Coping With Catastrophic Ensiled Forage Losses: Case Studies

Bill Seglar, *DVM, PAS*
Nutritional Sciences Manager
Pioneer Hi-Bred International, Inc.
7100 N.W. 62nd Ave., Box 1150
Johnston, IA 50131-1150

Abstract

Providing cattle the highest quality ensiled forages and grains possible for maximum milk and beef productivity is a goal for most crop growers and cattle feeders.

Pre-harvest weather related catastrophes such as flood, drought, wind, hail, and early frost can jeopardize this feeding goal, causing yield losses and reduction of nutrient quality of forages and grains. Harvest delays due to rainy seasons present another reason why quality crops may become less than ideal when fed out of the silo. These situations are out of the manager's control.

Post-harvest silage catastrophes within manager control include the ensiling of quality crops with less than ideal ensiling management practices. This includes situations where crops are ensiled with improper moisture, maturity, packing, sealing, and feedout management.

Aerobically unstable or Clostridial silages are the most common result when dealing with pre- and post-harvest catastrophes. Managing weather damaged crops prior to harvest and dealing with post-ensiling challenges requires managers to work with the principles of fermentation.[2,5]

Management of Pre-Harvest Catastrophes

The loss of forage and grain yields cannot be reversed, however decisions on how to best manage what is left must be properly assessed, analyzed, and then acted upon in the management of the crop. Weather damaged crops present ensiling similarities that include: 1) enhanced plant disease susceptibility, 2) increased crop epiphytic populations, and 3) increased probability of mycotoxins.[6,11]

Weather damaged crops may cause farmers to make impulsive decisions on how to handle the crop before the damage is totally assessed and options taken into consideration. Visual observations by those individuals assessing the situation should be backed by objective laboratory information to help with decisions. Rational analysis of the visual and laboratory findings should then be followed with a plan of action as soon as possible after the catastrophe occurs to take advantage of possible options.

Similarities of Weather Related Catastrophes

Floods contaminate crops with large amounts of organic debris, resulting in high levels of yeast, mold, and Bacillus spores that will enter the silo with the crop. Wind and hail damaged corn enhances the opportunity for undesirable aerobic microorganisms to enter damaged plant parts and become part of the harvested crop. The prevention of aerobic instability catastrophe requires critical attention by managers to ideal ensiling management practices such as packing, sealing, and maintaining proper feedout rates to assure a low pH environment exists and that oxygen will not be present in the storage structure. The use of a quality bacterial inoculant with the proven bacterial strains is necessary to overwhelm undesirable bacterial populations.

Weather damaged crops should be closely monitored for proper moisture and stage of maturity for harvest. Incomplete fermentation and increased likelihood of secondary Clostridial fermentation often result when crop managers make hasty decisions to harvest and ensile weather damaged corn before moisture levels drop into recommended levels. This is because fermentation bacteria deplete soluble sugars that are available for the production of silage acids. Large amounts of silage acids may be produced, however they will be diluted out in the wet forage mass and not be able to achieve a desirable low pH. An environment conducive to Clostridial activity develops if pH doesn't fall below 4.5.

Weather damaged crops dry down faster than normal crops, so that when proper harvest moistures are achieved, harvesting the crop as quickly as possible is essential. Prolonged silo filling time of frost damaged corn contributes to aerobic instability because of the accelerated drydown.[4]

Crop managers sometimes are forced to ensile wet forages such as fresh cut alfalfa with poor wilting conditions or corn forage that is slow to dry down. The incorporation of dry grain by-products, such as beet pulp, to lower moisture levels, or molasses to add substrate to wet forages, will help lessen the probability of secondary Clostridial fermentation.[2]

Large structures that are filled with forages of several qualities may cause good silage to become contaminated with poor silage. Segregation of stressed forages into separate silos is advisable, such as using bagged silos. Livestock managers who detect health and production problems from feeding the stressed silage then have the option of allocating the feed to other livestock groups or else disposed back into the field.

Immature corn that undergoes early frost or drought stress may accumulate toxic nitrate concentrations in the stover because reduced plant biochemical functions impede nitrogen from being converted to crude protein in corn grain. Nitrates should always be a consideration in frosted corn and sorghum crops. Sorghum should be harvested as silage 14 days after frost to lessen chances of nitrates. Raising chopper heads 12-18 inches from the ground will reduce much of the nitrate problem since nitrates tend to concentrate in the lower 1/3 portion of the plant.[8]

The ensiling process denatures half of the nitrates being introduced into the silo. Forage analysis for nitrates should be run if the crop suffers drought and/or early frost. Attention to nitrate feeding recommendations should be followed. Table 1 lists recommended nitrate-feeding tolerances of the various classes of cattle.

Harvesting and Feeding Weather Impaired Alfalfa

Nutritional results of impaired weather delays can directly affect nutrition of the forage. Fiber digestibility in alfalfa is primarily determined by harvest maturity, leaf retention, and environmental conditions. Advancing maturity increases fiber fractions resulting in reduced digestibility and intake potential. The loss of leaves reduces the leaf to stem ratio, increases fiber concentrations, and reduces neutral detergent fiber (NDF) digestibility. Exposure to rain or delayed wilting in the field can increase respiration losses, leaches water soluble carbohydrates, and results in increased leaf loss at harvest.[1,4]

Drought conditions generally result in lowered alfalfa yields but the quality is usually high. Stunted, but leafy plants increase the protein levels of the crop. Plants with fine stems result in lower fiber levels and higher digestibilities. The lack of moisture (less stem) along with high temperatures is usually offset by reduced digestibilities from increased lignification. The nutritional concerns are to provide adequate fiber and undegraded intake protein in the ration.

Table 1. Nitrate levels in forages for cattle

Nitrate Ion %	Nitrate Nitrogen ppm	Recommendations
0.0-0.44	<1000	Safe to feed under all conditions.
0.44-0.66	1000-1500	Safe to feed to non-pregnant animals. Limit use for pregnant animals to 50% of total ration on a DM basis.
0.66-0.88	1500-2000	Safely fed if limited to 50% of the total DM ration.
0.88-1.54	2000-3500	Feeds should be limited to 35-40% of the total DM in the ration. Feeds over 2000 ppm nitrate nitrogen should not be fed to pregnant animals.
1.54-1.76	3500-4000	Feeds should be limited to 25% of total DM in the ration. Do not feed to pregnant animals.
Over 1.76	>4000	Feeds containing these levels are potentially toxic. DO NOT FEED.

Adapted from: Cornell University

Wet conditions usually results in delayed harvest, resulting in alfalfa cuttings with high fiber and lower protein levels. Nutritional concerns are to provide adequate energy and limit excess fiber that result in reduced dry matter intakes.

Harvesting and Feeding Weather Impaired Corn

Immature corn suffering early frost produces grain with light test weights and diminished nutritional value if the test weight is less than 45 pounds per bushel.[3] Starch levels are reduced by 5-6% and often is overlooked by dairymen since this is not a routine measurement used in balancing diets. Nutritionists need to request starch analysis from their testing laboratories to determine this level. Another result of frost is that the stover will have higher soluble sugar levels, which needs to be assessed by the nutritionist.[3]

Comparing the nutritional value of the prior year's corn silage to new stressed crop corn silage is advisable. Routine NIRS analysis does not provide enough information about energy availability regarding how the damaged corn silage will feed, since energy predictions are based upon ADF driven regression equation. Running comparison corn silage samples through laboratories that offer starch analysis and digestibility testing will predict how the newly ensiled crop will differ from the old crop. The New York Dairy-One Forage Testing Laboratory from Ithica, NY offers laboratory services for both tests.

Dealing with Forage Shortages

Besides dealing with quality issues, dairy producers in catastrophic situations usually face forage inventory shortages. Drought that occurs early in the growing season gives the grower options of replanting with cereal grains, soybeans, sorghum, and other annual forages. Forage economic options must be considered if attempting to replant against purchase of dry hay from other parts of the country.

Dairymen usually experience shortages of corn silage inventories one or two months before fall harvest. Options are to harvest corn as green chop or to feed existing forage sources at greater amounts and incorporate higher inclusion rates of corn silage into dairy diets the next feeding season. Ruminal environments must adapt slowly over a 2-3 week period when transitioning from silage to green chopped corn. Maintaining diets with fermented silages minimizes the chances of ruminal acidosis. Existing forage inventories should be fed at higher inclusion levels until this year's corn is properly fermented.

Producers facing forage shortages usually feed the new silage crop before fermentation is complete. Forages require 2-3 weeks after ensiling to properly ferment, regardless of the storage structure. The only way to speed up fermentation is to incorporate a well researched inoculant that contains bacterial strains proven to promote fast fermentation efficiency. Usually forages treated with quality inoculants are completely fermented in one week.

Management of Post-Harvest Catastrophes

Before deciding to dispose of damaged silage, managers should utilize laboratories that offer fermentation testing services to determine silage quality in more detail. Cumberland Valley Analytical Services offers laboratory services to perform these tests. Silages that are ensiled with aerobic instability can be identified by poor bunklife (hot forages), less total energy availability, production of molds, animal intake and production problems, and mycotoxin production. Silages that undergo Clostridial secondary fermentation display green, slimy, unpalatable silage and loose up to 50% in dry matter and nutrients.

The Qualitative Forage Analysis

The quality of silage and high-moisture grain is dependent on management decisions and practices implemented before, during and after ensiling. Quality is determined by stage of harvest maturity, harvest moisture, ensiling management, type of storage structure, feed-out management, and the use of additives. Traditional forage evaluation methods will provide information about nutrient content for ration balancing purposes, but do not provide enough information to evaluate silage quality. The ranges in Table 2 represent averages and ranges of samples tested and are goals for achieving quality silages and high moisture corn. The table can be used as a worksheet by those individuals involved in silage management decisions. Normal values were determined by the Silage Technology Division of the NFIA[12] and are based upon European silage research. Nutritional values are from 1989 NRC for dairy cattle.[13] The following section provides interpretative information regarding ensiled forage and high moisture corn values.[4,9]

Interpreting Silage Quality from Nutritional, Fermentation, and Microbial Values[9]

Moisture

Proper moisture at harvest is critical for compaction of the silage mass, air exclusion, and to provide sufficient moisture to promote lactic acid fermentation. Ensiling at higher than normal moisture may lead to prolonged fermentation, excessive protein breakdown, and energy loss. Ensiling at lower than normal moisture may lead to aerobically unstable silage with yeast, mold, and Bacillus problems. Low moisture silages often have high levels of heat damaged protein and is monitored by ADIN as a % of total crude protein. (See bound protein discussion.)

ADF/NDF/RFV

Grass and alfalfa: ADF and NDF values (and relative feed value for alfalfa) indicate how much substrate will be available for fermentation. Abnormally high values indicate that less free sugars are available and that silage quality will be sacrificed. Overly mature grasses and alfalfa often do not completely ferment to drop pH into a desirable range because not enough substrate is available to complete fermentation.

Corn Silage. Fiber values are not predictive of availability of substrate. ADF is a predictor of amount of grain present in the grain:stover ratio. Corn forage usually has enough soluble sugars for completion of fermentation, regardless of ADF and NDF values. RFV is applicable to alfalfa only, and is not applicable to corn silage or grass forage.

Crude Protein

Grass and alfalfa. Predicts the maturity of the crop and correlates with ADF and NDF. Usually less crude protein indicates that less soluble sugars will be available for fermentation.

Table 2. Ensiled forage and high moisture (HMC) sample fermentation values

Test	Your Corn Silage	Normal Corn Silage	Your Alfalfa Silage	Normal Alfalfa Silage	Your Grass Silage	Normal Grass Silage	Your HMC	Normal HMC
***Nutritional**								
Moisture								
Bunker/pile		67-72		65-70		67-72		26-32
Stave/bags		68-68		60-65		63-68		26-32
Oxygen free		50-60		50-60		50-60		22-28
ADF, % DM		23-30		30		30		3
NDF, % DM								
RFV		**NA		150		NA		NA
NE-L, (mcal/lb DM)		.68-.70		0.64		0.75		0.93
NE-G, (Mcal/lb DM		.40-.47						.70-.73
Crude protein, % DM		7.1-7.9		20		18		10
Bound protein %ADIN/%TN		Less than 10-12		Less than 10-12		Less than 10-12%		NA
Ammonia nitrogen, % TN		Less than 10%		Less than 5%		Less than 10%		Less than 10%
***Fermentation**								
PH		Less than 4.0		Less than 4.5		Less than 4.2		Less than 4.2
Lactic acid %DM		Greater than 3.0		Greater than 2.0		Greater than 3.0		Greater than 1.0
Acetic acid % DM		Less than 3.0		Less than 2.0		Less than 3.0		Less than 1.0
Propionic acid % DM		Less than 1.0		Less than 1.0		Less than 1.0		Less than 0.1
Butyric acid % DM		Less than 0.1		Less than 0.1		Less than 0.1		Less than 0.1
Alcohol % DM		0		0		0		0
Microbial (*cfu/gm)**								
Yeast		Less than 100,000		Less than 100,000		Less than 100,000		Less than 100,000
Mold		Less than 100,000		Less than 100,000		Less than 1,000,000		Less than 100.,000
Bacillus		Less than 100,000		Less than 100,000		Less than 100,000		Less than 100,000
Mycotoxin (*ppm)**								
Vomitoxin		0		0		0		0
All 0thers		0		0		0		0

* All values expressed as dry matter basis
** NA = not applicable
*** cfu/gm = colony forming units per gram forage or grain
**** ppm = parts per million of forage or grain

Corn Silage and HMC: Usually is inverse to starch levels in the silage. Higher crude protein values usually indicate that less starch fill has occurred in grain. Drought stressed corn and lower starch yielding hybrids have higher crude protein values.

Bound Protein

Measured by ADIN (acid detergent insoluble nitrogen) and is expressed as a percentage of dry matter crude protein that is bound to ADF and not digestible by cattle. High ADIN indicates excessive heating during early fermentation and during storage by aerobic activity of yeast, molds, and especially Bacillus, which is highly thermophilic. High moisture corn bound protein will not be reflected by ADIN measures. Enzymatic pepsin insoluble protein must be determined and bound protein reported as the % pepsin insoluble nitrogen as a % of total nitrogen.

Ammonia Nitrogen

High ammonia indicates poor or extensive fermentation, indicating protein breakdown from proteolytic enzymatic activity contained within the crop. High ammonia-nitrogen forages may also be associated with proteolytic activity from Clostridial secondary fermentation (see butyric acid discussion) and present significant feeding problems. The use of anhydrous ammonia and urea as forage additives will cause high ammonia levels.

pH

pH is a key criterion to evaluate silage fermentation. Generally the lower the pH, the better preserved and more stable is the silage. However pH alone is not a totally accurate monitor of silage fermentation. Determination of silage acid levels that contribute to lowering pH is needed for further forage analysis.

Silage Acids

1. *Lactic acid.* The primary fermentation acid resulting from a desirable homofermentation. Ideal silage will have 3 times more lactic acid than what comprises volatile fatty acids. Depending upon the crop, levels will range from greater than 1-3%. Lactic acid is the strongest of all silage acids and its presence will drop pH more effectively than the other volatile fatty acids.

2. *Volatile fatty acids.* These acids evaporate quite easily when introduced to air and are what give silages their characteristic smell. Lactic acid in contrast has a bland odor and does not volatilize upon exposure to air. Lactic acid creates efficient fermentation because it is stronger than the volatile acids. The volatile fatty acids provide aerobic stability properties.

- *i.* *Acetic acid.* Provides silages with their characteristic vinegar odor and taste and is the preferred acid for maintaining aerobic stability. Usually found at less than 3% in silages. Anything over 3% suggests inefficient heterofermentative fermentation.
- *ii.* *Propionic acid.* Produces a sharp sweet smell and taste. Usually found at less than 1.0% in normal silages.
- *iii.* *Butyric acid.* Produces a rancid butter smell and taste. Quality silage should be less than 0.1%. Elevated levels indicate silage deterioration from secondary fermentation, which in the presence of unpalatable nitrogenous end products such as amines and amides, may lead to significant reduction in dry matter intake and energy level of the forage. Butyric acid and nitrogenous proteolysis is the result of Clostridial activity in the silo. (See ammonia nitrogen discussion)

3. *Ethanol.* Produces an alcohol smell and is an indication of yeast activity. Yeast converts sugars to alcohol and may metabolize lactic acid, which will raise pH and lead to unstable silage. The presence of ethanol is more prevalent in high moisture corn and corn silage.

Aerobic Microbial Counts

Yeast, mold, and Bacillus population counts indicate silage bunklife and are expressed in colony forming units per gram of feedstuff (cfu/gm). Aerobic microorganisms require oxygen from air penetration, indicating aerobic instability.

1. *Yeast.* Counts less that 100,000 are desirable. Yeast utilizes lactic acid as substrate in the presence of oxygen, causing the elevation of pH. Dry matter losses occur from the production of carbon dioxide, water, and heat. Yeast activity precedes mold growth.

2. *Mold.* Counts less than 100,000 are desirable. When lactic acid levels are diminished by yeast and pH rises above 4.5, the silage environment becomes conducive to mold growth. This results in musty, hot, energy depleted, and unpalatable silage.

3. *Bacillus.* Counts less than 100,000 are desirable. Fields may be highly contaminated with this aerobe at harvest. Bacillus is highly thermophilic in the presence of oxygen and is primarily responsible for high bound protein (ADIN) values in silages. (See bound protein description.)

Mycotoxins

Most diagnostic laboratories and kits identify mycotoxins that are produced by field produced molds. While a goal of quality silage is not to have mycotoxins, the presence of vomitoxin (DON) or zearalinone does not indicate poor quality silage. Vomitoxin may serve as a marker for other unknown mycotoxins.[10]

Case Studies

Flood Damaged Silages

Severe flooding occurred in northwestern Oregon in 1996, causing valley dairy farms to have bunker silos covered with floodwater. Dairymen were asking forage experts from industry, university, and extension if the affected silages would be safe to feed cattle. The consensus was that if silage density was good, then only the outer portions of the silage should be disposed and the inner mass would be safe to feed.

Feedback from Oregon veterinarian, GET, indicated that listeriosis (circling disease) was diagnosed on dairy operations where managers elected not to dispose spoiled silage. Laboratory analyses were performed to compare the fermentation quality of outer to center silage samples. The outer samples revealed high pH levels in excess of 6.0, a minimal presence of silage acids, and high yeast and mold cfu/gm counts. The center samples in contrast, maintained low pHs below 4.5, adequate silage acid concentrations, and normal aerobic microbial cfu/gm counts. The comparison verified that floodwater permeated the silage mass and washed out silage acids.

Listeria is a saprophytic bacteria that lives in plant/soil environments and survives well at low temperatures and with pHs greater than 5.5. Cattle ingesting spoiled and Listeria infected silage may develop symptoms of circling disease. The organism prefers aerobic conditions and survives well in a low dry matter environment. Quite likely, the existing Listeria spore population in the forage received additional spore loads of Listeria from the floodwaters. High population counts and ideal growing conditions created an ideal situation for the development of Listeria infected silage.

Silo situations where this organism will thrive besides flood damaged silage includes: 1) waste silage from bunkers being incorporated into the ration, 2) frozen silage on stave silo walls which thaws and fall onto good silage, and 3) balage systems where limited fermentation and poor management has caused spoilage. Corn silage has been implicated as more likely to cause the disease than other silages; however this is truer in sheep than cattle.[6]

Listeriosis problems were resolved once spoiled silage was disposed. In addition, the incorporation of approved tetracycline levels into cattle diets helped prevent disease symptoms.

Aerobically Unstable Silage

Laboratory testing and visual appraisal of dairy herds with health and production problems often leads to a diagnosis of mycotoxin contaminated forages as being the primary cause of the problems. Molds and mycotoxins in forages may contribute to problems in dairy cattle. However other circumstances may exist within the silage, such as aerobic instability, that provides greater explanations for impaired dairy performance. Full silos are sometimes disposed because of mycotoxin findings, when in reality other existing forage conditions could've been managed around to eliminate the need for disposal of ensiled forage and high moisture corn.

A Midwest expansion dairy was experiencing excessive late term abortions in mid-winter of 1998, along with delayed uterine involution and resulting infections in 75% of fresh cows and heifers. Veterinary and nutritional intervention included the analysis of blood serology and chemistry, fetal tissue histology and cultures, and nutritional evaluation. All laboratory results produced non-significant findings, except for detecting mycotoxins in the ensiled forages and high moisture corn. Vomitoxin (DON) and zearalenone (ZEN) levels ranged from highs of 8.8 ppm DON in haylage and 3.86 ppm ZEN in high moisture corn to lows of 2.2 ppm DON in corn silage and 0.15 ppm ZEN in dry hay. An adsorbant was incorporated into the diet. The abortion rate declined, however, delayed uterine involution of fresh cows persisted throughout the winter and into the next summer.

The attending nutritionist advised management that transition and fresh cow diets be reformulated to include dry hay and corn purchased from off farm sources to eliminate the toxins being introduced into the rations from ensiled feedstuffs. In addition, an anionic salt formulation was introduced into the transition ration. The owner of the dairy agreed to the ration changes, however forage inventory was a financial challenge. The dairyman requested further examination of his ensiled forages before deciding if the silages could be fed, or if they should be disposed back into the fields.

A major discovery upon intervention into the analysis of ensiled alfalfa, corn silage, and high moisture corn silages was that all mycotoxin analyses were performed based upon the ELISA (enzyme linked immune-stimulation assay). This mycotoxin diagnostic method has great credibility when testing dry grain, however it's accuracy is questionable when used to test ensiled forages and corn. This is because the test method may lack a pre-test clean up procedure, producing "false-positive" results from detecting plant debris as being mycotoxins. Forages diagnosed with mycotoxins from ELISA results should be confirmed with GC (gas chromatography), HPLC (high pressure liquid chromatography), or TLC (thin layer chromatography) techniques. All of these techniques have clean-up procedures that result in the collection of a pure extract.[14]

Samples were taken from all ensiled forages to determine mycotoxin levels using the HPLC technique at North Dakota State University's Veterinary Diagnostic Laboratory. The same samples were split and tested with the ELISA method to compare resulting values. Mycotoxin results indicated that vomitoxin was present at 0.6 ppm in HMC and 1.3 ppm in corn silage and negative for all others while the ELISA test showed all forages to be high in DON, ZEN, and aflatoxin. In the upper Midwest, aflatoxin is seldom diagnosed unless a severely drought stress geographic pocket existed for proliferation of the causative *Aspirgillus flavus* mold.

Samples of the forages and high moisture corn were sub-sampled for fermentation, microbial, and nutritional analyses to determine the fermentation quality of the forages. Table 3 summarizes test results in the silage evaluation comparison worksheet.

The high moisture corn underwent good fermentation, despite the ensiling moisture being on the low side of normal. However this crop was treated with a quality inoculant, which produced efficient fermentation even at the marginally low moisture level. Desirable fermentation is indicated by ideal: 1) pH, 2) silage acid, and 3) low ammonia nitrogen values. The microbial counts indicated that aerobic stability of the corn was good and the corn should've possessed good bunklife properties at feedout. The lower energy values probably are due to lighter test weight corn, since ADF for this sample is higher.

The corn silage was ensiled at lower than desired moisture for non-processed corn silage. However ideal fermentation also occurred in this silo as indicated by low pH, desirable silage acid levels, and low ammonia nitrogen levels. The corn silage bunker was also treated with an inoculant. Aerobic stability was good on this silage as indicated by the desirable pH, silage acid levels, and aerobic microbial counts.

Two alfalfa silages were analyzed because visual inconsistency was observed at the silo face. The farm's crop manager noted that weather delays caused harvesting of alfalfa at late maturity and over-wilted forage going into this silo. Water was added to the chopped forage as an attempt to add moisture back into the silage. The result was a silo filled with generally dry alfalfa mixed with wet and slimy pockets.

A comparison of the two alfalfa samples demonstrates that inconsistent and poor quality alfalfa silage out-weighed the false-positive mycotoxin levels. The first indication of inconsistency was moisture levels ranging form 63 to 72%. The forage was ensiled too mature as indicated by high ADF and NDF values and low RFV. A high production dairy ration using alfalfa should be in the 150 RFV range, which is reflective of 30% ADF and 40% NDF. Approximately half of the forage component of this diet came from the alfalfa silage. Another sign of inconsistency comes from ammonia nitrogen levels ranging from the wet sample at 14% to the dry sample of 2.9%.

Neither alfalfa sample demonstrated proper fermentation values, as indicated by high pH and low lactic acid levels. The wetter silage indicates signs of Clostridial activity by high butyric acid and ammonia nitrogen levels. The high Bacillus counts explains the high bound protein levels of the two samples. The presence of Bacillus may also explain low yeast and mold activity because Bacillus may act as an inhibitor of other aerobic activity.

The owner of this dairy elected to return to a wet forage ration for the transition and fresh groups using the HMC and corn silage inventory, but using a different bunker of 2nd crop alfalfa that he felt had consistent, higher quality. The problem alfalfa silage was allocated to heifers and early dry cows. Dry matter intake in this herd increased along with milk production. Uterine involution problems improved, probably from a combination of introducing an anionic salt program and consistent forages into the transition diet.

Clostridial Silage

The other general catastrophe that may occur in silage is when forage is harvested at higher than recommended harvest moisture. The following case study happened as a result of classical reasons for ensiling forages too wet, which are usually weather related. These include: 1) the crop wouldn't dry down, 2) a rainstorm was moving in, 3) the custom chopper showed up that day, and 4) just plain inadvertent unawareness.

A Wisconsin veterinarian questioned forage quality when his 600 dairy cow client ran into severe acidosis and displaced abomasum fresh cow problems after a 2nd crop alfalfa silage bunker was opened. An interview with the crop manager indicated that cutting alfalfa at proper maturity and ensiling at proper wilt times were respected in this operation. However, second crop alfalfa was advancing in maturity because of persistent rainy weather. The manager saw a 3-4 day dry weather period and decided to get the crop harvested and ensiled before the next thunderstorm. However, within hours after cutting, a fast moving weather front moved into the area and the crop manager decided to hasten silo filling, rather than risk ensiling rain damaged alfalfa.

Alfalfa silage samples were taken from 1st, 2nd, and 3rd crop silage bunkers and laboratory analyses were performed for comparison purposes. The results can be found in Table 4 (at the end of this paper). The 2nd crop alfalfa being fed to the dairy cows had 75% moisture, 5.5 pH, no lactic acid, 7% butyric acid, and 50% ammonia nitrogen levels. This was in comparison to 1st crop alfalfa that was fed previously, which had 68% moisture, 4.2 pH, 3% lactic acid, no butyric acid, and 3.5% ammonia nitrogen.

The suspect 2nd cut alfalfa silage presented a classical case of forage that underwent Clostridial second-

Table 3. Aerobic stability case study sample fermentation values

Test	*Sampled HMC*	Normal HMC	*Sampled Corn Silage*	Normal Corn Silage	*Sampled Wet Alfalfa Silage*	*Sampled Dry Alfalfa Silage*	Normal Alfalfa Silage
***Nutritional**							
Moisture	*26.4*	26-32	*64.2*	67-72	*71.7*	*63.4*	65-70
Dry matter	*73.6*	68-74	*35.8*	28-33	*28.3*	*36.6*	30-35
ADF	*3.6*	3	*31.1*	23-30	*45.5*	*38.6*	30
NDF	*7.62*	9	*45.8*	46-50	*56.1*	*49.5*	40
RFV		****NA	*NA*	NA	*88.6*	*110*	150
NE-L, (mcal/lb)	*0.89*	0.93	*0.68*	.68-.70	*0.54*	*.60*	0.64
Crude protein	*9.1*	10	*9.69*	7.1-7.9	*14.9*	*19.2*	20
Bound protein	****NA*	NA	*9.0*	Less than 10-12	*21.8*	*15.3*	Less Than 10-12
Ammonia nitrogen, % TN	*0.7%*	Less than 10%	*1.1%*	Less than 10%	*14.2%*	*2.9%*	Less Than 5%
Fermentation*							
PH	*4.01*	Less than 4.2	*3.8*	Less Than 4.0	*6.23*	*5.6*	Less than 4.5
Lactic acid	*1.6*	Greater than 1.0	*5.6*	Greater than 3.0	*0.2*	*1.3*	Greater than 2.0
Acetic acid	*.4*	Less than 1.0	*3.0*	Less than 3.0	*4.4*	*.88*	Less than 2.0
Propionic acid	*.05*	Less than 0.1	*.02*	Less than 1.0	*1.35*	*.08*	Less than 1.0
Butyric acid	*0*	Less than 0.1	*0*	Less than 0.1	*.61*	*0*	Less than 0.1
Microbial (cfu/gm)**							
Yeast	*84,000*	Less than 100,000	*100*	Less than 100,000	*100*	*10,000*	Less than 100,000
Mold	*Less than 100*	Less than 100,000	*700 Penicillin Aspirgillus*	Less than 100,000	*700 Aspirgillus*	*8,000*	Less than 100,000
Bacillus	*25,000*	Less than 100,000	*38,000*	Less than 100,000	*1,000,000*	*4,100,000*	Less than 100,000
Mycotoxin (**ppm)**							
Vomitoxin	*0.6*	0	*1.3*	0	*0*	*0*	0
All others	*0.0*	0	*0*	0	*0*	*0*	0

* All values expressed as dry matter basis
** cfu/gm = colony forming units per gram of forage or HMC
*** ND = not determined
**** NA = not applicable; relative feed value calculation only applies to alfalfa.
***** ppm = parts per million determined by gas chromatography

ary fermentation. Upon learning about this, the dairyman switched his transition and fresh cows to the better quality 3rd cutting alfalfa silage, indicated by the tabulated results in Table 4. Fresh dairy cows immediately showed a decline in fresh cow health problems. The option of disposing the problem silage back into the field was discussed, however an alternative salvage option of feeding the Clostridial 2nd crop alfalfa silage to heifers, steers, and a late lactation milking string was used with no resulting problems.

The traditional recommendation of feeding out 6 inches per day across the silo face was compromised with less feedout rates for lower inclusion levels into the diets. Clostridial silages are high in butyric acid, acting as a preservative and will inhibit yeast and mold activity. Molasses was incorporated into these rations to enhance palatability. In addition, the amount of alfalfa silage to be fed the next day was removed from the bunker and left on the bunker floor to "air-out" undesirable odors. Energy and protein values of the affected alfalfa was discounted by 50% for ration balancing since it was estimated this much was wasted by inefficient fermentation.

Feeding Silages with Abnormal Odors and Tastes

Clostridial silages become unpalatable primarily from nitrogenous proteolysis in the production of unpalatable amines, amides, and other nitrogenous end products. Clostridia that produce only butyric acid do not always impede appetites, as much as when the proteolytic end products are present. Yeast organisms that cause aerobically unstable and hot silages do not always deter appetites. Other yeast however, will produce objectionable odors and tastes from the production of various end products. Alcohol mixed with the vinegar odor of acetic acid produces a stinging smell that sometimes causes cows to refuse silages. Other yeast end products are methyl- and ethyl- acetates, which resemble the smell of fingernail polish remover. Many times producers make claims that cows are refusing silages from mycotoxins, when in reality it is the combination of high acetic acid levels, along with the presence of alcohol, and methyl-acetates that probably is really causing feed refusal.

Silage acceptance by dairy cows can be increased by removing a 12 or 24 hour supply of the silage to be fed and letting it "air out" to let the volatiles evaporate. When silage is unpalatable due to mold activity, the source of mold growth must be assessed. Those mold dense sections of ensilage should be disposed; usually this will be the top and sides of bunker silos. If there's a severe aerobic instability problem at the silo face and normal silage exists several feet within, then efforts

Table 4. Clostridial case study sample fermentation values

Test	*Sampled Alfalfa Silage 1st Crop*	*Sampled Alfalfa Silage 2nd Crop*	*Sampled Alfalfa Silage 3rd Crop*	Normal Alfalfa Silage
***Nutritional**				
Moisture	*68*	*75.0*	*69.5*	65-70
Dry matter	*32*	*25.0*	*30.5*	30-35
ADF	*31*	*35*	*30*	30
NDF	*42*	*45*	*40*	40
RFV	*143*	*127*	*152*	150
NE-L, (mcal/lb)	*.62*	*.57*	*.63*	0.64
Crude protein	*9.1*	*9.69*	*20*	20
Bound protein (ADIN/TN)	*4.5*	*6.3*	*7.2*	Less Than 10-12
Ammonia nitrogen, % TN	*3.5*	*50.0*	*3.8*	Less Than 5%
Fermentation*				
PH	*4.2*	*5.5*	*4.1*	Less than 4.5
Lactic acid	*3*	*0*	*2.5*	Greater than 2.0
Acetic acid	*1.4*	*1.0*	*1.8*	Less than 2.0
Propionic acid	*.6*	*.02*	*0.8*	Less than 1.0
Butyric acid	*0*	*7*	*0*	Less than 0.1
Microbial (cfu/gm)**				
Yeast	*84,000*	*100*	*100*	Less than 100,000
Mold	*Less than 100*	*Less than 100*	*700*	Less than 100,000
Bacillus	*2,500*	*Less than 100*	*1,000*	Less than 100,000
Mycotoxin (**ppm)**				
Vomitoxin	*ND*	*ND*	*ND*	0
All others	*ND*	*ND*	*ND*	0

* All values expressed as dry matter basis
** cfu/gm = colony forming units per gram of forage or HMC
*** ND = not determined
**** NA = not applicable; relative feed value calculation only applies to alfalfa.
***** ppm = parts per million determined by gas chromatography

should be made to dispose of the poor silage and increase feedout rates of the stable silage.

Summary

Producers who claim 100% field losses after weather damage and dairymen who dispose entire silos after experiencing feeding, health, and production problems often jump to hasty conclusions that result in costly management decisions. The physical reduction of forage inventory cannot be reversed, however decisions on how to best utilize what is left must be properly assessed, analyzed, and then decided upon how to best handle the crop and/or silage. If after analyzing silages, Clostridial and/or aerobic deterioration are beyond management, then the silo should be disposed of and other forage options considered. However, these occurrences are rare and other management options usually exist.

Bullet Points Regarding Ensiling of Weather Damaged Crops

- Assess severity of damage for salvage options
- Determine when correct harvest moisture exists for ensiling the crop
- Fill silo quickly to compensate for fast drydown
- Segregate weather damaged crops into separate storage structures
- Intensify silo management and inoculate with a well researched inoculant product

Bullet Points Regarding Aerobically Unstable Silages

- Assess fermentation, nutritional, and aerobic microbial values
- Determine degree of mycotoxin activity that might be present
- Allocate aerobically unstable silages to lower production groups
- Determine extent of spoilage and dispose or increase feedout rates
- Let volatiles air out

Bullet Points Regarding Clostridial Silages

- Assess degree of butyric and nitrogenous end-product production
- Allocate Clostridial silages to other groups, dilute, and use molasses
- Palatability decreases due to yeast volatiles and proteolytic end-products
- Let volatiles air out

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