# Assessment Schedule – 2023

## Agricultural and Horticultural Science: Demonstrate understanding of techniques used to modify physical factors of the environment for NZ plant production (91290)

### Assessment Criteria

| Achievement | Achievement with Merit | Achievement with Excellence |
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| *Demonstrate understanding* involves describing how techniques modify physical factors of the environment for commercial plant production. | *Demonstrate in-depth understanding* involves explaining how the use of techniques influences commercial plant production. | *Demonstrate comprehensive understanding* involves evaluating techniques used to modify physical factors in terms of economic and / or environmental and / or social impacts of commercial plant production. |

### Question ONE: Greenhouses

| | Sample evidence |
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| (a) | Explains how greenhouses allow the grower to modify two physical factors to improve crop production.<br><br>*Physical factor (1): Temperature*<br>Greenhouses are designed to trap heat. Sunlight enters the greenhouse and is transferred into heat energy. Additional heating can be provided, normally in the form of heated pipes of hot water. The greenhouse prevents cold air from mixing in with the warm air cooling the growing environment. At times high temperatures can be an issue, so vents in the ceiling can be opened, allowing warm air out and preventing the plant from experiencing heat stress. The elevated heat allows the growth of out-of-season crops, the production of crops early in the season, or the growth of crops that would otherwise not be able to be produced in that region.<br>*Physical factor (2): Air*<br>Carbon dioxide concentrations outside of greenhouses is around 400ppm. Inside greenhouses, during times of extensive photosynthesis, the carbon dioxide concentration can become very low, becoming a limiting factor for photosynthesis. To counter this, growers can pump carbon dioxide into the greenhouse, boosting photosynthesis and production. The carbon dioxide used is often a waste product of the heating of the greenhouse. |

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| (b) | Justifies the use of greenhouses in a commercial crop in terms of crop yield and timing.<br><br>Greenhouses allow growers to produce crops at a time when it would be difficult or impossible to grow them outdoors. They allow growers to manipulate the environment in a way that isn't possible in outdoor production, and to grow crops at a yield and quality that aren't possible in outdoor production. This allows indoor growers to have control of the market and demand higher prices. However, with these higher prices, the cost of production is considerably higher.<br>The environmental impact of greenhouses can vary depending on the location and material used. Energy costs associated with keeping the greenhouse warm can be high and, in areas without natural gas, can contribute to carbon emissions through the combustion of coal. In areas with natural gas, this carbon dioxide can be pumped into the greenhouse and taken up by plants.<br>*Yield*<br>Greenhouses allow growers to optimise the environment and provide ideal light, heat, temperature, and protection from pests to maximise production.<br>*Timing*<br>Greenhouses allow growers to produce crops out of season. This allows growers to receive higher returns and control market supply.<br>*Environmental impacts*<br>• A greenhouse creates a micro-climate. A grower has control over factors such as, frost, wind, light, temperature, water, humidity, air, and soil. This allows for the plant to grow in a stress-free environment. The plant is able to grow to its full potential. If a grower enhances the environment by intensifying a given factor or factors, the ability of the plant to perform plant processes such as transpiration, photosynthesis, and respiration is enhanced. This means that glucose levels are increased, which in turn increases plant growth, flavour, size and reduces time to harvest. With this in mind, a greenhouse can mean that more crops can be grown in a given year, increasing a grower's income.<br>*Economic*<br>• Greenhouses can be a sizeable economic investment with large up-front capital expenses and a large operating cost.<br>• While the cost of production is higher, the increase in yield and the ability to control timing increase the return.<br>• Greenhouses allow growers to supply markets year-round, enabling a year-round income. |

| N1 | N2 | A3 | A4 | M5 | M6 | E7 | E8 |
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| Some writing, but does not describe how greenhouses modify the environment to improve production. | Partial or insufficient description of how greenhouses modify the environment to improve production. | Describes how greenhouses modify one physical factor of the environment to improve production. | Describes how greenhouses modify two physical factors of the environment to improve production. | Explains how greenhouses modify one physical factor of the environment to improve production. | Explains how greenhouses modify two physical factors of the environment to improve production | Justifies the use of greenhouses in a commercial crop in terms of crop yield and timing with discussion of economic or environmental impacts. | Justifies the use of greenhouses in a commercial crop in terms of crop yield and timing with discussion of economic and environmental impacts. |

**N0** = No response; no relevant evidence.

## Question TWO: Irrigation systems

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| (a) | Describes how irrigation systems modify two aspects of the growing environment.<br><br>*Aspect (1): Soil moisture*<br>Irrigation allows growers to maintain soil moisture levels and prevent them from drying out. This prevents water becoming a limiting factor and enables growth through summer, a time when temperatures are higher, allowing for maximum growth. Water is needed for the plant to carry out photosynthesis and prevent plant stress.<br>*Aspect (1): Humidity*<br>Irrigation can also increase humidity. This can be desirable in high temperatures to prevent excessive transpiration, and reduce the risk of pests and disease. |
| (b) | Justifies the use of an irrigation system in terms of crop yield and quality.<br><br>Irrigation systems increase the water available to plants through the soil. This water is needed by the plant for photosynthesis and plant support and allows nutrients to be absorbed from the soil into the plant. Water can also increase the biological activity of the soil, leading to better soil structure and nutrient availability. Irrigation allows growers to maintain soil moisture levels over dry summer months, preventing soils from drying out and maintaining plant growth. Depending on the irrigation method selected, it can also be used as frost protection and nutrient application. Irrigation can lower soil temperatures and prevent plant stress, which can result in crops bolting or having a reduction in yield.<br>*Yield*<br>• Low soil moisture can affect flower and bud formation, resulting in fewer fruit setting.<br>• Lack of water during the spring and summer growing season for pasture will result in less feed available to livestock, with droughts potentially stopping growth of pasture.<br>• Lack of water in the soil can cause certain crops to fail through not being able to access nutrients in the soil.<br>*Quality*<br>• While some water stress can be good for certain fruit, too much can cause bud / fruitlet drop, and small stunted fruit.<br>• Irrigation systems allow growers to control when crops get water, i.e. control deficit irrigation.<br>• Irrigation can aid in preventing crops from going bitter.<br>*Environmental*<br>• Maintaining water levels in soil over summer prevents the soil from drying out, reducing erosion, and promoting soil health.<br>• Using irrigation increases the water in the soil pores. This means that more water is available for photosynthesis and ultimately plant growth. Water in pore spaces also means that nutrients in the soil can be dissolved and taken up by the plant, which improves photosynthesis and reduces deficiencies.<br>• Water in soil pores enables micro-organisms to work and break down organic matter which improves soil structure. |

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| | *Social*<br>• The over-extraction of water can lead to social problems, with local communities losing recreational use of streams and rivers, and the degradation of drinking water.<br>• Irrigation allows a boost in production, increasing land value, and bringing money into rural communities.<br>• The increase in production can lead to more jobs, providing employment opportunities. |

| N1 | N2 | A3 | A4 | M5 | M6 | E7 | E8 |
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| Some writing but does not describe how irrigation systems can modify the growing environment. | Partial or insufficient description of how irrigation systems can modify the growing environment. | Describes how irrigation systems can modify one aspect of the growing environment. | Describes how irrigation systems can modify two aspects of the growing environment. | Explains how irrigation systems can modify one aspect the growing environment. | Fully explains how irrigation systems can modify two aspects of the growing environment. | Justifies the use of an irrigation system in a commercial crop in terms of yield and quality with discussion of environmental or social impacts. | Justifies the use of an irrigation system in a commercial crop in terms of yield and quality with discussion of environmental and social impacts. |

**N0** = No response; no relevant evidence.

## Question THREE: Light

| | Sample evidence |
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| (a) | Describes how two management practices are used to modify access to light.<br><br>*Management practice (1): Pruning*<br>One of the functions of pruning is to allow light to penetrate into the canopy, which is important for flower bud development, fruit set, and growth. Pruning opens up the canopy, allows light to reach the lower branches and prevents shading. Pruning allows for more consistent quality fruit that ripen consistently, allowing for more fruit to be ready at harvest.<br>*Management practice (2): North-south planting*<br>As the sun rises in the east and sets in the west, a north-south row orientation allows for a more uniform exposure to the sun and prevents the plants from shading each other. When plants are shading each other, this reduces the rate they are carrying out photosynthesis, slowing growth and reducing sugar levels. |
| (b) | Justifies the use of one of the management practices used to modify light in terms of quality and timing.<br><br>For many crops, the grower's goal is to maximise light exposure so that the plant can carry out photosynthesis at a higher rate, producing sugars needed for fruit and biomass. Depending on the plant species, pruning, plant training, light reflective mulches, and north-south planting are all techniques that can increase the amount of light available to the plant. Exposure to light generally means warmer soil, increasing soil bioactivity, and drier leaves and buds, reducing fungal outbreaks. Higher photosynthesis rates will lead to fruit that have higher Brix levels and will ripen earlier and more consistently. In some groups, such as kiwifruit or mandarins, growers are paid a premium for fruit with high Brix levels. Fruit that are ripe early can be sold at a premium compared to those produced at peak season. Pruning orchards provides important non-harvest employment, reducing the seasonality of horticultural work.<br>*Quality*<br>• Light is needed for photosynthesis, which produces sugars to develop the fruit. Techniques such as pruning and north-south planting maximise the amount of sugar the plants produce, which results in better quality fruit. Fruit growing in shaded areas tend to have lower Brix levels and higher rates of skin blemishes.<br>• Shaded branches and leaves can suffer from pests and diseases, which can damage fruit or crops.<br>*Timing*<br>• Consistent light throughout the plant allows fruit to ripen consistently. This allows more fruit to be harvested in one go.<br>• More light allows the fruit to ripen earlier, allowing the grower access to the higher return shoulder season.<br>*Economic*<br>• Increased light throughout the plant allows for more consistent photosynthesis and a reduction in pests and diseases. This produces fruit or crops that are of a higher quality and a better consistency. This allows the grower to sell at a higher grade, getting a better return.<br>• Some plant light-increasing techniques, such as pruning or reflective mulches, come with a cost, but this cost should result in increased returns from better quality / earlier ripening fruit or crops. |

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| | *Social*<br>• Pruning and plant training are important employment opportunities in horticultural areas that help provide year-round employment.<br>• Higher returns to the grower mean more money can be spent on support services and in local communities. |

| N1 | N2 | A3 | A4 | M5 | M6 | E7 | E8 |
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| Some writing but does not describe a management practice used to modify access to light in outdoor plant production. | Partial or insufficient description of a management practice used to modify access to light in outdoor plant production. | Describes one management practice used to modify access to light in outdoor plant production. | Describes two management practices used to modify access to light in outdoor plant production. | Explains the effect of a management practice used to modify access to light in outdoor plant production. | Explains the effect of two management practices that are used to modify access to light in outdoor plant production. | Justifies the use of techniques used to modify light in terms of quality and timing with some discussion of economic or social impacts. | Justifies the use of techniques used to modify light in terms of quality and timing with thorough discussion of economic and social impacts. |

**N0** = No response; no relevant evidence.

## Cut Scores

| Not Achieved | Achievement | Achievement with Merit | Achievement with Excellence |
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| 0 – 7 | 8 – 13 | 14 – 19 | 20 – 24 |