Assessment Schedule – 2013

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

Evidence Statement

Question ONE: Outdoor vegetable production

Achievement	Achievement with Merit	Achievement with Excellence
Describes how the use of irrigation and plant spacing modifies physical factors of the environment for commercial outdoor vegetable production.	**Explains** how the use of irrigation or plant spacing modifies physical factors of the environment for commercial outdoor vegetable production, in terms of how plant processes effect yield or quality.	**Justifies** how plant spacing and irrigation modify the physical environment in commercial outdoor vegetable production, in terms of economic returns.

N0	No response; no relevant evidence.
N1	Some writing, but does not describe how irrigation *OR* plant spacing modifies physical factors of the environment for commercial outdoor vegetable production.
N2	Partial or insufficient description of how irrigation *OR* plant spacing modifies physical factors of the environment for commercial outdoor vegetable production.
A3	Describes how the use of irrigation *AND* plant spacing modifies physical factors of the environment for commercial outdoor vegetable production.
A4	Fully describes how irrigation *AND* plant spacing modifies physical factors of the environment for commercial outdoor vegetable production with reference to growth rates.
M5	Explains how the use of irrigation *OR* plant spacing modifies physical factors of the environment for commercial outdoor vegetable production, in terms of how plant processes effect yield *OR* quality.
M6	Fully explains how the use of irrigation *AND* plant spacing modifies physical factors of the environment for commercial outdoor vegetable production, in terms of how plant processes effect growth *AND* yield *AND* quality.
E7	Justifies the use of irrigation *AND* plant spacing to modify physical factors of the environment for outdoor vegetable production, in terms of economic returns. Comprehensive evidence given for the importance of *ONE* management practice in the production of outdoor vegetables in relation to economic returns, with the other management practice well supported.
E8	Justifies the use of irrigation *AND* plant spacing to modify physical factors of the environment for outdoor vegetable production. Comprehensive evidence given for the importance of BOTH management practices in the production of outdoor vegetables in relation to economic returns.

Q1	Evidence
(a) (i)	Describe how plant spacing modifies physical factors of the environment for an outdoor vegetable crop • 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.
(a) (ii)	Explain how plant spacing could affect the yield of an outdoor vegetable crop • The optimal plant spacing is a distance which allows a full canopy to be produced rapidly, and large enough to have a photosynthetic capacity to add a carbohydrate bulk to the end product, or 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. For example, 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. The number of vegetables produced may be fewer, but will be of a larger size, due to a greater photosynthetic capacity in the mature plant. • 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 maturation of the vegetable crop, and therefore crop yield.
(b) (i)	Describe how irrigation systems used in outdoor vegetable production modifies physical factors of the environment Irrigation systems such as centre pivots replace rain and provide water when the plant requires it, therefore removing or reducing the water variability on the productive capacity of the land. For example, in potatoes, the leading method of irrigation is the use of sprinkler systems on hilled furrows. Water is essential, as a moist seedbed needs to exist for planting in October, and therefore may necessitate early irrigation.
(b) (ii)	Explain how irrigation improves the growth and quality of outdoor vegetables • 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 yield and quality. Potatoes have little tolerance for water stress – the tuber quantity is influenced by water stress during tuber growth. 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.

	• Irrigation levels must be closely monitored, and a water schedule is 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, total yield, and price.
(c)	Justify the use of both controlled irrigation and plant spacing in the production of uniform, small potatoes by explaining why they are likely to produce a greater increase in economic returns if the techniques are used together Using closer plant spacing than normal can achieve the results required for small sized potatoes, while using irrigation increases yield and improves quality and timing to meet early December market requirements. Plant spacing helps to ensure a high quantity of potatoes is produced, whilst irrigation improves potato quality. Both use of 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 TWO: Outdoor fruit production

Achievement	Achievement with Merit	Achievement with Excellence
Describes how the use of mulches or north-facing land modifies physical factors to aid commercial outdoor fruit production.	**Explains** how mulching or the use of north-facing land provides higher quality fruit in commercial outdoor fruit production.	**Compares** the environmental impacts of planting on north-facing slopes with the use of mulching in commercial outdoor fruit production.

N0	No response; no relevant evidence.
N1	Some writing, but does not describe how mulching *OR* the use of north-facing land modifies the physical factors of the environment for commercial outdoor fruit production.
N2	Partial or insufficient description of how mulching *OR* the use of north-facing land modifies the physical factors of the environment for commercial outdoor fruit production.
A3	Describes how mulching *OR* the use of north-facing land modifies the physical factors of the environment for commercial outdoor fruit production.
A4	Fully describes how mulching *OR* the use of north-facing land modifies physical factors of the environment for commercial outdoor fruit production with reference to growth rates.
M5	Explains how mulching *OR* the use of north-facing land modifies physical factors of the environment for commercial outdoor fruit production, in terms of how plant processes affect fruit quality.
M6	Fully explains how mulching *AND* the use of north-facing land modifies physical factors of the environment for commercial outdoor fruit production, in terms of how plant processes affect fruit quality.
E7	Compares the environmental impacts of the use of mulching *AND* north-facing land in commercial outdoor fruit production. Comprehensive information in ONE management practice, with the other management practice well supported.
E8	Compares the environmental impacts of the use of mulching *AND* north-facing land in commercial outdoor fruit production. Comprehensive evidence given for the importance of BOTH management practices in the production of outdoor fruit.

Q2	Evidence
(a)	Describe how mulching improves soil conditions in outdoor fruit production • Mulch is an organic or inorganic material placed over the soil surface during the growing season. It insulates the plant and its roots from fluctuations in temperature and conserves the soil moisture. Mulch can reduce soil compaction caused by equipment and people, and reduces soil erosion. • Dark-coloured polyethene will warm the soil more than the pea straw, due to the absorption of heat from the sun. It raises the temperature by approximately 3°C. It is removed each year to allow the soil to recover, as it restricts the movement of gases between the soil and the air. • Pea straw insulates the soil, increasing its temperature. It also protects strawberries from rotting by eliminating contact with the ground, and adds nutrients back to the soil. Explain how mulching improves soil conditions, providing higher quality fruit in outdoor fruit production • Soil temperature affects the breakdown of parent material and how fast micro-organisms work. Micro-organisms will work more quickly in warmer soil (around 20°C), but will slow down if it gets too hot (above 35°C). Micro-organisms also slow down if the soil is too cold – they become inactive below 6°C. Micro-organisms are important in adding and returning nutrients to the soil, and for increasing the amount of nutrients available to the strawberries. The more nutrients available, the larger and higher quality the strawberries produced. • Warm soil provided by mulching increases root activity, allowing more chemical processes to occur in the plant such as respiration to increase plant growth and nutrient uptake. This in turn allows more photosynthetic material to be added to the strawberries, making them sweeter and bigger, and therefore a higher quality product. • The dark-coloured polyethene radiates heat from its surface, increasing the temperature around the fruit, improving the colour and ripening, and thus the quality of the strawberries. • Mulching layer kills off existing vegetation by eliminating light, resulting in no soil water loss due to transpiration by plants. Removing unwanted plant material reduces competition for nutrients, light, and water without the need for mechanical methods of weed control. • With no soil disturbance, evaporation losses are minimal, and so all ingredients for photosynthesis are maximised, thereby increasing crop yields. Mulching insulates the soil from extremes of temperature, and in doing so, plant processes proceed at a faster rate, resulting in higher yields.

(b)	Describe how north-facing land can improve outdoor fruit production The direction of the slope of the land determines how much light is received. A north-facing slope receives more light intensity than a south-facing slope, as the light is restricted to a narrow area. On the south-facing slope, the light is spread over a larger area. North-facing slopes also have more sunshine hours than south-facing slopes. With increased sunshine hours on north-facing land, more light is received, more leaves in the plant canopy are hit by higher light intensity, and the temperature of the soil will be higher earlier in the growing season. Explain how north-facing land can increase soil temperature and fruit quality • With increased sunshine hours on north-facing land, more light is received on the land, resulting in higher soil temperatures earlier in the growing season. Warmer soil leads to more root activity and higher metabolic rate, which increases the uptake of water and nutrients, as well as increasing root growth. A higher level of uptake enables plants to grow more quickly, and means that the fruit produced may be larger and of a higher quality and ripen earlier. • Soil temperature affects the breakdown of parent material and how fast micro-organisms work. Micro-organisms will work more quickly in warmer soil (around 20°C), but will slow down if it gets too hot (above 35°C). Micro-organisms also slow down if the soil is too cold – they become inactive below 6°C. Micro-organisms are important in adding and returning nutrients to the soil, and for increasing the amount of nutrients available to the strawberries. The more nutrients available, the larger and higher quality the strawberries produced. Compare the environmental impacts of planting on north-facing slopes and the use of mulching • On north-facing land, due to the improved soil conditions there is increased plant growth, which also means there is increased weed growth and pest reproduction. This can lead to an increase in the use of herbicides and pesticides. These can have a serious effect on the environment, in terms of spray drift affecting other plants in the surrounding area and pesticides harming wanted animals. In comparison, the use of mulches in producing strawberries reduces the growth of weeds, so herbicides are not needed. However, there will still be some use of pesticides on the strawberry plants themselves. • The use of mulches ensures that there are no bare soils. Bare soils are prone to wind erosion, and mulches reduce this. Reduced loss of topsoil reduces the need for fertilisers, and the effects of potential runoff into rivers and streams. The lack of wind erosion also reduces the likelihood of dust settling on fruit, improving the appearance of the fruit and leading to a higher quality product. However, the use of black polythene has disposal issues that would need to be addressed. North-facing land is usually slightly elevated, and therefore wind erosion may be more likely. • North-facing slopes dry out quicker than south-facing slopes, due to their slight elevation, higher sunshine hours, increased light quality, and higher soil temperatures. Plants grown on north-facing slopes must receive enough water, or their production will be effected. Mulches retain soil moisture, so plant production is not affected. • North-facing slopes, due to their elevation, can be a source of water runoff and nutrient leaching, so these would need to be addressed.

Question THREE: Agricultural crop production

Achievement	Achievement with Merit	Achievement with Excellence
Describes how the use of later planting or cultivation modifies physical factors to aid maize production.	**Explains,** in detail, how the use of later planting or cultivation modifies physical factors and affects the yield in maize production.	**Compares** the use of cultivation and no-cultivation on yield of maize production, in terms of economic and environmental impacts.

N0	No response; no relevant evidence.
N1	Some writing, but does not describe how late planting *OR* cultivation modifies the physical factors of the environment for commercial maize production.
N2	Partial or insufficient description of how late planting *OR* cultivation modifies the physical factors of the environment for commercial maize production.
A3	Describes how late planting *OR* cultivation modifies the physical factors of the environment for commercial maize production.
A4	Describes how late planting *AND* cultivation modifies the physical factors of the environment for commercial maize production, with reference to growth rates.
M5	Explains how late planting *OR* cultivation modifies physical factors of the environment for maize production in terms of how plant processes affect the yield produced.
M6	Explains how late planting *AND* cultivation modifies physical factors of the environment for maize production in terms of how plant processes affect the yield produced.
E7	Compares the economic *AND* environmental impacts of cultivation *AND* no-cultivation in the production of maize. Comprehensive information on ONE aspect, with the other aspect well supported.
E8	Compares the economic *AND* environmental impacts of cultivation *AND* no-cultivation in the production of maize. Comprehensive evidence given for the importance of BOTH aspects.

Q3	Evidence
(a)	Describe how planting the crop later in the year in the South Island may affect the yield of maize produced • Maize planted later is less likely to be exposed to frost during growth. Maize is sensitive to frost after the first two weeks of growth, so it is important that it is planted after the chance of frost has subsided. It requires 120–180 frost-free days to produce a silage crop. • Planting the maize later in the season ensures that the soil temperature has increased, improving seed germination. Explain how planting the crop later in the year in the South Island may affect the yield of maize produced If maize plants are planted later, they are less likely to be exposed to frost during early growth, and a higher soil temperature ensures better germination rates. This leads to larger, higher quality yields due to higher soil temperatures, increased sunlight hours, and reduced loss of plants. Earlier planting can lead to longer production times, due to delayed germination, lower sunlight hours, and reduced Growing-Degree-Days (GDDs) or crop damage from the frosts, which can reduce yields.
(b)	Describe how the practice of cultivation improves the production of maize • A cultivation system involves the soil being broken up using machinery, such as a plough, and nutrients being returned to the soil mechanically. The objective of soil cultivation is to maintain the existing structure of the soil or to improve the structure of poorly structured soil. • Cultivation changes the soil's structure, water properties, and stability so that plants will grow and produce optimally. This is done by loosening and aerating the top layer of soil, mixing in residue from the harvest, organic matter (humus), and nutrients evenly throughout the soil. Explain the advantages of using cultivation on the yield of maize produced • Cultivation ensures that the maize plants have warmer soils, increased amounts of soil water, nutrients, and oxygen in the soil for carrying out all the plant processes, thus increasing the maize's growth and yield. • Increased oxygen in root zone allows for healthy roots and for functions such as respiration for energy release, and nutrient uptake for incorporation into plant tissues. This increases growth and yield. • Warm soil temperatures encourage cell processes such as photosynthesis and breakdown of organic matter to release nutrients by soil organisms – both necessary for new growth and yield. • Cultivating mechanically also destroys weeds, reducing competition for the maize crop, improving production and therefore yield. The soil is exposed, and this can increase soil temperatures, aiding successful germination and maize growth, leading to a larger, higher quality crop in a shorter time, which increases profits. Compare the economic and environmental impacts of these two systems (cultivation versus no-cultivation) with respect to the yield of maize produced No-cultivation is when the soil is left undisturbed from planting to harvesting. Due to reduced working of the soil, there is less opportunity for soil water evaporation from sun or the wind, and therefore no soil water deficit. Soil structure will be preserved, which provides good aeration, root-run, and the ready entry of rainfall. It also increases the organic matter in the soil and reduces wind erosion. However, soil temperature can be lower at planting time, increasing germination and production time. Yields also tend to be lower than with cultivation. Comparatively, cultivation has higher initial costs associated with it, and whilst the environmental impacts can be quite negative, the overall end quality and yield of the maize produced is likely to be higher than with no-cultivation, thus making it more profitable.

	Economic • Cultivation of the seed bed is one of the biggest cost factors in maize production. • The costs associated with cultivation are not present in a no-cultivation situation. Seeding and harvesting costs would be similar. *Environmental* • Cultivation has some environmental impacts in terms of diesel fuels and consumption, as well as increased soil erosion by wind and water, and increased fertiliser runoff due to poor water infiltration. Soil can be compacted by machinery, thus making it difficult for both plants' roots and water to infiltrate. A no-cultivation programme reduces wind and water erosion due to thirty per cent of the soil being covered with plant residue after seeding. Weed control is poor, and this can lead to increased herbicide use and the costs associated with this. Environmentally, spray drift may cause damage to other plants and neighbouring farms. Due to no machinery passes, the soil is not compacted, increasing water and gas infiltration.

Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 7	8 – 12	13 – 18	19 – 24