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OUTSTANDING SCHOLARSHIP EXEMPLAR



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Scholarship 2021 Agricultural and Horticultural Science

Time allowed: Three hours
Total score: 24

ANSWER BOOKLET

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

Write your answers in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–23 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE: New technologies in primary production systems

PLANNING

Kiwifruit maturity testing - ensures fruit is ready for harvest

dry matter testing - eurofins 2018
not damaging fruit - Radiowaves

70% of growers returns from higher quality fruit due to 16Z

Packing

Using grading is highly labour intensive, so automated machines taking 1000 photos of individual fruit also ultraviolet.

CA - Storing of fruit

controlled atmosphere oxygen reduced to 2-3% to slow ripening process

artificial pollen

all terrain pollination
Green 40 bee visits
Gold 8 bee visits - can be done in 100% pollination. Rain only 2-3 days

Begin your answer to Question One here:

The Kiwifruit industry has ~~under~~ had large growth recently. This has caused for continued development and implementation of new technologies.

On orchard the fruit undergo maturity and dry matter testing before they can be harvested. Maturity testing ensures that the fruit will be able to sufficiently ripen by the time they reach the market overseas. Dry matter testing determines the ~~TCG~~ TCG (~~TCG~~ ^{taste} Zespri Grade) which is a large portion of the growers' payments. For gold Kiwifruit it equates to 70% of growers' returns and 40% for green. Because Dry Matter Testing has such a significant impact on growers' payments, growers will often retest multiple times over a period of time to ensure they get optimum results. The current ~~testing~~ ^{method for testing} for Dry Matter involves the chopping of a 10mm slice of fruit, then weighing the initial weight, and the weight after dehydrating. These results accurately show the dry matter in the fruit, however, the fruit are no longer able to be sold to market. Each testing involves 50 fruit. If a grower does multiple tests over multiple blocks there is potential to lose a significant sum of money. In 2018 Eurofins began developing methods of testing dry matter in fruit without damaging fruit. One method was able to calculate the dry matter in the fruit using the weight, circumference

and certain radio waves. By combining the circumference and weight to the time and resistance taken for radio waves to pass through the fruit, the dry matter was able to be determined without being damaged. Once such technologies have been introduced, commercially, growers will be able to continue to test fruit without lost profit. This also gives growers confidence to test more often before harvest so they know they can achieve optimum results for their fruit.

The packing of kiwifruit is a highly labour-intensive task. The packing process also involves grading of fruit. Fruit need to meet certain cosmetic and size grades. This also involves a large labour force. Recent introductions to packhouses are automated grading systems from an Auckland-based company called ~~Spectrim~~ Spectrim. The automated grading system takes a thousand photos of the fruit under ultraviolet light and processes these photos to determine the fruit's grade. By taking photos under ultra violet, the computer is able to pick up bruising on the fruit that is not yet visible to the human eye. Such bruising to the fruit may cause fruit to ripen too soon. If this occurs the fruit will release gases that will also promote the ripening of fruit around it. If this occurs growers will lose profit because the fruit

will not be able to be sold when it meets its export location. The use of automated grading in the packhouse reduces staffing issues and human error. It also frees up labour for the picking and packing processes which are currently understaffed due to Covid-19. Disadvantages of having an automated grading technology are the costs to install and maintain and also the cost of lost time if a breakdown or error was to occur with the system. As the technology improves, it will become greatly beneficial to packhouses.

Many seasonal staff in the kiwifruit industry are from overseas. With Covid-19 restrictions they are not able to enter the country. Controlled atmosphere coolstores enable fruit to be stored instead of being packed immediately after harvest. This reduces the need for seasonal staff as fewer staff can be used for a longer period of time due to fruit being able to be stored in the controlled atmospheres. These controlled atmospheres are completely sealed coolstores which have oxygen levels reduced to 2-3%. As the fruit uses oxygen to ripen, the reduced oxygen levels reduce the ripening process of the fruit. Because the fruit is not ripening, it can be left in storage for up to 12 months allowing it to be packed later in the year reducing the need for a large

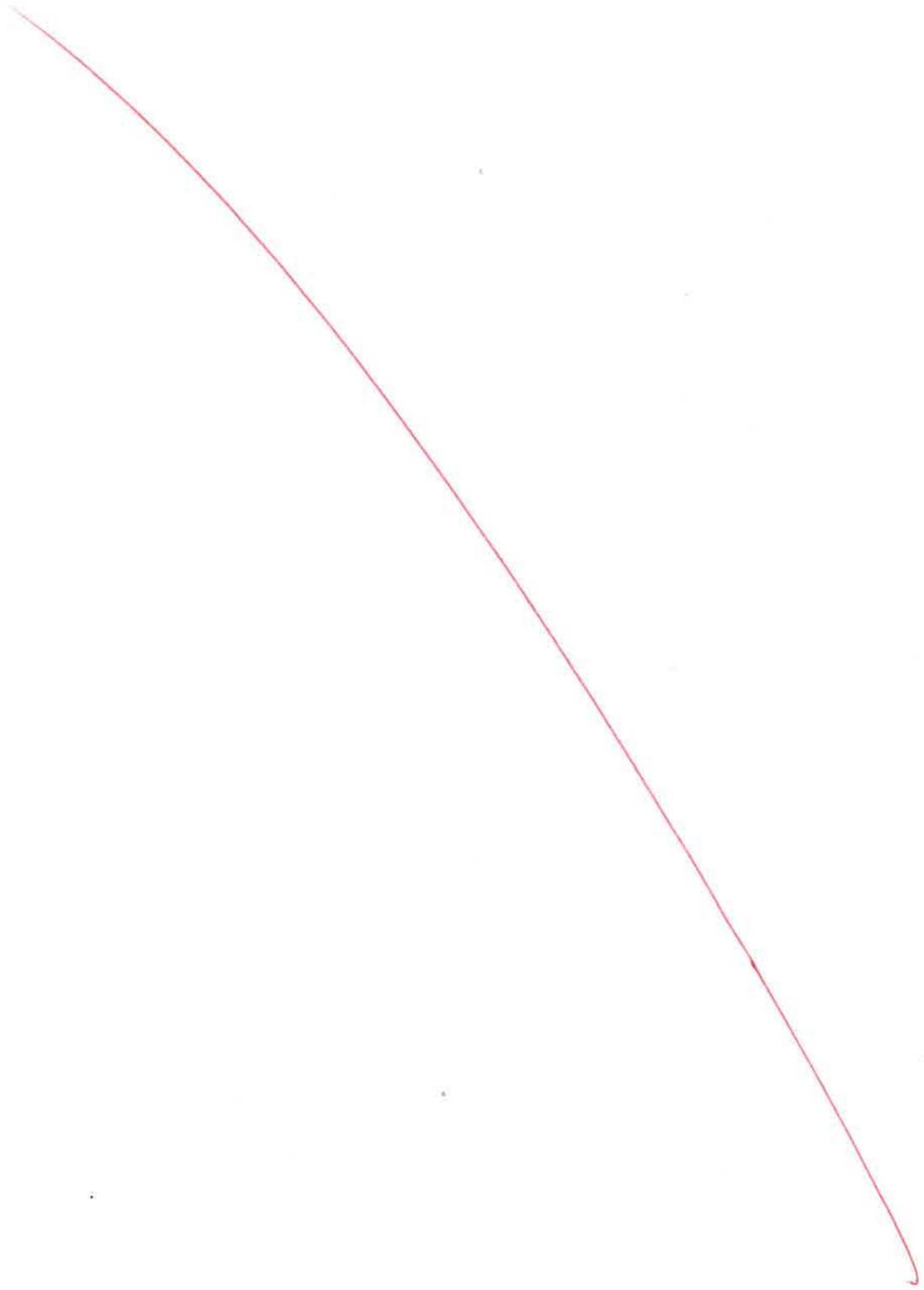
workforce over a short period of time. Controlled atmosphere can also be used to store fruit once packed and awaiting the arrival of ships to ~~travel~~ export overseas. This benefits the grower as it reduces the chance of lost fruit in the event of labour shortage or shipping delays.

For fruit to reach high levels of dry matter and taste quality, fruit must have a successful pollination. ~~Because growers~~ Because of a larger portion of growers' payments are determined by the dry matter, it is important that pollination occurs successfully. Gold Kiwifruit typically require ~~8~~ 8 bee visits to successfully pollinate the flower. Green Kiwifruit typically requires 40 bee visits to fully pollinate the flower. Growers have no way of controlling bees to ensure they make their required visits to each flower. Bees will also not operate in the rain. Kiwifruit flowers are only viable for pollination for 2-3 days. If it is raining during this time the flowers will not be successfully pollinated and growers can lose income. Bee keepers are also becoming reluctant to leave hives on orchards because the artificial wind shelters cause bees to become disorientated and potentially lost, not returning to the hive. This is because bees use the sun for orientation.

The artificial wind and hail cloths restrict and change angles of sunlight confusing the bees orientation. Because of these issues of using bees for pollination, new technologies have been using artificial pollination for successfully pollinating their orchards. These new technologies have been developed over the past fourteen years and are starting to become commercially viable to individual growers. The process involves milling of male flowers in the "popcorn" stage. Pollen is collected from these flowers through the complex milling process. This pollen is extremely expensive at \$7,000 a kilogram. It costs growers significantly but it is worthwhile as returns, from a successful pollination, are significantly ~~greater~~ greater. Pollen can be mixed with water and applied to the flowers as ~~the~~ "wet pollen". This is effective as it can be applied during the rain when bees are not active. It also enables growers to change rates of ~~what~~ amount of pollen applied per hectare ensuring 100% pollination rates to their orchard. Because of this growers will get higher levels of dry matter and less loss of fruit. Growers can also have multiple ~~visits from~~ sprays of artificial pollination to ensure flowers that open early and late are both fully pollinated. It is important growers get a successful pollination as ~~Kiwifruit can provide~~ gold Kiwifruit can still size up without pollination and look identical.

QUESTION TWO: The resilience of primary production systems to disruptive events

PLANNING



Begin your answer to Question Two here:

Covid-19 ~~is~~^{is} a disruptive event for the Kiwifruit industry. The industry relies on overseas seasonal workers during the harvest season. As visas for these overseas seasonal workers begin to expire, the industry will lose a significant portion of the workforce as travel restrictions prevent overseas workers entering the country so workers that leave the country can't be replaced by new overseas workers. The Kiwifruit industry contributes \$4 Billion to the New Zealand economy. Without overseas staff to pick and pack this produce, there is potential to lose this income. The New Zealand Kiwifruit industry needs to be resilient and create job opportunities ~~their last~~ that will continue for 12 months of the year. This will be more attractive to local New Zealanders and will help reduce staffing issues created by the loss of overseas workers if positions can be filled by locals.

Covid-19 also creates challenges in the working environment. Kiwifruit pickers are often paid on how much fruit they pick. This gives pickers an incentive to pick faster and move through orchards quickly. ~~By~~ During Covid-19 lockdowns, staff on the orchard had to ensure that they keep their distance from other workers at all times. This slowed down the picking process. To ensure workers continued to operate in a safe manner, some harvest crews

~~increased the payment~~ showed resilience and empathy to workers increasing the payment per bin to give incentive to continue working safely. Packhouses also had altered breaks and start of shift times to reduce contact with workers outside their direct bubble. During harvest there is 20,000 workers employed. These safety measures are put in place to stop the spread of Covid-19 from affecting Kiwifruit workers as in previous years these 20,000 workers would all be connected through some sort of link with mutual staff.

In New Zealand, Zespri controls the licensing of gold Kiwifruit. This enables them to gain revenue needed for future plant research. Each year Zespri releases over 700 hectares in tender, averaging over \$500,000 a hectare. If growers overseas begin to grow fruit, without licence it will reduce Zespri's income and also undermine New Zealand's supply of Kiwifruit to these countries. ~~China has begun~~ Small Chinese growers have begun growing gold Kiwifruit without being licensed from Zespri. They can then share plant materials to neighbouring growers who can also then grow gold Kiwifruit also. ~~China pays~~ New Zealand exports 20% of fruit to China because it is willing to pay a high price as it sees Kiwifruit as a luxury fruit. If Chinese growers develop further there will be less need for New Zealand fruit to be supplied. This will result in the Kiwifruit industry

having to send that 20% of exported fruit elsewhere at a lower price, reducing growers income. Another method that Zespri is trying to use to prevent such events is marketing. The Zespri labelled fruit is a high quality, luxury fruit that the Chinese market will be willing to pay the premium for over their locally grown fruit.

In 2009, a disease called psa entered New Zealand due to pollen imported from overseas. At the time the type of gold Kiwifruit grown was Hort 16A. This variety of fruit was very susceptible to psa. The psa was then spread between orchards by tools, machinery, equipment and vehicles. Psa killed and damaged many of the Kiwifruit vines. ~~including~~ In the years to follow, growers lost income due to sick and dying plants not producing a full canopy of fruit. Between 2010 - 2012 a newer variety of gold Kiwifruit, known as G3 was developed as being significantly more psa resistant although it took growers 2-3 years before they could develop a full canopy and be back to full production. During this 5-6 year window, many growers lost a significant amount of income due to the disease. The industry had shown resilience and we now sanitise tools between vines, wash machinery before ~~moving~~ shifting orchards and spraying copper

regularly during colder environments. If another disease, similar to psA, occurred it could affect G3 kiwifruit significantly. This would lead to the struggle of many orchards and would require the industry to show resilience to prevent spread of this disease. //

Sprays that have been put on the orchards can be seen negatively by public. With little knowledge of the true effects of certain chemicals, there is pressure on growers to stop using these products. It has recently been announced a plan to prevent the use of Highcane within the next five years. On the orchard, Highcane promotes both the timing and quantity of the bud burst. Without the use of Highcane some growers' yield may significantly decrease ~~fall~~ to almost half. Highcane also controls the timing of fruit, without it there will be less early start fruit, putting more pressure on pack-houses to pack ~~fruit~~ a large volume of fruit in a smaller time frame. With the loss of Highcane then the potential for growers to lose half their yield, they will potentially, lose half their income and so the industry needs to be resilient and create another method of promoting bud burst. Zespri is already ~~giving~~ giving incentive for growers to become organic. As the cost for conventionally grown kiwifruit tray is \$12.46 and the organic

growing kiwifruit is \$15.54 a tray, however growers are still hesitant to change as conventionally-grown fruit earns \$180,000 a hectare compared to organically grown fruit at \$160,000 a hectare so even though organic growers receive more per tray they are receiving less returns overall due to the reduced yield from not being able to apply certain sprays. //

Disruptive events between countries can change trade agreements which will affect the cost needed to export kiwifruit to those countries. Currently, Japan has dropped \$26 million in import tax ~~for~~ for kiwifruit. This has made it easier for Zespri to export to Japan increasing the market that kiwifruit can be sold in and hence increasing potential income for growers. //

QUESTION THREE: Freshwater management in New Zealand

PLANNING

Begin your answer to Question Three here:

Irrigation is important in New Zealand Primary Production. Both Dairy and Kiwifruit industries require water to help sustain production. For healthy high producing dairy cows, there needs to be sufficient grass to sustain the cows. To ensure the grass is ~~su~~ promote grass growth, growers can irrigate paddocks to ensure grass grows. The Kiwifruit industry also requires irrigation to ensure Kiwi fruit vines have sufficient water for photosynthesis and transportation of nutrients to occur. For orchards grown in drier climates growers can choose the use of bounty rootstock. This rootstock is significantly more resistant to extreme water gains or losses and is suitable for drier climates as it will not need as much irrigation. However, bounty rootstock is not as vigorous as other rootstocks, such as Bruno, and will take longer to establish the orchard. Levels of irrigations need to be monitored carefully to ensure there is sufficient water in catchments and rivers for years to come. When irrigating, growers need to be mindful of other water users. There could be other orchards further down the river that may also require water. There is also wild life and recreational activities that need to sustain suitable water levels further downstream. Examples of this are native birds that live by waterways. They need the water levels to maintain a certain

level to ensure ~~for~~ there's food for these native birds to survive. Recreational activities, such as fishing, also require water levels to be maintained. Without water there will be no fish for fishing. Boats and Kayaks also require water to launch and travel on waterways. If irrigation use becomes too high, there will become tensions between growers and recreational users of waterways due to the conflicts ~~and~~ and interests. ~~the~~

Nutrient-leeching occurs when fertiliser is applied to soil in larger quantities than plants and grasses can process. Both dairy and Kiwifruit industries ~~both~~ apply fertilisers to soils. Dairy farmers will apply fertilisers, high in nitrogen, to help promote leaf growth of the grasses. These nutrients enter waterways either in groundwater or surface run off. When these nutrients enter the waterways, these nutrients make the water dangerous to drink. Nitrogen in the water also promotes algae growth. Algae uses oxygen in the water and is therefore competing with fish. This reduces fish numbers making it harder for fishing to occur. Boating and Kayaks will also find it difficult to navigate through algae. The Kiwifruit industry also applies fertiliser. Fertiliser put on Kiwifruit orchards is both high in nitrogen for leaf development and potassium for fruit

development. The same issues occur in Kiwifruit industry as dairy with run off occurring. There is a simple solution to reducing nitrogen leeching in both dairy and Kiwifruit industries. If growers and farmers were to apply smaller amounts of fertiliser on a more frequent basis, the nutrients in the fertiliser will be absorbed by plants before they can be leached into waterways. However, growers and farmers are reluctant to apply smaller amounts more frequently because they will have more costs from contracting companies needed to apply the fertilisers. This causes tension between growers and farmers protecting the environment whilst also balancing economic costs. //

Dairy farmers and ~~also~~ Kiwifruit growers who use water for irrigation have potential for there to become cultural tensions between themselves and local Iwi who believe the water should be protected and not used for economic gains. //

Extra space if required.
Write the question number(s) if applicable.

ASSESSOR'S
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QUESTION
NUMBER

One to pollinated fruit without chopping fruit open. This means it can't be fruit-thinned effectively and unpollinated fruit will remain on the vines reducing the growers ~~average~~ dry matter during testing. This will reduce growers' income.

Extra space if required.
Write the question number(s) if applicable.

ASSESSOR'S
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QUESTION
NUMBER

Outstanding Scholarship Exemplar 2021

Subject	Agricultural and Horticultural Science		Standard	93105	Total score	19
Q	Score	Annotation				
1	7	<p>The candidate has presented a perceptive, articulate, and insightful response to the question. The adoption of new technologies in the Kiwifruit industry has been effectively discussed and their relevant advantages and disadvantages analysed – all backed up by relevant data. The technologies discussed are across the wider kiwifruit production system – growing (dry matter testing, pollination), processing (pack house automation), and distribution / marketing (controlled atmosphere storage).</p> <p>A well-structured clearly discussed answer.</p>				
2	7	<p>In this question, the Kiwifruit industry has once again been used as the context. The impacts of Covid -19 on a range of aspects (overseas workers, picking conditions) are fully discussed as are the issues around unlicensed growers and the impacts and consequences of the PSA disease outbreak and the potential removal of the chemical Hi-Cane.</p> <p>A broad set of disruptions clearly discussed.</p>				
3	5	<p>In this question, Dairy and Kiwifruit production systems have been used as the contexts to discuss freshwater management.</p> <p>The role of irrigation across both industries is analysed, the implications of this are discussed and the management of irrigation practices are</p> <p>The cultural 'value' of water has been identified and the tensions between obvious economic benefits and less 'measurable' 'social' indicators discussed.</p> <p>A greater discussion of the 'management' of water (over and above simply irrigation management) has prevented this answer scoring higher.</p> <p>Overall, a solid response to the question and at the Scholarship level.</p>				