Crop Rotation or Continuous Corn?
Agronomic Considerations

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University of Wisconsin-Madison

Wisconsin Fertilizer, Aglime & Pest Management Conference
Madison, WI
January 16, 2008
Crop rotation plan for Monticello

- Thomas Jefferson, like other enlightened farmers, took a scientific approach to farming with the help of his son-in-law, Thomas Mann Randolph (1768-1828), who managed much of Jefferson's land after marrying Martha "Patsy" Jefferson in 1790.

- Jefferson's careful consideration of a workable method of crop rotation for Monticello -- an innovative practice at the time -- demonstrates his interest in scientific farming.
Continuous corn? Or rotate in 2008?
Wisconsin Corn Acreage

Crop Acres

- Corn For Grain
- Corn For Silage
- Soybeans
- Forage Alfalfa
- Hay Other
- Oats
- Wheat All
- Total

Total Acres

Source: USDA-NASS
Continuous corn, or rotate in 2008?
Wisconsin Corn Use

Sources: USDA-NASS
NCGA: The World of Corn
Overview

• The Rotation Effect - What is it?

• Interactions to watch out for ...
The Rotation Effect - What is it?

• **Crop Rotation**
  - Universal management practice
  - Proven management decision that increases crop yields
  - Currently, increased economic benefit for monoculture

• **Rotation Effect**
  - The effect of all conditions, other than N, supplied by legumes in a rotation (Baldock et al. 1981)
  - Other non-legume crops can provide benefits as well (Robinson, 1966; Langer and Randall, 1981; Crookston et al., 1988)
  - Additional benefits of rotating crops
    - All production inputs can be optimized
    - Typical problems associated with monoculture are not apparent.

• **Mechanism for effect is unknown**
The rotation effect lasts two years increasing corn grain yield 10 to 19% for 1C and 0 to 7% for 2C...

Corn Yield Response Following Five Years of Soybean

Grain Yield (bushels/acre)

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Grain Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>178</td>
</tr>
<tr>
<td>1C</td>
<td>179</td>
</tr>
<tr>
<td>2C</td>
<td>162</td>
</tr>
<tr>
<td>3C</td>
<td>155</td>
</tr>
<tr>
<td>4C</td>
<td>156</td>
</tr>
<tr>
<td>5C</td>
<td>155</td>
</tr>
<tr>
<td>Cont.</td>
<td>151</td>
</tr>
</tbody>
</table>

Control treatments averaged across tillage treatments at Arlington, WI.

Source: Lauer
The rotation effect lasts two years increasing soybean grain yield 10 to 20% for 1S and 8% for 2C ...

Soybean Yield Response Following Five Years of Corn

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Grain Yield (bushels/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1987-2006</td>
</tr>
<tr>
<td>CS</td>
<td>54</td>
</tr>
<tr>
<td>1S</td>
<td>59</td>
</tr>
<tr>
<td>2S</td>
<td>53</td>
</tr>
<tr>
<td>3S</td>
<td>50</td>
</tr>
<tr>
<td>4S</td>
<td>50</td>
</tr>
<tr>
<td>5S</td>
<td>48</td>
</tr>
<tr>
<td>Cont.</td>
<td>49</td>
</tr>
</tbody>
</table>

Control treatments averaged across tillage treatments at Arlington, WI.

Source: Lauer

C = Corn, S = Soybean, Number = consecutive year of soybean
A one year break using soybean reduces the rotation effect in the second phase (NS to CC) ...

Corn Yield Response to Crop Rotation

1998 to 2000
Control treatments averaged across tillage treatments at Arlington, WI.

Cropping Sequence
C= Corn, S= Soybean, Number = consecutive year of corn

Source: Lauer

http://corn.agronomy.wisc.edu

Lauer © 1994-2007
University of Wisconsin - Agronomy
At least two break years are needed to measure a response in the second crop phase …

**Corn Yield Response to Crop Rotation**

- **1990-2004**
- Control treatments at Lancaster, WI.

**Cropping Sequence**

A= Alfalfa, C= Corn, O= Oat, S= Soybean, W=Wheat

**Source:** Stanger and Lauer, 2008
Adding a third crop does not increase corn grain yield, but does improve soybean grain yield ...

Corn and Soybean Yield Response to Crop Rotation

Cropping Sequence
C= Corn, S= Soybean, W=Wheat

Source: Lauer

2004-2006: Values averaged across seed fungicide treatments at Arlington, WI.

http://corn.agronomy.wisc.edu

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Management Decision Interactions with Rotation

**Significant**
- Tillage
- N rate
- CR Insecticide
  - CR Variant = NS (need all the time)
- Environment

**Non-significant**
- Plant density
- Row spacing
- Modern hybrids versus old hybrids
  - Modern hybrids can “handle” continuous corn
Modern corn hybrids and management practices have the same rotation response as older hybrids and practices ...

Corn Yield Response Following Five Years of Soybean Cycle 1: 1987-1996

Cycle 2: 1997-2006

Control treatments averaged across tillage treatments at Arlington, WI. Transgenic hybrids used since 1998.

Cropping Sequence

C= Corn, S= Soybean, Number = consecutive year of corn

Source: Lauer

http://corn.agronomy.wisc.edu
Tillage does not affect corn yield the first year following soybean, but improves yield 5% in the second year, and 9% in the third year ...

No tillage response is observed in the second cycle ...

Corn Yield Response Following Five Years of Soybean

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Conventional tillage</th>
<th>No tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>177</td>
<td>178</td>
</tr>
<tr>
<td>1C</td>
<td>180</td>
<td>179</td>
</tr>
<tr>
<td>2C</td>
<td>166</td>
<td>166</td>
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<tr>
<td>3C</td>
<td>162</td>
<td>162</td>
</tr>
<tr>
<td>4C</td>
<td>163</td>
<td>163</td>
</tr>
<tr>
<td>5C</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>CC</td>
<td>160</td>
<td>160</td>
</tr>
</tbody>
</table>

Source: Lauer

C= Corn, S= Soybean, Number = consecutive year of corn

Control treatments during 1987-2006 at Arlington, WI.
N fertilization response increases in 2C and 3C of the rotation, so err on the high side of the recommended N application range …

### Corn Yield Response to N Following Five Years of Soybean

**Average of Tillage Treatments**

Arlington, WI 1987 to 1994

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Grain yield (bushels/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>143</td>
</tr>
<tr>
<td>1C</td>
<td>149</td>
</tr>
<tr>
<td>2C</td>
<td>145</td>
</tr>
<tr>
<td>3C</td>
<td>137</td>
</tr>
<tr>
<td>4C</td>
<td>139</td>
</tr>
<tr>
<td>5C</td>
<td>139</td>
</tr>
<tr>
<td>CC</td>
<td>133</td>
</tr>
</tbody>
</table>

**Source:** Lauer

C = Corn, S = Soybean, Number = consecutive year of corn

**Cropping Sequence**

<table>
<thead>
<tr>
<th>C= Corn, S= Soybean, Number = consecutive year of corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>B= Low N, A= Rec N</td>
</tr>
</tbody>
</table>

Source: Lauer © 1994-2007

University of Wisconsin - Agronomy

http://corn.agronomy.wisc.edu
Rotation is more important in stress environments ...

Control Treatments of CS and CC Arlington and Lancaster, WI 1985 - 2006 (n= 65)

\[ y = -0.21x + 46.45 \]
\[ R^2 = 0.38 \]

- Weed outbreaks and species shifts
- Brown stem rot (Races A and B)
- Soybean cyst nematode
- Corn rootworm variant

Source: Lauer, unpublished

http://corn.agronomy.wisc.edu
Conclusions

- Mechanism for rotation effect is unknown
  - Hypothesis #1: One factor causes effect.
  - Hypothesis #2: Multiple factors cause effect and risk of expression depends upon the environment.

- The rotation effect lasts at most two years increasing grain yield 10 to 19% for 1C and 0 to 7% for 2C.

- At least two break years are needed to measure a response in the second continuous cropping year.
  - A one year break using soybean reduces the rotation effect in the second continuous year.

- Adding a third crop does not improve corn yield, but does improve soybean yield.

- Tillage does not affect yield the first year following soybean, but improves yield 5% in the second year, and 9% in the third year.

- N fertilization response increases in 2C and 3C of the rotation, so err on the high side of the N application range.

- Modern corn hybrids and management practices have the same rotation response as older hybrids and practices.

- Crop rotation is even more important in stress environments.
  - Continuous- versus rotated-corn results in yield advantages of 5 to 30% for rotated-corn.
Funding Sources: Wisconsin Corn Promotion Board, Wisconsin Corn Growers Association, Wisconsin Soybean Association, Wisconsin Soybean Marketing Board, Seed Companies, USDA-Hatch
2008 Corn Conferences

Rice Lake
January 10

Richland Center
January 22

Johnson Creek
January 21

January 24-25, 2008
Kalahari Resort
Wisconsin Dells, WI