Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

The role of agronomics in relation to meeting current and future agricultural and cropping systems challenges

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Canada

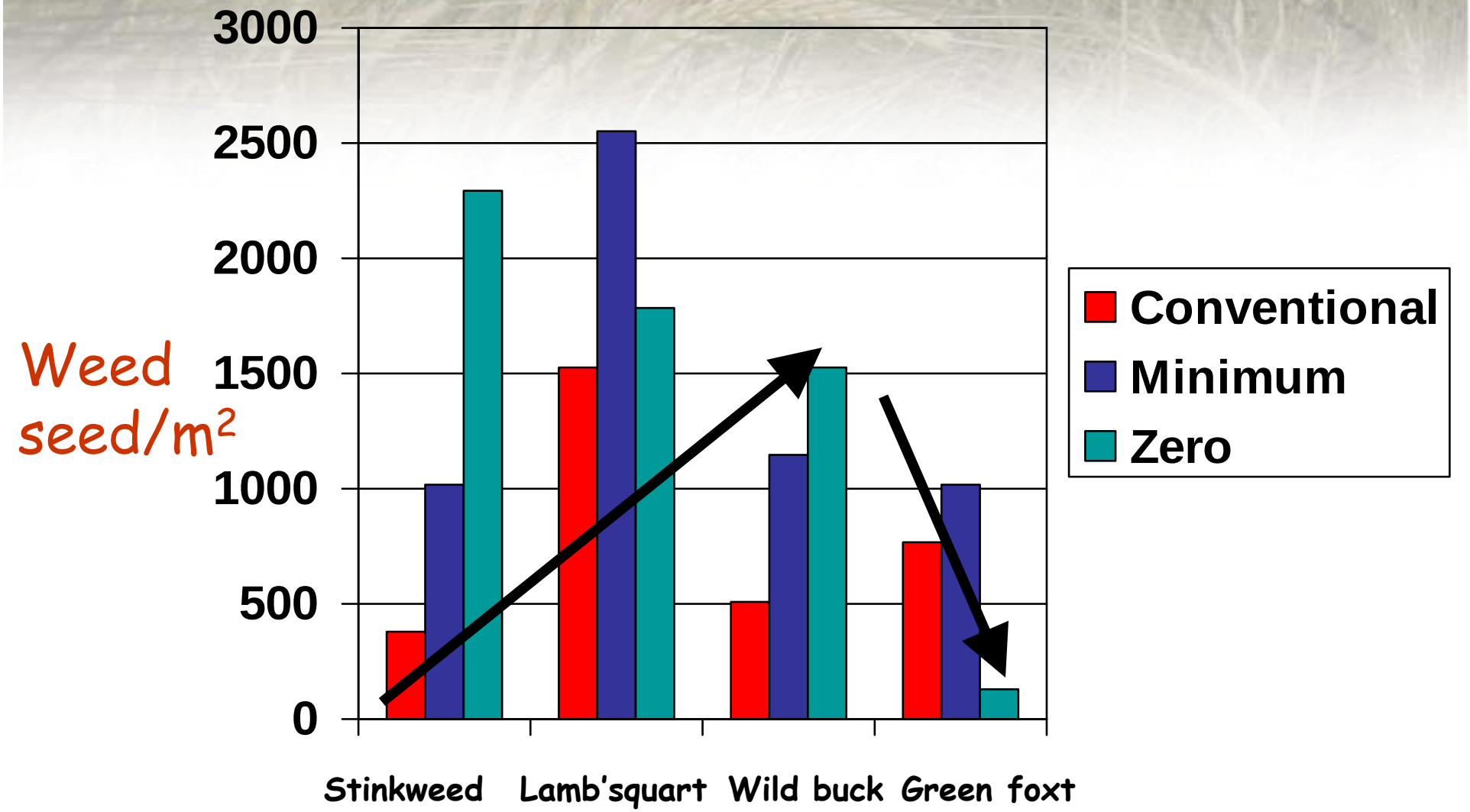
On-farm positive changes in crop production in western Canada

- Conservation tillage
- Crop rotation
- Seeding date
- Herbicide timing
- Crop seed rate
- Crop fertilization

Conservation tillage

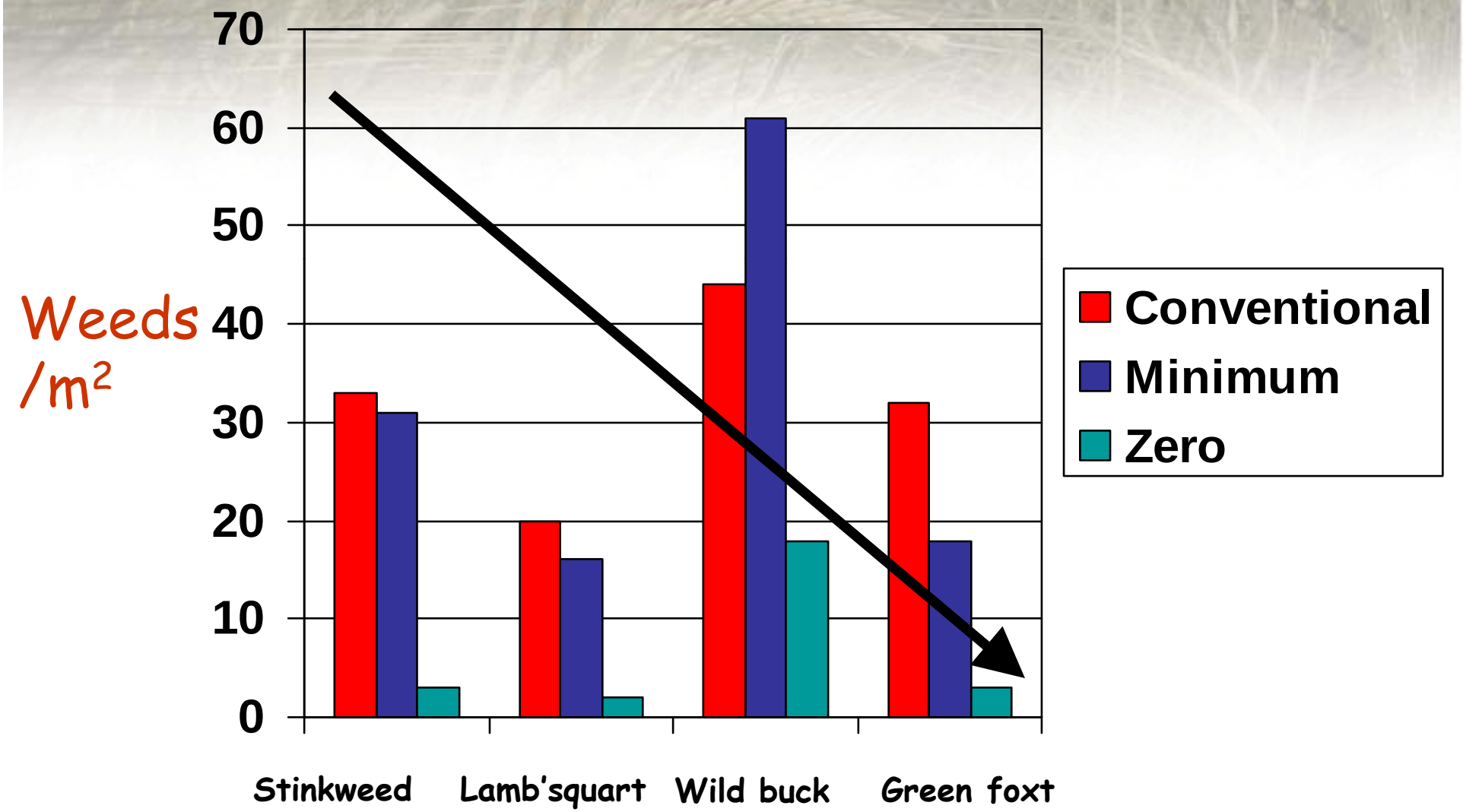
- Ground cover greatly reduces erosion
- Standing crop stubble facilitates greater 'snow trapping' and reduces evaporation
- More soil water for crop growth
- 70% of crops are direct-seeded
- 45% zero-till, 25% reduced till
- But what about the weeds?

Effect of tillage systems on weed seeds in the seed bank in fall

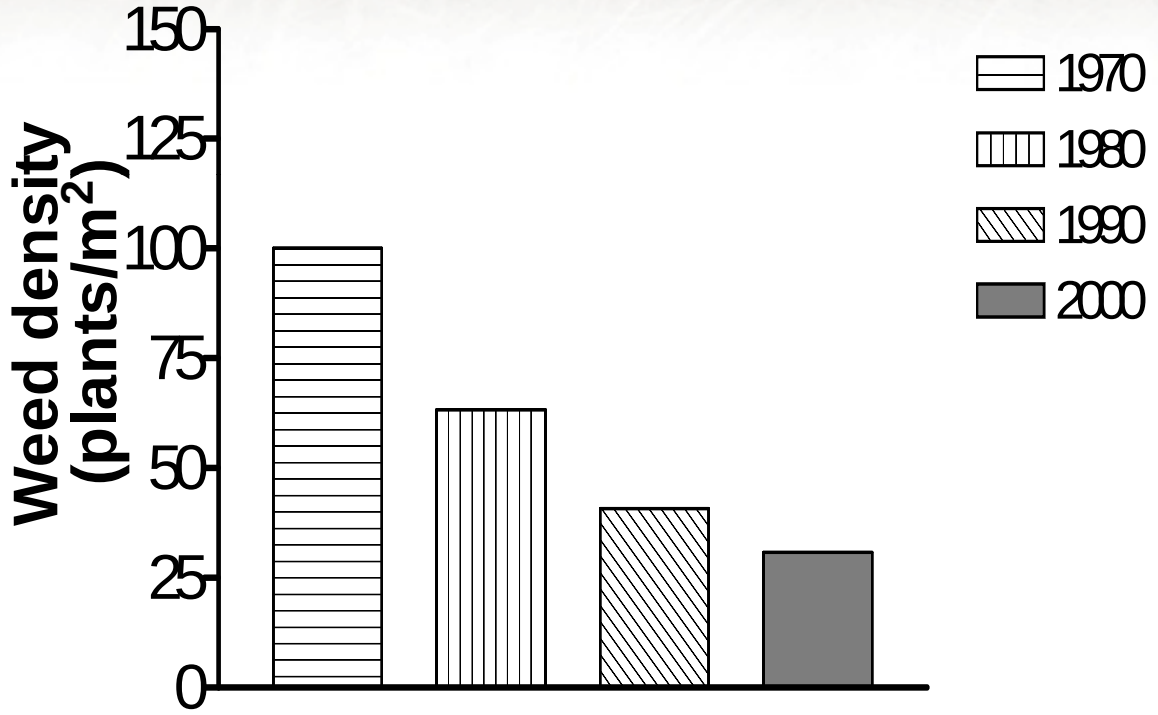


O'Donovan and McAndrew 1998

Effect of tillage systems on weed seedling emergence in spring

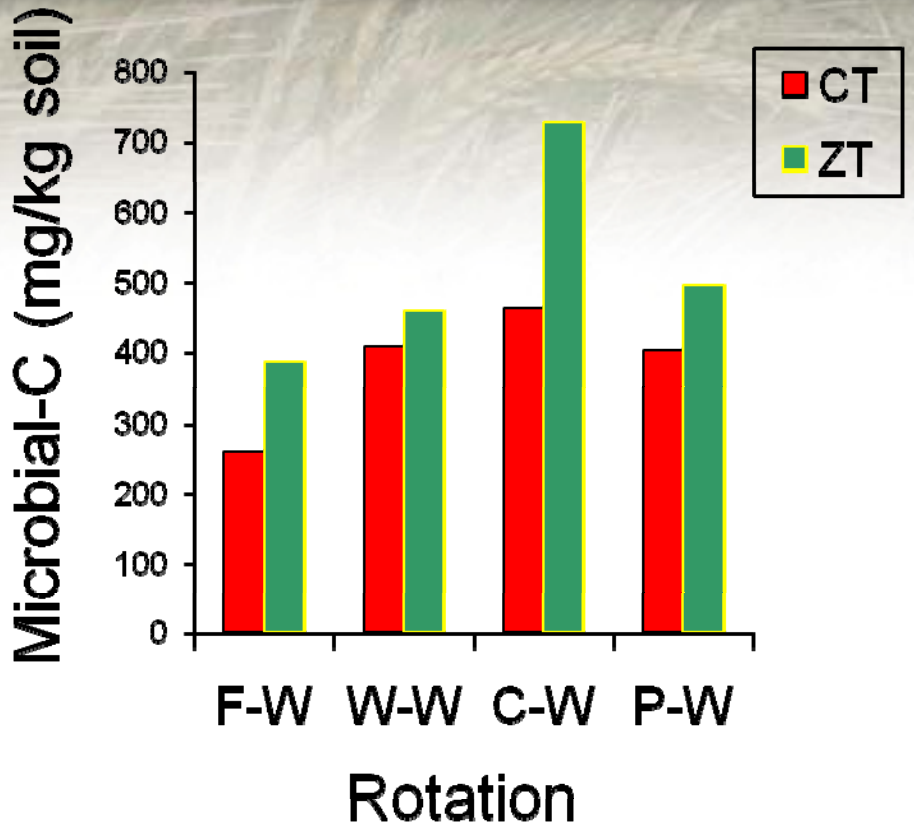


Weed surveys



Thomas et al. 2005

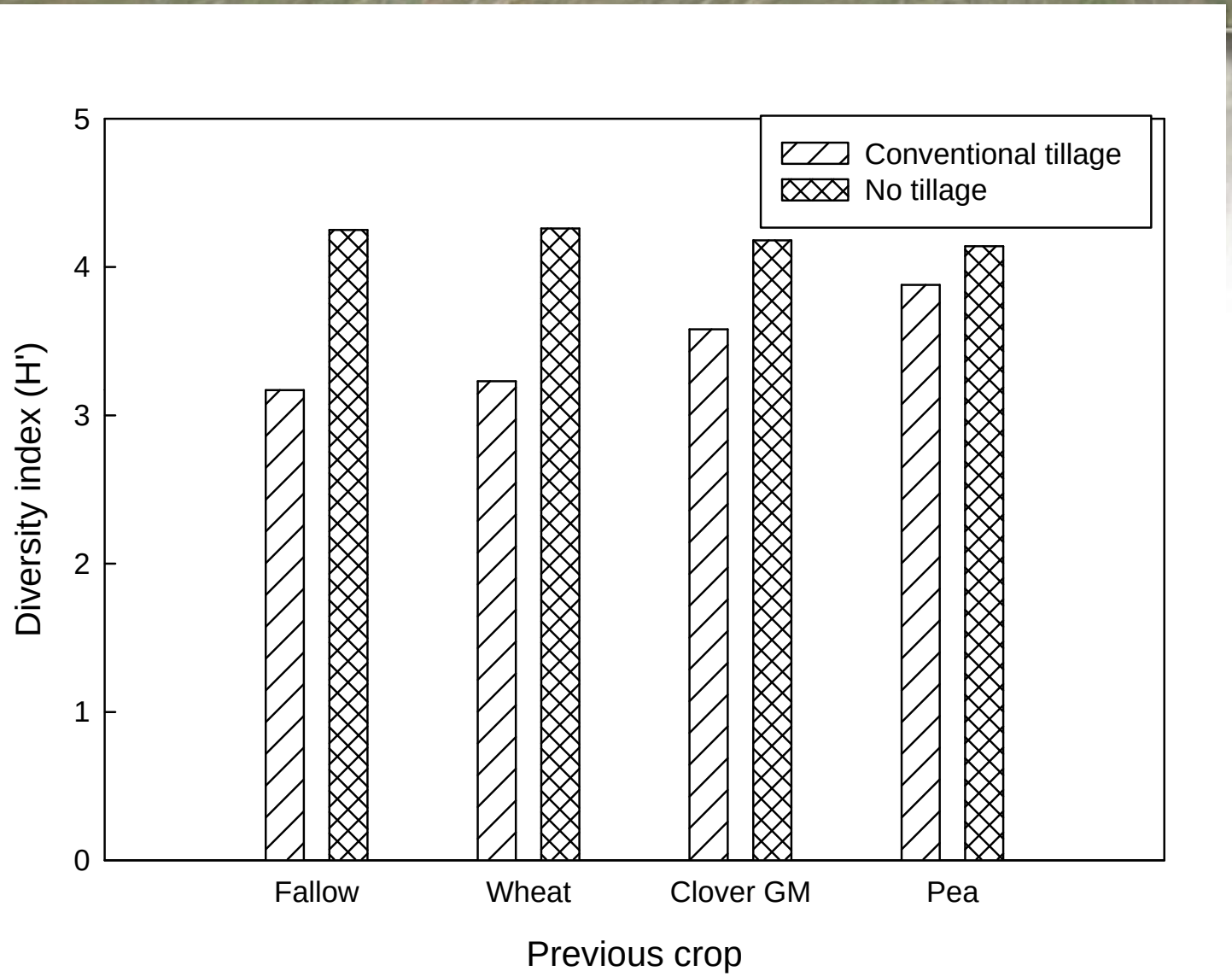
Microbial biomass



- Greater microbial biomass under ZT than under CT.
- Highest biomass in wheat following red clover and lowest biomass in wheat following summer fallow

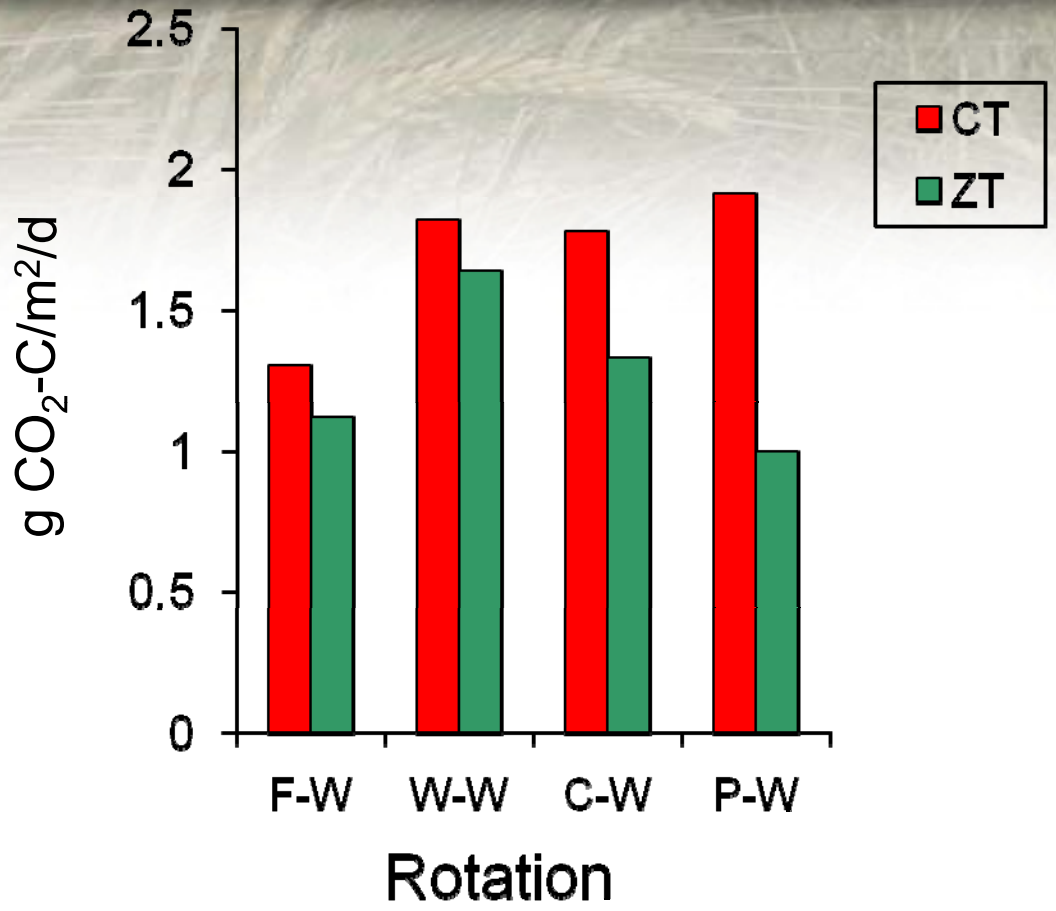
Lupwayi et al. 1998

No-till increases soil microbial diversity



Lupwayi et al. 1998

CO_2 evolution (Microbial Activity)

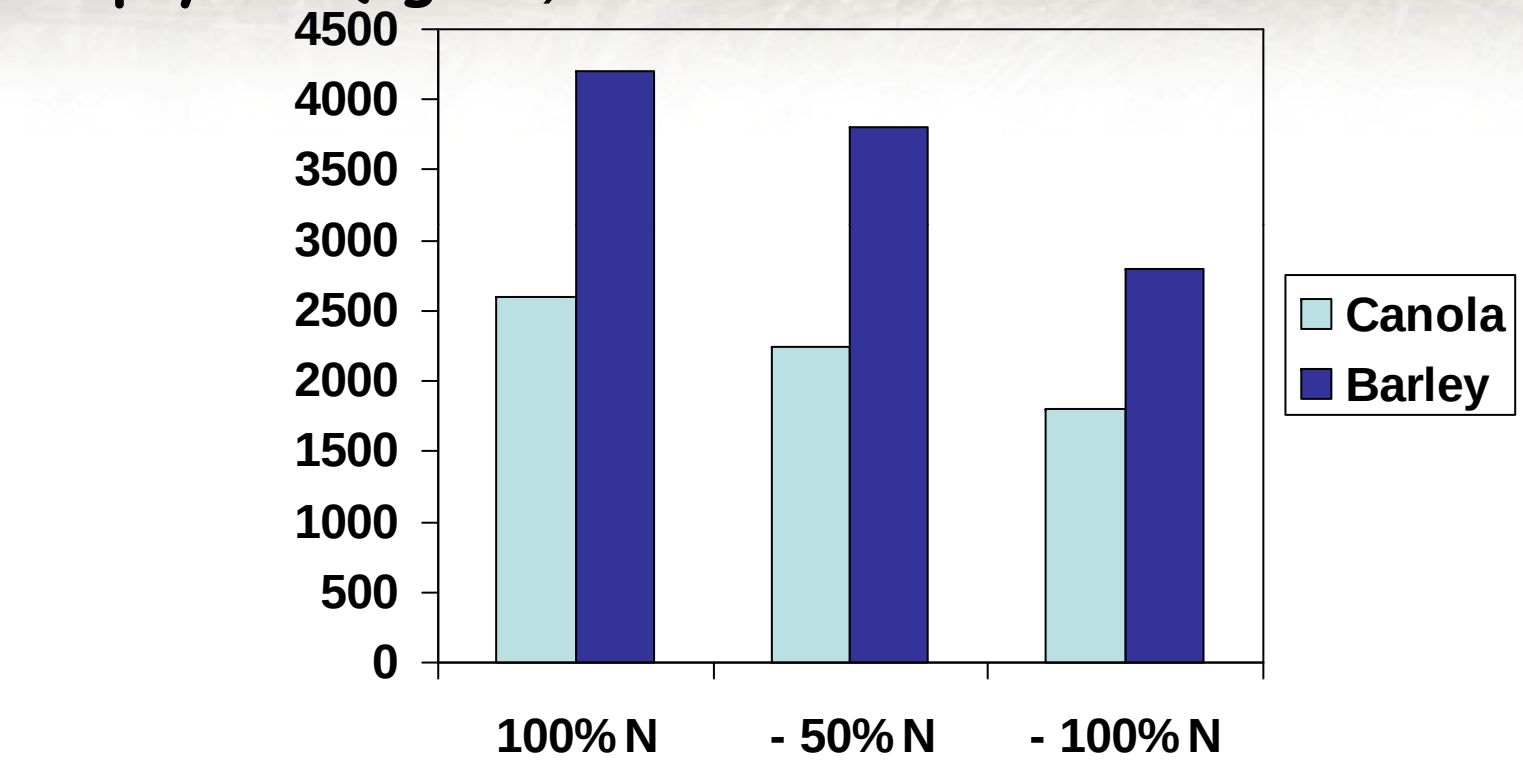


- Lower CO_2 evolution under ZT than under CT.
- Lowest CO_2 evolution in wheat following peas under ZT.

Where do we go from here with conservation tillage research?

- Beneficial arthropods as affected by tillage
- Phosphorus use efficiency in conservation tillage systems
- Micronutrient application in conservation tillage systems e.g. copper
- Nitrogen mineralization in well managed conservation tillage systems???

Impact of removing inputs on yield
[average over 4 years (2005 to 2008) at 5 locations]



N fertility

- Are we overestimating fertilizer N requirements on well managed fields
  - Credit No Till, continuous cropping, pulse rotations and long term fertilizer use?
  - Accurate estimates of N supplied by soil becomes more important
  - Do we need a method to predict N supply from soil

On-farm positive changes in crop production in western Canada

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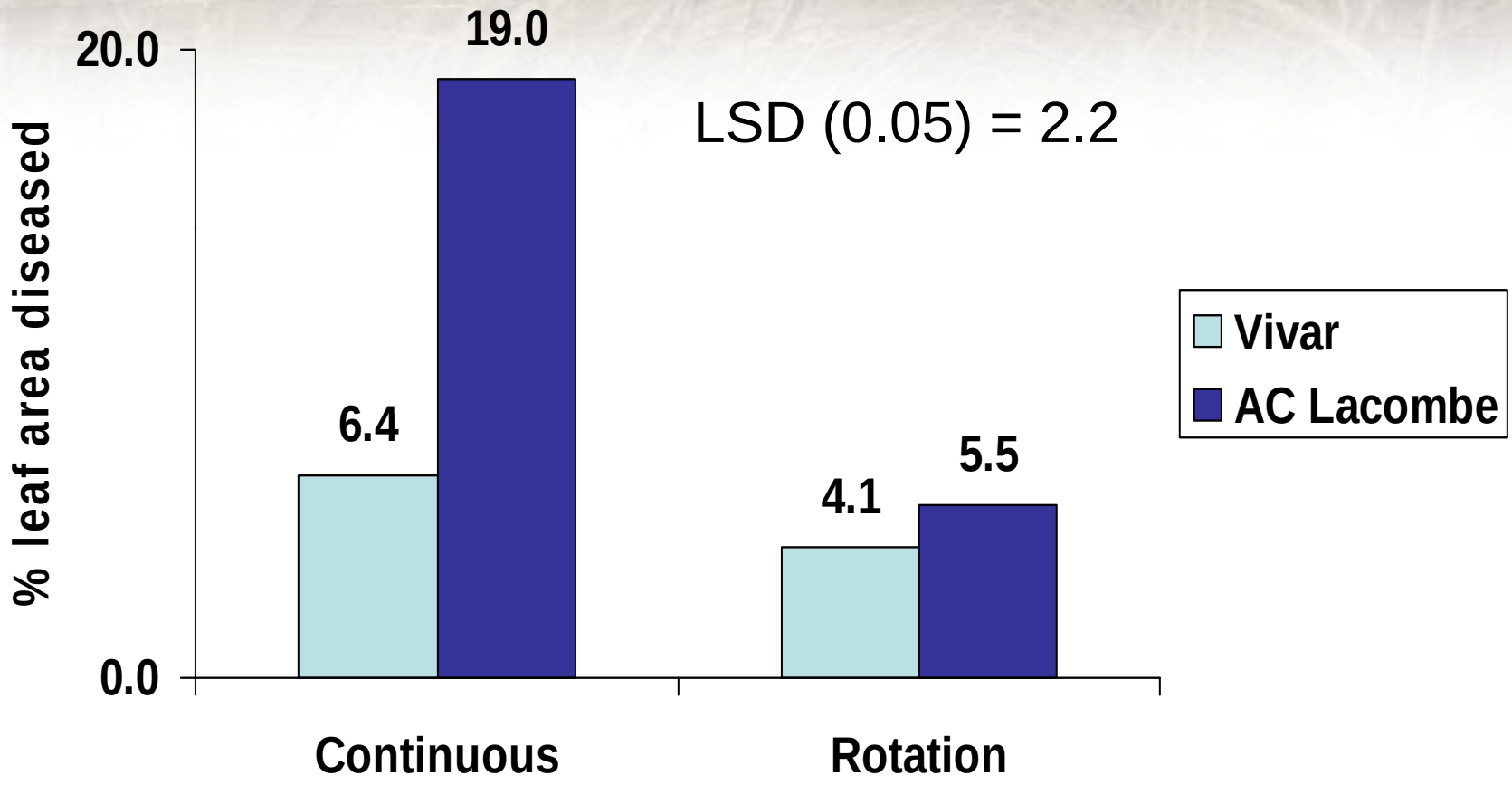
Crop Rotation

- Rotating cereals with oilseeds and pulses
- Diverse rotations are essential to effective long-term crop and pest management
- Facilitates herbicide rotation
- Much less monoculture cropping in western Canada than there used to be – introduction of HR canola, greater awareness of disease issues

Percentage leaf area diseased (flag leaf – 2) after 5 yr of continuous barley and barley in rotation with canola and field pea



Turkington et al.

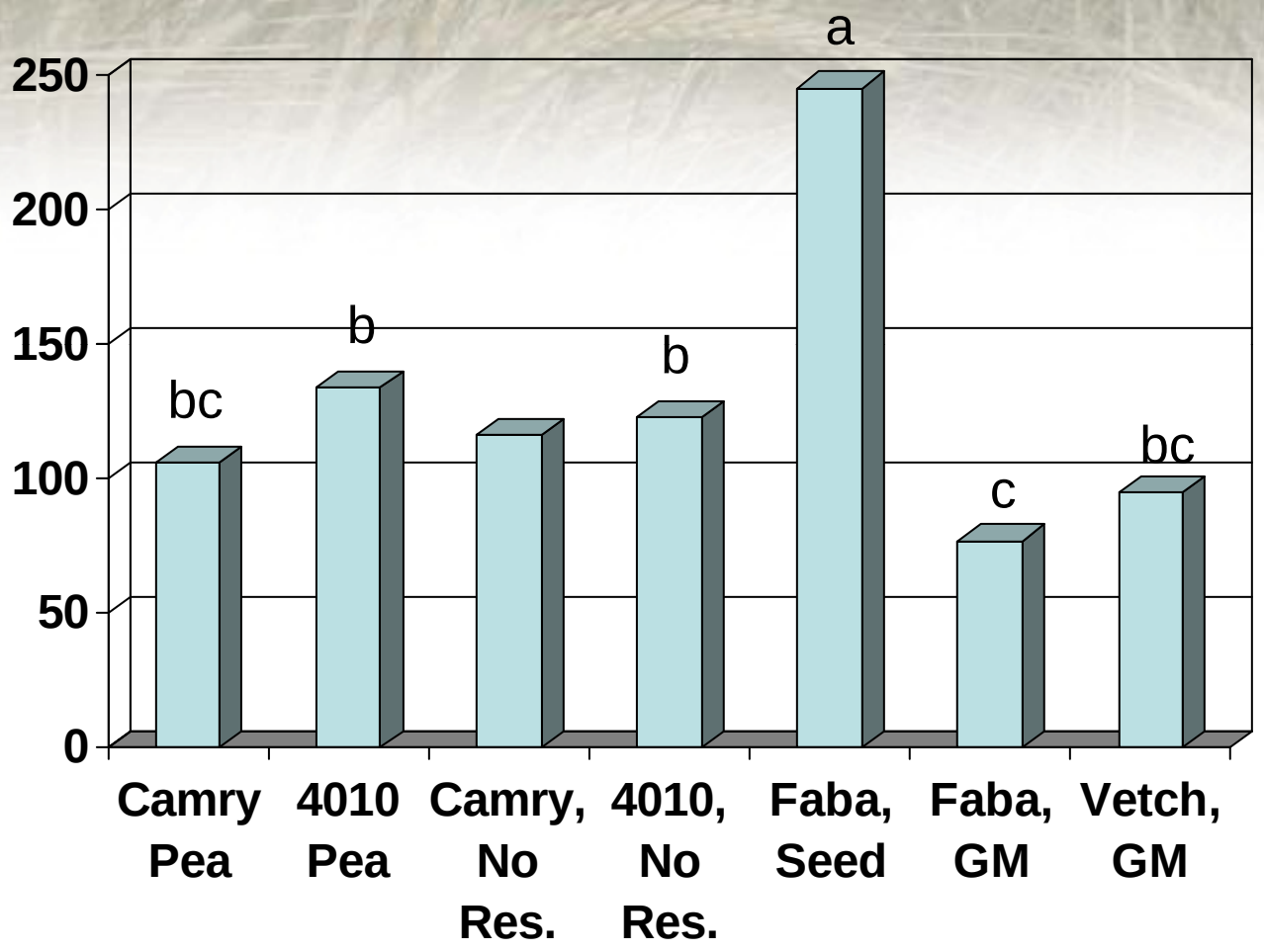
Pulses in rotation

- Better soil and crop health
- Reduced dependence on inorganic N fertilizers
- More sustainable weed management

N fixation ability of pulses

Trt	2007
1	Pea, Camry
2	Pea, 4010
3	Pea, Camry, stubble only
4	Pea, 4010, stubble only
5	Faba bean, seed
6	Faba bean, GM
7	Chickling vetch (AC Greenfix)
8	Barley

N Fixed (kg/ha) by various legumes



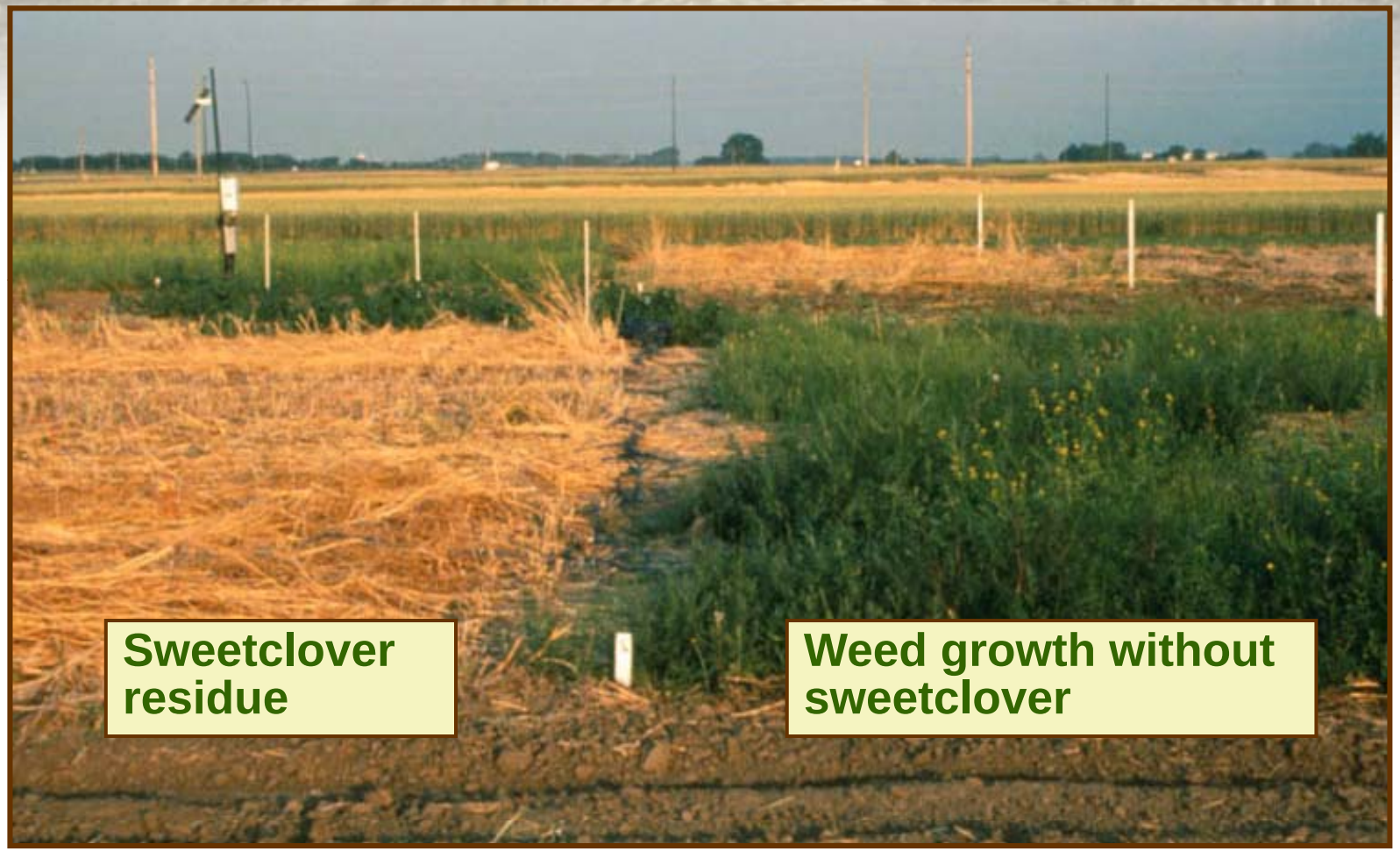
Faba > 4010 pea & Camry pea > GMs

Luwayi et al. (unpublished)

Green manure

- Widely used by organic farmers
- Sweetclover, red clover
- Limited use by conventional farmers

Weed suppression with sweetclover residue



J. Moyer, AAFC, Lethbridge

Pulses in rotation – the future

- "The knowledge of rotational effects of pulse crops in the Northern Great Plains remains imprecise and inadequate" - Miller et al. 2002
- Canola following a pulse – hybrids are avid users of nitrogen
- Are there disease issues?
- Prairie canola agreement

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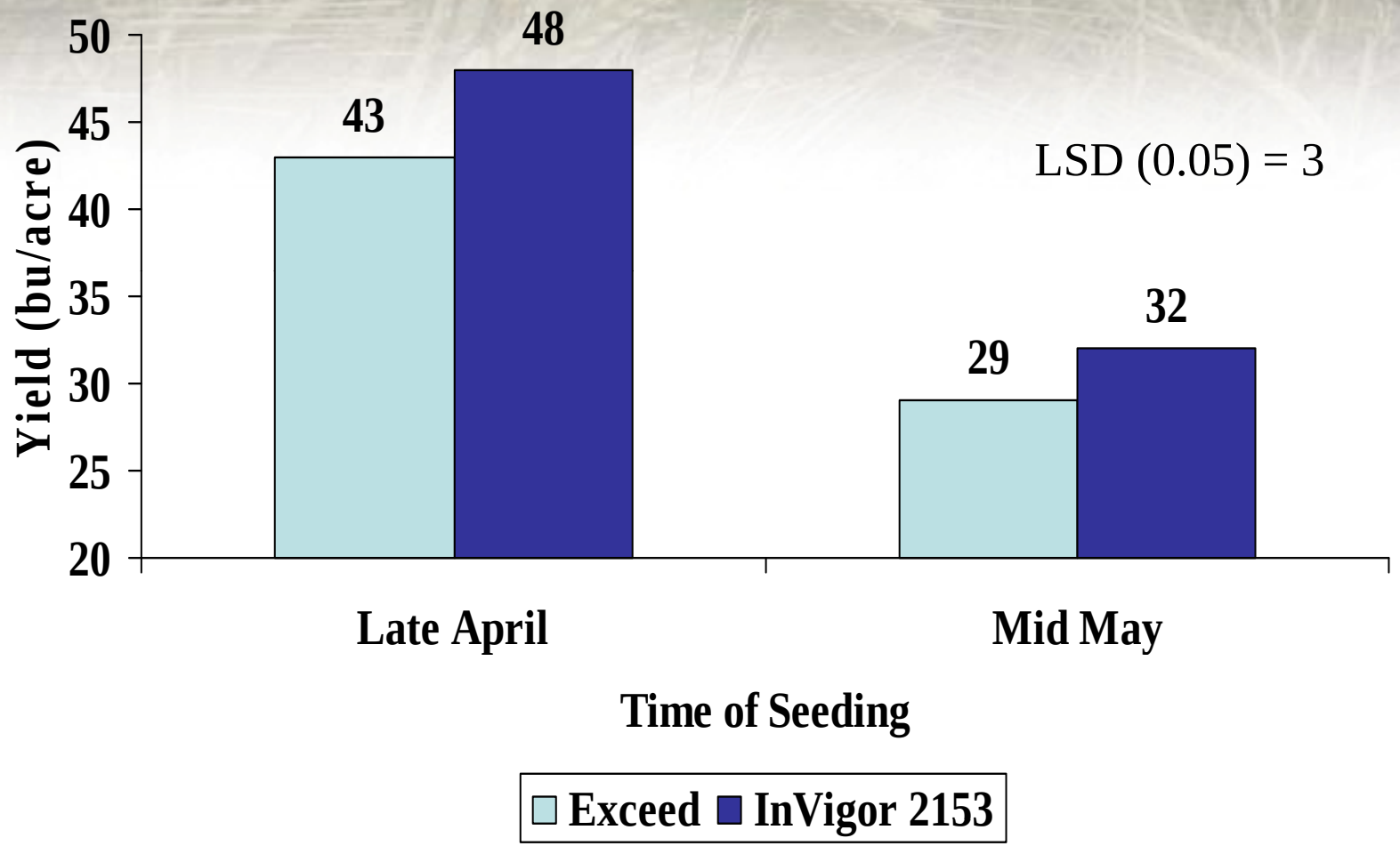
Never seed canola before the middle of May

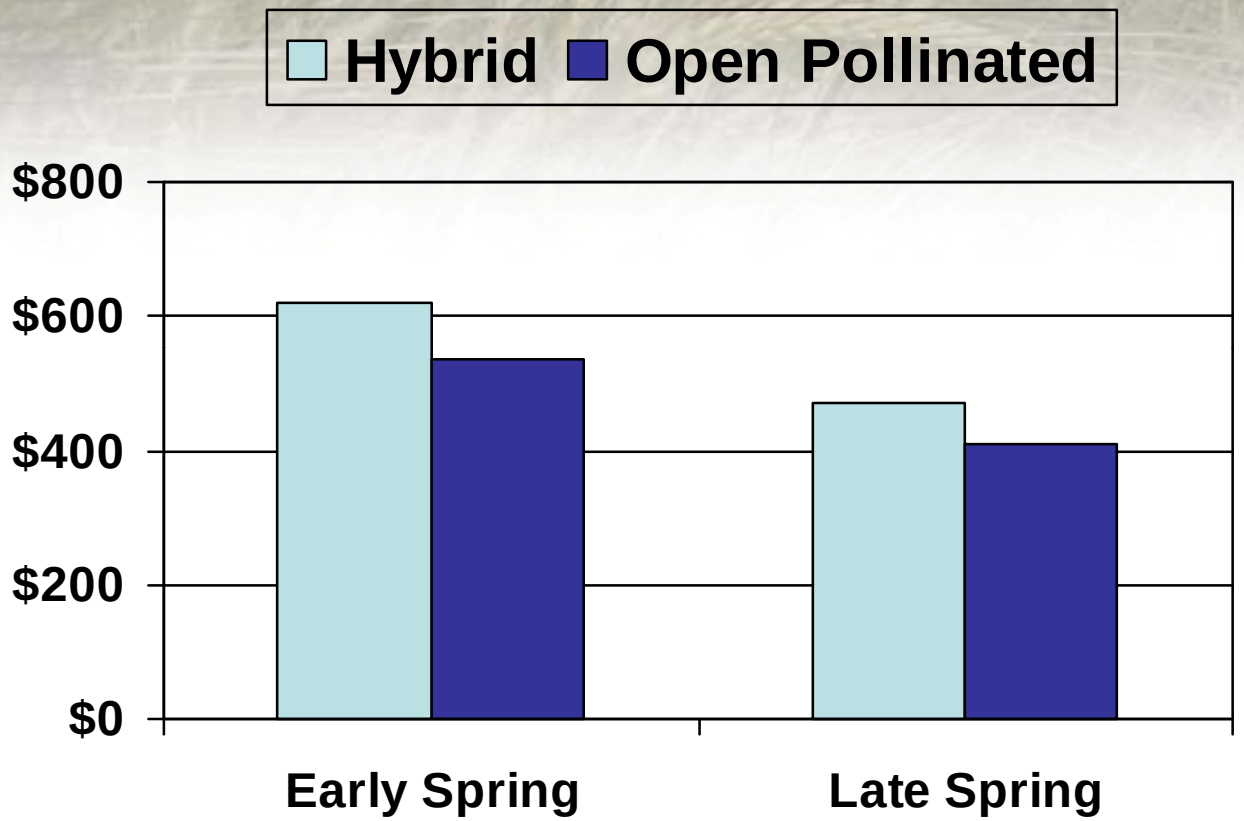
Clayton et al. 2004.

Never seed canola before the middle of May!



Clayton et al. 2005

Economics of canola seeding time



- Returns from hybrids are higher than open pollinated
- Early spring seeding has highest returns

Upadhyay et al. 2005

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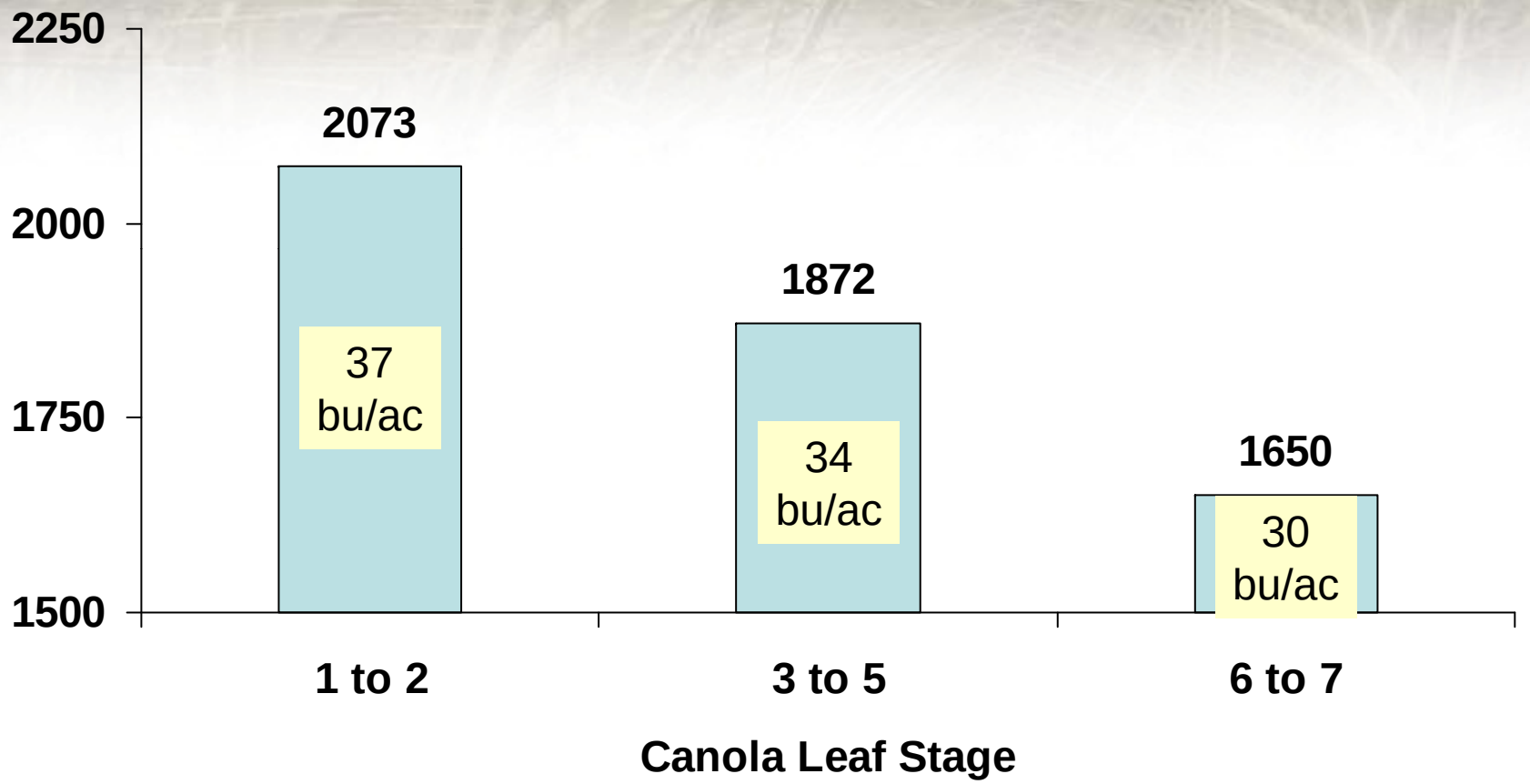
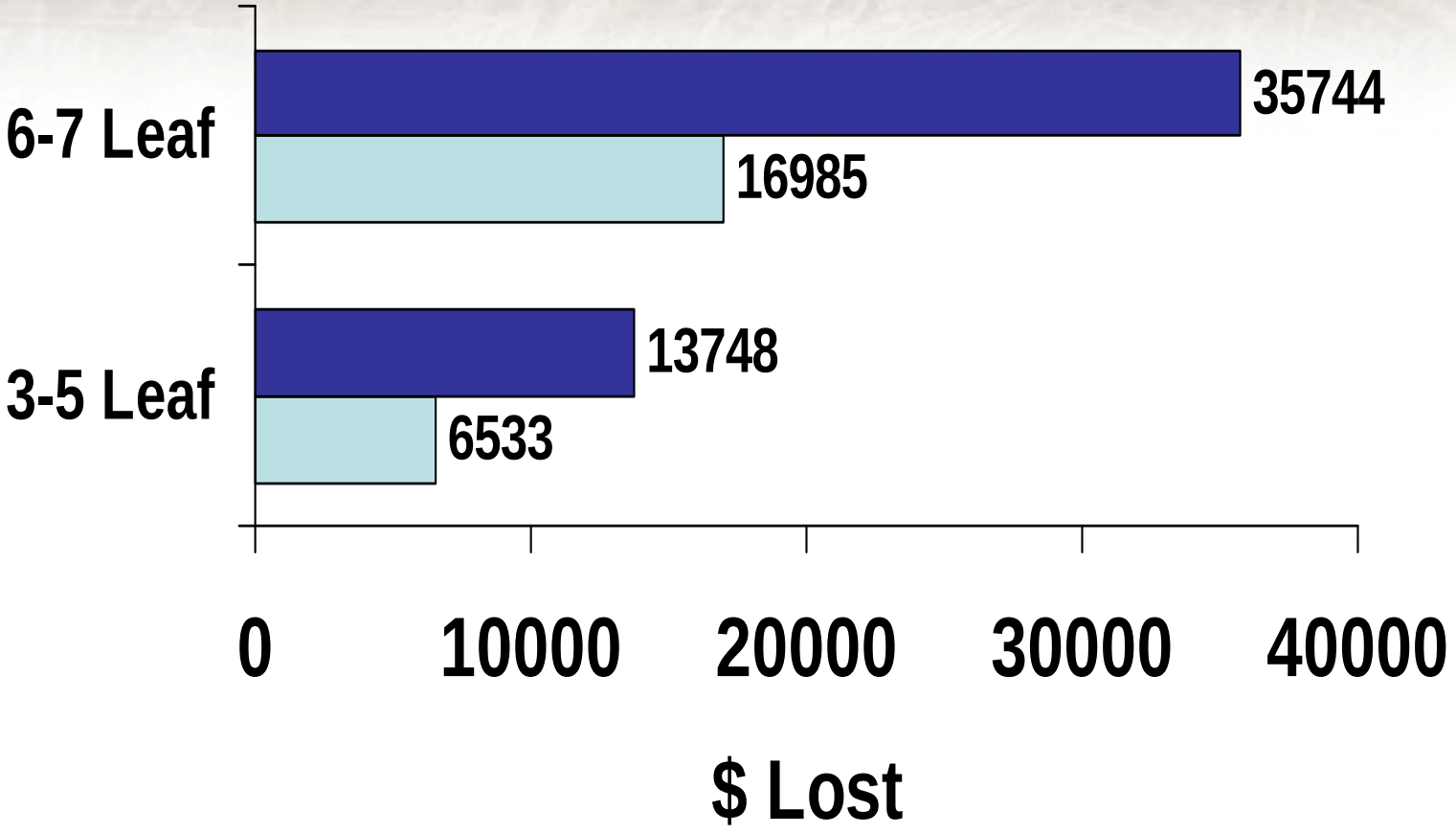
Time of Weed Removal - Canola Yield (kg/ha)



Means of 10 western Canada locations
CCC Agronomists - large-scale plots (9 x 122 m) in grower fields
Harker et al. 2008. Weed Technol. 22:747-749.

Waiting to Spray… $ lost / half section



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Barley seed rate effects on wild oats without herbicide

Normal seed rate

High seed rate

Do western Canadian growers reduce in-crop herbicide rates?

Province	Herbicide rate		
	< Recom.	> Recom.	None
Alberta	38%	13%	8%
Saskatchewan	26%	5%	12%
Manitoba	32%	9%	1%
Average	32%	9%	7%

Leeson et al. 2007; Thomas et al. 2007

Importance of crop competition in enhancing herbicide performance

Wild oat dw (g/m^2)

Herbicide	In crop	No crop
Difenz.	201	895
Diclofop	42	578
Flamprop	81	502

From Sharma and Vanden Born, 1983

Effect of 0.75x herbicide rates on wild oat control in wheat seeded at low and high seeding rates – yr 3

Normal seed rate

Double normal seed rate

O'Donovan et al. 2006

Crop seeding rate effects on herbicide efficacy in semi-dwarf barley (barley/canola)

25% herbicide rate
– normal seed rate

25% herbicide rate
- double seed rate

O'Donovan et al. 2001

Competitive barley varieties

Semi-dwarf - poor competitor

Tall - strong competitor

O'Donovan et al. 2000

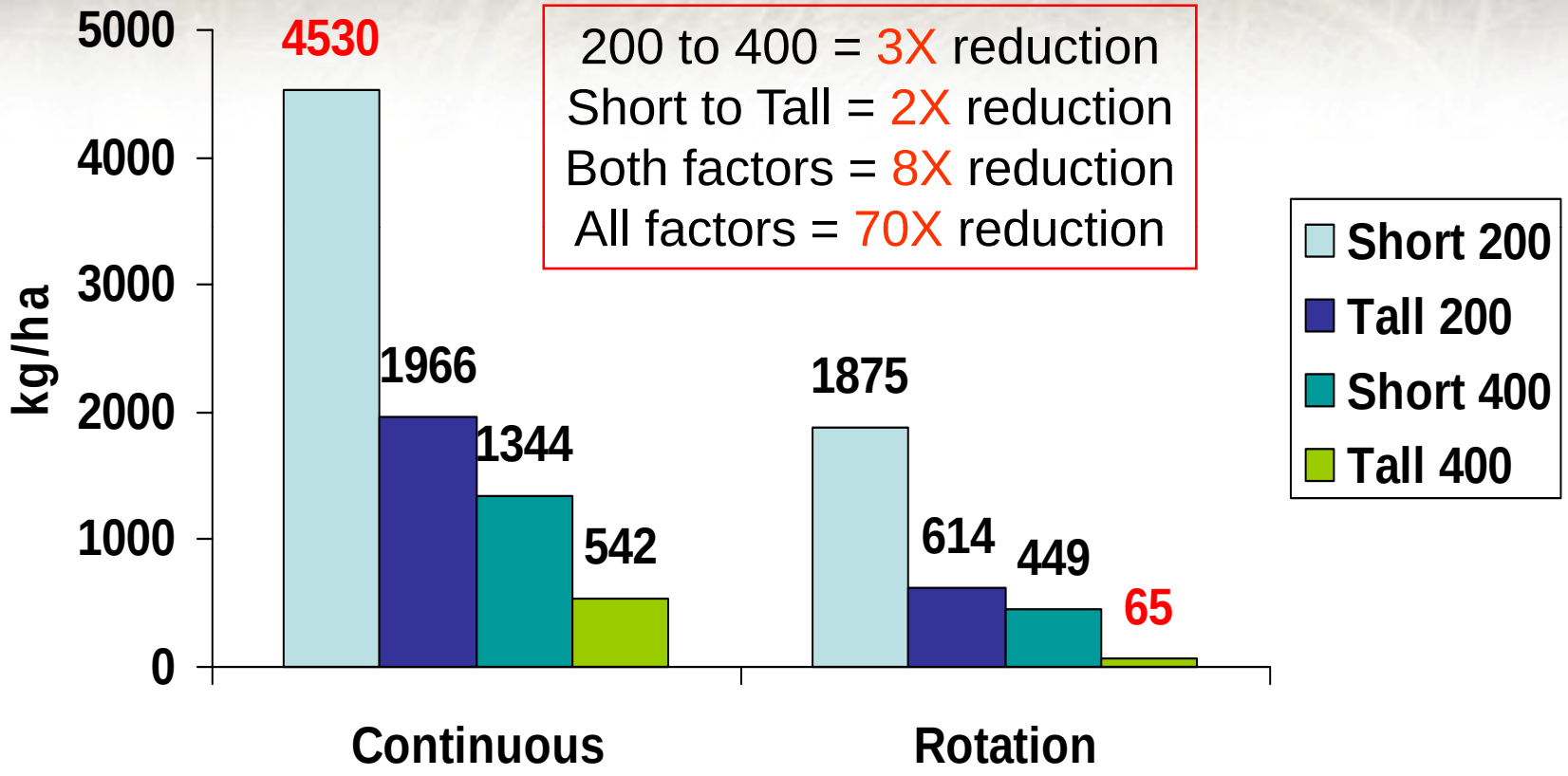
Seeding rate

- Improved crop competition and herbicide performance
- Earlier, more uniform maturity
  - reduced green seed content in canola
  - more uniform kernel size in cereals (better malt and feed quality)
  - Less risk of frost damage
- Farmers have increased seed rates by 30-50% in the last 6 years
- Less overall herbicide application

Continuous barley vs rotation; tall vs short barley; 200 vs 400 seeds/m^2; 25, 50 and 100% herbicide rate

Harker et al. 2009

Wild Oat biomass (maturity) in 2005 – 25% herbicide rate for 5 years



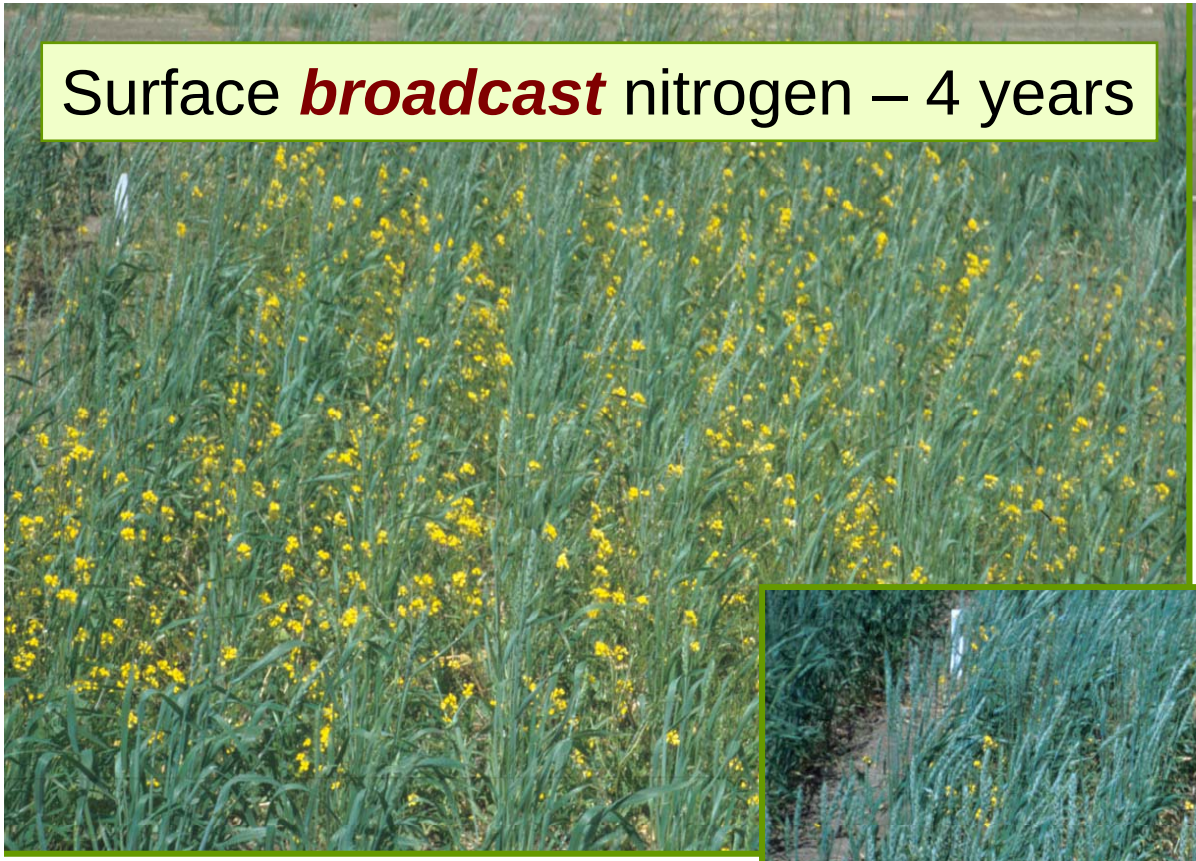
LSD (0.05) = 614

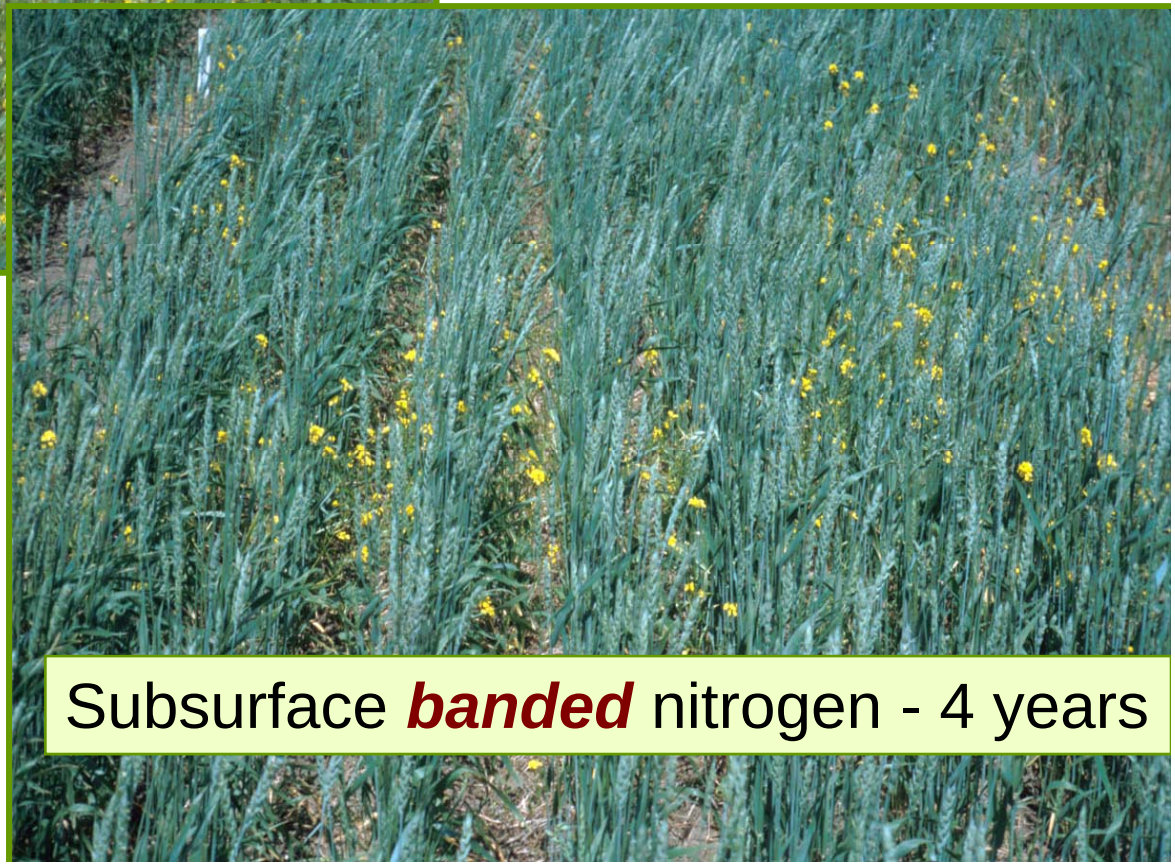
25% herbicide rate every year for 5 years

- Short
- 200 seeds
- B-B-B-B-B
- 25% Rate

25% herbicide rate every year for 5 years

Tall
400 seeds
B-C-B-P-B
25% Rate





50% reduction in surface broadcast fertilizer in favor of subsurface banded in the last 6 years.
Adoption of conservation tillage has facilitated this

Blackshaw et al. 2005

Weed resistance to glyphosate – when sound agronomy succumbs to the magic bullet

- 1996 - *Lolium rigidum* - Rigid Ryegrass
  - ✓ Australia, USA, South Africa
- 1997 - *Eleusine indica* – Goosegrass
  - ✓ Malaysia
- 2000 - *Conyza canadensis* – Horseweed
  - ✓ USA many States)
- 2001 - *Lolium multiflorum* - Italian Ryegrass
  - ✓ Chile, Brazil, USA
- 2003 - *Plantago lanceolata* - Buckhorn Plantain
  - ✓ South Africa
- 2003 - *Conyza bonariensis* - Hairy Fleabane
  - ✓ South Africa, Spain, Brazil, USA
- 2004 - *Ambrosia artemisiifolia* - Common Ragweed
  - ✓ USA (several states)
- 2004 – *Ambrosia trifida* – Giant ragweed
  - ✓ Indiana, Kansas
- 2005 - *Amaranthus palmeri* - Palmer Amaranth
  - ✓ USA (Georgia)
- 2005 – *Sorghum halepense* - Johnsongrass
  - ✓ Argentina
- 2005 – *Amaranthus rudis* – Common waterhemp
  - ✓ Illinois, Kansas
- 2006 – *Euphorbia heterophylla* – Wild poinsetta
  - ✓ Brazil
- 2007 – *Echinochloa colona* – Junglerice
  - ✓ Australia

No reports of glyphosate resistance in Canada – Yet!!

Source: Heap. 2008. www.weedscience.org

Palmer amaranth (*Amaranthus palmeri*)

Glyphosate resistant palmer amaranth in RR cotton in Georgia

- Georgia 2005 (1 site)
- Documented in RR cotton
- Other biotypes have developed resistance to herbicides in Groups B, C1 and K1
- Has this affected the land value?

S. Culpepper, University of Georgia

Objectives

- To determine the relative importance of various agronomic factors in relation to barley seed uniformity and yield and malt homogeneity and quality
- The project is the first of its kind in North America to link agronomic practices directly to quality as determined by the micro-malt assessment process (Mike Edney, Canadian Grain Commission)

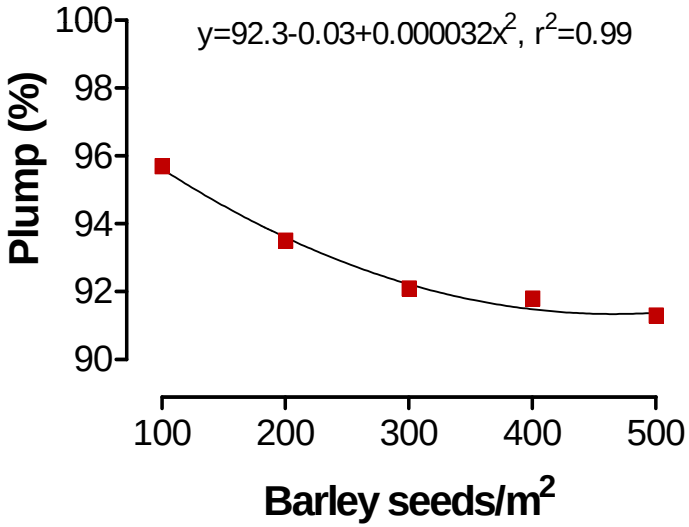
Agronomic factors investigated

- Variety
- Seeding date
- Seeding rate
- Nitrogen rate
- Stubble type
- Fungicide application
- Three research trials (zero tillage) at 8 locations

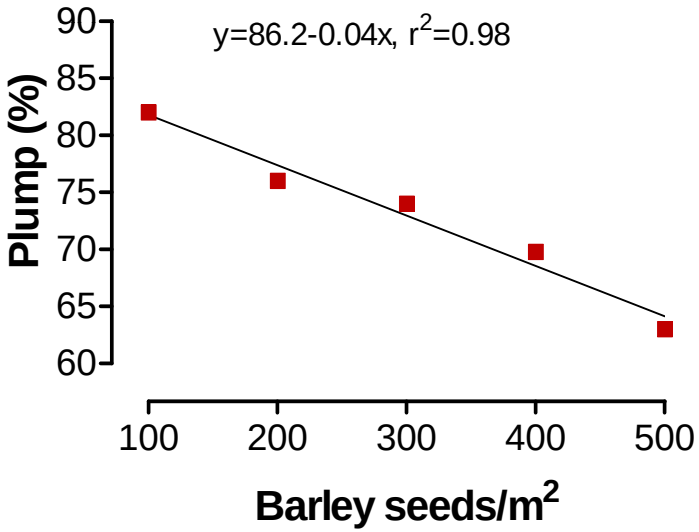
Relationship between seeding rate and plump seed in 2007

% plump seed sometimes decreased with increasing seed rate

Fort Vermilion



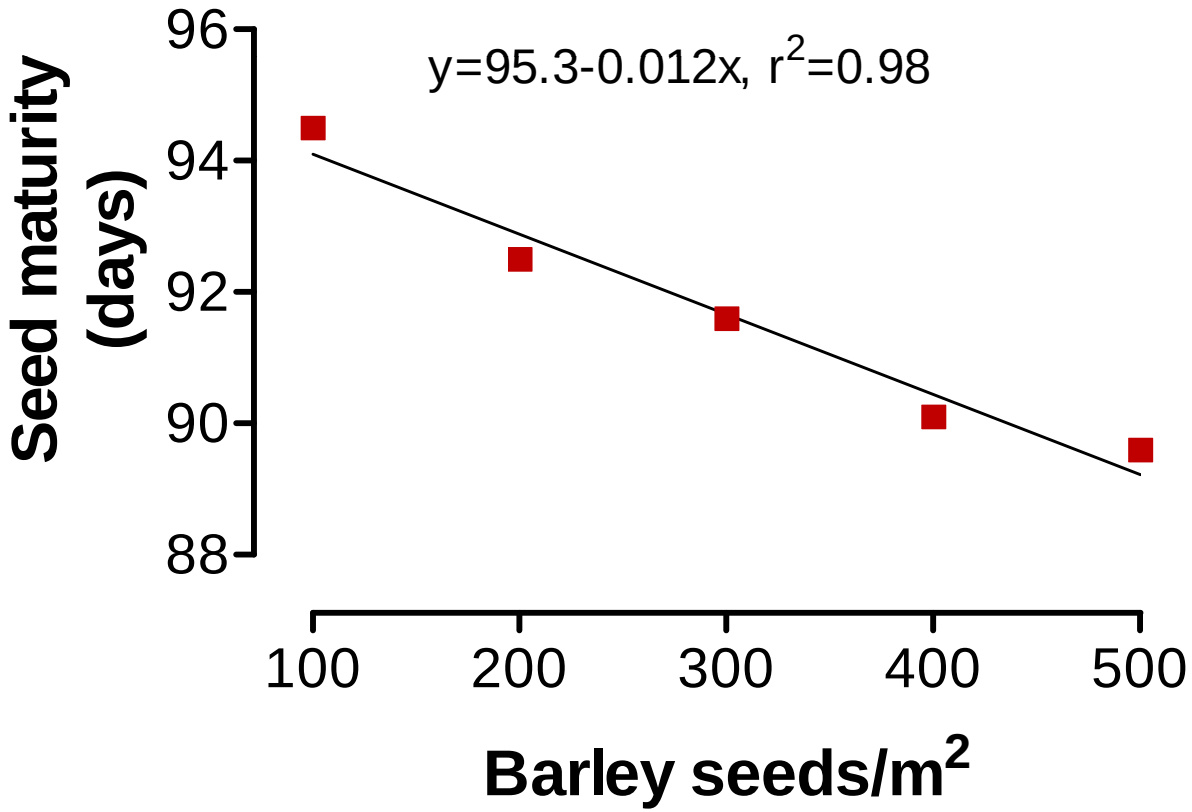
Scott



Relationship between seeding rate and days to maturity

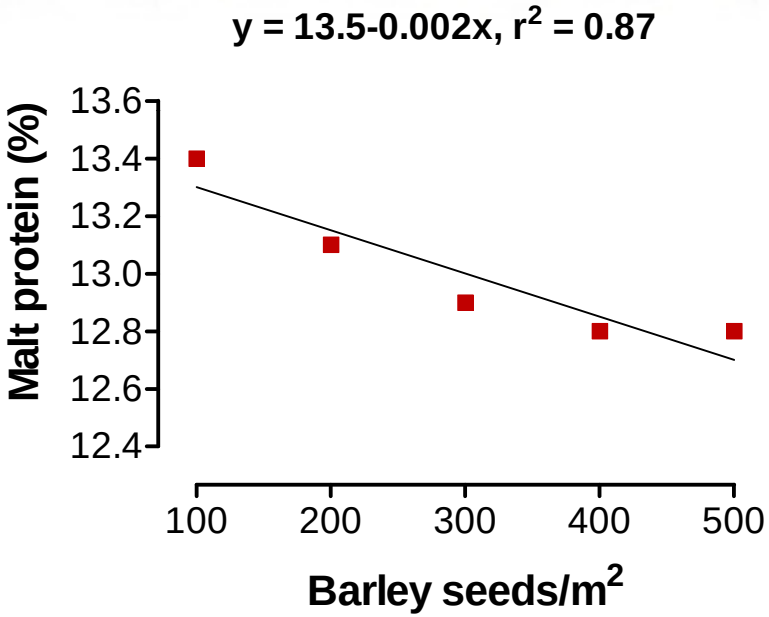
Days to barley seed maturity always decreased with increasing seeding rate

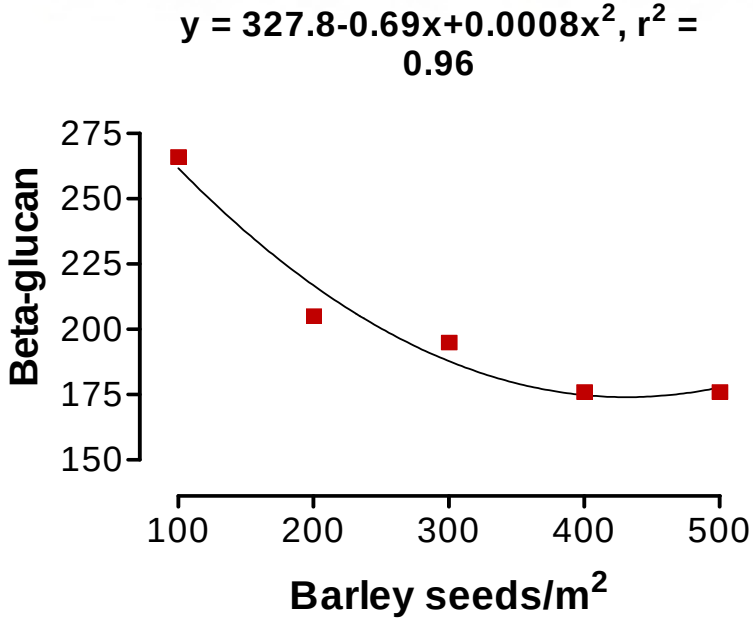
All Locations



Relationship between seeding rate and malt protein and beta-glucan

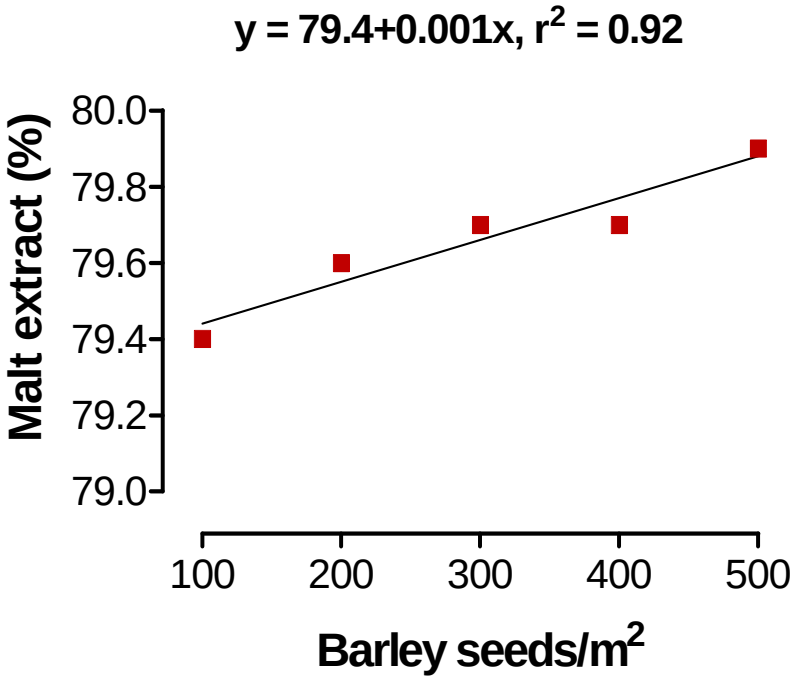
Malt protein and beta-glucan mostly decreased with increasing seeding rate





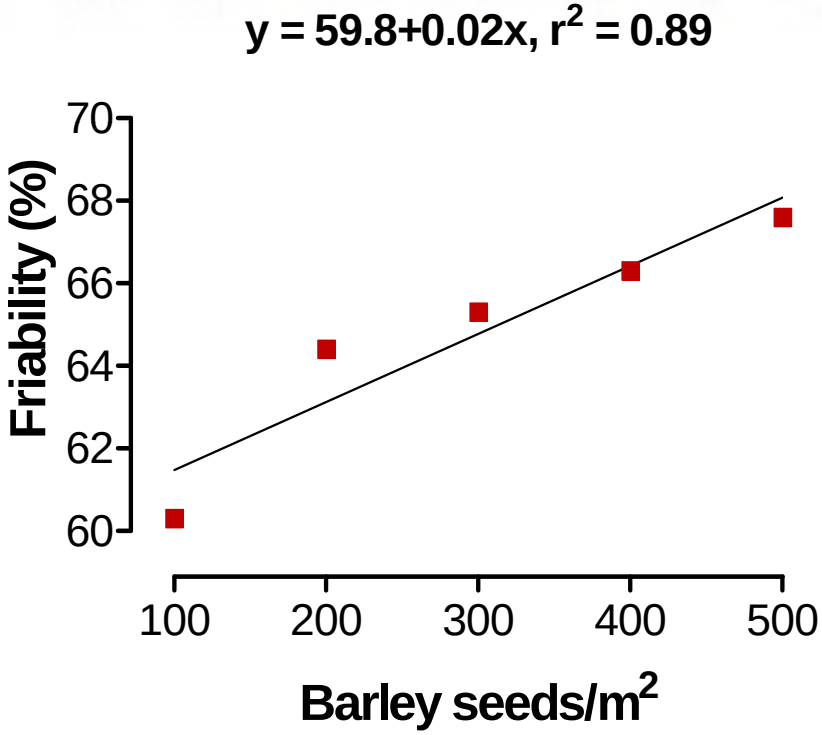
Relationship between seeding rate and malt extract

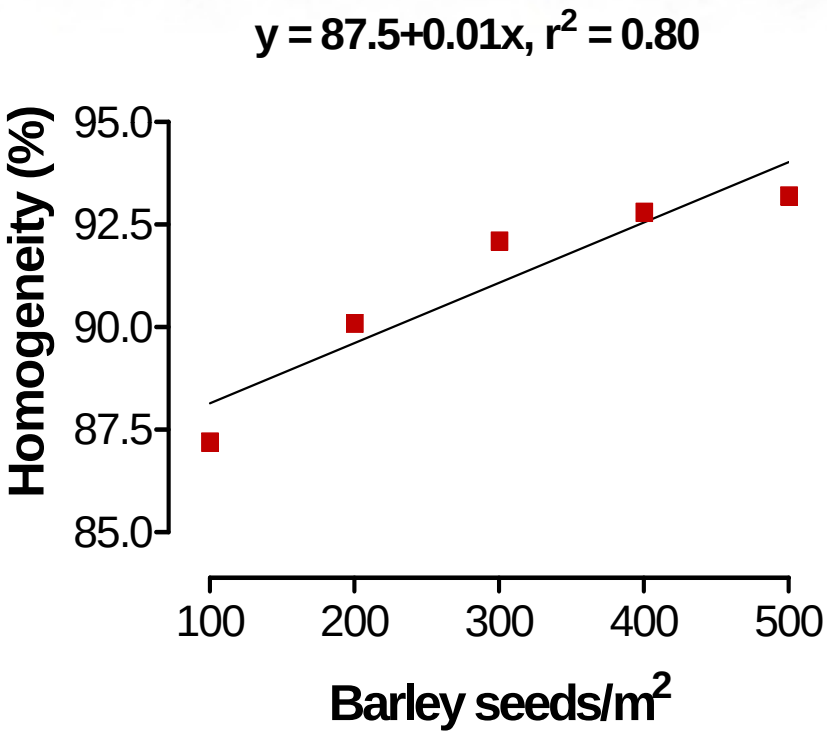
Malt extract increased with increasing seeding rate



Relationship between seeding rate on friability and homogeneity

Friability and homogeneity increased with increasing seed rate





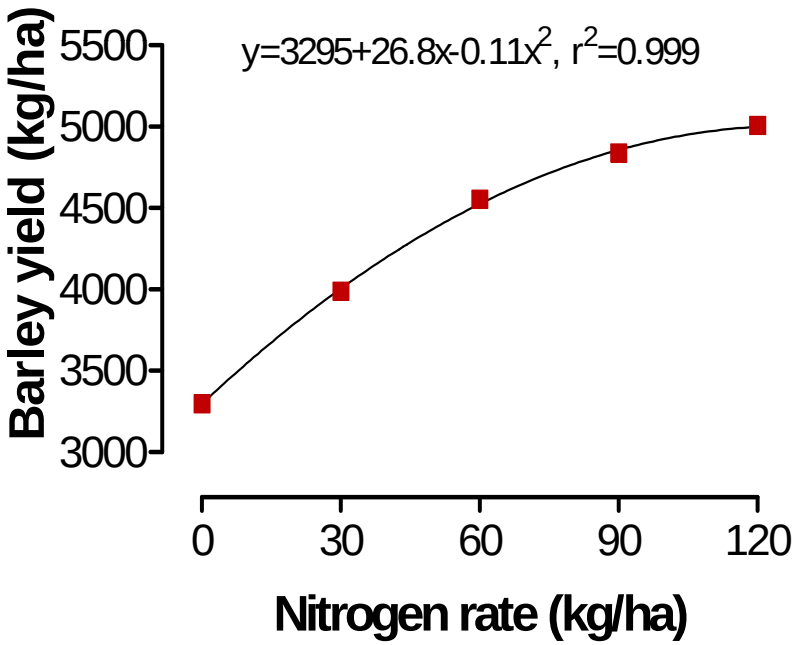
Why?

- More uniform kernel size and better modification at the higher seeding rates
- Edney et al. (unpublished)

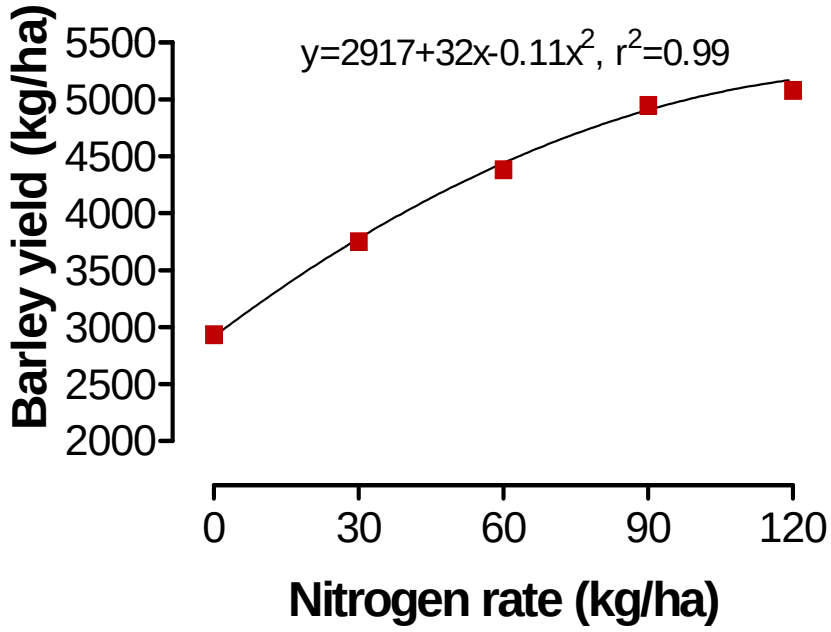
Relationship between nitrogen rate and yield

Barley yield mostly increased with increasing seeding rate

Lacombe



Indian Head

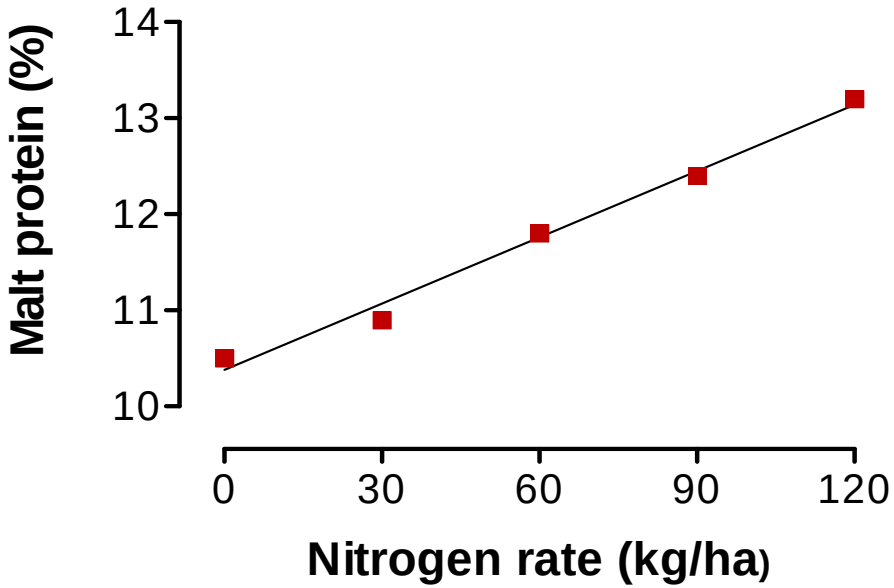


Relationship between nitrogen rate and malt protein and beta-glucan

Malt protein and beta glucan increased with increasing nitrogen rate

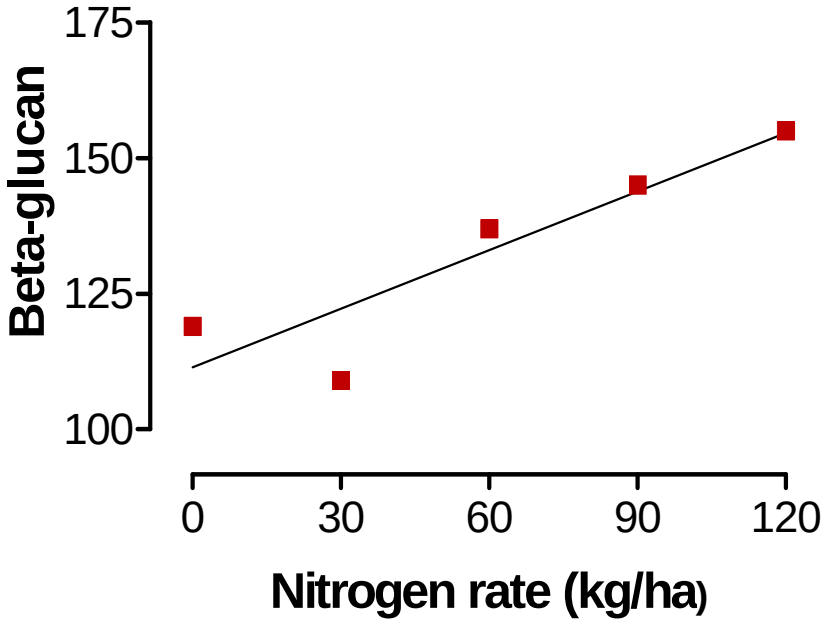
All locations

$y = 10.4+0.02x$, $r^2 = 0.99$



All Locations

$y = 111 +0.36x$, $r^2 = 0.82$

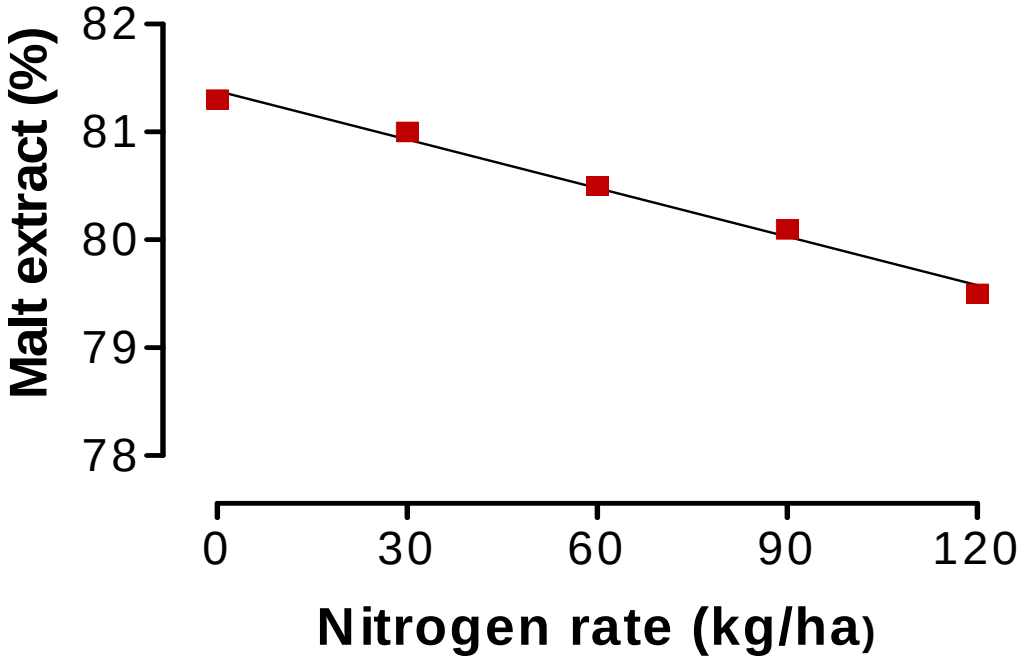


Relationship between nitrogen rate and malt extract and beta-glucan levels

Malt extract decreased with increasing nitrogen rate

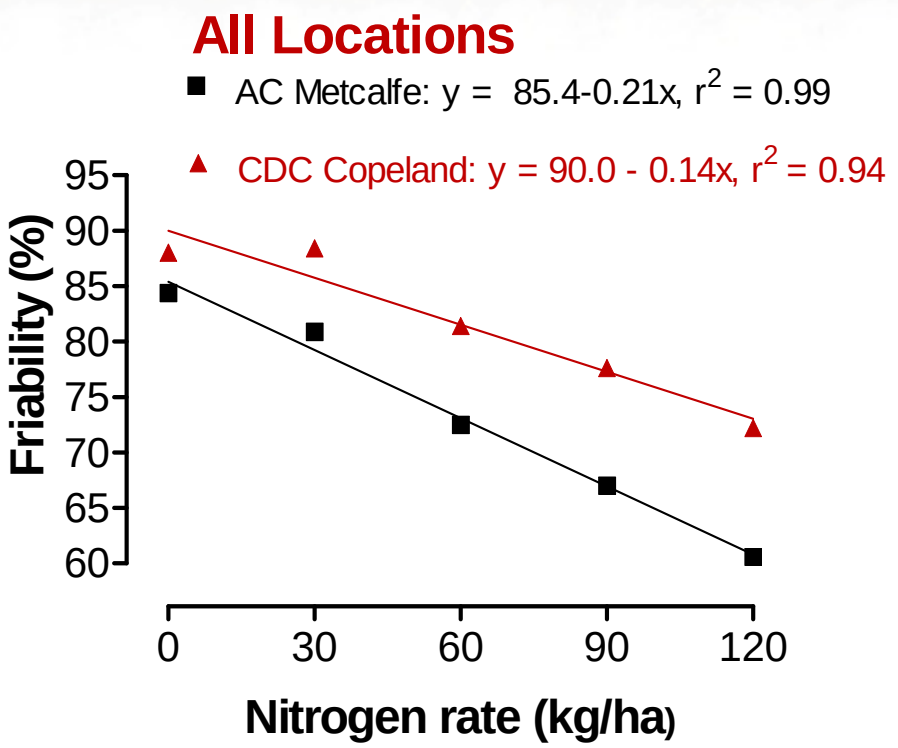
All Locations

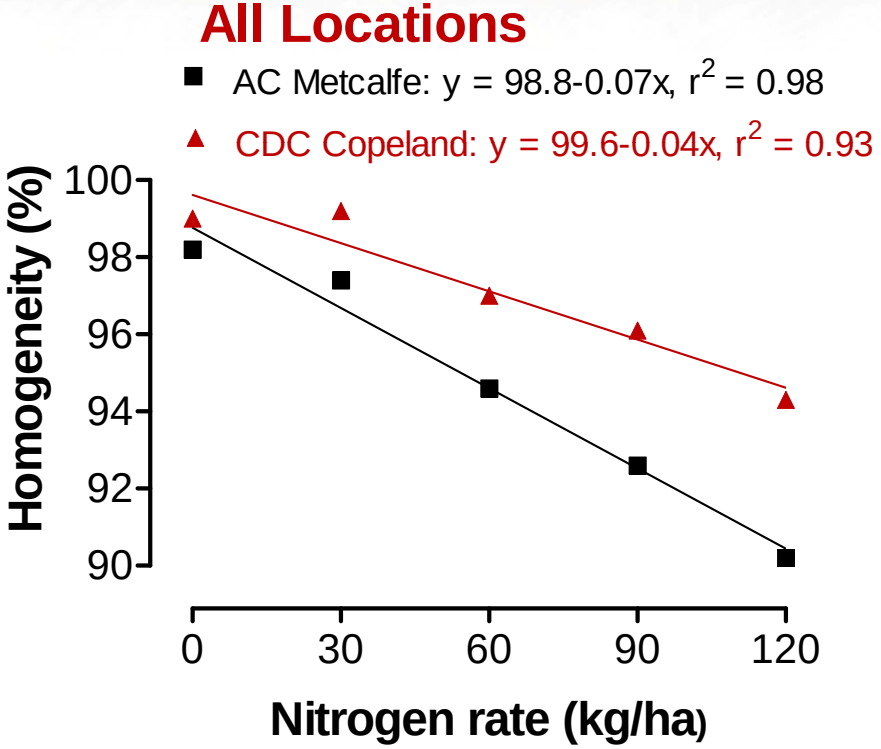
$y = 81.4 - 0.02x, r^2 = 0.99$



Interaction between nitrogen rate and barley variety on % friability and homogeneity

Friability and homogeneity decreased with increasing nitrogen rate but the negative effect was more pronounced with AC Metcalfe





Future malting barley agronomic research

- Can we mitigate the negative impact of nitrogen on malt barley quality without seriously impairing yield?
- How do other varieties respond to nitrogen in terms of malt quality?
- What about varietal mixtures in terms of responses to nitrogen, diseases and quality?

Conclusion

- Over the last 20 years or so, agronomic research has contributed significantly to on-farm crop production changes that are positive in terms of economics and sustainability
- The need for this research will continue into the future, and may intensify
- While advances in biotechnology may indeed revolutionize crop production in the 21st century, proper stewardship of the land through appropriate agronomic practices will always be a major priority

Acknowledgments

- Alberta Canola Producers Commission, Alberta Barley Commission, Alberta Agricultural Research Institute, Canadian Wheat Board, RAHR Malting, Matching Investment Initiative of Agriculture & Agri-Food Canada
- Superb scientists, technicians and extension and industry personnel at various locations across western Canada