IHARF Funding Sources

- Grain revenues from approximately 1200 ac of cropland comprise up to 50% of gross operating funds
- Additional revenues come from approximately 40-50 research / demo projects (annually) funded through government (provincial & federal), producer groups & private industry

### Source | % of Outside Funding (Cash & In-Kind) | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | AVG
---|---|---|---|---|---|---|---|---
Industry | | 49% | 30% | 36% | 33% | 17% | 28% | 32%
Producer | | 36% | 48% | 45% | 24% | 28% | 47% | 38%
Government | | 15% | 22% | 19% | 43% | 55% | 25% | 30%
Row Spacing Effects on Various Crops
Recent Field Trials

- Since acquiring the required equipment in 2009, IHARF & AAFC have conducted row spacing research with several crops:
  - Oat: 2009-2011 (SODC)
  - Canola: 2012-16 (SCDC)
  - Flax: 2014-2016 (ADOPT/SFDC)
  - Spring Wheat: 2013-2016 (AAFC)

- Row spacing ranges from 10-24” (25-61 cm) & was generally combined with other factors such as side-banded N rate, seeding rate, weed control & fungicide applications.
Equipment

Image Source: www.seedmaster.ca
Equipment

10 inch spacing

14” cm Spacing

12” cm spacing

16” cm Spacing
Row Spacing Effect on Banded Fertilizer Concentrations

- per 1 meter length of crop row
Oat Response to Row Spacing

Duration: 2009-11 (3 yr)

Treatments (20):
- 10, 12, 14 & 16” row spacing
- 18, 36, 53, 71 & 107 lb N/ac

Data Collected:
- Plant density
- Tiller frequency
- Panicle density
- Above-ground biomass
- Grain yield
- Grain quality

Oats: Effects on Plant Density

Tests of Fixed Effects:
- Row spacing (R): 0.001
  - R linear: <0.001
  - R quad: ns
- N Rate (N): ns
  - N linear: ns
  - N quad: ns
- R × N: ns
- Year (Y): 0.003
  - Y × R: ns
  - Y × N: ns
  - Y × R × N: ns

---

**Row Spacing × Plant Density**

- Emergence (plants/m²)
- Row Spacing (inches)
- Graph with data points labeled 'a' and 'b'

**N Rate × Plant Density**

- Emergence (plants/m²)
- Nitrogen Rate (lb N/ac)
- Graph with data points labeled 'a' and 'a'

---

Saskatchewan Oat Development Commission

IHARF Indian Head Agricultural Research Foundation

IHARF Winter Meeting & AGM 03/02/2016

9
Oats: Effects on Grain Yield

Tests of Fixed Effects:
- Row spacing (R): <0.001
- R linear: <0.001
- R quad: ns
- N Rate (N): <0.001
- N linear: <0.001
- N quad: <0.001
- R × N: 0.006
- Year (Y): <0.001
- Y × R: 0.012
- Y × N: <0.001
- Y × R × N: ns
Oats: Effects on Grain Yield

Row Spacing × Year × Grain Yield

Yield (bu/ac) vs. Row Spacing (inches)

- Diamonds represent 2009 data.
- Squares represent 2010 data.
- Triangles represent 2011 data.

LSD = 12.6
## Oats: Effects on Grain Quality

<table>
<thead>
<tr>
<th>Effect</th>
<th>Protein</th>
<th>Groat Yield</th>
<th>1000 seed wt</th>
<th>Test Weight</th>
<th>% Plump</th>
<th>% Thin</th>
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<td>Spacing (R)</td>
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<td>ns</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td>R quad</td>
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<td>N rate (N)</td>
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<td>N linear</td>
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<td>Y × R × N</td>
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<td>ns</td>
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</table>
Wheat Response to Row Spacing

Duration: 2013-16 (4 yr)

Treatments (20):
• 10, 12, 14 & 16 row spacing
• 18, 36, 71, 107 & 142 lb N/ac

Data Collected:
• Plant density
• Head density
• Straw N
• Grain Yield
• 1000 seed weight
• Test weight
• Protein

Source: Bill May, AAFC
Wheat: Effects on Grain Yield

INDIAN HEAD - 2013
Row spacing (R): $P = 0.010$
N Rate (N): $P < 0.001$
$R \times N: P = 0.939$

INDIAN HEAD - 2014
Row spacing (R): $P = 0.033$
N Rate (N): $P < 0.001$
$R \times N: P = 0.437$
SeedMaster Research Farm

HRSW 10” vs. 15” Row Spacing Trial

<table>
<thead>
<tr>
<th>Year</th>
<th>Spacing</th>
<th>Grade Offer</th>
<th>Test Weight (lb/bu)</th>
<th>Protein (%)</th>
<th>Moisture (%)</th>
<th>Yield (bu/acre)</th>
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<td>2013</td>
<td>10”</td>
<td>#2 Red</td>
<td>62.50</td>
<td>13.70</td>
<td>15.60</td>
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<tr>
<td>2014</td>
<td>10”</td>
<td>#2 Red</td>
<td>61.70</td>
<td>13.60</td>
<td>13.10</td>
<td>55.70</td>
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<td>2015</td>
<td>10”</td>
<td>#2 Red</td>
<td>62.90</td>
<td>14.70</td>
<td>13.90</td>
<td>58.93</td>
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3 Year Average 62.37 14.00 14.20 57.85

<table>
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<th>Year</th>
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<th>Grade Offer</th>
<th>Test Weight (lb/bu)</th>
<th>Protein (%)</th>
<th>Moisture (%)</th>
<th>Yield (bu/acre)</th>
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<td>15”</td>
<td>#2 Red</td>
<td>62.60</td>
<td>14.20</td>
<td>15.50</td>
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<td>15”</td>
<td>#2 Red</td>
<td>61.80</td>
<td>13.60</td>
<td>13.10</td>
<td>54.10</td>
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<tr>
<td>2015</td>
<td>15”</td>
<td>#2 Red</td>
<td>62.80</td>
<td>15.00</td>
<td>13.90</td>
<td>58.78</td>
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</table>

3 Year Average 62.40 14.27 14.17 57.17

Source: Owen Kinch

03/02/2016

2015 Soil & Crop Management Seminar

www.seedmaster.ca
Flax Response to Row Spacing

Duration: 2014-16 (3 yr)

Treatments (10):
- 10, 12, 14, 16 & 24” row spacing
- With and without foliar fungicide

Data Collected:
- Plant density
- Maturity
- Lodging
- Seed yield
Lafond (1992) showed declining plant density, increased height and no effect on yield as row spacing increased from 4 to 12” (Can. J. Plant Sci. 93: 375-382)
Flax: Effects on Seed Yield (IH-2014 & 2015)

**IH-2014**
- Overall F-test: $P < 0.001$ (RS)
- Linear: $P < 0.001$
- Quadratic: $P = 0.876$

**IH-2015**
- Overall F-test: $P < 0.001$ (RS)
- Linear: $P < 0.001$
- Quadratic: $P = 0.558$
Row Spacing × Fungicide Effects on Flax Yield

![Graph showing yield vs. row spacing with different conditions in 2014 and 2015, with significant p-values for 2014 and 2015.]
Flax at Varying Row Spacing (IH-2015)
Soybean Response to Row Spacing

Duration: 2014-17 (4 yr)

Treatments (15):
• 10, 12, 14, 16 & 24” row spacing
• 40, 50 & 60 seeds/m² (162-243k seeds/ac)

Data Collected:
• Plant density
• Maturity
• Pod clearance
• Seed yield
• 1000 seed weight
Soybeans: Effects on Seed Yield (IH-2014)

Row Spacing × Seed Yield

- Spacing: $P < 0.001$
- Linear: $P < 0.001$
- Quad: $P < 0.001$

Seed Rate × Seed Yield

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.148$
Soybeans: Effects on Seed Yield (IH-2015)

Row Spacing × Seed Yield

- Spacing: $P = 0.001$
- Linear: $P < 0.001$
- Quad: $P = 0.007$

Seed Rate × Seed Yield

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.047$
Soybeans: Effects on Seed Yield (IH-2015)

Row Spacing × Seeding Rate × Yield

Yield (bu/ac)

RS × SR: $P = 0.047$

Seed Rate (1000 seeds/ac)
Soybeans: Effects on Maturity (IH-2015)

Row Spacing × Maturity

- Spacing: $P = 0.147$
- Linear: $P = 0.053$
- Quad: $P = 0.662$

Seed Rate × Maturity

- Seed Rate: $P < 0.001$
- RS × SR: $P = 0.358$
Canola Response to Row Spacing

Duration: 2013-16 (4 yr)

Treatments (20, 20 & 10):
• 10, 12, 14, 16 & 24” row spacing (all trials)
• 0, 45, 90, 134 lb N/ac
• 30, 60, 90 & 120 seeds/m² (1.1-5.3 lb/ac)
• No in-crop herbicide & herbicide applied

Data Collected:
• Plant density
• Flower dates
• Crop & weed biomass
• Maturity
• Seed yield
• 1000 seed weight
• Green Count
Canola: RS Effects on Yield 2013-15 (RS × NR)

Row Spacing × Seed Yield

<table>
<thead>
<tr>
<th>Effect</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>0.024</td>
<td>0.195</td>
<td>0.009</td>
</tr>
<tr>
<td>NR</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS × NR</td>
<td>&lt;0.001</td>
<td>0.391</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RS lin</td>
<td>0.061</td>
<td>0.195</td>
<td>0.001</td>
</tr>
<tr>
<td>RS quad</td>
<td>&lt;0.001</td>
<td>0.063</td>
<td>0.169</td>
</tr>
</tbody>
</table>

---

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Row Spacing x N Rate Interactions (Indian Head 2013)

RS × NR: P < 0.001

Seed Yield (bu/ac) vs. Nitrogen Rate (lb N/ac)

- 10"
- 12"
- 14"
- 16"
- 24"

Poly. (10'')
Poly. (12'')
Poly. (14'')
Poly. (24'')
Row Spacing x N Rate Interactions (Indian Head 2015)

RS × NR: $P < 0.001$

Seed Yield (bu/ac) vs Nitrogen Rate (lb N/ac)

- 10"
- 12"
- 14"
- 16"
- 24"

Poly. (10'')
Poly. (12'')
Poly. (14'')
Poly. (24'')

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Canola: SR Effects on Yield 2013-15 (RS × SR)

Seed Rate × Yield

* NO INTERACTIONS B/W ROW SPACING & SEEDING RATE FOR CANOLA YIELD

Effect | 2013 | 2014 | 2015
--- | --- | --- | ---
RS | 0.002 | 0.216 | <0.001
SR | <0.001 | <0.001 | <0.001
RS × SR | 0.748 | 0.807 | 0.072
SR lin | <0.001 | 0.054 | <0.001
SR quad | <0.001 | 0.884 | 0.031

--- p-value ---
Canola: RS Effects on Weed Biomass 2013-15 (RS × HERB)

Effect | 2013 | 2014 | 2015 | p-value
--- | --- | --- | --- | ---
RS | 0.440 | 0.546 | 0.011 | 
HERB | <0.001 | <0.001 | <0.001 | 
RS × HERB | 0.657 | 0.594 | 0.012 | 
SR lin | 0.131 | 0.760 | 0.001 | 
SR quad | 0.316 | 0.482 | 0.176 | 

Row Spacing × Weed Biomass

Weed Biomass (kg/ha)

Row Spacing (inches)
Row Spacing x Herbicide Interactions (Indian Head 2015)

RS × HERB: $P = 0.010$

- Weed Biomass (kg/ha)
- Seed Rate (seeds/m²)

Control and Sprayed data points with error bars.
Take-home Messages

• Crops types evaluated vary in their ability to compensate for wide row spacing (work required on pea, lentil, faba bean & other cereals)

**MOST SENSITIVE:** FLAX > WHEAT ≥ OATS > SOYBEANS > CANOLA : **LEAST SENSITIVE**

• Seedling mortality increases with row spacing but still can achieve adequate plant populations & no negative row spacing effects on grain quality observed

• Maturity delays by row spacing less than that from ↑ fertility or ↓ plant density

• Sound agronomic management (i.e. timely & thorough weed removal) may be more critical with wider row spacing

• Overall, more yield variability with wider spacing but offsets to this include:
  • Reduced equipment cost, fuel consumption & horsepower requirements (per acre)
  • Reduce or eliminate tillage operations (including heavy harrowing) or other undesirable practices such as burning and seed under more challenging conditions
  • More timely seeding to due reduced land preparation requirements and/or larger drills
  • Improved soil & water conservation due to reduced disturbance & enhanced residues
  • Better suited for inter-row seeding resulting in improved seed-placement & further improvements in water conservation
Safe Rates of Seed-Placed vs Side-Banded Phosphorus Fertilizer in Canola
2015 Canola P Demo (ADOPT)

Treatments (5 rates x 2 placements):
• 18, 36, 53, 71 & 89 lb \( \text{P}_2\text{O}_5 \) ha\(^{-1}\) either side-banded or seed-placed plus a 0P control (P source = 11-52-0)

Data Collected:
• Emergence @ 2, 3 & 4 weeks past seeding
• Biomass @ 4 weeks past seeding
• Maturity
• Above-ground biomass
• Seed yield
• Thousand seed weight
• Percent green seed
P Effects on Canola Emergence
(4 wk after planting)

Emergence (plants/m²)

Fertilizer Rate (lb P₂O₅/ac)

-10 0 10 20 30 40 50 60 70 80 90 100

Side-band  Seed-placed

Effect / Contrast | Side-Band | Seed-Placed
-- | --- | ---
Pr. > F | 0.596 |
Lin | 0.804 | 0.422 |
Quad | 0.156 | 0.387 |
0 P vs P | 0.713 |
SB vs SR | 0.549 |

Agri-ARM Research Update 14/01/2016

IHARF
INDIAN HEAD AGRICULTURAL RESEARCH FOUNDATION

Canada
P Effects on Canola Biomass (4 wk after planting)

![Graph showing P effects on canola biomass](image)

<table>
<thead>
<tr>
<th>Effect / Contrast</th>
<th>Side-band</th>
<th>Seed-placed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr. &gt; F</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Lin</td>
<td>0.228</td>
<td>0.000</td>
</tr>
<tr>
<td>Quad</td>
<td>0.081</td>
<td>0.021</td>
</tr>
<tr>
<td>0 P vs P</td>
<td></td>
<td>0.001</td>
</tr>
<tr>
<td>SB vs SR</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>
P Effects on Canola Yield

![Graph showing the effects of P fertilizer rate on canola seed yield. The graph compares side-band and seed-placed fertilizer treatments. The table on the right lists statistical contrasts and their significance levels: Pr. > F < 0.001, Lin < 0.001 < 0.001, Quad 0.010 0.017, 0 P vs P < 0.001, and SB vs SR 0.275.]
Take-home Messages

- ONLY A SINGLE SITE-YEAR OF DATA, RESULTS MAY NOT BE REPEATABLE UNDER A BROADER RANGE OF CIRCUMSTANCES
- 11-52-0 rate or placement had no effect on canola emergence
  - Clay loam soil, < 4% organic matter, 9 lb Olsen-P ac\(^{-1}\) (~6 ppm)
  - Seed-bed utilization ~6%, seeded into moisture then very dry
- Significant benefit to seed-placement for early season biomass (popup effect) but did not carry through to yield
  - May have economic value under some conditions (i.e. heavy flea beetles)
- Very strong overall yield response to P fertilization
  - 12% yield increase with rates of 36-89 lb P\(_2\)O\(_5\) \(\text{ac}^{-1}\), regardless of placement
- At ~55 bu \(\text{ac}^{-1}\), this crop exported 52-63 lb P\(_2\)O\(_5\) \(\text{ac}^{-1}\) upon harvest
  - P fertilization is for long-term productivity of fields and not just short term profitability of individual crops
Seed Rates & Fungicide to Manage FHB in Durum
2015 Durum FHB Demo (ADOPT)

Treatments (3 seed rates x 4 fungicide):
• 200, 300 & 400 seeds m\(^{-2}\) seed rate
• Control, GS57-59, Fungicide @ GS60-65 & Dual application

Data Collected:
• Plant density, head density, heads per plant
• Visible FHB ratings
• Grain yield
• Test weight
• Thousand seed weight
• Fusarium damaged kernels
Seed Rate Effects on Durum Emergence, Head Density & Tillers (IH-2015)

Plant / Head Density (#/m²)

Seed Rate (seeds m⁻²)

2.8 A (heads/plant)  2.1 B  1.7 C

plants / m²  heads / m²

0 100 200 300 400 500 600 700 720

150 200 250 300 350 400 450

03/02/2016

2015 Soil & Crop Management Seminar
Seed Rate / Fungicide Effects on FHB Incidence (IH-2015)

![Graph showing FHB Incidence (%)](image)

- **FHB Index (%)**
  - **p-value**
  - **Fung** < 0.001
  - **SR** 0.003
  - **F x SR** 0.601
  - **C.V. (%)** 18.1

- **Seed Rate (seeds m⁻²)**
  - **200 seeds**
  - **300 seeds**
  - **400 seeds**

- **Treatment Groups**
  - **A**
  - **B**
  - **C**

- **Control**
- **T1**
- **T2**
- **DUAL**
Seed Rate / Fungicide Effects on Grain Yield (IH-2015)

<table>
<thead>
<tr>
<th>Seed Rate (seeds m(^{-2}))</th>
<th>200 seeds</th>
<th>300 seeds</th>
<th>400 seeds</th>
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<tbody>
<tr>
<td>CONTROL</td>
<td>D</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>T1</td>
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**FHB Index (%)**

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<tr>
<th>Factor</th>
<th>p-value</th>
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<tr>
<td>SR</td>
<td>0.523</td>
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<td>F × SR</td>
<td>0.252</td>
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<tr>
<td>C.V. (%)</td>
<td>3.6</td>
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Fungicide Effects on Leaf Disease in Durum (Aug 10, 2015)

Unsprayed

Prosaro 250 EC at heading
Seed Rate / Fungicide Effects on Test Weight (IH-2015)

<table>
<thead>
<tr>
<th>FHB Index (%)</th>
<th>p-value</th>
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<tbody>
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<td>SR</td>
<td>0.932</td>
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<td>F × SR</td>
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<td>C.V. (%)</td>
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<th>CONTROL</th>
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<th>T2</th>
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<td>300 seeds</td>
<td>400 seeds</td>
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Seed Rate / Fungicide Effects on Fusarium Damaged Kernels (IH-2015)

![Graph showing seed rate and fungicide effects on fusarium damaged kernels]

- Fung: 0.066
- SR: 0.004
- F × SR: 0.349
- C.V. (%): 24.5

<table>
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<tr>
<th>FHB Index (%)</th>
<th>p-value</th>
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**Legend:**
- 200 seeds
- 300 seeds
- 400 seeds

**Graph Key:**
- CONTROL
- T1
- T2
- DUAL

**Note:**
This graph illustrates the effects of different seed rates and fungicide treatments on fusarium damaged kernels. The y-axis represents the percentage of fusarium damaged kernels, while the x-axis shows the seed rate in seeds m⁻².
Take-home Messages

• ONLY A SINGLE SITE-YEAR OF DATA, RESULTS MAY NOT BE REPEATABLE UNDER A BROADER RANGE OF CIRCUMSTANCES

• ↑ seed rates reduced tillering & promoted uniform heading

• Fungicide reduced visible FHB infection but timing critical
  • T2 much better than T1 which was < 3 days earlier
  • Tendency (not significant) for less visible FHB at high seed rates

• Strong yield response to fungicide (but not seed rate) where check < T1 < T2 < Dual (20% yield increase w/dual app)

• Fungicide increased test weight (check < T1 < T2 < Dual) but only slight (not significant) reduction in FDK (T2 & Dual only)

• High seeding rate (400 seeds m$^{-2}$) had a more consistent, positive impact on FDK than fungicide applications
THANK YOU

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IHARF Crop Management
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