Assessment Schedule – 2016

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: Organic matter in Soils

Achievement	Achievement with Merit	Achievement with Excellence
Describes how spreading effluent to increase organic matter modifies physical factors of the soil.	**Explains** how the addition of organic matter affects plant production and improves pasture yield.	**Justifies** a farmer's decision to spread effluent on dairy pasture, taking into account the environmental and economic impact of this technique.

N1	Some writing, but does not describe how spreading effluent to increase organic matter modifies physical factors of the soil.
N2	Partial or insufficient description of how spreading effluent to increase organic matter modifies physical factors of the soil.
A3	Describes how spreading effluent to increase organic matter modifies physical factors of the soil.
A4	Fully describes how spreading effluent to increase organic matter modifies physical factors of the soil, with reference to growth rates.
M5	Explains how the addition of organic matter affects plant production and improves pasture yield, in relation to plant processes.
M6	Fully explains how the addition of organic matter affects plant production and improves pasture yield, in relation to plant processes AND growth rates.
E7	Justifies a farmer's decision to spread effluent on dairy pasture, taking into account the environmental and economic impact of the use of this technique. Clear evidence for superiority in ONE impact, either environmental or economic, with the other impact well supported.
E8	Justifies a farmer's decision to spread effluent on dairy pasture, taking into account the environmental and economic impact of this technique. Clear evidence for superiority of BOTH.

N∅ = No response; no relevant evidence.

Q1	Sample Evidence
(a)	**Describes** how spreading effluent to increase organic matter modifies physical factors of the soil. Spreading effluent on pasture increases the organic matter in the soil. Higher organic matter in the soil increases nutrient availability such as plant-available nitrogen, improves water-holding properties, and increases aeration through microbial and other organic activity. Other factors which could be changed are pH, which affects nutrient availability within the soil; soil texture and structure, which affects leaching of nutrients; and the natural weathering of the soil.
(b)	**Explains** how the addition of organic matter affects plant production and improves pasture yield. Organic matter improves soil air through larger pore spaces and increased microbe activity. Improved soil air increases root respiration, which raises the active uptake of nutrients and water absorption. This, in turn, increases the rate of photosynthesis, which produces more carbohydrates and plant tissue, thereby increasing the growth rate and pasture yield. Organic matter holds more water, thus increasing the rate of photosynthesis – which produces more carbohydrates and plant tissue, thereby increasing the growth rate and pasture yield. The addition of organic matter increases the plant-available nitrogen which can be taken up by the plant and used to make proteins, which produce more leafy growth. This is important in the process of photosynthesis, as the greater the leaf area, the greater the photosynthesis that can be carried out, and more energy can be provided to the plant to increase growth. An increase in nitrogen provides the nutrients needed for more growth and a higher pasture yield.
(c)	**Justifies** a farmer's decision to spread effluent on dairy pasture, taking into account the environmental and economic impact of this technique. *Environmental* Effluent is a natural product, but it needs to be managed with care as it is not a balanced fertiliser, being very high in potassium. This can lead to higher leaching levels of magnesium and create animal health problems if potassium soil test levels are high. Excessive effluent application can have negative environmental effects. Nutrients that are not efficiently used by the pasture or retained in the soil can leach into groundwater, and move from agricultural land into surface waters. Effluent management is critical to maintaining adequate, but not excessive, nutrient concentrations for maintaining optimal soil quality and pasture production. Dairy farmers are getting smarter and finding better ways of spreading the waste back onto the land to reduce waste and environmental risks. Spreading effluent during dry periods increases the amount of water that is supplied to the pasture which can increase yield. *Economic* Applying effluent meets the nutrient needs of the pasture. Dairy farm effluent is a valuable resource because of its nutrient value, and reduces the amount of inorganic fertiliser needed, and also the associated costs. This avoids wastage of both money and fertiliser. Effluent spreading leads to the supplementation of

	nutrients, and this increases plant growth and therefore yield, enabling the grower to get maximum output for minimum input. Effluent spreading builds up the organic matter in the soil, improving the soil structure, allowing it to hold more water, be better aerated, and have a higher nutrient level. It is cost-effective and makes dairy farming more efficient.

Question TWO: Hail

Achievement	Achievement with Merit	Achievement with Excellence
Describes a technique that can be used to reduce the impact of hail on fruit for export.	**Explains** how the technique modifies physical factors of the environment to improve the crop yield and quality for export.	**Justifies** the use of covers to improve the crop yield and quality for export, taking into account the social and economic impact arising from it.

N1	Some writing, but does not describe a technique that can be used to reduce the impact of hail on fruit for export.
N2	Partial or insufficient description of a technique that can be used to reduce the impact of hail on fruit for export.
A3	Describes a technique that can be used to reduce the impact of hail on fruit for export.
A4	Fully describes a technique that can be used to reduce the impact of hail on fruit for export, with reference to growth rates.
M5	Explains how a hail-prevention technique modifies physical factors of the environment to improve the crop yield and quality for export, in relation to plant processes.
M6	Fully explains how a hail-prevention technique modifies physical factors of the environment to improve the crop yield and quality for export, in relation to plant processes AND growth rates.
E7	Justifies the use of covers to improve the crop yield and quality for export, taking into account the social and economic impact arising from it. Clear evidence for superiority in ONE aspect, social or economic, with the other aspect well supported.
E8	Justifies the use of covers to improve the crop yield and quality for export, taking into account the social and economic impact arising from it. Clear evidence for superiority in BOTH aspects.

N∅ = No response; no relevant evidence.

Q2	Sample Evidence
(a)	**Describes** <u>an alternative technique to reduce the impact of hail on fruit.</u> A hail cannon (also known as anti-hail gun) is a shockwave generator used to disrupt the formation of hailstones in their growth phase. An explosive charge of acetylene gas and air is fired in the lower chamber of the machine. As the resulting energy passes through the neck and into the cone, it develops into a force that becomes a shockwave. This shockwave, clearly audible as a large whistling sound, then travels at the speed of sound into and through the cloud formations above, disrupting the growth phase of the hailstones. The device is fired every four seconds as a storm approaches and until it has passed through the area. What would otherwise have fallen as hailstones then falls as slush or rain. It is critical that the machine is running during the approach of the storm in order to affect the developing hailstones. These machines cannot alter the form of an already developed and therefore solidified hailstone. The aim is to stop hailstones forming by shattering the particles, reducing their possible damage. A less effective method is a hail rocket. Hail rockets are propulsions sent into the hail clouds, where they emit silver iodide particles, which stop the hail from forming, causing rain to fall instead. By injecting many extra ice-forming nuclei into the cloud at the right time and the right place, in weak updrafts where hail formation is beginning, it is possible to reduce the average size of fully grown hailstones. Small hailstones are more likely to melt on the way down and do less damage to fruit.
(b)	**Explains** <u>how the alternative technique modifies physical factors of the environment to improve the crop yield and quality for export.</u> Hail cannons and rockets aim to reduce the likelihood of hail falling on the fruit trees. As the hail is reduced to slush, there is no reduction in the number of buds, flowers or fruit from those trees, and therefore no reduction in yield or quality. This results in increased plant productivity. Reduction of hail means leaves can continue to photosynthesise, increasing glucose levels and plant growth. If hail forms and lands directly on mature fruit, it will cause the skin to split, mark or bruise. This reduces the quality of the fruit and may render it unsaleable. Physical damage to the trees can also allow entry for pests and diseases, further reducing quality and yield.
(c)	**Justifies** <u>the use of covers to improve the crop yield and quality for export, taking into account the social and economic impact arising from it.</u> A heavy hailstorm can wipe out months of hard work in a matter of minutes, almost always completely destroying the crop, with the consequent loss of income for the grower. A grower may choose to use covers rather than a hail cannon, due to social and economic factors. <u>Describes how covers modify physical factors of the environment</u> Hail covers are generally applied as an overhead canopy for protection against hailstorms, and can be pitched-roof or multi-span structures covered with material. This material is made of strong, knitted fabric which has an excellent strength / weight ratio and is ultra-violet-light stabilised. The covers protect the fruit from hail damage by providing a physical barrier, reducing / removing the impact of the hail on the fruit.

Explains how covers improve the crop yield and quality for export

Hail covers ensure that fruit is protected from the effects of hail, which damages the buds, leaves, and fruit, and bruises the surface of the fruit, leaving less fruit (if any) that will meet the high quality requirements for export. If hail damage can be avoided, then a higher quality product is grown. This results in increased plant productivity. Hail covers virtually eliminate the risk of hail and wind damage to valuable crops, while also providing a degree of frost protection. Hail covers prevent hail from also stripping the leaves from trees, which would reduce the surface area for light absorption, meaning less photosynthesis, lower levels of glucose produced, and therefore less plant growth.

Hail covers are usually white nets which can reduce light levels, preventing sunburn and increasing the temperature, resulting in less frost damage, thus increasing quality and yield. The temperature of production can be raised with the cover having insulation properties, and this can lead to more growth, due to a higher rate of photosynthesis and a higher quantity of fruit. It can also even out temperature fluctuations so that more steady growth is provided, leading to more uniform fruit, which is then able to be sold for a higher price, and is more suitable for export. It avoids overheating as fabric is often woven, allowing excess heat to escape.

Compares the two techniques, taking into account the social and economic impact

Hail cannons or rockets are less effective methods, and there is no guarantee they will work. If the grower is not there to set up the cannon or rocket when the storm is approaching, the whole crop may be destroyed, with loss of income. A hail cannon or rocket can have social effects on the local area, due to the loud noise they make when fired, and they may have to be fired repeatedly to get the desired effect. Their use is not limited to sociable hours, and the impact on the local area can be extreme. The economic factors affecting their use are the one-off cost of buying the cannon or rocket, and the cost of the explosives to load them with. However, hail cannons and rockets do not need to be replaced often. Results from their use can be variable, with the only modification to the environment being the reduction in hail.

Covers are a permanent installation and do not require additional attention once installed. If the grower is not present, the covers will still protect the crops regardless, providing more economic security. The grower will not be able to obtain hail insurance if covers are not installed, as they are deemed the most effective hail protection. Installing covers can be expensive, due to labour costs, but they are virtually maintenance-free during the growing season. Covers also modify other environmental factors, leading to a higher quality crop with a higher yield. The covers not only reduce the impact of the hail, they also warm and even out the temperature the fruit is exposed to, encouraging fruit growth and development. The covers do not have wider social implications as their main disadvantage is simply that they may not be visually appealing. This is less intrusive than the use of hail cannons or rockets. Covers can represent a large cash outlay, and they may need to be replaced regularly. However, the improvement in growing conditions, which leads to higher quality and more abundant fruit, will outweigh this negative economic impact.

Question THREE: Drought

Achievement	Achievement with Merit	Achievement with Excellence
Describes how one drought management technique reduces the impact of drought on plant production.	**Explains** how one drought management technique affects plant processes and reduces the impact of drought on the timing, quality, and yield of plant production.	**Justifies** the use of two drought management techniques in terms of their environmental and economic impact.

N1	Some writing, but does not describe a drought management technique that reduces the impact of drought on plant production.
N2	Partial or insufficient description of a drought management technique that reduces the impact of drought on plant production.
A3	Describes ONE drought management technique that reduces the impact of drought on plant production.
A4	Fully describes ONE drought management technique that reduces the impact of drought on plant production, with reference to growth rates.
M5	Explains how ONE drought management technique reduces the impact of drought on the timing, quality, and yield produced in plant production, in relation to plant processes.
M6	Fully explains how ONE drought management technique reduces the impact of drought on the timing, quality, and yield produced in plant production, in relation to plant processes AND growth rates.
E7	Justifies the use of TWO drought management techniques in terms of their environmental and economic impact. Clear evidence for superiority of ONE impact, environmental or economic, with the other impact well supported.
E8	Justifies the use of TWO drought management techniques in terms of their environmental and economic impact. Clear evidence for superiority of BOTH.

N∅ = No response; no relevant evidence.

Q3	Sample Evidence
	<u>**Describes** the effect of drought on plant production.</u> The most immediate consequence of drought is a fall in crop production, due to inadequate and poorly distributed rainfall.
	<u>**Describes** how TWO drought management techniques reduce the impact of drought.</u> A fall in crop production can be mitigated by irrigation techniques, water storage areas, composting, green manure crops, terracing, contour ploughing, conservation tillage methods (strip tillage, no tillage, minimum tillage, and direct drilling), eliminating competition (weeds), soil ripping (to increase soil depth), and soil testing. A water scheduling technique tells the grower when soil water is about to become a limiting factor for plant growth. The grower can then irrigate to ensure that water is available in the soil for plant growth. Water scheduling provides an accurate guide as to when to irrigate. A gun irrigator is an overhead, high-pressure sprinkler mounted on moving platforms. A large impulse sprinkler or gun rotates, and the irrigator winches itself towards a fixed point at the other end of the paddock. This system requires more pressure, since it has only one outlet covering a wide area. Centre pivot irrigation is a form of overhead sprinkler irrigation consisting of several segments of pipe joined together and supported by trusses, mounted on wheeled towers, with sprinklers facing downwards along its length. The machine moves in a circular pattern, and is fed with water from the pivot point at the centre of the circle. It allows controlled delivery of water to the crop, to prevent over- and under-irrigation. Low application rates of 6–8 mm can be applied every day if required, reducing run-off, leaching, wind drift, and evaporation losses. 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 soil moisture.
	<u>**Explains** how ONE drought management technique affects plant processes and reduces the impact of drought on the timing, quality, and yield of plant production.</u> Water is needed for transport of nutrients, cell division and elongation, chemical processes, and support. All these are enhanced by increased water supply. A suitable technique, used efficiently, is important so that plants receive optimum water at different stages of growth. It ensures that more water is consistently available to the plant, and that it is applied according to crop requirements. This will improve profitability and water-use efficiency by maximising the crop yield and quality, and decreasing water lost through deep percolation and run-off. This ensures that the maximum amount of water is available to the plant, which will increase photosynthesis and root production, and therefore yield. Allowing soil moisture to drop below critical levels reduces or stops canopy and vegetable growth during stressful periods, and for several days thereafter. For example, 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. Soil testing finds out what limitations soils have in terms of their water-holding capabilities. This allows the farmer / grower to provide the best solution, such as

adding fertiliser and organic matter to enrich the soil, giving it the best properties to maintain a supply of water to the plants. Having higher quality soil means that a higher yield will be produced, even when conditions become less favourable.

Drip irrigation prevents the crops from becoming water stressed, whilst using water efficiently. An optimal amount of water increases the rate of photosynthesis, which produces more carbohydrates and plant tissue, thereby increasing the growth, maturation (and therefore timing), and quality of the 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 the potential yield and quality. Potatoes have little tolerance of water stress. The tuber quantity is influenced by water stress during tuber growth. It is important to maintain available water at 50% of field capacity to favour tuber development and discourage plant diseases such as rots associated with wet soils.

Planting shelter reduces transpiration, and plant stress, and will increase crop yield.

Justifies the use of each technique in terms of their environmental and economic impact.

Crops require significant amounts of water, due to their perishable nature. Tree fruit and nut crops are not only comprised of large amounts of water, but the trees are also perennial plants. Stress not only affects the current season's crop, but future crops as well. Vegetables are also quite perishable but are annual crops, and thus only one year of production is affected. Since water is such a critical component of the growth and development of crops, irrigation is important when establishing a crop to withstand drought.

Although drought management decisions are generally the same for vegetable and orchard crops, orchardists look at such steps to ease their water shortage immediately, because they already have established perennial trees. Vegetable producers can evaluate all aspects of their water situation prior to planting, and may decide to reduce the size of planting, not plant at all, etc, depending on water availability. Aspects to be considered with orchard crops include the efficiency of the current irrigation methods, irrigation scheduling techniques, sub-optimal irrigation, block productivity, and more efficient irrigation systems.

The size of the operation can be adjusted to meet the capacity of the available water. Also, producers can try to stretch their operation past the limits of available water. In normal years, when there is significant rainfall, a deficit water budget can be used. With water budgeting excess water is not used, and plants are not stressed, leading to higher yields. However, in times of drought, irrigation can be pulled back to the minimum, with higher profit crops being the focus.

Scheduling is critical to the effectiveness of irrigation, and can also be used to improve the overall efficiency of the other methods as well. Knowing crop water use, based on crop canopy size – along with evaporation data, provides a sound basis for determining water requirements. This, along with the soil water-holding capacity, allows an irrigation schedule to be maintained.

Flood irrigated orchards may consider watering every other row, or just the middle row. Furrows can be used to more efficiently flood orchards or water every other furrow. Sprinkler irrigation offers the ability to irrigate uneven terrain effectively. However, the energy required to pressurise the water can become expensive. System efficiency can be reduced by poor nozzle sizing, evaporation losses, and operational pressures. These systems have a very high initial cost, but have tremendous outcomes in reducing the impact of drought. Few producers can afford to upgrade to improved irrigation systems during drought conditions.

General daily irrigation can take place using a gun irrigator or similar, and is not based on weather or other environmental conditions. This can lead to expensive water wasting, as well as surface run-off and pollution issues. The loss of soluble fertiliser through leaching, due to excessive irrigation and additional rainfall,

	could occur on free-draining soils. Over-irrigation can result from the use of gun irrigators, because poor distribution or management wastes water and may cause leaching of nutrients and chemicals, leading to water pollution. The gun irrigator's biggest advantage is its low capital cost compared with other systems. This allows growers to get into irrigation at relatively low cost. In addition, guns can be installed and maintained by the growers. However, because a single-orifice gun is used under pressure, this system is not efficient, due to poor distribution in windy conditions, resulting in uneven water application and sometimes a loss of water via wind drift. They can be moved between crop fields, but this is labour-intensive and time-consuming. Drip irrigation can improve water use efficiency (80–95%) and reduce total water use if the system is designed properly. This irrigation system prevents the crops from becoming water stressed, and uses water efficiently. Initially, there are increased labour costs for installation, but it is virtually maintenance-free during the growing season. Plastic mulch increases water-use efficiency on vegetable crops. Plastic mulch reduces evaporation, the downward movement of water, and weed growth. Organic mulches can also be used in vegetable and fruit operations. Such mulches also provide the potential for soil improvement, and the organic matter also increases soil water-holding capacity. Plastic mulch can be used to improve rainfall capture, thereby reducing pre-plant water requirements. Removing weeds reduces competition for water and can help maintain high yields during drought conditions. Using mulches ensures that there are no bare soils, which are prone to wind erosion. Reducing lost topsoil reduces the need for fertilisers and lessens the effects of potential run-off into rivers and streams. The lack of wind erosion also reduces the likelihood of dust settling on fruit, improving the fruit's appearance and leading to a higher quality product. However, the use of some mulch material, such as black polythene, has disposal issues that would need to be addressed. In drought conditions, a combination of techniques, and frequent monitoring of soil water levels, would be best approach to limit the impact on plant production.

Cut Scores

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