Nutrient Management Tools: The Yardstick in Wisconsin

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Environmentalist's view of how farmers manage manure.

The Yardstick
- The Yardstick is a Mass Balance Tool designed to help farmers identify the sources of nutrients entering and leaving the farm, allowing them to make more informed decisions on how to deal with nutrient loading.

What is a Mass Balance?
- Identifying all sources of nutrients entering and leaving the farm
  - Inputs: Feed, Fertilizer, purchased animals
  - Outputs: Milk, Meat, Crops sold.
  - Environmental sources: Legumes, Rain
  - Environmental Losses: Leaching
  - Goal is to be near zero.
Dutch Yardstick

- Developed in the Netherlands in ‘80’s.
- Used as an Environmental Taxation Tool
  - Import too much: Tax penalty
  - Below balance: Tax credit

Yardstick in the US

- Imported in mid 90’s by IATP (Institute for Ag Trade and Food Policy, Minneapolis)
- Adapted for use in the US by WI, MN
  - US version significantly easier to use

Yardstick Usage

- Four main projects in Midwest:
  - Blue Earth Basin (MN)
  - Apple-Ashwaubenon (WI)*
  - Mendota Watershed (WI)
  - Central Nebraska

* Apple-Ashwaubenon was my MS Thesis project

Excel Spreadsheet and paper version available

Some aspects are being incorporated into SNAP PLUS, covered in the next session
Focus

- Identify amount and sources of nutrients entering and leaving the farm
- Whole farm target, but animal enterprises can be isolated with some modifications to data collection

Focus

- Collects N, P, K data
- Micronutrients (Sulfur, Selenium) can be added with modifications
- Potassium data has been the key to getting dairy farmers to use Yardstick results

Usability

- Targeted to livestock farms, valid for cash grain.
- Paper version: If you passed 4th grade math, you can use the yardstick
- Electronic Version: Excel 95 or above (not MS Works Spreadsheet)

Usability

- Easy enough for a farmer to use, but best method is to have someone trained for data collection and results interpretation
- Can be used on any farm where the farmer has kept decent records.
- Some CCA’s have explored using the tool, none are.
Usability

- In-tool tables for common feed/crop nutrient values.

Expandability

- Most WI users have added a linked spreadsheet to deal with purchased feeds.

Outputs

- Basic Level: N, P, K surplus (deficit) on a per acre basis.

- Advanced: Ability to modify operation to determine nutrient impacts
  - How many acres do I need to add to be in a P balance?
  - What happens if I add 50 sows?
  - If I buy hay instead of growing it, what happens to my overall environmental impact?

Outputs

- Regulatory: A mass balance at some level is required by some WPDES large livestock permits currently
  - Too many variables to be used in a strict regulatory sense (poor year = low yields = more feed bought)
  - Long term trend is more important

Table 2 - Nutrient Composition of Common Crops and Forages*

<table>
<thead>
<tr>
<th>CROP</th>
<th>CP %</th>
<th>N %</th>
<th>P %</th>
<th>K %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>42.80%</td>
<td>6.85%</td>
<td>0.65%</td>
<td>1.82%</td>
</tr>
<tr>
<td>Corn</td>
<td>7.90%</td>
<td>1.26%</td>
<td>0.25%</td>
<td>0.33%</td>
</tr>
<tr>
<td>Oats</td>
<td>11.00%</td>
<td>1.78%</td>
<td>0.35%</td>
<td>0.37%</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>14.80%</td>
<td>2.36%</td>
<td>0.30%</td>
<td>1.40%</td>
</tr>
<tr>
<td>Red clover hay</td>
<td>12.50%</td>
<td>2.00%</td>
<td>0.22%</td>
<td>1.68%</td>
</tr>
<tr>
<td>Smooth bromegrass</td>
<td>10.00%</td>
<td>1.71%</td>
<td>0.28%</td>
<td>2.13%</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>6.50%</td>
<td>1.34%</td>
<td>0.27%</td>
<td>1.25%</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>12.50%</td>
<td>2.00%</td>
<td>0.30%</td>
<td>2.40%</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>4.10%</td>
<td>0.60%</td>
<td>0.06%</td>
<td>0.90%</td>
</tr>
<tr>
<td>Barley straw</td>
<td>4.60%</td>
<td>0.70%</td>
<td>0.10%</td>
<td>1.15%</td>
</tr>
<tr>
<td>Oats straw</td>
<td>3.75%</td>
<td>0.60%</td>
<td>0.15%</td>
<td>1.65%</td>
</tr>
<tr>
<td>Sugarbeets</td>
<td>5.00%</td>
<td>0.80%</td>
<td>0.10%</td>
<td>0.90%</td>
</tr>
</tbody>
</table>
Apple-Ashwaubenon 1997-1998

- 17 farms
- 13 dairies from 50 to 500 hd
- 4 cash grain operations
- Follow-up study (2001) now underway by UW Madison.

Sources of Nutrients

CP:P Ratios of various protein sources

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Crude Protein</th>
<th>Phos</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed</td>
<td>46</td>
<td>1.1</td>
<td>41.8</td>
</tr>
<tr>
<td>44% SBM</td>
<td>44</td>
<td>0.6</td>
<td>73.3</td>
</tr>
<tr>
<td>Corn Gluten</td>
<td>60</td>
<td>0.7</td>
<td>85.7</td>
</tr>
</tbody>
</table>

80% of the excess Phosphorus could be eliminated by reducing the P in the dairy ration from 0.52 to 0.38%.
Limitations

- Poor farm records
  - Over 17 farms, the heifer:bull calf ratio was 7:1
  - Tax records are not tonnage records
  - Most records came not from the farm, but from the supplier (feed mill, dealer, etc)

- Time
  - Depending on the farm’s records, completing the yardstick took between ½ and 22 hours to complete.
  - Having an experienced person who knows what records to look for (and where to find them) pays big dividends.

Nutrient Loading Changes

- Goal is to open farmers eyes and allow them to see where changes can be made
  - Main impacts are in how livestock are fed

Yardstick vs. a Nutrient Management Plan

- Scale: NMP is field level, yardstick is farm.
- Results: Just because a farm is in balance does not mean that nutrients are being applied in the right places at the right rates.

Future Vision

- Multi-year field scale mass balance will be a part of the SNAP PLUS software.
- Watershed Carrying Capacity studies?
Thanks for your time!

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Additional Slides if we have time or need to discuss further

Study Goals
- Do large farms have a greater potential to pollute (P) than small farms?
- Where is our P coming from -- -- and will Nutrient Management solve the problem?
  - Mass balance of different farm sizes best way to answer the question.

<table>
<thead>
<tr>
<th>Farm Type</th>
<th>Years</th>
<th>N Mean (lbs/acre)</th>
<th>P Mean (lbs/acre)</th>
<th>K Mean (lbs/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash grain farms</td>
<td>8</td>
<td>-9</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>All dairy farms</td>
<td>26</td>
<td>87</td>
<td>15</td>
<td>80</td>
</tr>
<tr>
<td>Less than 260 Lb/cow</td>
<td>26</td>
<td>124#/cow</td>
<td>21#/cow</td>
<td>106#/cow</td>
</tr>
</tbody>
</table>

Nitrogen movement off-farm

Nitrogen imports by source
Dietary P Management - On-Farm Phosphorus Balance

Dietary P Management - Why is P Fed at Excessive Levels?
- Reproductive Efficiency
  - Common belief that high P diets improve animal reproductive efficiency.
  - Research does not support this theory.
  - National Research Council recommends dietary-P levels of 0.32 to 0.38% - depending on milk production.
- Over-feeding statistics:
  - Survey of Wisconsin dairy farms found 85% fed P in excess of NRC recs and over half were fed in excess of 0.38% P.

Dietary P Management - NRC Feed Recommendations

National Research Council (NRC) Feed-P Recommendations

<table>
<thead>
<tr>
<th>Milk Production (lbs/day)</th>
<th>Dietary P Level (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>0.32</td>
</tr>
<tr>
<td>77</td>
<td>0.35</td>
</tr>
<tr>
<td>99</td>
<td>0.36</td>
</tr>
<tr>
<td>120</td>
<td>0.38</td>
</tr>
</tbody>
</table>


Dietary P Management - Why is P Fed at Excessive Levels?
- Reproductive Efficiency
- Affordable Protein Sources
  - Undegradable Protein Sources
    - Animal protein sources
    - Heat-treated sources
  - Other Protein Sources
    - Soybean meal
    - Distiller’s dried grain
- Affordable Nutrient Sources
  - Energy & Fiber Sources
    - Whole soybean, tallow, cottonseed
  - Nutrient sources can also provide a very high level of dietary-P.

Dietary P Management - Why is P Fed at Excessive Levels?
- Reproductive Efficiency
- Affordable Protein Sources
- Affordable Nutrient Sources
- Cattle are not harmed by over-feeding P at commonly found levels, BUT, manure-P levels increase with elevated levels of P intake.
Dietary P Management – Implications of a High-P Diet

<table>
<thead>
<tr>
<th>Dietary P (%)</th>
<th>Manure-P (%)</th>
<th>Spreadable Acres (acres/yr)</th>
<th>Acres Needed (acres/cow/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35</td>
<td>42</td>
<td>1.6</td>
<td>160</td>
</tr>
<tr>
<td>0.38</td>
<td>47</td>
<td>1.8</td>
<td>180</td>
</tr>
<tr>
<td>0.48</td>
<td>65</td>
<td>2.4</td>
<td>240</td>
</tr>
<tr>
<td>0.55</td>
<td>78</td>
<td>2.9</td>
<td>290</td>
</tr>
</tbody>
</table>

Farmers may need to manage dietary P intake in order to reduce manure-P.

Phosphorus Exports

Potassium Source

Potassium Exports (% of total)

Animal P Crop P Milk P Manure P

Phosphorus Exports (% of total)

Dairy Farms

Cash Grain

Potassium Exports (% of total)

Animal K Feed K Fertilizer K

Potassium Exports (% of total)

Dairy Farms

Cash Grain Farms

Soil test phosphorus level (ppm)

County Average

Mass Balance

Mass Balance w/deep injection


Title goes here
Conclusions

- Acres and cow numbers
  - DO NOT affect per acre phosphorus loading.
  - Increase per acre N and K loading.
- Phosphorus problem CAN NOT be solved by just looking at the fertilizer sources.

Conclusions

- Implementing the following eliminated surplus
  - Reduce feed P from 0.52 to 0.38%
  - Reduce % P in starter fertilizer (9-23-30 → 9-15-30)
  - Minor change in manure rates on some fields.