Environmentally Friendly Silage Management

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Overview

Main sources/causes of contamination by leachate

- Inadequate pre-wilting of herbage before ensilage. This greatly increases the volume of liquid leaching from the silage stack
- Siting of silage stacks too close to waterways, where leachates may contaminate surface and ground water
- Silage leachate entering directly or indirectly into surface and subsurface drainage systems
- Poor construction and siting of silage pits
- Poor coverage and sealing of silage stacks

Best Management Practices to avoid contamination

- Good silage production
- Siting and construction of silage pit
- Careful covering and sealing of stack

Introduction

As we are all aware, dairying has and continues to attract considerable attention about its environmental performance. Dairying has the potential to have significant detrimental effects on the quality of our environment because it is a high intensity farming system. Compared to many other farming systems, it involves large inputs and large outputs. In environmental terms, dairying is potentially a large consumer of natural resources, and potentially a generator of large amounts of pollutants and waste.

Notes:

Silage leachate is surplus water from silage, which carries soluble sugars, proteins and nutrients with it as it seeps out of the stack. Silage leachate is one of the most potentially contaminating wastes generated on the farm. It is considered to be 200 times stronger than raw domestic sewage, 40 times stronger than dairy shed waste and 8 times stronger than flushed piggery wastes. It is also extremely corrosive and can damage concrete and steel.

Silage leachate concentrate is very toxic to stream health so we need to carefully locate and manage the silage pit to avoid any potential leachate entering surface and ground water.

In New Zealand, it is estimated that 1.56 million tonnes of silage and balage were harvested (excluding maize silage and balage for own use) during the year ended 30 June 2002.

Properly made and stored silage not only results in a high quality supplementary feed but also minimises adverse effects on the environment.

Silage leachate

Leachate production relates to the moisture content of the cut pasture when it is placed in the bunker. Fortunately, the key to minimising silage leachate is making good quality silage.

The leachate draining from silage stacks is one of the strongest in terms of pollutant potential (Table 1). Entry of these high strength leachates into natural watercourses is likely to cause severe deoxygenation, resulting in adverse effects on water quality, fish, plants and other aquatic organisms.

The leachate is also very acidic and contains high levels of nutrients likely to cause algal proliferation (blooms).

Table 1 Comparison of pollutant characteristics of silage leachate with other common agricultural wastes

Type of Waste	**Pollutant Concentration (g/m3)**			
	Biological Oxygen	**Total Solid**	**Total Nitrogen**	**Total Phosphorous**
Silage leachate (pasture)	60,000 (20,000-70,000)	60,000 (40,000-140,000)	23,000	1,000
Dairy shed wastewater	1,500 (1,000-4,500)	7,200 (5,000-12,000)	210 (100-325)	35 (10-65)
Piggery wastewater	2,880-12,800	5,600-40,000	1,740 (1,075-2,500)	540 (110-950)

Figures from: Agricultural Waste Manual 1985

Biological Oxygen Demand (BOD) is a measure of biologically degradable material present in water. BOD is measured after incubating the sample in the dark at a specified temperature for a specific period of time, usually five days. This gives rise to the commonly used term BOD_5. The higher the measure of BOD_5, the greater is the organic pollution. The loss of oxygen affects the health of the stream life.

Covering stacks with a plastic cover to prevent the entrance of rainwater will help reduce the volume of leachate. For free-standing stacks, dig a shallow cut-off trench around the stack to prevent water runoff from the paddock entering the stack. Tyres, mesh covers, timber posts or concrete posts, can be used to hold the cover in place. For bunkers with sides, the cover should extend and be secured over the sides. The grass should be stacked higher in the middle to allow water to run off the cover.

Preservation process

We know that when pasture is ensiled, its sugars are converted into lactic acid by bacteria. It is the lactic acid that pickles the grass, allowing it to be preserved for a lot longer than it would have been if left in the open air. For good silage preservation, we need a rapid drop in pH to a level where there will be no butyric fermentation, so the silage is stable until it is needed.

Understanding the preservation process helps us to know what must get right to make high quality silage.

Notes:

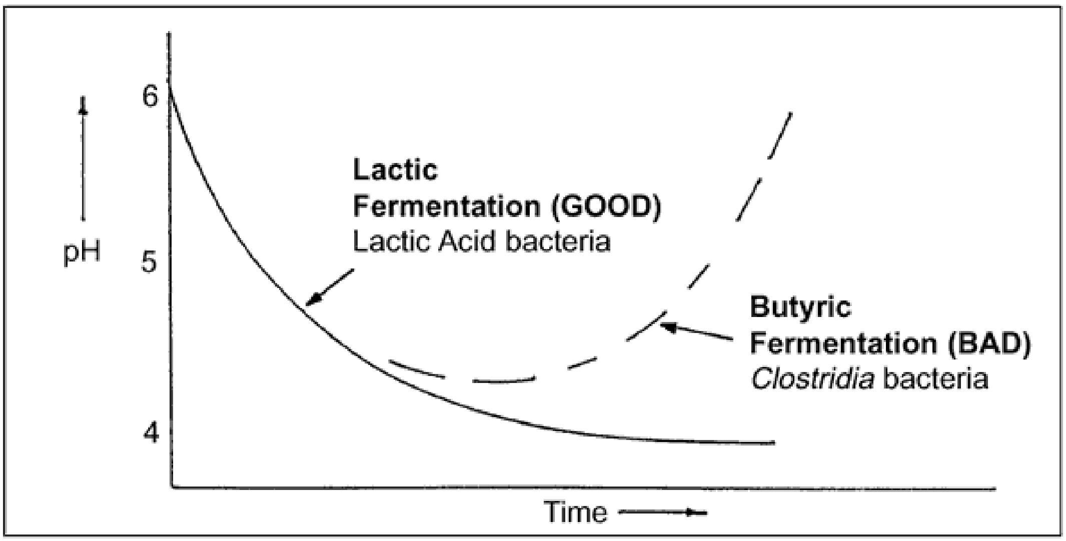

*Diagram courtesy of Nutritech (NZ) Ltd.

Figure 1 Changes in pH during silage preservation

Lactic fermentation

Once all the oxygen has been used up, anaerobic lactic bacteria (that only function when there is no oxygen) begin to multiply in numbers. As they do so, they turn sugars into lactic acid leading to drop in silage pH. This is shown as the solid line in Figure 1. Remember that a low pH preserves the silage, by preventing butyric fermentation.

The silage will be stable and well preserved at low pH, when the butyric fermentation is prevented. A very low dry matter (DM) pasture (<15%) is unlikely to reach a pH low enough to become stable. As DM% increases, the pH needed for silage to become stable also increases. As an example, for 25-30% DM pasture, a stable pH is 4 to 4.5, but for 35-40% DM pasture a stable pH will be 5 to 5.5.

Butyric fermentation

The dotted line on the diagram reveals that if the pH is not low enough for the silage to become stable, the butyric fermentation will occur. Butyric fermentation is caused by other anaerobic bacteria (*Clostridia*), which live in higher pH conditions than the lactic acid bacteria. To get energy, they turn lactic acid into acetic and butyric acid. They also get energy by breaking down protein into ammonia.

Butyric fermentation results in the breakdown of nutrients in the silage, and a drop in the palatability of the silage. The carbon-di-oxide and ammonia that is produced during butyric fermentation causes the pH of the silage to rise, which further makes the stack more suited to butyric fermentation.

There is a range of additives (such as acids, bacterial inoculants and soluble sugars) to increase the chances of good silage fermentation.

What happens when leachate reaches a waterway?

If leachate reaches a waterway it can have dramatic effects. As organisms break it down, they use up the oxygen that fish, plants and other aquatic life need for survival. Silage leachate is very acidic and has high levels of nutrients that can cause algal blooms. It has high ammonia levels, which are toxic to fish.

Discharging silage leachate is a waste of a valuable nutrient source. It can start flowing from stacks within 24 hours of construction and can continue for up to two months.

Well-made good quality silage will produce less leachate. Wilting the cut grass prior to ensiling will considerably reduce leachate quantity and increase the feed quality. Leafy grass with no wilting can produce about 500 litres of leachate per tonne of grass, whereas wilted to 25-30%, dry matter can only produce 0 to 30 litres of effluent per tonne of grass. A rough way of assessing the silage dry matter in the field is to twist a handful of cut grass and if no juice comes out and your hands are dry then the dry matter is normally about 25 to 30%.

Make silage during fine weather. It is better to have a minimum of six hours drying time in the paddock after cutting, but 24 hours is preferable. To increase the speed of wilting use mechanical conditioning and chopping.

Silage pit leachate is a dark and odorous liquid effluent that can discharge from silage stacks. Because this concentrated liquid is exceptionally toxic to stream life it is important to plan your silage pit location carefully to avoid any potential leachate entering a waterway. The most vulnerable time of year for leachate runoff is when the stack is open and exposed to the elements or is used as a self-feeding pit. Please see the legal requirements topic of this paper for the pit location details.

Silage bunker construction

To minimise the risk of pollution a silage bunker may be sited and constructed in a way that allows the collection and storage of silage leachate.

The walls and floors of a silage bunker must be capable of withstanding the hard knocks of farm machinery as well as resisting corrosion from silage leachate. Dexcel recommends that concrete with a water/cement ratio less than 0.4 : 1 should be used. Ideally, a concrete floor should be 125 mm thick.

Notes:

The silage bunker floor should be watertight and extend out beyond the bunker walls. Construct a nib wall along the sides.

Collect the leachate in a watertight storage sump, which is resistant to corrosion. This may be pumped out and used at regular intervals. The leachate can be added, after proper dilution, to other organic wastes treated on the farm such as farm dairy effluent.

In a compressed, air free silage or balEage the reaction uses up the oxygen and stops when all the oxygen is gone. If no more air is introduced through leaks in the stack then the reaction speeds up and high acidity occurs. So making good quality silage is important to reduce the amount of leachate from a stack. Silage pits are also required to have a waterproof concrete lining or equivalent and farmers have to ensure that ponding of leachate does not occur.

Best management practices

With relatively simple precautions in the production, siting, and management of silage stacks the potentially serious source of water pollution can be significantly reduced or avoided. The following are suggested guidelines to minimise the quantity and impact of leachates from silage stacks:

Silage production

- Well made good quality silage will produce little leachate
- Wilting cut grass or cereal crops before ensiling considerably reduces the quantity of effluent produced.
- Make silage during fine weather. A minimum of 6 hours drying in the field after cutting is required in fine weather, with around 24 hours recommended. However, even wilting for 5 to 6 hours can be beneficial.
- Mechanical conditioning can assist by increasing the speed and evenness of wilting.
- Suitable weather conditions for proper wilting are not always practically achievable, resulting in incidences of greatly increased leachate production. Precautionary measures should always be in place to deal with such cases when high levels of leachate production are unavoidable (having a system in place to collect the leachate produced).

Siting and construction

- Silage stacks should be sited well away from watercourses and the catchment areas of bores, wells and ponds. Greater distances are necessary where the land is steep, soils are course textured, or where groundwater may enter sensitive waterbodies.

- Do not construct silage pits on areas with underground field tile systems, springs or areas with high water tables. As well as causing decay within the stack, such inflows leach valuable nutrients from the silage.
- Properly constructed lined pits or bunkers allow improved compression and sealing of the silage stack, significantly improving quality and reducing waste.
- Expansion joints in concrete lined pits should be sealed with a flexible compound to stop entry of groundwater.
- A stormwater diversion channel should be constructed above silage pits dug into the hillside to prevent the entry of water runoff into the pit.

Drainage and land application

- Leachate from stacks should not be directed into normal drainage systems.
- Stacks can be drained into blind ditches used as soakage pits (only where stacks are sited well away from waterways or via a concrete sill into a sealed sump).
- The best disposal option is to spray irrigate or spread effluent onto pasture after 1:10 dilution at a rate of 25 m^3/ha. The mixture can provide 25-75 kg/ha of nitrogen, 25 kg/ha of phosphorus and 100 kg/ha of potassium making it a potentially useful fertiliser. Irrigation of undiluted effluent is possible at 10 m^3/ha, but may cause scorching of pasture, especially during hot weather. Land application of leachate requires facilities for its collection and storage. An effluent tank of at least 3 m^3/100 tonnes of grass ensiled is suggested.
- Silage leachate should not be directed into normal dairy shed oxidation pond systems.

Covering

- Careful covering and sealing of the stack with plastic film during and immediately after filling is important both for creating conditions conducive to high quality silage production and for minimising rainwater entry into the stack. The edges of the cover must be firmly sealed around the base so as to direct rainfall out and away from the stack and the cover must be well weighted down.
- The pit should be well fenced to prevent stock entering it and damaging the cover.

Baled silage (baleage)

- Let material you are going to bale wilt until it contains at least 25% dry matter.

Notes:

- Site bales away from waterways, bores, springs and land drains.
- Unwrap and feed out away from waterways, if possible.

These best management practices may not be applicable to every farm and the applicability may be restricted by the rules for effluent management in your area.

Legal requirements

The Resource Management Act (1991), which promotes sustainable management of natural and physical resources, says that every person has a duty to avoid, remedy or mitigate any adverse effects on the environment arising from any activity. Under the RMA, you are not allowed to let contaminants such as silage effluent get into waterways. This includes effluent that may leach through into groundwater.

Environment Southland's Regional Effluent Land Application Plan (Rule 5.4.4) clearly sets out the requirements that the discharge of leachate onto or into production land from silage pits is a permitted activity, provided that the following criteria are met:

a. the silage pit has an integral waterproof concrete lining, or equivalent thereof; and

b. there is no discharge of silage leachate directly to water including groundwater, or the coastal marine area by:

    i. tile drainage

    ii. overland flow

    iii. pipes, or stormwater drains

    iv. artificial free drainage areas; and

c. the rate of discharge does not result in any ponding of the agricultural effluent; and

d. any point where the silage pit leachate discharges onto or into land is not within:

    i. 20 metres of any water body, or wetlands listed in Appendix F, excluding aquifer

    ii. 100 metres from any existing potable water abstraction point

    iii. 20 metres of any property boundary

    iv. 100 metres from any residential dwelling; and

e. all pipelines, drains, pumps and reservoirs associated with the agricultural effluent management system are maintained so as to avoid any noxious, dangerous, offensive, or objectionable effect.

Pits also should be sited away from gullies or other locations where runoff can flow through the silage bunker. Further, do not locate silage pits on areas with underground field tiles, springs or high water tables, as this may cause decay in the stack, leach valuable nutrients and extend effluent production.

If you are farming in Southland and need further information, please contact Environment Southland at 0800 76 88 45. If you are farming in other areas, please contact your local Regional Council.

References

Dairying and the Environment Committee. 1998. Information Series.

Environment Southland's Regional Effluent Land Application Plan

Notes: