

Silage Storage Management

WHY BE CONCERNED?

Silage is an essential feed for livestock-based agriculture. It can be made from corn, silage crops such as grass and alfalfa, or from crop processing wastes. When properly harvested and stored, silage poses little or no pollution threat. However, improper silage-making and storing can result in liquid effluents, gases, malodors, undesirable microorganisms, and waste or spoiled silage. Silage processing and storing systems often are not designed to account for the potentially harmful effects that silage storage can have on the environment. The most common problems result when high-moisture silage forms a liquid effluent or when precipitation flows through silage, picking up nutrients and other chemicals and transporting them to surface or groundwater. Inadequate surface or subsurface drainage around silos, when needed, can result in cracking of concrete and effluent leakage, plus poor working conditions around the silos. Loss of effluent can represent a major loss of nutrient value in the silage, as well as pollution of wells and streams.

Liquid effluents from silage are typically highly acidic and rich in organic matter, nutrients, and salts. Upon entering a stream, the organic matter feeds bacteria that rob the water of oxygen, basically suffocating aquatic life. In fact, one gallon of silage effluent can lower the oxygen content of 10,000 gallons of fresh water below the level required for fish survival. Groundwater contaminated with silage effluent has a disagreeable odor and increased levels of acidity, ammonia, nitrates, and iron. Nitrate is an important potential contaminant from silage effluent when the nitrate in the ensiled crops is high. Also, the oxygen demand of silage effluent is 100 to 200 times greater than that of raw municipal sewage. Effluent from 300 tons of high-moisture silage has a comparable oxygen demand to that of sewage generated daily by a city of 80,000 people.

Along with the highly acidic nature, organic matter, nutrients, and salts found in silage effluent, the low pH created by the presence of acids in silage effluent can be corrosive to concrete and steel. The acidic effluent can also dissolve naturally

occurring metals in the soil or groundwater aquifer, thus increasing their concentrations in groundwater. Groundwater with high metal concentrations may require treatment before it is conveniently or safely used. Furthermore, silage effluent, especially when mixed with manure, can produce hydrogen sulfide and other poisonous gases.

The goal of Pennsylvania Farm•A•Syst is to help you protect groundwater and surface water, shared resources which are important to everyone.

HOW TO RANK GROUNDWATER AND SURFACE WATER PROTECTION USING THIS WORKSHEET

- You can select from a wide range of silage storage conditions and management practices that are related to potential groundwater contamination.
- You can rank your silage storage conditions and management practices according to how they might affect groundwater.
- Based on your overall ratings, you can determine which of your conditions or practices are reasonably safe and effective, and which might require modification to better protect groundwater.

HOW TO COMPLETE THE WORKSHEET

Follow the directions as listed on page 1 of the worksheet. The evaluation should take 15–30 minutes to complete and determine your ranking. Evaluate each silo that is part of your farmstead. There are spaces provided to rank up to three sites on your farmstead. If you have more than three sites, please use another worksheet. If you are unfamiliar with any of the terms used, refer to the glossary provided with this worksheet.

Information derived from Farm•A•Syst worksheets is intended only to provide general information and recommendations to farmers regarding their own farmstead practices. It is not the intent of this educational program to keep records of individual results. However, they may be shared with others who will help you develop a resource management plan.

WORKSHEET #8: SILAGE STORAGE MANAGEMENT

Use a pencil, in case you want to change an answer later. For each feature listed on the left that is appropriate for your farmstead, read across to the right and circle the statement that most closely describes conditions on your farmstead. Skip and leave blank any features that don't apply to your farmstead. Then look at the description you circled to find your "rank

number" (4, 3, 2, 1) and enter that number in the blank under "rank." Directions for overall scoring appear at the end of the worksheet. Allow 15 to 30 minutes to complete the worksheet and to determine the level of groundwater and surface water protection you are providing.

MANAGEMENT OR SITE CONDITIONS

	4 Best	3 Good	2 Fair	1 Poor	RANK (up to 3 silos)
SILAGE STORAGE					Site Identification
CROP MOISTURE CONTENT					#1 #2 #3
1. Crop moisture content	Typically, crops are harvested at or below 65% for conventional tower silos, 70% for earthen trench, bunker, or temporary stacks, and 60% for oxygen-limiting silos.	Up to 5% higher than recommended.	Up to 15% higher than recommended.	More than 15% higher than recommended. Excessive silage effluent production can also be an indicator of undesirable crop moisture.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
SILAGE STORAGE LOCATION					Site Identification
					#1 #2 #3
2. Tower silage storage	At least 100 ft. down-slope from well or surface water (stream, spring, etc.) for conventional tower and oxygen-limiting tower silos.	At least 50 ft. down-slope from well or surface water (stream, spring, etc.) for conventional tower and oxygen-limiting tower silos.	Within 100 ft. upslope from well or surface water (stream, spring, etc.) for conventional tower and oxygen-limiting tower silos.	Within 50 ft. of well or surface water (stream, spring, etc.) for conventional tower and oxygen-limiting tower silos.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
3. All other silage storages	At least 500 ft. down-slope from well or surface water (stream, spring, etc.) for balage, earthen trench, bunker, plastic bags, temporary stacks.	At least 250 ft. down-slope from well or surface water (stream, spring, etc.) for balage, earthen trench, bunker, plastic bags, temporary stacks.	Within 500 ft. upslope from well or surface water (stream, spring, etc.) for balage, earthen trench, bunker, plastic bags, temporary stacks.	Within 250 ft. of well or surface water (stream, spring, etc.) for balage, earthen trench, bunker, plastic bags, temporary stacks.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
4. Clean water management	All water from roofs and upslope areas, fields, impermeable surfaces, etc., is diverted away from the silo area.	Most clean surface water is diverted.	—	All water from roofs and upslope areas, fields, impermeable surfaces, etc., runs through the silo area.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
5. Subsurface drainage	Subsurface drainage installed, if needed, only clean water discharged.	Subsurface drainage installed, if needed, provisions made to treat discharge.	Subsurface drainage installed, if needed, no treatment of discharge.	No subsurface drainage, but springs and water (seepage apparent).	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
6. Traffic areas	Paved, drained away from silos.	Unpaved, but firm surface, drained away from silos.	Unpaved, poorly drained surface.	Unpaved, with ruts and areas for water to pond.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Site Identification #1. _____ #2. _____ #3. _____

4 Best	3 Good	2 Fair	1 Poor	RANK (up to 3 silos)
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TOWER SILAGE STORAGE CONDITION AND MANAGEMENT (Conventional tower silos and oxygen-limiting tower silos)					Site Identification		
					#1	#2	#3
7. Silage storage floor or surface condition	Concrete or asphalt surface. No cracks.	Concrete or asphalt surface has some cracks.	Surface has some permeable soils (silt loam) and has some cracks.	Surface has permeable soil (sand), not compacted.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Silage storage roof condition	Roof tight fitting. No leaks.	Roof tight fitting. Minor leaks.	Roof, but many leaks not repaired.	No roof.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Silage storage lining	New or relined in last 5 years.	Relined 6 to 25 years ago.	Relined 26 to 40 years ago.	Relined more than 40 years ago.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

ALL OTHER SILAGE STORAGES CONDITION AND MANAGEMENT (Balage, earthen trench, bunker silos, plastic silage bags, and temporary stacks)					Site Identification		
					#1	#2	#3
10. Silage storage floor or surface condition	Concrete or asphalt surface. No cracks.	Concrete or asphalt surface has some cracks.	Surface has some permeable soils (silt loam) and has some cracks.	Surface has permeable soil (sand), not compacted.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Silage storage cover condition	Cover in place.	Cover settled. Rainwater dumps onto floor.	Cover settled and torn. Water runs through silage.	No cover.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Silage storage management	Floor kept clean and loose silage cleaned up regularly.	—	Loose silage lying on floor sometimes cleaned.	Silage left lying on floor where it can spoil and leach.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

EFFLUENT COLLECTION AND DISPOSAL					Site Identification		
					#1	#2	#3
13. Effluent collection system (all types)	Designed system in place and maintained. Effluent to storage or filter area.	—	Designed system in place but not maintained.	No system in place.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

TOTAL
Use this total to calculate overall performance ranking.

HOW TO USE THESE RANKINGS

Step 1: Now that each feature has been ranked, add all these rankings together and put that value in the “Total” box at the end of the worksheet. Transfer that number to the box below.

Step 2: Divide the value in the “Total” box by the number of features ranked.

_____	divided by	_____	equals	_____
(total of rankings)		(# of features ranked)		(average ranking)*
*carry your answer out to one decimal place				

Step 3: Repeat for the remaining sites. Calculate the average ranking for all sites combined.

Step 4: Evaluate the overall management practices and site conditions.

3.6–4.0 = best management

2.6–3.5 = good management

1.6–2.5 = fair management

1.0–1.5 = poor management

This ranking gives an idea of how silage storage as a whole might affect water quality. This ranking should serve only as a very general guide, not a precise diagnosis. Since it represents an averaging of many individual rankings, it can mask any individual rankings (such as 1s and 2s) that should be of concern.

Step 5: Look over the rankings for individual features of each site:

Best (4s): the current ideal; should be the goal despite cost and effort

Good (3s): provides reasonable surface and ground-water protection

Fair (2s): inadequate protection in many circumstances

Poor (1s): poses a high risk of polluting surface water or groundwater

Regardless of the overall ranking, any individual rankings of “1” should receive immediate attention. Some concerns can be taken care of right away; others could be major or costly projects, requiring planning and prioritizing before taking action.

Step 6: Consider how to modify farmstead management practices or site conditions to better protect water quality. Contact the local conservation district, Cooperative Extension office, or the USDA Natural Resources Conservation Service for ideas, suggestions, or guidance.

GLOSSARY

Balage: A storage alternative to a silo structure for ensiling forage crops. Wilted grass or legume forage with more than 40 percent moisture is baled and then wrapped in plastic or placed in a bag. Locations for storing and handling of these packages should be designed to minimize potential water quality impacts from silage effluents.

Conventional tower silos: Upright silage storage structures that are filled from the top. Substantial pressures develop within these structures that promote the packing and removal of oxygen from the stored crop so that silage fermentation can take place. When silage is too wet, considerable quantities of effluent can be discharged from the silo as the pressures develop. Effluent flow away from these structures generally peaks within several days of filling, but can continue at slower rates for much longer. The flow is often concentrated in low areas or drainageways and can travel long distances, so it is a potential threat to nearby surface water. This is especially significant in the summer when normal stream flow is low and high temperatures favor biological activity.

Covered silage: Crops to be ensiled are placed on a firm surface and covered with plastic. Moisture content of crops to be stored in stacks should be similar to trench silos. Locations for storing and handling of these packages should be designed to minimize potential water quality impacts from silage effluents.

Earthen trench or bunker silos: Horizontal structures that have earthen, wooden, or concrete sides. Floors may be packed soil, concrete, or some other firm material. Relatively high moisture crops (65 to 70 percent) are mechanically packed into these structures to reduce the oxygen content of the crop so that silage fermentation can take place. In addition to effluent from high-moisture silage, significant runoff can occur due to rainfall across the large surface area of these silos.

Oxygen-limiting tower silos: Tightly constructed (typically glass-lined steel or poured concrete) upright silo storage structures used for low-moisture (less than 60 percent) forage crops and filled from the top. Since recommended moisture contents for the ensiled crops are generally lowest for these silos, internal pressure and potential for effluent are generally less. However, if higher moisture crops are stored, the leakage can be comparable to conventional upright silos.

Plastic silage bags: Crops to be ensiled are mechanically packed into plastic tubes. Moisture content of crops to be stored in the bags is similar to balage. Locations for storing and handling of the bags should be designed to minimize potential water quality impacts from silage effluents.

Silage effluents: Liquid pressed from crops ensiled at levels greater than the optimum moisture content or liquid resulting from precipitation flowing through silage. This liquid contains a variety of pollutants, depending on the crop and production practices, and environmental and management conditions contributing to its formation need to be assessed. The typical silage effluent has a low pH and is high in nutrients and biological oxygen demand. Potential contaminants in silage effluent are typically more concentrated than milkhouse waste, barnyard runoff, and raw manure.

Temporary stacks: The crop to be ensiled is placed directly on a soil or packed earth surface with no surrounding walls or other containment.

ACKNOWLEDGMENTS

The Pennsylvania Farm•A•Syst package contains the following Worksheets:

- Introduction
- Farmstead Map
- Preliminary Screening Quiz
- Worksheet #1—Water Well Condition and Construction
- Worksheet #2—Pesticide and Fertilizer Storage and Handling
- Worksheet #3—Household Wastewater Treatment System
- Worksheet #4—Barnyard Conditions and Management
- Worksheet #5—Milkhouse Waste Management
- Worksheet #6—Stream and Drainageway Management
- Worksheet #7—Petroleum Storage and Handling
- Worksheet #8—Silage Storage Management
- Overall Farmstead Ranking

Material for the Pennsylvania Farm•A•Syst package was developed by revision of Farm•A•Syst material from the University of Wisconsin Cooperative Extension Service, Virginia Cooperative Extension, and the National Farm•A•Syst/Home•A•Syst Program. Additional format and style features for the Pennsylvania package were adapted from the Ontario Environmental Farm Plan published by Ontario Farm Environmental Coalition, Ontario, Canada.

Partial funding for the development of the Pennsylvania Farm•A•Syst package was provided by the Pennsylvania Association of Conservation Districts through a Chesapeake Bay Program grant from the U.S. Environmental Protection Agency and the Pennsylvania Department of Environmental Protection.

Additional funding was provided as part of a 319(h) project with the Pennsylvania Department of Environmental Protection and USDA-EQIP funds from the USDA-NRCS.

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone 814-865-6713.

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Issued in furtherance of Cooperative Extension Work, Acts of Congress May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture and the Pennsylvania Legislature. T. R. Alter, Director of Cooperative Extension, The Pennsylvania State University.

This publication is available in alternative media on request.

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Produced by Information and Communication Technologies in the College of Agricultural Sciences -CAT UC176 3M902ps ICT4171