Agricultural and Horticultural Studies GA 3: Written examination

GENERAL COMMENTS

Areas of strength and weakness

Students demonstrated a general understanding of sustainability, erosion and salinity, basic plant growth and soil management practices, pest and disease prevention and control and technology. Application of this general knowledge to specific situations and knowledge of a broader range of types of environmental degradation needs to be strengthened.

The ability to analyse agricultural and horticultural management problems using basic **sustainability** concepts needs improvement. In preparing students, emphasis needs to be placed upon skills of analysing a situation by collecting and interpreting **environmental indicators** that can be used as a basis for recommending management techniques that will help achieve sustainability. Developing simple models or paradigms that students may use to guide analysis of any agricultural or horticultural ecosystem situation would enhance this.

The ability to analyse and discuss real and topical issues should be developed further through school-based activities that introduce students to the full range of **environmental degradation** issues associated with Agriculture and Horticulture. More emphasis should be placed on the range of management strategies for avoiding and rectifying these. Activities that evaluate and discuss a broad variety of articles in popular farming and horticultural journals and magazines would assist. This may also improve students' ability to evaluate the efficiency of a range of **recent technological developments**.

Many students could not draw on their experience of developing a business plan for their school-based enterprise to explain the production and financial aspects of **business planning**. Students should be able to discuss the processes involved with the planning, monitoring and evaluation of their enterprises.

Students demonstrated they developed specific knowledge across a range of common agricultural and horticultural situations. This was apparent in the quality of answers provided in the **pest and disease** question. These were answered well at a general level but required more specific detail.

Selecting from options

Students could choose between information relating to a range of different areas of Agriculture and Horticulture by selecting from provided lists of alternatives in Questions 4, 5, 6 and 8 and articles in Questions 9 and 10. Students handled the selection process well. In all questions a diverse range of options were chosen. The range of choice did not confuse the students.

Students received no marks for answers that used examples other than those provided with Questions 4, 5, 6 and 8. In Questions 9 and 10 they were quite selective, often choosing different articles for each question.

Student preparation for the examination

The examination was structured in a similar manner to the 2001 examination and students seemed well prepared. Students are advised to revise the content of the areas of study and key knowledge and skills from the study design and the specific criteria used to set the examination, and apply these to a range of land and plant management situations that may be found in agricultural and horticultural enterprises throughout Victoria. The study design and examination criteria ensure that this will continue to be important. To do well, students should have studied common agricultural **and** horticultural enterprise management practices, techniques, machinery and equipment.

SPECIFIC INFORMATION

All the examination criteria were used to set the paper and were assessed. The nature of the paper meant that some questions addressed several criteria. The following should be read in conjunction with the examination. The answers to each question, and any marking guidelines, are shown and these are accompanied by comments about students' responses.

Question	Marks	%	Response
Question 1	Parts a and b were well answered. Seventy per cent of students knew the role the sun played in photosynthesis but only 20% also knew about the affect day length may have on plant reproduction cycles.		
	a		*One mark up to four, for each <u>different</u> characteristic listed.*
	0/4	12	1. Physical support
	1/4	14	2. Moisture level
	2/4	33	3. Aeration
	3/4	31	4. pH
	4/4	10	5. Fertility, nutrient levels
	(Average mark 2.13)		6. Temperature
			7. Number of pest and/or disease organisms

	b 0/4 8 1/4 28 2/4 38 3/4 22 4/4 4 (Average mark 1.86)	*One mark, for each improvement or problem* **Improvements:** • better nutrient status • improve water holding capacity • improve soil structure due to increased organic matter. **Problems:** • may burn roots • may cause nitrogen binding • weed increase • may spread disease.
	c 0/3 30 1/3 51 2/3 16 3/3 3 (Average mark 0.92)	*One mark* for relating sunlight hours to photosynthesis and production/growth. *One mark* for stating day length influences reproductive and hormonal aspects of plant growth. *Extra mark* if difference is clearly explained in a way that indicates the student had some concept of the different processes involved.
Question 2	This question was generally well answered; however, with emphasis given to salinity on previous examinations and in the media it is surprising that many students could not explain even partially the cause of dry land salinity and could give no other alternative to trees to combat salinity problems. Students must realise that there are short- and long-term strategies to combat most environmental degradation problems that threaten farms. These must be combined to achieve sustainability in the short- and long-term. Trees are a long-term strategy.	
	a 0/3 12 1/3 30 2/3 47 3/3 11 (Average mark 1.56)	*One mark* for the correct location of discharge and recharge areas on diagram. (Salt-affected land, rocky outcrop) *One mark* for explaining the water table containing salts rises. *One mark* for explaining that evaporation leads to increased salt concentrations in topsoil.
	b 0/1 57 1/1 43 (Average mark 0.43)	*One mark* for identifying the top half of the slope.
	c 0/2 34 1/2 49 2/2 17 (Average mark 0.83)	*One mark for each correctly described way that a land manager could improve sustainability.* • plant salt tolerant pastures or crops in the discharge area • lower the water table by pumping • use drainage that reduces flow of water from recharge to discharge area • flush salt out from system with a combination of irrigation and drainage • reduce grazing pressure to reduce chance of compaction thus maintaining water flow through the soil from above.
Question 3	0/4 6 1/4 24 2/4 41 3/4 20 4/4 8 (Average mark 1.99)	*One mark for each limited description of a management practice, 2 marks for each full description.* ***Minimum tillage***: reducing the number of times soil is worked and left bare by use of herbicides rather than ploughing and fallowing. ***Grazing management***: maintain a foliage cover at all times in dry areas and seasons with appropriate rotations, stocking levels and supplementary feed. ***Soil management***: keep soil organic matter and soil moisture levels high to reduce dust formation. Don't work soil during windy periods ***Crop management***: keep ground covered during high risk periods such as dry windy weather. ***Farm planning***: plant windbreaks of appropriate size and density in locations that will keep wind off areas prone to wind erosion. Don't work soil during windy periods. This question was well-answered.

Question 4	0/6 1/6 2/6 3/6 4/6 5/6 6/6 (Average mark 2)	24 19 19 18 11 6 3	*Students were given 1 mark for a limited explanation of each microbial disease. Two marks for a more detailed explanation (see Table 1).* This list was drawn up from microbial diseases discussed in the suggested texts. Providing students with an extensive list gave plenty of options but most students gave vague or general answers, with only about 20% giving specific details. Students need to know specific control and prevention strategies for the main agricultural or horticultural pests and diseases. The difference between prevention and control is still not clear in many students' minds and needs to be addressed by teachers. Students should study a wide range of examples, as the range of choice on future examinations may be only a small sample of diseases/pests.

Table 1 Microbial diseases

Disease	**Problem**	**Prevention**	**Control**
General notes – relates to all answers. Answers need to have greater detail to get full marks.	*Causes loss of production, loss of quality of plant, destruction of tissue in plant thus loss of production.*	*This could include quarantine, management of environmental conditions, selection of resistant species, vaccination.*	*Drugs or chemical control, removing or destroying affected species, chemical and biological control of causal organism.*
Newcastle disease of poultry	Respiratory, nervous disorder. Viral. Reduced egg production and shell quality reduced.	Isolation, quarantine, good hygiene.	Culling, vaccination.
Fowl pox	Viral disease causing wart like scabs. Spread by mosquitoes or bird to bird. Drop in production and fertility.	Isolation from infected stock.	Vaccination.
Spotted wilt	e.g. Tomatoes, viral. Spread by sap insects, leaves wilt. Causes loss of production-plant efficiency reduced.	Hygiene is important, remove all weeds, destroy all infected plants, control sap-sucking insects.	Hygiene is important, remove all weeds, destroy all infected plants, control sap-sucking insects.
Tetanus (goats)	Fatal bacterial toxaemia. Symptom is stiffness of legs leading to tetanus spasms – may occur within days of severe hoof trimming, kidding, castrating or wounding of goat.	Vaccination at one month and a booster given four weeks later. Another booster one year later. Avoid contact with contaminants as passes through wounds.	Vaccination.
Black rot (cabbage)	Bacterial causes wilting.	Attention to hygiene in production.	
Powdery mildew	Fungus that spreads a white or ash grey film over the upper and lower surfaces of leaves, usually older leaves. Destroys tissue.	Create an environment that does not promote the fungus (need low humidity, good air flow)	Mancozeb and systemic fungicide Bayleton.
Bovine Spongiform Encephalopathy (BSE)	A fatal condition that affects the nervous system of cattle. Infected animals' brain develops tiny holes. Animal loses control over movement and shows changes in behaviour.	Be certain feed does not contain products derived from contaminated sources.	Destroy cattle in herd/farm when one animal is found infected.
Swine fever	Viral septicaemia of pigs. High mortality in young pigs.	Quarantine, hygiene, isolation.	Slaughter, disinfection of premises, burning infected material.

Foot and mouth	An Aphthoviris. Transmitted by healthy carriers, boots, clothing. Large blisters on tongue, lips, feet, udder etc., lameness. Spreads rapidly. Loss of production and death.	Quarantine and hygiene practices.	Slaughter affected animals.
Mastitis (cattle)	Bacteria entering the udder. Clots of pus in milk. Causes loss of production.	Clean dairy, milk cups, yards, and maintain good dairy milking practices.	Treated with penicillin.
Chronic Respiratory disease (CRD) in poultry	Birds become inefficient producers.	Antibiotics prior to disease being contracted.	Antibiotics.
Bacterial leaf spot	Yellow spots on leaf, causes loss of production.	Attention to hygiene in seed production. Use only disease free seed.	Cut away and burn infected parts. Spray the healthy foliage with copper oxychloride. Practice crop rotation with vegetables.
Rusts	e.g. Black stem rusts One of the most common of all fungal diseases. Uses plants nutrients, loss of tissue and reduced photosynthesis therefore loss in production.	Remove effects of host plant, pathogen environmental conditions, grow varieties resistant to rust, quarantine.	Sulphur, lime sulphur and Mancozeb plus garden fungicide.
Coccidiosis	In poultry caused by protozoan that enters during feeding. Parasite multiplies in intestine and burrows into the wall of intestine and caeca. Bloody droppings. Birds don't eat and have dirty ruffled feathers. Loss of production and quality.	Hygiene, coccidiosis tests, litter management.	Drug called Coccidiostat in feed.
Scabby mouth	Highly contagious viral disease of sheep. Scabby lesions on muzzle. Young sheep most susceptible.	Vaccination of lambs at marking.	Vaccination, Chlorhexidine ointment applied to scabby areas daily, heals in three weeks.
Blue Tongue	Insect born viral infection of cattle goats and sheep. Swelling of tongue and lips, salivation, fever. Spread by mosquitos.	Quarantine, vaccinate, new generation vaccines may be available soon?	Move animals from water logged and mosquito prone areas. Destroy affected cattle.
Enterotoxaemia (pulpy kidney)	Caused by bacteria (*Clostridium perfringens*). Outbreaks occur when sheep/calves up to two years old are on lush feed. Bacteria increase in small intestine which produces a poison which kills sheep.	Avoid sudden feed changes. Vaccination.	Not usually done. Antitoxin of electrolytes.
Johne's disease	Sheep, cattle, goats waste away, caused by bacteria (*Mycobacterium paratuberculosis*). Three- to four-year-old sheep usually infected. Loss of condition may cause death.	Destroy infected animals and segregate young stock on clean pasture.	No treatment; no vaccine to prevent.

Lumpy jaw	Fungal disease (*Actinomyces bovis*) occurs in cattle. Invades bony tissue, possible when milk teeth are shed or lost or other wounds. Jawbones affected by hard immovable swelling. Loss of production.	Destroy affected animals.	Penicillin (Intravenous injections) Affected animals should be isolated from the mob, especially when pus is discharging. They may be sent to an abattoir for slaughter. If the lesions are large or discharging, the affected animals should be destroyed on the property. Feed and water troughs used by affected animals should be disinfected.
Stem and Root rots	Roses, usually more serious in wet conditions. Caused by various fungal diseases (*phytophthora cinnamonni*). Kills the plant by attaching to the root system causing the roots to rot. Badly affected trees will eventually die.	Improve drainage, as damage is severe if drainage is poor. Remove all plants that have died.	Spray with Mancozeb, lime sulphur, or Bordeaux. On roses use Rose Gun or Black Spot insect killer.
Smuts	Fungal disease that causes black masses of spores. Cereal crops. Name for an order of parasitic fungi (*Ustilaginales*). Causes loss of crop production.		Fungicide.
Distemper	Viral infection of dogs. Poor diet increases susceptibility. Diphasic temperature, loss of appetite, cough, vomiting, diarrhoea. Death.	Isolate puppies then vaccinate.	Vaccinate.
Mosaic virus	Tobacco – causes mottling and slight puckering of leaves of tomatoes and peppers. Causes stunting. Fruit develops blotches as it ripens.	Hygiene, destroy affected plants.	Hygiene, destroy affected plants.
Foot rot	Invasion of foot by bacterium, facilitated by wet conditions.	Remove affected sheep, maintain feet in summer, keep off wet/infected areas.	Pare affected tissue formalin foot bath and vaccinate.
Crown gall (fruit trees)	Bacterial disease causes swollen growths that occur on the crown of the plant near soil level. Rounded growths are spongy with a roughened surface. Restricts flow of sap and may cause the plant to weaken and die. Bacteria live in soil and enter the crown through a wound cause by cultivation, insects or grafting.	Dip plants into bacterial solution prior to planting.	Remove small affected plants and destroy them. Established plants may be treated with Isolate K84, a sterile strain of the same bacterium.

Ringworm	Fungus (*Trichophyton spp*., Micros porion.) Circular patches on skin, hair scruffy. Lesions may develop.	Treat when it appears and isolate affected animals.	Systemic or topical fungicide application.
Black spot	Fungi, which produce dark spots on leaves on number of different types of plants, e.g. roses, fruit trees. Infected leaves wither and die prematurely – plant unsightly. Extensive defoliation can eventually kill a young plant. Worst when humidity is high or in tropical/subtropical regions.	Spraying fungicides such as Captan, copper oxychloride and Mancozeb. Ensure good air circulation by not overcrowding plants.	Collect fallen leaves. Cut off and destroy infected leaves. Spray leaves.
Peach leaf curl	Unsightly fungal disease that causes the leaves of peaches to wrinkle, blister and thicken soon after they appear. Leaves may turn various shades of yellow and pink and fall prematurely. Tree weakened and poor crop – economic.	Application of copper oxychloride early in the season or just before buds have burst will help prevent this disease.	Very little once buds have burst.

Question	Marks	%	Response
Question 5	0/4 1/4 2/4 3/4 4/4 (Average mark 2.09)	8 19 38 25 9	*Two marks for detailing what the organisation does and 2marks for an example that shows a clear link to sustainability. (See Table 2)* The sustainability example should clearly link to maintaining or improving one or more of the following: • economic productivity • physical and biological ecosystem • community institutions and values. Most students were able to adequately describe what one of the organisations does but many only gave an adequate example of how this influences farm sustainability.

Table 2 Organisations influencing management for sustainability on agricultural and horticultural operations

Horticultural Research and Development Corporation	Subsidised by horticultural businesses to do research and communicate results to growers etc. Helps improve production and environmental efficiency.
Local Water Boards	Manage the distribution of irrigation water. Maintain water quality and ensure fair distribution so many businesses can maintain production.
Pivot	Distribute and sell fertiliser; some advice regarding fertiliser requirements. Production efficiency maintained.
Landcare Groups	Advise and coordinate land management, especially revegetation, in a specific area. Maintain a healthy ecosystem that fosters production and biodiversity.
Victorian Farmers' Federation	Provide a coordinated voice for farmers and represent them, especially in a lobbying role, provide industry news, discussion forums. Help maintain social systems that allow farm enterprises to operate profitably.
Debco Pty Ltd	Distribute and sell a range of horticultural media, fertiliser and chemicals, some advice regarding product usage. Production efficiency maintained.

Murray Goulburn Trading Pty Ltd	Provide farmers inputs and help them market their products. Some advisory function. Production efficiency maintained.
Bureau of Meteorology	Provide weather predictions and forecasts. Historical records for planning.

Question	Marks	%	Response
Question 6	Question 6a was well answered. Question 6b was poorly answered with many students not able to suggest any appropriate management strategy or suggest two management strategies. Question 6c tested students' knowledge of 'Integrated Pest Management'. Few students understood IPM.		
	a 0/4 1/4 2/4 3/4 4/4 (Average mark 2.1)	 8 19 38 26 9	See Table 3 below. *For each environmental indicator if student had some but not a fairly full understanding of how these would help, partial marks were awarded.*
	b 0/4 1/4 2/4 3/4 4/4 (Average mark 1.3)	 29 27 30 13 1	See Table 4. *Two marks for each explanation showing a clear understanding of appropriate management changes in response to the sustainability threat.*
	c 0/6 1/6 2/6 3/6 4/6 5/6 6/6 (Average mark 0.73)	 61 21 9 5 3 1 0	*Two marks for detailed explanation of IPM (must include monitoring and prediction), 1 for partial explanations. One mark for each valid advantage and disadvantage.* IPM involves monitoring indicators that predict pest or disease likelihood. Action should only be taken when necessary. Reduce the number of chemicals and frequency of application to reduce the possibility of resistance being developed. Preference for 'natural' biological controls. Advantages: only spray when needed thus less waste, reduced chance of disease/pest resistance, marketing differentiation. Disadvantages: may be some reduction of crop quality due to acceptance of a level of damage, monitoring costs including time, requires more expertise.

Table 3 Environmental indicators that Bill should use to assess the suitability of the property for cut flower production and how these would help Bill decide whether the property was suitable.

Indicators	How these would help Bill decide whether the property was suitable for cut flower production.
Number of pest predators	Indicates that pests will be naturally limited, less pest problems, better production. Reduced need for pest control.
Soil organic matter	Bioactive soil may be healthier, helping with resistance to some disease organisms. Production enhanced by organic matter due to water retention, buffering effects.
Pesticide residue in the soil	Assuming non-toxic levels not likely to have a direct effect.
Area of remnant vegetation	May indicate larger range of pest predators. Reduced need for pest control.
Soil structure	Helps decide whether soil structure is suited to plant growth requirements, especially with regard to drainage and water holding capacity.
Level of nutrients in water tables and streams	May indicate salting, check suitability for irrigation.
Tree cover	May indicate larger range of pest predators. Home for predators. Influence on water table. Land available for production. Wind protection.
Soil fertility	Influence cost of production by indicating level of nutrient that needs to be added.
Prevailing winds	Need for windbreaks.
Rainfall	Is it adequate, at the right time in the right amounts?

Number of pests	Help with choosing crops and need for management strategies to minimise costs
Frog population	Indicator of the health of the soil/water system. Pest predator.
Water table level.	Indicator of water availability, likelihood of salt build up.
Extent of soil erosion	May limit the amount of productive land. May be costly to manage.
Soil pH	May influence nutrient availability and its suitability to the crop.
Water quality in streams	Pollutants may reduce use for irrigation or stock. Catchment's management indicator.
Soil bulk density	Indicates compaction. If high would reduce production and limit the range of crops that could be grown.
Soil salt levels	Can cut flower crops grow in soil containing this level of salt?
Soil water flows	If contaminated water flows into the property, may effect production, water logging and salting.
Plant species present	Can warn of soil fertility, water availability or drainage problems.

Table 4 Indicators that Bill should use to monitor sustainability of his cut flower production. Explain how Bill should alter his management if the indicator shows that sustainability is threatened.

Indicator	**What these measure**	**Explain how Bill should alter his management if the indicator shows that sustainability is threatened.**
Number of pests each season	Pest types and numbers each season can indicate many things; need to use other indicators to find specific causes.	If an increase then work out why pest is on the increase and rectify. May need to take immediate action to reduce numbers, e.g. spray, release predators.
Changes in soil organic matter	Indicates the health of the soil, or the level of addition or removal of organic matter.	Review harvesting and cultivation practices and change to those that will return organic matter or slow down its removal, e.g. not burning stubble, longer fallow between crops, change crop type.
Pesticide residue in the soil	Pesticide residue from drift or seepage or water source.	Should be none; if some appear source would need to be found and eliminated. Ensure sensitive crops or animals are kept clear of the area.
Area of remnant vegetation	How much clearing has been done.	Stop clearing. Indigenous plantings with clear land use management areas on property to protect remnants.
Soil structure changes	Changes to soil aggregate sizes and layers.	Assess organic matter status, change cultivation or grazing practices to reduce compaction or aggregate reduction. Minimum tillage.
Level of nutrients in water tables and streams	Levels of soluble ions in the water.	Look for source of the pollution and take action to stop it. Change to enterprises that can use/reduce the nutrients (water plants, fish farming) Monitor to see levels remain safe for stock.
Death of trees	Can indicate many things and needs to be linked to other indicators.	Establish cause and rectify problem, plant more trees, actively manage the remaining trees.
Changes in soil fertility	Nutrient availability in the soil over time.	Indicates deficiency or toxicity, may be linked to pH, indicates need for change to soil management. Change fertiliser regime or stimulate soil micro organism activity.
Prevailing winds	Long-term wind pattern changes are unlikely, but possible.	Review wind breaks and whole farm plan.
Rainfall	Long-term rain pattern changes are unlikely, but possible.	Review enterprise types; investigate drainage, storage and irrigation methods.
Number of pests	Change in populations over time.	If pest/types numbers are increasing cause will need to be established and some management practices to reduce the population introduced.

Frog population changes	Changes to number of frogs in an area, can indicate many things, need to use other indicators to find specific causes.	If frog population decreasing then what is causing this? Health of ecosystem in decline. Look for causes and rectify. Water quality, predators, and habitat loss?
Water table level variations	Changes in the level of water table below soil surface, must be considered in conjunction with precipitation in the recharge area.	Overuse of soil water, changes in recharge area. Plant trees in recharge area, drainage, review irrigation use.
Development of soil erosion	Increased soil loss.	Need for changes in land and catchment's management. Look closely at how plants and water are managed. What has changed that is allowing erosion to occur? Change practices or implement intervention strategies.
Soil pH changes	Level of free hydrogen ions changes.	Look for causes of pH change and rectify. Add lime or sulphate.
Changes to water quality in streams	Water purity, pH.	Look for causes and rectify, e.g. pollution up-stream, nutrient runoff.
Soil bulk density increase	Measures soil compaction.	Indicates compaction, if high would reduce production. Need for change to traffic and cultivation on land.
Soil salt levels	Salt concentrations in the soil.	Lower the water table, flush with irrigation; use salt tolerant crops or pasture. Plant trees in recharge area.
Soil water flows	Water movement through the soil layers.	Look for cause to the change and rectify. Use limes if appropriate, reduce compaction by traffic. Plant deep-rooted plants.
Variation in plant species present	Plant diversity and concentration changes, can indicate many things, need to use other indicators to find specific causes.	Different species require different responses. Look at cause and impact of the change.

Question	Marks	%	Responses
Question 7	Few students could adequately answer each of the questions. This is surprising given all students should have done a business plan as part of their school based enterprise. Teachers should ensure that students understand the enterprise planning and implementation process by discussing the purpose and structure of the major components involved with a business plan and how these relate to their enterprise.		
	a 0/3 1/3 2/3 3/3 (Average mark 1.1)	 30 40 20 10	*One mark, up to 3, for each different aspect mentioned in the explanation (after the SO) in each area* **How the production plan influences the business plan.** The production plan outlines the methods of production, aspects of inputs, processes and outputs associated with the enterprise, time line for production, risk factors and how to protect against likely risk. The production plan influences the business plan by showing what can be produced, how and with what resources and cost in what time frame. These define the production costs.
	b 0/3 1/3 2/3 3/3 (Average mark 1.24)	 26 38 22 14	**How the marketing plan influences the business plan.** Marketing: Product range and demand, pricing, location and distribution details, communication and promotion, market segmentation and targeting. The marketing plan influences the business plan by showing what can be sold for what price to whom, how and when. This then defines the marketing costs.
	c 0/3 1/3 2/3 3/3 (Average mark 1.18)	 22 47 22 9	**How the financial plan influences the business plan.** Financial: Budget, borrowing needs, cash flow, receipts and payments. Income, expenditure. The financial plan influences the business plan by predicting the over profitability of the enterprise (budgets), showing when income and expense will occur and what borrowing is required (cash flow). Actual expenditure and income may be compared with the plan to see how the enterprise is progressing.

Question 8	This question was poorly answered. Most students did not relate their answer to the information presented. This information contained clues that could be used by students in all parts of the question. This may be due to poor examination technique or an inability to apply knowledge to case studies. Very few students knew what whole farm planning (Question 8d) involved.		
	a 0/6 15 1/6 19 2/6 27 3/6 23 4/6 12 5/6 4 6/6 0 (Average mark 2.1)		*Two marks for fairly full answer, 1mark if brief and missing some aspects.* *Answers must match nominated erosion type.* **Erosion:** Reasons: The reasons given must correctly justify the type of erosion stated using detail from the case study, e.g. Foothills: implies sloped country with valleys and high stream flows; at wet times (gully erosion), clearing and heavy grazing on sandy clay-loam with high rainfall (sheet erosion). Previous mining activities may lead to an increased chance of both, as well as some tunnel erosion. Clearing trees and high grazing levels may also lead to wind erosion (although this is less likely). Prevention (stopping it happening): Keep the trees in risk areas, keep pasture cover. Reduce high water (wind) flow rates with diversion and/or water storage. Control (controlling it after it has happened): Physical controls and diversions of water flows to slow the rate and amount of flow to affected areas, fix (grade, bulldoze) damaged areas and plant and maintain grassed water ways, creek banks with trees and shrubs.
	b 0/8 15 1/8 21 2/8 21 3/8 18 4/8 15 5/8 6 6/8 3 7/8 1 8/8 0 (Average mark 2.33)		See Table 5. *Two marks in each section for a fairly full answer, 1 mark if brief and missing some aspects.*

Table 5 Types of environmental degradation

Problem	Why these may become a problem	How to monitor the problem
Soil nutrient depletion	Would only be a problem if following the clearing high rainfall caused leaching. But the higher stocking rates and supplementary feeding should provide nutrient replacement from the manure.	Soil test for nutrient levels on a regular basis. Visual inspection of plants for leaf discolouration. Change in plant diversity.
Decline in native pastures and environmental value of rangelands	Clearing, high stocking rates with cattle and supplementary feeding will reduce viability of native species and introduce seed sources from other areas.	Visual inspection and monitoring of area covered and the density of the native grasses. Satellite and aerial photography imaging.
Increase in salinity of dryland farming	On this property (foothills of Great Divide) there is not likely to be a problem but will cause problems further down the catchment due to clearing trees from the recharge area.	Catchment monitoring of salt and water table levels. Visual monitoring of plant populations. Satellite and aerial photography imaging.
Nutrient, salts and pollutants to wetlands, rivers and water bodies	Should not be a problem as soluble fertiliser application is not indicated in the case study.	Water quality tests. Monitor algal growth.
Soil acidification	Clearing and high rainfall may cause leaching that will contribute to this.	Regular soil pH tests. Monitor plant species present.
Loss of habitat and biodiversity	High due to clearing activity.	Visual inspection, sighting reports and recording species population counts.

Increase in salinity of irrigation farming	On this property (foothills of Great Divide) this is not likely to be a problem but will cause problems further down the catchment due to clearing trees from the recharge area, and surplus irrigation water flowing into the catchment ground water.	Catchment monitoring of salt and water table levels. Visual monitoring of plant populations. Satellite and aerial photography imaging. Monitor soil moisture depths so that the land is not over irrigated.
Contamination of ground water with nutrients, salt and pollutants	On this property (foothills of Great Divide) this is not likely to be a problem but will cause problems further down the catchment due to clearing trees from the recharge area and overgrazing.	Catchment monitoring of ground water quality.
Soil decline: biological and structural	Very likely due to clearing and compaction from overgrazing.	Monitor worm population or other biological indicator in soil. Monitor soil structure.
Riparian, remnant vegetation damage and rural tree decline	Tree and bush clearing is responsible for this. A whole farm plan is need to allocate areas for remnant vegetation and others for pasture etc.	Plant population diversity and coverage. Satellite and aerial photography imaging.
River flows	Interfered with due to clearing leading to silting and changes to the flow rate. May cause flooding downstream.	River species monitoring. Flow rate monitoring. Satellite and aerial photography imaging.
Contamination with residue of agricultural chemicals	Not indicated in the case.	Soil/water testing for pollutants.

Question	Marks	%	Response
Question 8 (continued)	**c** 0/6 1/6 2/6 3/6 4/6 5/6 6/6 (Average mark 1.46)	 34 23 19 14 7 2 0	*Two marks for each area if a fairly full answer, 1mark if brief and missing some aspects.* **Explain how sustainable Abby's Farm will be in relation to:** - **economic productivity** - **management of physical and biological ecosystem** - **impact of interfusion community.** Economic: The production strategy seems to rely on providing quick financial returns based on the high fertility of the soil. Cost of production is likely to increase dramatically over time causing strategy to not be economically sustainable. Loss of economic tourism activity for the area. Physical and biological: Proposed management strategy will lead to loss of biological diversity and degradation of soil and water resources due to habitat removal, erosion, water fouling and silting, soil loss, fertility reduction, likely weed and pest increases. Community: Loss of tourism will change social make up of region. Possible job losses. Clearing changes amenity of the area. Damage to historic gold fields alters cultural importance of the area.
	d 0/6 1/6 2/6 3/6 4/6 5/6 6/6 (Average mark 0.97)	 47 25 16 8 3 0 0	*If students identified problems in Abby's plan they should have been addressed in this question. Allocation of marks were made as follows:* *3 marks for how well the problems have been identified.* *1 mark for using whole farm planning principles,* *1 mark for matching objectives to land capability, and* *1 mark for considering the bigger picture and consulting with external agencies.* Problems with Abby's plans are that production is not sustainable, biodiversity loss, degradation of water and soil resources and cultural/community values are weakened. Whole farm planning approach involves identifying the different areas of land/habitat on her property that require different management strategies and treating each appropriately. Set management objectives that are more sustainable and that maintain biodiversity and healthy soil and water resources. Only use land for

		sustainable practices. Abby needs to use the strengths of her property in formulating a different plan, or find a new property more suited to this approach. Consult with organisations such as the water catchment's managers, local government regarding the tourism possibilities, and the DNRE regarding what is a realistic stocking level for the land.
	e 0/2 40 1/2 49 2/2 12 (Average mark 0.72)	*Two marks for the justification. It must link what the organisation does with sustainability problems indicated in the case study. Brief part answers received 1 mark.* The organisation must have the ability to advise on agricultural production in the area, the catchment's management, land management and community values and expectations.
Question 9 and 10	Question 9a was well answered. Questions 9b and 9c required the students to use their knowledge and experience to think through what the advantages and disadvantages of the new technology are likely to be. Most students relied only on the information presented in the article and could not fully answer these questions.	
	a 0/2 32 1/2 43 2/2 25 (Average mark 0.93)	**Currently used practices.** *Two marks for full answer, 1 mark for partial answer.*
	b 0/4 19 1/4 28 2/4 35 3/4 14 4/4 3 (Average mark 1.53)	**Advantages of changing from currently used practices.** *Each relevant advantage listed gained 1 mark, if well explained then 2 marks were awarded.*
	c 0/4 36 1/4 30 2/4 29 3/4 5 4/4 0 (Average mark 1.04)	**Problem of changing to new practices described in article.** *Each relevant problem listed gained 1 mark, if well explained then 2 marks.*
	Question 10a was well answered. Question 10b required students to use their knowledge and experience to think about how the new technology would improve the efficiency of the enterprises involved. Most students relied only on the information presented in the article and therefore did not fully answer this question. Most students still do not understand the concept of efficiency (compared with effectiveness) and this limited their marks.	
	a 0/4 16 1/4 11 2/4 32 3/4 32 4/4 9 (Average mark 2.06)	**Description of two items of machinery equipment or techniques.** *Basic description with aspects missing or poorly described gained 1 mark, detailed or full description gained 2 marks (for each item).*
	b 0/4 34 1/4 33 2/4 25 3/4 7 4/4 2 (Average mark 1.09)	**How the two items improve efficiency.** *One mark for explanation of how it effects production and 1 mark if it explains improved efficiency; income vs. cost (for each item).*

Nursery Production

Tough greenhouses

9a. Single skin plastic houses or glass houses with either growing in the ground or a potting media.
9b. Insulation. The double skin with air between will reduce heat transfer, improving efficiency. Hail damage: not being solid it acts like a cushion to the hail and does not shatter. The growing environment is optimised. Computer monitors nutrients, temperature and wind speed to suit the crop.
9c. Double skin may lower sunlight available for plant growth. Breakdowns are more likely due to increase use of technology. Production not adequate to cover the cost of the technology. Staff may need to be retrained to use the technology. Moisture in air between skins may lead to algal growth and lead to less sun being transmitted.
10a. Double skinned plastic green house. Provides a wall for the greenhouse that is not damaged by hail and insulates the crop. Hydroponics system: provides water and nutrients to the plants for their growth.
10b. Lowers costs: no hail damage, lower heating and cooling costs due to insulation. Ideal temperature and nutrients means no wastage. Increase in production: plants maintained in ideal growth environment (climate and nutrient) to maximise production.

Horticultural crops

Huge net shows its worth.

9a. Nashi trees grow in the open: uncovered with large spacing between the trees, without a training trellis.
9b. Reduced damage from hail, wind and birds leads to increased quality and prices for products. Reduces insurance premiums allowing income when crop fails and reducing production costs. Allows access to export markets.
9c. Paying for it. Production may not be adequate to cover the cost of the technology. Increased labour cost for maintenance. Restricts some machinery use under the net. Insects for pollination may be reduced.
10a. Crop net: physical barrier to protect the crop from hail and birds. Tatura trellis: supports the plant and trains it into the correct shape.
10b. Tatura trellis: lower cost due to easier pruning and picking. Higher income from better fruit quality. Efficient use of space for trees per hectare and sun use. Crop net: lowers cost due to insurance. Risk management possible. Allows access to better markets and improved income. Production is higher due to decreased crop losses.

Soil Management

Reclamation using trees

9a. Inaction. Soil cultivation to reduce weeds/competition and to break surface. Hope for rain. Irrigation to leach salt. Pumping to reduce water table levels. Single tyne deep ripping.
9b. Increase productive land available. Increase habitat and diversity of ecosystem. Erosion prevention.
9c. Labour and management costs not offset by increase in production. Need to fence off area until plants are established giving reduced productive area. Lower stock numbers.
10a. Glyphosate spray: herbicide. Kills all plants sprayed with it. Reduces competition for seeds sown. Winged ripper: sub-surface cultivation allows increased water and air movement through soil.
10b. Glyphosate spray: reduces competition from weeds allowing productive plants to grow. Possibly more efficient than cultivation and better for soil structure. Winged ripper: improves root-growing environment. Improved growth and thus shorter time to full production.

Irrigation Management

Probing new ground

9a. Digging a hole at the site to be monitored and seeing where moisture is.
9b. Accurate fertiliser and moisture application. Remote monitoring to save time.
9c. Costs not offset by savings or increased production. Technology failure/maintenance costs. Incorrect interpretation of data, operator not skilled enough to interpret it properly leading to poor decisions.
10a. C-Probe: measures soil conductivity which may be interpreted to show nutrient and moisture status of the soil. Multi-depth sensors: allows the measurements to be taken simultaneously from different soil depths. Profiles can be interpreted to monitor wetting depth of irrigation.
10b. C-Probe: tells when to water, improving efficiency of water use and farmer's time. Multi-depth sensors: tells how long to water, allowing more efficient placement of water and fertiliser into the root zone. Efficiency is achieved for both by using fewer resources to achieve the same production.

Pest Control

Natural-born enemies

9a. Static bird scaring devices not operated on a time basis, constantly operated or activated by farmer. No ability to vary operation in the short term.
9b. Reduces crop losses/damage caused by birds due to increased reliability. It is programmable, so suited to a variety of situations. Only activated when necessary, saves time, energy costs and less annoyance to neighbours.
9c. Reliance on technology: risk of failure higher Higher initial costs and maintenance cost: will returns cover these? Operator may not have adequate skill to achieve effective results.
10a. Bird Deter: detects presence of birds and activates deterrent via radio link. Computer: controls the nature of the deterrent. Allows the quick analysis of a large range of information and can store many different deterrent programs.
10b. Bird Deter: Reduces crop losses/damage caused by birds, hence increases production. Computer: makes varying and matching the deterrent type more efficient so should increase production. Efficiency would depend on the extent of the bird problem and the expected savings compared with cost.

Cropping and Pasture

High speed pasture drill

9a. Some combination of soil preparation, sowing and rolling/scarifying. Traditional equipment would need soil preparation that is not as precise with the seed placement and coverage.
9b. Faster operation means more chance of sowing when moisture levels are correct; reduced labour costs. Minimal tillage is better for soil structure. Range of situations handled may reduce need for other equipment. Range of terrain handled may be increased.
9c. Covering the cost of the equipment. Will savings/benefits justify it? Maintenance/down time risks. More technical skills are required to maintain and operate the equipment.
10a. Conserva-Tech No-Till seeder: accurately sow seeds at high speed without the need for pre-cultivation. Minimum tillage techniques: the use of techniques other than cultivation to control weed competition and prepare a seed bed for sowing crops or pasture plants
10b. Conserva-Tech No-Till seeder: less cultivation necessary and increased success with seed growth should lower cost, ensure pasture/crop establishment to provide increased returns. Handles a wide range of conditions. Consideration needs to be given to whether these will cover the cost. Minimum tillage techniques: maintains healthier soil, leading to longer-term biophysical sustainability. May lower costs in the short term.

Grazing

Computer-aided management decisions

9a. Historical stocking records for paddocks, diary and weather records. Farmer uses memory and trial and error. Computer spreadsheets calculating seasonal returns at different prices and yields may assist these.
9b. Increased confidence with management decisions such as leasing and investing in livestock or fertiliser. Uses historical and current records to predict optimum stocking rates and assess risk of increasing.
9c. Over reliance on computer compared with gut feeling or personal experience. High investment in computer/software technology. Need to know if skills are available. What happens in times of crisis? (e.g. computer crashes). Need to allow for maintenance time, data loading. Will returns justify set up cost?
10a. GrassGro simulator: software predicts profitability from various stocking rates based upon historical and current pasture, weather and market information. Optimum stocking rates: a management approach that attempts to ensure maximum long term returns from grazing. Balances grazing pressure with pasture growth appropriate for the season and seasonal risks probability. Computer and software: provides capability of integrating a large number of variables and data inputs to predict outcome according to a tested model.
10b. GrassGro simulator: efficiency of resource use. Getting the most out of available resources. Integrates many historical and current variables to provide analysis of alternative management options. Likelihood of success is increased. Risk is reduced. Optimum stocking rates: efficiency of resource use. Getting the most out of available resources. Computer and software: saves time and integrates more variables than would be otherwise possible to provide analysis of alternative management options. Likelihood of success is increased. Risk is reduced.

Dairy Farming

Inline temperature gauge

9a. Handheld temperature gauges used at the start of the operation. Water tested in a bucket.
9b. Safety. Less risk of farmers being burnt by hot water when testing the temperature. Hygiene, continual monitoring means little risk of temperatures dropping to unhygienic levels without being noticed.
9c. Reliance placed on the gauge. What happens if it is wrong? More difficult to maintain. Temperature difference at end of pipe compared with inline must be monitored if any changes to pipes or insulation occur.
10a. Inline temperature gauge: Measures temperature of fluids in pipes. Dairy hygiene techniques: ensures that conditions in dairy and of products are not suitable for microorganisms to grow. Appropriate combinations of temperature and chemical cleansing and product handling and storage techniques can be achieved.
10b. Inline temperature gauge: reduced injury/trauma time, less product spoilage lower costs and increased returns at little cost. Dairy hygiene techniques: less product spoilage, less transmission of disease leading to increased returns at little cost.

Poultry

Free-range poultry

9a. Birds have to make their way back to a fixed shed every night. Birds kept in enclosed deep litter systems. Reliance on mains electricity.
9b. Marketing advantages of free-range products. Land use advantages: spreads the stocking pressure of birds over larger area. More flexible land management. Pest/Disease control: clean land can be used for the birds, easier quarantine/isolation of diseased groups.
9c. Getting adequate returns to cover the costs. Increased labour and costs. Management more complex due to grazing function being introduced. Foxes and other predators may be a problem.
10a. Mobile poultry sheds: house and poultry can be transported. Self contained food, energy and water requirements. Solar collecting panels: collect the suns rays and convert them to usable form of energy so that the shed has lighting, heating and cooling without the need to be plugged in.
10b. Mobile poultry sheds: provide access to higher prices and specific markets for product. Will this cover the increased costs? Solar collecting panels: enable flexibility in the management of the sheds and provision of ideal growing environments for the poultry. Increased production (income) and easier management. Cost/benefits?

Pigs

Eco-shelter pig production

9a. Intensive piggery has lots of smaller pens and would be on concrete and mesh floors. Free range piggery would have dirt/mud areas for pigs to wallow and a sheltered area.
9b. Animal rights issues considered (health and happiness). Waste is marketable. Product is better (muscle tone).
9c. Disease/pests more readily spread as animals all in contact. Possible injury due to pig interactions. Handling of waste products is more difficult. Animal handling is more difficult due to bigger groups.
10a. Eco-shelter piggery: provides a suitable growth environment for the pigs. Deep litter bedding: provides bedding for the pigs. Absorbs the urine and partially breaks down the dung.
10b. Eco-shelter piggery: production of a quality product for the market, giving marketing advantages and efficiency advantages. Social acceptability. Deep litter bedding: turns waste into a marketable product (a cost that provides returns).