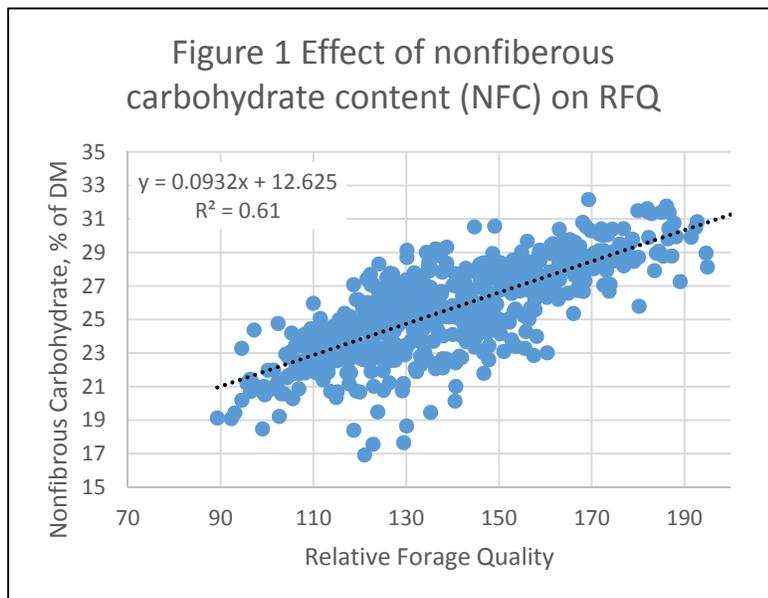


INFLUENCE OF HARVESTING TECHNOLOGIES ON QUALITY AND YIELD

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From the time forage is cut until it is fed the goal is to minimize dry matter and forage quality loss. The amount of decline is determined by the management during harvesting. The two major sources of loss during the harvesting process are respiration losses and leaf losses.

Respiration is the breaking down of starch and sugars to produce energy (heat) and carbon dioxide. The process occurs in growing plants to produce energy. It continues after mowing until the plant has dried to less than 60% moisture. Respiration also occurs when heating takes place in hay and silage.



Data suggest that 2 to 8% of the dry matter may be lost due to respiration after mowing. Figure 1 shows the relationship between nonfibrous carbohydrate (NFC, largely sugars and starch) on Relative Forage Quality. In a study conducted at Minnesota, Pennsylvania and Wisconsin where two cuttings were taken and raked with different types of rakes, the NFC content explained 61% of the variation in Relative Forage Quality. It should be recognized that some of the relationship is due to NFC loss due to respiration and some due to greater leaf content (which has more starch and sugars).

¹ Dan Undersander, Forage Agronomist, University of Wisconsin, Madison, WI. djunders@wisc.edu. In: Proceedings, 2015 Western States Alfalfa and Forage Symposium, Reno, NV, 2-4 December, 2015. UC Cooperative Extension, Plant Sciences Department, University of California, Davis, CA 95616. (See <http://alfalfa.ucdavis.edu> for this and other alfalfa conference Proceedings.)

Table 1 shows that, at current hay prices, a 4% dry matter loss results in \$8.00 loss per ton of hay. Losses are greatest in the West where forage is often cut with a large cutter bar and put into a windrow that fits between the swather tires. This hay often takes 5 to 7 days to dry for baling during which significant respiration losses occur. The single most important factor to drying the leaves to reduce respiration is to spread hay into a wide swath after mowing/conditioning. Some farmers of the same region put forage into a wide swath and bale it in two days. Not only does the faster drying time result in less dry matter loss but getting the hay off the field faster results in less wheel traffic damage to regrowth and higher yield of next cutting.

Table 1. Losses Due to Respiration			
Dry Matter Loss	2%	4%	8%
	Economic Loss (\$/t)		
Hay value \$239/t	\$4.78	\$9.56	\$19.12
Forage Quality Loss from 4% sugar/starch loss			
ADF, %	NDF, %	RFQ	Value, \$/t
30.0	40.0	153	\$239.00
--Forage quality if lose 4% dry matter of starch/sugars--			
33.0	43.4	134	\$125.00
Prices from Midwest Hay Market Report, Nov 6, 2015			

Respiration also causes a significant forage quality loss. Respiration is the breaking down of sugars and starch to give off carbon dioxide and heat. Lost starch and sugar were 100% digestible. As table 1 shows, loss of sugar/starch increases the content of remaining components. A 4% starch sugar loss would increase NDF slightly over 3%. Note that this is a drop of almost 20 points of RFQ. Thus if one had cut alfalfa at just below 40% NDF and lost 4% sugar/starch due to respiration, the harvested quality would be above 40% NDF which is currently selling for about \$114/t less!

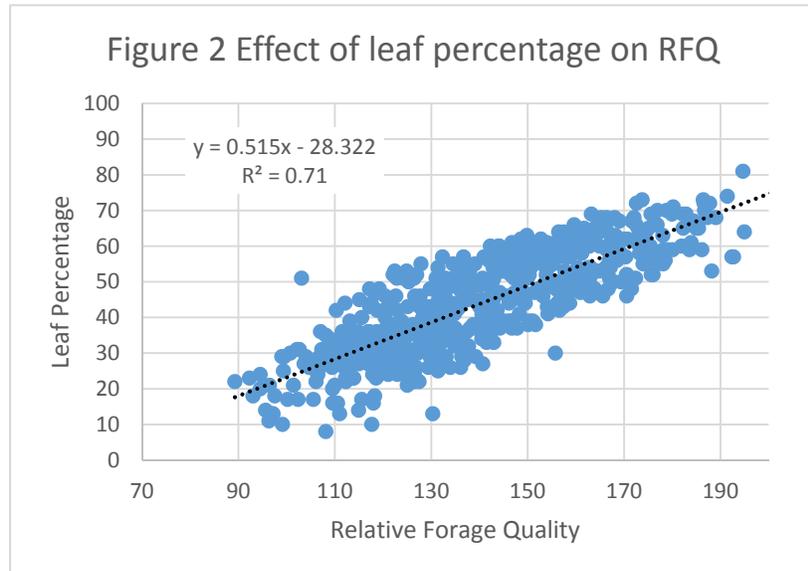
What can be done to minimize losses from respiration? The single most important practice is to spread forage into a wide swath so that more sunlight is intercepted and stomates (breathing holes in the leaves) stay open to allow rapid drying of the leaves. Respiration largely occurs in the leaves. Hay should be managed to dry to 60% or less moisture as quickly as possible. When forage moisture falls below 60% respiration is greatly reduced. Conditioning does not affect leaf drydown rate.

Hay that is put immediately into a windrow dries slowly inside the windrow since leaves are in the dark so stomates close. Also humidity within the windrow is high so that water evaporation is reduced and high respiration rates occur for an extended time. Thus growers should spread cut hay into a wide swath (and drive over it) rather than to make a windrow that fits between the wheels.

Note that if a grower insists on putting forage immediately into a windrow immediately after mowing and taking the respiration losses of sugar and starch, then the forage must be cut earlier to still be below 40% NDF (150 RFQ) after the respiration losses when baling or chopping. Cutting earlier to allow for the respiration losses means a yield loss of 160 to 200 lb/a for each day the alfalfa is harvested earlier. Earlier harvest also means greater stress on the stand thereby shortening its stand life.

Forage is often 75 to 78% moisture when cut so **the key to high yield of high quality forage is to manage so the first 15% moisture is lost as rapidly as possible.** Reducing the unseen losses of respiration will increase yield and forage quality. Additionally, getting hay off the field faster will increase the yield of the next cutting.

The second key to managing for high yield of high quality forage is to minimize leaf loss during the harvesting process. The bulk of the protein and energy is in the leaves so leaf loss represents a loss of both yield and quality. Figure 2 shows the relationship of leaf percentage to RFQ during the harvesting process. It is obvious that leaf loss is highly related to forage quality.



How can leaf loss be minimized during forage harvest? We know that several machinery factors relate to leaf retention including the following:

- ❖ Using a roller conditioner rather than a flail conditioner
- ❖ Avoid tedding the alfalfa
- ❖ Rake when above 40% moisture
- ❖ Some rakes cause more leaf loss than others, a merger results in the least leaf loss.
- ❖ Bale when forage is tough (with some dew)

Cutting height has a mixed effect on forage yield and quality. On the one hand alfalfa can be cut at any height above the crown without affecting yield of next cutting. On the other hand cutting low will increase soil contamination, especially with disc mowers and when soil is dry. Thus yield will be increased by lower cutting but forage quality will decline due both to inclusion of lower quality forage (stem bases) and to increased ash content.

In summary, high quality forage begins with cutting when forage quality is high since quality only declines after harvest. The least forage quality is lost during the harvesting process if forage is spread into a wide swath (covering 70 to 80% of cut area) to maximize initial drying rate and managing to minimize leaf loss during harvesting.