Harvest Management to Maximize Yield and Quality

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Introduction

Putting up quality alfalfa hay is a complex process that requires a great deal of expertise and some cooperation from nature as well. After all the decisions about what variety to plant, what fertilizer to use, and how much to irrigate have been made, a number of decisions concerning harvest management must be made. Many of these decisions will determine the profitability of the alfalfa hay operation. The objective of the hay producer is to produce as much hay as possible with adequate quality to meet market demands. To reach that objective the grower must wisely decide when to cut the alfalfa, how high to cut it, how wide a windrow to use, when and how to rake the windrows, and when and how to bale the hay. It is important not only to cut high yielding high quality hay but to maintain that quality through the curing and baling process as well.

When to Cut

One of the most important decisions is when to cut. To adequately understand when to cut one must understand how the alfalfa plant changes over time. Alfalfa grows fastest in the vegetative and bud stages prior to flowering. Yields are highest when plants are cut during early flowering (often called 10% bloom). Unfortunately, forage quality declines as the plant matures and falls below levels required by many dairy producers prior to 10% bloom. Thus there is often a compromise made between high yield and high quality. Several methods of harvest scheduling have been used including fixed time intervals, stage of growth, and crown shoot development.

Fixed Time Intervals

Harvest scheduling is often determined by a fixed time interval between cuttings. This is convenient for coordination with other field activities such as irrigation. Much research has been conducted on the effect of fixed cutting schedules on alfalfa yield and quality. The problem with fixed time intervals is that they do not allow for differences in temperature from location to location and from year to year which affects both growth and quality.

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Stage of Development

Harvest scheduling is also determined by stage of development. A harvest schedule based on plant maturity depends on the plant's stage of development and the number of harvests possible in a season. In general, cutting according to stage of development is superior to fixed intervals for consistent forage yield and quality. There are two methods of staging alfalfa plants. One is based on early work where developmental stages are broadly categorized as vegetative, bud, flower, and seed pod. Further refinement in stage may be expressed as percent, for example plants with 10% of the buds in flower would be called 10% bloom. As was seen in fixed interval schedules, a compromise between high yield and high quality may be necessary. Most investigations have shown that cutting at 10% bloom is the best compromise between yield and quality to optimize yield and quality. However, to meet dairy quality requirements harvesting at late bud may be required.

Another method for determining stage of development requires separating stems into 10 distinct stage categories. The stems in each category are then counted and stem number in each category is multiplied by the index value assigned to that category. This value is obtained for all categories and totaled. The sum of all values is then divided by the number of stems to give us an average stage called mean stage by count. This method is more time consuming than the previous method, but it provides researchers with a definite value for statistical analysis and regression. Using regression analysis, mean stage by count has shown to be highly correlated to forage quality. Research is continuing to validate this method for Northern California and other regions.

Crown Shoot Development

Harvests may also be determined by crown shoot development. Alfalfa regrows from buds located in the crown, the junction of the stem and the root at or below ground level. In northern areas where dormant varieties are used this method is not superior to stage of development because environmental conditions such as drought and lodging may affect new shoot elongation. In areas where flowering is not a dependable indicator of plant maturity (where lygus bugs blast flower buds or plants do not flower due to day length) crown shoot development may be superior. The rate of recovery following cutting is increased if crown shoots are present below cutting height. In general, cutting when crown shoots are present but less than 2 inches tall will optimize yield. Crown shoot growth is not as closely correlated to forage quality as stage of development.

It is possible to combine these three methods into an integrated system were all three have a place. The first cutting date can be determined by stage and subsequent harvests can be on a fixed schedule to fit with other farming operations. When checking stage of growth it would be wise to check for crown shoot length to ensure that they are not above cutting height.

How High to Cut

In general, forage yield increases as cutting height decreases. In most instances a stubble height of 2 inches will provide ample sites for regrowth while not significantly reducing yield. Higher cutting heights may be needed in frequent cutting schedules where the number of crown buds is diminished. However, stems arising from axillary buds provide less regrowth than stems originating from crown buds. In areas where snow pack is an important source of moisture, tall stubble left after the last cutting can trap snow. This not only would provide more moisture but would provide insulation reducing extremes in soil temperature.

Keeping What You Cut

Loss of dry matter at harvest can vary from 15 to 100%. Under good drying conditions, average losses are between 15 and 18%. After having taken such care to produce a high quality crop it is important not to loose yield or quality during the hay curing and baling operation. Losses in dry matter and quality occur due to rain, mechanical damage, and plant respiration. Rain commonly causes yield losses of up to 30% with a loss of 50% reported for heavy rain. Rain followed by inclement weather can result in total loss of the crop.

Mechanically Induced Loss

Alfalfa is handled by a number of machines during the cutting, curing and baling processes. In each operation some material is lost due to leaf shatter or breaking stems. Average losses due to mechanical handling range from 6 to 33% with instances of higher losses when hay is badly miss handled. In mowing and conditioning there is generally a 1 to 5% loss of dry matter when using a cutter bar and conditioner. Losses with a flail harvester are 6 to 11%. Losses when using a cutter bar and conditioner may be minimized by proper adjustment of both mechanisms. Sharp blades and proper alignment are important. A well adjusted conditioner can reduce losses by 1%, while severe conditioning will increase losses by 1 to 2%.

Tedding increases drying rates with only a 1 to 3% loss in yield when done properly, but tedding when alfalfa is dry can result in losses of 20% or more. Alfalfa is more prone to leaf loss as it dries. When moisture content drops below 30% shatter increases dramatically. Tedding is recommended at moisture contents of no less than 50%, but best results are obtained at 60% moisture. Windrow inverters are more gentle than tedders and usually only result in 0 to 1.5% loss in yield. Some material lost may even be recovered during raking.

Raking can result in yield losses ranging from 1 to 20%. Losses at raking vary due to hay moisture content and windrow density. Crop losses increase as hay moisture content decreases, particularly when moisture content drops below 30%. Thin windrows are more prone to shatter and loss than full windrows. Comparison of various rakes has produced variable results. However, wheel and side delivery designs seem to be similar in yield loss and rotary wheel and transverse chain designs produced more shatter. Increased losses with the later two designs is due to a sweeping action that pulls material through the stubble.

Baling generally results in losses of 2 to 5%, with greater losses possible if very dry hay is baled. There is more material lost in making round bales than the smaller rectangular bales. Yield loss at baling can occur as material is picked up and feed into the baler, pickup loss, or as material is compressed in the bale chamber, chamber loss. Pickup loss decreases in heavy windrows. Raked hay is less prone to pickup loss than unraked hay due to twisting that occurs in raking. Material that is twisted and entangled feeds more easily into the baler. Ground speed should not exceed the rotating speed of the pickup device in order to minimize pickup loss.

Chamber loss is most affected by moisture content of the hay. Night baling with moisture content at 18% will reduce chamber loss by half. Leaves loose moisture at a faster rate than stems but also rehydrate at a faster rate. Much of the moisture taken up at night is absorbed by the leaves, making them less prone to shatter. Most mechanically induced loss does not appreciably affect forage quality; however, chamber loss is 80% leaves and can lower forage quality significantly.

Respiration Loss

Plant respiration after cutting can result in up to a 19% reduction in yield. The plant continues to respire using valuable energy until it reaches 26 to 40% moisture. If the plant dehydrates and respiration stops in late afternoon, it may rehydrate at night and resume respiration. It is important to drop the moisture content of the plant below this level as quickly as possible. The soluble carbohydrates, which are the feed component most readily utilized by ruminants, are the fuel consumed by the plant in respiration. Plant respiration lowers feed energy levels and increases fiber in ADF and NDF analysis. Little plant protein nitrogen is lost due to respiration; however, protein may be converted to less available forms during respiration. Respirational losses are greatest in warm humid conditions and least in dry hot conditions. Under good drying conditions, respirational yield losses are 3 to 4%.

The Need for Speed

Rapid drying is important not only to reduce plant respirational losses, but to reduce the time drying hay covers growing plants, to reduce sun bleaching, and shorten the time between cutting and irrigation. Every day hay is laying in a windrow is a day of photosynthesis lost. Harvest management practices that will increase hay drying rates include wide windrows, conditioning, and proper tedding and raking.

Windrow Width

Research at the Klamath Experiment Station has shown that wide windrows dry faster than narrow windrows. A 6 foot wide windrow had a moisture content of 19.1% after

3 days of drying, while a 3 foot wide windrow had a moisture content of 32.8%.

Conditioning

Mechanical conditioning reduces the resistance of the plant cuticle and epidermis to water movement out of the plant. The effect of conditioning is most obvious after the plant has dehydrated to the point of stomatal closure and drying slows considerably, about 60% moisture content. Most commercial alfalfa operations have some form of mechanical conditioning. Conditioning can also be accomplished through the use of chemicals. Sodium and potassium bicarbonate is commonly applied to alfalfa at swathing to break down the plant cuticle and speed drying much as mechanical conditioning does. Chemical conditioners are effective on alfalfa and other forages with true stems. Chemical conditioners do not compensate for poor drying conditions and may not be as effective in poor drying conditions. The use of both mechanical and chemical conditioning does have a small but significant additive effect. Chemical conditioning increases the rate of reabsorption of water in a rain event and may contribute to increased losses due to leaching.

Summary

Maximizing yield and quality requires cutting at the appropriate time or stage of growth. To maximize yield and nutrient production cutting at flower initiation is appropriate. To produce higher quality hay required by many dairies, cutting at mid to late bud is required. Mean stage by count is another method for determining plant maturity and forage quality. Validation of this method in your area may soon provide another means of predicting forage quality and thus when to cut. Do not neglect examining crown buds for shoot elongation prior to cutting. Best regrowth is obtained by cutting after crown bud elongation has started but before crown shoots are above cutting height. To insure the maintenance of high quality hay through the curing and baling process do not handle hay (tedding, inverting, raking) when the hay is too dry. Baling losses can be minimized by raking windrows, maintaining an appropriate ground speed, and baling at night with a moisture content of around 18%. Respirational losses may be minimized by drying hay as quickly as possible. Rapid drying is facilitated by wide windrows and adequate conditioning. Properly adjusted machinery will reduce loss throughout the haying operation.