An Economic Approach to Wheat Production

Jessica Weber, M.Sc.,C.C.A, A.Ag.
WARC General Manager
Record Breaking Yields

- **246 bu/ac** – Northeast England in 2015
  - 277 bu/ac N fertilizer split in 4 apps., 165 lb/ac seeding rate, 4 fungicide applications, 4 PGR application

- **154 bu/ac** Shawridge Farms – Ontario
  - Early seeding
  - 7 inch rows
  - Total 160 to 190 lb/ac N and 30 lb/ac S
    - 60 to 70% at stem elongation
    - Two pass late fungicide system

- **249.68 bu/ac** from 29.39 acres
  - Eric and Maxine Watson, New Zealand
  - February 2017 (Winter Wheat)
Average Canadian vs. Sask. Wheat Yields

45.9 bu/ac  Canada

44.3 bu/ac  Saskatchewan
New Zealand & Ontario vs. Saskatchewan

What’s Common
- Early seeding
- Feed Varieties
- High Seeding Rates
- Focus on Head Development
  - Increased Nitrogen
  - Multiple Fungicide Passes

What’s Different
- Water Availability
- Growing Season
- Plant Growth Regulator
- Intensive Management
The Importance of an Ultra-Early Seeding System

- The effect of climate change on wheat in Canada:

Atmospheric CO$_2$ concentration

Temperature

Precipitation (decreased in growing season)
The Effect of Climate Change on Wheat in Canada

Wheat yield from 1981-2010 from the median yield of 30 modelling systems with a 2°C temperature increase.

From Asseng et al. 2014.
Wheat yield from 1981-2010 from the median yield of 30 modelling systems with a 4°C temperature increase.

From Asseng et al. 2014.
Effect of Climate Change in Canada on Wheat

- Canadian Studies show similar results:
  - Lychuk et al. 2017 ran seven climate scenarios for Scott, SK.
  - 4 of 7 indicated decreases in wheat yield.
    - Increased daily heat extremes.
    - Greater maximum temperatures.

- Several other studies have indicated the average planting window in Canada and the Northern U.S. has moved earlier in the season. (Lanning et al. 2012, Lanning et al. 2010, He et al. 2012 & He et al. 2012a).

- Studies results have indicated moving seeding dates 7-11 and 10-12 days earlier than conventional timing has no negative effects.
Early vs. Late Seeding

Southern Alberta:
- Targeted Seeding Date
  - After April 30th
- CWRS: -0.8% yield decrease per day
- CPS: -0.1% yield decrease per day

WHY?
- Increased solar capture
- Flowering prior to intense heat
- Utilizing early spring moisture
Dormant Seeding?

• What is it?
  • Fall planting Nov to Dec.
  • soil conditions inhibit immediate seed germination

• Where is it done?
  • Dakota Lakes, North Dakota
  • South Dakota
  • Ontario

• Conditions for dormant seeding:
  • Field free of deep, wet snow
  • Field-dry soil
  • Seeding Depth: 1 to 1.5 inches
  • No-till> Stale Seed Bed
  • Seed Treatment
  • Higher Seeding Rates

• 29% yield increase was associated with dormant seeding vs. normal seeding (April 1st) (Beck, 2009)
Higher Yields = Higher Seeding Rates?

Current Recommendations:

- CWRS Wheat
  - 200 to 300 seeds/m²

- CPS Wheat
  - 250 to 400 seeds/m²

- Soft White Wheat
  - 300 to 450 seeds/m²

Alberta Agriculture and Forestry, 2009
Optimal Seeding Rate for Spring Wheat

- Years: 2012 – 2013
- Location: Scott, Prince Albert, Indian Head, Swift Current, and Melfort
- Variety: Unity VB (CWRS)

Figure 1: The relationship between seeding rate and grain yield (combined means of eight site years). Maximum grain yield achieved at 306 seeds m\(^{-2}\).
Optimal Seeding Rate for Spring Wheat

- Max yield (59.6 bu/ac) @ 306 seeds/m²
- Max net returns @ 238-292 seeds/m²

![Graph showing net return of spring wheat at various seeding rates and grain prices at seed cost of $13/bu. Maximum economic return 238, 266 and 284 at seeds m² when grain prices are $100, $200 or $300 tonne⁻¹, respectively.]

\[
y = -0.0031x^2 + 1.7617x + 921.1 \\
y = -0.0021x^2 + 1.1187x + 614.06 \\
y = -0.001x^2 + 0.4758x + 307.03
\]
Effect of High Seeding Rates

Benefits:
- Reduced tillering
  - Duration of disease exposure
  - Uniform growth staging
- Improved weed control
- Better solar light capture

- Excessive lodging
  - Manage N applications
  - Utilize lodge resistant varieties
  - Plant growth regulators
# Calculating Your Seeding Rate

<table>
<thead>
<tr>
<th>SEED RATE CALCULATOR</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Enter desired plant density (plants /m²)</td>
<td>300</td>
</tr>
<tr>
<td>Enter seed thousand kernel weight (grams)</td>
<td>41.8</td>
</tr>
<tr>
<td>Weight (grams per seed)</td>
<td>0.0418</td>
</tr>
<tr>
<td>Seed survival (.8-1.0)</td>
<td>0.88</td>
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<tr>
<td>Seed Rate (kg/ha)</td>
<td>143</td>
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<tr>
<td>Seed Rate (lb/acre)</td>
<td><strong>127</strong></td>
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<td>Desired plant density (plants /m²)</td>
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<tr>
<td>Seed thousand kernel weight (grams)</td>
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<tr>
<td>Weight (grams per seed)</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Seed Rate (kg/ha)</td>
<td>119</td>
</tr>
<tr>
<td>Seed Rate (lb/acre)</td>
<td><strong>106</strong></td>
</tr>
</tbody>
</table>

- Know your TKW – it can make a difference!
  - 41.4 KTW = 105 lb / ac @ 250 seeds per sq. meter
  - 31.6 KTW = 80 lb / ac @ 250 seeds per sq. meter
Yield Components – Focus on Head Development

\[
\frac{\text{plants}}{m^2} \times \frac{\text{heads}}{\text{plants}} \times \frac{\text{florets}}{\text{head}} \times \frac{\text{seeds}}{\text{floret}} \times \frac{g}{1000 \text{ seeds}} = \text{Yield}
\]
Timing of Nitrogen

• Why is timing important?

• Nitrogen Partitioning: Yield vs. Protein
  1. soil uptake of soil nitrate prior to flowering †YIELD
  2. remobilization of stored vegetative N prior to flowering †YIELD
     †(65-86% total N grain filling)
  3. uptake of N after anthesis †PROTEIN

Protein

• Dribble Band vs. Foliar Application
  †Foliar Application: only 4-27% uptake < 32-70% soil application
  †Dribble Band: reduce leaf burn, reduce N volatilization, improved NUE

Van Sanford, D. A. and MacKown, C. T. 1987
Spiertz, J. H. J. and de Vos, N. M. 1983
Fungicides: To Spray or Not to Spray

- Factors:
  - Canopy Density
    - Higher Seeding Rate = More Uniform
    - Denser Canopy = Increased Disease Pressure
  - Varietal Selection
    - MS > MR
  - Application Timing
    - Yield Benefit?
      - Z58 to Z64 > Z38 soft white wheat

![Figure 1](image.png)

*Figure 1. Wheat developmental stages. From left to right: flag leaf (Z38), late heading (Z58), full heading but no flowering (Z60), and midflower (Z64).*
Standard Fungicide Application

0° & 18 inches above canopy
“Herbicide” type application

30° Forward & 8 inches above canopy
“Targeting head” type application

Top strip – facing direction of travel
Improved Fungicide

Dual Nozzles & 8 inches above canopy
“Excellent” Fusarium application

Dual Nozzles & 18 inches above canopy
“Sub-optimal” Fusarium application

Top strip – facing direction of travel
PGRs in Wheat Production

Indian Head 2014

Melfort 2014
PGRs in Wheat Production

No PGR
Unity Wheat 100N

Manipulator @ Zk 31
Unity Wheat 100N

No PGR
Goodeve Wheat 100N

No PGR
Goodeve Wheat 150N

Aug 1, 2015
PGRs in Wheat Production

INFLUENCE OF PGR AND VARIETY AVERAGED OVER N RATE ON WHEAT YIELD.
Why Not Intensively Manage Wheat?

• Poor economics?
• Not enough time?
• Logistic issues?

• Should different classes of wheat be managed differently?
• Does it differ between soil classes?
• Where are the best economic returns?
Input Study: Intensive Wheat Management

Big Thank You to the Funders and Project Leads: Jessica Pratchler and Stu Brandt

- Collaborators:
Input Study: Intensive Wheat Management

• To enhance wheat profitability by incorporating some or all components of intensive wheat management

• To identify how wheat classes and varieties are affected by enhanced wheat management

• To identify how these interactions vary in response to the various soil and climatic conditions across Saskatchewan

• To identify input combinations provide optimal yields and quality, while minimizing cost
Input Study: Intensive Wheat Management

- Sites: Indian Head, Melfort, Scott, Swift Current, and Yorkton
- RBCD with 4 replicates
- Years: 2017, 2018, and 2019
- Treatments: 6 Wheat Varieties x 3 Management Strategies
  - 18 treatments

Data Collection
- Plant Density
- Days to Maturity
- Yield
- Quality (TKW, Bushel Weights, Protein, %FDK, DON)
## Input Study: Intensive Wheat Management

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Class</th>
<th>Fusarium Resistance</th>
<th>Lodging resistance</th>
<th>Maturity</th>
<th>Yield</th>
<th>Protein</th>
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<tr>
<td>Carberry</td>
<td>CWRS</td>
<td>MR</td>
<td>Very Good</td>
<td>99</td>
<td>100</td>
<td>14.6</td>
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<td>AAC Cameron VB</td>
<td>CWRS</td>
<td>I</td>
<td>Fair</td>
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<tr>
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<tr>
<td>AC Andrew</td>
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<td>I</td>
<td>Very Good</td>
<td>+2</td>
<td>137</td>
<td>NA</td>
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<tr>
<td>SY Rowyn</td>
<td>CPSR</td>
<td>MR</td>
<td>Fair</td>
<td>-1</td>
<td>107</td>
<td>-1.1</td>
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<tr>
<td>AC Ryley</td>
<td>CPSR</td>
<td>MS</td>
<td>Poor</td>
<td>-2</td>
<td>110</td>
<td>-1.2</td>
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### Input Study: Intensive Wheat Management

<table>
<thead>
<tr>
<th>Management</th>
<th>Seed Treatment</th>
<th>Seeding Rate (seeds/m²)</th>
<th>N fertility (lb/ac N)</th>
<th>P fertility (lb/ac P₂O₅)</th>
<th>Fungicide @ Flag Leaf</th>
<th>Fungicide @ Anthesis</th>
<th>PGR App.</th>
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<tr>
<td>Conventional</td>
<td>No</td>
<td>200</td>
<td>75</td>
<td>25</td>
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<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Enhanced</td>
<td>No</td>
<td>300</td>
<td>98</td>
<td>33</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Intensive</td>
<td>Yes</td>
<td>360</td>
<td>120</td>
<td>40</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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Preliminary Results: Varietal Effect on Yield

Yield (bu/ac)

Carberry | AAC | Cameron VB | CDC | Utmost VB | AC | Andrew | SY | Rowyn | AC | Ryley

Melfort | Yorkton | Indian Head | Scott | Swift | Current
Preliminary Results: Varietal Effect on Protein

Swift Current > Indian Head > Scott ≥ Melfort

p<0.0001***
Preliminary Results: Management Strategy on Yield

Melfort, Yorkton, Indian Head, Scott p<0.0001*** ; Swift Current p<0.3302
Preliminary Results: Management Strategy on Protein

![Bar chart showing comparison of protein percentage across different strategies and locations.](chart.png)
# Seed Cost Expenses at Scott, SK 2017

<table>
<thead>
<tr>
<th>Seed Cost (s/m2)</th>
<th>lb/ac</th>
<th>Cost of CWRS Wheat</th>
<th>Cost</th>
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<tbody>
<tr>
<td>200</td>
<td>73</td>
<td>$16.43</td>
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<td>300</td>
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<td>360</td>
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<table>
<thead>
<tr>
<th>Seed Cost (s/m2)</th>
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<th>Cost of CPSR Wheat</th>
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<td>73</td>
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<tr>
<td>300</td>
<td>109</td>
<td>$19.51</td>
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<tr>
<td>360</td>
<td>131</td>
<td>$23.45</td>
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# Production Costs based on Dark Brown Soil Zone

<table>
<thead>
<tr>
<th></th>
<th>Conventional $ / ac</th>
<th>Enhanced $ / ac</th>
<th>Intensive $ / ac</th>
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<tr>
<td>Seed Treatment</td>
<td>0</td>
<td>0</td>
<td>5.56</td>
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<tr>
<td>N Fert</td>
<td>36.2</td>
<td>47.1</td>
<td>58.0</td>
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<tr>
<td>P Fert</td>
<td>14.6</td>
<td>18.9</td>
<td>23.3</td>
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<tr>
<td>Herbicide</td>
<td>31.0</td>
<td>31.0</td>
<td>31.0</td>
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<tr>
<td>Fungicide</td>
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<td>15.5</td>
<td>25.5</td>
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<tr>
<td>PGR</td>
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<td>10.0</td>
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<tr>
<td>Fuel Costs</td>
<td>19.35</td>
<td>19.35</td>
<td>19.35</td>
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<tr>
<td>Custom Spraying Costs</td>
<td>0</td>
<td>6.50</td>
<td>13</td>
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<tr>
<td>Cost of Spraying</td>
<td>0</td>
<td>4</td>
<td>8</td>
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<tr>
<td>Suggested Labour Costs</td>
<td>18.75</td>
<td>18.75</td>
<td>18.75</td>
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## Gross Revenue Based on Production Expenses Including Custom Spraying

<table>
<thead>
<tr>
<th></th>
<th>Yield (bu/ac)</th>
<th>$ / bu</th>
<th>Net Revenue</th>
<th>Production Expenses</th>
<th>Gross Revenue</th>
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<tbody>
<tr>
<td>CWRS</td>
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<td>66</td>
<td>$ 6.50</td>
<td>431.0</td>
<td>117.6</td>
<td>313.4</td>
</tr>
<tr>
<td>Enhanced</td>
<td>75</td>
<td>$ 6.50</td>
<td>486.2</td>
<td>163.1</td>
<td>323.1</td>
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<tr>
<td>Intensive</td>
<td>81</td>
<td>$ 6.50</td>
<td>524.9</td>
<td>215.4</td>
<td>309.5</td>
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<tr>
<td>CWSWS</td>
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<tr>
<td>Conventional</td>
<td>83</td>
<td>$ 6.00</td>
<td>499.8</td>
<td>114.2</td>
<td>385.6</td>
</tr>
<tr>
<td>Enhanced</td>
<td>92</td>
<td>$ 6.00</td>
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<td>81</td>
<td>$ 6.25</td>
<td>504.7</td>
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*Market price is based on protein of 13.5%; *Market price is based on protein between 9-11%; ^Market price based on protein of 13.0%
# Gross Revenue Based on Production Expenses

## Producer Spraying Costs

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<tr>
<th></th>
<th>Yield (bu/ac)</th>
<th>$ / bu</th>
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*Market price is based on protein of 13.5%; Market price is based on protein between 9-11%; Market price based on protein of 13.0%
Take Home Message

• **CWRS**: Enhanced > Conventional = Intensive
  - Over estimated our prices due to lower proteins – protein discounts?

• **CWSWS**: Intensive ≥ Enhanced > Conventional
  - Proteins were within malting barley 9-11%
  - Highest overall returns compared to CWRS ($75/ac); CPSR ($42/ac)

• **CPSR**: Intensive > Enhanced > Conventional
  - CPSR highly sensitive to intensive management
  - Over estimated our prices due to lower proteins – protein discounts?

• Custom Spraying vs. Producer Spraying: - $2.5/ac enhanced; - $5/ac intensive
  - **EXCEPT CWRS Intensive**: additional - $4/ac loss

• **Environmental Conditions**: Relatively dry year

  **Management strategy may be wheat class dependent on an economic basis**
What’s Next?

- Multiple Sites and Years- Will the trend change?
- Split applications of N?
- Ultra - Early Seeding & Dormant Seeding
- Combination of Ultra – Early Seeding and Management Techniques
Thank You!

- Agriculture Development Fund (ADF)
- Saskatchewan Wheat Development Commission
- NARF Technical and Summer Staff
- Western Applied Research Corporation
- East Central Research Foundation
- Indian Head Agricultural Research Foundation
- Wheatland Conservation Area

Saskatchewan Ministry of Agriculture and the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement.

https://www.westernappliedresearch.com/
Questions?

Crop Opportunity
March 13th
Dekker Centre, North Battleford

www.warc.ca