



National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard Agricultural and Horticultural Science Level 2

This exemplar supports assessment against:

Achievement Standard 91298

**Report on the environmental impact of the production of a locally
produced primary product**

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	<p>For Excellence, the student needs to report comprehensively on the environmental impact of the production of a locally produced primary product.</p> <p>This involves a concise, coherent and accurate evaluation of the overall impact of the production of a locally produced primary product on the environment. The overall impact includes the balance between positive and negative impacts.</p> <p>The student provides a balanced concise report of both the positive (1) and negative effects of dairy production that impact (2) on water, land, organisms and air resources.</p> <p>For a more secure Excellence, the student could provide a greater emphasis on the positive impact of dairy production. There is minimal discussion of positive impacts such as providing organic matter for soil organism activity (1).</p>

Student 1: Effects of water quality on users.

People need water to survive. Approximately 50% of New Zealand's population relies on ground water as a source of drinking water. Therefore the concern for water quality affects every single one of us. Water has many uses to human activities; personal consumption, production of produce, industrial use, hygiene, spiritual use and not to mention recreational use particularly in the summer. However, pollution and degradation of water quality is affecting users and its use. **Polluted water poses many health risks and any exposure to this can result in sickness / ill health. Polluted water by effluent whether human or animal (dairy cows) results in the release and multiplying of bacteria** (2). Bacteria such as E. coli are detrimental to people's health and can hospitalise people. If the water is polluted by this bacteria would you be happy to catch and eat fish in this environment. **Also with the high concentrations of nitrogen from effluent or fertiliser application health concerns for people, animals and aquatic life are at risk** (2). **Cows return a lot of organic matter through effluent which encourage worms and dairy pastures are long lasting, frequently limed which in term assists useful soil bacteria** (1). However, too much effluent, can prevent recreational activities from happening. **The resulting explosion from Eutrophication** (2) is disrupting recreational activities such as water skiing, fishing, and general summer swimming. Property owners, recreational and other users of the Rotorua Lakes are to be affected by the use of the herbicide diquat which will be used to control lake weed. Users are not to take drinking or irrigation water from the lakes until 24 hours after treatment⁸. The weeds make water activities difficult and often requires the cleaning of all gear in contact with the water to avoid the passing onto other lakes. Also swimmers come out of algae infested lakes smelling and requiring showers. The high levels of nitrogen is health risks to other users. Nine cattle died after drinking water from Lake Rotongaro. Also the health risks are similar to humans. Blue baby syndrome occurs to high N levels in drinking water. Levels exceeding 11.3mg/l is considered too high in NZ and poses serious risks to babies in the womb and infants under 6 months of age. Blue baby syndrome causes the infants to appear blue around the mouth and extremities and can result in difficulty breathing and possible death.

Conclusion: The primary production sector contributes significantly to New Zealand's economy. Over 40% of New Zealand's overseas income is sourced from agricultural and horticultural products (excludes forestry)¹. New Zealand has created a "100% Pure" image overseas, which is relied on hugely by exporters to sell their products; and it is working. But when we face the facts our waterways are far from clean. 57% of our waterways are considered clean enough to swim in for most of the year⁶. This is a worrying concern for the public and a lot off their blame is put on farmers in particular "dirty dairying". This is because of their extensive nitrogen use and effluent disposal. For NZ to tidy up its act and truly have a 100% pure image the waterways need to be cleaned up. Local councils and industries are setting standards for management practices to limit the loss of nitrogen into waterways and therefore revert the waterways back to their natural healthy state and be home to many native species and enjoyable and safe environments for people to interact in.

	Grade Boundary: High Merit
2.	<p>For Merit, the student needs to report effectively on the environmental impact of the production of a locally produced primary product.</p> <p>This involves a considered explanation of how production of a locally produced primary product impacts on the environment. A considered explanation includes pertinent information extracted from the data about impact.</p> <p>Throughout the report, the student has considered explanations of the dairy production practices of using nitrogenous fertilisers and the spreading of effluent, and the impacts they have on the water (1) and air components (2) of the environment. These impacts have been backed up by the use of pertinent information extracted from the data (3).</p> <p>To reach Excellence, the student could write a comprehensive evaluation involving both the positive and negative impacts of dairy production on the local environment.</p>

Student 2: Introduction.

The primary production sector contributes significantly to New Zealand's economy. Over 40% of New Zealand's overseas income is sourced from agricultural and horticultural products (excludes forestry)¹. However with significant reliance on production from the land impacts are often felt on the local environment. This includes features such as land / soil, water and air. Effects on the quality of these also have an effect on the co-existing living organisms (plants and animals).

Water is being affected largely in New Zealand. Water quality has been decreasing considerably in many areas where intensive farming such as dairying, is being carried out in the catchment zones. Nitrogenous fertiliser applications and dairy effluent is having the greatest effect on water quality; often leading to eutrophication. This affects the waterways relating ecosystems and recreational users, thus labelling it "dirty dairying". However, this name is unfavourable when the dairy industry attempts to sell its product abroad and locally, therefore management practices must be adopted to correct this perception.

Background to the environmental issues and causes of eutrophication.

Nitrogen from high nitrogenous fertilisers and dairy effluent is having damaging effect on the environment. The atmosphere and waterways are being devastated by the escaping nitrates (NO_3^-) and nitrous oxide. The atmosphere is being filled with three main gases; CO_2 , methane and nitrogen. This is accelerating the greenhouse gas effect due to higher concentrations. Human activity is the result of this increase, including intensive agriculture; i.e. dairying farming. Global warming is the result of the greenhouse gas effect however this is having a detrimental effect on ecosystems worldwide. Therefore it is important to reduce nitrate emissions from agricultural practices.

Nitrates escape into the atmosphere during fertiliser and dairy effluent application. This is due to volatilisation, where ammonium nitrogen NH_4^+ is converted by bacteria into nitrates NH_3^- which the soil can't absorb² (2). It is necessary for the nitrogen application to be quickly absorbed by the soil or plant to avoid this from happening.

Waterway contamination is also another significantly damaged environment by nitrogen. This may be either groundwater or surface water pollution. The nitrogen accesses these channels through leaching (diffuse) or run off (land overflow). Leaching occurs when soil moisture levels are at saturation and evidently can't absorb anymore nutrients causing the N to percolate past the root zone and into the water table (1). Also timing of application and application rates has a significant affect. It should only be applied as plants require it and the soil can absorb it. Large application rates over 50kg/N/ha causes wastage and the excess N makes its way into waterways³ (3). Application prior to heavy rainfall is a waste of the farmer's time and money along with causing damage to the environment, as N often flows off the paddocks and into open waterways. "Keep the nutrients in/on the land and not the water and no one losses"². When high concentrations of nutrients reach open waterways (streams, rivers and lakes) eutrophication occurs. This is where high nutrient levels of the water is accessed by aquatic plants and algae which causes them to grow and multiply in to unsustainable levels, to the extent where they deplete the water of oxygen. The lack of oxygen has a devastating effect on all other marine life in the water bodies (1).

	Grade Boundary: Low Merit
3.	<p>For Merit, the student needs to report effectively on the environmental impact of the production of a locally produced primary product.</p> <p>This involves a considered explanation of how production of a locally produced primary product impacts on the environment. A considered explanation includes pertinent information extracted from the data about impact.</p> <p>The student explains how the use of nitrogenous fertilisers and effluent from dairy production contributes to the degradation of soil, air and water (1). The use of pertinent information has helped to provide more depth to the explanation (2).</p> <p>For a more secure Merit, the student could provide a more detailed explanation of how dairy production impacts on the current or long term effects on the environment, and to be reinforced with further pertinent information.</p>

Student 3:

Eutrophication is caused by excessive levels of nitrogen in the water ways which causes plant life (mainly algae) to grow at a very fast rate which is why it is called an "algae bloom". This bloom can spread through the water way very quickly and in small streams it can even slow or stop the natural flow. The algae need oxygen to survive and because there are excessive amounts of algae there is often very little oxygen for left for natural plants, weeds and organisms to live so they die from insufficient oxygen levels (1).

Because of the algae bloom many recreational uses of the river can no longer take place as fish numbers are very low and quite often the water is too polluted to swim safely (Waikato and Manawatu rivers). The eutrophication often causes the river to become a dirty brown or red colour and in some cases where the river levels are low the algae dries out in the sun and starts to rot attracting sand flies and mosquitoes and a bad smell, these often stop people from using the river for recreation.

The main cause of eutrophication is nitrogen is nitrogen in the nitrate form, leeching or running off into a water source. There are two ways nitrogen can enter a waterway from a dairy farm, point and non-point sources.

Point source is where you can actually identify where the nitrogen is entering the water. It could be a runoff pipe from a feed pad, the stock actually defecating into the water or another way but is less common is when effluent is applied to the pasture in excessive levels and then you get heavy rain that washes a lot of the effluent directly into the water.

Non-point sources is things such as nutrient leeching. Nutrient leeching can happen for a number of reasons, it can be when nitrogen (urea) is applied and shortly after you get heavy rain that washes the nitrogen past the root zone of the plant and down into the underground water ways. It can also be when you apply effluent to soil that is already saturated (can't hold any more water) and the nutrients from the effluent is washed down past the root zone and into the underground water ways. Nitrogen leeching is more common in soils with larger pores (sandy soils, gravel and pumice) and can occur very rapidly.

Some new technologies that have been incorporated into pond systems are high tech effluent separators. This machine separates the hard, fibrous effluent from the liquid effluent. All of the effluent goes into a holding pond where it stays until it is pumped into the separator. In the holding pond the effluent gets mixed up so it doesn't separate. Once pumped in to the separator the effluent is separated. The liquid effluent (smaller than 0.5mm) is pumped into a storage pond or oxidation pond. The hard waste is pushed out of machine and is piled up soil can be out back onto the farm as organic matter. Putting this waste back on to the farm is not a bad practice as it only has between 10 – 15% nitrogen compared with oxidised effluent and urea, which are both between 40 and 50%² (2). These systems are very effective as they take out the use of a setting pond and reduce waste of useable effluent and organic matter but are very expensive to purchase which is why they are not that common⁵.

	Grade Boundary: High Achieved
4.	<p>For Achieved, the student needs to report on the environmental impact of the production of a locally produced primary product.</p> <p>This involves explaining how production of a locally produced primary product impacts on the environment.</p> <p>The student explains how nutrients from both fertilisers and effluent when applied to the land during dairy production impacts on water quality (1). Reference is made to bacterial contamination (2) and also to eutrophication (3).</p> <p>To reach Merit, the student could include a considered explanation utilising pertinent information extracted from the data about the impacts of fertilisers and effluent in dairy production.</p>

Student 4: Background to the Environmental Issue

There is no doubt that dairying has a detrimental effect on the quality of the environment within the last couple of decades. A characteristic to prove this is that dairy farming is a high intensive farming system. What does this mean? This means that dairying is a large consumer of natural resources and is a generator of large amounts of pollutants and waste.

Another characteristic is that it is a pasture based system and what this means is that dairy farmers have to work within the constraints and variability of landscape and climate. The third characteristic is the constraints. For example, Southland soils are susceptible to pugging and water logging. Draining systems are put into place to reduce water logging which can result in contaminants being rapidly transported from paddock to stream. The waterways criss-cross the agricultural landscape which are highly sensitive to contaminants. The rain and low evapotranspiration that makes drought aids the runoff and leaching of contaminants into the surface and ground waters, and makes some farm practices such as effluent disposal difficult.

Another environmental issue is leaching which means the loss of water soluble plant nutrients from the soil, due to rain and irrigation. Leaching is an environmental concern when it contributes to ground water contamination. The water from the rain, flooding and other sources seep into the soil and it can dissolve chemicals and carry them into the underground water supply.

Effects on the waterways.

Dairy effluent and nitrogen from fertiliser both have an effect on our New Zealand waterways. Dairy effluent can have a significant adverse effect from the discharge of ammonia from dairy effluent. It causes toxicity to the small inland waterways. Nitrogen from fertiliser can enter waterways relatively quickly if it is carried across the land surface by rainfall runoff (1). The discharge of nitrogen has an eutrophication effect through the growth of nuisance plants and algae (3) as explained in previous question.

Sedimentation also has an effect on waterways. Sedimentation in basic words means soil erosion which is caused by slips, pugging and green feed crops. Sedimentation from dairy farming can harm aquatic ecosystems by reducing light penetration and visual clarity. The effects from reduced light and visual clarity are that there is reduced vision for aquatic animals like fish and semi-aquatic birds and reduced plants photosynthesis and growth. Other effects of sedimentation include the degradation of substrates for bottom dwelling organisms, clogging of fish spawning gravels, smothering of estuarine animals and the infilling of lakes and reservoirs.

Another contaminant that has a negative effect to New Zealand waterways is faecal contamination. Faecal contamination has effects on humans and animals because they have the chance of catching a waterborne illness. There are a number of sources of how the waterways get polluted. These sources consists of direct deposition of faecal matter in waterways by livestock and the discharge of effluent to land soil and soil water which could flow to surface waters (2). Nitrogen, dairy effluent, faecal contamination which contains effluent and sedimentation are all negative factors to our waterways.

	Grade Boundary: Low Achieved
5.	<p>For Achieved, the student needs to report on the environmental impact of the production of a locally produced primary product.</p> <p>This involves explaining how production of a locally produced primary product impacts on the environment.</p> <p>The student explains the impact caused to soil from compaction (1), and the impact on water from excess nutrients from the management practices of effluent disposal and the application of nitrogenous based fertilisers utilised (2) in dairying production.</p> <p>For a more secure Achieved, the student could provide more links between eutrophication and the management practices of effluent disposal and the application of nitrogenous based fertilisers, and links between soil compaction and dairy farming management practices.</p>

Student 5:

Land / Soil.

The land / soil is being changed by dairy farming. The way dairy farming is doing this is by the cows. Cows are very heavy animals and they cause compaction of the soil, pugging and erosion (1). Pugging is not good for grass growth, as water will sit in the hoof prints and stop growth or / and slow it down. Compaction will not allowed air to get into the soil, therefore soil will become water logged very quickly (1). Cows will rub their heads / necks and scarp their hoofs at / on lose soil or potholes on sides of hills. This will lead to erosion and make grass growth minimal in that area.

Dairy farming is causing the modification of land / soil. The soil will have less air in it which is essential for growth in plant material. Its taking air out and anthing is helping it back into the soil. Pugging is something the farmer can't do much about. Cows will always leave hoof prints. What a farmer could do is put cows in dry paddocks when its wet and leave the wet ones till it dries out, this will minimise the negative environment impact.

Eutrophication.

The main causes of eutrophication are; the natural runoff of nutrients from soil and erosion, runoff of inorganic fertiliser containing nitrogen and phosphates and the run off of effluent manure from farms (2). Eutrophication is a natural process which occurs in lakes and estuaries. Although eutrophication is a natural process humans have been speeding up this process and one of the reasons why is that the boom in the agriculture industry is adding excessive amounts of plant nutrients such as nitrogen and carbon to the waterways. The natural process is when algae covers the surface which clocks the sunlight from getting to the lower parts of the water affecting submerged flora and damages the oxygen levels in water, with damaged oxygen levels all the organisms including fish are killed off only leaving the algae.

	Grade Boundary: High Not Achieved
6.	<p>For Achieved, the student needs to report on the environmental impact of the production of a locally produced primary product.</p> <p>This involves explaining how production of a locally produced primary product impacts on the environment.</p> <p>The student explains superficially how water quality is affected by effluent and fertilisers (1) used in dairy production.</p> <p>To reach Achieved, the student could expand on the concepts linking effluent and fertiliser in dairy production to the impact on water quality.</p>

Student 6: The Environmental Impact of Dairy Farming.

Water.

The number one problem that affects New Zealand's waterways is dairy farm effluent. Most dairy farms in New Zealand don't have an effective effluent disposal system, so the effluent that is being released into waterways isn't fully treated. This causes a deterioration in drinking quality especially in slow flowing rivers and streams as the effluent is aerated like it is in fast flowing water which breaks it down. Because of the effluent in the rivers and streams drinking water has to be treated to account for effluent.

Another major concern to New Zealand's water quality is fertilisers leeching into waterways. Because dairy farming is intensive the farmer must use fertilisers to boost crop yields to get better production. Excess fertiliser can leech through soils and into waterways causing and increase in nitrates in the water, this increased the amount of aquatic plant life (weeds) which over time decrease the oxygen levels (1).