High Quality Hay Management

To make high quality hay: cut it at the perfect time, dry it down as fast as possible, then put it up quickly at the optimum moisture level and store it out of the elements. Of course, if these were simple steps, every farmer would have premium hay every year.

The reality is that choosing the best time to cut hay requires scientific knowledge and careful weather observation. Biology and physics both influence the time required to dry hay to a desired moisture level. Once cut, hay begins to lose relative feed value (RFV) or relative forage quality (RFQ). Understanding how management factors can speed or impede the drying process is critical to consistently producing high quality hay.

In hay harvesting, each operation affects yield, measured as dry matter. Dry matter lost from each operation should be minimized whenever possible.

Average Dry Matter Losses as a Result of Various Harvesting Operations

• Factor in expected losses

Operation	Dry Matter Loss
Cutting	1 - 6 %
Conditioning	1 - 4 %
Raking	5 - 15 %
Baling	1 - 4 %
Rain (1 inch)	3 - 4 %
Storage	5 - 10 %

Species and Variety Selection

High quality hay is different for different farmers. While pure alfalfa makes a desirable dairy hay, many beef cattle owners require less rich feed and can do just as well with a quality grass or grass-mix hay. Farmers growing high quality hay must first choose species and varieties that will match their needs the best.

Some plant species are best for hay and some are best for pasture, while others work in both hay and pasture systems. *Seed Manitoba*, found online at www.seedmb.ca, features tables outlining longevity, winter hardiness, tolerance to salinity, drought and flooding for many forage species. The tables are a helpful first step in selecting plants to match a farm's specific hay or pasture needs.

Once species are selected, whether for pure or mixed stands, farmers can then work through choosing the best varieties for their particular growing conditions, soil type, disease pressures and management style. For Manitoba, winter hardiness will factor heavily into the longevity of any hay field, as will the disease resistance package each variety provides.

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Fertility

Forages for hay, pasture or both are the workhorses of any cropping system. Though they may seem to maintain productivity on marginal soils with little management, like any crop, forages require nutrients to grow. Too often, fertility of hay stands is overlooked, sometimes because stands seem to be producing fine with little fertilizer investment. In pastures, some of the removed nutrients are returned to the field in the form of manure, but in hay stands, almost all nutrients and top growth are removed when the hay is cut.

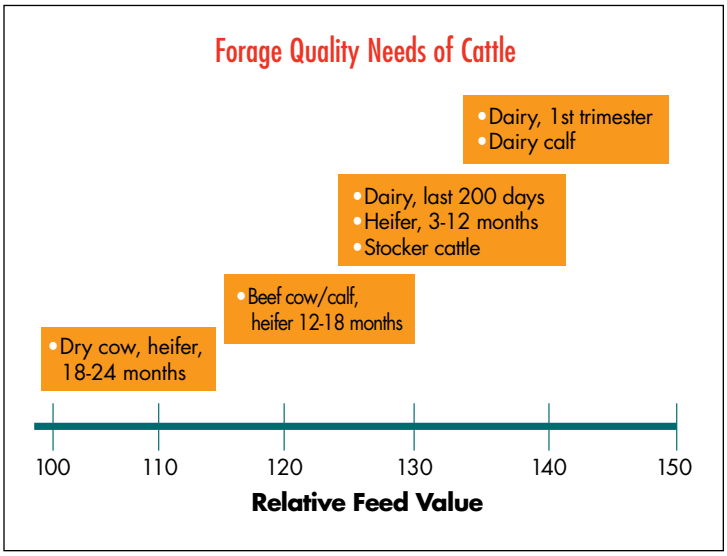
Without a comprehensive fertility plan, yield, stand quality and longevity are all reduced. Before establishing a hay stand, soil should be tested and correctly fertilized at seeding. A stand of grass hay removes about 16 kilograms of nitrogen (N), 5 kilograms of phosphorus (P), 24 kilograms of potassium (K) and two kilograms of sulphur (S) per tonne of hay. Pure alfalfa can remove approximately 22 kilograms of N, four kilograms of P and 20 kilograms of K per tonne of hay produced. Because quality and composition of hay is variable, these numbers are approximates only, but an analysis of the hay can give a more accurate picture of nutrient removal rates. For more information about fertilizer applications for hay, please refer to the *Manitoba Soil Fertility Guide* available through Manitoba Agriculture, Food and Rural Initiatives (MAFRI).

Note that the species or species mix within a hay stand will affect nutritional needs. Pure alfalfa stands require no added nitrogen, but rely heavily on phosphorus and potassium for root production and winter survival. Grass stands need nitrogen to thrive. Mixed stands can require more of a balance between the two. Frequent soil sampling is an accurate method of determining fertilizer needs of a hay stand throughout its lifespan.

Cutting Times

Deciding on the best time to cut hay involves considering factors such as weather, the species or species mix, the intended use and the maturity of the stand.

Not every farmer needs hay with a final RFV of 140 to 150. Hay intended for dry cows or heifers does not need to be of the highest quality to meet the nutritional needs of these animals. Aiming for a higher than needed RFV provides some built-in insurance should weather conditions turn less than favourable.



With pure alfalfa stands, aiming for a specific RFV at cutting is recommended. RFV is a measure of forage digestibility and potential daily forage dry matter intake. It is used to compare various feed supplies. It's important to note that grass and grass-mix stands have higher fibre content and thus reach 150 RFV more quickly than pure alfalfa stands. To achieve the same final RFV, alfalfa–grass mix stands should be cut on average one week earlier than a pure stand.

If the goal is a product with a RFV of 150, hay should be cut when RFV is approximately 180, because hay loses about five RFV points per day as it dries. It can lose even more if drying time is prolonged or if the hay is down during inclement weather.

Cut Early To Obtain High Quality With Grass			
Cutting Date	**Alfalfa**	**Alfalfa/Brome**	**Alfalfa/Timothy**
Week #1	275	217	230
Week #2	204	162	178
Week #3	164	138	178
Week #4	130	113	121
Week #5	116	105	101

A Predictive Equation for Alfalfa Quality (PEAQ) Measuring Stick.

Using a calendar to determine the cutting time is the least accurate method for achieving a desired quality with the best yield. Because each spring is unique in temperature, precipitation and growing degree days (GDD), the date hay is ready for a first cut can vary as many as three weeks from year to year. It typically takes 300 to 350 GDD to reach RFV of 180 for the first cut. About 350 to 400 GDD yields RFV closer to 160. An RFV of 140 would require 450 to 500 GDD.

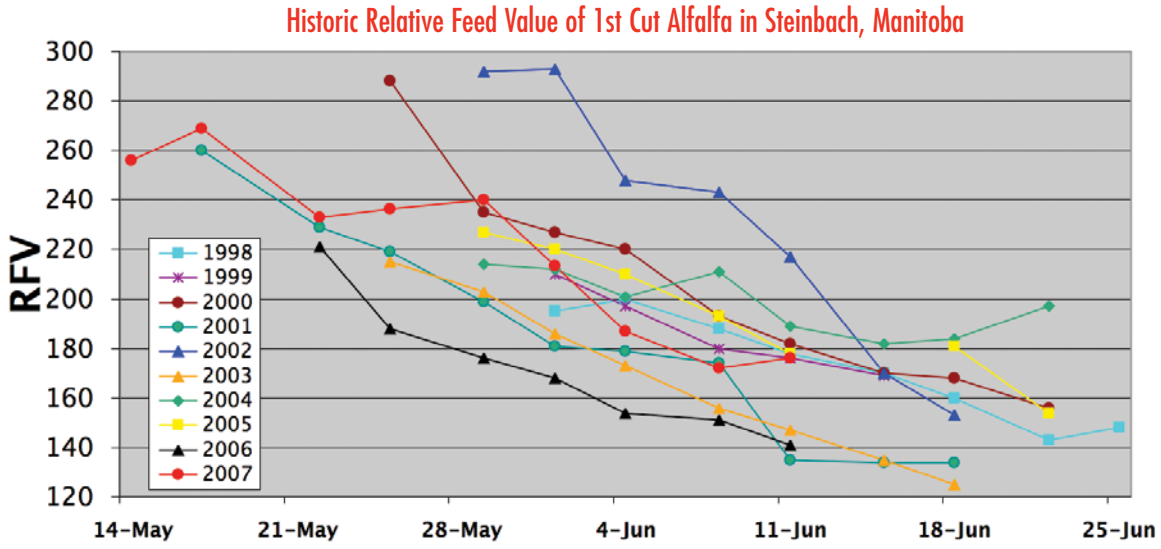


Table 1. The relative feed value on any given calendar date varies widely from year to year.
Data courtesy of South Eastern Crop and Soils Organization (SESCO).

A Predictive Equation for Alfalfa Quality (PEAQ) Measuring Stick.

Monitoring the stage of the crop is a more accurate method of choosing a cutting date. Here again, crop stage is heavily influenced by weather conditions and the same maturity stage at different times of the year can result in a different RFV. Because timing of the first cut can be tricky, a Predictive Equation for Alfalfa Quality (PEAQ) measuring stick, available from MAFRI, is the most accurate means of determining RFV at first cut. For second and subsequent cuts, crop staging and accumulated growing degree days will be a better guide.

Shortening Drying Time

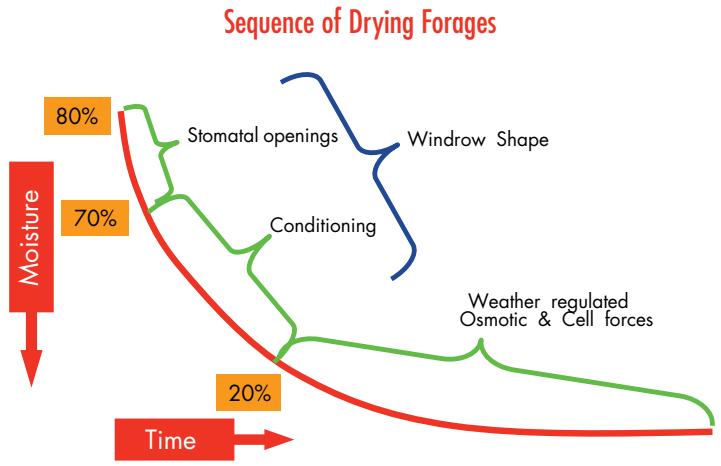
Understanding how cut hay dries and how losses occur during cutting, conditioning, raking and baling is the first step in choosing techniques for maintaining the quality of cut hay.

Rain is most detrimental to hay quality if it occurs in the first day or two after cutting when danger of leaching losses is higher. Two inches of rain in a single event is less detrimental than a half-inch of rain over four days, because wet plants respire longer, compromising quality and dry matter.

Predicting stretches of three or more days without any rain is difficult during the growing season. This is why using every possible management technique to hasten the dry down process is so important.

Cut hay begins to lose quality immediately, regardless of the weather. Why? One main reason for early RFV losses is because a freshly cut plant is still respiring. Plant respiration is the process where starch and sugar is converted and burned as energy. Plant energy, in the form of sugar and starch, is partially what accounts for total digestible nutrients (TDN) in hay. A cut plant continues to respire until its moisture drops below 40 per cent. Fresh cut hay has a moisture level around 80 per cent, meaning that respiration and the loss of starch and sugar continues for some time after cutting.

Shortening the amount of time it takes for cut hay to go from 80 per cent to under 40 per cent moisture directly adds to the bottom line, because dry matter (DM) and TDN losses slow after this point.



Courtesy of D. Undersander – University of Wisconsin.

Hay, be it alfalfa, grass or grass-mix, dries in three stages. Cut hay usually has a moisture rating of around 80 per cent. If dry hay (14 to 16 per cent) is the goal, hay needs to lose roughly 65 per cent more water before being ready to bale.

The first 10 per cent of moisture is lost through the stomates – small openings in the leaves that regulate the plant's temperature through water loss. Stomates open only in light. They close up at night and in the middle of a thick swath. If light can't penetrate the swath, such as is the case with a narrow windrow, it slows down the first stage of drying.

Recent research from Wisconsin has shown the benefits of a wide swath on drying time and thus hay quality. A wide swath is defined as one approximately 72 per cent of the mower cutting width. Unfortunately, as mowers have increased in size, swaths have not, leading to narrow, thick

swaths that inhibit drying. Table 2 illustrates how a swath measuring 65 per cent of the cutting width will dry more quickly (64.5 per cent moisture) than a conditioned hay swath 33 per cent of cutting width (66.5% moisture).

Table 2

Moisture Content six hours after cutting - comparing effects of conditioning and swath width			
	Width of Swath as % of Cutting Width		
Conditioned Hay	100%	65%	33%
No	63.5	64.5	69.5
Yes	57	63	66.5

Based on research by Herzmann (2004), University of Wisconsin

A wide swath increases overall hay quality because of two main factors – faster dry down and lower ash content. Because the crop dries more quickly, the respiration process shuts down sooner, conserving dry matter and TDN. Although it may seem counter-intuitive, a wide swath actually has lower ash content than a thick, narrow swath, because wide swaths sit up on the stubble and narrow swaths sag, causing soil to be picked up with the hay during baling.

Second stage drying takes place at a slower rate and brings the hay down from approximately 70 per cent moisture to approximately 20 per cent. It begins when the stomates have closed but water is still being lost from the leaf and stem surfaces. Any conditioning of the stem that occurred at cutting will speed both the second third drying stages.

The third and last stage of moisture loss involves water held in the stem. Roller or flail-type conditioning has the biggest effect on hay during this third stage of drying. In general, roller conditioners are more effective for alfalfa stands, whereas grass hay, with its finer leaves and stems, can be conditioned effectively with a flail-type conditioner.

With either conditioner type, proper adjustment is crucial. Roll pressure and clearance set too tightly can mean excessive damage to plants. Not enough pressure or too much clearance negates the use of the machine. With either type of conditioning, overdoing it can lead to leaf loss that counteracts the benefits of quickly dried hay.

Drying agents, usually of an alkaline or carbonate formulation, can increase the drying rate of cut hay where climate is dry and warm, but they are not as effective in cooler, higher moisture climates.

Time of Day

The time of cutting affects the nutritional composition of hay. Plant leaves accumulate sugar through photosynthesis during daytime and break down the sugars through respiration. This means plant sugars are lowest in the morning and highest in the evening.

Though hay cut late in the day has higher sugar and energy content, this can be lost when the drying effect of the sun is missed and the cut hay continues respiring through the night. Farmers must pay attention to weather conditions because warm nights can cause severe dry matter losses. Hay at 70 per cent moisture can lose almost two per cent of its dry matter in a 12-hour night at 20 C. At 30 C, dry matter losses can reach three per cent in one night.

Silage producers, who are not so dependent on a fast dry down, can capitalize on the increased sugars by cutting forage in the afternoon.

Swath Manipulation

Manipulating a swath, whether by tedding, raking or inverting can help the drying process, but each action risks loss of dry matter and hay quality. Tedding losses are minimized if the tedding is done before the crop drops below 40 per cent moisture. Tedding to spread out a narrow, deep swath is most effective if done within 24 hours of cutting for maximum benefit and lowest losses. It also creates the most uniformly dried hay. Tedding is not recommended for alfalfa crops because it can cause too much leaf loss, but it can be useful in thick grass hay.

Raking a swath exposes the wet underside to sunlight and air to increase the drying rate. Raking is best done at around 40 per cent moisture, because losses due to leaf shatter become greater as the swath becomes dryer. Early morning or late evening raking can help to minimize these losses. It is important to note that while raking helps to dry down the underside of a swath, the resulting thicker swath may still have wet pockets that dry more slowly because of swath density.

Swath inversion is the gentlest form of swath manipulation and results in the lowest leaf losses of the three types. The increased drying rate of inverted hay is not as significant as with tedding or raking, and the costs associated with inverting hay swaths must be justified by the final value of the product.

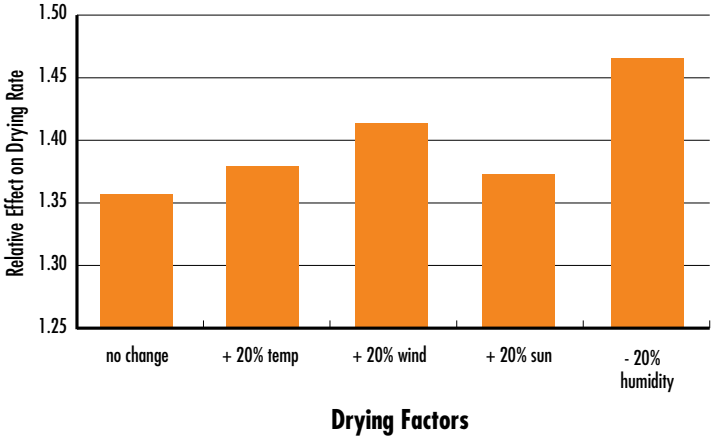
Baling and Storage

Hay at maximum quality comes from uniformly dry fields at optimal moisture levels.

Hay baled too wet is at risk of spoilage by bacterial and fungal growth. It can also be at risk for heating and spontaneous combustion. Hay baled too dry loses its dry matter and total digestible nutrients. If high-moisture hay or baled silage is the goal, MAFRI has a fact sheet titled *Baled Silage Production*.

Weather plays an important role in the rate of dry down. Warm, dry, sunny days speed drying, but farmers also need to pay close attention to other weather conditions when choosing the time to bale hay. Of all climate factors, wind speed and relative humidity have the biggest effects on the drying rate. Relative humidity is the amount of water vapour held in the air. Humid air will not absorb moisture as quickly, increasing the time it takes hay to dry. At a humidity level of 70 per cent or more, alfalfa will only dry to roughly 20 per cent, regardless of the sunshine, resulting in lower quality hay.

Effect of a 20% Change in an Environmental Factor on the Relative Drying Rate of Hay



Because wheel traffic damage affects regrowth yield the most two or more days after cutting, it is important to speed the drying process. The sooner machinery can get on and off the field, the less chance of future yield losses.

Once hay is baled at the proper moisture level, quality can only be maintained, never gained. If delivering hay to premium markets, protecting it from the elements is necessary. Hay stored outside or tarp-covered will be affected by weathering and spoilage. Storing hay on dry ground and under a roof is always preferred to maintain maximum hay quality.

How to Determine Hay Moisture

There are three ways to establish the moisture level of a hay swath. The most accurate method, oven drying, requires taking a random 100-gram sample cut into two-inch pieces and baking it in a microwave oven for a few minutes to dry it. The difference in weight indicates the percentage of moisture the original sample contained. Repeating the procedure with more samples will provide an average moisture level measurement.

A Koster Crop Tester is the second most accurate means of determining hay moisture levels. The concept is similar to oven drying, but uses a heater/fan drying unit, a scale and a screen-bottomed container.

Electronic moisture testers placed in the middle of the swath are the least accurate method of measuring swath moisture and the most prone to error. If using a moisture tester, be sure to place the probe of the meter deep into swath material and apply pressure to ensure contact between probe and the material.

Top Five Tips for Top Quality Hay

1. Choose the species and the varieties of hay crops to fit the farming need, the climate conditions, disease pressures and soil type.
2. Maintain fertility for best yields and increased stand longevity.
3. When estimating relative feed value at first cutting, use a PEAQ measuring stick instead of less accurate calendar dates and crop maturity expectations.
4. Spread hay into wide swaths for the quickest dry down.
5. Remove bales from the field and out of the elements quickly to maintain quality.

For More Information

- Your local Manitoba Agriculture, Food and Rural Initiatives Growing Opportunities Centre.
- Manitoba Agriculture, Food and Rural Initiatives website: **www.manitoba.ca/agriculture.**
- Your local Agriculture and Agri-Food Canada (PFRA) office.
- Manitoba Forage Council website: **www.mbforagecouncil.mb.ca.**

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