2013 Agricultural and Horticultural Studies GA 3: Written examination

GENERAL COMMENTS

Modifying climate and soil-growing media to maximise production was understood by most students at some level. Students were less able to provide a reasoned response to higher-order questions related to the modification of soils. Further work is needed in this area.

Students were required to choose a weed they had studied and outline prevention and control measures. While most students could state prevention and control measures, many responses lacked detail. The list of weeds that could be studied was published by the VCAA, and suggested websites cover biosecurity and integrated weed management for all weeds.

The use of specific ICT to help with the decision-making and monitoring of a weed was not well answered. A number of apps were mentioned, but their relevance was not evident.

The identification of pests and diseases and their subsequent signs/symptoms was generally well answered. The extended response on the creation of a biosecurity plan once again lacked rigour.

The understanding of a new or emerging technology in a horticultural or agricultural context is still not well understood by students. The study design defines a new or emerging technology as being no more than five years old, or one that it has been adopted by only a small number of agricultural and/or horticultural businesses. Answers such as GPS tractors indicate that students are not researching widely enough. Some students were able to state correct innovations, but were not able to explain how the technology works.

Most students were able to identify the greenhouse gases that contribute to climate change. Fewer were able to state two changes that could affect a business. Even fewer students could suggest a management option to minimise the impact of climate change. The connection between climate change (for example, less annual rainfall and its consequence, that is lower soil moisture content) and a subsequent mitigating practice (for example, plant an improved pasture species that can cope with lower moisture content) requires further study.

Students were required to select an agricultural or horticultural business and state what was required in a business plan. Most were able to outline some key points, but some were not as adept when giving examples of quality standards for their chosen business and ways of measuring them.

Environmental degradation and subsequent methods to either prevent or rectify is a large component of the study. Students were able to identify the various environmental degradation issues quite well. A method to rectify the problem and an explanation of how it works and how its success could be measured was not as well done.

The use of the scientific approach to set up a fertiliser trial to test a new formulation was not well understood by most students. More time needs to be spent on this area.

When preparing students for the examination, teachers must refer to the current *VCE Agricultural and Horticultural Studies Study Design* as well as the examination specifications and sample questions for Agricultural and Horticultural Studies. Students need to be able to apply their understanding to a range of land, plant and animal management techniques in agricultural and horticultural businesses throughout Victoria.

SPECIFIC INFORMATION

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.
The statistics in this report may be subject to rounding errors resulting in a total less than 100 per cent.

Question 1

Marks	0	1	2	3	4	5	6	Average
%	6	9	22	20	22	17	4	**3.1**

Increase the temperature of a glasshouse/polyhouse (any two of)

- install a heater, turn on a heater
- close the vents
- reduce shading
- change aspect
- increase thermal mass inside polyhouse – for example, concrete floor
- add heat mats

Decrease the humidity in a crop (any two of)

- do not use overhead water – use drippers
- introduce fans
- plant further apart
- increase airflow by pruning
- water at start of day, not night

Increase the water-holding capacity of potting mix or soil (any two of)

- add water-holding crystals, vermiculite, gypsum with compaction
- add organic matter, improve structure (worms, green manure)
- add clay

Question 2

Marks	0	1	2	Average
%	17	34	48	**1.3**

Students were required to state one advantage and one disadvantage of windbreaks in a grazing enterprise.

Advantages (any one of)

- reduce wind chill
- provide shade/shelter/protection
- reduce heat stress
- increased plant/stock production
- increased biodiversity
- soil protection reduced erosion
- improved appearance/aesthetics
- reduce water evaporation from dams and soil, leading to moister soils and better growth
- reduced heating and cooling losses in buildings

Disadvantages (any one of)

- reduced paddock size
- cost of establishment – fencing, plants, cultivation
- can harbour pest animals
- long-term degradation due to stock camping
- cost of maintenance – pruning
- lower moisture near trees

Question 3

Marks	0	1	2	3	4	Average
%	26	34	30	10	1	**1.3**

This question required students to explain the advantages and disadvantages of a fertiliser, rather than a legume, to improve a soil's fertility for a future crop.

Advantages of chemical fertiliser

- chemical fertiliser (for example, urea) is easily applied and gives a quicker response compared to establishing and growing lucerne/clover for a growing season
- flexibility – control rate of application
- can grow another crop sooner
- can control the composition

Disadvantages of chemical fertiliser

- nitrogen fertiliser is easily leached into waterways
- volatilisation of nitrogen fertiliser is also potentially a problem
- leaching
- can lead to acidification
- can reduce the fertility of soils over time

Advantages of legume phase (and therefore a disadvantage (relative) of fertiliser)

- Legume crops provide nitrogen for following crops by performing nitrogen fixation (when inoculated with the appropriate rhizobia).
- Lucerne can assist with dry land salinity by lowering the water table.
- It can provide a break in pest/diseases for other crops, and an opportunity to spray out a weed.
- Legumes can be turned into soil to improve structure.
- It increases organic matter, earthworms and beneficial micro-organisms and moisture retention.

Students were able to identify some advantages and disadvantages but were often not able to give a detailed explanation.

Question 4a.

Marks	0	1	2	Average
%	26	19	56	**1.3**

Students were required to identify two techniques to modify topography.

Techniques included

- laser levelling
- contouring
- terracing
- raised beds.

Question 4b.

Marks	0	1	2	Average
%	44	34	22	**0.8**

Students were required to explain the benefits of one of the techniques identified in part a.

- **laser levelling**: better control over water management; allows for precision irrigation, collection and recycling of irrigated water; reduces water entering and raising the water table
- **contouring**: reduced runoff; retains moisture in the soil; reduced likelihood of soil erosion; safer use of tractors and other vehicles; collection and recycling of irrigated water
- **terracing:** converts land that is too steep for cropping to land that can be cropped; increases the area available for crops; retains moisture; prevents the erosion of top soil
- **raised beds**: improved drainage; less water-logging; reduced impact of compaction if vehicles always use hollows between beds; easier maintenance for horticulture

Question 5a.

Marks	0	1	Average
%	48	52	**0.5**

A weed is **any** plant growing where the land owner does not want it to be. Students may also support their definition with a relevant example. The answer needed to include the term 'unwanted' or an equivalent word. A plant out of place was also accepted.

Question 5b.

Marks	0	1	2	3	Average
%	12	44	33	10	**1.4**

Weed control is essential to a business because

- weeds compete with the crop for light, nutrients and water
- weeds can be a harbour for disease if they are left untreated; for example, weeds can act as a bridge for rust infections in wheat
- untreated weeds can harbour pests and animals such as foxes and rabbits
- they can cause disputes between neighbours if left untreated
- they use stored moisture that could be used for crops in the next season
- they can decrease yields
- weeds can decrease the growth rate so that the harvest date is altered, and prices or demand decrease
- weeds can be toxic to stock
- seeds may infect quality standards; for example, numbers of weed seed may lead to loads of grain being downgraded
- weeds increase costs for control, as higher rates and more expensive spray regimes are used
- there are health effects from seeds and pollen; for example, asthma and hay fever
- seeds can get in wool.

Question 6a.

Marks	0	1	2	3	4	5	Average
%	10	29	30	19	12	1	**2**

Students were required to choose one weed from the table given. This question required students to highlight the steps involved in the development of an integrated management plan for each weed.

A general overview of Integrated Weed Management (IWM) is given below.

Strategies for all weeds should include

- an assessment of distribution and intensity of infestation, and monitoring of infestation
- decisions about treatment approach: physical removal; boom spray; spot spray; intense grazing; cultivation; mulching; competition by other plants (e.g. pasture improvement) and avoidance of reinfestation
- the steps that need to be covered include a system for managing weeds over a long period of time.

The plan is designed to reduce and minimise herbicide resistance.

Steps include

- review past actions
- assess the current weed status, and whether the infestation is affecting economic sustainability
- identify weed-management opportunities in the cropping system; for example, crop rotations or grazing opportunities
- timing of herbicide application
- rotation of herbicides so resistance does not increase – spot spraying
- mechanical means of control; for example, chipping, ploughing.

For IWM, the following steps should be considered.

- Accurately identify the weed as being a problem.
- Assess the scale of the problem (economic threshold).
- Prioritise the sequence for treating weedy areas.
- Plan the IWM program.

- Combine all available weed management options.
- When herbicides are used, repeated applications may be required for several years until the weed populations are below the economic injury level.
- To avoid/delay the onset of herbicide resistance, herbicide products with different modes of activity must be used on a rotational basis to reduce weed populations.
- Monitor and review the performance of all IWM practices – modify practices to achieve optimum weed management.

Some examples of treatments that could be incorporated in an answer are seen below.

Examples	Treatments
Deplete weed seed in target area soil seed bank.	• remove weed seeds in fallow, stubble and pre-sowing phase, done by reducing and destroying seed numbers • burning residues • encouraging insect predation of seed • inversion ploughing • delaying sowing until after germination of weeds so knock-down herbicides can be used
Kill weed seedlings in target area.	• before sowing or in crop • cultivation • knock-down herbicide • selective herbicides in crop • spot spraying of small infected areas • biological control
Prevent weed set.	• crop topping • spraying mature crop with knock-down herbicide • cutting hay • spot spraying
Prevent viable weed seeds from being added to the soil seed bank.	• collect weeds at harvest – bale, burn or use mechanical device • graze crop residues, animal dissection of seeds decreases their viability
Prevent introduction of viable weed seeds from external sources.	• ensure contractors remove residues from other farms • isolate and shear sheep before introduction to property • be sure of hay quality so that seeds are not re-introduced • feed hay in one area only • clean seed or used certified seed when sowing • if feeding stock grain that may have seeds, use a feed lot

This question was not answered well. Answers were often general, and did not include a comprehensive explanation of control measures.

Question 6b.

Marks	0	1	2	Average
%	72	21	8	**0.4**

Students were required to explain the use of an information and communications technology (ICT) for making decisions, monitoring and recording management of their selected weed.

Specific types of ICT applications can be seen below.

- evaluation of infestation level; mapping software, spreadsheet software to track changes
- mapping of infestation; GIS software
- information about local and regional level of infestation; departmental and weed CRC internet resources
- weather data guiding decisions about spraying and cultivation; BOM
- record-keeping software; various spreadsheets and accounting

- modelling of weed spread risk, modelling of weed population dynamics and crop-weed interactions, economic thresholds and DSS
- GIS applications and weed mapping

Student responses were not specific in regard to a specific ICT management tool and its application. A number of apps were mentioned, but their relevance to monitoring or recording of weed infestation was not evident.

Question 7a.

Marks	0	1	2	3	Average
%	19	34	23	24	**1.6**

Students were required to state whether the disease stated was a metazoal, microbial or metabolic disease.

Pests and diseases

Common name of pest or disease	Scientific name	Animal or plant it affects (host)	Class/Type
aphids	assorted species family: *Aphididae*	ornamental plants, vegetables	metazoal
coccidiosis	*Eimeria spp.*	poultry, cattle, sheep, pigs	microbial
one of the following: cattle lice sheep lice equine lice chicken body lice	 *Linognathus vituli* *Bovicola bovis* *Haematopinus asini* *Menacanthus stramineus*	 cattle sheep horses fowl	metazoal
hydatid tapeworm (hydatid disease)	*Echinococcus granulosus*	sheep, cattle, pigs, goats	metazoal
liver fluke	*Fasciola hepatica*	sheep, goats, cattle	metazoal
mastitis	The main mastitis pathogens are *Staphylococcus aureus, Streptococcus agalactiae* and *Streptococcus uberis.*	dairy cattle, sheep, goats	microbial
milk fever	hypocalcaemia	cattle, goats	metabolic
western flower thrip	*Frankliniella occidentalis*	ornamental plants, fruit and vegetable crops	metazoal

Students showed various levels of knowledge for this question. It should be standard practice that students know the type of disease-causing agent.

Question 7bi.

Marks	0	1	2	Average
%	13	43	44	**1.3**

One mark was awarded for one or two symptoms/signs listed. Two marks were awarded for multiple symptoms/signs listed and described.

Question 7bii.

Marks	0	1	2	Average
%	13	60	26	**1.2**

One mark was awarded for listing two effects. Two marks were awarded for listing two effects with a detailed explanation.

Question 7biii.

Marks	0	1	2	3	4	Average
%	24	26	28	20	3	**1.6**

Students were required to explain the reasons for having a biosecurity plan and then outline measures that could be incorporated into the plan for their selected pest or disease.

Reasons for having a biosecurity plan are outlined below.

- Effective biosecurity at the enterprise and industry level is considered to be extremely important in mitigating the risk of the introduction and/or spread of pest/diseases. This has been recognised by both industry and government as being particularly important in mitigating the risk of an emergent animal disease.
- A biosecurity plan contains all the measures that are utilised to mitigate the risks of disease entry or spread and all parties to the agreement are required to develop, implement and maintain a biosecurity plan/statement within their industry or jurisdiction. The plans/statements are endorsed by all other parties and undergo ongoing review and maintenance.

Students showed some understanding of the prevention techniques for their selected pest/disease. Many answers lacked detail. Many students were not able to fully explain what a biosecurity plan does.

For more details on pests and diseases, refer to the relevant DEPI website for Victoria.

Question 8a.

Marks	0	1	2	3	4	5	6	7	8	Average
%	14	9	17	8	20	5	18	3	5	3.4

Students were required to state four new and emerging technologies and provide a description for each.

Students continue to give examples of technologies that are not new or emerging, or not incorporated widely within the agriculture or horticulture fields. Some types of unacceptable technologies are listed below. It is not an exhaustive list but should provide guidance about what is not acceptable.

algae ponds	methane digester
artificial insemination (cervical/laparoscopic)	Nite guard predator deterrent
automatic calf/cow feeders	NLIS ear tags
automatic hay ring tipper	optiline drencher
automatic slaughtering machines	petrol post driver
autosteer tractor	refrigerated trucks
barley fish food	raised beds
bio-control agents	roundup-ready canola
CCTV	salt-tolerant wheat
drench capsules	sniffer bees
dung beetles for worm control	solar gates
Elders weather app/climate	solar panels
embryo transfer	solar-powered canola dryer
sexed semen	soy bean oil tires
feed-reducing methane emissions	swath control – variable spraying
fodder tech – sprout fodder	telematics
GM foods	tick-resistant cattle
GM	vaccination (CD-T toxoid)
GPS Tractors	vertical gardens
grape marc feed	wide-span tractors
laser levelling	wind turbines
LED lighting	

Students should be encouraged to explore the latest technologies being introduced into agricultural or horticultural businesses.

Question 8b.

Marks	0	1	Average
%	36	64	**0.7**

One mark was awarded if the technology being replaced was correctly identified.

Question 8c.

Marks	0	1	2	3	4	5	6	Average
%	28	14	17	21	12	6	3	**2.1**

Students were required to evaluate the positive and negative impacts of the new technology on all aspects of sustainability and explain why a business may or may not adopt this technology.

Students stated some of the positive and negative aspects of the technology, but often were not able to give examples in all sustainability areas such as economic, environmental and social. If not specifically stated, students were expected to always cover all three sustainability areas.

Question 9a.

Marks	0	1	2	3	Average
%	11	14	29	45	**2.1**

The question required students to list the major greenhouse gases linked to climate change.

- Cattle: One mark was awarded for methane or CH4 or CH_4.
- The use of nitrogen-containing fertiliser: One mark was awarded for nitrous oxide or N2O or N_2O, or laughing gas.
- The use of mains electricity in the milking shed: One mark was awarded for carbon dioxide or CO2 or CO_2.

This question was generally well answered.

Question 9bi.

Marks	0	1	2	3	4	Average
%	19	28	26	20	8	**1.7**

This question required students to identify two changes to the climate that could have an impact on the business. Students were asked to select from the list of businesses below.

- dryland cropping
- dairying
- irrigated fruit trees
- urban wholesale nursery

The table below outlines the likely changes to the climate and the subsequent impact on the business.

Change to the climate	Potential impact on the business
Dryland cropping	
decreased/increased rainfall	mostly reduced rainfall – reduced plant growth; crop failure; grain-filling failure
shifts in rainfall pattern	reduced plant growth if falling at wrong time; increased incidence of some pests, diseases, weeds; increased erosion; salinity
increased temperature	increased evaporation (or evapotranspiration) leading to reduced water and, therefore, reduced plant growth; plant heat stress; shortened season, reducing grain quality
increased rainfall variability	reduced plant growth if falling at wrong time; potential for increased incidence of weeds, pests and diseases
increased frequency of extreme hot days	plant death; damage to seeds and flowers; reduced grain quality
extreme events (wind, hail, fire, frosts, floods)	major damage; timing of activities; insurance costs
Dairying	
decreased rainfall	reduced plant growth; reduced availability of irrigation water; increased requirement for irrigation water; reduced on-farm feed; unsustainability in some regions
shifts in rainfall pattern	reduced plant growth at some times; reduced availability for irrigation water; reduced on-farm feed; unsustainability in some regions; increased incidence of some pests, diseases, weeds; increased erosion; salinity
increased temperature	plant stress; animal stress; milk storage requirement changes; change in pasture composition; reduced availability of irrigation water; increased requirement for irrigation water
increased frequency of extreme hot days	reduced plant growth; plant stress; animal stress; milk storage requirement changes
extreme events (wind, hail, fire, frosts, floods)	major damage
Irrigated fruit trees	
decreased rainfall	reduced plant growth; reduced availability of irrigation water; increased requirement for irrigation water; unsustainability in some regions
shifts in rainfall pattern	reduced plant growth at some times; reduced availability for irrigation water; unsustainability in some regions; increased incidence of some pests, diseases, weeds; increased erosion; salinity
increased temperature, reduced chilling	plant stress; post-harvest storage requirement changes; change in species/variety suitability; reduced availability of irrigation water; increased requirement for irrigation water; reduced chilling hours; damage to crop; crop failure
increased frequency of extreme hot days	reduced plant growth; plant stress; personnel stress; post-harvest storage requirement changes; damage to crop and flowers; crop failure
extreme events (wind, hail, fire, frosts, floods)	major damage
Urban wholesale nursery	
decreased rainfall	reduced plant growth; reduced availability of irrigation water; increased requirement/cost for irrigation water; unsustainability in some regions; change in customer requirements
shifts in rainfall pattern	reduced plant growth at some times; reduced availability for irrigation water; reduced on-farm feed; unsustainability in some regions; increased incidence of some pests, diseases, weeds; increased erosion; change in customer requirements
increased temperature, reduced chilling	plant stress; stock storage requirement changes; change in species/variety suitability; reduced availability of irrigation water; increased requirement for irrigation water; reduced chilling hours; damage to stock; increased power bills
increased frequency of extreme hot days	reduced plant growth; plant stress; personnel stress; stock storage requirement changes; damage/death to stock; reduced availability of irrigation water; increased

	requirement for irrigation water; increased power bills
extreme events (wind, hail, fire, frosts, floods)	major damage

Most students showed some understanding of the changes in climate and its likely impact on a specified business. Good answers related to the changes in climate, and focused on temperature and rainfall and their predicted variability. Students need to make a distinction between the change in climate; for example, reduced annual rainfall and its resultant effect – drought.

Question 9bii.

Marks	0	1	2	3	Average
%	42	34	20	4	**0.9**

Students were asked to suggest one management option that could be used to adapt the business to minimise the impact of climate change.

Examples of management strategies include the following.

Dryland cropping

- Consider earlier seeding and the use of varieties that have shorter growing seasons.
- Maximise water-use efficiency and soil moisture by using zero tillage, retaining crop residues and monitoring soil moisture to ensure any irrigation is optimised.
- Grow deep-rooted perennial crops where possible as they have the ability to improve water-use efficiency.

Dairying

- Consider climate-controlled production sheds through mechanical or natural air conditioning.
- Use misting in dairy yards.
- Change the calving pattern.
- Purchase dairy breeds that have improved heat tolerance.
- Build or maintain shelter and shade structures and/or re-establish shelter belts.

Irrigated fruit trees

- Increase the use of weather recording stations within horticultural growing regions for better predictive modelling for pests and diseases.
- Increase water storage capacity to better meet irrigation requirements.
- Improve water management technologies; that is, shifting from sprinkler to drip or micro-spray irrigation.

Urban wholesale nursery

- Improve water management technologies; that is, shift from sprinkler to drip or micro-spray irrigation
- Increase water storage capacity to better meet irrigation requirements.
- Build or maintain shelter and shade structures.
- Stock plants that tolerate reduced water requirements.

This question was answered poorly. Students were generally unable to suggest a relevant management strategy. The key question was how the farmer adapts their business to maintain production.

Question 10a.

Marks	0	1	Average
%	5	95	**1**

Students needed to name a product/service from their chosen enterprise.

Question 10b.

Marks	0	1	2	3	Average
%	19	37	24	20	**1.5**

This question required students to outline the key parts of a business plan that would need to be included for their business.

Students needed to include any three of the following.

- access to inputs
- production schedule
- timeline
- quality assurance
- marketing plan, including products to be supplied and market requirements
- establishment costs and ongoing production costs
- expected cash flows and returns

Most students showed some understanding of what was required in a business plan, but some answers lacked details.

Question 10c.

Marks	0	1	2	3	4	5	6	Average
%	14	4	15	16	14	11	25	**3.5**

Students were required to state two processes associated with the production of their product or service. They were then asked to state an occupational health and safety issue, regulatory or animal welfare issue associated with the process. A strategy to reduce the risk was also required.

Occupational health and safety issues could have included

- safe handling of machinery, correct licences and training
- handling large animals
- safe handling of chemicals.

Animal welfare issues could have included

- provision of required space for animals in intensive production
- provision of sufficient food/water
- maintaining proper health standards.

Regulatory issues could have included

- *Catchment and Land Protection Act 1994,* regarding water and noxious weed, chemical standards
- National Livestock Identification Scheme (NLIS)
- withholding periods.

Question 10di.

Marks	0	1	2	Average
%	33	61	6	**0.7**

A quality standard is 'a process or technique that sustains the quality of a product or service'. It consists of quality planning, data collection and analysis and implementation. It involves ongoing monitoring.

Question 10dii.

Marks	0	1	2	Average
%	34	45	22	**0.9**

For their selected business, students were required to give two examples of a quality standard.

Examples that were accepted included

- extent of blemishes on fruit
- protein level in grain
- inputs are free of disease
- water quality
- fat cover in livestock

- weight of animal within market specification
- quality of packaging
- monitoring of somatic cell count in milk
- protein content in milk.

Question 10diii.

Marks	0	1	2	3	Average
%	41	41	16	2	**0.8**

Students needed to explain how a producer could monitor the production process in order to meet the quality standards they identified in Question 10dii.

This question was poorly answered with many students unable to suggest any methods of monitoring quality standards.

Question 11a.

Marks	0	1	2	3	4	5	6	Average
%	8	5	9	9	14	18	38	**4.3**

Students were required to read a case study, identify three environmental degradation issues and provide evidence for each issue identified.

These included

- low soil pH
- algal blooms
- over use of nitrogenous fertilisers
- soil nutrient depletion/soil degradation
- soil erosion due to wind
- water logging
- soil compaction
- salinity.

Question 11b.

Marks	0	1	2	3	4	Average
%	20	21	27	22	11	**1.9**

After identifying the environmental degradation issue, students were required to state two techniques that could minimise land degradation.

The issues, evidence and techniques for rectifying the problem are listed below.

Issue	Evidence	Technique
soil pH is low	soil pH in cropping areas of 4.0 to 5.4 in grazing areas	• addition of lime will increase pH • ensure that legumes are not in rotation • decrease use of nitrogenous fertiliser or split applications of nitrogen • return plant materials to the paddock, i.e. retain stubbles, if hay is cut feed it back in the paddock • green manure or stubble incorporation
• overuse of nitrogenous fertilisers or nitrogen run-off into waterways • algal blooms	decrease in soil pH from 5.4 to 4, or algal growth in waterway	• split nitrogen application • use legumes in crop rotation • stop applying nitrogen fertilisers • use variable rate technologies to deliver nitrogen-based fertilisers to areas that are low in nitrogen only • use fertilisers that contain nitrogen but have less of an acidification effect, i.e. urea, ammonium nitrate or anhydrous ammonia • plant a buffer zone between the water's edge and paddocks where run off occurring • create a channel prior to streams, waterway's edge so that nitrogen-containing run-off is channelled into a catchment area
soil nutrient depletion/soil degradation	low organic carbon levels, decreasing soil pH, evidence of wind erosion	• low organic carbon levels – increase organic carbon levels by green manuring • retaining stubbles or stubble incorporation, mulching of stubbles • change of farm practice to minimum till or no-till methods • apply animal manure
overstocking	wind erosion due to stock powdering the soil	• decrease stock numbers as feed decreases • lock stock in a containment area and feed in a smaller area
wind erosion	soil blown up against fence lines	• decrease speed of wind at soil surface • retain stubbles • decrease stock numbers • addition of wind breaks • adopting minimum tillage or direct drilling techniques • control rabbit numbers as they can eat foliage and create warrens, diggings etc. loosen soilif erosion has started, rip the soil up so that furrows and large clods decrease, trap loose particles •

water logging/soil compaction	• water lies in low lying areas and growth of plants stunted in these areas • compaction, too much traffic through wet areas	• prevent stock and machinery from travelling across these areas when they are wet • deep rip to open up the soil • apply gypsum to improve drainage • plant deep-rooted crops in cropping area such as canola, and deep-rooted forage plants such as lucerne in grazing paddocks • increase organic matter to increase soil porosity and increase drainage
salinity, decrease in the depth of water table (below the soil surface)	• die-back of vegetation despite adequate rain fall • stunted growth of plants • animals camping in the area due to surface soil being cooler • appearance of white crystalline substance on soil surface	• plant salt-tolerant plants in these areas such as wheat grass and saltbush • deep ripping to improve drainage • use gypsum to improve drainage • pump salty water to the surface and allow to evaporate, perhaps sell the salt • laser levelling of paddocks to decrease recharge water entering in low lying areas • plant trees in higher areas to decrease the level of the water table

Question 11c.

Marks	0	1	2	3	4	5	Average
%	33	22	19	17	8	1	**1.5**

Student responses needed to be detailed to obtain full marks. The technique identified must have included a relevant discussion on how/why the technique would rectify the degradation issue and how the farmer could measure or see the success of the technique. The following table outlines possible techniques, how they work and how success could be measured.

Technique	How it works	Success measure
Farm management plan		
fencing according to soil type	Enables the paddocks to be treated uniformly according to their soil type; for example, there's no need to apply gypsum to a sandy soil.	Are yields increasing in the cropping areas? Have stocking rates increased, or are higher numbers being able to be kept for longer prior to sale? Increase in soil quality, i.e. increase in organic matter. Is the soil more friable, etc?
Low soil pH		
applying lime	Increases soil pH. Sandy soils are easier to increase than clay. Carbonate in lime reacts with acid in the soil, increasing pH.	Decrease in soil pH over a period of time.
decrease use of legumes in rotation	Legumes convert atmospheric nitrogen into a form of nitrogen the plant can use; e.g. nitrates or nitrites. This increases levels of soil nitrogen and decreases pH.	Is the pH of the soil increasing without legumes in the cropping cycle?
split applications of nitrogen	Add nitrogen at different times. Therefore plants can use what is added and excess not leached into waterways.	Measure soil pH. Is it increasing?
stop applying nitrogenous fertilisers	Will force plants to use available nitrogen in soil.	Measure soil pH. Is it increasing?
decrease plant removal from farm; for example, stubble retention or incorporation, green manuring	Most agricultural products are slightly alkaline; therefore, their removal leaves soil slightly more acidic.	Is maintaining the stubble or change in farming technique causing an increase in soil pH?
increase use of legumes in cropping rotation	Legumes convert atmospheric nitrogen into a form that plants can use. Soil nitrogen not used is bound up in plant tissue, may be used over successive seasons.	Over time, is the soil nitrogen level increasing?
use fertilisers that have less of an acidification effect	The amount of acid added to the soil by nitrogenous fertilisers varies according to fertiliser type. Most acidifying are ammonium sulphate, MAP and DAP. Less acidifying are urea, ammonium nitrate and anhydrous ammonia. Sodium and calcium nitrate are not acidifying.	Over time, does soil testing indicate an increase in soil pH?
stop applying nitrogenous fertilisers	Will force plants to use available nitrogen in soil.	Are amounts of nitrogen-based fertiliser purchases decreasing every year? Are costs decreasing?
use variable rate technology to deliver required amount of nitrogen to areas that require it	Delivers a set amount of fertiliser to areas of paddock dependent on yields from previous year and on soil testing. Areas low in nitrogen only given nitrogen-based fertiliser. This will decrease chance of run-off into waterways.	Are amounts of nitrogen-based fertiliser purchases decreasing every year? Are costs decreasing? Is there a decrease in nitrogen levels in the waterways?
split applications of nitrogen	Add nitrogen at different times and therefore plant can use what is added and excess is not leached into water ways	Measure soil pH. Is it increasing?
Soil nutrient depletion/low organic carbon (OC)		
increase soil carbon levels	Green manuring – incorporation of green crops or pastures into the soil increase organic carbon by decomposing and	• Over time, do soil tests indicate an increase in OC? • Has the appearance of the soil and

	supplying the soil with carbon.	texture improved over time? • Is the drainage of the soil increasing as OC levels are increasing? • Has fertility increased? • Has amount of soil biota increased (i.e. worms)?
retaining or incorporation mulching of stubbles	Incorporation into the soil increases OC by decomposing and supplying the soil with carbon.	• Over time, do soil tests indicate an increase in OC? • Has the appearance of the soil and texture improved over time? • Is the drainage of the soil increasing as OC levels are increasing? • Has fertility increased? • Has amount of soil biota increased? Are there worms?
change of farming practice to conservation tillage or direct drilling	Less soil disturbance and the retention of stubbles decreases the OC losses from the soil due to less exposure to air.	• Over time do soil tests indicate an increase in OC? • Has the appearance of the soil and texture improved over time? • Is the drainage of the soil increasing as OC levels are increasing? • Has fertility increased? • Has amount of soil biota increased? Are there worms?
addition of animal manures	Animal manures are high in organic matter, and hence OC, as well as other nutrients. Incorporation into the farm system boosts organic carbon levels.	• Over time, do soil tests indicate an increase in OC? • Has the appearance of the soil and texture improved over time? • Is the drainage of the soil increasing as OC levels are increasing? • Has fertility increased? • Has amount of soil biota increased? Are there worms?
Wind erosion		
decrease the speed of the wind at the soil surface	Grow windbreaks. A well-constructed windbreak diverts moving air over the top of the paddock or reduces the speed at which the air/wind moves over the paddocks surface.	• Has the height of the drift sand along fence lines decreased? • Is there less visible dust on windy days?
retain stubble by keeping a good cover on grazing paddocks	Root tissue helps to bind the small particles of soils together. Also decrease speed of wind on surface of paddock.	• Has the height of the drift sand along fence lines decreased? • Is there less visible dust on windy days?
decrease stock numbers	Stock cut the surface of the soil and loosen soil particles so that they can be shifted by the wind. Higher stock numbers increase the problem.	• Has the height of the drift sand along fence lines decreased? • Is there less visible dust on windy days?
use minimum tillage or direct drilling techniques	These practices minimise soil disturbance and hence the integrity of soil structure is maintained. These systems maintain a vegetative cover of the soil.	• Has the height of the drift sand along fence lines decreased? • Is there less visible dust on windy days?
control rabbit numbers	Rabbit diggings and warrens loosen the soil surface. Controlling numbers	• Has the number of warrens decreased? • Has the height of the drift sand along

	minimises soil disturbance and decreases susceptibility to wind erosion.	fence lines decreased? • Is there less visible dust on windy days?
ripping of soil	The throwing up of large clods of soil will trap loose particles and prevents them from travelling large distances.	• Has the height of the drift sand along fence lines decreased? • Is there less visible dust on windy days?
Overstocking		
monitor stock numbers in relation to vegetative cover, feed levels or amount of stubble	• Monitor stock numbers in relation to vegetative cover, feed levels or amount of stubble. If damage is noticed such as erosion, decrease in animal weight gain, baring out of areas, destruction of remnant vegetation, pugging in wet or compacted areas then decrease numbers. • Provide supplementary feed or place in feed lot or containment area. • Estimate carrying capacity of land depending on amount of fed.	• Has soil degradation decreased while numbers are maintained? • Are profits improving or at equilibrium despite numbers?
containment areas	Stock is kept in a specified area and kept off paddocks when feed levels and cover on paddocks are low or they are very wet. Only small areas of non-productive land are damaged by large numbers of stock. Can supplementary feed.	• By using the containment area, has the amount of soil compaction and wind erosion decreased over time? • Do remnant vegetation or grazing areas have more coverage and hence less soil degradation issues?
Water logging and compaction		
isolate wet areas	Prevent stock and machinery from travelling across wet areas and compacting the soil. Could also fence these off if required. Make machinery use designated laneways. Designated laneways also enable stock to be moved through less compaction-prone areas.	• Over time, has the amount of compaction decreased? • Has the water penetration in these areas increased? • Is crop germination better, and is crop or plant health improving?
deep ripping	Deep ripping causes the soil aggregates to be shattered or loosened after they have been forced together through machinery or livestock traffic. Soil pores are made larger.	• Over time, has the amount of compaction decreased? • Has the water penetration in these areas increased? • Is crop germination better, and is crop or plant health improving?
applying gypsum	The small particles that may be filling soil pores and affecting drainage or the small particles released after deep ripping can be made to join together by the addition of gypsum. Calcium ions cause small clay particles to adhere together, making larger soil aggregates and improving soil drainage.	• Over time, has the amount of compaction decreased? • Has the water penetration in these areas increased? • Is crop germination better, and is crop or plant health improving?
plant deep-rooted plants; for example, canola or lucerne	These plants have a large tap root that can help penetrate through the compacted soils and increase drainage and decrease compaction. In waterlogged areas they can utilise water from lower in the water table, thereby increasing drainage and decreasing water logging.	• Over time, has the amount of compaction decreased? • Has the water penetration in these areas increased? • Is crop germination better, and is crop or plant health improving? • Has the water table been lowered?

increase level of organic matter	Addition of organic matter, in the form of manures, green manuring and stubble retention help to build soil structure. Hence, the size of the pores between the soil aggregates, which improves drainage.	• Over time, has the amount of compaction decreased? • Has the water penetration in these areas increased? • Is crop germination better, and is crop or plant health improving? • Has the water table been lowered?
controlled traffic farming	Only pass heavy machinery over designated tracks in paddocks when sowing, spraying or harvesting. Do the same in grazing paddocks when fertilising seeding and spraying is occurring. It reduces areas where compaction occurs.	• Over time, has the amount of compaction decreased? • Has the water penetration in these areas increased? • Is crop germination better, and is crop or plant health improving? • Has the water table been lowered?
Salinity		
salt-tolerant plants	Can grow in areas of higher salinity than more common cereals and pasture plants. As they utilise water from the water table, the level of the water table may decrease, hence decreasing the recharge water from reaching the surface.	• Has the depth of the water table increased? • Is the area of salt scalding decreasing? • Is the stock camping elsewhere on hot days? • Is the die-back problem diminishing? • Can other volunteer plants that are not salt-tolerant survive?
improving soil drainage	Through deep ripping and use of gypsum you can enable water to penetrate through the hard pan and can drain through the water table. Flushing of the area with fresh water can then leach the salt away.	• Is the area of salt scalding decreasing? • Is the die-back problem diminishing? • Can other volunteer plants that are not salt-tolerant survive?
pump sub-soil water	Allows for evaporation. Could value-add by marketing salt if recrystallised and purified.	• Has the depth of the water table increased? • Is the area of salt scalding decreasing? • Is the die-back problem diminishing? • Can other volunteer plants that are not salt-tolerant survive?
laser levelling of the paddock	Removes low-lying areas. Decreases the amount of recharge water entering the water table in one particular area. Run-off could be caught in a dam and used for other purposes.	• Has the depth of the water table increased? • Is the area of salt scalding decreasing? • Is the die-back problem diminishing? • Can other volunteer plants that are not salt-tolerant survive?
tree planting in recharge area	Trees utilise soil water in various processes such as photosynthesis – hence removing it from the water table decreasing its level, and decreasing the amount of salt close to the soil surface. As the trees grow and the root system becomes more developed, the level of water in the low-lying areas should also decrease. Therefore, salinity decreases.	• Has the depth of the water table increased? • Is the area of salt scalding decreasing? • Is the die-back problem diminishing? • Can other volunteer plants that are not salt-tolerant survive?

Algal blooms		
use fertilisers that have less of an acidification effect	The amount of acid added to the soil by nitrogenous fertilisers varies according to fertiliser type. Most acidifying are ammonium sulphate, MAP and DAP. Less acidifying are urea, ammonium nitrate and anhydrous ammonia. Sodium and calcium nitrate are not acidifying.	• Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?
stop applying nitrogenous fertilisers	Will force plants to use available nitrogen in soil.	• Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?
use variable rate technology to deliver required amount of nitrogen to areas that require it	Delivers a set amount of fertiliser to areas of paddock dependent on yields from previous year and on soil testing. Areas low in nitrogen only given nitrogen-based fertiliser. Hence, decreasing excess and decreasing chance of run-off into waterways.	• Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?
split applications of nitrogen	Add nitrogen at different times. Then plant can use what is added and excess not leached into waterways hence increasing soil pH.	• Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?
plant shady trees on edge of waterway	Trees will use some of the nitrogen and shade will prevent water from increasing in temperature on hot days.	• Over time, is the water temperature at a lower average temperature? • Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?
plant a buffer zone of shrubs, grasses, etc., between the edge of the waterway and the paddocks where the run-off is coming from	The plants within the buffer zone will absorb and use the nitrates, etc., as they pass through the root system. It decreases the level of nitrogen containing compounds from reaching the water level.	• Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?
create a channel between the waterway and the paddocks. The channel may catch run-off water that contains nitrogen and divert it to a catchment dam	The channel prevents the water containing the excess nitrogen from entering the waterway. Channelling it into a dam means the farmer may utilise this water by pumping it back onto the paddock, so that nitrogen can be used by crops.	• Is the appearance of algal blooms decreasing? • Does water quality testing, i.e. for nitrates, show a decrease in the level of nitrogen?

Question 11d.

Marks	0	1	2	3	4	5	Average
%	47	24	16	10	3	0	1

The description of the small-scale trial should have included a discussion of the following points related to the setting up of a small-scale scientific test.

- choose different areas of the farm, not just the affected area as these can act as a comparison
- one area should be left untreated to act as a control
- several areas should be targeted so that repetition occurs to ensure more accuracy and decreases the chance of an incorrect or anomalous result
- treatment options should be various rates, depths, amounts and types of plants

- a statement of what suggested results may look like is required

The main components of a scientific experiment to help decide whether the new fertiliser was better than the old fertiliser include

- an aim or purpose for the investigation or formulation of an investigable question
- the design of the method to be undertaken to carry out the investigation
- identification of the variables within the experiment
- establishment of the controls against which the data is compared
- selection and use of appropriate materials
- safe and ethical processes when performing the investigation
- application of randomisation and repeatability when necessary
- recognition and elimination of experimental errors whenever possible
- identification of the relevant data to be recorded
- an understanding of how the data would be interpreted and analysed to show that the application of the new fertiliser was an improvement on the old.