# UWEX Soil Fertility Guidelines for Pastures in Managed Grazing Systems

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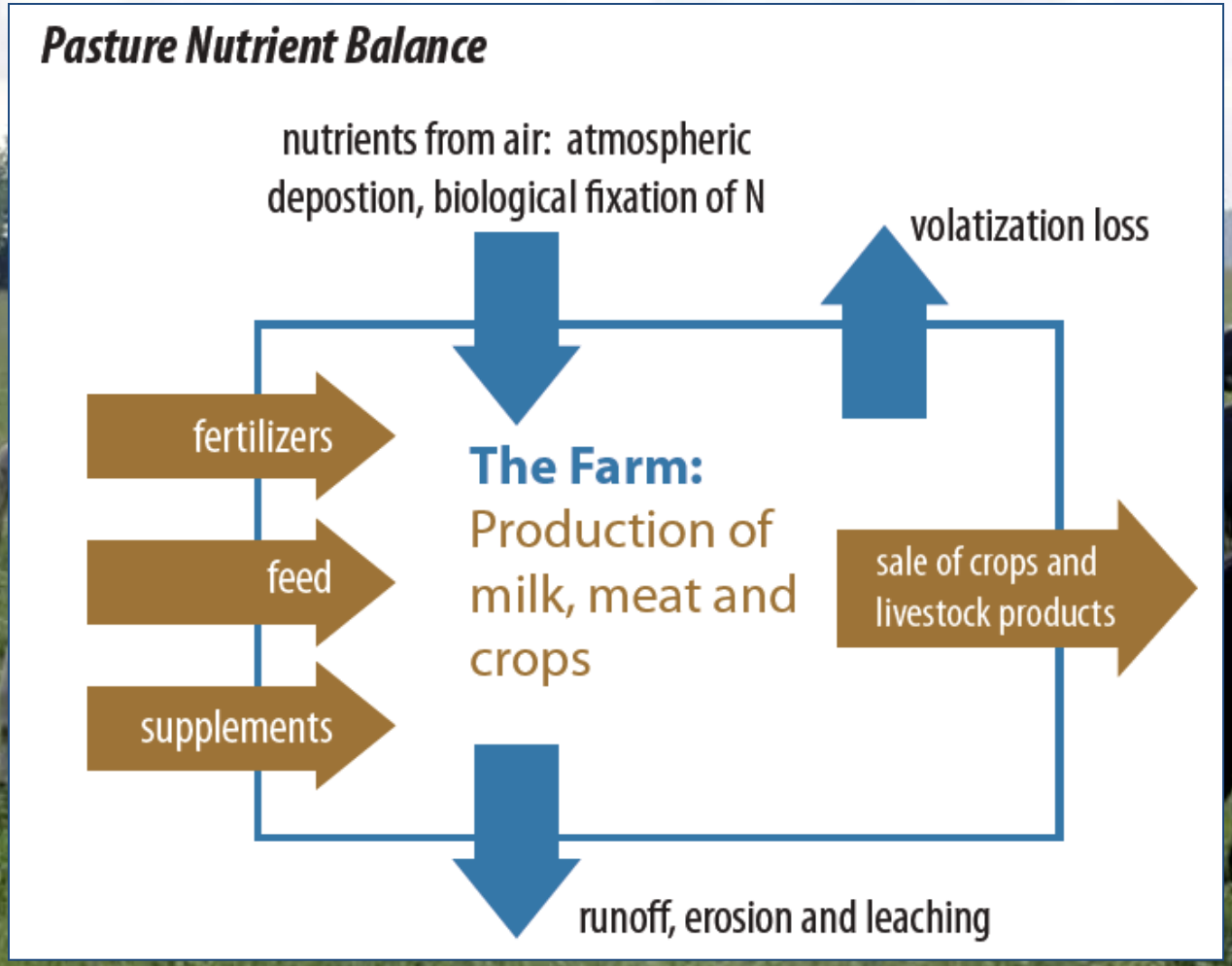
# Pasture nutrient balance



# Objective of UWEX Soil Fertility Management Guidelines

Maintain an adequate supply of soil nutrients to support economically optimal yield and quality of the crops grown while minimizing losses to the environment

# 17 Essential plant nutrients

Structural nutrients

| | |
|---|---|
| C | Carbon |
| O | Oxygen |
| H | Hydrogen |

Primary nutrients

| | |
|---|---|
| **N** | **Nitrogen** |
| **P** | **Phosphorous** |
| **K** | **Potassium** |

Secondary nutrients

| | |
|---|---|
| Ca | Calcium |
| **Mg** | **Magnesium** |
| **S** | **Sulfur** |

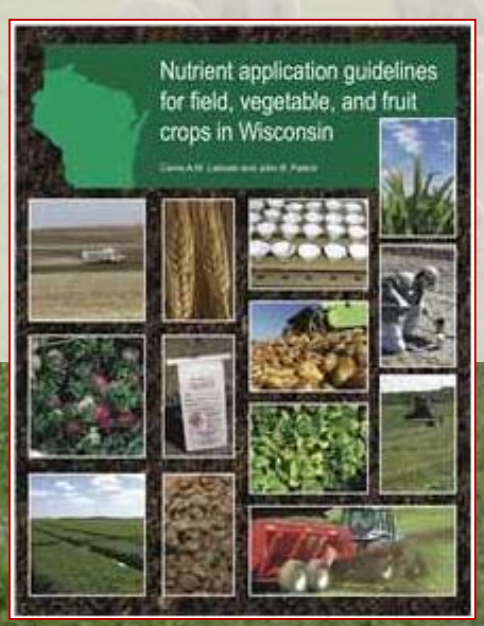
Micronutrients

| | | | |
|---|---|---|---|
| **B** | **Boron** | Mn | Manganese |
| Zn | Zinc | Cu | Copper |
| Fe | Iron | **Mo** | **Molybdenum** |
| Cl | Chlorine | Ni | Nickel |

# UWEX Soil Fertility Guidelines

Outlined in UWEX A2809

*Nutrient application guidelines for field, vegetable and fruit crops in Wisconsin*




*Carrie Laboski and John Peters*

**Newly revised - 2012**

# Soil nutrient application guidelines based on:

- Soil sampling and analysis (every 3-4 years)
  - Routine soil analysis
    - P Phosphorous, K Potassium, pH acidity, %OM Percent organic matter content
    - Secondary and micro nutrient tests are optional
- Soil type/series
- Crops in rotation/pasture species
  - Yield goal (tons DM/acre)
- Nutrient contributions from manure/urine deposition

# A Summary of Dairy Grazing Practices in WI

L. Paine and R. Gildersleeve

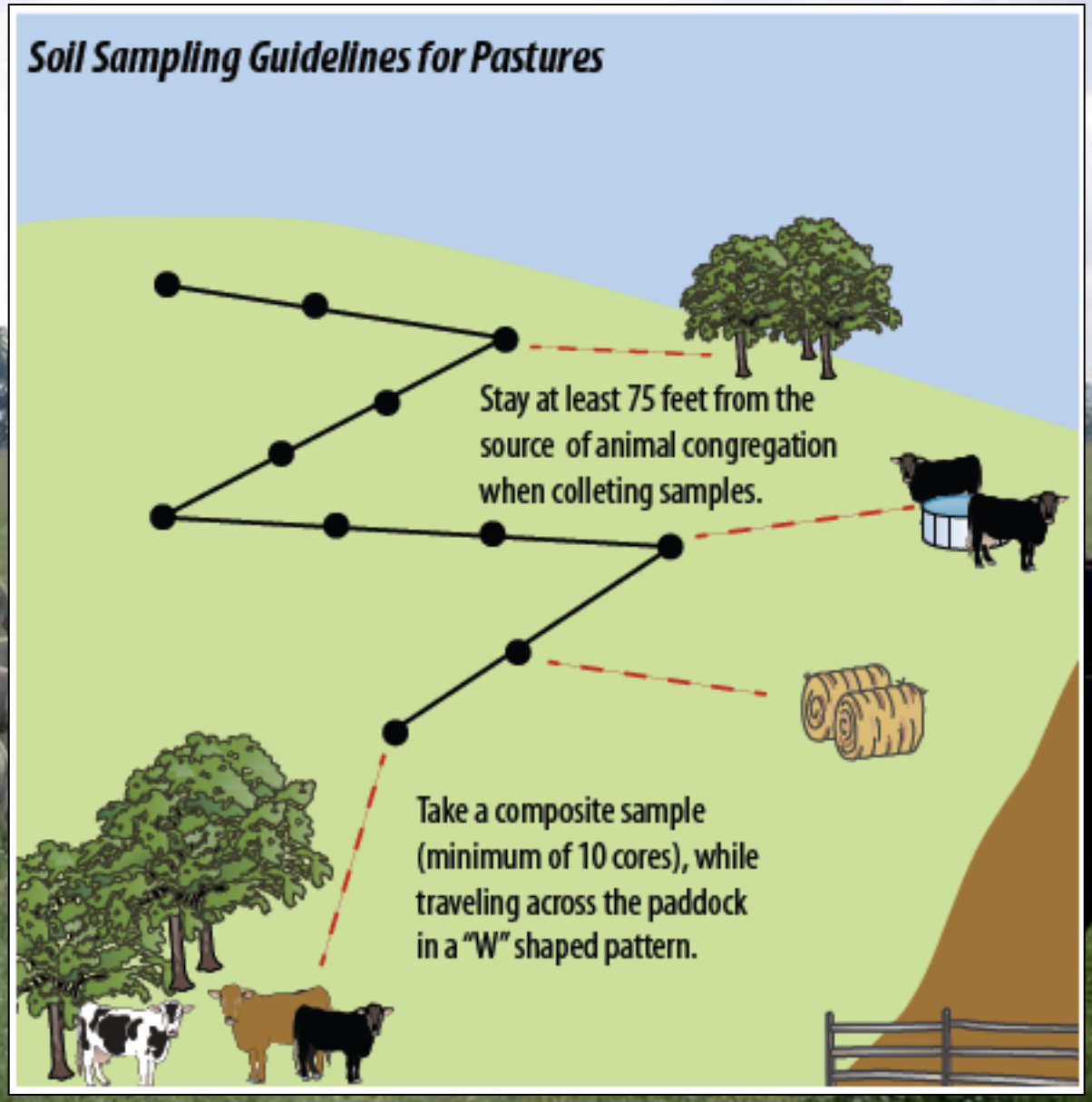
- 2010 survey of 1568 WI dairy farms using grazing practices
  - 771 farms responded
    - 49% use soil testing
    - 42% use commercial fertilizers on pastures
    - 44% use nutrient management planning

# Soil sampling

## Methods are important

- Samples need to accurately represent the fertility of the pasture;
- Use a soil probe - insert to a 6 inch depth;
- Take one “composite sample” per 5 acres of field/pasture. At least one composite sample should be taken in each field/paddock;
- Each composite sample should be made up of at least 10 cores. Use “W” shaped sampling pattern;
- See UWEX A2100 *Sampling Soils for Testing* for info

Avoid areas of concentration. Or, sample those areas separately, keeping with the one composite sample per 5-acre guideline



# Pasture crop categories in Wisconsin soil test program

## Pasture crop categories

- Pasture, grass
- Pasture, < 30% legume–grass seeding
- Pasture, < 30% legume–grass established
- Pasture, > 30% legume–grass seeding
- Pasture, > 30% legume–grass established
- Pasture, unimproved

## Pasture-related crop categories

- Red Clover
- Alfalfa
- Birdsfoot Trefoil
- Reed Canarygrass

# pH and Liming

- Soil pH regulates nutrient availability and influences microbial reactions in soil
- Lime need determined by species present
- Grasses and clovers do fine at pH=6.0
- Alfalfa requires pH=6.5-6.8
- Repeated N fertilizer applications (manure and urine also) have potential for acidifying soil surface

# Soil Acidity

- Managed with application of lime
  - Calcitic lime $CaCO_3$
  - Dolomitic lime $CaCO_3 \cdot MgCO_3$
  - Neutralization – it's the carbonate ion, not $Ca^{2+}$

    $Ca\mathbf{CO_3} + 2H^+ \longrightarrow Ca^{2+} + \mathbf{CO_2}\uparrow + H_2\mathbf{O}$
  - Gypsum is not a liming material

    $(Ca(SO_4) \cdot 2H_2O)$
  - Dolomitic lime is an important source of Ca and Mg

# UWEX Soil Fertility Recommendations for P, K, other nutrients

- Based on Sufficiency Level of Available Nutrients (SLAN) approach:
- There are definable levels of individual nutrients in the soil, below which crops will respond to additions of that nutrient;

  above which, probability of response is lower,

  = **“optimum”** level for the soil/crop rotation

# Soil test P and K interpretation ranges for pasture forages

| | | Soil test category | | | | | |
|---|---|---|---|---|---|---|---|
| | | Very low (VL) | Low (L) | Optimum (O) | High (H) | Very high (VH) | Excessively high (EH) |
| | Soil group[a] | soil test K ppm | | | | | |
| Soil Test P | Loamy | < 10 | 10–15 | 16–20 | 21–30 | — | > 30 |
| | Sandy, Organic | < 12 | 12–22 | 23–32 | 33–42 | — | > 42 |
| Soil Test K | Loamy | < 70 | 70–100 | 101–130 | 131–160 | 161–190 | > 190 |
| | Sandy, Organic | < 45 | 45–65 | 66–90 | 91–130 | — | > 130 |

# Pasture, Legume (<30%) Grass $P_2O_5$ Recommendations

| Yield Goal | Soil Test Level | | | |
|---|---|---|---|---|
| ton/ac | Low | Optimum | High | Ex.High |
| | lb/acre | | | |
| 2-3 | 60 | 35 | 20 | 0 |
| 3.1 - 4 | 75 | 45 | 25 | 0 |
| 4.1 - 5 | 90 | 60 | 30 | 0 |

# Pasture, Legume (<30%) Grass $K_2O$ Recommendations

| Yield Goal | Soil Test Level | | | | |
|---|---|---|---|---|---|
| ton/ac | Low | Optimum | High | V. High | Ex.High |
| | lb/acre | | | | |
| 2-3 | 160 | 130 | 65 | 35 | 0 |
| 3.1 - 4 | 210 | 180 | 90 | 45 | 0 |
| 4.1 - 5 | 260 | 230 | 115 | 60 | 0 |

# Nitrogen fertilization guidelines for pastures

| Crop | Yield range per acre | Soil organic matter content (%) < 2.0 | 2.0–9.9 | 10.0–20.0 | > 20.0 |
|---|---|---|---|---|---|
| | | lb N/a to apply [c] | | | |
| Pasture, grass [a,b] | 0.5–5 ton | 160 | 130 | 100 | 50 |
| Pasture, ≤ 30% legume-grass, seeding | 0.5–1.9 ton | 40 | 20 | 0 | 0 |
| Pasture, ≤ 30% legume-grass, established | 2–5 ton | 0 | 0 | 0 | 0 |
| Pasture, > 30% legume-grass, seeding | 0.5–1.9 ton | 30 | 10 | 0 | 0 |
| Pasture, > 30% legume-grass, established | 2–5 ton | 0 | 0 | 0 | 0 |
| Pasture, unimproved [a] | 1–4 ton | 120 | 100 | 70 | 30 |

[a] Split N applications into two to three applications per year. [b] Grass = includes bromegrass, orchardgrass, fescue, ryegrass, timothy (any combination).
[c] This is the total amount of N to apply including starter fertilizer.

# Nitrogen fertilization guidelines for pastures

- When significant legumes present, 30-50 lb N/ac/yr transferred to grasses, no N recommended
- However, if goal = max production, apply 80-100 lbs N/acre
  - May give grass competitive advantage over legumes, which will be lost over time.

# Nitrogen fertilization guidelines for pastures

- For tall grass pastures, up to 160 lbs N/acre will maximize production

  Split applications: 40-80 lbs N early June

  40-80 lbs N early August

- Nitrate poisoning caution
- Risk of some volatization loss (up to 20%) from urea applications
- Forage yield response dependent on rain, cooler temperatures

# Nitrogen fertilization guidelines for pastures

Economic return to N applications will depend on:

- Cost of N vs. value of additional forage produced
- Need for additional forage and timing of those needs
- Ability to use/manage additional forage

# *Nitrogen Management in Rotationally Grazed Pastures*

## Dr. Dennis Cosgrove, UW River Falls, 2006

Table 1. Yield increases from nitrogen application

| Species | Control Yield (lbsDM/acre) | May 1 | June 15 | August 1 | May 1 + June 15 | May 1 + June 15 + August 1 |
|---|---|---|---|---|---|---|
| | | Yield Increase (lbs DM/acre) | | | | |
| KB | 4365 | 246 | 14 | 232 | 710 | 885 |
| SB | 5293 | 1326 | 456 | 1002 | 1054 | 2019 |
| OG | 4654 | 1052 | 516 | 729 | 1062 | 1284 |

2 year trial @ UW River Falls, 2004-05

KB = Kentucky bluegrass + white clover

SB = Smooth bromegrass + alfalfa

OG = Orchardgrass + red clover

# Nitrogen application economics

## Example:

- 50 lbs N applied @ $.55/lb N = $28
- 1,000 lbs additional forage
  @ $130 per-ton = $65 gross return

- Net return to N ($65 - $28) = $37 per-acre

# Nutrient crediting
## of pasture-deposited manures

- Determined by:
  - Quantity of manure (urine and feces) deposited in tons per-acre
    - Estimated according to time spent grazing
  - Nutrient content of manure
  - Reliable crediting depends on good distribution of manure

# Total and available nutrient content of pasture-deposited manures

Source: Midwest Plan Service and American Society of Ag. Engineers

| | | Total Nutrients | | | Available Nutrients | | |
|---|---|---|---|---|---|---|---|
| | | N | $P_2O_5$ | $K_2O$ | N | $P_2O_5$ | $K_2O$ |
| | Dry Matter % | lb/ton | | | lb/ton | | |
| **Beef** | 8 | 14 | 4 | 9 | 6 | 3 | 7 |
| **Dairy** | 13 | 10 | 4 | 7 | 4 | 3 | 6 |
| **Sheep** | 25 | 19 | 10 | 19 | 8 | 8 | 15 |
| **Goat** | 32 | 22 | 5 | 15 | 9 | 4 | 12 |
| **Horse** | 14 | 7 | 2 | 2 | 3 | 2 | 2 |

Values differ slightly from manure Table 9.1, UWEX A2809

# How much manure is being deposited in the pasture?

[http://datcp.wi.gov/Farms/NutrientManagement/index.aspx](http://datcp.wi.gov/Farms/NutrientManagement/index.aspx)

MWPS Manure quantity estimation form

## Wisconsin Manure Quantity Estimation

V 09/01/03

Name:_____ Date:_____

| Animal | Size | Daily Manure Production To Apply | | | | | | Annual Manure Production To Apply | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lbs | Solid | | Liquid | | | | Number of Head | x Daily Total Tons or Gal. | x 365 Day Total | x % Collected | = Total Collected Tons or Gal. |
| | | Lbs/day | ft³/day | MWPS ft³/day x WI dairy & beef dilution factor | ft³/day & WI dilution | MWPS gal./day x WI dairy & beef dilution factor | gal./day & WI dilution | | | | | |
| ***Dairy*** | | | | | | | | | | | | |
| Calf | 150 | 13 | 0.200 | .21*1.8= | .37 | 1.53*1.8= | 2.80 | | | | | |
| Calf | 250 | 21 | 0.320 | .33*1.8= | .60 | 2.47*1.8= | 4.50 | | | | | |
| Heifer | 750 | 65 | 1.000 | 1.03*1.8= | 1.85 | 7.70*1.8= | 13.8 | | | | | |
| Lact. Cows | 1000 | 106 | 1.700 | 1.71*1.8= | 3.07 | 12.7*1.8= | 23.0 | | | | | |
| | 1400 | 148 | 2.400 | 2.38*1.8= | 4.28 | 17.7*1.8= | 32.0 | | | | | |
| Dry Cows | 1000 | 82 | 1.300 | 1.30*1.8= | 2.35 | 9.7*1.8= | 18.0 | | | | | |
| | 1400 | 115 | 1.820 | 1.82*1.8= | 3.33 | 13.6*1.8= | 25.0 | | | | | |
| ***Beef*** | | | | | | | | | | | | |
| Calf | 450 | 26 | 0.420 | .415*3.2= | 1.3 | 3.1*3.2= | 9.9 | | | | | |
| High Forage | 750 | 62 | 1.000 | 1.00*3.2= | 3.2 | 7.5*3.2= | 24.0 | | | | | |
| High Forage | 1100 | 92 | 1.400 | 1.48*3.2= | 4.8 | 11*3.2= | 35.0 | | | | | |
| High Energy | 750 | 54 | 0.870 | .87*3.2= | 2.7 | 6.5*3.2= | 20.8 | | | | | |
| High Energy | 1100 | 80 | 1.260 | 1.27*3.2= | 4.1 | 9.5*3.2= | 30.5 | | | | | |
| Beef Cow | 1000 | 63 | 1.000 | 1.00*3.2= | 3.2 | 7.5*3.2= | 24.0 | | | | | |
| ***Swine*** | | | | | | | | | | | | |
| Nursery Pig | 25 | 2.7 | 0.040 | | .04 | | .30 | | | | | |
| Grow-Finish Pig | 150 | 9.5 | 0.150 | | .17 | | 1.20 | | | | | |
| Gestating Sow | 275 | 7.5 | 0.120 | | .14 | | 1.00 | | | | | |
| Sow & Litter | 375 | 22.5 | 0.360 | | .42 | | 3.00 | | | | | |
| Boar | 350 | 7.2 | 0.120 | | .14 | | 1.00 | | | | | |
| ***Poultry / Other*** | | | | | | | | | | | | |
| Layers | 4 | 0.26 | 0.004 | | .004 | | .03 | | | | | |
| Broilers | 2 | 0.18 | 0.003 | | .003 | | .02 | | | | | |
| Turkeys | 20 | 0.9 | 0.014 | | .015 | | .11 | | | | | |
| Duck | 6 | 0.33 | 0.005 | | .006 | | .04 | | | | | |
| Sheep | 100 | 4 | 0.060 | | .055 | | .40 | | | | | |
| Horse | 1000 | 50 | 0.800 | | .827 | | 5.98 | | | | | |

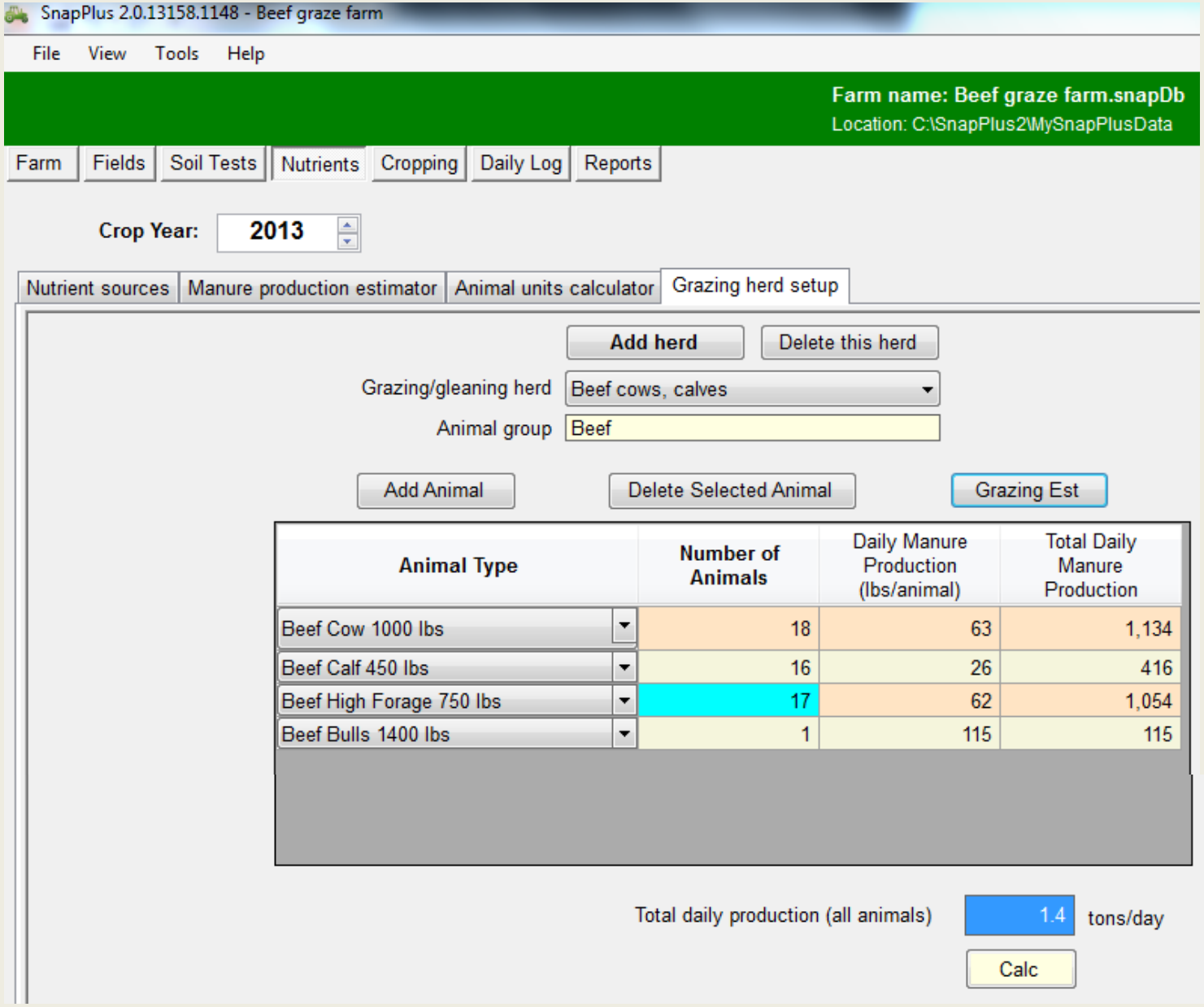
Source: Midwest Plan Service publication number MWPS-18 "Manure Characteristics" Section 1, copyright 2000. Solid volumes are as excreted. The liquid dairy and beef values are computed from the MWPS daily production and have approximately equal nutrient values annually as solid manure. MWPS liquid dairy and beef factors are multiplied by 1.8 and 3.2 respectively. Dilution on your operation may be substantially different. **Use manure analysis and manure storage volumes** to determine manure production whenever possible.

Manure quantities are likely to be more accurate estimated from storage size:

What is the manure storage pit size? _____ gallons or tons?

Multiply pit size x Number of times emptied/yr? _____ = Total annual manure collection

# SnapPlus Nutrient Management Planning software



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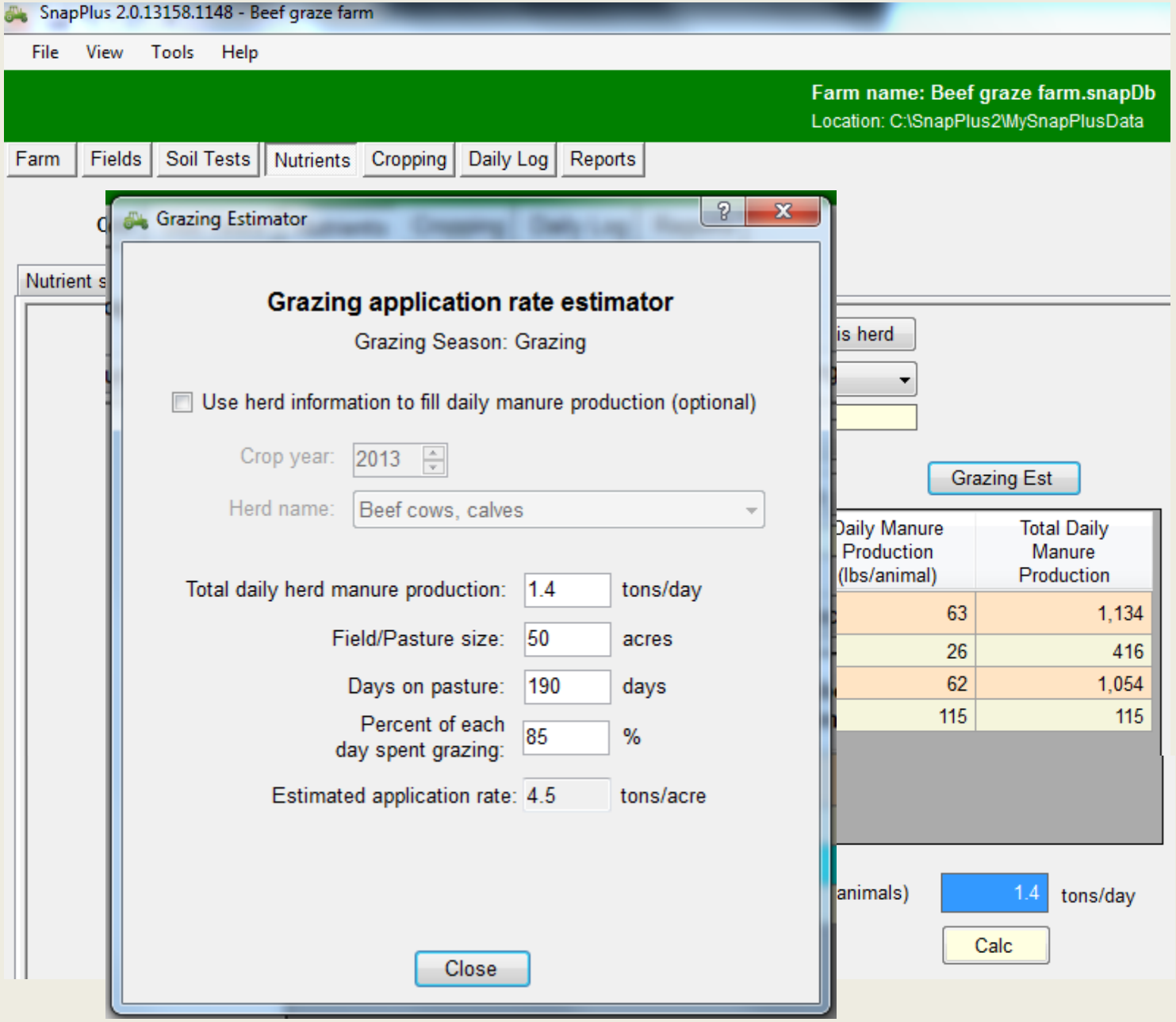

SnapPlus 2.0.13158.1148 - Beef graze farm

File View Tools Help

Sub-Farm: Show all fields. Field: 09

Farm name: Beef graze farm.snapDb
Location: C:\SnapPlus2\MySnapPlusData

Farm | Fields | Soil Tests | Nutrients | Cropping | Daily Log | Reports

Fast Facts

| Year | Soil Test | pH | OM | P | K | County | Acres | Pred. Soil | Symbol | Rest | Group | Texture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 2012-10-30 | 6.8 | 3.8 | 18 | 125 | Chippewa | 5.0 | Seaton | SfA | | L | Silt Loam |

[<] Rotation Wizard | Calculate all years | Add/Delete Years

| Crop Year (Fall to Fall): | 2012 | | | 2013 | | | 2014 | | | 2015 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop: | Pasture, rotational stock | | | Pasture, rotational stock | | | Pasture, rotational stock | | | Pasture, rotational stock | | |
| Yield Goal: | 3.1-4 | | | 3.1-4 | | | 3.1-4 | | | 3.1-4 | | |
| Tillage: | None | | | None | | | None | | | None | | |
| Soil Test Date: | 2012-10-30 | | | 2012-10-30 | | | 2012-10-30 | | | 2012-10-30 | | |
| Lime Rec: | NA | | | 0 | | | 0 | | | 0 | | |
| Irrigation / MRTN info: | Irrigated | | | Irrigated | | | Irrigated | | | Irrigated | | |
| Season notes: | | | | | | | | | | | | |
| (lbs/acre) | N | P2O5 | K2O | N | P2O5 | K2O | N | P2O5 | K2O | N | P2O5 | K2O |
| UW Recommendation: | 130 | 55 | 195 | 130 | 55 | 195 | 130 | 55 | 195 | 130 | 55 | 195 |
| Prior years' extra: | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 |
| Adjusted UW recommendation: | 130 | 55 | 195 | 130 | 55 | 195 | 130 | 55 | 195 | 130 | 55 | 195 |
| 1st & 2nd year legume credit: | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - |
| 2nd year manure credit: | 0 | 0 | 0 | 7 | 1 | 3 | 7 | - | - | 7 | - | - |
| This years' manure: | 18 | 14 | 32 | 18 | 14 | 32 | 18 | 14 | 32 | 0 | 0 | 0 |
| This years' fertilizer: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total credits & applications: | **18** | **14** | **32** | **25** | **15** | **35** | **25** | **14** | **32** | **7** | **0** | **0** |
| Over(+)/Under(-) adj UW rec: | **-112** | **-41** | **-163** | **-105** | **-40** | **-160** | **-105** | **-41** | **-163** | **-123** | **-55** | **-195** |
| Annual Total PI: | **0** | | | **0** | | | **0** | | | **0** | | |
| Particulate PI: | **0.0** | | | **0.0** | | | **0.0** | | | **0.0** | | |
| Soluble PI: | **0.1** | | | **0.2** | | | **0.1** | | | **0.1** | | |

# Optimizing nutrient cycling in pastures

- Supplying required nutrients with pasture-deposited manures requires even distribution of manure across and throughout the pasture
- Improved by good intensive rotational grazing practices:
  - Heavy grazing pressure in small areas for short periods of time
  - Provide water sources throughout the pasture
  - Limit access to typical “loafing” areas

# Thank you!

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