Take Home Points

- **Fertilizer placement** is the main tool to manage crop fertility in reduced tillage systems.

- **Yield responses** to fertilizer placement vary with tillage system, soil test levels, nutrient, weather, and soil types.

Bill Verbeten Cornell Cooperative Extension
Conventional Tillage Soil

Well - Mixed
Even Distribution of nutrients and pH
Little to No Residue
Warms and dries quickly
Conventional Tillage Soil

High Soil Erosion
Long term OM decreases
Moisture Lost Quickly
No-Till Soil

Adding Residue:
Reduces Erosion
Long-term increases OM
Conserve Moisture & Improve Drainage
No Till Soil

Stratification of nutrients and pH
Residue Interacts with Fertilizer
Warms and dries slowly

Triazine Herbicides

Nitrogen Fertilizer

Acidic pH~5.0

Neutral pH~6.5

Stratification of nutrients and pH
Residue Interacts with Fertilizer
Warms and dries slowly

Mn2+ HPO4-2 SO4-2 NO3-
Fe2+ HPO4-2 NO3-
Mg2+ H3BO3 K+
K+ Mn2+
Fe2+
Ca2+

NH4+ NO3-
K+

NO3- H2PO4-
Ca2+

Cu2+ MoO4-2 NO3- Zn2+
Cl-

MoO4-2 K+

H2PO4-

K+

Cl-
Fertility Challenges of No-Till

- Acidic surface pH
- Nitrogen lost in residue
- Phosphorous and potassium accumulate in the surface and are unavailable when the top 2 in. of soil dries out
Fertility Solutions for No-Till

- Frequent applications of lime (1-2 tons every 1-2 years)

- Apply nitrogen in starter, inject/side-dress

- Phosphorous and potassium should be placed in starter (2 by 2 in.) and/or deep banded (6-10 in.)
Should fertility in reduced tillage systems be managed like no-till or like conventional tillage?
Depends on the tillage system.
Strip & Zone-Till Soils

Less Stratification of nutrients and pH
Some Residue
Warms and dries quickly where tilled
Nutrient & pH Stratification?

- Not likely where strips and zones are tilled or vertical tillage implements are used
Response to Injecting Nitrogen?

- Yes
- Best to inject anhydrous ammonia or UAN solutions
- “Dribbling” UAN solutions has more losses than injecting, but less than broadcasting untreated UAN

Bill Verbeten Cornell Cooperative Extension
Response to Pop-Up Nitrogen?

- Again, yes, but need to avoid salt injury

- Limit Pop-Up N + K2O to 10 lb/acre in corn and drilled soybeans (7-8 inch rows)
  
  - 15-20 inch soybeans limit N+K2O 5 lb /acre, none for 30 inch soybeans

- Reduce by 50% if on sand or dry conditions

Bill Verbeten Cornell Cooperative Extension
Response to Starter Nitrogen?

- Limit **Starter N** + K2O to 100 lb/acre in corn and 70 lb/acre in 30 inch soybeans

- Limit N to 40 lb/acre in corn & 20 lb/acre in soybeans

Bill Verbeten Cornell Cooperative Extension
Responses to Starter or Deep Banded P?

- In no-till corn and soybeans, responses to low soil test P (Bray-1) regardless of application method (broadcast vs. starter vs. deep banding)

- Starter P increases early growth

  - Mallarino & Borges, Iowa State University

- However starter P is vital for wheat establishment & yield

Bill Verbeten Cornell Cooperative Extension
How much P in Pop-Up and Starter?

- 20 lb/acre P2O5 in **Pop-Ups**

- 100 lb/acre P2O5 in **Starter**
  - Often limited by N in MAP & DAP
    - (40 lb/acre N in Corn, 20 lb/acre N in Soybeans)

- High P applications can cause Zn deficiency

Bill Verbeten Cornell Cooperative Extension
Response to Starter or Deep Banding K?

- No-till corn and soybean yields increased with starter and deep banded K, even at optimal to high soil test K.

-Mallarino & Borges, Iowa State University

Bill Verbeten Cornell Cooperative Extension
No Till Corn Response to K Starter

- Colder springs increase responsive soil test level

-Bundy & Andraski, University of Wisconsin.
No-Till Corn Response to Starter K

![Graph showing the relationship between cumulative GDD and critical soil test K level with a quadratic equation and R^2 = 0.97.](image)
Corn Response to K in No-Till, Strip Till, & Mulch Till?

Tony Vyn, Ken Janovicek, and Tom Bruulsema,
*University of Guelph*

110 lb/acre K2O
What makes sense for K?

- Responses likely to pop-up & starter K applications in reduced tillage systems.

- Opportunity for deep K placement in zone & strip till

- Response to K fertilization will be greater in cool years
Most crops will still respond to between 10 and 25 lb/acre of sulfur regardless of tillage systems.

South Dakota State Fertility Guide 2005

### Sulfur Recommendations

<table>
<thead>
<tr>
<th>Sulfur Soil Test</th>
<th>Relative Level</th>
<th>Coarse, Tilled</th>
<th>Coarse, Strip-till or no-till</th>
<th>Medium/Fine, Tilled</th>
<th>Medium/Fine, Strip-till or no-till</th>
</tr>
</thead>
<tbody>
<tr>
<td>lb/acre 2 feet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 9</td>
<td>Very low</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>10 - 19</td>
<td>Low</td>
<td>25</td>
<td>25</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>20 - 29</td>
<td>Medium</td>
<td>15</td>
<td>25</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>30 - 39</td>
<td>High</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>&gt;= 40</td>
<td>Very high</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

1 Conventional tillage
Micro-Nutrients in Reduced Tillage?

- Micro-nutrient application most responsive to
  - Low OM, sandy soils
  - Dry years
  - pH extremes (i.e. not 6.0-7.0)
  - Extremely high OM soils
  - No manure application

Bill Verbeten Cornell Cooperative Extension
Increases in OM and Organic Nitrogen in Reduce Tillage?

- Long-term investment
- $1\%$ OM = 10 tons of OM in the plow layer
- Most residue (80-90%) is oxidized to CO2 within 2 years
Increases in OM and Organic Nitrogen in Reduced Tillage?

- Work in NY has shown that:
  - No OM addition decreases OM
  - Adding manure maintains OM
  - Adding 15-30 tons/acre of compost per year increase OM by 0.5% in 5 years

Bill Verbeten Cornell Cooperative Extension
Take Home Points

- **Fertilizer placement** is the main tool to manage crop fertility in reduced tillage systems.

- *Yield responses* to fertilizer placement *vary* with tillage system, soil test levels, nutrient, weather, and soil types.

Bill Verbeten, Cornell Cooperative Extension
Questions?
Nitrogen Stabilizers

Bill Verbeten
NWNY Dairy, Livestock, & Field Crops Team
Take Home Points

- Nitrogen stabilizers act as *nitrification inhibitors*, *urease inhibitors*, or *slow release fertilizers*.

- Nitrogen stabilizers *reduce nitrogen losses* for *varying amounts* of time (10 days to 10 weeks)

Bill Verbeten
Cornell Cooperative Extension
Nutrient Uptake Forms-N

- Crops take up
  - Mostly Nitrate, NO₃⁻
  - Some Ammonium NH₄⁺
The Nitrogen Cycle

Image Source: fertilizer101.org
Nitrogen Fertilizers

- **NH4+**
  - Anhydrous NH3
  - Urea Ammonium Nitrate (UAN)
  - Ammonium Sulfate (AMS)
  - Urea

- **NO3-**
  - Calcium nitrate
  - Potassium nitrate
  - Sodium nitrate

- Monoammonium phosphate (MAP)
- Diammonium phosphate (DAP)

Bill Verbeten Cornell Cooperative Extension
Nitrogen Fertilizers

- NH4+ fertilizers can be...
  - Lost through NH3 volatilization
  - Converted to NO3 (nitrification)

\[
\begin{align*}
\text{Urea} & \rightarrow \text{NH}_4^+ & \rightarrow \text{NH}_3 \\
\text{ammonium} & & \text{ammonia}
\end{align*}
\]

\[
\begin{align*}
\text{NH}_4^+ & \rightarrow \text{NO}_2^- & \rightarrow \text{NO}_3^- \\
\text{ammonium} & & \text{nitrate}
\end{align*}
\]
Nitrogen Fertilizers

- NO3- fertilizers can be...
  - Lost through denitrification
  - Lost through leaching from root zone
The Nitrogen Cycle

Image Source: fertilizer101.org
Nitrogen Fertilizers

- Urea fertilizers
  - Also lost through NH3 volatilization
  - And converted to NO3
Nitrogen Fertilizers

- **Nitrification Inhibitors**
  - Inhibits *Nitrosomonas* bacteria
  - Reduces losses for 4-10 weeks

- N-Serve & Instinct (Dow AgroSciences) **nitrapyrin**
- Guardian (Conklin) dicyandiamide, **DCD**

Bill Verbeten Cornell Cooperative Extension
Nitrogen Fertilizers

The Nitrogen Cycle

Nitrification Inhibitors

- Reduce N losses from Leaching & Denitrification

Bill Verbeten Cornell Cooperative Extension
Nitrogen Fertilizers

- **Urease Inhibitors**
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain International LLC)
  
  N-butyUrease Inhibitors
  - Agrotain (Agrotain Internationa
Nitrogen Fertilizers

- **Slow release**
  - Microbes break down protective layer
  - Sulfur coated urea, **ESN**, (Agrium)

- **Osmocote**
  (Scotts)

- Isobutylidene diurea, **IBDU**, (Nu-Gro)

Bill Verbeten Cornell Cooperative Extension
Nitrogen Uptake

From: plantsci.missouri.edu

Bill Verbeten Cornell Cooperative Extension
Take Home Points

- Nitrogen stabilizers act as nitrification inhibitors, urease inhibitors, or slow release fertilizers.

- Nitrogen stabilizers reduce nitrogen losses for varying amounts of time (10 days to 10 weeks)
Questions?