Crop Yield and Production Trends in Western Canada

• Data from Canada Grains Council (Statistics Canada).
• Examined crop production, area harvested and yield of canola and spring wheat from 1964/1965 to present.
• Actual yield results – takes everything into account!
• YIELD GAINS = better genetics + improved agronomic practices + improved farm machinery + better pesticides + environment, etc.
• Major publicity on how much wheat yields need to increase in the next 20+ years...
  ... often only the rate of genetic gain is mentioned.
  Yield increases represent much more than just genetic gain!
• What are the on-farm tends in western Canada?
Data Collection: Statistics Canada – Field Crop Reporting Series

• Data collection 6 times per year
  – Area, Yield, Production: March, June, July, September, November.
  – Stocks: December, March, July/August.

• Target Population
  – All farms in Canada enumerated in Census of Agriculture.
  – Not institutional, First Nations, farms in NWT, YT, NU & Atlantic.

• Cross-sectional design
  – Sampling stratified into homogeneous groups: farm size, crop area, etc.

• Sample Size: March: 13,000  June: 25,000  July: 15,000
  (2012) Sept.: 11,700  Nov.: 29,000  Dec.: 10,500

• Response is mandatory. Refusal rate = 8-9%

In this study:
  – Verified reported Yield by dividing Production / Harvested Area
  – 1981/82 to Present: Difference usually within 30 kg/ha (about 0.5 bu/ac).
Spring Wheat Yields by Province (1964/65 - 2012/13)

Spring wheat yield, 1964/65 - 2012/13

y = 30.926x + 1504.6
y = 26.242x + 1508.0
y = 17.617x + 1437.2

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Spring Wheat Yields by Province (1964/65 - 2012/13)
Trend Line Analysis

  - 1981: registration of Katepwa CWRS wheat.
  - 1982: registration of Westar *B. napus* canola.
  - Yield penalty associated with canola quality now overcome.
  - Canola well adapted and agronomic systems established.

  - WGRF wheat investment (1994) starts producing varieties.
  - Hybrid canola starting to be introduced – not yet popular.
  - Herbicide tolerant canola on about 50% of acres.

- Location of “break” is somewhat arbitrary and will affect results.

- Trend from 1981/1982 to present is most robust.
- What changed during the two periods?
Spring Wheat Yields by Province (1981/82 - 2012/13)

Spring wheat yield, 1981/82 - 2012/13

y = 39.47x + 1862.5
y = 26.874x + 1952
y = 22.266x + 1641.1

Graf 2013
Canola Yields by Province (1981/82 - 2012/13)

Canola yield, 1981/82 - 2012/13

\[ y = 29.943x + 1025.9 \]
\[ y = 24.051x + 1119.2 \]
\[ y = 17.105x + 1068.2 \]

Yield (kg/ha)
Yield Increases over Time

Based on exponential curve fitting

<table>
<thead>
<tr>
<th></th>
<th>AB</th>
<th>SK</th>
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<tbody>
<tr>
<td>1981/82 to 2012/13</td>
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</tr>
<tr>
<td>Spring wheat</td>
<td>63%</td>
<td>42%</td>
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Based on exponential curve fitting

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<tr>
<td>1981/82 to 1999/00</td>
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<td>40%</td>
<td>26%</td>
<td>14%</td>
<td>25%</td>
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<td></td>
<td>Canola</td>
<td>21%</td>
<td>5%</td>
<td>42%</td>
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Based on exponential curve fitting: Graf 2013

Yield Increases over Time
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Based on exponential curve fitting

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<td>17%</td>
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</tr>
<tr>
<td></td>
<td>Canola</td>
<td>50%</td>
<td>60%</td>
<td>17%</td>
<td>36%</td>
</tr>
</tbody>
</table>

Using percentage increase can be misleading...

- Number of data points and type of curve fitting affects results.
- Yield of canola is lower than wheat.
- E.g.: a 5¢ increase in a penny stock represents a large % increase compared to a 5¢ increase in a high value stock.
### Yield Increase per Year

Based on exponential curve fitting

<table>
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<tr>
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Graf 2013
## Yield Increase per Year

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Yield Increase per Year

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<tr>
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Remember that using percentage increase can be misleading...
For this time period (1981/82 - 2012/13):
Spring wheat yields increased at a rate of 26.3 kg/ha (0.39 bu/ac) per year.
Canola yields increased at a rate of 21.2 kg/ha (0.38 bu/ac) per year.
Prairie canola yield as a percent of wheat yield, 1981/82 - 2012/13

Based on this method of calculation, canola yields increased 0.17% per year faster than spring wheat.
**Comments: Spring Wheat**

1981/1982 to 1999/2000 *versus* 2000/2001 to present:
- What influenced the rate of gain?
- What was the yield gain per dollar invested?
  - 2011/12: Total Wheat Investment = approx. $25 Million.

**Spring Wheat:**
- WGRF supported varieties start to be registered.
- First CWRS varieties with ND germplasm (McKenzie, Superb, etc.)
- First semi-dwarf CWRS varieties (Superb, CDC Go, etc.)
- Wheat midge resistance introduced (Unity, Goodeve, etc.)
- FHB resistance breeding reduced rate of progress.

*Source: AAFC*

• What influenced the rate of gain?
• What was the yield gain per dollar invested?
  – 2011/12: Total Canola Investment = approx. $80 Million.

Canola:

• Excellent weed control with herbicide resistance.
• Hybrids introduced and eventually predominate.
• Lower yielding *B. rapa* (Polish canola) phased out.
• Increased investment by private industry.
Canola Grown and Managed in Preference to Wheat

Given that:
• The input costs of canola (not just seed) are higher than wheat.
• There is good potential for excellent net returns from canola.

The result has been:
• Better (best?) management practices are applied to canola.
• Canola is usually seeded on the best land available.
• As canola acreage increases the “next best” available land is likely to be diverted away from wheat (and other crops).
• Wheat has become a “secondary” crop that does not necessarily receive the same care as canola.

This trend also reduced the observed rate of yield gain in wheat.
For this time period, for every hectare taken out of spring wheat production, total spring wheat production was reduced by 1.03 tonnes.

(Average spring wheat yield over period = 2.22 t/ha)
For this time period, for every added hectare of harvested canola, total canola production increased by 2.08 tonnes. (Average canola yield over period = 1.50 t/ha)
Have Things Changed Since 2000/01?

1981/82 to 1999/00:
- Average spring wheat yield = 2.10 t/ha (31.3 bu/ac).
- Rate of yield increase = 1.25% per year.
- Average canola yield = 1.30 t/ha (23.2 bu/ac).
- Rate of yield increase = 0.92% per year.

2000/01 to 2012/13:
- Average spring wheat yield = 2.47 t/ha (36.7 bu/ac).
- Rate of yield increase = 2.94% per year (1.08 bu/ac per year).
- Average canola yield = 1.37 t/ha (29.9 bu/ac).
- Rate of yield increase = 2.62% per year (0.78 bu/ac per year).

Plant breeding investment required to sustain current overall rates of yield increase (based on 2011/12 investments)
- **Wheat:** $25 Million per year.
- **Canola:** $80 Million per year.
For this time period (2000/01 – 2012/13):

Spring wheat yields increased at a rate of 68.1 kg/ha (1.01 bu/ac) per year.

Canola yields increased at a rate of 41.5 kg/ha (0.74 bu/ac) per year.
Based on this method of calculation, canola yields decreased 0.19% per year relative to spring wheat.
For this time period (2003/04 – 2011/12):

- Spring wheat yields increased at a rate of 58.6 kg/ha (0.86 bu/ac) per year.
- Canola yields increased at a rate of 52.9 kg/ha (0.94 bu/ac) per year.
Selective Data Mining: Canola relative to S. Wheat (2003/04 – 2011/12)

Prairie canola yield as a percent of wheat yield, 2003/04 - 2011/12

By doing some “cherry-picking” of the data, this trend line indicates that canola yields increased 0.54% faster than spring wheat.

\[ y = 0.5364x + 64.562 \]
While yield net returns ultimately pay the bills...

• What is disease resistance worth vs. the cost of fungicides?
• KVD reduced progress in wheat – effects of removal just starting.
• Wheat yield gains were made with current registration system.
  • More difficult to determine differences with less testing.
  • Can’t tell the difference? Mediocrity increases.
  • Is there a “problem” that needs fixing?
• Yield may increase faster with fewer registration “impediments”.
  • Every trait added reduces effective population size.
  • What are some of these impediments?
A Double-Edged Sword

Fewer registration “impediments” may mean faster progress:
- Every trait added reduces effective population size.
- What are some of these impediments?

**Disease resistance:**
- Stem rust?
- Leaf rust?
- Stripe rust?
- FHB?
- Bunt?
- Loose smut?
- Leaf spots?

**Agronomics:**
- Early maturity?
- Sprouting tolerance?

**Pest resistance:**
- Wheat stem sawfly?
- Wheat midge?
- Wheat curl mite?

**Quality:**
- Sprouting resistance?
- Protein content?
- Milling yield?
- Consistency?

- Every trait added will slow down progress in other traits.
- What are the benefits/costs for these and other traits?
- Is the added cost of fungicides, potential grade loss, etc. offset by higher yields?
A Few Basic Conclusions

• Spring wheat yields have not stagnated in western Canada.
• On-farm spring wheat and canola yields have increased substantially, particularly since 2000/01.
• Observed rates of on-farm yield increase were faster from 2000/01 – 2012/13 than 1981/82 – 1999/00 for both crops.
• 1981/82 – 1999/00: S. wheat yields increased faster than canola.
• Since 2000/01: Rate of canola yield increase is faster than wheat.
• Environment plays a large role in observing yield potential.
• Greater breeding investment resulted in higher rates of progress.
• The registration system for wheat has not been a major “bottleneck” to the introduction of superior genetics.
Thank You

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Supplementary Information
1981/82 - 2012/13
complete set of graphs
Spring Wheat Yields by Province (1981/82 - 2012/13)

Spring wheat yield, 1981/82 - 2012/13

y = 39.47x + 1862.5
y = 26.874x + 1952
y = 22.266x + 1641.1

Linear (AB)
Linear (MB)
Linear (SK)

Graf 2013
Canola Yields by Province (1981/82 - 2012/13)

Canola yield, 1981/82 - 2012/13

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Graf 2013
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For this time period, for every hectare taken out of spring wheat production, total wheat production was reduced by 1.03 tonnes. (Average spring wheat yield over period = 2.22 t/ha)
For this time period, for every added hectare of harvested canola, total canola production increased by 2.08 tonnes. (Average canola yield over period = 1.50 t/ha)
PP Spring Wheat & Canola: Production & Harvested Area
(1981/82 - 2012/13)

Prairie Provinces: Total Production and Harvested Area - Spring Wheat & Canola

- Wheat Production
- Canola Production
- Wheat Area
- Canola Area
- Linear (Wheat Production)
- Linear (Canola Production)
- Linear (Wheat Area)
- Linear (Canola Area)
Alberta: Total Production and Harvested Area - Spring Wheat

\[ y = 55.796x + 5065.3 \]

\[ y = -16.232x + 2660.3 \]
AB Canola: Production & Harvested Area (1981/82 - 2012/13)

Alberta: Total Production and Harvested Area - Canola

Production (tonnes x 1000)
Harvested Area (Ha x 1000)

\[ y = 109.97x + 546.18 \]
\[ y = 40.957x + 812.24 \]
SK Spring Wheat: Production & Harvested Area (1981/82 - 2012/13)

Saskatchewan: Total Production and Harvested Area - Spring Wheat

Production (tonnes x 1000)
Harvested Area (Ha x 1000)

Production
Area
Linear (Production)
Linear (Area)

\[ y = -203.23x + 13029 \]
\[ y = -131.85x + 6926.5 \]

Graph 2013

SK Spring Wheat: Production & Harvested Area (1981/82 - 2012/13)
SK Canola: Production & Harvested Area (1981/82 - 2012/13)

Saskatchewan: Total Production and Harvested Area - Canola

Production (tonnes x 1000)
Harvested Area (Ha x 1000)

y = 160.36x + 210.49
y = 88.352x + 582.3
y = 88.352x + 582.3

Graf 2013
Manitoba: Total Production and Harvested Area - Spring Wheat

Production (tonnes x 1000)

Harvested Area (Ha x 1000)

\[ y = -38.241x + 4102.6 \]

\[ y = -31.295x + 1996.2 \]
1981/82 – 1999/00
complete set of graphs
Spring Wheat Yields by Province (1981/82 – 1999/00)

Spring wheat yield, 1981/82 - 1999/00

y = 42.681x + 1859.5
y = 15.386x + 2049.0
y = 23.161x + 1661.6

Graf 2013

Spring Wheat Yields by Province (1981/82 – 1999/00)

<table>
<thead>
<tr>
<th>Kg/ha</th>
<th>Bu/ac (wheat)</th>
<th>Bu/ac (canola)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>1000</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>1500</td>
<td>22</td>
<td>27</td>
</tr>
<tr>
<td>2000</td>
<td>30</td>
<td>36</td>
</tr>
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<td>2500</td>
<td>37</td>
<td>45</td>
</tr>
<tr>
<td>3000</td>
<td>45</td>
<td>54</td>
</tr>
<tr>
<td>3500</td>
<td>52</td>
<td>62</td>
</tr>
<tr>
<td>4000</td>
<td>59</td>
<td>71</td>
</tr>
</tbody>
</table>
Canola Yields by Province (1981/82 – 1999/00)

Canola yield, 1981/82 - 1999/00

\[ y = 13.914x + 1173.4 \]
\[ y = 26.396x + 1099.9 \]
\[ y = 3.4386x + 1203.2 \]

### Observed Values

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Graf 2013
For this time period (1981/82 – 1999/00):

- Spring wheat yields increased at a rate of 25.8 kg/ha (0.38 bu/ac) per year.
- Canola yields increased at a rate of 12.1 kg/ha (0.22 bu/ac) per year.
Based on this method of calculation, canola yields decreased 0.22% per year relative to spring wheat.
For this time period, for every hectare taken out of spring wheat production, total spring wheat production was reduced by 0.46 tonnes.

(Average spring wheat yield over period = 2.10 t/ha)
For this time period, for every added hectare of harvested canola, total canola production increased by 1.54 tonnes (Average canola yield over period = 1.30 t/ha)
PP Spring Wheat & Canola: Production & Harvested Area (1981/82 - 1999/00)

Prairie Provinces: Total Production and Harvested Area - Spring Wheat & Canola

Graf 2013
Alberta: Total Production and Harvested Area - Spring Wheat

Production ($\text{tonnes} \times 1000$)

Harvested Area ($\text{Ha} \times 1000$)

Linear (Production): $y = 83.709x + 4940.3$
Linear (Area): $y = -10.533x + 2638.4$

Graf 2013

Production
Area
Linear (Production)
Linear (Area)
Alberta: Total Production and Harvested Area - Canola

Production: $y = 89.823x + 818.85$

Area: $y = 52.703x + 761$

Production (tonnes x 1000)
Area (Ha x 1000)

Graph 2013

AB Canola: Production & Harvested Area (1981/82 – 1999/00)
SK Spring Wheat: Production & Harvested Area (1981/82 – 1999/00)

Saskatchewan: Total Production and Harvested Area - Spring Wheat

Production (tonnes x 1000) vs Harvested Area (Ha x 1000)

$y = -144.54x + 12699$

$y = -125.99x + 6906.4$

Graf 2013

SK Spring Wheat: Production & Harvested Area (1981/82 – 1999/00)
MB Spring Wheat: Production & Harvested Area (1981/82 – 1999/00)

Manitoba: Total Production and Harvested Area - Spring Wheat

Production (tonnes x 1000)
Harvested Area (Ha x 1000)

Production
Area
Linear (Production)
Linear (Area)

y = -8.8118x + 3843.2
y = -15.058x + 1856.4

Graf 2013
MB Canola: Production & Harvested Area (1981/82 – 1999/00)

Manitoba: Total Production and Harvested Area - Canola

\[ y = 76.241x + 99.412 \]
\[ y = 41.77x + 191.16 \]
2000/01 - 2012/13
complete set of graphs
Spring Wheat Yields by Province (2000/01 – 2012/13)

Spring wheat yield, 2000/01 - 2012/13

y = 78.022x + 2300.0
y = 15.386x + 2049.0
y = 68.681x + 1696.2

Graf 2013

Spring Wheat Yields by Province (2000/01 – 2012/13)

Spring wheat yield, 2000/01 - 2012/13

y = 78.022x + 2300.0
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Graf 2013

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Graf 2013

Spring Wheat Yields by Province (2000/01 – 2012/13)

Spring wheat yield, 2000/01 - 2012/13

y = 78.022x + 2300.0
y = 15.386x + 2049.0
y = 68.681x + 1696.2

Graf 2013
Canola Yields by Province (2000/01 – 2012/13)

Canola yield, 2000/01 - 2012/13

\[ y = 58.791x + 1411.5 \]
\[ y = 23.626x + 1573.1 \]
\[ y = 57.143x + 1115.4 \]

Table:

<table>
<thead>
<tr>
<th>Kg/Ha</th>
<th>wheat Bu/ac</th>
<th>canola Kg/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>1000</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>1500</td>
<td>22</td>
<td>27</td>
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<tr>
<td>2000</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>2500</td>
<td>37</td>
<td>45</td>
</tr>
<tr>
<td>3000</td>
<td>45</td>
<td>54</td>
</tr>
<tr>
<td>3500</td>
<td>52</td>
<td>62</td>
</tr>
<tr>
<td>4000</td>
<td>59</td>
<td>71</td>
</tr>
</tbody>
</table>

Graph:
- AB
- MB
- SK
- Linear (AB)
- Linear (MB)
- Linear (SK)

Graf 2013
For this time period (2000/01 – 2012/13):

- Spring wheat yields increased at a rate of 68.1 kg/ha (1.01 bu/ac) per year.
- Canola yields increased at a rate of 41.5 kg/ha (0.74 bu/ac) per year.
Prairie canola yield as a percent of wheat yield, 2000/01 - 2012/13

Based on this method of calculation, canola yields decreased 0.19% per year relative to spring wheat.
This graph removes the influence of 2012/13

By removing the influence of the relatively poor canola yields in 2012/13, the trend line indicates that canola yields increased 0.24% faster than spring wheat.

\[ y = 0.2424x + 65.89 \]
Prairie canola yield as a percent of wheat yield, 2003/04 - 2011/12

This graph removes the influence of 2000/01, 2001/02, 2002/03 and 2012/13

By doing some “cherry-picking” of the data, this trend line indicates that canola yields increased 0.54% faster than spring wheat.

\[ y = 0.5364x + 64.562 \]
Prairie Provinces: Total Production and Harvested Area - Spring Wheat

For this time period, despite an average reduction of 105,930 ha/yr in harvested spring wheat area, total spring wheat production rose by 196,430 tonnes/yr. (Average spring wheat yield over period = 2.47 t/ha)
For this time period, for every added hectare of harvested canola, total canola production increased by 2.25 tonnes.
(Average canola yield over period = 1.67 t/ha)
Alberta: Total Production and Harvested Area - Spring Wheat

y = 225.95x + 4709

y = 24.388x + 2016.4

Production (tonnes x 1000)

Harvested Area (Ha x 1000)

AB Canola: Production & Harvested Area (2000/01 – 2012/13)

Alberta: Total Production and Harvested Area - Canola

Production (tonnes x 1000)
Harvested Area (Ha x 1000)

Production
Area
Linear (Production)
Linear (Area)

y = 292.02x + 1257.1
y = 114.8x + 976.68
y = 292.02x + 1257.1

Graf 2013

AB Canola: Production & Harvested Area (2000/01 – 2012/13)
SK Spring Wheat: Production & Harvested Area (2000/01 – 2012/13)

Saskatchewan: Total Production and Harvested Area - Spring Wheat

Production (tonnes x 1000)

Harvested Area (Ha x 1000)

y = 42.68x + 7069.9

y = -85.925x + 4043.7

Graf 2013
Manitoba: Total Production and Harvested Area - Spring Wheat

- Production: $y = -72.201x + 3562.9$
- Area: $y = -44.394x + 1460.2$

MB Spring Wheat: Production & Harvested Area (2000/01 – 2012/13)

Graph 2013
MB Canola: Production & Harvested Area (2000/01 – 2012/13)

Manitoba: Total Production and Harvested Area - Canola

Production (tonnes x 1000)
Harvested Area (Ha x 1000)

Linear (Production)
Linear (Area)

y = 83.823x + 1268.9
y = 43.191x + 776.92

Graf 2013