Economics of Nitrogen Fertilization
Crop Rotation

Dr. John Sawyer
Soil Fertility Extension Specialist
Department of Agronomy
Iowa State University
Nitrogen Issues

- High N prices
  - High natural gas price
  - High crude oil price
  - Shutdown of U.S. ammonia production
  - Nitrogen producers finances
  - Product supply “just-in-time”
  - World fertilizer market
  - Price spread between N products

- Increased corn acreage

- Regulatory/Safety/Environment
U.S. Natural Gas Prices
$ Per MMBtu

Henry Hub Average Daily Price

January 2000 – October 2003

1992-99 Average
Ammonia Production Cost
1999 Base Year Cost: Adapted from TFI

Natural Gas Price, $ per MMBtu

Percent Natural Gas Cost, %

Production Cost, $ per ton

- Percent Natural Gas Cost
- Production Cost
Annual Corn and Soybean Acreage
Harvested for Grain In Iowa

Acreage, million acres

Year

Corn
Soybean

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Economic N Rate for Corn Production

- What is it?
- Risk management?
- Estimate an unknown future?
- Effect of N to Corn price ratio?
- What about high corn yielding years?
- Rotation effect?
Corn Following Soybean
Average Economic Optimum N Rate

100 Site-Years in Iowa (1979-2004) Corn-Soybean Rotation

- Economic N at 10:1 corn to N price ratio: 128 lb N/acre
- Yield at economic N: 172 bu/acre
- Maximum yield response: 149 lb N/acre
- Yield at maximum N: 173 bu/acre
Frequency Economic Optimum N Rate
111 C-S Responsive Site-Years Across Iowa (1992-2004)

Frequency of Economic Optimum N Rate

EONR, lb N/acre
Return to N
111 C-S Site-Years Across Iowa (1992-2004)

Corn-Soybean Rotation - Iowa

Price Ratio

Return to N, $/acre

N Rate, lb N/acre

0.05 = $0.11 lb N : $2.20 bu
0.10 = $0.22 lb N : $2.20 bu
0.15 = $0.33 lb N : $2.20 bu
N Rate Sufficiency
111 C-S Site-Years Across Iowa (1992-2004)

0.10 Price Ratio = $0.22 lb N : $2.20 bu
What About High Corn Yields and N Fertilization?
Soil Nitrogen and Carbon Management Project

Economic Optimum N Rate (10:1 Corn:N Price Ratio) Ranked by Site Maximum Fertilized Yield

Economic N Rate, lb N/acre

Maximum Yield, bu/acre

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Economic N Rate
Yield at Economic N
## 2004 Economic Optimum N Rate and Yield

### Corn Following Soybean

<table>
<thead>
<tr>
<th>County - Site</th>
<th>Grain Yield (bu/acre)</th>
<th>N Optimum (lb N/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyon</td>
<td>195</td>
<td>123</td>
</tr>
<tr>
<td>Cerro Gordo</td>
<td>241</td>
<td>151</td>
</tr>
<tr>
<td>Marshall</td>
<td>232</td>
<td>124</td>
</tr>
<tr>
<td>Boone</td>
<td>242</td>
<td>113</td>
</tr>
<tr>
<td>Pottawattamie</td>
<td>246</td>
<td>67</td>
</tr>
<tr>
<td>Wapello</td>
<td>224</td>
<td>75</td>
</tr>
<tr>
<td>Washington</td>
<td>201</td>
<td>197</td>
</tr>
</tbody>
</table>
Yield at Zero Applied N and Yield at Economic Optimum N Rate (10:1 Corn:N Price Ratio) Ranked by Site EONR Yield

Yield at EONR, bu/acre

Yield at EONR
Yield at Zero N

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Corn Following Corn
Return to N
37 C-C Site-Years Across Iowa (1992-2004)

Corn-Corn Rotation - Iowa

Return to N, $/acre

Price Ratio

N Rate, lb N/acre

0.05 = $0.11 lb N : $2.20 bu
0.10 = $0.22 lb N : $2.20 bu
0.15 = $0.33 lb N : $2.20 bu
N Rate Sufficiency
37 C-C Site-Years Across Iowa (1992-2004)

0.10 Price Ratio = $0.22 lb N : $2.20 bu
Maximum Net Return at 180 lb N/acre
Average Yield at Optimum = 142 bu/acre
(142 x 1.2) = 170 lb N/acre
Yield Relationship to Optimal N
111 C-S Site-Years Across Iowa (1992-2004)

Corn-Yield at Optimum, bu/acre

Optimum N, lb N/acre

Maximum Net Return at 120 lb N/acre
Average Yield at Optimum = 184 bu/acre
(184 x 1.2) – 50 = 171 lb N/acre
(184 x 0.85 x 1.2) – 50 = 138 lb N/acre

Corn-Soybean Rotation - Iowa
What About Crop Rotation Influence on N Fertilization?
Six Nitrogen Rate by Crop Rotation Sites
2000-2004 C-S and C-C Rotations

Corn Yield, bu/acre

Nitrogen Rate, lb N/acre

C-S Economic Yield: 161 bu/acre
C-S Economic N Rate: 108 lb N/acre
C-C Economic Yield: 137 bu/acre
C-C Economic N Rate: 167 lb N/acre

C-C 15% Lower Yield
C-C 59 lb N/acre Higher

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## Yield Difference Between C-S and C-C

<table>
<thead>
<tr>
<th>Year</th>
<th>C-S</th>
<th>C-C</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>160</td>
<td>156</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.2%</td>
</tr>
<tr>
<td>2001</td>
<td>146</td>
<td>115</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21.0%</td>
</tr>
<tr>
<td>2002</td>
<td>152</td>
<td>122</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>19.7%</td>
</tr>
<tr>
<td>2003</td>
<td>163</td>
<td>117</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28.1%</td>
</tr>
<tr>
<td>2004</td>
<td>200</td>
<td>204</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.1%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>165</strong></td>
<td><strong>140</strong></td>
<td><strong>25</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>16.2%</strong></td>
</tr>
</tbody>
</table>

Six Sites in Iowa, at 240 lb N/acre Application

Sawyer, Iowa State University; Five sites in 2004
### Frequency of Corn in Rotation

**Northeast Research Farm, 1998 - 2001**

<table>
<thead>
<tr>
<th>Crop</th>
<th>N rate applied to corn, lb N/acre</th>
<th>bu/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>45</td>
<td>105</td>
</tr>
<tr>
<td><strong>C-S</strong></td>
<td>93</td>
<td>153</td>
</tr>
<tr>
<td><strong>C-C-S</strong></td>
<td>97</td>
<td>154</td>
</tr>
<tr>
<td><strong>C-C-S</strong></td>
<td>41</td>
<td>100</td>
</tr>
<tr>
<td><strong>C-C-C-S</strong></td>
<td>95</td>
<td>146</td>
</tr>
<tr>
<td><strong>C-C-C-S</strong></td>
<td>39</td>
<td>102</td>
</tr>
<tr>
<td><strong>C-C-C-S</strong></td>
<td>44</td>
<td>92</td>
</tr>
</tbody>
</table>
## Corn In Rotation

**Northern Research and Demonstration Farm, 1985 - 1998**

<table>
<thead>
<tr>
<th>Crop</th>
<th>0</th>
<th>80</th>
<th>160</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N rate applied to corn, lb N/acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn, sp urea</td>
<td>53</td>
<td>108</td>
<td>134</td>
<td>146</td>
</tr>
<tr>
<td>Corn, fall urea</td>
<td>50</td>
<td>93</td>
<td>124</td>
<td>134</td>
</tr>
<tr>
<td>Corn</td>
<td>100</td>
<td>139</td>
<td>157</td>
<td>162</td>
</tr>
<tr>
<td>Soybean</td>
<td>42</td>
<td>43</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>Corn</td>
<td>153</td>
<td>152</td>
<td>160</td>
<td>156</td>
</tr>
<tr>
<td>Oats *</td>
<td>69</td>
<td>68</td>
<td>71</td>
<td>69</td>
</tr>
<tr>
<td>Hay</td>
<td>3.5</td>
<td>3.3</td>
<td>3.5</td>
<td>3.3</td>
</tr>
<tr>
<td>Hay</td>
<td>3.7</td>
<td>3.5</td>
<td>3.7</td>
<td>3.7</td>
</tr>
</tbody>
</table>

* Oats underseeded with forage legume, no harvest that year.
# Nitrogen Fertilizer Guidelines for Corn In Iowa

## Preplant N Applications

<table>
<thead>
<tr>
<th>Crop Category</th>
<th>N Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recently manured soils</td>
<td>0 to 90</td>
</tr>
<tr>
<td>After established alfalfa</td>
<td>0 to 30</td>
</tr>
<tr>
<td>2\textsuperscript{nd} - year after alfalfa</td>
<td>0 to 60</td>
</tr>
<tr>
<td>Corn after corn</td>
<td>150 to 200</td>
</tr>
<tr>
<td>Corn after soybean (no manure)</td>
<td>100 to 150</td>
</tr>
</tbody>
</table>

Pm-1714 Nitrogen Fertilizer Recommendations for Corn in Iowa, 1997  
Pm-905 Crop Rotations, Effect on Yields and Response to Nitrogen, 1984
Remember

- Account for all N sources
  - Starter
  - Weed and Feed UAN
  - DAP & MAP
- Manage N fertilizer products for best efficiency
- Account for previous crop
- Utilize manure nutrient sources
- Manage all crop production practices for optimal yield
ISU Agronomy Extension
Soil Fertility Web Site
http://extension.agron.iastate.edu/soilfertility

Acknowledgements for Nitrogen Research:

IDALS, Division of Soil Conservation – IFLM Program
Iowa Corn Growers Association
Maquoketa Watershed Project
Soil Nitrogen and Carbon Management Project
ISU Research Farms