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Education & Applied Research

The Manager

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The **Manager**

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Feed bunk management: Ensuring enough feed for all cows

By Betsy Hicks and Joe Lawrence

FOCUS: FORAGES & FEEDING

INSIDE

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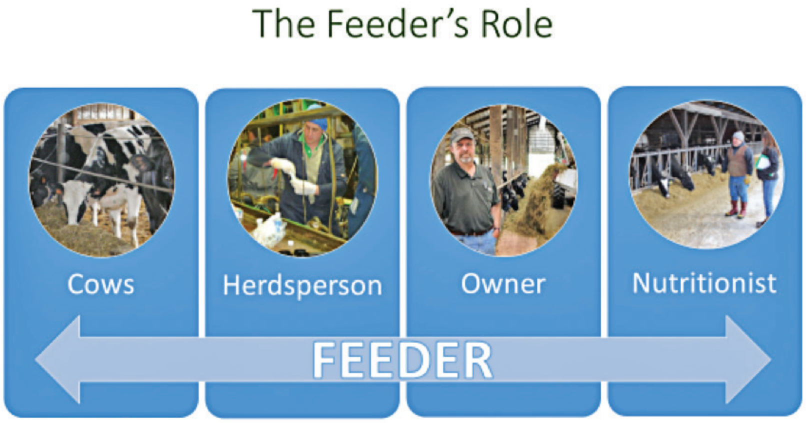
Even when producers put up the right quality of feed for a class of cows, ensuring that all cows have enough feed is a goal that has a few components to consider. Too much competition from other cows, not enough feed delivered, and a lack of communication between the farm team can all be threats to each cow consuming her daily allotment. When the farm team works together to ensure cows have adequate feed and their management allows for normal daily cow needs of rest, rumination, drinking, socialization, and eating, productivity is bound to increase.

FEEDBUNK COMPETITION

From a cow's perspective, competition from other cows can seriously alter her feeding strategy. Dominant cows spend more total time eating than cows of lower social rank (Olofsson, 1999). As competition increases, cows will on average eat for less time, eat more quickly, and show greater aggression when feeding. When feed is limited, cows that are dominant get to eat, and will eat 14 to 23 percent more than submissive cows. In turn, dry matter intake of submissive cows then suffers. Overcrowding can exacerbate differences in groups and also alter feed intake strategy. In overcrowded situations, Batchelder (2000) showed that after exiting a parlor, cows prefer to lay down versus competing at the feedbunk. They will spend more time standing in an alley waiting to lay down than they will eat. Cows in this situation also ruminate 5 to 25 percent less than cows that aren't overcrowded.

Grouping strategies can be a way to mitigate some of the risks of social competition and can can play a huge role in feeding behavior that in turn impacts cow productivity, animal well-being, herd health, and ultimately farm profitability. When grouped by parity, Grant and Albright in a 2001 Journal of Dairy Science article, showed that first-lactation cows' eating time increased 11.4 percent, meals per day increased 8.5 percent, and dry matter intake increased 11.8 percent. First-lactation cows benefit from being grouped separately for a few reasons: this class of animals is still growing, they produce milk in a different lactation curve than mature cows, and they have different nutritional and social needs.

Excessive time away from the pen can also compromise a cow's needs. A cow's ideal schedule includes 12 to 14 hours resting, 3 to 5 hours eating, 7 to 10 hours ruminating, 30 minutes drinking, 2 to 3 hours of social interaction, and 2.5 to 3.5 hours outside of the pen. When cows are away from the pen for longer than this, time for normal activities is reduced. Miner Institute has a Cow Time Budget Evaluator (whminer.org › pdfs › Time Budget Evaluator Miner Institute v3.0.xls) that identifies the impacts of reduced resting activity, based on time



and stocking density inputs from a pen of cows. The evaluator gives results for both average cows and elite cows. In general, elite cows show a higher loss of production and body weight when time budgets are negatively affected. Competition, overcrowding, and time away from pen all affect how much dry matter a cow will consume, and management of these areas can help to ensure cows have access to feed when they need it.

FEED AVAILABILITY

A second area of consideration is to ensure adequate feed is delivered to the pen. In general, dry matter changes, targeted refusals, and feeding for extra cows or extra feed can all impact how much feed is available when a cow wants to eat. Dry matter adjustment strategy should be discussed together by management, the nutritionist and feeders. The frequency of adjusting dry matter by forage, how dry matter is adjusted during a weather event, and feeding by volume versus weight in the event of a scale malfunction, should all be planned out and agreed upon. In addition to dry matter adjustments, daily refusals should also be monitored. Historically, farms have aimed for 5 percent refusals, but some farms are successfully managing 2 to 3 percent. Whatever the goal is, farms in general should avoid slick bunks and have feed available for at least 23 hours per day. Feed should be delivered at the same time every day, and feed wasted should be minimized. To successfully achieve this goal, farms should monitor cow behavior at the bunk, TMR consistency, and feed availability/feed push-ups. Feeding for higher refusals can be a strategy so that dry matter intake is not restricted, and sometimes cows may eat more feed and gain intake. Conversely, if intakes are declining and/or refusal rates are high, a conversation should be had to determine the cause. The manager, nutritionist, and feeder should all be on the same page about what adjustments should be made and when a diet reformulation should take place.

COMMUNICATION

Lastly, communication with others is key. The feeder's role is intertwined in so many factors that affect how they do their job, making it one of the most important roles on farm. Along

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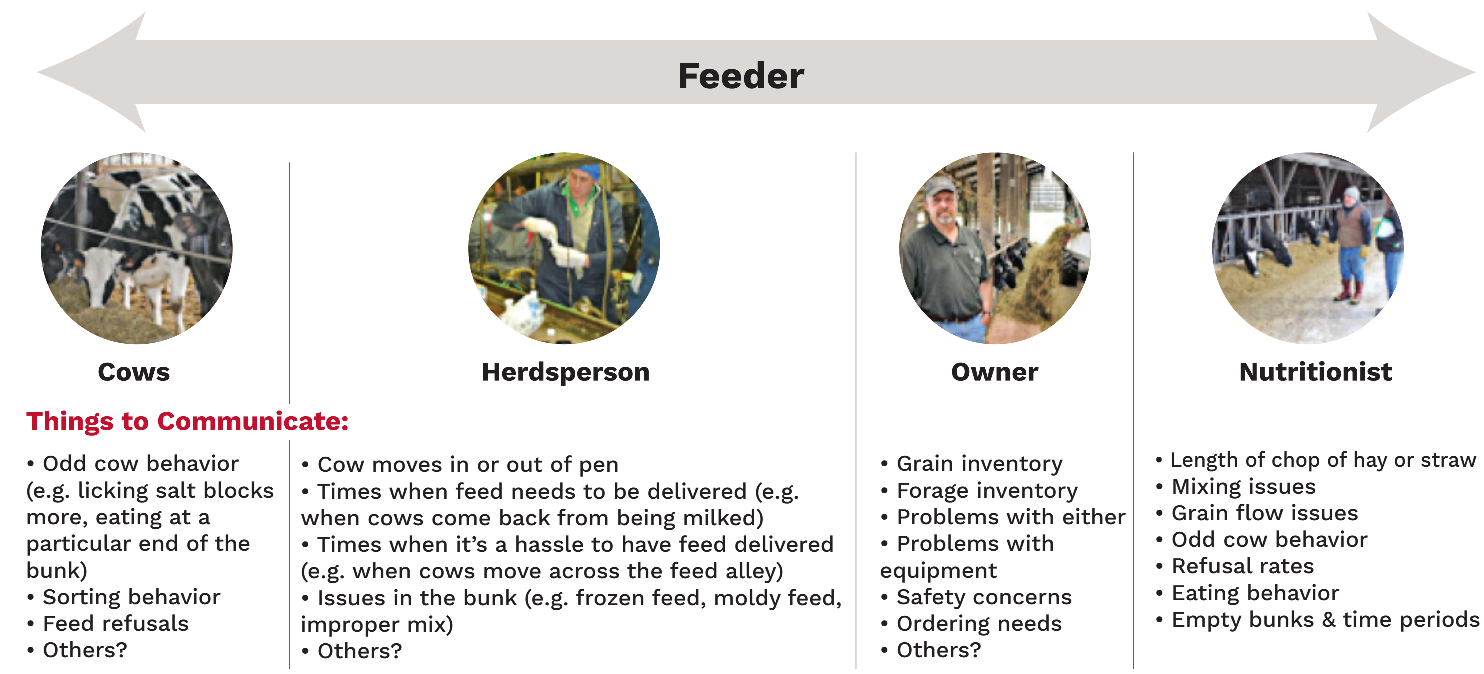
FIGURE 1
The feeder's role



Feed bunk management: Ensuring enough feed for all cows cont'd from page 3

TABLE 1

Feeder to herdsperson	Observations of the herd can include odd cow behavior (e.g. licking salt blocks more, eating at a particular end of the bunk), sorting behavior, and amount of feed refusals
Owner and feeder	Communicate such things as grain and forage inventory and problems with equipment and safety concerns, as well as ordering needs

with the feeder, the owner/manager, herdsperson, nutritionist, and the cows themselves should all communicate regularly. The feeder has a look at the cows at hours when the rest of the farm staff may not, and as such, they often see many things. Observations of the herd can include odd cow behavior (e.g. licking salt blocks more, eating at a particular end of the bunk), sorting behavior, and amount of feed refusals. These observations can be communicated to the herdsperson. The herdsperson can communicate cow moves in or out of a pen, times when feed needs to be delivered (e.g. when cows come back from being milked), and times when it's a hassle to have feed delivered (e.g. when cows have to move across the feed alley). The feeder can communicate to the herdsperson if there were issues at the bunk or with the mix (e.g. frozen feed or moldy feed, or an improper mix). The owner and the feeder should communicate things such as grain and forage inventory and problems with either, problems with equipment and safety concerns, as well as ordering needs. The feeder and the nutritionist should communicate desired length of chop of hay or straw for a mix, any mixing issues or grain flow issues, as well as odd cow behavior, eating behavior, and refusal rates or empty bunks and time periods. How well all parties work together definitely effects how effectively the farm performs and its efficiency and profitability. ∎

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Achieving and measuring silage density

By Joe Lawrence and Betsy Hicks

The topic of silage density in storage has garnered a great deal of focus in the last few decades, but it remains a key opportunity area on many farms for its role in 1) minimizing storage losses and feed quality deterioration, 2) optimizing the footprint of stored feed and resources committed to feed storage, and 3) allowing for accurate inventory calculations and management.

TABLE 1

Measure density on an as-fed (wet) instead of a dry matter basis

Dry Matter Density	Dry Matter Content	As-Fed Density
15	30	50.0
15	35	42.9
15	40	37.5

TABLE 2

Storage capacity at differing silage densities

Bunk Dimensions	Cubic Feed of Storage Capacity	Dry Matter Density	Storage Capacity (tons of dry matter)
40 feet wide × 200 feet long × 10 feet height	80,000 cubic feet	14	560
		16	640
		18	720

MINIMIZE STORAGE LOSS AND FEED QUALITY DETERIORATION

Work conducted by Kurt Ruppel in the 1990s established the correlation between silage density and dry matter losses and remains the basis for almost every discussion around silage density. This also established the idea that a dry matter density of 14 to 16 pounds (dry matter) per cubic foot was the minimum needed to keep dry matter losses at acceptable levels. The concept that this density is the minimum acceptable density, and not the target density, is key. There is a strong argument that a density of 18 pounds per cubic foot is a desirable and achievable goal.

More recently researchers at USDA-ARS and University of Wisconsin introduced the concept of measuring density on an as-fed (wet) basis rather than on a dry matter basis. This takes into account the fact that using a dry matter density ignores the role of moisture content. An example of this is shown in **Table 1**.

In this example we see that silages with different dry matter contents have the same dry matter density but much different as-fed densities, effectively giving a false sense of an acceptable density for a drier feed, when in reality this forage is not packed as well as the wetter feed. Many now reference 45 pounds (as-fed) per cubic foot as the minimum density to work towards, with the argument that a number closer to 50 is both desirable and achievable.

OPTIMIZE THE FOOTPRINT OF STORED FEED

The footprint of forage storage on a farm is often a significant investment of resources. This includes the land allotted for storage structures, financial investment, and environmental considerations related to collecting and managing water that collects in the storage area.

With a known volume of storage, the storage capacity at differing silage densities can be calculated. **Table 2** provides an example of this. In this case dry matter density is used to demonstrate the storage capacity in tons of dry matter.

If a farm is considering the addition of new storage structures, taking a hard look at silage density and the ability to significantly increase storage capacity of existing structures, may solve a farm's storage needs. In one recent scenario a dairy with approximately 800 milking cows was able to increase forage inventory from 9.5 to 14 months without building any new storage. An added benefit that is not taken into consideration in this example is that the increased density will also reduce shrink, thereby further increasing available inventory.

ACCURATE INVENTORY CALCULATIONS AND MANAGEMENT

In the accompanying article "Feed bunk management – Ensuring enough feed for all cows" (on page 2) a key to adequate and consistent forage for the herd is an accurate understanding of forage inventory. Accurate calculations of forage inventory require accurate storage volume measurements and an accurate understanding of overall density. Density can be – by far – the most challenging number to determine. Many efforts from spreadsheet-based models to physical coring of the silage have been used.

Coring the face of a pile is strongly discouraged for safety reasons and only provides a snapshot of the density for the specific area where the sample was taken. While this may be better than a wild guess, if the density in that particular spot, or even multiple spots, was not representative of the entire mass of forage then it could lead to significant errors when calculating available inventory. Some efforts have been made to core from the top of a pile which can address safety concerns, though caution is still needed, but it presents the same challenges in obtaining a value that is representative of the entire forage mass.

The University of Wisconsin has a spreadsheet to calculate average silage density (fyi.extension.wisc.edu/forage/harvest/#inventory) in a silo that, when accurate data is used to populate the spreadsheet, can provide a very accurate value for average density. Like any calculator, the results are only as accurate as the data entered, so taking time to record the needed inputs during silo filling is key. The inputs include silo height, silage delivery rate, silage dry matter, layer thickness, packing tractor weight, and the percent of time each tractor is actually packing. An important consideration is that while no tractor is packing 100 percent of the time it is reasonable to use 90 to 95 percent for most dedicated packing tractors. Any tractor that has the primary job of pushing is often only on the pile packing 50 to 60 percent of the time. ▮

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PRO-DAIRY Education & Applied Research

Factors limiting density

- Delivery rate is too high for packing weight
- Dry forage that is cut long may not pack as well
- Thick layers
- Poor base
- Too little space
  - ◇ Unsafe height
  - ◇ Slope of ramp is too steep
- Unsafe infrastructure

Considerations for effective packing

- Tires – Air pressure
- Minimize layer thickness
- Added weight
  - ◇ Concrete block
  - ◇ Tire ballast
  - ◇ Fuel tank
  - ◇ Rent a tractor
- Reduce slope of ramp
- Reduce fill rate
  - ◇ Fill multiple bunks at one time

PRO-DAIRY offers a number of highly rated online courses taught by leaders in the field. In Fall 2019 the forage management course featured topics ranging from crop selection and harvest management to storage management and forage feedout. For more information about PRO-DAIRY online courses, including current offerings, visit prodairy.cals.cornell.edu/online-courses.

Strategies to ensure quality forage for the entire dairy herd

By Betsy Hicks and Joe Lawrence

While weather is a constant challenge to maintaining forage supply, producers can control other threats to having enough feed. Mismatched storage capacity and lack of planning or design, incorrect estimates of feed quantity, inaccurate estimates of feed quality, and spoilage are four major areas where producers risk ensuring enough forage is available to feed the herd. Both harvest quality and management of feed in the silo have profound effects on silage quality at feeding (Limin Kung, University of Delaware). By harvesting feed at the appropriate quality and managing it carefully in the bunk, the risks of running out of feed are minimized.

DETERMINE FORAGE NEEDS

Producers can employ a few strategies to mitigate the risk of running out of feed. First, planning ahead for forage needs is a step that should be taken before most others. When forage needs are calculated, it should be noted that every group of animals on the dairy has a different nutritional requirement. To optimize forages grown, feeds should match the needs of each animal group, and the total tons needed should be calculated for each. Groups to calculate needs for include lactating cows, dry cows, youngstock by stage of growth, roughage for lactating cows, and bedding. The Dairy Herd Forage Needs Worksheet (Dairy Nutrition Fact Sheet, August 2012) can be referenced to help build forage needs for a dairy. When making calculations, guidelines for forage dry matter intake as a percent of body weight are presented in **Table 1**. Feeding losses should also be factored into the equation, increasing the total amount of forage needed. The number calculated, however, is only a measure of how much feed each animal group will need. It does not account for any storage losses prior to feeding, which should be evaluated by storage, and added to total forage needs.

MANAGE FORAGE STORAGE

A second strategy to mitigate risk is to evaluate the existing storage system. Of a farm's storage options, the capacity of each at different forage densities should be calculated. The system should also be evaluated for the flexibility to store forages of differing quality, what the best use of each option is, and whether storage losses the farm is currently experiencing are acceptable. When considering modifications or additions, a farm should always consider if losses can be minimized by changes in management or if additional options are needed. If the current setup leads to inaccessible feeds and more options are needed, the farm should also evaluate options for what may work best in the short-term versus what the best long-term strategy might be. Each harvest season the farm should have a storage plan in place with planned storage mapped out. Contingency plans for a surplus of either better or poorer quality feed should be thought out ahead of time to avoid problems of burying one feed behind another. Incorporating more than one storage option into your system will ensure greater flexibility and allow feeding the right quality of feed to the right class of animal. For more information see "Strategic forage storage planning" (Lawrence & Kuck, 2018) at prodairy.cals.cornell.edu.

Once feed is in the bunk, a farm should strive to understand the quantity of feed that is stored, as well as monitor and control inventory. To evaluate quantity of feed, two pieces of information are needed: volume and density (see accompanying article on page 4 for information on measuring density). Volume is traditionally measured by obtaining the length, width, and height of the forage pile. Some farms are now employing drone technology to help with inventory tracking. Drone flights can give nearly exact measurements of a bunk's volume and computerized models of the silo area are formed. These can help with inventory as well as forecasting shrink, but the return on investment is the greatest on 800-cow dairies or larger.

Miner Institute has an online calculator to help estimate forage inventory (whminer.com/mineroutreach.html) for a variety of silos. It also can be used to estimate days of silage left in inventory. Inventory control refers to how long a forage will be available at current feedout rates and allows for rate adjustments to either use up a feed faster or make a feed last longer. The University of Wisconsin Team Forage has a plethora of online tools to help establish and manage inventory (fyi.extension.wisc.edu/forage/making-a-feed-inventory/). Feed inventories should be established: 1) after harvest is completed in the fall, and projection rates are calculated to see if feed rates should be adjusted 2)

TABLE 1
Forage dry matter intake recommendations

Class of Animal	Forage DM Intake, % of BW
Lactating	1.5 – 2.0%
Dry Cows	1.2 – 1.7%
Heifers	1.0 – 2.0%

mid-winter to make corrections and adjust stored forage densities to improve accuracy of inventory and 3) after first cutting to give an early warning of inadequate supplies and a chance to make adjustment to feed rates.

EVALUATE FORAGE QUALITY

Understanding stored forage quality is key to being able to provide the right quality of feed to the correct class of animal on the dairy. If the dairy has done the due diligence of planning storage by cutting and/or quality, then this strategy is made easier. In any case, silage piles should be sampled following Hoffman, Shaver and Dyk's recommendations from the University of Wisconsin: 1) using a loader bucket or defacer, scrape across the face to create a pile on the bunker floor (safely away from the bunk face), 2) collect 5 to 8 hand grab samples, combine in a 5-gallon pail and mix, 3) take a representative sample (1 to 2 lbs) and place in a clean plastic bag. Steps 2 and 3 should be repeated for a second composite sample, and both bags should be labeled and stored in a cold place until shipping. Frequency of sampling is also outlined by Hoffman, Shaver and Dyk: with a small herd of 50 cows, frequency of sampling need only happen once a month, or when there is a suspected change in forage quality. A herd of 800 cows, however, would benefit from sampling every five days. New sample analysis should be used differently, depending on the situation of the sample. If there is a logical reason for the change, such as a new cutting or different year feed, the new sample's data should be used. However, if there is a small change in a primary nutrient, then the change in the nutrient composition should be averaged with the old nutrient composition data, and the mean value should be used when reformulating a ration.

PREVENT SPOILAGE

Finally, spoilage prevention and minimization are keys to ensure there is enough feed for the herd. Goals of a good silage manager are a tight, straight face; no excess feed pulled down; feed cover removed daily or as needed; and seams and edges weighed down. As a result, oxygen infiltration, re-fermentation, and temperature increase are all minimized, ensuring minimal loss of dry matter. Spoilage losses are inevitable but good management ensures these losses are small. The University of Wisconsin Team Forage estimates over $13,795 in losses per year when comparing poor management to good management per 100 cows with replacements.

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Corn silage forage quality: Hybrid genetics versus growing conditions

By Joe Lawrence and Allison Kerwin

Over the past four years a number of groups in the Northeast have initiated efforts to increase collaboration and enhance our understanding of corn silage hybrid forage quality through existing Corn Silage Hybrid Evaluation programs. This collaboration includes Cornell University, Penn State University, Professional Dairy Managers of Pennsylvania, University of Vermont, Western New York Crop Management Association, and the University of Maine.

The group has focused their efforts in three main areas: 1) aligning trial methods and report formatting to allow

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Corn silage forage quality cont'd from page 7

better cross-referencing of trial data from the various programs, 2) focusing on emerging forage quality parameters to improve the metrics utilized for hybrid comparisons, and 3) utilizing data from across the region to better understand the influence of growing conditions on hybrid performance.

This collaboration allowed us to identify a small subset of hybrids entered into multiple programs over the last two years. Differences in performance between the same genetics in different growing environments and different genetics in the same growing environment of this subset were compared.

FIGURE 1

Shift in starch content between growing seasons

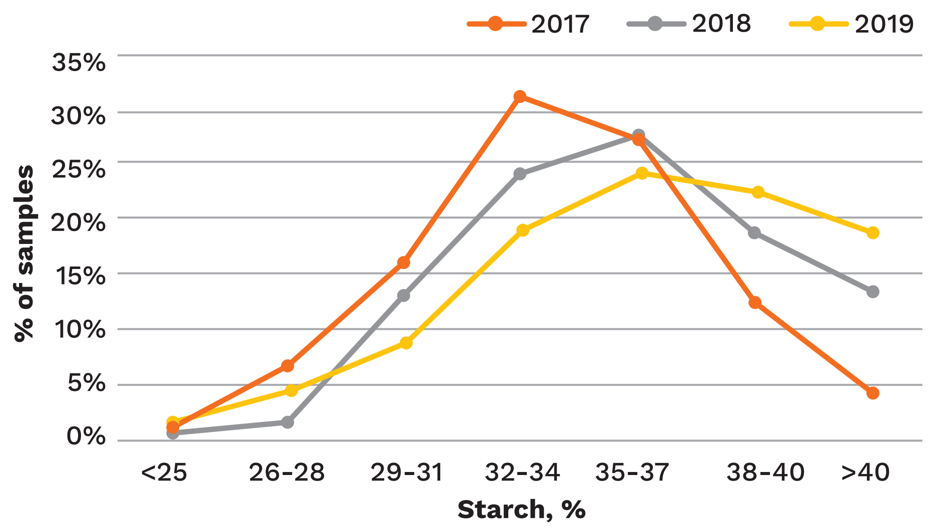
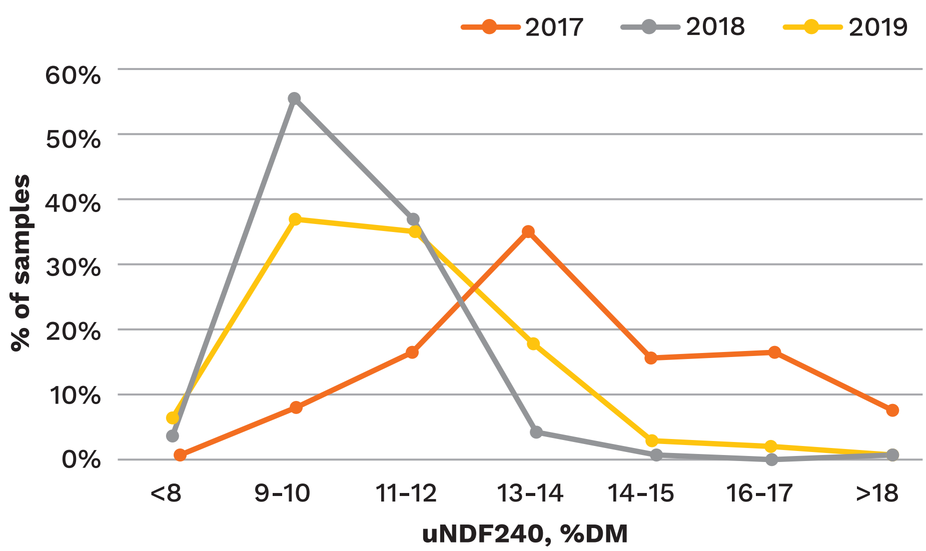


FIGURE 2

Shift in undigested fiber content between growing seasons



GROWING CONDITIONS IMPACT CORN FORAGE QUALITY

It has long been understood that weather conditions have an influence on key corn silage forage quality parameters. Generally, dry to moderate moisture conditions, and moderate heat prior to tasseling, is considered best to balance overall crop performance and fiber digestibility (Van Soest, 1996; Van Soest and Hall 1998; and Mertens, 2002).

In general, fiber digestibility can be quite high in drought-stressed corn, but obviously in this situation overall crop performance is likely to suffer. Excess moisture can also be detrimental to crop performance, however, even if overall performance is not hindered by the excess moisture we expect fiber digestibility to be lower.

As with any grass, we know that fiber digestibility is best prior to heading, or the switch from vegetative to reproductive growth stages. Fiber digestibility will decline further at the time of heading but does not change significantly after that. The difference with corn is that following heading (tasseling) the development of the ear contributes another important factor to overall forage quality – starch. Lauer (2019) shows the "double peak of corn silage quality" with the first peak in fiber digestibility at the late vegetative stages and second peak at traditional corn silage harvest timing when you optimize the content of starch with the fiber digestibility.

In regard to growing conditions post-tasseling, the biggest impact is clearly on ear development, or as it relates to forage quality – starch content. As we turn our attention more towards the total digestible nutrients that the crop contributes to the cow's diet, it is also of interest to consider the impact of ear-to-stover ratio. The ear acts to dilute out the fiber portion of the composite sample (ear plus stover) and thereby increases the proportion of digestible material in the whole plant.

As a farm looks for the best ways to select corn hybrids that meet the forage needs of their herd, it is important to recognize the role of genetics and environment. Genetic selection is important for a number of reasons including crop yield, forage quality, and pest tolerance, but if the influence of growing environment is not recognized in decision-making, looking at genetics alone may result in selecting hybrids that do not achieve the goals of the herd.

SEASON-TO-SEASON DIFFERENCE

Figures 1 and **2** show the shift in key forage quality parameters, starch content, and undigested fiber (uNDF at 240 hr), between growing seasons in our trials in New York and Vermont. This data is strongly correlated to the growing environment of these seasons. The 2017 growing season can be summarized by above-average rainfall and below-average heat accumulation corresponding to a greater proportion of samples having a higher uNDF240 value and lower starch content. This was followed by below-average, but generally adequate rainfall in 2018, and moderate heat, resulting in a much higher percentage of samples being more digestibile (lower uNDF) and having a higher starch content. While the 2019 results fall in between 2017 and 2018 in both growing conditions and these forage quality indicators.

WITHIN-SEASON VARIATION

Data gathered through the collaborative efforts in the Northeast over the last two years provide good insight and follow the pattern of previous studies. In 2018, we were able to compare four hybrids grown at seven different locations in Vermont, New York, and Pennsylvania. In 2019, three hybrids were grown at eight different locations. This allows for the comparison of the same genetics across multiple growing environments. In **Table 2** , the range (maximum – minimum) in mean values observed between 1) hybrids across all locations and 2) locations across all hybrids is presented for key crop performance indicators. In both years, it is evident that the range between locations is much greater than the range between hybrids, indicating that environment has a much greater influence on performance than the hybrid genetics. This is reflected in the observed R^2 values presented in **Table 1**. For interpretation purposes, when assessing starch in 2019, the environment explains 64 percent of the variation observed while the hybrid only explains 2 percent of the observed variation in starch.

Understanding hybrid performance in the context of growing conditions is critical when evaluating data from both private and public sources. In addition to the hybrid-specific data presented in public trial reports, the use of location averages and corresponding weather data from these reports is incredibly valuable for decision making. In fact, it can be as useful, or even more useful, than data from individual hybrids.

2019 TRIAL RESULTS

New York and Vermont Corn Silage Trials: Cornell:
blogs.cornell.edu/varietytrials/corn-silage/

University of Vermont:
uvm.edu/extension/nwcrops/research

Penn State/PDMP Corn Silage Hybrid Performance Trial:
extension.psu.edu/2019-results-pa-commercial-grain-and-silage-hybrid-corn-tests-report

Western New York Crop Management Association:
testplot.azurewebsites.net/

University of Maine Extension:
extension.umaine.edu/waldo/programs/ag/

References available upon request.

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TABLE 1

Environment has a much greater influence on performance than hybrid genetics

	Year	30-hr NDFD, % NDFom	240-hr uNDFom, % DM	Starch, % DM	Tons/acre, 35% DM
R^2 Environment	2019	0.52	0.42	0.64	0.52
	2018	0.60	0.47	0.49	0.75
R^2 Hybrid	2019	0.13	0.12	0.02	0.05
	2018	0.04	0.03	0.03	0.03

TABLE 2

Range for key crop performance indicators for 2018 and 2019 across locations and hybrids

	Year	30-hr NDFD, % NDFom	240-hr uNDFom, % DM	Starch, % DM	Tons/acre, 35% DM
Range across locations (parameter mean of all hybrids by location)	2019	7.1	4.1	12.1	11.7
	2018	8.6	3.9	11.2	15.1
Range across hybrids (parameter mean across locations by hybrid)	2019	2.0	1.1	1.5	2.3
	2018	2.0	0.9	2.4	2.2

Red clover: The other highly digestible legume

By Tom Kilcer

Red clover harvested on time can have NDFd30 digestibilities as good as those from highly digestible alfalfa but will grow on wetter soils.

Wide-swath greater than 80 percent of cutter bar, coupled with tedding 2 hours after mowing, allowed us to make haylage in a day from heavy first-cutting clover in the second year of stand.

In today's tight dairy economy, every acre, just like every cow, needs to be profitable. Adding red clover in a tight economical rotation, teamed with winter forage, can do that.

Red clover has been a marginal crop, grown on marginal acres, with marginal management, only after the real crops are in. Farmers are missing a huge opportunity with neglect of this forage. The dairy industry is shifting to higher digestibility forages that support high-forage diets. Shorter high-yield rotations that integrate sequential year-round cropping with winter forage have all increased interest in utilizing red clover. Recently, New York Farm Viability supported research that significantly contributed to moving red clover to the forefront of farmer crop/feeding plans. Thousands of acres across the northeast/northcentral do not support alfalfa. By applying red clover minimum/no-tilled in a short rotation with no-till corn and winter forage, very high economical yields of quality forage can now be achieved on soils that traditionally had not produced a reliable feed supply. Utilizing a modified wide (greater than 80 percent) swath same-day haylage, farmers can produce the same or better forage on poorer drained soils, as is produced by alfalfa on well-drained soils.

Red clover yields are equal to or exceed alfalfa for the first two to three years. Only in long rotations will alfalfa out-yield clover. Our replicated research was the first cut of the second year for both alfalfa and clover. Clover was a clear winner by a huge amount. The mean for all paired sites was 44 percent higher yielding clover than alfalfa in that one cut. Alfalfa was 2.7 tons dry matter/acre in first cut while the clover was 3.9 tons of dry matter/acre for the first cut. This is backed by multiple year results in the Cornell Plant Breeding legume trials where clover out-yields alfalfa the second year.

A major concern is that clover needs to be reseeded more often. First, with an intensive cutting schedule many alfalfa varieties are not maintaining economical stands very long. Second, older clover or cheap varieties do not support longer stands. With new genetics we have had red clover last well through the third year and, depending on the variety, sometimes into the fourth. A key factor missing in shorter-lived stands is inadequate liming and lack of topdressing. It is a legume like alfalfa, and needs to be fertilized, not forgotten. In a number of areas, insects such as the clover root weevil and the sitona weevil limit the productive years of red clover. Using the technique pioneered by Advanced Ag Systems of no tilling the legume into winter forage stubble in early June after haylage harvest is completed means that both of those insects will have already laid their eggs elsewhere so clover gets a year free of pressure. Thus, it delays the yield-robbing insect buildup.

The sleeper has been the phenomenal quality red clover produces. The majority of the components of legumes are rumen digested in the first 12 hours. In recent research funded by New York Farm Viability Institute, for each of the test locations clover was significantly higher in digestibility than alfalfa in that period. It also had significantly lower uNDFd 240 - the undigested portion. In short, the cow got more out of clover than alfalfa at the same NDF. On nearly all harvest dates, clover had equal to or more metabolizable protein than alfalfa. Enhancing that, from a nutritional standpoint, red clover has enzymes that inhibit protein breakdown. Bypass protein is incredibly expensive even though it is added in small amounts, so using red clover can produce more milk at a lower cost. This is a direct savings on the ration and is critical for organic farms that do not have the range of byproducts to supply needed bypass protein. Dr. Flythe of the Agriculture Research Service found clover also contains a compound that inhibits hyper-ammonia rumen bacteria from destroying protein, thus increasing the metabolizable energy for milk production. Maximizing use of clover protein and energy reduces off-farm purchased protein, which reduces importation of phosphorus onto the farm, and so aids in more nutrient balanced farms.

Red clover can have higher NDFd over regular alfalfa at 40 NDF harvest stage. This increase can be as much as the gain over regular alfalfa from using the new highly digestible alfalfas, yet it grows on wetter soils. The surprise was that in our research clover was at peak quality at the same time or up to a week earlier than the alfalfa in the sites paired with alfalfa in replicated plots. Using the old traditions of cutting it after alfalfa, especially in stands with grass, you are double handicapping (late clover, even later grass) the ability of the crop to produce equivalent milk to timely cut alfalfa.

In our research we found another major imposed handicap to clover yield is compacted plow pans limiting root growth. Most clover is grown on less-than-ideal drained soil types. At some time in the past the ground was plowed when the 4- to 8-inch layer was wetter than optimum. This leaves a smeared pan that lasts for years. (Freezing does not remove it.) We found in a silty clay soil that we could clearly see the compacted marks of the mole board plow when it was plowed for hay seeding 15 years before. There were no roots below the 7-inch limiting pan. This severely limits clover crop yield and longevity. In another study we deep-tilled a compacted sand on 30-inch center in corn, followed by a clover crop. When a drought struck, the clover grew a foot-wide strip on 30-inch centers and died in between the centers. Crops can't produce without roots, and most places where clover is planted are severely root limited. Correcting this by deep tilling before winter forage can release the full potential of the clover crop on your soils.

Work in Wisconsin found that cutting the first and second crop at 20 percent bloom (seeding year cut before bloom) and then taking a late harvest after a killing frost, maximized the yield and the stand. While maintaining high digestibility, this significantly reduces the cost per ton compared to alfalfa harvested five to seven times in an attempt to get quality. The 20 percent bloom for first cut matched very well with our measurements of when it reached 40 NDF for harvest. At two of the three sites, cutting at first flower had significantly higher NDFd30 than alfalfa. Harvest height also was a good predictor of peak quality with the mean of 33 inches. This is nearly the same as alfalfa reaching peak quality. Because these were straight clover stands, by the time 40 NDF was reached, the clover was starting to lodge. If planted with grass it would help to hold it up, but it would have to be harvested before straight alfalfa to match the grasses earlier maturity.

The biggest criticism with red clover – its perceived difficulty to dry – is a non-issue. Another NY Farm Viability Institute funded and replicated research project by Advanced Ag Systems LLC, with assistance from Cornell Cooperative Extension educators and area farmers, clearly showed with heavy yields, and under very adverse drying conditions, that we could get red clover to greater than 35 percent dry matter the day it was mowed with a modified wide swath haylage system. It is critical for the swath to be greater than 80 percent of cutter bar for same-day haylage to be consistently successful. When the mower's deflector was lowered to make a wide swath, the clover impinged into a lump on the deflector, and then dropped to the ground. Removing all deflector shields dramatically decreased swath density and increased photosynthetic drying. Conditioning had no effect on reducing the time for drying wide swath clover for haylage. Finally, the heavy yield, like that of winter forage, physically prevents the lower layers from drying. Recognizing these mechanical hindrances to drying, and the heavy yield of first-cut clover's impact on drying, adding a tedding two hours after mowing will correct these limitations. Proper tedding (fast-forward speed makes nondrying lumps) lifts and loosens the swath, spreading it to 100 percent plus of cutter bar width. More importantly, it brings the lower layers of material to the surface, and to critical sunlight for rapid photosynthesis drying. This drying for haylage uses moisture in the leaves exposed to sun and pulls moisture from the stem. Thus, the stem dries first and the leaves last. Because of this, the leaves are very flexible and not easily lost in correctly timed tedding.

In all of the studies on first-cutting red clover in wet weather, the narrow swaths were not ready to ensile (>30 percent dry matter) until 24 to 30 hours after mowing. In five of the six studies, the wide swath not tedded was ready to ensile in just over seven hours. (Due to the mowers available then, these swath widths were not greater than 80 percent of cutterbar width, and thus required more extended drying.) In all of these tests, wide-swath red clover with tedding two hours after mowing was ready to ensile in just over five hours (same-day haylage). Another result of our research showed that on first-cut red clover in more normal weather and unconditioned swath at 90 percent of cutterbar, the tedded treatment only required four hours to reach ensiling dry matter – the same as the paired alfalfa. Second-cutting red clover, especially laid at greater than 80 percent of cutterbar, may not need to be tedded at all depending on yield.

Tom Kilcer (www.advancedagsys.com) offers crop consulting through Advanced Ag Systems LLC.

Next steps for better silage yield maps

By Ben Lehman, Dilip Kharel, Karl Czymmek, and Quirine Ketterings

With yield monitor technology, silage growers can see the impact of management changes in every field section over time. Unfortunately, even with calibrated equipment and best operator practices, yield maps can look pretty confusing without some post-harvest processing. Worse, maps that have not been properly cleaned can be misleading. Using a strategy called "yield data cleaning," growers can make decisions using yield data with more confidence and little added effort or cost (**Figure 1**).

Cornell University's Nutrient Management Spear Program has been working with corn growers in New York to develop an easy and accurate method for yield data cleaning. We have found that in most cases a whole farm's yield data can be cleaned in one to two hours per harvest season using free software. We have also found that clean data provide a better map, a more accurate yield estimate, and a more reliable farm record.

YIELD EDITOR FOR DATA CLEANING

Correcting errors in yield data used to take a long time, even with expensive software. In 2012, yield data cleaning took a giant step forward. The USDA-ARS published the next generation of the freely available Yield Editor software (ars.usda.gov/research/software/download/?softwareid=370), making it faster than ever to build a more accurate yield map. Yield Editor can fix issues like overlapped passes and makes it easier to find and fix issues related to yield monitor sensors. The Nutrient Management Spear Program has used Yield Editor to clean over 82,000 acres of corn silage data for New York dairy farms in the past two years, and it has found that uncleaned data can over or under-estimate silage yield by as much as 5 to 7 tons per acre for yields ranging from 15 to 30 tons per acre (at 35 percent dry matter).

FIND AND FIX SENSOR DELAYS

Silage choppers have two main yield sensors: flow (for pounds of crop) and moisture (for moisture content determination). Most sensors are in the rear of the harvester, so by the time the corn is "sensed" the harvester can be up to 50 feet further along the pass from where the corn was chopped. Yield Editor can shift data back along the path of the chopper to correct for this gap (**Figure 1**). The exact gap in time between harvest and the crop reaching the sensors, called a "flow delay" or "moisture delay," may change annually based on equipment, operators and field conditions. Flow and moisture delay corrections produce a better map and are critical to an accurate yield estimate.

FIGURE 2

On the left, no start pass delay has been applied. On the right, start pass delay was set to three, causing an artificially low yield record to be removed.

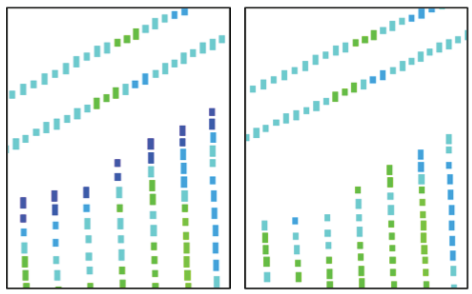
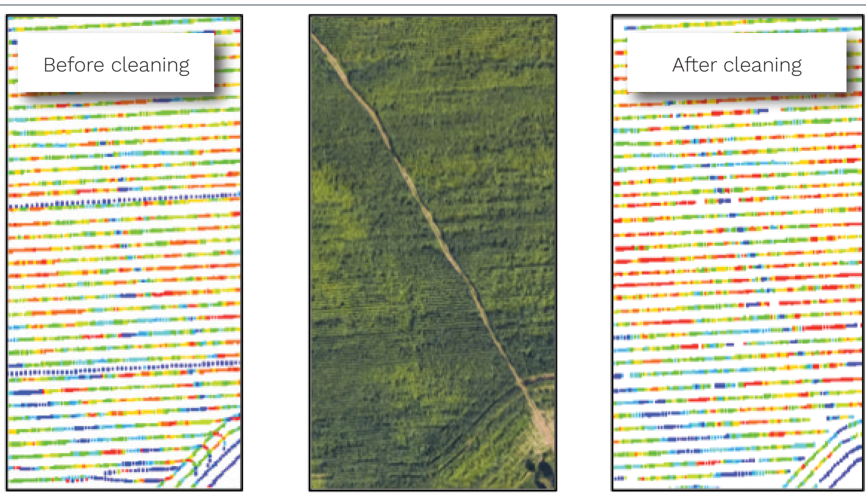


FIGURE 1

Yield maps with "cleaned" data more closely match actual yield trends and field characteristics



CLEANING UP FIELD EDGES

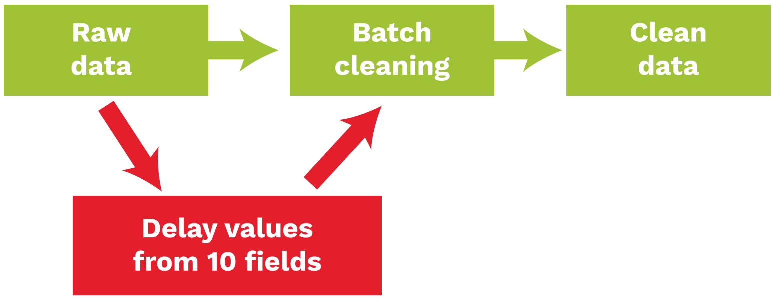
Yield estimates are often much lower than the actual yield when the chopper is slowing down or ramping up to speed. "Start pass" and "end pass" delays remove a set number of unreliable datapoints from the beginning and end of each harvester pass (**Figure 2**). Applying the correct start and end pass delays produces more accurate yield estimates near field edges. Just like flow and moisture delays, start and end pass delays change annually with field conditions, equipment, and operator practices.

BATCH CLEANING

Data cleaning does not need to be

FIGURE 3

A whole year of yield data (all fields) can be cleaned in one "batch" submission



done one field at a time for large farms. We use Yield Editor to manually clean 10 sample fields with known features and then apply the average cleaning settings (the number of seconds for each delay error) farm-wide. This is called "batch cleaning", and is both fast and accurate (**Figure 3**).

Finding the best delay values for each field can be tough at first, but there are options to speed up the learning curve. Try to pick sample fields with features like grass waterways or within-field tree lines. This makes it easier to find patterns in Yield Editor's flow and moisture maps, which will be the most obvious when the best cleaning settings are applied (**Figure 1**). The better you know your fields, the faster cleaning can be done. No experience is necessary, but some computer skills are a big help.

After cleaning, yield data can be imported into AgLeader SMS or similar crop management software. Batch cleaning saves a complete copy of the original uncleaned data. Growers can compare the raw data with clean data to see how and where changes have occurred. Raw and cleaned data should be saved along with other essential farm records.

MOVING FORWARD

The Nutrient Management Spear Program created a step-by-step guide to use Yield Editor for corn silage and grain yield monitor data cleaning and then published a Yield Data Cleaning Protocol (nmsp.cals.cornell.edu/publications/extension/ProtocolYieldMonitorDataProcessing2_8_2018.pdf). The protocol walks users through the process of selecting the best flow, moisture, start and end pass delays for each field. The guide also contains troubleshooting help and tips to speed up the data cleaning process.

Today, yield data cleaning will almost always be worth the time for corn growers with yield monitors. High-quality decision-making requires high quality information, and yield documentation is no exception. Once data are in AgLeader format, data cleaning can be done in one to two hours per farm per year by selecting ten fields with known within-field features, determining the four delay values, and then batch cleaning to correct errors in all harvested fields. Yield data cleaning is not a replacement for yield monitor calibration and good operator practices, but it is an essential step toward reliable yield data.

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Best timing of harvest for brown midrib forage sorghum yield, nutritive value, and ration performance

By Sarah E. Lyons, Quirine M. Ketterings, Greg Godwin, Debbie J. Cherney, Jerome H. Cherney, Michael E. Van Amburgh, John J. Meisinger, and Tom F. Kilcer

Forage sorghum is a drought- and heat-tolerant warm-season grass that can be used for silage on dairy farms. Since it requires a soil temperature of at least 60°F for planting, the recommended planting time for New York is early June, unlike corn, which is usually planted earlier in the spring. This would allow time for a forage winter cereal harvest in mid- to late-May prior to sorghum planting. Forage sorghum also has comparable forage quality to corn silage for most parameters except for starch, which is typically lower in forage sorghum. The main question for this research was: Can forage sorghum be harvested in time for establishment of a fall cover crop or winter cereal double-crop in New York? To answer this question, we conducted seven trials in central New York from 2014 through 2017 to evaluate the impact of harvesting at the boot, flower, and milk growth stages versus the traditional soft dough stage on the yield and forage quality of

Continued on page 14

FORAGES & FEEDING

Best timing of harvest for brown midrib forage sorghum yield *cont'd from page 13*

a brown midrib (BMR) forage sorghum variety.

FIELD TRIALS

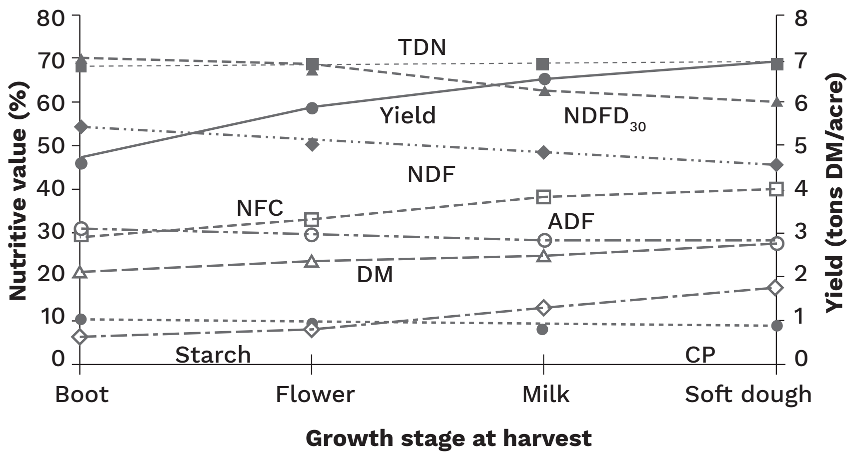
Seven trials were planted between early June and early July on two Cornell research farms in central New York. Sorghum was planted at a 1-inch seeding depth and 15-inch row spacing (15 lbs/acre seeding rate). Two N-rates as urea treated with Agrotain (Koch Agronomic Services, LLC, Wichita, KS) were broadcast at planting (100 and 200 lbs N/acre) with the goal of having a non-N limiting scenario for these sites. Alta Seeds AF7102 (Alta Seeds, Irving, TX) was used for all trials. Forage sorghum was harvested at the boot, flower, milk, and soft dough stages. Harvest was done using a 4-inch cutting height. Measurements included dry matter (DM) yield and forage quality, including total digestible nutrients (TDN), neutral detergent fiber (NDF) analyzed on an organic matter basis with amylase, 30-hour NDF digestibility (NDFD30), non-fiber carbohydrates (NFC), acid detergent fiber (ADF), dry matter (DM), crude protein (CP), and starch content. Forage quality parameters were entered into the Cornell Net Carbohydrate and Protein System (CNCPS) version 6.55, a ration formulation software, to predict how sorghum harvested at various growth stages would perform in a typical dairy total mixed ration (TMR) compared to corn silage. Forage sorghum, at each of the different growth stages, was substituted for 0, 25, 50, 75, and 100 percent of the corn silage fraction of the diet, and metabolizable energy (ME) allowable milk and metabolizable protein (MP) allowable milk were predicted.

IMPACT

Timing of forage sorghum harvest impacted both yield and forage quality. Yield did not increase beyond the flower stage for four trials or beyond the milk stage for one trial. For two trials, yield continued to increase until the soft dough stage. Averaged across all trials, yield increased from 4.8 tons DM/acre at the boot stage, to 6.0 tons DM/acre at the flower stage, and 6.8 and 7.1 tons DM/acre at the milk and soft dough stages, respectively (**Figure 1**). These results suggest that, in most cases, forage sorghum can be harvested at the flower or milk stage without losing a substantial amount of yield. With later harvests, forage quality parameters of DM, starch, and NFC were increased while CP, NDF, and NDFD30 were decreased.

FIGURE 1

Summary of yield and forage quality of BMR brachytic dwarf forage sorghum as impacted by growth stage at harvest



These are averages of seven trials in central New York from 2014 to 2017. Quality parameters include total digestible nutrients (TDN), neutral detergent fiber (NDF) analyzed on an organic matter basis with amylase, 30-hour NDF digestibility (NDFD30), non-fiber carbohydrates (NFC), acid detergent fiber (ADF), dry matter (DM), crude protein (CP), and starch.

Without adjusting for DM intake, 100 percent inclusion of forage sorghum harvested at the soft dough stage resulted in predicted ME allowable milk (90 lbs) that was similar to the 100 percent corn silage TMR (92 lbs) across sorghum inclusion amounts (**Figure 2A**). The lower starch content of less mature sorghum resulted in reduced ME allowable milk at greater inclusion in the diet, averaging 87, 88, and 89 lbs for 100 percent inclusion of sorghum at the boot, flower, and milk stages, respectively. Predicted MP allowable milk for all sorghum growth stages was similar to that of corn silage (**Figure 2B**).

IMPLICATIONS

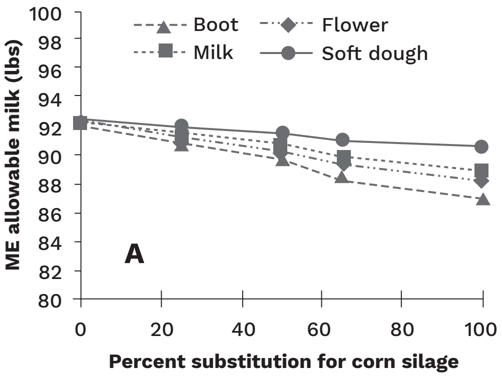
Forage sorghum can be a good alternative to corn silage in double-cropping rotations with winter cereals grown for forage in New York. The BMR forage sorghum in this study could be harvested as early as the late-flower to early-milk growth stage without losing significant amounts of yield. However, early harvesting did affect forage quality, resulting in greater NDFD30, NDF, ADF, and CP, and less NFC, starch, and DM. Forage sorghum could replace corn silage in a dairy TMR, but energy supplements are needed if sorghum is harvested before the soft dough stage due to a lower starch content at the earlier harvest dates. Additional forage may also be needed in a sorghum-based TMR due to changes in fiber digestibility at different growth stages. The higher moisture content of less mature sorghum may also call for adjustments in chop length and/or silage additives, such as inoculants, for proper fermentation.

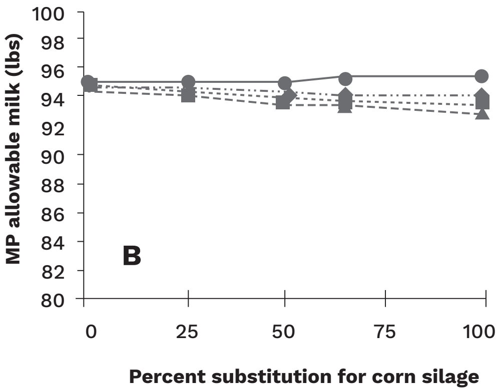
ACKNOWLEDGEMENTS

This work was supported by Federal Formula Funds, and grants from the Northern New York Agricultural Development Program (NNYADP), New York Farm Viability Institute (NYFVI), and Northeast Sustainable Agriculture Research and Education (NESARE).

FIGURE 2

Metabolizable energy (ME) allowable milk (A) and metabolizable protein (MP) allowable milk (B) of BMR brachytic dwarf forage sorghum predicted with the Cornell Net Carbohydrate and Protein System (CNCPS) version 6.55





Harvest took place at four growth stages, and sorghum was substituted for different percentages of corn silage in a typical dairy total mixed ration. Values are averages of seven trials in central New York from 2014 to 2017.

For questions about these results, contact **Quirine M. Ketterings** at (607) 255-3061 or qmk2@cornell.edu, and/or visit the Cornell Nutrient Management Spear Program website at: nmsp.cals.cornell.edu. **Sarah E. Lyons**, **Quirine M. Ketterings**, and **Greg Godwin** are with the Nutrient Management Spear Program at Cornell. **Debbie J. Cherney** and **Michael E. Van Amburgh** are with the Department of Animal Science at Cornell. **Jerome H. Cherney** is with the Soil and Crop Sciences Section of the School of Integrative Plant Science at Cornell. **John J. Meisinger** is with USDA-ARS Beltsville Agricultural Research Center. **Tom F. Kilcer** is with Advanced Agricultural Systems, LLC.

RECORDED WEBINARS

PRO-DAIRY regularly offers webinars in English and Spanish. These webinars are recorded and a full list is available at prodairy.cals.cornell.edu/webinars. *Spanish webinar topics include nutrition, reproduction, calving, milk quality, herd health, cow comfort, animal handling, and human resource management. Select webinar titles in English include:*

DAIRY CATTLE NUTRITION

Creating the perfect dining experience

Current research and topics in feed bunk management.

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This webinar covers what shredlage is, research results, and current harvest recommendations.

MILK QUALITY

Robotic milking systems – Effective use of reports to monitor milk quality and maintenance

Robotic milking systems generate a tremendous amount of data that can be used for management decisions. It can be overwhelming. Dr. Rick Watters, Cornell University College of Veterinary Medicine, discusses how to use reports to pinpoint the information that can impact milk quality and maintenance management decisions.

FORAGE MANAGEMENT

Make the most of advances in forage management

Many exciting developments, from improved forage varieties, to precision equipment, to advances in the understanding of fiber digestibility, continue to enhance the value of forages in feeding programs. Here we address harvest and storage strategies that are at times the missing link to capitalize on these advances.

NUTRIENT MANAGEMENT

Preparing for manure spills and other emergencies on your dairy – Who is part of your response team?

This webinar is designed to help farmers and their consultants think about their emergency response team as it relates to manure spills and other on-farm emergencies. Mark Burger, Soil and Water Conservation District, shares the successful model they created in Onondaga County, New York. He highlights lessons learned, potential improvements, and how they connected to the county 911 system.

FARM BUSINESS MANAGEMENT

Valuing Farmland Proximity – methods for valuing proximity in farmland purchasing decisions

This webinar focuses on how to objectively assess the value of land proximity when making decisions about buying farmland. Professor Jenny Ifft, Cornell Dyson, is developing a data set of New York farmland transactions from 1999 to present. She is interested in determinants of New York and U.S. farmland values and its effect on farm profitability and structure.


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