects.

- (b) Give **one** precaution, not already mentioned, which would have to be taken so that the comparison of the yields from each cultivar was valid and explain the reason for it.

Same age of plant OR planting density / temperature / sunlight / CO₂ / same fertilizer / pesticide treatment OR same irrigation / soil ph/nutrients

Precaution _____

Reason _____

Effect rate of photosynthesis OR glucose produced OR rate of plant growth

2

12. Genetically modified (GM) crops are evaluated in field trials.

Certain experimental procedures are required when setting up field trials to compare GM and non GM crops.

Give **one** such procedure and explain how it allows valid conclusions to be drawn.

2

Procedure Same number of plants/volume of fertiliser/water applied

Explanation To ensure conditions are the same to be a valid comparison

Breeding Programmes & Field Trials

13. Write notes on plant and animal breeding under the following headings:
- (i) inbreeding 3
 - (ii) crossbreeding. 6

(i) inbreeding

1. Relatives are bred (for several generations).
2. (this) eliminates heterozygosity or increases homozygosity or population breeds true
3. inbreeding depression occurs
4. Inbreeding depression is an accumulation of deleterious, homozygous, recessive alleles.
5. inbreeding depression reduces reproductive success/reduces fertility/leads to poor reproductive rates.

(ii) crossbreeding.

- a. cross breeding is breeding different breeds/cultivars/varieties.
 - b. results in F1 hybrid.
 - c. offspring have improved/desirable characteristics/traits/alleles
- OR**
- offspring have characteristics from each parent.
- d. new alleles introduced.
 - e. crossbreeding produces a (uniform) heterozygous F1.
 - f. F1/hybrid/crossbreed has hybrid vigour.
- OR**
- F1/hybrid/crossbreed has increased vigour/disease resistance/growth rate/yield.
- g. F1/hybrids/crossbreeds are not usually bred together as F2/offspring are too varied.
 - h. parent breeds maintained to produce more crossbreeds.

(maximum 6)