Making Hay When the Sun Shines (or When it Doesn't!)

Harvesting hay on the Martens' organic farm in western New York.

by Mary-Howell & Klaas Martens

It all seems so simple — a lush field of mixed grasses and legumes, cut at the just right stage of maturity, dried in the hot summer sun to the right moisture, and baled or wrapped on a bright sunny day, which then provides high-quality, inexpensive feed for your animals all winter. Right?

Unfortunately, this isn't always the case. Sometimes, the rain seems to always come at all the wrong times; the hay won't get dry or else won't grow because of drought. The custom bagger is busy when your hay is ready, your haybine breaks and the parts won't be in for three days, the bag breaks and there are big areas of spoilage, your hay customer (or your cows) complain about low hay quality or mold.

"Everyone" knows that organic dairy cows need to eat high quality forages, year round. Pasture is best during the grazing season, but how can we organic grain farmers and dairy farmers better provide high quality forages throughout the entire year?

CROP SPECIES

When choosing forage species for a new stand, evaluate the crop by:

1. Ecological adaptation — Forage species differ in their response to climate, soil fertility, soil drainage, grazing management and pest tolerance. Species thriving in an established pasture are usually the ones best adapted to the current combination of site and management. If you want to establish different species, you may have to change the management, soil fertility or soil drainage. For hay, management choices may depend on whether the crop is for on-farm use or for sale. When hay is a cash crop in rotation with row crops, it may make sense to keep the hay part of the rotation short. That lets you take better advantage of the nitrogen fixed by the hay and reduces the amount of fertility removed by haying.

2. Growth habit and intended use — Forage species and species mixes are not all equally adapted to both pasture and hay management, especially if you are trying to spread out harvest/use throughout the season. One of the benefits of a species mixture is to even out yield and quality when there are variations in soil conditions across a field. Different species have different adaptations, so the proportions in the mix will adjust over time to local conditions. There is also a symbiotic relationship between root systems of different species. For example, an alfalfa/grass mix will provide nitrogen to the grass, and help protect the alfalfa against winter-kill.

3. Geographical distribution — Geographical regions have favored forage species, generally based on their response to typical weather and day length. Some forages grow better in cool weather, while others do best in warm weather. For example, tall fescue is more tolerant of hot and dry weather than is orchardgrass; timothy is least tolerant of these conditions. Tall fescue is most tolerant of freezing weather in the fall, so it is often the best choice for fall and winter grazing. The amount of spring growth flush varies considerably between different grass species.

4. Stand longevity — This is the result of a species' tolerance to accumulated disease and insect pressure, and its ability to move into openings in the stand. Some forage species increase plant size by tillering (Kentucky bluegrass, orchardgrass, tall fescue, timothy) or by growing larger crowns (alfalfa, red clover, birdsfoot trefoil). Other species invade open areas by moving growing points underground (Kentucky bluegrass, tall fescue, smooth bromegrass, reed canarygrass).

5. Stand diversity — Hay fields and pastures benefit from increased diversity. Seeding only a single forage species will often result in other unintentional plants invading more quickly. While many of these native "weeds" may indeed be highly nutritious and palatable, well-adapted initial mixes will slow weed encroachment if the stand is managed properly. A few useful forage legumes include red and white clovers, alfalfa, birdsfoot trefoil and lespedeza. Useful grasses include timothy, fescues, reed canary grass, annual and perennial ryegrass, orchardgrass and bromegrass.

6. Think outside the box — Unconventional hay species can be profitable because sometimes they can extend season or geographical area. Such unconventional species can include oats, field peas, Austrian winter peas, triticale, barley, rye, millet, sorghum, buckwheat, sorghum/sudangrass and even soybeans! These crops can produce rapid emergency forage in the spring, and can serve as effective nurse crops for getting a seeding off to a good start without sacrificing yield. They can also be used as short-term crops to reduce weed pressure and improve soil condition. Many of these species can make good-quality baleage, but generally they do not dry quickly enough to be suitable for dry hay.

YIELD & QUALITY

Forage yield is largely determined by:

• Soil type (deep soils are more productive than shallow soils),

• Soil fertility (high-fertility soils are more productive than low-fertility ones),

• Soil drainage,

• Forage species (deep-rooted species are more productive than shallow-rooted species),

• Nitrogen availability (legume in mixture or applied N),

• Grazing and haying management.

Forage quality is best determined by:

• Plant growth stage at harvest (as plants mature, quality goes down),

• Legume content (at a given growth stage, legumes are higher quality than grasses),

• Soil fertility (fertile, well-balanced soils produce nutrient-rich, well-balanced hay),

• Grazing intensity or hay harvest damage,

• Plant species (some forage species have anti-quality components).

Final hay quality can be no higher than the forage crop you begin with, which is, of course, determined by the growing and harvesting conditions. The single most important factor determining quality is the stage of plant maturity at harvest. As a plant matures, and in response to lengthening daylight, the forage increases in fiber, reducing the crude protein and digestible dry matter. Grasses grown in July and August will have a higher fiber content and a lower quality than the same forage crop harvested earlier. Medium red clover and birdsfoot trefoil retain good quality much later into the summer than alfalfa.

Removing hay, year after year, without maintaining soil fertility can result in poor stands and lower-nutrient forage. Most farmers do not fertilize their forage fields sufficiently, especially with trace minerals. On farms feeding their own forage, it is particularly important that soil mineral nutrient levels are maintained at optimal levels. Sulfur, selenium, cobalt, copper, zinc, manganese, boron and zinc are critical in cattle enzyme systems. Since it is more efficient and effective to supply these minerals through feed than through supplements, the soil should be monitored with testing, and amendments should be added to the soil when necessary. Mineral imbalances can also profoundly affect hay quality. Extremely high potassium will cause hay to mature early and be bitter, and can cause severe health problems in cows. Extremely high or low soil magnesium can cause magnesium deficiency in the forage, inducing grass tetany in the spring.

HARVEST

Knowing when to cut and when to bale the hay takes experience, skill and luck. There are many "little things" that a skilled farmer can do to put up better quality hay. These include keeping the knives sharp to make clean cuts, having the haybine adjusted correctly so it doesn't make wads in the windrow, not driving over windrows, and using a tedder to fluff up the windrows if they get rained on. Hay cut in the afternoon will have higher sugar content. Stacking a hay mow correctly will make a big difference in retaining quality. Placing the cut edge up will help let water leave the bales, as will alternating layers of damp hay with a cured, dried material such as straw.

Fans and drying floors in hay barns can help preserve quality, especially in wet years. As with grain, hay will reach an equilibrium moisture with the ambient air. Using drying floors during extended wet periods may not dry the hay sufficiently, but adding a small portable heater in front of the air-intake fan under a drying floor can raise the air temperature slightly and lower the humidity enough to dry the hay economically.

Most hay is sold heavily on visual appraisal — yet the "experts" tell us that color is probably the worst possible indicator of quality. A sweet, fresh smell and soft texture are probably better indicators of palatability. When taking a forage sample for testing, try to drill core samples out of a representative number of bales. Many dairy farmers buy hay on protein level, which may be misleading since the lab "protein" tests actually test for *nitrogen levels,* and not all nitrogen present may be in the form of protein. Hays with a low NDF score tend to be softer, more palatable, and will make more milk because of higher energy content.

INOCULANTS/PRESERVATIVES

Conventional farmers feel that hay preservatives and inoculants are very important to maintain quality and prevent spoilage, especially when harvest conditions are less than optimal or when the forage is not at the optimal moisture content. However, many commercially available inoculants and preservatives are not permitted under organic stan-

dards — *check with your certifier before use!* Inoculants should be suited to the kind of forage being harvested — different species and methods of storage require different inoculants. In a pinch, plain salt or mineral salt, sprinkled on each layer of bales when filling a mow, makes a fine economical preservative when the hay is slightly damp.

WRAPPED OR UNWRAPPED?

Many of us remember long, hot summer days of childhood, baling, unloading, and stacking small square bales of hay, the rattling of the elevator and the thunk of bales, scrambling around the wagons, grabbing a bale with thistle thorns or broken string, and learning the *right* way to stack a mow. It was hot and exhausting, but very productive work with lots of people working together, and it resulted in barns full of sweet-smelling bales, stacked to the roof. With the coming of big round balers and plastic, those days are largely over for most farmers.

Certainly, improvements in technology and equipment has allowed us to bale at higher moistures, harvest earlier for higher quality and more quickly with less labor, but plastic has also brought new problems and challenges.

Research at the University of West Virginia shows that plastic-wrapped haylage will have slightly higher forage quality over dry hay harvested from the same field on the same day. This is due to less field loss during harvesting the wetter haylage and less heat loss during fermentation when wrapped properly, which results in better nutrient availability. On average, plastic wrap results in hay about 1 point higher in crude protein and 2 points in total digestible nutrients (TDN).

Some university research also shows significant hay quality differences when different thicknesses of plastic are used, either by using multiple layers or thicker plastic. Many farmers harvesting forage for sale will wrap with extra layers of plastic to make a more durable package that is resistant to tearing. Setting bales on the ends where the plastic is thickest and making sure the ground is clear of sharp objects will decrease damage and spoilage. Wrapped hay bales should be handled as little as possible, and then only with a grabber, not a spear.

University of Kansas researchers report that often farmers don't realize how large their hay losses are. For unwrapped round bales stored outside on the ground for one season, 25 percent loss of dry matter is common. Coarse-stemmed forages are generally more vulnerable to loss of quality than fine-stemmed hay. Regardless of hay type, the most spoilage occurs where bales come in contact with the ground and wick moisture from the soil. Any exposed surfaces of bales stored outside are subject to weathering and loss of quality. Weathering may be limited to the outer 4 to 8 inches of an individual bale, but that affects a surprising amount of hay. According to University of Minnesota data, a layer 4 inches deep over the entire surface (including the ends) of a bale measuring 5 feet in diameter represents nearly one-fourth of the bale's total volume. If the bale is weathered to a depth of 8 inches, nearly half of its volume is affected.

To save space and for ease of transport, round bales are frequently stored outside, stacked in pyramid fashion with two parallel rows, with bales butted end-to-end, topped with a single row. However, this is one of the worst ways to store bales for long periods unless the whole stack is covered with a tarp. In stacks left uncovered, moisture from rain or snow is held wherever the rounded sides of the upper row's bales come in contact with bales in the two rows below.

Most agree that there is usually no good way to dispose of the plastic after the forage is used. The better quality plastic wrap may consist of layers of different plastic types, making it hard to recycle. Used plastic is often dirty and torn, and many disposal facilities really

Learn More

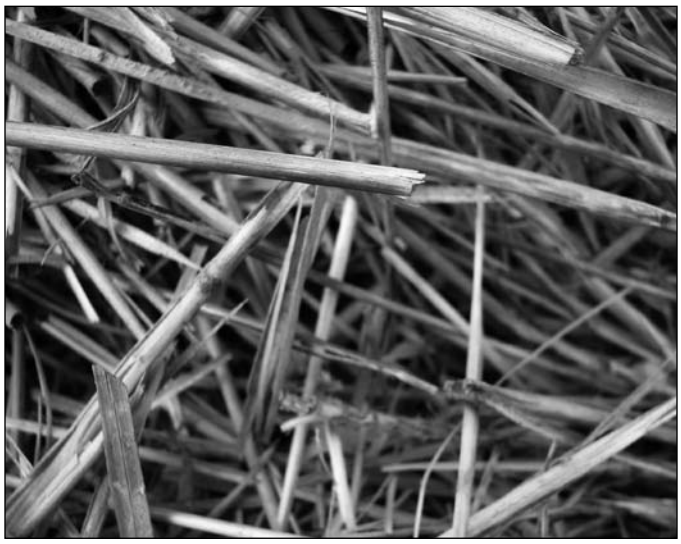
The Natural Resource, Agriculture, and Engineering Service (NRAES), part of Cornell Cooperative Extension, has recently produced three very useful books on pasture-based livestock production. They include many useful charts, plenty of good detail, and information about sustainable management:

Forage Production for Pasture-Based Livestock Production (141 pages, $25)

Forage Utilization for Pasture-Based Livestock Production (185 pages, $27)

Managing and Marketing for Pasture-Based Livestock Production (116 pages, $21)

For more information, contact NRAES, Cooperative Extension, P.O. Box 4557, Ithaca, New York 14852-4557, phone 607-255-7654, e-mail *nraes@cornell.edu,* website *www.nraes.org.*



don't want it. Farmers must locate designated landfills that accept used agricultural plastic. Burning plastic releases dangerous dioxin gases and is generally discouraged.

SPOILAGE

Plastic wrapping does help maintain hay quality by keeping moisture out, but it can also keep excess moisture *in.* Individual wraps may actually promote spoilage when hay is baled at a high moisture content. Molds can grow on forages or grains at any point in the crop production cycle if conditions are right. Mold prefers moisture levels greater than 12 percent, temperatures above 23 F, at least 0.5 percent oxygen, and moderate pH.

Ensiled forage nearly always meets those temperature and moisture requirements, so *eliminating oxygen* is the key to restricting mold growth in silage. Wet weather during harvest and harvest following frost (forage is drier and harder to pack) can increase mold. Tears and punctures to plastic wrap can result in pockets of spoilage. As mold grows, forage nutrients are converted to carbon dioxide and fungal metabolites. Human exposure to hay molds, even if not actually toxic, can cause lung irritation, allergic reactions and even Farmer's Lung.

Conditions that encourage mold growth in forage also increase the risk of mycotoxin problems. The presence of visible mold does not necessarily mean there are mycotoxins present, but they can be present, and even when mold is *not* visible. Many common forage spoilage molds do not produce mycotoxins, but some do, and mold color is not a reliable indicator of toxins. It is important to remember that while grain most often gets the "bad rap" for mycotoxins on farms, forages are equally likely to be the source when symptoms are seen.

Poor weight gain, reproductive problems, reduced feed intake, lowered milk production and suppression of the immune system are common early symptoms of mycotoxin presence, but these symptoms can also reflect other totally unrelated causes. In forages, careful sampling is especially important to detect mold problems, because small pockets of mold can be enough to cause problems even when the majority of the forage is fine. In addition to the fungal species that produce mycotoxins on grains, microbes causing botulism and listeriosis can also live in improperly fermented forage.

COSTS & VALUE

Several factors are important when determining the price of forage. These include quality and form of product, cost of alternative feed products, cost of transportation to the point of use, and availability and demand.

Quality is best determined by taking a representative sample and obtaining a forage analysis. Consider not only protein and moisture, but also energy content (fiber level), mineral levels, and especially the nitrogen-to-sulfur ratio, which is an indication of the quality of the protein. Relative levels of calcium, potassium and magnesium are also important. All these readings will help estimate how healthy animals will be eating this hay and whether it will be palatable.

The dry matter content is an important consideration, especially when purchasing higher-moisture forage products. Silage and baleage generally contain 50-75 percent moisture, so it is important to convert the price to dry matter or hay equivalent basis when evaluating price. Because moisture also affects fermentation, moisture contents outside the normal range may produce a feed that is lower in nutrient quality and palatability.

One way to determine hay price is to convert the quoted price to a dry matter equivalent and then convert the dry matter price to an as-fed price. For example, if hay at 90 percent dry matter costs $119 per ton, then it costs $132.22 per ton of dry matter. With dry matter costing $132.22 per ton, then the equivalent quality baleage at 60 percent moisture is worth about $53 per ton.

If dry hay is selling for $119 per ton at 90 percent dry matter, then a 1,200-pound bale of similar quality baleage with 60 percent moisture (or 40 percent dry matter) should be $32 per bale ($53 per ton) while a 70 percent moisture 800-pound bale is worth $16. If you pay the same amount for both bales, that would bring the 800-pound wetter bale to a forage dry matter cost of $267 per ton!

Keep in mind the cost of transportation, since forages are bulky materials, hard to load and requiring a specialized truck able to take a longer and higher load than other commodities. With fuel prices being high, long-distance transportation can add significantly to the final cost of the forage. For this reason and others, working with nearby neighbors to supply forage needs is a good idea.

Mary-Howell and Klaas Martens, and their three children, farm 1,400 acres of organic grains in the Finger Lakes area of western New York. They also own and operate Lakeview Organic Grain, an organic feed and seed business in Penn Yan, New York. They can be contacted at *kandmhfarm@sprintmail.com.*

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