NYS
Department of
Agriculture &
Markets

AEM

AGRICULTURAL ENVIRONMENTAL MANAGEMENT
INFORMATION SHEET

Silage Storage

Introduction

Silage is made by fermenting chopped corn, alfalfa, and other forbs and grasses in tower or bunk silo and is used by many farms as a main source of feed for livestock. It is important to harvest forages at the optimum moisture content and store silage in well maintained, covered facilities to encourage proper fermentation, preserve forage quality, and minimize losses to the environment. If it is not harvested or stored properly, fermentation juices (commonly called leachate); runoff containing leachate, and/or feed solids may escape from the storage. Once leachate or contaminated runoff flows away from the storage, it can degrade the quality of ground and surface water sources.

Environmental Concerns

Silage leachate contains high concentrations of nutrients and acid, and has a high Biochemical Oxygen Demand (BOD). The BOD of silage leachate is approximately 5 times greater than manure and 100 times greater than municipal sewage. If leachate is allowed to enter surface waters, it can feed microorganisms which in turn consume oxygen dissolved in the water. As little as one gallon of leachate can lower the oxygen content of 10,000 gallons of water to levels that impair fish survival. On-going losses of leachate to surface waters can result in large-scale fish kills and the death of other aquatic species. It is the most common cause of fish kills in New York attributed to farms. Silage leachate can also increase the concentrations of phosphorus, nitrate, and ammonia in surface and groundwaters. All of these substances, in excessive amounts, can degrade water quality, cause algae blooms, odor issues, and can be harmful to aquatic habitats. Not only can leachate degrade aquatic habitats, it can also cause potential health concerns for humans and other animals if the contaminated water is use for drinking water. The leachate is also very acidic and has the ability to corrode metals and concrete overtime.

Potential Economic Benefits

Making silage is a biological process, involving the fermentation of forages by bacteria. Fermentation occurs when anaerobic bacteria (i.e. those that thrive in low/no oxygen conditions) consume carbohydrates, proteins, and other nutrients in the forage and produce acids as a by-product. Eventually the bacterial activity slows as the pH drops and the fermentation acids preserve the quality of the silage in a very stable environment until it's fed to livestock. This enables much of the nutrition of the fresh forages harvested during the growing season to be captured for feed out throughout the year. An environment for proper forage fermentation is created by a few key practices.

- Mowing and chopping the forages at optimal moisture content;
- Firmly packing the chopped forage to squeeze out oxygen and favor conditions for anaerobic bacteria;
- Immediate sealing or covering the packed forages, often when sheets of thick plastic, weighted down; and
- Proper feed-out to reduce the amount of spoiled feed, as well as, enhance the nutrient content of silage.

Maintaining adequate amounts of high quality silage for a herd can boost production while saving on purchased feed and supplements. Additionally, these practices can reduce the potential for leachate to form and runoff which, in turn protects structures and cement pads from acid corrosion and nearby surface and groundwaters. Maintenance associated with the repair of corroded or cracked structures/ pads along with costs associated with best management practices used to address leachate issues can be greatly reduced or eliminated with proper management.

For More Information:
Cornell University Cooperative Extension – Silage and Dry Hay Management

Summary of Pollution Prevention Practices

Harvest and Store Silage at Optimal Moisture Content – Suggested Moisture Content (%)

- Tower Silos – 62% - 68%
- Bunk Silos – 65% - 70%
- Ag Bags – 65% - 70%

Keep Clean Water from Entering the Storage Area

- Diversions, drainage trenches, roofs, or plastic covers over bunk or upright silos keep clean water from mixing with the silage. This maintains the quality of the feed while reducing the potential of leachate runoff.

Collect and Manage Silage Leachate

- Any low-flow leachate should be collected and treated
- Low-flow and high-flow leachate can be diverted to a manure storage facility, but never to an under barn storage. Gases can form that can sicken or kill cattle and humans.
- A low-flow, high-flow separation system is an approach that uses both collection and vegetated treatment. It decreases the total amount of material collected by collecting only the highly concentrated low-flow wastes (dry-weather leachate) and diverting low concentration high-flow wastes (precipitation driven runoff)to vegetated treatment areas.

Use Natural Resources Conservation Service Approved Best Management Practices with Conservation Systems

- Best Management Practices (BMP's) are designed to minimize nutrient loss associated with silage leachate.
- Practices designed to manage silage leachate should be implemented according to NRCS Standards and Specifications.

Summary of Regulations

State Regulations

NYS Department of Environmental Conservation:

CAFO Permit

Part 703: Surface Water and Groundwater Quality Standards

Federal Regulations

US EPA:

General Information on CAFOs

Summary of the Clean Water Act

Background Information for Worksheets

What is the moisture content (%) of silage stored in horizontal silage storages? – Bunker Silos

Forages chopped for bunk silos should have a moisture content of 65%-70% at harvest. Keeping the moisture content of silage in this range will minimize the associated leachate and reduce the amount that could potentially run off and contaminate water resources, while allowing enough moisture for proper fermentation. If a forage is too dry for a particular storage type, the silage may not ferment, but rather rot from the activities of aerobic bacteria and fungi. Likewise, is a forage is too wet, a different set of anaerobic bacteria may drive the fermentation and lead to lower quality, sometimes unusable silage. Moisture content may be measured by one of the following methods: Koster Tester, microwave and scale, or laboratory. Forage analysis can also be used to assess the moisture content of the silage.

What is the moisture content of silage stored in tower silos? – Upright SilosThe optimal moisture content for silage to be harvested and stored in tower silos should be around 65% (62%-68%). Keeping the moisture content of silage in this range will minimize the development of leachate reducing the amount that could potentially run off and contaminate water resources, as well as, encourage proper fermentation.

What is the moisture content of silage stored in Ag Bags? – Ag Bags

If utilizing ag bags to store silage, the bags should be filled evenly with silage that has less than 65% - 70% moisture. The bag should also have a consistent shape. If the bag is filled with excessively high moisture silage, it may exhibit noticeable bulging from leachate accumulation. These bulges could then leak from the bag and potentially contaminate nearby water resources.

For More Information:
Harvesting Corn Silage at the Right Moisture
Cornell Cooperative Extension - Determining Forage Moisture

What is the site condition of the ag bag area? – Ag Bags

Ag bags should be located on a hardened surface to allow for easy loading and unloading. The surface should be graded away from any water course and toward a grassed buffer/treatment area in case any leachate runs off of the site. While locating ag bags along field edges is a preferred location by landowners, they should not be stored along field edges that serve as riparian buffers. Any spoiled or waste feed should be cleaned and disposed of in a proper area. Ag bags should not be located on a surface that is extremely muddy and rutted, near a watercourse, or on a surface where flows are directed towards water resources.

For More Information:
Cornell Cooperative Extension – Poorly Managed Bagged Silage

Background Information for Worksheets

What is the size and type of temporary silage piles? – Temporary Storage Piles

Temporary silage piles should not be a regular practice on the farm. Piles on bare ground can increase the risk of leachate contaminating water resources. If temporary storage is necessary because of an unexpected high yield be sure to cover the pile to reduce spoilage and leachate production. If temporary piles occur on an annual basis because of inadequate storage facilities, consideration should be given to expanding or constructing storage facilities, or utilizing ag bags. Having a proper silage storage area will reduce the risk of silage leachate running off, creating kill zones, and/or contaminating water resources including groundwater.

Is clean water excluded from, the silage storage area? – Bunker Silos

Clean water should be excluded from the silage storage area to prevent it from mixing with leachate and running off. Common types of clean water exclusion are footer drains, diversion ditches, and covering and sloping of the pile. These exclusions prevent clean water from entering the storage. Design these systems so they don't collect dirty water. It is important to maintain all clean water exclusions to ensure that they function properly. If these systems come in contact with leachate, all water collected will have to be treated as 'dirty water' and collected or treated. This is evidenced by the presence of odor, color, or algae growth at the outlets.

Is clean water diverted from the silo loading area? – Upright Silos

Clean water should be excluded from the silage loading area to prevent it from mixing with any spilled feed and running off. Exclusions should be able to control water from a 25 year 24 hour storm. Keeping the loading area clean and dry will prevent water from becoming contaminated with leachate or waste feed.

Is clean water excluded from the silage storage area? – Ag Bags

Outside surface water should be diverted and excluded from the ag bag area. If outside surface water is allowed to run through the ag bag storage area this could facilitate the mixing of spoiled/spilled feed or leachate with clean water runoff. The contaminated runoff could then potentially pollute surface or ground water resources.

Is clean water excluded from the silage storage area? – Temporary Storage Piles

If temporary storage piles are utilized, outside surface water should be excluded from the site. This type of storage method is the most susceptible to leachate and runoff. Keeping clean outside water away from the storage area will reduce the potential of leachate seeping into groundwater resources or running off into nearby waterways. Locating temporary piles in suitable areas is the most effective method for control.

Background Information for Worksheets

Is there a well-maintained roof or cover that diverts rain water from the silage area? – Bunker Silos, Upright Silos, Temporary Storage Piles

A roof or permanent cover is another method that excludes clean water from the silage storage area. Preventing clean rain water from falling on the silage reduces spoilage and therefore reduces the potential of leachate forming and running off. Roofs must be constructed tall enough to allow for not only the storage of feed but also the equipment needed to properly compact the material to facilitate ensiling. If a roof or other permanent cover is utilized, a thick, plastic sheet will still need to be placed on the silage storage surface after filling and packing in completed.

Are there noticeable leachate leaks through cracks or holes in silage storage floors, walls, or foundations? – Bunker Silos, Upright Silos

Cracks or holes in the silo structure may allow leachate to flow out into unprotected areas. The leachate could then cause a kill zone to form or could contaminate waterways or groundwater. Silage storage floors, walls, or foundations should be inspected on a regular basis for the presence of cracks or holes. If they are found, the cracks or holes should be repaired promptly to keep leachate from flowing away from the site. It should also be routine procedure to check all outlets from drain tiles located underneath or around the silos to monitor for leachate leaks.

How is spoiled silage and waste feed dealt with? – Bunker Silos, Upright Silos, Ag Bags, Temporary Storage Piles

Spoiled silage and waste feed should be collected and removed from the site and disposed of properly in accordance with the farmer's nutrient management plan. Spoiled feed can be spread on fields or used as cover material for mortality compost piles. It is important to not let spoiled feed accumulate as it can readily develop leachate, produce undesirable odors, create unsightly conditions, provide feed for pests and potentially contaminate ground and surface water resources.

For More Information:
Cornell Cooperative Extension – Excessive Surface-spoiled Silage in Bunker Silos & Drive-over Piles

Is leachate production causing kill zones? – Bunker Silos

A kill zone is an area where vegetation has been killed off as the result of a direct flow of a highly concentrated nutrient source. If kill zones are developing, it can be assumed that low-flow (high concentration) silage leachate is being directly outletted into a vegetated area with no treatment or installed practices are not functioning as designed due to maintenance or construction issues. Ideally, no kill zones should be present on any side of the bunk silo. It is also acceptable if small kill zones that appear are repaired quickly. Less desirable conditions around the bunk silo would be the presence of several small kill zones or significant kill zone areas with no sign of repair. Consistent monitoring and maintenance to prevent cracks or leaks, adjustment of the system to collect more of the low flow, regular emptying of the low flow collection, and maintenance of the VTA components can help prevent kill zones from occurring.

Background Information for Worksheets

What is the vegetated flow distance from the silage storage to the nearest watercourse? – Bunker
Maintaining a long vegetated flow distance between the storage and the nearest watercourse will help prevent surface water contamination by leachate. It is best that the distance be greater than 1000 feet or, at a minimum, within the range of 400 feet to 1000 feet so if leachate were to escape the storage, it would have a better chance of being treated by the vegetation and soil before reaching the watercourse. If the silage storage is located between 100 feet and 400 feet the risk is moderate and may benefit from conservation practices. If less than 100 feet from the watercourse, the chances of the surface water source becoming contaminated greatly increase and formal conservation practices should be considered.

What is the vegetated flow distance from the silage storage to the nearest watercourse? – Ag Bags
The ag bag storage location should be located as far away from any watercourse as possible to reduce the risk of water resource contamination. It is best to be greater than 500 feet away from the nearest watercourse. If this is unattainable, an acceptable distance range is between 350 and 500 feet.

What is the vegetated flow distance from the storage piles to the nearest watercourse? – Temporary Storage Piles
Temporary storage piles pose the greatest risk to water resources. Temporary silage piles are prone to forming leachate and should be located greater than 1000 ft. and no less than 600 ft. from the nearest watercourse.

What is the potential of silage storage to contaminate groundwater? – Bunker Silos, Upright Silos, Ag Bags, Temporary Storage Piles:

- ***What is the depth to groundwater and/or bedrock?***
  If the silage storage is located in an area where the water table is high or the bedrock is near the surface the risk of contaminating groundwater increases. If leachate infiltrates the soil, there is less material for it to have to flow through making it easier to reach and contaminate groundwater.

- ***Is there a potential for groundwater pollution due to the permeability of the soils? What is the soil type?***
  It is important to know what types of soils exist at the silage storage site. Not only is it important to know the soil type, it is also important to know what characteristics (i.e. drainage class) the soil has. The more permeable and well drained the soil is, the more likely it is that groundwater may become polluted by leachate.

- ***How far is the silage storage from a well and is it up or down slope?***
  The silage storage should be located as far away from a well as possible to reduce the risk of contamination. Additionally, to help safeguard leachate from polluting a drinking water supply, the silage storage should be located down slope from the well. If leachate runs off from the storage it has less of a chance to contaminate the well if the storage is located down slope.

Background Information for Worksheets

- ***What was the result of the most recent water supply nitrate test?***
  It is important to have water wells tested for nitrates on a regular basis. If the results of the test are elevated, it could signify that leachate from silage storage has contaminated the water supply. It is important to detect any contamination early because water containing high levels of nitrates can be harmful if consumed by humans or animals.

For More Information
NRCS Web Soil Survey
- Define Area of Interest
- Soil Data Explorer →Soil Properties and Qualities→Water Features→Depth to Water Table

  AND
- Define Area of Interest
- Soil Data Explorer →Suitabilities and Limitations for Use→Water Management→Storm Water Management – Infiltration

What is the potential for silage leachate to reach a tile drainage system (farmstead or field)? – Bunker Silos, Upright Silos, Ag Bags, Temporary Storage Piles

If a silage storage or vegetated treatment area used to treat leachate is located near or over top of a tile drainage system, the potential for silage leachate reaching the drainage system would be high. Additionally, the system would not meet NRCS Standards. If leachate were to infiltrate a tile drain, it would become mixed with drainage and flow directly to the tile outlet. This may deliver potential contamination a long distance.

How is silage leachate and contaminated runoff collected and handled? – Bunker Silos

There should be some type of collection and/or treatment system that is designed to deal with silage leachate. The best type of system would be one that is designed to transfer both high and low flow rates of leachate to an existing approved storage and land applied in accordance with a nutrient management plan. Another acceptable system is one that is designed to collect low flow rates of silage leachate for subsequent field application and high flows are directed to a vegetated treatment area (VTA). Systems where no leachate collection exists and leachate is drained to a VTA can pose moderate risk depending on the site. Those sites where leachate directed to a ditch or some type of concentrated flow leading to a watercourse are not adequate. The risk of contaminating surface or groundwater resources greatly increases when a complete collection/treatment system is not in place.

For More Information
NRCS Waste Transfer (634) Standard
NRCS Vegetated Treatment Area (635) Standard

Background Information for Worksheets

How is silage leachate and contaminated runoff collected and handled? – Upright Silos

In a properly managed tower storage less than 40 foot high, you should not see any silage leachate. However, if leachate is present it should be completely collected in a properly designed storage structure and land applied. If there is no collection system, at a minimum, leachate should drain to a vegetated treatment area and not be allowed to enter a watercourse. If leachate is found to be coming from the tower silo, the silo should be checked for cracks or leaks. Eliminating or properly collecting and handling leachate can greatly reduce the risk of water resources becoming contaminated.

Is there a VTA? – Bunker Silos

If a VTA is installed it can be a very effective at treating high-flow silage leachate. A VTA is defined as an area of permanent vegetation used for agricultural wastewater treatment. If designed properly, it will help improve water quality by reducing the loading of contaminants from agricultural operations. To be designed properly, an evaluation of the Nitrate Leaching Index and Soil Phosphorus need to be completed. The VTA must be planned based on the type of nutrients to be treated, the size of the existing bunk silo and flow distance, as well as, its ability to treat nutrients.

If yes, has Nitrate Leaching Index evaluation and soil phosphorus testing been completed?

Nitrate Leaching Index evaluation is an indicator of the potential for nitrate to reach groundwater. Soil phosphorus testing evaluates the soil for phosphorus loading. Values of Morgan P above 80 indicate that the soil may be approaching phosphorus saturation. Both the Nitrate Leaching Index and soil phosphorus test need to be completed before the VTA is constructed to determine if the site is appropriate. Failure to complete the evaluations could result in an improperly sited VTA that could have a high potential of contaminating water resources. For an existing VTA, the NRCS standard (NRCS-NY 635) requires a Phosphorus soil test to be completed in the lower third of the VTA every 5 years to determine if phosphorus saturation is occurring.

Vegetated Treatment Area

For More Information:
Cornell University Nutrient Management Spear Program
Cornell University Phosphorus Soil Testing Methods

Are any other high-moisture commodities (i.e. brewers' grain) stored? – Bunker Silos, Upright Silos, Ag Bags, Temporary Piles

High moisture commodities such as brewers' grain are sometimes used as feed on certain types of agricultural operations. Because they are high moisture, leachate will be present and needs to be controlled.

If yes, is leachate from these storages appropriately collected and treated?

Like silage leachate, leachate from the high moisture commodities should be collected and treated. Collection methods can include total collection in an approved storage for land application or collection of low flows for land application and directing high flows to a vegetated treatment area.

SUMMARY

AEM Tier 2 Assessments document environmental stewardship and establish benchmark conditions on the farm. They also identify resource concerns and areas of opportunity. The AEM Tier 2 worksheets also help to further establish baseline data that can be used to prioritize issues for Tier 3 planning.

Tier 2 Assessments should be completed on-site with the farmer. When the initial assessment is completed, appropriate feedback in the form of an AEM Tier 2 Worksheet Summary should be provided to the farmer. The summary should include an overall level of concern for the worksheet, explanation of the overall ranking, a list and description of items of greatest concern, as well as, documentation of what is being done well and what areas need improvement. After the evaluation is complete, the farm should be given a ranking which will determine their priority to advance to the AEM Tier 3 planning phase. Appropriate ranking categories that could be used are: High, Medium, or Low Priority. A ranking procedure that has been approved by your local AEM Team should be used to make the ranking determinations.

AEM