Introduction

Large bale silage has become popular in Ontario as an option for storing excellent quality forage. By making silage, a farmer can be more aggressive and consistent in cutting schedules as it reduces the weather risk factor. A few farmers use this as their main storage system, but it is more commonly a flexible second system of storage when silos are full and the weather doesn't permit drying. It produces a long stem haylage, which is very acceptable to all types of ruminants.

The system makes use of equipment such as large round balers, which are readily available. Baleage may be fed using the same equipment as dry, large bales. This provides flexibility, to make as little or as much large bale silage as the weather dictates. Also, baling requires less horsepower than chopping haylage. The front tires of the tractor carry not only the extra weight of the wet bales but more of the tractor weight is transferred to them as well. This reduces traction. Heavier equipment and four wheel drive tractors may be required when handling these heavier bales.

The cost and the disposal of the plastic coverings have been a major concern. Cost is rationalized by considering the higher protein and energy value of the stored forage and the importance of the storage itself. Reduced harvesting losses, which improve yields, and the higher quality of the whole forage crop as the harvest is moved ahead, should be
considered when determining the cost benefit of the system. Presently, landfills are still accepting the used plastic but projects looking at reuse of the plastics are underway.

Mold development was discovered this past spring when round bale silage was kept over the winter to be fed in the spring. This has challenged us to consider the reasons for this deterioration. There is less or incomplete fermentation resulting in a higher pH, or less acidic environment, and a more unstable silage than conventional haylage. Maintaining an airtight storage is also more difficult with this system. It is very important to carefully manage the harvest, storage and feeding of round bale silage to provide good, quality feed.

Silage-Making Process

To appreciate the factors contributing to quality in round bale silage, an understanding of the silage-making process is necessary. The ensiling process results in the acidification of forage material as a result of fermentation in the absence of oxygen.

There are two main phases in the ensiling process. The first is an aerobic phase. Oxygen is consumed by living plant material through the process of respiration. Plant enzymes and microbes consume oxygen and burn up plant water-soluble carbohydrates (sugars) to produce carbon dioxide and heat. The idea is to minimize the time when water-soluble carbohydrates are being consumed. The longer the period of aerobic activity, the more heat is produced which will raise temperatures and increase the risk of heat damage.

The second phase is initiated when all the oxygen is used up. Anaerobic bacteria will begin to multiply rapidly and the fermentation process starts. Ideally lactobacilli species, which produce lactic acid using the water-soluble carbohydrates as an energy source, will predominate. The lactic acid will lower the pH of the silage. Fermentation stops after 2 to 4 weeks when the pH becomes so low that all microbial growth is inhibited.

Large Bale vs. Chopped Silage

Large bale silage is not chopped like conventional silage. It is, therefore, more difficult to exclude oxygen and obtain a well-packed, high-density package. Soluble sugars in the plant, which are used during fermentation, are less available and are released slower. Lactic acid bacteria that reduce pH in fermentation are less active, slowing fermentation. The final pH of large bale silage is usually higher than chopped silage and may be above a stable pH level. It is clear that problems may arise considering the challenges to fermentation of round bale silage. In practice, many farmers are successfully storing and feeding good quality material with this system. These farmers recognize the importance of crop maturity, moisture content, bale density, speed of storing, etc. that all come together to influence the quality of round bale silage.

Moisture Content

The moisture content of silage at storage is one of the more important factors affecting quality. Large bale silage can be stored at moisture levels ranging from 40% to 60%. At either end of the range, the risk of storage problems increases. Therefore, harvest should be geared to wilt material to an average of 50% moisture.

Many farmers prefer to harvest round bale silage on the “dry” side, which may be as low as 30% moisture. This exact moisture is difficult to establish at times because moisture determination on the farm is sometimes more qualitative than absolute. Drier forage makes handling bales easier, especially where loader equipment is small. The main problem is to
be able to exclude the oxygen. Dry silage contains more oxygen that must be used up in fermentation. It is extremely important to have tight bales made with a variable chamber baler when moisture levels approach 40%. It is difficult to make tight bales with mature forage because the coarse material won't pack but it is safer to wilt more vegetative alfalfa and grass to drier moisture levels. If the material is not well packed, more heat is produced from prolonged respiration. Heat damage may increase dry matter losses and bind protein, lowering the feed quality.

Extended wilting of the forage increases the risk of harvest losses. If the weather forecast is predicting rain, silage made on the wet side will reduce weather losses. Round bale silage should be stored without rain damage.

Silage stored too wet will have strong-smelling butyric acid rather than lactic acid formation. Butyric acid may be produced with moisture levels above 70%. Clostridial-type micro-organisms may also grow in this situation and reduce the quality of the silage. Bales with higher moisture content are more likely to freeze or have more effluent that collects at the bottom of the silage bags. Problems with frozen large bales have been reported. These problems are more apt to occur as moisture levels increase above 50% and during extremely cold winters.

Moisture levels from 45% to 55% offer the best storage for crops harvested for silage. The moisture in the silage should come mostly from the plant. Surface moisture from dew or rain doesn't appear to provide sufficient wetting for fermentation. Large bale silage from forage originally intended for hay that had been rained upon or that was just too tough to dry bale often will not store well. Large bale silage will salvage this type of forage but the product may lack the high quality expected.

Species and Maturity

Species and maturity of the forage affect silage fermentation. Early-flowering legumes and vegetative grasses contain adequate sugars for fermentation by bacteria. Protein and energy values for livestock are optimal at this stage. Our concepts of quality forage will produce the best material for fermentation.

Grasses are easier to ferment than alfalfa and red clover as they contain a higher sugar content than the legumes; in fact, close to twice the amount. Mature legumes may lack sufficient sugar content for good fermentation. Wilting concentrates the sugars in the plant so that a minimum content is present to complete fermentation.

These factors explain some of the reasons why it is more difficult to make silage with legumes than grasses. In second and third cuts, where regrowth is made up mostly of alfalfa, more attention must be paid to moisture levels and stage of cutting. This material is more difficult to ferment. If the alfalfa gets too mature and coarse, it may not pack in the bale, letting more oxygen in, which must be used up in fermentation. Stems may poke holes in the plastic, letting more oxygen in, allowing mold growth, especially in warm weather.

Baling and Handling

The key to good large bale silage is the exclusion of oxygen quickly and completely. Start with a very compact bale to reduce air pockets in the bale. Tight bales are made by reducing the tractor speed and picking up hay directly from the windrow that hasn't been raked. If raking is required to allow faster drying, try to maintain a wide windrow. Hard-core balers are preferred. Both roller and belt type balers can be used. Bale density should be in the range of 12 lb/ft³. This equates to a weight of 1200 pounds in a typical 4' x 4' round bale at 50% moisture. Plastic twine is recommended for tying bales, as the oil-based preservative in sisal twine will degrade plastic.

Bales should be moved to the storage area immediately. If left too long they will begin to heat and lose feed value. The sun may evaporate moisture on the outside of the bale, making stems brittle. Bales, especially higher-moisture bales, lose shape making them more difficult to wrap. Storage should be complete 6 hours after baling and not later than 12
Plastic Storage Type

The trend in storage systems is toward using stretch wrap on individual bales or continuous line wrappers. Polyethylene tubes are still quite widely used but many are using tubes of stretch plastic. Systems that minimize oxygen re-entry at feeding will reduce silage deterioration.

The major suppliers of plastic wrap will guarantee plastic for up to one year. Properties of plastic include ultra-violet light inhibitors, stretch, puncture resistance and stickiness. Cheaper plastic often is of reduced quality. Most manufacturers recommend at least four layers of plastic with up to six layers for storage up to a year.

Large bale silage may be stored in bags, tubes or stacks. The oxygen present within any of these "containers" is not sufficient to cause excess respiration. If the oxygen can be kept out successfully throughout the storage time, good quality, large bale silage can be made by any of these methods.

Storage Time and Location

The longer the time in storage the higher the risk of silage deterioration. Large bale silage which is fed out in the fall or winter has generally not been a problem. Cool temperatures work in favour of preservation, keeping microbial activity limited. When temperatures start to increase in late March, molds that were in the silage at low levels may develop into a problem. If fermentation hasn't been complete, spoilage will be more severe.

Farmers have observed fall silage put up in late summer or early fall does not change colour or have any acid smell. This indicates fermentation either did not take place or was very limited. Cooler temperatures and lower numbers of bacteria may be responsible. It is possible fermentation will start again as temperatures warm up in the spring, but this assumes oxygen has not penetrated over winter. This silage is best fed out during the fall and winter to avoid spoilage.

Plastic will attract rodents and just about any other animal capable of putting holes in plastic. The storage area should be clean of vegetation as much as possible to prevent cover for rodent movement and be protected from other animals.

Mold Development

Secondary mold growth may take place as round bale silage is removed from the tubes. If the silage has not properly fermented or contains high populations of yeast and / or mold, oxygen entering the tubes will quickly deteriorate the silage. The implications of oxygen breakdown are important with round bale silage systems using tubes because oxygen may enter the tube as soon as it is opened. Slow feed out through the spring and summer may cause problems. Bales should be fed within one week in the summer, two weeks in the fall and early spring, and four weeks during the winter after opening the tube or storage structure.

Livestock will usually still consume moldy material unless there are too many spores, which cause lung irritations. Humans can also be affected by these spores, which can lodge within the lungs. The acids produced by fermentation are volatile and thus may migrate from the bale if air enters or may also be leached with moisture migration. This leaves areas where molds may establish.
A white mold or yeast is very common. It produces a large spore which will not irritate lung tissue or cause feed refusal. Other molds which may occur are aspargillus, a grey / blue mold, which may aggravate allergies or abortions in cattle, and fusarium, a red or pink mold which can produce vomitoxin, T2, and other toxins that cause feed refusal, vomiting and estrogen production in livestock. The spores produced by the molds usually cause the most damage. White mold is not a problem but the other coloured molds should be regarded with care. The acids produced by fermentation inhibit mold growth. Fusarium grows at 40 - 60° F; but Aspergillus and Penicillin grow at 65 - 95° F. This silage would be just warm to the touch. As outside temperatures rise, the temperature of the material will rise into these ranges.

Manure should not be applied to the forage stand before harvest as this introduces undesirable bacteria to the forage which may stimulate mold growth. Raking seems to make the problem worse. Rain during wilting may splash soil-borne bacteria and mold onto the forage. Manure contamination will spoil a pocket of the bale but not necessarily the entire bale unless other problems exist.

Summary

We recognize that baleage does not reach as low a pH as chopped haylage. This means that greater emphasis must be put on good silage-making processes, especially the exclusion of oxygen. The length of storage time and how long the bales are exposed to oxygen before feed out must be adjusted to weather conditions. In general, successful use of baleage will involve:

1. Baling a good quality forage within 40% - 60% moisture content in a very compact, even bale.
2. Avoid contamination by manure use or from soil-borne bacteria splashed up with rains or by raking.
3. Store the bales quickly excluding the oxygen as soon as possible. Monitor bales to maintain a continuous seal.
4. Size the storage structure to allow efficient, quick feed out.
5. Use good quality plastic to produce a sealed environment.

Weather conditions are the prime reason that most people try the round bale silage system. The quality of the material produced, the use of existing equipment and the ability of scheduling harvesting operations to reduce the weather risk have increased the popularity of the system. It offers flexibility and the ability to store forage quickly if required. These reasons will increase the use of round bale silage in the future. It will be fed in more operations for longer periods of the year. Greater attention to the silage-making process will be needed to maintain the quality of the feed with these increased demands.

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