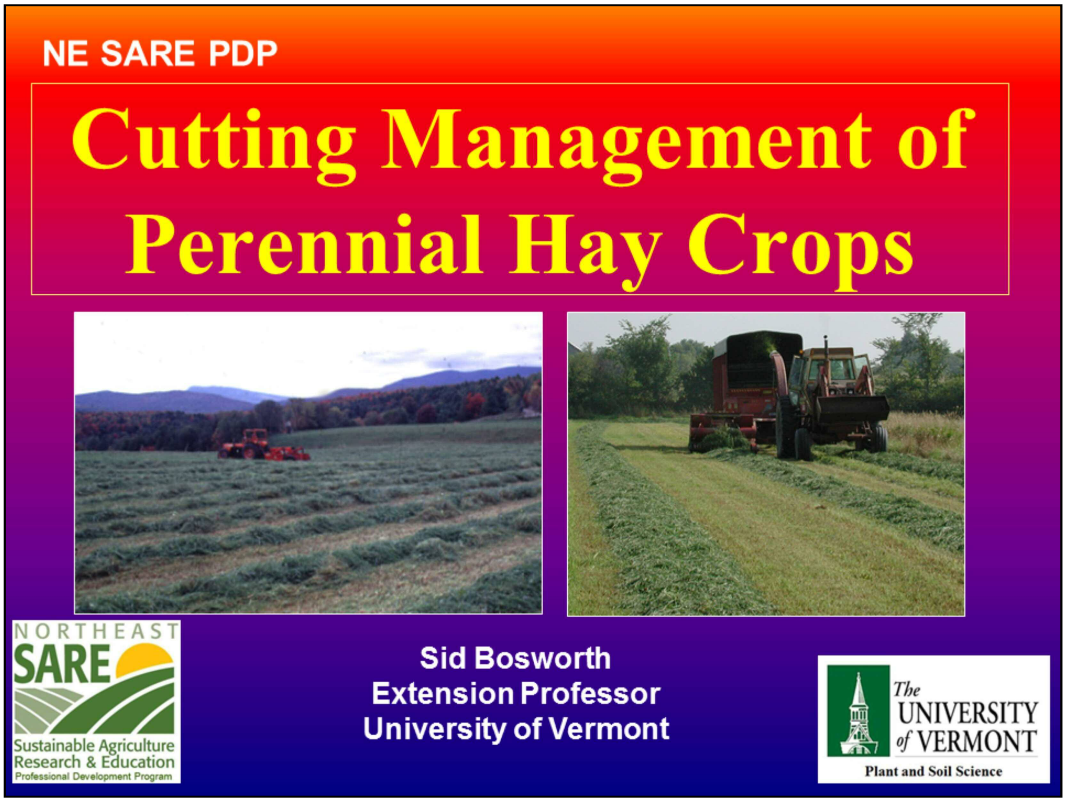


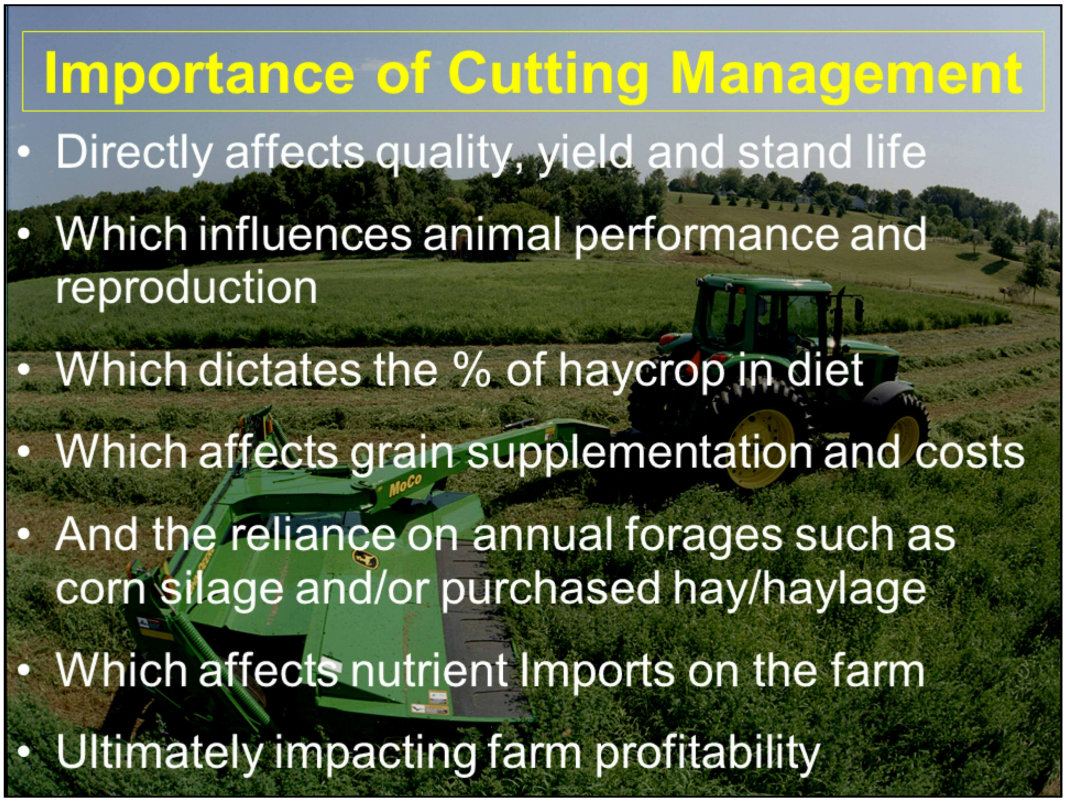
This presentation is a modification of a lecture I give in my Forage and Pasture Management Course at UVM.

Whether harvested for hay or hay crop silage (haylage, baleage), the time in which perennial forage crops are harvested is certainly an important factor in affecting profitability of a dairy or livestock farm, especially one that requires high quality forage. But cutting management will also affect yield and stand life all important economic considerations.

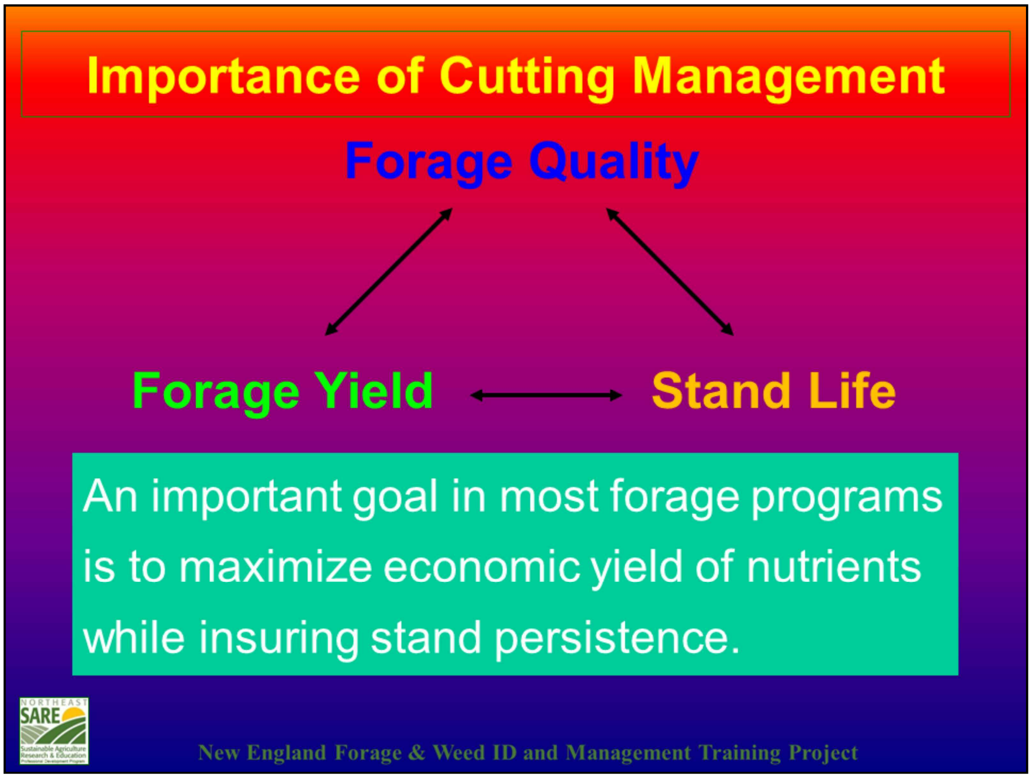
What is Cutting Management?

- Timing of first harvest in a season
- Frequency of harvest (time interval)
- Timing of the last harvest
- Number of harvests per year
- Cutting height

We can define cutting management by the list above. This would be applicable to both hay crop management or pasture management.



For a forage based dairy or livestock farm, cutting management is critical for many reasons.



Often, a forage farmer has to make compromises that balance these three elements of a forage system since they all affect the profitability of the farm.

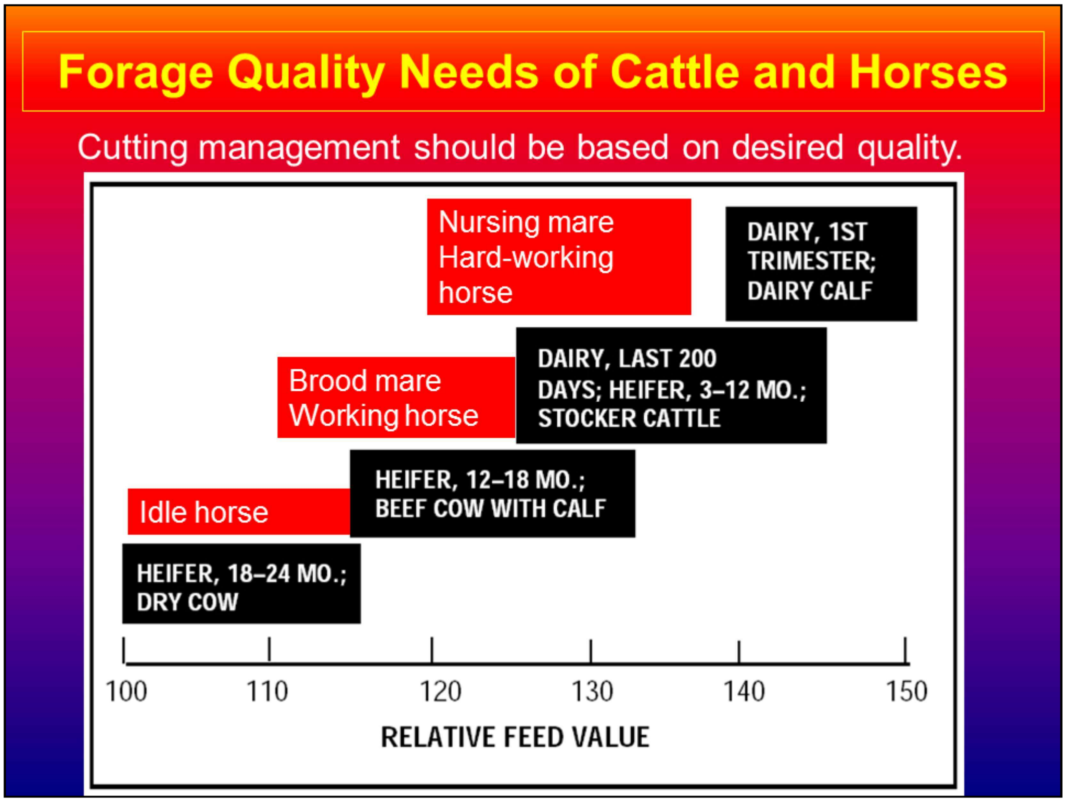
The intensity and investment in the type of cutting management a farm has depends on many considerations. Here are a few. The forage quality goals of the farm should be a primary consideration. But this can affect yield and stand life which certainly are economic considerations. Generally, a high quality program causes a sacrifice to yield and stand life.

A high quality forage program is going to be more consistent and successful if the forage is growing on moderate to well drained soils allowing a wider selection of forage species to grow and a wider window of time to harvest. Some species are more suited to high quality, intensive management compared to others.

The crop program, storage systems and cutting strategies might be quite different if the farm utilizes custom harvest verses harvesting their own. If the farm cuts and harvests their own forage, is there adequate harvest equipment and labor for a high quality program? Is equipment properly maintained to reduce risks of untimely breakdowns. Does the cost of production and harvest also account for equipment replacement costs?

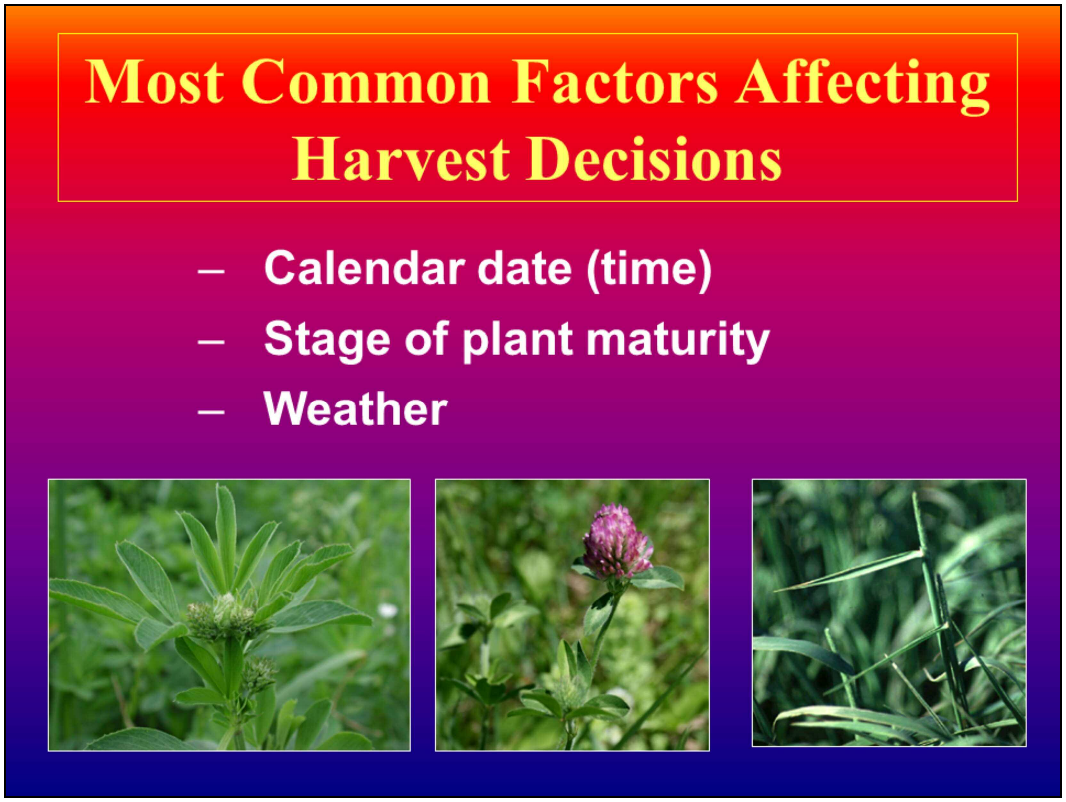
Types of forage systems – haylage/bunk, haylage/upright, haylage/surface, baleage, combined haylage/hay, combined haylage/pasture, all hay, etc. Each of these may affect the timeliness of cutting and harvesting.

Also, higher quality usually means a higher intake of forage per animal per day; therefore, more land will be required due to both less yield and higher feed demand.



Cutting management should mostly be based on the quality needs of the livestock operation since time of cutting so closely affects forage quality. A dairy farm that is trying to achieve high milk production is going to invest in an infrastructure that assures timely harvests and high quality forage. A horse boarding operation that maintains idle to slightly active horses will not need near the quality and only invest in the basic equipment to meet their hay quantity needs.

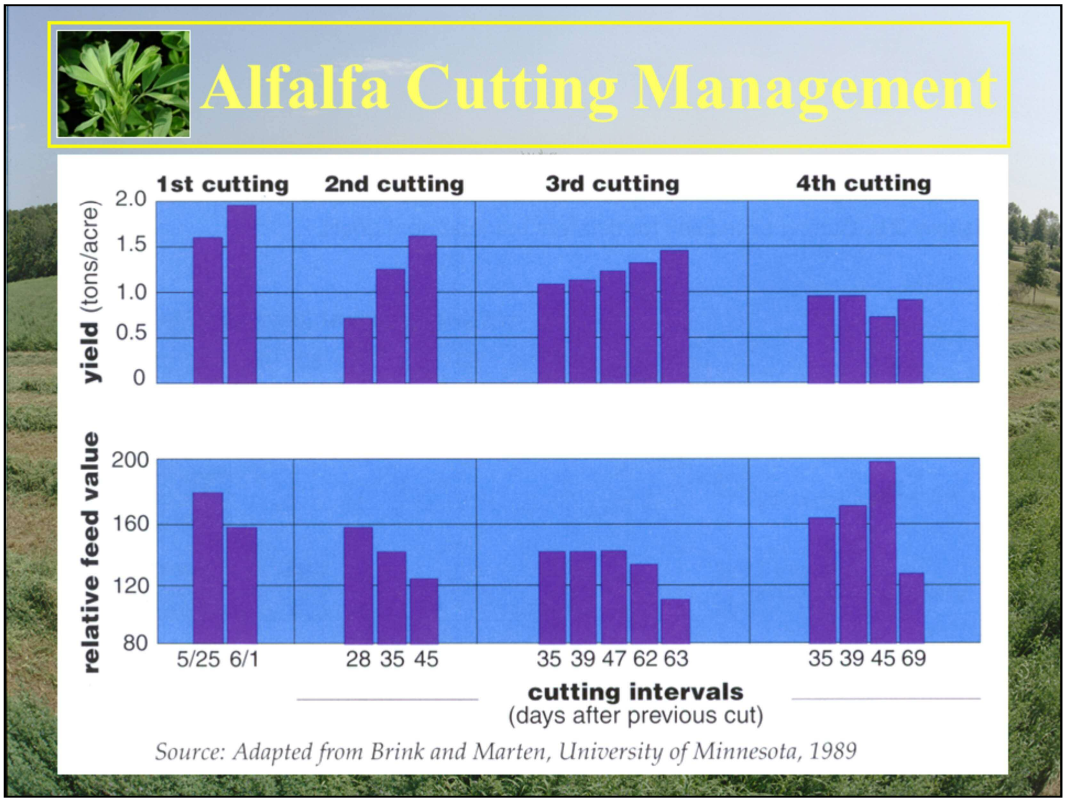
For all forages - legumes, grasses or mixtures - it is important to focus on the first cut and make that a priority. When evaluating farms, inquiring about first harvest and all the factors involved can give good clues about the overall management and priorities of a farm.



Farmers that are concerned about forage quality will often use calendar date and crop stage of maturity to make timely harvest decisions. Much research has looked at these variables to more accurately predict for optimum quality. The major growth stages of legumes include the following: early vegetative, late vegetative, bud, flower and pod. Vegetative stage occurs before any flower buds are present. The **bud stage** refers to flower buds usually at or near the ends of the stems. Normally, you can see them but often you have to also feel for them. Flower stage refers to when the stem has at least one flower. For clovers, flowers are arranged in a **head.**

Individual stems can be staged but the practical approach to staging a stand or field would be to look for the time of early events. In other words, early bud would be when the first buds occur in the stand. Early bloom the same way. You can also define by the degree of stage. For example, 10% bud or bloom stage would be when at least 10% of the stems have at least one bud or bloom, respectively. Fifty percent bud or bloom would be when 50% of the stems have at least one bud or bloom, respectively. There are more technical methods for staging such as weighted means by weight or by count; however, these usually require too much time to be practical for most farm applications.

Lets look at some specific crops and we will start with alfalfa. When grown on a well, drained soil, this forage legume has the greatest yield and quality potential of most other forage crops. However, it still has to be carefully managed.



This graph shows the results of a large cutting management study conducted in Minnesota about 20 years ago. The top graph shows the average yield of alfalfa and the bottom graph shows relative feed value. In the study, two cutting dates were compared for the first harvest, three intervals were compared for second, five intervals for third and four for fourth cut.

To summarize:

1. The cutting with the highest potential quality and yield is the first one. This is because the plants are growing under optimum temperature and usually adequate moisture for alfalfa. The summer harvests are generally the lowest in digestibility and RFV because higher temperatures usually cause an increase in cell wall lignification.
2. The harvests that drop in quality the most rapidly are the first and second; therefore, these should take priority in a timely early cut.
3. The third harvest had an interval of 47 days before showing a decline in RFV.
4. The fourth harvest was in the fall. Yield was not affected by a longer interval. RFV went up with a longer interval because the plants are undergoing changes in structure in the fall as days become shorter and temperatures cool off. We often find ADF and NDF to be quite low in fall cuts of alfalfa probably because much of available carbohydrates produced by photosynthesis are being shunted to the roots for winter storage. Although ADF and NDF are low, there may not be much energy in the forage. So, it is always worth looking at the sugar content and non-structural carbohydrates on you forage analysis.

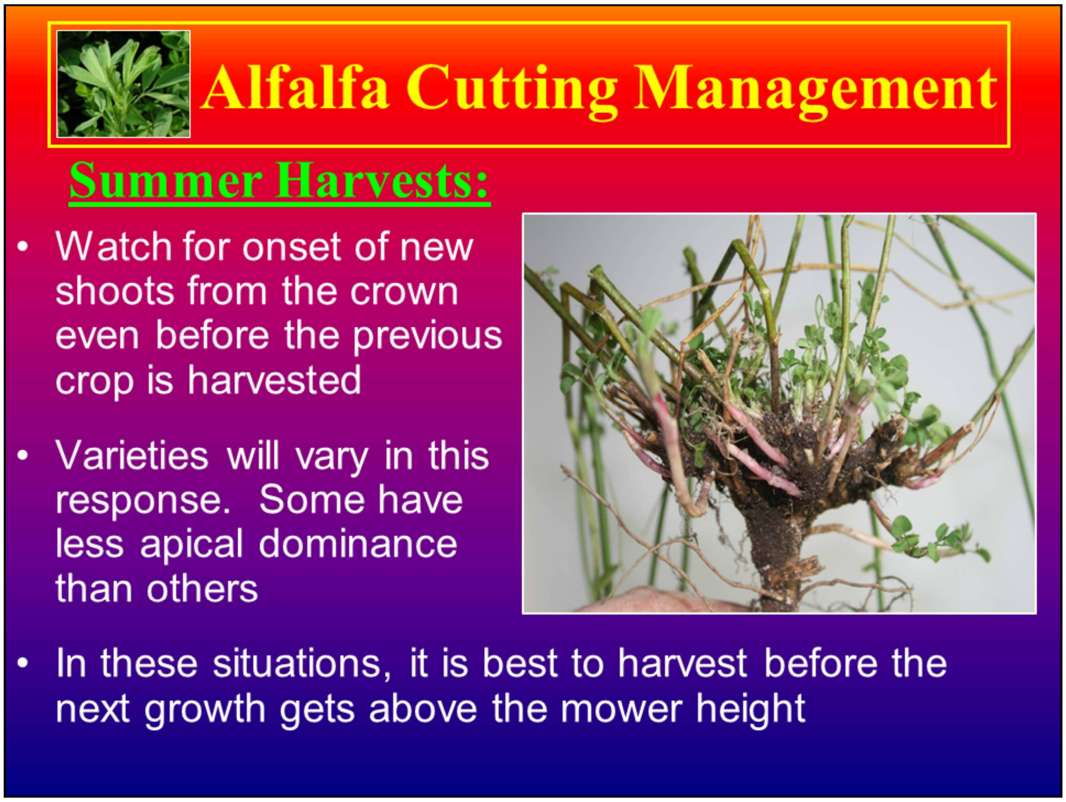
To generalize from the previous slide, here are a few points to consider. Since quality did not drop for 47 days at the 3rd harvest, it is best to delay this cutting and allow for a build up of root energy reserves to prepare for the next winter.

Alfalfa Cutting Management

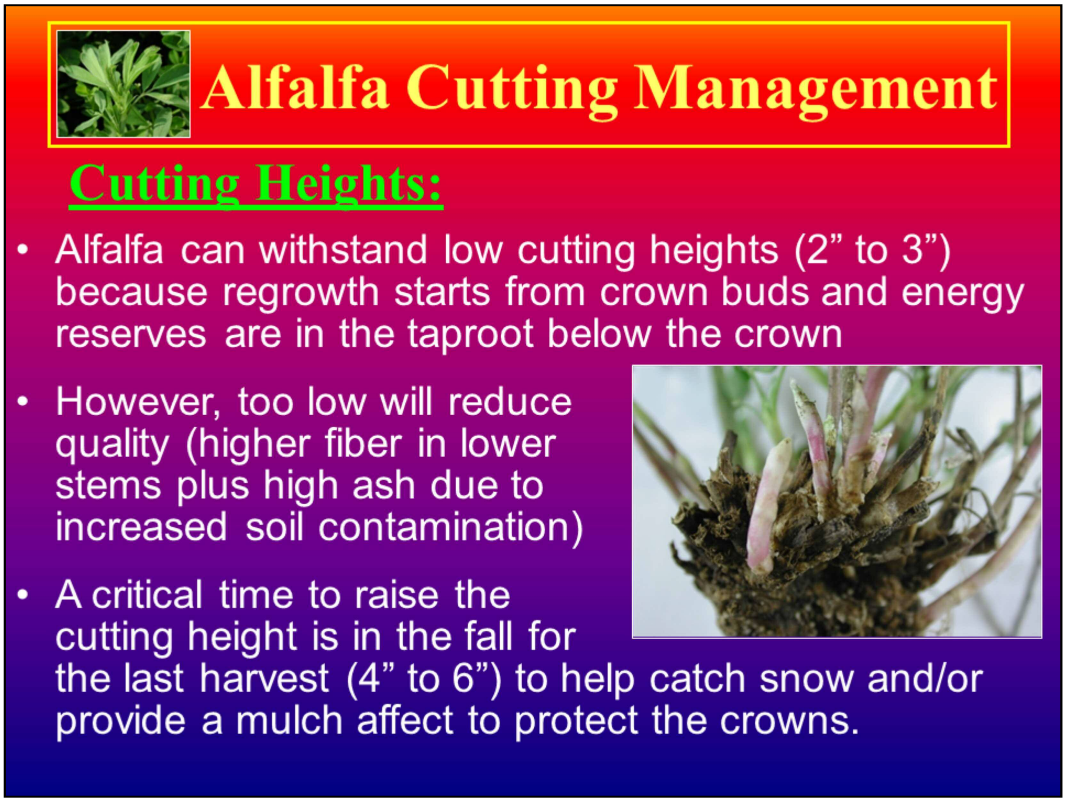
More on First Cut:

- The maturity rate of alfalfa is very response to temperature so be ready to cut early if an early, warm spring
- If it is a cold, cloudy spring that significantly delays maturity, it may be best to cut by a target date even if the stand has not reached bud stage
- Target dates vary across New England from the end of May in southern, lower elevation regions to the 2nd week in June in northern, higher elevation areas.

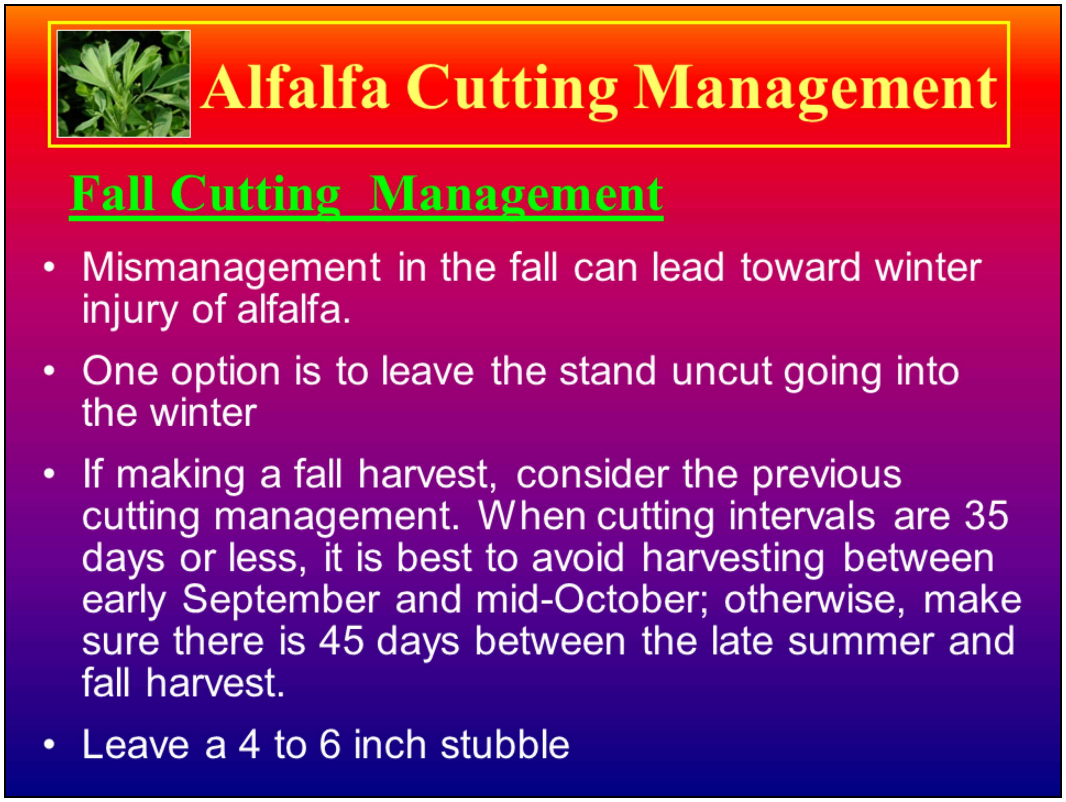
Higher temperatures coupled with dry conditions can often accelerate alfalfa plant development so it makes sense to cut early when this happens.



Alfalfa has fairly high apical dominance; however, in the summer, crown shoots can sometimes develop quickly and begin to grow which before the preceding crop has been removed. This phenomenon is also cultivar dependent. Regardless, if this happens, it is best to harvest before this next crop gets above the mower height.



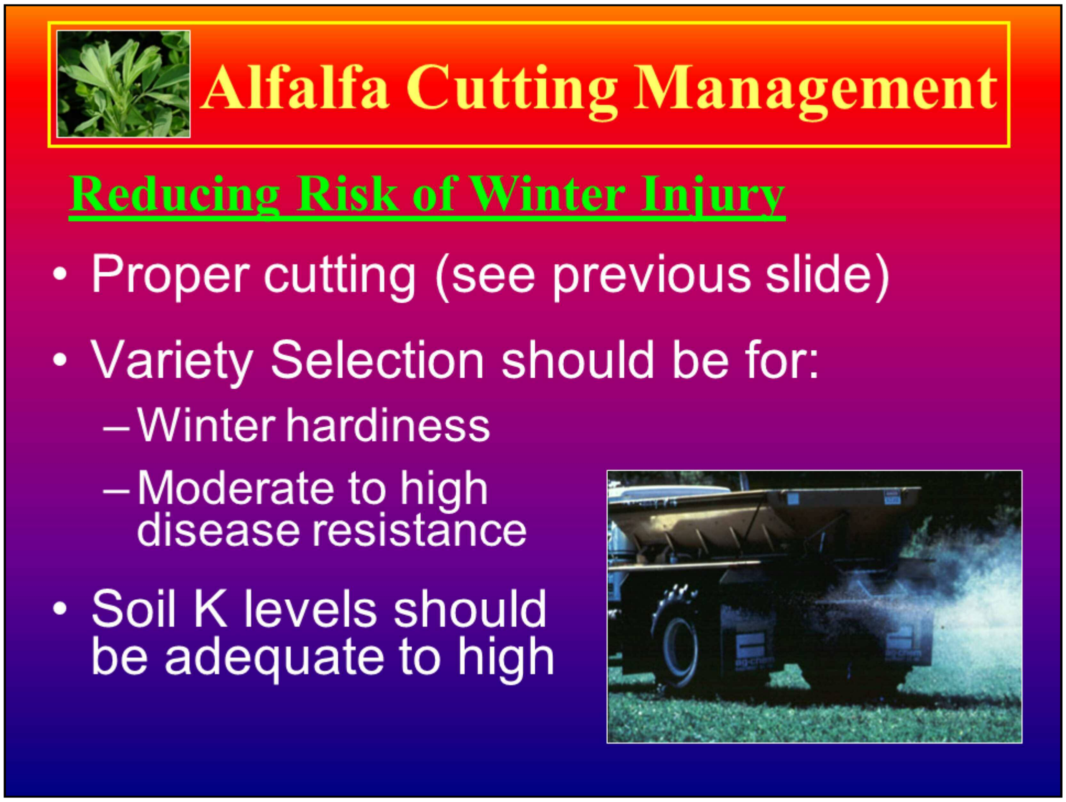
Cutting height matters.



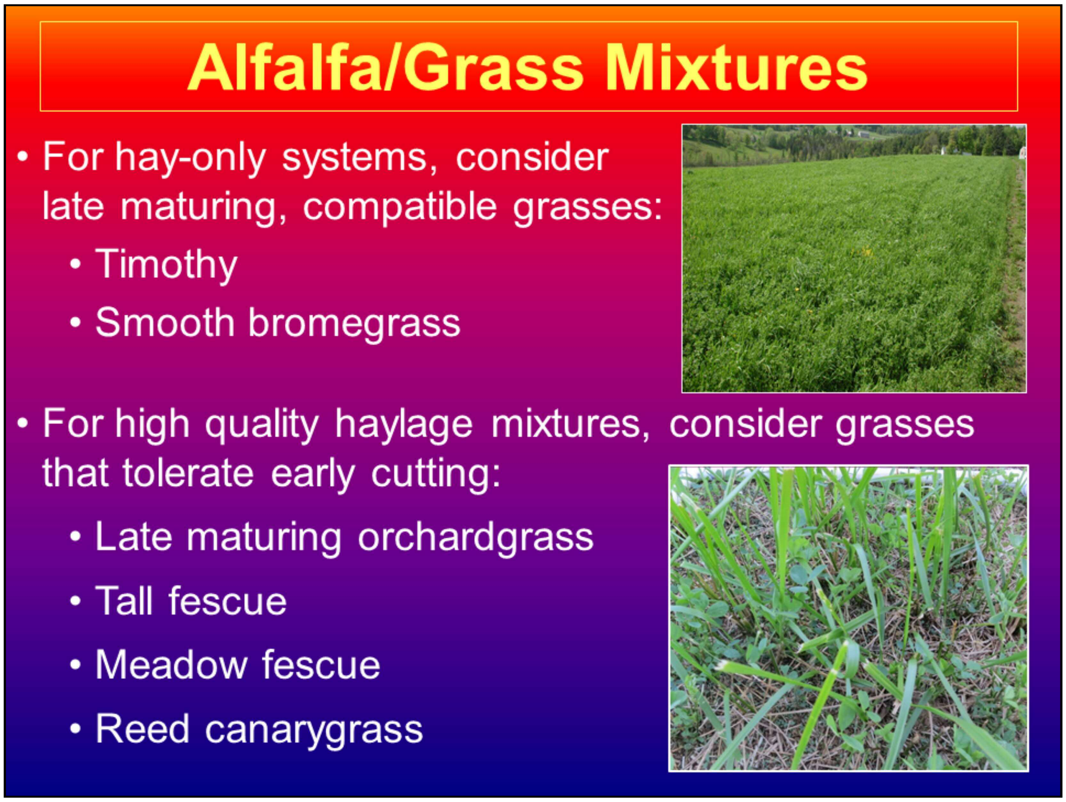
Fall management should allow time for stored energy reserves to build back up. The best practice to assure stand longevity is to not even cut during the fall period. Leaving an uncut stand of alfalfa provides a mulch that protects the crown. It also means that there is one less time that machinery is driving over and impacting the crowns, particularly during a period of the season when the soil is often wetter making the stand more vulnerable to crown injury.

But many farms may need that extra forage from a fall harvest so leaving it may not be an option. In that case, to lessen the risk of winter injury, it has generally been recommended to delay the fall harvest until after the last killing frost (usually by mid October). However, if the summer harvest cutting interval has been more than 35 days and if there have been at least 45 days since that cut, then there has usually been adequate time for stored energy reserves to be recharged, even if the cutting is made in late September.

A longer stubble in the fall helps to catch and hold snow which helps to moderate fluctuating winter temperatures. The stubble can also provides holes in case there is ice sheeting which can kill a stand due to oxygen depletion.



Besides proper fall cutting (or not cutting), other factors that influence winter injury and stand longevity include variety selection and adequate soil K levels. A good tiime to make an annual application of K fertilizer on alfalfa is after that last summer cut. This allows tiime for the plant to take up K in the fall as it prepares for the winter.



Cutting management can be important in maintaining alfalfa in an alfalfa-grass mixture. One factor is cutting height. To maintain alfalfa dominance in the mix, it is best to cut at a short height. A high cutting will favor the grass.

Alfalfa/Grass Mixtures

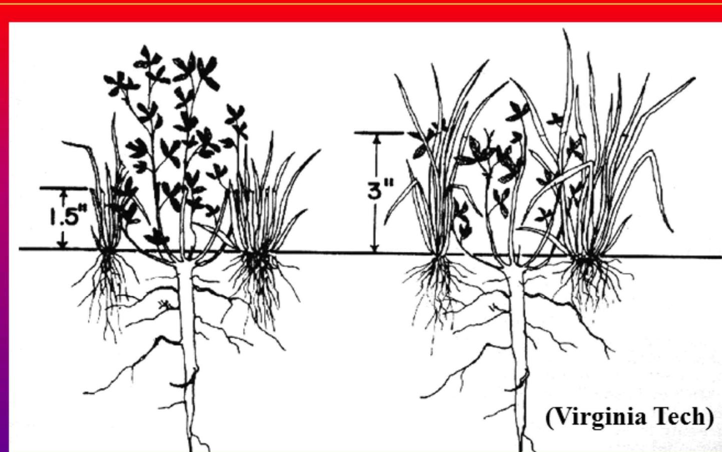
To maintain and sustain alfalfa in the mixture:

- Grow on moderate to well drained soil
- Maintain soil pH at 6.7 to 7.0
- Make sure soil P and K levels are adequate for alfalfa (grasses are very competitive for K when soil levels are low)
- Set cutting height for alfalfa (2” to 3”)

Soil fertility is another important factor in maintaining a good mix of legume with grass. Grasses are much more efficient to utilizing soil potassium , and at low soil K levels, the grasses will have a competitive advantage.

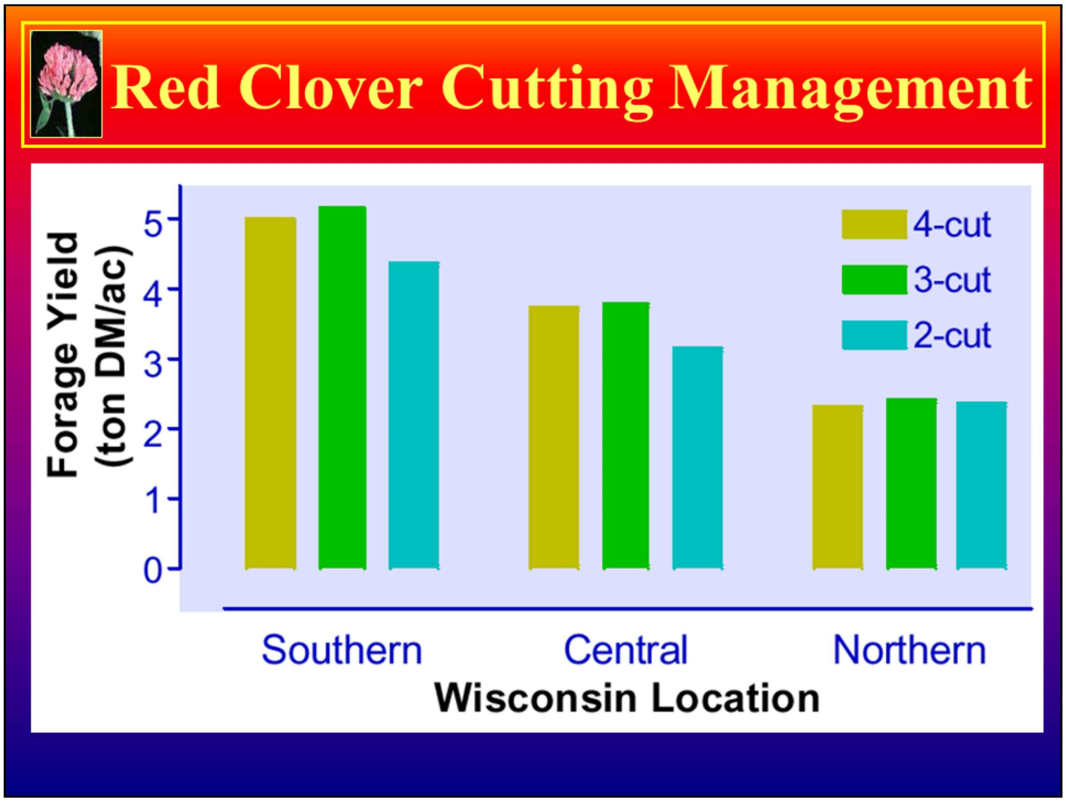
Alfalfa/Grass Mixtures

- A lower cutting or grazing height tends to favor the legume.
- For grasses, a low defoliation height removes more leaf area and part of the stored energy reserves; therefore, their regrowth is reduced relative to the regrowth rate of the alfalfa

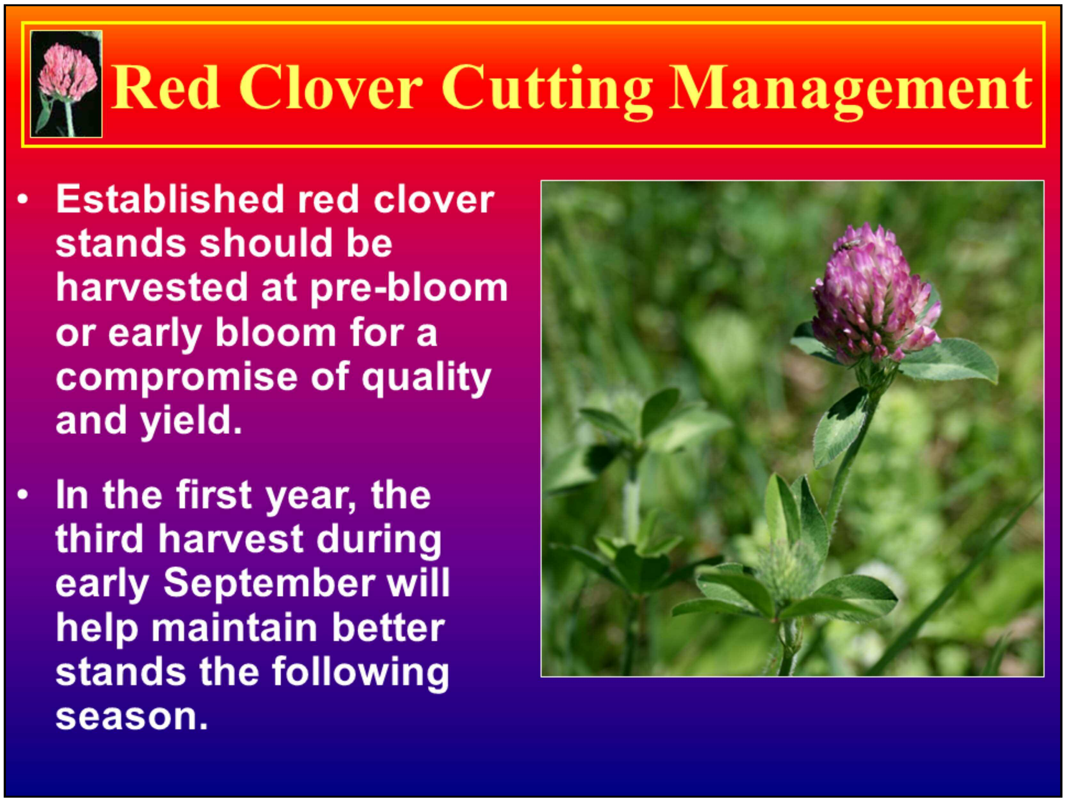


This is a review from our discussion on the response of plants to defoliation. As a management tool, cutting height can have a huge effect on botanical composition.

Red clover is a good, short-term, high yield and high quality forage crop for New England when harvested for silage. It can be cut three or four times per year. It tolerates a wider range of soil drainage and pH than alfalfa and is very compatible most grasses. Usually, it is grown in mixture with a grass. It is difficult to make quality hay with red clover. It is slower to dry down compared to grasses an alfalfa.

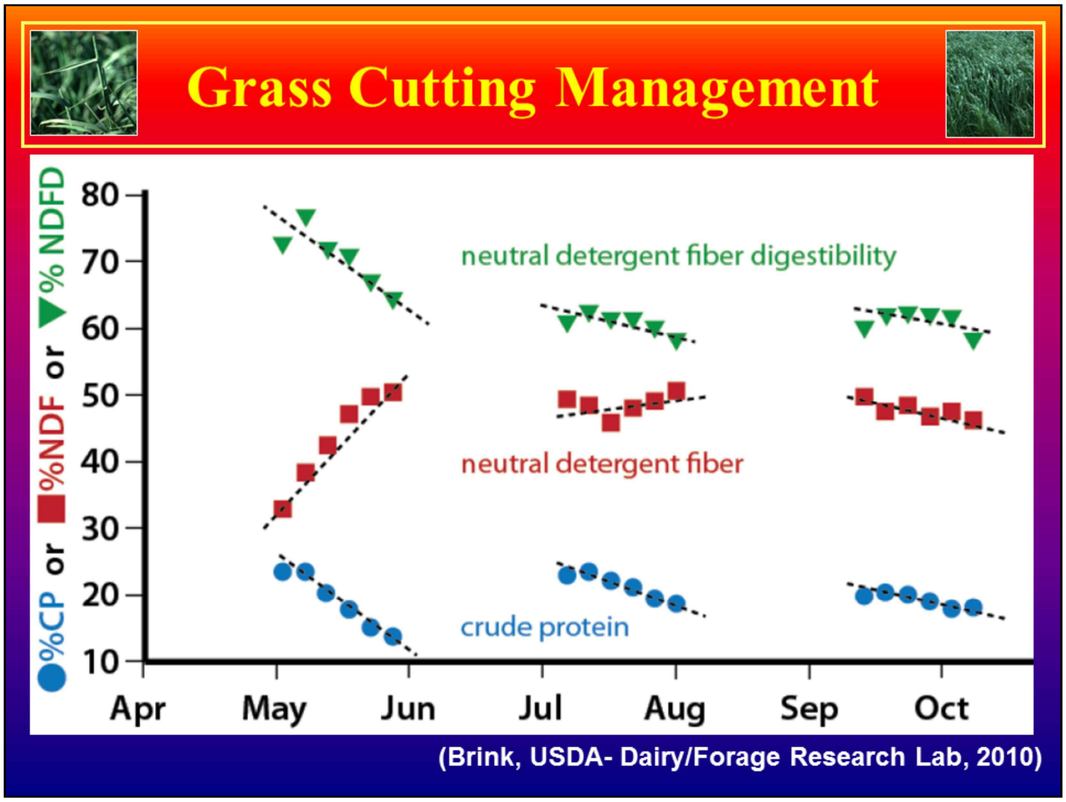


This graph shows the yield of red clover in three locations of Wisconsin. My point here is that red clover can be managed somewhat like alfalfa and obtain good yields and good quality. The one difference is that red clover is a short term perennial often only lasting two to three years whereas alfalfa can often persist for five to six years.



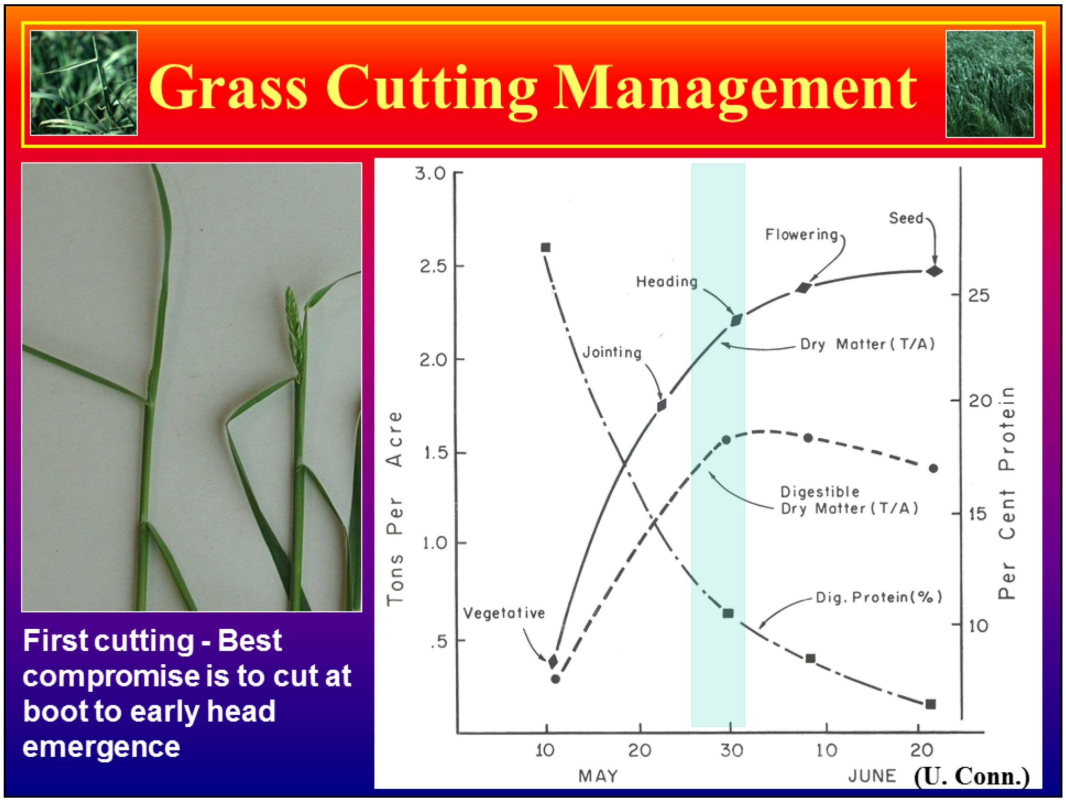
Generally, modern cultivars of red clover can be harvested for high quality by cutting early bloom three or sometimes four cuts per year. Unlike alfalfa, it is actually better to take a fall harvest of red clover in the first year. Research has shown that this help maintain a better stand the following year.

Cutting management of grasses vary by species. Generally, grasses need a higher cutting height than alfalfa or red clover since much of their stored energy is in the lower sections of the stems.



This graph is a summary of research conducted in Wisconsin looking at changes in crude protein, NDF and digestible NDF of orchardgrass, tall fescue and meadow fescue during the spring, summer and fall periods. Like the graph we saw of alfalfa, the highest potential quality is during the first growth period but quality also drops rapidly. The rate of change in quality is far less during aftermath grass forage growth. The NDF digestibility of summer harvests was not as high as the spring period due to higher lignification during summer months. Past research has shown that lignification of the cell wall increases with higher temperatures.

There is an old saying - When in Head, The Quality is Dead! That is certainly true for farms needing high quality. However, cutting at an early heading stage is fine for medium quality forage that may be suited for many livestock classes. And cutting in the heading stage usually results in better yields and a stronger, more persistent stand.



This graph shows the relationship of yield and quality over time during that first growth period when cool season grasses are undergoing their reproductive stage. If cut at pre-jointing, quality is higher but yield is greatly sacrificed. However, later slides will show that for high quality forage, that may have to be done at the expense of optimizing yield.

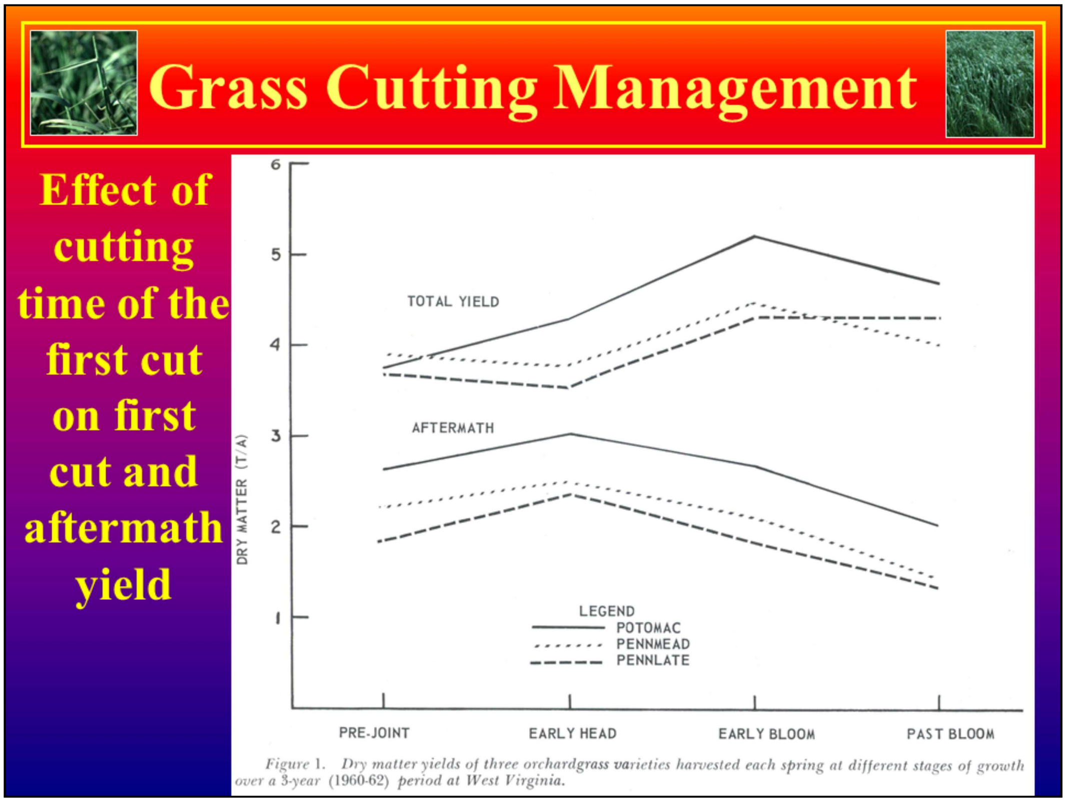


Figure 1. Dry matter yields of three orchardgrass varieties harvested each spring at different stages of growth over a 3-year (1960-62) period at West Virginia.

Timing of the first cut is critical. This graph is from work done throughout the Northeast back in the 1960's. In this study in West Virginia, they compared yields of three cultivars of orchardgrass cut at four different times for the first harvest (pre joint, early head, early bloom and post bloom). Overall, the highest annual yield was when the first cutting was made at early bloom stage. However, the best aftermath yields (and best quality) was achieved when the first cut was made at the early head stage.

Grass Cutting Management

Effect of number and frequency of harvests of four cool season grasses on annual DM yield and net economic return under different environmental conditions in PA.

Hall, MH. 1998. J. Prod. Ag. 11: 252 – 254.

Treatments		Dry conditions†		Normal to wet conditions†	
Species	Harvest schedule	DM	Economic return‡	DM	Economic return‡
	no./yr × interval	ton/acre	$/acre	ton/acre	$/acre
Orchardgrass	2 × 70 d	3.97§	88	5.35	159
	3 × 45 d	3.77	97	5.64	217
	3 × 35 d	3.04	97	--	--
	4 × 35 d	--	--	5.55	258
Reed canarygrass	2 × 70 d	3.78	96	5.48	197
	3 × 45 d	3.63	97	5.86	250
	3 × 35 d	2.87	108	--	--
	4 × 35 d	--	--	5.15	247
Smooth bromegrass	2 × 70 d	4.45	130	6.31	233
	3 × 45 d	3.89	117	6.19	283
	3 × 35 d	2.77	103	--	--
	4 × 35 d	--	--	4.89	252
Timothy	2 × 70 d	4.13	106	5.70	172
	3 × 45 d	3.70	88	5.25	194
	3 × 35 d	2.89	87	--	--
	4 × 35 d	--	--	4.54	172

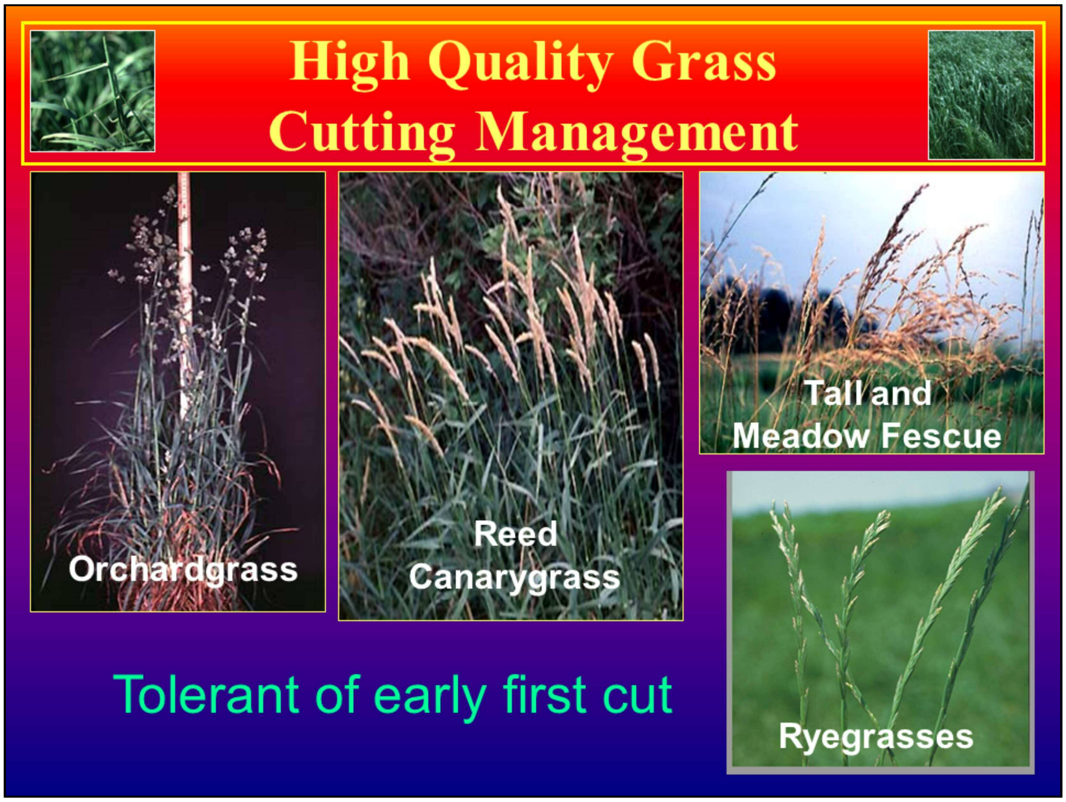
† Dry and wet conditions averaged 70 and 135%, respectively, of normal (29.6 in. by 1 Oct.). Reduced plant growth permitted only three harvests to be made from the four-harvest treatment in dry years.

‡ Based on relative value of the harvested forage ($65/ton hay with a forage quality of 16% CP and 60% DDM) minus costs for harvesting ($28/harvest) and fertilization.

§ All values are the mean from two years.

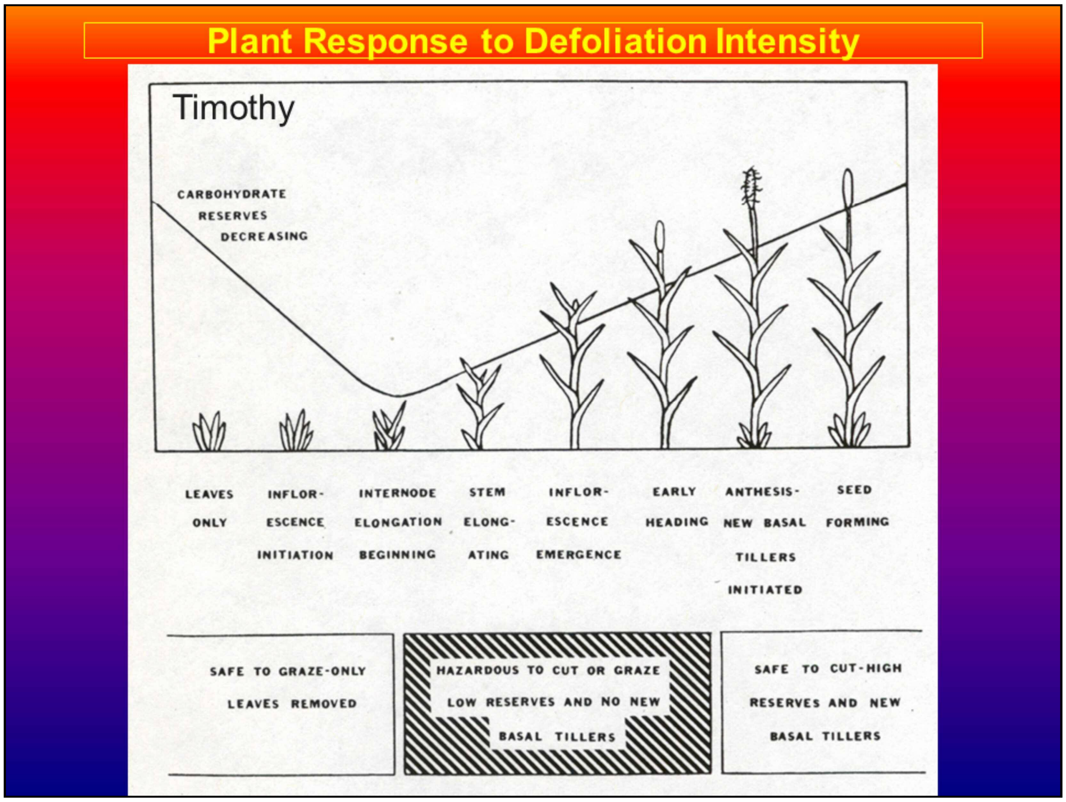
This four year study conducted by Marvin Hall in the early 90's in central Pennsylvania. The results were as follows:

- In dry years, greatest DM yields for all species were obtained when two or three harvests per year where taken on a 70 or 45-d interval, respectively. During growing seasons with normal or above normal rainfall, greatest yields of smooth bromegrass and timothy were again achieved when harvested two or three times per year; however, yields of orchardgrass and reed canarygrass were greatest when harvested three or four times per year.
- Regardless of rainfall during the growing season or grass species, forage quality improved and value of the forage increased from $49 to $8l/ton (1995 values) as harvest interval decreased from 70 to 35 days, respectively.
- In dry years, the number of harvests (harvest interval) made no difference in net economic return regardless of the grass species. This response is logical because harvest schedules that produced the greatest yields also produced forage of the lowest quality, resulting in similar economic return for all harvest schedules.
- In growing seasons when rainfall is normal or above normal, frequent harvests (35 or 45-d intervals) tended to result in the greatest net economic return per acre. Frequent harvests also produced the highest quality forage but did not negatively affect forage yield as much as in dry years. An exception to this trend was for timothy, where harvest frequency had no effect on economic return.

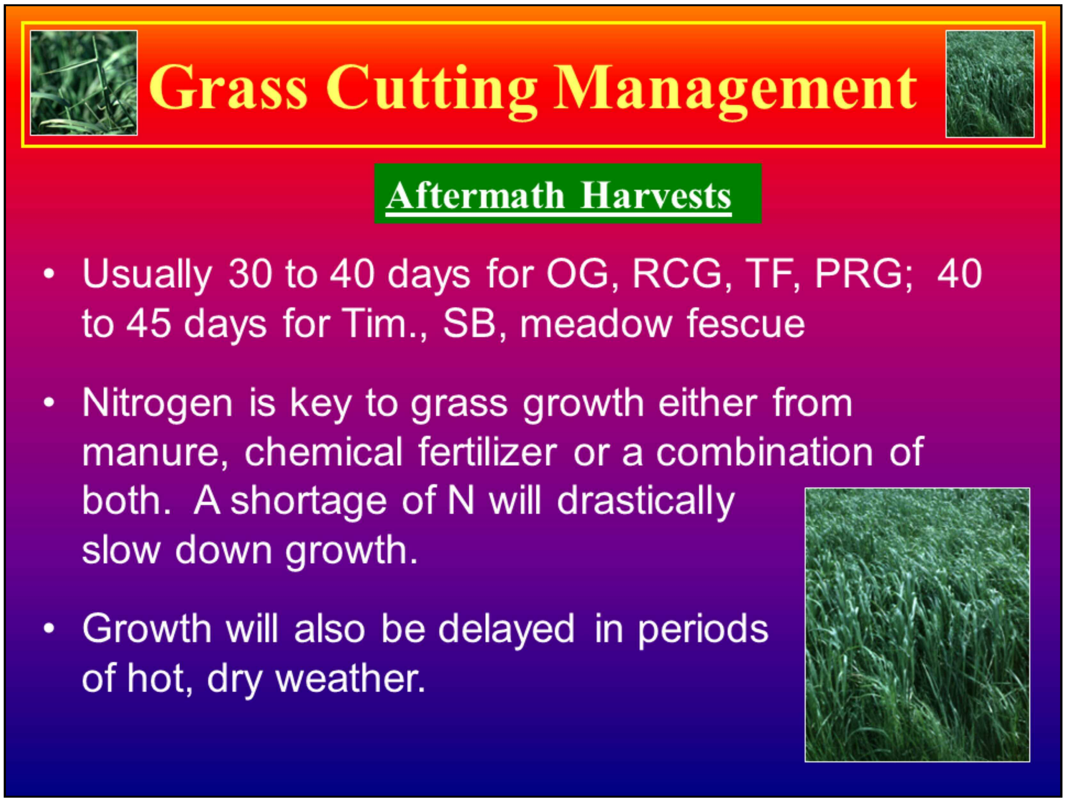


These grass species have the greatest potential for high quality because they can withstand early cuts.

These species can't tolerate an early cut.



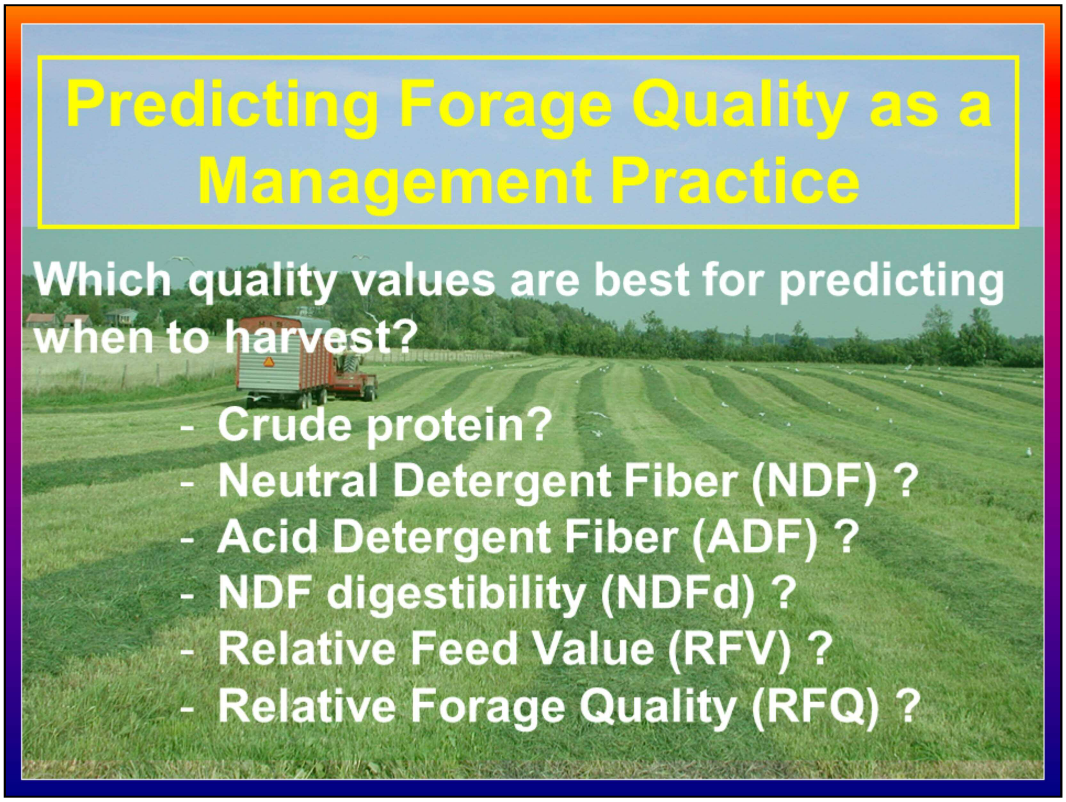
Remember that timothy and smooth bromegrass need a longer time before harvesting. If harvested before head stage, their stands can be weakened.



Deciding when to take the 2nd and 3rd cut of grasses is depended upon many conditions. Dry weather and short supplies of water and nitrogen can greatly slow down growth, yet, quality will continue to decline.

Generally, it is best to raise the cutting height (3" to 4") for grasses to maintain thick stands.

Although we can guess in the field as to when to cut, there are very few decisions made on actual forage quality values. Over the years, there have been several methods evaluated for predicting when to cut at a time to achieve the optimum forage quality. This next discussion will be about some of the methods used predicting when to cut based on research and models of changes in forage quality in the field.



Before discussing the models to predict quality, it would be important to review the quality parameters that have been evaluated and used in these models. There are many quality parameters used in defining the nutritional value of feed. All can be important to a nutritionist that is trying to balance a ration using forages and grain. However, from a forage management perspective, it may be best just to target one or two of the most important parameters for making cutting decisions.

So, which ones would be best for predicting when to optimally harvest forage? You would want one that is reliably measured across laboratories, one that is primarily influenced by plant stage of maturity and less by other external factors.

Crude protein is probably the feed value that farmers and others think of when asked about forage nutritional value; however, it can be easily influenced by soil nitrogen levels, type of forage (legume verses grass), as well as stage of plant maturity. Therefore, CP can be quite variable and not very suited to be used as a parameter for predicting when to harvest.

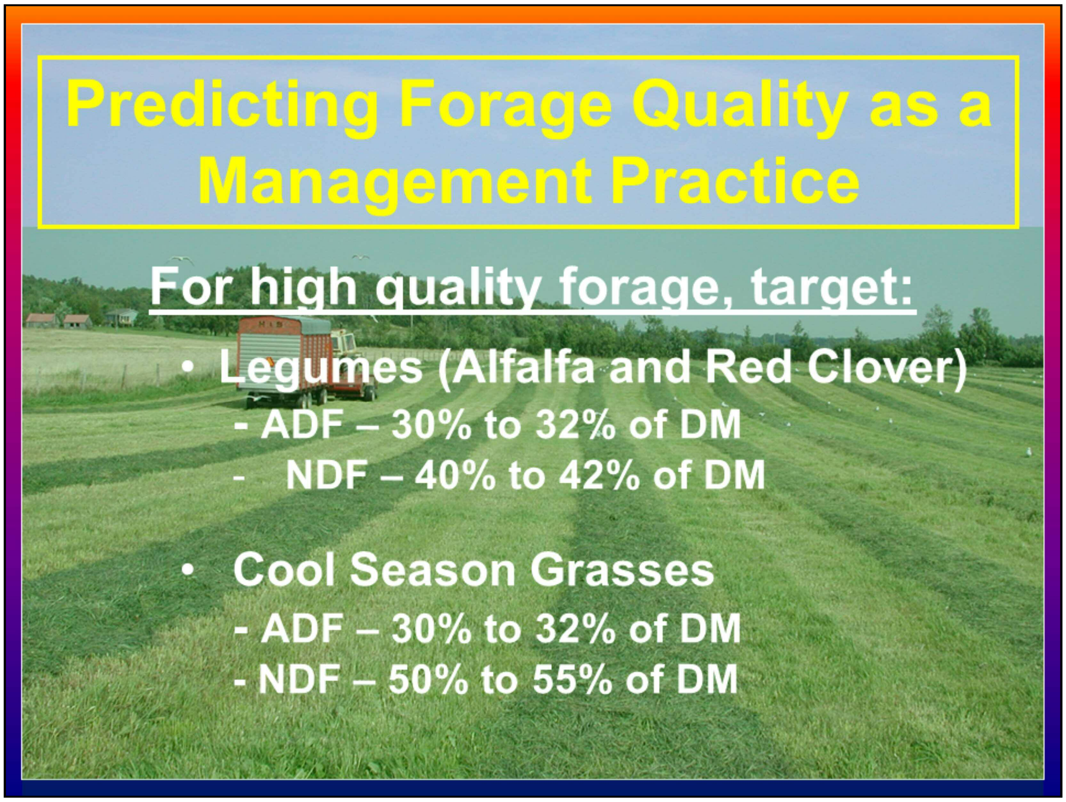
NDF is probably the best parameter to use. As a measure of total cell wall content it's level is probably most consistent with changes in plant stage of maturity. It is also a chemical method that has been used for over 50 years and we find excellent lab to lab consistency. It reflects the potential intake of forage. However, the composition of cell wall of grasses is quite different than legumes such that optimum NDF levels of grasses are about 10% units higher than legumes. Therefore, the use of NDF in mixtures can be challenging.

ADF is more consistent between forage species and types and may be a good supplement to NDF. Optimum ADF levels for high quality are similar between grasses and legumes; therefore, it is probably better suited for mixtures since optimum NDF levels vary so much between legumes and grasses.

Although **NDFd** is an important value for prediction forage energy content, I think it is too variable both in the field and across laboratories to be reliable for predicting optimum harvest times. Also, there is much debate and certainly variation between NDFd 24 hour, 30 hour and 48 hour fermentation times. It is best used by nutritionists in balancing rations for specific feeds on specific farms.

Relative Feed Value was first proposed in the 1980's as a one-number index to describe overall quality. It was intended to assist in alfalfa hay markets when making decisions based on nutritional value. It is solely based on ADF (which predicts digestible DM) and NDF (which predicts DM intake) and all forage is compared to a medium-quality alfalfa equaling 100. The problem with RFV as a prediction parameter is that it discriminates against grasses since their optimum NDF is 10% units higher than legumes. If you are using this to predict quality of pure stands of alfalfa, it works well, but not mixtures.

Relative Forage Quality was first proposed in the early 90's as an alternative to RFV. It uses the same relative index for comparing quality but it includes crude protein and NDF digestibility in the equation. It gives a more fair evaluation of grasses and could potentially be used in models. Again, my concern is that NDFd varies across labs and as that improves, this parameter will most likely become the best one to use for making cutting decisions.



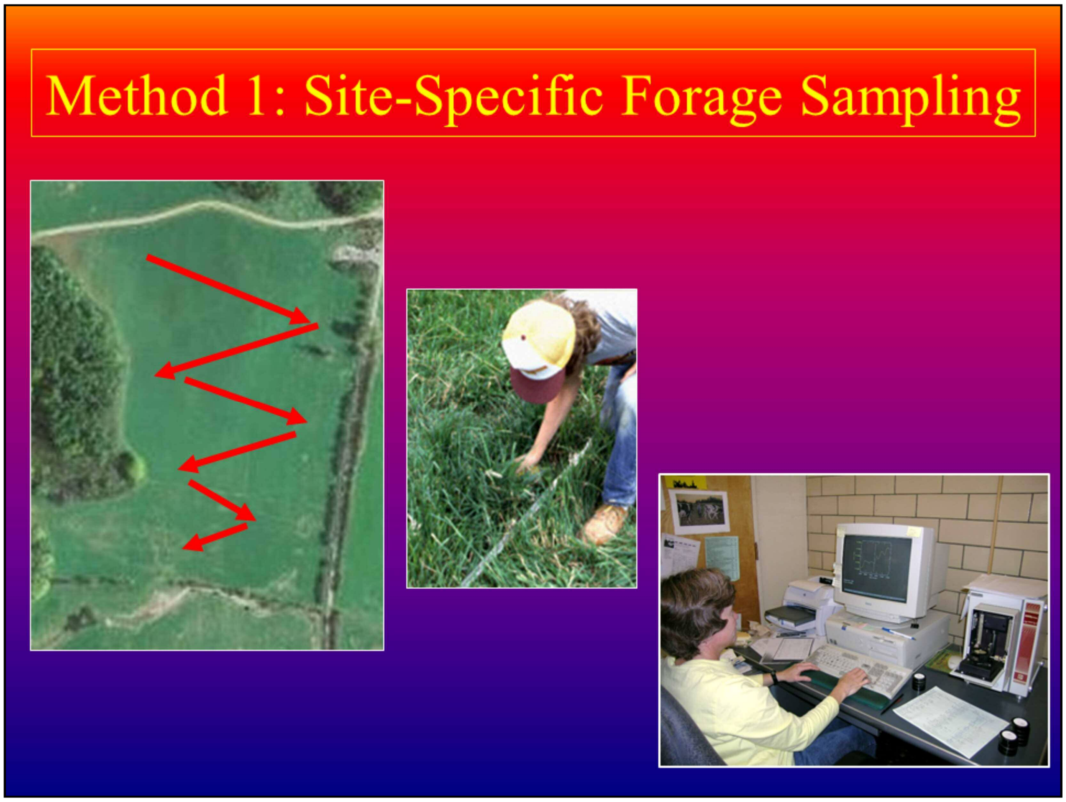
For the time being, we'll stick to ADF and NDF. This slide shows targets for high quality forage that would be used for lactating dairy cows when fed in a mixed ration. *If ADF or NDF exceed these limits, reduced forage intake and decreased digestibly will greatly affect animal performance and would require more grain supplementation. There would also be a reduction in the amount of this forage that could be in the ration.*

Note that the target ADF is similar for both legumes and grasses. Generally, the energy estimates for legumes and grasses are similar at the same levels of ADF. However, the composition (cellulose, hemicellulose and lignin) of the total cell wall (NDF) is quite different between legumes and cool season grasses. Inherently, grasses have a higher NDF content compared to legumes at comparable maturity levels. On average, it is about 10 percentage units higher. Although higher, the NDF of cool season grasses is more digestible than legume NDF and, therefore, should be interpreted differently.

Existing Methods for Predicting Forage Quality in the Field

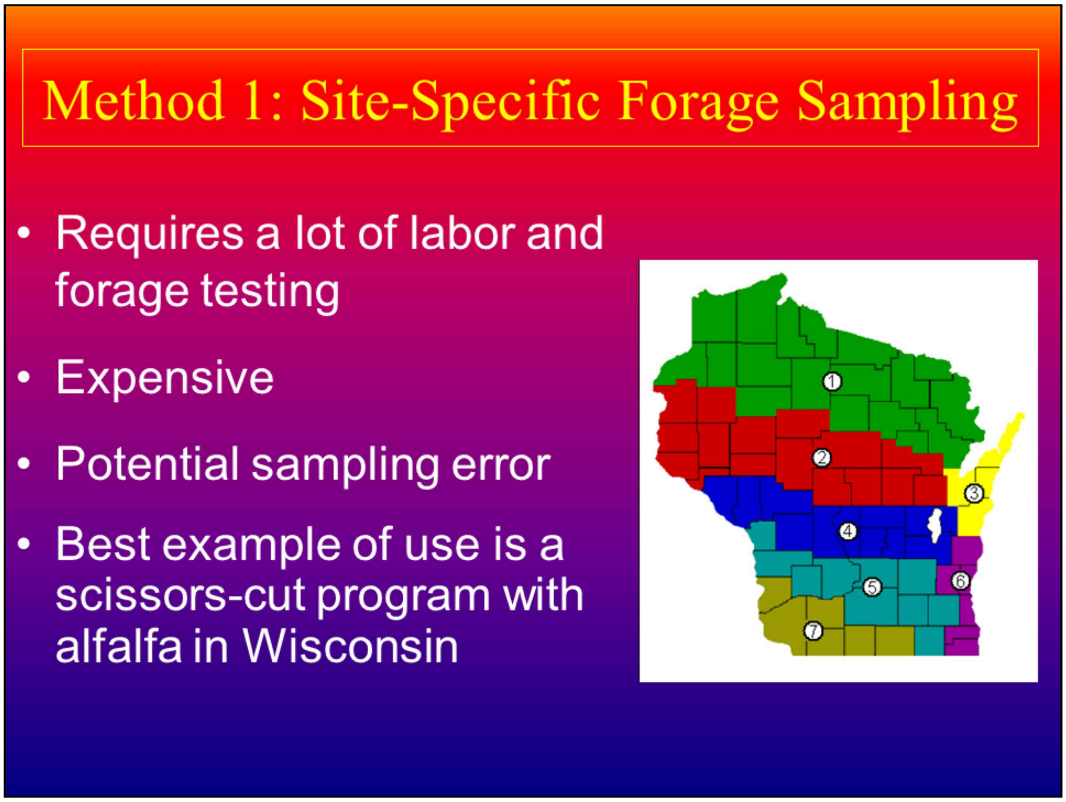
1. Site-specific forage sampling and testing using NIRS methodology
2. Use of mathematical prediction equations based on plant morphological characteristics and plant height
3. Prediction equations based on weather data especially temperature (growing degree days)

There are three major approaches to modeling forage quality in the field.



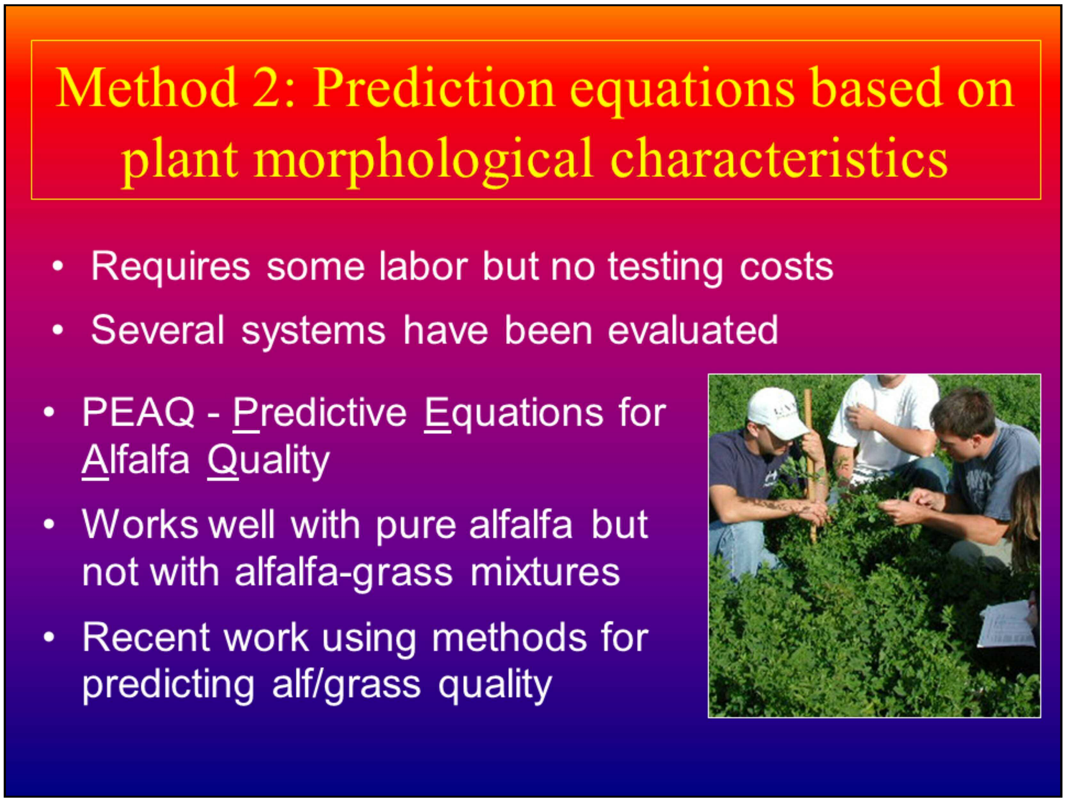
The first one is site specific sampling. Like soil sampling, the idea is to get a "representative" forage sample from the field and test it in the lab for quality. With NIR technology, quality can be measured very quickly to make this a feasible approach.

Some farms begin sampling a week before they think it should be ready to better predict how close they are to their target. Some nutrition consultants will collect from target fields amongst their farmer customers so they can get the word out.



This method is labor intensive and can be expensive if there are a lot of fields involved. There is also potential sampling error if sampling is done too quickly and improperly.

Some Extension services (Wisconsin, Illinois) offer region or statewide programs in which selected target fields are sampled once a week starting in mid-May. All the data is posted on websites so farmers can track the progression. This works well with a single forage crop like alfalfa but in New England where field slope, aspect, elevation, textural type and species vary so much it would be a challenge to interpret unless on a fairly narrow regional bases.



The second method of predicting quality uses certain plant morphological indicators such as reproductive maturity and height.

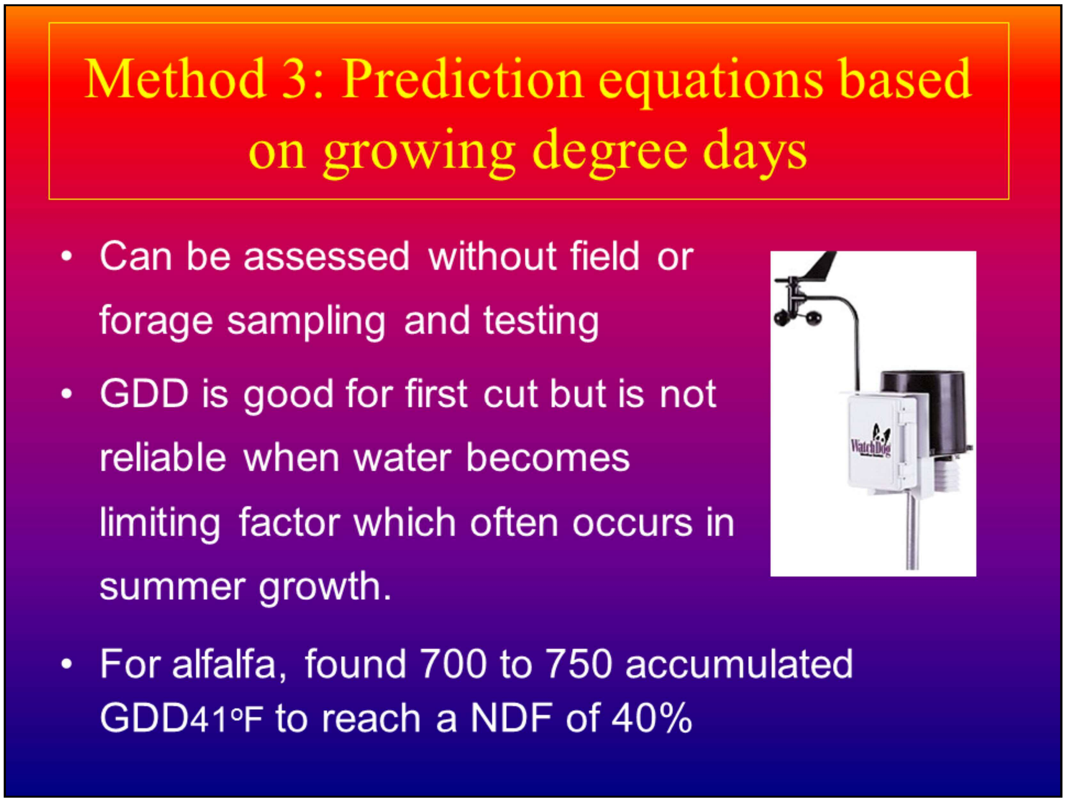
The PEAQ was first introduced in the 1990's and uses stage of maturity and plant height to predict NDF content. It works pretty well for first and second cutting of alfalfa but is not very accurate when grown in a mixture with grass.

Method 2: Prediction equations based on plant morphological characteristics

Max. alfalfa	%Grass in the stand (dry matter basis)								
height, in.	10	20	30	40	50	60	70	80	90
14	23.5	26.7	29.9	33.1	36.3	39.5	42.7	45.9	49.1
15	24.3	27.5	30.7	33.9	37.1	40.3	43.5	46.7	49.9
16	25.1	28.3	31.5	34.7	37.9	41.1	44.3	47.5	50.7
17	25.9	29.1	32.3	35.5	38.7	41.9	45.1	48.3	51.5
18	26.8	30.0	33.2	36.4	39.6	42.8	46.0	49.2	52.4
19	27.6	30.8	34.0	37.2	40.4	43.6	46.8	50.0	53.2
20	28.4	31.6	34.8	38.0	41.2	44.4	47.6	50.8	54.0
21	29.2	32.4	35.6	38.8	42.0	45.2	48.4	51.6	54.8
22	30.1	33.3	36.5	39.7	42.9	46.1	49.3	52.5	55.7
23	30.9	34.1	37.3	40.5	43.7	46.9	50.1	53.3	56.5
24	31.7	34.9	38.1	41.3	44.5	47.7	50.9	54.1	57.3
25	32.5	35.7	38.9	42.1	45.3	48.5	51.7	54.9	58.1
26	33.4	36.6	39.8	43.0	46.2	49.4	52.6	55.8	59.0
27	34.2	37.4	40.6	43.8	47.0	50.2	53.4	56.6	59.8
28	35.0	38.2	41.4	44.6	47.8	51.0	54.2	57.4	60.6
29	35.8	39.0	42.2	45.4	48.6	51.8	55.0	58.2	61.4
30	36.7	39.9	43.1	46.3	49.5	52.7	55.9	59.1	62.3
31	37.5	40.7	43.9	47.1	50.3	53.5	56.7	59.9	63.1
32	38.3	41.5	44.7	47.9	51.1	54.3	57.5	60.7	63.9
33	39.1	42.3	45.5	48.7	51.9	55.1	58.3	61.5	64.7
34	40.0	43.2	46.4	49.6	52.8	56.0	59.2	62.4	65.6
35	40.8	44.0	47.2	50.4	53.6	56.8	60.0	63.2	66.4

(Cornell Un.)

Jerry Cherney of Cornell came up with a system for predicting NDF levels in alfalfa-grass mixtures based on alfalfa height and some visual assessment of the amount of grass in the stand. This table provides the interpretation. Being able to estimate the percentage of grass in the stand takes practice.

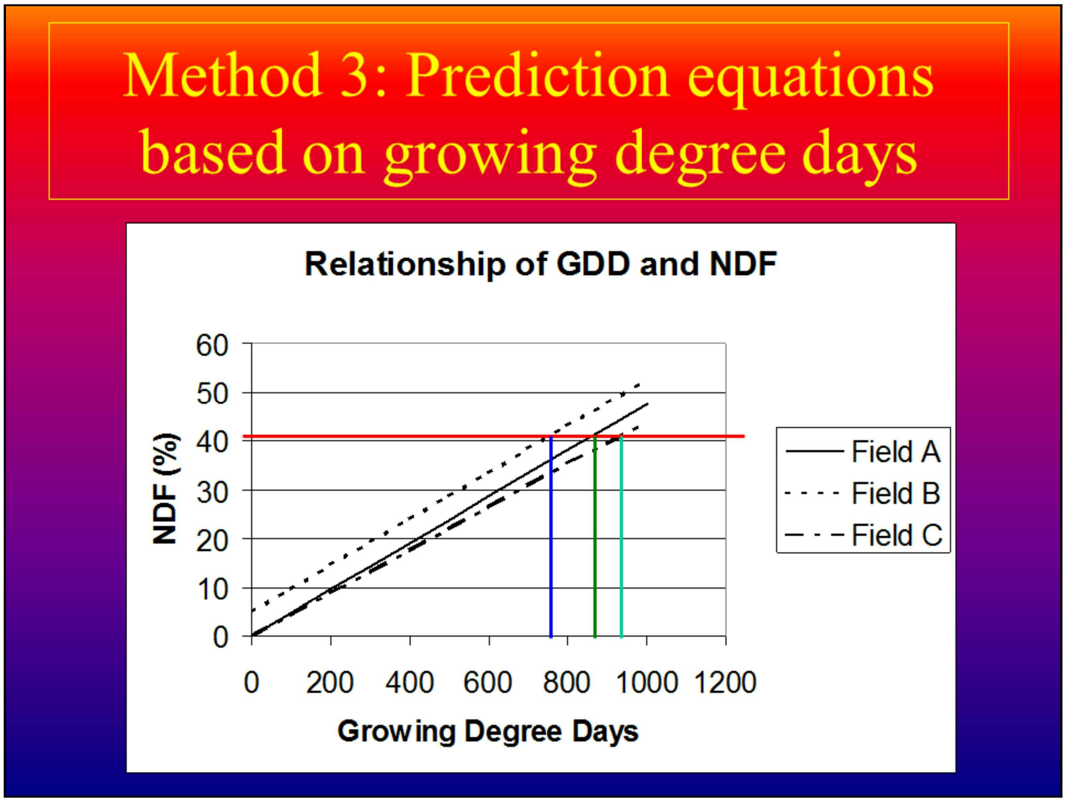


A third approach to modeling forage quality utilizes temperature and growing degree days. The advantage of this method is that it would require no field assessments and no testing costs. It works pretty well for the first growth because water is usually adequate and, therefore, temperature is the main variable influencing growth rate of the crop. This method is not as predictable for summer growth due to the interaction of deficit water stress with temperatures.

For alfalfa and cool season grasses, a base of 41 F is used for calculating growing degree days. To calculate a GDD or one day, take the average temperature and subtract 41 from it. The formula is:

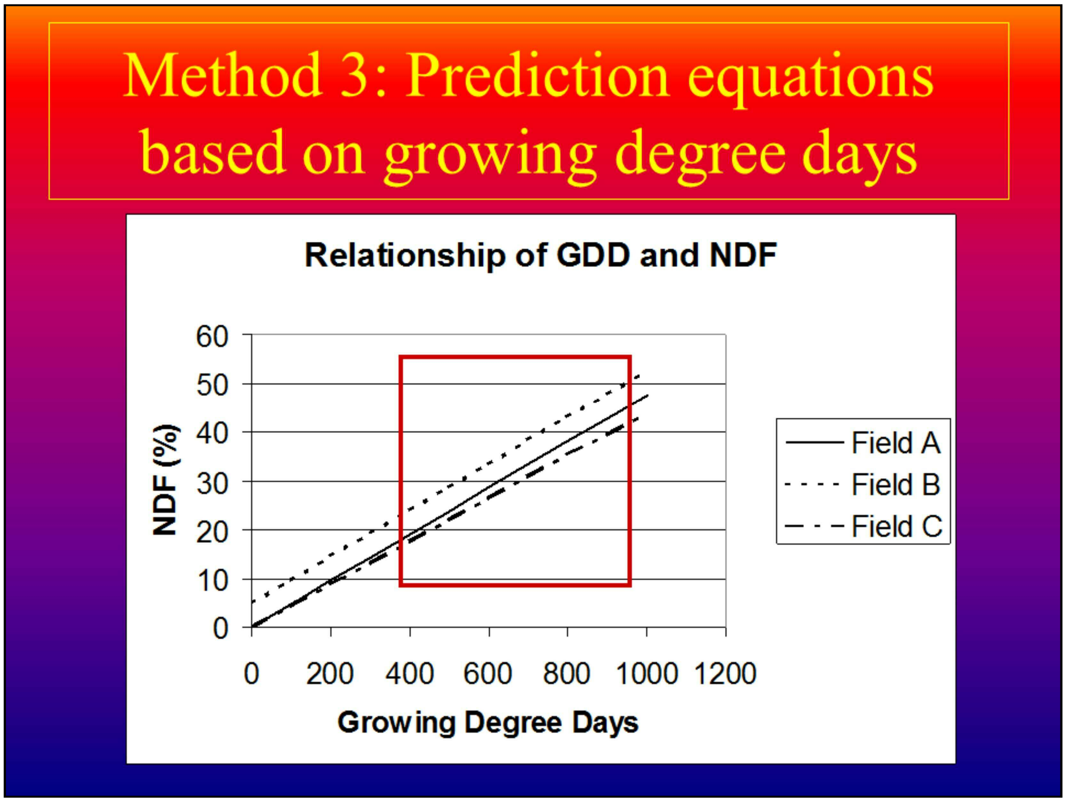
GDD = (Tmax – Tmin)/ 2 - 41 (if a minus number, set at “zero”).

Start tracking GDDs March 1 to calculate accumulated GDDs.

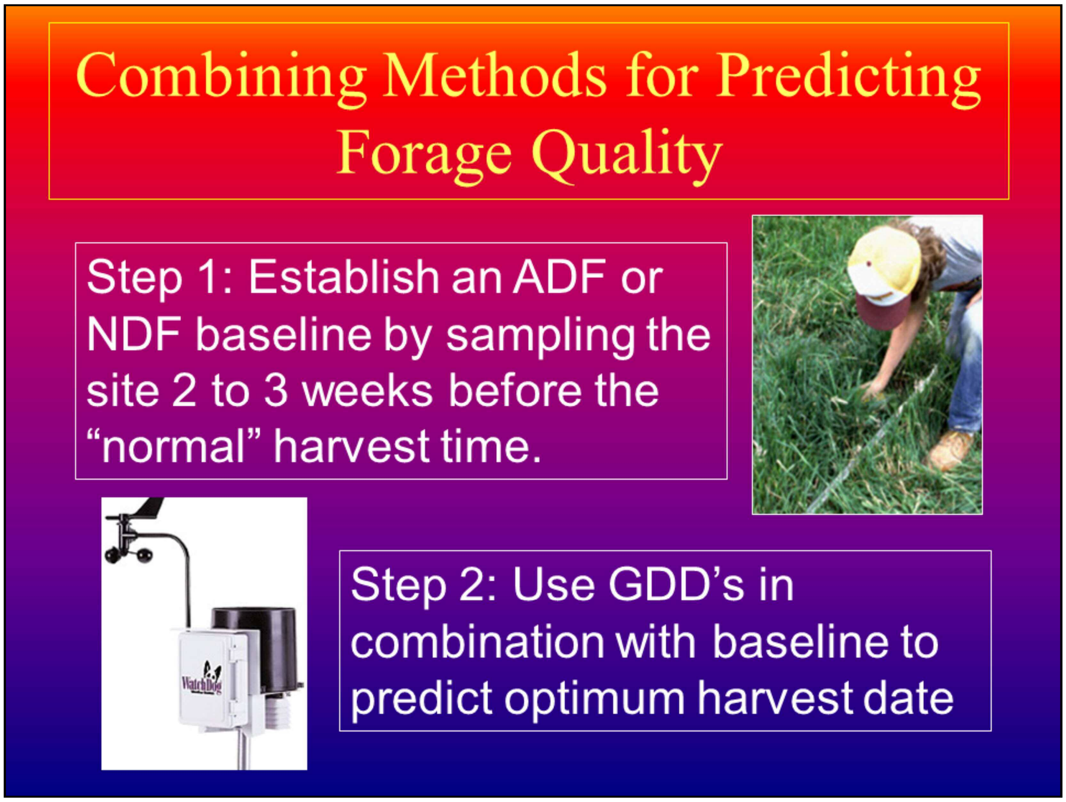


In this example comparing the relationship of changes in NDF with cumulative growing degree days, the slope or rate of change is similar for each of the fields; however, the intercept is different. For Field B, the GDDs to reach 40% NDF was less than 800 while the requirement for Field C was over 900. The problem with using growing degree days alone is that doesn't do a good enough job of predicting when growth initially starts in the spring. This may also vary by variety and soil conditions.

And this graph is only for pure alfalfa. It the stands were mixed alfalfa/grass like most are in New England, this relationship would be much more complicated.



However, if a more narrow window was used, perhaps using GDD in combination with other methods that measure quality about mid-way (sampling or PEAQ), our accuracy could improve.



Combining methods may improve precision of prediction. For example, a sampling method is used 2 to 3 weeks before the "normal" harvest to get a baseline. Then growing degree days can be used to model changes in quality and predict an optimum harvest date.

What about just using time as a factor rather than GDD's? We know that on average, grasses increase in NDF about 0.75 to 1.0 units per day and alfalfa increases about 0.5 units per day. However, this rate can vary from year to year and site to site. See next slide.

Changes in NDF During Spring Growth

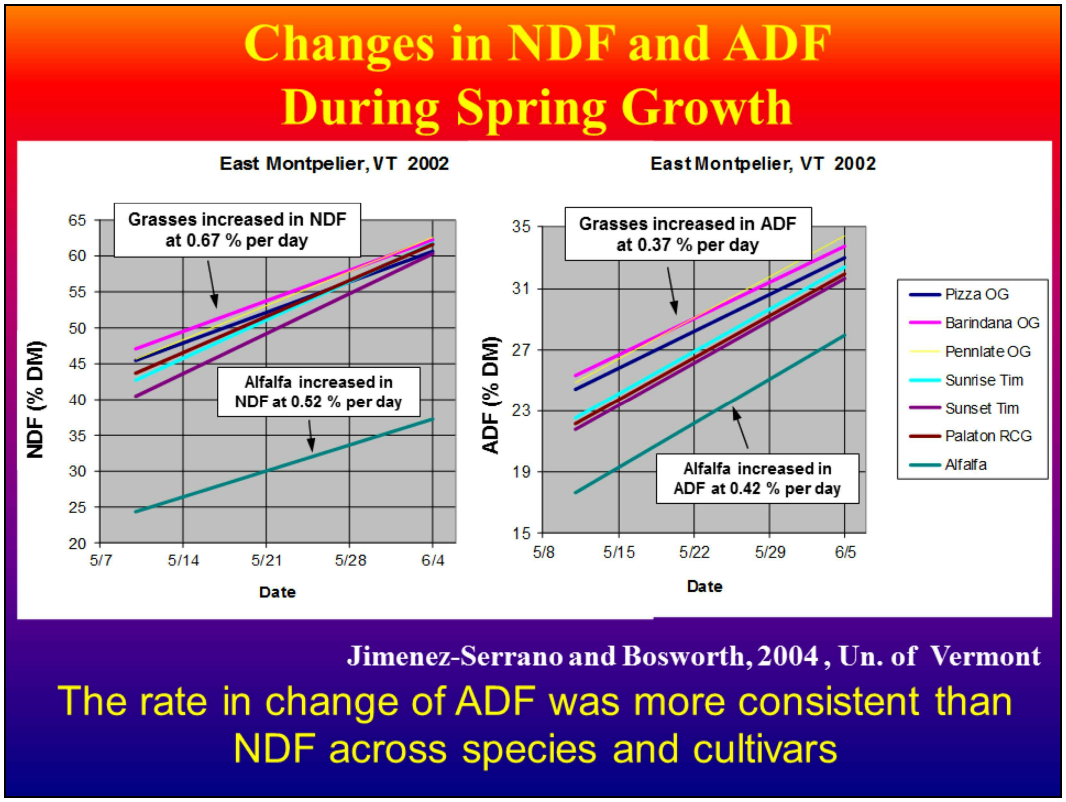
Location	Year	All Grasses NDF/day	All Grasses NDF/10GDD
S. Burlington	2002	0.70	0.45
	2003	0.92	0.52
E. Montpelier	2002	0.67	0.55
	2003	0.69	0.43
	Average	**0.75**	**0.49**
		Alfalfa	
E. Montpelier	2002	0.51	0.36
	2003	0.54	0.35
	Average	**0.52**	**0.35**

Jimenez-Serrano and Bosworth, 2004 , Un. of Vermont

This table is a summary of research in Vermont looking at rates of change in NDF of the first growth period of three grass species based on time (change in NDF per day) and based on temperature (change in NDF per 10 units of accumulated growing degree days).

Using time as a factor (ie., changes in NDF per day), you can see that there is a lot of variation from year to year and site to site when trying to predict NDF levels in grasses. However, there was much less variation in using growing degree days. This research would support the notion that using GDD could be a potential tool for predicting quality for grasses as well as alfalfa.

As already discussed (but worth repeating), one problem with using NDF in the prediction for legume/grass mixtures is that the rate of change in alfalfa is less than grasses. You would need to know exactly the proportions of alfalfa to grass to be able to use this method.



These graphs show the change in NDF (left) and ADF (right) for six grass treatments and alfalfa in central Vermont in 2002. Grasses increased in NDF at a greater rate than alfalfa, whereas, the increase in ADF was approximately the same rate for the grasses and alfalfa. This supports the notion that ADF might be a better predicting variable than NDF for alfalfa/grass mixtures since their rate of change is more consistent.

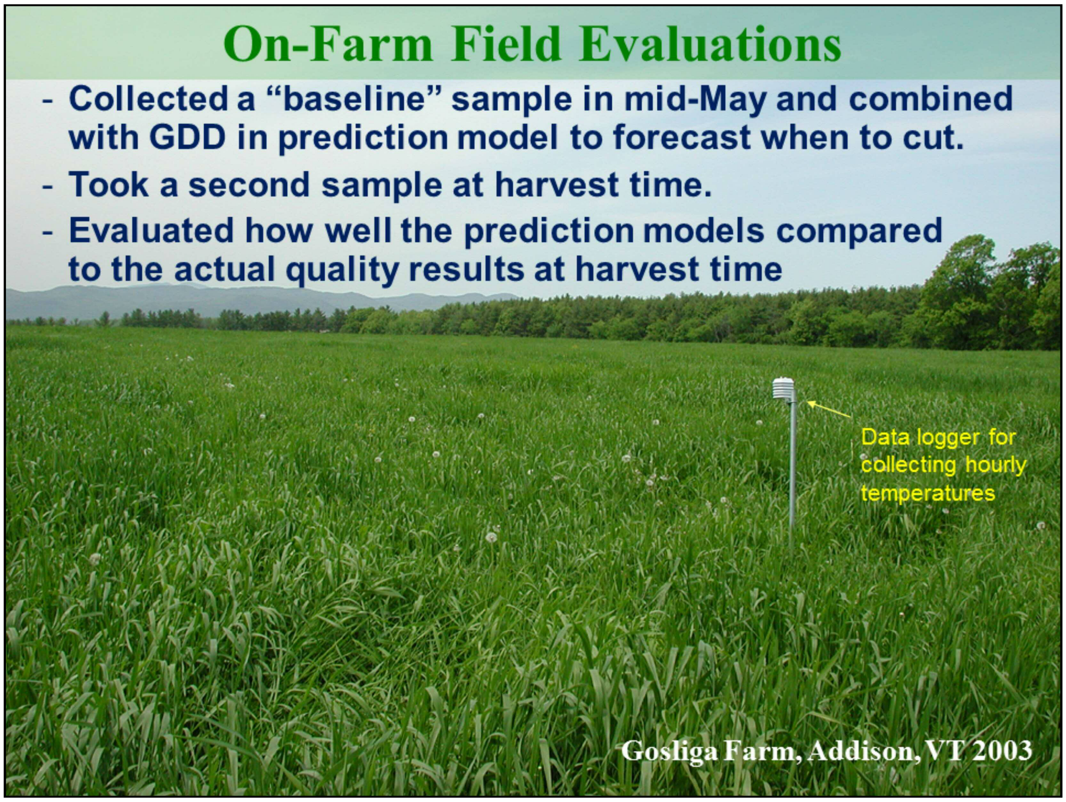
Changes in ADF During Spring Growth

		All Grasses	
Location	**Year**	**ADF/day**	**ADF/10GDD**
S. Burlington	2002	0.40	0.28
	2003	0.53	0.30
E. Montpelier	2002	0.37	0.31
	2003	0.46	0.28
	Average	**0.44**	**0.29**
		Alfalfa	
E. Montpelier	2002	0.42	0.30
	2003	0.50	0.32
	Average	**0.46**	**0.31**

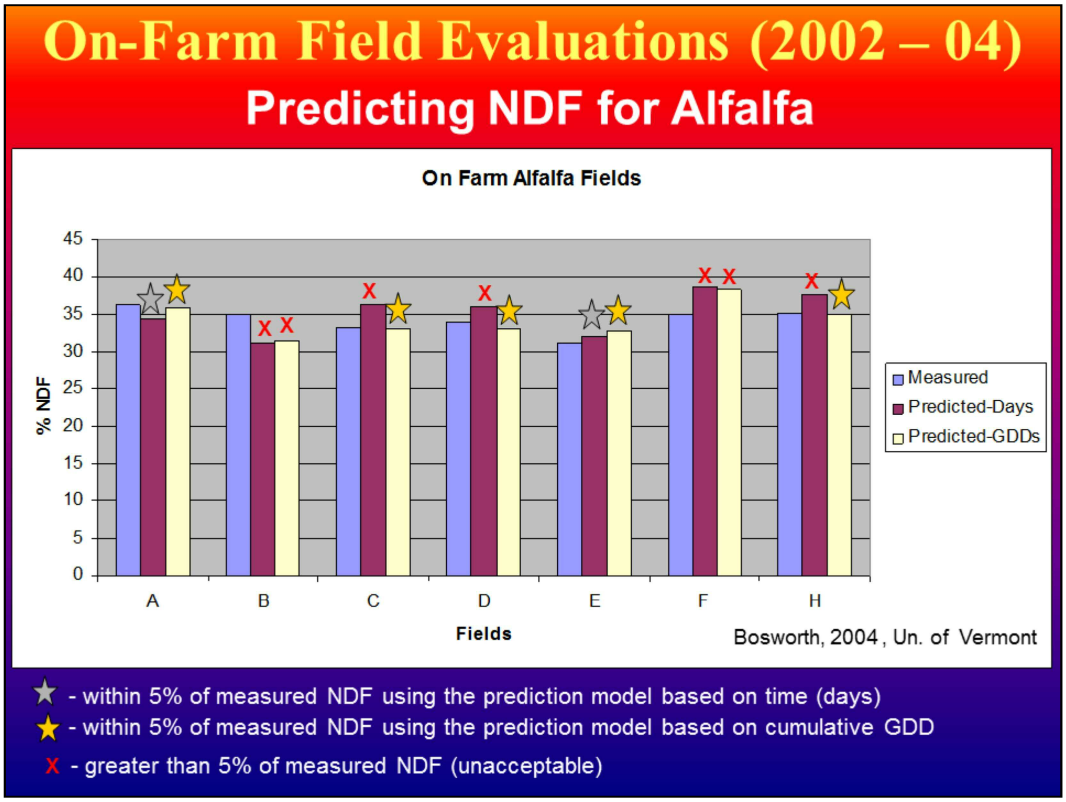
Jimenez-Serrano and Bosworth, 2004 , Un. of Vermont

Looking at the whole study, there was a lot of year to year and site to site variation in the change in ADF per day. However, the rate of change in ADF per 10 units of Growing Degree Day was much more consist across years and locations.

Since ADF of alfalfa changes at about the same rate as that of grasses, it is probably a better measure to predict quality of mixtures than NDF (see next slide).

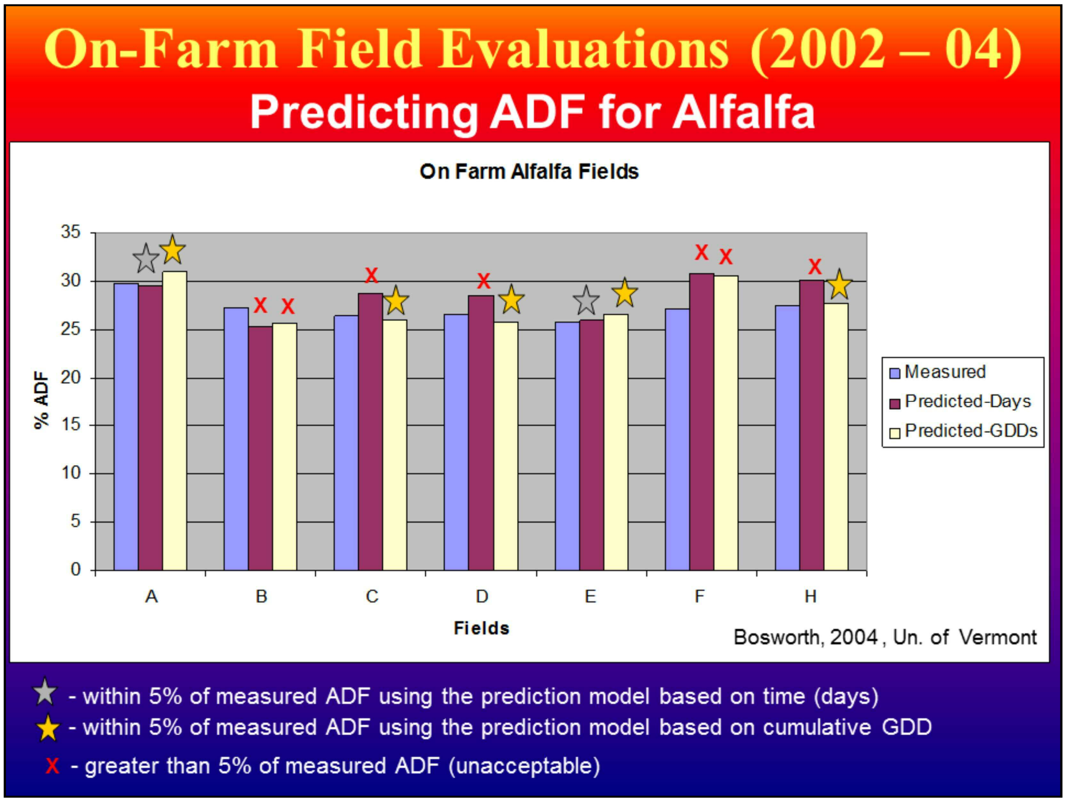


In the Vermont study between 2002 and 2004, several on-farm fields across Vermont were evaluated to test this prediction method. The fields varied in species from pure alfalfa, pure grass and mixtures.



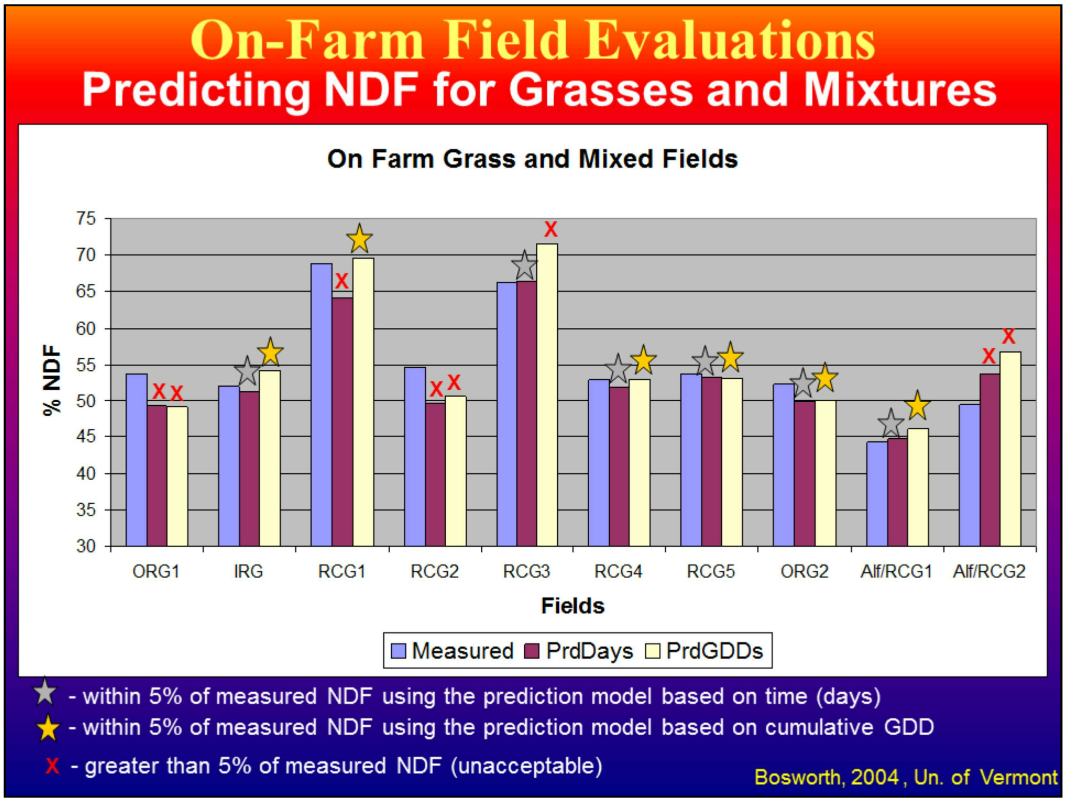
This graph shows the actual measured NDF at time of harvest (blue bars) compared to the two prediction methods for seven alfalfa fields in Vermont. The red bar used a prediction method based simply on rate of change of NDF per day and the yellow bar predicted NDF using the GDD method. Both methods used a baseline measure of NDF and ADF (see next slide) in which 12 to 15 subsamples were collected from the field about two to three weeks prior to harvest, mixed, dried, ground and sent to a lab for analysis.

Using the model based on an time (average rate of change per day) to predict NDF was not reliable since five of the seven fields had predictions that were over or under by greater than 5%. On the other hand, the predicted NDF using the GDD method was within 5% of the actual measured NDF in five of seven fields; therefore, this method does have potential.

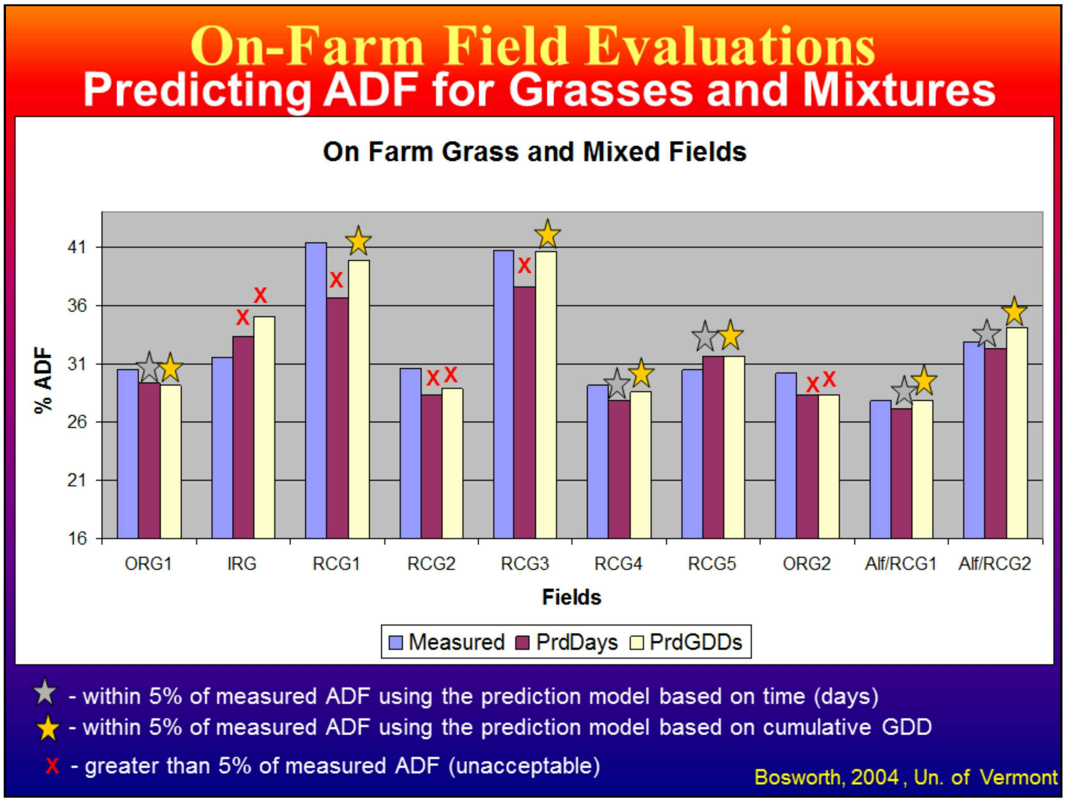


The relationship of predicted ADF to actual ADF at time of harvest was similar to that of NDF with the same fields either being within or out of 5% variation.

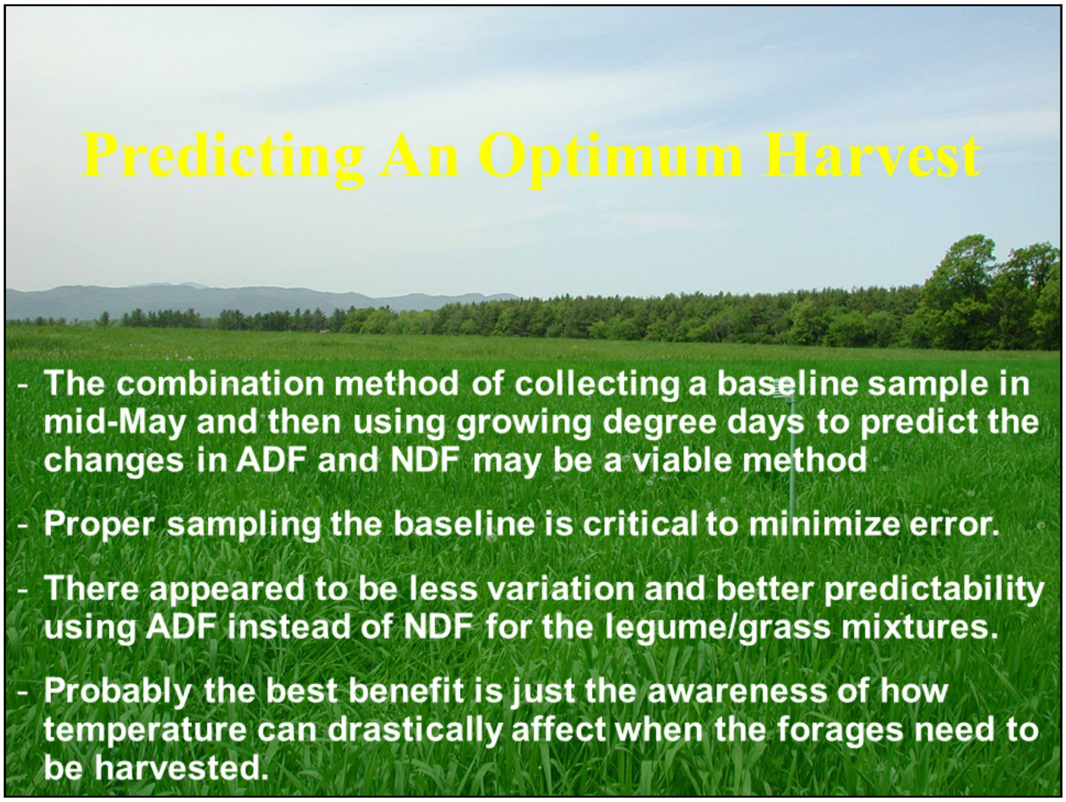
Based on these results, the GDD method is far superior for predicting NDF or ADF of alfalfa compared to using an average rate of change per day. This is not surprising since alfalfa rate of maturity is very responsive to temperature.



When evaluating straight grass or mixed grass/legume stands, the GDD method predicted NDF within 5% of the actual NDF in 6 of the 10 fields using either prediction method, only 60% success. Since initiation and rate of grass maturity is influenced by day length and soil nitrogen status, perhaps GDD is not as good of a predictor as it is with alfalfa. It is not surprising to see poor results with alfalfa – grass mixed stands since their levels and rates of NDF are quite different.



Only five out of the 10 fields predicted ADF using days, whereas, seven of the 10 fields predicted ADF using the GDD method. ADF was better at predicting harvest time of the mixed stands compared to the NDF but there were only two fields, not enough to draw any conclusions.


Predicting An Optimum Harvest
- The combination method of collecting a baseline sample in mid-May and then using growing degree days to predict the changes in ADF and NDF may be a viable method
- Proper sampling the baseline is critical to minimize error.
- There appeared to be less variation and better predictability using ADF instead of NDF for the legume/grass mixtures.
- Probably the best benefit is just the awareness of how temperature can drastically affect when the forages need to be harvested.

In summary…