Winter Wheat in Minnesota
Why even consider HRWW?

• Yield potential
  – Making use of advantageous growing conditions
• Fewer inputs
  – Weed control costs
• Labor and machinery efficiencies
• Erosion control
  – No-till and cover crop incentives available (EQIP)
• Crop insurance
  – HRWW insured as HRSW
Average Price in ND

$/bu.


HRSW HRWW

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

$/bu.
Net Return Advantage of HRWW over HRSW per Harvested Acre*

<table>
<thead>
<tr>
<th>Region</th>
<th>Net Return Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
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<tr>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>8</td>
<td>29</td>
</tr>
</tbody>
</table>

Calculations use 1999-2005 average yield per harvested acre and 2006 NDSU projected budgets.
Dr. Andrew Swenson’s enterprise analysis over 1995 - 2005 showed that HRWW:

- Is, on average, more profitable than HRSW but has higher risk of abandonment.
- Yields have increased faster than HRSW.
- Price is about 10 to 15 percent less than HRSW.
- Has herbicide and seed cost advantage over HRSW, but higher yields increase fertilizer and trucking costs.
- Abandonment has improved but is much higher than HRSW.
HRWW Challenges

• Winterkill
  – Snow cover essential for survival

• Green Bridge - volunteer HRSW poses risks:
  – Leaf rust & tan spot
  – Hessian fly
  – Barley Yellow Dwarf virus
  – Wheat Streak Mosaic virus

• Suitable previous crops:
  – Barley
  – Canola
  – Soybean (narrow planting window)
  – Wheat (but it’s not without risk)
Cold Acclimation

- Induced when soil temperature < 50°F
- Genetic differences
- Follows bell shaped curve:
  - Increases in the fall
  - Peaks between December and February
  - Decreases in the spring
- Decreases with:
  - Inadequate fall P fertilization
  - Delayed planting
Winter Hardiness

Source: Dr. Brian Fowler, CDC Saskatoon
Winter Hardiness

Source: Dr. Brian Fowler, CDC Saskatoon
# Winter Hardiness

<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>Maximum Length (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.0</td>
<td>150.0</td>
</tr>
<tr>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>-15.0</td>
<td>0.5</td>
</tr>
<tr>
<td>-20.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Source: Winter Wheat Production in North Dakota
# Importance of Snow

<table>
<thead>
<tr>
<th>Snow Depth - 22°F - 44°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 – 2.5</td>
</tr>
<tr>
<td>2.5 – 3.5</td>
</tr>
<tr>
<td>3.5 – 4.7</td>
</tr>
<tr>
<td>≤ 4.7</td>
</tr>
</tbody>
</table>

Source: Winter Wheat Production in North Dakota
Sources of Winterkill

- Lethal temperatures at crown
  - Ice crystal formation
- Desiccation
  - Lack of snow cover
- Suffocation
  - Ice sheeting in fall
  - Flooding in the spring
- Soil heaving
Correlation between Winterkill and Grain Yield (Casselton, 2004)

Source: Dr. Joel Ransom, NDSU
Cultural Practices

• Minimize winterkill by:
  – Variety selection
  – Planting within optimum window
    • 2 to 3 leaf wheat optimum growth stage
    • Avoid fall infections of tan spot, BYDV, WSM
  – No-till seeding and maintaining standing stubble
  – Use starter fertilizer
Winter Wheat Following Soybeans
Objectives

• To determine whether winter wheat can be planted successfully following soybeans.

• To determine the effect of standing stubble of soybeans on winterkill.
Materials & Methods

• Two locations:
  • Ellsworth Danielson - Fosston
  • Eric Nymann – Plummer

• Split-plot design with 4 replicates:
  • Whole plot – tillage (no-till versus chisel)
  • Split plot – variety (differ in winter hardiness)

• Using a 10’ air seeder with 10” spacing and 6” shovels

• Split plots are 10’ by 100’.
Residue
## Correlations

### Growing Year 02/03

<table>
<thead>
<tr>
<th></th>
<th>Spring Stand</th>
<th>Spring Vigor</th>
<th>Winterkill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Vigor</td>
<td>0.74**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winterkill</td>
<td>-0.84**</td>
<td>-0.54**</td>
<td></td>
</tr>
<tr>
<td>Hardiness</td>
<td>0.29*</td>
<td>0.21</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

### Growing Season 03/04

<table>
<thead>
<tr>
<th></th>
<th>Spring Stand</th>
<th>Spring Vigor</th>
<th>Winterkill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Vigor</td>
<td>0.83**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winterkill</td>
<td>-0.88**</td>
<td>-0.81**</td>
<td></td>
</tr>
<tr>
<td>Hardiness</td>
<td>0.47*</td>
<td>0.35</td>
<td>-0.30</td>
</tr>
</tbody>
</table>

** indicates significance at the 0.01 level.
* indicates significance at the 0.05 level.
## Means for Whole Plot Treatment

Comparisons of means between no-till and conventional tillage winter wheat following soybeans combined across two locations in Minnesota locations in 2003 and 2004

<table>
<thead>
<tr>
<th>Trait</th>
<th>2003 No-till</th>
<th>2003 Conventional</th>
<th>LSD (0.05)</th>
<th>2004 No-till</th>
<th>2004 Conventional</th>
<th>LSD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Stand (#/m²)</td>
<td>256.1</td>
<td>250.7</td>
<td>ns</td>
<td>222.7</td>
<td>227.0</td>
<td>ns</td>
</tr>
<tr>
<td>Winter Kill (%)</td>
<td>12.9</td>
<td>16.4</td>
<td>ns</td>
<td>30.1</td>
<td>39.4</td>
<td>ns</td>
</tr>
<tr>
<td>Spring Vigor¹</td>
<td>5.0</td>
<td>4.9</td>
<td>ns</td>
<td>5.9</td>
<td>5.0</td>
<td>ns</td>
</tr>
<tr>
<td>Grain Yield (kg/ha)</td>
<td>4004.0</td>
<td>3783.0</td>
<td>ns</td>
<td>3034.0</td>
<td>2780.0</td>
<td>200.0</td>
</tr>
<tr>
<td>Test Weight (kg/hl)</td>
<td>79.3</td>
<td>78.9</td>
<td>ns</td>
<td>78.3</td>
<td>81.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Grain Protein (%)</td>
<td>12.3</td>
<td>12.6</td>
<td>0.1</td>
<td>10.9</td>
<td>11.6</td>
<td>0.1</td>
</tr>
</tbody>
</table>

¹ 1=poor 9=excellent
Winterkill

Fosston, 2003

Fosston, 2004
Discussion

- In each of the four site-years, the winter wheat germinated and emerged before the arrival of cold weather forced dormancy.
- The no-till method provided more surface residue and tended to reduce the amount of winterkill and improve spring vigor.
- The delay in planting in this experiment did not result in such a large decrease in winterhardiness of Roughrider or Ransom, that the amount of winterkill interfered with the yield potential of the variety. Tandem, the moderate winterhardy variety, showed more than 35% winterkill at two site-years and no grain yield was recorded for one of those two site years.
- The no-till method of planting yielded a higher grain yield in both years of the experiment when combined across locations. However, grain protein content was lower for the no-till method.
Conclusions

• Winter wheat can successfully be established and grown following soybeans when more winterhardy varieties are selected.
Effect of crop residue on winter survival of selected varieties, 2003-04, ND.

Source: Dr. Joel Ransom, NDSU
Genetic Differences

Useful selection pressure in Williston in 2003

Excessive selection pressure in Williston in 2003

Photos: Dr. Phil Bruckner, MSU
Variety Selection

• Most winterhardy HRWW
  – NDSU: *Roughrider*, Ransom, and *Jerry*
  – CDC: Falcon, Buteo

• Most disease resistant
  – Jerry, Millennium

• Lodging resistant
  – CDC Falcon, CDC Buteo, Millennium, Infinity CL

• Yield Potential
  – Jerry, Millennium, Ransom
Evaluation of Common Inputs in HRWW
Objectives

• To determine which inputs commonly used in spring wheat are applicable in winter wheat and how these inputs interact with different winter wheat cultivars.
Materials & Methods

- Four locations:
  - Lamberton, Fergus Falls, Prosper, Crookston
- 2x2x8 partial factorial in split-plot design with 3 replicates:
  - Whole plot – planting date
  - Split plot – variety and input combinations
- No-till into standing (wheat) stubble
## ‘Drop-Out’

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seeding Rate</th>
<th>Seed Treatment</th>
<th>N Split</th>
<th>Fungicides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F 5</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>3</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<tr>
<td>4</td>
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<td>6</td>
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<td>7</td>
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<td>+</td>
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<tr>
<td>8</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
No-till Winter Wheat
Heading date and plant height of cv Jagalene and Jerry as affected by planting date in Lamberton, Prosper, and Crookston in 2008.

<table>
<thead>
<tr>
<th>Planting Date</th>
<th>Heading Date (June)</th>
<th>Plant Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crk</td>
<td>Prpr</td>
</tr>
<tr>
<td>Early</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>Optimum</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>Late</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>ns</td>
<td>1</td>
</tr>
</tbody>
</table>
Grain yield of cv Jagalane and Jerry across planting dates in Lamberton, Prosper, and Crookston in 2008.

<table>
<thead>
<tr>
<th>Treatment</th>
<th><strong>Lamberton</strong></th>
<th><strong>Prosper</strong></th>
<th><strong>Crookston</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jagalane</td>
<td>Jerry</td>
<td>Jagalene</td>
</tr>
<tr>
<td>1 (Check)</td>
<td>49</td>
<td>63</td>
<td>79</td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>61</td>
<td>94</td>
</tr>
<tr>
<td>3</td>
<td>62</td>
<td>60</td>
<td>99</td>
</tr>
<tr>
<td>4</td>
<td>59</td>
<td>68</td>
<td>91</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>64</td>
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<td>6</td>
<td>56</td>
<td>71</td>
<td>91</td>
</tr>
<tr>
<td>7</td>
<td>56</td>
<td>60</td>
<td>92</td>
</tr>
<tr>
<td>8</td>
<td>61</td>
<td>62</td>
<td>99</td>
</tr>
</tbody>
</table>

LSD(0.05) | ns            | ns          | ns            | ns          | ns            | ns          | ns
Discussion

• Little to no winterkill at any location in 2008.

• Delay in heading date and reduction in plant height in Prosper and Lamberton.

• No differences were detected in grain yield, test weight, or grain protein in Crookston and Prosper.
Discussion

• A significant input combination x planting date interaction was found in Lamberton. However, initial interpretation of the data does not answer which input was most influential.

• Need to increase # replications
Fertility Management

• Nitrogen N):
  – $N_{\text{rec}} = (2.5 \times YG) - \text{STN}_{0-24}$
  – Split apply N with 30 – 40 lbs/A PPI
  – Balance in early spring

• Phosphate (P):
  – Aids in winter survival
  – Apply as starter (MAP, DAP)

• Other nutrients:
  – Similar to HRSW
Spring Stand Evaluation

• Walk your fields early but have patience……..

• Do stand counts:
  – Determine uniformity of stand
  – Factor in tillering with favorable environment

• Don’t be too hasty with decisions:
  – ~ 15-17 plants/ft² is adequate
  – Consider partial replant with HRSW.
Fall Disease Management

• Avoid green bridge:
  – Remove volunteer HRSW (2 week gap)
  – Delay planting to back of optimum window

• Scout before dormancy:
  – Leaf rust and tan spot
Spring Disease Management

• Consider all HRWW varieties to be:
  – Susceptible to tan spot and Septoria spp.
  – Susceptible to FHB

• Scout actively for foliar pathogens, especially early in the season
  – Consider early season systemic fungicide application at half labeled rate

• Keep eye on disease forecasting systems for stripe rust, leaf rust, and FHB.
Weed Management

• Volunteer grasses (HRSW, quack grass):
  – Fall burndown to avoid green bridge

• Winter annuals:
  – Fall burndown of emerged winter annuals (biennial wormwood, field pennycress)

• Summer annuals:
  – 2,4-D, bromoxynil (most often no need to control grassy weeds like wild oats, foxtails etc.)
Pest Management

- Fall Pest Management:
  - Avoid green bridge:
    - Remove volunteer HRSW (2 week gap)
    - Delay planting to back of optimum window

- Spring Pest Management:
  - Business as usual
Summary

• HRWW is viable alternative to HRSW:
  – Economic incentives (EQIP and Crop Insurance)
  – No-till and standing stubble desirable:
    • Snow cover essential to reduce winterkill
    • Soybeans can serve as previous crop
  – Vigilance needed to avoid problems
    • Avoid green bridge
    • Scouting essential in first half growing season.
Winter Wheat in Minnesota

- Full-color, 12-page publication describes the best management practices for winter wheat production in Minnesota.