ALFALFA HAYLAGE AND SILAGE

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Even with extended grazing systems, typical winter weather conditions in Kentucky necessitate the production of some stored forage for livestock during winter. Hay has traditionally been the way of storing this forage. However, when rain occurs during haymaking operations, the losses can be severe both in yield and in forage quality. Harvest losses are greatest for very dry forage and are low for very wet material like direct cut silage. Silage offers an opportunity to avoid most of the rain damage during harvest because the crop only needs to be left out overnight in most cases to be ready to bale. One of the advantages of silage in preserving legume forages like red clover and alfalfa is that more of the leaf is retained when the crop is put up at a much higher moisture level.

FORAGE PRESERVATION

Climatic conditions in much of the U.S. necessitate the production of feed for livestock during winter. Hay is the most common storage form for this forage. Spring growth tall fescue and other cool season grasses are commonly harvested and stored outside in large round bales until feeding. Legume hay and mixtures with these grasses generally provide higher quality hay than grasses alone. Under typical storage conditions, weathering and other storage losses reduce the proportion of the grass hay crop available for livestock feeding by one-third or more. Legume and mixed hay is affected even more dramatically by hay harvesting and storage conditions. Recently developed techniques for preparation of round bale silage appear to offer an excellent opportunity for reducing preservation and storage losses in both yield and quality.

Preservation as silage rather than hay reduces total harvesting losses by reducing physical losses, which impact primarily the leaf component. At high moisture levels the leaves are not brittle and losses during raking are low. As moisture declines, the leaf component dries faster than the stem and can be susceptible to shatter even when average crop moisture is well above a safe level for baling hay. Our previous research showed that shattered leaf collected from alfalfa baled at moistures between 20 and 30% in mid-afternoon was extremely dry, near 10% moisture.

SILAGE FERMENTATION

Silage preservation depends upon the development and maintenance of anaerobic conditions. The ensiling process has predictable phases which are will understood. Aerobic respiration by plant enzymes and by microbes on the crop continues after the forage is ensiled. Plant enzymes oxidize carbohydrates and produce carbon dioxide, water, and heat. Plant proteases can cause proteolysis and

form peptides, free amino acids, and amides. Respiration is inhibited as anaerobic conditions develop. Some of the management practices recommended for conventional silage production, such as fine chopping, rapid silo filling, adequate compaction, and tight sealing are recommended in order to minimize this aerobic phase. With respect to rapid exclusion of oxygen and tight sealing, these same factors hold for the production of silage in round bales.

By greatly shortening the field exposure time required for curing, silage offers the opportunity to greatly reduce losses in alfalfa yield and quality during harvest. Compared with outside-stored round bales of hay, silage also reduces yield and quality loss during the storage process.

Good silage preservation depends upon the development and maintenance of anaerobic conditions. The ensiling process has predictable phases that have been described. For example, the respiration that is normal in the cut crop during curing continues after the forage is ensiled. Plant enzymes oxidize carbohydrates and produce carbon dioxide, water, and heat. Plant proteases can cause proteolysis and form peptides, free amino acids, and amides. Respiration is inhibited as anaerobic conditions develop. Some of the management practices recommended for conventional silage production, such as fine chopping, rapid silo filling, adequate compaction, and tight sealing are recommended in order to minimize this aerobic phase. With respect to rapid exclusion of oxygen and tight sealing, these same factors hold for the production of silage in round bales.

Once oxygen levels are reduced by aerobic organisms and plant enzymes, the second phase of the ensiling process involves the production of acids that reduce silage pH and which account for the preservation of the silage. Lactic acid bacteria should become the predominant bacteria, and lactic acid is often the predominant acid, although acetic and propionic acids may predominate in legume silages. Lactic acid bacteria are of two types, homofermentative that convert carbohydrates to lactic acid; and heterofermentative, which also produce acetic acid, ethanol, and mannitol in addition to lactic acid.

Fermentation can reduce silage pH to values as low as 3.5, however, wilted silages such as those that would ordinarily be used in baled silage may only reach pH's in the range of 4.8 to 5.2. Such silages are not as stable as more acidic silage but usually have lower fermentation losses. The extent of the pH decline depends somewhat on the amount of fermentable carbohydrates present. Fermentation is limited in haylage because of its low moisture levels and preservation depends on the maintenance of anaerobic conditions during the entire storage period.

Sugars and other readily fermentable carbohydrates are present in high concentrations in some silage crops, such as corn, making their preservation relatively simple. Perennial forages, especially legumes, however, may not have sufficient concentrations of fermentable carbohydrates to lead to final silage pH levels low enough to preserve the material as effectively as corn silage. Legumes such as alfalfa also have greater buffering capacities, meaning that more acidity is needed to reduce silage pH by a given amount. Even with these limitations, our research has shown that

alfalfa can be preserved very effectively as round bale silage. However, grass silages are generally easier to preserve than legume silages because grasses have a lower buffering capacity and sugar concentrations of 10 to 20%. Because of these differences, legume stands with a grass component would be most suitable for silage production.

BALED SILAGE

Most Kentucky producers do not have the choppers, wagons and silos necessary to move to a chopped-silage system. The round bale silage system offers an opportunity to gain the forage quality and yield retention of silage at a lower initial cost compared with a chopped silage system. All of the major forage crops grown in Kentucky can be harvested effectively as balage. In general, harvesting forage crops in the transition stage between vegetative (leafy, immature) and reproductive or flowering stage will produce the best compromise between yield and quality. Round baled silage has several advantages compared with hay or chopped silage but there are also concerns or disadvantages to consider.

Producing Baled Silage

Silage bales are frequently about twice the weight of similar-sized bales of dry hay. With variable chamber balers, bale diameter can be reduced to 42 to 48 inches if necessary to reduce bale weight. Bales should be formed as tightly as practical. Slower ground speeds during baling increases bale density. A dry-matter density of 10-12 lb per cubic foot is considered ideal. A typical silage bale (4 feet in diameter by 5 feet in length) should weigh 1300 to 1550 pounds and contain 600 to 650 pounds of dry matter. Bales can be handled using bale spikes prior to the wrapping process but avoid making holes in the plastic after wrapping because this will allow greater entry of air during the storage process.

Wrappers

Three main types of wrappers are available for use in producing round bale silage. Some are also capable of wrapping mid-sized or large rectangular bales as well as round bales. Wrappers vary widely in cost depending on the basic design and on options, such as the bale-loading arm, selected. Labor availability and the number of bales to be wrapped are major factors in selecting the best wrapper for a given operation. Based on UK research and experience of producers, it appears that the three-point hitch wrapper is suitable for smaller operations, wrapping 100 to 200 bales per season; the individual wrappers are suitable for producers wrapping 200 to 400 bales per season and the in-line wrappers are ideal for producers wrapping larger numbers of bales.

Individual Bale Wrappers:

Platform Wrappers. The most common type of wrapper is the individual bale wrapper that use a single roll of UV-treated stretch film. These wrappers vary widely in cost from about $5,000 to $12,000 or more depending on features. The recommended method for wrapping using these units is to overlap the plastic one-half of the previous layer. With this system two complete layers of plastic are applied with each complete revolution of the bale. We recommend 4 layers for the individual wrap machines unless the bales are very dry or intended for long-term storage, where 6 layers are preferred.

Swinging-Arm Wrappers. With this type of wrapper, the bale rests on powered rollers that turn it as an arm, with the film roll attached, swings around the bale. Hydraulic cylinders open the rollers to pick the bale up from the ground. Some have rollers underneath the frame to help support the weight of heavy bales.

Row Bale Wrappers

In-Line Wrappers. These wrappers consist of a large hoop on which two or three rolls of plastic film move around the bale as it is pushed through. Since no plastic is applied to the ends of the bales except for the beginning and end of the line, these types of machines use much less plastic than the individual wrap design. Because of this, we have recommended that 6 layers of film be applied during in-line wrapping. These wrappers generally cost slightly more than the upper-end of the individual wrap units.

Three-Point Hitch Bale Wrapper. With this unit, individual bales are wrapped from a single roll of film moved back and forth by the operator as the bale is turned. Film should overlap the end of the bale several inches to ensure that film contact is made with adjacent bales in the row. The continuous row is formed by jamming individually wrapped baled end-to-end. The first and last bales in the row should be wrapped completely by hand or a plastic barrier inserted and dry hay bales applied in order to avoid deterioration during storage.

Other Considerations

Recommended moisture levels for baled silage are generally between 45 and 65%, covering the range between wilted silage and haylage. The ideal moisture appears to be 50-60% because there is considerable fermentation in that range and less heat damage and mold are observed compared with low-moisture silage. As an alternative to rain damage on windrows, baling and wrapping at lower moisture levels around 30% may salvage the crop, however, our observations indicate that significant mold can occur on alfalfa bales wrapped below 40% moisture.

Damage to plastic during handling or storage can introduce oxygen into the bale and allow spoilage. Any holes made during bale transport and placement into storage should be repaired immediately by taping. Holes allow oxygen to enter and lead to the

same problems that occur if bagging is delayed too long. To minimize storage losses due to spoilage, we suggest in Kentucky that bagged silage bales be fed during the winter following their production and that baled hay be carried over if excess feed is available. The storage period for bagged or wrapped silage is also reduced by baling the fall cut of alfalfa or other forages that comes during October or November in this area when hay curing conditions are generally very poor.

Cost

With four layers of film and an individual wrap machine, plastic cost per bale is around $2.50. In line wrappers use much less plastic per bale even with 6 layers, probably no more than one-half the amount used by individual wrapping. The cost of the machine itself will vary depending on the unit itself and on the number of bales wrapped. Several counties have purchased wrappers that are made available to producers. As wrapping becomes more common, custom operators are also becoming available in some areas.

SUMMARY

Baled silage offers a way for Kentucky farmers to conveniently and inexpensively produce silage with present hay making equipment (adapted to wet forage). Bale wrappers vary in cost from approximately $3,000 to over $18,000 depending on the level of automation and control desired. The benefits of making baled silage come from more timely harvest, lower dry matter losses during curing and storage, less chance for rain damage, and better retention of leaves in high quality forage crops like red clover and alfalfa. Disadvantages include handling heavy bales, maintaining plastic integrity, adapted baling equipment to handle wet forage, and plastic disposal.