CALS Integrated Nutrient Management for Dairy and Livestock Farms PWT

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The sustainability of dairy and livestock farms in New York State will depend greatly on their ability to protect air and water quality from the effects of excess nutrients.
CALS Integrated Nutrient Management for Dairy and Livestock Farms PWT

- Soil Resource and Landscape Characteristics
- Water Quality
- Soil Fertility Management
- Animal Nutrient Management
- State and Federal Policy
- Farm Business Records
- Precision Agriculture
- GIS and Information Management
- Hydrology and Soil Erosion

Integrated Nutrient Management PWT
CALS Integrated Nutrient Management for Dairy and Livestock Farms PWT

Goals:

1. Improve communication:
   • within the CALS community;
   • between the CALS community and stakeholders.

2. Enhance program planning and implementation of various CALS nutrient management research and educational efforts, *focusing on integration of knowledge across disciplines and department boundaries*.

3. Transfer of research based understanding to farmers and other stakeholders.

4. Identification of gaps in knowledge (research needs) that need to be addressed to make our farms more profitable while protecting the environment.
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http://www.INMPWT.cce.cornell.edu

Vision

The CALS Nutrient Management for Dairy and Livestock Farms Program Work Team is a group of Cornell faculty and staff, extension educators, consultants and producers.

This group is working together to improve profitability and competitiveness of New York farms while protecting the environment by assessing current knowledge, identifying research and educational needs, facilitating new research, technology and knowledge transfer and aiding in the on-farm implementation of strategies for managing nutrients.

Current Events

June 23, 2004, 10:00-3:00

Topic: Chesapeake Bay Program Watershed Model Forum.

Speakers: Gary Shenk, EPA CBP.

Room: Hagan Room, S1009 Vet College Ahmnn, Cornell Campus. Lunch provided.

Hosted by:
Upper Susquehanna Coalition
Nutrient Management Spear Program

Initial Focus:

Nutrient management needs for

**Animal Feeding Operations**

including environmentally and agronomically sound use of both inorganic and organic nutrient sources, development of nutrient management software (Cropware) and risk management tools (P index, N leaching index).
Quantifying On-Farm Nutrient Balances: Toward Sustainable Dairy Farming
Ag Context

• CAFO Regulations
  – closer link between application rates and crop needs
  – risk assessment
• NYS water quality standards
  – visual impact can result in fines
  – can our guidelines prevent runoff/leaching?
• Ammonia emissions
  – barns as point sources?
  – ammonia losses from spreading?
• Total Maximum Daily Loads (TMDL’s)
• Message to the field: apply less nutrients
  – we need to look at current feasibility
  – develop workable solutions
The Dairy Farm System

Feeding and Herd Management Component

Feed Storage Component

Crop Sales

N-Fixation

The Dairy Farm System

Manure Management Component

Manure Export

Milk, Meat, and Animals

Purchased - Feed

- Animals

Crop Sales

N-Fixation

Feed

Milk, Meat, and Animals

Manure Export

N-P-K

Fertilizer

Soil, Crop & Erosion/Runoff Management Component
Assume:

- A milking cow eats 45 lbs of feed dry matter per day
- Of the 45 lbs of dry matter:
  - 50% from concentrate
  - 50% from forage
- This gives a yearly dry matter intake from forage:
  - $45 \times 0.5 \times 365 = 8200$ lbs of forage dry matter per year
Back of the envelope
dairy calculations

• 8200 lbs of dry matter + losses + supply buffer
  – ~5 tons of dry matter from forage crops/cow

• Average crop yields: 5.3 tons of dry matter/acre
  – This gives the equivalent of ~1.5 animal units per acre

• Good to excellent crop yields: 7.7 tons of dry matter/acre
  – This gives the equivalent of ~2 animal units per acre
  – Enough feed for one milking cow plus replacement

• This is how NE dairies are organized today!
Back of the envelope
dairy calculations

INPUT

OUTPUT

N fixation
Feed
N-P-K

Nutrient Budgeting on Dairy Farms
## Mass Nutrient Balance (MNB):

<table>
<thead>
<tr>
<th>Size of dairy farm</th>
<th>45</th>
<th>320</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INPUT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>purchased fertilizer</td>
<td>1.2</td>
<td>2.0</td>
<td>10.0</td>
</tr>
<tr>
<td>purchased feed</td>
<td>1.0</td>
<td>8.4</td>
<td>14.2</td>
</tr>
<tr>
<td>purchased animal</td>
<td>0.0</td>
<td>0.03</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>10.4</td>
<td>24.2</td>
</tr>
<tr>
<td><strong>OUTPUT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>milk</td>
<td>0.36</td>
<td>3.8</td>
<td>5.5</td>
</tr>
<tr>
<td>animals sold</td>
<td>0.05</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>crops sold</td>
<td>0.02</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>0.43</td>
<td>4.3</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>REMAINDER</strong></td>
<td>1.8</td>
<td>6.2</td>
<td>18.2</td>
</tr>
<tr>
<td><strong>% excreted as manure</strong></td>
<td>81%</td>
<td>59%</td>
<td>75%</td>
</tr>
</tbody>
</table>

(Klausner, 1997)
Does that make sense?

- A milking cow excretes ~10% of body weight/day as manure
- A 1400 lbs cow (~1.5 AU/acre) excretes ~25 tons per year
- Cow + replacement (~ 2 AU) excretes ~36 tons per year
- Let's say an average manure sample from storage contains:
  - 10 lbs of N per ton of manure
  - 4 lbs P$_2$O$_5$ per ton of manure
- If under very good crop management, we can have 2 AU/acre
  - this gives 360 lbs of N and 144 lbs of P$_2$O$_5$/acre per year!
- CNCPS estimates: ~400 N, 130 P$_2$O$_5$ per cow as excreted

(Van Amburgh)
Issues

• Soils are accumulating phosphorus
• Air quality
• Surface water contamination
• Groundwater/well contamination
Soils

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

- 1976-1980
- 1981-1985
- 1986-1990
- 1991-1995
- 1996-2000

Regression equation:

\[ y = 4.6859x + 26.119 \]

\[ R^2 = 0.8628 \]

(Ketterings, Kahabka, Reid, 2004)
What happens to our soils?

(Ketterings, Kahabka, Reid, 2004)
Air Conflicts

• Concern:
  – air emissions of NH$_3$
  – odor/neighbor relations

• Solution:
  – incorporate manure

• Challenge:
  – fall incorporation?
  – Balancing for N?
Surface Water Conflicts

• Concern
  – P runoff

• Solution
  – Storage/Timing
  – Incorporation
  – Further from water

• Challenge
  – Soil erosion?
  – Groundwater/N?
  – Impact of intense spreading at various scales?
Groundwater/well Conflicts

• Concern:
  – N leaching

• Solution:
  – Surface application
  – Reduced rates
  – Timing/storage

• Challenge
  – Air emissions/odors
  – Individual wells versus aquifers
Solutions???

- Standard Best Management Practices offer limited impact?
- Risk indices (only buy us time)
- Source reduction – precision feeding and forage
- What on-farm reductions are possible/practical??
- Treatment/export?
  - Driven based on biological limitations?

What are we telling the producers?
The Dairy Farm System

- Cows
- Manure
- Soil
- Crops
- Feed Storage Component
- Feeding and Herd Management Component
- Soil and Crop Management Component
- Manure Management Component

- Feed
- N-Fixation
- Milk, Meat, and Animals
- Manure Export
- Fertilizer
- Milk, Meat, and Animals
- Purchased Feed
- Purchased Animals
- Crop Sales
Precision Dairy Farming

- **Animal Nutrition**
  - Feed closer to actual requirements
  - Reduce purchased feed
  - Optimize forage quality
  - Optimize home grown forage utilization

- **Crop Nutrition**
  - Optimize nutrient utilization
  - Reduce fertilizer purchase
  - Reduce allocation risk spatially and temporally

Not your typical BMP’s!

To have impact, we need to work closely with producers at the farm-scale level.
Mass Nutrient Balance: Performance Measure

- Review annual inputs and outputs
- Set targets - absolute or % based??
- Incorporate economic indicators
- Meet by precision feeding/forage and crop nutrition management
- Not a substitute for conventional BMP’s
- CNMPS could perform with modifications

This will get producers involved and allows us to evaluate if we can reduce dairy farm losses by 40%