Assessment Schedule – 2019

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

Assessment Criteria

Question ONE: Light

Achievement	Achievement with Merit	Achievement with Excellence
Describes how growers can increase the intensity of light provided to plants.	**Explains** how LED lighting can improve light quality and affect crop yield.	**Justifies** the use of LED lighting for cut flowers in terms of economic factors.

N1	N2	A3	A4	M5	M6	E7	E8
Identifies a method, but does not describe another method used to increase light intensity, other than an artificial light source.	**Partially describes** another method used to increase light intensity, other than an artificial light source.	**Describes** another method used to increase light intensity, other than an artificial light source.	**Fully describes** another method used to increase light intensity, with reference to plant growth.	**Explains** how the use of LED lighting improves the quality of light provided to plants *OR* improves crop yield, in relation to plant processes.	**Fully explains** how the use of LED lighting improves the quality of light provided to plants and improves crop yield, in relation to plant processes and growth rates.	**Justifies** a grower's decision to use LED lighting for cut flowers over another method in terms of quality and production timing, taking into consideration the economic impact of the use of this technique. Clear evidence for superiority for ONE aspect, either quality or timing, with the other impact well supported.	**Justifies** a grower's decision to use LED lighting for cut flowers over another method in terms of quality and production timing, taking into consideration the economic impact of the use of this technique. Clear evidence of the superiority of BOTH methods is demonstrated.
N0 = No response; no relevant evidence.							

Q1	Sample Evidence
(a)	**Describes** how growers can increase the intensity of light provided to plants. Light intensity can be increased by providing reflective surfaces, such as reflected mulches or white-painted glasshouse frames, around the plants so that light that would have been absorbed by the ground / structures is reflected towards the plants. Plants need to have adequate space around them so that they are not shading each other. Increasing the amount of light provided to plants will increase the rate at which photosynthesis is carried out, allowing a faster rate of growth. Pruning, thinning and canopy management such as leaf plucking is one way to decrease shading. Row orientation, ie North South planting and the aspect of the property.

(b)	**Explains** how the use of LED lighting can improve light quality and affect crop yield. Light quality refers to the wavelength of light. The use of LED lighting allows the grower to control the wavelength of light provided to the plants. By providing more light that the plants can use, i.e. blue and red light, the grower is able to maximise the rate at which the plants can grow, increasing the yield. As different wavelengths of light have different effects on plants, different LEDs can be used, depending on the crop being grown. Blue light is responsible for vegetative and leaf growth and important for seedlings and young plants, because it helps reduce plant stretching. Red light is important in the regulation of flowering and fruiting. It also helps increase stem diameter and promotes branching.
(c)	**Justifies** the method of using LED lighting to flowers destined for the cut flower market by comparing and contrasting the use of artificial light with another method of changing light levels. Light is used by plants for photosynthesis to produce carbohydrates for growth and plant processes. Light is also used by plants to stimulate flowering. Sunlight provides light with wavelengths across the spectrum. However, plants make best use of blue (430–450 nm) and red light (640–680 nm). The exact frequencies that plants can make the best use of varies from species to species. The type of frequency that the plants are exposed to can affect the type of growth exhibited. Blue light encourages vegetative growth and is often used on seedlings to encourage root growth, while red light encourages stem, fruit, and flower production. The use of LED lighting allows growers to expose plants to light recipes (mixtures of particular frequencies) to best stimulate not just the growth of plants, but the type of growth required. Cut flower growers can use light recipes to establish plants and then different combinations of light to promote flowering. In some plants, the length of day can trigger flowering, so the use of artificial lights such as LED lighting can allow out-of-season flowers to be grown, allowing year-round production. Other methods of modifying light levels, such as using reflective surfaces, can promote growth but can make use of only what is provided by the sun. In a glasshouse, surfaces are often painted white, and white flooring is used to ensure that any light hitting these surfaces is reflected. While reflective surfaces increase the light reaching plants, cloudy conditions and seasonal day length can reduce production. Also, there is no opportunity to extend the length of the day, as there is with artificial lighting. *Economic* LED lighting is expensive to set up and run. While the running cost of LED lighting is considerably less than older versions of artificial lighting, due to much less energy being lost as heat, it is still an ongoing cost. This means the use of artificial light is suitable for only high-value crops such as cut flowers. The use of reflective surfaces has an initial set-up cost that is considerably less than LED lighting, and there are no running costs other than general maintenance. This makes reflective surfaces suitable for lower-value crops. *Quality* The use of LED lights can help growers produce bigger and healthier plants, by increasing the rate of photosynthesis and controlling the form of the plant. This allows the plants to invest more energy into reproductive structures, producing bigger and higher-quality flowers. Growers producing higher-quality flowers can sell these at higher prices, justifying the increased cost of the lighting. By comparison, relying on natural light can put growers at risk when weather conditions are poor. *Timing* Artificial lights such as LEDs allow growers to control the length of time for which the plants are exposed to light. Growers can use this to stimulate plants into flowering and producing flowers out of season. Flowers produced out of season can command a price premium, allowing growers to get more for their flowers.

Question TWO: Shelterbelts

Achievement	Achievement with Merit	Achievement with Excellence
Describes attributes of an effective shelterbelt OR how shelterbelts modify the environment.	**Explains** the effect of shelter on crop quality and timing.	**Justifies** the use of shelterbelts in terms of environmental and economic impacts.

N1	N2	A3	A4	M5	M6	E7	E8
Partially describes a shelterbelt, but does not describe an attribute of shelterbelts.	**Describes** shelterbelt attribute but insufficient description.	**Describes** ONE attribute of an effective shelterbelt *OR* **describes** how shelterbelts modify the environment.	**Describes** TWO attributes of an effective shelterbelt *OR* **fully describes** how shelterbelts modify the environment.	**Explains** how shelterbelts can affect crop quality OR production timing, in relation to plant processes.	**Fully explains** how shelterbelts can affect crop quality and production timing, in relation to plant processes.	**Justifies** the use of shelterbelts in terms of crop quality and production timing, taking into consideration the environmental and economic impacts arising from it. Clear evidence for superiority of ONE impact, with the other well supported.	**Justifies** the use of shelterbelts in terms of crop quality and production timing, taking into consideration the environmental and economic impacts arising from it. Clear evidence for superiority of BOTH impacts demonstrated.
N0 = No response; no relevant evidence.							

Q2	Sample Evidence
(a)	**Describes** attributes of an effective shelterbelt. *Height* The size of the area protected by the shelter is proportional to the height of the shelter. Good protection is provided for 10 to 15 times the height of the shelter. This means a shelter of 10 metres will give wind protection for 100 – 150 metres away. The amount of protection decreases as distance from the shelter increases. *Permeability* Shelter should be a wind filter (about 90%), not a solid barrier. Solid shelter causes wind turbulence on both sides of the belt, which can cause damage to crops. Shelter that reduces wind speed by 40 to 50% achieves the smoothest airflow and provides maximum protection. *Length* Must be wide enough to stop winds blowing around the side, harming the crop. Must ensure there are no gaps, as these would allow wind to funnel through.

(b)	**Describes** how shelterbelts modify the environment. Shelterbelts can reduce wind speed, leading to an increase in soil and air temperature and humidity, and a reduction in moisture loss. Lower wind speeds reduce wind damage to soil and plants. Poorly designed shelterbelts can lead to a build-up of cold air, which can cause frosts to be more severe. Living windbreaks can compete for light, space, nutrients, and water, and take up space that could be used for other plants. **Explains** the effect of shelter on crop quality and production timing. Shelterbelts reduce wind speed, preventing damage to plants and fruit. High winds cause damage to new growth and can lead to defoliation and loss of flowers. Pollination, fruit set, and fruit size can all be reduced. Wind can also cause fruit abrasion and increased water use. A lack of shelter reduces opportunities for spraying, leading to pest damage. Good shelter leads to increased temperatures and healthier plants, promoting faster growth. **Justifies** the use of shelterbelts in terms of economic and environmental impacts. Shelter is necessary for establishing and then maintaining high levels of fruit production and quality in kiwifruit orchards. Unless kiwifruit vines are sheltered, high winds can cause loss of replacement canes and growing points on young vines, defoliation, and loss of flowers. Pollination efficiency, fruit set, plant size, and fruit size can all be reduced. Excessive wind also causes fruit abrasion, increased water usage of the crop, desiccation of vines, reduced opportunity to spray, and disruption of irrigation. Setting up and maintenance of shelterbelts is an expense, with artificial shelterbelts having a higher initial cost but lower ongoing maintenance costs. *Environmental impact* Shelterbelts lower wind speed, which promotes insect activity. They can produce microclimates that favour a greater variety of species. They can also act as a habitat for native biodiversity, and as they are less disturbed by mowing and spraying, they can act as environmental refuges. *Economic impact* Without shelterbelts, fruit quality is usually lower and would be unlikely to meet the requirements for export grade fruit. Fruit take longer to reach maturity. Poor pollination leads to smaller fruit due to lower seed count. While shelterbelts involve an initial set-up cost and ongoing maintenance costs, these are outweighed by the premium prices growers can obtain for higher-quality fruit.

Question THREE: Water usage

Achievement	Achievement with Merit	Achievement with Excellence
Describes a way of reducing the amount of water needed by crops ***or*** how irrigation can modify the environment.	**Explains** how irrigation can affect crop quality and quantity.	**Justifies** the use of an irrigation system and analyses its environmental, economic, and social impacts.

N1	N2	A3	A4	M5	M6	E7	E8
Does not describe another method used to reduce the amount of water needed by crops.	**Partially describes** ONE method used to reduce the amount of water needed by crops	**Describes** ONE method used to reduce the amount of water needed by crops *OR* **describes** how an irrigation system modifies the environment.	**Describes** TWO methods used to reduce the amount of water needed by crops *OR* **fully describes** how irrigation systems modify the environment.	**Explains** how the environment can be modified to reduce water usage *OR* **explains** how an irrigation system can modify the environment and influence plant production.	**Fully explains** how the environment can be modified to reduce water usage *AND* **fully explains** how an irrigation system can modify the environment and influence plant production.	**Justifies** the use of an irrigation system and analyses its environmental, economic, and social impacts. Clear evidence for superiority of ONE impact, with another impact well supported.	**Justifies** the use of an irrigation system and analyses its environmental, economic, and social impacts. Clear evidence for superiority of at least TWO impacts.
N0 = No response; no relevant evidence.							

Q3	Sample Evidence
(a)	**Describes** ways of modifying the environment to reduce the amount of water needed by crops. • The use of shelter such as shelterbelts can reduce wind speed, which reduces the rate of transpiration from plants. • The use of mulches under plants prevents or slows the rate of evaporation of water from soil. Higher organic matter levels in the soil will hold on to the water better. • The use of techniques such as conservation tillage, or no till systems, increase water infiltration and reduce water loss by evaporation and surface runoff. No-till farmed soils have a water penetration rate twice that of conventionally tilled soils. The lack of soil disturbance promotes mycorrhizal fungi, which increase soil retention.

(b)	**Explains** how irrigation systems can modify the environment. • Irrigation systems increase the soil water availability. This allows the nutrients in the soil to become available to the plant. Water also increases micro-organism activity, which is beneficial for structure and nutrient availability. If too much water is applied, this can lead to waterlogging and runoff. Over time, this can lead to damage to the structure of the soil and pollution of waterways. • Maintaining water levels in soil over dry summer months prevents soil from drying out, reducing wind erosion and promoting soil health. • Irrigation can increase humidity in the area irrigated. • Plants grow better and the ground has more cover from the elements. • Irrigation systems can be used in winter to prevent frost damage. Water freezes on the leaf buds, preventing damage by sub-zero temperatures. This maximises photosynthesis for fruit production. **Justifies** the use of an irrigation system in terms of crop quality and quantity, and analyses its environmental, economic, and social impacts. *Quality* Irrigation is needed for growing high-quality cherries, as cherries form when water availability is low. Larger fruits are obtained when trees are irrigated regularly throughout the growing season. Frequent irrigation also makes more nutrients available from the soil, further contributing to larger fruit size. Fruit quality (flavour, firmness, and colour) is better when trees receive sufficient but not excessive irrigation. *Quantity* Low soil moisture affects flower bud formation, bloom, and fruit set. Flower buds of deciduous fruits are initiated in early summer, develop slowly in autumn and winter, and bloom in spring up to eight or nine months after bud initiation. If soil moisture is low during the flower bud formation period, fewer flowers will develop. *Environment* The use of water in Otago is under pressure from farmers, growers, landowners, and the environment. Excessive water take can lead to low water flows and higher water temperatures, while runoff caused by excessive irrigation can lead to sediment and nutrient enrichment, leading to eutrophication. *Economic* Irrigation systems can be expensive to install, at over $4000 per hectare. If there isn't a water source within or near the orchard, the grower may have to invest in an irrigation scheme. These costs need to be balanced by the increase in quality and quantity of cherries produced. In many cases, cherry orchards would not be viable without investment in an irrigation system. *Social* The over-extraction of water can lead to social problems, with local communities losing recreational use of streams and rivers, and the derogation of drinking water. On the positive side, irrigation allows land that otherwise could not be used for cherry and other fruit orchards to be developed. This increases land values and brings money and employment into the rural communities of Central Otago.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 12	13 – 18	19 – 24