2021.M40

2021L024A1EL

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2021

Agricultural Science

Higher Level

Monday 21 June Afternoon 2:00 – 4:30

220 marks

Examination Number

Day and Month of Birth

For example, 3rd February is entered as 0302

Centre Stamp

Instructions

There are **two** sections to this examination.

It is recommended that you spend about 50 minutes on Section **A** and 100 minutes on Section **B**.

Section **A** Answer any **seven** questions from this section. There is internal choice in **four** questions.

Each question carries 10 marks.

Section **B** Answer any **three** questions from this section. There is internal choice in **two** questions.

Each question carries 50 marks.

Write your Examination Number and your Day and Month of Birth in the boxes on the front cover.

Write your answers in blue or black pen. You may use pencil for sketches, graphs and diagrams only.

Write your answers in the spaces provided to all parts of the examination into this answerbook. You are not required to use all the space provided.

There is extra space at the end of Section **A** and at the back of the booklet. Label any extra work clearly with the question number and part.

Section A — 70 marks

Answer any **seven** questions.

Each question carries 10 marks.

Question 1

(a) Identify each of the following plants.

A

B

C

A:
B:
C:

(b) Using a named example, other than the plants shown at part (a) above, distinguish between annual and biennial lifecycles.

Question 2 Answer **either** (a) **or** (b).

Herbicide resistance confirmed in wild oats

The wild oat is one of the most widely recognised weeds in Ireland's tillage fields. If left unchecked, this predominantly spring-germinating self-pollinating weed can substantially reduce crop yields due to its competitiveness.

Control of wild oats includes hand-rogueing, direct drilling, crop rotation and total herbicides. However, some growers report increasing control difficulties when using herbicides.

To investigate these reports further, Teagasc collected samples from six wild oat field populations that survived the use of the total herbicide. Teagasc found in all of the six cases the control of wild oats with these total herbicides did not work. This is extremely serious for future control of wild oats on these farms and it is vital to eliminate these weeds, or at least to contain these resistant weeds to the fields where they were found.

(Adapted from Farmers Journal, 2020)

(a) **(i)** Explain herbicide resistance.

(ii) State how direct drilling and crop rotation could control wild oats in a crop.

Direct drilling:
Crop rotation:

(iii) Describe **two** reasons for the importance of controlling these herbicide resistant wild oats in the future.

1.
2.

Or

(b) A student wanted to investigate the capillarity in both a compacted soil and an uncompacted soil.

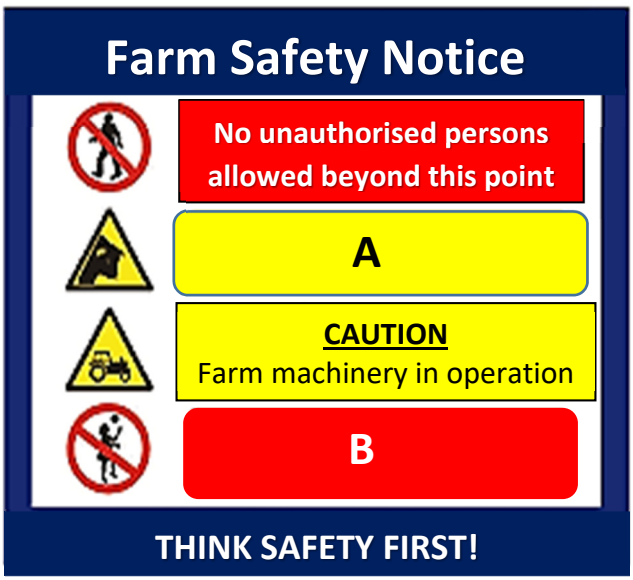
(i) State a prediction for this investigation.

(ii) Describe a suitable method the student could use to carry out this investigation.

(iii) Identify **one** way the student could improve the accuracy of this investigation.

Question 3 Answer **either** (a) **or** (b).

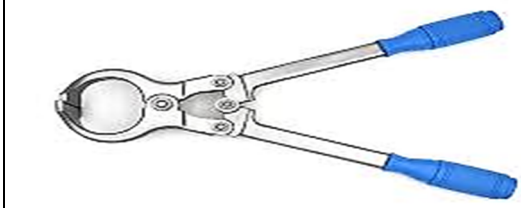
(a) The following is an example of a farm safety notice displayed at the entrance to a farm.



(i) State the meaning of symbols **A** and **B** on the sign.

A:
B:

(ii) State the function of **C** and **D**.

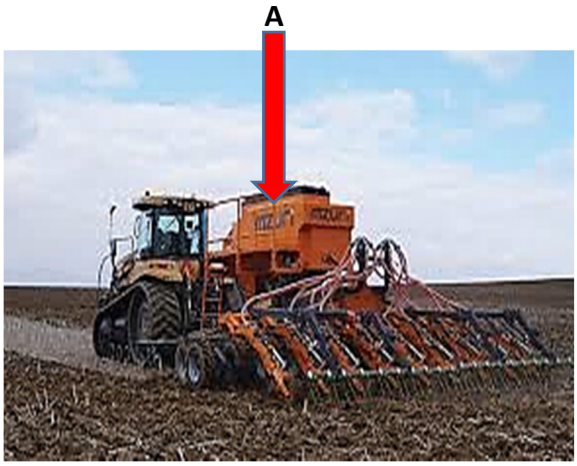
C	D
	

C:
D:

(iii) In relation to picture **C** at part (ii) above, state **one** advantage of using this piece of equipment to enhance sustainability of the farm.

Or

(b) **(i)** Identify the farm machines, labelled **A** and **B,** which are attached to each tractor**.**



A:
B:

(ii) The tractor in picture **A** is fitted with two tracks instead of four wheels. Suggest **one** advantage of using a tractor fitted with tracks.

(iii) State **one** way machine **A** can enhance environmental sustainability.

(iv) Outline **one** disadvantage of using machine (method) **B** when feeding high producing animals.

Question 4

Study the photograph of the farm layout below and answer the questions which follow.

(a) Identify **one** way in which the farm in the photograph could become more energy efficient.

(b) State **two** ways in which the farmyard is suited to economy of labour.

1.
2.

(c) Apart from your answer to part (a) above, suggest **two** ways in which the farmer could make the farmyard more environmentally sustainable.

1.
2.

Question 5

In relation to a catch crop **or** energy crop you have studied answer the following questions.

Name of chosen crop.

Named crop:

(a) Describe **two** ways in which the production of your chosen crop contributes to sustainability.

1.
2.

(b) Describe the damage caused by a named pest to your chosen crop.

Named pest:

(c) Describe the first **two** growth cycle stages of your chosen crop.

1.
2.

Question 6 Answer **either** (a) **or** (b).

(a) **(i)** Identify the part of the plant where respiration takes place by placing a tick (✓) in the correct box.

Ribosome	
Mitochondria	
Chloroplast	

(ii) Outline **two** ways in which a farmer can increase airflow through soil to allow for increased respiration in the rhizosphere.

1.
2.

(iii) Describe **two** ways soil compaction impacts on the physical properties of soil.

1.
2.

Or

(b) **(i)** Describe **one** role animal respiration plays in the carbon cycle.

(ii) Compare **two** effects of continuous tillage and permanent grassland on the soil organic matter content.

1.
2.

(iii) Suggest **two** ways a farmer could increase the amount of organic matter in soils.

1.
2.

Question 7

(a) All agriculture depends on biodiversity. Explain biodiversity.

(b) State **one** reason why biodiversity is important on Irish farms.

(c) Outline **three** ways in which farmers can increase biodiversity on their farm.

1.
2.
3.

Question 8

The following is a kill out sheet (lairage docket) for 2 Aberdeen Angus (AA) heifers and 2 Limousine (LM) heifers from John's farm. Analyse the sheet and answer the questions which follow.

Tag number	Breed	Sex	Age (months)	Conformation	Fat	Carcase Weight (kg)
217981261073	AA	E – Heifer	Under 24	O+	3+	308
235207471646	AA	E – Heifer	Under 24	R-	4-	321
215038714153	LM	E – Heifer	Under 24	R+	3+	367
214346622696	LM	E – Heifer	Under 24	U-	3+	385

(a) Briefly explain the term conformation.

(b) As part of the Bord Bia quality assurance scheme John gets a 20c bonus per kg for each animal in addition to the factory base price. Calculate the total amount John obtained for tag number 215038714153.

	Factory Base Price (cent / kg)			
	U- 3+	R+ 3+	R- 4-	O+ 3+
	395	395	380	375
Total amount / heifer (€)	1597.75	**?**	1284.00	1216.60

Calculation:

Total:

(c) John is also part of the Aberdeen Angus producer group which gives a 15c bonus per kg for in-spec cattle (Conformation U+, U=, U-, R+, R=, R-, O+, O= and fat class 2+, 3, 4-, 4=). Calculate which heifers were worth more money to John, the Aberdeen Angus or the Limousine heifers.

Calculation:

Heifers:

Question 9

(a) Explain genomic selection.

(b) Outline **two** advantages of using genomically selected animals in a named animal enterprise.

Named animal enterprise:

1.
2.

(c) Describe how farmers have made genetic improvements in their animal enterprise based on physical traits of their animals.

(d) Antibiotic resistance is a consequence of evolution via natural selection. Farmers have a major role to play in reducing the rise in antimicrobial resistance. Discuss **one** way in which farmers can reduce the need for antibiotic use on their farms.

Question 10

The Murphy family operate one of Ireland's sheep dairy farms in Co. Galway. They produce artisan products for a niche market. Their produce is available in approximately 50 shops and in some of Ireland's top restaurants.

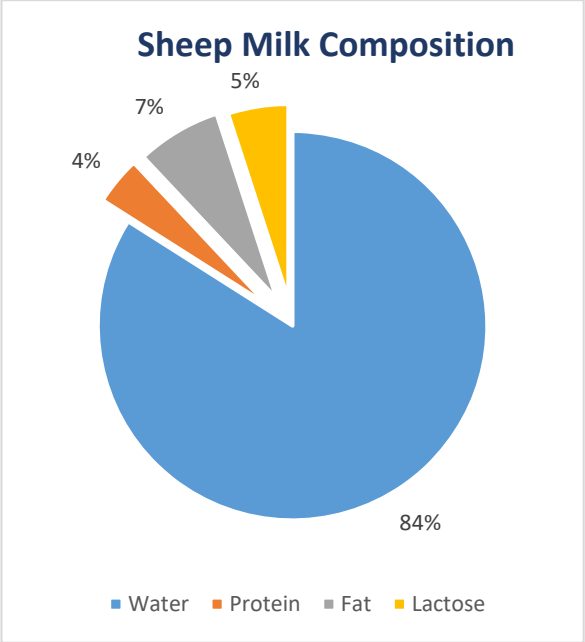
(a) Distinguish between artisan produce and a niche market.

(b) Suggest **two** reasons why sheep dairy farming is suited to Ireland.

1.

2.

(c) Compare the composition of sheep's milk shown in the pie chart to your knowledge of cow's milk in relation to the water content.



(Adapted from Nutritionbridge, 2020)

Question 11 Answer **either** (a) **or** (b).

(a) **(i)** Distinguish between the duration of oestrus and the oestrous cycle in cattle.

(ii) Identify the part of the female reproductive system where ovulation occurs.

(iii) Describe **two** advantages of artificial insemination (AI) in cattle **or** sheep **or** pigs.

Name of animal:

1.
2.

Or

(b) **(i)** Outline **two** differences between the monogastric and ruminant digestive systems.

1.
2.

(ii) Briefly describe a named disorder of the ruminant digestive system under the following headings.

Named disorder:

Symptoms:

Treatment:

Prevention:

Question 12

The manager of a 250 sow integrated pig unit was alerted that some of his young bonhams (piglets) were ill. On inspection of the bonhams, he noticed that they were breathing quickly, weak, had a scour and their skin was pale.

(a) Identify the disease that the bonhams are suffering from based on all of the symptoms described above.

(b) State the cause of the identified disease.

(c) Suggest how these bonhams could be treated for this disease.

(d) Describe **two** biosecurity practices carried out on Irish pig farms.

1.
2.

Additional writing space for **Section A**.
Label all work clearly with the question number and part.

Section B — 150 marks

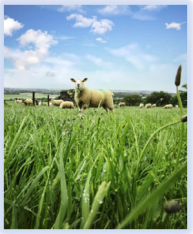
Answer any **three** questions.

Each question carries 50 marks.

Question 13 Answer (a) **with either** (b) **or** (c).

(a) Read the article about multi-species swards and answer the questions which follow.

UCD trials indicate increased ewe milk production and lamb weight gain in flocks grazing multi-species swards



The definition of multi-species, is a mixture composed of two or more species, consisting of grasses (e.g. perennial ryegrass and timothy), herbs (e.g. chicory and plantain) and legumes (e.g. white and red clover) used in grazing mixtures. The different species bring a range of benefits to the sward.

The main challenges with multi-species swards include ensuring persistency of the herbs and to a lesser extent, the legumes in the sward. Blanket herbicide application is not possible post-emergence as any herbicide that will kill broadleaf weeds will also kill the herbs, and finally establishment can be challenging particularly in the autumn.

(*Adapted from Irish Independent, 2020*)

(i) Identify **one** plant named in the article that can fix atmospheric nitrogen.

(ii) Outline **two** management practices farmers could employ to overcome the challenges of growing multi-species swards.

1.
2.

(iii) Name **one** grazing system that could be applied to a multi-species sward **and** outline **two** advantages of the named grazing system in managing the sward.

Name:
1.
2.

(iv) You are asked to address a group of farmers who are thinking about sowing a multi-species sward on their farm. Providing evidence from the article and with your own knowledge, construct an argument convincing them why it would be good to sow a multi-species sward on their farm.
Your plan should include at least **four** specific benefits.

(v) Describe an investigation a student could carryout to determine the botanical composition of the multi-species sward described in the article.

(b) Briefly explain the role of each of the following in the nitrogen cycle.

Nitrobacter:

Nitrosomonas:

Denitrification:

Or

(c) Evaluate the impact of **three** different crop management practices on all animals living in the farms ecosystem.

1.

2.

3.

Question 14

(a) Compare **two** different systems of animal production for a chosen livestock enterprise under the following headings at an identified stage in the animal's production cycle.

Name of production system	1.	2.
Identified stage of production cycle		

Housing:

Nutrition:

Production targets:

(b) **(i)** Identify each of the following cattle and sheep breeds.

A

B

C

D

A:
B:
C:
D:

(ii) In relation to **two** named breeds of pig **or** horse **or** poultry that you have studied, compare **two** characteristics of each breed which make them suitable for intensive production.

Name of breed	1.	2.

1.
2.

(iii) Discuss **two** factors that are taken into account when considering the welfare of calves in a calf to beef enterprise from birth to weaning.

1.
2.

(c) The following is a Beef HealthCheck report. The report is to assist farmers and their veterinary practitioners to control losses due to liver fluke and pneumonia through capture, analysis and reporting of abattoir data from post mortem meat inspections.

Analyse and interpret the report and answer the questions that follow.

Beef HealthCheck Report			
Liver results		**Lung Results**	
Liver lesions result in reduced performance		Lung lesions result in reduced performance	
Score		**Score**	
1	**Normal liver:** No liver abnormalities detected.	1	**Normal lung:** No lung abnormalities detected.
2	**Liver damage by fluke but no live fluke:** Fluke may not be observed because the animal was (i) treated and cured, (ii) has undergone 'self - cure' or (iii) live fluke may have been present but not observed.	2	**Limited lung damage:** This animal had limited lung damage as a result of pneumonia (viral / bacterial infection).
3	**Liver damage by fluke and live fluke:** Fluke may be present because the animal was (i) not treated, (ii) re-infected after a previous treatment, (iii) treated with a product that only kills adult fluke, leaving young fluke alive, (iv) given a product to which the fluke have become resistant.	3	**Extensive lung damage:** This animal had extensive lung damage as a result of pneumonia (viral / bacterial infection).
4	**Liver other:** Liver damage due to other causes, e.g. tumours.	4	**Lung other:** Lung damage due to other causes, e.g. abscess or tumour.
5	**Liver abscess:** may occur following gut damage from a high grain diet or as an infection from a 'navel ill' or other infection.		

Beef HealthCheck Report					
Tag	Sex	Age (months)	Carcase (kg)	Liver Score	Lung Score
IE 1234567-8-0001	E	20	330	1	3
IE 1234567-8-0002	C	22	360	3 / 5	1
IE 1234567-8-0003	D	40	400	2	1
IE 1234567-8-0004	B	44	500	1	2
IE 1234567-8-0005	E	19	340	3	1
IE 1234567-8-0006	C	20	350	2	4
IE 1234567-8-0007	D	56	410	4	1

A = young bull	B = bull	C = steer	D = cow	E = heifer

(Adapted from Animal Health Ireland, 2019)

(i) Determine the liver score for the farmer's 22 month old steer and state **one** conclusion you can make about the liver health of the steer based on the liver score.

Liver score:
Conclusion:

(ii) Determine the lung score for the 20 month old heifer and state **one** conclusion you can make about the lung health of the heifer based on the lung score.

Lung score:
Conclusion:

(iii) Comment briefly on the overall health of the seven animals based on the report.

(iv) Using evidence from this report construct an animal health plan for the farm in relation to future dosing, vaccinations and prevention of these diseases. Provide **three** recommendations for the farmer.

1.

2.

3.

Question 15

(a) A student carried out an investigation to compare how application rates and source of organic fertiliser in autumn will affect grass dry matter (DM), earthworm population and spring soil nutrient availability in the hope of increasing food production, in-line with *Foodwise 2025*.

(i) State a hypothesis for this investigation.

(ii) Identify the independent **and** dependent variables in this investigation.

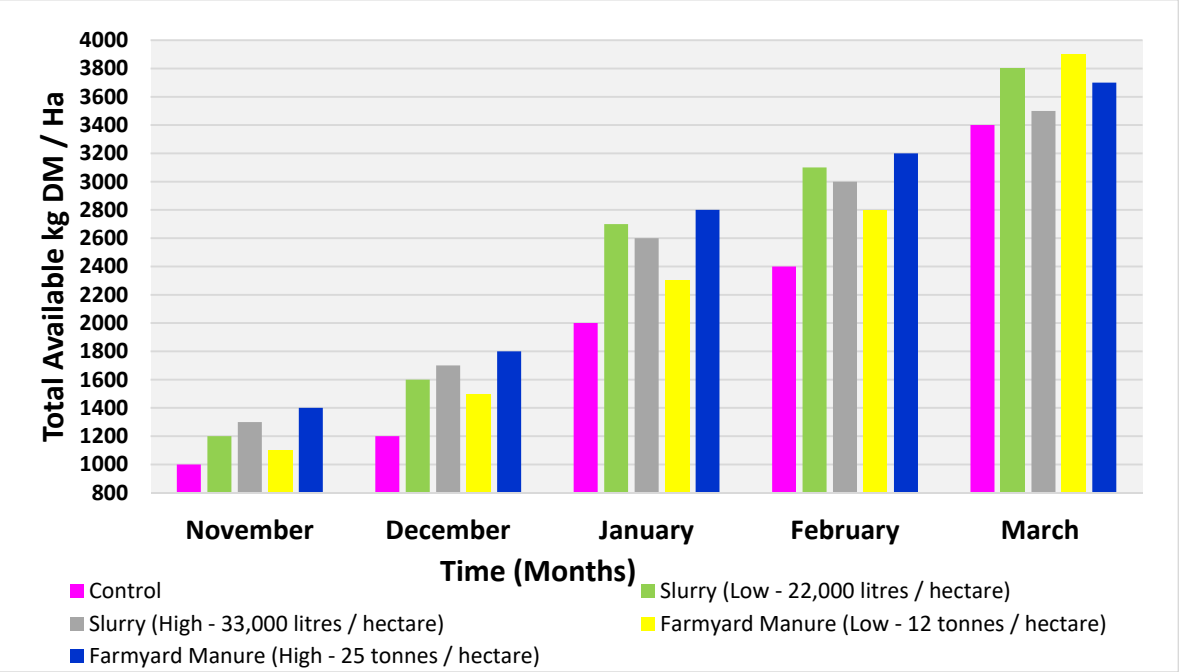
(iii) Describe **two** ways a farmer could spread slurry while reducing the impact on the environment.

1.
2.

(iv) The student determined the % DM of the grass.
Describe a method the student could have used to carry out this investigation.

(v) List **one** systematic error that could have occurred when the student was carrying out this investigation.

(b) The following is a graph of the student's results showing the total available dry matter (DM) over a five month period following the application of the organic fertiliser in the autumn. Analyse the graph and answer the questions which follow.



(i) Identify which treatment is the most beneficial organic fertiliser for a steady supply of herbage over the five month period.

(ii) Calculate the increase in kg DM / ha of herbage over the five month period for the treatment you have identified at part (i) above compared to the increase in the control treatment.

Most beneficial treatment calculations	Control treatment calculations

(iii) A beef farmer wants to have early spring grass for his spring calving herd to turnout in late February. Using evidence from the data, outline the advice you would give him in relation to the source and application rates of organic fertiliser.

(iv) Using the findings of the students investigation over the five month period, discuss what advice you would give the farmer in relation to the source and application rates of these organic fertilisers.
Your advice should include at least **three** specific recommendations.

1.

2.

3.

Question 16 Answer both (a) **and** (b) with **either** (c) **or** (d).

(a) Two dairy farmers (Dan and Joe) are comparing the amount of money they are getting paid for their milk. Analyse the data in the table and answer the questions which follow.

	Dan	**Joe**
Supply (litres, kg)	50,000 L (51,500 kg)	50,000 L (51,500 kg)
Protein **A** = €5.48 / kg	3.5 %	3.3 %
	1,803 kg	1,700 kg
	?	€9,316
Fat **B** = €3.35 / kg	4.45 %	3.96 %
	2,292 kg	2,039 kg
	?	€6,830
Processing cost deduction **C** = €0.04 / litre	€2,000	€2,000

(*Adapted from Agriland, 2019*)

(i) Calculate which farmer (Dan or Joe) earns a higher price for their milk.

Calculation:

Earns higher price:

(ii) Describe **two** ways a farmer could increase the % fat and protein content of their milk.

1.
2.

(iii) Joe received his monthly statement on milk quality and noticed that his total bacterial count (TBC) and somatic cell count (SCC) were higher than anticipated. Construct a plan for the advice you would give Joe in order to reduce the TBC and SCC levels in his milk in order to achieve the best quality milk. Your plan should include at least **three** specific recommendations.

Milk quality parameters	Joe's farm bulk sample results for 5/11/2020	Creamery advice
TBC	75,000 cfu / ml (cfu – colony forming unit)	51,000 – 100,000 cfu / ml Fair milk quality – bacteria present – investigate the cause and address the issues.
SCC	320,000 cells / ml	300,000 – 400,000 cells / ml Unstable control of mastitis and SCC. Review mastitis control.

1.
2.
3.

(b) Joe wants to investigate and get results in relation to the quality of a sample of milk over time. Describe, with the aid of a labelled diagram, how Joe could carry out this investigation in a school laboratory or on his farm.

Labelled diagram:

(c) Read the article on 'Sustainable Dairy Production in Europe' and answer the questions which follow.

Sustainable Dairy Production in Europe

The European Union's top priorities include at least a 40% reduction of the emission of greenhouse gases (GHGs) from 1990 levels, 27% improvement in energy efficiency and 27% share of renewable energy by 2030.

In Ireland, the Irish dairy sector acknowledges that sustainable development and climate change are pressing challenges that must be acted on and is committed to continuing to contribute to solving these issues while exporting our produce to over 155 countries worldwide.

(Adapted from Sustainable Dairy in Europe, 2019)

(i) Outline how the European Union would achieve their top priorities.

(ii) In relation to our export markets, state **one** reason why it is important for the dairy industry to ensure sustainable development.

(iii) Outline **two** characteristics of Irish food composition based on grass-fed animals.

1.

2.

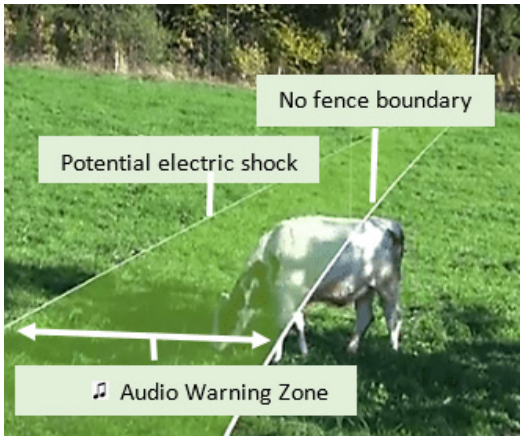
(iv) Discuss **two** management practices farmers can employ to ensure quality, safe and traceable food for the consumer.

1.

2.

Or

(d) The application of technology in Agriculture is increasing. Virtual fencing (VF) is one such technology; it enables the confinement or movement of animals without the use of fixed fencing. The VF system requires that the animals wear a Global Positioning System (GPS) collar which emits an audio warning when the animals approach the VF boundaries.



(Adapted from onpasture.com, 2018)

(i) Outline **two** advantages of using virtual fencing on farms.

1.
2.

(ii) List **one** disadvantage of using virtual fencing on Irish farms.

(iii) Describe **two** grassland management practices which should be employed to ensure beef cattle reach their target liveweight gain in their second summer.

1.
2.

(iv) State **one** safety consideration farmers should take during grassland management practices.

Question 17

(a) Soil sampling for analysis is important to determine soil index and fertiliser requirements.

Outline **two** procedures to be followed when taking soil samples for analysis.

1.
2.

(b) Below is a soil index reference sheet and two sets of soil sample results. Analyse the tables of results and answer the questions that follow.

Sample No: 554115	**Field 1 – Permanent pasture (mainly silage production)**							
Test Parameters	**Result**	**Very Low**	**Low**	**Normal**	**High**	**Target Value**	**Response to Fertiliser**	**Fertiliser Recommendations**
pH	5.3					6.5 – 7.5		
Lime Requirement t/ha	5.2							
Phosphorus (P) mg/l	1.77					8.00	Definite	39 kg/ha P
Potassium (K) mg/l	28.4					150	Definite	85 kg/ha K

Sample No: 554116	**Field 2 – Permanent pasture (main grazing block)**							
Test Parameters	**Result**	**Very Low**	**Low**	**Normal**	**High**	**Target Value**	**Response to Fertiliser**	**Fertiliser Recommendations**
pH	6					6.5 – 7.5		
Lime Requirement t/ha	3.75							
Phosphorus (P) mg/l	6.42					8.00	Unlikely	19 kg/ha P
Potassium (K) mg/l	157					150	None	0 kg/ha K

(i) Determine the P and K soil indexes for field 2.

Nutrient	Field 2
P	
K	

Reference Soil Index				
Soil Index	**Description**	**Response to fertilisers**	**Soil test range for each index (mg/l)**	
			P	K
1	Very low	Definite	0 – 3.0	0 - 50
2	Low	Likely	3.1 – 5.0	51 - 100
3	Medium	Unlikely	5.1 – 8.0	101 – 150
4	High	None	≥ 8.1	≥ 151

(ii) Suggest **one** reason why the P and K indexes in field 1 are very different to the P and K indexes for field 2.

(iii) Discuss the implications for the farmer of the low pH in field 1 in relation to liming and the uptake of nutrients.

(iv) Some macronutrients do not appear on the table. Identify any **two** other macronutrients and state their role in plant growth.

1.
Reason:
2.
Reason:

(v) Outline **two** ways in which farmers can increase the K levels on their land.

1.
2.

(vi) Briefly describe **two** ways a farmer can prevent P leaching from the soil and potentially damaging water quality.

1.
2.

(c) Cation exchange capacity (CEC) is a useful indicator of soil fertility.
Describe how a student would investigate the cation exchange capacity of a soil.

Labelled diagram:

Question 18

(a) Discuss the effect of each of the following on the productivity of a named crop, giving **two** points for each heading.

Named Crop:

Soil quality:
1.
2.

Crop preservation:
1.
2.

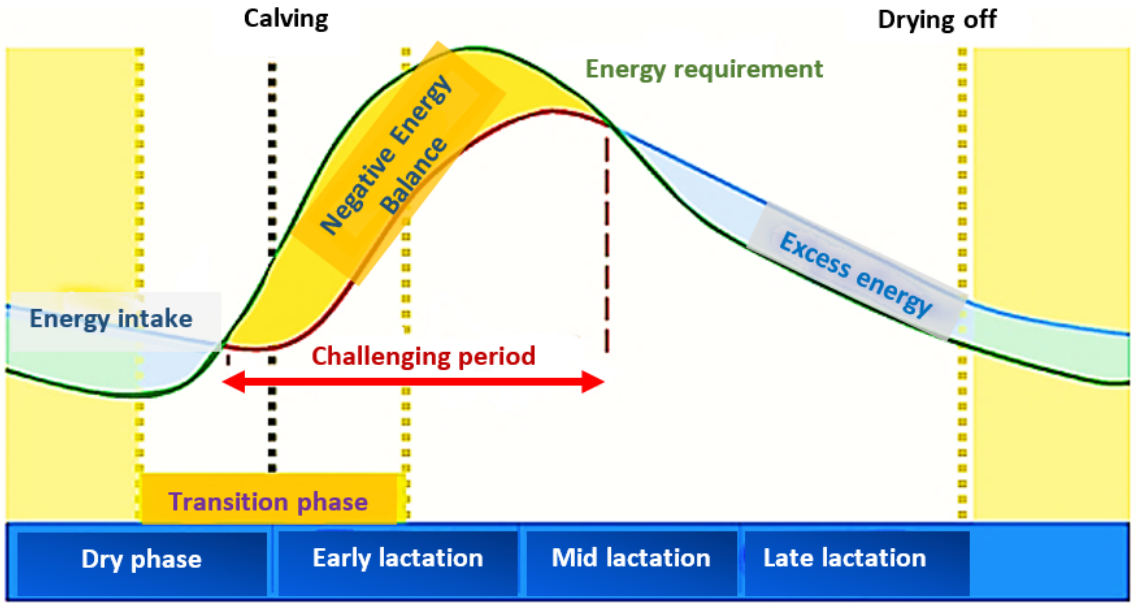
(b) A mixed tillage and dairy farmer in County Meath plans on increasing her dairy herd from 85 cows to 120 cows.
Discuss **three** challenges she will face in relation to sustainable intensification.

1.

2.

3.

(c) Analyse the graph showing the lactation period of a dairy cow and answer the questions which follow.



(Adapted from Shauman, 2015)

(i) Explain what is the drying off period.

(ii) Outline **one** reason for the negative energy balance in early lactation.

(iii) Suggest **two** ways a farmer could limit the negative energy balance in early lactation.

1.
2.

(iv) State **one** implication for the breeding season if the cows are still in negative energy balance.

(v) As the cows move to mid lactation their energy balance requirement switches to excess energy. Describe the feeding regime that you would implement at this stage, commenting on the feed type and level of concentrates.

(vi) State the length of the lactation period (in days).

(vii) Briefly describe **two** methods of heat detection used on Irish farms.

1.
2.

Additional writing space for **Section B**.
Label all work clearly with the question number and part.

Acknowledgements

Images

Images on page 3	irishwildflowers.ie; pixabay.com
Image on page 4	farmersjournal.ie
Image on page 5	pixabay.com
Images on page 6	safetysignsireland.ie; iherdman.com; spaldings.co.uk
Images on page 7	zerograzer.ie; fginsight.com
Image on page 8	teagasc.ie
Image on page 10	pixabay.com
Images on page 15	agronigeria.ng; nutritionbridge.com
Image on page 18	checinternational.org
Image on page 22	independent.ie
Images on page 27	suffolksheep.org; texel.uk; irishshorthorn.com; britishblue.org
Image on page 31	foodwise.ie
Images on page 35	medium.com; agriland.ie
Image on page 38	farmersjournal.ie
Image on page 39	onpasture.com
Image on page 40	teagasc.ie
Image on page 41	googlemaps.com
Image on page 45	shaumann.info

Texts

Text on page 4	*Herbicide Resistance Confirmed in Wild Oats.* <https://www.farmersjournal.ie/herbicide-resistance-confirmed-in-wild-oats-578319> - (21 October, 2020).
Text on page 22	*UCD Trials indicate increased ewe milk production and lamb weight gain in flocks grazing multi-species swards*. <https://www.independent.ie/business/farming/agri-business/ucd-trials-indicate-increased-ewe-milk-production-and-lamb-weight-gain-in-flocks-grazing-multi-species-swards-39287377.html> (16 June, 2020).
Text on page 38	Kavanagh, Zoe. *Sustainable Dairy in Europe*. < https://ndc.ie/wp-content/uploads/2019/06/FINAL-fact-book.pdf> (June, 2019).

Do not write on this page

Leaving Certificate – Higher Level

Agricultural Science

Monday 21 June

Afternoon 2:00 – 4:30