VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2004 Agricultural and Horticultural Studies GA 3: Written examination

GENERAL COMMENTS

Areas of strength and weakness

Students demonstrated a general understanding of soil, plant, and whole enterprise management practices; however, knowledge of specific examples of these varied greatly between students. Students' understanding of the many ways to control a plant's growing environment needs strengthening.

The understanding of environmental degradation types and rectification techniques was adequate, although the difference between sustainable short-term and long-term treatments still needs to be made clear. When asked to suggest a solution to an environmental degradation type, students generally gave one treatment rather than a process that combined a number of treatments.

More depth of knowledge is required on a range of common pests and diseases. Few students provided detailed treatment or control strategies. The concept of monitoring pest numbers or indicators in Integrated Pest Management (IPM) needs to be emphasised.

The ability to analyse agricultural and horticultural management problems using basic sustainability concepts needs improvement. In preparing students for this, emphasis needs to be placed on the skills needed to collect and interpret environmental indicators that can be used to guide management techniques to achieve or maintain sustainability. Students should know what areas enterprise managers need to monitor in order to maintain financial, biophysical and social sustainability.

Many students were able to describe the production practices, machinery and equipment of a commercial agricultural/horticultural business; however, the answers indicated that a large proportion of students were limited to their school-based enterprise experience. Students must be able to relate their schoolwork to commercial activities.

Choice of options to answer

Students should select from provided lists of alternatives in Questions 1, 4, 5 and 6. Students handled the selection process well. In all questions, a diverse range of options was chosen.

Formula answers

In preparing students, teachers must refer to the current Study Design and the examination criteria. 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.

Marking policies

A marking scheme was developed to guide examiners. Marks were allocated to specific elements of the correct answer or according to descriptive criteria.

Where lists or alternatives were provided, examiners had general guides for the answers as well as specific answers to the alternatives. The specific answers were provided to guide the examiners in judging the accuracy of students' responses. They often contained more information than was expected of the students.

Marks were not deleted if students provided elements that were not correct.

SPECIFIC INFORMATION

Some questions addressed several of the examination criteria. The allocation of marks was determined by comparing students' answers with the marking scheme.

The answers to each question and some marking guidelines are shown. These are followed by general comments about the students' responses to the questions. This report should be read in conjunction with the 2004 examination, which can be found on the VCAA website.

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Question 1

Pest/disease	No. student responses	Pest/disease	No. student responses
botflies	21	Johne's disease	11
black spot	48	liver fluke	45
cabbage moth	30	mastitis	96
coccidiosis	7	powdery mildew	58
crown gall	9	rusts	33
damping off	3	ticks	48
none selected	3		

Question 1a

Marks	0	1	Average
%	18	82	**0.8**

One mark was given for a response that matched one in the table below. General 'plant' or 'animal' statements were not accepted.

Question 1b

Marks	0	1	2	3	Average
%	14	33	37	16	**1.6**

Three marks were given for a complete, detailed list of symptoms; two marks if it was clear that the student knew the main symptoms but had not described them fully; and one mark if incomplete symptoms were described.

Answer Guide: Questions 1a and 1b

Pest or disease	Question 1a Type of ag/hort enterprise most affected	Question 1b Main symptoms
black spot	roses	• dark coloured spots with fringed borders, which may be on both sides of the leaf • usually more serious in wet/humid conditions • premature defoliation • unsightly spots on the leaves of the flower, therefore difficult to sell
botflies	horses	• eggs on hair • coat looks tatty • horse is off its feed • restlessness when the larvae are in the rectum prior to passage • horse may be run down and unthrifty • the larvae damage the horse by interfering with the passage of food, causing stomach lesions • lesions may be a site of secondary infection
cabbage moth	vegetables and ornamentals	• outer leaves of plant are eaten by caterpillars • white moths fly around • leaves are unsightly and therefore will not fetch as much money or will not sell • eats crop leaves
coccidiosis	poultry	• birds off their feed – lack of appetite • dirty, ruffled feathers • scouring with watery faeces which may contain blood • dehydration • anaemia • reduced amount of eggs laid • caused by a protozoan that enters during feeding • the parasite multiplies in intestine and burrows into the wall of the intestine and caeca

crown gall	fruit trees – stone fruits, roses, pome fruits, grapes	• roughened lumps, mainly on roots and base of trunk • formation of galls on the roots or stems, usually at or below ground level • despite its name (the crown is the head of foliage), the tumorous growths usually occur on the stem below ground level • affects food and water supply • reduces growth
damping off	generally refers to sudden plant death in the seedling stage due to the attack of fungi. Fungi are soil born	• infected seeds becomes soft and mushy, turn a brown to black colour and eventually disintegrate • seeds that have germinated and become infected develop water-soaked spots that enlarge and turn brown • the infected tissue collapses, resulting in the death of the seedling • penetration and death of seeds before they emerge is termed pre-emergence damping off • seedlings may die after they have emerged, yellowing and wilting in humid conditions
Johne's disease	beef cattle, sheep, goats, deer, alpaca and llama in Australia	• prolonged diarrhoea • poor digestion • excessive weight loss • low fever • diseased animals do not refuse feed until they are severely affected • causes thickening of the intestinal wall, which blocks the normal absorption of food. The animal is hungry and eats but cannot absorb any nutrients. This results in wasting and finally death • results from an infection with bacteria called *Mycobacterium paratuberculosis* • grows very slowly, causes a gradually worsening disease condition, and is highly resistant to the infected animal's immune defences • a herd problem that worsens with time, reducing production and profit • infected animals may harbour the organism for years before they test positive or develop disease signs • the economic impact of Johne's disease in a herd may include some or all of the following: 1. premature culling of infected or clinical animals leading to reduction in culling other less productive animals and/or an increase in the overall cull rate 2. decreased milk production in infected animals (reported in some studies to be as high as 25% over a lactation) 3. decreased weight and salvage value at slaughter 4. loss of valuable animals, infected or exposed animals and their genetics 5. loss of marketing and show opportunities 6. breeding problems 7. increased veterinary costs
liver fluke	sheep	• weakness in sheep • anaemia and ill thrift in chronic cases • death, if severe and accompanied by bottle jaw
mastitis	dairy cows	• appears all of a sudden, with redness, heat, pain, hardness or swelling and sometimes fever; the general state is affected, with lack of appetite and loss of production

		• milk becomes yellowish, then watery; there may be blood in the milk, body temperature is low • trauma following a change of habits, parasitic electricity, transport, a fall, blow or nervous shock • reduces the amount of milk produced before calving and after a difficult calving, a first calving, or a calving by a big producer. • a predisposition to repeated congestive and inflammatory acute mastitis can be caused by an excess of fast sugars • contaminated environment
powdery mildew	cucurbits – rockmelon, cereal crops, fruit trees, grapes, flowering annuals, indoor plants	• circular white powdery spots on older leaves and main stem • destroys tissues • coats the plant in a powdery layer of fungus • fungus spreads a white or ash grey film over the upper and lower surfaces of leaves
rusts	cereal crops specific ornamentals: gerberas, pelargoniums, poplars, willows, vegetables: beans	• yellow spots/patches on the upper surface of leaf • rusty brown pustules on underside of leaf • caused by fungi with air born spores
ticks	mammals, cattle, dogs	• fever up to 42ºC • anorexia • depression • increased respiratory rate, particularly following exertion • muscle tremors and reluctance to move • may result in death of the animal • abortions in early pregnancy • reduced quality of meat due to lack of movement • scratching • patchy or uneven coat

Question 1c

Marks	**0**	**1**	**2**	**3**	**Average**
%	26	34	29	11	**1.3**

Method of prevention or control used	**No. student responses**	**Method of prevention or control used**	**No. student responses**
Biological techniques	16	Management practices	96
Chemicals	202	Organic practices	10
Cultural practices	7	Pheromones	3
Eradication	30	Quarantine	20
Genetic techniques	10	None selected	8
Induced sterility	11		

Answer Guide: Question 1c

Pest or disease	**How to prevent or control**
black spot	• spray when apparent • maintain low humidity • spray with Mancozeb, lime sulphur, or Bordeaux. On roses use rose gun or black spot insect killer
botflies	• maintain a clean environment. Remove eggs • drench with oral boticide to control larvae in stomach during winter
cabbage moth	• chemical sprays • dipel • physically remove • companion planting may help

	• reduce monoculture approach • parasitic wasp
coccidiosis	• drug called coccidiostat in feed
crown gall	• attention to hygiene in production • treat propagation material with Isolate (an antibacterial dip) • select resistant rootstocks
damping off	• ensure proper growth conditions for plant and not for fungi • seed and roots must be kept moist and warm until the roots have penetrated the soil and the seedlings have emerged. As the seedlings continue to grow, moisture at the soil surface can be decreased, and the damping-off fungi then will have less of an advantage. When watering, thoroughly saturate the soil and then apply no more water until soil approaches the point at which plants wilt. This procedure will keep surface soil dry for a maximum amount of time. Avoid frequent sprinkling because this generally keeps surface soil too moist and promotes fungal growth • preventive measures are based on eliminating fungi (drenching media with 'Fongarid') that cause damping-off or providing chemical barriers to prevent the fungi from growing in the planting medium • soil for growing transplants in flats can be steam pasteurised
Johne's disease	• the key to controlling this disease is prevention. The key to prevention is management. Testing needs to be one part of a total commitment to eliminating the disease from the herd. Testing will do the following: 1. evaluate absence or the extent of infection 2. identify infected animals 3. determine the intensity of a control program 4. monitor progress of control efforts • Once the extent of the problem is identified, appropriate management and sanitation procedures need to be put in place to accomplish the following goals: 1. prevention of highly susceptible newborn calves and young animals from oral manure contamination by infected adults (from the dam, environment, feed or water) 2. prevention of all other susceptible animals from ingesting low levels of infected manure, especially by contamination of feed and water 3. reduction in the total farm exposure level to *M. paratuberculosis* by removing the bacteria from the environment and reducing the number of infected animals that are shedding the bacteria
liver fluke	• drench affected sheep with 'Fasinex' which will destroy both mature and immature fluke • keep sheep away from wet fluke prone areas
mastitis	• administer antibiotics • maintain a clean environment • quarantine affected animals (a sound explanation as to why and how was needed here)
powdery mildew	• chemical control (YATES Mancozeb and systemic fungicide Bayleton) • management – maintain a clean environment, low in humidity
rusts	• treat with fungicide (Mancozeb, Zineb, sulphur sprays) • control by pruning and destroying diseased foliage to reduce spore spread • increase ventilation, air movement
ticks	• traditionally, effective control of tick fevers has been achieved by a combination of measures directed at both the disease and the tick vector. More recently the trend has moved towards strategic control programs to minimise problems associated with resistance to tickicides, chemical residues in cattle and environmental concerns over the continued use of insecticides • tick control by acaracide dipping has been widely used in endemic areas. Acaracides used for this purpose include various synthetic pyrethroids, amitraz and some organophosphates. Dipping is compulsory in Queensland for cattle leaving defined tick areas; otherwise dipping is at the discretion of farmers. Dipping may be done as frequently as every four to six weeks in heavily infested areas. Many producers in the tick endemic area have changed to Bos indicus type cattle because of their greater resistance to tick infection. Ticks' increasing resistance to available acaricides has forced the development of integrated strategies for tick control

	• an anti-tick vaccine is also commercially available in Australia.

Three marks were given for a detailed explanation of how the method prevents or controls the pest/disease. Answers needed to include appropriate timing of applications or treatment with regard to the host or pest/disease lifecycle, seasons or environmental conditions. Two marks were given if the student showed an understanding, albeit incomplete, of how the method prevents or controls the pest/disease. One mark was given for choosing a relevant method. No marks were awarded if the method chosen was not appropriate for the pest/disease.

Examiners were aware that some overlap exists between methods, especially 'management practices', and allowed for this.

Question 1d

Marks	0	1	2	3	Average
%	54	23	16	7	**0.8**

One mark (up to a total of three) was given for each Integrated Pest Management (IPM) strategy listed from:

- full knowledge of the pest/disease
- monitor indicators that predict pest or disease likelihood.
- weigh up cost/environmental considerations
- only take action when necessary.
- reduce the number of chemicals and frequency of application to reduce the possibility of resistance being developed
- preference for 'natural' biological controls.

Most answers were too general. Students were required to show specific knowledge of a variety of symptoms, types and timing of treatments, hygiene practices and environmental management. Often it seemed that the concepts underlying Integrated Pest Management (IPM) were not understood.

Question 2a

Marks	0	1	2	Average
%	26	48	26	**1.0**

One mark (up to a total of two) was given for each item listed from:

- introduce spray misting/fogging systems inside a glasshouse or polyhouse
- water paths and benches to increase humidity
- adjust airflow by opening or closing doors or vents, or by using fans
- increase the temperature in the presence of moisture.

Question 2b

Marks	0	1	2	Average
%	15	38	48	**1.3**

One mark (up to a total of two) was given for each item listed from:

- adjust vents or doors
- apply whitewash, shade with cloth
- use a heat blanket or poly socks
- use heaters/coolers or hot beds.

Question 2c

Marks	0	1	2	Average
%	50	39	11	**0.6**

One mark (up to a total of two) was given for each item listed from:

- alter the organic matter levels
- add a water absorbing substance (for example gels, clay, perlite or vermiculite)
- improve the surface tension of soil particles
- break up compacted soil to increase aggregates.

Question 2d

Marks	0	1	2	3	Average
%	59	22	14	5	**0.7**

- the cation exchange capacity of soil particles is altered according to the H+/OH- balance. At different pH the various ions are attracted more or less strongly to the soil particles, hence making them more or less available for plant uptake
- availability of nutrients influenced by pH
- pH affects solubility of macronutrients.

Three marks were given for a fairly full, correct explanation. Two marks where given when the student's understanding was obvious but the explanation was incomplete. One mark was given where some relevant, correct information was provided but the student's understanding of the role of pH was not explained.

This question tested student's understanding of how to manage a plant's growing environment. Half the students were able to do this with some level of success. Temperature control was better understood than humidity, water holding capacity and the pH nutrient interaction. Students need to clearly understand how to control all aspects of a plant's environment if they are to effectively manage agricultural or horticultural activities.

Question 3a

Marks	0	1	2	Average
%	44	38	17	**0.8**

One mark (up to a total of two) was given for each item listed from the following aspects of vegetation cover that land managers should be monitoring:

- total cover at ground level
- type of cover
- health of cover
- tree cover
- tree root exposure in gully areas.

Question 3b

Marks	0	1	2	Average
%	23	54	23	**1.0**

One mark (up to a total of two) was given for each item listed from the following types of environmental degradation:

- erosion
- weed infestation
- waterway siltation
- mass wasting.

Question 3c

Marks	0	1	2	3	4	Average
%	32	31	23	12	2	**1.2**

One mark (up to a total of four) was awarded for an explanation of a sustainable management strategy, such as:

- control grazing and or cropping to minimise bare ground and grazing pressure on desirable species
- protect desirable species by fencing and not clearing recharge areas
- ensure cover is present during high-risk periods such as high winds, rain and runoff
- use wind breaks
- control drainage/runoff.

One mark was given for an appropriate name. Two marks were given for a name and a vague explanation. Three marks were awarded for a fairly full explanation and an extra one mark was given if the student explained why it was a sustainable management strategy.

Question 3d

Marks	0	1	2	3	Average
%	36	28	28	7	**1.1**

One mark (up to a total of three) was given for each strategy to maintain short-term economic production listed from:

- plant salt-tolerant species in discharge area
- fence off salt affected land
- plant deep rooted crop/pasture plants such as Lucerne
- pump to lower water table
- implement strategies to improve water use in the recharge areas
- mine the salt
- divert water away with a drain.

Note: Flushing with irrigation was not an acceptable answer as it is 'dryland' salinity.

Question 3e

Marks	0	1	2	3	Average
%	33	37	25	6	**1.1**

One mark (up to a total of three) was given for each strategy to ensure long-term sustainability listed from:

- plant trees in recharge areas
- fence affected areas to enable efficient land use strategies
- develop a catchment's plan with adjoining farmers
- plant deep rooted crop/pasture plants such as Lucerne
- monitor salt/water table levels.

Students' overall understanding of the major degradation issues such as erosion and salinity was encouraging. The ability to observe (monitor) and understand the importance of clearly obvious aspects such as the amount and type of vegetation cover requires more emphasis.

It is important that students gain experience in interpreting what is visibly obvious in the environment via on site experience or class case studies. In most cases, the sustainable management of degraded land/water entails some short-term strategies to maintain economic and social viability, while longer-term strategies emphasise the biophysical environmental issues. Very few students were aware of the difference and hence Questions 3d and 3e were poorly answered.

Question 4

Business type	No. student responses	No. students who chose Ag. in Q. 6	No .students who chose Hort. in Q. 6
Growing a cereal crop	48	39	9
Managing poultry for meat	5	3	2
Managing poultry for fresh eggs	41	26	16
Rearing cattle for the beef market	67	59	8
Rearing pigs for the meat market	3	2	1
Rearing sheep to produce wool/prime lambs	33	32	1
Producing milk for the whole milk market	25	22	3
Managing vines to produce a crop of grapes	20	8	13
Fish breeding	9	6	2
Designing an ornamental garden	5	2	3
Maintaining an ornamental garden	5	1	4
Growing flowering plants in a glasshouse	43	14	29
Container growing of ornamental plants	18	10	9
Field growing a vegetable, herb or flower crop	46	20	27
Growing indigenous plants for revegetation use	4	3	1
Hydroponic plant production	17	5	12
Managing trees to produce a crop of fruit	8	6	2
Yabby breeding	9	5	4
No selection	4	1	3

Question 4a

Marks	0	1	2	3	Average
%	17	28	29	26	**1.7**

One mark (up to a total of three) was given for each item of information included in a marketing plan listed from:

- what the market wants and when
- how the market finds out about and purchases the product
- how much the market will pay for the product
- how the market wants to receive the product.

Question 4b

Marks	0	1	2	3	Average
%	8	29	41	22	**1.8**

One mark (up to a total of three) was given for each item of information needed to develop a financial plan listed from:

- cost of production
- how much can be sold at what price
- projected cash flow (includes both of the above over time).

Questions 4a and 4b were answered well, although in a general manner. Very few answers specifically addressed the 'chosen commercial business'.

Question 4c

Marks	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average
%	4	3	5	7	9	10	10	9	14	8	8	5	3	2	1	2	**6.6**

The following descriptions were used to award marks for this question:

- 15 marks: demonstrated a clear understanding of what is involved in the enterprise by fully describing the production activities in the correct sequential order
- 8 to 14 marks: understood the enterprise. The mark allocated was dependent upon the degree of description and the fullness and accuracy of the activity listing
- Less than eight marks: did not seem to understand what production activities are involved with the enterprise. Activities were not listed in a sequential order; some isolated activities listed but poorly described.

Answers had to be specific to the business type chosen. General business planning headings were not acceptable, as production activities were asked for.

See the table below for brief examples. The table gives broad overviews that were used to guide examiners. Detailed descriptions have not been added, but were expected of students.

Question 4d

Marks	0	1	2	3	4	5	Average
%	9	22	24	28	12	5	**2.3**

The following descriptions were used to award marks for this question:

- four marks: a fairly complete list was provided of equipment and machinery required for each activity
- three marks: most of the main equipment/machinery was listed
- two marks: a number of main items of equipment/machinery had been left out
- one mark: more equipment/machinery was left out than included
- one extra mark was given if the list of equipment /machinery required related to a commercial context.

Students were not given marks for generalised tool names (for example, a 'digging tool' could mean a trowel, spade or back hoe).

See the table below for brief examples. The table provides a restricted list that was used to guide examiners. Detailed lists were expected of students.

Answer Guide: Questions 4c and 4d

Business	Question 4c Production activities	Question 4d Machinery/equipment required
growing a cereal crop	Carry out maintenance and preparation of machinery. Seed bed to be prepared in autumn when the moisture level in the soil is high enough. Sow the seed. Weed control. Pest and disease monitoring, prevention and control. Harvest considerations. Stubble management. Grain storage, protection and transport.	Combine harvester, seeding equipment, tractor, cultivation equipment, spray equipment, trucks, storage bins, augers.
managing poultry for meat	Prepare housing, heating, cooling, water and feed requirements. Introduce day-old chicks, keep warm. Monitor and maintain environment, feed and water, look after health. Litter/waste management. Slaughter, plucking and cleaning, packaging, chilling/freezing.	Housing, feeders, drinkers, incubator if growing from eggs, lighting, timers, feed storage bins, augers, plucking and packaging equipment, cool storage, delivery van/trucks.
managing poultry for fresh eggs	Choose stock (ensure the health of the hens before buying). Hygiene and safety considerations of living quarters (for example, replace litter in sheds on a regular basis). Appropriate feed. Nutrition considerations. Water. Pest and disease monitoring, prevention and control. Harvest storage and packaging. Productivity monitoring.	Housing, feeders, drinkers, incubator if growing from eggs, lighting, timers, feed storage bins, augers, egg grading equipment, cool storage, delivery van/trucks.
rearing cattle for the beef market	Selection of appropriate stock (ensure the health of the cattle before buying). Pasture care. Hygiene and safety considerations of living quarters (for example, fencing). Appropriate feed. Nutrition considerations. Mating and calving considerations. Water. Pest and disease monitoring, prevention and control.	Cattle yards, fencing, dogs, motorbikes, utes, tractors, drench gun, feed troughs, water troughs, pasture management equipment, weighing scales.
rearing pigs for the meat market	Selection of appropriate stock. Ensure pigs are free of internal and external parasites such as mange and worms. Ensure housing is adequate regarding water, temperature and air movement. Monitor mating of sows with boar. Manage pregnancy and set up farrowing section in shed. Manage birthing procedures. Perform animal husbandry tasks such as de-tailing, teeth trimming, and iron injection. Monitor nutrition of sow and piglets, and adjust accordingly. Continually monitor for signs of pests and disease. Check water/feed/temperature daily. Weigh piglets to monitor growth rates.	Farrowing crates, weighing scales, nipple drinkers, vaccination gun, drench gun and teeth trimmers.
rearing sheep to produce wool/prime lambs	Choose stock (ensure the health of the sheep before buying). Pasture care. Hygiene and safety considerations of living quarters (for example, fencing). Appropriate feed. Nutrition considerations. Ensure adequate water. Pest and disease monitoring, prevention and control. Feet management. Culling and selection strategies. Shearing and fleece management. Wool marketing.	Sheep yards, shearing shed, shears, wool press, sorting table, fencing, dogs, motorbikes, utes, tractors, drench gun, water troughs, pasture management equipment, paring knife/shears, crutching equipment, elastrator.
producing milk for the whole milk market	Stock selection (ensure the health of the cows before buying). Pasture care. Hygiene and safety considerations of dairy and living quarters (for example, fencing). Appropriate feed. Nutrition considerations. Water. Pest and disease monitoring, prevention and control. Mating and calving. Daily harvesting routines. Monitoring quality and health.	Dairy-herringbone/rotary, refrigerated tank for the milk, calf feeding equipment, fencing, dogs, motorbikes, utes, tractors, AI equipment, water troughs, fencing equipment.
managing vines to produce a crop of grapes	Consider which vines are suitable for the climate. Examine soil. Modify soil if needed. Consider drainage. Install watering system, usually black poly	Spray equipment, pruning equipment (secateurs and loppers), packaging equipment, picking equipment, trellis.

	set above the ground which individually waters each vine. Prune in the winter. Beehives for cross pollination. Fertilise at the beginning of the growing season. Pest and disease monitoring, prevention and control. Harvest considerations.	
fish breeding	Choose the species to be bred. Choose the starting point and end point of the enterprise. Buy a breeding pair of fish. Collect/hatch eggs. Produce and sell juveniles. Buy juveniles and grow on. Choose the growing environment for the species (indoor tanks or outdoor earthen ponds). Breeding pairs are generally placed in individual tanks, with a spawning substrate. Many species spawn year-round. Eggs are laid on spawning substrates and then the eggs and parents are separated (to prevent the parents eating the young) and young fish are transferred to grow out units. Monitor for pests and diseases. Maintain/check that a suitable environment is provided for the fish, especially in tanks. Maintain/check filters and temperature. Harvest, store and package.	Tanks, ponds, filter, scales, nets.
designing and implementing an ornamental garden	Establish design brief with client, survey site. Complete site analysis – aspect, sun, soil, drainage, existing plants and hard landscape features. Draft design concept, get approval. Proceed to detailed plans and plant selection. Draw final plans, planting list and construction details. Remove unwanted materials, establish levels, excavate and fill as needed, lay irrigation and organise services such as electricity and water access. Do hard surfaces, ameliorate soil, top dress, plant, mulch, water, advise owner of maintenance requirements, present invoice and get paid. Do a BAS.	Surveying equipment, soil testing kit, drafting paper, overlays, pens/pencils, computer CAD program, printer, reference books, trade listings, pricing catalogues.
maintaining an ornamental garden	Examine soil, plant species and microclimates present. Modify soil if needed. Consider drainage. Prune. Install/maintain watering system. Consider environmental factors. Fertilise plants as required by plants. Apply/top dress mulch. Construct/maintain edgings, paths, and retaining walls. Weed control. Plant summer annuals in spring. Plant winter annuals in early autumn. Pest and disease monitoring, prevention and control. Develop pruning schedule and mowing/lawn maintenance schedule.	Secateurs, knapsack sprayer, hand tools, mower, brushcutter, pruning saw, brooms/blowers, wheelbarrow.
growing flowering plants in a glasshouse	Design production schedule. Decide on target markets. Select suitable plants/cultivars for selected growing times. Select appropriate media type (hydroponics/soil or container). Undertake propagation activities as necessary, (for example, cuttings for carnations or offsets for tulips). Prepare media (soil pH), enriched with fertiliser prior to planting. Use cold treatments such as bulb storage prior to planting to force growth. Control growing environment as necessary (lighting, cooling, ventilation, irrigation). Provide support structures. Monitor and control pests and diseases. Harvest flowers (for example, tulips are harvested when the flower bud is 50% coloured to maximise flower life). Apply post harvest treatments/dips to maximise flower life. Grade flowers based on flower size, colour and stem length. Bunch and package (for	Propagation equipment (secateurs, hormone gel), glasshouse monitors, cool stores.

	example, into bunches of 10 with elastic bands). Store for immediate use in water or dry store in cool room. Market/sell.	
container growing of ornamental plants	Timeline specifics depend on the plants being grown. Organise inputs. Buy inputs (seeds, tubestock). Take cuttings (conifers in winter, softwood in mid to late spring, semi-hardwood in late summer). Consider which growing media is suitable for the plants. Install/maintain/monitor watering system. Fertilise at the beginning of the growing season. Pest and disease monitoring, prevention and control. Weed control. Harvest and market.	Nursery trolleys, secateurs, propagation equipment, seedling trays, heat beds/misting systems, media, pots, potting machine/potting up benches.
field growing a vegetable, herb or flower crop	Examine soil. Modify soil if needed. Consider drainage. Install/maintain watering system. Consider environmental factors. Fertilise at the beginning of the growing season. Apply/top dress mulch. Weed control. Plant summer annuals in spring. Plant winter annuals in early autumn. Provide growing support for flowers (lift wire mesh progressively as the plant grows). Harvest and post-harvest requirements.	Soil tiller, rotary hoe, hand tools, spray unit, irrigation equipment.
growing indigenous plants for revegetation use	Timeline specifics depend on the plants being grown. Organise inputs. Collect seeds, seed trays or direct tube/field sow. Consider which growing media is suitable for the plants. Install/maintain/monitor watering system. Fertilise at the beginning of growing season. Pest and disease monitoring, prevention and control. Weed control. Harvest and market.	Nursery trolleys, secateurs, propagation equipment, seedling trays, heat beds/misting systems, media, pots, potting machine/potting up benches.
hydroponic plant production	Timeline specifics depend on the plants being grown. Organise inputs. Check water sources for quality and reliability. Install/maintain/monitor hydroponic system. Plant plants in chosen media. Monitor nutrient levels and growing environment; adjust as necessary. Pest and disease monitoring, prevention and control. Harvest and market.	Nutrients, mixing cylinders, H_2O testers for pH and salinity, hydroponics piping, pumps and filters, media to support plant roots.
managing trees to produce a crop of fruit	Consider which fruits are suitable for the climate. Examine soil. Modify soil if needed. Consider drainage. Install watering system, usually black poly set above the ground and individually watering each plant. Prune in the winter. Beehives for cross pollination and fruit set. Fertilise at the beginning of the growing season. Fruit set management. Pest and disease monitoring, prevention and control. Weed control. Harvest storage and packing considerations.	Spray equipment, fruit picking bags (open at the bottom also), secateurs, loppers, chain saw, grading machine, packaging equipment, trellis.
yabby breeding	Given the prolific breeding characteristics of yabbies, hatcheries are not necessary to produce juveniles. Juvenile stocking in grow out ponds can be achieved in a number of different ways: stock the pond with a parent population and allowing natural population dynamics to occur; stock the pond with brood stock at a rate of one male to three females; stock the pond with berried females; or breed the yabbies in a smaller pond or tank and re-stock them into grow out ponds. Monitor for pests and diseases. Maintain/check that a suitable environment is provided for the yabbies – especially in tanks. Maintain/check filters and temperature. Harvesting schedules. Packaging storage and distribution.	Tanks, ponds, filter, scales, nets.

Questions 4c and 4d allowed students to go into detail about all the production activities of a commercial business. The better answers demonstrated an accurate grasp of sequencing the activities and gave detailed descriptions of each activity and the machinery required. These questions were well answered, although many students still described their own enterprise and hence details about commercial activities and commercial scale equipment were lacking.

Question 5

Area of technology	Specific examples	No. student responses
biological pest or disease control	the use of bacteria to control caterpillars	20
	introduction of rust species to control specific weed species	18
	own example	47
	none given	1
genetic manipulation	the transfer of genes for flower colour from one plant to another	11
	the insertion of insecticide resistant genes into oil seed crops	13
	own example	15
	none given	1
alternative energy sources	the use of gas produced from piggery waste	5
	heat banks in solar glasshouses	1
	own example	8
	none given	0
reproduction manipulation	inducing simultaneous ovulation in a herd of cattle	22
	micropropagation of plants using tissue cultures	0
	own example	10
	none given	0
innovation in resource management	partial root zone drying of vines	1
	cell grazing ewes and prime lambs	8
	own example	4
	none given	0
remote sensing	the use of global positioning systems to help manage community parks and gardens	7
	monitoring land degradation using global positioning systems and satellite photography	15
	own example	25
	none given	0
computer software	grazing simulation models	3
	environmental control systems	3
	own example	33
	none given	1
radiation usage	irradiation of food to increase storage life	3
	electronic beams to disinfect fruit	0
	own example	1
	none given	0
climate control and modification	the use of heat blankets in glasshouses	46
	double skinned polyhouses	34
	own example	26
	none given	3
other		9
none		15

Question 5a

Marks	0	1	2	3	4	Average
%	29	24	26	16	5	**1.5**

The following descriptions were used to award marks for this question:

- four marks: the student had detailed knowledge of the technology and how it is applied, including what practices it has replaced

- three marks: the student knew about the technology but the answer lacked detail or was vague about some areas and how they are applied, including what practices it has replaced
- two marks: the student's knowledge was limited to generalisations about the technology
- one mark: isolated facts or very limited information about the technology were provided.

Students had to use the table headings and could not add their own area of technology (such as 'machinery'). If students gave their own example it had to be recent technology. See table below for answers.

Question 5b

Marks	0	1	2	3	4	5	6	Average
%	32	25	19	12	9	2	0	**1.5**

The following descriptions were used to award marks for this question:

- six marks: the student either gave six points or discussed three issues, and three areas of sustainability were covered
- four marks: the student either gave four points or discussed two issues, and two areas of sustainability were covered
- Two marks: the student either gave two points or discussed one issue, and one area of sustainability was covered.

Marks were awarded for an answer to this question even if the answer in 5a was not relevant or correct. In this case, if the answer provided for 5b was correct for what the student discussed in 5a it was still possible for students to be awarded marks.

Answer Guide: Questions 5a and 5b

Specific examples	Question 5a What it does and practices it replaces	Question 5b How to judge the sustainability of the technology
Biological pest or disease control		
The use of bacteria to control caterpillars	Bacteria kill the leaf-eating caterpillar after being ingested. Replaces spraying with non-specific chemicals (for example, *Bacillus thuringiensis*)	As the bacteria only kills caterpillars that ingest it, there is little impact on other insects or animals on the food chain. Thus, the economic potential of crops improves with little environmental costs.
Introduction of rust species to control specific weed species	Many weed species have fungi or bacteria that can attack them. A classic example in Victoria is the rust that reduces blackberry problems (*Rubus fruticosus*). It is attacked by the rust fungus *Phragmidium violaceum*. Replaces spraying with herbicides that may be expensive, dangerous and non-specific.	Economically more sustainable due to reduced spraying and labour costs. Often creates more productive land or more biodiversity. May impact on berry growers (productive crops). Not a total solution.
Genetic manipulation		
The transfer of genes for flower colour from one plant to another	Relaces traditional plant breeding involving many crosses, growing plants, selecting for desirable traits and the breeding up numbers of plants with these traits. It involves isolating the gene responsible for colour, extracting it and then inserting it into the nucleus of the plant you want to have the characteristic.	Quicker than breeding so potentially cheaper, but requires expensive technology. Does it increase the economic sustainability of a crop without damaging the environment? Will transferred genes cross into wild populations? What are the ethics of genetic manipulation?
The insertion of insecticide resistant genes into oil seed crops	Similar to above. Stops insects damaging the crop.	Similar to above. Will problems arise from human consumption of genetically modified products? Consumer resistance may influence economic productivity.

Alternative energy sources		
The use of gas produced from piggery waste	Fermenting piggery waste can produce biogas. The methane produced may be used to fuel generators, or for heating needs. The waste produced is clean and a high quality fertiliser. It replaces letting the waste rot and dry out for later disposal on pastures as a fertiliser.	Environmentally better as it conserves energy, there are less greenhouse emissions and it's not as smelly as the alternative. Economically better as it converts waste into an earning product. May be dangerous, but with planning and care it improves the sustainability of enterprises.
Heat banks in solar glasshouses	Heat collected during the day is stored in rock floors or benches or silos and then air is passed over these to heat the glasshouse at night. The alternative is to use heaters at night.	Energy efficiency is improved. Production is improved. Results in lower cost, better returns and environmentally there are less greenhouse gasses produced by not using external energy sources.
Reproduction manipulation		
Inducing simultaneous ovulation in a herd of cattle	Induces ovulation so all cows ovulate and can be mated at the same time, leading to calving in a tighter time frame which reduces management problems and allows for better supervision of calving. Replaces natural ovulation and variable mating and calving times.	Sustainability would depend on the management savings and whether the intensive calving period can be managed adequately. Calving percentages would need to be maintained, and problems reduced or the same.
Micropropagation of plants using tissue cultures	Propagation of plants from a small number of cells on a growth medium in a controlled environment to ensure genetic consistency of plants propagated compared with seeds. Replaces growing from cutting or corms.	Can get more plants produced in a shorter amount of time from a small sample of plant material. New species/varieties get to market more quickly. More advanced technology is needed so as to be sustainable (for benefits to outweigh the costs).
Innovation in resource management		
Partial root zone drying of vines	Irrigating one side of a plant at a time and leaving half the root system in a 'drought' improves water efficiency and plant growth. Replaces full root zone watering.	Sustainable if less water is used for the same levels of production at the same or lower cost.
Cell grazing ewes and prime lambs	Cell grazing involves high intensity mob grazing with long recovery periods between grazing. Replaces less intensive grazing systems and free ranging.	Cell grazing is thought to allow pasture plant roots to grow to a greater depth in the soil and exploit nutrients to depth; consequently no additional fertiliser should be required. More sustainable if it saves costs due to less fertiliser used, maintains production and does not harm the environment (overgrazing may lead to erosion).
Remote sensing		
The use of global positioning systems to help manage community parks and gardens	GPS's can be used to map and locate resources such as mature trees and capital assets in parks. This can be linked to management reporting and the control of maintenance databases used by many different crews. Specialist staff are involved. Replaces location finding based on the visual attributes of an area.	Allows precise and accurate location finding. Would only be more sustainable if errors/problems in mapping, locating and/or managing resources using visual methods currently exist.
Monitoring land degradation using global positioning systems and satellite photography	Satellite photography over time enables the monitoring of changes to many aspects of land and water management. Weed, pest nutrients, degradation, and foliage cover can be monitored from satellites. Replaces data collection from large areas at ground level	Can allow for earlier detection and treatment of problems than may be possible with ground based systems. Sustainability depends on the level of risk being monitored by the technique. High-risk, high-value.

Computer Software		
Grazing simulation models	Grazing models enable land managers to alter variables and see the impact of changes without actually undertaking them. They reduce some of the guesswork in altering grazing systems. Replaces having to guess with only experience as a guide.	Only sustainable if the model has a high degree of reliability and is used within the parameters of its design. Can help reduce stress on the environment by predicting problems before they arise and can improve productivity by reducing the risk of trying new systems.
Environmental control systems	Can maintain an optimum growth environment for plant or animals by the use of sensors/controls linked to software that model the ideal environment. Replaces manual/visual monitoring of environmental variables and manual control of vents, heaters, coolers and sprinklers.	Higher capital cost must be offset by increased returns or lower running costs. Should be more efficient and environmentally more sustainable.
Radiation usage		
Irradiation of food to increase storage life	Irradiation reduces spoilage, bacteria, insects and parasites and, in certain fruits and vegetables, it inhibits sprouting and delays ripening. Replaces chemical treatments or expensive packaging.	Assuming the food value is not affected (as claimed by supporters) then it should be environmentally desirable as it reduces chemical residue problems. Increased efficiency due to longer shelf life, easier storage and transportation. Less waste.
Electronic beams to disinfect fruit	Fruit and vegetables are disinfected by 'electronic pasteurisation' with focused electron beams that kill insects (fruit flies). This enables exporters to gain access to new and high value international markets for Australian producers. Replaces chemical disinfection.	Increases marketing potential and thus demand for and return from products. Fewer harmful chemicals used. Technology is expensive, so returns would have to be reliable.
Climate control and modification		
The use of heat blankets in glasshouses	A heat blanket over the top of glasshouse crops reduces the loss of heat at night. It replaces the need for heating to maintain growth.	Sustainable if savings justify costs. Environmentally better as it reduces fuel use.
Double skinned polyhouses	Insulates the polyhouse and reduces energy loss by using air pressure to keep two-ply layers separated over the crop. Replaces single skin polyhouse.	Reduces energy consumption and improves crop growth in colder climates. Sustainability depends upon ability to save on heating. The minor loss of light due to the extra layer is not normally significant enough to affect crop growth.

Almost half of the students were able to adequately describe a recent technology (Question 5a). A small, but still significant, percentage described a technology that had been in use far longer than any of the examples given, and thus was not considered recent. Students need to be aware of a range of recent technologies and should be able to discuss the issues involved with using these.

Question 5b was challenging for students and only about 25% answered it well. Students needed to apply the concepts of sustainability to evaluate the new technology. Most answers were far too general and were not answered in reference to the specific example.

Question 6

Two alternatives were offered. Students had to decide between an Agricultural or Horticultural case study.

Question	Horticulture	Agriculture
%	36	64

Question 6ai

Marks	0	1	2	3	4	Average
%	18	32	34	13	3	**1.5**

Horticultural Answers	Agricultural Answers
• weeds produce seeds that can germinate in the pots and compete for nutrients/moisture and light • weeds in pots reduce the value of the pot and need to be removed, hence increasing costs • weeds could be hosts to pests and diseases that affect the pot plants • weeds germinate in gravel and require removal to maintain accessibility and safety.	• heavy infestations results in reduced pasture for cattle, thus reducing milk production • consumption of ragwort can affect cows' metabolism and cause sickness and death.

Question 6aii

Marks	0	1	2	3	4	5	6	Average
%	13	30	25	17	10	3	1	**2.0**

Horticultural Answers	Agricultural Answers
• reduce the source of the weed seeds. Talk with property owners. Spray the infested land and plants with alternative species that are not a problem. Negotiate the use of the land and make it productive • cover the crop to prevent seeds getting into the pots • use weed mat over the gravel • remove by hand • plant windbreaks on the north and west boundaries to reduce seed drift onto the property • spray crop with selective herbicide. Spray gravel with Roundup or a similar product • use pre-emergent herbicides.	• spray the ragwort on the property with a selective herbicide at or prior to flowering • ensure the pasture is not overgrazed at times when ragwort seeds would be germinating • talk to neighbouring farmers and organise a planned eradication program • windbreaks may reduce the flow of seeds onto the property.

Question 6bi

Marks	0	1	2	3	Average
%	43	36	17	4	**0.9**

Horticultural Answers	Agricultural Answers
• less time is needed to keep the plants upright • less wind damage to plants • less water used due to lower evapotranspiration • better plant growth due to less moisture stress caused by wind • more even and efficient water application from overhead sprinklers • trees may house predators of insect pests that affect the crop • less weed seeds blown in.	More pasture will be available because: • the reduced wind speed reduces evapotranspiration, hence there is more available moisture for plant growth and better plant growth conditions • the indigenous plants will house a wide range of beneficial insects/birds that will prey upon pasture pests such as the cockchafers, leading to less loss of pasture.

Question 6bii

Marks	0	1	2	3	Average
%	21	46	26	7	**1.2**

Horticultural Answers	Agricultural Answers
• the windbreak may shade the area and reduce photosynthesis and hence growth of the crop	The environment for cows is improved because: • shade is provided in summer, resulting in less heat

• trees may prevent adequate air movement and thus increase the risk of fungal and some pest problems • trees reduce the possible production area • trees may house insect pests that affect the crop and/or can be a source of viral or bacterial infections • trees require maintenance • there is the possibility of damage caused by falling debris.	stress • shelter from winds reduces heat loss • less dehydration of cattle due to reduced wind flow.

Question 6ci

Marks	0	1	2	3	Average
%	34	34	26	5	**1.1**

Horticultural Answers	Agricultural Answers
Overhead systems waste water and are likely to cause more leaf and root disease problems than either drip or capillary bed watering systems. Drip systems will reduce water wastage from evaporation and run off. A well-managed drip system will ensure that all plants have the optimum moisture levels and hence achieve optimum growth with minimum waste. Automated systems often end up watering at times that waste water (for example, when it is hot or windy). A dam could be established to use rain water and recycled water for irrigation.	A principle of whole farm planning is to fence according to soil types. Paddocks need access via a lane way and not via other paddocks. The present paddocks are too large. They need to be about four hectares in size and, while fenced according to soil types, as square as possible for ease of management. Should work on a 21 day cycle of day/night paddocks. This maximises the use of pasture.

Question 6cii

Marks	0	1	2	3	Average
%	36	30	26	8	**1.1**

Horticultural Answers	Agricultural Answers
Wastewater needs to be collected and reused via a catchment plan for the surface flow. Any drainage system should reduce the mud problem and ensure that leached nutrients are not flushed into the storm water drains. Ideally no run off should go into the storm water drain as the system should enable the collection for treatment and reapplication/recycling. This may also reduce fertiliser requirements. Pots should be raised onto mesh; this helps with air pruning of roots and H_2O monitoring.	Dams need to be fenced and have water pumped from them into troughs located centrally in paddocks. The riparian zone should be planted with indigenous species. This ensures that water is filtered and not polluted by cattle, reduces disease spread, and allows easy access to water that minimises pasture damage.

Question 6ciii

Marks	0	1	2	3	Average
%	39	36	22	3	**0.9**

Horticultural Answers	Agricultural Answers
The drainage system should collect all the run off from under the crop so that it can be sand-filtered, pasteurised/sterilised (UV or Calcium hypochlorite, chlorine) and measured and adjusted for nutrient levels. The aim is to make the run off safe to reuse on the crop.	Lane ways need to be arranged so that each four hectare paddock has a gate that opens onto it. The gate needs to be positioned so that it opens in the corner closest to the dairy. The use of a main lane way reduces the compaction of soils in paddocks, thus making the pasture more sustainable.

Question 6d

Marks	0	1	2	3	4	5	6	Average
%	24	16	23	18	16	3	1	**2.0**

Horticultural Answers	Agricultural Answers
EPA, Specialist Irrigation/H_2O treatment firms, Nursery Industry Association. These organisations: • have the ability to give specialist unbiased advice • sell the products required and can advise on their use (not necessarily unbiased advice) • issue licenses/permits • can train staff to use systems • have research capability to help solve problems • provide contacts.	DNRE, Landcare. These organisations: • have the ability to give specialist unbiased advice • sell products required and can advise on their use (not necessarily unbiased advice) • issue licenses/permits • can train staff to use systems • have research capability to help solve problems • have local knowledge/community involvement.

The case study questions could have been answered better if students used the information provided in the case study to develop and support their answers. Most answers were based on knowledge being applied in a general manner.