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In the first 48 hours

Transition milk offers more IgG than colostrum

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CURRENT ISSUES

INSIDE

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Why there is no such thing as colostrum quality

Vimal Selvaraj, Kasey Schalich, and Rob Lynch

In the early 1800s, Adolf Brix introduced specific gravity measurements as a method to estimate the sugar concentration in liquids. Even today sugar concentration by percentage mass is measured using the Brix refractometer in the beverage industry, including for ripening wine grapes and other juices and beer. In 1978, the Brix refractometer was first experimented as a crude method to estimate the immunoglobulin G (IgG) concentration in horse colostrum. Since the late 1990s the dairy industry has recommended this method to determine IgG content in cow colostrum. Given the original design and use of the Brix refractometer, and the distinct physical properties of proteins and sugars, we performed a simple study to investigate the question: What components in colostrum make up the Brix score?

To address this, we measured the Brix score of colostrum samples before and after removal of lipids, proteins, and sugars. Our results showed that lipids did not influence Brix scores, but sugars and proteins have an almost equal influence on the Brix score, indicating that colostrum Brix scores are a reflection of both the sugar and protein content. To us these results were quite eye-opening, as variations to sugar content or proteins other than immunoglobulins do not appear to be discussed with regards to how they can influence colostrum Brix scores. Identifying these variables then raised another important question: How well correlated is the relationship between colostrum IgG concentration and Brix scores?

In a field test, we collected colostrum samples from primiparous and multiparous Holstein cows with a range of low to high Brix scores and directly quantified the sample IgG concentrations in the lab. We did not find a significant correlation. In other words, our results show that high Brix colostrum does not necessarily mean it has high IgG, and low Brix does not mean it has low IgG. Given the makeup of variables that contribute to the Brix score, this finding that Brix scores and IgG concentrations are not correlated made sense.

HANG ON, THIS GOES AGAINST PREVIOUS RESEARCH!

So why are our results so different from previous research that seemed to establish a relationship between Brix and IgG? The answer is because we are simply using new and more rigorous technology to specifically quantify IgG. This is in contrast to older laboratory techniques that, while cutting-edge when first used in the 1970s to 1990s, today over 30 to 50 years later, are known to have significant shortcomings as highlighted in several studies. Ultimately, in light of these findings on how IgG is just one of several variables

that contribute to the Brix score, we offer two points to consider in the formulation of calf feeding protocols.

FIRST

Because Brix score and IgG concentration are not correlated, the concept of "colostrum quality" does not have strong evidence. This means that since we aren't gaining any information about IgG concentration from checking the Brix, four liters of any available colostrum can just be fed to calves for their first meal.

SECOND

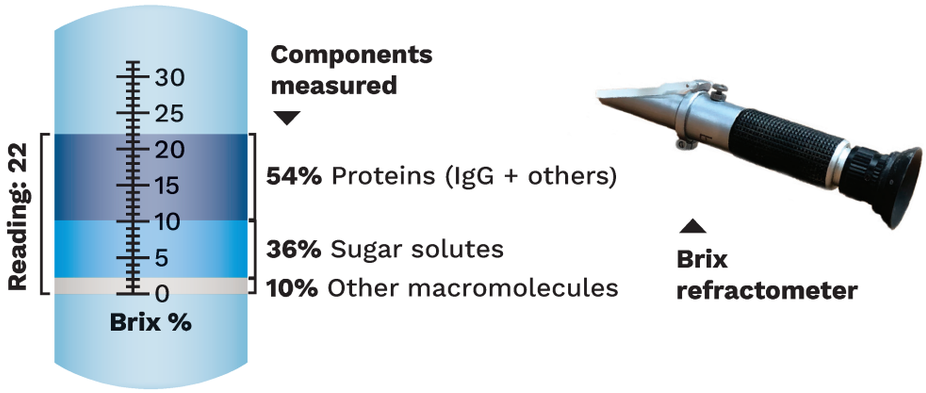
While research has made clear the importance of feeding IgG to calves, the relevance of which IgG is fed (what specific pathogens the IgGs binds to) has not received appropriate equal consideration. From immuno-physiology we know that the IgG a cow provides is specific to the pathogens on that dairy. As such, IgG in maternal colostrum is much more protective and relevant to the environment where the calf is raised than IgG in commercial replacements that is likely derived from cows living far off site and exposed to a different cohort of pathogens. Therefore, even lower levels of highly relevant IgG are far superior than high levels of irrelevant IgG.

CONCLUSION

Ultimately, we believe that our results are exciting because they indicate producers do not need to measure colostrum Brix scores or have to worry about having enough colostrum above a "cut-off" Brix score. We now know such cut offs are quite arbitrary. For the first meal, we recommend just feeding four liters of colostrum. It is much better for neonatal calves than any replacement formula. Colostrum, irrespective of its Brix score, is still the finest choice for feeding calves. ▮

FIGURE 1

Component breakdown of a representative sample Brix score of 22



Only 54 percent of a Brix score represents proteins (IgG and other protein components in colostrum). The remainder of the Brix score is made up of sugars (36 percent) and other non-protein macromolecules (10 percent). All these represent variables that contribute to a Brix score reading.

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Reference

Schalich KM, Reiff OM, Nguyen BT, Lamb CL, Mondoza CR and Selvaraj V. (2021). Temporal kinetics of bovine mammary IgG secretion into colostrum and transition milk. Journal of Animal Science. doi:10.1093/jas/skab083.

"Producers do not need to measure colostrum Brix scores... We now know that such cut-offs are quite arbitrary."

CURRENT ISSUES

Transition milk has a lot of immunoglobulins

Vimal Selvaraj, Kasey Schalich, and Rob Lynch

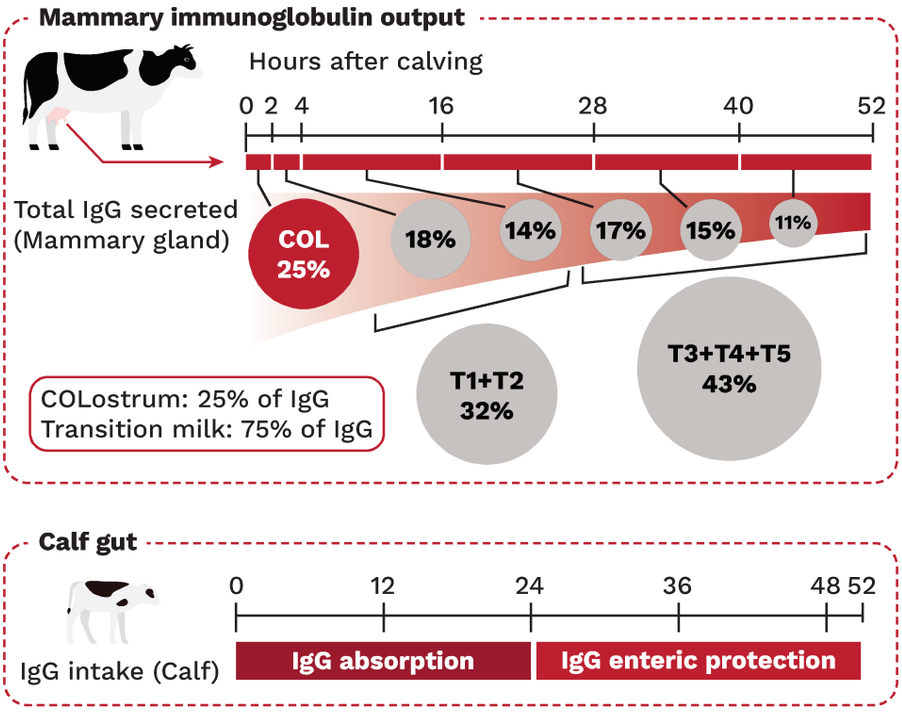
Antibodies in the dam's colostrum, specifically immunoglobulins G and A, are the reason why newborn calves are able to immediately combat bacterial and viral pathogens in the environment. Based on early research, the predominant recommendation to improve calf survival rates and health has been to feed newborn calves first-milking colostrum to obtain maternal IgG.

Yet even with a single colostrum feeding, failure of passive transfer (FPT) still occurs at high rates, ranging between 12.1 to 37.1 percent in different studies on North American dairies. Recognizing this problem, it is being increasingly advocated to provide a second colostrum feeding to calves. But is this enough? And what do we know about the IgG content of transition milk? Could it also provide immunological value to calves? From a physiology perspective we reasoned that transition milk might also have high levels of IgG that can be collected and fed to the calf not only to increase the amount absorbed before gut closure, but also fed after gut closure to protect against harmful microorganisms inside the gut that would otherwise cause gastrointestinal infections. This is called enteric protection.

To investigate this possibility, we measured the IgG content in six sequential, complete milkings including colostrum (less than two hours after calving) and transition milk (4, 16, 28, 40 and 52 hours after calving) in Holstein dairy cows. To our surprise, we found that only 25 percent of all IgG is secreted into colostrum and that the remaining 75 percent of IgG is secreted into the next five milkings in transition milk **(Figure 1)**. Together with findings that we presented in our companion article "Why there is no such thing as colostrum quality," it is clear that feeding transition milk would have substantial benefits, especially considering that we do not know the full profile of other beneficial immune, growth, and developmental factors that are not present in milk replacers. From a practical standpoint, while transition milk might not look like golden colostrum, it still has very high IgG content (together with other physiological components) and is highly valuable to feed.

FIGURE 1

Transition milk contains 75 percent of the postpartum mammary IgG output



By measuring mammary IgG secretion over the first 52 hours postpartum, we found that only 25 percent of total IgG is secreted in the first milking (colostrum) while 75 percent is secreted into transition milk in the next 5 subsequent milkings. The first two transition milk collections (T1 and T2) contain 32 percent of IgG secreted, while the third through fifth transition milkings (T3, T4, and T5) contain 43 percent of all IgG. Feeding transition milk would offer additional IgG for absorption during the first 24 hours in the calf and IgG enteric protection for the subsequent period of time.

Source: Getty Images

HOW COULD PRODUCERS APPLY THIS NEW INFORMATION ON MAMMARY IGG SECRETION KINETICS TO FEED MORE IGG TO THEIR CALVES?

For one approach, we designed a simple postpartum milk collection and calf feeding protocol that is based on our research on mammary IgG

secretion kinetics and others' research on the gastric emptying rate and natural suckling patterns of calves. We call this protocol the COLostrum-Transition milk feeding method, or COLT feeding method **(Figure 2)**, with COLT2 providing one colostrum (COL) and two transition milk feedings (T2) and COLT5 providing one colostrum (COL) and five transition milk feedings (T5). The COLT2 feeding method enables producers to provide about 74 percent more IgG to calves before gut closure compared to only providing a single four-liter feeding. For producers who desire to capture even more immune and developmental benefits of feeding transition milk we suggest the COLT5 feeding method, which provides five transition milk feedings to calves (T5) and would thus provide about 44 percent more IgG to the calf than the COLT2 feeding method.

COULD FEEDING TRANSITION MILK REALLY BE WORTH THE EXTRA TIME AND EFFORT FOR AN ALREADY TIME-AND-LABOR-STRAPPED HERDSPERSON?

In agreement with some others who have already begun advocating for this approach, we believe it could. First, it allows for producers to take advantage of a free, natural IgG resource to invest in calf immunity up front, thereby reducing the need to purchase and use antibiotics on sick calves. As antibiotics seriously harm the establishing gut microbiome in calves and are major contributors to the public health threat of antimicrobial resistance (AMR), preventing the need to use them is a good thing. Second, while IgG is primarily talked about in the context of absorption before gut closure, feeding immunoglobulins beyond the timing of gut closure is extremely valuable to extend protection against pathogens in the gut by binding and immobilizing pathogens that cause problems like scours. Third, besides IgG, many researchers have noted that early mammary secretions have key nutrients, growth factors, and other signaling factors that are crucial for both development of the calf gut and whole body via mechanisms that we are just beginning to understand.

CURRENT LABOR LIMITATIONS VERSUS THE LONG-TERM PAYOFF

While the reality of labor limitations on dairy farms cannot be understated, especially in the United States, an up-front investment into feeding transition milk to neonatal calves could at least help reduce labor spent on the headache of treating and monitoring sick calves. Others' research also suggests an additional return on investment from feeding transition milk, including better animal development, lower age at first pregnancy, and higher milk production later in life. We find the growing dairy science research interest on transition milk to be an exciting opportunity to leverage biology for improved calf health in the industry. Whatever the primary motivation for the producer, we believe that implementation of the COLT2 and COLT5 feeding methods will be a valuable investment into the future milking herd. ▮

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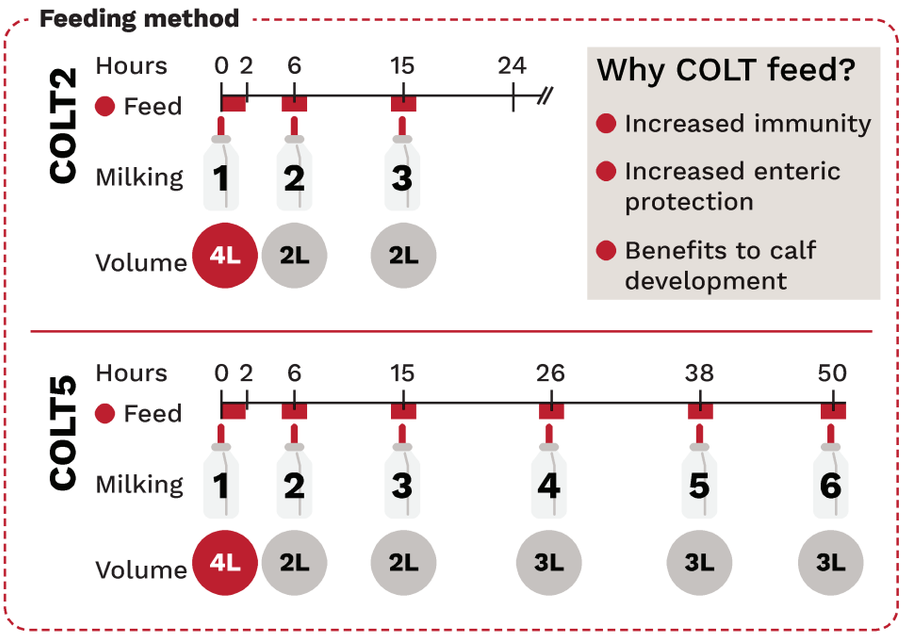
FIGURE 2
The COLostrum-Transition milk/COLT feeding method



By considering mammary IgG secretion kinetics, natural calf suckling behavior and gastric emptying rates, we designed the mammary-matched COLT2 [1 colostrum (COL), two transition milk (T2)] and COLT5 [1 colostrum (COL), five transition milk (T5)] calf feeding programs, which could improve calf health by maximizing the IgG fed for both absorption (before 24 hours of life) and enteric protection (after 24 hours of life).

CURRENT ISSUES

Renewable energy options from biogas

Lauren Ray and Peter Wright

Anaerobic digestion of dairy manure and other organic material (e.g., food waste) produces biogas that can be used for renewable energy options. The options in use today include generating electricity and heat using a combined heat and power (CHP) system and producing renewable natural gas (RNG). Other systems have been proposed to work with anaerobic digestion or on their own; these include hydrothermal liquefaction (HTL) to produce biocrude oil, pyrolysis to produce biochar, and pelletizing manure for combustion. CHP systems operating on biogas can use different prime movers, including the common reciprocating internal combustion engine, a gas turbine (e.g., microturbine), and a fuel cell. Each of these requires a level of raw biogas conditioning but can operate on the natural biogas composition of approximately 50 to 60 percent methane and 40 to 50 percent carbon dioxide that an anaerobic digester produces. RNG requires more extensive biogas conditioning and compression to produce a product gas containing typically greater than 97 percent methane for use in compressed natural gas (CNG) vehicles or in place of pipeline natural gas. Each of the renewable energy options are discussed and compared below **(Table 1)**.

COMBINED HEAT AND POWER (CHP)

CHP systems use a prime mover (e.g., engine-generator, microturbine, or fuel cell) to generate electricity and produce heat as a byproduct that can be captured via heat exchangers. Heat is needed to maintain anaerobic digestion's operating temperature of 100°F (typical of mesophilic anaerobic digestion) throughout the year. Each CHP system differs in capital cost, operating and maintenance expense, electric and thermal efficiencies, and gas conditioning requirements **(Table 1)**. Selection should be based on the priorities and needs of the project.

Typically, CHP systems fueled by biogas produce more electricity than the on-farm annual usage. Therefore, it is important to consider the local utility interconnection requirements and tariffs that are offered. Can all the electricity or any excess not used onsite be exported to the utility grid and at what compensation rate? What is the maximum power demand of the farm site and how does the CHP system capacity compare? CHP systems typically produce excess heat beyond what the anaerobic digester requires that may be used by another on-farm or nearby enterprise.

RENEWABLE NATURAL GAS (RNG)

Producing RNG from biogas has been expanding in recent years due to market opportunities such as the California Low Carbon Fuel Standard (LCFS). RNG is anaerobic digestion biogas that has had hydrogen sulfide (H_2S) removed to trace levels, moisture and carbon dioxide (CO_2) removed, and has been compressed to meet utility pipeline or transportation fuel station specifications. The level of biogas conditioning is much higher with RNG than with CHP systems, therefore increasing the cost and maintenance requirements of those components. **Figure 1** shows the anaerobic digestion biogas conditioning process components needed for electricity and heating systems (CHP included) and that are needed for RNG production. Economies of scale for RNG systems usually begin in the 250 to 300 scfm range of biogas flow, typically aligning with a 3,000-cow dairy.

"Co-digestion of food waste with dairy manure is an opportunity for farms of smaller size to consider renewable energy production opportunities."

In addition to biogas, the anaerobic digester produces digested material as the effluent. This material can be separated and the liquids used for fertilization (typically after long-term storage) and the solids used for bedding, soil amendment, or other products. The design of the anaerobic digested effluent handling and treatment system is a key part of the anaerobic digester project that can impact the farm's permits and nutrient management plan.

OPPORTUNITY FOR FOOD WASTE AD

Co-digestion of food waste with dairy manure is an opportunity for farms of smaller size to consider renewable energy production opportunities. New York State passed a Food Donation and Food Scrap Recycling Law that requires large food scrap generators to donate and recycle food scraps if they are located within 25 miles of an organics recycler, beginning January 1, 2022. The NYS Department of Environmental Conservation has estimated that the

Continued on page 8

TABLE 1

Comparison of commercially available renewable energy options from anaerobic digestion biogas

	Reciprocating internal combustion (IC) engine[1]	Microturbine (small gas turbine)	Fuel cell	Renewable natural gas (RNG)
Single package size range (multiples possible)	1 kW – 10 MW	30 kW – 1 MW	200 kW – 2.8 MW	Typ. 100+ scfm
Example value of processed biogas[2] ($/MMBTU)	$4.70	$4.10	$6.75	$68 (dairy manure) $25 (food waste)
Biogas processing cost[3] ($/MMBTU)	$4.40 – $5.35	$4.30 – $6.85	$10.40 – $18.40	$7.00 – $20.00
Gas compression (fuel pressure in psig)	No/blower (1 – 5)	Yes (1 – 5)	No/blower (1 – 5)	Yes (1 – 5)
H_2S removal target (ppmv)	< 200 – 545[4]	< 5,000 – 6,500	< 1 – 2[4,5]	< 4
Other biogas cleaning?[6]	moisture removal	moisture removal	fuel reformer[7]	moisture removal, CO_2 removal, O_2 and N_2 limits
Electric efficiency (HHV)	27 – 37%	24 – 30%	30 – 63%	N/A
Heat recovery efficiency from cooling system (MMBTU/hr)	12 – 36%	No cooling system	10 – 16%	N/A
Heat recovery efficiency from exhaust (MMBTU/hr)	17 – 24%	36 – 48%	10 – 20%	N/A

[1] All table values except single package size are given for the most typical unit size range of 100 kW – 1.1 MW.
[2] Assumes $0.05/kWh value of electricity (typical of Upstate NY utility tariffs). For RNG, assumes participation in CA LCFS; however, values of federal RINs and LCFS credits can vary with time and project Carbon Intensity (CI).
[3] Assumes that biogas exists at $0; therefore, a new digester construction will increase the cost. Evaluating the Air Quality, Climate & Economic Impacts of Biogas Management Technologies. (2016). EPA/600/R-16/099.
[4] Riley, D.M. et al. (2020). Techno-Economic Assessment of CHP Systems in Wastewater Treatment Plants. MDPI Environments.
[5] U.S. EPA. (2007). Biomass Combined Heat and Power Catalog of Technologies.
[6] It is assumed that siloxanes are not present in the manure-based anaerobic digester gas, even with organics co-digestion. Siloxanes need to be removed to trace levels if they are present.
[7] Solid oxide fuel cells (SOFCs) do not need to remove moisture or CO2 from the biogas; other FC types do.
Source: CHP prime mover data obtained from US DOE CHP Database (doe.icfwebservices.com/chpdb/).

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Renewable energy options from biogas, cont'd from page 7

law will keep more than 250,000 tons of food out of landfills annually, resulting in a very significant greenhouse gas (GHG) reduction for the state. Digestion of organic material allows for both the reduction of methane, a potent GHG, and the avoidance of CO_2 from combustion of fossil fuel for energy needs. **Table 1** indicates the difference in value under the CA LCFS program for RNG from dairy manure only versus RNG from food waste or co-digestion. Alternative state and corporate programs are developing that may allow for increased value from co-digestion. Programs that better value co-digestion will be important to support the unique challenges of pre-processing food waste and post-processing the increased nutrient load. ▮

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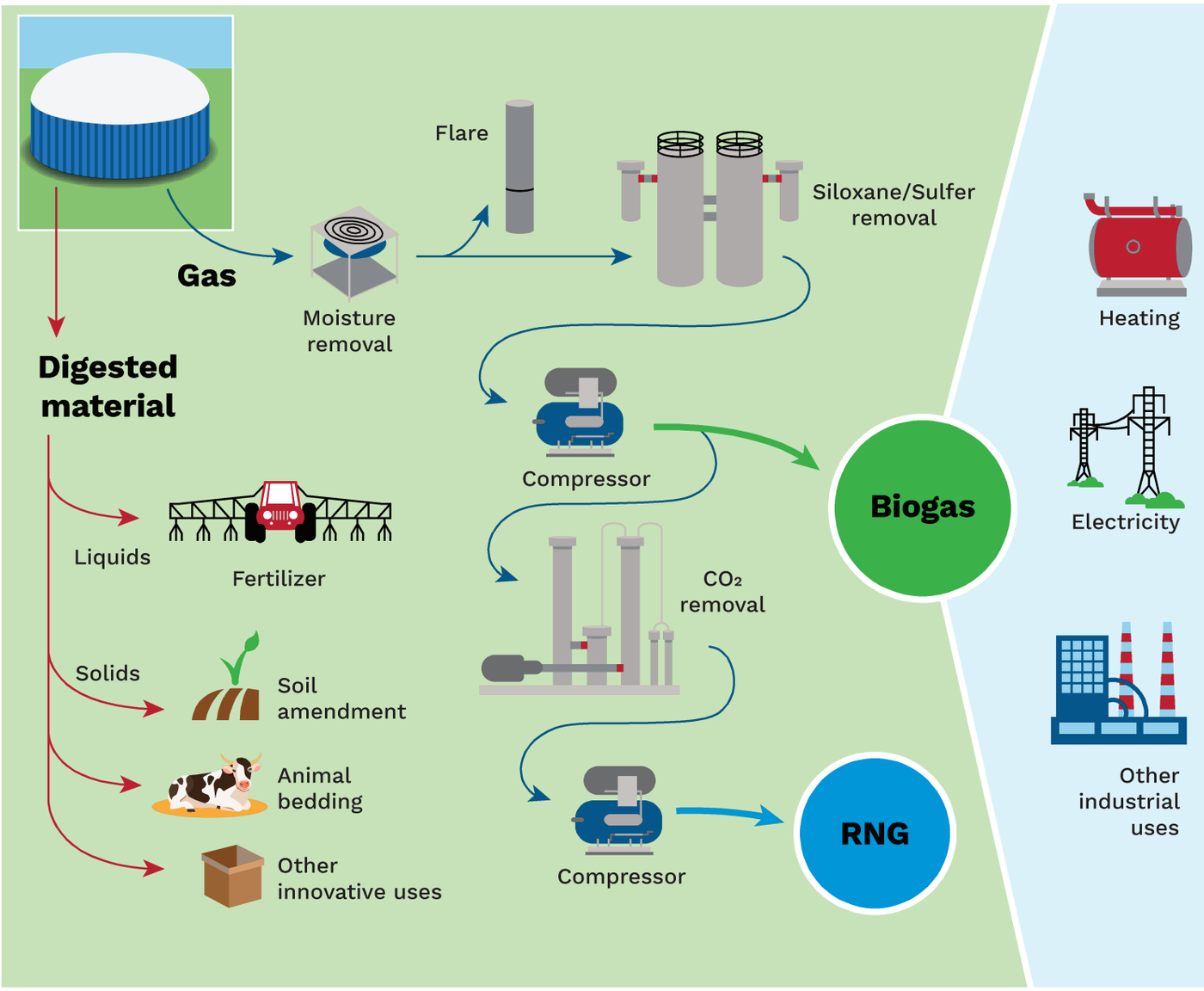
FIGURE 1
Anaerobic digestion products, biogas treatment, and end uses



Siloxane removal applies to municipal wastewater applications and not manure or food waste applications.
Source: An Overview of Renewable Natural Gas from Biogas (epa.gov).

RNG development opportunities: Considerations before a contract

Jennifer Bockhahn, Lauren Ray, and Peter Wright

Renewable natural gas (RNG) production from dairy manure is an opportunity for farms to obtain an additional income while also participating in the reduction of greenhouse gases (GHG), moving the dairy farm toward sustainability. Multiple developers are offering to assist with capital, technology, and management. However, a number of factors should be considered before signing a contract with a developer.

When evaluating RNG development, producers should do their due diligence. The producer should be sure to consider: Who will own and operate the anaerobic digester and biogas cleanup? How will the capital and operating costs be financed? How will the dairy be compensated? What is the impact on herd management and manure management? How long will the agreement be and how will it end? What are permitting and tax implications?

The farm will be entering a long-term partnership with another party, and it is important to understand all the impacts. Questions useful to starting the due diligence process are listed in the sidebar.

EQUIPMENT OWNERSHIP AND LOCATION

The additional technology added to the farm may include a digester or digesters, a gas cleanup system, and a mechanism to move the gas offsite including compressors, and either truck loading or direct pipeline injection. The producer should be sure to investigate the digester developer and the technology. Things to think about when planning this project include:

- Location of the new equipment
- Site access agreement for initial investigations
- Ground lease agreement for the land used
- License agreement if needed
- What happens to the land before construction, during construction, and after construction?
- Transferability: if the farm is sold or if the developer sells
- Insurance and indemnification: who is covered and for what?

OPERATION

The operation of the anaerobic digester is essential to the success of an RNG project, as it is the central component of gas production. Ensure that this piece of technology will be designed correctly and work well for your farm's bedding, feeding, and manure collection systems. When it comes to adding an anaerobic digester to a farm, operation will depend on many factors. When the digester is proposed, ensure you are agreeable with the design, location, and designed operational strategies. What additional labor will need to be provided by the farm to operate the system? Digesters often require a knowledgeable operator for optimal function.

Some components of digester operation that are often overlooked include:

- Who supplies and pays for the utilities required to operate the digester?
- Will combined heat and power be used to heat the digester in winter months?
- Where will the interconnection point be to the energy transmission system?
- What happens if there is a shortfall in manure supply or other biological events? Including:
  - Reseeding
  - Upset conditions
  - Severe or unusual weather conditions
  - Herd infection or disease

Continued on page 10

CHECKLIST OF RNG DEVELOPER QUESTIONS

A successful RNG developer will be able to answer these questions and will not need to hide behind "confidentiality"

- Who will own the digester and equipment?
- How will the project be financed?
- What will be the compensation to the farm?
- What will be the effect on the dairy operations?
- What will be the effect on the dairy manure management?
- Will there be any permitting needs and who obtains them?
- Who will operate the new enterprise? What is the expected project term?
- Who can terminate the agreement and why?
- What are the tax implications?
- How many dairy projects have they developed and how many are operating?
- What dairy farms has the digester developer already contracted with?
- How long do they need to conduct due diligence on this project before construction?
- How long will construction take?
- If significant upside occurs, how will it be shared with the dairy?
- If there is a significant downturn, how will it impact the dairy?
- Who owns the rights to develop future manure-related revenue?
- What is their source of capital, and are they open to the dairy participating?
- Can the developer arrange for you to talk independently and privately with other dairy farmers with developed projects?
- Who does the developer have a long-term contract for the sale of energy with?

CURRENT ISSUES

RNG development opportunities: Considerations before a contract, *cont'd from page 9*

Newly developed Renewable Natural Gas (RNG) site for a dairy farm.

Photo credit: REVLNG.

FINANCING AND COMPENSATION

The financial components surrounding the digester can be complex. Farms want to ensure that they will be coming out net positive in the agreement. Financial components that need to be agreed on and understood include who receives the carbon credits, who receives the tax credits, and if the developer has financing and funding already in place (from whom, what amount, and what are the conditions). Financial plans are negotiated to ensure financial ability to perform and available capital for the project.

One of the draws to RNG for dairy farms is the diversified and additional compensation available to the producer. Possible financial compensation can be found in a signing payment/bonus, progress payments at development stages, lease payments, and commercial operation compensation. Commercial operation compensation can come in the form of a profit share, a price per energy unit, compensation per cow, tax credits, and carbon credits. It is important to understand the agreement and terms exactly. For example, if compensation is agreed on a per-cow basis, understand if that is based on individual animal production or an average.

EFFECT ON DAIRY ANIMAL OPERATIONS AND WASTE MANAGEMENT

The RNG development company focus will be on Carbon Intensity (CI) score, total solids (TS), volatile solids (VS) and other aspects affecting energy production abilities which may impact how the farm is expected to operate. It is important to inquire and understand what changes will and will not be needed to your current animal husbandry practices. Animal rations, bedding, housing, herd size, replacements, stocking density, health management, and water use all are factors in manure's energy production abilities and therefore should be discussed before signing on to an RNG project.

Changes may also be expected to the farm's methods of waste management. Flush water, manure dilution, bypass, manure collection, solid separation, and other pre-digestion treatment and handling may need to be changed to meet your contract's expected RNG production. Then there are considerations that come with the digester. What is the nutrient form and composition of digestate? How long will manure be in digestion? Is post-digestion separation and treatment possible? How will the temperature and outflow of digestion be controlled? Further down the line it is important to know who will pay for changes and upgrades, repairs, maintenance, manure transport costs, and the required frequency of digester cleaning. Finally, it is important to consider what changes will be required to your farm's nutrient management plan, field application practice, and how this may impact any existing third-party exports.

PERMITTING CONSIDERATIONS

Project permitting can be a long and uncertain process. Each state and county will have its own permitting expectations including CAFO, zoning variances, air and water permits. Making an operational change such as adding RNG to your farm has the potential to trigger a site compliance review of your current CAFO permit. Therefore, be sure that you do not agree to a number of cows in the contract that exceeds your permit requirements. This can also present an opportunity for CAFO expansion or bring your permit into compliance. Some permits may need continual reporting.

When it comes to the siting and construction of the facilities, considerations should be put into:

- Will variances be needed for building heights or other aspects?
- What neighborhood meetings, county meetings and other public hearings with comments will be required?
- Will there be any water or watershed permitting requirements?
- Will there be any air quality issues from emissions from engines, flares, boilers and/or methane leaks?

TERM, TERMINATION, AND TAXES

Reading through the contract, there are specific areas that should

be outlined. First, the terms of the agreement, and options of renewal or extension terms while understanding at whose initiatives they are set. When the project does come to termination, what happens to the facilities, cleanup, and the covering of termination costs? Discuss the assignability of interests and ensure an agreement is reached that satisfies both parties.

Taxes are the other inevitable part to consider. The first major tax consideration is the effect of property taxes; they may move from agricultural to commercial. Who will be responsible for covering the change in cost, and the likely incremental increase in taxes over the contract term? How will tax credits earned be allocated? There are likely also to be taxes on the production and sale of both the energy and any manure byproducts. Ensure that there is an understanding of which party will be responsible for these taxes.

Finally, it should be clear and understood what exit opportunities are present and how this can change over the project stages. During the long-term contract, many things can change including farm ownership, future opportunities for renewable energy, changes in policy, and changes in expertise. Ensure that the termination of the contract accounts for evaluating these changes over the contract term.

FOOD WASTE

In addition to all the above considerations, there is an opportunity to digest not only dairy manure but food waste as well. Some states have started to institute laws to divert food waste from landfills and encourage organics recycling. A great way to recycle food waste is through anaerobic digestion. It allows for not only the nutrients to be recycled, but for the emissions to be captured and converted into renewable energy as well. Bringing food waste onto a farm should only occur after considering odor, extra nutrient load, volume available in the digester, sources of reliable and predictable food scraps, possible contaminants, and the likely reduced price for RNG that comes from co-digestion.

CONCLUSION

Working towards carbon neutral dairy farms is a notable goal. A significant and economically viable option for this is to consider the production of RNG to offset farm methane emissions into a renewable fuel while bringing additional income to the farm. Carefully consider the relationship with the developer, as both entities need to mutually benefit. ▮

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Employee compensation: Are you in the ballpark?

Richard Stup

"Labor Shortage!" scream the headlines in the national newspapers, the talking heads on the news shows, and the social media newsfeeds. It seems that the rest of the economy is just catching up to the labor challenge that agriculture has faced for the last 10 years. Companies across the economy, and in all industries, are struggling to find enough people, from manufacturers to restaurants to retail. The transportation industry is particularly hard hit. Truck drivers are in extremely short supply and seaports can't move product through efficiently. These factors have an impact on dairy supply chains, pricing, and export sales. For employees, including farm employees, these labor shortages create opportunities to find new jobs, and often higher pay, in the process.

Of course, we know that pay is not the only factor when employees decide where to work. Employees are human beings with a variety of needs that can be met through work. Location and flexible hours are critical to some employees so they can coordinate their work hours with family time or to meet childcare responsibilities. Some employees just love to work in farming with animals, crops, the outdoors, and the people in agriculture. Others have a particular connection of loyalty and commitment to their employer, a family bond that exists whether they are related or not.

Farm employers can, and should, use all of these non-pay factors to retain and attract employees but they should also keep employee pay competitive with the labor market. Why? First, we all need money to meet the essentials of life, and the cost of living goes up every year. But it's more than that. Compensation, the combination of pay and other valuable benefits, is connected with employees' sense of value and fairness. If an employee discovers that she is compensated significantly less than peers who do similar work for the same or other employers, then she is likely

Continued on page 12

CURRENT ISSUES

TABLE 1

Average farm employee tenure, hours, and compensation

	Frontline employee (n=114)	Middle manager (n=58)
Tenure with current employers (years)	7.7	11.4
Overall work experience (years)	12.6	16.9
Regular hours worked	2,569	2,539
Regular wages	$41,298	$48,995
Overtime hours worked	137	119
Overtime wages	$3,138	$3,114
Total hours worked	2,706	2,658
Total paid wages	$44,436	$52,109
Bonus or incentive paid	$2,431	$2,857
Total value of benefits	$7,283	$10,519
Total compensation per year	$54,324	$65,041
Regular wages per hour	$16.29	$19.59
Total compensation per hour	$20.24	$25.12

TABLE 2

Percent of employees receiving benefits by position level

Benefits	Frontline employee (n=110)	Middle manager (n=57)
Paid time off (pto) or vacation	85%	86%
Disability insurance	51%	60%
Farm produce (milk, meat, vegetables, etc.)	50%	56%
Clothing	47%	49%
Housing	42%	47%
Paid sick days	41%	46%
Retirement	36%	46%
Paid family leave	35%	42%
Utilities	33%	37%
Health insurance	32%	28%
Recreational use of farm property	23%	26%
Other	22%	25%
Continuing education or off-farm training	18%	21%
Meals	15%	21%
Transportation to work or other places	15%	14%
Life insurance	10%	12%
Personal use of vehicle	5%	12%
Farm commodities	4%	9%

Employee compensation: Are you in the ballpark?, *cont'd from page 11*

to perceive this as an injustice and a sign of underappreciation. You don't need to offer the highest compensation but you need to be "in the ballpark" or within a reasonable range of similar employment opportunities.

To help farm employers obtain accurate information about employee compensation, Cornell Agricultural Workforce Development conducted a benchmark survey of farm employee compensation. Farms of all types and locations could participate in the online survey but the majority responded from New York and Pennsylvania. We conducted the benchmark from February to April 2021, and asked employers to anonymously share detailed information about one or more employees' 2020 work, position, responsibility, experience, and compensation at various levels in their organizations. The strength of this approach is that we got detailed compensation and work information about real, individual employees. Most other surveys gather generic information about how farms compensate generic groups of employees.

Our final dataset included 218 employees, including frontline, middle manager, and senior manager representation. All farm sectors are included in the study with slightly over half working in dairy farms, 20 percent in fruit, 12 percent in vegetable, and the balance in all other sectors. It is helpful to compare among industry sectors because talented employees certainly have opportunities to move among dairy, fruit, or vegetable positions, or even to work in another industry. We collect data about all types of employees, but most farmers are interested in how competitive they are with full-time, permanent (not seasonal) positions. All information

reported in this article applies to full-time, permanent employees.

Table 1 presents the average 2020 tenure, hours, and compensation for frontline employees and middle managers in our study. The frontline employees in our study had close to eight years of tenure with their employers and over 12 years of experience. For the regular hours they worked, they earned on average $16.29. Some employees were paid overtime. When that was included total paid wages came to $44,436. Total compensation includes the value of bonus or incentive pay and benefits, giving our average frontline employee $54,324 for the year, or $20.24 in total compensation per hour worked.

Bonus or incentive pay averaged $2,431 in 2020 for frontline employees, which seemed unusually high, about $1,000 more than a similar study we conducted in 2017. The year 2020 included many COVID-19 relief programs from the federal government. Discussions with farm employers revealed that some of these funds were frequently passed along to employees in the form of one-time bonuses.

Middle managers earned about $25.12 per hour in total compensation - $19.59 of that was regular wages and the remainder came from overtime pay, bonus, incentives, and benefits. Regular wages were $3.30 per hour higher for middle managers versus frontline employees. Bonus or incentives represented about four percent of both frontline and middle manager total compensation. Benefits were a little more important for middle manager compensation, representing about 16 percent of total compensation compared to 13 percent for frontline employees.

Table 2 shows what portion of the employees in the study received a variety of different work-related benefits. Overall, the benefit profile is similar between frontline employees and middle managers. Paid time off, disability insurance, and farm produce were all received by more than half of the employees. Work clothing and housing were quite common with nearly half of employees receiving them.

Clearly, farm wages are well above regulatory minimum wage, even in high minimum wage states like New York. USDA's Economic Research Service measures hourly farm wages (not benefits) twice per year. For 2020, they reported that farm wages were about 60 percent of the value of non-farm wages, up from about 50 percent in 1990. Non-farm wages, however, included both urban and rural employment. Farm wages were likely much more competitive in the rural communities where most farm jobs were found. Nevertheless, farm wages still lag behind non farm wages, and farm employers, especially in hot labor markets, must be conscious of the need to compete with other industries for employee talent.

Farm employers should consider these average hours, wages, and benefits and how your employee compensation stacks up in comparison. Keep in mind that these are averages. There were many employees in our study with compensation both higher and lower than the amounts reported here. High-performing employees are much in demand at other farms and in other industries so you may need to increase compensation to retain them in your team. ▮

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Links

- Cornell Agricultural Workforce Development: agworkforce.cals.cornell.edu
- USDA Economic Research Service's Farm Labor site: ers.usda.gov/topics/farm-economy/farm-labor

"Farm employers should consider average hours, wages, and benefits and how your employee compensation compares. Keep in mind that these are averages. Many employees in our study had compensation both higher and lower than the amounts reported here."

CURRENT ISSUES

Winter calf care

Kathy Barrett

Keeping calves warm in winter is good for calves and good for the farm. Calves that are not cold stressed are healthier and more productive throughout their lives. If you think about the body condition of dairy calves, they don't have a lot of fat on them. They're pretty lean with only two to four percent body fat. This means they don't have much in the way of energy reserves to use if they get cold. As temperature decreases, basic maintenance requirements for the calf increases. Calves need more nutrients just to stay warm. Nutrients for growth and health are available only after the maintenance requirements are met. If there is an energy deficit, they have less energy for their immune system which then limits their ability to fight disease and simply grow. All in all, not a good scenario, but one that can be offset by management. Addressing changing nutrient requirements is crucial. The increase in nutrient requirements can sneak up on a farmer because young calves will feel the cold before we do. Calves less than three weeks of age need extra energy to keep warm when temperature is below 59°F. That may not feel all that cold to us, but it does to a calf. Calves older than three weeks need extra energy to keep warm when the temperature is below 42°F. Wind and wet conditions mean the calf must work even harder to stay warm, increasing the nutrient requirements further.

Photo credit: Jason Kosk.

Belinda Thompson, retired clinical professor in population medicine and diagnostic sciences (PMDS) at the Cornell University Animal Health Diagnostic Center (AHDC), feeds a calf.

INCREASED NUTRITIONAL NEEDS

Feeding a greater volume of milk may be part of the answer but it's important to look at the nutrient content of the milk to make sure you're providing optimal energy intake. That requires balancing both fat and carbohydrates. This is where your nutritionist comes in. They can recommend the appropriate feeding rate whether it's milk or milk replacer, based on your situation. More importantly they can adjust the milk replacer and starter feed composition to compensate for the cold weather as well. When possible, spread out the feedings to three times a day to facilitate nutrient availability more evenly throughout the day, which translates into less stress on the calf.

WATER

Cold, dry air can cause dehydration. The two most common findings on a youngstock necropsy are dehydration and undernutrition. This illustrates how important ample water is to calf health during the cold weather. Depending on the age of the calf, they should drink one to two gallons of water a day. Feed warm, not cold water. The calf will have to use energy to warm cold water up to their body temperature. Feeding water at 101 to 102°F is ideal, but if that isn't doable shoot for at least 80°F as fed. This can be tough in the cold weather especially if calves are in hutches. Water can be heated to a higher temperature allowing for some cooling off by the time it gets to the calves. Of course, frozen water is the same as no water.

DRAFT FREE

Calves and drafts don't mix, especially young calves. Air movement over a dry calf, less than three weeks old, at a temperature under 50°F in excess of one MPH is considered a draft. If

you can feel the draft, your calves can too. Calves will have to use energy to counteract the chilling effect a draft has on their body temperature – yet another challenge they don't need. If calves are in hutches, keep them dry, well bedded, and opening south. If calves are moved from hutches to inside housing during the winter, be sure to monitor the ventilation. Providing good ventilation at a rate of four air exchanges per hour while avoiding drafts is critical to promote calf health. Adequate ventilation prevents the buildup of pathogens, ammonia, dust, and moisture in the air, all of which can compromise calf health and growth.

BEDDING AND CLEANLINESS

In the winter months straw bedding is the preferred material for calves. Straw insulates better than sawdust and other bedding choices. Calves can nestle down into the straw to keep warm. The University of Wisconsin has developed a nesting score that ranges from one to three that describes the amount of bedding needed to provide a calf a comfortable environment. During the cold weather they recommend a nesting score of three, which is where the calf's legs are not visible when laying down.

Clean and dry is key no matter what bedding material is used. Cold and wet is a recipe for disaster for calves. A calf will have to use extra energy just to maintain body temperature in these conditions. Dirt and mud will increase the pathogen load at a time when the calf's immune system is already challenged. Using disinfectant is effective but it works better after dirt and organic material has been removed. Follow the label for the disinfectant – their efficacy can be impacted by temperature, concentration used, pH of the water, water hardness, and presence of organic matter.

CALF JACKETS

Calf jackets that are clean, dry, and well fitted are another way to keep calves warm and dry. If the calves are outside, a waterproof jacket is the way to go. Wash the jackets in between calves to reduce pathogen exposure. ▮

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UPCOMING PROGRAMS

NORTHEAST DAIRY CONFERENCE

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Where: Syracuse/Liverpool, NY

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Tom Overton, PhD, Professor of Dairy Management, Chairman of the Department of Animal Science at Cornell University

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Dave Balbian, Betsy Hicks, and Margaret Quaassdorff, CCE Regional Dairy Specialists

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Daryl Nydam, DVM, Faculty Director, Atkinson Center for Sustainability, Department of Population Medicine and Diagnostic Sciences, Cornell College of Veterinary Medicine

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Lindsay Ferlito, NNY CCE Regional Dairy Specialist

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Rob Lynch, DVM, Cornell PRO-DAIRY, and Margaret Quaassdorff, NWNY CCE Regional Dairy Specialist

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