2019 VCE Agricultural and Horticultural Studies examination report

General comments

The 2019 VCE Agricultural and Horticultural Studies examination covered all parts of the current study design. The 2019 examination was the final examination for the current study design, which is to be replaced in 2020 by the *VCE Agriculture and Horticultural Studies Study Design 2020–2024.*

Students showed good understanding of the modification of climate and soils. However, the effect of windbreaks on minimising soil degradation needed to be better understood along with other positive outcomes related to livestock.

The study design specifically covers forms of land degradation and prevention and control measures, but responses demonstrated limited understanding of some of these. Salinity as a form of land depredation needed further study.

Students were required to give an integrated management strategy for the control of a selected weed. Many students gave a response that was not specific, rather than presenting information on all aspects of the weed they had chosen to study.

Students were able to identify the operations undertaken on the farm that contribute to global warming; however, they could not describe how the effects of climate change will affect the productivity of their chosen business.

Quality standards and how they are measured quantitatively needs to be better understood by students. Teachers are encouraged to have students focus on several agricultural or horticultural industries, the products being produced and how they is grown to a specific quality standard.

Generally, responses needed to be more detailed. Many students were not able to give a considered response due to lack of understanding of the context of the question; practice in learning to interpret and answer questions thoroughly is encouraged.

Students needed 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 been included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

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Question 1a.

Marks	0	1	2	3	4	5	Average
%	1	4	10	32	32	20	**3.5**

Students were required to read a short scenario and then describe one possible technique to achieve each of the following outcomes.

Increase the water-holding capacity of a sandy soil:

- add organic matter, compost, humus
- mix in other soil types (clays or loams)
- add water-holding crystals
- add vermiculite

Minimise the turbidity of water in a dam that provides drinking water for livestock:

- use flocculating agents
- grassed waterways catchment
- filtration
- control storm water flows; reduce upslope erosion
- stock exclusion
- avoid bank erosion
- fence off the dam-control access
- add lime or gypsum
- add straw
- reduce algal growth
- reduce infestation of fish, such as European carp

Decrease the humidity in a glasshouse or polyhouse:

- minimise water use
- provide good air flow/fans/vent
- water in the morning

Maximise the germination of hard-coated seeds:

- add hot or boiling water
- abrasive sanding/nick (scarification)
- soak in water or acid solution
- expose to heat and smoke
- vernalisation/chilling
- passing through appropriate animals
- microwaving

Reduce the effect of wind on a cut flower crop:

- plant a windbreak
- align the rows across prevailing wind
- grow in polyhouse
- provide a wire support

Students generally showed good understanding in modification of soil and climate.

Question 1bi.

Marks	0	1	2	Average
%	44	42	13	**0.7**

Students were required to suggest how the management technique of planting windbreaks improves soil stability in a broad acre-cropping situation. Possible responses included:

- slows the severity of high winds at ground level
- minimises the wind force
- reduces the ability of the wind to move soil particles.

Many students incorrectly thought that it was the trees' root systems holding the soil together, rather than the trees slowing the wind down.

Question 1bii.

Marks	0	1	2	Average
%	49	27	24	**0.8**

Students needed to state one other soil management technique that Maxwell should consider in order to help stabilise his soil.

- stubble retention
- avoid cultivation/minimum tillage
- attempt to keep vegetation cover on the soil surface, especially during summer
- reduce stocking rates of livestock

Question 1c.

Marks	0	1	2	Average
%	8	54	38	**1.3**

Using the context of an agricultural enterprise producing prime lambs, students were required to state two benefits of introducing windbreaks. These included:

- provide shelter from rain and wind when ewes are lambing
- provide shade for stock
- reduce wind chill
- reduce heat stress
- increased plant/stock production
- increased biodiversity
- soil protection/reduced erosion
- improved appearance/property value
- reduce water evaporation from dams and soil
- reduce evapotranspiration from the pasture
- increase pasture growth
- reduce wind speed and erosion
- reduce spray drift from neighbouring properties

Most students could identify one benefit of windbreaks in this context.

Question 1d.

Marks	0	1	2	3	Average
%	8	39	41	12	**1.6**

Students needed to describe three benefits of using a green manure crop to improve the soil condition for growing a future crop. Possible responses included:

- improve soil structure
- provide a break in pests/diseases

- add organic material to the cropping area
- improve soil nutrient levels
- legume crops provide nitrogen
- increase organic matter, earthworms and micro-organisms
- aid in moisture retention

Question 2a.

Marks	0	1	2	3	Average
%	11	31	40	18	**1.7**

Students were required to outline one method of prevention or rectification that a land manager could use to address each of the following soil degradation issues.

Compaction/hardpan:

- Prevention:
  - reduce stock access – use lanes, rotational grazing
  - keep machinery on alleyways
  - minimum use of large machinery
  - minimum tillage – improves soil structure without creating a hardpan through traditional cultivation
- Rectification:
  - deep rip
  - improve organic matter – add compost or turn green manure crops
  - aeration

Salinity:

- Prevention:
  - fence off and maintain trees in recharge area for dry land salinity
  - fence out affected discharge area for dry land salinity
  - apply appropriate levels of irrigation water
- Rectification:
  - plant salt-tolerant trees/shrubs/pasture
  - fence off and plant trees in recharge area for dry land salinity
  - fence out affected discharge area for dry land salinity
  - pump water from water table to salt pan to lower water table

Acidity:

- Prevention:
  - apply nitrogenous fertilisers at appropriate levels and time of year
  - reduce plant/stock removed from property
  - reduce use of legumes in pastures
- Rectification:
  - apply suitable lime at 1–2 ton/Ha and incorporate, ideally with suitable biology

Students showed good understanding of the rectification of acidic soils, however, many students were not able to adequately explain the prevention or rectification of compacted or saline soil. The planting of deep-rooted trees was not an adequate response for rectification of saline soils.

Question 2b.

Marks	0	1	2	Average
%	15	38	47	**1.3**

Students were asked to suggest two benefits of improving organic matter content of soil or other growing media. Possible responses included:

- improves biological activity in soil
- provides nutrients for micro-organisms in the soil
- binds soil particles into aggregates for improved structure
- improves moisture-holding capacity
- improves nutrient-holding capacity
- increases crop growth and yield, therefore increases income

Question 2c.

Marks	0	1	2	3	4	Average
%	20	37	31	11	1	**1.4**

Students needed to explain the term ‘soil compaction’ and describe its impact on productivity.

Compaction of soil is the compression of soil particles into a smaller volume, which reduces the size of pore space available for air and water.

Impact on productivity:

- inhibits/prevents moisture penetration through the soil profile
- restricts plant root penetration
- limits soil moisture reserves
- may cause waterlogging
- increases water run-off
- potential to increase flooding when rainfall is high

This question was generally answered poorly. Many students explained how soil compaction is caused, rather than explaining what it is, demonstrating a need to read the question carefully.

Question 2d.

Marks	0	1	2	Average
%	51	35	14	**0.7**

Students were required to describe the possible impact of introducing high levels of grain into animals’ diet during a drought.

- can cause subacute ruminal acidosis (SARA) by reducing the pH of the rumen if wheat, barley or lupins are given
- loss of appetite
- lethargy, drowsiness
- isolation
- bloat
- diarrhoea, scouring
- rumen microbe death
- death
- increased feed costs
- lameness, warm feet

Most students were able to identify that the high grain overload would cause SARA, however, a number of students were not able to adequately describe the impacts on the animal.

Question 2e.

Marks	0	1	2	Average
%	55	32	13	**0.6**

Students needed to describe how Paula would manage her animals' health while feeding them high levels of grain. Possible responses included:

- Use a buffer such as bicarbonate/sodium bentonite/Rumensin to reduce the impact of sudden change in diet.
- Supplement the affected group with magnesium oxide, magnesium phosphate, and Epsom salts or other proprietary supplements that contain a form of absorbable magnesium.
- Feed cereal hay to maintain a balance between roughage and concentrate.
- Implement changes to diet slowly.
- Avoid feeding grains that may cause SARA (e.g. wheat).

Half of the cohort could not suggest a strategy to manage the livestock while being given a high grain diet. This metabolic disease was one of the prescribed diseases for 2019, and students should learn all aspects of disease management including prevention and control.

Question 3a.

Marks	0	1	2	Average
%	12	79	9	**1.0**

This question related to the prescribed list of weeds. Students were required to state which weeds from the prescribed list would particularly affect crops. These were:

- annual ryegrass
- brome grass
- wild radish

Question 3b.

Marks	0	1	2	Average
%	22	52	26	**1.1**

Students needed to select a weed from the list and state two ways by which their chosen weed could be spread.

Common name of weed	Spread by
Annual ryegrass (Wimmera ryegrass)	Hay, harvested seed, machinery, animals
Brome grass	Hay, harvested seed, machinery
Capeweed	Hay, machinery, carried on animals, wind
Gorse/furse	Birds, carried on animals
Serrated tussock	Hay, carried on animals, machinery
Wild radish	Hay, harvested seed, machinery

Most students could state one type of seed dispersal. It is important to know how a weed is spread as it allows farmers to undertake successful biosecurity measures.

Question 3c.

Marks	0	1	2	Average
%	21	40	39	**1.2**

Students needed to state two reasons why their chosen weed could have a detrimental impact on production in their chosen type of business.

Common name of weed	Problem for farmer
annual ryegrass (Wimmera ryegrass)	• Competes with crops • Contaminates crops and hay • Costs of control: herbicides, labour, machinery • Produces an extremely high number of seeds per plant • Highly competitive • Can be infected by ergot fungus • Many populations have developed resistance to both selective and non-selective herbicides
brome grass	• One of the most competitive grass weeds in cereal crops • Wheat yield can be reduced by 30–50% • Seeds contaminate grain. • Costs of control: herbicides, labour, machinery • Left uncontrolled in fallow, will act as a green bridge to cereal diseases
capeweed	• Competes with pastures • Contaminates hay (but not crops) • Costs of control: herbicides, labour, machinery • Can be poisonous for stock
gorse/furse	• Competes with pastures • Contaminates hay (but not crops) • Costs of control: herbicides, labour, machinery • Can cause injury to stock • Can contaminate wool
serrated tussock	• Competes with pastures • Contaminates hay • Costs of control: herbicides, labour, machinery • Can cause injury to stock • Can contaminate wool
wild radish	• Competes with crops • Contaminates crops • Costs of control: herbicides, labour, machinery

Question 3d.

Marks	0	1	2	3	4	5	Average
%	18	23	27	20	11	2	**1.9**

Students needed to explain how their chosen weed could be controlled in a grazing or cropping business using an integrated weed management plan. Responses should have included:

- one strategy that could be used to control the weed, including the specification of any herbicides if suggested.
- an outline that gives the timing for efficient management or control of their chosen weed.
- a method for monitoring and recording the integrated weed management plan to determine its success.

Common name of weed	**Strategy** **(include herbicide(s) if applicable)**	**Timing**
Annual ryegrass (Wimmera ryegrass)	Improving crop competition. Optimum sowing rates essential, as row spacing >250 mm will reduce crop competitiveness.	Sow early before weeds are established
	Burning residues to remove surface seeds and seedlings; avoid grazing crop residues. Use a hot fire back-burning into the wind.	Late summer/early autumn to achieve a hot burn
	Inversion ploughing to bury seed 100 mm deep. Use of skimmers on plough is essential for good results.	Autumn
	Autumn tickle: light cultivation to stimulate weed seed germination. Once weeds have germinated they can then be eradicated.	Autumn/winter Best when weed seedlings are eradicated immediately prior to sowing.
	Using herbicides. Avoid overuse of one herbicide group as resistance is a problem. Use Glyphosate before sowing crop/pasture. Add carfentrazone if annual ryegrass has fewer than two leaves.	Autumn/winter Best when weed seedlings are eradicated immediately prior to sowing.
Brome grass	A rotation of a break crop (especially herbicide-tolerant canola) followed by imidazolione-tolerant (Clearfield®) wheat.	Needs to span several years to reduce seed bank as seeds are viable for three years.
	Improving crop competition. Optimum sowing rates essential, as row spacing >250 mm will reduce crop competitiveness.	Sow early before weeds are established.
	Burning residues to remove surface seeds and seedlings; avoid grazing crop residues. Use a hot fire back-burning into the wind.	Late summer/early autumn to achieve a hot burn.
	Inversion ploughing to bury seed 100 mm deep. Use of skimmers on plough is essential for good results.	Autumn

Capeweed	In clover pastures, spray-grazing with 500–1000 mL/ha of 2,4-D amine(500 g/L) in winter or spray-topping with 500 mL/ha paraquat(250 g/L) at budding in spring for a number of years will lead to very low levels. Resistance to diquat and paraquat has been reported from Victoria.	Winter/spring
	Manual removal before flowering is effective.	Late autumn, winter
	Mowing is only effective if repeated regularly and close to the ground to prevent flowering.	Late autumn, winter
	Cultivation can be variable as capeweed transplants readily in wet conditions.	Autumn or winter when soil is dry
	Grazing is generally ineffective as a control technique but intense rotational grazing can be used to reduce the proportion of capeweed present.	Late autumn, winter
	Replant shrub and tall species to increase shade in disturbed areas.	Autumn, winter, spring
Gorse/Furse	Dozing, ripping and root raking is effective on established stands, providing cultivation, herbicides or grazing are used to control seedlings.	Any time of year
	Burning does not provide much control but it does encourage seed to germinate so it may then be killed by cultivation, herbicides or grazing. Stands are usually rolled or desiccated before burning to achieve a fire that is as hot as possible.	Best results in autumn
	Seedlings are sensitive to competition so vigorous pastures should be planted as soon as the major infestation has been controlled.	Autumn, winter, spring
	Several biological controls have been trialled including Gorse Spider Mite, Gorse Seed Weevil, Gorse thrips and the moth Anisoplaca ptyoptera, with variable results.	All need to be ongoing over several years. Application usually in spring or summer when weeds are actively growing and conditions favour the biological agents.
	Goats are particularly effective for controlling gorse seedlings and regrowth at stocking rates of 5 per ha. In patchy infestations sheep are used to consume pasture so the goats concentrate on the gorse.	Any time of year
	Mowing and slashing are generally ineffective because regrowth normally occurs.	Not generally used
	Metsulfuron, triclopyr, Grazon® and glyphosate are the most commonly used herbicides. These all work better when applied with an organosilicone surfactant such as Pulse® Penetrant or Silwet®.	Best when the plants are actively growing in spring and summer.

Serrated tussock	Implement farm hygiene strategies: Purchase stock from serrated tussock free areas. Use clean seed and clean machinery.	All year but particularly spring/summer when seeding occurs.
	Improving pasture competition. Optimum sowing rates essential. Fertilise and spread pasture seeds on treated areas.	Autumn or early winter (after autumn break)
	Plant shelter belts to reduce spread by wind from infested properties.	Autumn preferably so that can establish before summer but could be winter or early spring.
	Manual removal Remove odd plants by chipping.	Autumn to spring before seed is produced.
	Burn or slash top growth in winter, mouldboard or disc plough to 10 cm to turn tussocks over, then cultivate to control seedling in preparation for replanting to pasture (preferably perennial) in the following autumn/winter.	Winter
	Use Flupropanate, 2,2-DPA and tetrapion or flupropanate for chemical control.	Spot spray plants in spring to early summer.
Wild radish	Farm hygiene to prevent wild radish infesting clean areas. Do not use contaminated crop seed or feed contaminated produce.	All year
	Autumn tickle: light cultivation to stimulate weed seed germination. Once weeds have germinated they can then be eradicated.	Autumn/winter. Best when weed seedlings are eradicated immediately prior to sowing.
	Pre-emergence mixtures of metribuzin plus pendimethalin give good control of wild radish. Use of diflufenican-based products (e.g. Brodal®) is preferred. Diflufenican will remain in the soil for some weeks and control later germinating seeds. Larger vegetative plants should be treated with metosulam (e.g. Eclipse®) plus oil. Once the flowering stem has emerged, triasulfuron (e.g. Logran®) plus oil is preferred. At the hard dough stage of cereals 2,4-D may be used to reduce seed viability and twist radish plants down to the ground so the harvester may pass over the top of them. Just before harvest, green radish can be desiccated with diquat. Diuron plus MCPA is a useful alternative where resistance requires management.	Autumn In cereals, early control is required to gain the maximum yield benefits. Spraying at the three-leaf stage of wheat normally returns 4–5 times more yield than spraying at tillering. Winter/Spring Spring/Summer

Monitoring and recording general approach

Record extent of weed infestation before treatment period, at regular intervals during mitigation measures and after treatment period.

Monitoring:

- undertaken by a licensed weed contractor
- during spring over a set period
- weed audit to be conducted at the end of the treatment period to compare previous weed infestation levels with current levels.

Recording:

- conduct a weed audit and prepare a final summary report on the effectiveness of the weed management strategy.

It was obvious students had prepared an answer for a question on integrated weed management. A large number of students were unable to modify their answer to cover the point required, so many responses were generic in their content and not specific to the selected weed.

Question 4a.

Marks	0	1	2	3	Average
%	15	26	21	38	**1.9**

Students needed to refer to a table of prescribed pests and diseases and state whether they were metabolic, metazoal or microbial.

Type of disease/pest	Example
metabolic	subacute ruminal acidosis (SARA)
metazoal	aphids, intestinal worms, Queensland fruit fly, western flower thrip, rusts
microbial	mastitis, coccidiosis,

This question was generally well answered by students.

Question 4b.

Marks	0	1	2	Average
%	11	45	44	**1.3**

Students were required to list two symptoms or signs that would indicate the presence of their chosen pest or disease.

Common name of disease/pest	Symptoms or signs
aphids	• aphids are visible • wilting • discolouration • visible secrections • presence of ants • stunted growth

intestinal worms (ruminants)	• anaemia – eyes and gums • loss of condition • eggs in manure – use FWEC • dirty back end of animals – diarrhoea, scouring • barbers pole – lethargic, easy to push over
coccidiosis	Poultry: • blood in droppings • diarrhoea • weakness and listlessness • pale comb or skin • blood located at the vent site of the bird • decreased food or water consumption • ruffled feathers • weight loss (in older chickens) • decreased growth rate (in young chickens) • failing to lay eggs or laying eggs inconsistently Cattle and sheep: • foul-smelling, profuse scouring with or without blood in the faeces. • straining. • pale gums and membranes around the eyes (anaemia). Pigs: • Sows: No symptoms present. They are carriers. Lactating piglets: In the early stages, diarrhoea is the main symptom. In late stages, faeces can have different consistency and colour, which can vary from yellow to grey or green, or can have blood, depending on the severity of the disease. Dehydration is common. • Weaners and growers: Slow growth. Loose faeces, which is sometimes bloody.
one of wheat, barley, grapevine, rose rust	• discolouration of stems and leaves • stunted growth • streaky appearance of wheat leaves
mastitis	• swelling of udder • heat in udder • hardness, redness, pain in udder • milk watery, flakes, clots and/or pus
subacute ruminal acidosis	• decreased milk production • reduced fat • unexplained diarrhoea
Queensland fruit fly	• flies in traps • damage to fruit

Western flower thrip	• distortion of young leaves and fruit • spotting on flowers • yellow speckled areas on leaves • silvered appearance of older leaves • black spots of excrement on leaves • small insects in the flowers or on the undersides of young leaves in your crop

Most students could state at least one sign or symptom that the plant or animal exhibited.

Question 4c.

Marks	0	1	2	Average
%	17	52	32	**1.2**

Students were asked to suggest two effects that their chosen pest or disease would have on a type of agricultural or horticultural business.

Pest or disease	Business	Effects on business
aphids	ornamental plants, vegetable production, nurseries	• reduced productivity • visual look • vector for diseases • cost of control
intestinal worms (ruminants)	livestock enterprises	• reduced productivity • cost of control
coccidiosis	poultry, sheep, cattle pigs	• cost of control • loss of productivity • death of stock
one of wheat, barley, grapevine, rose rust	wheat, barley, grapevine, rose	• lower yield/value of crop • cost of control
subacute ruminal acidosis	cattle, sheep, goats	• reduced milk production • reduced productivity • cost of control • loss of stock
Queensland fruit fly	fruit and vines	• loss/lower value of fruit • reduced productivity • cost of control
western flower thrip	ornamental plants, fruit, vegetables	• loss/lower value of plants/fruit • reduced productivity • cost of control
mastitis	beef, dairy cattle, sheep, goats	• reduced milk production/quality of milk • cost of control • loss of stock

Question 4di.

Marks	0	1	2	Average
%	23	38	40	**1.2**

Students needed to state two examples of agricultural or horticultural enterprise inputs that are potential biosecurity risks. Possible responses included:

- plants/plant material
- potting mix
- seeds
- machinery
- new stock
- neighbouring stock
- wild birds
- hay
- manure in horticulture (not fertilisers)

Most students were able to state at least one input that could bring about a risk, but many had difficulty stating a second input.

Question 4dii.

Marks	0	1	2	Average
%	11	43	46	**1.4**

Students were required to state two techniques a farmer could use to manage a biosecurity risk due to visitors entering the farm. Possible responses included:

- clean overalls, hair nets, shoe covers for visitors/contractors/vets
- wash incoming machinery/tools/equipment used by visitors
- ask visitors if they have been in contact with relevant diseases/pests
- keep a log of visitors
- appropriate signage to warn visitors of the biosecurity status of the business

Most of the cohort could state one biosecurity measure that could prevent the introduction of a pest, weed or disease; however, many struggled to identify two.

Question 5a.

Marks	0	1	2	3	Average
%	68	25	6	0	**0.4**

Students needed to explain why it would be better for a property's fence line or boundary line to follow a natural feature, such as a ridgeline or waterway. Responses needed to cover:

- For ease of management and access, it is more desirable to align fence lines or boundary lines to follow natural features, rather than to cut across streams or ridgelines.
- More efficient management is possible when a paddock has a consistent soil type.
- Steep terrain may require different management procedures than flat.

Students generally did not score highly on this question, with only a third of the cohort showing adequate understanding. This concept should be covered more explicitly when learning about whole farm planning.

Question 5bi.

Marks	0	1	2	Average
%	34	47	19	**0.9**

Students were asked what indicators, other than plants, would be noticeable prior to any rehabilitation of waterlogged soil caused by a saline discharge area. Responses should have included:

- bare ground
- lack of structure
- easily eroded by wind/rain/water
- salt crust on surface

Question 5bii.

Marks	0	1	2	Average
%	68	32	0	**0.3**

The names of two plant species that are likely to be dominant prior to rehabilitation of waterlogged soil caused by a saline discharge area were required. These included:

- sea barley grass
- couch
- wheat grass
- puccinellia (sweet grass or salt grass)
- strawberry clover

Some students were able to state at least one salt-tolerant plant. When covering the topic of salinity, environmental plant indicators should be studied in detail.

Question 5ci.

Marks	0	1	2	3	Average
%	29	59	10	2	**0.9**

Students were given a scenario and asked to suggest three factors that could have prompted the advice given. Possible responses included:

- pH 6.0 and lower
- low calcium levels
- low clover presence or clover not persisting
- low CEC (cation exchange capacity)
- indicator grass/weed species like couch grass/sheep sorrel/oxalis
- signs of calcium deficiencies (chlorosis of new leaves, necrosis along the edges of leaves and death of leaf buds)

Question 5cii.

Marks	0	1	2	Average
%	28	52	20	**1.0**

Two benefits of crop rotation for future cereal crops were required from students. Possible responses included:

- help fix organic nitrogen for the benefit of the clover and any following crop/pasture/plant

- green manure
- increases soil fertility
- increases crop yield
- increase in soil nutrients
- limits concentration of pests and diseases
- reduces the stress of weeds
- improves the soil structure

Students were generally able to state the benefits of crop rotation for cereal crops.

Question 5di.

Marks	0	1	Average
%	73	27	**0.3**

Students needed to state what documentation must accompany the sale of livestock. Possible responses included:

- NVD (National Vendor Declaration)
- eDec
- Pig Pass

Question 5dii.

Marks	0	1	2	3	Average
%	6	5	31	57	**2.4**

Students were asked to name three species of ruminant animals that are likely to be found on a farm. Possible responses included:

- cattle
- sheep
- goats
- deer

Question 5diii.

Marks	0	1	2	3	Average
%	21	21	18	40	**1.7**

Students needed to state three vital welfare issues that must be addressed when managing livestock. Responses should have covered three of the following:

- clean water, adequate feed and shelter
- replacement, reduction, and refinement
- freedoms of animal welfare:
    - freedom from hunger and thirst
    - freedom from discomfort - an appropriate environment including comfortable shelter
    - freedom from pain, injury or disease
    - freedom to express normal behaviour
    - freedom from fear and distress

Most students were able state two or more welfare issues related to livestock.

Question 6a.

Marks	0	1	2	Average
%	5	27	68	**1.6**

Students were required to name two specific new or emerging technologies that provide improvement to agricultural or horticulture enterprises. The study design defines new technology as having been readily available for fewer than five years and emerging technology as still in the developing stages and not yet commercially available. Some possible technologies included:

- Virtual fencing (eShepherd)
- (Integrated) Harrington Seed Destructor
- MooCall Calving Sensor
- Flowhive
- RIPPA Ag Robot

Question 6b.

Marks	0	1	2	3	Average
%	15	25	46	14	**1.6**

Students were required to describe how one of the technologies named in part a. works.

Virtual Fencing (eShepherd)	• The system includes a collar containing GPS and a means of delivering an audio signal and a pulse. • GPS boundaries are loaded into the collar. Using Google Maps and a computer or tablet, virtual boundaries can be set to a specific point on the property. • When the animal approaches the virtual fence, the collar emits a beeping warning. If the animal continues towards the virtual boundary, the device will deliver a single pulse.
(Integrated) Harrington Seed Destructor	• The chaff stream from a combine harvester is intercepted and fed directly into a high speed mill that pulverises the chaff including weed seeds. • The pulverised chaff and seeds are returned to the field
MooCall Calving Sensor	• A sensor is mounted at the base of the tail. • The sensor gathers hundreds of pieces of data a second. • It can accurately predict when your cow is most likely to give birth by measuring tail movement patterns triggered by labour contractions. • When contractions reach a certain level of intensity over a period of time it sends a text alert to a phone on average one hour prior to calving.
Flowhive	• Flow Frame is the self-contained food grade plastic honeycomb frame that hangs in the Flow Super. • This has the patented ‘split cell’ technology, allowing a beekeeper to harvest honey without opening the hive. • A Flow Key is inserted and turned through 90 degrees to split the flow frame cells containing the honey. • The honey flows down through the split cells and drains out into a container. • After the honey has drained out the frame is reset using the Flow Key.

RIPPA Ag Robot	• Has onboard computers and sensors using GPS to navigate. • It is trained to learn the layout of the rows of vegetables and traverses the rows autonomously. • Cameras linked to software monitors crops for weeds, pests and health factors. • Monitoring is then used to autonomously determine actions such as spraying weeds or fertilising.
Auto drench gun (e.g. Te Pari G20)	• The Te Pari G20 is an electronic, battery operated drench gun. • The dose rate can be set manually or the gun can be connected by wi-fi to electronic scales so that dose rates can be calculated automatically for each animal.

Students were generally able to describe how their chosen new or emerging technology works, including its functions and operation.

Question 6c.

Marks	0	1	2	3	Average
%	23	40	24	13	**1.3**

Students were required to identify an agricultural or horticultural enterprise where their chosen technology could be used and explain how this will impact on the sustainability of the enterprise.

Responses depended on the technology selected, and may have included, for example:

- reduce the use of fertilisers, herbicides and pesticides
- reduce the use of fossil fuels
- improve soil fertility/structure (e.g. Harrington Seed Destructor)
- improve animal welfare (e.g. Flow Hive, MooCall)
- improve working conditions for staff
- reduce labour costs
- improve productivity

Most students were able to state an environmental, social or economic impact related to their chosen technology, however, few were able to state all three.

Question 6d.

Marks	0	1	2	Average
%	25	56	18	**1.0**

Students were asked to describe the old technology or methods used before the chosen new or emerging technology was introduced, including its functions and operation.

Responses depended on the technology selected, and may have included, for example:

- Harrington Seed Destructor: the old technology was to burn stubble or use cultivation or herbicides.
- Flow hive: the old technology involved opening the hive and removing the frames.

Most students were able to describe the old technology in simple terms but were unable to give a complete description.

Question 6e.

Marks	0	1	2	Average
%	35	46	19	**0.9**

Students were asked to give one advantage and one disadvantage of their chosen new or emerging technology for an agricultural or horticultural enterprise, excluding cost.

Responses depended on the technology selected, and may have included, for example:

Harrington Seed Destructor

Advantage: burning stubble reduces the amount of organic matter being returned and recycled to the soil. By not burning stubble, the soil has higher organic content.

Disadvantage: the Harrington seed destructor is heavy and thereby contributes to soil compaction as it moves across the field.

Flow hive

Advantage: does not open the hive; therefore, less disturbance to the bees and more efficient.

Disadvantage: being a different system, staff and management would need special training to be able to use the system.

Most students were able to state one advantage or disadvantage; however, many had difficulty in identifying a second.

Question 7a.

Marks	0	1	2	3	4	Average
%	17	21	26	19	17	**2.0**

Students were required to select a business type and explain two ways in which their chosen type of business could contribute to climate change. Possible responses included:

- production of CO_2 by combustion of fossil fuels in vehicles such as tractors and transport vehicles
- clearing of agricultural/horticultural land and trees
- production of N_20 by overuse of nitrogen-based fertilisers
- production of methane by ruminant digestion
- production of methane from effluent
- increased methane production with grain-fed animals.

Question 7b.

Marks	0	1	2	Average
%	20	62	17	**1.0**

Students were required to select a climate change issue and then identify two impacts that their selected climate change issue could have on production in their chosen type of business. The following table indicates possible responses.

Change to the climate	Impacts on irrigated vegetable production
increase in mean temperatures	• increased evaporation (or evapotranspiration) leading to reduced water and reduced plant growth • plant heat stress • reduced availability of irrigation water • increased requirement for irrigation water • reduced chilling hours • increased plant growth due to higher temps and CO_2 levels • earlier maturation/bolting
decrease in average annual rainfall	• reduced plant growth • potential of crop failure • reduced availability of irrigation water • increased requirement/cost for irrigation water
shift in rainfall patterns	• reduced plant growth if falling at wrong time • increased incidence of some pests, diseases, weeds • increased erosion • salinity • reduced availability for irrigation water
increased frequency of very hot days	• plant death • damage to foliage and flowers • reduced plant growth • plant stress • reduced bee pollination activity
increased incidence of extreme weather events	• major damage to crops and infrastructure • timing of activities
Change to the climate	**Impacts on dryland cropping**
increase in mean temperatures	• increased evaporation (or evapotranspiration) leading to reduced water and reduced plant growth • plant heat stress • shortened season, reducing grain quality/quantity • higher protein levels may be experienced
decrease in average annual rainfall	• reduced plant growth • crop failure • grain-filling failure • higher protein levels may be experienced

shift in rainfall patterns	• reduced plant growth if falling at wrong time • increased incidence of some pests, diseases, weeds • increased erosion • salinity
increased frequency of very hot days	• plant death • reduced grain quality • reduced plant growth • plant stress • loss of crop due to fire
increased incidence of extreme weather events	• major damage • timing of activities • potential increased frost damage
Change to the climate	**Impacts on animal production**
increase in mean temperatures	• increased evaporation (or evapotranspiration) leading to reduced water and reduced pasture growth • animal stress: loss of production, fertility rates • change in pasture composition • reduced availability of pasture irrigation water • increased requirement for irrigation water
decrease in average annual rainfall	• reduced pasture growth • reduced availability of irrigation water • increased requirement for irrigation water • reduced on-farm feed
shift in rainfall patterns	• reduced plant growth if falling at wrong time • increased incidence of some pests, diseases, weeds • increased erosion and salinity • reduced availability for irrigation water • reduced on-farm feed • unsustainability in some regions
increased frequency of very hot days	• plant death • damage to seeds and flowers • reduced grain quality • reduced plant growth • plant stress • animal stress • milk storage requirement changes • loss of natural vegetation and windbreaks
increased incidence of extreme weather events	• major damage • hail damage • timing of activities • insurance costs

Change to the climate	Impacts on plant nursery business
increase in mean temperatures	• increased evaporation (or evapotranspiration) leading to reduced water and reduced plant growth • plant heat stress • shortened season • reduced availability of irrigation water • increased requirement for irrigation water • reduced chilling hours
decrease in average annual rainfall	• reduced availability of irrigation water • increased requirement for irrigation water • change in customer requirements
shift in rainfall patterns	• increased incidence of some pests, diseases, weeds • reduced availability for irrigation water • increased requirement for irrigation water
increased frequency of very hot days	• damage to foliage and flowers • reduced plant growth • plant stress • plant death increased requirement for irrigation water
increased incidence of extreme weather events	• major damage to plants and infrastructure • hail damage • timing of activities

Most students could state only one impact their chosen climate change issue could have on production in their chosen type of business.

Question 7c.

Marks	0	1	2	Average
%	24	50	26	**1.0**

Students were required to suggest two changes that a farmer in their chosen type of business could make to better cope with the selected climate change issue.

Change to the climate	Management options for irrigated vegetable production
increase in mean temperatures	• changing variety/breed • timing of planting • improved strategies for better use of water on the property • improve water holding capacity of soil – add organic matter, stubble retention
decrease in average annual rainfall	• improved strategies for better use of water on the property • improve water holding capacity of soil – add organic matter
shift in rainfall patterns	• improved strategies for better use of water on the property
increased frequency of very hot days	• use of sprays to keep crops cool

increased incidence of extreme weather events	• plant windbreaks • install hail netting
Change to the climate	**Management options for dryland cropping**
increase in mean temperatures	• changing variety • timing of planting • improved strategies for better use of water on the property
decrease in average annual rainfall	• improved strategies for better use of water on the property
shift in rainfall patterns	• improved strategies for better use of water on the property
increased frequency of very hot days	• plan to harvest earlier • use heat tolerant varieties
increased incidence of extreme weather events	• plant windbreaks
Change to the climate	**Management options for animal production**
increase in mean temperatures	• keeping cows cool while waiting to be milked • altering housing, shade cloth over animals • ensure quality water is available
decrease in average annual rainfall	• ensure quality water is available • use drought-tolerant species
shift in rainfall patterns	• improved strategies for better use of water on the property
increased frequency of very hot days	• ensure quality water is available • plant windbreaks • install shelters
increased incidence of extreme weather events	• plant windbreaks • install shelters
Change to the climate	**Management options for a plant nursery**
increase in mean temperatures	• changing variety/breeds • timing of planting • improved strategies for better use of water on the property • improve water holding capacity of potting mix – add organic matter
decrease in average annual rainfall	• improved strategies for better use of water on the property • improve water holding capacity of soil – add organic matter
shift in rainfall patterns	• improved strategies for better use of water on the property
increased frequency of very hot days	• use of sprays to keep crops cool • use shade cloth
increased incidence of extreme weather events	• plant windbreaks • install hail netting

Students were generally able to state a management strategy for their chosen business. Only a third of students could state two.

Question 8a.

Marks	0	1	2	Average
%	43	43	14	**0.7**

Students were required to choose one type of agricultural or horticultural business that they studied or one that they were familiar with in terms of its business operations and state one key quality standard for the final product and describe how it would be measured. Possible responses included the following.

Quality standard	How it would be measured
extent of blemishes on fruit; size and colour of fruit	colour charts or blemish photos, weight
protein and moisture level in grain	laboratory methods to measure
weight and fat cover of livestock within market specifications	scales/fat scan
protein/fat content; somatic cell count in milk	laboratory methods to measure

This question was generally not well answered, with responses general in nature and lacking detail.

Question 8b.

Marks	0	1	2	3	Average
%	21	45	21	14	**1.3**

Students were required to state three important considerations when developing a business plan and deciding on or evaluating a location for their chosen type of business. Possible responses included:

- physical environment:
    - aspect
    - topography
    - water
    - sunlight
    - temperature
    - humidity
- how they match the requirements of crops, stock, infrastructure
- proximity to markets – location in relation to suppliers and customer location
- government regulations associated with business:
    - permit requirements
    - management of water
    - use of chemicals and machinery
    - health and safety

Question 8c.

Marks	0	1	2	3	Average
%	22	17	32	29	**1.7**

Students needed to identify one health and safety risk to an employee in their chosen type of business, describe how this potential risk could occur and suggest one strategy that could be used to minimise the risk.

Students needed to give a specific danger/disease/illness related to the business.

Possible responses included:

- cattle: crush injuries, chemicals, sun
- cropping: machinery, sprays
- nursery: lifting, chemicals
- orchards: sprays, sun

Students were generally able to state a health and safety risk or a strategy to mitigate the risk. Answers mostly lacked detail and hence did not answer all aspects of the question.

Question 8d.

Marks	0	1	2	Average
%	29	52	19	**0.9**

Students were required to explain how their chosen type of business could have an impact on the environment. Responses should have discussed impacts related to:

- air
- water
- vegetation
- soil from pollution and contamination

An alternative could be to consider the impact on the wider environment by considering the farm's contribution to climate change.

Question 8e.

Marks	0	1	2	Average
%	49	51	0	**0.5**

Students were required to state two important reasons for developing a cash flow estimate as part of their business plan for their chosen type of business. Responses should have covered the following elements:

- positive cash flow on a short-term basis, thus able to pay bills
- better budgeting and planning for purchasing
- know where your business is at any point in time/profitability
- key detail about the predicted movement (i.e. flow) of money in/out of the business, for example, monthly.

Students were only able to state one reason for developing a cash flow estimate as part of their business plan. No student was able to state a second reason.