Reconsidering Red Clover

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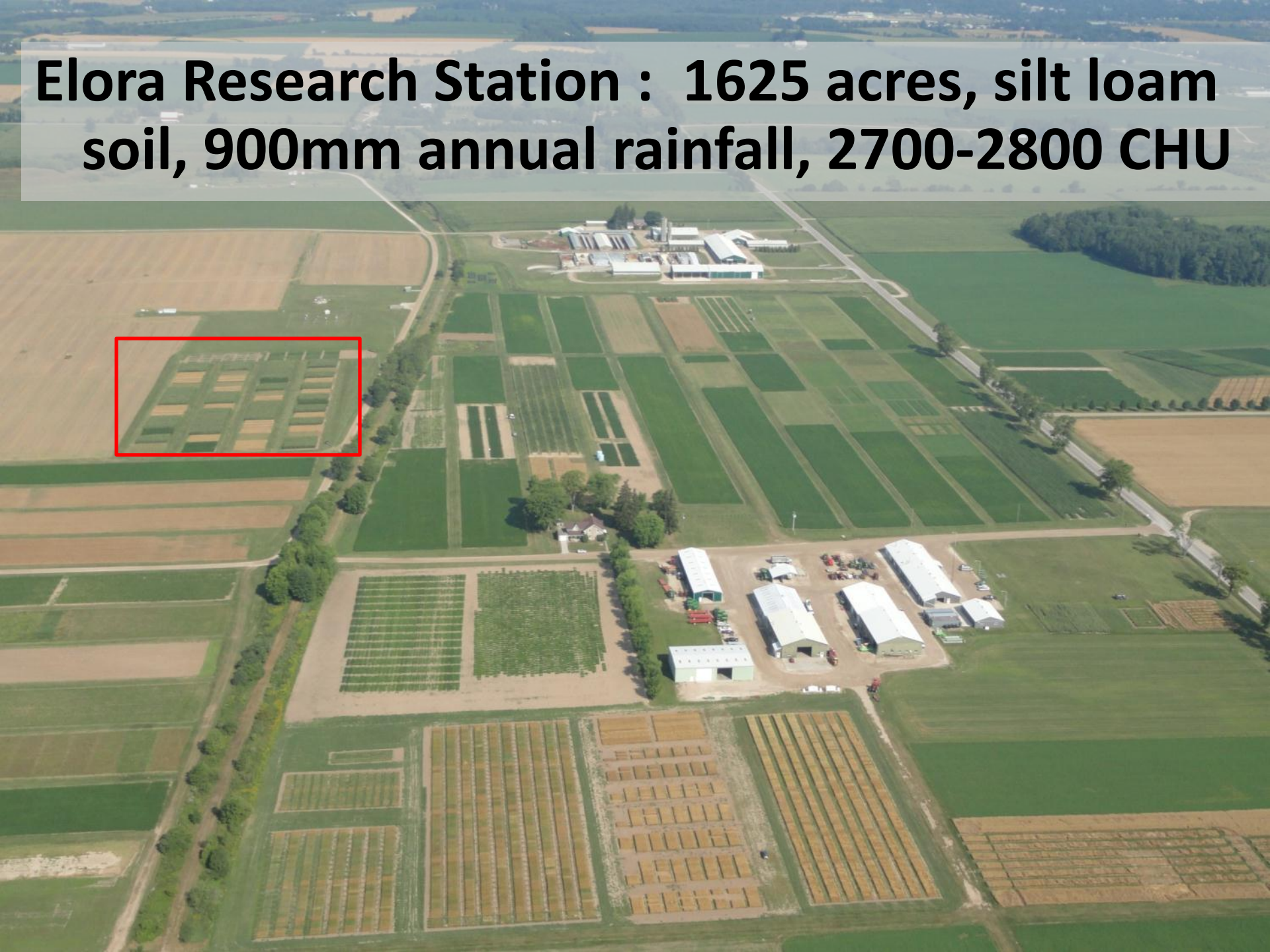
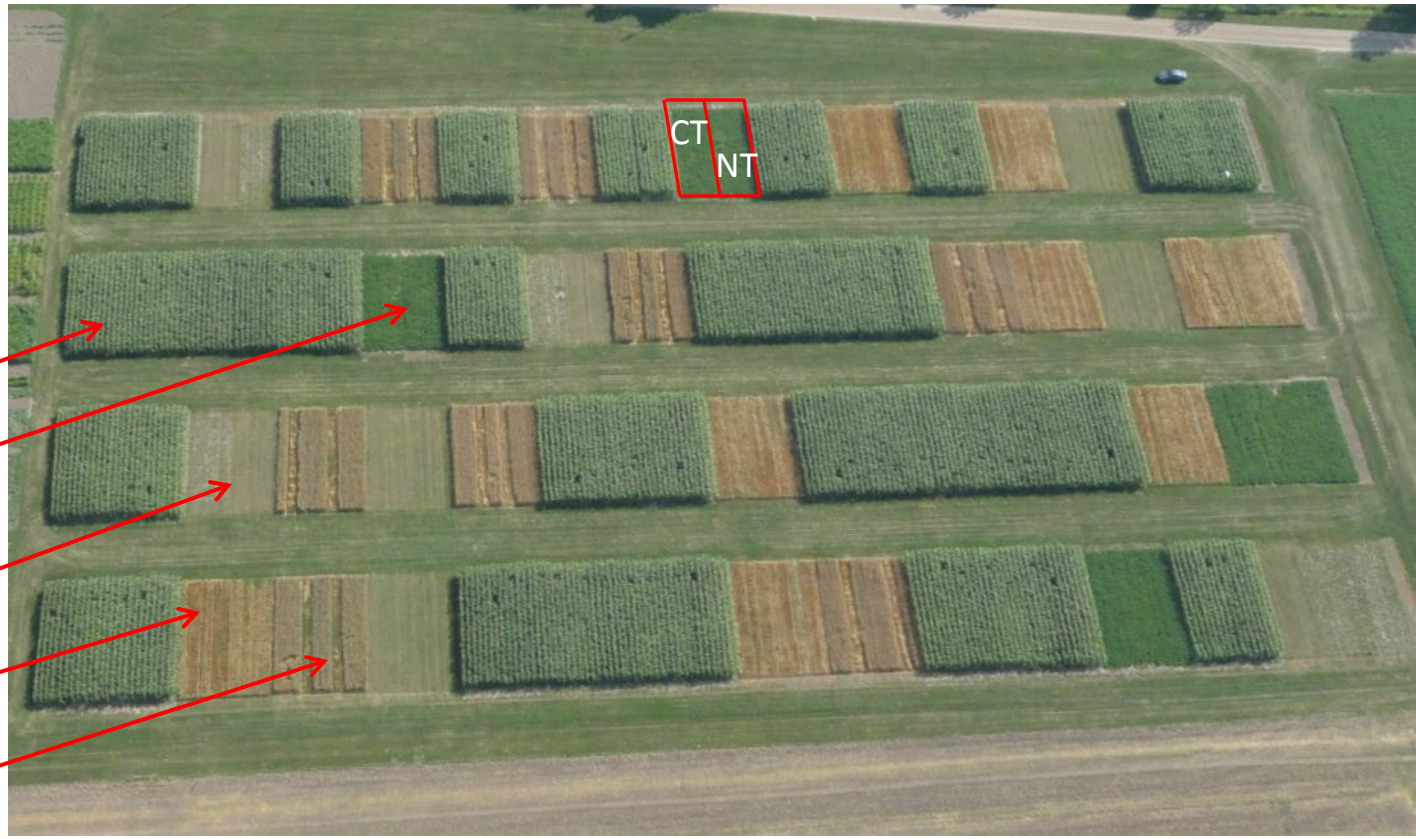
Addition of winter wheat provides ”niche” for cover crop opportunity

- In a corn/soybean/winter wheat rotation winter wheat rotation often perceived as contributing the least to profitability…but perhaps it is equal or more
- Longterm trials at Elora Research Station and Ridgetown Campus demonstrate that addition of winter wheat provides
  - Increase of yield and yield stability of corn and soybean
  - Reduction of corn N requirement
  - Net return from wheat straw
  - An opportunity for cover crop and associated benefits

Elora Research Station : 1625 acres, silt loam soil, 900mm annual rainfall, 2700-2800 CHU

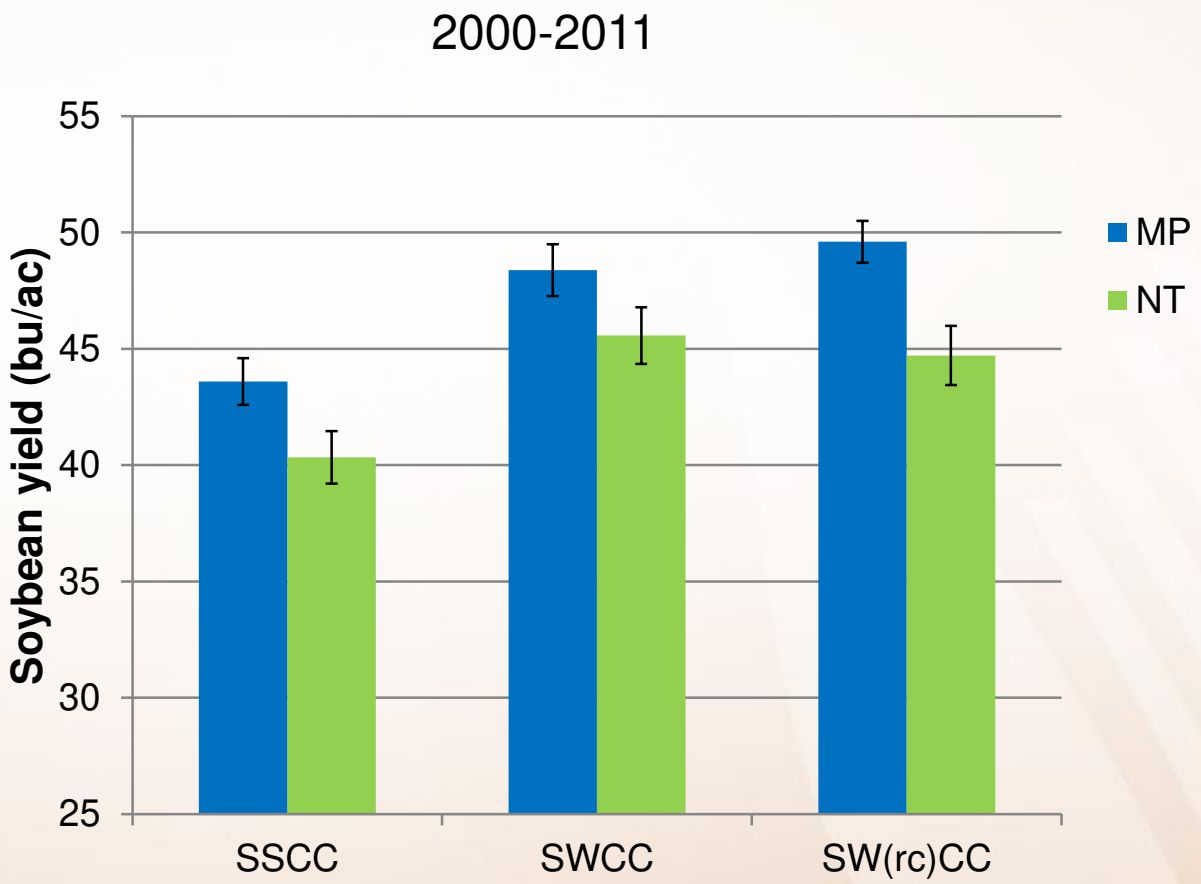


Long-term rotation trial, 2011

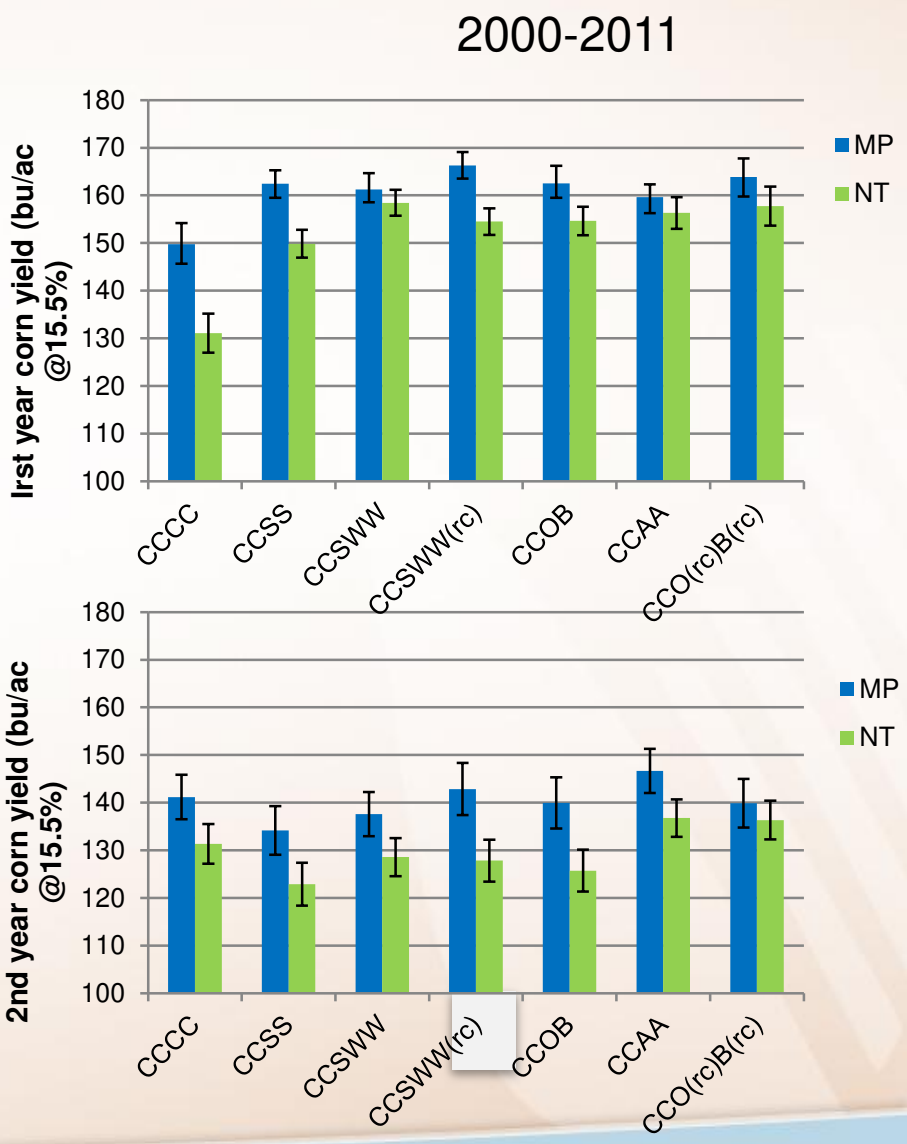


- Initiated in 1980
- Rotations – CCCC, AAAA, CCAA, CCSS, CCSW, CCSW(rc), CCOB, CCO(rc)B(rc)
- Conventional tillage and no-till

The “Rotation Effect” Wheat on Soybean Yields - Elora



The "Rotation Effect" Wheat on Corn Yields - Elora

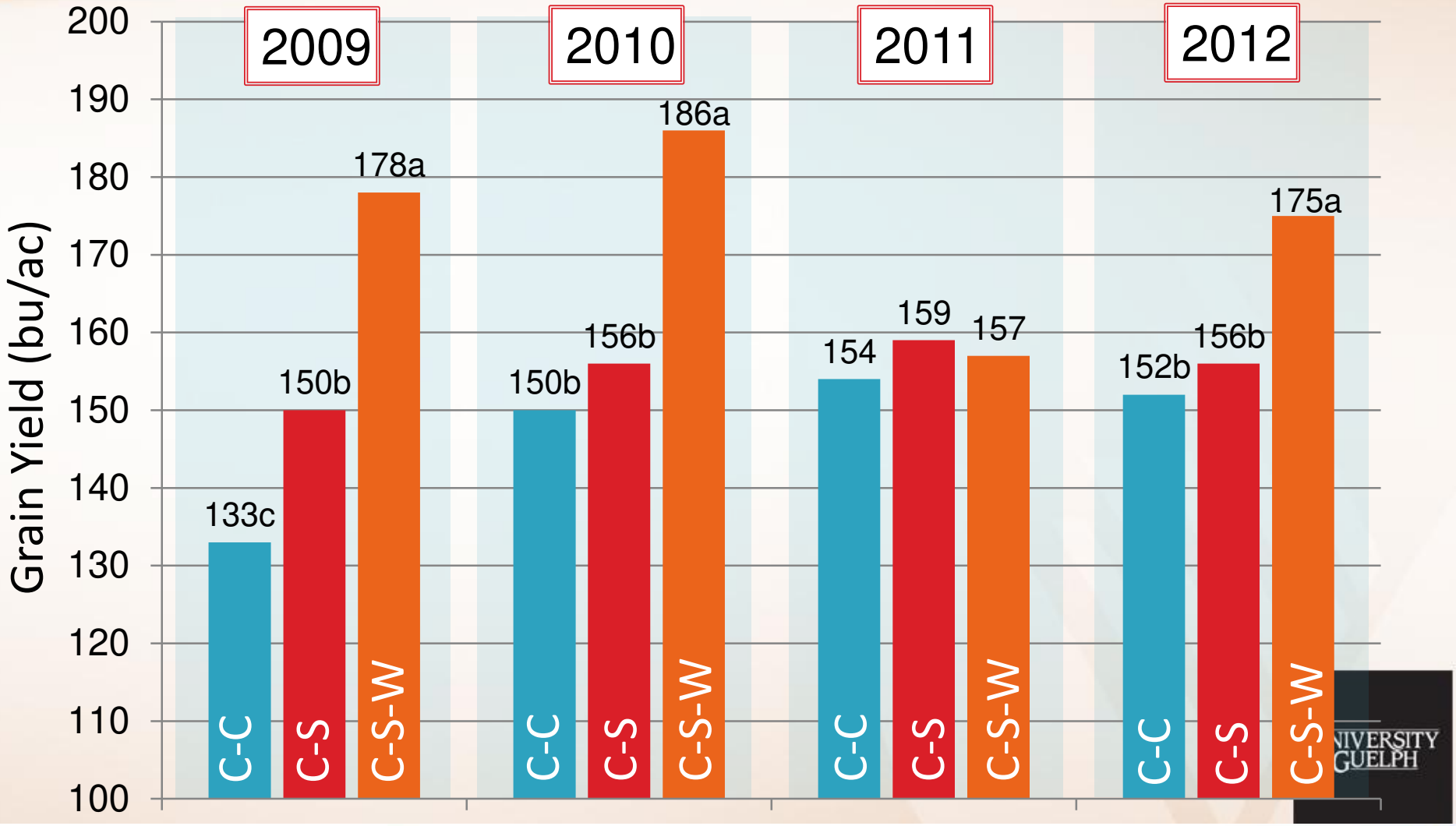


Ridgetown Long-Term Tillage-Rotation

- Established 1995 (by Doug Young)
- 5 Crop Rotations
  - C-C
  - S-S
  - C-S
  - C-S-W
  - S-W
- 4 N treatments in corn and wheat
- Red clover underseeded in wheat plots

1. The "Rotation Effect"

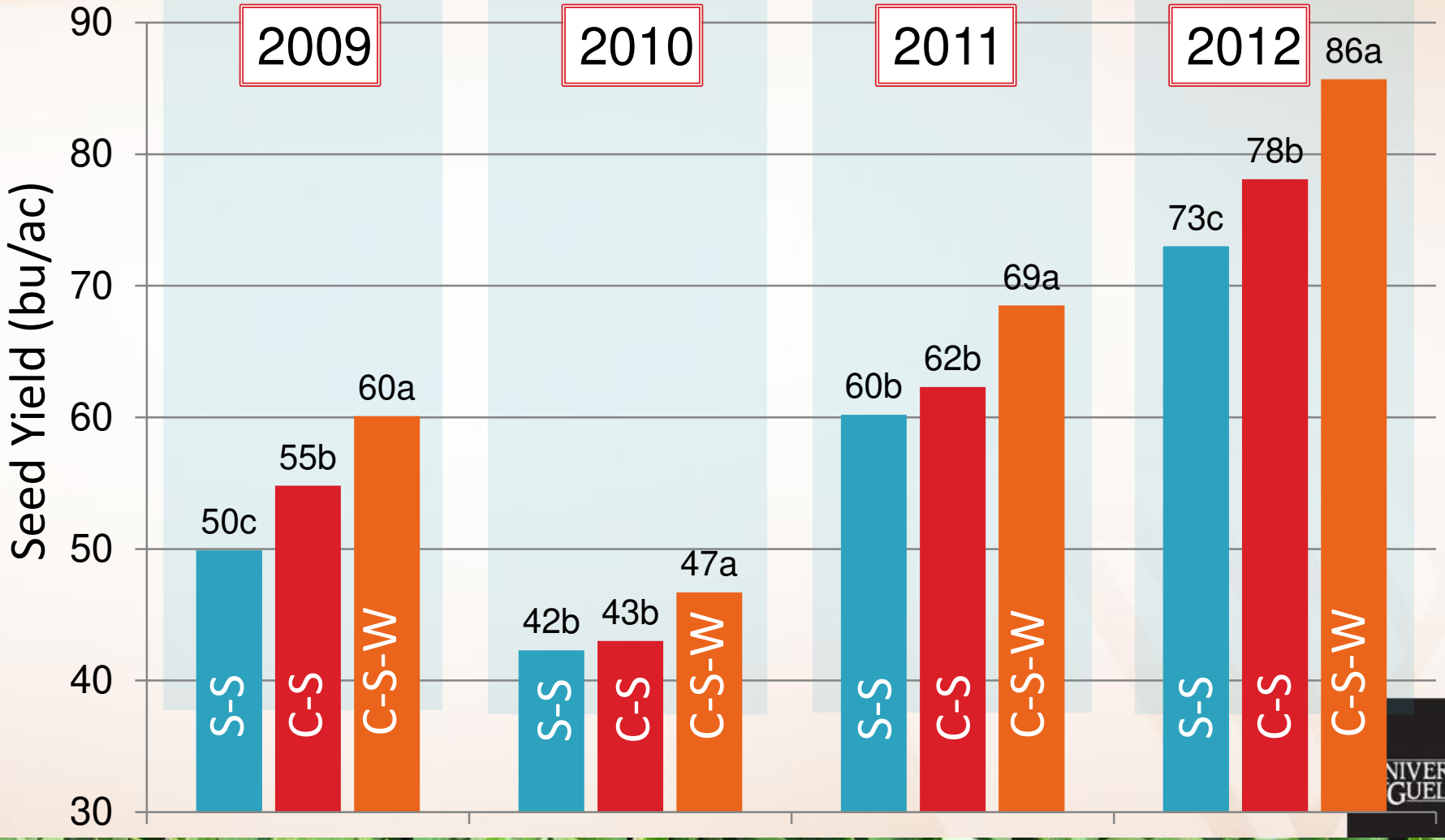
Wheat on Corn Yields Ridgetown 2009-12



Note: Mean separation within year (p=0.05)

1. The "Rotation Effect"

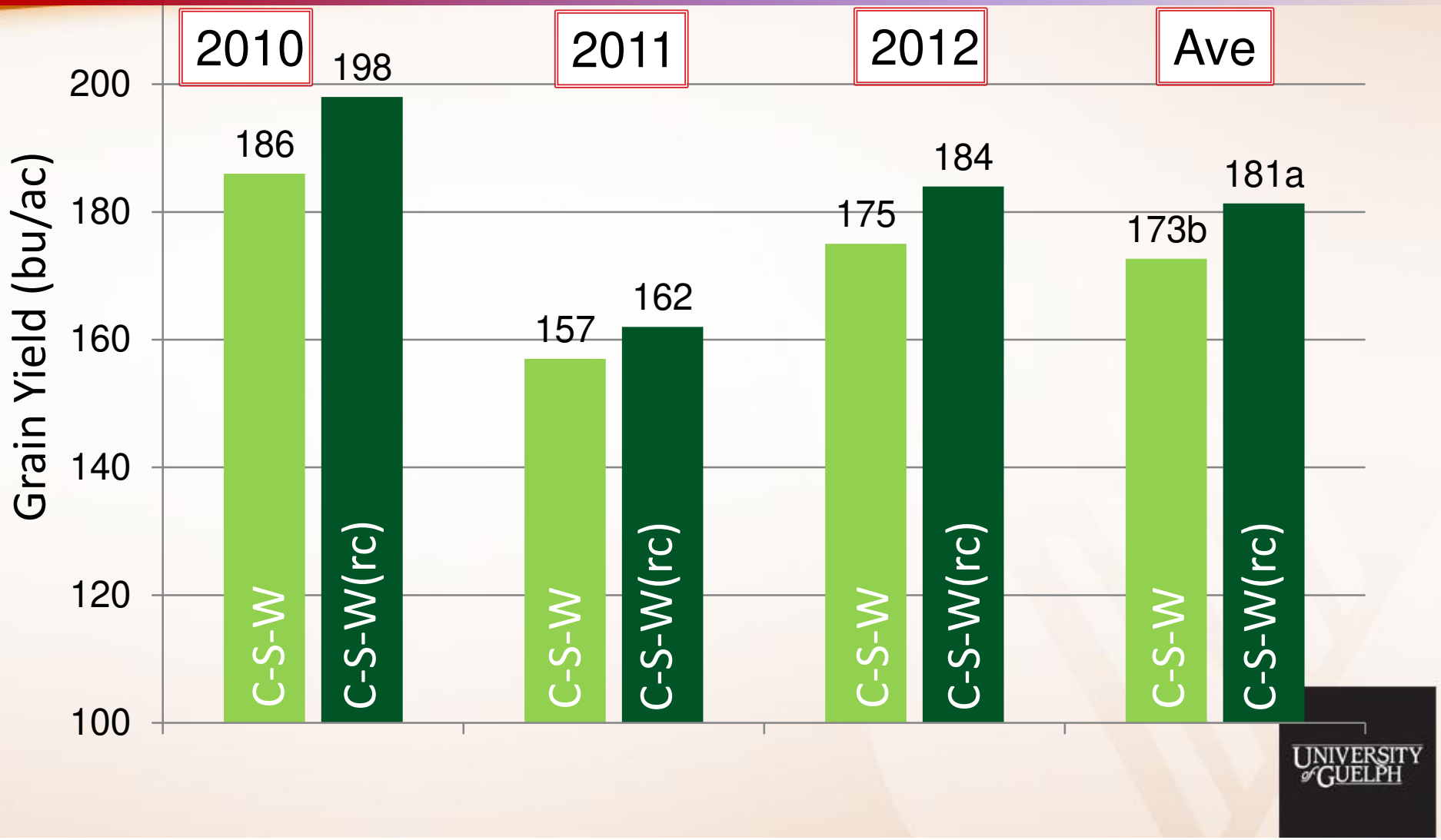
Wheat on Soybean Yields Ridgetown 2009-12



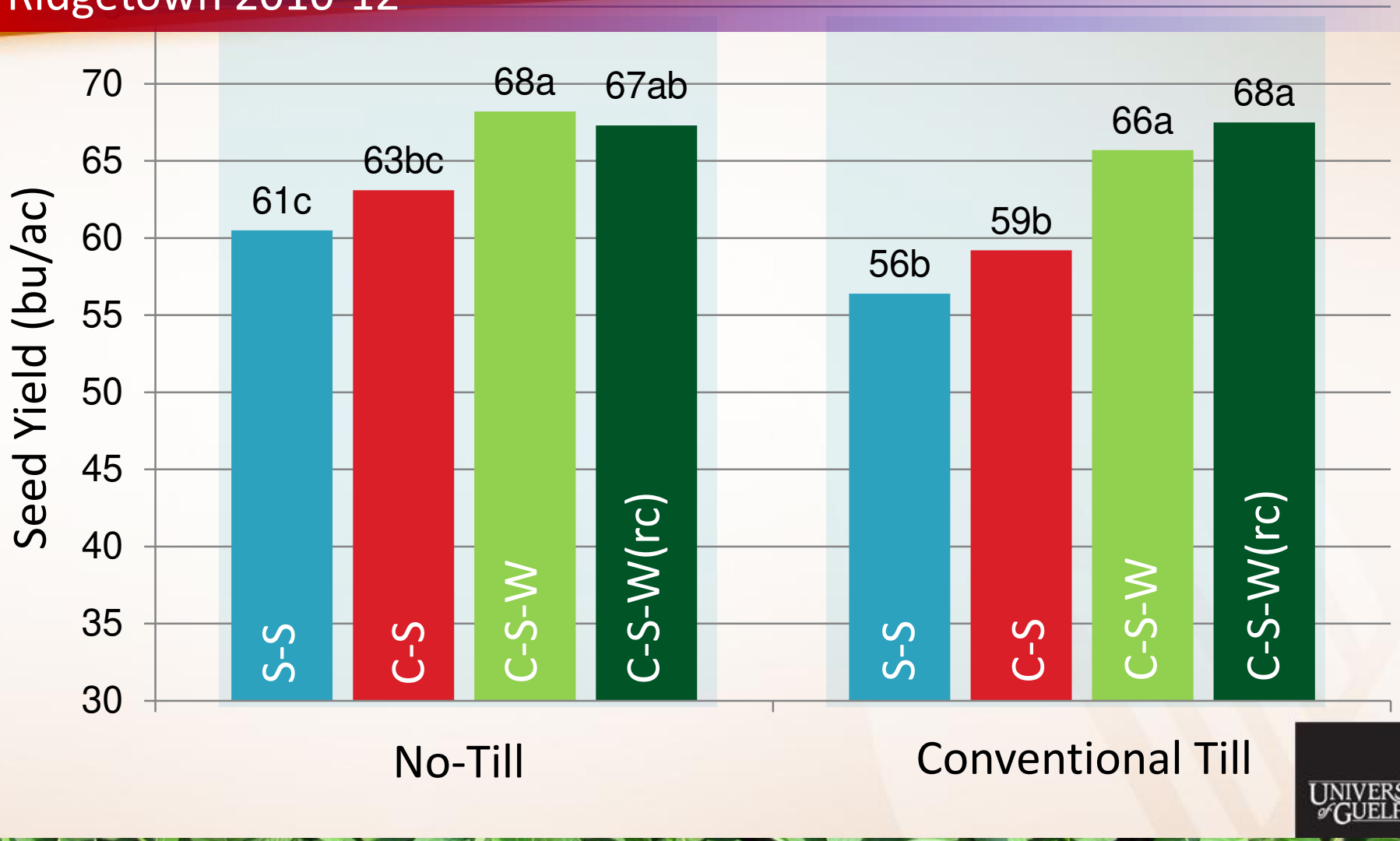
Note: Mean separation within year (p=0.05)

Corn Yields after Wheat +/- Red Clover,

Ridgetown 2010-12



Soybean Yields with Wheat +/- Red Clover,
Ridgetown 2010-12



Note: Mean separation within tillage system (p=0.05)

Table 2. Analysis of maximum economic rates of nitrogen, yield gains and profits associated with red clover inter-seeded to winter wheat under different tillage systems and maize and nitrogen prices.

Tillage system	Maize price [1]	N cost	Cover crop	MERN [2]	MEY [3]	Gross return [4]	Profit
	$ Mg^{-1}	$ Kg^{-1}		Kg N ha^{-1}	Mg ha^{-1}	$ ha^{-1}	
Conventional tillage	150	1	No red clover	143	9454	1293	89
			Red clover	79	9886	1382	
			Difference,	**	**	**	
			Rotational effect (%)		4.57%		
	100	1	No red clover	129	9338	822	66
			Red clover	74	9841	888	
			Difference	**	**	**	
			Rotational effect (%)		5.38%		
	150	1.5	No red clover	129	9338	1234	118
			Red clover	74	9841	1352	
			Difference	**	**	**	
			Rotational effect (%)		5.38%		
	100	1.5	No red clover	107	9068	772	90
			Red clover	63	9713	863	
			Difference	**	**	**	
			Rotational effect (%)		7.11%		

Analysis was conducted using paired comparison of red clover/no red clover for different tillage groups and N rates on a subset of 28 site-year from the Ontario Nitrogen Database project [79–124]. [1] Maize price after drying, handling and marketing; [2] Maximum Economic Rate of Nitrogen (MERN) calculated using quadratic-plateau functions; [3] Maximum Economic Yield (MEY) at MERN; [4] Gross return based on nitrogen cost and maize yield at MERN with clover establishment cost estimated at $40 ha^{-1}; ns: non significant; ** significant at $p < 0.01$.

Gaudin et al, 2013. Agron.

Estimated gross margin of C/S rotation

	Corn	Soy
Yield (bu/ac)	175	50
$/bu	5.25	12.00
Gross Revenue ($/ac)	918.75	600.00
Operating Expenses ($/ac)	477.00	231.00
Gross Margin ($/ac)	441.75	369.00

Operating expenses taken from 2012 OMAFRA Crop Budgets - (http://www.omafra.gov.on.ca/english/busdev/facts/pub60.htm)
Nutrient price taken from October 2012 - Ridgetown Input Price Survey - http://www.ridgetownc.uoguelph.ca/research/research_reports_topic.cfm?ref=FARM_INPUT_PRICES

Estimated gross margin of C/S/W rotation – No red clover

	Corn	Soy		Wheat
Yield (bu/ac)	175	50		80
$/bu	5.25	12.00		7.00
Gross Revenue ($/ac)	918.75	600.00		560.00
Operating Expenses ($/ac)	477.00	231.00		274.00
Gross Margin ($/ac)	441.75	369.00		286.00
Adj Gross Margin ($/ac)	487.69	417.00		368.50
GM Diff ($/ac)	45.94	48.00		82.50
True Gross Margin ($/ac)	**441.75**	**369.00**		**462.44**
Adjustments				
Rotation Adjustment (%)	5	8		0
Straw Revenue ($/ac)				82.50
Red Clover (adj for stand success) (%)	0	0		0
Red clover N Adj (adj for stand success) ($/ac)	0.00			
Double crop revenue - oat/pea				Bonus

Straw Value		
Straw yield	2500	lbs
Straw value in winrow	0.04	$/lb
Nutrient removal	0.007	$/lb
Net straw value	0.033	$/lb

Red cover N credit		
Ncorn N rate reduction	75	lbs/ac
Nitrogen cost	0.5	$/lb
Red clover success rate	0.00	

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Estimated gross margin of C/S/W rotation – Red clover

	Corn	Soy		Wheat
Yield (bu/ac)	175	50		80
$/bu	5.25	12.00		7.00
Gross Revenue ($/ac)	918.75	600.00		560.00
Operating Expenses ($/ac)	477.00	231.00		274.00
Gross Margin ($/ac)	441.75	369.00		286.00
Adj Gross Margin ($/ac)	571.13	447.00		368.50
GM Diff ($/ac)	129.38	78.00		82.50
True Gross Margin ($/ac)	**441.75**	**369.00**		**575.88**
Adjustments				
Rotation Adjustment (%)	5	8		0
Straw Revenue ($/ac)				82.50
Red Clover (adj for stand success) (%)	5	5		0
Red clover N Adj (adj for stand success) ($/ac)	37.50			

Straw Value		
Straw yield	2500	lbs
Straw value in winrow	0.04	$/lb
Nutrient removal	0.007	$/lb
Net straw value	0.033	$/lb

Red cover N credit		
Ncorn N rate reduction	75	lbs/ac
Nitrogen cost	0.5	$/lb
Red clover success rate	1.00	

Operating expenses taken from 2012 OMAFRA Crop Budgets - (http://www.omafra.gov.on.ca/english/busdev/facts/pub60.htm)
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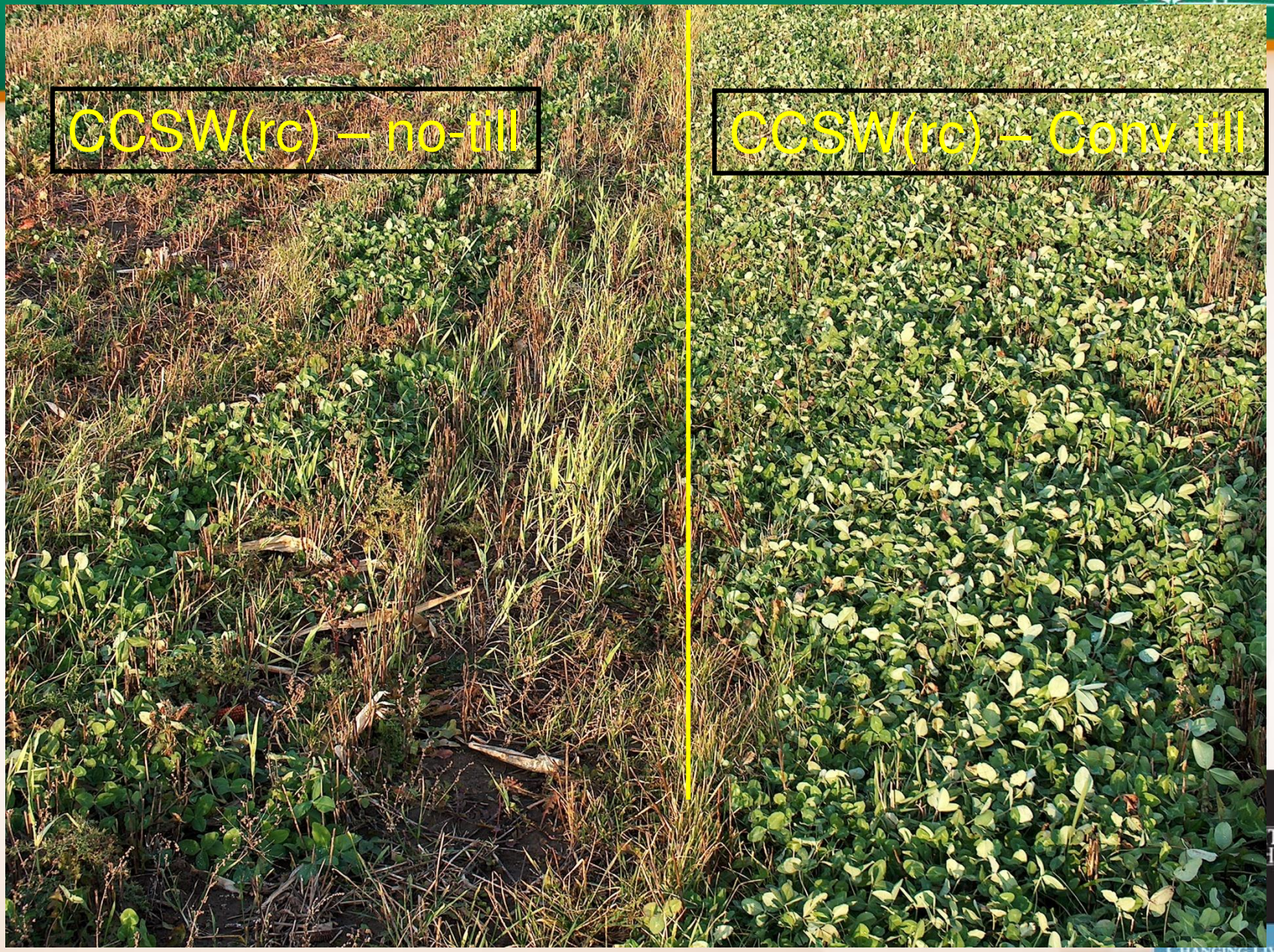
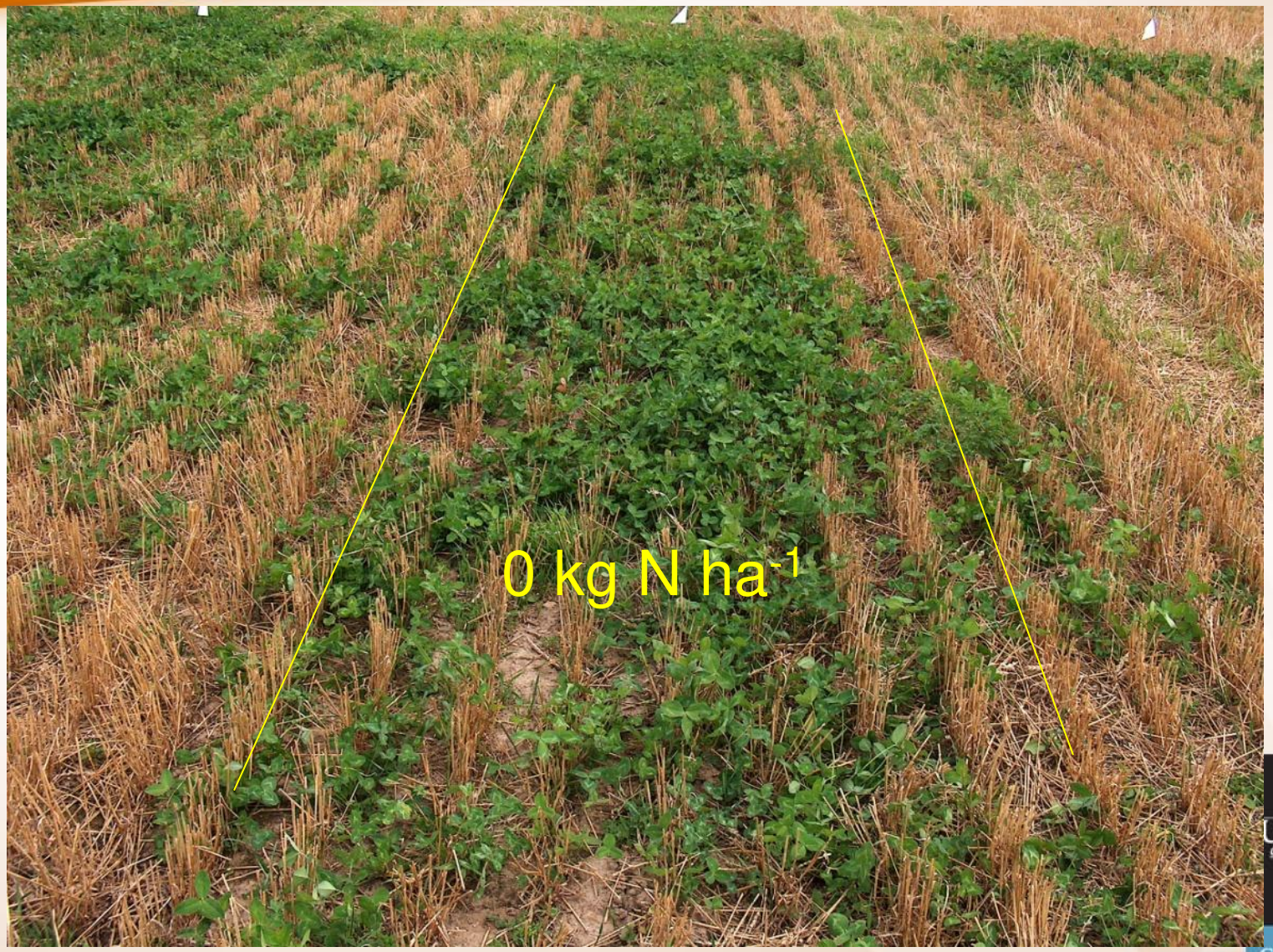
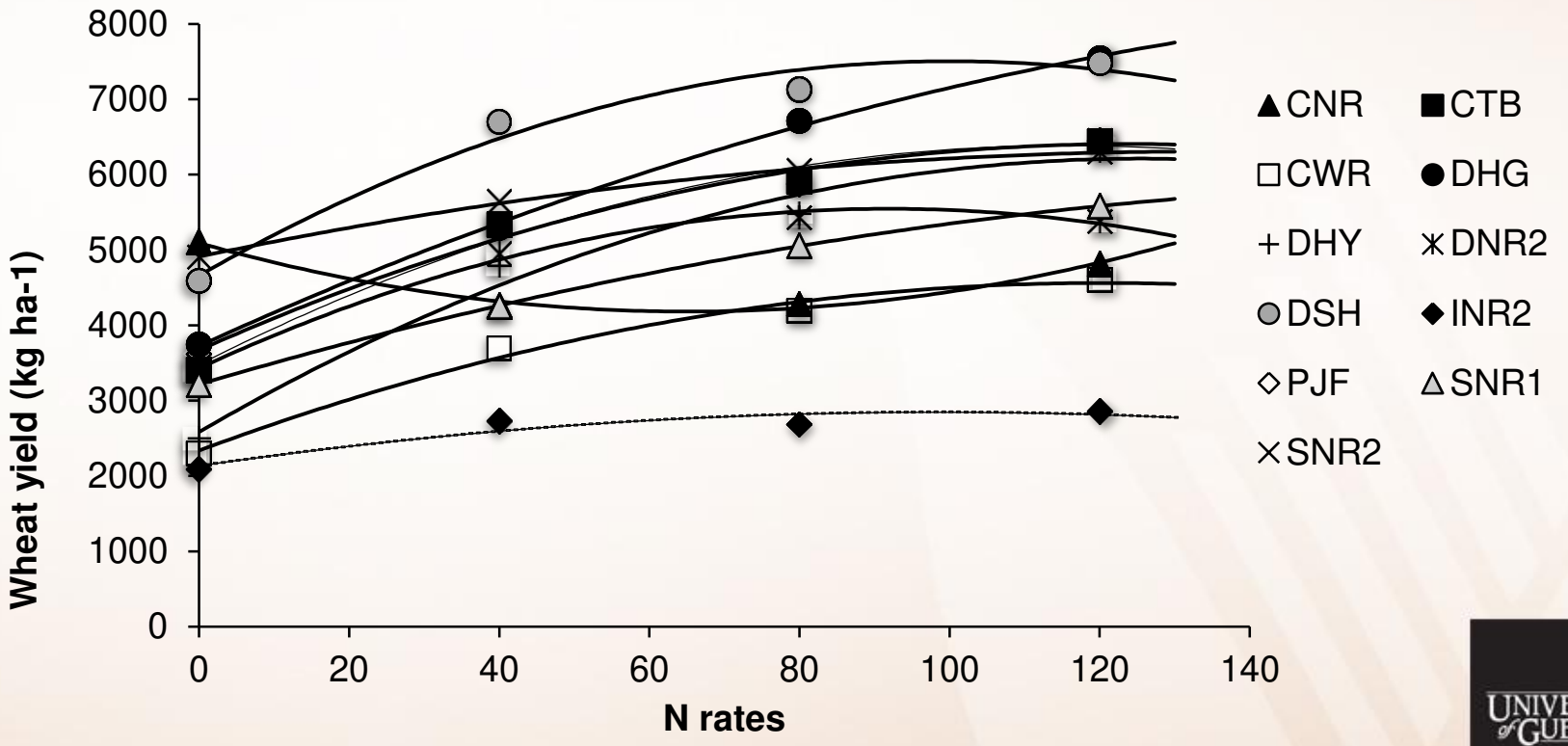
Overcoming red clover non-uniformity

- Red clover broadcast timing
- Drilling versus broadcasting
- Wheat row spacing
- Wheat tillage system
- Wheat N rate
- Drought tolerance

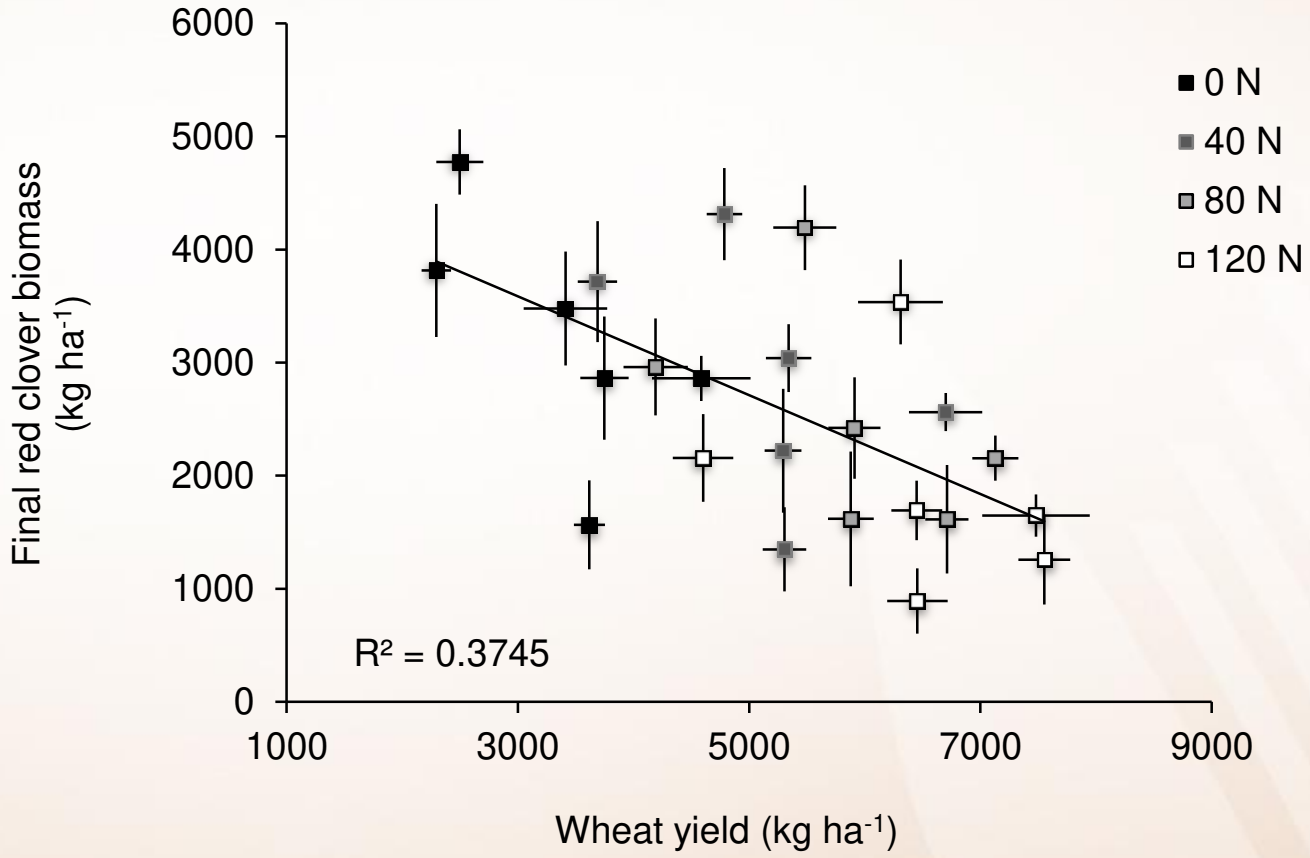

CCSW(rc) – no-till
CCSW(rc) – Conv till

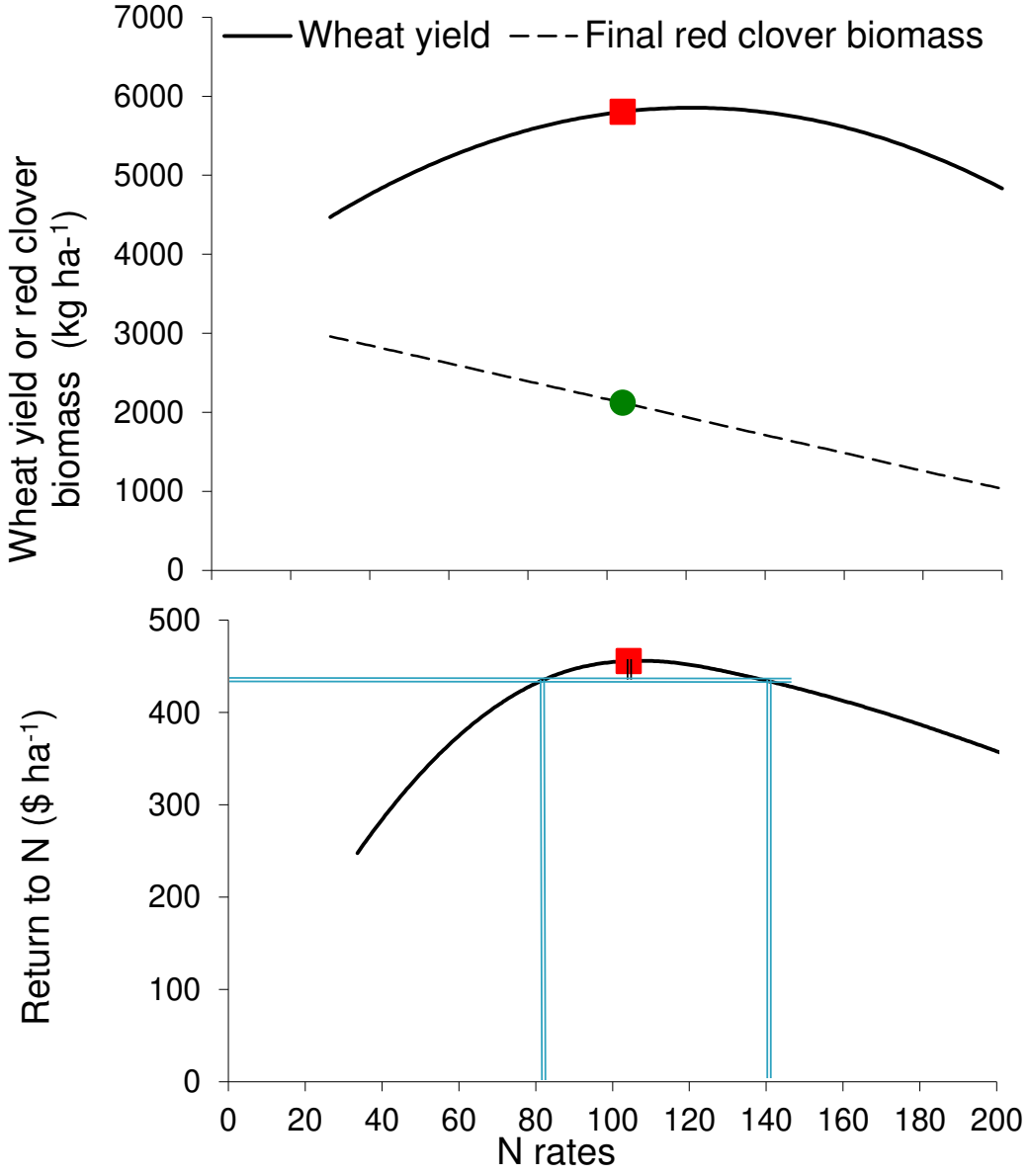

0 kg N ha-1

Wheat biomass N response curves



Effect of wheat yield on red clover biomass



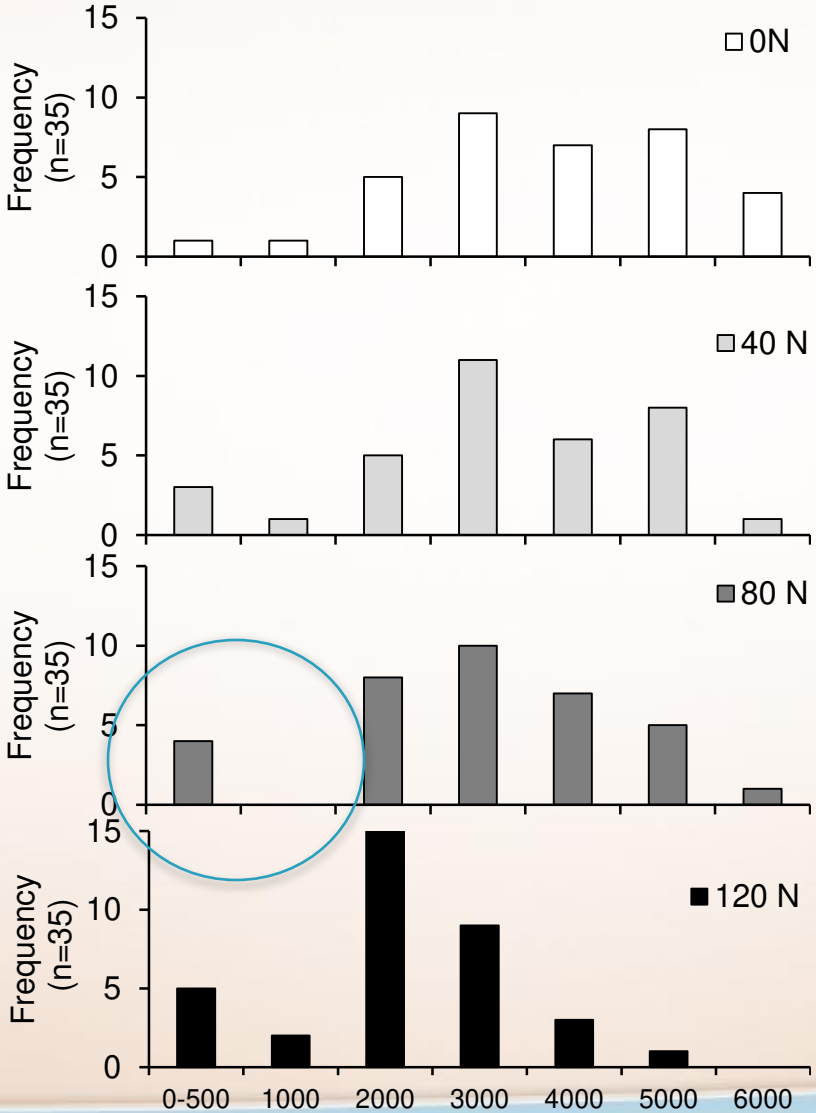


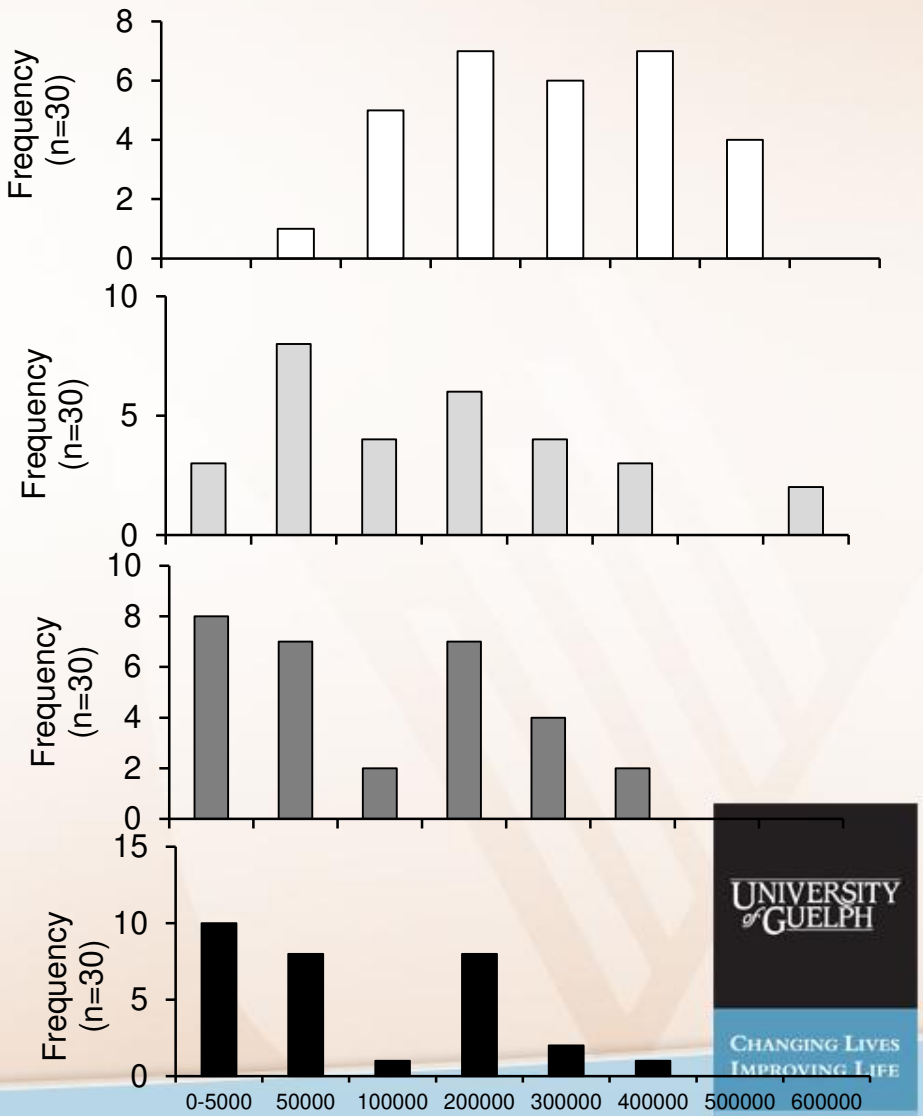
MERN = 104 kg N ha^{-1}

Yield at MERN = 5910 kg ha^{-1}

RC biomass at MERN = 2119 kg ha^{-1}

Effect of N on RC biomass and stand count distribution

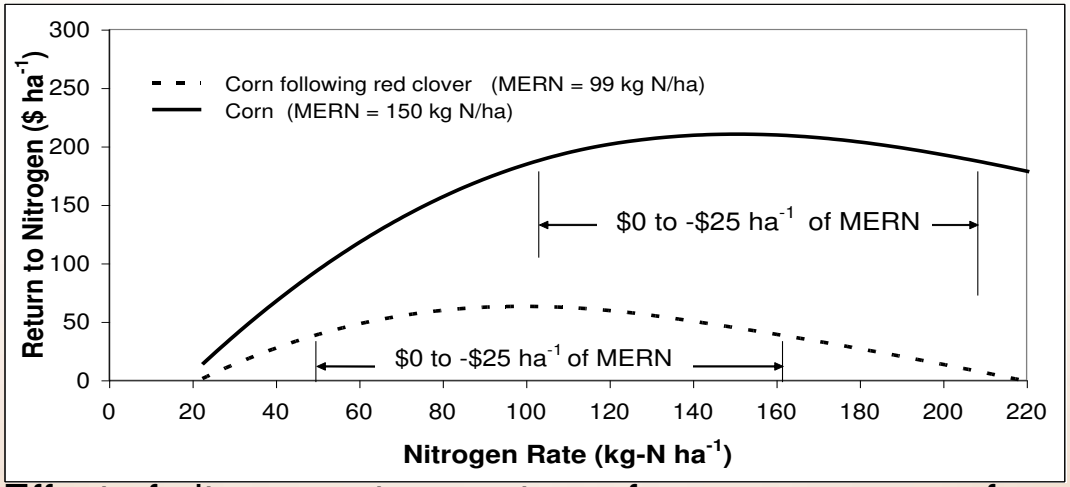




Poor red clover stands – variable N application?

Key questions:

- Can ground-based or UAV image systems map variable stands?
- What is the relationship between image and RC biomass?
- What is the relationship between RC biomass and nitrogen credit?
- Does N application equipment match spatial scale of RC variability?
- Is it economical?



Effect of nitrogen rate on returns for corn, average of 19 pair-wise comparisons between 1990-99. (N @ 1.00 $Cdn kg-1, corn @ 100 $Cdn t-1)

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