Assessment Schedule – 2017

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: Greenhouse crops

Achievement	Achievement with Merit	Achievement with Excellence
Describes two techniques used in greenhouses to modify the physical factors of temperature or growing media.	**Explains** two techniques used in greenhouses to modify the physical factors of temperature or growing media, and how each technique improves the timing of crop production.	**Justifies** one technique used in greenhouses in terms of its economic and environmental impact.

N1	Some writing, but does not describe two techniques used in greenhouses to modify the physical factors of temperature or growing media.
N2	Partial or insufficient description of two techniques used in greenhouses to modify the physical factors of temperature or growing media.
A3	Describes two techniques used in greenhouses to modify the physical factors of temperature or growing media.
A4	Fully describes two techniques used in greenhouses to modify the physical factors of temperature or growing media, with reference to growth rates.
M5	Explains two techniques used in greenhouses to modify the physical factors of temperature or growing media, and how each technique improves the timing of crop production in relation to plant processes.
M6	Fully explains two techniques used in greenhouses to modify the physical factors of temperature or growing media, and how each technique improves the timing of crop production in relation to plant processes and growth rates.
E7	Justifies one technique used in greenhouses in terms of its economic and environmental impact. Clear evidence for superiority in ONE impact, with the other impact well supported.
E8	Justifies one technique used in greenhouses in terms of its economic and environmental impact. Clear evidence for superiority in BOTH impacts.

N0 = No response; no relevant evidence.

Q1	Sample Evidence
(a)	Question: Explain TWO techniques used in greenhouses to modify the physical factors of temperature or growing media, and how each technique improves the timing of crop production. **Describes** two techniques used in greenhouses to modify the physical factors of temperature or growing media. *Greenhouse* Temperature regulation is easier in a greenhouse as the environment is protected by either glass or plastic. The structure separates the growing areas from outside. If the temperature is too cold, heat (or hot water) produced by heaters is piped through the greenhouse, where conduction from the pipes heats the surrounding air. The temperature can be reduced by using ventilation and fans. Greenhouse-grown plants generally require high temperatures during the day, and lower night-time temperatures, for good growth. *Hydroponic growing system* Using a hydroponic growing system allows the grower to have full control over the nutrients and water available to the plant for growth. A careful balancing act is needed to balance the supply of nutrients and water to the growing media. Greenhouse crops always have the ideal / optimum level of water and nutrients available to them, so their growth is unrestricted by nutrient deficiency, as the grower can readily alter the proportions of soluble nitrogen, phosphorous, potassium, and calcium in the hydroponic mix, in the required concentrations. **Explains** two techniques used in greenhouses to modify the physical factors of temperature or growing media, and how each technique improves the timing of crop production. *Greenhouse* Warmer temperatures enhance bee activity, thus increasing fruit set. Warm temperatures also increase the rate of photosynthesis, transpiration, and respiration, which produces more carbohydrates and improves fruit health, size, and colour. This will speed up the growth of the plants and shorten the time for the fruit to form, ripen and mature, thus reducing the time till harvest and to market. The increased sugar produced will ripen the fruit more quickly and make it sweeter and larger. Greenhouse production allows the grower to produce crops at a time of year when it is difficult to grow them outdoors, because of adverse climatic conditions or the high cost of controlling the environment. *Hydroponic growing system* The crop yield is increased and the crop timing improved because nutrients are delivered to plants at the required stages of plant growth. This optimum amount of nutrients and water at all times leads to better growth and development due to an increase in the rate of photosynthesis, transpiration, and respiration. The ability to supply nutrients in precise amounts to match crop growth and development requirements, speeds up the growth of the plants, and shortens the time for the fruit to form, ripen and mature, which enhances crop timing by reducing the time till harvest and to market.

(b)	Question: Justify one of the techniques used in greenhouses in terms of its economic and environmental impact. Greenhouse production allows the grower to produce crops at a time of year when it is difficult to grow them outdoors, because of adverse climatic conditions or the high cost of controlling the environment. This means that indoor growers have control of market supply, and provided demand is maintained, higher prices are received. This, in turn, must cover the higher production costs to be economic, but high financial returns from the export market make greenhouse production viable. Environmental impacts can vary depending on whether glass or plastic is used. Glass requires a greater financial outlay, but is longer-lasting. It has been the preferred traditional protective environment because of its permanence. However, glass is one of the least efficient materials for retaining heat, due to its high heat transfer rate (i.e. allowing heat energy to be conducted through the glass very easily), and consequently, poor insulating characteristics. Toughened safety glass offers more thermal efficiency than normal glass, and will usually last a lot longer, due to its strength and durability. However, it is more expensive. Glass provides better light quality, resulting in increased photosynthetic rates, so plants will mature more quickly to meet market windows. As glass is significantly heavier than the materials used in a plastic house, the glasshouse frame will obviously need to be substantially stronger and designed specifically for glass. Glass doesn't diffuse light, and therefore there is a risk that plants might burn. It also has a lower impact resistance when compared to plastic coverings, and therefore can break much more easily. Glass is very rigid, and does not allow for movement or shift in the glasshouse frame and / or foundations. It lasts for a long time, has a more pleasing look to the eye, reducing visual pollution, and has good light clarity. A plastic house provides good clarity but, at about 89% clarity, is not quite at the level of glass. It is also strong and durable, making it a long-lasting option, but it may need to be replaced more regularly than glass. It can be used in a double-layered configuration, separated by flutes. This provides a double glazing effect and improves the thermal insulation of this product. Commercial plastic houses are commonly made of a triple coating of plastic. If a plastic house is used, the plastic house frame must be designed to accommodate the panels securely, ensuring they will not blow out, and are sealed around the edges to maximise the thermal efficiency of the house. It will also keep the moisture, mould, and bugs out of the inner cavity; otherwise, pests and disease can be spread to plants, and humidity levels can become an issue. It has good longevity and holes can be easily patched, although it is prone to scratch damage. Plastic is more readily recycled than the heat-treated panes of glass used in a glasshouse. Therefore, using a plastic house may not only be cheaper, but may also have a less adverse effect on the environment, due to lower carbon dioxide emissions and better use of environmental resources. Overall, producing tomatoes and capsicums in a greenhouse is an economically and environmentally sensible decision.

Assessment Criteria

Question TWO: Growing potatoes

Achievement	Achievement with Merit	Achievement with Excellence
Describes how two techniques are used by potato growers to modify the physical factors of the environment to improve the quality of potatoes produced.	**Explains** how two techniques are used by potato growers to modify the physical factors of the environment to improve the quality of potatoes produced.	**Evaluates** both these techniques in terms of their economic or environmental impact on commercial potato production in New Zealand.

N1	Some writing, but does not describe how two techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced.
N2	Partial or insufficient description of how two techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced.
A3	Describes how two techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced.
A4	Fully describes how two techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced, with reference to growth rates.
M5	Explains how two techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced, in relation to plant processes.
M6	Fully explains how two techniques are used by potato growers to modify physical factors of the environment to improve the quality of potatoes produced, in relation to plant processes and growth rates.
E7	Evaluates BOTH of the techniques in terms of the economic or environmental impact on commercial potato production in New Zealand. Comprehensive evidence given for superiority of one technique, with the other technique well supported.
E8	Evaluates BOTH of the techniques in terms of the economic or environmental impact on commercial potato production in New Zealand. Comprehensive supporting evidence of superiority is given for BOTH techniques.

N0 = No response; no relevant evidence.

Q2	Sample Evidence
(a)	Question: Explain how TWO techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced. **Describes** how TWO techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced. *Plant spacing* Plant spacing modifies the amount of light that the plant canopy is exposed to. To maximise crop growth, the plants need to be spaced at a distance where the plants are not competing with each other for light. They need to be planted so that the maximum available leaf area is exposed to the light, even when fully grown, and there is no shading from other plants. For example, in potatoes, if the plant spacing is close, more tubers will grow per plant, but the tubers will be smaller in size. Plant spacing modifies the amount of soil space that the plant has access to. Some plants require a large root space for uptake of water and nutrients, and some require a particular amount of soil space in which to grow adequate-sized tubers. *Irrigation* Irrigation systems such as centre pivots replace rain and provide water when the plant requires it, thereby removing or reducing the water variability on the productive capacity of the land. Increasing water increases plant growth and tuber production. This can increase the quality of the potatoes produced. **Explains** how TWO techniques are used by potato growers to modify physical factors of the environment in order to improve the quality of potatoes produced. *Plant spacing* Perlas are small potatoes; their small size means they cook easily and consistently, retain their goodness, and taste delicious. To ensure their quality, the optimal plant spacing is a distance that allows a full canopy to be produced rapidly, and is large enough to have a photosynthetic capacity to add a carbohydrate bulk to the end product, or is a distance that allows the plant to produce the optimal size of the required vegetable due to the optimal amount of soil space. Close plant spacing will reduce the space of the canopy, reducing the ability of the plants to photosynthesise. This reduces the plant's ability to develop large vegetables, as it does not have the photosynthetic capacity to add bulk. *Irrigation* An optimal amount of water increases the rate of photosynthesis, which produces more carbohydrates and plant tissue, thereby increasing the growth, maturation, and quality of the vegetable crop. There are critical stages in the plant cycle that require good soil moisture levels, such as at flowering and vegetable development. These determine the growth and quality of the crop. For example, potatoes require good soil moisture levels at flowering, as this determines the potato set and thus the potential quality. Potatoes have little tolerance for water stress so it is important to maintain available water at 50% field capacity to favour tuber development, and at the same time discourage plant diseases such as rots associated with wet soils, which reduce quality.

(b)	Question: Evaluate BOTH of the techniques in (a) in terms of their economic or environmental impact on commercial potato production in New Zealand. Potato plants which are closer together increase tuber density relative to the canopy size. This limits the photosynthetic capacity to bulk each tuber. The total yield per plant is not reduced, but the tubers are smaller in size. A higher number of smaller potatoes provides higher returns, due to more tubers being sold. A wider than optimal spacing can increase the time it takes for a plant to reach its full canopy, which can reduce the carbohydrate supply to vegetables. Plants need access to the optimal amount of soil air, water, and nutrients. Soil air increases root respiration, which increases the active uptake of nutrients and water. This, in turn, increases the rate of photosynthesis, which produces more carbohydrates and plant tissue, thereby increasing the growth and hastening the maturation of the crop. In the case of Perla potatoes, the plant spacing must be optimal to produce many potatoes of a smaller size, thus increasing economic returns. Irrigation levels must be closely monitored, with water schedules often used to keep soil water potential within a narrow range. Over-irrigation causes soil erosion, disease susceptibility, and nitrogen leaching, leading to increased nitrogen crop needs. In potatoes, over-irrigation can produce oversized potatoes that are often hollow-hearted (an undesirable characteristic), and can also reduce tuber growth by restricting plant physiological activity and nutrient uptake, and increasing disease susceptibility. Allowing soil moisture to drop below critical levels reduces or stops canopy and vegetable growth during stressful periods, and for several days thereafter. In potatoes, this effectively shortens the tuber bulking period and can also cause a variety of internal and external tuber defects, leading to losses in tuber quality, market grade, and price. Plant spacing closer than normal can achieve the results required for small potatoes, while using irrigation increases yield and improves quality and timing to meet early market requirements. Plant spacing helps to ensure a high volume of potatoes is produced, whilst irrigation improves potato quality. Both methods increase the efficiency of the process of photosynthesis and allow the grower to produce a large quantity of small potatoes, ensuring higher economic returns, and increasing the economic viability of the tubers.

Question THREE: Growing kiwifruit

Achievement	Achievement with Merit	Achievement with Excellence
Describes how the fan modifies a physical factor of the environment to increase the quantity of kiwifruit produced.	**Explains** how the fan modifies a physical factor of the environment to increase the quantity of kiwifruit produced.	**Justifies** the kiwifruit grower's use of a fan over an alternative technique for modifying a physical factor of the environment; considers the economic and social impact of each technique.

N1	Some writing, but does not describe how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced.
N2	Partial or insufficient description of how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced.
A3	Describes how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced.
A4	Fully describes how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced, with reference to growth rates.
M5	Explains how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced, in relation to plant processes.
M6	Fully explains how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced, in relation to plant processes AND growth rates.
E7	Justifies the kiwifruit grower's use of a fan over an alternative technique for modifying a physical factor of the environment; considers the economic and social impact of each technique. Clear evidence for superiority in ONE impact, with the other impact well supported.
E8	Justifies the kiwifruit grower's use of a fan over an alternative technique for modifying a physical factor of the environment; considers the economic and social impact of each technique. Clear evidence for superiority in BOTH impacts.

N0 = No response; no relevant evidence.

Q3	Sample Evidence
(a)	Question: Explain how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced. **Describes** how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced: Wind machines or fans are basically a large fan mounted at the top of a 10-metre tower, which mixes warmer air from that height with the colder air at ground level to increase the overall temperature throughout the orchard. They are turned on when the air temperature drops close to 1°C to avoid sub-zero temperatures, which would freeze and destroy buds that would develop into fruit. Air movement prevents frost from settling on developing buds that have the potential to form fruit. If frost forms, cellular material freezes and buds die. **Explains** how the fan modifies a physical factor of the environment in order to increase the quantity of kiwifruit produced: If a frost occurs in spring when the kiwifruit flower buds are beginning to open, irreversible damage will be done to the crop. Flower buds blacken and are unable to open, killing the flower (ovary or the surrounding tissues). Open flowers and leaves become brown, are 'frost burnt', and eventually fall off the plant. A late frost can destroy all emerging buds, flowers and fruit, and even a light frost can reduce the quantity significantly. This means that buds are unable to develop and flowers are unable to be pollinated or fertilised, so therefore cannot develop into fruit, significantly reducing quantity. Wind machines keep buds safe from freezing, meaning that fruit quantity is maintained.
(b)	Question: Justify the kiwifruit grower's use of a fan over an alternative technique for modifying the physical factor of the environment identified in (a). In your answer, consider the economic and social impact of each technique. Wind machines keep buds safe from freezing, meaning that fruit quantity is maintained, even if there are early frosts. Wind machines are expensive, and many are required per orchard to provide effective protection. However, a large helicopter costs $1 000 per hour; and just 25 hours will pay for one wind machine, which provides a permanent solution. Both techniques provide a similar result in terms of fruit yields. Socially, helicopters create problems because of their noise on calm nights, especially in kiwifruit-growing regions close to cities / towns such as Tauranga and Te Puke. There is also a noise component with wind machines, and their height and number present a visual hurdle, especially in winter months. Wind machines are permanent fixtures under the direct control of the grower. Once in place, a turn of a switch begins their operation, unlike helicopters, which have to be booked, sometimes at short notice, and may not be readily available. Both techniques would be equally effective given that their mode of action (mixing warmer air with cold air) is the same: to ensure temperatures do not drop below zero, and freeze and destroy buds that would develop into fruit. Wind machines offer greater reliability, especially for new growers who have yet to establish their reputation with helicopter operators. Large, established growers may be able to justify owning a helicopter.

Cut Scores

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