

# **31<sup>ST</sup> KENTUCKY ALFALFA CONFERENCE PROCEEDINGS**



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Garry Lacefield & Christi Forsythe, Editors*

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*Fayette County Extension Office  
Lexington, Kentucky*

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University of Kentucky • College of Agriculture • Cooperative Extension Service  
Kentucky Forage and Grassland Council  
Kentucky Department of Agriculture

## Schedule for the Day

- 7:30 Registration, Visit Exhibit, Silent Auction
- 8:00 Welcome - Dr. Garry Lacefield
- 8:15 Alfalfa Varieties for Today and Tomorrow - Dr. Ray Smith
- 8:30 Keys to Getting a good Stand of Alfalfa - Dr. Garry Lacefield
- 8:45 Making your Fertilizer Dollar go Further - Dr. Greg Schwab
- 9:00 Hay Drying, Preservatives, Conditioning, Ash Content, etc. - Dr. Dan Undersander
- 9:45 Discussion
- 10:00 Break, Visit Exhibits, Silent Auction
- 10:30 Alfalfa Hay for Horses: Myth vs. Reality - Dr. Laurie Lawrence
- 11:00 Dollars & Cents of Alfalfa Production - Mr. Kenny Burdine
- 11:30 What's New in Hay Harvesting Equipment - Dr. Dan Undersander
- 12:00 Lunch and Alfalfa Awards
- 1:00 KFGC Business Meeting
- 1:30 Silent Auction Results
- 1:45 Forage Spokesman
- 3:00 Adjourn

# FOREWORD

This conference marks the thirty-first consecutive year we have come together to address problems and potentials of alfalfa. We are certainly encouraged with the interest in and opportunities for alfalfa in Kentucky. We are optimistic that we will observe expansion in acres, yield, and markets. It is our hope that the information presented herein and the discussions of the day will be of value to each of you in your alfalfa program.

On behalf of the Program Committee, I would like to express our thanks to each of you for your faithful participation over the past thirty-one years. I also want to thank all speakers, moderators, committee members, and workers for their many contributions.

My personal thanks to the Program Committee, the Kentucky Forage and Grassland Council, and the Kentucky Department of Agriculture for their encouragement and assistance. I also want to thank all the exhibitors for their important contributions and financial support. A special thanks is extended to Mrs. Christi Forsythe for her assistance in preparing and editing the program and proceedings.

Garry Lacefield  
Program Chairman  
XXXI Annual Kentucky Alfalfa Conference

**Visit our Extension Forage Website**

**<http://www.uky.edu/Ag/Forage>**

## KENTUCKY ALFALFA AWARDS

The Kentucky Alfalfa Awards Program was initiated in 2000 at the 20<sup>th</sup> Anniversary of the Kentucky Alfalfa Conference. The Awards Program is funded annually from revenues generated each year for the Silent Auction during the Annual Conference.

<b>Year</b>	<b>Warren Thompson Industry Award</b>	<b>Charlie Schnitzler Producer Award</b>	<b>Garry D. Lacefield Public Service Award</b>
2011	Bill Bracy	Todd Clark	Dan Undersander
2010	Jeff Medlin	Charles Powell	Don Ball Joe Bouton
2009	Ken Carpenter	John McCoy	Ray Smith
2008	Mike Phillips	Clayton Gerald	John Baylor
2007	Bret Winsett	Bill Payne	Dan Grigson
2006	Scott Cooper	George Eckler	Laurie Lawrence
2005	Barney Booher	Roy Reichenbach	Ken Johnson
2004	Gary Coughlin	Minos Cox	Mike Collins
2003	Phil Howell	Lee Robey	Monroe Rasnake Jimmy Henning
2002	Tom Keene	John Nowak	Billy Ray Smith
2001	Bill Talley	Larry Jeffries	Timothy H. Taylor W. C. Templeton, Jr.
2000	Warren Thompson	Sue Schnitzler*	Garry Lacefield

\*Accepted on behalf of her father who was tragically killed in a farming accident on March 11, 1991.

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# ALFALFA VARIETIES FOR TODAY AND TOMORROW

*S. Ray Smith*

Forage Extension Specialist  
University of Kentucky

There are a number of new alfalfa varieties that have come on the market in the last few years. In fact, it can be hard keeping up with all the developments. In the following pages I will overview most of the important traits that can be found in new varieties. These include Roundup Ready®, potato leafhopper resistance, hybrids, lodging resistance, rapid regrowth, higher quality, resistance to new diseases, and more... Many times I am asked “Are new varieties really worth the cost?” The best way to answer that question is to consider work by Dr. Jimmy Henning where he summarized 24 location years of Kentucky alfalfa yield data and found that the best 5 varieties in each test yielded 0.9 tons/A higher than the checks. Over a 5 year stand life this conservatively translates into more than \$400 added profit. New varieties can make a difference! That being said, the most important thing that you should do when you go to your local seed dealer is to be an educated consumer. Review recent variety test results by going to the Kentucky Forage Website at [www.uky.edu/Ag/Forage](http://www.uky.edu/Ag/Forage) and clicking on “Forage Variety Trials” or “Forage Trials: Other States”.

## **Roundup Ready® Alfalfa**

The most significant thing in alfalfa varieties for 2011 is the January 27, 2011 decision by USDA to deregulate Roundup Ready Alfalfa (RRA) without conditions. This was the final step in an extensive environmental review process by the USDA over the last 46 months. If you would like to know more about the safety of Roundup Ready Alfalfa you can review the complete Environmental Impact Statement at: [http://www.aphis.usda.gov/biotechnology/downloads/alfalfa/gt\\_alfalfa%20\\_feis.pdf](http://www.aphis.usda.gov/biotechnology/downloads/alfalfa/gt_alfalfa%20_feis.pdf). Most importantly, seed dealers in Kentucky and surrounding states should hopefully have Roundup varieties for this spring seedings.

Extensive research shows that Roundup Ready® varieties have excellent tolerance to Roundup, good disease resistance, and good yield potential. Roundup tolerance is definitely a useful trait in alfalfa, but Roundup Ready® varieties are not necessarily superior for other traits. Roundup Ready® varieties will be best used on fields where traditional weed control strategies have been unsuccessful. Some current advertisements promote Roundup Ready® varieties as significantly higher yielding and higher quality. These statements are not untrue, but they are based on the fact that weedy stands are lower yielding and lower quality than clean stands. Therefore, if you keep your existing stands weed free, then you will also produce high yields of high quality forage.

The advantages of Roundup Ready® alfalfa are self-explanatory, but let me list a few advantages: Improved likelihood of successful establishment, decreased competition from weeds and/or cover crops, decreased crop injury from herbicides, increased management flexibility, no crop rotation restrictions, decreased herbicide costs, and ease of use. There are a few things to remember when planting these varieties. For example, the first varieties released have about 90% Roundup tolerant plants and about 10% conventional plants. That means when you spray Roundup the first time, you will kill around 10% of your stand. Therefore, know that some alfalfa plant death is normal. Monsanto recommends that you use an early spray even if weeds populations are low. If you wait until the stand is more mature, the loss of the conventional plants might leave spaces in the field. Roundup Ready® alfalfa varieties will be available in multiple brands with the same combination of traits/germplasm available to growers in conventional varieties.

### **Potato Leafhopper Resistance**

Plant breeding companies have continued to make progress in the development of potato leafhopper (PLH) resistant varieties. These varieties not only show high levels of resistance to PLH feeding, but also have good forage production and high levels of disease resistance. The most recently released varieties have been through 4 to 5 stages of improvement since the first varieties came on the market almost 15 years ago. For example, results from a regional trials seeded in Ames, IA and S. Charleston, OH in the showed that the newest PLH resistant varieties yielded 15 to 50% higher than the checks during the seeding year when subjected to PLH feeding. To review the most recent potato leafhopper variety resistance trials in Ohio go to: <http://oardc.osu.edu/forage2010/table6.asp>. Note: even the most resistant varieties may require an insecticide spray during the seedling year since young plants are the more venerable to damage.

### **Standfast® Technology**

CalWest Seeds has continued to develop their line of alfalfa varieties with Standfast® Technology. This trademarked phrase refers to varieties with improved lodging and/or improved rate of regrowth. Company data indicates that these varieties showed minimal lodging in tests where other varieties were almost flat (note: try to cut any alfalfa before it lodges, but that's not always possible especially during rapid spring growth). Interestingly, the European genetics that provides lodging resistance also provides for faster regrowth. The first variety with this trait "Attention" was not well adapted in Kentucky, but new varieties show a good combination of yield, lodging resistance, regrowth, and disease resistance.

## **Hybrid Alfalfa**

Dairyland Seeds released the first hybrid alfalfas in 2001 after many years of development. Research over the last 50 years has shown that hybrid alfalfa has the potential to significantly increase alfalfa yield. There is still some debate as to whether a hybrid variety will show significantly higher yield at each cutting, but a University of Wisconsin report indicated that hybrids consistently yielded in the top 10% of varieties over 25 test environments [www.uwex.edu/ces/crops/uwforage/HybridAlfalfa.html](http://www.uwex.edu/ces/crops/uwforage/HybridAlfalfa.html). In other words, hybrids definitely appear to show strong yield stability from location to location. This translates into a variety that should show high yield on your farm. Dairyland has continued to improve the technology they use to produce hybrid seed and the genetics of the varieties. The latest hybrid alfalfa varieties are worth considering in your operation.

## **Improved Quality**

WL Alfalfa and other companies have made significant improvements in alfalfa quality over the last 10 years. WL's merger with Forage Genetics International in 2000 has meant a combining of forces in the development of improved quality varieties. If you are producing for a market that pays for top quality then a high quality variety may be an option for you. Remember though that cutting management is still the most important factor to insure high quality. When comparing varieties advertised for high quality, make sure to compare at the same stage of maturity. Almost without exception, an alfalfa variety cut at the bud stage will be higher quality than one cut at a bloom stage.

## **Grazing Tolerance**

Americas Alfalfa and other companies have released a number of grazing tolerant varieties during the late 20 years. In the last 10 years, grazing tolerance has been combined with traffic tolerance to provide further benefits from dual purpose alfalfa plantings. If you are planning to pasture your alfalfa stand for much of the growing season, then consider planting a grazing tolerant variety. Before planting, consult variety test bulletins that show variety differences to grazing tolerance. In Kentucky, go to [www.uky.edu/Ag/Forage](http://www.uky.edu/Ag/Forage), click on "Forage Variety Trials" and look at the Alfalfa Grazing Tolerance Reports from the last few years.

## **General Purpose Alfalfa**

One of the major goals of all alfalfa breeding companies is the development of solid general purpose varieties with high yield, good disease resistance, and long stand life. Pioneer is one such company that continues to produce good general purpose alfalfas for their customers. In addition to solid varieties with proven performance,

Pioneer has recently released varieties with potato leafhopper resistance, lodging resistance and other traits.

### **New Traits: Bloat Resistance, By-pass Protein, Pharmaceuticals, etc...**

A tremendous amount of research is taking place on the development of biotech or genetically engineered alfalfa varieties. These include the development of bloat resistant alfalfa through the expression of tannins. Low levels of tannins would also provide by-pass protein. Progress is being made on "low lignin alfalfa" that will result in improved fiber digestibility. The USDFRC estimates that a 10% increase in cell wall digestibility (from lower lignin) would increase milk and beef production by \$350 million/yr and reduce manure production by 2.8MM tons/yr. Companies are developing biopharmaceutical products using alfalfa as the protein production platform. In other words, alfalfa is genetically engineered to produce pharmaceuticals which are later extracted from the plant material. The recent deregulation of Roundup Ready Alfalfa should now make it easier for other genetically modified alfalfa varieties to come on the market.

### **New Varieties for 2011**

For a complete listing of alfalfa varieties go to [www.alfalfa.org](http://www.alfalfa.org) and download the Alfalfa Variety Leaflet. This was published before Roundup Ready Alfalfa was approved so check with your local seed dealer for the Roundup Ready varieties they are carrying. In the November 2010 issue of "Hay and Forage Grower" Fae Holin overviewed the 37 new conventional, proprietary alfalfa varieties available this year. Nineteen are listed in the National Alfalfa & Forage Alliance NAFA pamphlet (NAFA) pamphlet. Since alfalfa varieties in the fall dormancy range of 3, 4 and 5 are best adapted to Kentucky, I will only list these below:

#### **Fall Dormancy 3:**

eXclaim, marketed by LG Seeds and AgReliant Genetics, exhibits moderate multifoliolate leaf expression. It has high resistance to anthracnose, race 1; aphanomyces, race 1; bacterial, fusarium and verticillium wilts; phytophthora root rot; pea aphid; and stem nematode. The variety is resistant to blue alfalfa aphid.

Ezra, sold by Seedway, LLC, has high resistance to anthracnose, race 1, and fusarium wilt; with resistance to phytophthora root rot and verticillium and bacterial wilts. The variety, developed by Cornell University breeders, is susceptible to aphanomyces, race 1.

## Fall Dormancy 4:

4S417, from Mycogen Seeds, has high resistance to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; aphanomyces, race 1; and northern root knot and stem nematodes. It provides moderate resistance to southern root knot nematode.

AmeriStand 445NT, marketed by America's Alfalfa, exhibits moderate multifoliolate leaf expression. The variety has high resistance to bacterial and fusarium wilts; phytophthora root rot; spotted alfalfa aphid; stem nematode; anthracnose, race 1; and northern root knot nematode. It shows resistance to verticillium wilt; aphanomyces, race 1; and pea aphid.

AV4211, from AgVenture, has high resistance to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; aphanomyces, race 1; and stem and northern root knot nematodes. It is resistant to aphanomyces, race 2, and offers moderate resistance to southern root knot nematode.

Dairyland Seed's HybriForce-2420/Wet is a branch-root hybrid alfalfa offering high resistance to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; aphanomyces, race 1; and northern root knot and stem nematodes. It shows resistance to aphanomyces, race 2, and southern root knot nematode.

LS 604, marketed by Byron Seeds, has high resistance to anthracnose, race 1; bacterial and fusarium wilts; phytophthora root rot; and aphanomyces, race 1. It is resistant to verticillium wilt.

Legacy 449-APH2, from Legacy Seeds, is highly resistant to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; and aphanomyces, races 1 and 2.

A Chemgro Seeds variety, Milestone II is highly resistant to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; aphanomyces, race 1; and stem and northern root knot nematodes. It shows resistance to aphanomyces, race 2, and southern root knot nematode.

Radiance HD, from Ampac Seed, has high resistance to anthracnose, race 1; bacterial and fusarium wilts; phytophthora root rot; and aphanomyces, race 1. It is resistant to verticillium wilt.

Rebound 6.0, from Croplan Genetics, has high multifoliolate leaf expression. The alfalfa has high resistance to anthracnose, race 1; bacterial, fusarium, and verticillium wilts; phytophthora root rot;

aphanomyces, races 1 and 2; and spotted alfalfa aphid. It's resistant to pea aphid and stem nematode.

Red Falcon BR, from Blue River Hybrids, has high resistance to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; aphanomyces, race 1; and stem and northern root knot nematodes. It's resistant to aphanomyces, race 2.

ReNew, from T.A. Seeds, exhibits high resistance to bacterial, fusarium and verticillium wilts; phytophthora root rot; anthracnose, race 1; aphanomyces, race 1; and northern root knot and stem nematodes. It's resistant to aphanomyces, race 2, and shows moderate resistance to southern root knot nematode.

Seneca, marketed by R.M. Seeds, has high resistance to bacterial, fusarium and verticillium wilts; anthracnose, race 1; phytophthora root rot; aphanomyces, race 1; and stem and northern root knot nematodes. It shows resistance to aphanomyces, race 2.

NuTech Seed's Sonic has high resistance to bacterial, fusarium and verticillium wilts; anthracnose, race 1; phytophthora root rot; aphanomyces, races 1 and 2; and stem and northern root knot nematodes.

#### **Fall Dormancy 5:**

Triple Trust 500, from Central Farm Supply, has high resistance to anthracnose, race 1; bacterial, fusarium and verticillium wilts; phytophthora root rot; aphanomyces, race 1; and pea aphid. It's resistant to northern root knot nematode and shows moderate resistance to stem nematode.

#### **Marketing Company Contact Info:**

AgReliant Genetics – 317-896-5552; AgVenture – 888-999-0859; Ampac Seed – 541-928-1651; Blue River Hybrids – 800-370-7979; Byron Seeds – 800-801-3596; Central Farm Supply – 859-588-0265; Chemgro Seeds – 800-346-4769; Dyna-Gro Seed – [www.dynagroseed.com](http://www.dynagroseed.com); Legacy Seeds – 866-791-6390; LG Seeds – 800-752-6847; Millborn Seeds – 888-498-7333; Mycogen – 800-692-6436; Renk Seed – 800-289-7365; NuTech Seed – 800-942-6748; R.M. Seeds – 866-399-3640; Seedway, LLC – 800-952-7333; T.A. Seeds – 866-753-5503.

# KEYS TO GETTING A GOOD STAND OF ALFALFA

*Garry D. Lacefield*  
Extension Forage Specialist  
University of Kentucky

Profitable alfalfa production requires high yields of high quality forage, a long stand life and skillful marketing of the end product. This requires attention to details, timely action and advanced planning. There are four basic prerequisites for a successful alfalfa program: establishment, production, harvesting and marketing with a very specific goal within each component (Table 1).

<b>Table 1. Successful Alfalfa Production: Practices and Goals</b>
Establish for STAND Produce for YIELD Harvest for QUALITY Market for PROFIT

The first and critically important step is establishment. High yield will not be possible unless there are enough healthy plants to produce. Advanced planning and attention to details are required for establishment than any other area of production. Many steps are involved and MOST are controllable. Our challenge is to control the controllable so we end with a desirable stand capable of yield-quality-persistence and ultimately PROFIT.

## **Establishment for STAND**

1. Site Selection: Alfalfa requires a deep, well-drained soil for optimum production and stand life.
2. Soil test and fertilize: A soil test is the most economical investment in an alfalfa fertility program.
3. Variety selection: Variety selection can make the difference between profit and loss, between high yields and medium to low yields, between short stand life or longer stand life. At the University of Kentucky we test alfalfa varieties at different locations across Kentucky. See our website  
<http://www.uky.edu/Ag/Forage/ForageVarietyTrials>

[2.htm](#) or stop by your County Extension Office for the latest results of how these varieties perform under Kentucky conditions.

4. Inoculation: The majority of alfalfa seed sold is pre-inoculated. If raw seed is purchased, inoculate at the time of seeding with the proper strain of rhizobium.
5. Weed control: Use tillage or herbicides to begin with a clean weed-free seedbed. Weeds can dramatically reduce alfalfa stands, yields, forage quality and stand longevity.
6. Seeding: There are four major details that must be considered during the seeding process:
  - A. Select a seeding method that will result in uniform distribution and good seed-to-soil contact. Many methods for prepared seedbeds and no-till can be successful if the above is obtained.
  - B. Seeding dates are critical. Alfalfa can be seeded in late-winter, early spring or late-summer. Each has advantages and disadvantages and can vary drastically from year-to-year depending on the environment (remember last August-September with no water and very few acres were seed).
  - C. Seeding depth. Alfalfa has small seeds (225,000/lb). As a result, it is very easy to get it too deep. Regardless of seeding method, the seed should not be planted deep. The ideal depth for our soils would be approximately  $\frac{1}{4}$ - $\frac{1}{2}$  inch with good seed/soil contact. Alfalfa seed must absorb 125% of its weight in water so good seed/soil contact is critical.
  - D. Seeding rate. The normal seeding rate for alfalfa is 15-20 lbs/A.

The goal is to place viable seed of a good variety at the appropriate rate and date uniformly at the right depth and in good seed to soil contact. Accomplishing this will increase our chances of success.

During establishment, monitor new stands for signs of insects or weeds and control as required.

### **Summary**

It is difficult to predict the probability of success in establishing alfalfa when so much depends on weather. The steps outlined above do not guarantee success, but if followed, they can increase the probability of obtaining thick, vigorous alfalfa stands. Once these stands are obtained, the alfalfa must be marketed directly or through livestock, and perennial plants must be managed to keep stands for several years to realize top profits. Such management can avoid or at least minimize the re-establishment costs that can occur if alfalfa is not properly managed.

More detailed information is available at the UK Forage Website:  
<http://www.uky.edu/Ag/Forage/ForageVarietyTrials2.htm>

### **Selected References:**

Ball, D.M., C.S. Hoveland and G.D. Lacefield. 2007. Southern Forages 4<sup>th</sup> Edition. IPNI, Norcross, GA.

Lacefield, G.D., D. Ball, D. Hancock, J. Andrae, and R. Smith. 2009. Growing Alfalfa in the South. National Alfalfa and Forage Alliance. [www.alfalfa\\_forage.org](http://www.alfalfa_forage.org)

Lacefield, G.D., J.C. Henning, M. Rasnake, and M. Collins. 1996. Alfalfa: The Queen of the Forage Crops. AGR-76. U.K. Coop. Ext. Serv., Lexington, KY.

# MAKING YOUR FERTILIZER DOLLAR GO FURTHER

*Greg Schwab*

Extension Soil Management Specialist  
University of Kentucky

## **Introduction**

Alfalfa is a high quality, valuable forage crop that can be successfully produced on most well drained soils in Kentucky, for hay and silage, and for grazing. Fertilizing alfalfa can be uniquely challenging because it is a perennial crop. In addition, high-yielding alfalfa removes a tremendous amount of soil nutrients when compared to other crops grown in Kentucky. A thorough understanding of alfalfa's growth habits, nutrient requirements, and the soil nutrient supply mechanisms for alfalfa is necessary to effectively manage fertilizer inputs and maximize profitability while minimizing the environmental impact.

## **Fertilizing Perennial Crops**

The goal of any fertilizer management program should be to maximize the profitability of the crop. Growers should be aware, however, maximum yield and maximum profit are seldom the same. Often, additional yield can be obtained with additional inputs, but the cost of these inputs may exceed the value of the additional yield. Consider the example of an alfalfa producer who could increase his alfalfa yield by five bales per acre by adding 50 lbs of potassium fertilizer. The additional fertilizer would only be a wise decision if the value of the five bales exceeds the cost of the 50 lbs of fertilizer.

Perennial crops, like alfalfa, present an added challenge: one year's productivity is not the only topic of concern, but also the overall longevity of the crop. Often, early management decisions will determine the number of years the stand will remain productive. Fertilizer decisions prior to planting are particularly of importance, since this is the only opportunity the producer will have to incorporate immobile soil nutrients such as P and K. After planting, annual fertilizer applications can only be broadcast to the soil surface.

## **Alfalfa Establishment**

One of the most common mistakes producers make is not properly preparing for alfalfa establishment. Soil samples should be collected from perspective alfalfa fields at least the fall prior to planting. Actually, it is much better to sample a year and a half (two falls) before establishing. Early sampling gives the producer time to correct nutrient deficiencies and make adjustments in soil pH. Soil pH is probably the most important soil test measurement; the solubility of all other plant nutrients is a function of pH

(Figure 1). In addition to nutrient solubility, the survival of rhizobium (nitrogen fixing) bacteria is dependent on soil pH. If the soil pH is below 6.4, lime should be applied according to the soil test recommendation. Soil test recommendations should be adjusted depending on the quality of limestone that is available and the depth of mixing into the soil. Your local county extension agent can help make the needed adjustments. Added lime should always be incorporated into the soil. If more than 4 tons of lime are required, the lime should be mixed into the soil by applying ½ of the recommended rate before plowing and the other ½ after plowing followed by disking. The reaction of limestone is not immediate, so if the soil is extremely acidic (pH 5.3 or lower), it is advisable to collect new soil samples in the spring to reassess pH and the feasibility of planting. If the spring pH is below 6.2, the producer has four options: 1) delay planting for one year to allow the limestone more time to react, or 2) apply 1 lb sodium molybdate (6.4 oz of molybdenum) per acre 3). drill 400lb aglime per acre with seed. 5) use lime-coated seed. Uniform distribution of sodium molybdate can be achieved by broadcast application of 20 to 40 gallons of water per acre, followed by disking it into the soil. It is important not to add more than 2 lbs of sodium molybdate per acre during a given five-year period of time.

A productive stand of alfalfa removes many pounds of phosphorus (P) and potassium (K) per acre per year. The goal of your P and K fertilizer program should be to maintain soil test (Mehlich III) P at or above 60 lbs/acre and soil test K at or above 300 lbs/acre. Because of this goal, it is imperative to have soil test values at or above these levels at planting. If fall soil tests show low or very low levels of P or K, the producer should apply the recommended fertilizer in the fall, then resample in the spring and apply additional fertilizer if needed. Phosphorus and K are very immobile in the soil, so incorporation of these elements is also beneficial. Once the alfalfa is established, rhizobium bacteria living on the roots may supply all of the nitrogen (N) required by the crop. However, research has shown that 30 lbs N/acre applied at planting is needed for crop establishment.

### **Fertilizing Established Stands**

Adequately fertilized alfalfa removes approximately 14 lbs P<sub>2</sub>O<sub>5</sub> and 55 lbs K<sub>2</sub>O per harvested ton. This is a much higher nutrient removal rate than grain crops or pastures. However, nutrient removal rates alone cannot be used as the basis for fertilizer recommendations. Soils contain a large amount of nutrients in primary and secondary minerals. For example, a Crider silt loam in Princeton has 32,600 lbs/acre of total mineral K just in the surface 7 inches. The nutrients in these minerals are not extracted by the soil test solution, but are slowly available to the plant. Additional nutrients can be taken up from the subsoil and are also not measured in a routine 6 inch soil sample. For these reasons, soil test results are not absolute measurements of plant available nutrients, they only give an indication of the amount of fertilizer that is required for maximum productivity. Soil tests have been calibrated in Kentucky based on alfalfa yield response research trials. The results of these calibration studies are the foundation to the fertilizer recommendations (Kentucky Lime and Nutrient Recommendations AGR-1

found at <http://www.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf>). When soil test levels are above 50 lbs P/acre and 300 lbs K/acre research studies show that yield is not limited by these nutrients. In order to assure that yield is not limited, we recommend fertilization until soil test values (for the composite field sample) are 60 lbs P/acre and 450 lbs K/acre. Phosphorus and K recommendations in AGR-1 are designed to maintain soil test levels near 60 lbs P/acre and 300 lbs K/acre. Unfortunately, not all soils in the state have the same ability to supply nutrients (especially K) to the crop. Soils in the Pennyroyal region of the state, like the Crider mentioned above, have a tremendous amount of mineral potassium and do not require as much fertilizer to maintain the 300 lb/acre soil test level. Soils in the Bluegrass (especially outer Bluegrass) have an ability to convert fertilizer K to unavailable forms (K fixation), so these soils often require more potassium to maintain 300 lbs of soil test K. In order to accurately monitor soil test levels for crops like alfalfa, it is important for alfalfa producers to sample soil annually. With good sampling procedures, the producer will be able to fine-tune the fertilizer recommendations for the specific cropping system/soils. These changes should be made when a clear downward or upward trend is observed.

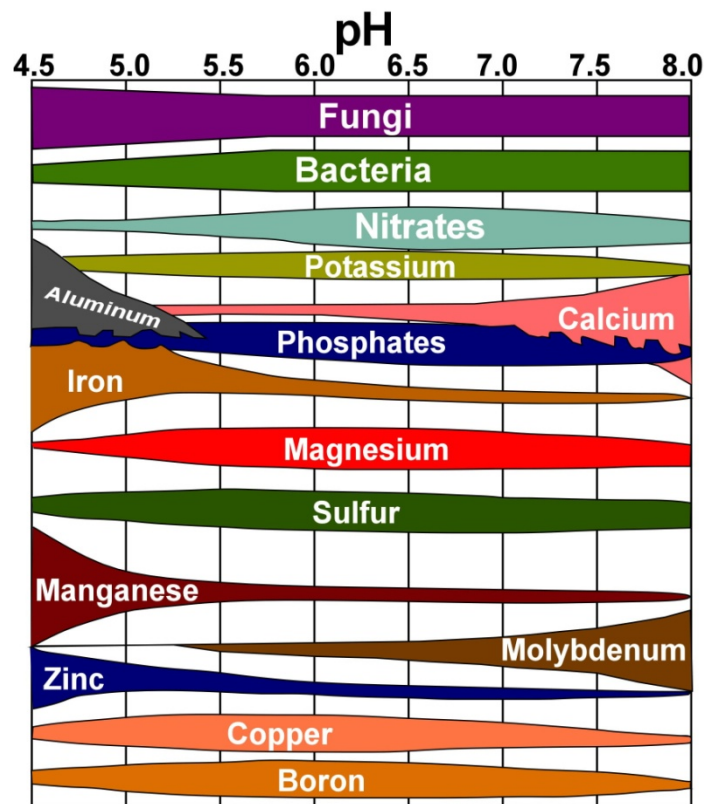
### **Avoid Luxury K Consumption**

Luxury consumption of potassium by forage crops is a phenomenon that should concern all forage producers. Simply put, luxury consumption occurs when a plant is supplied with more than adequate amounts of K. When an alfalfa plant is adequately fertilized, the K concentration in the tissue is usually between 2.5 and 3%. If the soil supply of K exceeds the needs of the crop, tissue K concentrations can be as high as 4.5%. For grain crops, like corn or wheat, luxury consumption is not a problem, because excessive K remains in the tissue (leaves and stalk) and is returned to the soil with the fodder. For alfalfa (and any other crop where the entire plant is harvested), the excessive K is removed as hay or silage and is not recycled in the soil. Luxury consumption can increase K removal rates to 90 lbs K<sub>2</sub>O per ton (55 lbs is normal removal). Probably the main drawback to luxury consumption is that fertilizer applied to increase soil test K can be immediately removed with the first harvest, leaving low soil test K and possibly causing future K deficiency.

There are several ways to limit the risk of luxury consumption. First, try to maintain soil test K near 300 lbs/acre, thus limiting the supply of K to the plant. At this soil test level, only small rates of K fertilizer will be recommended. Second, avoid applying any K fertilizer between the last fall harvest and the first cutting the following spring. The freezing and thawing of the soil through winter months usually releases enough K (from soil fixation sites) to supply crop needs for the first cutting. The first cutting is also the highest yielding cutting, so more hay harvested with a higher K concentration equals more lbs of K removed from the soil. If soil test K is allowed to slip below the medium range, then split applications during the summer months should also reduce the effects of luxury consumption.

## Conclusions

Properly managed alfalfa stands can provide profitable yields for 6 or more years, while poorly managed fields may not last more than three years. Understanding and managing the fertilizer input is one of the keys to alfalfa stand longevity. Analysis of UK soil tests relative to age of stand has indicated that many alfalfa stands failed (i.e. low stand count and weed encroachment) because soil K levels were not maintained by fertilization. It is critically important to have the appropriate soil pH, P and K levels prior to planting to obtain maximum plant density. Additionally, delaying nutrient application until after the crop has been established usually results in high fertilizer application rates, and increases the need for split application as well as the risk of luxury K consumption. Because of the valuable nature of alfalfa and the high rate of nutrient removal, soil samples should be collected in the fall of each year after establishment. Lime and phosphorus fertilizer can be added anytime, but K fertilizer should not be applied in the period between the last fall cutting and the first spring cutting. Taking these steps will maximize nutrient use efficiency and help to minimize the effects of rising fertilizer prices.



**Figure 1.** The availability of plant nutrients, toxic elements and microbial activity as influenced by soil pH. Wider bars indicate increased availability (activity).

# HAY DRYING, PRESERVATIVES, CONDITIONING, ASH CONTENT

*Dr. Dan Undersander*  
University of Wisconsin

Drying forage for hay has always been a challenge. While we cannot control the weather we can manage cut forage to maximize drying. The purpose of this paper is to give a few principles of hay and silage making and discuss machinery available relative to these principles. Then we will also talk about minimizing ash in hay to optimize the total digestible nutrients of the forage.

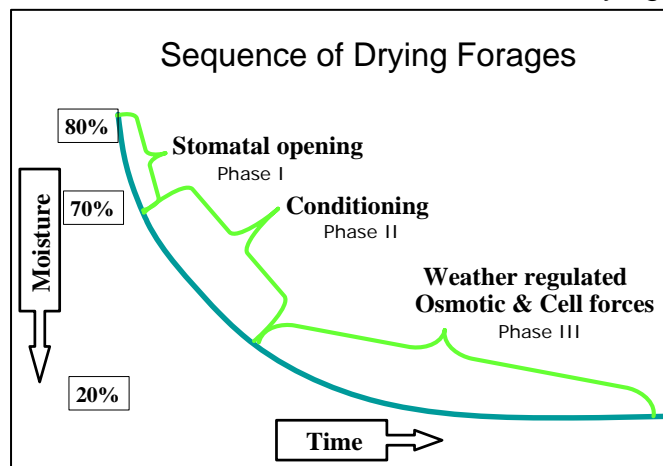
## Understanding Forage Drying

Our understanding of conditioning and the need for conditioning has changed as we have revisited the factors affecting forage drying. In drying hay we need to maximize use of sunlight to enhance drying to minimize fuel use and cost of drying. Remember that, if we cut a 2 t/a dry matter yield, we must evaporate about 5.7 tons of water per acre from the crop before it can be baled or 3 t/a of water per acre before it can be chopped for silage.

If we understand and use the biology and physics of forage drying properly, not only does the hay dry faster and have less chance of being rained on, but the total digestible nutrients (TDN) of the harvested forage may be higher.

The general pattern of drying forages is shown in the figure below. When forage is cut, it has 75 to 80% water and must be dried down to 60 to 65% moisture content for haylage and down to 12 to 16% moisture content for hay (lower figures for larger bales).

The first phase of drying is moisture loss from the leaves through the stomates. (Approximately 60% of plant water is in the leaves.) Stomates are the openings in the leaf surface that allow moisture loss to the air to cool the plant and carbon dioxide uptake from the air as the plant is growing. Stomates open in daylight and close when in dark and when moisture stress is severe. Cut forage laid in a wide swath maximizes the amount of forage exposed to sunlight. This keeps the stomates open and encourages rapid drying, which is crucial at this stage because plant

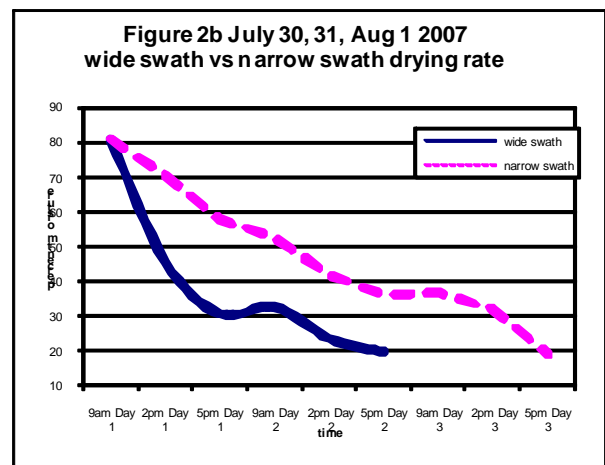
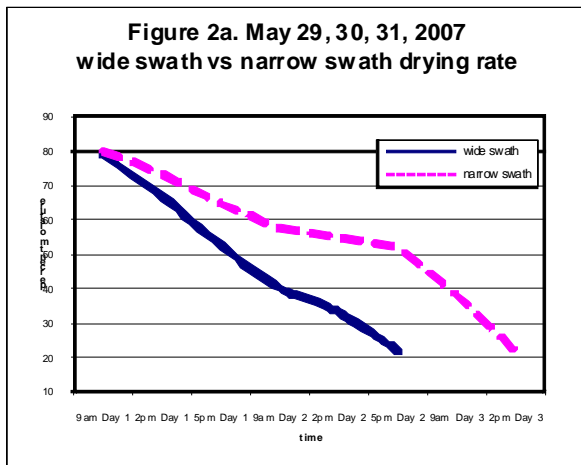


respiration continues after the plant is cut. Respiration rate is highest at cutting and gradually declines until plant moisture content has fallen below 60%. Therefore, rapid initial drying to lose the first 15 to 20% of moisture will reduce loss of starches and sugars and preserve more total digestible nutrients in the harvested forage. This initial moisture loss is not affected by conditioning.

The second phase of drying (II) is moisture loss from both the leaf surface (stomates have closed) and from the stem. At this stage conditioning can help increase drying rate, especially on the lower end.

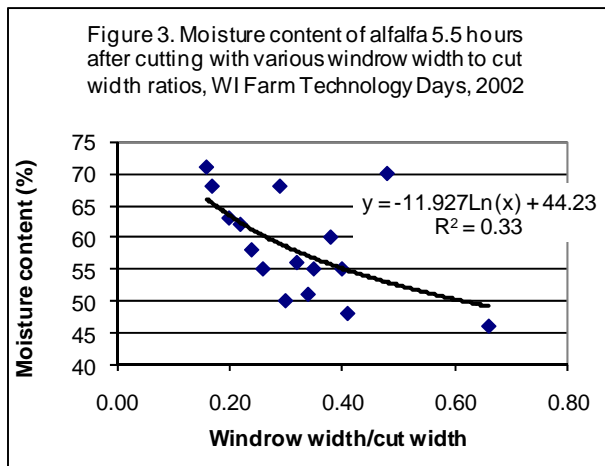
The final phase of drying (III) is the loss of more tightly held water, particularly from the stems. Conditioning is critical to enhance drying during this phase. Conditioning to break stems every two inches allows more opportunities for water loss since little water loss will occur through the waxy cuticle of the stem.

Understanding these principles will allow us to develop management practices in the field that maximize drying rate and TDN of the harvested forage. **The first concept is that a wide swath immediately after cutting is the single most important factor** maximizing initial drying rate and preserving of starches and sugars. In trials at the UW Arlington Research Station (Figure 2a & 2b), where alfalfa was put into a wide swath, it reached 65% moisture in 10 hours or less and could be harvested for haylage the same day as cutting. The same forage from the same fields put into a narrow windrow was not ready to be harvested until 1 or 2 days later!



In fact, **a wide swath may be more important than conditioning for haylage.**

The importance of a wide swath is supported from drying measurements taken at the Wisconsin Farm Technology Days in 2002 (Figure 3), where different mower-conditioners mowed and conditioned strips of alfalfa and put the cut forage in windrow widths of the operators' choice. Moisture content of the alfalfa was measured 5.5 hours after mowing. Each point is a different machine that included sickle bar and disc mowers and conditioners with, steel, rubber or combination rollers. Across all mower types and designs, the most significant factor in drying rate was the width of the



windrow. The machinery industry is rapidly responding to produce equipment that can make wide swaths.

In Figure 3, note the one outlying point at 70% moisture content and a windrow-width/cut-width ratio of 0.48. This shows how much drying can be slowed by improper adjustment of the conditioner.

We used to make wide swaths in the past, but have gradually gone to making

windrows that are smaller and smaller percentages of the cut area as mowers have increased in size. Generally, as mowers have gotten bigger, the conditioner has stayed the same size, resulting in narrower windrows. There is some variation among makes and models and growers should look for those machines that make the widest swath.

Putting alfalfa into wide swaths (72% of cut width) immediately after cutting results in improved quality of alfalfa haylage compared to narrow windrows (25% of cut width) in a study at UW Arlington Research Station in 2005 (Table 1). Alfalfa was mowed with a discbine, conditioned, and forage was sampled two months after ensiling in tubes. The alfalfa from the wide swaths had 2.3% less NDF, and 1.8% more NFC. The NFC difference is both a quality and yield difference as the 1.8% loss in narrow windrows was to respiration where starch is changed to carbon dioxide and lost to the air. The haylage from the wide swath had almost 1% more TDN and more lactic and acetic acid. The higher acid content would indicate less rapid spoilage on feedout and the overall improved forage quality would be expected to result in 300 lbs more milk per acre.

**Table 1 Difference in composition of alfalfa haylage made from narrow and wide swaths, UW Arlington, 2005**

Factor	Wide	Narrow	Difference
NDF, %	37.8	40.1	-2.3
NFC, %	38.4	36.5	1.8
Ash, %	9.3	9.9	-0.6
TDN, 1X	63.5	62.6	0.9
Lactic acid, %	5.6	4.6	1.0
Acetic Acid, %	2.4	1.9	0.5
Relative Forage Quality	166	151	15

Some are concerned that driving over a swath will increase soil (ash) content in the forage. In Table 1, the ash content of haylage from wide-swath alfalfa was actually less than from narrow windrows. While narrow windrows are not usually driven over, they tend to sag to the ground, causing soil to be included with the windrow when it is picked up. Wide swaths tend to lay on top of the cut stubble and stay off the ground. Further driving on the swath can be minimized by driving one wheel on the area between swaths and one near the middle of the swath where cut forage is thinner.

Grasses, especially if no stems are present, must be into a wide swath when cut. When put into a windrow at cutting, the forage will settle together, dry very slowly and be difficult to loosen up to increase drying rate.

In summary, an extensive series of studies Rotz and Chen collected 5,000 data points on conditioned alfalfa from 1977 to 1984 in East Lansing, MI. They recorded weather data including temperature, relative humidity, solar insolation and wind velocity, and crop-related data such as maturity, cutting, soil moisture content, swath density (width and yield) and swath surface temperature. When finished, Rotz and Chen had an equation that described 75% of the variability associated with hay drying. Their results state that hay drying is improved with increased plant surface area exposed to the sun, greater solar radiation, higher temperature and lower swath density. Their equation also states that drying is decreased with higher soil moisture. The factors not included in the model (e.g., wind speed and relative humidity) may also play a role in hay drying by either influencing other factors in the equation or making up the 25% of the variance not described by the equation.

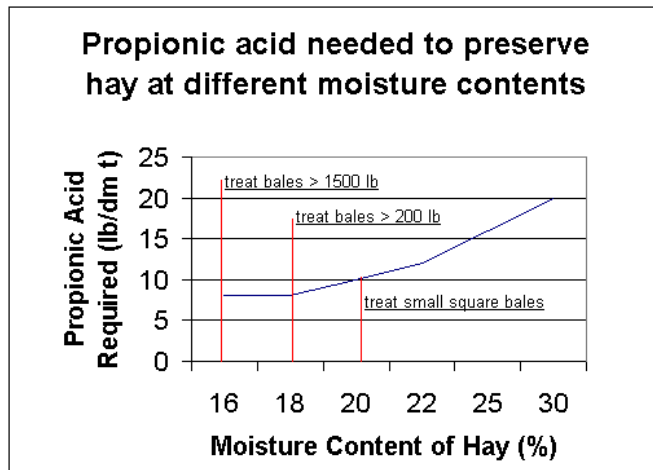
**Preservatives/Dessicants.** First, it is important to recognize that two totally different types of products with different modes of action are sold: one is a desiccant which is a compound applied to the hay at cutting to increase drying rate and the other is a preservative which is applied to hay as it is baled to allow baling of wetter than normal hay without spoilage during storage. Both products are usually applied through a spray system, which costs \$600 to \$1000, either on the mower (for dessicants) or on the harvesting equipment (for preservatives).

The desiccants that are effective contain potassium or sodium carbonate. This compound disturbs the waxy cuticle of the alfalfa stem to allow it to dry faster. Desiccants work only on legumes such as alfalfa, trefoil, and clovers. Effectiveness varies with climatic conditions. Desiccants reduce drying time most when drying conditions are good. Thus, they tend to work better on second and third cuttings in Wisconsin. They are recommended for hay making and are of less usefulness when forage is harvested as haylage.

Preservatives are applied to the hay as it is harvested and prevent heating and spoilage of hay baled at high moisture contents. Preservatives are cost effective if used only when needed to prevent rain damage to hay and if applied uniformly to windrow as it is entering the baler. The most effective preservatives for alfalfa are organic acids, (primarily propionate and acetate) and their derivatives such as sodium diacetate.

Propionate (propionic acid) has been most commonly used and any product containing a high percentage of this compound will be effective. Use of ammonium propionate (also called buffered propionic acid) rather than propionic acid is recommended because the product is less caustic - therefore safer to handle and less corrosive to machinery. When purchasing preservatives, compare cost on a per pound of propionic acid basis. Other additives do little if anything to preserve hay. Some hay preservative products dilute the propionic acid and require greater product use rates.

Rates of propionic acid required to preserve hay vary with the moisture content of the hay. As indicated in the chart above, the amount of propionic acid required varies from 10 lb/ton for hay at 20-25 % moisture, 20 lb/ton for 25-30 % moisture and 30 lb/ton for 30-35 % moisture. Note that rates are for pounds of propionate not product. Therefore a product with 50% propionate would need to be applied at twice the above rates.



Use of preservatives for hay above 35% moisture is not recommended.

Anhydrous ammonia is an effective preservative for grasses. Anhydrous ammonia should not be used on alfalfa due to the potential for formation of toxic compounds. Anhydrous ammonia can be injected into bales or released into a stack of bales covered and tightly sealed with plastic. Ammonia should be applied at the rate of 20-40 lbs/ton with higher rates used for hay near 35% moisture and lower rates used when moisture is near 20%.

Currently, evidence is not sufficient to indicate that any microbial hay preservatives are effective in preserving hay.

**Raking.** Raking should occur when hay is above 40% moisture to reduce leaf loss. Tedding and raking/merging can also enhance drying by ‘fluffing’ up the windrow to expose different portions of the hay to sunlight and to allow air movement through the windrow. Each can cause leaf loss in alfalfa (increasingly with greater dryness of the forage). Tedding is seldom necessary for alfalfa if one started with a wide swath but is useful for grasses. Grassy hay often needs to be raked twice (or teded and then raked into a windrow) since grass leaves settle together more than alfalfa hay.

### Summary of hay drying recommendations

Mowing and conditioning to maximize hay drying rate should:

- Begin with a wide swath (greater than 70% of cut area) to maximize leaf drying and stop respiration.
- Keep the swath off the ground to enhance drying and reduce soil contamination.

## Ash in forage

We haven't paid much attention to ash until recently when we have begun using the summative equation to estimate energy of forage. Now instead of estimating energy from acid detergent fiber most estimate energy from the following summative equation:

$$\text{Total digestible nutrients (TDN)} = \text{NFC} \cdot .98 + \text{CP} \cdot .93 + \text{FA} \cdot .97 \cdot 2.25 + \text{NDF} \cdot \text{NDFD}/100 - 7$$

NFC = non-fiber carbohydrates = DM - Ash - CP - EE - NDF, % of DM

CP = crude protein, % of DM

FA = fatty acids = EE - 1, % of DM

EE = ether extract, % of DM

NDF = neutral detergent fiber, % of DM

NDFD = (48 hr in vitro NDF digestion), % of NDF

When estimating energy from ADF, the ash content is unseen. Now that ash content is used to calculate the non-fiber carbohydrates (NFC), it is obvious that each 1% ash is 0.98% less NFC (and therefore TDN). While some minerals are necessary for the forage growth and may be beneficial to animals eating the forage, we want to keep the ash content to the minimum because ash provides no calories and, in fact, ash replaces nutrients.

Ash in forage comes from two sources: internal, e.g. minerals like calcium, magnesium, potassium and phosphorus, and external, e.g. dirt, bedding, sand, etc. The average internal ash content of alfalfa is about 8% and of grasses is about 6%. Additional ash in a hay or silage sample is contamination with dirt, sand, etc. As shown in table 2, a summary of ash content of forage samples submitted to the University of Wisconsin Soil and Forage Analysis Laboratory, the average ash content of haylage is 12.3% and of hay is 10.3%. Assuming the silage is mainly alfalfa and the hay has a higher percentage of grass, forage samples are averaging about 4% ash contamination from external sources. Note that some samples have been as high as 18%. This means some farmers have fed almost 1 pound of dirt for each 5 pounds of hay or silage!

Type	Statistic	% Ash
Haylage	Average	12.3
	Maximum	18.0
	Minimum	5.7
Hay	Average	10.3
	Maximum	17.6
	Minimum	8.8

Growers can do several things along each step of harvesting, storage and feedout to minimize ash.

- ✓ **Avoid harvesting lodged forage** -as dirt often sticks to the downed forage when the soil is wet. This can't always be avoided but can be reduced by

planting varieties that stand better and by harvesting early in the spring to reduce the potential for a wind storm knocking the alfalfa/grass down.

✓ **Raise the cutter bar of a disc mower** - to lower ash and raise forage quality. Research suggests that alfalfa can be cut as short as 1.5 inches for maximum yield. Each inch above this height will result in 0.5 t/a less yield for the year. (Though, if the mixture includes smooth bromegrass, orchardgrass, or timothy, cutting height should be 3 to 4 inches to avoid shortened stand life of the grass). However, lower cut forage with a disc mower will have higher ash content when the soil surface is dry. Thus, raising the cutter bar lowers ash and raises forage quality while lowering the cutter bar results in greater yield. Each individual must decide on the tradeoffs they want to take but generally a cutting height of 2.5 to 3 inches seems best in most cases.

✓ **Use flat knives on the disc mower** – to pick up the least ash when mowing. Several disk knife types are available as shown in the picture. The flat knife at the left will

pick up the least ash while the middle knife, at a 14 degree angle, will create some suction to pick up more



downed hay and ash (when soil is dry). Generally, those settings that pick up downed hay best also result in the most ash content when the soil is dry so one needs to decide which is most important.

✓ **Keep windrow off the ground** – by starting with a wide swath and placing the cut forage onto dense stubble will eliminate harvesting a layer of soil on the bottom of windrows. Putting hay into a wide swath also increases drying rate. The windrow should be high enough so that it can be raked or merged without the rake touching the ground.

✓ **Keep rake tines from touching the ground** – this can be done if the forage is on top of stubble and the ground is level. Wheel rakes tend to incorporate more ash because they are ground driven. We should visualize that, when we are raking and raising a cloud of dust, we are adding 1 to 2 percent ash to the hay.

✓ **Minimize moving hay horizontally** to reduce stones and other ash. It is better to move two swathes on top of a third in the middle rather than to rake all to one side.

✓ **Using a windrow merger** rather than raking will result in hay or silage with less ash content since the windrow is picked up and moved horizontally by a conveyor rather than being rolled across the ground. Merging can result in 1 to 2% less ash in the hay or silage. Mergers may not be economical for small operations but **Custom harvesters may be an option** to consider if merged hay with lower ash content is desired.

Store hay bales off the ground since bales that set on the ground pick up water from the soil and mold. This molding process causes loss of TDN and increases the ash concentration. More important, the wet hay will pick up a layer of ash on the bottom if bales are sitting on the ground.

**Store silage piles/tubes on concrete or asphalt** to minimize ash contamination. Silage can be removed with minimal dirt contamination when conditions are dry but dirt may be picked up with the silage when conditions are wet and it is muddy around the silage pile or tube.

There will always be some soil contamination of grass and legume hay or silage. However appropriate harvesting and storage management can reduce the ash content of the hay or silage. We should all try to be 1 or 2 % below the averages in table one. Anyone with 10% or less ash has done a good job of minimizing ash content of hay or silage.

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# ALFALFA HAY FOR HORSES: MYTHS VS. REALITY

*Laurie Lawrence, Ph.D.*

Professor, Equine Nutrition  
Department of Animal and Food Sciences  
University of Kentucky  
Lexington, KY 40546-0215  
llawrenc@uky.edu

## **Does it really matter if hay has some mold in it?**

Hay that is high in dust or mold can irritate the horse's respiratory tract. Optimum athletic performance depends on a healthy respiratory tract, therefore dusty/moldy hay should never be fed to horses used (or intended for) athletic events. A chronic respiratory disease commonly called "heaves" can be aggravated by moldy and dusty hay. Horses with heaves can have so much difficulty breathing that even mild exercise is impossible. In addition, moldy hay may contain toxins that could affect the horse if they are ingested.

Horse owners should not rely on the nutritional wisdom of horses to prevent problems associated with moldy hay. Horses will usually avoid small patches of moldy hay, but selectivity decreases as hunger increases. Also, in one study horses accepted slightly moldy red clover just as readily as clean alfalfa!

## **What about hay treated with a preservative?**

While it is relatively easy to grow good quality hay in Kentucky, our climate often makes it hard to make mold-free bales. Some preservatives may reduce molding in hay that must be baled under non-ideal conditions. In a study conducted several years ago, three batches of hay were prepared from the same field of alfalfa. One batch of hay was cut and allowed to dry to about 20% moisture before baling (the control hay), the other two batches were baled at a higher moisture content, but one of those batches was treated with a preservative at the time of baling. The preservative was a combination of acetic and propionic acids. During the first week after baling the higher moisture hay without preservative had much higher internal bale temperatures than the control hay or the higher moisture hay treated with the preservative. After several weeks in storage the bales were examined for mold. The untreated hay baled at the higher moisture content had too much mold to be acceptable to horses, whereas the same hay that had been treated with the preservative was virtually indistinguishable from the control hay.

The control hay and the preservative treated hay were then fed to growing horses and intakes between the two hays were not different. In a separate experiment, horses were given a choice between treated and untreated hay. In that study, the horses preferred

the untreated hay. However, as noted above, when horses did not have a choice, they ate preservative treated hay readily. So, if the choice is preservative treated hay with no mold, or untreated, but moldy hay, then the preservative treated hay is definitely a better choice!

### **How much hay should I purchase for my horse?**

The answer to this question will depend on whether the horse lives in pasture with lots of edible grass or if it lives in a stable or in a paddock with limited grass. When horses have access to abundant pasture all day (and night), they probably will not need hay. However, as pasture availability declines, then hay should be substituted for the pasture. In Kentucky, hay is usually fed to pastured horses from about the middle of November until the middle of April, but the exact schedule will depend on the amount of grass in the pasture. When we have dry periods in the summer or fall that affect pasture growth then hay is often offered to the horses.

If a horse lives inside all of the time or lives in a paddock with limited grass, then it will receive hay every day, all year. We have measured hay intake by stabled horses in a variety of experiments. The amount of hay a horse will consume is affected by animal factors (age, body weight, lactation, etc) and by forage factors (type, stage of maturity, etc). In general, an 1100 lb horse will consume between 15 and 20 lb of hay each day. But, many horses will consume more than that, and an extra allowance should be made for waste. So, if a horse owner expects to feed hay every day to a stalled horse, they should plan on about 20 to 25 lb per day (or about 3.5 to 4.5 tons/horse/year). If the horse is pastured most of the time then the hay required will be much less.

Of course, nutrient needs can be met by feeding less forage and more concentrate, but restricting hay intake too much can increase the risk of digestive disturbances and behavior problems. The *minimum* hay (or equivalent pasture) intake for any horse should be above 1 lb of hay for each 100 lb of body weight. This amount of hay will not meet nutrient needs but hopefully it will provide enough fiber to reduce the risk of digestive disorders.

It is important to remember that the amount of hay a specific horse will need is influenced by the nutrient requirements of the horse as well as the nutrient content of the hay, as well as any other feeds the horse is receiving. Lactating mares will consume higher amounts of forage than horses at maintenance. Elite performance horses and weanlings might receive somewhat lower levels of forage because they will be receiving significant amounts of concentrate. During cold weather, horses that live outside may need extra hay to compensate for the calories they use to maintain body temperature.

### **What is the best kind of hay for horses?**

Endophyte-infected tall fescue hay should not be fed to pregnant mares, but otherwise most types of hay can be used for horses as long as they are clean and mold-free. Common hay types fed to horses include alfalfa, timothy, orchardgrass, bromegrass,

Bermudagrass and red clover. We have recently evaluated teff hay for horses. Teff is a summer annual grass that originated in Africa. Like other warm season grasses it can be somewhat high in neutral detergent fiber, especially if it is not harvested until late maturity. We found that horses prefer alfalfa and timothy to teff, but that they will accept teff hay more readily if it cut at an earlier stage of maturity.

The most important consideration when selecting a type of hay for a specific horse is the requirement of the horse. If a horse has high nutrient requirements then a hay with a higher nutrient density (more nutrients per pound) should be selected. If a horse has low nutrient requirements then a hay with low nutrient density should be chosen. In general legume hays harvested in early maturity have the highest nutrient density; whereas grass hays harvested in late maturity have the lowest nutrient density. If you are feeding growing horses or lactating mares, then early maturity alfalfa or alfalfa-grass mix may be desirable. If you are feeding idle, adult horses that tend to be over-weight, then a late maturity grass hay might be the most appropriate.

### **Doesn't alfalfa make horses sick?**

Good quality alfalfa hay that is fed in appropriate amounts will not make a normal horse sick. But, allowing horses unlimited access to very high quality alfalfa hay may result in some digestive upset (such as diarrhea). Horses that have restricted exercise and low nutrient needs can also get too fat if too much high quality alfalfa hay is fed. Therefore, it may be necessary to restrict the amount of very high quality alfalfa that is fed to some horses; especially those with lower nutrient requirements. High quality alfalfa is most useful for horses with high nutrient requirements such as weanlings and lactating mares. Mid and late bloom alfalfa hay as well as alfalfa-grass mixes can be fed to most classes of horses.

Recent research suggests that alfalfa can be more beneficial to the equine digestive tract than some other hays. Many performance horses develop stomach ulcers. No one understands exactly why horses get stomach ulcers, but stress and diet have been proposed as the two most likely causes. A study at Texas A&M University examined the stomachs of horses in training that were receiving diets of forage and grain. When alfalfa was used as the forage, the incidence and severity of the stomach ulcers was less than when grass hay was used as the forage. This study supported an earlier experiment in Tennessee that suggested that a high concentrate diet that contained alfalfa hay was healthier for the stomach than a diet that utilized grass hay. These researchers have suggested that alfalfa might buffer stomach acid more effectively than grass hay because it is higher in calcium, protein and potassium.

Horse owners should be aware that alfalfa hay has been associated with a few problems in horses. Alfalfa hay that may be contaminated with blister beetles should not be fed to horses. Blister beetles contain a toxin that can be fatal to horses. In some parts of the U.S., a small percentage of horses fed alfalfa hay have developed intestinal stones. These "enteroliths" are composed of magnesium and other minerals that collect around some type of small object. If an enterolith becomes large enough it can block the

gastrointestinal tract and cause colic, and potentially death. Although enteroliths can occur, their incidence is quite low.

### **Doesn't the high protein content of alfalfa cause problems?**

A normal adult horse will not be negatively affected in any way by a diet that contains a small or moderate excess in protein. On a dry matter basis, good quality spring pasture grass contains about the same concentration of crude protein as average mid to late bloom alfalfa hay! The excess nitrogen in high protein feeds will be excreted in the urine, so horse owners may find that horses will drink more water and urinate more when they are fed alfalfa than when they are fed a grass hay.

It is a common myth that excess protein causes bone and joint problems in growing horses. Research studies have found that excess calories and rapid growth may predispose horses to growth problems; but excess protein without excess calories is not a factor. A good general guideline for feeding growing horses is to use a nutritionally balanced diet and feed it in amounts that result in moderate, even growth.

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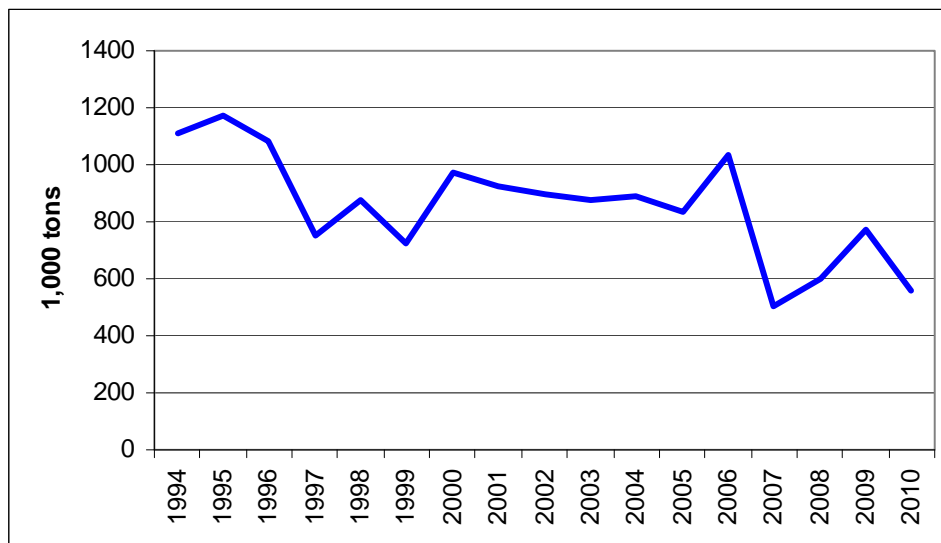
# DOLLARS & CENTS OF ALFALFA PRODUCTION

*Kenny Burdine*  
Extension Agricultural Economist  
University of Kentucky

The last several years have been incredibly challenging for all of Kentucky agriculture and hay producers have been no exception to the rule. Statewide, alfalfa yields have been below average in 3 of the last 4 years due to challenging weather in 2007, 2008, and again in 2010. In addition to the weather challenges, producers are also dealing with higher costs of fuel, fertilizer, and machinery. These challenges make budgeting especially important looking ahead to the 2011 growing season.

Alfalfa has always been somewhat under that radar screen in terms of production in Kentucky. Despite being a fairly profitable hay crop historically, it has remained fairly small in terms of acreage in the state. From the mid 1990's through 2007, Kentucky's alfalfa hay acreage generally ranged from 250 to 300 million acres. Since 2007, acreage has dropped drastically and was estimated at 200 million for 2010. This decrease is likely the result of recent challenging growing conditions, increased costs, and competition for ground from other crops. Figure 1 below shows Kentucky alfalfa production trends, which reflect both acreage and yield affects.

**Figure 1: Kentucky Alfalfa / Alfalfa Mix Hay Production (1994 – 2010)**



Source: USDA NASS

When estimating cost and returns, yields are perhaps the most challenging factor to predict in advance. USDA estimates alfalfa yields each year, which can be used as an index of overall alfalfa yield in the state. State average yields over the last four years

have ranged from 1.8 tons per acre in 2007 (spring freeze and summer drought) to 3.5 tons per acre in 2009. In the fall, yields for 2010 were estimated to be 2.8 tons per acre. Of course many producers see considerably better yields than these based on their management practices and stand quality, so these should be used as general guidelines only.

In addition to weather and yield concerns, rising input costs have also been a major concern for alfalfa producers over the last several years. Rising fuel and fertilizer prices have drastically changed the breakeven prices for alfalfa hay. Generally speaking, prices for Nitrogen and Phosphorus peaked in 2008, while Potash prices peaked in 2009. Fertilizer prices were lower in 2010, providing some relief on the cost side, but are expected to rise again in 2011.

The final economic factor worth discussing is price. Nationally, alfalfa prices peaked in 2008 / 2009, a time of high feed prices and relatively low production levels, and have trended downward since then. As we move into 2011, feed prices are going to be near those 2009 levels. As the price of feeds, such as corn and bean meal increase, the value of hay should also increase based on its substitute value.

Finally, I would make the point that hay prices tend to be very localized. Since hay is an expensive commodity to transport, local markets have a greater impact on price than larger market trends. The market for quality alfalfa mix hays in Kentucky is largely driven by the equine and dairy sectors, both of which have dealt with serious economic challenges in recent years.

Figure 2 presents an estimated alfalfa budget for 2011. This budget skeleton is available on-line in spreadsheet form at the UK Ag Econ Forage website at the following address: <http://www.ca.uky.edu/agecon/index.php?p=210>. Simply click on Forage Budgets and look for alfalfa. While attempts have been made to make this budget as realistic as possible, one should clearly modify this budget based on their own situation.

The budget is set up for alfalfa square bale hay production and assumes a yield of five tons per acre. The assumed sale price is \$150 per ton or \$4.50 per 60 lb square bale. This price is meant to include production and moving costs, not delivery to buyer. One should also be aware that this price would represent the price of an average alfalfa bale sold. In some cases, lower quality bales may move at a considerable discount to higher quality bales. Cost estimates are based on the best estimates available, but certainly should be changed based on actual quotes in the producer's area. Since the return is to land and management, producers should ask themselves if this adequately compensates them for owning the land and managing the crop.

**Figure 2: Estimated Alfalfa Budget for 2011**

**ALFALFA HAY ENTERPRISE  
ESTIMATED COSTS AND RETURNS**

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<b>Total Acres in Enterprise:</b>	<b>200</b>	acre					
<b>Number Bales per Acre:</b>	<b>166.7</b>						
<b>Weight per Bale:</b>	<b>60</b>	lbs					
	<b>AMOUNT</b>		<b>UNIT</b>	<b>PRICE</b>	<b>FREQUENCY</b>	<b>TOTAL</b>	<b>TOTAL</b>
<b>GROSS RETURNS</b>						<b>Per Acre</b>	<b>Enterprise</b>
Hay (Sold or On-Farm Value)	5		tons	\$150.00	annually	\$750.00	\$150,000
<b>VARIABLE COSTS</b>							
Seed	20		lbs	\$5.00	every 5 years	\$20.00	\$4,000
Nitrogen	0		lbs	\$0.45	annually	\$0.00	\$0
Phosphorus	75		lbs	\$0.73	annually	\$54.75	\$10,950
Potassium	300		lbs	\$0.48	annually	\$144.00	\$28,800
Boron	2		lbs	\$10.00	every 2 years	\$10.00	\$2,000
Lime	2		tons	\$20.00	every 2 years	\$20.00	\$4,000
Herbicides	1		acre	\$30.00	annually	\$30.00	\$6,000
Hay Preservative	1		acre	\$0.00	annually	\$0.00	\$0
Fuel and Oil	1		acre	\$40.00	annually	\$40.00	\$8,000
Repairs	1		acre	\$30.00	annually	\$30.00	\$6,000
Custom Application	1		acre	\$5.00	annually	\$5.00	\$1,000
Equipment Rental	1		acre	\$0.00	annually	\$0.00	\$0
Cash Land Rent	1		acre	\$0.00	annually	\$0.00	\$0
Hired Labor	3	hours / ac		\$10.00	annually	\$30.00	\$6,000
Interest (1/2 year)	\$383.75		dollars	6.0%	annually	\$23.03	\$4,605
<b>TOTAL VARIABLE COST</b>						\$406.78	\$81,355
<b>RETURN ABOVE VARIABLE COST</b>						\$343.22	\$68,645
<b>FIXED COSTS</b>							
Annual Interest on Investment	1		acre	\$30.00		\$30.00	\$6,000
Annual Depreciation of Capital Assets	1		acre	\$50.00		\$50.00	\$10,000
Insurance: Casualty and Liability	1		acre	\$10.00		\$10.00	\$2,000
Operator and Family Labor	3	hours / ac		\$10.00		\$30.00	\$6,000
<b>TOTAL FIXED COST</b>						\$120.00	\$24,000
<b>TOTAL COSTS</b>						\$526.78	\$105,355
<b>RETURN TO LAND AND MANAGEMENT</b>						\$223.22	\$44,645
<b>Break Even Price</b>	<b>\$81.36</b>	per ton to pay <b>VARIABLE</b> costs at	<b>5.0</b>	tons per acre			
<b>Break Even Yield</b>	<b>2.7</b>	tons to cover <b>VARIABLE</b> costs at	<b>\$5.00</b>	per ton			
<b>Break Even Price</b>	<b>\$105.36</b>	per ton to cover <b>TOTAL</b> costs at	<b>5.0</b>	tons per acre			
<b>Break Even Yield</b>	<b>3.5</b>	tons to cover <b>TOTAL</b> costs at	<b>\$150.00</b>	per ton			

University of Kentucky, College of Agriculture, Cooperative Extension Service.

Finally, I think it is important that we look at the sensitivity of this return to land and management per acre to both price and yield. This will help the producer think about the level of risk that is involved with the alfalfa enterprise this year. Table 1 below is a simple sensitivity table that shows estimated returns to land and management using the same set of assumptions as shown in the budget estimate in Figure 2. The only items changed from the budget in Figure 2 are price per ton and yield per acre.

**Table 1. Return to Land and Management as Price and Yield Change**

Yield	Price per ton Received (price per 60# bale)				
	\$100 (\$3)	\$133 (\$4)	\$167 (\$5)	\$200 (\$6)	\$233 (\$7)
<b>3.5 tons</b>	(\$176.78)	(\$61.28)	\$57.72	\$173.22	\$288.72
<b>4.0 tons</b>	(\$126.78)	\$5.22	\$141.22	\$273.22	\$405.22
<b>4.5 tons</b>	(\$76.78)	\$71.73	\$224.73	\$373.23	\$521.23
<b>5.0 tons</b>	(\$26.78)	\$138.22	\$308.22	\$473.22	\$638.22
<b>5.5 tons</b>	\$23.22	\$204.72	\$391.72	\$573.22	\$754.72
<b>6.0 tons</b>	\$73.22	\$271.23	\$475.23	\$673.22	\$871.23

Table 1 provides some insight into how sensitive return to management is to yield per acre and the price received for alfalfa hay. This is a better way to look at the upcoming year than a single snapshot as in Figure 2. Notice that, at a price of \$100 per ton, money is still lost at a five ton per acre yield. On the other end of the spectrum, note that if yields are as low as 3.5 tons per acre, price must be around \$150 per ton (\$450 per 60# bale) to cover all costs. Producers should look at Table 1 and think about where their yields are in a typical year and what prices they have been moving hay for recently.

While 2011 will likely be another challenging year for Kentucky farmers, alfalfa has the potential to make a positive contribution to farm income if production costs are reasonable and weather allows for decent production levels. I would strongly recommend that each producer work through a budget similar to Figure 2 for their operation and generate a sensitivity table similar to Table 1. Soil conditions, fertilizer costs, machinery compliments, and many other factors will vary greatly across operations in Kentucky. The more effort that is made to adjust the proceeding numbers, the better position the producer will be in to evaluate the costs and returns from alfalfa hay production in the upcoming year.

# WHAT'S NEW IN FORAGE EQUIPMENT?

*Dr. Dan Undersander*  
University of Wisconsin

The forage equipment industry is changing in response to farmers' needs. These changes consist of innovations to increase capacity, to improve the usability of the machine, and to improve the quality of the product. Most changes are occurring with existing equipment, but some totally new product innovations are occurring.

The size of machinery has increased to allow more-efficient harvesting. Some of this equipment will be used on larger operations and some will be used for contract forage harvesting, which has expanded rapidly across the U.S. in the last 15 years. Currently, self-propelled disc mowers have increased to almost 32 feet (in three banks), the largest rakes and mergers are 30 feet or wider, and the largest forage harvester has a 1020 Hp V-12 engine and can harvest up to 400 t/hour.

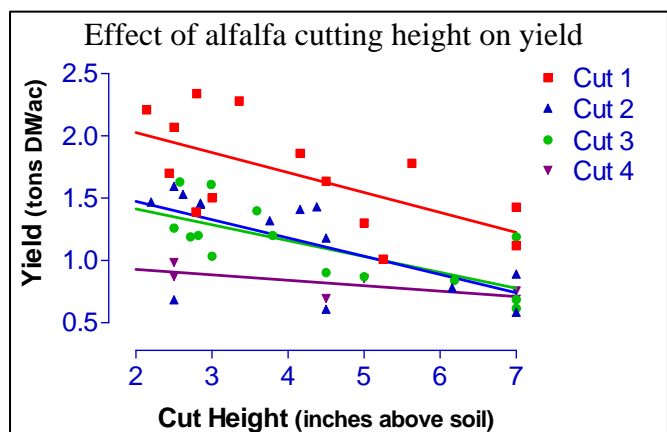
The purpose of this paper is to give a few principles of hay and silage making and discuss machinery available relative to these principles.

## Mowers

Some design improvements in mowers include differing knife types for different needs and changes with weight load distribution. Most growers are rapidly switching from sickle to disc mowers due to reduced maintenance requirement.

Data is clear that the disc mowers do not reduce alfalfa yield or stand life more than that of sickle bar mowers.

Differing knives are available for disc mowers and the choice among them should be made with some deliberation. The most common are knives that are angled at about 14° to enhance picking up downed forage. Mowers with these knives really do pick up downed forage better than those with flat knives. However, angled knives pick up soil more when the ground is dry. Angled knives can add 1 to 2% ash to the harvested forage. So the grower must decide which is more important – picking up downed forage or having less ash in the forage.



Cutting height should be adjusted according to management goals. Lower cutting height results in higher yield (graph as left) of alfalfa (as long as crown is not cut) but

should be 3 to 3.5 inches if grass is included to allow rapid regrowth. Higher cutting height will also reduce ash content.

Some are concerned that driving over a swath will increase soil (ash) content in the forage. In Table 1, the ash content of haylage from wide-swath alfalfa was actually less than from narrow windrows. While narrow windrows are not usually driven over, they tend to sag to the ground, causing soil to be included with the windrow when it is picked up. Wide swaths tend to lay on top of the cut stubble and stay off the ground. Further driving on the swath can be minimized by driving one wheel on the area between swaths and one near the middle of the swath where cut forage is thinner.

Grasses, especially if no stems are present, must be into a wide swath when cut. When put into a windrow at cutting, the forage will settle together, dry very slowly and be difficult to loosen up to increase drying rate.

### **Conditioning Equipment to Enhance Drying**

As the industry has realized the value of making a wide swath for drying, it has changed equipment designs to allow wider swaths. Some farmers are now asking for disc mowers without conditioners when haylage is the only form of forage to be harvested, since conditioning is not necessary for haylage.

The argument continues as to which of the current conditioner types are best. Flail conditioners were developed in Europe for grasses and are generally the least expensive. Roller conditioners were developed in the U.S. for alfalfa. Some data has shown that roller conditioners will dry alfalfa faster than flail conditioners and that the opposite is true for grasses. However, the difference is small and in individual field trials one may indicate faster drying depending on machine adjustments and drying conditions. Clearly, flail conditioners will increase leaf loss in alfalfa by 1 to 4%, resulting in quality loss. They also make a less uniform windrow, which can result in less consistent chop length.

Steel roller conditioners, rubber roller conditioners, and combinations of the two are available. Data has shown little difference among them. The sharper, firmer corners of the steel rollers may break stems slightly better in some circumstances, but they also suffer more damage from stones and other foreign materials.

The key to increased drying and minimized leaf loss with flail and roller conditioners is proper adjustment for field conditions.

Some new forage harvesting methodology has become available in recent years. This includes macerating, superconditioning, and reconditioning.

Macerator technology was initially invented by the USDA Dairy Forage Research Center, Madison, WI, and further developed by the Prairie Machinery Agricultural Institute (PAMI), Portage la Prairie, Manitoba. It clearly enhanced drying rate (Savoie et

al., 1993) and improved animal performance (Charmley et al., 1999) by shredding the forage and pressing it into a mat that is laid on top of the forage stubble. The challenge has been the low throughput and high energy requirement, making development of field units slow. A macerating unit is currently on the market that does enhance drying rate compared to standard conditioning but the unit macerates less than the original design to facilitate throughput.

Superconditioning (breaking/smashing the stems more thoroughly than standard conditioners) has been commercially available for several years. Tests have consistently shown 3- to 6-hour drying advantages of superconditioners with steel rolls over standard conditioners. However, the units have significant additional cost and horsepower requirement. One unit is available with “high impact” conditioning where the rubber rolls are solid except for narrow ‘v’ slits.

Reconditioning is running the windrow through a conditioner a second time after partial drying has occurred. Some farmers have fabricated such units by removing the mowers of mower conditioners, and some units are commercially available. Reconditioners are generally used on the day of baling after the dew is gone to help remove the last 5% of water prior to baling. Such units help in baling timothy for export where forage must be 12% or less at baling. Little advantage has been demonstrated for reconditioning alfalfa. Alfalfa will also suffer some leaf loss during the reconditioning.

Wide-thin fins are attachments to the back baffle of conditioners that spread the windrow wider (up to 100% of the cut width). If your mower-conditioner is making a swath less than 70% of the cut area these would be a good addition.

Generally speaking, wide swaths provide the greatest improvement in drying rate of hay. Other technologies provide lesser drying rate gain and have marginal cost effectiveness.

## **Raking**

Swaths or windrows should always be combined to make the largest windrow the harvesting machinery can handle. Large windrows are the most energy and labor efficient for harvesting. Large windrows also reduce wheel traffic on the field resulting in less soil compaction and plant damage.

Raking should occur without the rake tines touching the ground. Tines scraping the ground add soil to hay reducing forage quality. Thus powered rakes are better than wheel rakes which are ground driven by the tines.

Mergers are another excellent tool where the hay is picked up and moved on a conveyer across the field into a windrow. Mergers result in less leaf loss and less ash in the hay than rakes which move the hay across the ground. However, one should examine the cost of mergers and compare to the value of the product obtained.

## **Baling**

Several manufacturers are marketing features on the balers that take advantage of electronic technology to produce more consistent bales: with round bales this means more uniform density and shape; with square bales this means more uniform bale flakes for breaking apart to feed.

Moisture sensors are available that determine bale moisture. When these are tied to preservative applicators the opportunity exists to only apply preservative when needed and at the needed rate for the particular moisture of hay being baled.

The newest thing on the market for balers is bale cutters. This option for either round or square bales cut the hay length. The final theoretical cut length can be as short as 1.5 inches. However, the shorter the hay is cut the more energy required, more knives, greater maintenance and number of knives that need replacing. Using fewer than the total knives to get final hay to be 4 to 6 inches long will provide the most economical benefit with less knife expense and energy cost. Hay harvested with bale cutter has no benefit in hay making or silage fermentation (if wrapped in plastic) but data has shown that animals will have higher forage intake and less feeding losses. Additionally cut-hay bales will break apart easier when used in a TMR or for bedding.

Other new features on bales include more detailed electronic monitoring and control of baler functions, constant bale flake size, tighter round bales and other modifications.

## **Summary**

Mowing and conditioning equipment should be bought with the essentials to drying hay or haylage in mind:

- Use a roller conditioner for alfalfa, and a flail conditioner for grass hay.
- Can the mower conditioner make a wide swath (greater than 70% of cut area) to maximize leaf drying and stop respiration?
- Reconditioners, macerators, etc will increase drying rate but at greater cost in terms of initial capital investment and fuel use.

Raking should occur with tines not touching the ground. Windrows should be merged to the biggest that harvesting equipment can handle. Use of a merger will reduce leaf loss of alfalfa and ash contamination.

Bale cutters will improve quality of final product in terms of reduced feeding losses and improved animal performance.