Government of **Western Australia**
School Curriculum and Standards Authority

PLANT PRODUCTION SYSTEMS

ATAR course examination 2020

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.

2020/65779

Section One: Multiple-choice **20% (20 Marks)**

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

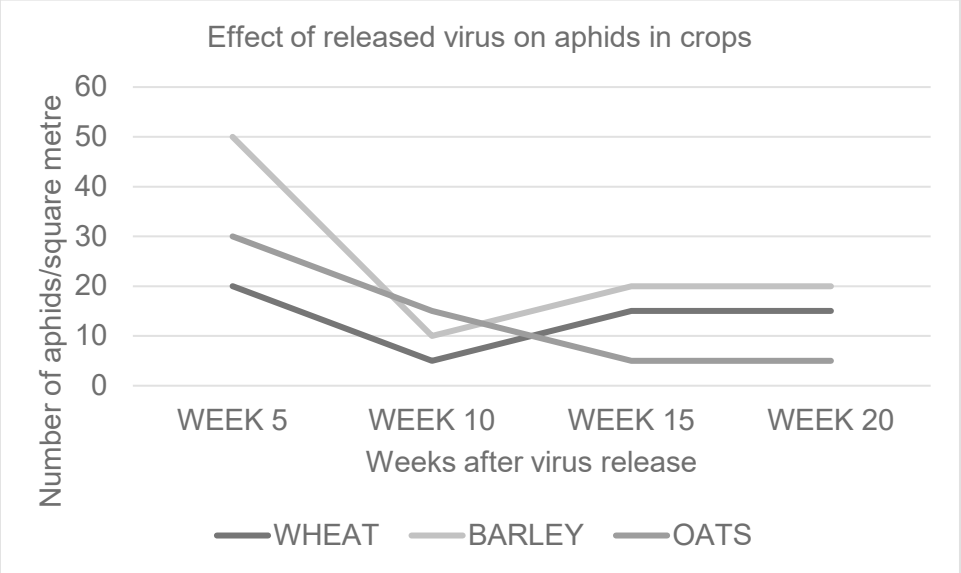
Section Two: Short answer **50% (101 Marks)**

Question 21 **(19 marks)**

(a) Clarify, using a relevant example, the role biological control measures play in pest management. (3 marks)

Description	Marks
States a relevant example	1
Clarifies biological control is part of an IPM strategy, reducing the reliance on chemical control, using a natural predator	2
States biological control is a natural control method or similar	1
Total	**3**
Examples include: • aphids eaten by ladybirds • parasitic wasps that lay eggs in larva.	
Accept other relevant answers.	

(b) (i) Using the table above, graph the data. (6 marks)



Description	Marks
Relevant title	1
X axis named	1
Y axis named	1
Line graph selected	1
An appropriate legend/key provided	1
All data lines are accurately plotted	1
Total	**6**
Allocate a maximum of 4 marks if a column graph is used.	

Question 21 (continued)

(ii) Outline **one** relevant conclusion you could draw from the graph in part (b)(i). (2 marks)

Description	Marks
Outlines a relevant conclusion, e.g. all crops had the aphid numbers reduced with oats going down to five, however the aphids in wheat and barley regained some numbers and levelled off after 15 weeks as the aphid population stabilised in the presence of the virus	2
Makes a simple or general statement that is relevant to the graph, e.g. aphid control using the virus is better in oats	1
Total	**2**
Accept other relevant answers.	

(iii) Explain **two** areas of potential experimental error in this trial. (6 marks)

Description	Marks
For each of the two areas	
Explains a relevant potential experimental error, describing how that error could influence the data	3
Outlines a relevant potential experimental error, stating how the error could influence the data	2
States a relevant potential experimental error	1
Total	**6**
Answers could include: • data were collected from three farms – environmental conditions could have affected aphid numbers, i.e. amount of rainfall, temperature, presence of frosts • aphid count could vary between farms due to crop density, collection method, collection timing • human error, diligence in finding aphids (very small), method of randomisation for collection • no knowledge of whether virus was present • no control, i.e. no knowledge of what would happen to aphid numbers with no virus release. • lack of replication	
Accept other relevant answers.	

(iv) Outline how **one** of the errors in part (b)(iii) could be rectified in a future investigation.
(2 marks)

Description	Marks
Outlines how an error, identified in part (b)(iii), can be rectified	2
States a relevant fact about rectifying a future trial, linked to one of the errors identified in part (b)(iii)	1
Total	**2**

Answers could include:

- environmental conditions – undertake trial at one farm to minimise error, analyse the data, find the standard deviation, repeat same trial at other sites then apply a standard error test to determine any significance in the data differences
- use controlled environments (hot-houses) at different sites to minimise the environmental variable
- select sites that have identical environmental conditions
- have a control
- have the same people conduct the experiment and collect aphids on each farm.

Accept other relevant answers.

Question 22 **(14 marks)**

(a) Refer to the above diagram. Replace producers (plants) with annual crops. Explain the effects this will have on the flow of energy and recycling of nutrients in this ecosystem.(4 marks)

Description	Marks
Explains the level of energy required by native plants all year round and how recyclers benefit from a continuous source of material which will help to keep the ecosystem in balance	4
Describes how the flow and recycling is reduced – short growing time, less energy required, less organic matter to recycle due to the harvesting effects of man and animals	3
Outlines that flow of energy and recycling of nutrients would be less due to the seasonal nature of annuals	2
States either flow of energy or recycling of nutrients would be less due to the seasonal nature of annuals	1
Total	**4**
Answers could include: • plant producers will apply fertilisers as an outside source of nutrients – this will affect recycling by providing large amounts of nutrients in a short period of time for the annual crop, creating feasts and famines for primary/secondary consumers • when the crop is harvested a large proportion of the nutrients are exported out of the ecosystem. These nutrients need to be replaced to have a balanced ecosystem. If there is not enough food for primary consumers, the population of secondary consumers will dwindle and decomposers will have less to break down • annuals are only active during their growing season and only remove nutrients when they are actively growing, reducing the flow of energy and ultimately the recycling of nutrients in the ecosystem, causing population fluctuations of those primary consumers that rely on plants and in turn on the secondary consumers • the annual crop could be a legume which fixes atmospheric nitrogen in the plants roots which ultimately remains in the soil until the roots are decomposed • the build-up of nitrogen is a positive for the ecosystem nutrients and will only benefit the ecosystem in the following crop.	
Accept other relevant answers.	

(b) Outline how the change to annual crops in part (a) would affect the ecosystem's biodiversity. (2 marks)

Description	Marks
Outlines population changes between primary and secondary consumers due to the reduction in producers for part of the year	2
States that the ecosystem's biodiversity would decrease due to the lack of food all year round	1
Total	**2**
Answers could include: • surges in consumer populations as crops grow, which will die out once crops are harvested • large numbers of unwanted consumers will be controlled by crop growers, to the detriment of beneficial consumers • less diversity of plants, less for pollinators to do, use of pesticides will lower biodiversity further.	
Accept other relevant answers.	

(c) Outline **two** short-term plant production strategies and **two** long-term management strategies that could ensure intergenerational equity is **not** compromised in an agricultural ecosystem.

(8 marks)

Description	Marks
For each of the four strategies	
Outlines a strategy that could provide future generations with an agricultural ecosystem that is not compromised	2
Statement about a strategy that relates to an agricultural ecosystem and its effect on intergenerational equity	1
Subtotal	**2**
Total	**8**

Answers could include:

Short-term:

- reduce reliance on chemical fertilisers by switching to mineral/organic fertilisers
- use improved varieties that have higher yields, greater disease/insect resistance
- use minimum till methods to reduce soil structure degradation
- choose pesticides that have lower impacts on the non-target/native species
- make decisions to reduce leaching of fertilisers into waterways and remanent vegetation
- growing legumes in a crop rotation to improve nitrogen availability
- introducing technologies that reduce traffic on the paddock and improved understanding of nutrient requirements
- fence-off saline areas and/or waterways.

Long-term:

- use integrated pest management as the basis of pest control to reduce reliance on pesticides and the detrimental effects they have on ecosystems
- re-fence according to land use, planting natives back into the system, protecting waterways from livestock/eutrophication and lowering the water table to address salinity
- monitor the agricultural ecosystem for change over time e.g. survey biodiversity at regular intervals.

Accept other relevant answers.

Question 23 **(19 marks)**

(a) Describe the above graph as it relates to the rate of plant growth. (3 marks)

Description	Marks
Describes how sugar production and consumption are closely linked to growth. The rate of growth would slow/stall if the rate of photosynthesis fell below the rate of respiration	3
Outlines that while photosynthesis (and the production of sugar) is restricted to daylight hours, plants respire constantly, using some of the sugar plants to grow	2
Makes a general statement such as plant growth only happens during daylight hours	1
Total	**3**
Accept other relevant answers.	

(b) Outline how each of the following factors affects the rate of plant growth. (8 marks)

Description	Marks
For each of the four factors	
Outlines how the factor affects the rate of plant growth – deficiencies of inorganic nutrients in the soil will slow growth due to nutrient limitation of plant growth	2
Makes a general statement that relates to the rate of plant growth – if inorganic nutrients are not available the rate of growth will slow	1
Subtotal	**2**
Total	**8**
Answers could include: • most of the essential major and minor nutrients come from the soil and without them the plants metabolic functions will be affected, slowing and impeding the plants life cycle • availability of inorganic nutrients – deficiencies in the soil will slow growth or development which makes them more susceptible to diseases • day length – increases or decreases photosynthetic activity due to the amount of sunlight available, thus affecting production of glucose which in turn will affect plant growth • canopy density – leaves at the top/on the edge receive more light therefore there is more photosynthetic activity. The denser the canopy, the more shading to lower plants/leaves. Plant stems push upwards to gain more light, using valuable glucose for stem elongation rather than leaf production • insect and disease damage – leaf damage will reduce photosynthetic activity and removal of stored sugars will stunt the plants growth rate.	
Accept other relevant answers.	

(c) (i) Outline **one** method used to determine accurately the amount of water available in the soil. (2 marks)

Description	Marks
Outlines how the probe can detect when there is a water deficit so remedial watering can be done to prevent wilting	2
States using a soil moisture probe	1
Total	**2**
Answers could include: • varying types of probes, from tensiometers to remote sensor monitoring. Uses an electric current to detect the amount of water near the root zone, giving producers ample time to replenish before wilting occurs • soil moisture mapping using satellite imagery.	
Accept other relevant answers. Note: for one mark accept that water availability in the soil is a function of field capacity minus wilting point.	

(ii) Explain **two** strategies that can be applied to increase soil water availability in a dry-land cropping system. (6 marks)

Description	Marks
For each of the two strategies	
Explains the strategy linking how it makes soil water more available, for example, process of minimum tillage to increase water availability; reduces loss of topsoil moisture by retaining the soils structure and retaining organic matter at the surface which acts like a blanket to reduce evaporation	3
Outlines the strategy with some linking to how it makes soil water more available, for example, how minimum tillage increases soil water availability – reduces evaporation of topsoil moisture	2
States the strategy, for example, minimum tillage	1
Subtotal	**3**
Total	**6**
Answers could include: • summer weed management – removes plants that use any rainfall that falls between harvest and seeding, in the next year. Spraying using weed sensors keeps the cost down. Most summer weeds are of little value to stock and can provide a green bridge for insects and diseases • mulching – utilising the previous seasons stubble cover to lower the soil surface temperature by knocking it down and creating an organic mat to reduce evaporation • deep ripping – creating pathways through the soil for water to percolate. In most cases deep ripping also breaks down hard pans which are an impediment to water movement into the sub-soil. Allows water to be stored in the sub-soil.	
Accept other relevant answers. Mulching, deep-ripping, wetting agent, clay spreading, fallowing, reduce salinity, maintain a neutral pH, no till farming.	

Question 24 (17 marks)

(a) Name a plant production system that would benefit from the application of GA and state the role it would play. (2 marks)

Description	Marks
Names a plant production system that would benefit from the application of GA – for example, barley	1
States the role – for example, increase in germination rate during malt production	1
Total	**2**
Answers could include: • sugar cane – increases elongation of internodes to increase yield • seedless grapes – increases stalk length so there is more space for grapes to enlarge • citrus trees – to delay senescence and maintain firmer fruit rind • cabbages – increased flowering stem growth which reduces time for seed production to occur.	
Accept other relevant answers.	

(b) (i) Propose an hypothesis to test this belief. (1 mark)

Description	Marks
Provides a statement giving the direction of the relationship between the independent and the dependent variables, for example, if the stem is longer, then harvesting time is reduced	1
Total	**1**
Answers could include: • if the stem is longer, then harvesting time will not be increased • if the stem is longer, then harvesting time will be decreased • if the stem is longer, then harvesting time will be not be affected.	
Accept other relevant answers.	

(ii) Outline the steps of an investigation to test the hypothesis in part (b)(i), taking into consideration **four** key aspects of experimental design. (8 marks)

Description	Marks
For each of the four aspects: replication, randomisation, controls, variables	
Outlines the key aspects to test the hypothesis with consideration to the aspect of experimental design	2
States an aspect of experimental design	1
Subtotal	**2**
Total	**8**
Answers could include: • replication – carried more than once, using the same conditions/method so that the statistical accuracy of the trial is increased • randomisation – trees of the same size are selected randomly from the edges and middle, to avoid selecting trees that are easy to get to or are influenced by shade or competition from other trees (on the edge) • controls – trees of the same size are identified and not sprayed • variables – selected trees need to be the same size and shape, same variety, receiving the same nutrition and water during the trial.	
Accept other relevant answers. Note: variables may be expressed as the independent and dependant variable where one mark is given for each correct variable.	

(c) (i) State whether the difference in tree height is significant. (1 mark)

Description	Marks
Yes, the difference in tree height is significant	1
Total	**1**

(ii) Outline how you reached your answer in part (c)(i). (2 marks)

Description	Marks
Outlines the difference in the two means is 17, which is more than twice the standard error, meaning the differences are significant	2
States that the standard error is less than the difference in the two means	1
Total	**2**

(iii) Consider how bias could have affected the results in the data summary. (3 marks)

Description	Marks
Considers how the speed of the pickers may be intentionally or unintentionally adjusted due to fatigue, affecting the results and causing them to be unreliable	3
Outlines how a bias, such as speed of pickers, is difficult to overcome where physical effort and stamina are required	2
States a relevant bias – different picking speed of pickers	1
Total	**3**
Answers could include: • number of trees to be picked – pickers get tired the longer they pick • number of mangoes on each tree may vary • some pickers are faster than others at picking, different skill levels.	
Accept other relevant answers.	

Question 25 (15 marks)

(a) The image above shows how fungicide resistance develops in stages. State what is shown at each stage. (3 marks)

Description	Marks
One – fungicide is applied to a population that has fewer resistant fungi	1
Two – the resistant fungi survive once a pesticide is used, some susceptible fungi survive because they weren't exposed	1
Three – the survivors are resistant to the action of the chemical and lead to the next generation replacing the susceptible fungus	1
Total	**3**

(b) (i) Give **one** reason why identifying the mode of action (MOA) in selecting a pesticide is important. (2 marks)

Description	Marks
Gives one reason of the role the MOA plays in reducing the resistant population. By changing it at regular intervals it slows the rate of resistance to chemical groups	2
States that the MOA is the mechanism the pesticide uses to control susceptible pests or similar	1
Total	**2**
Accept other relevant answers.	

(ii) Explain **two** strategies, other than the use of chemicals, that will slow the rate of pesticide resistance in a plant production system. (6 marks)

Description	Marks
For each of the two strategies	
Explains a strategy, other than the use of chemicals, that will slow the rate of pesticide resistance, for example, explains how biosecurity can minimise resistance by requiring visitors to meet at a designated point, machinery wash down areas, buying plant inputs from a reputable seller who has certified seed, reduce cross boundary contamination by maintaining buffer zones of susceptible crops	3
Describes a strategy, other than the use of chemicals, that will slow the rate of pesticide resistance, for example, describes how biosecurity can slow the rate of pesticide resistance by minimising the introduction of pests from other farms that may have developed resistance to a pesticide used	2
States a relevant strategy, for example, using biosecurity	1
Subtotal	**3**
Total	**6**
Answers could include: • mechanical control – slashing, cultivation prevents weeds from setting seed and replenishing the soil seed bank. Also removes host plants of some insect pests so they have no cover while the pest develops • crop rotations – wheat/canola/lupins is an example of using different species to break disease cycles that build up in the soil and require a particular plant to infect • biological solutions – release parasitic wasps at critical times • cultural – such as burning stubble/dry matter to destroy over-summering populations • genetic – breeding varieties that have greater resistance to pests and diseases.	
Accept other relevant answers.	

(c) Explain how the quarantine system operates to minimise the entry of foreign plant diseases and if necessary, to control their spread into Australia's plant production systems. (4 marks)

Description	Marks
Explains how the quarantine system operates to minimise the entry of foreign plant diseases and if necessary, to control their spread into Australia's plant production systems, for example, the role of Australian Quarantine and Inspection Service (AQIS) (from its use of x-ray machines and sniffer dogs etc.) to the inspection and certification of imports to meet Australia's importation requirements. Once a plant disease has entered Australia quarantine becomes the responsibility of each states Agriculture Department and their biosecurity measures for each disease will vary depending on the severity of the disease and different production areas	3–4
Outlines how the quarantine system operates to minimise the entry of foreign plant diseases, for example, the role of AQIS at all entry points, both of imports and exports, enforcing quarantine laws	2
Makes a general statement about entry of a foreign plant disease, for example, all plant material is checked at ports and airports before it is released into plant production systems	1
Total	**4**
Answers could include: • spraying imported equipment/machinery/transport • ensuring importers declare what they are importing • restricting import from places where plant diseases are endemic • constantly updating databases on foreign diseases • training personnel to recognise plant diseases • having significant fines for illegal importation of plant material • educating the general public about the dangers of bringing unprocessed products into Australia.	
Accept other relevant answers.	

Question 26 **(17 marks)**

(a) Outline **one** advantage a gross margin has over a budget. (2 marks)

Description	Marks
Outlines a relevant advantage of gross margins, for example, a gross margin is able to compare enterprises of a similar nature by using a quantifiable measure such as per hectare	2
Makes a relevant statement that shows that gross margins have an advantage, for example, a gross margin shows how an enterprise is performing	1
Total	**2**
Accept other relevant answers.	

(b) State which variety and rate of N (units) will give the best return ($). (2 marks)

Description	Marks
Variety – Hollamby	1
Rate of N (units) – 20 units of N	1
Total	**2**

(c) (i) Explain why this practice would be environmentally responsible. (3 marks)

Description	Marks
Explains the affect nitrogen has on the environment	3
Describes how the environment is affected by nitrogen	2
States a relevant fact about nitrogen and the environment	1
Total	**3**
Answers could include: • plants are able to utilise smaller applications, leaving less chance of unused N being moved into the environment through volatilisation • reduces risk of run-off and/or leaching of fertiliser into broader environment • reduces exposure of N to saturated soils where there is greater chance of leaching and denitrification.	
Accept other relevant answers.	

(ii) Calculate the value of A, B, C and D in the budget on page 20. (4 marks)

Description	Marks
A = $750/ha	1
B = $810/ha	1
C = $480/ha	1
D = $505/ha	1
Total	**4**

(iii) State which fertiliser application method is more profitable. (1 mark)

Description	Marks
Split application $305 (single application is $270)	1
Total	**1**

(iv) There is a late start to the growing season resulting in forecast wheat yields being reduced by 25%. Outline the effect this will have on the choice of fertiliser application method. (2 marks)

Description	Marks
Outlines that decision is not merely financial. May still go ahead with split application because it is environmentally appropriate	2
States that split application still has a financial benefit	1
Total	**2**
Answers could include: • the profit/hectare is $5/hectare in favour of a split application so has slight financial benefit	
Accept other relevant answers.	

(v) Explain **one** management strategy the farmer could adopt to minimise the possibility of a financial loss in the cropping enterprise. (3 marks)

Description	Marks
Explains a relevant strategy to minimise a financial loss	3
Describes a relevant strategy to minimise a financial loss	2
Makes a relevant statement about a strategy to minimise a financial loss	1
Total	**3**
Answers could include: • reduce input costs by getting quotes, buying in bulk • multiple peril insurance • forward contract • soil test against yield maps to determine nutrient requirements for different soil types and apply fertiliser to target specific production requirements rather than a general soil top-up • use technology, such as GPS/self-steer, to reduce overlapping and thus reduce the quantity of inputs • use varieties that are more suited to a late break, which means having a choice available at seeding time • complete gross margin analysis with other enterprises to compare expected profit/hectare and make enterprise adjustments in line with higher margins.	
Accept other relevant answers.	

Section Three: Extended answer **30% (40 Marks)**

Question 27 **(20 marks)**

(a) Outline **two** variations in plant product quality and state how each will affect the plant production system's financial returns. (4 marks)

Description	Marks
For each variation	
Outlines a variation in plant product quality that will affect financial returns	2
Makes a relevant statement that identifies a variation in plant product quality	1
Subtotal	**2**
Total	**4**
Answers could include: • wheat – screenings/weight of small seeds will downgrade the product and attract a price penalty. Grain moisture no more than 12.5% • barley – protein/if protein is too high, greater than 9%, the grain is downgraded from malting to feed with a significant price difference. Grain moisture content should be less than 12.5% before delivery • mandarins – low brix readings will result in fruit being downgraded. Fruit with a rind puncture is rejected • potatoes – under 18% DM (dry matter) will result in potatoes being rejected. Penalties for bruising apply.	
Accept other relevant answers.	

(b) State the quality assurance (QA) system used in the plant production system and describe **two** on-farm practices that focused on meeting the QA standards. (7 marks)

Description	Marks
States recognised QA program	1
Subtotal	**1**
For each on-farm practise	
Describes a relevant farm practise and how it relates to meeting QA standards	3
Outlines a relevant farm practise and why it relates to meeting QA standards	2
States a relevant farm practise that relates to meeting QA standards	1
Subtotal	**3**
Total	**7**

Answers could include:

- Grain Care, Fresh Care, HACCP, ISO 22000, Fodder Care
- Grain Care on-farm practices
- paddock records that detail all chemical applications, including, date/rate/WHP/batch number. When grain is delivered, it is tested for pesticides before it is sold. Grain that is still within the WHP or over maximum residue limit (MRL) can be rejected at the destination and a trace-back investigation started to find the source of contamination
- record of varieties used in each paddock to make sure segregation of grains is practiced during harvest. Each variety is grown for its protein, hardness and end product. Mixing varieties will devalue the grain because the buyers cannot be guaranteed consistent quality for the various end uses.
- Fresh care strategies:
  - register of all employees who have completed food safety awareness training. The training ensures that the participants have a full understanding of the standards, how they are applied to that business, what needs to be implemented to remain compliant and how to prepare for a compliance audit
  - conducts risk assessments for each growing site to determine the risk of heavy metals. Where the risk is high relevant control measures, monitoring and verification of work undertaken is implemented.

Accept other relevant answers.

(c) Identify a variation in product quality caused by weather and outline a strategy the producer could use to minimise financial losses. (3 marks)

Description	Marks
Identifies variation in product quality caused by weather	1
Subtotal	**1**
Outlines a strategy to minimise losses	2
States a strategy to minimise losses	1
Subtotal	**2**
Total	**3**

Answers could include:

- frost damage – sow a mix of crops/sow a mix of crop maturity times. Cut the affected area for hay
- hail damage – prune damaged branches, clean up fallen fruit, fertilise to encourage new growth, harvest fruit early to avoid sunburn from reduced foliage
- failed crop – poor establishment rains, patchy germination, graze off to a level where soil remains protected.

Accept other relevant answers.

Question 27 (continued)

(d) Identify a technology that has been recently introduced to the plant production system. Explain how this technology could affect the producer's financial return.

(6 marks)

Description	Marks
Identify a technology in the plant production system	1
Subtotal	**1**
Explains how the technology can affect financial return including reference to the cost versus benefit of the technology	5
Explains the technology and how it can affect financial return	4
Describes how the technology can affect financial return	3
Outlines the technology	2
Names a technology	1
Total	**6**

Answers could include:

- auto-steer – machinery uses GPS guidance to minimise overlap, saving on input costs such as seed, fertiliser and pesticides. Less human error, operator able to spend more time monitoring machine rather than steering
- robotics – unmanned weeders that sense, identify and treat weeds. Can operate 24 hours a day. In some crops will replace the need for the use of herbicides. A step towards a more organic approach to growing food that doesn't have to sacrifice yield to weeds
- improved water use efficiency – use of soil probes/geospatial images to determine watering rates in irrigation systems
- use of Geographic Info Systems (GIS) that assess soil and weather data to provide growers with predictive models
- variable rate technology
- remote sensing.

Accept other relevant answers.

Question 28 **(20 marks)**

(a) Discuss the issues surrounding climate change, including its causes and the impact plant production can have on climate change. Examine the potential consequences of climate change on plant production in Western Australia. (10 marks)

Description	Marks
Climate change	
Discusses the causes of climate change including human activity releasing greenhouse gases especially CO_2 and the destruction of vegetation. Discuss how plant production can contribute to and help alleviate climate change	5–6
Explains the causes of climate change including human activity releasing greenhouse and the destruction of vegetation. Explains how plant production can contribute to or help alleviate climate change	3–4
Outlines the causes of climate change and the impact plant production can have on climate change	2
States correct facts about climate change	1
Subtotal	**6**
Potential consequences	
Examines a range of potential climate changes that are or could be occurring in Western Australia and indicates how they could affect plant production	4
Describes potential climate changes that are or could be occurring in Western Australia and indicates how they could affect plant production	3
States a potential relationship between climate change and plant production in Western Australia	2
Indicates that climate change will affect plant production	1
Subtotal	**4**
Total	**10**

Answers could include:

Issues including causes of climate change:

- rising greenhouse gases like CO_2, CH_4
- human activity particularly burning fossil releases greenhouse gases
- destruction of vegetation removes carbon sink and ability to reduce CO_2 in the atmosphere
- there are other greenhouse gases CH_4, and water vapour
- plant production involves using energy that releases CO_2 e.g. diesel in tractors or making fertiliser and pesticides
- growing plants also takes CO_2 out of the air
- organic matter in the soil can store carbon rather than having it released into the atmosphere. Reducing tillage stores more carbon.

Potential consequences of climate change on plant production:

- changes in rainfall – most of WA relies on winter rainfall to grow crops, pasture and fill dams. Too little or too much at the wrong time of the year has an adverse effect on farm incomes. Unseasonal rain, particularly during harvest can damage crops, delay harvest and result in a downgraded product
- rising temperatures – causes plants to develop quicker, causing a drop in yield due to the shorter photosynthetic activity. Higher evapotranspiration rates stresses plants, particularly during their reproductive stage/grain fill, leading to pinched grain/lower yields of inferior quality grain. Also influences the spread of diseases, pests and weeds
- changes in the time and length of seasons – crops that receive insufficient rain at seeding and during their growing season vary in yield and quality. Dry seeding can create soil degradation issues if insufficient rain falls to initiate germination.

Question 28 (continued)

• more significant destructive weather events – hail causes significant damage to all crops but is not generally widespread. The summer cyclone season can provide beneficial rain provided it can be retained in the sub-soil. Heavy rainfall on bare soil causes erosion and infrastructure damage. As most of this rain falls in summer it creates a summer weed problem that must be controlled.
Accept other relevant answers.

(b) Evaluate how a plant producer would assess the risk of climate change to their plant production system and propose risk mitigation strategies to create long-term sustainability for the system. (10 marks)

Description	Marks
Climate change	
Evaluates climate change risk by identifying the main risks and applying a risk assessment matrix. Risk is supported by general trends in climate	4
Describes how producers can use climate data/trends to apply to their plant production system to assess risk on a scale of low to extreme, depending on the likelihood and consequence of an occurrence	3
Outlines that risk is assessed by combining the likelihood of an occurrence and the consequence of that occurrence	2
States that risk is assessed by identifying the likelihood or the consequence of that occurrence	1
Subtotal	**4**
Answers could include: • examining climate data and long range forecasts based on predictive models – for example the Indian Ocean Dipole activity • consulting climatologists/agronomists • join focus groups to see what other plant producers are doing in response to coming change in the region • applying a risk matrix to various parts of the plant production system to identify where the greatest risk lies and put in place strategies that are pre-emptive • use of long-term averages in the farming system to assess trends/cycles that will affect the production system.	
Risk mitigation strategies	
Proposes risk mitigation strategies that are clearly aligned to long-term sustainability. Shows a clear understanding of the timeframe for change	5–6
Proposes risk mitigation strategies are described, with links to long-term sustainability identified	3–4
Outlines relevant risk mitigation strategies	2
States a risk mitigation strategy	1
Subtotal	**6**
Total	**10**
Answers could include: • selling up and moving to a different climatic area, using the accumulated assets/skills to re-establish the farming business • changing crop variety which has been developed for changing circumstances • growing crops that suit the climatic conditions. This may require an upskilling of cropping methods, pests/diseases knowledge, harvesting/storage standards and adapting/upgrading current machinery to be fit for purpose • find alternative crop growing methods e.g. shade house, irrigation • investing 'off farm' to supplement the income, spreading the risk.	

Question 29 **(20 marks)**

(a) State the main difference between genetic modification (GMO) and cross-breeding. Explain, using an example for each, how **both** of these breeding techniques are carried out.(11 marks)

Description	Marks
States main difference that cross-breeding occurs naturally between sexually compatible plants whereas GMO requires human intervention	1
For each example	
A relevant example is given for a genetically modified and cross-breeding technique	1
Subtotal	**2**
For explanation of genetic modification and cross-breeding	
Explains how the breeding technique is carried out	4
Describes how the breeding techniques is carried out	3
Outlines how the breeding technique is carried out	2
States a fact about a breed technique	1
Subtotal	**8**
Total	**11**

Answers could include:

- cross-breeding – select parent plant with desired characteristics. Remove the pollen from the plant you intend to cross. Take male pollen from one parent and transfer onto female stigma of another plant for fertilisation. Collect seed and sow into a trial site. Select and eliminate those plants that don't have the desired characteristics. Continue to grow the best performing plants for the desired characteristics by bulking up the seed
- examples include apples, development of the Pink Lady and Bravo varieties. Mace wheat, a cross between Wyalkatchem and Stylet, renowned for its high yields in a variety of environments
- GMO – identify segments of DNA that are the code for a gene that is responsible for the feature that is desired. Isolate the DNA segment. Clone the segment by introducing it into a host such as a bacterium where it will multiply the introduced DNA segment. Transference of the cloned DNA to the target plant, where it produces the desired effect
- examples include:
  - transgenic cotton that contains a bacterium that kills a major moth pest of cotton
  - Round-up Ready Canola that can resist the action of round-up when it is sprayed for weeds
  - safflower that can produce higher levels of oleic acid in their seeds.

Accept other relevant answers.

Question 29 (continued)

(b) Evaluate the role of GMO plants in Australian agriculture, using the triple bottom line tool to measure sustainability. (9 marks)

Description	Marks
Environmental	
Evaluates the role of GM plants on the environment	3
Outlines how GM plants have impacted the environment	2
Makes a relevant statement about GM plants and the environmental aspect of the triple bottom line	1
Subtotal	**3**
Economic	
Evaluates the role of GM plants on the economic aspect	3
Outlines how GM plants have impacted the economic aspect	2
Makes a relevant statement about GM plants and the economic aspect of the triple bottom line	1
Subtotal	**3**
Social	
Evaluates the role of GM plants on the social aspect	3
Outlines how GM plants have impacted the social aspect	2
Makes a relevant statement about GM plants and the social aspect of the triple bottom line	1
Subtotal	**3**
Total	**9**

Answers could include:

Environment

- in favour – pesticide use has been reduced which means less damage to biodiversity from pesticides. Only three crops currently licenced for GM. Less resistance to developed pesticides. Reduced contamination of water ways with less spraying. Less mechanical weeding that reduces soil degradation.
- not in favour – out crossing of GM with non-GM that contaminates a product which is entering a non-GM market. Accelerated the evolution of herbicide resistant crops which has created additional operational challenges and costs.

Economic

- in favour – increased yields due to decreased pest problems. Reduced costs due to less pesticide use. Consumers benefit from lower priced products.
- not in favour – opposition to GM plant products in one of Australia' s main trading partners, the European Union, which restricts our market opportunities.

Social

- in favour – supports a culture of research and development. Approved for use by the Regulator only after they show they are safe people and the environment. Greater food security, enhanced nutrient composition and food quality. Safer for farmers to use given there is less pesticides used.
- not in favour – could pose hazards to human health, from toxicity and increased risk of allergies. Seed prices controlled by large bio-tech companies, prices can be out of reach of some farmers. Concerns about food safety and product labelling deficiencies for those consumers who want GM free products. The unknown side effects of changing a plants original form. Keeping the GM technology within the boundaries of a farm is difficult and can lead to disputes from neighbours.

Accept other relevant answers.
Candidates will either support or refute GM plants.

Published by the School Curriculum and Standards Authority of Western Australia
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