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January 19
Key Management Practices for Profitable Corn Production in the Northern Corn Belt

Joe Lauer
University of Wisconsin-Madison

2010 Wisconsin Corn Conferences
Overview

• Corn yield progress
• Keys to high corn yields and profitability
  ✓ Match hybrids to soils
  ✓ Combine traits, tillage and residue to impact water use
  ✓ Cost of production & economics – hybrids, BYE, risk management
  ✓ Seed treatments
  ✓ Optimum planting configurations
    ❑ Optimum seeding rates
    ❑ Row spacing
    ❑ Planting date
  ✓ Eliminate weeds
  ✓ Nitrogen and soil fertility
  ✓ Rotation
  ✓ Harvest and store carefully
Corn yield in Wisconsin and the U.S. since 1866

- Wisconsin:
  - 1866 to 1929 = 0.0 bu/A yr
  - 1930 to 1995 = 1.4 bu/A yr
  - 1996 to 2008 = 1.2 bu/A yr
  - 2007 to 2030 = 6.5 bu/A yr

- United States:
  - 1866 to 1929 = 0.0 bu/A yr
  - 1930 to 1995 = 1.7 bu/A yr
  - 1996 to 2008 = 2.4 bu/A yr

The yield march continues ...
Top 10 most common yield limiting factors …

• And NO, it isn’t about inputs.

• The three most important management decisions are:
  
  Hybrid Selection,

  Hybrid Selection,

  Hybrid Selection.

• The main management objective is to **reduce stress** on the corn plants during the growing season …
### Ten Keys to Increased Corn Yield and Profitability

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1)  | Match hybrids to soils  
|     | ✓ Cold tolerance in NT systems |
| 2)  | Combine traits, tillage and residue to impact water use |
| 3)  | Cost of production & economics - hybrids, BYE, risk management |
| 4)  | Seed treatments |
| 5)  | Optimum planting configurations  
|     | ✓ Optimum seeding rates |
|     | ✓ Row spacing |
|     | ✓ Planting date |
| 6)  | Eliminate weeds |
| 7)  | Nitrogen and soil fertility |
| 8)  | Rotation |
| 9)  | Harvest and store carefully |
| 10) | Information management  
|     | • “Growers will be starving for information as they drown in it.”  
|     | • Need basic agronomy and basic genetics  
|     | • Need basic data on environmental issues  
|     | • Web 2.0 - Social networking of growers.  
|     | • Big issues  
|     | ✓ Data management  
|     | ✓ Environmental issues  
|     | ✓ Disease management |

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http://corn.agronomy.wisc.edu
#1 Match hybrids to soils
#1 Match hybrids to soils …

• Crops in the Midwest are challenged by:
  ✓ Wet springs result in lack of root surface area
  ❑ Drainage is critical
  ✓ Dry and hot conditions during pollination, kernel set, and grain filling

• In the northern Corn Belt, pay special attention to maturity

• Pray for (Ideally) …
  ✓ Spring dry enough for early planting, but wet enough to activate herbicides and promote good stands with uniform emergence
  ✓ Summer with timely rain (1-inch per week), lots of sunshine, and temperatures in mid-80's (day) and low 60's (night)
  ✓ Fall with sunny, dry weather to speed dry-down & allow harvest of “22% moisture corn” by November 1
Keys to Successfully Selecting Hybrids

- Understanding G x E
- Selection strategy that predicts future hybrid performance
  - Multi-location average
  - Consistent performance
- Pay attention to seed costs
- Every hybrid must stand on its own
- Buy the traits you need
What is G x E?

- **Genotype by Environment**
  - Hybrids (genotypes) often respond (or interact) differently in different environments
    - Soils,
    - Diseases,
    - Insects,
    - Fertility,
    - and especially weather!
  - Called different things by seed companies.
    - “Fix / Flex”
    - “Offensive / Defensive”
    - “Racehorse / Workhorse”

- If G x E did not exist, we could grow one trial at one location and predict hybrid ranking around the world.
#2 Combine Traits, tillage and Residue to impact water use
#2 Combine traits, tillage and residue to impact water use

- Tillage is not necessary, except in continuous corn
- “It is all about stand establishment.”
- Tillage responses more often measured in the northern corn belt (~5-7% increase).
- Less difference observed between tillage systems when using Round-up Ready crops.
  - CB and CR traits can control insect build-up that occurs with trash
- Tillage systems take time to equilibrate.
- Do you have reason to suspect compaction?
  - Sub-soil
  - How was it caused?
1) 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 ...

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

**Corn Yield Response Following Five Years of Soybean**

- **Conventional tillage**
- **No tillage**

Control treatments during 1987-2006 at Arlington, WI.

**Source:** Lauer, unpublished

C = Corn, S = Soybean, Number = consecutive year of corn
Yield advantage of chisel plow tillage over no-till 1986-2002
(“Long” Rotation trial, n=6608 plots)

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#3 Cost of production and economics
Objectives

- Cost analysis of grain enterprises
- Emphasize soil and water conservation, efficiency, profitability, and competitiveness vs. productivity alone
- Recognize the way efficient growers integrate practices into a system

Divisions

- Corn, Cash Crop
- Corn, Dairy and Livestock
- Corn, Silage

“Green Fields – Blue Waters” Award
How much does it cost to produce corn in WI?

Data derived from PEPS cash corn division

Cost per Acre ($/A)
Cost per bushel ($/bu) using PEPS yield average
Cost per bushel ($/bu) using USDA yield average

Source: Lauer
# Corn Cost of Production ($/ A)

<table>
<thead>
<tr>
<th>District</th>
<th>Cost/ A</th>
<th>Cost/ Bu</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>$515</td>
<td>$2.71</td>
</tr>
<tr>
<td>2</td>
<td>$539</td>
<td>$2.25</td>
</tr>
<tr>
<td>3</td>
<td>$566</td>
<td>$2.41</td>
</tr>
</tbody>
</table>

## 10 Year Average

<table>
<thead>
<tr>
<th>District</th>
<th>Cost/ A</th>
<th>Cost/ Bu</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$301</td>
<td>$1.70</td>
</tr>
<tr>
<td>2</td>
<td>$323</td>
<td>$1.60</td>
</tr>
<tr>
<td>3</td>
<td>$334</td>
<td>$1.58</td>
</tr>
</tbody>
</table>

Source: Lauer (2000-2009)
Average corn production costs for major inputs

Data derived from PEPS cash corn division

Source: Lauer
How can you get involved in PEPS?

• Contest versus Verification options
• Does it pay to grow corn on my farm?
  ✓ Do I know my production costs?
  ✓ If I do, how do I compare?
  ✓ How efficient is my operation?
  ✓ Am I a good steward?
  ✓ If I make changes, how does that affect my bottom-line?

• What role can agents/dealers/consultants play in PEPS?
  ✓ Promote among producers who would benefit (helping with forms, soil loss and yield checks)
  ✓ Encourage National Corn Growers Association yield contestants to enter
  ✓ Provide input to PEPS committee from “real world”
  ✓ Financial sponsorship
Producing corn the “old fashioned way” - Do we go back to the way it was?

• **Agronomic short answer = No!**
  ✓ $100 per bag difference = $40 per acre (80,000 seeds per bag planted at 32,000 seeds per acre)

• **Economic short answer = Maybe!**

  • **Pros**
    ❑ Safety: Do not need to handling pesticides
    ❑ Efficacy: Traits work
    ❑ Insurance (BYE), “Peace of mind”

  • **Cons**
    ❑ Expense: Projections are $500 per bag
    ❑ Resistance potential, “The Grand Experiment”

• **How much yield gain can you predict?**
  ✓ Gain pays for seed price increases.

• **What is the value of traits?**
  ✓ What needs to be accounted for?

• **How do you make comparisons?**
  ✓ Isolines (or Families) – if available
    ❑ Breeder – yes
    ❑ Producers – Not a good choice. You have access to the entire commercial hybrids market
  ✓ Traits by themselves versus Stacked
  ✓ Trial mean

• **Trade-offs**

  ✓ **Pros**
    ❑ Safety: Do not need to handling pesticides
    ❑ Efficacy: Traits work
    ❑ Insurance (BYE), “Peace of mind”

  ✓ **Cons**
    ❑ Expense: Projections are $500 per bag
    ❑ Resistance potential, “The Grand Experiment”

• **Remember “Traits do not increase yield, they protect yield.”**
### Breakeven matrix ($/A) between two hybrids for various seed bag cost differences

<table>
<thead>
<tr>
<th>Yield increase (bu/A)</th>
<th>$50 Bag difference</th>
<th>$100 Bag difference</th>
<th>$150 Bag difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn Price ($/bu)</td>
<td>Corn Price ($/bu)</td>
<td>Corn Price ($/bu)</td>
</tr>
<tr>
<td>2.50</td>
<td>3.00</td>
<td>3.50</td>
<td>4.00</td>
</tr>
<tr>
<td>0</td>
<td>-$20</td>
<td>-$20</td>
<td>-$20</td>
</tr>
<tr>
<td>2</td>
<td>-$15</td>
<td>-$14</td>
<td>-$13</td>
</tr>
<tr>
<td>4</td>
<td>-$10</td>
<td>-$8</td>
<td>-$6</td>
</tr>
<tr>
<td>6</td>
<td>-$5</td>
<td>-$2</td>
<td>$1</td>
</tr>
<tr>
<td>8</td>
<td>$0</td>
<td>$4</td>
<td>$8</td>
</tr>
<tr>
<td>10</td>
<td>$5</td>
<td>$10</td>
<td>$15</td>
</tr>
<tr>
<td>12</td>
<td>$10</td>
<td>$16</td>
<td>$22</td>
</tr>
<tr>
<td>14</td>
<td>$15</td>
<td>$22</td>
<td>$29</td>
</tr>
<tr>
<td>16</td>
<td>$20</td>
<td>$28</td>
<td>$36</td>
</tr>
<tr>
<td>18</td>
<td>$25</td>
<td>$34</td>
<td>$43</td>
</tr>
<tr>
<td>20</td>
<td>$30</td>
<td>$40</td>
<td>$50</td>
</tr>
</tbody>
</table>

Assume: 80,000 seeds/bag planted at 32000 seeds/A for final population of 30000 plants/A
Spreadsheet for calculating crop seed prices

http://corn.agronomy.wisc.edu/Season/DSS.aspx

<table>
<thead>
<tr>
<th>Hybrid / Variety</th>
<th>Hybrid A ($)</th>
<th>Hybrid B ($)</th>
<th>difference ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Price ($)</td>
<td>150.00</td>
<td>250.00</td>
<td>-100.00</td>
</tr>
<tr>
<td>Kernels/Seeds per bag (no./bag)</td>
<td>80,000</td>
<td>80,000</td>
<td>0</td>
</tr>
<tr>
<td>Seed Population (number/acre)</td>
<td>32,000</td>
<td>32,000</td>
<td>0</td>
</tr>
<tr>
<td>Potential plant death (%)</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Acres per bag (acres/bag)</td>
<td>2.27</td>
<td>2.27</td>
<td>0.00</td>
</tr>
<tr>
<td>Herbicide Cost ($)</td>
<td>25.00</td>
<td>18.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Insecticide Cost ($)</td>
<td>20.00</td>
<td>0.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Fungicide Cost ($)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Insurance Cost ($)</td>
<td>15.00</td>
<td>10.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Harvest Moisture (%)</td>
<td>20.00</td>
<td>20.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Drying ($/point*bushel)</td>
<td>0.06</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>Drying Cost ($/bushel)</td>
<td>0.27</td>
<td>0.27</td>
<td>0.00</td>
</tr>
<tr>
<td>Handling Cost ($/bushel)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Hauling Cost ($/bushel)</td>
<td>0.04</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Trucking Cost ($/bushel)</td>
<td>0.11</td>
<td>0.11</td>
<td>0.00</td>
</tr>
<tr>
<td>Storage Cost ($/bushel)</td>
<td>0.12</td>
<td>0.12</td>
<td>0.00</td>
</tr>
<tr>
<td>Yield adjustment ($/bushel)</td>
<td>0.56</td>
<td>0.56</td>
<td>0.00</td>
</tr>
<tr>
<td>Yield adjustment ($)</td>
<td>84.00</td>
<td>84.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Total Input Cost ($)</td>
<td>210.00</td>
<td>222.00</td>
<td>12.00</td>
</tr>
</tbody>
</table>

Economic advantage ($/acre) of Hybrid A or Hybrid B. Seed price difference = $100 per bag: A = $150, Hybrid B = $250.

<table>
<thead>
<tr>
<th>Yield advantage</th>
<th>Crop Price ($/bushel)</th>
<th>$2.50</th>
<th>$3.00</th>
<th>$3.50</th>
<th>$4.00</th>
<th>$4.50</th>
<th>$5.00</th>
<th>$5.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>bushel/acre</td>
<td></td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Hybrid A yields less than</td>
<td>12</td>
<td>$18</td>
<td>$24</td>
<td>$30</td>
<td>$36</td>
<td>$42</td>
<td>$48</td>
<td>$54</td>
</tr>
<tr>
<td>Hybrid B yields more than</td>
<td>8</td>
<td>$8</td>
<td>$12</td>
<td>$16</td>
<td>$20</td>
<td>$24</td>
<td>$28</td>
<td>$32</td>
</tr>
<tr>
<td>Hybrid A = Hybrid B</td>
<td>0</td>
<td>$12</td>
<td>$12</td>
<td>$12</td>
<td>$12</td>
<td>$12</td>
<td>$12</td>
<td>$12</td>
</tr>
</tbody>
</table>

http://corn.agronomy.wisc.edu
#4 Seed Treatments
#4 Seed Treatments

## The Problem
- Historically seedling emergence is a problem in WI
- Changing farmer practices
  - Earlier planting dates
  - Increased acreage where corn is planted into reduced tillage seedbeds.
  - Seed environment is often cool and wet
  - “Slow-growth” syndrome in reduced tillage systems causes delayed emergence, poor seedling growth, and difficult stand establishment
- “Today there are more chances than ever for disease development from soil pathogens.”

## Race - Pathogen v. Corn
- Environments which favor seedling blight have high enough temperatures to start corn germination followed by a period of low temperatures
  - (Dickson, 1929; referring to the 1921 season).
- “… that other factors being constant, the relative growth rates of the host and pathogen determine to a considerable degree the severity of pre-emergence and seedling infection at different temperatures.”
  - (Leach, 1947)
# Efficacy of Corn Seed Treatments

<table>
<thead>
<tr>
<th>Disease</th>
<th>Favorable Environment</th>
<th>Captan</th>
<th>Maxim</th>
<th>Apron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhizoctonia</td>
<td>Rainfall followed by cool and then warm weather</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Fusarium</td>
<td>??</td>
<td>Good</td>
<td>Excellent</td>
<td>Poor</td>
</tr>
<tr>
<td>Pythium</td>
<td>Likes cold and wet</td>
<td>Poor</td>
<td>Poor</td>
<td>Excellent</td>
</tr>
<tr>
<td>Helminthosporium</td>
<td>??</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Penicillium</td>
<td>??</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Aspergillus</td>
<td>??</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
</tbody>
</table>

*derived from Pedersen, U. of Illinois*
Take home message ... The number of days from planting to emergence is a key factor in establishing the amount of seedling disease that will be infecting the crop.

• Growers must do ALL of the right things to minimize early season STRESS

• It is hard to make money raising “runts”

• Rain a growers best friend or worst enemy

✓ Rainfall - soon after planting that results in saturated or nearly saturated soils - is a bigger factor on yield than is date of planting or tillage type

✓ Grower’s today plant large numbers of acres of corn each day-increasing the at risk acres when a major weather front comes through

• There is no second chance to do things right the first time
#5 Optimum Planting Configurations
#5 Optimum Planting Configurations – Plant density

- **Plant density**
  - Has the most potential to move a farmer from current yield levels
  - Might be the place to start when moving off the yield plateau.
  - Plant densities for maximum yield are increasing as newer hybrids are commercialized.

- **Row spacing**
  - Narrower is better
  - Decision has low impact on yield

- **Seeding depth**
  - 1.5 - 2 inches

- **Planting date**
Yield Components of Corn

- Number of rows
- Kernels per row

Yield

- Kernel number
- Kernel weight

Ears per area
Increasing plant density increases grain yield ... but there is a risk

Source: Lauer, 2006
(Arlington, WI (1987 to 2005, n= 867 plots)
Is Plant Density at Maximum Yield Changing?
Annual grain yield increase at optimum plant density = 2.8 bu/A

Source: Lauer
Arlington, 1987-2003 02PD, n= 867 plots
Guidelines for Choosing an Appropriate Plant Density for Corn

• May have the most potential to move a farmer from current yield levels.

  ✓ Might be the place to start for moving off the “yield plateau.”
  ✓ Optimum plant densities seem to be increasing as newer hybrids are commercialized.
    - Grain yield increases to plant densities of 38,100 plants/A.

• The EOPD for seed:corn price ratios between 0.5 and 1.5 is 29,800 to 36,200 plants/A.

  ✓ The plant density of 32,700 plants/A is within $1.00 of the EOPD for ratios between 0.5 and 1.5.

• In general, silage yield increases as plant density increases.

  ✓ But, a trade-off exists where quality decreases with increasing population.
  ✓ Thus, the EOPD is the same for corn grown for silage or grain.
Guidelines: How do you know if an environment is responsive? Let the plants tell you how your field is doing ...

- Tillered v. Runt plants
- Prolific v. Barren shoots
- Big v. Small ears
- Full ear tips v. Nose-back
- Lodging
Guidelines: One place to begin is evaluate your plant density for each field …

• Reference Strips for On-Farm Testing Plant Density

• Field specific

• At least one strip per field. Total of 3-4 strips per farm.

• Increase plant population 10% in one-strip.

✓ Plant majority of field to normal plant density

✓ Ideally 2-3 strips per field

<table>
<thead>
<tr>
<th></th>
<th>30K</th>
<th>33K</th>
<th>30K</th>
</tr>
</thead>
</table>
Potential Grain Yield Using Calculated Components
Assume 90,000 kernels/bu and 56 lb/bu; kernel mass = 282 mg

<table>
<thead>
<tr>
<th>Plant density (number/A)</th>
<th>Row spacing (number/A)</th>
<th>Plant spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 000</td>
<td>15 in</td>
<td>28</td>
</tr>
<tr>
<td>25 000</td>
<td>15 in</td>
<td>17</td>
</tr>
<tr>
<td>30 000</td>
<td>15 in</td>
<td>14</td>
</tr>
<tr>
<td>35 000</td>
<td>15 in</td>
<td>12</td>
</tr>
<tr>
<td>45 000</td>
<td>15 in</td>
<td>9</td>
</tr>
</tbody>
</table>

Kernels/ear: 0
Grain(lb)/ear: 0.12, 0.25, 0.37, 0.50, 0.62
Grain yield (bu/A): 0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500
Corn response to plant density in Wisconsin

Varies by location and hybrid (GxE)

Concerns: Lodging and Drought
What Does the Relationship Between Grain Yield And Plant Density Look Like?

Total forms = 8; GxE n = 5571 cases (123 locations; 631 hybrids; 80,822 plots)
Trials with min PD < 28,000 and max PD > 34,000

Optimum

- Linear and - Quadratic

+ Quadratic

None

Trials with min PD < 28,000 and max PD > 34,000

+ Linear

- Q = 2%

- L + Q = 1%

26%

15%
Increasing plant density increases grain yield ... but there is a risk

\[
y = -0.07x^2 + 5.69x + 77.67
\]

\[R^2 = 0.24\]

Source: Lauer
Arlington, 1987-2005, n= 867 plots

http://corn.agronomy.wisc.edu
Should We Be Concerned About Seed Costs?

• Seed costs have dramatically increased over the last few years.
  ✓ Transgenic hybrids and technology fees has driven the cost of seed
    ❑ In the early 1990s, premium seed would run about $80 - $100 per bag.
    ❑ Premium hybrids cost $150 - $250 per bag.

• The plant density that maximizes corn yield is increasing over time.

• When grower returns are low, farmers are concerned about the cost of all inputs for corn production

• Ultimately, optimum plant density is affected by both seed cost and corn price.
The Maximum Return to Seed (MRTS) Strategy
Price ratio of seed:corn (i.e. \$/1000 seeds ÷ \$/bu corn).

<table>
<thead>
<tr>
<th>Price of seed</th>
<th>Price of corn ($/bu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/80 K bag</td>
<td>$/1000 seeds</td>
</tr>
<tr>
<td>$0</td>
<td>$0.00</td>
</tr>
<tr>
<td>$40</td>
<td>$0.50</td>
</tr>
<tr>
<td>$80</td>
<td>$1.00</td>
</tr>
<tr>
<td>$120</td>
<td>$1.50</td>
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<tr>
<td>$160</td>
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<td>$200</td>
<td>$2.50</td>
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<td>$240</td>
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<td>$280</td>
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<td>$320</td>
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<tr>
<td>$360</td>
<td>$4.50</td>
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<td>$400</td>
<td>$5.00</td>
</tr>
</tbody>
</table>
Maximum return to seed at Arlington, WI

Seed: Corn Price Ratio

- 0.0 = Yield (bu/A)
- 0.25
- 0.50
- 0.75
- 1.00
- 1.25

Grower return to seed ($/A) for each $1/bu grain price

Harvest plant density (x 1000/A)
## Price Ratio of Seed:Corn
(i.e. $/1000 seeds ÷ $/bu corn)

<table>
<thead>
<tr>
<th>Price of seed</th>
<th>Price of corn ($/bu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/80 K bag</td>
<td>$/1000 seeds</td>
</tr>
<tr>
<td>$40</td>
<td>$0.50</td>
</tr>
<tr>
<td>$60</td>
<td>$0.75</td>
</tr>
<tr>
<td>$80</td>
<td>$1.00</td>
</tr>
<tr>
<td>$100</td>
<td>$1.25</td>
</tr>
<tr>
<td>$120</td>
<td>$1.50</td>
</tr>
<tr>
<td>$140</td>
<td>$1.75</td>
</tr>
<tr>
<td>$160</td>
<td>$2.00</td>
</tr>
<tr>
<td>$180</td>
<td>$2.25</td>
</tr>
<tr>
<td>$200</td>
<td>$2.50</td>
</tr>
<tr>
<td>$220</td>
<td>$2.75</td>
</tr>
<tr>
<td>$240</td>
<td>$3.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$1.00</th>
<th>$2.00</th>
<th>$3.00</th>
<th>$4.00</th>
<th>$5.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>0.25</td>
<td>0.17</td>
<td>0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>0.75</td>
<td>0.38</td>
<td>0.25</td>
<td>0.19</td>
<td>0.15</td>
</tr>
<tr>
<td>1.00</td>
<td>0.50</td>
<td>0.33</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>1.25</td>
<td>0.63</td>
<td>0.42</td>
<td>0.31</td>
<td>0.25</td>
</tr>
<tr>
<td>1.50</td>
<td>0.75</td>
<td>0.50</td>
<td>0.38</td>
<td>0.30</td>
</tr>
<tr>
<td>1.75</td>
<td>0.88</td>
<td>0.58</td>
<td>0.44</td>
<td>0.35</td>
</tr>
<tr>
<td>2.00</td>
<td>1.00</td>
<td>0.67</td>
<td>0.50</td>
<td>0.40</td>
</tr>
<tr>
<td>2.25</td>
<td>1.13</td>
<td>0.75</td>
<td>0.56</td>
<td>0.45</td>
</tr>
<tr>
<td>2.50</td>
<td>1.25</td>
<td>0.83</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>2.75</td>
<td>1.38</td>
<td>0.92</td>
<td>0.69</td>
<td>0.55</td>
</tr>
<tr>
<td>3.00</td>
<td>1.50</td>
<td>1.00</td>
<td>0.75</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Source:** Lauer, 2006

http://corn.agronomy.wisc.edu
As Seed:Corn price ratios increase, economic optimum plant density decreases ...

- Symbols represent the economic optimum return to plant density (EOPD).
- Error bars are the low and high ends of the range of profitability (within $1/A of EOPD) at each seed:corn price ratio.

Source: Lauer, 2006

http://corn.agronomy.wisc.edu
#5 Optimum Planting Configurations - Row spacing

Methods

- 15 total site-years (5 Sites x 3 Years)
- 4 hybrids per Site
- 5 populations per site (23000, 26400, 29800, 33200, 36500 plants/A)
- 3 row widths (15, 22, 30 in)
- 2640 total plots

Corn response to row width in Michigan 1998-1999. Each value is the mean of 880 plots.

<table>
<thead>
<tr>
<th>Row width (in)</th>
<th>Yield (bu/A)</th>
<th>Moisture (%)</th>
<th>Stalk Lodging (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>177 c</td>
<td>19.6 a</td>
<td>1.60 b</td>
</tr>
<tr>
<td>22</td>
<td>181 b</td>
<td>19.2 b</td>
<td>1.92 a</td>
</tr>
<tr>
<td>15</td>
<td>184 a</td>
<td>19.2 b</td>
<td>1.65 b</td>
</tr>
</tbody>
</table>

#5 Optimum Planting Configurations - Planting date

- **Priceless!**
  - “Sets up the season”
  - “Double-whammy”: late = low yield AND higher moisture

- **Focus on seedbed conditions and calendar date rather than soil temperature.**

- **Follow local extension recommendations**
  - Crop insurance requirements

- **Disadvantages of early planting**
  - Seedling diseases
  - Crusting
  - Late spring frost
  - European corn borer
Grain yield is decreasing 0.5 bu/A per day on May 15 and accelerates to 2.5 bu/A per day on June 1 ...

\[ y = -0.04x^2 + 8.68x - 268 \]
\[ R^2 = 0.68 \]

Source: Lauer (Full-season hybrid at Arlington 1997-2006)
#6 Eliminate Weeds
#6 Eliminate Weeds

- We have many options to control weeds in corn

- Timeliness is key
  - Early season weed competition costs us yield in high yield environments.

- Yield cost of delaying weed control
  - Critical periods of competition
  - Timing
  - Weed density
Yield Cost of Delaying Weed Control

Source: Knezevic et al. (2003)
#7 Nitrogen
And Soil Fertility
#7 Soil Fertility

- It’s not the place to cut costs.
- Follow extension recommendations
- Soil test and only apply needed nutrients:
  - Use cheapest form of fertilizer per unit of N, P, or K and apply efficiently
  - Use manure and legume credits to reduce purchased fertilizer costs
  - Don’t cut back on overall N supplied unless over applying
  - Don’t use micronutrients unless soil test recommends
# Nitrogen Guidelines for Corn in Wisconsin

## N:Corn Price Ratio (see other side)

<table>
<thead>
<tr>
<th>SOIL</th>
<th>PREVIOUS CROP</th>
<th>LBS N/acre (total to apply)</th>
</tr>
</thead>
<tbody>
<tr>
<td>high/very high yield potential soils</td>
<td>Corn, Forage legumes, Legume vegetables, Green manures</td>
<td>0.05: 165 135-190; 0.10: 120-155; 0.15: 100-135; 0.20: 90-120</td>
</tr>
<tr>
<td></td>
<td>Soybean, Small grains</td>
<td>0.05: 110 110-160; 0.10: 100-130; 0.15: 85-115; 0.20: 70-100</td>
</tr>
<tr>
<td>medium/low yield potential soils</td>
<td>Corn, Forage legumes, Legume vegetables, Green manures</td>
<td>0.05: 120 100-140; 0.10: 90-120; 0.15: 85-110; 0.20: 80-100</td>
</tr>
<tr>
<td></td>
<td>Soybean, Small grains</td>
<td>0.05: 90 75-110; 0.10: 60-70; 0.15: 50-60; 0.20: 45-55</td>
</tr>
<tr>
<td>sands/loamy sands</td>
<td>Irrigated—All crops</td>
<td>0.05: 215 200-230; 0.10: 190-220; 0.15: 180-210; 0.20: 175-200</td>
</tr>
<tr>
<td></td>
<td>Non-irrigated—All crops</td>
<td>0.05: 120 100-140; 0.10: 90-120; 0.15: 85-110; 0.20: 80-100</td>
</tr>
</tbody>
</table>

1 Maximum return to N (MRTN) rate. 2 Range within $1/acre of MRTN rate. 3 Includes N in starter. 4 Subtract N credits for forage legumes, legume vegetables, animal manures, green manures. 5 Subtract N credits for animal manures and second year forage legumes.
## N: Corn Price Ratio

<table>
<thead>
<tr>
<th>Price of N ($/lb N)</th>
<th>3.00</th>
<th>3.50</th>
<th>4.00</th>
<th>4.50</th>
<th>5.00</th>
<th>5.50</th>
<th>6.00</th>
<th>6.50</th>
<th>7.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.45</td>
<td>0.15</td>
<td>0.13</td>
<td>0.11</td>
<td>0.10</td>
<td>0.09</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>0.50</td>
<td>0.17</td>
<td>0.14</td>
<td>0.13</td>
<td>0.11</td>
<td>0.10</td>
<td>0.09</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>0.55</td>
<td>0.18</td>
<td>0.16</td>
<td>0.14</td>
<td>0.12</td>
<td>0.11</td>
<td>0.10</td>
<td>0.09</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>0.60</td>
<td>0.20</td>
<td>0.17</td>
<td>0.15</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
<td>0.10</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>0.65</td>
<td>0.22</td>
<td>0.19</td>
<td>0.16</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>0.70</td>
<td>0.23</td>
<td>0.20</td>
<td>0.18</td>
<td>0.16</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td>0.75</td>
<td>0.25</td>
<td>0.21</td>
<td>0.19</td>
<td>0.17</td>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
</tr>
<tr>
<td>0.80</td>
<td>0.27</td>
<td>0.23</td>
<td>0.20</td>
<td>0.18</td>
<td>0.16</td>
<td>0.15</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
</tr>
<tr>
<td>0.85</td>
<td>0.28</td>
<td>0.24</td>
<td>0.21</td>
<td>0.19</td>
<td>0.17</td>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>0.90</td>
<td>0.30</td>
<td>0.26</td>
<td>0.23</td>
<td>0.20</td>
<td>0.18</td>
<td>0.16</td>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>0.95</td>
<td>0.32</td>
<td>0.27</td>
<td>0.24</td>
<td>0.21</td>
<td>0.19</td>
<td>0.17</td>
<td>0.16</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>1.00</td>
<td>0.33</td>
<td>0.29</td>
<td>0.25</td>
<td>0.22</td>
<td>0.20</td>
<td>0.18</td>
<td>0.17</td>
<td>0.15</td>
<td>0.14</td>
</tr>
</tbody>
</table>
### Some guidelines for using ranges

<table>
<thead>
<tr>
<th>Situation</th>
<th>Portion of Range to Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
</tr>
<tr>
<td>&gt; 50% residue cover at planting</td>
<td></td>
</tr>
<tr>
<td>Previous crop is small grain on medium/fine textured soils</td>
<td>✓</td>
</tr>
<tr>
<td>100% of N is from organic sources</td>
<td></td>
</tr>
<tr>
<td>Plus up to 20 lb N/a in starter fertilizer may be applied</td>
<td></td>
</tr>
<tr>
<td>If there is a likelihood of residual N (carryover N)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
- If there is a likelihood of residual N, additional N fertilizer may be applied as a starter fertilizer.
- Use PPNT if there is a concern about residual N carryover.

Lauer © 1994-2010
University of Wisconsin - Agronomy
Some guidelines for using ranges

<table>
<thead>
<tr>
<th>Situation</th>
<th>Portion of Range to Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium &amp; fine-textured soils with &lt; 2.0 % OM</td>
<td></td>
</tr>
<tr>
<td>Medium &amp; fine-textured soils with &gt; 10.0 % OM</td>
<td>✓</td>
</tr>
<tr>
<td>Course-textured soils with &lt; 2.0 % OM</td>
<td>✓</td>
</tr>
<tr>
<td>Course-textured soils with &gt; 2.0 % OM</td>
<td>✓ ✓</td>
</tr>
</tbody>
</table>
A range of N rates can produce profitable yields.

Economics clearly drives the profitable N rate.
Effect of price level on profitable range

0.10 N: Corn price ratio ($/lb N : $/bu grain)

- $0.22 : $2.20
- $0.33 : $3.30
- $0.44 : $4.40
- $0.55 : $5.50

Return to N, $/acre

N rate, lb/acre
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ib N/ a (Total to Apply)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
#8 Crop Rotation
#8 Crop Rotation

- “Easiest yield you can get.”
- “The gift that keeps on giving.”
- Corn yield increases 10-19% when rotated with soybean.
- The rotation effect lasts at most two years.
  - Depends upon the length of the break
    - 2 or more break years → Yield of 2nd year corn > continuous corn.
    - 1 year break → Yield of 2nd year corn = continuous corn.
- The rotation effect is even more dramatic in stressful years.
The rotation effect can last up to 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

Control treatments averaged across tillage treatments at Arlington, WI.

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

Source: Lauer
Rotation is more important in stress environments ...

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

\[ y = -0.21x + 46.45 \]
\[ R^2 = 0.38 \]
Yield Contest Winners - DO NOT use Crop rotation, but DO use High Plant Densities

Ken Beaver, Sterling, NE
- 2001: 319 bu/ A
- 39,000 plants/ A

Herman Warsaw, Saybrook, IL
- 1985: 370 bu/ A
- 20+ years continuous corn
- 36,000 plants/ A

Francis Childs, Manchester, IA
- 2002 World Record = 442 bu/ A
- 30+ years continuous corn
- 45,000 plants/ A
#9 Harvest Carefully
#9 Harvest and Store Carefully

- **Trade-off between field losses and drying cost**
  - Recommended to harvest between 20 and 25% moisture
- **For safe storage, drying is usually required (< 15%)**
#9 Disease Management

• “What is good for the crop is good for the pest.”

• Disease management goal is to improve corn canopy leading to yield increase and disease decrease.

• Genetic resistance is the cheapest control

• Scout for these in particular...
  ✓ Anthracnose
  ✓ Northern Corn Leaf Blight
  ✓ Diplodia
  ✓ Fusarium/Gibberella

• Foliar applied fungicides?
  ✓ Headline
  ✓ Quadris
## Corn and Fungicide in Wisconsin

<table>
<thead>
<tr>
<th>Year</th>
<th>Previous Crop</th>
<th>Tillage</th>
<th>No Fungicide</th>
<th>With Fungicide</th>
<th>Fungicide Increase</th>
<th>Did it pay?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>--------------</td>
<td>----------------</td>
<td>--------------------</td>
<td>-------------</td>
</tr>
<tr>
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</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Corn</td>
<td>No-till</td>
<td>216</td>
<td>222</td>
<td>6</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Soybean</td>
<td>No-till</td>
<td>203</td>
<td>230</td>
<td>27*</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>No-till</td>
<td>205</td>
<td>210</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Soybean</td>
<td>No-till</td>
<td>206</td>
<td>208</td>
<td>2</td>
<td>No</td>
</tr>
<tr>
<td>2006</td>
<td>Soybean</td>
<td>Chisel</td>
<td>226</td>
<td>229</td>
<td>3</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Corn</td>
<td>Chisel</td>
<td>214</td>
<td>217</td>
<td>3</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Corn</td>
<td>Chisel</td>
<td>227</td>
<td>227</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>2005</td>
<td>Corn</td>
<td>Chisel</td>
<td>181</td>
<td>186</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Soybean</td>
<td>Chisel</td>
<td>199</td>
<td>211</td>
<td>12</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Soybean</td>
<td>Chisel</td>
<td>212</td>
<td>213</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>2004</td>
<td>Soybean</td>
<td>Chisel</td>
<td>200</td>
<td>211</td>
<td>11*</td>
<td>Yes</td>
</tr>
</tbody>
</table>

---

**Source:** Lauer  
Headline @ VT - Arlington
Guidelines for Using a Fungicide on Hybrid Corn

- Spraying in 2008? Consider:
  - hybrid susceptibility,
  - disease pressure at VT,
  - weather conditions at VT,
  - previous crop,
  - the amount of crop residue present,
  - fungicide and application cost,
  - grain price, and
  - directions & restrictions on label

- In general, a fungicide application is not recommended on resistant hybrids.

- On susceptible hybrids, a fungicide application may be warranted if disease is present on the third leaf below the ear leaf or higher on 50 percent of the plants at tasseling.

- With intermediate hybrids, a fungicide need only be applied if conditions are favorable for disease development
  - Spray if disease is present on the third leaf below the ear leaf or higher on 50 percent of the plants at tasseling, and
  - the weather is warm and humid, and
  - the field has a history of Gray Leaf Spot and/or Anthracnose, and
  - >35 percent corn residue is present.

host (susceptible)  pest (virulent)  disease (favorable)
#10

Information Management
#10 Information Management
What do we do with all these yield maps?

- Precision farming and yield maps are ~15 years old.
  - Crop yields typically vary over space and time. This in-field variability is the focus of precision agriculture – how to manage it, diminish it, or overcome it (Lamb, 1997).
  - Tremendous costs
    - Infrastructure / Equipment / Data
    - People / Time
  - Generated lots of data
- To successfully implement variable rate technology, we need predictable patterns of grain yield variability.
- **Bottom line:** Time is required before yield maps are useful.
  - “Farming for your sons and daughters.”
So far little economic benefit seen with yield maps ...

**Equipment**
- **Sensitive**
  - Requires frequent calibration ("GI GO")
- **Sophisticated**
  - Requires time to learn electronic skills in order to operate equipment and software.
- Requires both yield monitor AND GPS data.

**Data**
- **Computer resources**
- **Management**
- **Software for Analysis**
  - Sophisticated and complicated

**People**
- **Lack of local technical assistance**
- **Decision making**
  - Uncertainty for recommendations
- **Most benefit is to people in the field rather than absentee owner operators who do little or no field work.**
  - Data requires interpretation (notes)
Challenges with Site Specific Management and Prescription Farming

• Ultimately the goal is to make a profit from your predictions
  ▪ To make a good prediction you need to variance estimates (requires a minimum of three crop years).

• The size of the cell is important. It depends on:
  ▪ Size of equipment (less important with modern variable rate technology)
  ▪ Proper calibration of yield monitoring and mapping equipment
  ▪ The number of pixels (points) that estimate yield in each cell

• Yield is the ultimate integrator of the environment
  ▪ Soybean yield is not a good predictor of corn yield.

• Long term commitment: After a management change is made, time is required to evaluate the change (minimum of 3 crop years) before further changes can be tested.
What crop management decisions can be managed in responsive environments?

**Maybe**
- Hybrid
- Plant density
- Fertilizer: N, P, K, micro, starter, lime
- Pesticide
  - Fungicide
  - Herbicide

**No**
- Rotation
- Tillage
- Row spacing
- Seed treatment
- Planting date
- Harvesting
- Drying
What do we do with all these yield maps?

• Keep collecting them ("Let your fields tell you what is happening")
  ✓ Associate GIS data with yield and moisture measurements
  ✓ Collect other agronomic notes
  ✓ Invest in storing and managing data until you have enough years

• Future crop yield gains will likely occur with agronomic management decisions within fields ("The Last Frontier").
Ways To Increase Grower Return

• Substitute information for more expensive purchased inputs:
  ✓ Hybrid performance data
  ✓ Soil tests
  ✓ Manure analysis
  ✓ Pest scouting
  ✓ Crop consultant
  ✓ On-farm trials??
Agronomic and economic consequences of corn management decisions in WI

1. Weather / Environment

2. Hybrid
   - Top to bottom ranking = 0 to 30% change
   - Presence or absence of genetic traits = 0 to 100% change

3. Date of Planting
   - May 1 to June 1 = 0 to 30% change
   - Also need to add moisture penalty

4. Pest Control
   - Timeliness
   - Weeds > Insects > Diseases
   - Good v. Bad = 0 to 100% change

5. Plant Density
   - 32,000 to 15,000 plants/A = 0 to 22% change

6. Rotation
   - Continuous v. Rotation = 0 to 30% change
   - Greater consequence in ‘stress’ environments

7. Soil Fertility
   - 160 v. 0 lb N/A = 20 to 50% change

8. Harvest Timing
   - Oct. 15 to Dec. 1 = 0 to 20% change

9. Tillage
   - Chisel v. No-till = -5 to 10% change
   - No-till = energy savings
   - Cultivation: Yes v. No = 0 to 10% change

10. Row Spacing
    - 30-inches to 15-inches = 0 to 5% change
Summary

• Grain yield increases are occurring faster in Corn Belt counties outside of Wisconsin.

• The most expensive corn crop ever planted occurred in 2009.

• Optimum plant populations for grain yield are higher than currently recommended levels.

• Pay attention to seed costs

✓ When the seed price difference between two hybrids is greater than $50 per bag, it is unlikely that the more expensive hybrid will pay for itself (grain price = $3.50 per bu).

 ❏ The best we can predict is 16 bu/A. Typical gain we can predict is 7 bu/A.
Thanks for your attention!
Questions?

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Kalahari Resort
Wisconsin Dells, WI