

Assessment Schedule – 2014**Agricultural and Horticultural Science: Analyse a New Zealand primary production environmental issue (91532)****Evidence Statement**

Achievement	Achievement with Merit	Achievement with Excellence
<p>“Analyse” involves:</p> <ul style="list-style-type: none"> explaining the environmental issue arising from the primary production management practices explaining potential courses of action to mitigate the negative impacts of the management practices recommending sustainable production practices. 	<p>“Critically analyse” involves:</p> <ul style="list-style-type: none"> explaining, in detail, the environmental issue arising from primary production management practices evaluating potential courses of action to mitigate the negative impacts of the production management practices recommending sustainable production management practices that best address the issue. 	<p>“Comprehensively analyse” involves:</p> <ul style="list-style-type: none"> evaluating the environmental issue arising from primary production management practices justifying potential courses of action to mitigate the negative impacts of the management practices recommending and justifying sustainable production management practices that best address the issue and are economically viable.

N0	No response; no relevant evidence.
N1	Attempts to describe the issues for the environment that can arise from nutrient gains and losses for a specific production system, but several errors are apparent in the description.
N2	Describes the issues for the environment that can arise from nutrient gains and losses for a specific production system, providing some accurate information. A management practice has been offered, but details are unclear in terms of the impact on the environment.
A3	Clearly explains the issues for the environment that can arise from nutrient gains and losses for a specific production system. A management practice other than nitrification inhibitors has been provided, with some link to how it could mitigate against nutrient losses.
A4	Explains the issues for the environment that can arise from nutrient gains and losses for a specific production system correctly. An example of a management practice that could be used as an alternative to nitrification inhibitors for the management of nutrients for a specific intensive agricultural or horticultural production system has been provided and explained in general terms, plus there has been an attempt to discuss the relative strengths and /or weaknesses of the chosen practice.
M5	Explains the issues for the environment that can arise from nutrient gains and losses for a specific production system. Provides an example of a management practice that could be used as an alternative to nitrification inhibitors for the management of nutrients for a specific intensive agricultural or horticultural production system, and evaluates (relative strengths and weaknesses) a potential course of action that could mitigate the negative environmental implications, with some attempt to compare this practice with an alternative practice.
M6	Explains the issues for the environment that can arise from nutrient gains and losses for a specific production system. Provides in detail an example of a management practice that could be used as an alternative to nitrogen inhibitors for the management of nutrients for a specific intensive agricultural or horticultural production system. Evaluates (relative strengths and weaknesses of) a potential course of action that could mitigate the negative environmental implications, with some attempt to compare this practice with an alternative practice.

E7	Evaluates (relative strengths and weaknesses of) the potential course of action that could mitigate the negative environmental implications, and a comparison is made between this practice and an alternative practice in detail, <i>AND</i> gives a partial justification of a selected course of action that is economically viable. Gives a comprehensive evaluation of a selected course of action that is economically viable, which involves consideration of at least one other factor from social and/or economic and/or environmental implications.
E8	Evaluates (relative strengths and weaknesses of) a potential course of action that could mitigate the negative environmental implications in detail. Evaluates ONE potential course of action that would mitigate the negative environmental implications, and gives partial evaluation of a second course of action <i>AND</i> gives a comprehensive evaluation of a selected course of action that is economically viable, which involves consideration of at least two of the social and/or economic and/or environmental implications.

Cut Scores

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 2	3 – 4	5 – 6	7 – 8

Appendix: Examples of possible answers

PART A

Nutrients can be gained and lost within an agricultural or horticultural production system. Explain the issues for the environment that can arise from these gains and losses for a specific production system.

Nutrients in an agricultural production system such as a dairy farm can be lost through nitrate leaching below the root zone. This can cause the aquifers below the root zone to become contaminated with nitrate. Research indicates that levels of nitrate with an N equivalency greater than 11.3 mg/L are harmful to human health. As well as this, nitrate levels above 5 mg/L will cause excess plant growth, decreasing the quality of water and the biodiversity within it.

In areas such as Manawatu and parts of Canterbury, there is evidence that nitrate levels are in excess of 10 mg/L. The problem this causes for the environment is that excess nitrogen can cause eutrophication of waterways, as the excess N causes a proliferation of plant growth in the water, resulting in excess plant growth, decreased light and water clarity, a reduction in the natural biodiversity of the water system, and the risk of algal blooms. Eventually, if left unchecked, these water ecosystems can effectively “die” from a lack of oxygen available for the flora and fauna, and the anoxic conditions result in an anaerobic environment replacing the existing aerobic one.

Other losses for the agricultural production system can be in the form of N₂O, which is a harmful greenhouse gas. Such losses of nitrogen to the atmosphere also represent a waste of available nutrient resources for plant growth in a production system. Added phosphorus, whilst less soluble than nitrate and therefore less susceptible to loss through leaching, can cause similar problems to N if lost into waterways. Phosphorus binds tightly to soil particles, and therefore can be carried into waterways with soil from erosion and run-off. Phosphorus is an essential nutrient for plant growth, and excess P in a production system can cause eutrophication and algal blooms.

In summary

Increased nutrient levels in the water result in a degraded water environment for organisms, due to:

- accelerated growth of algae
- compromised water clarity
- loss of habitats for organisms
- lowered O₂ levels in water
- pathogen contamination due to *E. coli* and other bacteria found in effluent
- streams, ponds, and rivers becoming shallower, due to increased sedimentation
- higher water temperatures.

Negative economic impact:

- Cost of fertilisers to the farmer, at around \$600/tonne.
- Cost of effluent treatment.
- The set-up costs of treatment and storage ponds, etc.

Social impact:

- Human health risks – pathogens in effluent make waterways unsafe for swimming.
- Eutrophication of waterways – growth of algae and side effects of eutrophication take away use of waterways from the public for activities like fishing and swimming.

PART B

Give an example of a management practice that could be used as an alternative to nitrogen inhibitors for the management of nutrients for a specific intensive agricultural or horticultural production system.

Example of an alternative technology

Variable rate irrigation(VRI) on a dairy farm

Explain how this technology can assist in the management of nutrients to minimise environmental impacts.

Explanation:

Variable rate irrigators are called this because they can vary the application rate of irrigation by using software embedded into the irrigation system. VRI allows farmers to apply exactly the right amount of water to specific areas under the irrigator. This is achieved by individually pulsing sprinklers on and off, while also controlling the system speed to modify the application depth along the length of the irrigator. Among the powerful properties of soil is the ability to filter effluent and extract the nutrients for the benefit of the pasture, micro-organisms, and soil animals.

Injecting effluent through spray irrigation systems allows for low rates to be applied with minimal manual input, making it a preferred method compared with other alternatives. Installing VRI technology onto a centre-pivot or lateral-move irrigator can transform that effluent dispersal system from sufficient to smart.

The difference VRI technology creates is the ability to vary application depths along the length of the irrigator to match the soil's ability to retain the nutrients from the effluent. A key principle is the application of effluent only to soils with sufficient water-holding capacity, at suitable application rates to allow infiltration. The precision VRI system controls every individual sprinkler along the length of the irrigator, so tracks, drains, and troughs can be avoided. Buffered avoidance zones, as required by many consents, can be placed around environmentally sensitive areas and waterways.

Smart effluent management with precision VRI can therefore lighten a farm's environmental footprint and improve the bottom line at the same time.

PART C

Discuss the strengths and weaknesses of using the technology described in Part B to address the environmental, social, and economic impacts of the nutrients used in this specific horticultural or agricultural production system.

Strengths and weaknesses of variable rate irrigation (VRI)/effluent application for a dairy farm:

Strengths

Precision VRI is greatly beneficial in the management of nutrients, because it can be adjusted to compensate for the following situations:

- Different crops, or non-crop areas, under the one irrigator.
- Varying soil types – rates can be adjusted to minimise the likelihood of nutrient-leaching.
- High run-off areas can be better managed.
- Low areas prone to getting wet and boggy, causing ponding, can receive less water.
- Environmentally sensitive areas can be managed more effectively, and rates can be altered, depending on season and land use.
- Tests have shown variable fertiliser rate applications using crop sensors reduced a traditional application of 70 kg/ha of urea to an average rate of 49 kg/ha across a paddock. This was because high nitrogen zones were measured and excluded, as were gateways and water trough areas. This saved \$19/ha in urea.
- Case studies indicate that not only does the system lower water use, it also reduces drainage and has the potential to reduce leaching from agricultural land. Variable rate irrigation can reduce a farm's water, nutrient, and carbon footprints.

In summary, increased pasture production, significant irrigation water savings, reduced energy requirements, and reductions in nutrient losses are all possible with a VRI system.

Weaknesses

Effective effluent application requires a knowledge of the volume and nutrient content of the effluent being distributed, the area necessary to handle the effluent effectively, and of soil properties and groundwater conditions. Solid particles within the effluent will need to be screened/filtered to prevent nozzle blockages on the irrigator.

Whilst farmers may have a good general feel for their land – knowing where the boggy corners and the dry slopes are, and recalling which parts hold on well in the summer, and which ground to skirt carefully in the winter to avoid getting stuck. However, to set up a VRI system you need more than anecdotes, holes, and watching for ponding – hard data is needed, and therefore additional costs would be incurred for data recording, using methods such as GPS mapping or electromagnetic mapping (EM). It costs \$50/ha to soil-survey a paddock with electromagnetic mapping, creating a detailed soil map, which is then used to drive information on the irrigator.

The ability to apply effluent across the land surface to promote pasture growth needs the right infrastructure. A VRI system is only effective on relatively flat land, and therefore has limitations on rolling or hill country. A VRI system is part of a centre pivot, which often requires a capital investment of several hundred thousand dollars to set up from scratch, and this may not be economically viable.

The other major limiting factor with a VRI system is water availability. Each district or zone has variable consented takes, and the water supply may not be altogether reliable, and/or the allocation amount may fall short of the farm's requirements.

Possible comparisons with other management practices

One important strategy for helping to manage the nitrogen problem is the way we look after riparian and wetland areas. Wetlands are really important parts of our landscape that act as filters for some of the run-off, particularly for filtering out nitrogen that is passing through wetlands. It is essential to protect the wetlands that we have remaining, and reinstate some that have been drained and are perhaps overgrazed, and to make sure that we don't allow stock to graze those riparian zones, as they will either cause treading damage or excrete urine or dung directly into the waterways.

Strengths and weaknesses of riparian management by tree-planting

Strengths

- Reduces both point source and non-point source contamination of streams from nutrients.
- Increases biodiversity by selecting native species.
- Shading of streams reduces the light and keeps water cool, and therefore helps slow down plant growth, thus preventing overgrowth.
- Roots act as a natural filter for contaminants before they reach the stream edge.
- Can prevent stock entering the water and causing point-source contamination, thereby improving animal health and water quality.
- Can prevent erosion of the stream banks, and therefore the amount of sediment that enters the stream; sediment can reduce clarity and increase nutrient concentrations and water temperature as stream becomes more shallow.
- Reduces the pathways for runoff, thus reducing P contamination.
- Now able to be tax-deductible, and therefore it becomes an operating expense rather than a capital expense.
- Can enhance the beauty of the area, and increase the value of the land and experience for other stakeholders.

Weaknesses

- Costly, and requires ongoing maintenance.

- Reduces the amount of land available for grazing.
- Does not have a significant effect on nitrification, therefore has limitations for tackling nitrogen-leaching problems in areas such as the Canterbury plains.

Possible other points of comparison

Reduce the usage of nitrogenous fertilisers in farming systems

If less fertiliser is applied, the level of nitrogenous compounds entering the land / water is reduced. This would reduce eutrophication in waterways and have positive benefits for plant and animal life.

Plant riparian margins alongside waterways

The plants intercept a proportion of the nutrients that are moving from the soil system to the waterway, via surface run-off or shallow groundwater. Animals are kept out of the streams, preventing direct contamination from urination and faeces. There are other benefits to water quality in addition to reducing nutrients, eg lower water temperatures and improved bank stability.

Select slow-release, organic, or RPR/PAPR fertilisers

Nutrients are released slowly and at a rate at which the plants are able to take up a much larger proportion. These are less soluble, and hence release their nutrients slowly over a longer period of time. As a result, the potential for leaching and loss of N-nutrients from the root zone of the plant is reduced. With fewer nutrients leaching beyond the root zone, waterways will have less eutrophication.

Cap stocking rates and /or restrict specific farming types in certain areas, to limit the potential production of effluent and its impacts

Strengths:

- Puts a limit on the numbers of animals / effluent-producing operations that are allowed in a particular area.
- Allows matching of an area's environment and its ability to handle intensive farming with the numbers of farms operating there.

Weaknesses:

- Huge economic impacts for both individual farmers and whole communities that are reliant on particular effluent-producing farming operations.
- Requires an organisation and people to enforce the restrictions – costs would be significant.

Examples of impacts that may be woven into discussion surrounding nutrient management

Negative environmental impacts

- Increased level of nutrients (especially phosphates and nitrates) in surface water. This causes an increase in the growth of nuisance weed and algae growth, affects stream life, and decreases water clarity.
- Smell of effluent when collected / dispersed onto land.
- Emission of nitrous oxide (N₂O) gas from soils that have high nitrate levels.

Economic impacts

Negative:

- Dairy effluent systems cost upwards of \$20,000 to install, and require annual maintenance costing between \$2,000–\$5,000.
- Non-compliance costs / fines can be imposed by regional councils, and can be as high as \$50,000 or more.

Positive:

- The spreading of waste effluent back onto land / pasture recycles significant quantities of nutrient back into the soil. Savings in fertiliser costs are in the region of \$100–\$300 / ha / yr.

Social impacts of an effluent system for nutrient dispersal

- Smell of effluent when collected / dispersed onto land.
- Once contaminated, water resources may take years to clean up – this limits land use options, and potentially the ability to carry out certain farming operations on areas supplied by the contaminated water.
- Other downstream users may be affected by nutrient and coliform contamination occurring upstream, eg a mussel farmer may not be able to export shellfish because bacterial/algae levels in the growing water have become excessive, due to the activities of farmers upstream.
- The use of surface water (streams and lakes) for recreational purposes (swimming, fishing, etc) is adversely affected, if it becomes excessively contaminated and high in nitrates and bacterial pathogens like *E. coli*.
- Human health risk from water with high levels of nutrients (nitrogen) and pathogenic bacteria.