Otago Regional Council

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MEMORANDUM

To: **Dolina Lee**

From: **Mark Crawford**

Date: **1/11/2023**

Re: **Silage Impacts to the Environment**

Name	Role	Date Completed
Jason Augspurger	Reviewer 1	15/11/2023

Purpose

Policy has requested a commentary noting that the key issue for the environment from the ensiling process is the impact from silage leachate.

Data and Methods

A review of science papers was completed, with a google search based on silage effluent management and silage leachate was made plus a review of Grasslands Journals.

Discussion

Silage in NZ Farming systems

Ensiling pasture has overtaken hay as the conserved pasture feed for farm systems in New Zealand. This is due to the reduced time taken to conserve the pasture (reducing the dependency on weather) plus it can be cut at an earlier stage of maturity and thus is of higher feed quality than hay (deRuiter, Dalley, Hughes, & al, 2017).

The objective of silage production is to ferment the crop to lower the pH to inhibit putrefying bacteria, thus preserving the protein content of the fodder. Nutritionists recognised that ensiling at optimum moisture content is important to maximize digestibility and avoid losses from poor fermentation. Ensuring optimal dry matter content, rapid wilting, proper compaction, and effective sealing can help retain the nutrients and feeding value of the silage. It's essential to feed out silage quickly once exposed to air to prevent spoilage[1]. In addition to the negative effects that ensiling high moisture crops has on silage quality such as clostridia fermentation, there are increased risks of effluent (Gebrehanna & al, 2014)

Environmental Impacts of Silage

The potential environmental risks associated with silage leachate/effluent are the contamination of surface and groundwater, particularly during spring summer and early autumn when the production of silage is greatest. At these times river and streams can experience low flows and higher water temperatures making them more vulnerable. Silage effluent production occurs soon after the silage has been cut, peaking at 10 days post ensiling. Ninety percent of the total effluent produced is done so by day 20-26 (Gebrehanna & al, 2014) This then can lead to pulses of silage effluent contaminating the water ways.

The key reasons why silage leachate is so damaging to the environment is due to the;

1. Oxygen demand: Average biological oxygen demand (BOD) and chemical oxygen demand (COD) of several surveyed studies exceeded 49,000 mg owing to its high concentrations of soluble organics. These can rapidly decrease dissolved oxygen demands (DO) concentrations and it has been quoted that 1 L of silage effluent can deplete the DO in 10,000L of water below levels critical for fish survival. (Gebrehanna & al, 2014).
2. Nutrients: Nitrogen and phosphorus concentrations in silage effluent are typically high. If discharged into surface waters silage effluent increases risk of eutrophication, while there are also risks to groundwater due to high nitrate concentrations in some cases.
3. The high concentrations of lactic acid and other VFAs in silage effluent confers a low pH, ranging from 3.5 to 5. This can alter soil binding sites and could thus promote the leaching of metals bound in the soil matrix. This is especially a concern in areas with shallow groundwater or tiled drain systems (Gebrehanna & al, 2014). There are also P leaching risks. The pure organic acids that are typically found in silage effluent have been found to solubilize different rock phosphates (RP) at rates of 710 to 3900 mg P/kg RP depending on the acid:RP ratios (Choudhray & al, 1995).Given the relatively high variability in silage quality, it is prudent to have proactive measures in place to handle effluent if it is produced. This includes having an appropriate storage facility and a plan for safe disposal.

Silage storage

Collection systems should intercept effluent before it can reach a soil or water system -ideally at the source. Effluent storage systems should not be located near surface water systems or wells.

[1] https://www.dairynz.co.nz/feed/supplements/grass-silage/

DairyNZ have the following guidelines relating to the environment and storage.

- At least 45 metres from any farm dairy
- At least 50 metres from waterways, open drains or dams, and the catchment areas of bores; further away if the land is steep, soils are coarse textured, or ground water may enter sensitive waterways.
- Away from gullies or other places where run-off catchment water can flow into the storage area not prone to flooding or that has a high water table away from any subsurface drains.
- Silage leachate should never enter waterways as it is highly toxic to aquatic life.
- The walls and floor of a silage bunker must be capable of withstanding the hard knocks of tractors and other machinery as well as resisting corrosion from leachate.
- The silage bunker floor should be watertight and extend out beyond the bunker walls.
- Properly covering stacks to keep the oxygen out and prevent rainwater entering is crucial to reduce the volume of leachate.

Environment Southland note the following in controlling leachate;

1. Choosing a low-risk site and designing the silage stack carefully to reduce leachate production or runoff risks. Ensure the chosen site for the stack is well back from any waterways, drains or tiles, and avoid wet or gravel areas. Keep in mind property boundaries, neighbours, water abstraction points and critical source areas. Design your stack to sit on an impermeable base to prevent loss to groundwater. Divert rainwater away from the stack and collect leachate to spread onto pasture when grass growth resumes.
2. Work with contractors and plan ahead with weather forecasts to ensure pasture is appropriately wilted to 25- 32% dry matter. Rapid wilting also reduces the quantity of sugars lost, leading to higher quality silage.
3. Collecting any leachate that is produced and adding this to an existing effluent management system. Note that leachate must be diluted with water or liquid effluent before applying to pasture.

Recommendation

The key impact for silage making on the environment is the containment of the silage leachate/effluent. Therefore, safe containment and disposal of leachate/effluent is a high risk activity requiring additional consideration under the Land and Water Regional Plan.

Permitted activity conditions around appropriate site selection, distance from water bodies, impermeable base, plus adequate storage for the leachate is advised. The Farm Environmental plan would be required to deal with the good management practices involved in both the process of silage making and the silage leachate/effluent disposal.

References

Choudhray, M., & al, e. (1995). Dissolution of Rock Phosphate in silage leachate. *Communications in Soil Science and Plant Analysis*, 1095-1104.

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