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Module 7 Units 3 – 4

Agricultural Sciences

Agricultural genetics

This support pack for the **Agricultural genetics** module in the **Agricultural Sciences Grade 12 CAPS curriculum** provides valuable revision activities. All activities have the answers provided. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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Module 7 – Agricultural genetics

Unit 3 Selection

Short questions

1. Various possible answers are provided for the following questions.Write only the correct letter (A–D) next to the question number.

1.1 The proportion of observable differences between individuals due to genetics is ..... .

A mutualism
B heritability
C atavism
D biometrics

1.2 The survival of rabbits that can run faster and therefore escape the jackal more frequently, is an example of ..... .

A artificial selection
B natural selection
C mass selection
D pedigree selection

1.3 ..... is a selection method that focuses on the quality of the ancestors rather than on the individual.

A Artificial selection
B Natural selection
C Mass selection
D Pedigree selection

1.4 The most intensive form of breeding is ..... .

A inbreeding
B upgrading
C cross-breeding
D line breeding

1.5 The breeding of a mule is an example of ..... .

A species crossing
B in crossing
C cross-breeding
D natural crossing

5 × 2 (10)

2. Supply ONE word/term for each of the following descriptions. Write only the word/term next to the question number.

2.1 The study of measurable biological characteristics
2.2 The crossing of a bull with his daughter
2.3 The progeny that is born when a horse is crossed with a donkey
2.4 The sum of gene effects of a breeding animal as measured by the performance of its progeny
2.5 When people use selective breeding to produce new varieties of a species

5 × 2 (10)

3. Choose the description from column B that matches a concept in column A. Write only the correct letter (A–E) next to the question.

Column A		Column B	
3.1	Upgrading	A	The progeny displays a high degree of homozygocity
3.2	Inbreeding	B	Animals are more resistant to disease
3.3	Line breeding	C	Rapid system of breeding
3.4	Cross-breeding	D	Animals have high durability
3.5	Species crossing	E	Progeny are sterile
		F	Increased uniformity of appearance

5 × 2 (10)

Longer questions

4. Study the following information about the estimated breeding value (EBV) of two species of farm animal and answer the questions that follow.

Species	Characteristic	Heritability %
Boran cattle	Birth-weight Post-weaning weight Meat tenderness Lean meat Slaughter weight	38 30 65 38 90
Angora goats	Birth-weight Post-weaning weight Lean meat Fleece weight	35 60 35 12

4.1 Define the term 'estimated breeding value'. (2)
4.2 Define the term 'heritability'. (2)
4.3 Why is it useful for a farmer to know the heritability of a characteristic? (2)
4.4 What use does EBV have for a farmer? (2)
4.5 Compare how heritability and EBVs are expressed. (2)
4.6 As a boran cattle farmer, which most important characteristic would you use to select animals for breeding programmes to improve your herd? Give a reason for your answer. (2)
4.7 As a goat farmer, would a selection and breeding programme be useful for improving fleece weight in your flock? Give a reason for your answer. (2)
4.8 Name ONE other method apart from selection and breeding that a goat farmer could use to improve thefleece weight of a flock. (1)
4.9 Would selection and breeding for increased birth weight be more successful in beef cattle or goats? Give a reason for your answer. (2)

5. A Dorper sheep farmer wants to increase the weaning weight of his herd. The average weaning weight of the herd is currently 28 kg. The lamb farmer selects the ram and ewe with the highest weaning weight to start a breeding programme. The weaning weight of the ram is 32,5 kg and that of the ewe is 29,3 kg. The heritability of weaning weight in Dorper sheep is 70% (0,7).
5.1 Calculate the EBV of each parent. (2)
5.2 Calculate the combined EBV of the parents. (2)
5.3 Calculate the expected genetic gain. (2)
5.4 Calculate the expected weaning weight of the offspring. (2)
5.5 The actual average weaning weight of the offspring was 31.3 kg. Would you say that the breeding programme was successful? Give a reason for your answer. (2)

6. Answer the following questions about biometrics.

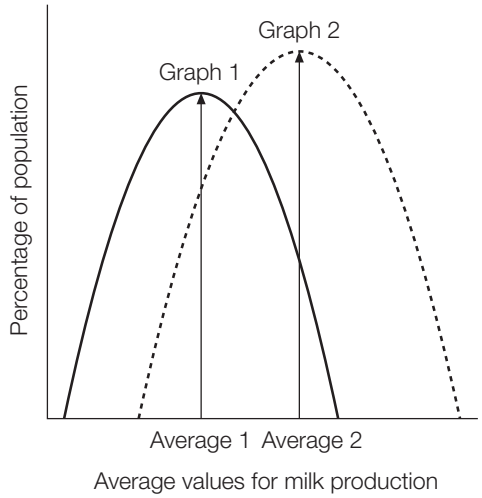
6.1 Explain the importance of biometrics for selection and breeding. (2)

6.2 Describe the advantages of the mixed model used in biometrics. (2)

6.3 What is the name of the mixed model used in South Africa to evaluate the genetic value of South Africa's livestock? (2)

6.4 What types of records does the model named in question 6.3 use? (2)

7. The two curves below represent the average milk production of a dairy herd (solid line) and that of a later generation of the same herd (dotted line)



7.1 Give a reason for the bell shape of the graph with the average in the centre. (3)

7.2 Give a reason for the higher average in the second graph (average 2) compared to that of the first graph (average 1). (2)

7.3 Deduce from the graph the part of the population (graph 2) that you would select for breeding purposes. (2)

Unit 4 Genetic modification or engineering

Short questions

1. Various possible answers are provided for the following questions.Write only the correct letter (A–D) next to the question number.

1.1 Genetic engineering is also called ..... .

A genetic manipulation
B genetic selection
C genetic translation
D genetic modification

1.2 The genes used in DNA technology are obtained from host cells called ..... .

A gene supplies
B gene donators
C gene factories
D gene laboratories

1.3 Genetic engineering utilises a process where the genetic material is ..... .

A removed
B inserted
C selected
D inoculated

1.4 Genetic engineering is the only existing tool available for producing ..... .
- **A** vaccines
- **B** drugs
- **C** both A and B
- **D** none of the above

1.5 One of the following is not an aim of genetic modification.
- **A** to increase resistance of plants to positive environmental influences
- **B** to improve appearance and flavour
- **C** to produce unfamiliar oil and plastic
- **D** to improve resistance to pests

5 × 2 (10)

2. Supply ONE word/term for each of the following descriptions. Write only the word/term next to the question number.

2.1 The type of breeding where plant a with a resistance to drought is crossed with plant b that has a strong root system

2.2 The system on which traditional breeding relies

2.3 The mineral in which genetically modified rice is rich

2.4 The process whereby restriction enzymes are used to cut and remove the gene of interest from the selected chromosome

2.5 The attachment of a second copy of an undesirable gene the wrong way around to make it inactive

5 × 2 (10)

Longer questions

3. Answer these questions about genetic engineering.

3.1 State TWO aims of employing the process of genetic engineering in plant breeding. (2)

3.2 List the six stages of the genetic engineering process. (6)

3.3 State TWO potential environmental benefits of this process. (2)

4. Answer the following questions about genetic manipulation.

4.1 List THREE reasons why genetic manipulation may be a solution for improving food supply. (3)

4.2 List THREE applications of the genetic modification of plants. (3)

4.3 Give TWO reasons why some people are supporters of traditional breeding of plants. (2)

4.4 Briefly describe TWO potential risks of GM crops. (2)

4.5 Give TWO reasons why each of the following plants is genetically modified:

4.5.1 maize (2)

4.5.2 rice (2)

Memorandum

Unit 3

Short questions

1.1 B **1.2** B **1.3** D **1.4** A **1.5** A (10)

2.1 Biometrics **2.2** Inbreeding **2.3** Mule **2.4** Progeny performance
2.5 Artificial selection (10)

3.1 C **3.2** F **3.3** A **3.4** B **3.5** E (10)

Longer questions

4.1 Estimated breeding value (EBV) is an estimate of how much better or less than average the offspring of an individual will be for a particular characteristic. (2)

4.2 Heritability is the degree to which a characteristic is determined by genetic factors, as opposed to environmental factors. (2)

4.3 It allows the farmer to know whether to concentrate on selection and breeding, or improve the environmental conditions on a farm. (2)

4.4 An EBV is a useful tool to help farmers to select which individuals to use for breeding. Selecting individuals with high breeding values gives a greater chance of success in a breeding programme. A positive breeding value indicates the offspring of an individual will be better than average. A negative breeding value indicates the offspring will be less than average. (2)

4.5 Heritability is expressed on a scale of 1–100%. A breeding value is expressed as a positive or a negative number. (2)

4.6 Slaughter weight (90% heritability) as it has the highest heritability and thereby has the highest probability of being passed on to offspring by the genes. (2)

4.7 No. Fleece weight has a low heritability (12%). This means that it is determined more by environmental factors than genetic factors. (2)

4.8 Better management – nutrition (1)

4.9 It should be more successful in cattle than in goats. In cattle, birth weight has a heritability of 38% and in goats it has a heritability of 35%. (2)

5.1 Average weaning weight of the herd = 28 kg
Weaning weight of the ram = 32,5 kg
Weaning weight of the ewe = 29,3 kg
EBV of ram = 32,5 – 28 = +4,5 kg
EBV of ewe = 29,3 – 28 = + 1,3 kg (2)

5.2 Combined EBV of parents: EBV of ram + EBV of ewe = 4,5 + 1,3 = 5,8 ÷2 = +2,9 kg (2)

5.3 Expected genetic gain = combined EBV of parents × heritability = 5,8 × 0,7 = 4,06 (2)

5.4 Expected weaning weight of offspring = average weaning weight of herd + expected genetic gain = 28 kg + 4,06 = 32,06 (2)

5.5 Yes. The breeding programme was a success because the actual average weaning weight increased. (2)

6.1 Biometrics is very useful for improving the accuracy of evaluating and selecting individuals for breeding programmes. (2)

6.2 The mixed model uses not only the performance of the individual, but also the performance of its parents and offspring. This greatly increases the accuracy of the evaluation. It also uses equations to eliminate the effects of environmental factors. (2)

6.3 BLUP (Best Linear Unbiased Prediction) (2)

6.4 It uses EBVs from the National Livestock Improvement Scheme. (2)

7.1 Most of the population produce at the average (number of population at the average value); some of the population produce above the average; some of the population produce below the average. (3)

7.2 The genes of the later generation improved with regard to milk production/there was a response to selection in this herd. (2)

7.3 The animals in the population that produce above the average (that produce the most milk). (2)

Unit 4

Short questions

1.1 D **1.2** D **1.3** B **1.4** C **1.5** A (10)

2.1 selective breeding **2.2** selection **2.3** iron **2.4** gene splicing **2.5** gene silencing (10)

Longer questions

3.1 Aims of genetic engineering (any two):

- Rapid improvement of genetic make-up
- Build in DNA from another organism to manipulate characteristics of plant
- Change the genetic make-up of a plant
- Change/improve the characteristics of a plant (2)

3.2 Stages of the genetic engineering process:

- The scientist finds and isolates the gene with the desired characteristics.
- The scientist makes several copies of the isolated gene.
- The scientist transfers the desired genes to the plants' own genes.
- The scientist checks the genetically modified tissue and creates a new plant using the tissue.

- The scientist checks that the inserted genes function as expected.
- The scientist also checks that the inserted gene appears in the plant's progeny. (6)

3.3 Potential environmental benefits of genetic engineering:

- Reduce the need for chemical spraying/herbicides
- Produce plants tolerant to extreme conditions (cold, drought, salinity). (2)

4.1 Reasons why genetic manipulation may be a solution for improving food supply (any three):

- Plants that can grow in drought
- Production yield is higher
- Pest-resistant plants
- Virus-resistant plants
- Cold-resistant plants (3)

4.2 Applications of the genetic modification of plants (any three):

- Resistant to drought
- Resistant to viruses
- Resistant to cold
- Resistant to pests (3)

4.3 Reasons for supporting traditional breeding (any two):

- No negative effects on human health
- No negative effects on environment
- No chance that new gene will end up in another plant gene (2)

4.4 Potential risks of GM crops:

- GMO crops have not been researched for long and may have a potential health risk.
- Some GMO crops are herbicide resistant and may contribute to the creation of super weeds. (2)

4.5.1 Maize (any two):

- Resistant to herbicides
- Resistant to drought
- Resistant to viruses (2)

4.5.2 Rice:

- Contains vitamin A
- Contains iron (2)