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Tick-Tock in the Barn: How internal clocks are associated with cow health during the transition period

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Have you ever wondered why waking up earlier than usual can leave you feeling tired for the rest of the day? Or why traveling across different time zones can cause jet lag and lead to disorientation and fatigue? These effects occur because everyone has an internal clock (AKA circadian rhythm) that runs on a roughly 24-hour cycle and helps regulate sleep, metabolism, and other daily body functions. When you experience jet lag after a long flight, it's because your internal clock is temporarily out of sync with the new time zone.

Animals, including dairy cows, also have an internal clock, and in many ways, their daily timing may be even more tightly regulated than in humans because of consistent milking and feeding routines on most dairy farms. However, this internal clock can be challenged during the transition from late pregnancy to early lactation. Changes in housing, diet, and hormonal shifts that occur around calving can disrupt the normal internal clock and make it harder for cows to adapt to early lactation. When this timing is disrupted, metabolic and immune function may be compromised, increasing the risk of disease and reducing milk production. Understanding how the cow's internal lock responds during this period can help producers design management strategies that better support health and performance.

The Role of the Internal Clock

The internal clock helps the body anticipate predictable daily events and align biological processes with regular environmental cues, such as the day-night cycle, feeding time, and milking routines. When management schedules are consistent, cows don't just respond after something happens – their bodies begin preparing ahead of time through coordinated changes in hormones and metabolism.

A practical example is the milking routine. On farms with consistent schedules, cows often become more active and vocal as milking time approaches, and their bodies are already preparing for milk letdown. This is one reason why consistency matters: when timing cues change from day to day – such as frequent shifts in milking or feeding time – those anticipatory rhythms can be weakened, which may ultimately affect production and cow comfort.

Under typical dairy management conditions, cows usually produce more milk in the morning, whereas milk fat and protein tend to be higher later in the day. Many metabolic indicators in dairy cows also follow an internal clock, with blood metabolites such as free fatty acids (FFA; fat released from body reserves), glucose, and insulin fluctuating throughout the day. A study from Pennsylvania State University examined how changes in feeding time affect these daily rhythms in lactating cows (Salfer & Harvatine, 2020). Cows experienced an 8-hour fasting period that occurred either during the day or overnight. The results showed that altering feeding time shifted the daily patterns of milk synthesis and blood metabolites,

demonstrating that feeding schedules interact with the cow's internal clock to influence metabolism.

The rumen also follows an internal clock that affects digestion and fermentation. For example, ruminal ammonia levels tend to be highest in the early morning, likely reflecting protein breakdown during the overnight period when feed intake is low (Ying et al., 2015). In contrast, volatile fatty acid (VFA) concentrations generally peak later in the day as fermentation activity increases after feeding. Ruminal pH also follows a daily cycle, typically rising before feeding and becoming more acidic 10 to 12 hours later during active fermentation. These daily changes in fermentation patterns are closely linked to shifts in rumen microbial activity. In particular, the timing of starch and fiber delivery influences how rumen microbes ferment feed across the day (Salfer et al., 2021).

The Role of the Internal Clock during the Transition Period

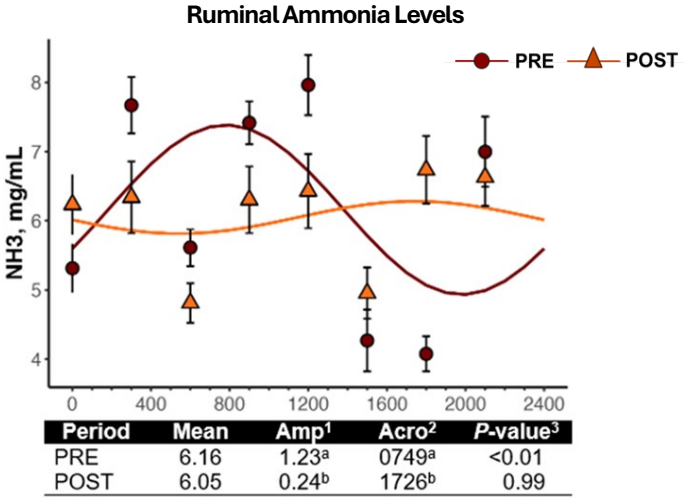
The transition period, characterized by significant physiological, metabolic, and hormone challenges, requires precise nutritional and management strategies to support cow health and optimize early lactational performance. Emerging evidence suggests that biological timing systems, such as the internal clock, may influence how these processes are organized across the day by interacting with environmental cues like feeding and light-dark cycles. However, how this internal clock regulation contributes to metabolic and immune adaptations during the transition period in dairy cows remains an active area of research.

During this period, cows typically experience a reduction in feed intake in the days leading up to calving, which can persist into early lactation and result in inadequate nutrient intake. When energy intake does not meet the demands of milk production, cows enter a state of negative energy balance and mobilize energy from body reserves, particularly body fat. This mobilization leads to increased concentration of FFA in the blood, which is associated with a higher risk of metabolic disorders such as ketosis.

Research from Virginia Tech (Begalli, 2025) compared the daily rhythms of blood metabolites and rumen VFAs in cows during the prepartum and postpartum periods. Blood and ruminal fluid samples were collected frequently from 40 cows at approximately −14 and +14 ± 2d relative to calving. Overall glucose concentrations were higher before calving than after calving. In addition, glucose displayed a clear dairy rhythm during the prepartum period, fluctuating in a regular 24-hour pattern, whereas this rhythm was not detected postpartum.

The timing of peak FFA concentrations was consistent in both pre- and postpartum, indicating that fat mobilization follows a predictable daily pattern. In both periods, FFA concentrations peaked in the early morning (~ *700 h* / 7:00 a.m.), before feeding, when glucose availability is lower, and energy demands are high. In contrast, ketone bodies (BHB) concentration postpartum was highest later in the day (~ *1700 h*/ 5:00 p.m.), consistent with previous observations that ketone levels can rise several hours after feeding. This likely reflects ketone production in liver later in the day as circulating energy substrates, including FFA, are utilized. Together, these results indicate that the time of day when samples are collected can influence ketosis diagnosis, with cows sampled in the afternoon or evening more likely to exceed commonly used BHB thresholds than cows sampled in the morning. From a management perspective, administering propylene glycol in the morning–before or around the FFA peak–may help increase glucose and insulin concentrations, reduce fat mobilization, and potentially reduce ketone production.

Although it is well known that diet changes around calving affect rumen fermentation, our results highlight something less obvious: changes in the timing of rumen nitrogen use across the day. Before calving, ruminal ammonia showed a clear daily



Period	Mean	Amp[1]	Acro[2]	*P*-value[3]
PRE	6.16	1.23[a]	0749[a]	<0.01
POST	6.05	0.24[b]	1726[b]	0.99

Figure 1. Dairy pattern of ruminal ammonia (NH_3) concentrations before (PRE) and after (POST) calving with the x-axis reflecting the time of day *(24 h)*. Ruminal fluid from the same cohort of cows was evaluated at -14 and +14 ± 2 days relative to calving. Amplitude (Amp1) is the difference between the peak value and the mean value. Acrophase (Acro2) is the time of day when the variable reaches its peak.

pattern, rising and falling at predictable times. After calving, this daily pattern largely disappeared, with ammonia levels remaining more constant throughout the day. This suggests that, in early lactation, the normal daily coordination between protein breakdown in the rumen and how rumen microbes use nitrogen may be altered. These changes in timing (not just in amount) could influence how efficiently dietary protein is used during the transition period.

To support cow health and performance during the transition period, management practices that promote consistency and predictability can be implemented. Dairy producers should prioritize consistent feeding schedules and minimize unnecessary disruptions to daily management routines. Maintaining regular management patterns may help support metabolic stability and rumen function during this challenging period, with potential benefits for milk production and overall cow health.

Perfect Planting for Spring

Authored by Andy Overbay, ANR Extension Agent — Smyth County, Virginia Cooperative Extension; aoberbay@vt.edu

Several years ago, I was holding a meeting for local school cafeteria managers and staff on the importance of serving high-quality, cold milk with school meals. The subject of how clean is clean enough came up, and I offered a suggestion from my days running the farm dairy: "My goal was for the barns to be so clean that if you were to drop an ice cream cone on the floor, you'd feel comfortable picking it up to eat it." A local farmer shared her barns could never be that clean. "Neither were mine," I confessed. "I never achieved that goal; that was where I set the bar." The point was that if you develop an "*Aww, that's good enough*" attitude on some things, that becomes the standard for everything. It is also true that "good enough" is a rolling scale. What is good enough for you may be a different level when good enough is applied by an employee.

Perfection on the farm is rarely achieved; however, I often wonder how many dollars are lost per acre and per farm on "that'll do" execution. No one has done more practical work on perfect planting than David Hula. I had the privilege of visiting his farm while on a tour of Virginia's Eastern Shore farms, and I can attest to the fact that David's approach to record-setting corn can be seen by how organized his shop is and how well-maintained the farmstead is kept. Hula's approach to perfection is not so much 'to do everything correctly' as it is 'to eliminate as many mistakes as possible.'

As we enter into the planning stages for this year's growing season, it is never too early to start getting things ready for our latest attempt at perfection. Our first steps for the perfect stand should have already happened. Soil testing to check the ground's ability to support our coming year's crop can never be overlooked. It's been over 40 years since a seasoned college professor of mine shared "Fertile soils will occasionally produce a crop failure, but infertile soils will never produce a bounty."

Of all the soil test evaluations, make sure your pH is correct for the crop you have chosen. A point or two, high or low, in pH will bind other plant nutrients up to the point where your investment in fertilizers is neutralized.

Along with checking your soils' fertility, selecting the crop you are going to grow is just as important. Our local tractor club loves to have wheat on hand for demonstrations with our reaping, binding, threshing, and baling operations. Winter wheat was accidentally planted in the spring, thinking that since it was warmer, the wheat would just do that much better. The result was a crop that got about 4-6 inches high and turned yellow. That cold weather dormancy is when winter wheat puts down its roots and gets ready for a great surge in the spring. Without that cold weather, winter wheat can't function.

Once we have the soil ready and the crop selected, the planter needs to be ready to place that seed perfectly. First, is the planter or drill balanced and calibrated properly? If you've ever seen a planter pulled down the road looking like a dragster, with its rear-end noticeably higher than the front, you can tell it needs to balanced or leveled. Using the adjustments on the tongue or toolbar, your planter should go up to transport and down to begin seed placement as level as possible. This keeps your seed placement at the optimal depth and your planter at its most efficient. You also need to check your planter or drill for signs of wear. Openers, seed drops and closers and row cleaners can all wear, of course. They also do not need to be worn out to affect your approach towards perfection.

Coulters should run together to form a nicely shaped "V" trench in the soil that allows the seed to be dropped at exactly the correct depth. As the coulters

wear, they separate from each other to the point where the "V" trench is shaped more like a "W" and a small band of soil is left undisturbed by the planter. The seed dropped in a "W" trench is generally planted too shallow. Add in closers that are worn just as much as the openers, and you have an expensive bird feeder.

While we are on the subject of seed placement perfection, let me share some personal experience on soil preparation. This again goes back to my undergrad days when a college professor shared that "the rougher you can leave the soil surface, the better off you'll be." His point was to avoid as much tillage as possible and use no-till as much as you could. Our heavy clay soils were easily compacted. Even trying to avoid using the same ground as entry points or pathways, by the time manure spreaders, fertilizer tenders, planters, forage harvesters, and silage trucks finished with the clay banks, they had to be ripped or chisel-plowed. Even with vertical tillage and winter freeze/thaw cycles, the chunks left on the surface made spring fieldwork a challenge. First, navigating the ground was like crossing railroad tracks without the benefit of approaches and pavement. Second, many clods were too large for pre-emergent weed treatments to adequately do their job. Smoothing those areas with a cultimulcher was a great help. Not only did it help in weed control, but because it smoothed the surface, we were planting, the seeds germinated more uniformly, and our stands were more uniform and productive.

A drill or planter that hits a soil "speed bump" tends to rise up as it strikes the obstacle, leaving seed too shallow for proper seed-to-soil contact. Conversely, as it plunges back down after the shock, it buries the seed too deep until forward motion brings it back to normal depths.

Finally, you need to calibrate your drill or planter before you put it in the field. My colleagues and I used to help check seed meters on older planters. You'd be surprised how many meters came from the factory with the belts in backwards. As far as drills go, there are some great how-to videos online. I encourage you to search for my friend, Dr. Chris Tuetch, at the University of Kentucky. Chris and I were in the same "new hire" class with Virginia Cooperative Extension nearly 26 years ago. There's no one I trust more as far as forages go.

That brings us to an important point. People you can trust are the most important assets you have. Experience is not always the best teacher, although it will likely be the most expensive. Look for someone who will share their failures as well as their successes. Success is difficult to duplicate, but mistakes breed like crazy.

Upcoming Events

In-Person Meetings for the Winter Meeting Series with Dr. John Currin (Continuation from previous webinars) Hands-on demonstration with calving tools/Live demonstration using a calf model to address calving challenges.

Dates and locations:

- Mar 2nd - Montgomery (night)
- Mar 10th - Tazewell (night)
- Mar 12th - Patrick (night)

March 10, 2026
Calf Workshop (Including Lung Scan Workshop)
Rockingham

March 14, 2026
4-H Dairy Bowl Contest

March 16, 2026
Smyth County Farm Management Meeting
Difficult calving workshop with Dr. John Currin

March 21, 2026
Hokie Dairy Day

If you are a person with a disability and require any auxiliary aids, services, or other accommodations for any Extension event, please discuss your accommodation needs with the Extension staff at your local Extension office at least 1 week prior to the event.

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