Nutrient Management Strategies for Dairy-Based Agriculture

Meeting Production and Environmental Challenges through a Variety of Technical Applications

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Newark, DE, August 21-24, 2011.
Our Premise: The sustainability of dairy farms in will depend on protecting air & water quality from the effects of excess nutrients.
Future of Dairy

• Drivers of current imbalances
  – External price pressures/fluctuations
  – Low cost of fertilizer + low nutrient density of dairy manure
  – Underestimating/poor (academic) understanding of the real value of manure
  – Lack of economical manure treatment and handling systems
Typical Dairy Feeding Strategy

- Forage is cheap to grow, but $$ to haul long distances=dairy is mostly tied to land base
- 50% DMI from forage; 4-4.5 tons DM/cow
- Harvest 5-8 tons DM/acre (~1-1.5 cows)
- Cow excretes 26 tons manure/year,
  - 350 lbs N, 140 lbs P₂O₅:

<table>
<thead>
<tr>
<th>Corn Silage Yield (tons/acre at 65%DM)</th>
<th>15</th>
<th>17</th>
<th>19</th>
<th>21</th>
<th>23</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₂O₅ removal (lbs/acre)</td>
<td>56</td>
<td>63</td>
<td>70</td>
<td>78</td>
<td>85</td>
<td>93</td>
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Implications for P Levels in Soils

Annual Accumulation

Samples testing high or very high in P (percentage of all samples)

y = 4.7x + 26
$R^2 = 0.86$

The Dairy Farm System

- Feed
  - Purchased - Feed
  - - Animals

- Crop Sales

- Cows

- Feeding and Herd Management Component

- Manure
- Manure Management Component

- N-P-K Fertilizer

- Soil
  - Soil and Crop Management Component

- Crop Sales

- Manure Export

- Milk, Meat, and Animals

NUTRIENT USE EFFICIENCY
Four Main Management Areas

- Feeding and Herd Management
- Soil and Crop Management
- Feed Storage (bunkers)
- Manure Management (treatment/handling)
- Management to displace/reduce inputs
Herd Management

- Cow comfort, herd health, and reproduction
- Well-balanced rations
- Scales to weigh harvest and removal rates
- Dry matter intake measurements
Herd Management

- No P mineral additions to ration
- Low CP (<16%) diets

- New York farm example:
  - ~60 g N/cow/d less urinary excretion
  - 1100 cows = ~26.5 tons N less in the environment over 365 d lactation
  - In 2009, $0.40/cow/d reduced
  - >$160,000 annually
Soil and Crop Management

• Maximize yield and quality
  – Hybrids, fertility, timeliness, soil health (cover crops, reduced tillage)
• Fertilizer to supplement manure and other on-farm nutrient sources
• RTK, GPS, yield monitors, variable rate manure, lime, seed placement
Manure incorporation in no-till systems
Forage Storage

• Poor management can result in 30-50% DM loss
• Reduce losses:
  – Harvest high quality forage (timely)
  – If silage, well packed bunks
  – Preservative/additives applied
  – Covered to exclude air and water
Manure Management

• Appropriate ammonia conservation
• Solids recovery (bedding or export)
• Anaerobic digester/odor control/summer
• Covered storages
• RO/UF- many challenges
• Ammonia recovery
Whole Farm Approach

• What is needed?
  – Recognition of multiple intervention points
  – Farmer driven implementation of tools for decision making and technology
  – Good record keeping (yield monitors)
  – Use of crop and herd indicators of performance - economic and environmental
  – Annual evaluations – whole farm balances
  – Regulatory push
Mid Atlantic data from:
http://www.mawaterquality.agecon.vt.edu/MidAtl/P_state_trends/MidAtl_Pbalance_peracre_crop_bystate.php

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New York

NYS: 13.8
NYS: 17.4
What Did We Do in New York?

Scales:

• State
• Region
• County
• Farm

{ Policy development?

} Farm-level management changes!
What Did We Do in New York

- CAFO Regulations
- Land Grant Guidelines
- P index
- N index

Diagram:

- EPA
- NYS DEC
- CAFO Permit
  - Collect and Treat Runoff From 25 Year, 24 Hour Storm
  - CNMP Driven by NRCS Standards
  - NRCS Waste Management System (312)
    - Nutrient Management Plan (590)
    - Record Keeping (748) and other standards as needed
New York: Policy and Outreach

- Large farm regulations (CAFO)
- Small farm voluntary assessments
- Extension outreach:
  - P index extension program
  - Soil/crop and herd approach both
  - Economic wins
  - Profitability and environmental protection
  - On-farm research network
What Did We Do in New York

• On-farm research network
Farmer Involvement
Quotes

• “When the research is done on our own ground with our own practices and in our climate, we’re more confident with the results.”
  – Jerry Coller, dairy farmer
Quotes

• “The history of collaboration and trust between the public, academic, and private sector stakeholders in New York State has lead to a track record of efficient problem solving.”
  – Rich Wildman, Agricultural Consulting Service

• “Good research coupled with effective communication and on-farm planning has brought incredible benefits to New York agriculture.”
  • Bill Gallenger, crop consultant
A 20% reduction in P use in 2007 compared with 2000!

Cumulative P load reduction between 2002 and 2007 of 56.8 million lbs of $P_2O_5$
Farm Phosphorus Balance

[Graph showing phosphorus balance per unit of available land (pounds per tillable acre) with annual milk production per mature cow (in pounds).]
P remaining/acre on dairy farms
NYS Upper Susquehanna Watershed
Mid Atlantic data from:
http://www.mawaterquality.agecon.vt.edu/MidAtl/P_state_trends/
MidAtl_Pbalance_peracre_crop_bystate.php
Soils Very High in Soil Test P (>40 lbs/acre Cornell Morgan test)

Upper Susquehanna Watershed data
Lessons Learned

The key solution lies in finding ways to *economically* increase nutrient use efficiency on farms and, thereby, decrease nutrient imports and/or increase exports in sales while reducing nutrient loadings to watersheds.

Regulations should *recognize* and *address* farm, state, and regional nutrient imbalances.
Lessons Learned

• For farm level impact:
  – Recognize change is necessary
  – Technology will help but not uniformly
  – Win-win situations first
  – Believable results, reliable data
  – Farmer involvement and accountability (on-farm)
  – Trust-based farmer, advisor, researcher relationship
People make the difference!
Lessons Learned

• For state level impact:
  • Land applied manure use must be linked to reasonable conservation + crop uptake
  • Apply common sense to influence sound decision-making (farmers, regulators)
  • Change via policy, incentives, measuring and monitoring
Tools

• Knowing a farm's nutrient mass balance is one step toward improving our understanding of nutrient movement onto, within, and away from a land-based farm.

• Benchmarks need to be established that give farms flexibility but hold them accountable.
Dairy evaluates mass nutrient balance

Bill and Penney Cook, operators of Aurora Ridge Dairy, Aurora, N.Y., with their partner Jason Burroughs, the dairy consists of 1,500 dairy cows and 3,000 acres of corn for silage and alfalfa hay. It’s earned a well-deserved reputation of being well-managed and productive.

The Cooks and Burroughs first learned about the concept of “mass nutrient balance” in the early 1990s when they participated in a project with Cornell researchers trying to better understand the flow of nutrients into, within, and away from dairies.

The partners are aware of public concerns about the potential impact of dairy farm nutrients, and they’re interested in finding ways to reduce any environmental impact. So last year when Caroline Rasmussen, mass nutrient balance project manager, approached Bill Cook about the project, he was willing to take another look at his dairy’s mass nutrient balance. He would learn how his 2004 results compared to the 1993 mass nutrient balance study, and the study results would provide direction for what nutrient areas Aurora Ridge could work on next.

Study results

Compared to the 1993 mass nutrient balance, Cook learned the following from the 2004 study:

- Like virtually all dairies, Aurora Ridge continues to import more phosphorus (P) than it exports annually. But the dairy’s P use has become much more efficient because it has cut the balance per acre by about 50%.

- This makes sense to Cook: The dairy is importing much more P in milk due to increased milk production while cutting back on P use in dairy rations and crop fertilizers over the years.

- The nutrient (N) balance data indicated the N balance per acre was a little higher than it had been in 1993.

- Cook wanted to learn more about how mass nutrient balance figures are calculated, what the numbers mean and, especially, what profitable opportunities exist to use N differently.

“[I] called a meeting at the farm that included our crop and feed managers, nutritionist and crop consultant, as well as Cornell research and Extension faculty, to discuss our farm mass balance data and to look at potential areas of improvement,” Cook says.

“As a result, we are getting more conservative with protein in the ration. We are willing to do this as long as we can continue to have high milk production. So far it’s working.”

On the crop side, Aurora Ridge Dairy is also looking at ways to make better use of nitrogen from manure and feed.

“The mass balance concept is always in the back of our minds now when we make decisions that affect nutrient use, especially in terms of nitrogen,” Cook says.

To track progress annually, the dairy plans to calculate a farm mass nutrient balance each year, as long as it makes sense.

“There is a lot more to learn about how to manage a farm mass nutrient balance, but there is a body of evidence indicating that dairy farms do have extra nutrients that can be lost to the environment, and we need to find ways to reduce those losses,” Cook says. “Bringing fewer nutrients to the farm in the first place and using the nutrients that are on the farm more efficiently seems like good places to target.”

By Karl Czymmek

Environmental goals in words

Aurora Ridge Dairy’s environmental mission statement reads:

- “Aurora Ridge Dairy will strive to be excellent stewards of the soils, water and air. We will farm in a manner that utilizes the natural advantages of these soils to grow high-quality forages, utilizing nutrients produced by the dairy. We will work hard to control nutrients, pathogens and odors from leaving our dairy.”

- “We are aware that every decision we make as managers has an impact on the environment. We will make every effort to make environmentally informed decisions.

- We will work to maximize and reuse our inputs. We will recycle as much of the material that comes onto the farm as possible, including the paper, plastics, metals, oils and tires.

- We will keep the farm buildings and properties clean, neat and well maintained.

- We will work to have the farm blend in with the natural beauty of the area.

- We are committed to meet and exceed environmental regulations to protect the health of our families, employees and neighbors.

- We will move forward preserving and improving soil productivity, recycling nutrients for crop use, recycling other consumables, and considering any technology that helps to reduce inputs.

- We will especially consider technologies that will have a positive impact on our neighbors.

- We are committed to continued improvement in everything that we do.”

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Next Generation

• Educate the next generation of college graduates to address complex issues of interdisciplinary nature.
• “This course helped me connect dairy farming to its environmental impact and how minimizing environmental impact is also economically sound.”
  – Student in 2011 course
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In Summary - Dairy

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