

24th Kentucky Alfalfa Conference Proceedings

Volume 24, Number 1
Garry Lacefield & Christi Forsythe, Editors

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Cave City Convention Center

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

Schedule for the Day

- 8:00 Registration, Visit Exhibits, Silent Auction
- 8:45 Welcome - *Dr. Jimmy Henning, Mr. Tom Keene, Mr. Ken Johnson*
- 9:00 Why Graze Alfalfa? - *Dr. Garry Lacefield*
- 9:20 Fertilizing Alfalfa for Profit - *Dr. Monroe Rasnake*
- 9:40 Thermometers for Measuring Temperature in Hay - *Dr. Doug Overhults*
- 10:00 Break
- 10:30 Principles and Practices of Successful Alfalfa Establishment - *Dr. Gary Bates*
- 11:00 Roundup Ready Alfalfa - *Mr. Dan Foor*
- 11:30 Hybrid Alfalfa: Reality or Pipe Dream? - *Mr. Mike Velde*
- 12:00 Lunch, Awards Presentations, Silent Auction Results
- 1:00 Breakout Sessions
1. Balancing Agronomics & Economics of Alfalfa Hay Production –
Mr. Brian Lacefield and Dr. Garry Lacefield
 2. Marketing Kentucky Alfalfa - *Mr. Tom Keene and Mr. Nicky Baker*
 3. Moisture - Temperature Management During Alfalfa Hay and Silage Making & Storing - *Dr. Mike Collins*
- 2:00 Break
- 2:20 Repeat Breakout Sessions
- 3:20 Adjourn

FOREWORD

This conference marks the twenty-fourth 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 twenty-four 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 for 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
XXIV Annual Kentucky Alfalfa

Conference

KENTUCKY ALFALFA AWARDS

The Kentucky Alfalfa Awards Program was initiated in 2000 at the 20th 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.

Year	Warren Thompson Industry Award	Charlie Schnitzler Producer Award	Garry D. Lacefield Public Service Award
2004			
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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GRAZING ALFALFA

Garry D. Lacefield
Extension Forage Specialist
University of Kentucky

Over the past decade we have had several people address “Alfalfa as a Grazing Crop” including Warren Thompson, Gary Bates, Ken Johnson, Jason Sandefur, Byron Sleugh, and myself. Each has done an excellent job discussing the merits of this remarkable crop and the opportunities it offers for grazing. At the end of the Conference last year, I (as I always do) asked for your suggestions concerning topics for this year’s conference. As it has been for the past decade, “Grazing” was the most requested topic. In today’s presentation, let’s go back and revisit the question, “Is Grazing Alfalfa Right for You?”

Alfalfa is a high yielding, high quality, deep-rooted, versatile forage legume well adapted throughout the U.S. Gains per animal and per acre can be excellent with acceptable stand persistence when present technology is used. Is grazing alfalfa right for everyone? Only you can answer that question. This presentation attempts to give you information that will hopefully help you with that answer.

Alfalfa is the most important forage legume grown in the United States. Grown over a wide range of soil and climate conditions, it has the highest yield potential and feeding value of all perennial forage legumes. This versatile crop can be used for hay, pasture, silage, green-chop, pellets, cubes and soil improvement. Because of its many merits, especially yield, quality and versatility, it can be used successfully in many animal feeding programs.

As we begin to look at this topic “Grazing Alfalfa”, let’s first assume you have land capable of growing alfalfa successfully and let’s assume you have animals to feed on the farm and finally let’s assume you want to do the best job possible of supplying pasture that meets the animals’ needs and has the potential to make you money.

Let’s approach the topic by simply asking a few questions:

Do you need a high-producing pasture plant? With proper grazing management, alfalfa’s **high yield potential** can be converted to high levels of animal production per acre. Liveweight gains per acre are quite high for grazing beef cattle, with total season gains of 500 to over 800 lb/acre in research trials and on-farm demonstrations. Milk production per acre and per animal can be high when grazing alfalfa.

Do you need a high quality pasture plant? Alfalfa's **quality for grazing** is excellent, resulting in total season average daily gains over 2 lb/day in grazing trials and demonstrations.

Do you need pasture legumes that grow well during summer? Alfalfa's deep root system makes it more **drought tolerant** than our other cool-season legumes and grasses. Although alfalfa does not make maximum growth during summer droughts, it usually provides good summer pastures. During extreme drought this aspect becomes even more important since cool-season grasses become dormant.

Do you want a versatile pasture plant? Alfalfa can be ideal on farms where it can be used for hay, silage, or grazing. Virginia workers studied systems of grazing alfalfa based on need and environmental conditions. Systems of grazing the early spring growth provided quality feed and delayed the first hay harvest until more favorable weather for curing. Other systems provide grazing during midsummer when cool-season grasses are often less productive. Comparing the systems shows that total season yield is not reduced by any graze-hay systems.

Do you want to extend the productive life of some of your alfalfa hay fields? For old alfalfa fields that have been used for hay but where some of the stand has been lost or become weedy, grazing can extend the stand's useful life a year or more. Grazing may also rejuvenate some stands by reducing grass and weed competition. *Research results* – When alfalfa stands decline to less than 3 plants/sq ft, optimum hay yields usually cannot be achieved. Excellent beef gains have been made on alfalfa stands with as few as 1 plant/sq ft although productivity per acre suffers.

Do you want to reduce your machinery cost and lower your fertilizer expenses? Over 40% of the cost of producing alfalfa hay is machinery and equipment. In a total grazing system, this cost can be eliminated or certainly minimized. Under grazing, most of the plant nutrients are returned as dung and urine. Annual fertilizer needs therefore would be lower than where plant nutrients are removed from a field as hay.

Do you want a pasture plant that has a high potential for profit? One of the most comprehensive analysis that I am aware of was presented at the 26th National Alfalfa Symposium in Michigan by Dr. Al Rotz. The following was excerpted from his presentation:

“Grazing of alfalfa is an economically viable option for dairy farms. The grazing strategy used and other assumptions of the analysis will effect the benefit received. With the strategy evaluated in this study where grazed alfalfa is used to supplement confined feeding through a total mixed ration, many of the inputs in feed production are reduced and the need for purchased feeds is

reduced. The overall result is an annual return to management or farm profitability of \$100 to \$240/cow.

When deciding between grazing and confined feeding systems, other factors such as bloat control and general animal health must be considered as well. Bloat is a recognized problem, particularly when alfalfa is grazed. Feed additives such as sodium bentonite are sometimes used to reduce the risk of bloat, but the risk still exists. Other health issues are not conclusive, but other than risk of bloat, animal health is generally recognized as maintained or improved through grazing. To evaluate the possible detrimental effects of bloat, an analysis was done where the culling rate of the herd was increased to 40% to model a greater loss of animals. Livestock expenses were also increased by \$5/cow/year to cover feed supplements and medication related to bloat control. With a greater number of primiparous cows, milk production may decline. Given that production can be maintained at 20,000 lb, this change had little effect on the total feed and manure cost, but the return to management decreased by about \$30/cow (Table 1)."

Table 1. Sensitivity of the total feed and manure cost and the net return over this cost to changes in various assumptions used to describe the grazing system for a herd producing 20,000 lb/cow.		
Change in grazing system	Reduction in feed & manure cost (\$/cwt)	Increase in net return (\$/cow)
Base grazing system	.73	142
20% lower yield of grazed alfalfa	.50	98
6 year alfalfa stand life	.77	150
20% greater fence costs	.68	132
10 h/wk for grazing management labor	.66	128
14 year machinery life	1.05	238
Smaller equipment and forage structures	1.08	212
40% culling rate and bloat control additive	.71	111
SOURCE: Rotz, C.D. 1996. 26 th National Alfalfa Symposium, East Lansing, Michigan. March, 1996.		

Is alfalfa right for you? If you answered YES to some of the previous questions, it is at least worthy of your consideration; but wait, let me tell you some of the problems and make a few comments about them.

The most frequent concern of producers considering grazing alfalfa is bloat, but it can be minimized with precautions. Producers may lose more money from the fear of bloat than from bloat itself if it keeps them from efficiently using the alfalfa pasture.

Additional Fencing – Alfalfa must be grazed on a rotational basis. Doing so requires that fields be subdivided so that cattle are restricted to one area for a

time, and then moved to another area. This system gives the grazed area time to regrow before grazing again. Fencing does not have to be elaborate or complex. Simple low-cost electric fences that restricts animals to a given area are adequate. Access to water and minerals is also important.

Greater Management and Labor Inputs – Although some consider this category to be a disadvantage, advocates of controlled grazing do not always agree. Once the necessary fencing is in place, time studies have shown that the amount of additional labor required for rotational grazing is quite small compared to harvesting hay. In addition, regularly moving cattle to new pastures lets the producer observe them more closely and therefore permits greater cattle-pasture management efficiency.

Stand Decline – If alfalfa plants are not grazed properly, stands decline. Grazing animals may damage alfalfa crown during wet and muddy conditions. In addition, damage to new crown shoots can occur when cattle are left on an individual paddock after new shoots develop. These disadvantages can be minimized with the following practices:

- To avoid damage to stands, use a “sacrifice paddock” next to the alfalfa where you can put cattle during extreme wet and muddy conditions.
- Do not let cattle graze an individual paddock for over 7 to 10 days to minimize damage to newly developed shoots. Exceptions to the 10-day rule include the first grazing in spring and times when alfalfa is dormant (during drought and after freeze-down).
- Use a grazing tolerant variety.

Now, Alfalfa Grazing – Is it right for you? Only you can answer that question; however, I hope you will agree that Alfalfa – Queen of the forage Crops based on its merits, its long standing track record throughout the World, its well documented research and demonstration results, and the many satisfied farmers, it is certainly worthy of your consideration.

Selected References

Ball, D.M., C.S. Hoveland, and Garry Lacefield. 2002. Southern Forages. Phosphate & Potash Institute and Foundation for Agronomic Research, Norcross, GA.

Lacefield, G.D., J. Henning, R. Burris, C. Dougherty, and C. Absher. 2002. Grazing Alfalfa. U.K. Cooperative Extension Service ID-97.

Henning, J., G.D. Lacefield, M. Rasnake, R. Burris, J. Johns, K. Johnson, and L. Turner. 2000. Rotational Grazing. U.K. Cooperative Extension Service ID-143.

FERTILIZING ALFALFA FOR PROFIT

Monroe Rasnake

Extension Agronomist

University of Kentucky

Alfalfa has a high yield potential in relation to most other forages. However, this potential can only be realized on a long-term basis if the nutrient needs of the plant are adequately provided for. In addition, the ability of alfalfa plants to survive the heat and drought of summer and the cold of winter depends on an abundant supply of plant nutrients.

If alfalfa is harvested from a field as hay – which is true for most Kentucky grown alfalfa – large amounts of nutrients are removed along with it. For example, good quality alfalfa hay contains about 15 pounds of phosphate and 60 pounds of potash per ton. A good crop of alfalfa producing five tons of hay per acre would then remove 75 pounds of phosphate and 300 pounds of potash per acre. With a five year stand life, this adds up to a total removal of 375 pounds of phosphate and 1500 pounds of potash. The value of these nutrients at today's prices amounts to about \$320 total or \$12.80 per ton of hay.

This is the value of nutrients removed from the soil. Logically, these will need to be replaced at some time in the future in order to maintain long-term soil fertility. We do have some buffer capacity for nutrient supply in our soils. It is in the form of stored nutrients from prior fertilizer applications (in the case of phosphorus) and nutrients released from soil minerals (as is the case with potassium). Therefore, a more realistic approach to cost of fertilizer alfalfa fields may be to look at a "normal" fertilizer program. Based on my experience and the current UK soil test recommendations, a "normal" alfalfa fertility program for Kentucky would consist of 50 pounds of phosphate, 150 pounds of potash, one pound of boron and one ton of lime per acre per year to produce a five ton per acre yield. This would cost \$52.60 or \$10.52 per ton of alfalfa hay produced.

If it is available, manure can be used to supply much of the nutrients needed by an alfalfa crop. The ideal time to apply manure on alfalfa land would be to a corn crop in rotation between alfalfa stands. The corn crop would benefit from nitrogen in the manure and residue from the old alfalfa stand. It would also provide the break between alfalfa crops that is recommended to avoid autotoxicity problems and concerns with carryover of pest problems from one alfalfa stand to the next. Manures can be applied to existing stands of alfalfa as well. We discussed in more detail the potential for manure use on alfalfa at the 17th Kentucky Alfalfa Conference in 1997.

At this point, I want to calculate the value of nutrients available from manure and estimate how much the cost of fertilizing alfalfa over a five year period can be reduced through the use of manure. Based on average nutrient

content of manures as reported in UK Extension publication AGR-1 “Lime and Nutrient Recommendations”, a ton of fresh dairy cattle manure contains nine pounds of phosphate and 12 pounds of potash while broiler litter has 55 pounds of phosphate and 45 pounds of potash. The value of these nutrients as compared to fertilizer would be \$4.20 for dairy and \$21.70 for broiler manure. If 20 tons of dairy or five tons of broiler litter per acre were applied before planting a rotational corn crop (a rate that should supply the nitrogen needs of the corn crop), it would replace \$84 and \$108.50 worth of phosphate and potash fertilizer over the five year life of the alfalfa stand. If we add the value of nitrogen in manure to the corn crop and boron for the alfalfa, manure can be shown to be a valuable resource.

The response of alfalfa to proper soil fertility in terms of yields was discussed at the 20th Kentucky Alfalfa Conference in February, 2000. Certainly, good fertility is necessary to obtain economic yields of alfalfa. There are two consequences other than low yields that can occur if fertility needs are not taken care of. The first is the cost of reestablishment.

Establishing a stand of alfalfa is expensive – averaging about \$250 per acre. Only about \$75 of this cost is fertility related. A stand failure related to low soil pH or low phosphorus – the most common causes – represents a cash loss of at least \$200 per acre. There is also a loss of production for at least one growing season. It is obviously too much to risk in order to save a few dollars on lime and fertilizer. That is why our recommendations stress the need to take care of soil fertility needs well in advance of seeding alfalfa.

Another potential consequence if fertility needs of the crop are not adequately met is early stand failure. The ability of alfalfa plants to resist stresses such as drought, cold injury, insects and diseases depends on an adequate supply of plant nutrients. Stand life can easily be reduced one or two years if fertility needs are not met. If establishment costs are spread out over five years of a stand producing five tons per acre, they amount to about \$50 per acre per year or \$10 per ton of alfalfa. If the stand only lasts four years and yields are reduced to four tons per acre, annual establishment costs become \$62.50 per acre and \$15.60 per ton of alfalfa produced.

Hopefully, these comparisons illustrate how important lime and fertilizer are to producing alfalfa for profit. Planning for alfalfa establishment should start a year ahead of seeding time with a soil test to assess lime and fertilizer needs. This will allow adequate time to get soil pH and fertility where it needs to be before seed is placed in the ground.

Measuring Hay Temperatures

Doug Overhults

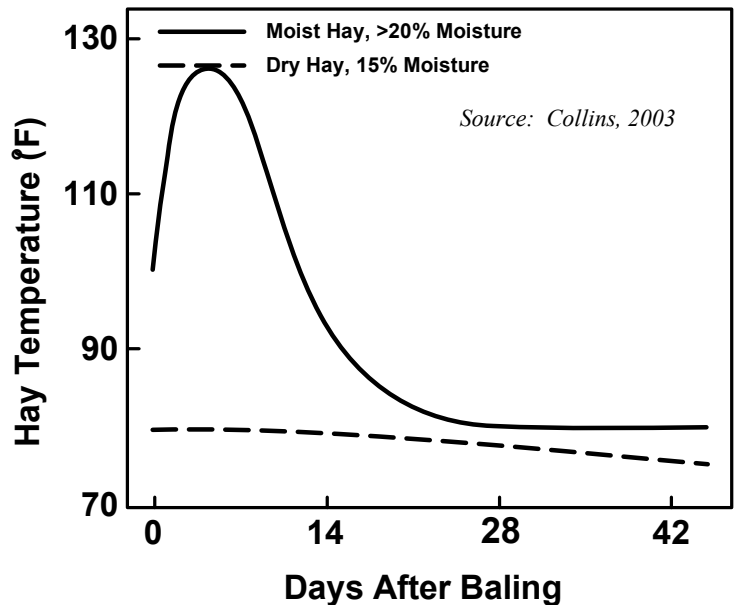
Extension Agricultural Engineer

University of Kentucky

It is well known that baling hay at the right moisture content is the key to preventing excessive heating in the bale. It can be quite a challenge, though, to get all of the hay baled without some of it being a bit wetter than is desirable. That's when trouble can begin, and we have to be concerned about heating that could damage the hay or even lead to spontaneous combustion. Fortunately, the heating process does take some time to develop and we do know what temperatures signal that a critical situation may be developing. So, monitoring bale or stack temperatures is one good way to find out what is happening inside the bale and to help avoid that nasty surprise that no one wants to see – a hay fire.

What are we looking for?

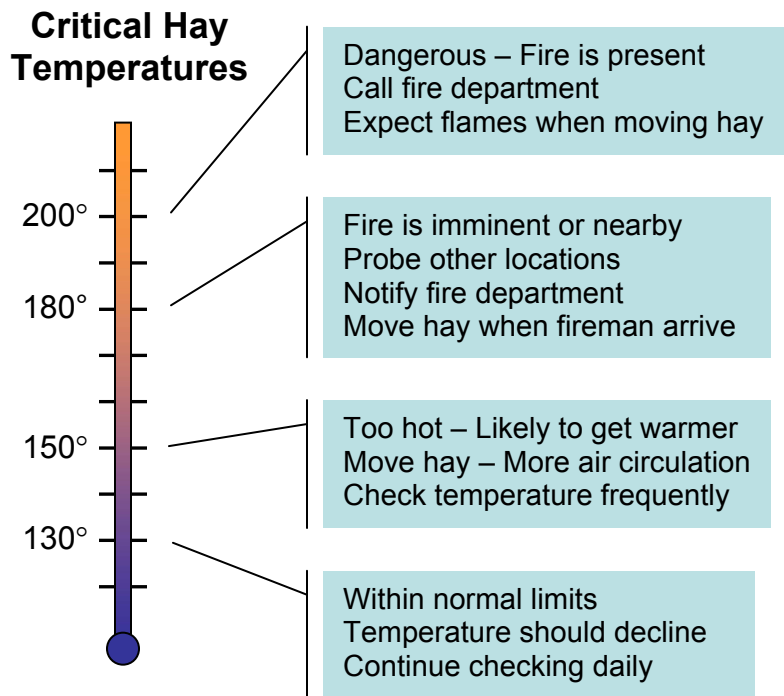
Most hay goes through one or more heating cycles (a "sweat") immediately after baling. It is not unusual for internal bale temperature to exceed 100° F, and it may go as high as 130° F if enough moisture and oxygen is present. The graph shown here illustrates a typical heating cycle for moist and dry hay. Under normal conditions, the moist bale temperature peaks slightly below 130° F and then begins to decline. If the hay was wetter, we might see the peak temperature exceed 130° F. Notice that the dry hay heats very little at all, and if the bale moisture was somewhere between 15 and 20% we would expect the peak temperature would also be in between the two lines shown on this graph.



Graphs like this one are what we find when we measure temperatures in a single bale out in the open. If the temperature peaks at less than 130° F, there may be some loss of hay quality but the heating does not create a fire danger. With free air circulation all around the bale, both heat and moisture are lost out the sides and ends of the bale. A single bale rarely heats enough to catch on fire. However, when we place the bale in a stack with other bales that are also

heating, we create a situation where heat cannot be transferred to the edges of the stack as rapidly as it is produced. If the bales we stacked are a bit wetter than they should be, temperatures can easily go above 130° F. Once the temperature reaches 140 to 150° F, some other microbial growth and chemical reactions start to generate heat at a faster rate. Then there is a real risk that the temperature may very rapidly rise above 200° F where spontaneous combustion can occur.

What we are really trying to do in measuring hay temperatures is to avoid a potential catastrophe by making sure that we know ahead of time if a critical situation might be developing. From a quality perspective, it is best if hay temperatures stay well below 130° F, but there is little risk of fire up to that point. It is a continued temperature rise above 130° F that signals potential danger, and detecting those conditions is the purpose of monitoring bale or stack temperatures. Some critical points on the temperature



scale are shown in the graphic above, and some suggested actions for those designated conditions are also given. Remember, too, that temperatures can rise significantly in a matter of hours when a critical situation is developing.

Where do we need to measure temperatures?

We know that the heating process is related to moisture, so it makes sense to monitor the hay that we think might have been too damp when baled or may have gotten wet after it was baled. With reasonably uniform moisture in the bale, the highest temperature is likely to be near the middle where heat is retained for the longest time. That implies that we should be looking near the center of a bale or deep into a stack. If the core is loosely formed in a large round bale, the highest temperature may be found in the more tightly packed hay 6 to 12 inches away from the center.

Probe square bales from the side and round bales from the end. A temperature probe should be long enough to reach the middle part of the bale. Probes for large packages will need to be at least 18 to 36 inches in length, depending on the size and type of bale that you have. It's probably not feasible

to measure every bale, so concentrate on bales that seem most likely to have a problem. Generally, those are the ones with the wettest hay. It's a good idea to probe a bale in 3 or 4 different places, perhaps from each end or side, to see if temperatures are warmer in some areas than in others. If you find a warm spot, then continue your daily monitoring in that same general area of the bale.

It may be more difficult to reach the center of a stack, but it's important to get at least 5 to 10 feet down from the top or in from the side. The most critical factor is to be able to reach an area where the wettest hay is stored. It is best to probe in several locations and at different depths to locate the warmest area.

What equipment can I use?

Several different types of thermometers can be used and no great precision is required. Accuracy within 5 ° F is sufficient. Durability, temperature range, ease of use, and cost are probably the more important factors to consider. The table that follows shows some examples of different types of hay thermometers and some features of each type. Any hay thermometer should be capable of reading temperatures up to at least 200° F.

A simple glass thermometer can be used by attaching a string or thin wire and lowering or pushing it into a probe that has been inserted into the hay. These can be pocket models with a case, longer laboratory type thermometers, or candy thermometers. Some are made with metal armor that partially surrounds the glass tube for added protection. However, no glass thermometer, with or without armor, should be inserted directly into a bale because they break very easily. Also because they are easily broken, do not use mercury thermometers. Only spirit filled thermometers should be used. This avoids any risk of contaminating hay with mercury in the event of a broken thermometer.



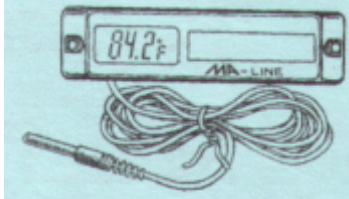

Electronic thermometers with remote sensors and a digital readout can be used for this application. Common indoor/outdoor thermometers of this type could be used for some measurements, but most of them have a maximum upper temperature reading of about 160° F. A better choice is to look for instruments used in the heating and air conditioning industry. They are likely to be available with a higher temperature range. Most electronic thermometers require batteries although some are solar powered with or without a battery backup. Avoid LED displays as they are often hard to read in bright light. An LCD (liquid crystal display) is a better choice.

Long stem dial thermometers, also sold as "compost thermometers," are probably the most rugged and reliable. Unfortunately, the price increases considerably as the dial size and stem length increases. It is tempting to insert these thermometers directly into a bale without using a probe but that is not a good idea. Inside the thermometer stem, the sensing element is near the tip and there is a long helical connection through the stem to the dial. Bending or

crimping the stem can severely affect the thermometer's accuracy or even render it inoperable.

A multitude of low cost dial or digital thermometers with an attached stem are available. They may be usable for a few applications, but are not always well suited to measuring hay temperatures. The stems are often too short and/or too thin, to be practical for inserting deep into a hay bale, and the attached dials or digital readouts are usually too large to be inserted into a reasonable size pipe probe.

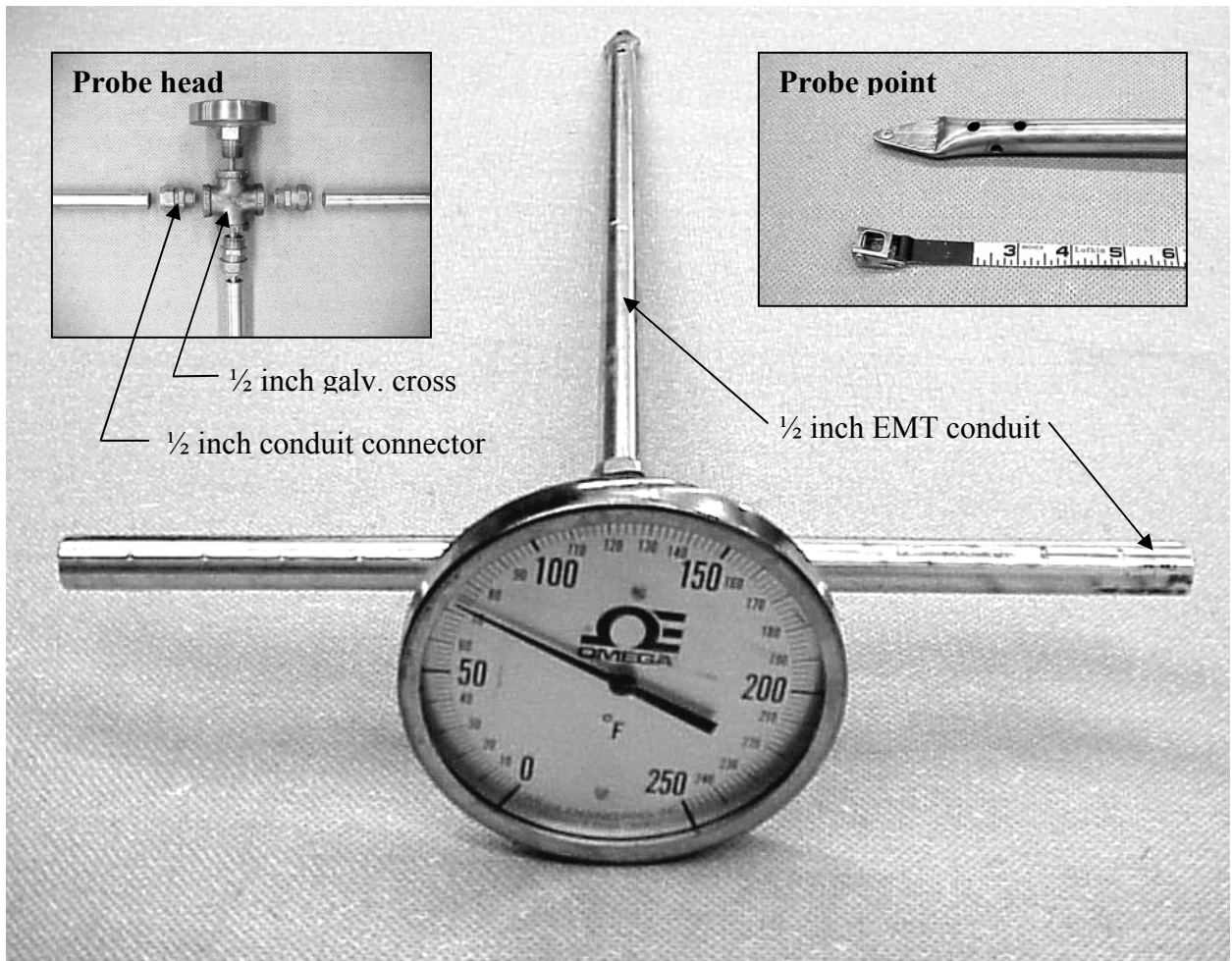
Thermometers for measuring hay temperatures

	<p>Spirit filled glass thermometers</p> <ul style="list-style-type: none"> - With or without metal armor - Use with string to lower into probe - Avoid mercury filled thermometer
	<p>Dial reading with capillary tube</p> <ul style="list-style-type: none"> - Variable capillary length to 100 ft. - Capillary damage affects accuracy - Insert capillary in tube for protection
	<p>Digital reading with remote sensor & cable</p> <ul style="list-style-type: none"> - Battery and/or solar cell powered - Limited temperature range on indoor/outdoor models - Heating/air conditioning models have higher temperature range
	<p>Dial reading with long stem</p> <ul style="list-style-type: none"> - Also called "compost thermometers" - Stem lengths to 6 ft. - Stem damage affects accuracy - Stem not strong enough for direct insertion into hay bale - Available as a probe with handles

How can I make a temperature probe?

It's an easy project to make a hay probe from $\frac{1}{2}$ or $\frac{3}{4}$ - inch steel pipe or electrical conduit. A probe for large bales should be about 3 feet long. To probe stacks, it should be 6 to 10 feet long. One end should be closed either by squeezing the tube together or by welding a small bolt or rod into the end of the tube. If the tube was squeezed together, a rivet will help keep it from separating. Then grind the end to a moderately sharp point. Drill 3 or 4 small holes ($\frac{1}{4}$ inch diameter) through the pipe near the pointed end. Handles can be attached to the other end by using pipe and/or conduit fittings. Long-stem dial thermometers can be purchased with threaded pipe fittings which will screw directly into the handle assembly. Other types of thermometers may require some additional fittings or adapters if they are to be permanently mounted in the probe. The picture below shows a completed thermometer probe. Similar probes can also be purchased from commercial sources.

Hay Thermometer Probe



Where can I find it?

Thermometers should be available at many local sources such as farm supply stores, hardware stores, heating & air conditioning suppliers, or general merchandise vendors. In addition, there are many catalog or internet sources from which thermometers and other hay testing equipment can be obtained. Following is a partial list of sources:

Ever Ready Thermometer Co., Inc
2555 Kerper Blvd.
Dubuque, IA 52001
Phone: (800) 553-0039
Fax: (563) 589-0516
<http://www.ertco.com/index.html>

Gempler's
P.O. Box 44993
Madison, WI 53744
(800) 382-8473
<http://www.gemplers.com>

JHL Supply
P.O. Box 720
Fulton, NY 13069
(800) 537-1339
Fax: 315-592-4796
<http://www.hvactool.com/index.php3>

Omega Engineering, Inc.
P.O. Box 4047
One Omega Drive
Stamford, CT 06907-0047
(800) 826-6342
<http://www.omega.com>

Lesman Instrument Co.
215 Wrightwood Ave.
Elmhurst, IL 60126-1112
(800) 953-7626
<http://www.lesman.com/index.html>

NASCO - Fort Atkinson
901 Janesville Avenue
P.O. Box 901
Fort Atkinson, WI 53538-0901
(800) 558-9595
Fax: (920) 563-8296
<http://www.nascofa.com/prod/Home>

ESTABLISHING ALFALFA USING NO-TILL TECHNIQUES

Gary Bates
Forage Specialist
The University of Tennessee

There have been many changes in agriculture over the last 50 years. One of the greatest has been the use of no-till planting methods. The development of drill and herbicides has made no-till seedings as successful as seeding into prepared land.

WHY USE NO-TILL?

There are several advantages to no-till planting. First is the obvious decrease in soil erosion. There are several other reasons, however. With no-till, planting can occur soon after a rain, while the soil must be allowed to dry before disking to prepare for conventional seeding. After planting, the soil retains moisture longer when no-till is used, because the soil is not directly exposed to the sun. Cost comparisons between conventional and no-till plantings generally show the expenses for both to be similar. No-till plantings require less fuel and labor than conventional planting, but require a chemical kill of the existing vegetation.

STEPS FOR SUCCESSFUL NO-TILL ESTABLISHMENT OF ALFALFA

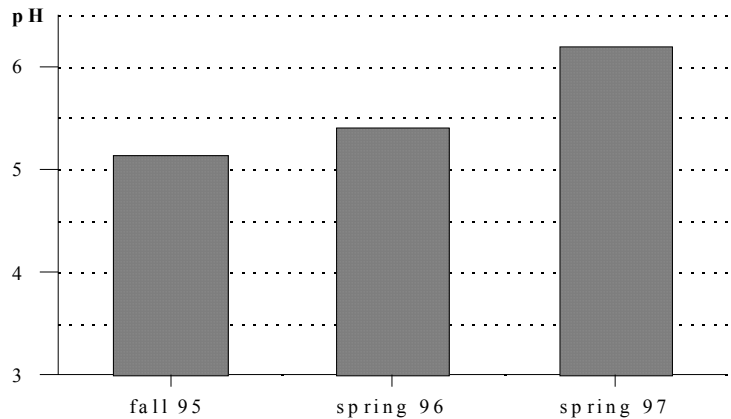
Most people who have tried to establish alfalfa through no-till methods can tell of great successes and total failures. As the successes and failures are compared, it becomes evident that several points may make the difference between these two. In order to be effective with no-till planting of alfalfa, research and experience has shown the following details should be focused on.

(1) Don't forget the basics of alfalfa establishment. Most of the same things that are important for conventional establishment are still important with no-till. Select a deep, well-drained soil. Also be sure to select an adapted variety with resistance to any diseases that have been a problem for previous alfalfa stands. Just because an alfalfa stand is planted no-till does not mean that wet feet will not be a problem, or that an unadapted variety will become golden.

(2) Prepare for establishment at least one year ahead. Proper planning can often prevent many of the potential problems that can occur during alfalfa establishment. Starting early when getting a field ready can ensure that the last minute problems that creep up can be minimized.

A. Soil test and apply lime as needed. Research has shown that liming on top of the soil is as effective as when the lime is incorporated, it just takes longer to move into the soil. Figure 1 shows the length of time required for the pH to be raised from 5.3 to above 6 in a no-till system. Don't expect to apply lime one month ahead of planting and to have the pH high enough to be successful.

Figure 1. Changes in pH after liming no-till planting. (Ritchey and Tyler. 1998. UT Master's Thesis)



B. Clean up weed problems.

Most weed problems are easier to take care of before the alfalfa is seeded rather than after. Weeds like curly dock, buckhorn and broadleaf plantain, as well as horsenettle can be chemically controlled before alfalfa is seeded. Once the alfalfa is present, the herbicide options are drastically limited. Often times, the weeds can't be controlled in alfalfa, they can only be suppressed. Plan ahead and get rid of these problems before they cause severe problems.

(3) Seed at the proper time. The time of seeding may be one of the biggest differences between seeding methods of alfalfa. Conventionally seeded alfalfa can be seeded in both the spring and fall. With no-till, experience has shown that spring seedings are best. Sclerotinia crown rot can be a major problem with fall-seeded alfalfa, but its greatest potential for damage is with no-till alfalfa. This fungus is a problem on young alfalfa seedlings going into the first winter. After the stand is established, the plants develop tolerance to the fungus. Spring seeding allows the alfalfa plants to become well established before winter. Fall seedings, especially with no-till, result in plants that are young as winter approaches, which increases the susceptibility of the alfalfa plants to sclerotinia crown rot.

Experience has also shown that the seeding window for spring seeding is longer for no-till than for conventional plantings. Killed sods retain moisture longer into the late spring, so plantings can occur later with no-till. Plantings can be made 2-4 weeks later with no-till compared to planting in conventional seedbeds.

(4) Seed into killed vegetation. A major reason for stand failures with alfalfa is weed competition. With conventional seeding, all existing plants are

killed by mechanical means. In simple terms, they are plowed up. With no-till seeding, since the field is not worked, herbicides need to be used to kill existing vegetation. The two most common chemicals used are glyphosate and paraquat. Both are non-selective herbicides, but their modes of action are different. The best herbicide to use will depend upon your specific conditions. Contact your local Extension agent for help in determining which herbicide to use. Be sure to read and follow all label instructions.

One of the most consistent sods to plant into is wheat. A successful program has been to kill the original sod in the fall, seed wheat in October, spray the wheat with paraquat in April/May, and seed the alfalfa the day after spraying. Plants like tall fescue are easier to kill in the fall than spring, so the fall spray will kill those, and wheat is easily killed by paraquat, so plant competition is removed by the spring spray. This is not the only program that can be successful, but it has worked well for many producers.

(5) Plant the proper amount of seed. For both no-till and conventional seeding, 15-20 lb per acre of seed is required. Without the proper number of seed, there is no way to get enough plants to provide a full stand. The reason this is pointed out in this paper is because of the difference in machinery. For many no-till plantings, drills are not owned, but are rented. Most drills have some type of seed flow chart to help with seeding rates. However, as drills age and are used over more acres, the actual seed flow may vary considerably from expected values from the chart. Also, some of the coatings used on alfalfa and other legume seeds may cause the seed to flow faster than predicted by the calibration charts on drills. It is not unusual to have increases in seed flow up to 30-40 percent above that of uncoated seed.

It is important to calibrate a no-till drill before seeding to ensure the proper seeding rate is used. For both coated and uncoated seed, a 15-20 lb per acre seeding rate is still recommended. Calibrating the drill will prevent an extra trip to buy more seed because all of the original seed was drilled on half of the field.

(6) Plant when moisture is available. In order for a seed to germinate, it must take in water and swell before the young root and stem begin to emerge. The moisture in the surrounding soil is critical for seed germination. A good stand of alfalfa will depend on planting the alfalfa into a moist soil so plenty of moisture is available. Just because the drill is able to get into the soil does not mean there is enough moisture for germination. There is generally not a problem with a lack of moisture with spring seedings, but it is important to keep this point in mind.

(7) Plant at the proper depth. Research has shown that seeding depth is a critical factor in alfalfa emergence and establishment (Figure 2). For a seed to become established, it has to germinate and push up through the soil. Once the young leaves are exposed to sunlight, they can begin to produce energy by photosynthesis to grow. Until this occurs, they depend on stored energy in the seed to develop. The deeper a seed is planted, the more energy required to get

through the soil. Small seeded plants like alfalfa have very limited amounts of energy stored in the seed, so they should be planted shallow. Recommended depths for alfalfa seeding are $\frac{1}{4}$ to $\frac{1}{2}$ inches deep. It is preferable to be on the more shallow side of this recommendation.

Most no-till drills have been designed to be heavy enough to cut through sod and into the soil with coulters. The depth that a drill will place seed can vary based on soil moisture and the amount of pressure that is put on the press wheels. Be sure to run the drill in the field before seeding to determine the depth the coulters are cutting. If the drill is cutting a furrow deeper than $\frac{1}{4}$ to $\frac{1}{2}$ inches, adjust the drill to make a more shallow furrow. On most drills this is done by putting more pressure on the press wheels, which will raise the coulters.

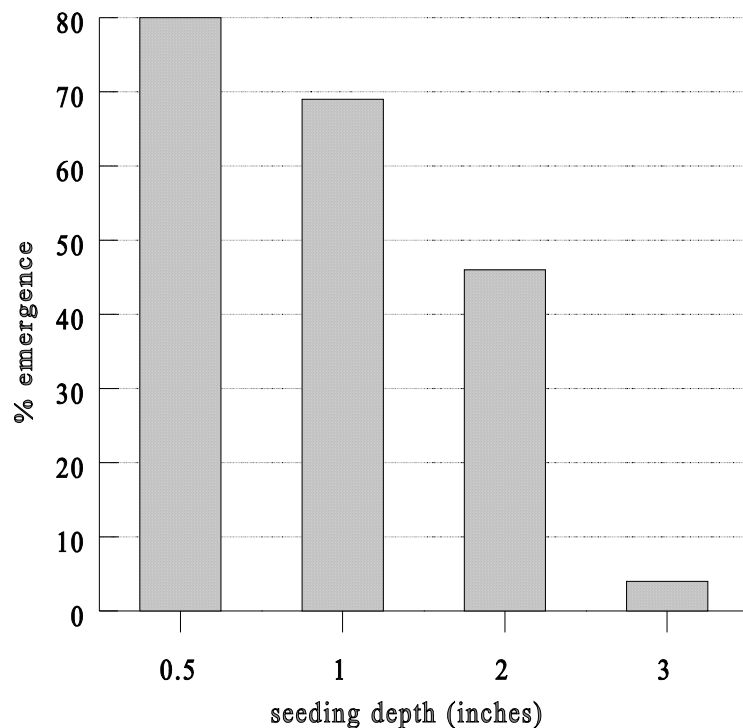
(8) Control weeds after planting. One of the major weed competitors for spring seeded alfalfa is crabgrass. If not controlled, crabgrass can cause a severe reduction in the number of alfalfa plants that become established. Several grass herbicides are available for use in the situation. The proper one to use will be based on the presence of other types of grass or broadleaf weeds. Be sure to keep an eye on a newly seeded field of alfalfa. This will allow you to treat the fields before the weeds become a competitive problem.

When spring seeding of alfalfa is first mentioned to some producers, weed pressure is often listed as the number one problem. Often times it is viewed as a great enough problem that some people avoid spring seedings. If no-till seeding is to be used, it is better to have weeds, which can be chemically controlled, than to have sclerotinia crown rot, which has no method of treatment, and can completely wipe out a stand of fall-seeded alfalfa.

CONCLUSION

No-till establishment of alfalfa is a viable and attractive alternative to the conventional seeding of alfalfa. Attention to detail is often the difference between

Figure 2. Effect of seeding depth on alfalfa emergence. (Murphy and Army. 1939. Agron. J. v 31 p 17.)



getting a good stand, and getting a stand that is weak and will be difficult to deal with. Just as with conventional alfalfa, select a good variety, remove all existing vegetation, get the fertility in good shape, plant seed the proper depth, and control weeds after planting are the key points. The difference between the two planting methods occur mainly because of the differences in the way some of these tasks are accomplished.



Roundup Ready® Alfalfa Update

24th Kentucky Alfalfa Conference

February 26th, 2004

Daniel O. Foor

Product Manager, Monsanto

ROUNDUP READY ALFALFA IS NOT APPROVED FOR SALE OR DISTRIBUTION IN THE U.S. ROUNDUP ©BRAND HERBICIDES ARE NOT REGISTERED FOR THIS USE. IT IS A VIOLATION OF FEDERAL LAW TO PROMOTE ANY UNREGISTERED HERBICIDE USE.

Always read and follow herbicide label directions.

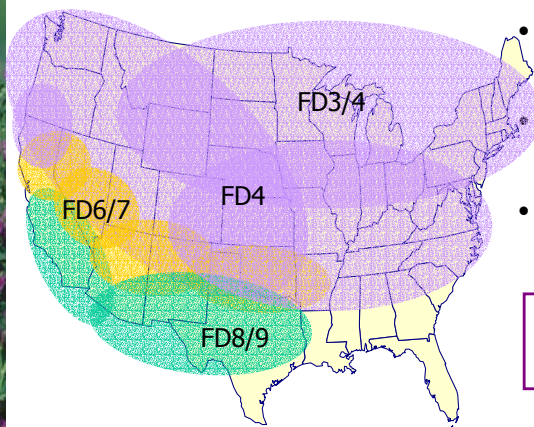


Introduction- Project Background

- Monsanto and Forage Genetics International are working together in a business partnership to develop Roundup Ready® alfalfa.
 - Monsanto is a leader in Roundup Ready trait technology.
 - Forage Genetics International is a leader in the development of elite alfalfa genetics.
- We will broadly license this technology to other seed companies so that it will be available in the brands that growers trust.
- We're excited about the potential this product holds for alfalfa growers and will share the value with those who choose to purchase it.



Introduction- Variety Availability



- Winter hardy FD3/4
- Semi-dormant FD6/7
- Non-dormant FD8/9

RR Cultivars for All Major Markets



Introduction- Weeds in Alfalfa



- Weeds in alfalfa production can:
 - Compete with alfalfa seedlings during establishment (In some cases cause stand failure),
 - Significantly reduce yields,
 - Lower forage quality,
 - Increase susceptibility to disease and insects,
 - Reduce stand life,
 - Can be toxic to livestock,
 - Decrease grower profitability.



Introduction- Weed Control Challenges



- Weed control in alfalfa can be challenging.
 - At seeding, when weed control is critical, weeds can germinate faster and out-compete alfalfa seedlings.
 - Currently available control products have limitations including:
 - Requirements for soil incorporation,
 - Narrow window of application,
 - Narrow weed control spectrum,
 - Relatively long pre-harvest intervals,
 - Risk of crop injury,
 - Crop rotation restrictions.
 - Cover crops have advantages and disadvantages



Introduction- Roundup Ready Alfalfa



- Roundup Ready alfalfa, like other Roundup Ready crops, has been developed to tolerate over-the-top applications of Roundup[®] brand agricultural herbicides.
- The result is an effective and flexible weed control tool for alfalfa growers.



Potential Benefits of Roundup Ready Alfalfa



Roundup Ready alfalfa will offer growers a simple, dependable tool for control of broadleaf and grassy weeds for the life of the alfalfa stand

- Effective weed control in the seedling year is important to stand establishment. The Roundup Ready system can provide weed control without risk of crop stunting or injury when establishing alfalfa.
- Fewer weeds lead to less foreign matter in forage and better quality animal feed. The Roundup Ready system can help meet demands for cleaner, more dependable forage.
- The family of Roundup agricultural herbicides has an excellent 25-year history of safe use. The Roundup Ready system replaces the need for pre-plant incorporated treatments and post-emergence treatments of commonly used herbicides having less favorable environmental characteristics.



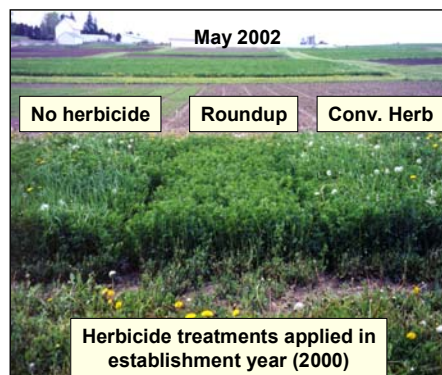
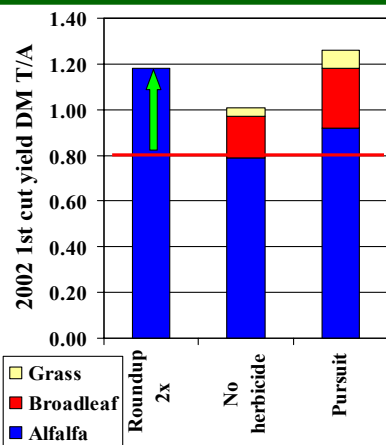
Management Considerations



- Weed control during stand establishment
 - Weed control before and after seeding is critical for establishing a healthy stand.
 - Test results conducted by Monsanto and Forage Genetics indicate:
 - Roundup applications prior to seeding and shortly after seedling emergence result in excellent stands nearly free of weeds.
 - Excellent crop safety with respect to forage yield and quality.
- Weed control in mature stands may be important to maintaining forage quality.



2000 UW Herbicide Study

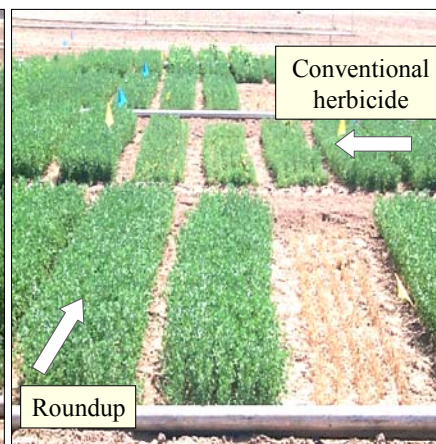
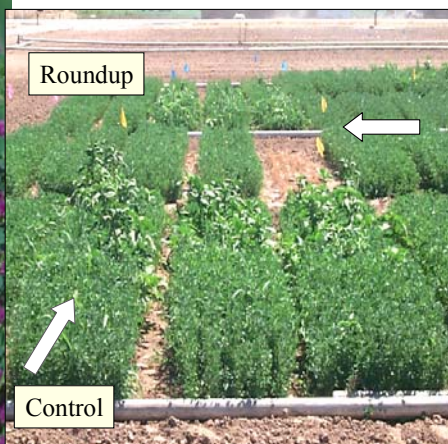


Demo Plot – Idaho June 2000



Excellent weed control, no yield lag

Excellent crop safety



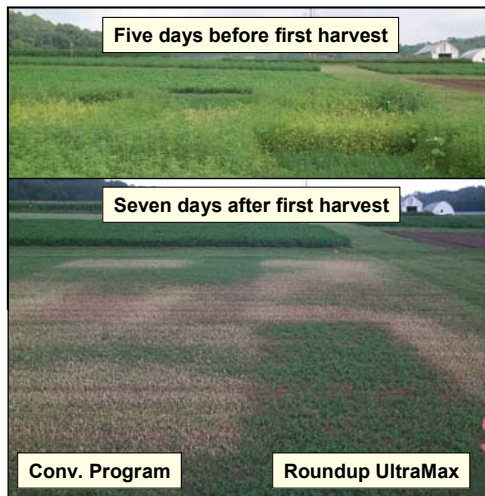


2001 Wisconsin Seeding Study

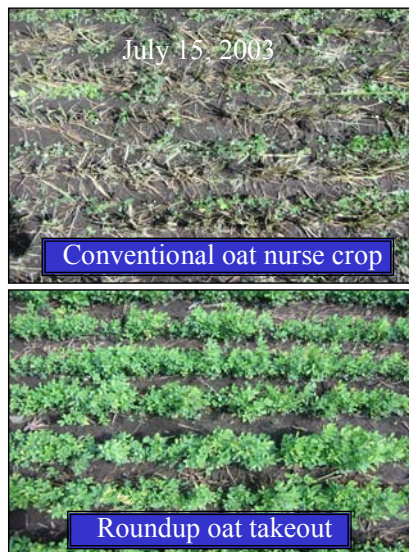


Product concept testing to evaluate efficacy and crop safety

- Plot area infected with weed seed.
- RR alfalfa seed used to establish plots
- Various herbicide treatments applied
- Only Roundup gave effective weed control



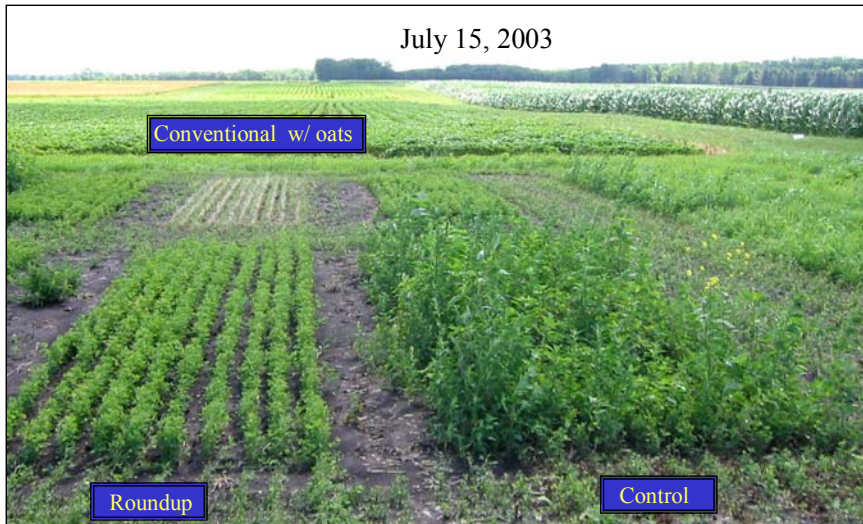
2003 U of MN Weed Control Study





2003 U of MN Weed Control Study

July 15, 2003



2003 Wyoming Efficacy Study

WEED CONTROL & ALFALFA RESPONSE CONTROL			WEED CONTROL & ALFALFA RESPONSE CONTROL		
RATE	BRDLF GRASS (%)	ALFALFA T/A	TIMING	BRDLF GRASS (%)	ALFALFA T/A
2	95	95	CO-2LF	87	88
3	97	97	2-4LF	92	92
4	97	97	4-6LF	98	96
			CO-2LF+3wk	100	100
			2-4LF+3wk	100	100



2003 Iowa Fall Weed Control Study



.75 AE WeatherMax- Fall

Not Treated



Management Considerations



- Stand take-out and volunteer management
 - **Diligent Takeout.** Use appropriate commercially available herbicide treatments alone or in combination with tillage to terminate the stand.
 - **Clean Start.** If necessary, utilize tillage and / or additional herbicide application(s) after alfalfa stand termination, and before the planting of the subsequent rotation crop.
 - **Plan for Success.** Rotate to crops with known mechanical or herbicidal methods for managing volunteer alfalfa; break rotation cycle if necessary.
 - **Timely Execution.** Administer “in crop” mechanical or herbicidal treatments for managing alfalfa volunteers in a timely manner.



Stand Take Out Trials- Nebraska



Management Considerations



- Specific management guidance will be communicated via:
 - Monsanto Technology Use Guide
 - Monsanto Regional Technical Bulletins
 - Monsanto, FGI and seed-partner field technical and sales staff.



Commercial Timelines



- Monsanto and Forage Genetics International commit to dairymen, livestock producers, and hay growers that all necessary regulatory submissions will be made and approvals obtained for Roundup Ready alfalfa, in the U.S. and major alfalfa export markets, before commercial planting occurs
- Regulatory approvals are only one of the key commitments we will meet prior to commercial launch. These commitments include:
 - confirm product efficacy;
 - make necessary regulatory filings and obtain approvals;
 - meet quality specifications;
 - engage growers and users, as well as the seed and feed industries and academics, to prepare for the introduction of Roundup Ready alfalfa to the alfalfa value chain.



Commercial Timelines



- Commercialization will occur once all necessary regulatory approvals are obtained in the U.S. and major alfalfa export markets.
 - USDA submission made in Q2 2003.
 - EPA submission for proposed Roundup brand labels made in Q2 '02.
 - FDA submission made Q4 2003.
 - Ex-U.S. submissions to be made in coming year.
- Commercial launch is expected in 2005.



Alfalfa Quality Traits in the Pipeline



- Reduced Lignin
 - Increased digestibility
 - More efficient feed conversion
- Increased Tannin content
 - Improved nitrogen utilization
 - Decrease need for protein supplements



Next Generation of Biotech Traits



Yield

- Photosynthesis
- Seed development
- Plant structure
- Nutrient utilization
- Harvest ability

Quality

- Starch / Carbohydrates
- Lipids / Oils
- Protein

Pest

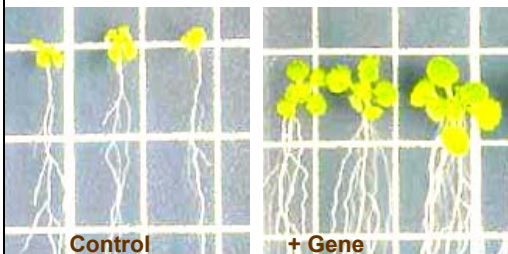
- Disease resistance
- Insect resistance

Stress

- Heat tolerance
- Cold tolerance
- Drought tolerance
- Nutrient conversion



New Genes entering the Pipeline



Control

+ Gene



Soybean

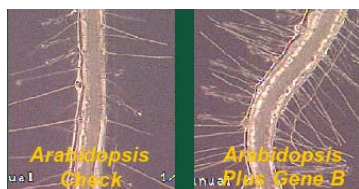
Control

With Gene

Stress Tolerance

(Better performance on less water)

Nutrient Utilization
(better growth on lower fertilizer)



Arabidopsis
Check

Arabidopsis
Plus Gene B



Control

With Gene



Thank you for your time!!!

Questions???



Hybrid Alfalfa: Reality or Pipe Dream?

Dairyland Seed Company

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ABSTRACT

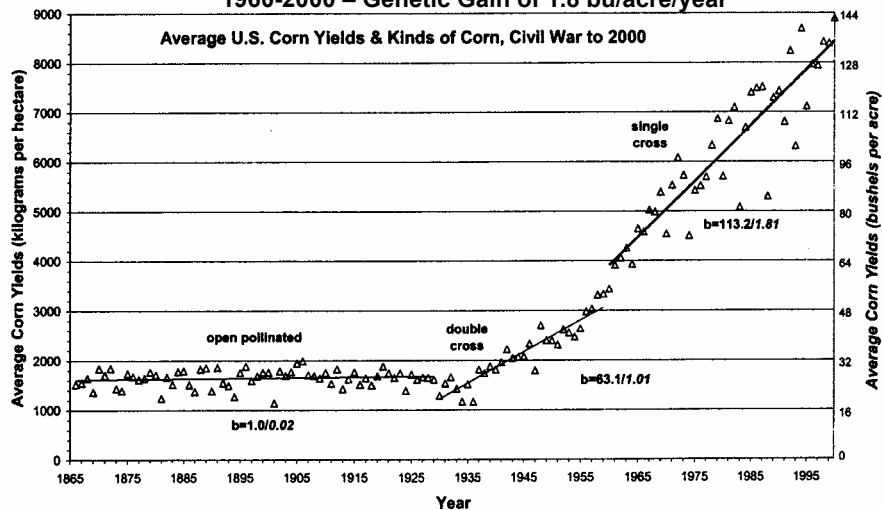
Progress in increasing alfalfa forage yield has been minimal over the past 20 years. This is due primarily to lack of pollen control in open pollinated synthetic varieties. All alfalfa varieties to date have been open pollinated synthetic varieties. New alfalfa hybridization technology provides the tools to overcome the forage yield barriers that have been hindering alfalfa breeders from making progress

Key Words: forage yield, alfalfa, hybrid, hybridization, msSUNSTRA.

Historically alfalfa breeders have struggled in increasing forage yield capabilities. In a study that looked at the history of alfalfa yields in university trials, the University of Wisconsin found no genetic gain in forage yield in alfalfa varieties in the Midwest for the past 17 years (Wiersma et al., 1997). The USDA reported that alfalfa yields in recent years showed a slight decline. In contrary, hybrid corn has shown 1.8-2.0 bushels genetic gain per year (Figure 1) for the past 40 years.

Figure 1. The History of Corn Yields (Troyer et al.)

1860-1930 – Total Gain of 2 bu/acre
 1930-1960 – Genetic Gain of 1 bu/acre/year
 1960-2000 – Genetic Gain of 1.8 bu/acre/year



Average U.S. Corn Yields & Kinds of Corn, Civil War to 2000; periods dominated by open pollinated, by four-parent crosses, and by two-parent crosses are shown, *b* values (regressions) indicate average gain per year; data compiled by USDA.

Just as open pollinated corn showed no yield gain from 1860-1930, alfalfa breeders have struggled with the same lack of progress. The primary reason for the lack of alfalfa forage yield gain has been the inability to control pollen flow in open pollinated synthetic varieties. When corn breeders went from open pollinated corn to double cross and eventually to single crosses, grain yield improved significantly. Controlling pollination by hybridization of alfalfa will allow alfalfa breeders to overcome this yield barrier.

Dairyland Seed Company released the first hybrid alfalfa in March of 2001. Hybrid alfalfa is being released to alfalfa growers across the greater hardy and semi-dormant alfalfa production areas of the United States. Non-dormant hybrid alfalfa varieties will be released in the near future. The features and benefits of hybrid alfalfa are listed in Table 1. Hybrid Alfalfa's are products of Dairylands exclusive patented msSUNSTRA Hybrid Alfalfa Technology.

Table 1. Features and benefits of hybrid alfalfa.	
<u>Feature</u>	<u>Benefit</u>
Increase spring vigor	Allows for earlier cutting for increased quality with less risk of stress and stand loss.
Faster regrowth with more vigorous plants	Photosynthesis starts sooner, which increases yield due to better use of water and nutrient uptake.
More resilient plants	Provide greater forage yield production in years 3-4.
Fine Stems	Excellent potential for high quality forage. Herbage tends to dry faster than large stemmed varieties.
Hybrid Yield	Increase in forage yield capabilities. Eight to fifteen percent in state trials. Ten to twenty five percent in farmer strip plots.
Drought Tolerance	Quick ground cover to reduce moisture loss. Deep rooted to capture moisture.
Shade Tolerant	Competes well with nurse crops.
Traffic tolerant	Tolerates wheel traffic when soil conditions are wet.

As alfalfa breeders explore biotechnology possibilities, hybrid technology can be a platform to bring new technology traits quickly to the market in agronomically superior genetics. In addition, for biotech traits that need strict seed production isolation, gene outflow can be contained with hybrid technology using male sterility.

References

Weirsmas, D. W., D. J. Undersander, J. G. Lauer, and C. R. Grau. 1997. Lack of Alfalfa Yield Progress in the Midwest. CAIC Abstract

Troyer, A.F. 2000. Temperate corn--background, behavior, and breeding. P. 393-466. *In* A.R. Hallauer (ed.). Specialty Corns, 2nd edition. CRC Press, Boca Raton, FL.



BALANCING AGRONOMICS AND ECONOMICS OF ALFALFA HAY PRODUCTION

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Area Extension Specialist, Farm Business Analysis & Extension Forage
Specialist
University of Kentucky

Alfalfa has high-yielding, high-quality, persistent, and profitable potential if given adequate management and a balance of several agronomic and economic considerations. How can we account for the differences among producers who have the average alfalfa yields of 3.0 tons/A with the top hay producers who average approximately 5.0 tons/acre and the producer who has achieved the record yield of 10.13 tons/acre? Is the answer “luck”, better soils, moisture and growing conditions? The answer may certainly be yes, but. Yes, the factors above are important and can explain some differences; however, we believe the overall difference is the management of research-based farmer-proven “agronomic and economic practices.”

Why can some producers make money on alfalfa hay fields with low yields while others lose money at high yields? Could it be that the farmer with low yields gets high prices and vice versa – well maybe – but it is more likely that profitability resulted in overall management of their agronomic and economic factors to keep cost of production as low as possible and use all marketing strategies available to obtain the best prices.

The purpose of this paper is to examine some of the agronomic practices to see if they are indeed in balance with the economics of producing quality alfalfa hay.

Alfalfa Establishment & Production Cost

Alfalfa is not the cheapest forage crop to establishment with cost ranging from \$50 to well over \$300 per acre to establish the stand. Production costs can also show considerable variation ranging from \$75 to over \$300 per acre. Table 1 shows the average cost for establishing and producing an acre of alfalfa hay in the Midwest. In this budget “out of pocket expenses” was \$172.21 for establishing and \$87.64 for production. Total cost was \$382.18 for establishing and \$306.01 for production.

Table 1. Economics of alfalfa production in establishment year and succeeding production years. Midwest 2002.

	<u>Establishment</u> per acre	<u>Production</u> per acre
Operating costs		
Input Expenses		
Fertility	\$18.00	\$38.15
Lime	\$39.00	---
Alfalfa Seed	\$50.00	---
Herbicide	\$13.00	---
Overhead	\$12.19	\$12.19
Pest Scouting	\$5.00	\$5.00
Crop Insurance	\$7.00	\$7.00
Part time labor	---	\$4.23
Irrigation	\$0.00	\$0.00
Energy expenses	\$10.91	\$9.75
Repair and Maintenance	\$7.34	\$6.60
Input interest	\$9.77	\$4.72
Subtotal	\$172.21	\$87.64
Allocated Overhead		
Land Charge	\$75.00	\$75.00
Property Taxes	\$22.00	\$22.00
Management	\$6.00	\$18.18
Labor	\$30.63	\$28.21
Interest and Insurance	\$46.93	\$46.64
Depreciation	\$29.41	\$28.34
Subtotal	\$209.97	\$218.37
Total	\$382.18	\$306.01

Source: Dr. Dan Undersander, University of Wisconsin.

Considerable variations exist when comparing alfalfa hay production budgets (Table 2). We compared budgets from Kentucky and eight other states. Range for establishment was from \$112-382 and range for production was \$87-423. Average "out-of-pocket" expenses for establishing was \$176 and \$142 for production.

Table 2. Alfalfa Hay Establishment and Production Cost Averaged Over Nine States.				
	Operating Cost \$/A		Total Cost \$/A	
	Range	Average	Range	Average
Establishment	112-234	176	246-382	285
Production	87-229	142	289-423	331

In this presentation, we will not attempt to “balance” all economic and agronomic factors involved in alfalfa hay production. We will address some of the factors we consider critical to successful, profitable alfalfa hay production.

Select the right soil

This has been one of the most basic agronomic recommendations. Alfalfa requires deep, well-drained, fertile soils for optimum production and persistence. Growing alfalfa on shallow, poorly drained soils will reduce yield and stand life. Let’s make this easy and just assume a reduction in productive stand life of two years. Let’s further assume an establishment cost of \$200/A. Disregarding the two extra years of production and likely more production each of the first two years on the better soils and only look at persistence we find establishment costs on the poor soil of \$100 per acre (\$200/2 yrs), and an establishment cost of \$50/A (\$200/4). We balance our agronomic recommendations with positive economic returns.

Soil test and apply needed fertilizer

Without question, the most basic of our agronomic recommendations – but can we always balance with economics. A good friend called one day to indicate he had gotten all his soil test results and was making plans for his fertilizer application and indicated he was having trouble, “balancing his soil test results with his check book.” Fertilizer is not cheap, but guessing how much to apply can be very expensive. A soil test is the most important agronomic and economic recommendation we make relative to our overall alfalfa fertility program. If we choose to bypass a soil test and “guess” at the rate we must guess well – too little fertilize and we reduce yield and possibly stand life, too much and we pay a high fertilizer bill.

The University of Kentucky Soil Testing Laboratories charge \$4.00 per sample. Counties usually charge for processing and mailing, resulting in a cost to the producer of around \$5.00. Some counties have programs that offer some

financial assistance for soil testing. The bottom line is that a soil test is a great “INVESTMENT” in alfalfa establishment and production.

Lime and fertilize as needed: Alfalfa removes large amounts of nutrients from the soil. A ton of alfalfa hay contains up to 60 lbs of nitrogen, 15 lbs of phosphate, 60 lbs of potash, and 30 lbs of calcium, plus the micronutrients. Nitrogen fertilizer is not necessary because alfalfa gets nitrogen from the air by converting atmospheric nitrogen to a chemical form by special bacteria in the nodules on the roots. Soils vary considerably in their ability to supply nutrients. We call your attention to Dr. Monroe Rasnake’s paper on page 5 of these proceedings for more detailed information on “Fertilizing Alfalfa for Profit.”

Select good varieties and seed on time with the right amount of seed

Establishing a good stand of alfalfa is expensive and time consuming. A failure will drastically increase the establishment cost, result in a year’s loss of production and possibly increase soil erosion problems. There are many agronomically important aspects of establishment that are important including: variety selection, seeding rate, date, depth, and seeding method. For most producers it is generally accepted that they can balance agronomics and economics of most of the basic, such as seeding rate, date, depth and method that will result in a uniform distribution of seed in good seed-soil contact at approximately ¼ inch depth. They further realize that there are some seeding date “windows” that will increase chances of success. It’s in our opinion that the greatest opportunity in this establishment area to better balance agronomic and economics is variety selection.

Variety Selection: A basic agronomic recommendation is to use high quality seed of a proven variety. The University of Kentucky has a very active and aggressive variety testing program with test locations in Lexington, Princeton, Bowling Green and Eden Shale and occasionally at Quicksand and other locations.

Table 3 shows a seven year average dry matter yield for varieties seeded at Bowling Green, Kentucky in April 1996. Over the seven year period, total yields varied by 8.0 tons per acre from the lowest to highest variety. Since there

Table 3. Dry matter yields (tons/acre) of alfalfa varieties sown April 19, 1996, at Bowling Green, Kentucky.

Variety	7-yr Total
Garst 631	38.07
WL 324	37.92
Affinity + Z	37.26
WL 252 HQ	37.20
DK 133	37.18
Imperial	37.16
Depend + EV	37.04
TMF-Generation	36.79
Supercuts	36.76
Choice	36.73
645	36.68
DK 127	36.63
Gem	36.28
ABT 405	36.19
Innovator + Z	36.06
Saranac AR	36.03
Demand	35.38
Rushmore	35.34
WL 325 HQ	35.30
Fortress	34.91
Legacy	34.10
Apollo	34.16
Buffalo-B	33.26
Arc	32.67
Buffalo-A	30.42

was no significant differences in dry matter yield over the seven years among the top thirteen varieties let's compare the average of the top with Buffalo-A Table 4. The average of the top 13 had a yield increase of 6.62 T/A over Buffalo-A over the first seven years. Cost per acre for seed of the top varieties was more than Buffalo Table 5. In this case, if we assume an average of \$3.50 for top varieties and \$1.00 for Buffalo-A then the cost for seeding 15 pounds per acre is \$52.50 and \$15.00, respectively. When prorated over the first seven years, that is only \$5.36 more per year for any of the better varieties.

Table 4. Dry matter yield for average of top thirteen varieties versus Buffalo-A.	
Variety	Dry Matter Yield T/A
Average of Top 13	37.04
Buffalo-A	30.42
Difference	6.62

Table 5. Seed cost per pound and per acre for average of top thirteen and Buffalo-A.			
Variety	Average Seed Cost/lb \$	Seed cost/acre @ 15 lbs/A rate \$	Seed cost/acre per year \$
Average of Top Thirteen	3.50	52.50	7.50
Buffalo-A	1.00	15.00	2.14
Difference	2.50	37.50	5.36

Return on investment will vary depending on price per ton (Table 6); If we assume \$80.00 per ton for hay, our return on investment would be \$529.60 (80x6.62). We realize there would be some extra cost for twine, mowing more hay, etc., however, after we subtract an additional seed cost of \$37.50, we are left with \$492.10 which can buy a “whole bunch of baler twine.”

Table 6. Economic Return on Investing in Improved Alfalfa Varieties.	
Dollars/Ton	Total*
40	265
60	397
80	530
100	662
120	794

*6.62 T/A increase over seven years.

What conclusions can be made? First, alfalfa is a high yielding crop. Even the worst variety had an average yield of 4.35 T/A over seven years. That

yield is more than our state average. With adequate management, this would have been a profitable variety; however, by investing in any of the top varieties, a potential greater profit of almost \$500.00 per acre could have been realized.

Control Pests: Is it always economical to control weeds, insects, and diseases? No! Is it economical to control pests when they reach some threshold that will reduce yield, quality and/or stand persistence? Yes! Assuming that “threshold” is based on sound agronomic data and control measures are selected based on research proven, economically feasible, environmentally sound information.

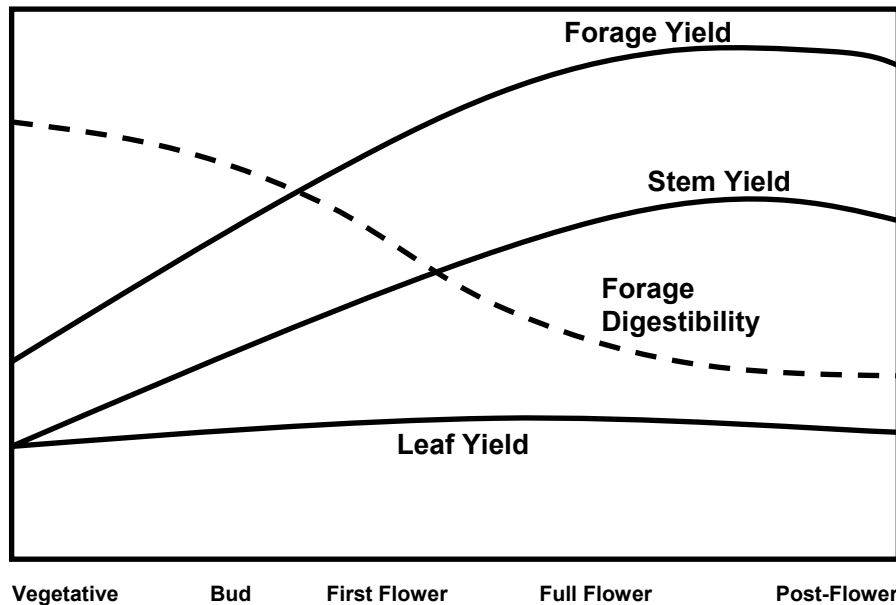
Our first recommendation is to select varieties with as much genetic resistance as possible. Certainly great strides have been made in reference to many diseases, and progress is being made on some insect fronts. With Roundup Ready technology forthcoming perhaps weeds will also be taken care of genetically.

Harvest for Quality

Factors which affect alfalfa hay quality include: growing conditions, harvesting, curing, handling, storage, fertility, varieties, pests and presence of other plant species. However, the stage of maturity when harvested is the most important factor and the one where management can have the greatest impact. As alfalfa plants advance from the vegetative to reproductive stages, fiber and lignin increase, and protein, digestibility, metabolizable energy and acceptability to livestock all decrease (Figure 1). Early cut hay makes a more desirable feed because it contains more of the nutrients associated with high quality. Hay cut at an early stage of maturity is also more palatable and is consumed in larger quantities by livestock. Thus, using early cut hay improves animal performance and reduces the amount of late cut hay needed.

Can we afford to go the extra mile to produce higher quality? This is an excellent question and as an agronomist, I say yes. As an economist, I say maybe. If we sell by the bale and quality is not considered, then the answer is likely No – go for the highest yield and sell “total pounds” of hay. However, buyers and sellers are becoming more quality conscious and alfalfa-quality will play an increasingly important role in marketing.

Figure 1. Forage yield relative to quality at different growth stages.



Let's look further into the aspect of quality. Table 7 shows results of work in Wisconsin relating quality, number of cuts, and milk production. Early-frequent-cut alfalfa was highest in crude protein, lowest in fiber and produced over twice as much milk per acre as late cut, low quality hay. Workers in Tennessee evaluated alfalfa hay and its impact on quality and beef performance (Table 8). Early cut hay was higher in protein, lower in fiber, consumed in higher amounts and produced higher average daily gains.

Table 7. Estimated grade, average concentration of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and milk yield in Wisconsin*.					
Estimated Grade	Number of Cuts	CP %	ADF %	NDF %	Milk lb/A
Prime to 1	4	22	31	43	10,688
No. 1	4	21	32	44	9,120
No. 1 to 2	3	19	35	46	7,022
No. 2	2	17	36	48	4,259

SOURCE: Adapted from D.A. Rohweder et al., University of Wisconsin.

*Wisconsin Forage Council Green Gold Project.

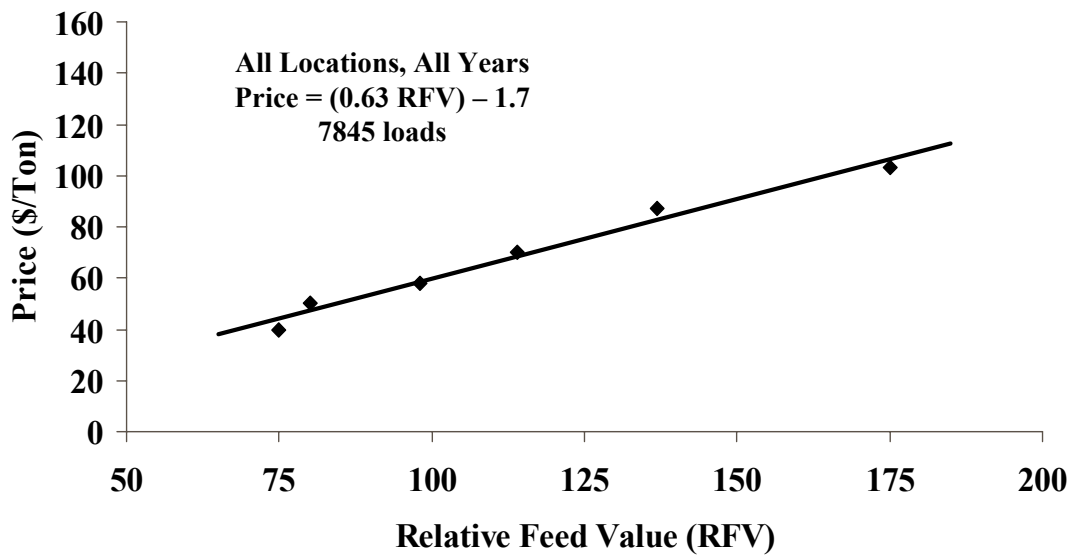
Table 8. Effect of alfalfa hay quality on performance of 550 lb beef steers.			
High Quality	Good	Fair	Poor
Crude Protein	18.7	15.9	13.7
Crude Fiber	29.4	35.4	46.7
Animal Performance			
Hay consumed, lb/day	17.1	16.5	13.8
ADG, lb	1.85	1.49	-0.06

SOURCE: University of Tennessee

The most comprehensive studies relating quality to profit have been done in Wisconsin (Figure 2). Over the past sixteen years with over 7800 lots of quality tested alfalfa hay sold at hay auction there was a highly correlated positive relationship between quality and price. For each one point increase in RFV, there was a corresponding \$0.86 increase in price. Recent data (Dr. Dan Undersander) showed that for each day delay in harvest beyond the late bud stage, RFV declined 5 points each day. That represents a change in value of \$4.30 (5 points x 86¢/day) loss per day.

FIGURE 2.

1985 - 2001 Auctions



Source: Minnesota Forage UPDATE

Summary

It is not always possible to balance all agronomic recommendations with positive economic returns. Many factors are involved and some beyond our control. Good varieties, well fertilized, and properly managed stands don't produce good yields during droughts; likewise, supply and demand drastically impact price. Research data, along with farmer experiences, have clearly demonstrated that attention to details, wise decision making on management practices, keeping production cost low, wise marketing strategies, along with back-to-basics, tried and proven agronomic recommendations have the greatest potential of resulting in positive, consistent economic returns.

MARKETING KENTUCKY ALFALFA

Mr. Tom Keene
Charles T. Creech, Inc.

In order to market Kentucky produced alfalfa, we need to go back and look at our operation to see if we can produce high quality alfalfa. We can start doing this by determining what the best land use is given the particular soils and topography that makes up your farm layout. There are other things we need to be aware of after we determine our ability to grow alfalfa; is the terrain suitable for harvesting alfalfa using different types of harvesting equipment? Also do we have the equipment necessary to produce alfalfa, either as a grazing tool, grass hay or as silage? Then, if we do harvest it in such a way other than with livestock, do we have the storage facilities capable of keeping our product of the highest quality as we go through the sales season?

If we have determined forages and alfalfa are suitable to be grown on our farming operation, do we want to make alfalfa our crop of choice or do we want to look at some of the other forage based crops that might be more suitable to our operation? Some of those include but are not limited to; clover, orchardgrass, timothy, fescue, and a mix of some of those above.

After we've decided what crop we want to grow, then I think it's advantageous for us to start looking at production cost associated with that crop. Production costs include many different things like; seed cost, fertility and liming cost, seed bed preparation, weed control, pest management, harvesting cost, storage and handling cost. We also should not forget the cost of the land; how much are we going to charge per acre as the cost of land use.

Once we have looked at our cost, then we need to look at how we are going to market the production. The most efficient way to market Kentucky produced alfalfa (forages) is through grazing. We have many different options when grazing alfalfa; beef, dairy, sheep, goats. All these are venues that utilize forages to their utmost. It can give you a great return in terms of "pounds of gain per day" or "pounds of milk produced per day". Other utilizations for forage crops are silage, biomass, wildlife habitat, etc. but the one we want to target most is cash hay, primarily alfalfa hay.

If we are going to grow alfalfa for cash hay purposes, then what are the different markets that are available to us that we might pursue once the hay is produced. The dairy market is certainly the largest consumer of alfalfa hay throughout the country. The dairy market has the ability to utilize most of the hay produced in Kentucky. Secondly, we have the horse market, they would not utilize as much quantity as the dairy industry, but they have the capability to use the "fancier" hay produced on Kentucky farms. Then we proceed to other market

possibilities such as goats, sheep, beef, biomass, etc. Then decide on the primary one to two markets you want to supply with high quality alfalfa hay.

Next, we want to determine an acceptable price for our hay. When we say acceptable, we want to make sure we delineate between what we would accept as a price and what we wish to have or what a desired price might be. Some of the things we need to take into consideration when determining an acceptable price are; what is the production cost? (what it is costing us to produce a ton of hay or a ton of silage for the market?) what is the cost of the money you have invested? What are your storage costs? if you have to build a building or utilize a structure already on your farm; you need to contribute a cost to that. How many times are you going to handle the product, are you going to put it up, put it in the barn, handle it again. Is there a hauling cost associated with it? A couple things you need to decide on; are going to price your hay by the bale or by the ton. You want to keep in mind are there any loading and unloading charged that you want to pass on that you will incur as you move your product. So pricing and determining a price is much more complicated then it might seem on the outside, but it's crucial to consider all of these figures to see if you can make a profit at this endeavor.

Once we've determined all these numbers we need to start looking at quality. Quality varies across the board quite a bit; there are several things that go into making good quality hay. First, you want to get your seed bed prepared, get your plant up and growing and control the weeds and insects and so forth. Then you want to harvest it when its ready to be harvested, in other words maturity is very key when producing hay for these markets. You don't want it to get ripe or over mature because the value can suffer quite a bit. One tool that is readily available to Kentucky hay producers is the hay testing program offered by the Kentucky Department of Agriculture. I would recommend that everyone utilize that program if you are going into marketing cash hay or silage in Kentucky or the southeast. Certainly, you don't want to have any rain damage; you want to make sure it is free of any trash or foreign matter. You want to make sure it is put up in a dry condition so it doesn't mold or heat up. You want to be concerned about weeds and weed problems that are visible when the hay is purchased. Also, it may not be a quality thing but packaging is very important. What package does the market want that you are trying to sell to? You want to keep all those things in mind when talking about producing and selling a quality product.

Another thing I want to touch on is accessibility. If you are selling hay to someone and you have to deliver it or you are going to load a truck and they are going to deliver it; you want to make sure of the accessibility of the end user. Will a tractor trailer get around easily on their farm when they get there? What type of truck is going in there and can they get around; can they get turned, can they make it to the barn or storage building they are going to unload at? Are there any low wires hanging or any obstacles that might cause problems?

Tarping is an issue. If your product is going to be shipped several miles, does it need to be tarped and who will pay the tarping charge? Transportation cost, are they included your pricing? Is your hay sold FOB your facility, or is it sold at a designated price when it gets to the end user?

Are you required to collect and pay sales tax to the state? Good recording keeping here is a must. Many headaches can be avoided by being sure of the tax status with whom you are selling your hay.

And one of the last things to keep in mind is, how are you going to collect your money? Are you going to sell it on a cash basis, will you accept a check, will accept a cashier's check, do you have the ability to accept credit cards? Will you be selling your hay on a COD basis or a pre-paid basis? Don't be afraid to ask for your money; don't be afraid to ask for it upfront. If you get a check from someone, make sure it's good; get it to the bank immediately. Because nothing will leave a more sour taste in your mouth than selling a high quality load of hay to someone that doesn't pay for it. So always be sure to collect your money.

In closing, just wanted to reiterate that marketing Kentucky produced hay is a very diverse and complicated system, but it's very doable and we have the ability to grow excellent quality alfalfa here in Kentucky. Our main challenge is to get it in a package that is sellable and attractive to the end user. This can certainly be accomplished through good management, hard work, and a stroke of good luck every now and then.

And as I always say when I give one of these presentations, remember "GREEN is GOOD and BROWN is BAD" when it come to selling hay in virtually any market.

MARKETING KENTUCKY ALFALFA

Nicky Baker
Hay/Beef Producer
Fredonia, Kentucky

I'm Nicky Baker, a fifth generation farmer from the Fredonia Valley area in Western Kentucky. I'm blessed to have Crider and Pembroke soils, which are ideally suited for raising good alfalfa. I sold my first alfalfa hay in 1976 or 1977. I've seen many changes since then, both in production and especially in marketing.

The main key to marketing hay over the years is flexibility. Don't gear up too heavy for the one specific market. Keep your options open and remember there aren't any government payments.

Milk prices fluxuate so some years dairymen are looking for hay and other years they are not. In my area the horse market is mostly recreational. When the economy is good, people spend on horses and everything else for that matter. When things tighten up, the horse is the first one to go on a diet. Right now, the killer horse market is way down. Recently, the new player has become the meat goat market. How it develops is anyone's guess. Over the years, once in awhile someone buys a few bales for milk goats.

I learned early on that all alfalfa won't sell. Especially now, with more production and everyone doing a better job, common hay won't pay its way in a square bale. As I have increased alfalfa acreage and decreased tobacco production, I have added around 225 head of beef cows. Greater emphasis is placed on grazing, especially in late summer. Graded feeder calf sales or CPH sales now play a major role in marketing hay.

My latest venture in selling alfalfa came this year when I sold the entire 3rd and 4th cuttings standing in the field. All I had to do was cut, ted, and put it in a wide row. I'm still not quite sure I recommend it, but it cut out the labor and repair bills. Time will tell.

MOISTURE – TEMPERATURE MANAGEMENT DURING ALFALFA HAY AND SILAGE MAKING & STORING

Michael Collins
Department of Agronomy
University of Kentucky

In some areas of the country, producers store a substantial portion of their forage for winter feeding as silage or haylage. However, hay remains the most popular storage method for forage. Hay stores well for long periods and is better suited to cash sale and transportation than silage. Mechanical conditioning, which gained acceptance during the 1950's is probably still the greatest single change in hay harvesting and storage technology during this century. However, a number of other noteworthy changes and innovations have occurred in recent years which have helped to reduce the extent of losses during hay harvesting and storage.

Developments in hay harvesting technology in recent years include chemical desiccants such as potassium carbonate, chemical and biological additives at the time of baling, and swath and windrow management equipment such as tedders and windrow inverters.

The general relationship between forage moisture concentration at harvest and losses during the field and storage phases is shown in **Figure 1**. Harvest losses are greatest for very dry forage and are low for very wet material like

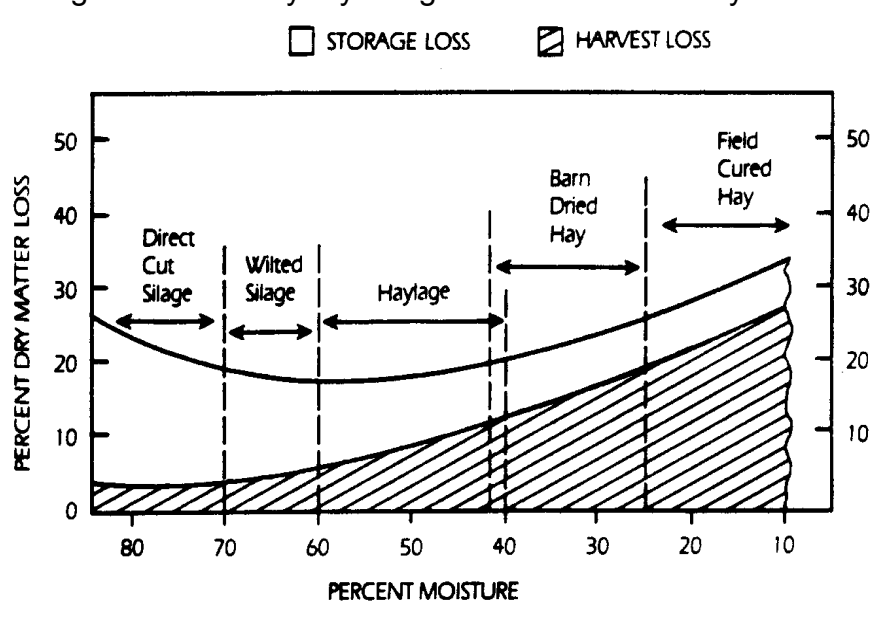


Figure 1. Relationship between forage moisture concentration and field and storage losses.

direct cut silage. However, the latter is subject to excessive storage losses due to seepage and to quality deterioration. Storage losses are generally minimized by harvesting at low moisture levels.

High moisture hay, baled between 20 and about 30% moisture has lower harvesting losses than dry hay but can suffer high storage losses and quality loss if not adequately preserved or dried. Many options are available in haying equipment and in new products marketed for use in hay curing and preservation is such that making informed choices can be very difficult. Research information is not available on all of these new products, however, representatives of most of the categories have been studied.

Under high humidity, relatively cool conditions, hay does not dry as rapidly as under low humidity high temperature conditions. A good corollary is found in the way in which tobacco leaves become moist and pliable under high humidity conditions. Likewise, under high humidity conditions hay may not be able to reach the 20% moisture level recommended for baling dry hay regardless of the time spent in the field. **Figure 2** shows equilibrium moisture concentrations measured for alfalfa hay over a range of humidity conditions at a temperature of

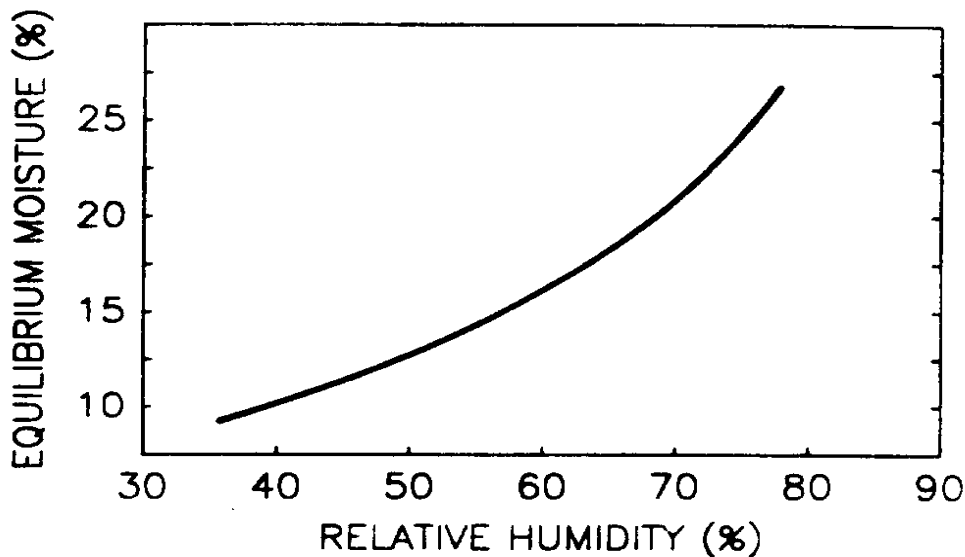


Figure. 2. Equilibrium moisture concentrations of alfalfa hay at different temperatures and humidity levels (Adapted from Hill et al., 1977).

77°F. At a relative humidity of 80%, this graph indicates that alfalfa would not dry below 25 to 27% moisture. It is because of this problem and in order to reduce the likelihood of rain damage that alfalfa hay is sometimes baled at moisture levels above 20%. Our data comparing alfalfa hay storage in round and rectangular bales indicates that for storage without heat damage, alfalfa in round bales should be slightly drier (18% moisture) than similar alfalfa in rectangular bales.

PRESERVING MOIST HAY

Baling hay at elevated moisture levels can reduce losses by reducing leaf loss and by helping to avoid rain damage. However, when hay is baled above 20% moisture steps should be taken to prevent the microbial growth that is responsible for heat damage and dustiness.

Respiration and Microbial Growth

Respiration and microbial growth, and some elevation in temperature during hay storage are normal and do not necessarily harm feeding value. Hay with more than 20% moisture may undergo excessive mold growth and heating that reduces both yield and digestibility compared with dry hay. Populations of fungi in stored hay peak after about 1 week of storage and this corresponds to the peak temperatures reached in the stack.

Health Effects

Mold spores contribute to colic in horses and are responsible for significant losses for this economically important industry. Breathing spores of the fungus *Aspergillus fumigatus* during the handling of moldy hay can cause farmer's lung, a sometimes debilitating disease in which the fungus grows in lung tissue. Hay with a significant amount of mold and mold spores can be utilized in cattle rations because these livestock are less sensitive.

Heat Damage

Heat damage may occur in moist hay as a result of plant and microbial respiration and chemical reactions. The moisture range in which the maximum amount of heating occurs is in the 20-40% moisture range for hay. This is close to the range in moisture for dry haylage at which excessive heating is observed. Dry hay does not heat excessively because it lacks the necessary moisture to support microbial growth. Plant enzymatic activity and microbial growth can elevate temperatures to 160°F within a few days. When the temperature goes above this level, it becomes too hot for continued microbial growth and further heating results from chemical reactions. These reactions are responsible for raising the temperature to levels at which spontaneous combustion may occur.

Heating during hay storage reduces forage quality. The extent of the heat damage is related to the color change during storage is related to the amount of heat damage in composition during heating of hay or silage are detrimental to forage quality. When hay heats sufficiently to cause a very dark brown to black color, its protein may be nearly indigestible.

Moisture Loss During Storage

The evaporation of water dissipates the heat generated in moist hay. The thermal conductivity of dry hay is actually less than that of moist hay. Thus, as

hay moisture declines due to heating, the transfer of heat to the outside air becomes less effective. Hay temperature may not rise sharply until most of the moisture has been evaporated. This heat generation in a mass of hay is caused by the growth of microbes that require oxygen. Because of the distance, the centers of large hay stacks tend to be low in oxygen supply and spontaneous combustion occurs outside this zone.

The data in **Figure 3** indicate the importance of proper preservation of moist alfalfa hay in order to maintain quality. As moisture concentration increased in alfalfa baled in large round bales without any preservative or drying

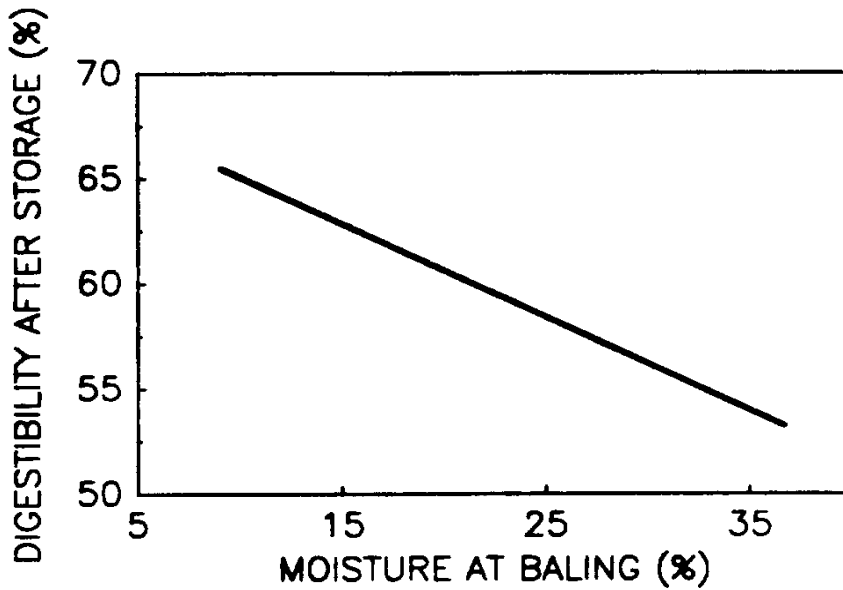


Figure 3. Relationship between moisture level at baling of alfalfa hay and hay digestibility after storage (From Collins et al, 1987).

treatment, the digestibility of the hay after storage decreased sharply. All of this hay was very similar in digestibility at the time of baling. This decrease in digestibility is directly related to the heating that occurs when hay is baled at elevated moisture levels. Microorganisms are responsible for this heating and the resulting increase in heat-damaged protein and molding can be very detrimental to quality. Thermophilic bacteria, the actinomycetes, grow well at high temperatures and contribute to the attainment of very high temperatures that result in hay fires in some instances. The hay temperature information below shows temperatures at which fire danger becomes important. Temperatures well

HAY TEMPERATURE (°F)						
70	110	150	190	230	270	310
			----FIRE DANGER----			
-PLANT RESPIRATION-						
-FUNGI AND BACTERIA-						
-HEAT RESISTANT BACTERIA-						

below that level can still reduce quality significantly. This moist hay can be preserved by the addition of organic acids at the time of baling. Propionic acid has been widely tested as a hay preservative and has proven

to be very effective when it is well distributed and applied at the proper rates. The most common rate recommendations for applying organic preservatives to hay are shown below. These rates are calculated on an active ingredient basis. In products containing some water, this must be considered in determining the product application rate. The rate applied must be increased for wetter hay because of the importance of maintaining the level of preservative in the water contained in the hay.

Hay Additives

Additives are sometimes used to aid in the preservation of hay above 20% by preventing microbial growth during storage. Materials shown to be effective in the preservation of moist hay include sodium diacetate, propionic acid, ammonium propionate, urea, anhydrous ammonia and others. In addition to control of microbial growth, some materials, such as ammonia and urea, may also enhance forage quality by increasing crude protein concentration and increasing fiber digestibility.

The amount of propionic acid that needs to be applied to ensure acceptable control of microbial growth is greater for hay that is higher in moisture. Apparently, the critical factor is to maintain the necessary

APPLICATION OF BUFFERED ORGANIC ACIDS TO HAY

Hay Moisture	Application Rate
20-25%	10 lb/ton
25-30%	20 lb/ton
30-35%	30 lb/ton

concentration of propionic acid in the water contained in the hay. Thus, hay with more moisture requires more organic acid for preservation. Hay heating and molding can be controlled by the

application of rates as low as 6 lb/ton for 25% moisture hay under controlled conditions but under field conditions about twice that rate is needed to ensure preservation.

Ammonium propionate is a buffered propionic acid material that is less volatile than propionic acid and is also less corrosive. The low pH of acid preservatives is involved in their effectiveness but it is not the only factor since ammonium propionate is effective even though it is less acidic. Formic acid, sodium diacetate, propionic acid and ammonium propionate were tested and all were found to be effective in the inhibition of fungi and actinomycetes when each organism was grown separately in culture.

Moisture Variation Within The Field

Research has shown that it is important to achieve good distribution of the material in the bale. Buffered products have the benefits of being less volatile than acid products, however with that advantage comes the problem that these materials do not move around to equalize within the bale. Some very volatile

products like ammonia move so well that the anhydrous ammonia can simply be released within a stack of hay and will diffuse throughout the mass with a short time. Even the acid forms of organic acids do not move that readily but the buffered forms remain where they are placed during the application process.

Wet spots that have more moisture than the application rate is adequate for can still result in moldy areas within an otherwise well preserved bale. In a field study using alfalfa from a small field (5 acres), moisture at the time of baling varied widely depending upon the density of the swath at a particular location. Variation above and below that average will mean that some hay will receive more material than needed and other hay will receive less. Moisture levels ranged from 58 to 80% and averaged 69%. A propionic acid application rate of 19 lb/ton would be sufficient to obtain a rate of 3% of the average water content. However many of the bales were above 69% moisture and would require more material. It would be necessary to apply 28 lb/ton to insure adequate preservation of 99% of the bales from this field. These results point up the importance of wide swaths and tedding to help improve the uniformity of the moisture concentration.

Measuring Moisture In Hay

It is critical that we have dependable information on the moisture concentration in the hay in order to be sure of adequate storage if it is dry hay or that the preservative rate is adequate if preservatives are being used. A typical home microwave oven is an excellent method for determining hay moisture. Later in this article, a microwave method that can be used for either hay or silage is described.

Electronic probe testers are also available for field use in moisture determination. Of the units tested, the "Delmhorst" moisture unit did the best job of predicting actual oven moisture determinations. Based on the variation we found between measurements on the same bale, it would be necessary to take 12 readings to estimate moisture concentration within +2%. Also, although the correlation with actual oven moistures was very good, the probe reading was not identical to the actual moisture concentration. At about 17% moisture, the two would give identical readings but above that moisture level, probe readings underestimated the actual moisture concentration. A rule-of-thumb system for estimation of hay moisture when a tester is unavailable is shown below.

The same unit discussed above has been modified to automatically probe the bale inside the bale chamber between plunger strokes. These readings can be averaged and accessed continuously to allow moisture monitoring. We have the possibility of using moisture measurements of the bale either inside the bale chamber or just after tying to adjust preservative application rate continuously. If this could be accomplished it would insure adequate rates of preservative for every bale whether they needed more or less than the average.

In the absence of testing equipment, hay moisture can be estimated using changes in texture visual characteristics during drying. The table below illustrates how this system works.

QUICK ESTIMATION OF MOISTURE CONTENT OF HAY	
Moisture Range	Hay Condition
30-40%	Leaves begin to rustle and do not give up moisture unless rubbed hard. Juice easily extruded from stems using thumbnail or knife or with difficulty by twisting
25-30%	Hay rustles-a bundle twisted in the hands will snap with difficulty, but should extrude no surface moisture. Thick stems extrude moisture if scraped with thumbnail
20-25%	Hay rustles readily-a bundle will snap easily if twisted - leaves may shatter-a few juicy stems may remain
15-20%	Swath-made hay fractures easily-snaps easily when twisted-juice difficult to extrude
* Source: Hoard's Dairyman 132. 1987.	

SILAGE

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

Silage Fermentation

Silage preservation depends upon the development and maintenance of anaerobic conditions. The ensiling process has predictable phases which are well understood. Aerobic respiration by plant enzymes and by microbes on the crop continues after the forage is ensiled. Plant enzymes oxidize carbohydrates and produce carbon dioxide, water, and heat. Plant proteases can cause proteolysis and form peptides, free amino acids, and amides. Respiration is inhibited as anaerobic conditions develop. Some of the management practices recommended for conventional silage production, such as fine chopping, rapid silo filling, adequate compaction, and tight sealing are recommended in order to minimize this aerobic phase. With respect to rapid exclusion of oxygen and tight

sealing, these same factors hold for the production of silage in round bales.

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

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

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

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

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

than legume silages because grasses have a lower buffering capacity and sugar concentrations of 10 to 20%. Because of these differences, legume stands with a grass component would be most suitable for silage production.

Baled Silage

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

Producing Baled Silage

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

Wrappers

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

Individual Bale Wrappers:

Platform Wrappers. The most common type of wrapper is the individual bale wrapper that use a single roll of UV-treated stretch film. These wrappers vary widely in cost from about \$5,000 to \$12,000 or more depending on features.

The recommended method for wrapping using these units is to overlap the plastic one-half of the previous layer. With this system two complete layers of plastic are applied with each complete revolution of the bale. We recommend 4 layers for the individual wrap machines unless the bales are very dry or intended for long-term storage, where 6 layers are preferred.

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

Row Bale Wrappers

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

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

Checking Moisture for Silage Production

Forage moisture greatly affects storage behavior of hay and silage. Accurate moisture information is important because excessively wet forage is

MICROWAVE MOISTURE TEST

- Step 1 - Weigh a paper plate to hold the sample during drying. Alternatively, “tare” or “zero” the scale with the empty plate to remove this weight from the calculation. A paper sack will also work for holding the forage sample during drying.
- Step 2 - Mix your sample and weigh exactly 100 grams onto the paper plate.
- Step 3 - Place the plate and sample into an oven, ideally one with a turntable to help avoid hot-spots in the sample, and set it at full power for 3 to 5 minutes. Check and mix the sample before repeating the drying process for an additional time of 1 to 2 minutes depending on how dry it was after the initial drying period. Repeat as needed to dry the sample without charring. Reduce the time to 30 seconds toward the end of the process.
- Step 4 - Drying is complete when no weight loss occurs after a 30 second drying period in the microwave.

Note: Older ovens needed a glass of water inside during drying to avoid damage to the oven magnetron but newer ovens do not.

Calculations:

CASE 1 (With a weighed paper plate or bag is used to hold the sample)
(Dry sample weight) Dry plate plus sample weight minus the empty plate weight

(Wet sample weight) Weight of plate plus 100-gram fresh sample

CASE 2 (With a tared paper plate or bag is used to hold the sample)
(Dry sample weight) Sample weight after drying is completed
(Wet sample weight) Sample fresh weight, normally 100.0 grams

MOISTURE % = (Wet weight – Dry weight)/Wet weight X 100

prone to heating during storage with resulting loss in forage quality and in rare cases spontaneous combustion fires can occur. On the other hand, overly dry hay suffers excessive physical losses during raking and baling which are

especially detrimental to quality of forage legumes. Recent developments in silage production using the round bale silage system increase the need for measuring forage moistures between 35 and 75% moisture.

Two tests are described below, the twist test and the microwave test. The “twist test” gives a quick, but less accurate estimate of forage moisture concentration. The microwave test uses a postal scale readable to one-tenth gram along with any typical microwave oven to dry a small sample of forage completely before reweighing for quick calculation of the moisture concentration. Of the two methods, the microwave test takes more time but is also more accurate than the twist test.

TWIST TEST FOR MOISTURE IN SILAGE

>70% Moisture: Some moistening or moisture appears at the breaking point when a handful of forage is twisted multiple times. This forage is too wet for silage production. This forage will break when twisted hard.

50-60% Moisture: Surface moisture almost completely absent but some leaves are flaccid and some juice can be expressed from stems or leaves if pressed hard using the thumbnail.

40-50% Moisture: Surface moisture is absent and some leaves are becoming brittle. Some juice may be expressed using the thumbnail. Stem may break near the cut end.

30-40% Moisture: Leaves begin to rustle and juice is difficult to express using the thumbnail. Stem breaks up 2 to 3 inches from the cut end.

Other Considerations

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

Damage to plastic during handling or storage can introduce oxygen into the bale and allow spoilage. Any holes made during bale transport and placement into storage should be repaired immediately by taping. Holes allow oxygen to enter and lead to the same problems that occur if bagging is delayed too long. To minimize storage losses due to spoilage, we suggest in Kentucky that bagged silage bales be fed during the winter following their production and

that baled hay be carried over if excess feed is available. The storage period for bagged or wrapped silage is also reduced by baling the fall cut of alfalfa or other forages that comes during October or November in this area when hay curing conditions are generally very poor.

Cost

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

Summary

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