



# **PLANT PRODUCTION SYSTEMS**

## **ATAR course examination 2018**

### **Marking Key**

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

## Section One: Multiple-choice

20% (20 Marks)

Question	Answer
1	D
2	C
3	D
4	C
5	D
6	A
7	B
8	B
9	C
10	A
11	C
12	A
13	A
14	B
15	D
16	D
17	B
18	A
19	C
20	B

Section Two: Short answer

50% (109 Marks)

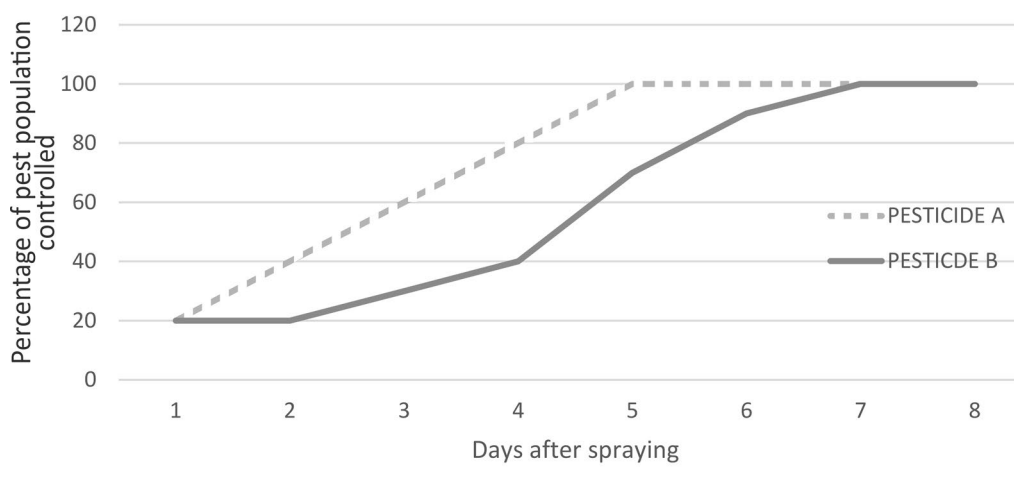
Question 21

(16 marks)

- (a) Two pesticides are available to control an insect in a ripe crop. Graph the results, using the data table below that shows the percentage of pests controlled. (6 marks)

Description	Marks
Relevant graph title	1
Y axis has pest population, axis clearly labelled	1
X axis has time, axis clearly labelled	1
Pesticide A is accurately plotted as a line graph and labelled	1
Pesticide B is accurately plotted as a line graph and labelled	1
Plotted lines start at 1 on X axis and 20 on Y axis	1
<b>Total</b>	<b>6</b>
Answers includes, but are not limited to the following:	
<ul style="list-style-type: none"> <li>graph title – Comparison of pesticide performance</li> </ul>	

**Comparison of pesticide performance**



Note: If there is a scaling error, a maximum of 5 marks can be awarded.

Question 21 (continued)

(b) (i) Define economic threshold (ET). (2 marks)

Description	Marks
Detailed relevant definition	2
Basic relevant definition	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>The pest's population level or extent of crop damage at which the value of the crop destroyed exceeds the cost of controlling the pest.</li> </ul>	

(ii) Consider the graph in part (a). State which pesticide is more effective at the point where the ET equals 60%. (1 mark)

Description	Marks
At 60% Pesticide A is working faster than Pesticide B	1
<b>Total</b>	<b>1</b>

(iii) Describe **one** relevant factor that would enable the ET to be estimated. (2 marks)

Description	Marks
Description of relevant factor	2
Statement about relevant factor	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following:                     the development of economic thresholds may require; <ul style="list-style-type: none"> <li>knowledge of pests, including pest life cycle and relevant environmental factors such as temperature and moisture levels</li> <li>how this relates to crop development stage and the nature of the specific damage caused to the crop (i.e. root damage, leaf damage, growing point damage)</li> <li>estimate of crop yield at time of infestation and expected value at point of sale compared to the costs of control.</li> </ul>	

(iv) Explain which pesticide is a better choice if the withholding period (WHP) for both pesticides is 5 days. (3 marks)

Description	Marks
Pesticide A	1
Explanation of relevant choice	2
Statement about relevant choice	1
<b>Total</b>	<b>3</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>Pesticide A controls all pests within the WHP, thus enabling harvest to take place whereas Pesticide B is still controlling the pest/population that will take another 2 days to eradicate, thus delaying harvest.</li> </ul>	

- (c) Describe how the pest could become resistant to either of the pesticides in part (a). (2 marks)

Description	Marks
Description of how the pest could become resistant	2
Statement about pest resistance	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>continuous use of the same pesticide (i.e. mode of action) will result in increased proportion of resistant members in each following generation.</li> </ul> Other answers may be based on: <ul style="list-style-type: none"> <li>incorrect application rates</li> <li>ineffective application method</li> <li>genetic variation within the same species that enables it to survive.</li> </ul>	

## Question 22

(15 marks)

- (a) Complete the table below. (6 marks)

Environmental change	Transpiration response	Reason
High humidity	Decreased transpiration	Low diffusion of water vapour due to high moisture concentration around leaf
Low light intensity	Decreased transpiration	Stomata remain closed
Strong wind	Increased transpiration	Reduces boundary layer on leaf surface

Description	Marks
1 mark for each correct answer	1–6
<b>Total</b>	<b>6</b>

- (b) Select two environmental changes from part (a) and describe how transpiration rates can be manipulated artificially to improve production. (4 marks)

Description	Marks
For each of <b>two</b> environmental changes (2x2).	
Description of how transpiration rates can be manipulated artificially	2
Statement about how transpiration rates can be manipulated artificially	1
<b>Total</b>	<b>4</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>temperature – whitewash glasshouses/plastic igloos to increase reflection of sunlight</li> <li>light – shade cloth, gradually moving from a high shade area to low shade to harden the plant up</li> <li>humidity – mist irrigation in hot houses, surround plant with free standing water source</li> <li>wind – windbreaks (artificial or tree lines) to reduce wind and therefore decrease transpiration.</li> </ul>	

## Question 22 (continued)

- (c) State how **two** end products of photosynthesis are used. (2 marks)

Description	Marks
Relevant statement about glucose	1
Relevant statement about oxygen	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>oxygen – released as a waste product</li> <li>oxygen – used during respiration</li> <li>glucose – used during respiration as a source of energy</li> <li>glucose – converts to starch and is stored.</li> </ul>	

- (d) (i) State which hormone plays an important role in a plant's ability to take full advantage of available light for photosynthesis. (1 mark)

Description	Marks
Auxin	1
<b>Total</b>	<b>1</b>

- (ii) Describe a relevant commercial use for the hormone selected in part (d)(i). (2 marks)

Description	Marks
Description of a relevant commercial use for the hormone selected in part (d)(i)	2
Statement about a relevant commercial use for the hormone selected in part (d)(i)	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>encourages the vigorous growth of roots of cuttings so that several new plants can be propagated from a single plant.</li> </ul> Other answers may be based on: <ul style="list-style-type: none"> <li>initiate development of fruit without pollination</li> <li>inhibits lateral growth</li> <li>prevention of premature fall of fruits</li> <li>prevention of sprouting of tubers (potatoes) in storage.</li> </ul> Note: apply follow through marks for incorrect hormone in d(i).	

## Question 23

(14 marks)

- (a) Complete the following gross margin analysis of the current variety and the new variety. Round to the nearest dollar. (2 marks)

	<b>New Variety</b>	<b>Current Variety</b>
Income (\$ per tonne)	\$350	\$350
Yield (tonnes per hectare)	1.5	1.0
Income (\$ per hectare)	\$525	\$350
Costs (\$ per hectare)		
Seed	\$150	\$50
Fertiliser	\$100	\$100
Weed control	\$75	\$75
Fungicide	\$0	\$50
Gross margin (\$ per hectare)	A	B

<b>Description</b>	<b>Marks</b>
A = \$200	1
B = \$75	1
<b>Total</b>	<b>2</b>

- (b) Apart from financial gain, describe another reason why you would choose one variety over another. (2 marks)

<b>Description</b>	<b>Marks</b>
Description of relevant reason	2
Statement about relevant reason	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>choose A because although the seed is more expensive there is no use of the fungicide which will reduce ecosystem effects on non-target species, less applications in-crop which will reduce machinery costs</li> <li>choose B because it is not GM and does not have the associated issues of contamination of non-GM crops to contend with.</li> </ul>	

## Question 23 (continued)

- (c) (i) Recalculate the gross margins in part (a). Round to the nearest dollar. (2 marks)

Description	Marks
Gross margin A = \$272 or \$273	1
Gross margin B = \$117 or \$118	1
<b>Total</b>	<b>2</b>

- (c) (ii) Describe the effect your calculations in part (c)(i) will have on your crop decision making. (2 marks)

Description	Marks
Description of relevant effect	2
Statement about relevant effect	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>GM variety now has a greater increase in gross margin. Provided there is a market for the GM product grower should stay with the GM variety.</li> </ul> Note: accept relevant answers in relation to non-GM variety.	

- (d) Explain
- one**
- positive impact genetically modified organisms (GMO) might have on the natural ecosystem. (3 marks)

Description	Marks
Explanation of relevant impact	3
Description of relevant impact	2
Statement about relevant impact	1
<b>Total</b>	<b>3</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>reduction in the volume and frequent use of pesticides, less contamination of water supplies and less damage to non-target species, particularly natural predators and pollinators.</li> </ul>	

- (e) Other than GMO, identify and describe a new technology that could be used to reduce costs in the gross margin in part (a). (3 marks)

Description	Marks
Identifies a relevant new technology	1
Description of relevant new technology	2
Statement about relevant new technology	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>3</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>weed control – weed seeker technology; infrared camera's recognise weeds and chemical is directed to only that weed, reducing costs, reducing resistance and effect on the environment</li> <li>fertiliser application – Variable Rate Technology; rates of fertiliser applied varies with soil/crop requirements. Nutrients applied where they are needed. Savings on fertiliser costs and fertiliser waste, which does contribute to contamination of water courses</li> </ul> Other answers could be based on: <ul style="list-style-type: none"> <li>GPS</li> <li>remote steering</li> <li>biofuels.</li> </ul>	



## Question 24

(16 marks)

- (a) Identify an Australian plant product and nominate its major export destination. (2 marks)

Description	Marks
Plant product	1
Export destination	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>• wheat – Asia/Middle East</li> <li>• barley – China</li> <li>• vegetables – UAE, Asia</li> <li>• sugar – Asia.</li> </ul>	

- (b) Describe how Australia has a comparative advantage for the plant product in part (a). (2 marks)

Description	Marks
Description of how Australia has a comparative advantage	2
Statement about Australia's comparative advantage	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>• wheat – Australia has the suitable environment for growing wheat, plenty of land, low cost of production, clean/disease free product whereas Asia has a large manufacturing industry, underpinned by cheaper labour costs.</li> </ul>	

- (c) Explain how Australia maintains its global competitiveness in the plant product selected in part (a). (3 marks)

Description	Marks
Explanation of how Australia maintains its global competitiveness	3
Description of how Australia maintains its global competitiveness	2
Statement about how Australia maintains its global competitiveness	1
<b>Total</b>	<b>3</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>• Australian farmers tend to be innovative and adopt technology to remain efficient. This helps to increase productivity even though the soils are of low quality, on the driest continent and with continual climate variability by adopting appropriate techniques.</li> </ul> Other answers may be based on: <ul style="list-style-type: none"> <li>• low levels of subsidies</li> <li>• high level of food safety, both leaving and entering Australia.</li> </ul>	

## Question 24 (continued)

- (d) Explain **one** protection strategy Australia can use against foreign products entering Australian markets. (3 marks)

Description	Marks
Explanation of a relevant protection strategy	3
Description of a relevant protection strategy	2
Statement about a relevant protection strategy	1
<b>Total</b>	<b>3</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>tariffs – a tax imposed on imported goods. Three primary functions are to raise revenue, protect domestic industries and to remedy a trade distortion with another country that has imposed a tariff on Australian exports</li> <li>quarantine – regulations that prevent the importation of plant and animal material that do not meet the strict pest and disease free status required to protect our domestic production. Reduces dumping of inferior products and known pests from international destinations.</li> </ul>	

- (e) If there was an outbreak of a highly-contagious plant disease in Australia, describe **one** strategy that could be implemented at each of the following levels to mitigate the effect of the disease.

local

national

international

(6 marks)

Description	Marks
For each of the <b>three</b> strategies (3x2)	
Description of a relevant strategy	2
Statement about a relevant strategy	1
<b>Total</b>	<b>6</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>local; farm biosecurity plan, restricting access of visitors to production areas, clean vehicles, boot baths in and out of production areas</li> <li>national; implementation of an incident response plan (i.e. Emergency Plant Pest Response Deed – Plantplan) supported by government and/or industry, or state-based border inspection to prevent the transport of plant diseases</li> <li>international; AQIS, inspection of incoming and outgoing products at all ports and airports, restricted product lists.</li> </ul>	

## Question 25

(16 marks)

- (a) (i) List **two** environmental changes that are taking place in the agricultural regions of Western Australia due to climate change. (2 marks)

Description	Marks
Reduced rainfall	1
Higher temperatures	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>extreme events – intensity and frequency of bushfires</li> <li>cyclones – increase in intensity</li> <li>shifting season rainfall – more summer rain</li> <li>lower rainfall in marginal areas</li> <li>higher temperatures, shorter growing seasons</li> <li>greater variability in seasonal conditions.</li> </ul>	

- (ii) Select **one** environmental change from part (a)(i) and describe the effect it will have on biodiversity in natural ecosystems. (2 marks)

Description	Marks
Description of a relevant effect	2
Statement about a relevant effect	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>extreme events – destruction of habitat/localised populations of native species</li> <li>reduced rainfall – reduction in available food, native species relocate leaving gaps in the ecology of the region. Less run-off into waterways which support native species</li> <li>increased temperatures – interferes with natural mating, spikes can cause some species death because they are unable to migrate.</li> </ul>	

- (b) Choose a plant enterprise you are familiar with and describe how an adaption to its production system could meet **one** of the changed circumstances identified in part (a)(i). (2 marks)

Description	Marks
Description of a relevant adaption	2
Statement about a relevant adaption	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: Example of adaption: <ul style="list-style-type: none"> <li>cereal cropping – new variety that is drought tolerant enabling areas of unreliable/low rainfall to remain viable.</li> </ul> Other answers may be based on: <ul style="list-style-type: none"> <li>direct drilling</li> <li>minimum tillage</li> <li>stubble mulching.</li> </ul>	

Question 25 (continued)

- (c) Identify a farm resource. Describe **one** short-term and **one** long-term improvement that could ensure its sustainability in the face of climate change. (5 marks)

Description	Marks
Relevant farm resource selected	1
Description of a short-term improvement	2
Statement about a short-term improvement	1
Description of a long-term improvement	2
Statement about a long-term improvement	1
<b>Total</b>	<b>5</b>
<p>Answers include, but are not limited to the following:</p> <ul style="list-style-type: none"> <li>farm resource – water, soil, native vegetation</li> </ul> <p>Short term:</p> <ul style="list-style-type: none"> <li>water; grow varieties with lower water requirements/greater drought tolerance</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>checking for leaks</li> <li>scoop dams of silt to improve holding capacity</li> <li>clean roaded catchments of weeds.</li> </ul> <p>Long term:</p> <ul style="list-style-type: none"> <li>water; install more efficient irrigation systems and/or practices ensuring that water is moved and placed effectively, therefore decreasing evaporation loss.</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>increase water holding facilities (more dams)</li> <li>utilise available ground water via bores</li> <li>adopt water harvesting techniques at seeding through machinery adaptations.</li> </ul>	

- (d) (i) Define intergenerational equity. (2 marks)

Description	Marks
Detailed relevant definition	2
Basic relevant definition	1
<b>Total</b>	<b>2</b>
<p>Answers include, but are not limited to the following:</p> <ul style="list-style-type: none"> <li>is the concept that we pass on the natural and cultural environment to the next generation in as good or better condition than we found it.</li> </ul>	

- (ii) Choose one of the demands of the triple bottom line and explain a strategy that will support intergenerational equity in the face of climate change. (3 marks)

Description	Marks
Explanation of a strategy that supports intergenerational equity in the face of climate change	3
Description of a strategy that supports intergenerational equity in the face of climate change	2
Statement about environmental, social or economic factors	1
<b>Total</b>	<b>3</b>

Answers include, but are not limited to the following:

- environmental – reduce the carbon footprint by adopting more sustainable energy sources such as the installation of renewable energy (i.e. solar and/or wind) to reduce greenhouse gas emissions.

Other answers may be based on:

- environmental – carbon storage
- social – maintaining employment opportunities in farm businesses
- economic – maintain quality to ensure viable prices, invest off-farm, reduce overheads, adapt production systems to maximise income, lower input costs.

Question 26

(15 marks)

- (a) (i) List **four** causes of variation in product quality and/or quantity. (4 marks)

Description	Marks
Any <b>four</b> of the following	1–4
<b>Total</b>	<b>4</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>• poor seasonal conditions</li> <li>• lack of nutrition</li> <li>• disease</li> <li>• insect damage</li> <li>• rain/hail damage</li> <li>• poor harvesting technique</li> <li>• poor post-harvest handling/storage/packing/transport.</li> </ul>	

- (ii) Describe the on-farm practices that could be used to manage **two** of the variations listed in part (a)(i). (4 marks)

Description	Marks
For each of <b>two</b> practices (2x2). Must be taken from (a)(i)	
Description of relevant on-farm practice	2
Statement about relevant on-farm practice	1
<b>Total</b>	<b>4</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>• poor post-harvest handling/storage/packing/transport – maintain equipment to reduce damage to the product and contamination from pests and residues.</li> </ul> Other answers may be based on: <ul style="list-style-type: none"> <li>• lack of nutrition – soil test/tissue test</li> <li>• correct cool room temperature</li> <li>• clean/disinfect silos</li> <li>• disease – select resistant variety, use break crop, monitor, use fungicide</li> <li>• insect damage – monitor, spray</li> <li>• rain/hail damage – cover (e.g. table grapes)</li> <li>• poor harvesting technique – maintain machinery, upskill labour, invest in better harvest technology.</li> </ul>	

## Question 26 (continued)

- (b) Identify a plant quality assurance (QA) program and explain how it could mitigate the risk of a poor-quality product being marketed. (4 marks)

Description	Marks
Relevant QA program identified.	1
Explanation of mitigating risk	
Description of mitigating risk	3
Statement about mitigating risk	2
	1
<b>Total</b>	<b>4</b>
<p>Answers include, but are not limited to the following:            Examples of quality assurance programs:</p> <ul style="list-style-type: none"> <li>Freshcare, Supplier Excellence Program, Graincare, Feedsafe, SQF (Safe Quality Food)</li> </ul> <p>Example using Freshcare:</p> <ul style="list-style-type: none"> <li>the Freshcare program provides a code of practice and detailed training materials to assure fresh produce is safe to eat, meets customers' specifications and legislative requirements and has been produced with care for the environment. Audits are undertaken pre-certification and both self and third party to verify compliance with standards during harvest.</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>Graincare is based on Hazard Analysis Critical Control Point (HACCP), managing food safety risks on the farm such as recording the use of pesticides, identifying risk, implementing a control measure and keeping a record of the process and outcome for audit purposes.</li> </ul>	

- (c) Identify **one** type of market feedback and describe how a plant producer could use this information to plan future production. (3 marks)

Description	Marks
Market feedback	1
Description of how market feedback could be used	
Statement about how market feedback could be used	2
	1
<b>Total</b>	<b>3</b>
<p>Answers include, but are not limited to the following:            Examples of market feedback:</p> <ul style="list-style-type: none"> <li>\$/tonne, c/kilogram, grade based on hectolitre weight, screenings, protein %, oil %.</li> </ul> <p>Example description:</p> <ul style="list-style-type: none"> <li>greater care during harvest to reduce product damage such as bruising, skinning, cracking, which can be achieved by adjusting machinery and/or timing of the operation.</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>adjust production program by using a more suitable variety</li> <li>adjust fertiliser rates/irrigation rates to optimise growth</li> <li>adjust/replace harvester to reduce screenings.</li> </ul>	

## Question 27

(17 marks)

- (a) Write a relevant hypothesis to test ryegrass growth rate. (2 marks)

Description	Marks
Complete, relevant hypothesis	2
Part of a relevant hypothesis	1
<b>Total</b>	<b>2</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>nitrogen applied as a spray will stimulate a faster growth rate than top-dressed nitrogen on ryegrass pasture.</li> </ul>	

- (b) Using control, randomisation and replication aspects of experimental design, describe an investigation to test the hypothesis in part (a) with the following resources: (6 marks)
- one hectare of land in the corner of a 100 hectare paddock
  - two varieties of ryegrass.

Description	Marks
For each of the <b>three</b> aspects (3x2)	
Description of relevant investigation	2
Statement about relevant investigation	1
<b>Total</b>	<b>6</b>
Answers should include: <ul style="list-style-type: none"> <li>control – an area that has not been treated, to compare with the foliar and top dressed treatments</li> <li>randomisation – foliar, top dressed and control treatments are distributed such that each has an equal chance of displaying the possible growth rates</li> <li>replication – a number of treatments to reduce the chance of experimental error.</li> </ul>	

- (c) The results were inconclusive. Evaluate the investigation in part (b) and describe an improvement that can be made for a future investigation. (4 marks)

Description	Marks
Evaluation of the investigation	2
Statement about the investigation	1
Description of improvement	2
Statement about an improvement	1
<b>Total</b>	<b>4</b>
Answers include, but are not limited to the following: <ul style="list-style-type: none"> <li>evaluation; the trial site position in the corner could have caused experimental bias due to soil type, topography, former headlands. Two varieties of ryegrass is an additional variable, which may have different agronomic properties</li> <li>improvement; greater number of sites across the paddock so that each soil type can be replicated. Select one ryegrass variety to test for nitrogen response.</li> </ul>	



## Question 27 (continued)

- (d) (i) The following data is from a similar investigation under the same climatic conditions. What conclusion can you draw from this data? (2 marks)

Description	Marks
Interprets pasture growth rate using granular application is significant	2
States granular application is better	1
<b>Total</b>	<b>2</b>

- (ii) Explain the usefulness of standard error when analysing the results in part (d)(i). (3 marks)

Description	Marks
Explanation about the usefulness of standard error when analysing the results which is linked to a recommendation	3
Description of the usefulness of standard error when analysing the results	2
Statement about the usefulness of standard error	1
<b>Total</b>	<b>3</b>
<p>Answers include, but are not limited to the following:</p> <ul style="list-style-type: none"> <li>the difference between the two means is more than twice the standard error. The differences are significant, not due to chance or experimental error or environmental effects. A recommendation related to application method can be made.</li> </ul>	

## Section Three: Extended answer

30% (40 Marks)

## Question 28

(20 marks)

- (a) Define water availability. Explain **two** factors that would influence water entry into the soil and how those two factors can be managed for a plant production enterprise you have studied. (7 marks)

Description	Marks
Water availability definition – Difference between field capacity and wilting point in the soil	1
For each of the <b>two</b> factors (2x3)	
Explanation of factor and how it can be managed	3
Description of factor and how it can be managed	2
Statement about factor or how it can be managed	1
<b>Subtotal</b>	<b>6</b>
<b>Total</b>	<b>7</b>
<p>Answers include, but are not limited to the following:            Example for soil type:</p> <ul style="list-style-type: none"> <li>Particle size characteristics (i.e. clay, loam and sand) determine the way that water enters the soil. Sand due to a larger particle size permits the effective infiltration of water into the soil. Clay, with its fine particle size results in a slower infiltration of water. Gypsum can be applied to heavy clay soils to break up aggregates allowing greater infiltration. Clay spreading on sandy soils allows for greater water retention.</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>stubble cover: helps water to be drawn into the ground. Balance between standing stubble and horizontal as runoff can be an issue</li> <li>tillage system: untilled on clay vs that on sand, deep ripping to help root zones access lower water zones</li> <li>physical constraint: compactions- decrease air pockets in soils. Controlled traffic systems, ploughing, deep ripping, no stock</li> <li>chemical constraints: salts, adding gypsum to modify the calcium:sodium ratio</li> <li>evaporation of surface: management of stubble cover</li> <li>weeds: uses stored water, herbicide or physical control (depending on the soil type).</li> </ul>	

- (b) If 3 kilograms of phosphorus per tonne of produce is removed at harvest and a 2.7 tonnes/ha crop was harvested:

- (i) calculate how many kg/ha of phosphorus would be required to replace the lost phosphorus after harvest. (1 mark)

Description	Marks
Lost phosphorus per hectare: $2.7 \times 3 = 8.1 \text{ kg/ha}$	1
<b>Total</b>	<b>1</b>

## Question 28(b) (continued)

- (ii) for each fertiliser in the table above, calculate the cost per kilogram of the phosphorus. (3 marks)

Description	Marks
Fertstar: $810/10/14 = \$5.79/\text{kg P}$	1
Fertflow: $876/10/17.7 = \$4.95/\text{kg P}$	1
Fertgras: $660/10/9.1 = \$7.25/\text{kg P}$	1
<b>Total</b>	<b>3</b>

- (iii) select the most cost-effective fertiliser and calculate the cost per hectare to replace the lost phosphorus. Answers should be correct to two decimal places. Show your workings. (2 marks)

Description	Marks
Selects Fertflow	1
Cost per hectare: $8.1 \text{ kg} \times \$4.95 \text{ of Fertflow} = \$40.09/\text{ha}$	1
<b>Total</b>	<b>2</b>
Answer could also include: \$40.10/ha (based on method of rounding used)	

- (c) In a plant production enterprise you have studied, identify a plant growth stage that requires nitrogen fertiliser. Explain **two** strategies that farmers can use to reduce the fertiliser's harmful environmental impacts. (7 marks)

Description	Marks
Plant growth stage identified	1
For each of <b>two</b> strategies (2x3)	
Explanation of strategy to reduce harmful environmental impacts	3
Description of strategy to reduce harmful environmental impacts	2
Statement of strategy	1
<b>Subtotal</b>	<b>6</b>
<b>Total</b>	<b>7</b>
<p>Answers include, but are not limited to the following:            Examples of plant growth stages:</p> <ul style="list-style-type: none"> <li>• seeding, tillering, booting, grainfilling</li> </ul> <p>Example for type of nitrogen:</p> <ul style="list-style-type: none"> <li>• Choosing a granular type of nitrogen fertiliser, depending on soil type, may reduce leaching and therefore eutrophication of waterways. Granular fertiliser will only be released once wet whereas liquid fertiliser has the potential to leach immediately in light (i.e. sandy) soil types.</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>• application method: broadcasting – allows more fertiliser to be spread when needed, liquid application can be placed out with chemical control thus decreasing diesel consumption</li> <li>• placement when seeding – deep banding, in furrow etc. Nitrogen placed in the potential root zone area so it can be used</li> <li>• timing and amount are the biggest decision to reduce environmental impacts. Rain events will play a factor with leaching in sandy soils and potential run off.</li> </ul>	

## Question 29

(20 marks)

- (a) Explain **three** reasons why plant breeding programs are necessary for the future sustainability of Australian agriculture. (12 marks)

Description	Marks
For each of the <b>three</b> reasons (3x1)	
Relevant reason	1
<b>Subtotal</b>	<b>3</b>
For each of the <b>three</b> explanations (3x3)	
Explanation of relevant reason	3
Description of relevant reason	2
Statement about relevant reason	1
<b>Subtotal</b>	<b>9</b>
<b>Total</b>	<b>12</b>
<p>Answers include, but are not limited to the following:</p> <p>Example of a reason:</p> <ul style="list-style-type: none"> <li>enable crop yields to be maintained or improved in response to variable environmental conditions.</li> </ul> <p>Example explanation:</p> <ul style="list-style-type: none"> <li>Many crop-growing regions in Australia have low and variable rainfall patterns. It is likely that this will become a bigger problem as our climate changes. Hence, in order to maintain production it will be necessary to have access to crop varieties that are more tolerant of water stress and higher temperatures in the future.</li> </ul> <p>Other answers may be based on:</p> <ul style="list-style-type: none"> <li>improve yields and reduce production costs to stay competitive on the world market</li> <li>pest/disease resistance reduces yields, increases use of pesticides</li> <li>quality criteria is upgraded for new and existing markets</li> <li>salinity/acidity tolerance affects yields</li> <li>increasing demand to feed a growing world population.</li> </ul>	

- (b) Describe **four** basic steps involved in breeding a new crop variety. (8 marks)

Description	Marks
For each of <b>four</b> basic steps (2x4)	
Description of relevant step	2
Statement about relevant step	1
<b>Total</b>	<b>8</b>
<p>Answers include, but are not limited to the following:</p> <p>Basic step descriptions:</p> <ol style="list-style-type: none"> <li>collect and select varieties that between them have the characteristics required in the new variety</li> <li>crossbreed the collected varieties to combine the desired characteristics</li> <li>select from the offspring of the crosses those individual plants that have the desired characteristics</li> <li>evaluate the selected offspring for the presence of the desired characteristics under paddock conditions.</li> </ol>	

## Question 30

(20 marks)

- (a) Discuss **two** important budget variables that have a significant effect on the profitability of a plant production enterprise in the short-term. For each variable, identify a possible risk that could influence profitability and propose a strategy to minimise that risk.

(10 marks)

Description		Marks	
For each of <b>two</b> variables (2x2)			
Lists an important budget variable and discusses its effect on enterprise profitability		2	
Lists an important budget variable		1	
<b>Subtotal</b>		<b>4</b>	
For a risk/strategy related to each of <b>two</b> variables (2x3)			
Identifies an appropriate risk and presents an appropriate strategy to minimise the risk		3	
Identifies an appropriate risk and states a fact about minimising the risk		2	
Identifies an appropriate risk but does not mention a strategy to minimise risk		1	
<b>Subtotal</b>		<b>6</b>	
<b>Total</b>		<b>10</b>	
Answers for a crop, but are not limited to the following:			
Budget variable	Effect on gross margin	Possible risk	Strategy to minimise risk
Price – \$/tonne received for product	Higher price for the product will increase the gross margin	Market flooded by too many suppliers, good seasons in competitor markets etc. that reduce the local prices and result in a lower gross margin	Diversification of enterprises so not just reliant on the price of one product; store product until price increases
Yield – tonnes/ha	Increasing average yield will increase the gross margin	Low rainfall, frost, pest outbreaks etc. that reduce yield and hence lower gross margin	Reduce inputs on low rainfall years so gross margin less affected; grow different varieties that are more resistant to pests
Variable costs e.g. fuel, fertiliser, seed, labour, machinery, etc.	Higher variable costs will reduce the gross margin	Labour shortage driving up labour prices; increase in oil prices driving up fuel prices etc. that result in lower income and hence lower gross margin, fertiliser shortage drives up prices	Invest in more machinery when labour prices high; hire seasonal labour rather than permanent staff use global positioning systems and variable rate technology systems to reduce fuel and fertiliser costs; retain seed from previous year; buy fertiliser in bulk to secure early and lock in price.

- (b) Describe **two** long-term strategies that farmers could adopt that would address both rising costs and changing climate patterns, while maintaining profitability. (10 marks)

Description	Marks
For each of <b>two</b> strategies (2x5)	
Detailed description of how the long-term strategy addresses both rising costs and changing climate patterns	5
Briefly describes how the long-term strategy addresses both rising costs and changing climate patterns	4
Outlines how the long-term strategy addresses both rising costs and changing climate patterns	3
States a relevant long-term strategy that addresses both rising costs and changing climate patterns	2
Lists a relevant long-term strategy that addresses either rising costs or changing climate patterns	1
<b>Subtotal</b>	<b>5</b>
<b>Total</b>	<b>10</b>
<p>Answers could be, but are not limited to the following:</p> <p>Broadacre cropping  Rising costs – inputs, machinery replacement, marketing, compliance and financial costs. Long-term strategies are:</p> <ul style="list-style-type: none"> <li>• using short-term debt, e.g. concessional loans, deferring tax</li> <li>• yield mapping technology to identify productive sites</li> <li>• GPS guidance to reduce overlap.</li> </ul> <p>Climate change – increased incidence of frost, decreased rainfall, increased hot spells. Long-term strategies are:</p> <ul style="list-style-type: none"> <li>• change enterprise mix, adjust livestock/crop ratio to take advantage of land capability</li> <li>• introduce dual purpose crops, such as grazing cereals.</li> <li>• find new markets for existing crop residues, such as biofuel for straw</li> <li>• diversify into new agricultural products</li> <li>• change enterprise size to ensure efficiencies of scale</li> <li>• reduce localised risks by farming in a wider geographical area</li> <li>• use multi-peril insurance</li> <li>• create an off-farm income stream, e.g. rentals, shares.</li> </ul> <p>Horticulture  Rising costs – inputs, machinery replacement, marketing, compliance and financial costs. Long-term strategies are:</p> <ul style="list-style-type: none"> <li>• using short-term debt, e.g. concessional loans, deferring tax</li> <li>• yield mapping technology to identify productive sites</li> <li>• GPS guidance to reduce overlap.</li> </ul> <p>Climate change – decreased chill factor required for fruit set, increased temperature causing leaf burn/lower quality crop, lower rainfall run-off leading to less water available for irrigation. Long-term strategies are:</p> <ul style="list-style-type: none"> <li>• more efficient irrigation practices, e.g. sub-surface drip</li> <li>• growing more tropical/sub-tropical species that can handle the heat</li> <li>• improve water harvest catchments and storage (to reduce evaporation)</li> <li>• grow crops under shelters or greenhouses</li> <li>• growing less heat tolerant crops further south.</li> </ul>	

## ACKNOWLEDGEMENTS

- Question 21(b)(i)** Definition of economic threshold adapted from: Economic threshold. (2017). In *Wikipedia*. Retrieved October, 2018, from [https://en.wikipedia.org/wiki/Economic\\_threshold](https://en.wikipedia.org/wiki/Economic_threshold)  
Used under Creative Commons Attribution-ShareAlike 3.0 Unported licence
- Question 24(d)** Definition of tariffs adapted from: Ministry of Economy, Trade and Industry. (n.d.). *Chapter 4: Tariffs*, p.39. Retrieved October, 2018, from <http://www.meti.go.jp/english/report/downloadfiles/gCT0004e.pdf>

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