Whole Farm Nutrient Mass Balances

In Summary

Nutrient Management Spear Program

http://nmsp.cals.cornell.edu
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What is a nutrient mass balance?

- **Balance** = **Imports** – **Exports** (just farm boundaries).
- We only measure what is **reasonably feasible** to measure.

**Imports** are:
- Feed
- Fertilizer
- Animal
- Bedding, Manure

**Exports** are:
- Milk
- Animal
- Crop
- Manure, others

**Balance** can be calculated per tillable acre (nutrient recycle land base) or per cwt of milk (nutrient use efficiency).
### Why do we care?

<table>
<thead>
<tr>
<th>Mass balance (Imports &lt; Exports)</th>
<th>Time period</th>
<th>Desirable/Undesirable</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative</strong></td>
<td>Short term</td>
<td>Desirable</td>
<td>If soil test P and K are high</td>
</tr>
<tr>
<td></td>
<td>Long term</td>
<td>Undesirable</td>
<td>Soil P and K mining → yield losses</td>
</tr>
<tr>
<td><strong>Surplus</strong> (Imports &gt; Exports)</td>
<td>Short and Long term</td>
<td>Desirable</td>
<td>Inefficiencies in plant and animal production</td>
</tr>
<tr>
<td><strong>Large Surplus</strong> (Imports &gt;&gt;&gt; Exports)</td>
<td>Short and Long term</td>
<td>Undesirable</td>
<td>Nutrient losses to the environ. Soil P and K buildup. Low nutrient use efficiency Maybe economic losses</td>
</tr>
</tbody>
</table>
New York dairy farms operate with a wide range of mass balances per acre and per cwt, regardless of their size.

**Distribution of mass balances across New York dairies**

<table>
<thead>
<tr>
<th>Distribution Across NY dairies*</th>
<th>NMB (lbs/acre)</th>
<th>NMB (lbs/cwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N  P  K</td>
<td>N  P  K</td>
</tr>
<tr>
<td>Minimum</td>
<td>-35 -7 -45</td>
<td>-1.3 -0.11 -0.73</td>
</tr>
<tr>
<td>Maximum</td>
<td>211 45 132</td>
<td>2.6 0.47 1.69</td>
</tr>
<tr>
<td>&quot;Feasible&quot;</td>
<td>0 to 105 0 to 12 0 to 37</td>
<td>0 to 0.88 0 to 0.11 0 to 0.30</td>
</tr>
</tbody>
</table>

*Based on 102 dairy farms in 2006

- Farms with “feasible” mass balances have:
  - low risk of losing nutrients to the environment (per acre)
  - high nutrient use efficiencies (per cwt).
and have the same NMB per acre (80 lbs/acre), but produces twice more milk, and hence has a higher nutrient use efficiency. Indeed, works in the Optimal Operational Zone.

EXAMPLE 1: ⭐ and ⭐ produce the same amount of milk per acre (6,000 lbs/acre), but ⭐ has lower NMB, and hence a lower risk of losing nutrients to the environment.

EXAMPLE 2: ⭐ and ⭐ have the same NMB per acre (80 lbs/acre), but ⭐ produces twice more milk, and hence has a higher nutrient use efficiency. Indeed, ⭐ works in the Optimal Operational Zone.
What causes excessive NMB?

**Mass balance**

- **Per acre**
  - High if
    - N > 105 lbs/ac
    - P > 12 lbs/ac
    - K > 37 lbs/ac

- **Total imports**
  - High risk if
    - > 195 lbs N/ac
    - > 30 lbs P/ac
    - > 63 lbs K/ac

- **Feed**
  - High risk if
    - > 1.0 AU/ac
  - Purchased feed (lbs/ac)
    - High risk if
      - > 121 lbs N/ac
      - > 20 lbs P/ac
      - > 38 lbs K/ac
  - Feed use efficiency (%)
    - Can be improved if
      - N < 20%
      - P < 25%
      - K < 11%
  - CP and P (%) in purchased feed
    - Can be reduced if
      - > 27-30% CP
      - > 0.60% P
  - CP and P (%) in all feed
    - Can be reduced if
      - > 17% CP
      - > 0.40% P

- **Fertilizer**
  - Could be reduced if
    - > 39 lbs N/ac
    - > 7 lbs P/ac
    - > 38 lbs K/ac

- **Other indicators**
  - Milk/cow
    - Could be increased if
      - < 20,000 lbs/cow per yr
  - Exports
    - Could be increased if
      - < 20,000 lbs/cow per yr
  - Crops
  - Manure

**Animal density (AU/ac)**

- High risk if
  - > 1.0 AU/ac

**Homegrown feed (%)**

- High risk if
  - < 62-65%

**Overall crop yields**

- Could be increased if
  - < 4.7 tons/ac
Contact

- **Mass balance software and input data sheets**
  
  → [http://nmsp.cals.cornell.edu/projects/massbalance.html](http://nmsp.cals.cornell.edu/projects/massbalance.html)

- **Mass balance website**

  → [http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/MassBalances.html](http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/MassBalances.html)

- **To get more information, please contact**

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