Silage Management: Common Problems and Their Solution

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Introduction

Regardless of the size of an operation, dairy producers know problems occur in every silage program. This paper describes possible causes and solutions for 10 common problems, which include:

- Safety issues for bunker silos and drive-over piles
- Effluent
- Large variation in the dry matter (DM) content and/or nutritional quality of the ensiled forage
- Missing the optimum harvest window for whole-plant corn
- Clostridial, butyric acid-containing hay-crop silage
- High levels of acetic acid, particularly in wet corn silage
- Heat-damaged silage
- Aerobically unstable corn silage during feedout
- Excessive surface-spoiled silage in sealed bunker silos and drive-over piles
- High ‘forage in’ versus ‘silage out’ losses in bunker silos, drive-over piles, and bags

Beef and dairy producers (and their nutritionist) should discuss these problems and solutions with everyone on their silage team as a reminder to implement the best possible silage management practices (Bolsen, 1995).

Safety Issues for Bunker Silos and Drive-Over Piles

Consistently protecting workers, livestock, equipment, and property at harvest, filling, and feeding does not occur without thought, preparation, and training. You have nothing to lose by practicing safety; you have everything to lose by not practicing it (Murphy and Harshman, 2006).

Major hazards and preventive measures

- Tractor roll over
  - Roll over protective structures (ROPS) create a zone of protection around the tractor operator. When used with a seat belt, ROPS prevent the operator from being thrown from the protective zone and crushed by the tractor or equipment mounted on or drawn by the tractor.
  - A straight drop off a concrete retaining wall is a significant risk so never fill higher than the top of a wall.
  - Install sighting rails on above ground walls. These rails indicate the location of the wall to the pack tractor operator but are not to hold an over-turning tractor.
  - Consider adding lights to the rail if filling will occur at night.
  - Form a progressive wedge of forage when filling bunkers or piles. The wedge provides a slope for packing, and a maximum 3 to 1 slope minimizes the risk of a tractor roll-over.

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√ Backing up the slope can prevent roll backs on steep slopes.
√ Use low-clearance, wide front end tractors and add weights to the front and back of the tractors to improve stability.
√ When using front-end loaders to carry feed into the silo, do not carry bucket any higher than necessary to help keep the center of gravity low.
√ Front-wheel and front wheel-assist drive tractors provide extra traction and stability.
√ When two or more pack tractors are used, establish a driving procedure to prevent collisions.
√ Dump trucks, which are used to transport chopped forage in large-scale operations, can roll over on steep forage slopes, particularly if the forage in not loaded and packed uniformly.
√ Raise the dump body only while the truck is on a rigid floor of the storage area to prevent turn overs.

• Entangled in machinery
√ Keep machine guards and shields in place to protect the operator from an assortment of rotating shafts, chain and v-belt drives, gears and pulley wheels, and rotating knives on tractors, pull-type and self-propelled harvesters, unloading wagons, and feeding equipment.
√ “The accident happened on Saturday June 14, 1974 while making wheat silage at Kansas State University’s Beef Cattle Research Unit. The blower pipe plugged for about the 10th time that afternoon. I started to dig the forage out from the ‘throat’ of the blower, and the PTO shaft was making one more revolution … zap! The blower blade cut off the ends off three fingers on my right hand” (Bolsen, 2006).

• Run-over by machinery
√ Never allow people on foot (especially children) in or near a bunker or pile during the filling operation.
√ Properly adjust rear view mirrors on all tractors and trucks.

• Fall from height
√ It is easy to slip on plastic when covering a bunker, especially in wet weather, so install guardrails on all above ground level walls.
√ Use caution when removing plastic and tires, especially near the edge of the feeding face.
√ Never stand on top of a silage overhang in bunkers and piles, as a person’s weight can cause it to collapse.

• Crushed by an avalanche/collapsing silage
√ The number one factor contributing to injuries or deaths from silage avalanches is overfilled bunkers and drive-over piles!
√ Do not fill higher than the unloading equipment can reach safely, and typically, an unloader can reach a height of 12 to 15 feet.
√ Use proper unloading technique that includes shaving silage down the feeding face and never ‘dig’ the bucket into the bottom of the silage. Undercutting, a situation that is quite common when the unloader bucket cannot reach the top of an over-filled bunker or pile, creates an overhang of silage that can loosen and tumble to the floor.
√ Never allow people to stand near the feeding face, and a rule-of-thumb is never be closer to the feeding face than three times its height.
√ Fence the perimeter of bunkers and piles and post a sign, “Danger: Do Not Enter. Authorized Personnel Only”.

• Complacency
√ Mac Rickels, a dairy nutritionist in Comanche, TX, almost lost his life the day he took silage samples from a bunker silo with a 32-foot high feedout face
(Schoonmaker, 2000). Rickels said, “Even though I was standing 20 feet from the feedout face, 12 tons of silage collapsed on me. I didn’t see or hear anything. I had been in silage pits hundreds of times, and you just become kind of complacent because nothing ever happens. It just took that one time.”

√ Think safety first! Even the best employee can become frustrated with malfunctioning equipment and poor weather conditions and take a hazardous shortcut, or misjudge a situation and take a risky action (Murphy, 1994).

√ It is always best to take steps to eliminate or control hazards ahead of time rather than to rely upon yourself or others to make the correct decision or execute the perfect action when a hazard is encountered.

**Effluent**

Effluent has a very high biochemical oxygen demand. It should always be contained near the silo of origin and never allowed to enter groundwater and/or a nearby pond or watercourse. When seepage occurs, the plant materials that threaten water quality are also nutrients that are lost from the silage.

**Causes**

- Forage ensiled at too low DM content for the type and size of silo.
- Forage was not pre-conditioned when cut.
- Forage was in a windrow that was too bulky for the time allowed for field-wilting.
- Weather did not allow the forage to be field-wilted properly before chopping.
- Person(s) responsible for determining the DM content of the forage made a mistake.
- Whole-plant corn, sorghum, or cereal was harvested at an immature stage of growth.

√ Silage contractor does not arrive at the scheduled time.

√ Chopping began too early because of the number of acres to harvest.

**Solutions**

- Use weather forecasts to make forage management decisions.
- Take advantage of new mowing, cutting, and conditioning equipment technologies.
- Coordinate the merging of windows with the time of chopping.
- Monitor the dry-down rate and whole-plant moisture content of each field of corn or sorghum so the harvest can begin at the proper time.
- Select a range of corn or sorghum hybrids with differing maturities to widen the effective harvest window.

**Large Variation in the DM Content and/or Nutritional Quality of the Ensiled Forage**

**Causes**

- Interseeded crops of different maturity.
- Multiple cuttings or multiple forages ensiled in the same silo.
- Delays in harvest activities because of a breakdown or shortage of machinery and equipment.
- Seasonal or daily weather affects crop maturing and field-wilting rates.
- Differences among corn hybrids. Hybrids with the stay-green trait tend to be wetter at a given kernel maturity than non stay-green hybrids.

**Solutions**

- Use multiple silos and smaller silos that improve forage inventory control.
- Ensile only one cutting and/or variety of ‘hay-crop’, field-wilted forage per silo.
- Minimize the number of corn and/or sorghum hybrids per silo.
- Shorten the filling-time but do not compromise packing density.
Missing the Optimum Harvest Window for Whole-Plant Corn

**Causes**

- Harvest equipment capacity is inadequate.
- The crop matures in a small harvest window.
- Warm, dry weather can speed the maturing process and dry-down rate of the grain and forage parts of the plant.
- Wet weather can keep harvesting equipment out of the field.
- Sometimes it is difficult to schedule the silage contractor.

**Solutions**

- Plant multiple corn or sorghum hybrids with different season lengths.
- Improve the communication between the beef or dairy producer, crop grower, and silage contractor.
- Change harvest strategy, which might include kernel processing, shorter theoretical length of cut (TLC), or adding a pack tractor.

Clostridial, Butyric Acid-Containing Hay-Crop Silage

**Causes**

- The forage is ensiled too wet and undergoes a fermentation dominated by clostridia.
- Alfalfa and other legumes, which experience a rain event in the field after mowing, are at a higher risk because rain leaches soluble sugars from the forage.
- The forage is harvested too wet for the type and size of storage.

**Solutions**

- Chop and ensile all forages at the correct DM content for the type and size of silo.
- Proper packing to achieve a minimum density of 15 lb of DM per ft³ excludes oxygen and limits the loss of plant sugars during the aerobic phase (Visser, 2005; Holmes, 2006).
- Apply a homolactic bacterial inoculant (HLAB) to all forages to ensure an efficient conversion of plant sugars to lactic acid.
- Do not contaminate the forage with soil or manure at harvest.
- If it is not possible to control the DM content by wilting, the addition of soluble sugars can reduce the chance of clostridial fermentation and the problems associated with butyric acid silages.

High Levels of Acetic Acid, Particularly in Wet Corn Silage

**Causes and symptoms**

- When the whole-plant has a low DM content at harvest, it is predisposed to undergo a prolonged, heterolactic fermentation.
- This silage has a strong ‘vinegar’ smell, and there will be a 2 to 3 feet layer of bright yellow, sour smelling silage near the floor of a bunker silo or drive-over pile.

**Solutions**

- Ensile all forages at the correct DM content and especially not too wet.
- Use a HLAB inoculant to ensure an efficient conversion of plant sugar to lactic acid.

Heat-Damaged Silage

**Causes and symptoms**

- This silage has a dark brown color and a burnt caramel/tobacco smell.
- Heat-damaged silage typically has reduced digestibility of the protein and energy components.
In well-managed silage, the temperature of the ensiled forage should not increase more than 8 to 10°F above the ambient temperature at harvest, and when the temperature of the ensiled forage exceeds 115 to 120°F during the first 1 to 2 weeks, heat-damage can occur.

Most of the heat is from plant and microbial respiration, which continues as long as oxygen is present in the ensiled mass.

Chemical reactions, called Maillard or ‘browning’, bind plant sugars and hemicellulose with proteins and amino acids.

**Solutions**

- Before filling a bunker silo, seal cracks in the walls and/or line walls with polyethylene.
- Harvest at the correct stage of maturity and especially not too mature.
- Ensile all forages at the correct DM content and especially not too dry.
- Do not chop forages too long, which would typically be longer than 1-inch TLC if the crop is processed or ½-inch if not processed.
- Achieve anaerobic conditions as quickly as possible in the ensiled forage mass.
- Fill silos in a timely manner and distribute the forage evenly in the silo.
- Achieve a minimum packing density of 15 lb of DM per ft³.
- Cover/seal the surface as quickly as possible following filling (within 24 hours).

**Aerobically Unstable Corn Silage During Feedout**

Research into the processes of aerobic deterioration has not explained why corn silages differ in their susceptibility to aerobic deterioration. Microbes, primarily lactate utilizing yeast, as well as forage and silage management practices contribute to aerobic stability of an individual corn silage (Uriarte-Archundia et al., 2002).

**Solutions**

- Harvest at the correct stage of kernel maturity and especially not too mature.
- Ensile at the correct DM content and especially not too dry.
- In normal conditions, do not chop longer than ¾-inch TLC if the crop is processed or ½-inch if not processed.
- Achieve a minimum packing density of 15 lb of DM per ft³.
- Maintain a uniform and rapid progression through the silage during the entire feedout period. Remove a minimum of 6 to 12 inches per day in cold weather months and 12 to 18 inches per day in warm weather months.
- Minimize the amount of time corn silage stays in the commodity area before adding it to the ration. It might be necessary to remove silage from a bunker or drive-over pile and move it the commodity area twice daily.
- Do not leave corn silage rations in the feed bunk too long, especially in warm, humid weather.
- Add about 2 to 4 lb of a buffered propionic acid product per ton of total mixed ration if heating does occur.
- Consider re-sizing a silo and subsequent feedout face for the time of year a silage will be feedout.
- Feed from ‘larger feedout faces areas’ in cold weather months.
- Feed from ‘smaller feedout faces areas’ in warm weather months.

**Excessive Surface-Spoiled Silage in Sealed Bunker Silos and Drive-Over Piles**

**Solutions**

- Achieve an optimum packing density (minimum of 15 lb of DM per ft³) within the top 3 feet of the silage surface.
- Shape all surfaces so water drains off the bunker or pile, and the back, front, and side slopes should not exceed a 3 to 1 slope.
• Seal the forage surface immediately after filling is finished.
• Two sheets of polyethylene or a single sheet of oxygen barrier (OB) film is preferred to a single sheet of plastic (Bolsen, 2004; Berger and Bolsen, 2006).
• Overlap the sheets that cover the forage surface by a minimum of 3 to 4 feet.
• Arrange plastic sheets so runoff water does not contact the silage.
• Sheets should reach 4 to 6 feet off the forage surface around the perimeter of a drive-over pile.
• Put uniform weight on the sheets over the entire surface of a bunker or pile, and double the weight placed on the overlapping sheets.
  √ Bias-ply truck sidewall disks, with or without a lacework of holes, are the most common alternative to full-casing tires.
  √ Sandbags, filled with pea gravel, are an effective way to anchor the overlapping sheets, and sandbags provide a heavy, uniform weight at the interface of the sheets and bunker wall.
  √ Sidewall disks and sandbags can be stacked, and if placed on pallets, they can be moved easily and lifted to the top of a bunker wall when the silo is being sealed and lifted to the top of the feedout face when the cover is removed.
  √ A 6- to 12-inch layer of sand or soil or sandbags is an effective way to anchor sheets around the perimeter of drive-over piles.
• Prevent damage to the sheet or film during the entire storage period.
  √ Mow the area surrounding a bunker or pile and put up temporary fencing as safe guards against domesticated and wild animals.
  √ Develop a rodent control program for the farm.
  √ Use a mesh or resistant secondary cover to exclude birds.
• Store waste polyethylene and cover weighting materials so it does not harbor vermin.
• Regular inspection and repair is recommended because extensive spoilage can develop quickly if air and water penetrate the silage mass.
• Discard all surface-spoiled silage because it has a significant negative effect on DM intake and nutrient digestibility (Whitlock et al., 2000; Bolsen, 2002).
• Full-casing discarded tires were the standard for many years to anchor polyethylene sheets on bunker silos. These waste tires are cumbersome to handle, messy, and standing water in full-casing tires can help spread the West Nile virus, which is another reason to avoid using full-casing tires on beef and dairy operations (Jones et al., 2004).

High ‘Forage In’ vs. ‘Silage Out’ Losses in Bunker Silos, Drive-Over Piles, and Bags

Solutions

• Select the right forage hybrid or variety.
• Harvest at the optimum whole-plant DM content.
• Use the correct size of bunker or pile, and do not over-fill bunkers or piles.
• Employ well-trained, experienced people, especially those who operate the forage harvester, pack tractor, or bagging machine. Provide training as needed.
• Apply a HLAB inoculant.
• Achieve an optimum and uniform packing density in bunkers and piles (a minimum of 15 lb of DM per ft³).
• Provide an effective seal to the surface of bunkers and piles and consider using double polyethylene sheets or OB film.
• Follow proper face management practices during the entire feedout period.
• Start a silage quality control program and schedule regular meetings with your team.

**Profitability of HLAB-Treated Corn Silage for Growing Cattle and Lactating Dairy Cows**

Many dairy producers, nutritionists, and custom silage operators are concerned about whether it is economical to use a HLAB when making corn silage. Presented in Tables 1 and 2 are examples from spreadsheets, which show the profitability of inoculating whole-plant corn silage with HLAB.

*Growing cattle*

The cattle in this example had an average weight of 650 lb, a DM intake of 2.62% of body weight, a ration DM intake to gain ratio of 7.1, and an average daily gain of 2.39 lb. The cattle performance responses to HLAB-treated corn silage were a 0.05 lb increase in DM intake (17.0 vs. 17.05 lb/day) and an improved ration DM to gain ratio of 0.15 (6.95 vs. 7.1). The DM recovery response was 1.3 percentage units for HLAB-treated silage compared to the untreated silage (83.8 vs. 82.5). The gain per ton of ‘as-fed’ whole-plant corn ensiled was 91.78 lb for the HLAB-treated vs. 88.45 lb for untreated corn silage, which was an increase of 3.33 lb. With a cattle price of $1.20 per lb and a HLAB cost of $0.75 per ton of crop ensiled, the net benefit per ton of crop ensiled was $3.25.

*Lactating dairy cows*

The dairy herd in this example had an average milk production 75 lb/day per cow and a DM intake of 52 lb/day. The increase in net income with HLAB-treated corn silage, calculated on a ‘per cow per day’ and ‘per cow per year’ basis, came from increases in both forage preservation and silage utilization improvements. The additional ‘cow days’ per ton of crop ensiled because of the increased silage recovery (1.5 percentage units) and increased milk per cow per day (0.25 lb) gave an increased net income of 16.2¢ per cow per day and $49.50 per cow per year. The increased net return per ton of whole-plant corn ensiled was $6.99.

**Profitability of Sealing Bunker Silos and Drive-Over Piles**

A spreadsheet to calculate the profitability of sealing corn and alfalfa silages in bunker silos and drive-over piles was developed from research conducted at Kansas State University from 1990 to 1995 and equations published by Huck et al. (1997). Huck et al. (1997) noted that about 75% of the total tons of corn and sorghum silage made in Kansas from 1994 to 1996 were not sealed, and the value of silage lost to surface spoilage was $7 to 9 million annually. Presented in Table 3 are examples from the spreadsheet. The profitability of properly sealing bunkers and piles with 6-mil standard plastic or an improved OB film makes it clear that producers should pay close attention to the details of this ‘highly troublesome’ task.


Bolsen (2004) compared the OB film to 6-mil standard black plastic in two field trials conducted from September 2003 to May 2004. The first trial was with whole-plant corn at a commercial feedyard near Dimmit, TX; the second trial, with high moisture (HM) corn was at a feedyard near Garden City, KS. In Trial 1, the OB film and standard plastic were applied to side-by-side, 40 ft wide x 60 ft
long areas of the bunker surface; in Trial 2, the OB film and standard plastic were applied to side-by-side, 130 ft wide x 60 ft long areas. The standard plastic and OB film was weighted with either full-casing, discarded car tires (Trial 1) or truck sidewall disks (Trial 2). A thin tarpaulin was put on the film ahead of the tires or sidewalls because the OB film did not have protection from ultraviolet light. The sealing materials were removed about 240 day post-filling and samples taken at 0 to 6, 6 to 12, and 12 to 18 inches from the surface at four locations across the width of each test area.

There was virtually no visible discoloration or surface spoilage in the OB film-sealed bunkers; however, there was visible mold and aerobic spoilage in the standard plastic-sealed bunkers, particularly in the top 12 inches of corn silage. The corn silage and HM corn in the top 0 to 18 inches under the OB film had better fermentation profiles and lower estimated additional spoilage losses of OM compared to the corn silage and HM corn under the standard plastic (Table 4).

When compared to standard plastic in a 1,152-ton capacity bunker silo, OB film would result in the net saving of $490 of corn silage in the original top three feet (Table 3). In a 180 x 280 drive-over pile of corn silage, OB film would produce a net savings of $6,140 of silage in the original top three feet compared to standard plastic (Table 3). In a 100 x 150 drive-over pile of alfalfa haylage, OB film would produce a net savings of $18,600 of haylage in the original top three feet. Additional information about the OB film is located at www.silostop.com.

References


Bolsen, K.K. 2004. Unpublished data. Kansas State University, Manhattan, KS.

Bolsen, K.K. 2006. Personal testimony. Kansas State University, Manhattan, KS.


Table 1. Profitability of HLAB-treated corn silage for growing cattle.¹

<table>
<thead>
<tr>
<th>Ration ingredients</th>
<th>DM basis (%)</th>
<th>Untreated DM, %</th>
<th>HLAB DM, %</th>
<th>Untreated ration (lb/day)</th>
<th>HLAB ration (lb/day)</th>
<th>Response²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn silage</td>
<td>87.5</td>
<td>33.3</td>
<td>33.3</td>
<td>14.88</td>
<td>14.92</td>
<td></td>
</tr>
<tr>
<td>Other silage or hay</td>
<td>0</td>
<td>90.0</td>
<td>90.0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grain or supplement</td>
<td>12.5</td>
<td>90.0</td>
<td>90.0</td>
<td>2.12</td>
<td>2.13</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>17.0</td>
<td>17.0</td>
<td>17.05</td>
<td>17.05</td>
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<td>Avg. cattle wt, lb</td>
<td>650</td>
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<td>Cattle price, $ per lb</td>
<td>1.20</td>
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<tr>
<td>Avg daily gain, lb</td>
<td></td>
<td>2.39</td>
<td>2.45</td>
<td></td>
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<td></td>
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<tr>
<td>DM intake, lb per day</td>
<td></td>
<td>17.0</td>
<td>+ 0.05</td>
<td>17.05</td>
<td></td>
<td></td>
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<tr>
<td>Ration DM per lb of gain, lb</td>
<td></td>
<td>7.1</td>
<td>- 0.15</td>
<td>6.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silage per lb of gain, lb of DM</td>
<td></td>
<td>6.21</td>
<td></td>
<td>6.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silage per lb of gain, lb as-fed</td>
<td></td>
<td>18.7</td>
<td></td>
<td>18.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM recovery, % of the ensiled crop</td>
<td></td>
<td>82.5</td>
<td>+ 1.3</td>
<td>83.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain per ton of as-fed crop ensiled, lb</td>
<td></td>
<td>88.45</td>
<td></td>
<td>91.78</td>
<td></td>
<td></td>
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<tr>
<td>Value of the extra gain per ton of crop ensiled, $</td>
<td></td>
<td>---</td>
<td></td>
<td>4.00</td>
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<td></td>
</tr>
<tr>
<td>Cost of HLAB per ton of crop ensiled, $</td>
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<td>---</td>
<td></td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net benefit per ton of HLAB-treated crop ensiled, $</td>
<td></td>
<td>---</td>
<td></td>
<td>3.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Numbers in bold are user inputs and changeable; HLAB = homoladic bacterial inoculant and DM = dry matter.
²Response is a 19-trial average across all HLAB products (Bolsen et al., 1992).
Table 2. Profitability of HLAB-treated corn silage for lactating dairy cows.1

<table>
<thead>
<tr>
<th>Ration ingredient</th>
<th>DM intake, lb/day</th>
<th>DM, %</th>
<th>As-fed, lb/day</th>
<th>Feed cost, $ per lb</th>
<th>Feed cost, $ per day</th>
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<tbody>
<tr>
<td>Corn silage</td>
<td>15.0</td>
<td>33.3</td>
<td>45.0</td>
<td>0.0175</td>
<td>0.79</td>
</tr>
<tr>
<td>Other silage/haylage</td>
<td>9.0</td>
<td>45.0</td>
<td>20.0</td>
<td>0.030</td>
<td>0.60</td>
</tr>
<tr>
<td>Other forage/hay</td>
<td>4.0</td>
<td>88.0</td>
<td>4.6</td>
<td>0.060</td>
<td>0.27</td>
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<tr>
<td>Grain/supplement</td>
<td>24.0</td>
<td>88.0</td>
<td>27.3</td>
<td>0.075</td>
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<tr>
<td>Total</td>
<td>52.0</td>
<td>96.9</td>
<td></td>
<td></td>
<td>3.71</td>
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<tr>
<td>Corn silage required per cow per year, tons</td>
<td></td>
<td></td>
<td></td>
<td>7.94</td>
<td></td>
</tr>
<tr>
<td>HLAB cost per ton of crop, $</td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
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<table>
<thead>
<tr>
<th>Component</th>
<th>Untreated corn silage</th>
<th>HLAB corn silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage recovery, % of crop ensiled2</td>
<td>85.0</td>
<td>(1.5)</td>
</tr>
<tr>
<td>Silage recovered per ton of crop ensiled, lb</td>
<td>1,700</td>
<td>1,730</td>
</tr>
<tr>
<td>Amount of corn silage fed per cow per day, lb</td>
<td>45.0</td>
<td>45.0</td>
</tr>
<tr>
<td>Cow days per ton of crop ensiled</td>
<td>37.74</td>
<td>38.41</td>
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<tr>
<td>Extra cow days per ton of crop ensiled</td>
<td></td>
<td>0.67</td>
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<tr>
<td>Milk production per cow per day, lb</td>
<td>75.0</td>
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<tr>
<td>Milk gained per ton of crop ensiled, lb</td>
<td></td>
<td>49.9</td>
</tr>
<tr>
<td>Milk price, $ per lb</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>Increased milk value per ton of crop ensiled, $</td>
<td>7.49</td>
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</tr>
<tr>
<td>Increased milk per cow per day, lb</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Increased milk value per ton of crop ensiled, $</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>Extra milk value per ton of crop ensiled, $</td>
<td>8.93</td>
<td></td>
</tr>
<tr>
<td>Increased feed cost per extra cow day, $</td>
<td>2.92</td>
<td></td>
</tr>
<tr>
<td>Increased feed cost per ton of crop ensiled, $</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>Increase net return per ton of crop ensiled, $</td>
<td>6.99</td>
<td></td>
</tr>
<tr>
<td>Added cost of HLAB: per cow per day, $</td>
<td>0.020</td>
<td>5.96</td>
</tr>
<tr>
<td>per cow per year, $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Added income as milk: per cow per day, $</td>
<td>0.182</td>
<td>55.50</td>
</tr>
<tr>
<td>per cow per year, $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net benefit with HLAB: per cow per day, $</td>
<td>0.162</td>
<td>49.50</td>
</tr>
<tr>
<td>per cow per year, $</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Numbers in **bold** are inputs by the producer and changeable; HLAB = homolactic bacterial inoculant and DM = dry matter.

2Shown in parenthesis is the response to HLAB expressed in percentage units.
Table 4. Effects of standard plastic and oxygen barrier (OB) film on pH, fermentation profile, estimated additional spoilage loss of organic matter (OM), and ash content in corn silage and high moisture (HM) corn at 0 to 18 inches from the surface at 240 days post-filling.

<table>
<thead>
<tr>
<th>Item</th>
<th>Corn silage</th>
<th></th>
<th>HM corn</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>std plastic</td>
<td>OB film</td>
<td>std plastic</td>
<td>OB film</td>
</tr>
<tr>
<td>DM content, %</td>
<td>29.2</td>
<td>31.6</td>
<td>72.3</td>
<td>73.2</td>
</tr>
<tr>
<td>pH</td>
<td>4.28</td>
<td>3.78</td>
<td>4.70</td>
<td>4.09</td>
</tr>
<tr>
<td>Estimated OM loss$^{1,2}$</td>
<td>27.3</td>
<td>8.4</td>
<td>12.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>2.7</td>
<td>6.8</td>
<td>0.86</td>
<td>1.08</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>2.6</td>
<td>2.2</td>
<td>0.25</td>
<td>0.31</td>
</tr>
<tr>
<td>Ash</td>
<td>11.2</td>
<td>9.1</td>
<td>2.10</td>
<td>1.98</td>
</tr>
</tbody>
</table>

$^{1}$Values are estimated additional spoilage loss of OM, calculated from ash content using the equations described by Dickerson et al. (1992).

$^{2}$Ash content of the face samples was 8.4% for the corn silage and 1.85% for HM corn.