



# CATTLE SENSE

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## /// Nutrient Synchrony: Theory and Practice

Think back to that basic grade school science project where the student starts seeds or potato plants, some with adequate soil, water and light, and others without one of these inputs. My boys each did this when they were small, and they saw for themselves that failing to meet just one requirement would dramatically limit (or prevent) growth, even if all other needs were provided for. This is of course true for all living things, including the rumen microflora. That's why scientists continue to evaluate the potential benefits of meeting *their* requirements more accurately and consistently. In particular, there has been a fair bit of research directed at managing the timing, or "synchrony," of nutrient supply in the rumen, to ensure the bacteria have a 'balanced diet' available to them at all times.

The goal is to avoid lags or slumps in the availability of one nutrient (i.e., energy or nitrogen), relative to the supply of other nutrients. This can happen frequently, due either to the fact that different diet components degrade at different rates, or to cattle eating patterns. For example, in most grazed forages, digestion rates are much slower for the carbohydrates than the protein in the same feed. We can also create asynchronous situations by feeding relatively large amounts of readily available energy all at once, without providing supplemental protein at the same time. Since this imbalance of nutrient supplies does occur on a regular basis, it should not be surprising that both the microbes and the cattle have mechanisms in place to deal with them. The downside, however, is that these biologic adjustments are accompanied by reductions in efficiency and at least some irreversible loss of nutrients.

The most obvious scenario we want to avoid is limiting or decreasing microbial growth and activity. In our forage-based diets, especially, the amount of energy and protein available to the animal is directly tied to the number of, and fermentation activity of, the rumen bacteria. And since we measure the lifespan of these organisms in minutes, rather than hours or days, it is logical to address synchrony on a time scale smaller than the 24 hours (or longer) that we usually apply to balancing diets.

### Improving on Nature

Scientists have been addressing this issue for over 40 years, evaluating the effect of improved nutrient synchrony on feed utilization and microbial efficiency (the volume of microbial cell proteins produced relative to the amount of feed consumed). Several trials done in England have utilized varied ingredients or feeding sequence to alter the timing of ruminal energy and nitrogen degradation in sheep; the results summarized below support the concept of synchronized nutrient availability:

- ✓ Greater energy retention;
- ✓ Greater feed efficiency;
- ✓ Reduced plasma urea nitrogen;
- ✓ 27% increase in microbial protein production;
- ✓ 13% improvement in microbial efficiency.

Work from Michigan State University showed similar responses in sheep fed low-quality forage diets. Here, feeding programs designed to better match the timing of nutrient availability led to a 65% reduction in peak rumen ammonia concentration, and an 11 – 20% improvement in microbial efficiency.

Researchers have also looked at the role of managed synchrony in cattle. At Penn State, lactating cows were fed to create a four-hour lag between nitrogen and energy release in the rumen; peak rumen ammonia concentration rose 33%, with a corresponding elevation in mean rumen pH. In University of Arizona work, pairing rapidly degraded protein with rapidly degraded starch increased the flow of microbial protein from the rumen of lactating Holsteins. Using forage-fed beef steers given isotope-labeled urea, scientists at North Carolina State University found that “closer coordination of ruminal fermentation of carbohydrate and nitrogen sources provided greater and more efficient capture of dietary N as tissue protein.”

### Put to the Test

Of course, changes at the rumen level are only of practical importance if they are reflected in improved animal gains, milk production, or feed efficiency. And it appears those questions are going to require additional research. The title of an invited review paper, prepared for a 2007 symposium, summed the situation up nicely: “Nutrient Synchrony: Sound in Theory, Elusive in Practice.” The fact is, while we can consistently show apparent improvements in rumen function, these changes do not always elicit a significant change in key production measures. The jury is still out on how much of this discrepancy is due to the influence of the animals’ natural compensation mechanisms, or an inability to adequately control all the potentially confounding factors in a research setting.

### A Broader Look

A more recent proceedings paper (Firkins, 2010) addressed nutrient synchrony from a slightly different perspective. Dr. Firkins began with the assumption that microbial protein is the cheapest and best source of metabolizable protein. However, our ability to predict microbial protein production and availability is highly variable – in part because so many of the activities and metabolic pathways within the cow (and her rumen microbes) are continually switching back and forth in response to short-term shortages and excesses of specific nutritional compounds. This is important, because the better we can predict the supply of microbial protein, the more precisely we can formulate diets to maintain desired production and at the same time minimize the excretion of unused (extra) nutrients into the environment. However, effectively manipulating feed management to maintain a more steady state—and therefore more efficient diet utilization—is not simple; the overall system is complicated and convoluted. The requirements of specific microbial species, the biochemical role of individual amino acids, and the intermediate digestion products of different feedstuffs all come into play. But he also emphasized that, at least for dairy cows, feeding *pattern* probably exerts a greater influence on synchrony than degradability of diet components.

### Is There a Take-Home Message?

The premise of nutrient synchrony – fine tuning the timing of microbial nutrient supply to support improved digestibility, microbial protein production and efficiency – is sound. And the potential benefits have real value. In a beef cow or stocker production setting, the practical application at this time may simply be selecting supplementation programs that provide needed nutrients in complementary forms, consumed over time in small quantities.