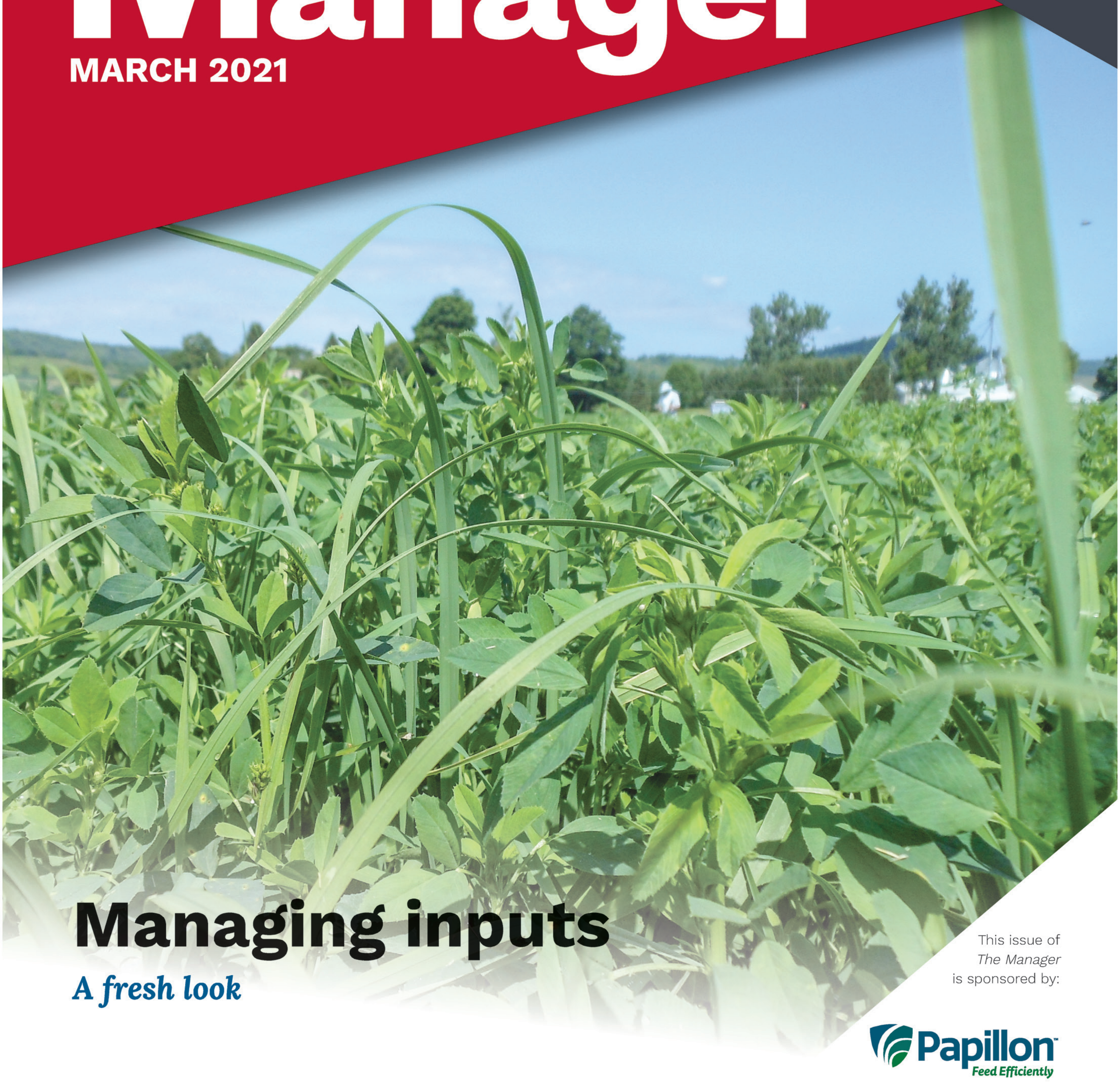
PRO DAIRY
Education & Applied Research

The Manager

MARCH 2021



Managing inputs

A fresh look

The **Manager**

MARCH
2021

FOCUS:

MANAGING INPUTS

INSIDE

JULIE BERRY
Communications Manager
Cornell CALS PRO-DAIRY
jrb7@cornell.edu

DR. TOM OVERTON
Director
Cornell CALS PRO-DAIRY
tro2@cornell.edu

Is day-to-day variation in bunkers worth correcting?

Jerry Cherney, Matt Digman, and Debbie Cherney

Everyone knows that feed from haylage and corn silage bunkers will vary in composition from day to day. What is not so clear is the magnitude of this variation, and whether it might be worth it, economically and environmentally, to rebalance dairy rations daily to correct the variation. Providing excess feed likely will mitigate the effects of day-to-day silage variability, but this increases feed costs and is less environmentally acceptable.

Many farms rebalance dairy rations weekly. A few attempt daily rebalancing. A better understanding of day-to-day variability of bunkers within a week is the first step to assess the potential benefits of daily rebalancing of rations. The most practical component to focus on for daily rebalancing is dry matter (DM) concentration; however, DM can be difficult to measure accurately, particularly in mixed haylage.

MEASURING DM ON THE FARM

Farms typically do not have a laboratory drying oven, but there are several methods to generate DM values on farm. A Koster moisture tester, a microwave oven, or a kitchen air fryer can be used to accurately determine the moisture in a ~100-gram sample in about 30 minutes or less. All require a small scale to weigh wet and dry forage.

Anyone who has attempted to dry forage in a microwave oven, however, knows how easy it is to char the sample or start a fire. A Koster tester or an air fryer have two main concerns: 1) the time involved to get a result and 2) getting a representative subsample to dry. A 100-gram subsample is very small, decreasing the odds of getting a representative subsample. Adequate subsampling is as critical as the original sampling process.

SILAGE VARIABILITY IN BUNKERS

Every measurement has inherent error. Even a simple tape measure has error associated with readability. If you are to employ a measurement technique to manage on-farm variability, the first step is to understand how that variability compares to the measurement error. What we are looking for is a high variability in the measured parameter and a relatively low measurement error. Consequently, we needed to first assess the variation due to sampling and analysis (measurement error) before we can effectively evaluate the actual day-to-day variation in bunkers.

Sampling bunkers

We collected corn silage and alfalfa-grass haylage samples daily from seven dairy farms in central and western N.Y. during the winter of 2019 to 2020, with a total of 24 weeks of haylage and 22 weeks of corn silage, sampled daily. Grass percent in mixed alfalfa-grass haylage from farm to farm ranged from 10 percent to 90 percent. Size of silage bunkers ranged from 40 to 110 feet wide with silage stacked 10 to 30 feet high.

THE MANAGER Sponsored by:

Cornell CALS
College of Agriculture and Life Sciences

Papillon™
Feed Efficiently

Farm crews daily defaced bunkers, and samples were collected from eight to 10 different spots in the pile across the bunker width soon after defacing, avoiding approximately 6 feet on the ends of the bunkers. An O-ring sealed plastic bucket was filled with silage (about 8 to 10 lbs.). Samples were either processed daily immediately after collection, or they were kept at low temperature in sealed buckets until processed. A good representative sample collected from bunkers tends to be too large to process for analysis, such that subsampling of the larger sample is required.

To estimate the variability in sampling and analysis, we collected multiple samples and used multiple subsampling of those samples on several farms. All samples were evaluated for DM in duplicate, and all laboratory analyses were performed in duplicate. This study was recently published in the Journal of Applied Animal Science. For additional details of the study, please refer to this journal.

Figure 1 shows the range of measurement error for DM compared to crude protein (CP). There is much more error associated with sampling and analysis of DM versus CP. As might be expected, mixed haylage was more variable than corn silage, but much more variable for DM. This variation in sampling and analysis needs to be considered when assessing the actual day-to-day variation in bunker forages.

Weekly variation in DM

We assumed that we need at least a five percent unit range in DM over a week to potentially benefit from daily ration rebalancing. We added two percent units to take into account sampling/analysis variability. A seven percent unit threshold for weekly range in DM was exceeded 14 percent of weeks for corn silage and 42 percent of weeks for alfalfa-grass haylage **(Figure 2, red lines)**. A significant range in weekly variability was also found for forage quality traits such as NDF, ADF, and fiber digestibility.

It is very difficult to evaluate the impact of changes in DM between formulated rations and fed rations. When complex computer models assess the impact of transient changes in ration DM, they often conclude that cows will give up body fat instead of reducing milk production. Therefore it is not practical to simply associate daily variability in forage DM with a loss of x lbs. of milk per day. Nevertheless, it seems likely that daily ration balancing can be economically and environmentally beneficial, if on-farm estimations of DM can be determined with sufficient accuracy.

Bunker sampling issues

There are safety risks to sampling bunkers. At the onset of daily sampling, we were primarily concerned about the risk of bunker face collapse. After many weeks of daily sampling, we reassessed our risks in this order:

1 Slipping on ice, often present on bunker floors, frequently lightly coated with snow (plus the requirement to wear slippery disposable boot covers).

2 Avoiding the almost constant vehicle traffic, with operators in a hurry and not expecting anyone to be wandering around near bunkers.

3 Small, but deadly, risk of bunker face collapse.

All three of the above could result in serious injury.

SUMMARY

A representative bunker sample requires collection of enough material

Continued on page 4

FIGURE 1

Sample variation associated with sampling and analysis of dry matter (DM) versus crude protein (CP).

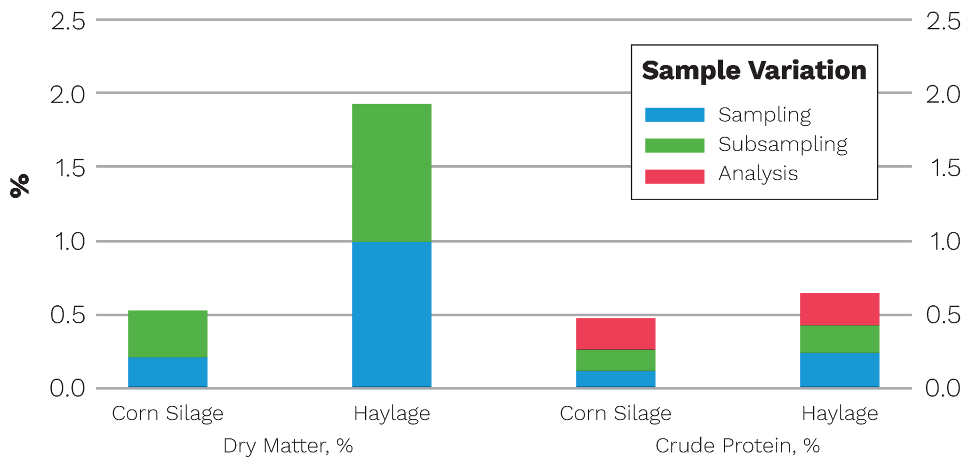
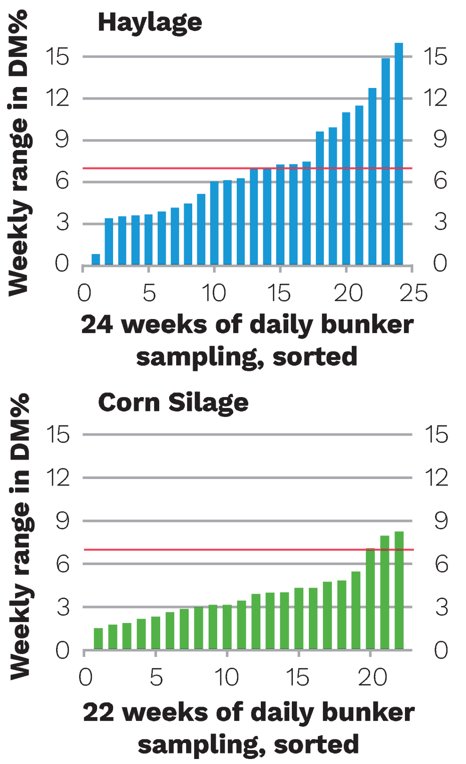


FIGURE 2

Weekly range in dry matter (DM) percentage in haylage and corn silage, sorted from smallest to largest.



***Is day-to-day variation in bunkers worth correcting?**, cont'd from page 3*

Sampling bunkers can be dangerous.

that it will need to be subsampled to process the sample for analysis. All silage sampling is subject to sampling, subsampling, and analysis variability. Consistent sampling procedures and consistently utilizing the same forage analysis laboratory can minimize variability in all three. In practice, sampling and analysis errors are likely to be larger than we observed, as we were meticulous in our procedures.

Taking into account the random error due to sampling and analysis, weekly variation in silages was still large enough to potentially benefit from daily rebalancing of rations. Other options to heated drying methods, such as handheld near infrared (NIR) analyzers, may be practical for on-farm moisture estimations. A better understanding of day-to-day variability over a week will be helpful when determining the accuracy required for on-farm silage moisture determinations.

ACKNOWLEDGEMENTS

Funding for this study was provided by the U.S. Alfalfa Farmer Research Initiative of the National Alfalfa & Forage Alliance, and by the New York Farm Viability Institute. ▮

Jerry Cherney (jhc5@cornell.edu) is a forage crop specialist at Cornell University. **Matt Digman** (matthew.digman@gmail.com) is a biological systems engineer at the University of Wisconsin. **Debbie Cherney** (djc6@cornell.edu) is a ruminant nutrition specialist at Cornell University.

Greenhouse gas footprint tools on farms

Olivia Godber and Karl Czymmek

Carbon footprint, carbon neutral, net zero, greenhouse gases, methane emissions; what does it all mean? The phrase "carbon footprint" is a little misleading. The carbon footprint of a person, a farm, or a product, such as milk, is the total of all greenhouse gases (GHGs) emitted on an annual basis. However, not all GHGs contain carbon. One important GHG that comes from farming activities includes nitrous oxide, or N_2O, which does not contain carbon. Along with methane (CH_4) and carbon dioxide (CO_2), these three gases have important heat trapping traits and are the key GHG emission concerns from agriculture, including dairy farms.

Most scientists agree that human activities contribute to climate change. Human activities are also being affected by climate change, and agriculture is no different. As a result, there is a need for the agricultural industry to not only look at ways to reduce its carbon footprint, but also increase its resilience to the impacts of climate change on both crops and livestock. Depending on the location, changes to local climatic conditions and increased occurrence of extreme weather events, including both drought and flooding, are resulting in increased soil loss, spread of crop and animal disease and pests, and reduced yield and quality of crops and pasture.

Climate change and the need to reduce GHG emissions are topics with great global interest as well, particularly when it concerns agriculture, and dairy in particular. These issues have taken a center stage within the media and policy decisions over recent years. Civil society is also becoming more concerned and making demands on the agricultural industry to "go green." In response, retailers are taking action within their supply chains to maintain customer satisfaction, or approval of their products.

In October 2020, the Innovation Center for U.S. Dairy announced their Net Zero Initiative (NZI), stating that the U.S. dairy industry will become carbon neutral by 2050. In addition, there are an increasing number of global, regional, and state climate change targets for dairy and the agricultural industry in general, while processors and retailers are also taking actions to cut the carbon footprint of their supply chains to satisfy customer concerns. As a result, some dairy farmers are being required to calculate, report, and reduce the carbon footprint of their farm production, and this is expected to expand over time. 25 Climate Alliance states and territories are committed to reducing GHG emissions by at least 26 to 28 percent below 2005 levels by 2025.

HOW CAN YOU CALCULATE A CARBON FOOTPRINT?

Whole-farm evaluation or assessment tools have been developed to help farmers calculate their farm's carbon footprint and GHG emissions based on their management practices, the biological processes that occur on the farm as a result of these practices, and the influence of local climate conditions. Ideally, an initial assessment sets the "baseline" footprint of the farm; the starting point based on the current situation. This baseline can be used to identify emission "hot-spots," and when combined with information on the farm's management practices, emission reduction opportunities can be identified, and reduction targets and strategies set. Annual assessments should then be used to monitor progress over time, along with the impact of any management changes.

This type of whole-farm carbon footprint assessment not only allows a farmer to understand their farm's GHG emissions, but also to develop effective mitigation strategies, sustain farmlands, and provide a means to communicate or report its performance to key audiences, such as consumers, milk processors, retailers, and governing bodies. It may also allow entry into niche or price-premium markets. Though not always the case, farmers may find additional benefits from carbon footprint assessments. For example, the opportunities to reduce GHG emissions may also reveal opportunities to reduce costs and increase productivity. Other benefits include reducing soil erosion and degradation, reducing phosphorus and nitrogen runoff, improving water quality and retention, controlling air pollutants (e.g., ammonia and hydrogen sulfide), and increasing soil fertility. This will have both a positive impact on the environment, in addition to increasing resilience of farms against the effects of climate change.

WHAT INFORMATION IS NEEDED TO CALCULATE A CARBON FOOTPRINT?

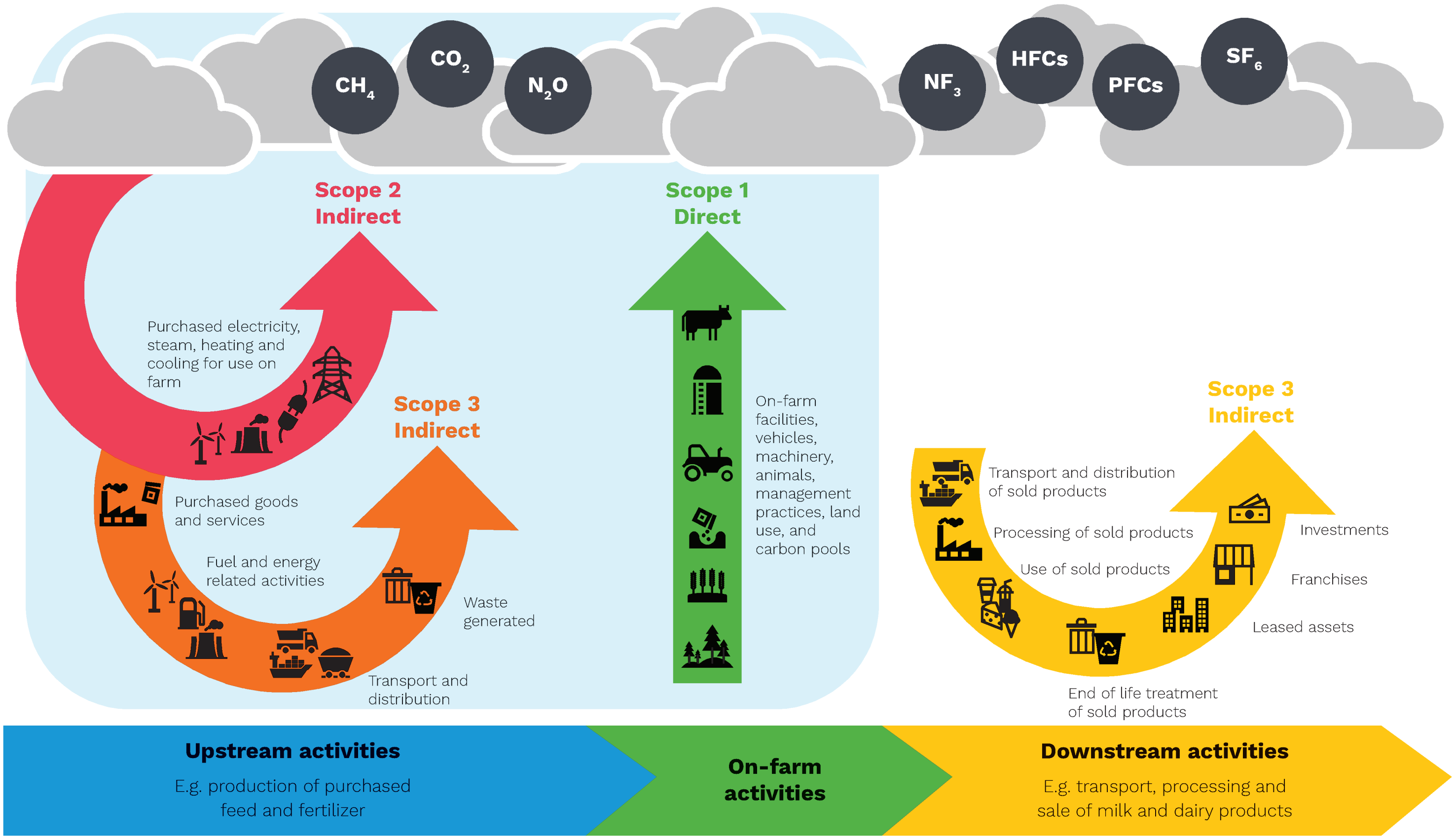
When calculating carbon footprints, it is important to establish the boundary for the assessment – what is and isn't going to be included. GHG emission sources can then be classified as direct or indirect. Direct emissions are owned or controlled by the farm (e.g., methane emissions from enteric fermentation). Indirect emissions are not controlled or owned by the farm, but a portion of these emissions are a consequence of the activities on the farm (e.g., those associated with the production of feed and fertilizer that they import and use on the farm). Emissions are also split into three more categories, referred to as "scope." The first category (scope 1 emissions) include all direct emissions, the second category (scope 2 emissions) include the generation of electricity, heat, or steam that is purchased by the farm, and the third category (scope 3 emissions) are all other indirect emissions (e.g., emissions associated with the production of feed and fertilizer that they import and use on the farm - "upstream emissions" and the emissions associated with packaging, transport and retail of milk, and disposal of the final product waste materials - "downstream emissions").

The movement of carbon into and out of carbon stores (sometimes referred to as pools or stocks) must also be reported. The capture and

Continued on page 6

FIGURE 1

An example of a "grass-to-gate" carbon footprint boundary of a dairy farm and the direct (Scope 1) and indirect (Scope 2 and Scope 3) greenhouse gas emissions associated with it.



MANAGING INPUTS

Greenhouse gas footprint tools on farms,
cont'd from page 5

FIGURE 2

Key sources of greenhouse gases from dairy farms. The breakdown of greenhouse gas (GHG) emissions by source for a dairy farm “grass-to-gate” carbon footprint.

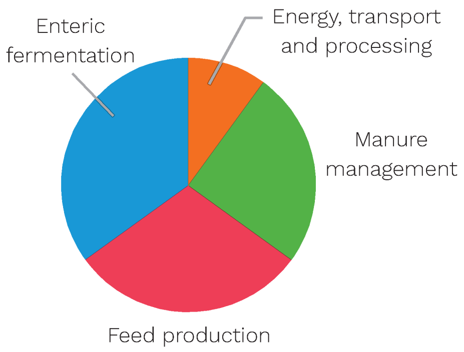
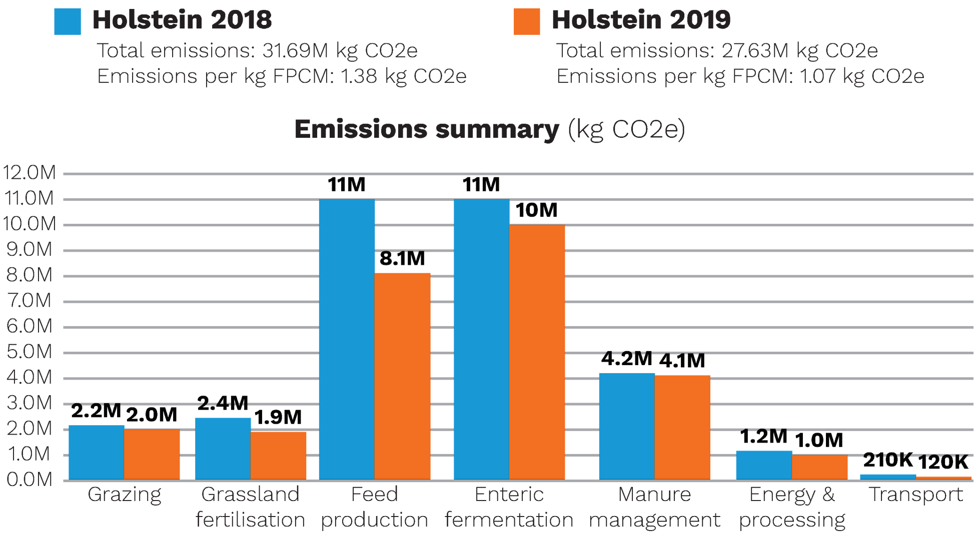


FIGURE 3

An example output from the Cool Farm Tool comparing results of a dairy herd in 2018 and after changes in management practices in 2019.



long-term storage of carbon will be an important route to reaching net zero. Carbon capture (sometimes referred to as carbon sequestration) and carbon storage take into account emissions and removals associated with land use change within the last 20 years. This includes both the conversion of land between land use categories, and a change in tillage practices. The burning or liming of land prior to conversion must also be included. The removal of carbon dioxide by woody vegetation (e.g. trees, hedgerows) is an example of carbon capture or sequestration into long-term carbon storage and should be included in the assessment. However, the carbon dioxide removed by herbaceous vegetation (e.g. crops, grasses) cannot be included in the assessment as the carbon storage is only short-term. It is important to remember that no carbon storage is permanent, as any soil disturbance or removal of vegetation can release the stored carbon.

It is routine to conduct a carbon footprint assessment on dairy farms “from grass to gate” which includes all scope 1 and 2 emissions, and “upstream” scope 3 emissions **(Figure 1)**. This covers the manufacture and transport of cropping inputs (e.g., fertilizer, herbicides, pesticides, and any water used for irrigation), through feed production (including production of imported feed), and ending with milking of the cows and milk storage until it leaves the farmgate. Transport, processing, and retail of the milk (“downstream” emissions) are not included in the farm carbon footprint. Emissions relating to any by- or co-products (such as crop by-products sold, animals moving into the beef sector, etc.) should not be included in the farm's milk carbon footprint.

THE COOL FARM TOOL

The Cool Farm Tool is an example of a whole-farm assessment tool or calculator that is being developed for use on a wide range of farming systems globally. It estimates on-farm greenhouse gas emissions and soil carbon sequestration, and it has been adopted by a range of multinational companies. To date, there has not been robust testing of the tool's suitability for use in U.S. dairy systems, and users in both the U.K. and U.S. have identified limitations in the current version. However, Cool Farm Tool is under continuous development based on feedback from users, and improved input options are being included as reliable science and data become available at regional levels.

The dairy module calculates the GHG emissions as a total for the whole farm, and on a unit of fat- and protein-corrected milk (FPCM) produced basis to allow comparison between farms. The FPCM adjusts the milk production to a standard with four percent fat and 3.3 percent true protein. The carbon footprint of each feed crop produced on-farm is calculated per unit of crop, and per unit area, with emissions allocated to co- and by-products as necessary. The crop carbon footprint takes into account fertilizer production and use, energy use, soil characteristics (texture, organic matter content, moisture, drainage and pH), any land use change, tillage practices, crop residue management, wastewater management, and pesticide emissions. The overall milk carbon footprint for the farm includes these feed crop production emissions, in addition to the emissions relating to grazing management, feeding practices (including feed production emissions for imported feed), enteric fermentation, manure management, machinery use and energy, and transport. Emissions related to the use and application of manure are attributed to the crop.

The Cool Farm Tool allows a farm to

simulate changes to their management practices to see effects on the carbon footprint results. There is also an option to add economic information for the farm, which provides additional insight into potential benefits and trade-offs any management changes may have, including the financial impact of those changes. Although this will not indicate any effects on productivity, it will allow a farmer to compare the potential gains and trade-offs for different strategies and pick those most suited to their farm and targets.

The main drawback of the Cool Farm Tool, as is the case of most farm assessment tools, is that the evaluation is based on what was done in the previous year. Therefore, it can be laborious to collect the required data for the first assessment, and some data may be missing and must be estimated. During the initial assessment, it is worthwhile to make notes of the missing data to ensure it is collected in subsequent years, and then develop an efficient method of recording the required data throughout the year. Any assumptions made in the first year need to be clearly documented, and corrected when possible, or taken into account when comparing footprints in future years, or with other farms.

CONCLUSION

The need is growing for U.S. dairy farms to calculate and reduce their carbon footprint to meet the Net Zero Initiatives set by the Innovation Center for U.S. Dairy, in addition to other global, regional, and state climate change targets, requirements set by individual retailers, and satisfaction, or approval, of consumers. The Cool Farm Tool is a freely available, globally recognized whole-farm evaluation tool that can calculate the emissions of a dairy farm, identify emission hot spots, run scenarios to determine the best mitigation opportunities, and track progress over time. These opportunities often have additional benefits for the farm, including increased productivity, greater resilience to the effects of climate change, and improved bottom lines. We will test this and several other GHG footprint tools on N.Y. dairies over the next two years and will report what we learn in future articles.

Olivia Godber is a post-doctoral research associate with Cornell's Nutrient Management Spear Program. **Karl Czymmek** is a specialist with Cornell CALS PRO-DAIRY.

Double-cropping with forage sorghum and forage triticale in New York: Best timing for sorghum harvest and triticale planting

Sarah Lyons, Quirine Ketterings, Greg Godwin, Jerome Cherney, Debbie Cherney, John Meisinger, and Thomas Kilcer

Double-cropping with both warm- and cool-season forages in New York can have many benefits, including providing a source of forage yield in the spring that potentially leads to greater total season yields than a monocrop system, increasing rotation diversity, and providing year-round soil cover. Winter cereals such as triticale are great options for double-cropping in the Northeast, as they overwinter and can produce high forage yields in the spring. Yet, depending on weather and growing season condition, a winter cereal crop harvested for forage can delay corn silage planting to mid-May or later. Sorghum is a potentially useful alternative to corn silage for double-cropping rotations, as sorghum can be planted later than corn. While it is possible to harvest forage sorghum earlier than the recommended soft-dough growth stage without compromising yield, it was not known how sorghum harvest timing would impact total season yield of both forage crops in the rotation. Here we present findings of a field trial to evaluate the impact of sorghum harvest timing on the combined yield of forage triticale and forage sorghum in a double-cropping rotation.

FIELD RESEARCH

A double-cropping study with forage sorghum (brachytic dwarf brown midrib variety 'AF7102') and forage triticale ('Trical 815') was conducted at the Musgrave Research Farm in Aurora, New York, from October 2015 to June 2018. The study was initiated with triticale planting in mid-October, 2015. Each spring, the triticale received multiple rates of nitrogen (N) at dormancy break in mid- to late-April and was harvested in mid- to late-May at flag-leaf stage. Sorghum was planted between early and mid-June once the soil temperature stayed consistently above 60°F. Sorghum received either no N or 200 lbs. N/acre at planting, and it was harvested four times in the fall between early September and mid-October, approximately two weeks apart. Triticale was planted a day after sorghum harvest. Data is included from the plots that received 120 lbs. N/acre for triticale and 200 lbs. N/acre for sorghum, where N supply was not expected to limit yield of either crop.

RESULTS

In 2016, sorghum yield was highest when harvested after mid-September

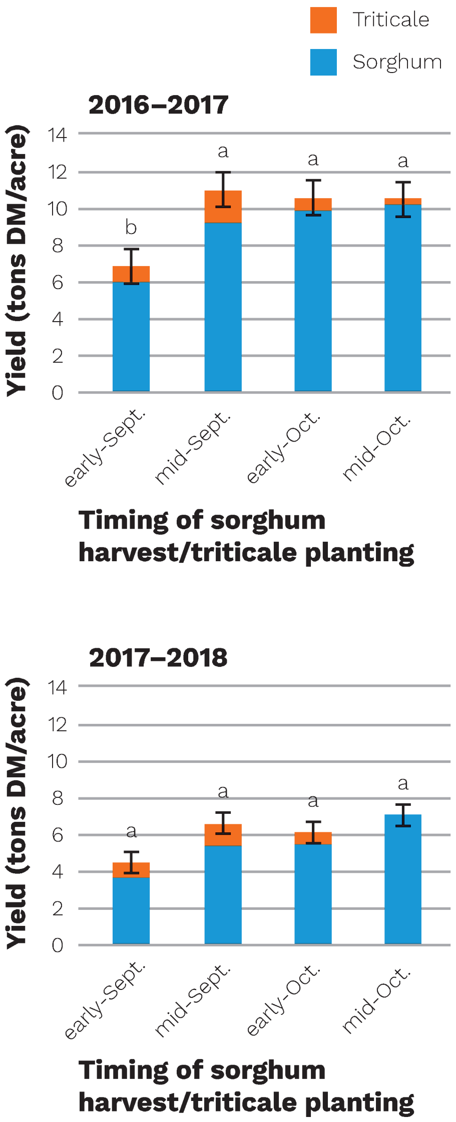
Continued on page 8

MANAGING INPUTS

Double-cropping with forage sorghum and forage triticale in New York: Best timing for sorghum harvest and triticale planting, *cont'd from page 7*

FIGURE 1

Total season yield for a double-crop rotation study with forage sorghum and triticale in central New York from 2016 to 2018. Triticale was planted the day after sorghum harvests in the fall. Triticale was harvested at the flag-leaf stage in May. Sorghum was fertilized with N at planting (200 lbs. N/acre) and triticale was fertilized with N at dormancy break in the spring (120 lbs. N/acre).



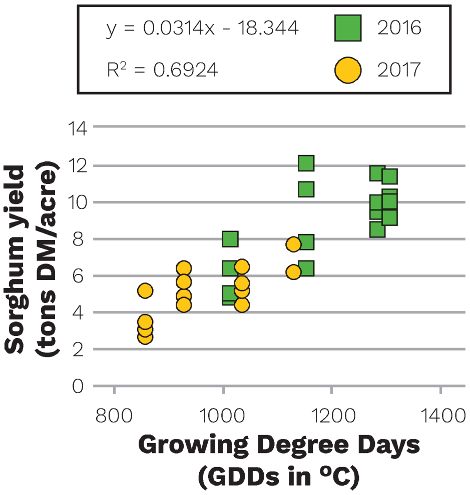
(late-flower to early-milk growth stage or later), and the following triticale yield was highest when planted in mid-September **(Figure 1)**. Because of the larger contribution that sorghum had, overall total season yield did not increase after the mid-September sorghum harvest and triticale planting date that year. In the second year of the study (fall 2017 to spring 2018), sorghum yield was maximized at the last harvest date, and, as with the year before, triticale yielded highest when planted in mid-September. Total season yields were lower in the second year compared to the first year, most likely reflecting weather; fall 2016 was warmer and drier, while fall 2017 was cooler with higher rainfall. There were more growing degree days (GDDs) by mid-September 2016 than by the last harvest in mid-October 2017 **(Figure 2)**.

CONCLUSIONS AND IMPLICATIONS

Forage double-cropping can be both economically and environmentally beneficial in upstate New York. Sorghum, a crop well-adapted to warm and dry climates, planted in early or mid-June will likely reach maximum yields earlier in years with more GDD (by 1,151 GDD in °C or 2,072 GDD in °F in mid-September 2016 in this study) compared to years with fewer GDD (such as 2017 in this study). We recommend that sorghum grown in New York during warm, dry years can be harvested once ~1,150 GDD (°C scale; 2070 GDD in °F scale) have accumulated. This can support both sorghum and triticale yields. If 1,150 GDD have not accumulated by the soft-dough growth stage (cool, wet years), harvesting sorghum at soft dough is recommended to maximize total season yield. ▮

FIGURE 2

Forage sorghum yield as related to growing degree days (GDDs) from 2016 to 2017. The GDDs were calculated by subtracting the lower threshold growing temperature for sorghum (10°C) from the average daily temperature (in °C). The average daily temperature was calculated by subtracting the minimum temperature from the maximum temperature and dividing by two: (Temperaturemax – Temperaturemin)/2. To convert from GDD in °C used here to GDD in °F, multiply by GDDs in °C by 1.8.



FULL CITATION

Lyons, S.E., Q.M. Ketterings, G.S. Godwin, J.H. Cherney, D.J. Cherney, J.J. Meisinger, and T.F. Kilcer (2019). Double-cropping with forage sorghum and forage triticale in New York. Agronomy Journal 111:3374-3382. doi:10.2134/agronj2019.05.0386.

ACKNOWLEDGEMENTS

This work was supported by Federal Formula Funds, and grants from the New York Farm Viability Institute (NYFVI) and Northeast Sustainable Agriculture Research and Education (NESARE). For questions about these results, contact Quirine M. Ketterings at (607) 255-3061 or qmk2@cornell.edu, 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, Department of Animal Science, Cornell University. **Jerome H. Cherney** is with the Soil and Crop Sciences Section of the School of Integrative Plant Science. **Debbie J. Cherney** is with the Department of Animal Science, Cornell University. **John J. Meisinger** is retired from the USDA-ARS Beltsville Agricultural Research Center, Beltsville, MD. **Thomas F. Kilcer** is with Advanced Agricultural Systems, LLC, Kinderhook, NY.

Food waste coming on the farm? Consider where the nutrients go and manure processing for nutrient export

Pete Wright, Karl Czymmek, and Tim Terry

OPPORTUNITIES FOR FOOD WASTE ON DAIRY FARMS

Public policy is increasingly evolving to reduce or divert waste from limited landfill space. One way to accomplish this is by reducing the many tons of organic waste such as food processing waste, food scraps, and spoiled fruits and vegetables that are landfilled annually. These materials have nutrients and organic matter that can be beneficial to farms when managed properly. Dairy farms are used to handling large volumes of manure, and they have equipment and expertise that could be useful to manage organic material diverted from landfills. So what are the options for dairy farms?

Dairy farms may have more opportunities to take organic materials diverted from landfills in the future. This food waste may benefit the farm by providing organic solids as soil amendments, nutrients (if needed on the farm), and energy if fed through an anaerobic digestion (AD) system. The tipping fees that accompany the food waste may provide a revenue stream for the farm, but there will likely be extra equipment, labor, and structural costs, as well as management time to properly handle these materials. Before planning to take food wastes, the farm should examine their manure handling system and nutrient management plan (NMP) to determine the impact of additional volume and nutrients, and if they have enough land for sound nutrient recycling. There are advanced manure treatment technologies that may enable excess nutrients to be removed and or exported off the farm if adequate land base is not available to recycle the nutrients according to a nutrient management plan.

Diverting food waste and other organics from landfills saves space in the landfills and also reduces the potential release of methane as the organic material degrades in the landfills. Many landfill operations have systems to capture the biogas produced and either flare it or convert it to renewable energy by generating electricity through an engine generator or cleaning the biogas to upgrade it to pipeline quality and selling it as renewable natural gas (RNG).

There is quite a variety of potential organic material that may be offered to farms for recycling and each source needs to be evaluated for its handling requirements and impact on the farm system. Food waste from food processing plants will generally be delivered in bulk. If these materials have a high liquid content, handling and storage will need to be carefully managed if the liquid cannot be contained because runoff to streams can be problematic. The concentration of volatile solids (VS) (that can be converted to biogas in an AD) and nutrients may vary depending on the source and dilution water. Because of the dilution that occurs, any cleaning chemicals will likely not be a concern. Rejected food products that have expired, don't meet standards, or have been recalled, will typically have a consistent nutrient content but will need to be de-packaged. There are de-packaging machines. Post-consumer organic wastes will also vary in content (depending on menu changes) but may be provided more consistently, although still may change as attendance changes in schools or the hospitality industry. Post-consumer products very likely will also have sorting problems where non-organic materials have been inadvertently included.

The farm can expect an added revenue stream from food waste. Tipping fees for food waste can be considerable as landfilling may be prohibited or landfill tipping fees may be high. If the food waste can be added to an anaerobic digester there will be substantially increased biogas production depending on the food waste source. Food waste typically contains much more biodegradable VS (that are converted to methane) than manure.

Using food waste residue in a nutrient management plan takes careful management. The nitrogen and phosphorous in food waste may be more readily available than the nutrients from manure. The carbon in food waste will typically also degrade faster than manure. Building organic matter in soils with food waste may not occur to the degree you may want.

There are detriments to importing food wastes, besides the potential packaging from post-processed waste and incidental trash items mixed with post-consumer waste. Think about how confusing it is at events or retail locations when there are three different bins for you to toss things into after a meal. The additional mass and additional nutrients will need to be incorporated into your farm's manure system and your NMP. The extra volume will fill storage space so either more storage will be needed or the storage period will be reduced. Extra volume means an increase in spreading costs (extra labor, equipment, and energy use need to be considered as well). If it costs one cent a gallon to truck to the farthest fields and you get seven cents a gallon tipping fee, your net is reduced. The nutrients recycled back to the land need to be balanced. A high-phosphorous (P) food waste may push the farm out of a balance for P. Having a NMP that accounts for the additional nutrients will help protect the environment while satisfying both regulators and concerned neighbors. Farms with a CAFO permit must account for these nutrient sources in their nutrient management plans. Certainly there can be adjustments to the NMP. Cropping more land that will be able to receive the added nutrients, increasing yields, double-cropping to

Continued on page 10

MANAGING INPUTS

Food waste coming on the farm? Consider where the nutrients go and manure processing for nutrient export,

cont'd from page 9

take up more nutrients or exporting the nutrients are all possibilities.

Added revenues from the importation of food waste may improve the opportunity to use advanced manure treatment technology to reduce mass and nutrients. AD will only reduce the mass of the volatile solids (VS) that is biodegraded, leaving most of the processed digestate with all of the nutrients to be dealt with. AD will create a homogeneous liquid that will be easier as a consistent liquid to further treat.

Table 1 shows a number of manure treatment technologies to remove nitrogen (N) and/or phosphorus (P) with a brief description. The table assumes that the co-digested manure has gone through an anaerobic digester and a solid liquid separator.

The capital and operating costs of each of these advanced manure treatment technologies need to be evaluated with a partial budget including the value of the tipping fees, reduced transportation costs, and any by-product sales. Fact sheets on advanced manure technology are available on the manure treatment section of the PRO-DAIRY website (cals.cornell.edu/pro-dairy/our-expertise/environmental-systems/manure-management/manure-treatment).

TABLE 1

Manure treatment technologies to remove nitrogen (N) and/or phosphorus (P).

Manure Treatment Technology	Description
TREATING SOLIDS AFTER AD AND SOLID LIQUID SEPARATION	
Windrow composting	Composting solids outside can produce bulk compost for export but may require a large area and months of curing.
Accelerated composting	Composting solids in a more controlled environment with air added and mixing frequently will produce a compost product for bagged sales.
In-vessel drum composting	Mixing, heating and aerating solids for a short period will produce a partially composted product suitable for bedding.
Evaporation mixing	Solids are heated, mixed and aerated until at 20 percent moisture, so they can be exported in bulk or pelletized.
Gasification/Pyrolysis	Solids are heated, mixed and aerated until at 20 percent moisture, so they can be exported in bulk or pelletized.
TREATING LIQUIDS AFTER AD AND SOLID LIQUID SEPARATION	
Vermifiltration	Filtering the liquids through a raised worm bed. Worms and vermicompost can be sold. Low nitrogen liquid remains for irrigation.
Nitrogen removal	Liquids processed chemically or biologically to release N as N2. Low nitrogen liquid remains for irrigation.
Centrifugation	Liquids are centrifuged to obtain a solid (for further treatment or export) and a dilute liquid for irrigation.
Dissolved Air Flocculation (DAF)	Liquids are aerated (with or without a flocculent) so solids can be skimmed off for further treatment leaving a dilute liquid for irrigation.
Reverse osmosis	Dilute liquids under pressure move nutrients through a selective membrane to produce a lower concentrated liquid.
Ultrafiltration	Dilute liquids under pressure remove very fine particles based on a limited pore size (bacteria, etc.) to produce less concentrated liquid.
Sequencing batch reactor	Alternating between aerated mixing and anaerobic settling allows high P semi-solid removal (from luxury uptake by bacteria) and a low P liquid.
Hydrothermal carbonization/ liquification	Under controlled high pressure, and high temperature a bio-oil, dilute liquid and biochar can be produced.

Pete Wright, **Karl Czymmek**, and **Tim Terry** are specialists with Cornell CALS PRO-DAIRY.

Soil organic matter as a nitrogen source

Karl Czymmek, Jonathan Berlingeri, and Quirine Ketterings

Plants need nitrogen to grow and produce high-quality crops. How much will be required is difficult to predict with absolute certainty. What we do know is that the soil in crop fields can be a very important source of nitrogen for crop growth. Farmers and crop advisors will need to better understand a soil's ability to supply nitrogen to ensure that added nitrogen from fertilizer and manure is enough for optimum yields. Estimating the nitrogen contribution from soil is challenging as weather conditions and management can greatly influence the supply. However, some estimation is needed as mistakes in nitrogen fertilizer management can be costly.

LET'S DO A CALCULATION

If a farm field with a silt loam soil has

3.5 percent organic matter by weight and we assume there are about two million pounds of soil per acre in the top six inches of soil, the total amount of organic matter in that "acre-furrow slice" is about 70,000 pounds. If organic matter has an average of about 10 percent nitrogen, there are approximately 7,000 pounds of nitrogen per acre in the top six inches of soil. Only a small portion of this nitrogen will be available to a growing crop each season, but a small portion of 7,000 pounds can be significant. A common and possibly conservative rough estimate is that one percent of the total nitrogen will be available each year to a crop. In this example, 70 pounds of nitrogen is expected to be available for crop uptake due to breakdown of soil organic matter alone. Fields with higher overall organic matter, a history of manure addition, or large amounts of active organic matter are likely to provide even more nitrogen to a crop each year.

All nutrient management plans should account for soil's natural ability to supply nitrogen. Granted, in most situations, nitrogen made available through organic matter mineralization alone is not enough to support optimum crop yields for corn or grass, but ignoring this contribution can result in excess nitrogen application with fertilizer and manure.

We know crops like corn and grass hay that take up large amounts of nitrogen, and are unable to fix nitrogen from the air, will suffer significantly when nitrogen is in short supply. We also know that due to unavoidable losses and biological inefficiencies, more nitrogen needs to be supplied than will be taken up by the crop.

To the farmer, the yield and quality penalties for not supplying enough nitrogen are substantial. However, excess nitrogen has environmental implications. In wet conditions, nitrogen fertilizer remaining after harvest is not likely to be carried over to the next growing season and may be lost to the environment. Increasingly, in irrigated regions, we are hearing about groundwater concerns from the nitrate form of nitrogen leaching into groundwater.

In addition, the retail chain is increasingly interested in production practices on dairy farms, and processors are being asked by many organizations to fill out forms about practices used on the dairy farms that ship milk. Some retailers want to know how much nitrogen is used to produce a ton of corn silage. This suggests that it will also be important to continue to refine dairy farm nitrogen use to maintain a market for milk. Routine annual evaluations of nitrogen management are an essential step toward this goal. Such assessments leverage data from current practices to provide a basis to fine-tune estimations of nitrogen supply from organic matter, crop residue, and manure applications under various weather conditions and management practices. ▮

Karl Czymmek is with PRO-DAIRY and the Cornell Nutrient Management Spear Program. **Jonathan Berlingeri** and **Quirine Ketterings** are with the Cornell Nutrient Management Spear Program.

In pursuit of improved nitrogen management for corn silage: Tracking field nitrogen balances

Jonathan Berlingeri, Karl Czymmek, and Quirine Ketterings

There are numerous approaches to manage nitrogen to fertilize crops. Many of the pros and cons were described and summarized in the 2018 Agronomy Journal publication "Strengths and Limitations of Nitrogen Rate Recommendations for Corn and Opportunities for Improvement." This document was co-authored by 21 research and extension specialists representing 12 land-grant universities, USDA-Agricultural Research Service, and the International Plant Nutrition Institute. This publication (acsess.onlinelibrary.wiley.com/doi/full/10.2134/agronj2017.02.0112) ends with the recognition that we must be mindful that ease of use and cost to farmers are two factors that have profound effects on the adoption rate of any improvement in nitrogen recommendation systems. As the authors stated: "We must keep it practical and inexpensive to ensure that it is realistic for farmers to use on a routine basis."

SO, WHAT CAN WE DO?

For the success of any improved system, it is important to be able to evaluate if a shift in management was an improvement after all. While on-farm replicated trials are a great way to evaluate practices, including nitrogen management, not every farm can implement such trials. Tools such as the pre-sidedress nitrate test (PSNT) to monitor soil nitrate levels before fertilizing or cornstalk nitrate test (CSNT) used as a measurement of the nitrogen status of the corn plant, can help. However, taking soil or stalk samples adds to the peak workload of farmers and farm advisors, and there is a cost associated with sample collection and analysis. Is there any other way to

Continued on page 12

MANAGING INPUTS

In pursuit of improved nitrogen management for corn silage: Tracking field nitrogen balances*, cont'd from page 11*

check on nitrogen management that takes into account not only nitrogen added from fertilizer and manure but also nitrogen supplied by soil organic matter mineralization, nitrogen from cover crops, and crop residues (shoots and roots), and nitrogen supplied with manure, based on information already collected? This is where field nitrogen balances come in.

WHAT IS A FIELD NITROGEN BALANCE?

In its most straightforward description, a field nitrogen balance is the difference between the nitrogen accumulated in the crop over a growing season (nitrogen uptake) and the amount of nitrogen made available to the crop (nitrogen supply) within the boundary of a farm field. Thus, the nitrogen balance is the amount of nitrogen applied and released to the soil solution not taken up by the plant. The bigger this number, the greater the amount of nitrogen that is available for loss to the environment. Soil organic matter mineralization will take place in every growing season. Crop residues, past and current manure applications, and fertilizer additions will supply nitrogen as well. All these sources need to be taken into account when calculating a nitrogen balance. While estimates of nitrogen from soil, crop residues, and previous years' manure application can be somewhat uncertain, nitrogen balances calculated without these components are incomplete and could trigger the incorrect assumption that more fertilizer is needed. Field testing can help farmers become more comfortable with crediting these various sources of nitrogen.

If we take into account the major nitrogen supplies as shown in **Figure 1** and the total nitrogen supply greatly exceeds nitrogen uptake, the difference (i.e. nitrogen not used by the crop) is susceptible to loss to the environment. Thus, a nitrogen balance can help us identify where the risk of nitrogen loss is largest, allowing for troubleshooting and evaluation of other approaches in future years. This assessment is most useful when a farm derives nitrogen balances for every field and then ranks the fields based on the balance **(Figure 2)**, enabling selection of fields with the most excessive balance for alternative management. Ideal balances are greater than zero but not extreme in normal circumstances. If fertilizer or manure applications contribute to a large N balance, this indicates opportunities to adjust rates without impacting yield.

Our suggestion: measure yield and start tracking nitrogen supply. Once yields are determined, derive field N balances, rank them from low to high as done in **Figure 2**, and consider why balances are the way they are. Focus specifically on fields with negative balances and fields with balances that are, for example, 100 lbs. of nitrogen per acre or higher. Fields will differ in their ability to cycle nitrogen and therefore it is important to evaluate each individually. Nitrogen efficiency in poorly drained fields is often lower than for better-drained fields, so drainage issues can play a role in nitrogen balances too. For fields with the highest balances, was the yield low this year due to drought or a pest control problem? If so, address pest control issues or evaluate the field under more optimal growing conditions before making major changes. Is the field well-drained and high-yielding but balances are still high? Then the nitrogen applied may have been more than the crop needed. ▮

Karl Czymmek is with PRO-DAIRY and the Cornell Nutrient Management Spear Program. **Jonathan Berlingeri** and **Quirine Ketterings** are with the Cornell Nutrient Management Spear Program.

FIGURE 1

Field nitrogen balances can be derived by subtracting nitrogen uptake by a crop (grey bars) from nitrogen sources for plant growth (nitrogen from fertilizer, manure, soil organic matter mineralization, and crop residues or sod).

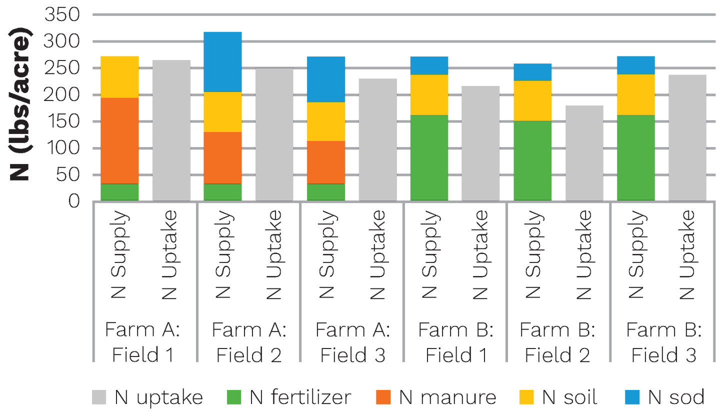
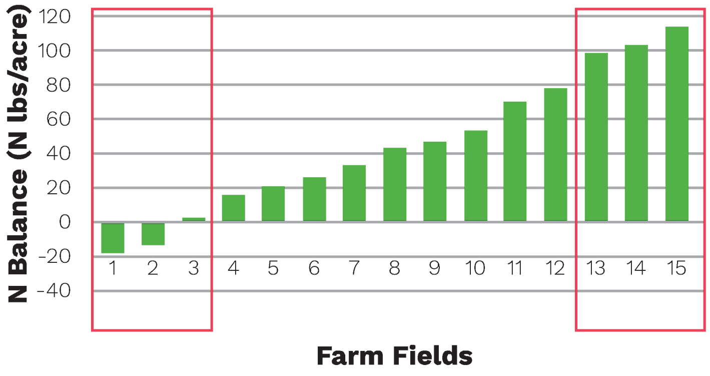


FIGURE 2

Assessment of nitrogen balances for corn silage (nitrogen supply – nitrogen uptake) for every field on a farm in a specific growing season allows farmers to identify fields where further analyses is needed and where management changes may be considered in future years.



Biological control of corn rootworm with native N.Y. entomopathogenic nematodes

Elson Shields

In 2021, the level of corn rootworm (CRW) resistance to the current Bt-RW corn varieties will increase another significant level with associated yield losses. Throughout the corn-growing regions of the U.S. and Canada, increased CRW root damage, yield losses, and increased levels of CRW resistance have been reported to all commercial corn varieties containing all of the different BT toxins effective on CRW. This increased CRW root damage, yield losses, and increased levels of CRW resistance have also been reported in N.Y. and the northeastern U.S.

Corn growers need to seriously consider implementing CRW strategies to reduce the selection of increased resistance in CRW, to protect this technology and protect their yields, because new GMO-RW technologies are a few years from widespread availability.

Biological control is the use of naturally occurring insect diseases, parasites and predators to reduce pest insect populations.

Classical biological control is the use of these organisms which are so adapted to the environment where they are released that they continue to reduce the insect pest population for multiple years from a single introduction/application.

Thirty years of research in New York has yielded a new biological strategy for corn rootworm in New York and throughout the Corn Belt. The discovery of using native New York entomopathogenic nematodes (EPNs) that have not lost their genetic ability to persist across adverse conditions, along with mixing EPN species to cover the agricultural soil profile, controls soil insects including CRW, across multiple growing seasons with a single application. This new strategy has opened a new door in biological control of a broad range of agricultural soil insect pests.

The concept of using native EPNs in EPN species mixes to tackle soil insect pest problems was developed during research to find an effective management strategy for alfalfa snout beetle, an insect that destroys alfalfa in a single year with its root feeding larvae. Alfalfa snout beetle is currently restricted in North America to nine northern New York counties and a small portion of southeast Ontario, Canada. Currently, the concept of applying a single application of native persistent EPNs for multi-year control of alfalfa snout beetle has been applied to more than 28,000 alfalfa snout beetle-infested acres. As a result, alfalfa stand life has returned to four to six years rather than one to two years. Within this research, it was observed that these native EPNs are also effective on CRW, when the alfalfa field was rotated to corn.

CRW BIOLOGICAL CONTROL RESEARCH

In 2014, research was initiated at the Cornell Musgrave Farm to test the concept of using the same technology developed to combat alfalfa snout beetle against CRW in continuous corn. A first-year cornfield was planted in 2014 and inoculated with native New York persistent EPNs. Starting in 2015 and continuing through 2020, six rows of the following Bt-RW traited corn varieties were planted both in the nematode-treated areas and the areas where EPNs were not present. Those Bt-RW varieties were 1) non-Bt-RW, 2) Yieldgard (Cry3Bb1), 3) Herculex (Cry34/35) and 4) Smartstak (Cry3Bb1 + Cry 34/35). The research was designed to compare the impact of persistent EPNs against CRW within a Bt-RW trait package. For example, non-Bt-RW was planted in both the EPN-present plot areas and the non-EPN-present area and could be directly compared. Similar comparisons could be made with the other three Bt-RW trait packages.

During the first week of August each year, roots from each treatment were dug, washed, and scored for CRW larval feeding damage. Root damage scoring used the zero to three Iowa scale, where economic losses start occurring between a rating of 0.5 (1/2 root node damaged) to 1.0 (one full node damaged) depending on the level of soil moisture and conditions for root regrowth.

DISCUSSION OF THE RESULTS

In the research areas where non-Bt-RW corn was planted for the past seven years, results indicate a significant reduction of CRW feeding damage in the areas where New York native, persistent EPNs were inoculated in 2014. In 2016, very heavy CRW larval pressure resulted in almost two root nodes destroyed (1.85) in areas where EPNs were absent, a level significantly above where economic losses occur (0.5 to 1.0). By comparison, the areas where EPNs were inoculated in 2014 and present, the CRW root feeding damage was 0.2 root nodes damaged, well below the economic loss level (89 percent reduction in damage). The following two years (2017 and 2018) were very wet during the CRW larval hatching period and the larvae drowned from field capacity soils. CRW populations were reduced area-wide and started building again in 2019. In 2019, the CRW larval population started building with the root feeding damage 0.5 nodes where EPNs were absent, an economic threshold level during the drought of 2019. In areas with EPNs, the damage was reduced to sub economic levels (0.25 nodes damaged) and a damage reduction of 50 percent. Similar results were recorded in 2020 with the non-EPN plots suffering 0.6 nodes damage and the presence of EPNs reduced the damage to 0.1 node (86 percent).

Starting in 2019, field emergence cages were placed in the field to collect emerging CRW beetles. Within those

Continued on page 14

MANAGING INPUTS

Biological control of corn rootworm with native N.Y. entomopathogenic nematodes, *cont'd from page 13*

field cages, the soil became very dry and indicated the impact of droughty soils on EPN activity against CRW. CRW feeding is not hampered by dry soils because they are feeding on a water source, the plant roots. However, since EPNs move about in the soil on the film of water on each soil particle, dry soils reduce their ability to search and find insect hosts. Those results are indicated in 2019 (under droughty soils) where the soils became extremely dry and the activity of EPNs was greatly reduced (24 percent). In 2020, the soil in the field cages had a higher water content and the control by EPNs returned to a higher level of control with an 86 percent damage reduction.

During the past seven years of the study, the resident CRW population has developed resistance to one of the Bt-RW traits as reported in **Table 2**. In 2016, the CRW root damage in both areas (without EPNs and with EPNs) was very low (0.2 nodes damaged) and sub-economic. Wet spring soils in 2017 reduced the CRW larval population and no root damage was present. However, in 2018 the results started to become interesting. In areas without EPNs, the CRW root damage on the Bt-RW traited variety was 0.7 nodes, an economic level in a Bt-RW trait package previously not being damaged by CRW. The presence of EPNs reduced the damage 86 percent to a sub-economic level (0.1 node damaged). In 2019, damage to the Bt-RW traited corn increased to 1.1 nodes damaged, an economic level and the presence of EPNs reduced the damage 82 percent to sub-economic level (0.2 nodes damaged). Similar results occurred in 2020, with CRW feeding damage equal to 0.8 root node damaged without EPNs present and a sub-economic level in the presence of EPNs (0.2 nodes damaged, 75 percent damage reduction).

As with the non-Bt-RW traited corn, field emergence cages were placed in the field in 2019, to collect emerging CRW beetles. Within those field cages, the soil became very dry and indicated the impact of droughty soils on EPN activity against CRW. In 2019, the CRW root damage level was 1.9 nodes damaged without EPNs and 0.7 nodes damaged, a 63 percent reduction in root damage with EPNs present. In 2020 within the cages, CRW damage was 1.4 nodes damaged without EPNS and the damage level was reduced to a sub-economic 0.3 nodes damaged when EPNs were present (79 percent damage reduction).

RESULTS SUMMARY

Research results over seven growing seasons from the Cornell Musgrave Farm strongly indicate the inoculation of fields with New York native EPNs will provide sufficient CRW control in rotated corn to allow you to grow non-Bt-RW corn without additional protection **(Table 1)**. In New York corn rotated with alfalfa, the usual rotation is four years alfalfa and four years corn. In this rotation, CRW is a potential economic problem for years two, three and four, with increasing risk each year of continuous corn. The usually sub-economic level of CRW larvae in year two corn will help to increase the resident EPN population for the typically higher numbers of CRW larvae in years three and four. Decreased CRW control was only observed under the conditions of extremely dry soil during June and July, which limit the EPNs' ability to locate and kill CRW larvae. Under these conditions, the impact of drought on yield has a greater impact than increased CRW root damage from reduced EPN efficacy. One additional benefit of soil inoculated with native New York EPNs is the suppression of wireworm and white grub in first-year corn. These insects build up during the alfalfa/grass portion of the rotation and at times damage first-year corn. Research has shown that these EPNs attack these insects as hosts during the alfalfa/grass crop and the populations of these insects are dramatically reduced when the field is rotated to corn.

Data in **Table 2** indicates that EPNs are not only compatible with Bt-RW traits in corn, but when those traits begin failing due to CRW resistance

TABLE 1

Corn rootworm damage in the presence and absence of EPNs in non Bt-RW traited corn. CRW damage was rated using the Iowa 0-3 scale.

Year	No EPNs	EPNs	EPNs Damage Reduction
2016	1.85		
2017 & 2018	No significant CRW pressure		
2019	0.5	0.25	50%
Droughty soil (within emergence cages)	2.1	1.6	24%
2020	0.6	0.1	86%
Drier soil (within emergence cages)	0.7	0.1	86%

TABLE 2

Corn rootworm damage in the presence and absence of EPNs in failing Bt-RW traited corn. CRW damage rated using the Iowa 0-3 scale.

Year	No EPNs	EPNs	EPNs Damage Reduction
2016	0.2	0.2	89%
2017	No significant CRW pressure		
2018	0.7	0.1	86%
2019	1.1	0.2	82%
Droughty soil (within emergence cages)	1.9	0.7	63%
2020	0.8	0.2	75%
Drier soil (within emergence cages)	1.4	0.3	79%

development, the presence of EPNs reduce the damage to below the economic threshold. This activity of EPNs under Bt-CRW traited corn provides a mortality factor independent of the Bt toxin, delays the development of CRW resistance by killing the toxin survivors, and extends the life of Bt-RW traits against CRW.

ACKNOWLEDGEMENTS

These research results, and their application to New York and U.S. agriculture, were made possible only with the long-term financial support of Northern N.Y. Agricultural Development Program, N.Y. Farm Viability Institute, Cornell University, and USDA funding from Hatch and multi-state programs.

Elson Shields (es28@cornell.edu) is a professor with the Department of Entomology, Cornell University.

Native New York EPNs expand to the national corn production scene

Positive New York research results on controlling CRW has created an interest in New York native EPNs across the Corn Belt, resulting in a number of cooperative research and demonstration projects across several states. Their efficacy is being evaluated at Pennsylvania State University and the University of Vermont. In 2017, research plots were established in the high plains of northwest Texas under center pivot irrigation. In 2019, cooperative research was initiated in Roswell, New Mexico, under irrigation. At both these locations, the Bt-RW traited corn was suffering extreme CRW feeding damage. In 2020, additional sites were established in northeast Iowa and western Nebraska. Both areas have reported Bt-RW failures. In all sites, New York native EPNs have established and persisted at populations sufficient to suppress CRW larvae. Multi-year research will document the suppression of CRW damage in the presence of EPNs and the interim data looks excellent and promising.

HOW ARE NATIVE EPNS APPLIED?

There are two methods developed to apply native EPNs to your field.

Pesticide sprayers

All sizes of pesticide sprayers, from 30 ft. to 120 ft. booms, have been successfully used to apply native EPNs to New York fields by adhering to the following requirements.

1. Remove all filters and screens from the sprayer lines and nozzles. These screens and filters block nematodes and prevent them from being applied.

2. Change the nozzles to a "stream type" nozzle so the stream of water/nematodes hits the ground in a solid stream. With nozzle spacing around 24," there will be a stream of concentrated nematodes and water every 2 ft. or so. Water splash hitting the ground fills in some of the gap between the application streams.

3. Apply nematodes in a minimum of 50 gpa. There needs to be enough water to thoroughly wet the area where nematodes are applied under all conditions to allow the nematodes to enter the soil.

4. Application needs to be either in the evening or on cloudy/rainy days. Nematodes are easily killed by UV (ultraviolet light) and need time to enter into the soil where they are protected.

5. Once the nematodes are dumped into the tank, they need to be applied on the field within an hour. During the hour in the tank, the tank needs to be agitated to keep the nematodes suspended in the water.

Liquid Dairy Manure

Native EPNs have been successfully applied in liquid dairy manure if the manure is spread on the field within 30 minutes of adding the nematodes to the tanker. Most growers add the nematodes during tanker filling to mix the nematodes through the manure and spread the manure on a field within 30 minutes. If the manure is not spread within 30 minutes, the nematodes start dying from lack of oxygen.

NEMATODE SOURCE AND COST

The cost of native New York EPNs run between $50 to $75 per acre, depending on the quantity purchased. Native New York EPNs can be purchased from Mary DeBeer, Moira, N.Y., (518) 812-8565 or md12957@aol.com. We have worked closely with Mary on the rearing practices to prevent her cultures of New York native EPNs from losing their persistent genetics. Mary has provided New York persistent biocontrol nematodes to farmers for six years.

In addition, interested farmers can contact the Shields' Lab at Cornell to purchase nematodes or to answer any questions (Cornell University – Shields' Lab es28@cornell.edu).

UPCOMING PROGRAMS

2021 VIRTUAL HERD HEALTH AND NUTRITION CONFERENCE

cals.cornell.edu/pro-dairy/events-programs/conferences-seminars

April 5 – 6, 2021

Presented in collaboration with Northeast Agribusiness and Feed Alliance, this annual conference provides an opportunity for dairy producers, veterinarians, feed industry representatives, and agriservice personnel to increase their knowledge of current herd health and nutrition management techniques while interacting with other professionals.

TROUBLESHOOTING HERD HEALTH ISSUES ON YOUR DAIRY PODCAST SERIES

cals.cornell.edu/pro-dairy/events-programs/podcasts

PRO-DAIRY and Cornell Cooperative Extension have launched a new podcast series: Troubleshooting Herd Health Issues. Episodes discuss specific areas to examine when experiencing issues in different life stages of the dairy cow including: pre-weaned calves, weaning transition, post-weaned heifers – disease and growth issues, heifers – reproduction, calving, transition cow issues, and mastitis.


MIN-AD
MIN-AD