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New Zealand, Agricultural Pollution

The Dangers of Unmitigated Agricultural Pollution in New Zealand

Over 80% of marine pollution comes from land runoff, much of which comes from agricultural areas (NRDC). Pollution from agricultural runoff is the leading cause of water quality degradation in lakes and streams (NRDC). Agricultural pollution is a huge problem facing countries all over the world. Nitrogen and phosphorus from farm soil, along with chemicals from pesticides, get into waterways and wildlife through runoff from farms, leading to the destruction of wildlife and the death of plants and animals (NRDC). One of the countries with a large agricultural pollution problem is New Zealand (Stuff NZ). Runoff from New Zealand farms is actively degrading the water quality of water bodies and river systems all throughout the country.

New Zealand is a developed country consisting of 600 islands off the southeastern coast of Australia (Air New Zealand). It has a mild, subtropical climate (Country Reports). Agriculture is the nation's largest industry, generating 5.65% of the nation's GDP (Statistica). Its total population consists of over 5 million people (Data Commons), and in 2021, over 118 thousand people worked in the agricultural sector (Figure.nz). The median hourly income of citizens of New Zealand is 18.35 USD (New Zealand Shores). The country's major exports are beef and sheep meat, wool, fruit, vegetables, and wine (Privacy Shield).

The average farm size in New Zealand is about 200 hectares (AHDB). Around 40% of the land in New Zealand is exotic grassland, land covered with grasses that are not native to the country (Ministry for the Environment). This land is used for the dairy, sheep, and beef industries (Ministry for the Environment). About 8% of the land in New Zealand is exotic forest, land covered in non-native forestry, and is used for the forestry industry (Ministry for the Environment). Non-native species have been introduced to nearly half of the land in New Zealand, leading to a decrease in the biodiversity of the native species of the country in the past decades (Ministry for the Environment).

A family in New Zealand contains an average of 2.7 people (Stats NZ). The typical family dwelling is a single-family house (Te Ara). Since agriculture is the largest industry in New Zealand, most residents work in the agricultural sector, however, the next most common labor areas are construction and tourism (NZ Pocket Guide). One hundred percent of people in New Zealand have access to clean water, electricity, and roads, and nearly all families live near a grocery store with fresh food available daily (New Zealand Clean Water Access 2000-2022). While proximity to a grocery store is not a barrier to proper nutrition, the high cost of living and the abundance of processed food force some families to sacrifice the health of their food to feed themselves (New Zealand Clean Water Access 2000-2022).

Much of the traditional cuisine in New Zealand is influenced by the Maori people, one of the groups native to the Islands. In New Zealand, the typical diet consists of seafood, especially fish, lamb, venison, and pork. Along with these proteins, New Zealand sweet potatoes and kiwis are typically used in many dishes (100% Pure New Zealand). Most families get their food from a local grocery store, and prepare it in an electric or gas oven or stove (Will Fly For Food). However, a cooking technique used by the Maori for over 2,000 years, called the hāngī, translating to “earth oven”, is also used to cook traditional Maori dishes (Te Ara). This technique steams food in a hole in the ground using hot stones (Te Ara).

In the past, New Zealand has invested in renewable energy, and currently 84% percent of its energy is renewable (Invest New Zealand). However, the country still faces many environmental problems, most notably: waterway and wildlife damage from the agricultural sector. Ninety-five to ninety-nine percent of the rivers in pastoral, urban, and non-native forested areas are contaminated with agricultural pollution, and nearly 60% of rivers in the country have nitrate levels above 11.3 mg/L of nitrate nitrogen (National Library of Medicine). The safe drinking water limit, determined by the World Health Organization, is 11.3 mg/L of nitrate nitrogen (National Library of Medicine). However, even nitrate levels only at 10 mg/L can cause adverse health effects, including methemoglobinemia (MN Department of Health). Runoff from dairy farms and crop farms is the main contributor to New Zealand’s pollution problem. Excess water from farms carries nutrients from fertilizer, lost sediment from the land, and cattle waste into nearby waterways, adding more nitrates into the water (US EPA Web Archive). This damages the health of the freshwater systems in New Zealand, as an abundance of nitrates in waterways can cause eutrophication. Nitrates stimulate the growth of algae, causing dissolved oxygen levels to drop, preventing oxygen-reliant aquatic wildlife from surviving, and ultimately reducing biodiversity (US EPA Web Archive). Since high concentrations of nitrates can be hazardous to human health, these nitrates make drinking water toxic and contaminate the water supply (MN Department of Health).

An area heavily affected by runoff from agriculture is the Selwyn River basin, part of which is located in the Canterbury Plains, an area with many dairy farms. This river experiences regular algal blooms, which occur due to an excess of nitrates in the water from farm runoff. This has reduced the available drinking water in this area. Upstream to the Canterbury Plains, the pollution has made the river toxic to humans, making an area that used to be used for recreational swimming now hazardous to humans. The river feeds into Lake Ellesmere, one of the most polluted lakes in New Zealand due to the algae dispensing into it by the Selwyn River. The pollution has led to the death of wildlife that depend on these bodies of water, and a reduction in the available water supply. (ABC News)

Not only is this problem an environmental one, but it is also an economic one. Currently, the national goal for the maximum concentration of nitrate nitrogen in rivers is 2.4 mg/L, which is lower than the WHO’s safe drinking water limit. Many dairy farmers, however, feel that they cannot reduce their nitration pollution to meet this limit, and will be forced out of business if the limit is not raised. Only 1 mg/L of nitrate nitrogen is needed to trigger eutrophication in waterways, so even at current limits, negative effects on wildlife will likely still occur. Dairy farmers, however, will not be able to sustain their businesses if the levels are not raised even further. The dairy industry is a key part of the agricultural sector in New Zealand. If the industry shrinks dramatically, many citizens working for the dairy industry would lose their jobs, and small dairy farm communities would be destroyed. The number of dairy products available would also likely decrease, leading the available food supply for the people of New Zealand to shrink. Pollution in the rivers also affects tourism, another major New Zealand industry. Rivers and other bodies of water that used to be used for swimming, and other recreational activities are no longer safe for humans to be in, leading the available jobs and profit from tourism and recreational water activities to decrease. (ABC News)

There are, however, many possible solutions to the water pollution crisis in New Zealand. For plant farms, the primary way to reduce nitrate pollution is to limit the application of nitrate-based fertilizers. These fertilizers are often used as nitrates stimulate the growth of plants (Grapefrute). However, too many nitrates can cause the overgrowth of crops, or be toxic to certain plants and wildlife, causing crops and wildlife to die (Grapefrute). Instead of using nitrate fertilizers, farmers can use urea or ammonium-based fertilizers (Grapefrute). This solution would limit nitrate fertilizer use, but not eliminate it. While these fertilizers work well for many plants, like peas, strawberries, and corn, other plants, like eggplant, pepper, and tomato, do not react well to them (Pro Mix). To solve this problem, current research is looking at how to insert the genes from pea plants into plants that do not work as well with the urea and ammonium fertilizers, in an effort to get those other plants to accept the non-nitrate fertilizers (Pro Mix). These genetically altered plants could then be used in the future to further limit the use of nitrate fertilizers. This would allow the food supply and types of crops grown in New Zealand to remain the same while making farming more environmentally friendly.

Precision irrigation is another alternative to the overuse of fertilizers. This type of irrigation uses irrigation sensors which allow farmers to give their plants the exact quantities of water and fertilizer the farmers need to support the development of crops. The most precise and efficient type of irrigation is drip irrigation, which uses long tubes that run along the rows of crops, just over or just below the surface of the soil. These pipes dispense water directly onto the stem and roots of the plants. This type of irrigation allows for maximum water absorption by the roots and produces the least amount of runoff from the crop field. Drip irrigation is, however, the most expensive and labor-intensive type of irrigation, so it is primarily a solution for smaller farms. Precision spray irrigation is another type of precision irrigation that can be used on larger farms. It uses spray nozzles that come up from the ground, rather than traditional spray irrigation that sprays water above the plants, which allows the water to be sprayed closer to the plant's roots. This reduces the water that gets trapped on top of, and ultimately evaporates off of, plant leaves. This also reduces runoff as regular spray irrigation would require more water, as more water is wasted through evaporation, leading to more runoff into a nearby waterway. (Smart Watering)

Although precision irrigation reduces runoff, and would therefore reduce nitrate pollution from agricultural land, precision irrigation might not be economically feasible for all farmers due to its expense. For example, drip irrigation costs 2.50 to 4.50 USD per square foot (Little John’s Lawns). If a farmer had to purchase this with their own money, the prices of their produce would likely rise as production costs would rise. The average family of four in New Zealand already spends around 400 USD per week on groceries, so an increase in product price would likely decrease the ability of families to afford food (Simple New Zealand). This solution could still work, however, it would likely affect New Zealander’s food consumption patterns by decreasing food purchased and consumed.

Another alternative to nitrate fertilizers is nitrification inhibitors. These are chemical compounds that slow down nitrification, the process by which reduced nitrogen compounds are oxidized into nitrate and nitrite by microorganisms. These can be added to fertilizer or added directly to the soil of the farmland, and they decrease the overall amount of nitrates in the soil, crops, and farm runoff. (Frontiers In)

A solution to nitrate runoff for both plant farms and dairy farms is vegetation filter buffers. These would be utilized for farms that are located along a stream, river, lake, or ocean. A filter buffer, or filter strip, is an area of vegetation bordering the edge of a farm and the edge of a waterway. It catches contaminants from runoff before they get into the water. These plants slow the movement of water from the fields into the waterways, letting silt, sand, and other sediments drop out of the water. As the water flow decreases, more runoff penetrates the soil, leading the number of dissolved nutrients in the soil to increase, and keeping dissolved nitrates out of the rivers. Farmers can plant nitrate-absorbing plants, like plants in the legume family, together with the traditional buffer vegetation. These plants would absorb the nitrates deposited in the soil from the runoff slowed by the buffer. Sediment removal from vegetation filter buffers exceeds 50%, and these buffers can remove up to 90% of nitrates in farm runoff. These buffers also improve the stability of streambanks. Soil that falls into waterways can increase dissolved nitrate levels in the water, so increased stability of stream banks would decrease the likelihood of soil eroding and polluting the water. (AGBMP)

To reduce nitrate pollution from specifically cattle and dairy farms, runoff control is another solution. Runoff control involves collecting farm runoff, mainly composed of cattle manure, in a storage lagoon on the edge of the farm away from a water source. These lagoons keep the manure and runoff out of nearby waterways, which therefore keeps excess nitrates out of the water (Extension — University of Missouri). These storage lagoons can then be paired with ion exchange technology to take the nitrates out of the manure. The manure can then be used to fertilize the soil without adding more nitrates. Ion exchange is done by running the water through a tank with resin beads attached to chlorine ions. The beads then replace the nitrate ions in the water with harmless chloride ions (Wastewater Digest). This technology would minimize the number of nitrates left in the manure and runoff, and ensure that even if there is a leak in the storage space, nitrates would not get into nearby rivers.

Another way ion exchange can be used is for it to be paired with controlled drainage. This combination applies to plant farms; controlled drainage uses pipes that run under the fertile soil of a farm and right above the water table. These pipes catch water absorbed by the soil that was not absorbed by the roots of the crops (Transforming Drainage). These pipes then lead the water to a central control structure where it can be purified and then disposed of into a nearby waterway (Transforming Drainage). Controlled drainage keeps runoff from seeping into nearby rivers, instead allowing farmers to collect and clean water before it travels into nearby waterways. Ion exchange technology can also be used in the control structure to remove any nitrates in the runoff, preventing nitrates from entering the river.

Sadly, all of these solutions would have a financial burden. On average, vegetation filter buffers cost 233 USD per acre (AGBMP). The average cost of storing manure and applying it as fertilizer is about 306.13 USD per cow (AG Proud). This doesn't include ion exchange technology, which would likely increase the cost greatly. There is no concrete estimate for ion exchange yet, as this technology has not been widely used for large farms. Ion exchange would also include the cost of replacing the resin beads after they have used all of their chlorine ions. The installation of the pipes for controlled drainage costs about 1,000 - 10,000 USD per 100 linear feet, which does not include the final storage unit, and general operation costs (Angi). New Zealand farmers currently receive no subsidies for farming, so in order to promote the adoption of these nitrate-pollution prevention strategies, the New Zealand government could offer subsidies to farmers to pay for the technology (Australian Economic Center). These subsidies would incentivize the use of nitrate pollution prevention technology, and allow farmers to afford its installation. Brazil, another country where agriculture represents a large portion of its GDP, spends around 700 million USD annually on agricultural subsidies (Reuters). Scaling to the different countries' GDP, a recommended amount of money for New Zealand to spend on agricultural subsidies would be around 108.7 million USD annually (The World Bank). This is not an exact recommendation, as Brazil and New Zealand produce different crops in different areas of the world, however, this is a ballpark estimate of how much money New Zealand could dedicate to government subsidies.

The money for subsidies could come from either federal money allocated towards decreasing agricultural pollution, or from an increase in sales tax on dairy products and produce. In 2021, the New Zealand government allotted 50 million USD towards decreasing emissions from the agriculture sector (NZ Herald). This includes 37 million USD towards "integrated farm planning systems for farmers and growers" (NZ Herald). This money could be turned into subsidies given to farmers who adopt nitrate-pollution prevention strategies and could fund general funds and grants to give to farmers in order to support the implementation of these technologies. Another way to increase the amount of money available for subsidies would be to increase the sales tax on dairy, fruits, and vegetables. New Zealand currently has a sales tax rate of 15%, and by raising it by even a fraction of a percent, New Zealand could create funds for limiting nitrate pollution (Trading Economics). This, however, would increase the price of groceries, which would negatively affect New Zealand consumers and families, leading to a reduced ability of New Zealand citizens to afford food. Due to this negative economic effect, this strategy should likely be used after the allocated 37 million USD is used.

In conclusion, water pollution from nitrate runoff is a problem for New Zealand that could potentially affect the availability of food, safe drinking water, and recreational swimming areas for years to come. In order to protect wildlife, and the well-being of its citizens, New Zealand needs to prioritize the protection of its waterways, by incentivizing the implementation of technologies that minimize and eliminate nitrate in farm runoff and manure storage areas. Minimizing nitrogen entering the waterways will lead to a preserved environment that will keep New Zealand beautiful for many years to come.

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