Pierce Co. No-Till Users Group Roundtable
Focus on Nutrients

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# Roadmap

- Nitrogen
  - Forms of N – important facts
  - When should you use inhibitors/stabilizers/extenders
  - Effect of price level on MRTN rate guidelines
- Liming
- P & K



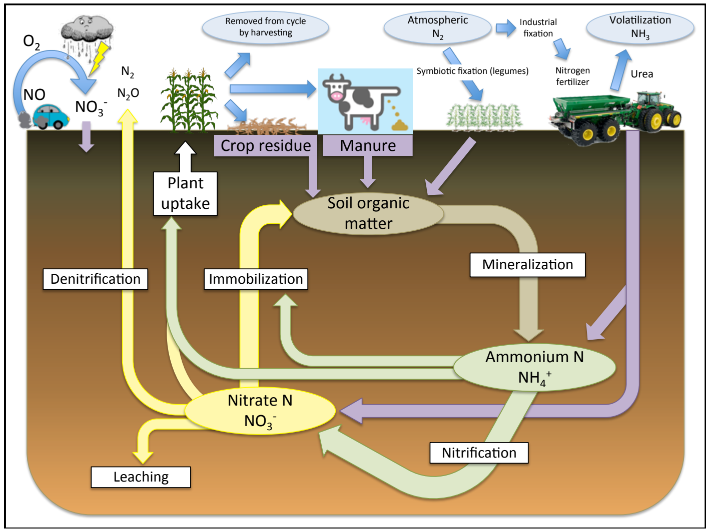
# Forms of N fertilizer

| Fertilizer Material | N Content (%) | $NH_4^+$ (%) | $NO_3^-$ (%) | Urea (%) |
|---|---|---|---|---|
| Anhydrous Ammonia | 82 | 100 | - | - |
| Ammonium Polyphosphate | 10 | 100 | - | - |
| Ammonium Thiosulfate | 12 | 100 | - | - |
| Aqua Ammonia | 20 – 25 | 100 | - | - |
| Urea Ammonium Nitrate (UAN) | 28 – 32 | 25 | 25 | 50 |
| Ammonium Sulfate | 21 | 100 | - | - |
| Ammonium Nitrate | 33-34 | 50 | 50 | |
| Monoammonium Phosphate (MAP) | 11 | 100 | - | - |
| Diammonium Phosphate (DAP) | 18 | 100 | - | - |
| Urea | 46 | - | - | 100 |
| ESN (poly coated urea) | 44 | - | - | 100 |



# N Loss Pathways

- Urea
  - Volatilization
    - Surface application without incorporation
      - Need 0.25" of rain in ~2 days to limit volatilization
- Nitrate
  - Leaching
  - Denitrification
- Ammonium
  - None




## When should you use stabilizers/ extenders?



## Comments on N Stabilizers/Extenders

- Just because a sales person says it works doesn't mean it does
  - Ask to see independent University data
    - Ask your Extension Agent/Specialist for help
- <u>Using an inhibitor/extender in all situations is inappropriate</u>
  - Especially if you think that you are guaranteed a increase yield
- Inhibitors/extenders do have a place in some situations



## What are N Stabilizers/Extenders?

- Urease inhibitors
- Nitrification inhibitors
- Slow/Controlled release materials

It's critical to know the mode of action of the stabilizer/extender to determine if it will be useful for your situation

# Common N Inhibitors/Extenders

| Product | Active Ingredient | Mode of Action |
|---|---|---|
| Agrotain | NBPT | Urease inhibitor |
| Agrotain Plus | NBPT<br>Dicyandiamide (DCD) | Urease inhibitor +<br>nitrification inhibitor |
| SuperU | NBPT<br>Dicyandiamide (DCD) | Urease inhibitor +<br>nitrification inhibitor |
| NServe | Nitrapyrin | Nitrification inhibitor |
| Instinct | Nitrapyrin, encapsulated | Nitrification inhibitor |
| ESN | | Poly-coated urea, slow release |

Not necessarily an exhaustive list, but these products have known efficacy when used appropriately and a situation for N loss exists.



# Urease inhibitors



# Urea hydrolysis and N volatilization

$$(NH_2)_2CO + 2H_2O \xrightarrow{urease} (NH_4)_2CO_3$$

urea → ammonium carbonate

$$(NH_4)_2CO_3 + 2H^+ \longrightarrow 2NH_4^+ + CO_2\uparrow + H_2O$$

$$NH_4^+ + OH^- \longrightarrow NH_3\uparrow + H_2O$$

Urease Inhibitor



# Corn yield increase from NBPT with surface applied urea and UAN

- Effective in reducing conversion of surface applied urea and UAN

| Sites | Number of sites | Yield Increase | |
|---|---|---|---|
| | | Urea | UAN |
| | | ------- bu/a ------- | |
| All | 78 | 4.3 | 1.6 |
| N responsive | 64 | 5.0 | 2.8 |
| With sig. $NH_4^+$ loss | 59 | 6.6 | 2.7 |

Yield increase sig. (P<0.01)

Hendrickson, 1992

## Nitrification inhibitors



## Nitrification

- $NH_4^+$ —X→ $NO_2^-$ ——→ $NO_3^-$

Nitrification Inhibitor

Denitrification
- Poorly drained soils
- Saturated soils
- Need:
  - Low $O_2$
  - OM
  - Nitrate

Leaching
- Sandy soils
- Highly permeable



## Effect of Instinct applied preplant with 28% UAN at Arlington in 2008-2010

| Year | N Rate | Without Instinct | With Instinct | P value |
|---|---|---|---|---|
| | lb N/a | Yield (bu/a) | | |
| 2008 | mean of 80 & 120 | 173 | 178 | 0.25 |
| 2009 | mean of 40 & 80 | 196 | 196 | 0.91 |
| 2010 | mean of 40 & 80 | 196 | 201 | 0.14 |

| Year | May | June | July |
|---|---|---|---|
| | Rainfall departure from normal (inches) | | |
| 2008 | -0.2 | 9.6 | 1.0 |
| 2009 | 0.3 | 0.3 | -1.7 |
| 2010 | 0.7 | 3.6 | 5.4 |

| Year | Preplant | Sidedress |
|---|---|---|
| | $EONR_{0.10}$ (lb N/a) | |
| 2008 | 144 | 113 |
| 2009 | 69 | 59 |
| 2010 | 96 | 57 |

Instinct costs ~$10/a



## Effect of Instinct and time of manure or urea application on 0-1' soil nitrate (PSNT) results at Arlington, WI, 2011

| Timing | Manure - Instinct | Manure + Instinct | Urea - Instinct | Urea + Instinct |
|---|---|---|---|---|
| | 0-1' soil nitrate, lb N/a | | | |
| No Manure/Urea, No Instinct | 32 | | | |
| Fall 2010 | 43 | 44 | 39 c | 56 c |
| Spring 2011 | 97 | 75 | 157 a | 111 b |

Fall applied Instinct did not affect spring presidedress soil nitrate concentrations.

Spring applied Instinct results in less nitrate at presidedress; meaning more N remained as $NH_4$ which has the potential to decrease N losses from denitrification of leaching.

## Effect of Instinct and time of application on corn grain and silage yield at Arlington, WI, 2011

| Source | Timing | Instinct No | Instinct Yes | Instinct No | Instinct Yes |
|---|---|---|---|---|---|
| | | Grain Yield, bu/a | | Silage Yield, T DM/a | |
| Urea – 100 lb N/a | | | | | |
| | Fall 2010 | 140 | 161 | 7.23 | 7.84 |
| | Spring 2011 | 150 | 163 | 7.57 | 8.65 |
| | Mean | 145 b | 162 a | 7.40 b | 8.25 a |
| | | | | | |
| Dairy Manure | | | | | |
| 7,083 gal/a | Fall 2010 | 136 | 142 | 7.25 | 7.54 |
| 8,500 gal/a | Spring 2011 | 136 | 157 | 7.15 | 8.40 |
| | Mean | 136 | 149 | 7.20 b | 7.97 a |



## Effect of nitrification inhibitors on corn yield and N recovery, 4-year average at Hancock, WI

| Inhibitor | Timing | Yield | Recovery |
|---|---|---|---|
| | | bu/a | % |
| No | PP | 116 | 37 |
| | SD | 134 | 63 |
| Yes | PP | 121 | 51 |
| | SD | 134 | 65 |

All treatments received 140 lb N/a
PP = preplant
SD = sidedress

Sidedress applications are preferred to nitrification inhibitors on sandy soils.



## Relative probability of increasing corn yield using a nitrification inhibitor

| Soil type | Time of nitrogen application: Fall | Spring preplant | Spring sidedress |
|---|---|---|---|
| Sands & loamy sands | Not recommended | Good | Poor |
| Sandy loams & loams | Fair | Good | Poor |
| Silt loams & clay loams | | | |
| Well drained | Fair | Poor | Poor |
| Somewhat poorly drained | Good | Fair | Poor |
| Poorly drained | Good | Good | Poor |

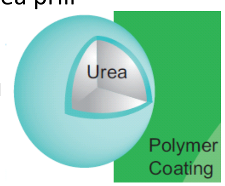
Note: Table was based on data collected in the upper Midwest.



## Slow release materials

## Slow release: how do they work

- Poly coated materials (eg. ESN)
  - Polymer coating surrounds the urea prill
    - Heat expands the polymer
      - Water enters & dissolves urea
      - Dissolved urea moves out, into the soil
- Other kinds of coatings
  - Natural or synthetic polymers
  - Waxes, parafins
  - Elemental sulfur






## Slow/controlled release

- Work well in sandy soils to reduce leaching
- Probably better to apply preplant
  - Applying at sidedress may result in N not being available when the crop needs it
- If surface applied, may not be very effective if it is dry



## Effect of price level on corn N rate guidelines



## 2014 Fertilizer & Grain Prices (subject to change)

| CORN | FERTILIZER |
|---|---|
| $4.60/bu (Sept. 2014) | Urea = $0.53/ lb N |
| $4.64/bu (Dec. 2014) | UAN = $0.62/ lb N |
| | NH3 = $0.39/ lb N |

N:Corn Price Ratio = 0.11, 0.13, 0.08

## N:Corn Price Ratio Table

Price of Corn ($/bu corn)

| Price of N* ($/lb N) | 3.00 | 3.25 | 3.50 | 3.75 | 4.00 | 4.25 | 4.50 | 4.75 | 5.00 | 5.25 | 5.50 | 5.75 | 6.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0.20** | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 |
| **0.25** | 0.08 | 0.08 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 | 0.04 |
| **0.30** | 0.10 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 |
| **0.35** | 0.12 | 0.11 | 0.10 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 |
| **0.40** | 0.13 | 0.12 | 0.11 | 0.11 | 0.10 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 |
| **0.45** | 0.15 | 0.14 | 0.13 | 0.12 | 0.11 | 0.11 | 0.10 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 |
| **0.50** | 0.17 | 0.15 | 0.14 | 0.13 | 0.13 | 0.12 | 0.11 | 0.11 | 0.10 | 0.10 | 0.09 | 0.09 | 0.08 |
| **0.55** | 0.18 | 0.17 | 0.16 | 0.15 | 0.14 | 0.13 | 0.12 | 0.12 | 0.11 | 0.10 | 0.10 | 0.10 | 0.09 |
| **0.60** | 0.20 | 0.18 | 0.17 | 0.16 | 0.15 | 0.14 | 0.13 | 0.13 | 0.12 | 0.11 | 0.11 | 0.10 | 0.10 |
| **0.65** | 0.22 | 0.20 | 0.19 | 0.17 | 0.16 | 0.15 | 0.14 | 0.14 | 0.13 | 0.12 | 0.12 | 0.11 | 0.11 |
| **0.70** | 0.23 | 0.22 | 0.20 | 0.19 | 0.18 | 0.16 | 0.16 | 0.15 | 0.14 | 0.13 | 0.13 | 0.12 | 0.12 |
| **0.75** | 0.25 | 0.23 | 0.21 | 0.20 | 0.19 | 0.18 | 0.17 | 0.16 | 0.15 | 0.14 | 0.14 | 0.13 | 0.13 |

*Price of N = [$/ton fertilizer x (100 / % N in fertilizer)] / 2000



## Corn N rate guidelines - MRTN

### University of Wisconsin Nitrogen Guidelines for Corn

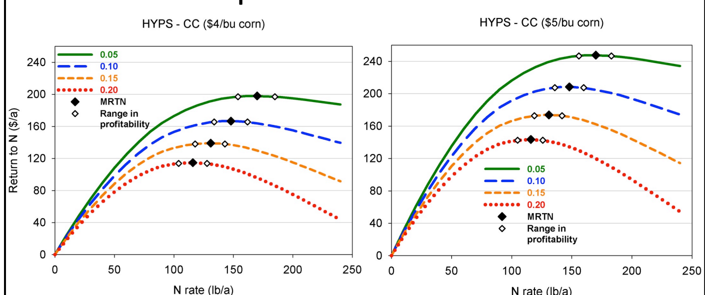
N:Corn Price Ratio (see table on other side)

| Soil[1] | Previous Crop | 0.05 | 0.10 | 0.15 | 0.20 |
|---|---|---|---|---|---|
| | | **lbs N/acre** (total to apply)[2] | | | |
| **loamy:** high yield potential soils | **Corn**, Forage legumes, Legume vegetables, Green manures[5] | **190**[3] 170-------210[4] | **165** 155----180 | **150** 140---160 | **135** 125----150 |
| | **Soybean**, Small grains[6] | **140** 125------160 | **120** 105----130 | **105** 95--115 | **90** 80----105 |
| **loamy:** medium yield potential soils | **Corn**, Forage legumes, Legume vegetables, Green manures[5] | **145** 130-----160 | **125** 115----140 | **115** 105---125 | **105** 95--110 |
| | **Soybean**, Small grains[6] | **130** 110-------150 | **100** 85------120 | **85** 70---95 | **70** 60---80 |
| **sands/ loamy sands** | Irrigated—**All crops**[5] | **215** 200-----230 | **200** 185----210 | **185** 175---195 | **175** 165---185 |
| | Non-irrigated—**All crops**[5] | **140** 130---150 | **130** 120---140 | **120** 110---130 | **110** 100---120 |

***Several footnotes – important to read them!!!***
Must still take N credits for forage legume, legume vegetable, green manure and animal manure



## Effect of price level on MRTN & range of profitable N rates

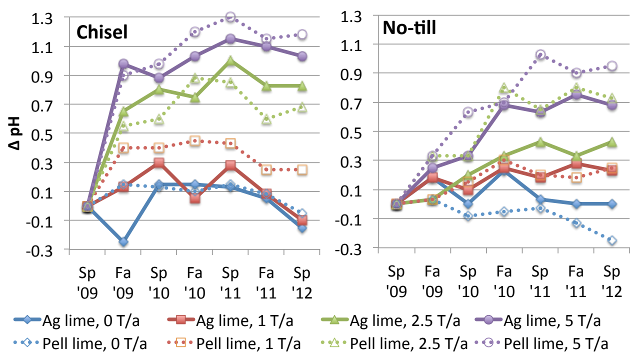



Graphs are based on 2010 database



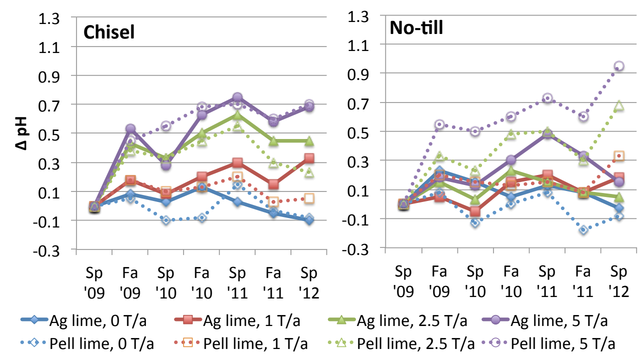
## Efficacy of Ag Lime & Pell Lime in No-till vs Chisel

## Increase in soil pH (Δ pH), 0- to 2-inch depth






## Increase in soil pH (Δ pH), 0- to 8-inch depth






## Conclusions – Chisel Plow

- No clear advantage to using pell lime with regard to increasing soil pH
  - Effectiveness of either lime source is related to application rate
  - Chisel plowing provides adequate mixing of the lime with the soil



## Conclusions – No-till

- There may be a slight advantage to using pelletized lime if a pH changed is desired through a 8-inch depth,
  - Though individual depth increments did not show this advantage
- If smaller pH changes are desired then, pelletized lime applied at a 1 to 2.5 T/a rate could be as effective as ag lime with a neutralizing index of 70-79 at 5T/a

## Conclusions – Profitability

- In spring 2013, ag lime with a neutralizing index of 80-89 cost approximately $33/T and pell lime cost approximately $194/T
- Pell lime needs to be applied at agronomic rates to effectively change soil pH
- ***Regardless of tillage system, traditional ag lime is a more cost effective liming source***



## Phosphorus & Potassium



## Soybean & corn yield response to K application at Arlington

- Site A, established in 2011
- Site B, established in 2012
- Both sites were no-till and previous crop was alfalfa
- Treatments broadcast applications of 5 rates of $K_2O$ (0 – 160 lb $K_2O$/a) at each of 4 rates of $P_2O_5$ (0 – 90 lb $P_2O_5$/a)
  - Treatments applied to same plots in spring of each year
- Rotation established with soybean in 2011 and 2012



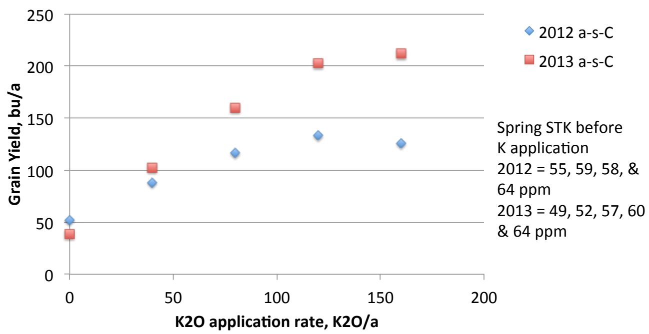
## Effect of no-till surface broadcast $P_2O_5$ and $K_2O$ rates applied in spring 2012 & 2013 on 2013 corn grain yield at Arlington

| $P_2O_5$ rate | $K_2O$ rate, lb/a | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | 160 | Mean † |
| lb/a | ---------- | ---------- | ---------- bu/a | ---------- | ---------- | |
| 0 | 38 | 89 | 158 | 198 | 203 | 137 |
| 30 | 28 | 116 | 162 | 206 | 214 | 145 |
| 60 | 46 | 119 | 162 | 194 | 223 | 149 |
| 90 | 43 | 85 | 159 | 213 | 211 | 142 |
| Mean ‡ | 39 d § | 102 c | 160 b | 203 a | 212 a | |

† $P_2O_5$ rate $p$ = 0.55.
‡ $K_2O$ rate $p$ <0.01. $P_2O_5$ rate x $K_2O$ rate $p$ = 0.84. CV = 18%.
§ Mean values followed by the same letter are not significantly different at the 0.10 probability level.

- These results suggest that:
  At low soil test levels, K is more limiting than P, OR
- Surface application of P in notill is not effective at increasing yield, regardless of the rat of P applied.

# No-till corn yield response to K fertilizer application at Arlington




2012 drought impacted the site



# Thank You!

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