Making Sense of the Nitrogen Cycle
Dirk Philipp, Assistant Professor
Animal Science

Nitrogen (N) is the most limiting nutrient for plant growth and should be managed accordingly to make the most efficient use of synthetic fertilizer and manure. This is of importance to all dairy operations. In conventional dairies, manure and/or synthetic N fertilizer is applied to crops that may be used as feed such as silage, and in pasture-based dairies, cows may periodically graze pastures that are part of the overall forage management plan, under which most of the N is recycled. In either case, N from whatever source has to be converted to nitrate ($\text{NO}_3^-$) or ammonium ($\text{NH}_4^+$) in the soil before it becomes plant available.

Making sure that much of the nitrogen is accessible to plants and can be used when needed depends on management decisions, for which basic knowledge of the N cycle is of benefit. In the case of applying mineral fertilizer such as urea, the enzyme urease is necessary to catalyze the reaction in which urea is converted to carbon dioxide and ammonia, which can be partly lost to volatilization. In the next reaction, ammonia is converted to ammonium, which then can be taken up by plant roots. This ammonium is even further converted to nitrate, which is also plant available and preferably taken up. This step is called nitrification and is one of the most sensitive soil processes. The process involves microbes (Nitrosomonas, Nitrobacter) and is heavily dependent on soil conditions, including optimum pH (around 7), temperature and oxygen levels.

Therefore, keeping up with soil testing for judging liming requirements and maintaining soil organic matter for sustained soil tilth is necessary.

Unfortunately, nitrate can easily be lost to leaching, because the negatively charged soil particles cannot adsorb the equally charged nitrate. Long-term storage for N can be accomplished by increasing soil organic matter. The soil bacteria incorporate nitrate into humus.

Because dairy operations have to deal with large amounts of manure, nitrogen management strategies are different from a row crop situation, where synthetic fertilizer can be applied in a more targeted fashion. Recycling N in a grazing situation poses a different problem, because N in manure and urine is highly concentrated and thus is difficult to incorporate and mineralize by soil organisms. In a review paper by Rotz (J. Anim. Sci. 2004, 82:119-137), nitrogen losses through volatilization from manure patches were estimated to be about 5 percent, a relatively minor amount. Nitrogen volatilization from urine can be much higher, as most of the excreted N (55 to 75 percent) is present in urine. Losses may be anywhere between 5 to 66 percent of urinary N, with greater losses during dry, hot weather and smaller losses under cool, moist conditions. Leaching losses of N can be higher under grazing than under manure spreading because of the high concentrations of N under a urine patch that can reach a concentration of 1,000 pounds N/acre.
Controlling Johne’s Disease on Your Farm

Jeremy Powell, Associate Professor and Veterinarian
Animal Science

Johne’s disease is a chronic, incurable infection of the intestinal tract caused by Mycobacterium avium ss. paratuberculosis (also known as MAP). This pathogen is resistant to extreme environmental conditions and can survive in the environment (soil, pasture, pens, etc.) for long periods of time. Infection usually occurs in young animals, but clinical signs of the disease do not usually develop until animals are 18 months of age or older. Calves typically become infected at a young age by being exposed to MAP in contaminated pens, nursing colostrum from a manure-contaminated teat or through being fed milk from an infected cow. Transmission can also occur from the dam to calf before the calf is born (in utero).

A herd can be unknowingly exposed when an infected, nonsymptomatic heifer or cow is purchased and brought onto a farm. Although showing no signs of illness, she could be shedding infectious organisms and contaminating pens and pastures, thereby exposing susceptible animals. At some point, the introduced animal may show clinical signs of the disease, but by then, she has exposed several other animals in the herd.

The prevalence of this disease in U.S. dairy herds is estimated to be approximately 68 percent. The most common signs associated with Johne’s disease are rapid weight loss and severe diarrhea, leading to drastic weight loss and lowered milk yields. Infected animals continue to have good appetites, but they tend to “waste away” as a consequence of the disease. The infection affects the lining of the small intestine, causing a thickening of the wall. This leads to very poor absorption of nutrients and, subsequently, diarrhea, slow emaciation and eventual death.

Testing for the disease can include testing manure, blood or milk. A blood test or milk test can be done on individual animals to screen Johne’s in the herd. Manure from a suspect animal can be tested using a fecal culture or a PCR test to aid in diagnosing possible cases. Currently, there is no cure or satisfactory treatment for this disease. The best way to control this disease is through good management practices and purchasing animals from a certified Johne’s-free herd. Some management practices that can help minimize risks of spreading Johne’s include:

- Remove calves from dams within one hour of birth and provide colostrum from known Johne’s negative cows.
- Separate young stock housing areas from adult housing areas, and do not feed unpasteurized waste milk to the calves.
- Avoid using the same equipment (loader buckets, skid steers) to handle feed and manure.
- Before entering calf housing, thoroughly wash and disinfect boots to remove all manure.
- Ear notch known positive animals to easily identify them as high-risk shedders.

Youth Dairy Activities Planned for 2013

Steven M. Jones, Assistant Professor
Animal Science

One of the great educational opportunities for 4-H youth is participation in dairy activities. These activities help 4-h’ers develop a better understanding of cattle and the dairy industry. Dairy activities of many kinds are available to Arkansas youth through the University of Arkansas Cooperative Extension Service program.

In March, scholarship applications, dairy project journals and National Dairy Conference applications will be judged to determine winners who will attend national events and scholarship recipients. The next National 4-H Dairy Conference will be conducted September 29 until October 2, 2013, in Madison, Wisconsin. This conference is held annually during the World Dairy Expo for youth 15 to 18 years old. Arkansas will send two youth delegates.

The Arkansas Junior Dairy Ambassador Program was established in 2012. Organizers included Arkansas Farm Bureau, University of Arkansas Cooperative Extension Service and representatives from the Arkansas dairy
industry. The Arkansas Dairy Ambassador should have an interest in dairy and be in the age range of 14 to 19. The winner of the Arkansas Junior Dairy Ambassador Program will be required for the following time commitments:

- Participate in dairy promotion activities such as the Dairy Proclamation signing with the Governor, which is held in June.
- Present a report at the annual State Dairy Foods Contest on dairy promotion activities in which he or she has participated in the past year.
- Seek out opportunities to participate in county and state promotion activities for the dairy industry.
- Present awards during the Arkansas State Fair Dairy Show.
- Present awards during the Dairy Days Dairy Show.

Applications for 2013 will be accepted through May, with interviews conducted during the 4-States Dairy Days in June.

The 2013 Youth Dairy Camp will be conducted at the Benton County (Arkansas) Fairgrounds June 20-21. Cost will be $35 for youth and adults. The educational workshops this year will include dairy cattle evaluation and selection, cattle nutrition and health, the dairy industry and its importance to health and economy and dairy industry current issues. The final workshop on Friday morning will focus on dairy showmanship.

The 24th Annual 4-States Dairy Days activities will kick off in the afternoon of Friday, June 21, following Youth Dairy Camp. These activities include Dairy Quiz Bowl, the Dairy Skillathon, an ice cream social and the Dairy Ambassador Competition.

On Saturday, June 22, activities will start with a pancake breakfast. Afterward, there will be a Dairy Judging Contest for youth. Also scheduled for the day are:

1) Exhibitors’ lunch  
2) Silent auction  
3) Select heifer sale  
4) Senior fitting contest  
5) Exhibitors dinner  
6) Showmanship contest (19 and under)  
7) Dairy olympics

The All-Breed Dairy Cattle Show will be on Sunday, June 23. At the conclusion of the show, there will be a commercial dairy heifer sale. For additional information, contact Steve Jones (sjones@uaex.edu) or Tim or Nikki Crawley (tlcrawley@centurytel.net) or view the web site (4statedairydays.org).

Our 4-H youth are some of the dairy industry’s best resources for educating the general public on dairy production. They accomplish this through their interaction with their peers and through their 4-H activities such as speeches and demonstrations, community service events and at fairs and shows. They just need factual information, and they will put it to good use. Here are some examples of information provided by request from youth to educate the nonfarming consumer.

Why have dairy farms become so large and industrial?

Like other business owners, many dairy farm families are expanding to improve efficiencies. These improvements provide high-quality, affordable milk and dairy foods. Dairy farms have modernized to provide better cow care, improve milk quality and use fewer natural resources. Many have also become larger to allow siblings, children or other family members to join the family business. The USDA estimates the average dairy farm in the U.S. is about 200 cows. All dairy farmers, regardless of their farms’ size or ownership, follow strict regulations and best management practices for the health of their families, their cows and their neighbors. The look of the family farm and the technologies may have changed, but the traditional values of caring for the land and animals continue.

Source: Get the Facts on midwestdairy.com

Why can’t farming look like it did 40 years ago?

Farming – also referred to as production agriculture – is about feeding the world. According to U.S. Census Bureau data, the world population in 1961 was about 3 billion people. Today it exceeds 6.9 billion people. By 2050, it is estimated that more than 9 billion people will inhabit the planet. In 1961, the U.S. population was about 184 million people. In 2010, it was more than 308 million, a 67 percent increase. If agriculture today were no more productive than it was in 1961, it would require expanding farmland by more than 60 percent, or the food supply per person would be that much smaller. It takes less than half as much land on a per-person basis today to produce our meat, dairy and poultry supply compared to 45 years ago. Increases in agricultural productivity have made this possible. American farmers provide more high-quality food than ever before. In fact, one farmer now supplies food for more than 150 people in the U.S. and abroad – compared with just 25.8 people in1960 – and on less land every year. Production of food worldwide rose in the past half century, with the World Bank estimating that between 70 and 90 percent of the increase resulted from modern farming practices rather than more acres cultivated. Efficiency is one of the core elements of sustainability.

Source: Get the Facts on midwestdairy.com
Recently published research out of the University of Florida (Journal of Dairy Science, 2012) examined the effects of a dual-purpose inoculant on the characteristics of farm-scale silage production. Silage inoculants can be homofermentative or heterofermentative, meaning the anaerobic byproduct is a singular volatile fatty acid {lactic acid} or mixed fatty acid {lactic acid + other fatty acids}. While lactic acid is important for a rapid decline in pH for preservation, the presence of acetic acid helps control aerobic spoilage by reducing yeast and mold growth. The dual benefits of homo- and heterofermentative inoculants have been marketed in combination.

The corn silage used for the study was harvested at 34 percent dry matter (half milk line stage) and chopped to a 0.75 inch length. Treatment comparison was a dual purpose inoculant (Buchneri 500, Lallemand Animal Nutrition). The silage was packed into Ag-bag silos and sealed for 166 days. Silage was removed from the bags at a rate of 1,100 pounds/day.

The proportion of good silage (silage that was not moldy, dark, hot or slimy) was 4.4 percentage units greater with inoculated silage compared to nontreated silage. Overall, 92 to 97 percent of the silage was considered “good.” Nutrient composition, including protein, fiber components, nonfibrous and water-soluble carbohydrates, did not differ between the good portion of treated and nontreated silage.

The proportion of bad silage was 7.8 percent and 3.4 percent, respectively, for control and inoculated silage. Nutrient loss in the bad silage was greater in control than inoculated; however, the chemical composition was not affected by treatment. The pH of treated silage was 3.91 (0.08 unit lower than nontreated silage). As a percentage of dry matter, lactic acid and acetic acid were similar between treatments; however, the lactate-to-acetate ratio average was 5.4:1, which was 2.35 units greater than control. Acetic acid did, however, vary with time and exceeded control levels for the first 20 days of exposure. Average temperature of the treated silage in storage was 2.5 percent lower than control silage; however, the maximum, minimum and temperature range were not affected by treatment.

Evaluation of mold counts indicated less mold growth on treated silage. Aerobic stability was highly variable and not statistically different between treatments. Aerobic stability was evaluated as the time required for silage temperature to exceed ambient temperature by 4 degrees. Overall, the inoculant response was not spectacular. Comparing the control silage to targets, 92 percent of the control silage was rated good by visual assessment. Moisture content was on target (60 to 65 percent). pH was within acceptable range (3.8 to 4.2). Lactic acid was within an acceptable range of 5 to 10. Acetic acid was already fairly high (1 to 3 percent in silages not inoculated with L. Buchneri). Overall, the profile of the control silage suggests the silage was managed quite well. Under these conditions, the inoculant slightly reduced the proportion of silage visually assessed as “bad,” increased acetic acid content in early aerobic exposure and reduced yeast and mold.

Production and Efficiency
Shane Gadberry, Associate Professor
Animal Science

Since coming to Extension in 1996, my work has focused on beef cattle management. Upon the retirement of Dr. Wayne Kellogg, who orchestrated the dairy teaching, research and recently extension, my colleagues and I have offered to assist Arkansas’ dairy industry within our specific areas of expertise, mine being ruminant nutrition. In dealing with mature beef cows, I have always been fascinated by the comparative management of inputs and subsequent output responses in beef cow-calf and dairy cow systems. Case in point number one, as Arkansas dealt with managing beef herds through drought, we’ve included early weaning as a management option in our educational efforts. Beef cattle producers hesitated at the thought of early weaning until they were reminded that the dairy industry is built on weaning calves shortly after birth.

Another case in point is the primary output in the beef cow-calf system is pounds of weaned calves produced, which is measured at one point in time and is influenced by maternal, genetic and environmental factors such as quality of forage and supplements available to the calf pre-weaning. The calf weight itself is affected by variation in gut fill. As a result, subtle changes to beef cow management inputs may not necessarily influence the final output at an economically measurable level. In the dairy system, however, milk is a direct product of the cow that is measurable at the herd and cow level on a daily basis. A subtle management change to this system has the potential to have an economic impact that would possibly go unrecognized in a beef cow-calf system. At the same time, response to input changes in dairy management can be detected early with the proper tools.
While differences exist in these cow systems, similar underlying goals and objectives remain.

- In both systems, the producers want to sell their product at the highest price to increase profitability. Although some management practices influence market price (breed type in the beef and milk components in the dairy system), the market is generally controlled by external factors. Therefore, benchmarking and managing production costs are critical to profitability. Monitoring input costs can help identify mechanisms to reduce variable costs of production such as fertilizing according to soil test recommendations or purchasing/booking ingredients, fertilizer and seed during the off-season when prices can be lower. Eliminating fixed or overhead costs may follow partial budgeting the trade-offs among forage quality, yield, custom-harvest rates and owned equipment depreciation.

- In both systems, producers must manage herd health and body condition for high reproductive success. Body condition scoring becomes valuable when producers begin to look beyond the average score or spot score but examine the proportion of their females within each score category at different stages in the production cycle. This information can determine the direction of whole herd adjustments versus grouped adjustments, replacing the single-diet concept to a multiple-diet concept. Replacement heifers should be developed to target both breeding and first-year milk. Dr. Hutjens, emeritus professor with the University of Illinois, reported at the 2012 Western Canadian Dairy Conference that Holstein heifers must gain over 1.7 pounds/day to calve at 23 to 24 months of age, weigh 1,250 pounds following calving and produce milk yields above age-adjusted herd average.

- In both systems, feed additives and micro minerals can impact immunity, reproduction and nutrient utilization. Dr. Hutjens, at the same conference, ranked the following technologies: 1st choice – monensin, 2nd choice – silage inoculants, 3rd choice – organic trace minerals, 4th choice – yeast-based products, 5th choice – rumen buffers and 6th choice – biotin. These choices are clear indicators of economic response differences to decisions between dairy and beef cow systems.

- Both systems benefit from analysis of diet ingredient composition, shrink and fecal evaluation. Consider the following ration formulation aids:
  - Ingredients that are highly variable in nutrient composition (hays, silages, co-product feedstuffs) should be routinely tested for nutrient composition. Analysis should be complete, not basic, if formulating for rumen, degradable and nondegradable protein, fat, specific carbohydrates and amino acid supply.
  - A mixer test for uniformity of mix for a given mixing time can help minimize cow-to-cow variability in diet offered and prevent excessive mixing, which leads to increased operating cost.
  - Evaluate diet and chopped silage for particle size proportions using a particle separator to aid in silage processing and effective fiber management.
  - Fecal scores can be used to assess the excreted portion of diets. This can help identify feed situations including excessive, poorly degraded fiber or inadequate effective fiber and excessive protein in the diet.
  - Manure analysis of starch can help determine utilization of grains either added to the diet or derived from silage. High fecal starch can indicate the need for greater grain processing.

- High input costs have stimulated both systems to recognize the importance of increasing feed efficiency. However, both systems are currently trying to establish how best to define efficiency and evaluate efficiency at the individual cow level. Efficiency is commonly defined as outputs/inputs. An example would be fat adjusted milk yield per unit of feed. Conversion has also been used to define efficiency. This is simply the inverse of efficiency. A conversion example would be the units of feed required to produce a given quantity of fat-adjusted milk yield. While the conversion of calories to milk is more efficient than the conversion of calories to weight gain, these traditional systems don’t necessarily quantify true metabolic efficiency. Researchers among various species (beef, dairy and swine) are beginning to examine residuals as a means of defining efficiency. Residuals of intake, production or a combination have been proposed. Residuals are established for a group of animals. For example, a group of cows are fed the same diet and individual intake is measured along with cow weight, condition and possibly milk production. The group data is used to establish an estimated level of intake based on the remaining parameters (three in this example). On an individual basis, the cow that eats less than what was expected for her size, condition and level of production is considered more efficient. If the cow eats more than expected for her size, condition and production,
she is less efficient. The goal would be to identify females that are capable of producing more with less feed. Another area of efficiency being examined is specific nutrient utilization efficiency. Drs. Normand St-Pierre and William Weiss, Ohio State University, at the Western Canadian Dairy Conference warned that defining efficiency in such a manner has a consequence of being at a level that is below the level that maximizes profit. Efficiency can also be examined at the economic level as these inputs and outputs are converted to values.

While the theme of these comments allude to comparisons of beef cow and dairy cow systems, the hidden message is – if you want to manage it, you must first measure it, and then remeasure it to quantify its response to change. Utilization of management tools such as soil testing, pasture inventories, feedstuff nutrient analysis, feed mix uniformity, body condition scores, fecal nutrient analysis and scores and measures of production efficiency bring valuable information to the table where decisions are made, cost of production is reduced and the system becomes more sustainable.