Soil Sampling - Soil Testing
Why Do We Soil Test ??

- Determine how much fertilizer to apply?
- Determine how much nutrient is available from the soil?
Why Do We Soil Test ??

• Determine the amount of plant available NO$_3$-N
• Identify fertility trends
• Estimate probability of nutrient response
• Estimate long-term nutrient sufficiency
• Estimate long-term average nutrient rates
• Soil amendments
• Diagnosing problems / problem solving
<table>
<thead>
<tr>
<th>Relative Value Of Information Provided By Soil Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil fertility status over time</td>
</tr>
<tr>
<td>Probability of yield response</td>
</tr>
<tr>
<td>Relative long-term yield averaged over a number of years</td>
</tr>
<tr>
<td>Average long-term optimum nutrient application rate over a number of years</td>
</tr>
<tr>
<td>Relative yield for specific field in individual year</td>
</tr>
<tr>
<td>Optimum nutrient application rate for specific field in individual year</td>
</tr>
</tbody>
</table>
Yield Response to Fertilizer

Soil Test Values

- Very Low
- Low
- Medium
- High
Person Doing The Sampling Should Be A Trained Professional.

• Consistency in depth of sample
• Appropriate number of subsamples
• Proper care of collected samples
• Attention to details
How Many Subsamples Should Be Collected For Each Sample Submitted To The Lab?
How Many Subsamples Should Be Collected For Each Sample Submitted To The Lab?

15-20 Subsamples per Sample Submitted To Laboratory
Number Of Subsamples Required For Composite Sample Accuracy With 80% Confidence. (adapted from NDSU)

- 5% Level Of Accuracy: 181 Number Of Cores per Sample
- 10% Level Of Accuracy: 46 Number Of Cores per Sample
- 15% Level Of Accuracy: 21 Number Of Cores per Sample
- 20% Level Of Accuracy: 12 Number Of Cores per Sample
- 25% Level Of Accuracy: 8 Number Of Cores per Sample
<table>
<thead>
<tr>
<th>Reproducibility (%)</th>
<th>Accuracy Level</th>
<th>N</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+/- 5%</td>
<td></td>
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</tr>
<tr>
<td>70</td>
<td></td>
<td>90</td>
<td>117</td>
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<tr>
<td>75</td>
<td></td>
<td>107</td>
<td>143</td>
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<td>80</td>
<td></td>
<td>137</td>
<td>181</td>
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<td>85</td>
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<td>171</td>
<td>223</td>
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<td>90</td>
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<td>227</td>
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<tr>
<td>95</td>
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<td>325</td>
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<td></td>
<td>+/- 10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td>23</td>
<td>30</td>
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<td>75</td>
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<td>28</td>
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<td>80</td>
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<td>34</td>
<td>46</td>
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<tr>
<td>85</td>
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<td>44</td>
<td>55</td>
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<td>90</td>
<td></td>
<td>58</td>
<td>75</td>
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<tr>
<td>95</td>
<td></td>
<td>81</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>+/- 15%</td>
<td></td>
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</tr>
<tr>
<td>70</td>
<td></td>
<td>10</td>
<td>14</td>
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<td>75</td>
<td></td>
<td>13</td>
<td>16</td>
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<tr>
<td>80</td>
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<td>85</td>
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<tr>
<td>90</td>
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<td>25</td>
<td>34</td>
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<tr>
<td>95</td>
<td></td>
<td>36</td>
<td>48</td>
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<tr>
<td></td>
<td>+/- 20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td>7</td>
<td>8</td>
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<tr>
<td>75</td>
<td></td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td>9</td>
<td>12</td>
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<tr>
<td>85</td>
<td></td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>90</td>
<td></td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>95</td>
<td></td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>+/- 25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td>6</td>
<td>8</td>
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<tr>
<td>85</td>
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<td>7</td>
<td>9</td>
</tr>
<tr>
<td>90</td>
<td></td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>95</td>
<td></td>
<td>14</td>
<td>18</td>
</tr>
</tbody>
</table>
EXAMPLE OF THE RELATIONSHIP BETWEEN NUMBER OF SOIL CORES PER COMPOSITE SAMPLE AND ERROR

MEAN SOIL P = 19ppm
It’s Inch-to-Inch Variability That Causes Problems
Inch-to-Inch Soil Test Variability. (Kansas State University)

12 Samples From Across 12 inches

0-6” Bray P-1 (ppm)

1 2 3 4 5 6 7 8 9 10 11 12

68 58 58 58 68 61 58 70 58 46 39
Dividing and Sampling Fields

Similar soil in entire field except for a knoll in one corner and a few low spots.
Dividing and Sampling Fields

"A" portion of the field was previously in alfalfa (4 years prior). Sample the two areas separately.
Topography would make good 'management zones' in many areas. In this case three separate sample would be collected.
Prior Manure Application Practices May Make It Desirable To Change Application Patterns and/or Split Fields For Soil Sampling.
Should I Intensively Sample Rather Composite Sample?

Have long known that fields vary

- Advent of GPS and computer systems allows us to deal with identified variability

- Eventually, I think, most fields will have multiple samples collected
Intensive Sampling
Can You Make A Better Management Decision For The Whole Field Knowing Spatial Variability Within That Field – Or Knowing Just The Average?
Simulated Corn Net Returns To Varying Uniform P Application Rates

<table>
<thead>
<tr>
<th>P Rate (Lb P2O5/A)</th>
<th>Net Returns ($/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>15</td>
<td>130 bu/a, $14.90</td>
</tr>
<tr>
<td>30</td>
<td>139 bu/a, $29.51</td>
</tr>
<tr>
<td>45</td>
<td>144 bu/a, $35.65</td>
</tr>
<tr>
<td>60</td>
<td>147 bu/a, $36.83</td>
</tr>
<tr>
<td>75</td>
<td>148 bu/a, $34.04</td>
</tr>
<tr>
<td>90</td>
<td>149 bu/a, $29.72</td>
</tr>
<tr>
<td>105</td>
<td>150 bu/a, $25.26</td>
</tr>
<tr>
<td>120 bu/a</td>
<td>$14.90</td>
</tr>
<tr>
<td>Variable</td>
<td>$45.82</td>
</tr>
</tbody>
</table>
How a Composite Sample can Overestimate Soil test levels in a Field
Relative Value Of Various Sampling Systems
(based on one person's experiences and biases!)

- Single Composite Sample: 10
- Composite With History: 40
- Composite Georeferenced With History: 60
- Large Grids: 60
- Management Zones: 50
- Multi Layer Smart: 70
- Small Grids: 100
Intensive Sampling System Summary

- There is no ‘best’ sampling system

- GPS Technology increases value of soil testing regardless of sampling system adopted

- Value of soil testing increases with history

- Intensive sampling systems have value for fields under uniform nutrient management as well as fields that have nutrients variably applied

- GPS technology has value beyond yield monitors and variable rate applications.

- Consistency is the over-riding concern for soil sampling.
How Deep Should A Sample Be Taken?

- Sampling depth - 6 to 7 inches for P, K, OM, pH
- Sampling depth - 24 inches for Nitrate-N test
Distribution of soil P after three years of tillage and fertilization. (Minnesota)
Distribution of Soil P in Continuous Corn After 5 Years of Tillage at Cornbelt Field – Powhatan, KS

<table>
<thead>
<tr>
<th>Depth (In.)</th>
<th>Moldboard Plow</th>
<th>No-tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>34</td>
<td>72</td>
</tr>
<tr>
<td>2-4</td>
<td>44</td>
<td>36</td>
</tr>
<tr>
<td>4-6</td>
<td>56</td>
<td>30</td>
</tr>
<tr>
<td>6-8</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>8-10</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>
When Should Samples Be Taken?

- Consistency is most important.

- When sampling fits best in business – crop rotation cycle. Firms soils a key.

- Theoretically, as close to crop as possible - BUT - far enough in advance to use results for **planning** purposes.
How Often Should I Sample?

- Conventionally every 3-4 years
- Every year until history established

Lime and Fertilizer P For Alfalfa In North Central Kansas
(Gordon and Whitney, 1991-93)

### Alfalfa Yield (ton/acre)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>9.7</td>
<td>10.1</td>
<td>10.4</td>
<td>10.3</td>
<td>17.4</td>
</tr>
<tr>
<td>6.4</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>18.4</td>
</tr>
<tr>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>18.8</td>
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<tr>
<td>9.7</td>
<td>10.1</td>
<td>10.4</td>
<td>10.3</td>
<td>18.8</td>
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<tr>
<td>6.4</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>18.8</td>
</tr>
</tbody>
</table>

### Bray P Test (ppm)

<table>
<thead>
<tr>
<th>Application</th>
<th>1991</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 P2O5</td>
<td>30</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

Alfalfa established March 1991, Initial Soil pH = 5.1 and Bray P-1 Soil Test = 30 ppm
Should Samples Be Dried Before Submitting To Laboratory?

- Preferably No
- For Nitrate - Yes if not immediately sent to Laboratory
Drying Soil Samples

• Nitrate should be dried the day collected, or frozen

• Precautions
  • Do not apply any heat
  • A fan may be used to speed up drying
  • Spread out on a clean paper
  • Protect from contamination
  • No microwaves
Table 2. Effects of soil probe lubricants on soil chemical Analysis (Blaylock et al., 1995. Wyoming).

<table>
<thead>
<tr>
<th>Lubricant</th>
<th>Organic Matter</th>
<th>NO3-N</th>
<th>P</th>
<th>K (ppm)</th>
<th>Fe</th>
<th>Mn</th>
<th>Zn</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>No lubricant</td>
<td>1.67</td>
<td>1.4</td>
<td>14</td>
<td>249</td>
<td>11.4</td>
<td>1.5</td>
<td>0.8</td>
<td>1.7</td>
</tr>
<tr>
<td>WD-40</td>
<td>1.59</td>
<td>1.3</td>
<td>16</td>
<td>248</td>
<td>13.2</td>
<td>1.8</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>PAM</td>
<td>1.66</td>
<td>2.1</td>
<td>16</td>
<td>263</td>
<td>13.5</td>
<td>3.8</td>
<td>1.1</td>
<td>2.3</td>
</tr>
<tr>
<td>Dove Soap</td>
<td>1.67</td>
<td>2.6</td>
<td>14</td>
<td>280</td>
<td>10.1</td>
<td>1.3</td>
<td>0.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Motoroil</td>
<td>1.63</td>
<td>1.6</td>
<td>16</td>
<td>265</td>
<td>12.5</td>
<td>1.4</td>
<td>0.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Silicone</td>
<td>1.62</td>
<td>1.3</td>
<td>16</td>
<td>246</td>
<td>9.9</td>
<td>1.3</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>LSD_{0.05}</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.7</td>
<td>0.8</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>
How Do I Choose A Lab?

- Appropriate Tests/Extractants
- Good Quality Control
- Accurate Results
- Service
- Turnaround Time
- Cost
- Recommendations
What Tests Are Useful? What Tests Can Be Interpreted

• There is no value in running tests that have no interpretation for solving problems
  – Bray P-2
  – Copper
  – Manganese
  – Magnesium
  – Cation Percentage of CEC
  – Others
Useful Soil Tests

Available Nitrate-N
Bray P-1 Extractable P
Olsen Extractable P
Mehlich III Extractable P
Exchangeable K
DTPA Extractable Zn
Chloride

Soil pH
Lime Requirement / Buffer pH
Soil Organic Matter
Cation Exchange Capacity / Sum of Cations
Exchangeable Sodium Percentage

Soluble Salts
Excess Lime
Questionable Value

Bray P-2 Extractable P
Ca, Mg, Cu, Mn

Percent Ca, K, Mg Saturation
Base Saturation Percentage
Cation Ratios
Useful Soil Tests

Available Nitrate-N
Bray P-1 Extractable P
Olsen Extractable P
Mehlich III Extractable P
Exchangeable K
DTPA Extractable Zn
Chloride

Soil pH
Lime Requirement / Buffer pH
Soil Organic Matter
Cation Exchange Capacity / Sum of Cations
Exchangeable Sodium Percentage

Soluble Salts
Excess Lime
## Soil Test Report

**K-State Research and Extension**  
Soil Testing Laboratory  
2308 Throckmorton Plant Sciences  
Center Manhattan, KS 66506-5503  
Tel: (785)532-7897 Fax:(785)532-7412  
www.oznet.ksu.edu/agronomy/SoilTesting/

### Soil Test Results

<table>
<thead>
<tr>
<th>METHODS USED:</th>
<th>1:1</th>
<th>SMP</th>
<th>Mod. W.B.</th>
<th>Cd Reduction</th>
<th>Mehlich</th>
<th>Ammonium Acetate</th>
<th>DTPA</th>
<th>Ca-P</th>
<th>CaNO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Number</td>
<td>Sample ID</td>
<td>Soil pH</td>
<td>Buffer pH</td>
<td>Organic Matter %</td>
<td>Nitrate Nitrogen ppm</td>
<td>Surface</td>
<td>Profile</td>
<td>Phosphorus ppm P</td>
<td>Potassium ppm K</td>
</tr>
<tr>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

### Fertilizer Recommendations

<table>
<thead>
<tr>
<th>Pounds Actual Nutrient Per Acre</th>
<th>Special Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample ID</td>
<td>Previous Crop</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
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</tbody>
</table>

### Comments:

Submitted By:
<table>
<thead>
<tr>
<th>Soil Test Procedure</th>
<th>Reliability / Usefulness</th>
<th>Comments Relative To Best Fit and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil/Water pH</td>
<td>*****</td>
<td>Extensive research base supporting test. Indicates if liming is required. Values may vary up to 0.5 unit during year. Value &gt; 7.3 generally indicates the presence of calcium carbonate (free lime). Value &gt; 8.4 Indicates potential alkali/sodic soil problem.</td>
</tr>
<tr>
<td>Salt pH</td>
<td>****</td>
<td>Theoretically better than water pH – less variability throughout the year. Lacks widespread research base across most of country. Used by University of Missouri.</td>
</tr>
<tr>
<td>Buffer pH or Buffer Index</td>
<td>*****</td>
<td>Extensive research base supports use. Provides best estimate of how much lime required. SMP Buffer most widely used. Woodruff buffer possibly better on low CEC soils (sands).</td>
</tr>
<tr>
<td>% Organic Matter</td>
<td>****</td>
<td>Most laboratories used reliable procedures. Primarily used to determine relatively stable organic fraction. Fresh crop residues in soil samples results in faulty (high) values.</td>
</tr>
<tr>
<td>Cation Exchange Capacity (CEC)</td>
<td>***</td>
<td>Is most commonly estimated by summing cations (exchangeable K+, Ca++, Mg++, Na+, H+) Summing cations provides good reliability on neutral-acid soils – overestimates on calcareous soils. Provides only marginally useful information, within geographic region generally estimates soil texture.</td>
</tr>
</tbody>
</table>
## Usefulness Of Common Soil Test Procedures For The Great Plains & Corn Belt

<table>
<thead>
<tr>
<th>Soil Test Procedure</th>
<th>Reliability / Usefulness</th>
<th>Comments Relative To Best Fit and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble Salts (EC)</td>
<td>***</td>
<td>Most useful in arid regions to diagnose saline soil problems. Saturated paste extract method more reliable (and larger data base) than 1:1 soil:water method.</td>
</tr>
<tr>
<td>Excess Lime</td>
<td>***</td>
<td>Typically only indicates the presence of lime – not the amount. Typically classed as None, Low, Medium, High depending on degree of fizzing from HCl (acid)</td>
</tr>
<tr>
<td>Cation Ratios</td>
<td>*</td>
<td>Ca:Mg ratio most frequently referenced. Unreliable for nutritional or potential grass tetany diagnosis. Provides no useful information for crop production or nutrient management planning.</td>
</tr>
<tr>
<td>% Base Saturation</td>
<td>*</td>
<td>Estimate of proportion of CEC associated with basic cations (sum of K+, Mg++, Ca++ and Na+). Provides no useful information for crop production or nutrient management planning.</td>
</tr>
<tr>
<td>% K+, Mg++, Ca++, H+ Saturation</td>
<td>*</td>
<td>Estimated proportion of CEC associated with each cation. Provides no useful information for crop production or nutrient management planning.</td>
</tr>
<tr>
<td>Exchangeable Sodium Percentage (ESP)</td>
<td>***</td>
<td>Useful for diagnosing alkali/sodic soils and estimating amendment requirements. Generally requires subsoil samples to determine extent of problems.</td>
</tr>
<tr>
<td>Soil Test Procedure</td>
<td>Reliability / Usefulness</td>
<td>Comments Relative To Best Fit and Precautions</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Phosphorus – Bray P-1</td>
<td>* to *****</td>
<td>Highly reliable on non-calcareous soils – Most extensive correlation/calibration research base. Unreliable and inaccurate on calcareous soils – may provide false low results.</td>
</tr>
<tr>
<td>Phosphorus – Olsen P</td>
<td>*** to ****</td>
<td>Developed for high pH-calcareous soils – largest research base for these soils. Has small research base for neutral-acid soils, but it is the preferred test for high pH-calcareous soils.</td>
</tr>
<tr>
<td>Phosphorus – Mehlich II or Mehlich III</td>
<td>*** to ****</td>
<td>Limited crop response research correlation/calibration base as compared to Bray P-1 or Olsen. Interpretation similar to Bray P-1. Works on Wide range of soils (acid-neutral-calcareous) Interpretation of results further complicated depending on if laboratory uses ICP vs. colorimetric procedure.</td>
</tr>
<tr>
<td>Phosphorus – Bray P-2</td>
<td>*</td>
<td>Originally developed to detect residual rock phosphate application to acid soils. While touted by some to measure ‘residual P’, it is poorly calibrated, provides no useful information and should not be used.</td>
</tr>
<tr>
<td>Potassium (exchangeable ammonium acetate)</td>
<td>*** to ****</td>
<td>Generally acceptable performance, especially for historical purposes. Fails to reflect K fertilizer application on some soils while Low soil test values not always associated with K fertilizer response (especially sands).</td>
</tr>
<tr>
<td>Zinc – DTPA Extractable</td>
<td>** to ****</td>
<td>Good reliability for responsive crops on calcareous soils. Much less confidence on neutral-acid soils.</td>
</tr>
</tbody>
</table>
### Usefulness Of Common Soil Test Procedures For The Great Plains & Corn Belt

<table>
<thead>
<tr>
<th>Soil Test Procedure</th>
<th>Reliability / Usefulness</th>
<th>Comments Relative To Best Fit and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc – HCl Extractable</td>
<td>**</td>
<td>Limited research base and reliability on calcareous soils (where most Zn responses expected).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited research base from low organic matter, sandy, neutral-acid soils</td>
</tr>
<tr>
<td>Sulfur - Sulfate</td>
<td>** to ***</td>
<td>Limited calibration base; due to inconsistent crop response.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil texture (sands), low organic matter and crop grown better indicator of S need.</td>
</tr>
<tr>
<td>Calcium</td>
<td>**</td>
<td>Insufficient calibration research base. Calcium deficiencies rare.</td>
</tr>
<tr>
<td>Magnesium</td>
<td>**</td>
<td>Insufficient calibration research base. Magnesium deficiencies rare.</td>
</tr>
<tr>
<td>Manganese</td>
<td>**</td>
<td>Insufficient calibration research base. Deficiencies rare (most likely on over limed soils in eastern U.S.).</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>*</td>
<td>Insufficient calibration research base. Molybdenum deficiencies very rare.</td>
</tr>
<tr>
<td>Boron</td>
<td>**</td>
<td>Insufficient calibration research base. Most confident in test for alfalfa grown in WI, MN, MI sands.</td>
</tr>
<tr>
<td>Copper</td>
<td>*</td>
<td>Insufficient calibration research base. Copper deficiencies rare. Copper deficiencies most likely (though not very common) for wheat in northern organic soils.</td>
</tr>
</tbody>
</table>
Consistency: The Key To Successful Soil Sampling Programs

• Regardless of Sampling Scheme Used, Decisions Based On Soil Testing Can Be No Better Than The Sample Submitted To The Laboratory

• Accuracy and Consistency Depends On:
  • Adequate number of subsamples per sample, regardless of size

• Sampling Depth
  • pH, and K increase with depth – P, Zn, OM decrease
  • KSU research base and interpretations uses 0-6” samples

• Georeferencing
  • For composite sample programs georeference cores
    • Records sample location
    • Records number of subsamples

• Consistency Of Methodology Is The Key Regardless Of System Used

The investment is greater in intensive sampling systems, therefore the importance of proper collection is greater.
Nutrient Recommendations
# Nutrient Management Plan

## Name: Field ID: Acres: Date: 11/18/02

<table>
<thead>
<tr>
<th>Address:</th>
<th>Legal Description:</th>
<th>Crop:</th>
<th>Yield Goal:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone:</td>
<td>Predominant Soil Type:</td>
<td>Next Crop:</td>
<td></td>
</tr>
<tr>
<td>Cell Phone:</td>
<td>Soil OM:</td>
<td>Bray / Mehlich ( Olsen P:</td>
<td></td>
</tr>
<tr>
<td>E-Mail:</td>
<td>Soil pH:</td>
<td>Soil pH:</td>
<td></td>
</tr>
<tr>
<td>Irrigated:</td>
<td>CEC:</td>
<td>Exch. K:</td>
<td></td>
</tr>
<tr>
<td>Soil EC:</td>
<td>Soil Sample Date:</td>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

## Soil Test Information

<table>
<thead>
<tr>
<th>Surface Sample Depth: inches</th>
<th>Profile Sample Depth: inches</th>
<th>Sulfur: ppm / lb/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Texture: %</td>
<td>Profile NO3-N: Lb/a</td>
<td>DTPA-Zn: ppm</td>
</tr>
<tr>
<td>Soil OM:</td>
<td>Bray / Mehlich ( Olsen P:</td>
<td>Profile Cl: ppm / lb/a</td>
</tr>
<tr>
<td>Soil pH:</td>
<td>ppm</td>
<td>Other:</td>
</tr>
<tr>
<td>Buffer pH:</td>
<td>ppm</td>
<td>Other:</td>
</tr>
</tbody>
</table>

## Environmental Risk Assessment

Specific Problems identified:
- See back of form

Comments On Addressing Problems:

## Suggested Best Management Practices

- [ ] Field map attached
- [ ] Recent soil test information
- [ ] Soil test history attached
- [ ] TMDL issues addressed, if applicable
- [ ] Manure Management Plan attached, if needed
- [ ] Nutrient application rates within guidelines
- [ ] Nutrient Right-Objectives of Conservation Plan addressed
- [ ] Estimated erosion loss calculated
- [ ] P Index calculated, if needed
- [ ] Leaching Index determined
- [ ] Wet management practices indicated, if needed
- [ ] All environmental risks identified
- [ ] Certified Advisor/Planner signature
- [ ] Producer signature

## Environmental Management Indices:

- **RUSLE Soil Erosion:** ton/acre
- **P Index:** (if needed)
- **Leaching Index:** High Medium Low
- **Manure Application:** Yes No

## Map:

- [ ] N

## Overall Conservation Plan Objectives:

- [ ] P TMDL Area
- [ ] N TMDL Area
- [ ] P Soil Test Greater Than 50 ppm Bray / Mehlich III
- [ ] Sheet / Rill Erosion Concerns
- [ ] Gully Erosion Concerns
- [ ] Stream Bank Erosion Concerns
- [ ] Water Well in Field
- [ ] Soil Flood Frequency Class (Occasional or greater)
- [ ] Adjacent To Intermittent/Perennial Stream
- [ ] Shallow Water Table (less than 10’ deep)
- [ ] Irrigated Field
- [ ] Manure Applied
- [ ] Manure Application adjacent To Homes, Buildings, etc.
- [ ] Other Environmental Concerns (detail below)

## Crop Nutrient Requirements, Timing and Sources

<table>
<thead>
<tr>
<th>N</th>
<th>P2O5</th>
<th>K2O</th>
<th>S</th>
<th>Zn</th>
<th>Cl</th>
<th>Lime (as ECCE)</th>
</tr>
</thead>
</table>

## Nutrient Credit

- [ ] Residual Soil Nitrate N
- [ ] Soil Organic Matter N
- [ ] Previous Crop Adjustment
- [ ] Irrigation Water
- [ ] Manure (from attached worksheet)

## Planned Nutrient Applications

<table>
<thead>
<tr>
<th>Source / Material</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting/Starter</td>
<td>✔</td>
</tr>
<tr>
<td>Fertilizer - Surface</td>
<td>✔</td>
</tr>
<tr>
<td>Fertilizer - Incorp.</td>
<td>✔</td>
</tr>
<tr>
<td>Knife - preplant</td>
<td>✔</td>
</tr>
<tr>
<td>Sidedress</td>
<td>✔</td>
</tr>
<tr>
<td>Topdressing</td>
<td>✔</td>
</tr>
<tr>
<td>Irrigation</td>
<td>✔</td>
</tr>
<tr>
<td>Fertilizer - Sidedress</td>
<td>✔</td>
</tr>
</tbody>
</table>

## Total Nutrients Supplied

- [ ] Crop Advisor/Nutrient Planner: Date: ____________________________
- [ ] Producer: Date: ____________________________

---

**Crop Advisor/Nutrient Planner**: Date: ____________________________

**Producer**: Date: ____________________________

---

**Nutrient Management Plan Checklist**

- [ ] Estimated erosion loss calculated
- [ ] P Index calculated, if needed
- [ ] Leaching Index determined
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- [ ] All environmental risks identified
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**Environmental Risk Assessment**

- [ ] Field map attached
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**Overall Conservation Plan Objectives**

- [ ] P TMDL Area
- [ ] N TMDL Area
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- [ ] Manure Application adjacent To Homes, Buildings, etc.
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**Environmental Risk Assessment**

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**Environmental Management Indices**

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---

**Crop Advisor/Nutrient Planner**: Date: ____________________________

**Producer**: Date: ____________________________
# Lime

## Lime Recommendations (Lb ECCE/A) ¹

<table>
<thead>
<tr>
<th>Buffer pH</th>
<th>Target pH = 6.8</th>
<th>Target pH = 6.0</th>
<th>Target pH = 5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7.2</td>
<td>0</td>
<td>0</td>
<td>750</td>
</tr>
<tr>
<td>7.0</td>
<td>750</td>
<td>375</td>
<td>250</td>
</tr>
<tr>
<td>6.8</td>
<td>1750</td>
<td>875</td>
<td>500</td>
</tr>
<tr>
<td>6.6</td>
<td>3000</td>
<td>1500</td>
<td>750</td>
</tr>
<tr>
<td>6.4</td>
<td>4500</td>
<td>2250</td>
<td>1000</td>
</tr>
<tr>
<td>6.2</td>
<td>6250</td>
<td>3125</td>
<td>1500</td>
</tr>
<tr>
<td>6.0</td>
<td>8250</td>
<td>4125</td>
<td>2000</td>
</tr>
<tr>
<td>5.8</td>
<td>10250 *</td>
<td>5125</td>
<td>2500</td>
</tr>
<tr>
<td>5.6</td>
<td>12500 *</td>
<td>6250</td>
<td>3000</td>
</tr>
<tr>
<td>5.4</td>
<td>15250 *</td>
<td>7625</td>
<td>3750</td>
</tr>
<tr>
<td>5.2</td>
<td>18000 *</td>
<td>9000</td>
<td>4500</td>
</tr>
<tr>
<td>5.0</td>
<td>20000 *</td>
<td>10375 *</td>
<td>5250</td>
</tr>
</tbody>
</table>

¹ Based on 6.67 " Soil Depth

* When lime recommendation exceeds 10,000 lb ECCE/A, we suggest applying one-half rate, incorporate, wait 12-18 months and the retest
** Soil Depth is the depth of incorporation through rotation.
*** For No-Till systems, assume 2 inch depth of incorporation (~ 1/3 of rate for 6-7 inch depth)

If Buffer pH >= 7.3 then lime recommendation = 0

If Buffer pH < 7.3 then lime recommendation = following:

- If Lime recommendation < 250 then the lime recommendation = 250
- If Lime Recommendation > 20,000 then the lime recommendation = 20,000

\[
\text{Target pH of 6.8} = \left( \left( 25620 - (6360 \times \text{Buffer pH}) + (\text{Buffer pH} \times \text{Buffer pH} \times 391) \right) \times \text{Depth (inches)} \right)
\]

\[
\text{Target pH of 6.0} = \left( \left( 12810 - (3180 \times \text{Buffer pH}) + (\text{Buffer pH} \times \text{Buffer pH} \times 196) \right) \times \text{Depth (inches)} \right)
\]

\[
\text{Target pH of 5.5} = \left( \left( 6405 - (1590 \times \text{Buffer pH}) + (\text{Buffer pH} \times \text{Buffer pH} \times 98) \right) \times \text{Depth (inches)} \right)
\]
Secondary and Micronutrients

• Will offer tests and rec’s for S, Zn, Fe, Cl and B

• Deficiencies of and response to these nutrients have been documented in Kansas
Sulfur

S Rate = (CF x Yield Goal) - (2.5 x %OM) - STS - ManS - Irr. Water S

Example:

Dryland wheat with 60 bu yield goal on 1% OM soil, 3 ppm soil test

S Rate = (0.6 x 60) - (2.5) - (22) = 10 lb/ac
Sulfur

Wheat S Recommendation (bu/a)
S Rate = ( 0.6 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Corn S Recommendation (bu/a)
S Rate = ( 0.2 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Grain Sorghum S Recommendation (bu/a)
S Rate = ( 0.2 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Corn Silage S Recommendation (ton/a)
S Rate = ( 1.33 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Forage Sorghum Silage S Recommendation (ton/a)
S Rate = ( 1.33 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Sunflower S Recommendation (cwt/a)
S Rate = ( 10 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Brome, Fescue & Bermuda Grass S Recommendation (ton/a)
S Rate = ( 5.0 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Alfalfa S Recommendation (ton/a)
S Rate = ( 6.0 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S

Soybean S Recommendation (bu/a)
S Rate = ( 0.4 x Y Goal ) - ( 2.5 x % OM ) - Profile S - Manure S Credit - Irrigation Water S
## Chloride

**Wheat, Corn and Sorghum**

<table>
<thead>
<tr>
<th>Profile Soil Chloride</th>
<th>Chloride Rec.</th>
<th>ppm</th>
<th>lb/a</th>
<th>lb Cl/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4</td>
<td>&lt; 30</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 6</td>
<td>30 - 45</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 6</td>
<td>&gt; 45</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Test is not well calibrated

**Alfalfa, Corn, Sorghum and Soybeans**

<table>
<thead>
<tr>
<th>DTPA Extr. B</th>
<th>Boron Rec.</th>
<th>ppm</th>
<th>lb B/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.5</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.6 - 1.0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1.0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* **DO NOT BAND APPLY BORON**

## Zinc

**Corn, Sorghum and Soybeans**

Zn Rate = 11.5 - (11.25 x ppm DTPA Zn)

- If DTPA Zn > 1.0 ppm then Zn Rec = 0
- If DTPA Zn <= 1.0 ppm then Minimum Zn Rec = 1

**Wheat, Sunflowers and Oats**

Zn Rate = 0*

* May Desire To Apply Zinc Depending On Incorporation Opportunity

**Alfalfa, Brome, Fescue, Bermuda, Others**

Zn Rate = 0
Chloride

Wheat, Corn and Sorghum

<table>
<thead>
<tr>
<th>Profile Soil Chloride ppm</th>
<th>Chloride Rec. lb Cl/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4</td>
<td>&lt; 30</td>
</tr>
<tr>
<td>4 - 6</td>
<td>30 - 45</td>
</tr>
<tr>
<td>&gt; 6</td>
<td>&gt; 45</td>
</tr>
</tbody>
</table>

Boron

Alfalfa, Corn, Sorghum and Soybeans Boron Recommendation

<table>
<thead>
<tr>
<th>DTPA Extr. B ppm</th>
<th>Boron Rec. lb B/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.5</td>
<td>2</td>
</tr>
<tr>
<td>0.6 - 1.0</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 1.0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Test is not well calibrated
** DO NOT BAND APPLY BORON

Zinc

Corn, Sorghum and Soybeans Zinc Recommendation

\[
\text{Zn Rate} = 11.5 - (11.25 \times \text{ppm DTPA Zn})
\]

If DTPA Zn > 1.0 ppm then Zn Rec = 0
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Wheat, Sunflowers and Oats Zinc Recommendation

\[
\text{Zn Rate} = 0^*
\]

* May Desire To Apply Zinc Depending On Incorporation Opportunity

Alfalfa, Brome, Fescue, Bermuda, Others Zn Recommendation

\[
\text{Zn Rate} = 0
\]
KSU N Recommendations

$N_{rec} = [YG \times N/bu] - SOM - PCA - Man - Tillage - PNST$

Where:

- **YG** = Expected yield
- **N/bu** = lb N/bu to produce the whole plant
- **SOM** = N mineralized from soil organic matter.
- **PCA** = Previous crop adjustment.
- **MAN** = Residual manure
- **Tillage** = Impact of no-till on system.
- **PNST** = Profile Nitrogen Soil Test.
KSU N Rec Model

\[ \text{Nrec} = (\text{YG} \times \text{N/bu}) - \text{SOM} - \text{PCA} - \text{Man} - \text{Tillage} - \text{PNST} \]

Where:
- \text{YG} = \text{Expected yield}
- \text{N/bu} = \text{lb N/bu to produce the whole plant}
- \text{SOM} = \text{N mineralized from soil organic matter.}
- \text{PCA} = \text{Previous crop adjustment.}
- \text{MAN} = \text{Residual manure}
- \text{Tillage} = \text{Impact of no-till on system.}
- \text{PNST} = \text{Profile Nitrogen Soil Test.}
Corn and Grain Sorghum

\[
N_{\text{rec}} = \text{[YG \times 1.6]} - \text{SOM} - \text{PCA} - \text{MAN} - \text{PNST}
\]

218 lb N/A = \text{[180 \times 1.6]} - 40 - 40 - 0 - 30

Previous Crop – Soybeans

2% Soil Organic Matter

20 lb N/A Credit For Each 1% Soil Organic Matter
Corn Nitrogen Recommendations

<table>
<thead>
<tr>
<th>Yield Goal (Bu/A)</th>
<th>Soil Organic Matter Content (%)</th>
<th>Total Soil + Fertilizer N Required At Various Yield and Soil Organic Matter Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>90</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>120</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>180</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>210</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>240</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

N Rec\textsuperscript{2,3} = \text{Y Goal x 1.6} - \% \text{SOM x 20} - \text{Profile N} - \text{Manure N} - \text{Irr. Water N} + \text{Previous Crop Adj.}

\textsuperscript{1} Total N requirements presented only include Yield Goal and Soil Organic Matter Adjustments. These Total N requirements should be adjusted for Profile Soil Nitrate, Previous Crop, Manure Application and Irrigation Water Nitrate-N Adjustments.

\textsuperscript{2} Maximum fertilizer N recommendations are 230 Lb N/A for Dryland Corn production and 300 lb N/A for Irrigated Corn production.

\textsuperscript{3} Minimum N fertilizer recommendation is 40 Lb N/A.
Nitrogen Rate Recommendation Adjustments

Soil Organic Matter (SOM) Adjustment

Lb N/A Adjustment = % SOM x 20

Irrigation Water Nitrate N

Lb N/A = ppm Nitrate-N in Water x 0.226 x Inches Irrigation Water Applied

Previous Crop/Tillage Adjustment

Corn, Wheat 0 Lb N/A
Sorghum, Sunflowers + 20 Lb N/A
Soybeans - 40 Lb N/A
## Warm Season Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Excellent Stand (&gt; 5 plants/ft(^2))</th>
<th>Good Stand (2 - 5 plants/ft(^2))</th>
<th>Fair Stand (1-2 plants/ft(^2))</th>
<th>Poor Stand (&lt; 1 plant/ft(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>- 120 Lb N/A</td>
<td>- 80 Lb N/A</td>
<td>- 40 Lb N/A</td>
<td>0 Lb N/A</td>
</tr>
<tr>
<td>Red Clover</td>
<td>- 80 Lb N/A</td>
<td>- 40 Lb N/A</td>
<td></td>
<td>0 Lb N/A</td>
</tr>
<tr>
<td>Sweet Clover</td>
<td>- 110 Lb N/A</td>
<td>- 60 Lb N/A</td>
<td></td>
<td>0 Lb N/A</td>
</tr>
<tr>
<td>Fallow</td>
<td>- 20 Lb N/A</td>
<td>0 Lb N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without Profile N Test</td>
<td>0 Lb N/A</td>
<td>0 Lb N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Profile N Test</td>
<td>0 Lb N/A</td>
<td>0 Lb N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Manure N
- **Inorganic N**: 100% of Manure Worksheet value
- **Organic N**: 100% of Manure Worksheet value

### Profile N Test (2 foot sampling depth, if possible)
- **Default**: - 30 Lb N/A if Profile N Sample Not Collected
- **Lb N/A**: \(0.3 \times \text{Sampling Depth (inches)} \times \text{ppm Profile Nitrate-N}\)
Wheat

\[ \text{Nrec} = [\text{YG} \times 2.4] - \text{SOM} - \text{PCA} - \text{MAN} + \text{Tillage} - \text{PNST} \]

\[ 70 = [50 \times 2.4] - 20 - 0 - 0 + 0 - 30 \]

- 20 lb N/A Credit For Each 1% Soil Organic Matter
# Wheat Nitrogen Recommendations

## Total Soil + Fertilizer N Required At Various Yield and Soil Organic Matter Levels

<table>
<thead>
<tr>
<th>Yield Goal (Bu/A)</th>
<th>Soil Organic Matter Content (%)</th>
<th>Total Soil + Fertilizer N Required (LbN/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>30</td>
<td>62</td>
<td>57</td>
</tr>
<tr>
<td>40</td>
<td>86</td>
<td>81</td>
</tr>
<tr>
<td>50</td>
<td>110</td>
<td>105</td>
</tr>
<tr>
<td>60</td>
<td>134</td>
<td>129</td>
</tr>
<tr>
<td>70</td>
<td>158</td>
<td>153</td>
</tr>
<tr>
<td>80</td>
<td>182</td>
<td>177</td>
</tr>
<tr>
<td>90</td>
<td>206</td>
<td>201</td>
</tr>
</tbody>
</table>

\[
N_{Rec}^{2,3} = Y_{Goal} \times 2.4 \quad - \quad %\text{ SOM} \times 10 \quad - \quad \text{Profile N} \quad - \quad \text{Manure N} \quad + \quad \text{Previous Crop Adj.} \quad + \quad \text{Tillage Adj.} \quad + \quad \text{Grazing Adj.}
\]

1 Total N requirements presented only include Yield Goal and Soil Organic Matter Adjustments. These Total N requirements should be adjusted for Profile Soil Nitrate, Previous Crop, Manure Application and Irrigation Water Nitrate-N Adjustments.
Nitrogen Rate Recommendation Adjustments

**Soil Organic Matter (SOM) Adjustment**

\[ \text{Lb N/A Adjustment} = \% \text{ SOM} \times 10 \]

**Irrigation Water Nitrate N**

\[ \text{Lb N/A} = \text{ppm Nitrate-N in Water} \times 0.226 \times \text{Inches Irrigation Water Applied} \]

**Previous Crop/Tillage Adjustment**

- Corn, Wheat - No-Tillage: +20 Lb N/A
- Corn, Wheat - Conventional./Minimum Till: 0 Lb N/A
- Sorghum, Sunflowers - All Tillage Systems: +30 Lb N/A
- Soybeans - All Tillage Systems: 0 Lb N/A
Cool Season Crops

Alfalfa (assumes stand destruction with tillage)
- Excellent Stand (> 5 plants/ft²) - 60 Lb N/A
- Good Stand (2 - 5 plants/ft²) - 40 Lb N/A
- Fair Stand (1-2 plants/ft²) - 20 Lb N/A
- Poor Stand (< 1 plant/ft²) - 0 Lb N/A

Red Clover (assumes stand destruction with tillage)
- Excellent Stand - 40 Lb N/A
- Good Stand - 20 Lb N/A
- Poor Stand - 0 Lb N/A

Sweet Clover (assumes stand destruction with tillage)
- Excellent Stand - 55 Lb N/A
- Good Stand - 30 Lb N/A
- Poor Stand - 0 Lb N/A

Fallow
- Without Profile N Test - 20 Lb N/A
- With Profile N Test - 0 Lb N/A

Manure N
- Inorganic N 100% of Manure Worksheet value
- Organic N 50% of Manure Worksheet value

Profile N Test (2 foot sampling depth, if possible)
- Default - 30 Lb N/A if Profile N Sample Not Collected
  \[ \text{Lb N/A} = 0.3 \times \text{Sampling Depth (inches)} \times \text{ppm Profile Nitrate-N} \]

Grazing Adjustment
- 40 lbs N per 100 Lbs Beef Weight Gain
Nitrogen

Wheat N Recommendation (bu/a)

\[
N \text{ Rate} = (2.4 \times Y \text{ Goal}) - (10 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment} + \text{Grazing Adjustment}
\]

Corn N Recommendation (bu/a)

\[
N \text{ Rate} = (1.6 \times Y \text{ Goal}) - (20 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment} - \text{Irrigation Water N}
\]

Grain Sorghum N Recommendation

\[
N \text{ Rate} = (1.6 \times Y \text{ Goal}) - (20 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment} - \text{Irrigation Water N}
\]

Corn Silage N Recommendation (ton/a)

\[
N \text{ Rate} = (10.67 \times Y \text{ Goal}) - (20 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment} - \text{Irrigation Water N}
\]

Forage Sorghum Silage N Recommendation

\[
N \text{ Rate} = (10.67 \times Y \text{ Goal}) - (20 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment} - \text{Irrigation Water N}
\]

Sunflower N Recommendation (ton/a)

\[
N \text{ Rate} = (7.5 \times Y \text{ Goal}) - (20 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment} - \text{Irrigation Water N}
\]

Oats N Recommendation (bu/a)

\[
N \text{ Rate} = (1.3 \times Y \text{ Goal}) - (10 \times \% \text{ OM}) - \text{Profile N} - \text{Manure N Credit} + \text{Prev Crop Adjustment} + \text{Tillage Adjustment}
\]

Brome, Fescue & Bermuda Grass N Recommendation (ton/a)

\[
N \text{ Rate} = (40 \times Y \text{ Goal}) - \text{Profile N} - \text{Manure N Credit} - \text{Irrigation Water N}
\]

New Seeding - Legume

\[
N \text{ Rate} = 20
\]
Phosphorus and Potassium
P Recommendations - 160 Bu/A Corn *

Bray P-1  6 ppm - 40 P$_2$O$_5$ / A
Bray P-1  6 ppm - 100 P$_2$O$_5$ / A
Bray P-1  6 ppm - 120 P$_2$O$_5$ / A
Bray P-1  16 ppm - 0 P$_2$O$_5$ / A
Bray P-1  16 ppm - 60 P$_2$O$_5$ / A
Bray P-1  16 ppm - 85 P$_2$O$_5$ / A
Bray P-1  16 ppm - 15 P$_2$O$_5$ / A

* May not be current
Yield Response To Fertilizer Phosphorus
Ellis County

<table>
<thead>
<tr>
<th>N</th>
<th>P</th>
<th>1986 Wheat</th>
<th>1987 Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>23</td>
<td>46*</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td>80</td>
<td>0</td>
<td>34</td>
<td>46</td>
</tr>
<tr>
<td>80</td>
<td>15</td>
<td>37</td>
<td>55</td>
</tr>
<tr>
<td>80</td>
<td>45</td>
<td>38</td>
<td>51</td>
</tr>
<tr>
<td>80</td>
<td>60</td>
<td>34</td>
<td>69</td>
</tr>
<tr>
<td>80</td>
<td>75</td>
<td>37</td>
<td>67</td>
</tr>
</tbody>
</table>

Single fertilizer treatment made July 1, 1985
Effect Of P Addition/Removal On P Soil Test
(Hooker, KS, 1983)

Year

Bray P-1 (ppm)


- 0 Lb/A/yr
- 40 Lb/A/yr
- 80 Lb/A/yr

18.7 Lbs/ppm
23.9 Lbs/ppm
19.7 Lbs/ppm
Effect Of Manure Compost On P Soil Test

(Schlegel, KS, 1990)
Corn, Grain Sorghum and Wheat P Sufficiency

Kansas State University

Bray P1 Soil Test (ppm)

% Yield

- Corn
- Grain Sorghum
- Wheat

One Site-Year
Relationship Between P Application Rate And Crop Yield Response

Yield Response vs. P or K Application Rate

Individual Site-Years

Sufficiency Recommendation At A Given Soil Test
Relationship Between P Application Rate And Crop Yield Response

On The Average, The Rates Needed To Achieve Single Year Optimum Economic Yield At Different Soil Test Levels
Sufficiency Recommendations

- Estimate the amount of P and K that, on the average, provides optimum economic returns in the year of application.

- Results in about 95% of maximum yield.

- No consideration of future soil test values, but results in maintaining soil test values in crop responsive range.

- No P or K is recommended at soil test values above the ‘critical’ soil test value.
Sufficiency Recommendations

- Unless initial soil test values are initially high, little year-to-year flexibility in nutrient application exists.
- Nutrient application is required every year.
- Minimizes input costs in early years.
- Eventually, recommended rates stabilize at rates that maintain soil test levels.
- Best suited for short land tenure situations.
Build-Maintenance Approach

% Yield

- 100%
- 95%
- 50%

Soil P or K Test Level

- V. Low
- Low
- Medium
- High
- V. high

Apply Build-Up Plus Maintenance Nutrients

Apply Maintenance Nutrients

No Nutrients Recommended
Corn, Grain Sorghum and Wheat P Sufficiency

Kansas State University

Bray P1 Soil Test (ppm)

% Yield

- Corn
- Grain Sorghum
- Wheat
Build-Maintenance Recommendations

- Manages a controllable factor by building soil test levels to a target value then maintaining in a predefined target range.

- No P or K is recommended at soil test values above the ‘maintenance’ soil test range.

- Soil test values are main focus. Maintains soil test values non-responsive range.

- Results in close to 100% of maximum yield.
Build-Maintenance Recommendations

- Provides flexibility in nutrient application, time management and cash flow.

- Nutrient application is not required every year.

- Higher fertilizer costs than sufficiency programs in early years.

- Eventually recommended rates stabilize at rates that maintain soil test levels.

- Better suited for longer land tenure situations.
Nutrient Build – Maintenance Concept

Recommended Nutrient Rate

Nutrient Build

Maintenance ~ Crop Removal

P 20 ppm  30 ppm  50 ppm
K 130 ppm  160 ppm

Soil Test Level

Starter

K-State Kansas State University
Different Recommendations Carry Different Types Of Risk

- 'Sufficiency' Fertility Programs
  - High Risk
  - Risk Of Last Increment Of Input Being Non-Economical

- 'Build & Maintenance' Fertility Programs
  - Low Risk
  - Risk Of Input Limiting Crop Productivity
  - 6 Year Program
  - 4 Year Program

- Economic Programs
  - High Risk
  - Low Risk
  - Level Of Input Flexibility
  - Soil Test Level
Individual Operators Have Different Objectives And Experiences For Given Fields/Situations

- Producers Vary In How They Wish To Manage Risk
- Fields Vary In Environmental Sensitivity
- Fields Vary In Length Of Anticipated Land Tenure
- Individual Cash Flow Positions Vary Year-To-Year
- Landlords and Tenants Often Have Different Expectations Of Nutrient Management Program
Phosphorus Management Model For Kansas Crop Production and Manure Management.

Relative Yield (%)

100 %  95 %  50 %

Nutrient Recommendation

Manure Allocation
No Application

Crop Responsive Soil Test Range

Bray 1 Soil Test (ppm)

Manure Management Range
Environmental Risk Range

Sufficiency Recommendation

Build Recommendation

Maintenance Recommendation

Starter Statement

20 ppm Critical Value

30 ppm Upper Build

20 ppm

10 ppm

10 ppm

30 ppm

50 ppm

Upper Manure Limit

Starter Statement

Starter Statement
Bray P1 vs Mehlich III Colorimetric

Excludes Calcareous Soils

\[ y = 1.15 \times \text{Bray} - 1 \]

\[ R^2 = 0.91 \]
Bray P1 vs Mehlich III ICP

Excludes Calcareous Soils

\[ y = 1.2 \times \text{BrayP} + 5 \]

\[ R^2 = 0.93 \]
Mehich-3 Colorimetric vs. ICP Determinations

M3-ICP = 1.03 M3-Col + 6.7

\[ R^2 = 0.98 \]

Includes All Soils
Corn P and K Sufficiency Recommendations

<table>
<thead>
<tr>
<th>Bray P-1 (ppm)</th>
<th>0-5</th>
<th>6-10</th>
<th>11-15</th>
<th>16-20</th>
<th>21+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Yield (Bu/A)</td>
<td>80</td>
<td>120</td>
<td>160</td>
<td>200</td>
<td>240</td>
</tr>
<tr>
<td>Lb P₂O₅/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lb K₂O/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Expected Yield (Bu/A)</td>
<td>0-40</td>
<td>41-80</td>
<td>81-120</td>
<td>121-130</td>
<td>131+</td>
</tr>
<tr>
<td>Lb P₂O₅/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lb K₂O/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Crop Removal³

1  Corn P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.

2  Starter application of small amounts of nutrients found in 100 pounds of a complete NPK or NPKS fertilizer may be beneficial regardless of P soil test level, especially when for cold/wet soil conditions and/or high surface crop residues.

3  Crop removal numbers provided for comparative purpose only. If crop removal exceeds nutrient applications, soil test levels would be expected to decline over time.

Corn Sufficiency P Rec = [ 50 + ( Exp Yield x 0.2 ) - ( Bray P x 2.5 ) - ( Exp Yield x Bray P x 0.01 ) ]

If Bray P > 20 ppm then basic P Recommendation = 0
If Bray P < 20 ppm then the minimum P Recommendation = 15 Lbs P₂O₅/A
If Bray P > 20 ppm then starter P suggested

Corn Sufficiency K Rec = [ 73 + ( Exp. Yield x 0.21 ) - ( Exch K x 0.565 ) - ( Exp Yield x Exch K x 0.0016 ) ]

If Exch K > 130 ppm then basic K Recommendation = 0
If Exch K < 130 ppm then the minimum K Recommendation = 15 Lbs K₂O/A
If Exch K > 20 ppm then starter K suggested
## Corn P and K Build-Maintenance Recommendations

### Phosphorus Build-Maintenance Corn Recommendations

<table>
<thead>
<tr>
<th>Bray P1</th>
<th>4 Year Build Timeframe</th>
<th>6 Year Build Timeframe</th>
<th>8 Year Build Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Test</td>
<td>(ppm)</td>
<td>Lbs P2O5/A</td>
<td>(ppm)</td>
</tr>
<tr>
<td>0-5</td>
<td>105</td>
<td>132</td>
<td>158</td>
</tr>
<tr>
<td>6-10</td>
<td>83</td>
<td>109</td>
<td>135</td>
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<tr>
<td>11-15</td>
<td>60</td>
<td>87</td>
<td>113</td>
</tr>
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<td>16-20</td>
<td>38</td>
<td>64</td>
<td>90</td>
</tr>
<tr>
<td>21-30</td>
<td>26</td>
<td>53</td>
<td>79</td>
</tr>
<tr>
<td>31+</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Potassium Build-Maintenance Corn Recommendations

<table>
<thead>
<tr>
<th>Exch. K</th>
<th>4 Year Build Timeframe</th>
<th>6 Year Build Timeframe</th>
<th>8 Year Build Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Test</td>
<td>(ppm)</td>
<td>Lbs K2O/A</td>
<td>(ppm)</td>
</tr>
<tr>
<td>0-40</td>
<td>268</td>
<td>289</td>
<td>310</td>
</tr>
<tr>
<td>41-80</td>
<td>178</td>
<td>199</td>
<td>220</td>
</tr>
<tr>
<td>81-130</td>
<td>77</td>
<td>98</td>
<td>119</td>
</tr>
<tr>
<td>131-160</td>
<td>21</td>
<td>42</td>
<td>62</td>
</tr>
<tr>
<td>161+</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Notes

1. Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.

2. Recommended amounts of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are based on crop nutrient removal at the indicated yields (0.33 lb P<sub>2</sub>O<sub>5</sub> / bu and 0.26 lb K<sub>2</sub>O / bu).

3. Starter application of small amounts of nutrients found in 100 pounds of a complete NPK or NPKS fertilizer may be beneficial regardless of K soil test level, especially when for cold/wet soil conditions and/or high surface crop residues.

**Corn P Build-Maintenance Rec** = \((20 - \text{Current P Soil Test}) \times 18\) + P2O5 Removal In Grain

**Years To Build**

**Corn K Build-Maintenance Rec** = \((130 - \text{Current K Soil Test}) \times 9\) + K2O Removal In Grain

**Years To Build**
## P and K Crop Removal

<table>
<thead>
<tr>
<th>Crop</th>
<th>Unit</th>
<th>P2O5</th>
<th>K2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>60.00</td>
</tr>
<tr>
<td>Red clover</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Fescue, tall</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Corn</td>
<td>lbs/bu</td>
<td>0.33</td>
<td>0.26</td>
</tr>
<tr>
<td>Corn silage</td>
<td>lbs/ton</td>
<td>3.20</td>
<td>8.70</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>lbs/bu</td>
<td>0.40</td>
<td>0.26</td>
</tr>
<tr>
<td>Sorghum silage</td>
<td>lbs/ton</td>
<td>3.20</td>
<td>8.70</td>
</tr>
<tr>
<td>Wheat</td>
<td>lbs/bu</td>
<td>0.50</td>
<td>0.30</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>lbs/cwt</td>
<td>1.50</td>
<td>0.60</td>
</tr>
<tr>
<td>Oats</td>
<td>lbs/bu</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>Soybeans</td>
<td>lbs/bu</td>
<td>0.80</td>
<td>1.40</td>
</tr>
<tr>
<td>Native grass</td>
<td>lbs/ton</td>
<td>5.40</td>
<td>30.00</td>
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Nutrient
Recommendations