Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Agronomy Update

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125 YEARS of AGRICULTURAL RESEARCH
ANS de RECHERCHE en AGRICULTURE

Rooted in Science • Innovating for the Future
S'enraciner dans la science • Innover pour l'avenir

Contributors

- **Bill May, AAFC – Indian Head**
- **Chris Holzapfel, IHARF**
- **Brian McConkey, AAFC Swift Current**
- **Fran Walley, U of Saskatchewan**

Questions

- **Nitrogen Management Options for logistical reasons rather than for efficiency?**
- **Canola Fertility and Re-Cropping Studies.**
- **Why we need to maintain the focus on finding ways to increase yields?**

Question: Alternate strategies to reduce fertilizer handling at seeding time.

Options for Nitrogen Form, Timing and Placement

Placement and Timings	Nitrogen Forms		
	Ammonia	Urea	Liquid UAN
In-Soil Fall	√	√	√
In-Soil Spring	√	√	√
In-Soil @ Seeding	√	√	√
Late Fall Broadcast	X	√	√
Early Spring Broadcast	X	√	√
In-Crop Broadcast	X	√	√

Challenge
Balancing Efficiency with Practicality or Logistics

Options to reduce fertilizer handling at seeding time

Placement and Timings	Nitrogen Forms		
	Ammonia	Urea	Liquid UAN
In-Soil Fall	√	√	√
In-Soil Spring	X	X	X
In-Soil @ Seeding	X	X	X
Late Fall Broadcast	X	X	X
Early Spring Broadcast	X	X	X
In-Crop Broadcast	X	√	√

Options to reduce fertilizer handling at seeding time

Placement and Timings	Nitrogen Forms		
	Ammonia	Urea	Liquid UAN
In-Soil Fall	√	√	√?
In-Soil Spring	X	X	X
In-Soil @ Seeding	X	X	X
Late Fall Broadcast	X	X	X
Early Spring Broadcast	X	X	X
In-Crop Broadcast	X	√?	√

Some are questionable!

Options to reduce fertilizer handling at seeding time

Placement and Timings	Nitrogen Forms		
	Ammonia	Urea	Liquid UAN
In-Soil Fall	√	√	√?
In-Soil Spring	X	X	X
In-Soil @ Seeding	X	X	X
Late Fall Broadcast	X	X	X
Early Spring Broadcast	X	X	X
In-Crop Broadcast	X	√?	√

If we remove the questionable ones,
What are we left with?

!

Options to reduce fertilizer handling at seeding time

Placement and Timings	Nitrogen Forms		
	Ammonia	Urea	Liquid UAN
In-Soil Fall	√	√	X
In-Soil Spring	X	X	X
In-Soil @ Seeding	X	X	X
Late Fall Broadcast	X	X	X
Early Spring Broadcast	X	X	X
In-Crop Broadcast	X	X	√

Final List of Possibilities if you want to reduce fertilizer handling at seeding...

Closer look at UAN applied after seeding or in-crop…

Important Information

- Peak N uptake in canola is between start of flowering and end of pod formation.
- Peak N uptake in spring wheat is just prior to appearance of flag leaf.
- In-crop N applications requires earlier applications

In-Crop UAN Application – Some questions?

- Do you need some starter N at seeding?
- If so, what is the proportion of starter N at seeding?
- What about timing?
- What about losses for surface dribbling UAN?

Some Answers to the Questions

- Risks can be reduced if a minimum of 50% of the target N rate is applied at seeding based on studies with wheat and canola
- In-crop applications in spring wheat – up to the 5.5 leaf stage
- In-crop applications in canola – from start to mid-bolting stage
- No effects on grain protein in spring wheat at this growth stage.

What about UAN losses from surface dribble applications?

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (66%) kg/ha	UAN-N (34%) 3 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
Brandon/2005					
Brandon/2006					
Brandon/2007					
Indian Hd/2005					
Indian Hd/2006					
Indian Hd/2007					

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (66%) kg/ha	UAN-N (34%) 3 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
Brandon/2005	70				
Brandon/2006	70				
Brandon/2007	70				
Indian Hd/2005	31				
Indian Hd/2006	44				
Indian Hd/2007	90				

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (66%) kg/ha	UAN-N (34%) 3 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
Brandon/2005		46	24		
Brandon/2006		46	24		
Brandon/2007		46	24		
Indian Hd/2005		21	10		
Indian Hd/2006		29	15		
Indian Hd/2007		59	31		

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (66%) kg/ha	UAN-N (34%) 3 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
Brandon/2005				1.5	6.2
Brandon/2006				2.8	11.6
Brandon/2007				1.7	6.9
Indian Hd/2005				1.0	15.0
Indian Hd/2006				5.6	37.3
Indian Hd/2007				5.8	18.6

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (50%) kg/ha	UAN-N (50%) 5 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
S. Current/2005	60				
S. Current/2006	90				
S. Current/2007	90				
Ottawa/2005	100				
Ottawa/2006	100				
Ottawa/2007	100				

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (50%) kg/ha	UAN-N (50%) 5 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
S. Current/2005		30	30		
S. Current/2006		45	45		
S. Current/2007		45	45		
Ottawa/2005		50	50		
Ottawa/2006		50	50		
Ottawa/2007		50	50		

What about UAN losses from surface dribble applications?

Location/Year	Total N Applied kg/ha	Urea Side-band (50%) kg/ha	UAN-N (50%) 5 leaf stage kg/ha	UAN-N losses as ammonia Kg/ha	UAN-N Losses %
S. Current/2005				1.2	4.0
S. Current/2006				2.4	5.3
S. Current/2007				3.9	8.7
Ottawa/2005				2.1	4.2
Ottawa/2006				0.7	1.4
Ottawa/2007				7.7	15.4

Summary of Losses

# of Locations	12
Maximum Losses %	37.3
Minimum Losses %	1.4
Mean %	
Median %	

Summary of Losses

# of Locations	12
Maximum Losses %	37.3
Minimum Losses %	1.4
Mean %	15.9
Median %	6.9

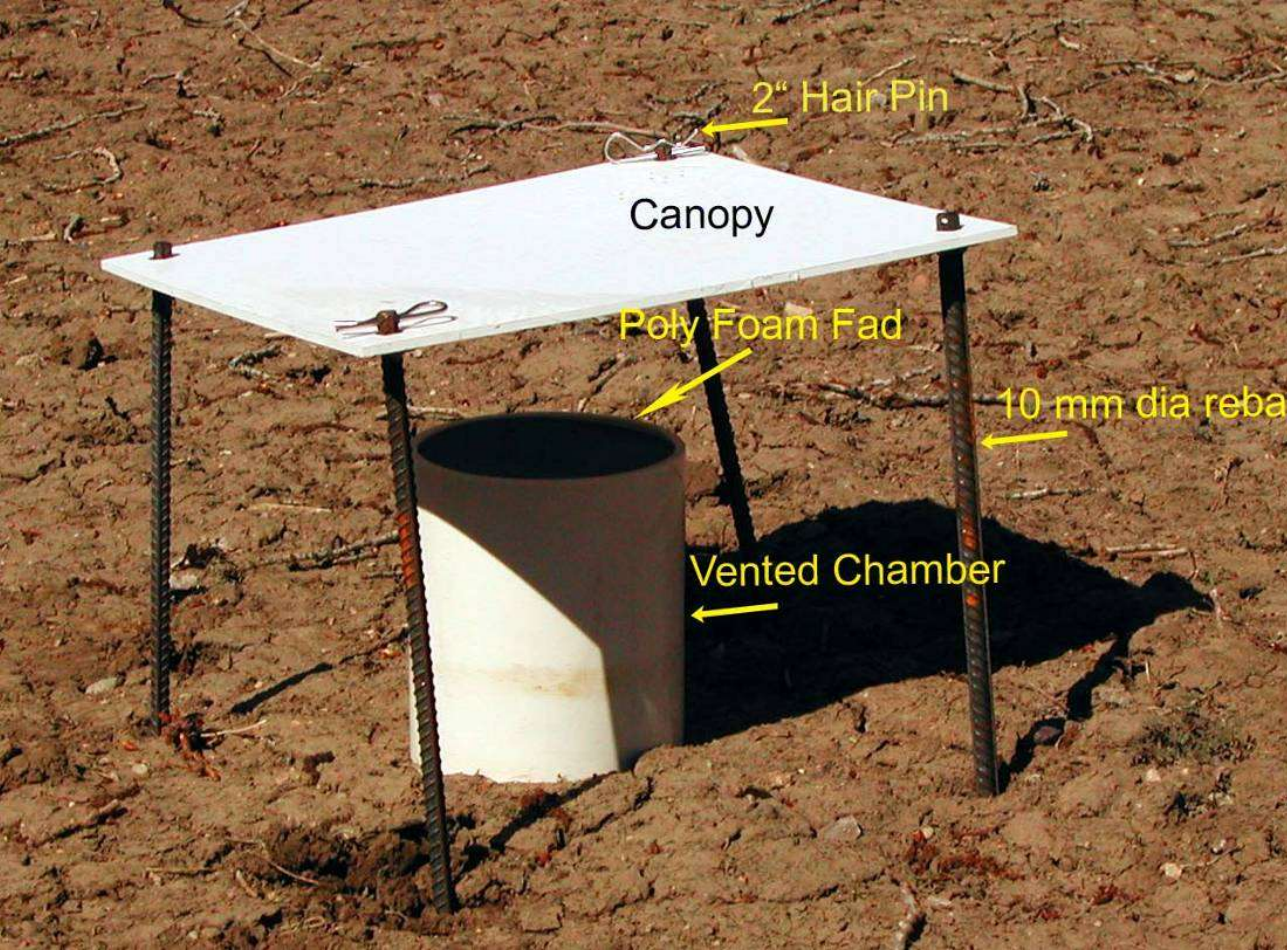
Summary of Losses

# of Locations	12
Maximum Losses %	37.3
Minimum Losses %	1.4
Mean %	**15.9**
Median %	**6.9**

What about UAN vs Urea from losses surface applications?

Location/Year	% Losses as Ammonia	
	Urea	UAN
S. Current/2005	6.5	3.5
S. Current/2006	10.1	5.1
S. Current/2007	14.3	7.1
Mean	10.3	5.2

What impact does methodology have on the result?


2" Hair Pin
Canopy
Poly Foam Fad
10 mm dia reba
Vented Chamber

What impact does methodology have on the result?

1. No rainfall was allowed into the containers so we don't have the benefit of rainfall moving the fertilizer into the soil.
2. The presence of the acidified disk would create a diffusion gradient within the chamber
3. End-result is a probable over-estimation of the values reported or worst case scenario.

Conclusions for UAN Surface Applied

1. Based on grain yield results, surface applied UAN is not high risk.
2. Banding ammonia in the fall results in some loss possibly 10-20%.
3. Field and plot trials support in-Crop UAN applications based on grain yields.

What about Urea?
Fall Band vs Side Band@seeding

Crop	Grain Yield (kg/ha)		
	Fall-Band	Side-band @seeding	
Spring wheat	1693	1754	+4%
Flax	1136	1320	+16%

Conclusions about In-Crop UAN Surface Applications

1. Low overall risk
2. Equipment in is place to do it i.e. a sprayer
3. Some Investments in dribble surface band nozzles

Canola Production

Canola Production

Factors affecting overall productivity

- -Soil Fertility
- -Crop Rotations / Recropping


Canola Re-Cropping
Field Pea Management Study
Indian Head, SK

Description of Study

- Three Rotations
  - Continuous Pea
  - Wheat – Pea
  - Wheat – Wheat -Pea
- Duration 1995-2011 (17 years)
- No canola on this land prior to 2012
- Re-Cropped to Canola in 2012

Canola
Results - 2012

Field Pea Rotation	Plants # m^{-2}	Grain Yield (bus/acre)
Wheat – Pea	73	34.6
Continuous – Pea	65	33.8
Wheat – Wheat - Pea	71	34.7
Significance	ns	ns

General Conclusions

-17 Years of different field pea intensities did not influence canola grain yields.

Other Studies – Melfort and Scott
Canola Yields (bus/ac)

Crop Rotation	Dry Years (2000-2003)	Moister Years (2004-07)
Continuous Canola	16.0	31.3
Canola – Wheat	23.9	37.8
Canola – Wheat – Pea	**26.1**	**41.0**
Canola – Wheat – Pea –Wheat	23.0	39.6
Canola – Wheat – Flax -Wheat	23.0	37.4

Other Studies – Melfort and Scott Canola Yields (bus/ac)

Crop Rotation	Dry Years (2000-2003)	Moister Years (2004-07)
Continuous Canola	16.0	31.3
Canola – Wheat	**23.9**	**37.8**
Canola – Wheat – Pea	26.1	41.0
Canola – Wheat – Pea –Wheat	**23.0**	**39.6**
Canola – Wheat – Flax -Wheat	23.0	37.4

Conclusion

- -Inclusion of Field Pea in Canola Rotations cannot be attributed to yield declines.
- -Key is to make sure you allow enough years between canola crops.

Making Nitrogen with Legume Crops
Is this approach feasible to enhance canola yields?

-Project was initiated in 2008

-Serious concerns were raise about the escalating price of nitrogen fertilizers

-Interest was shown in making more nitrogen from pulse crops.

Study Description

Year 1 - 2009

Crop	Fertilizer Rates
Field Pea	26 kg P_2O_5/ha (No N fertilizer)
Lentil	26 kg P_2O_5/ha (No N fertilizer)
Fababean	26 kg P_2O_5/ha (No N fertilizer)
Fababean (GreenManure)	26 kg P_2O_5/ha (No N fertilizer)
Canola	26 kg P_2O_5/ha + 65 kg N / ha
Spring wheat	26 kg P_2O_5/ha + 60 kg N / ha


Year 2 – 2010 Canola
Year 3 – 2011 Barley
Year 4 – 2012 Canola

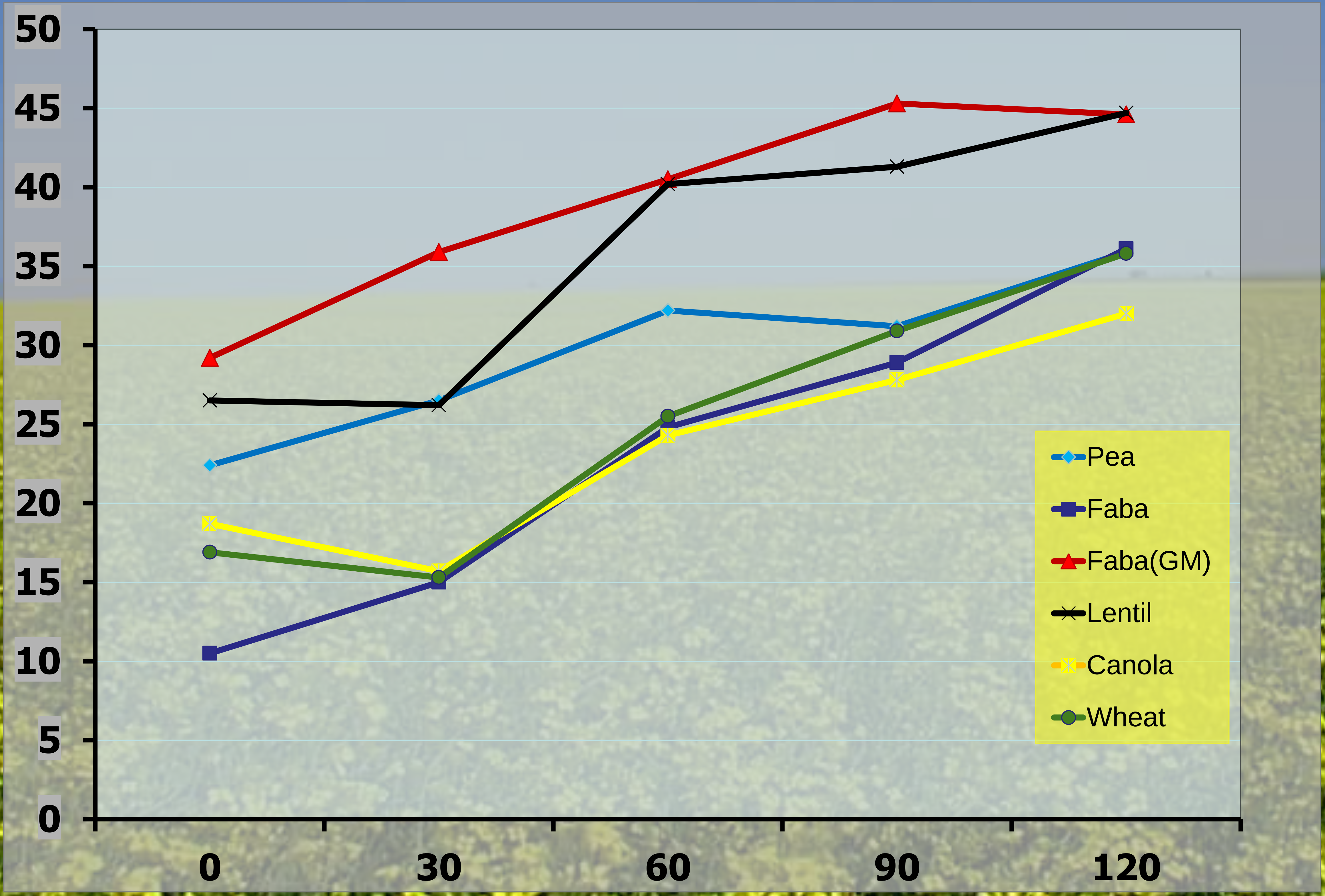
Year 2 – 2010 Canola
Year 3 – 2011 Barley
Year 4 – 2012 Canola

Crop	Fertilizer Rates (kg N/ha)				
	0	30	60	90	120
Field Pea	x	x	x	x	x
Lentil	x	x	x	x	x
Fababean	x	x	x	x	x
Fababean (GreenManure)	x	x	x	x	x
Canola	x	x	x	x	x
Spring wheat	x	x	x	x	x

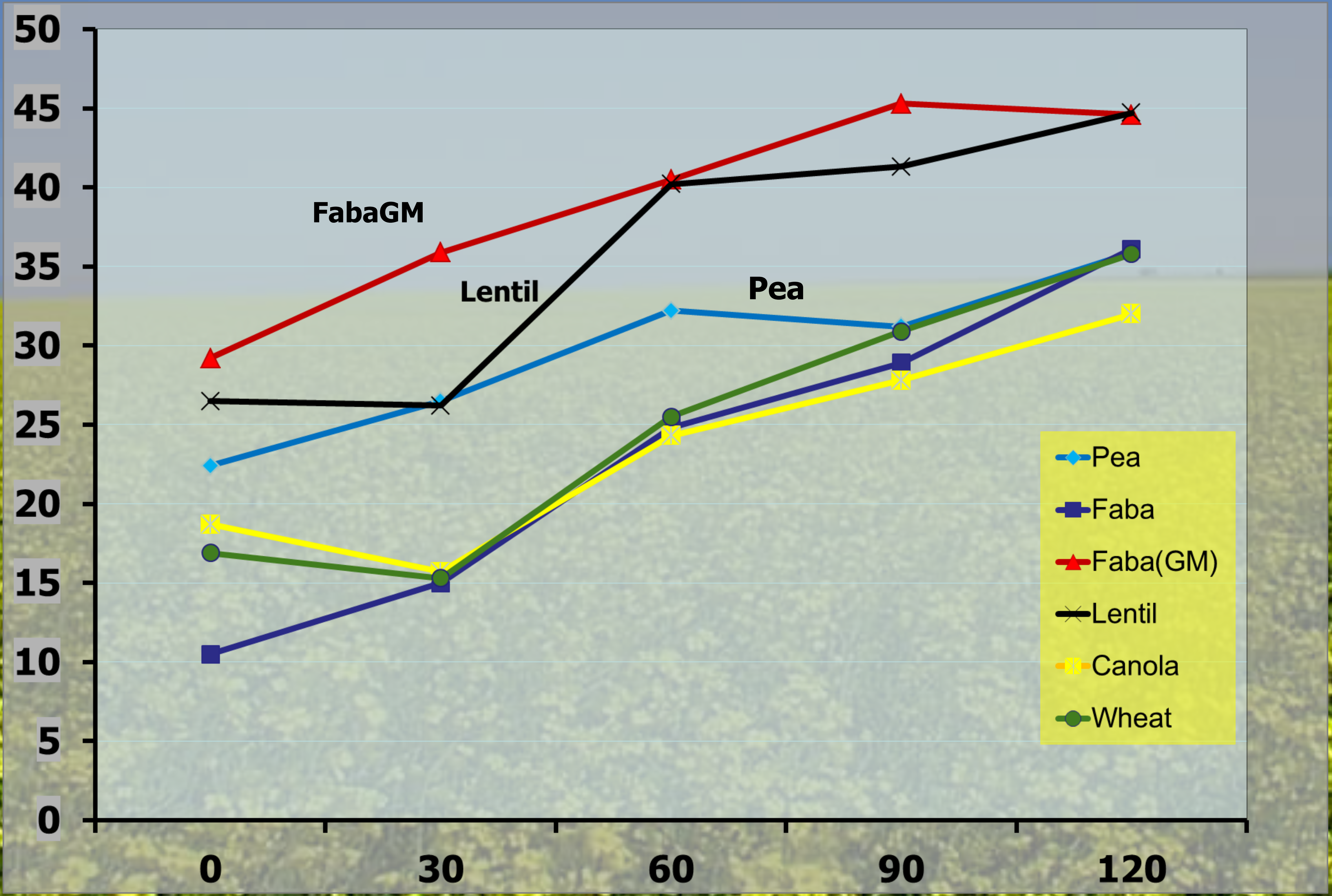
Year 1 – 2009 - Results

Crop	Grain Yield kg/ha	Straw Yield kg/ha	Straw N Yield kg/ha
Field Pea	4016	5344	56
Lentil	3127	4178	44
Fababean	4961	3746	30
Fababean (GreenManure)	-	4782	153
Canola	1883	6776	21
Spring wheat	3863	6188	25

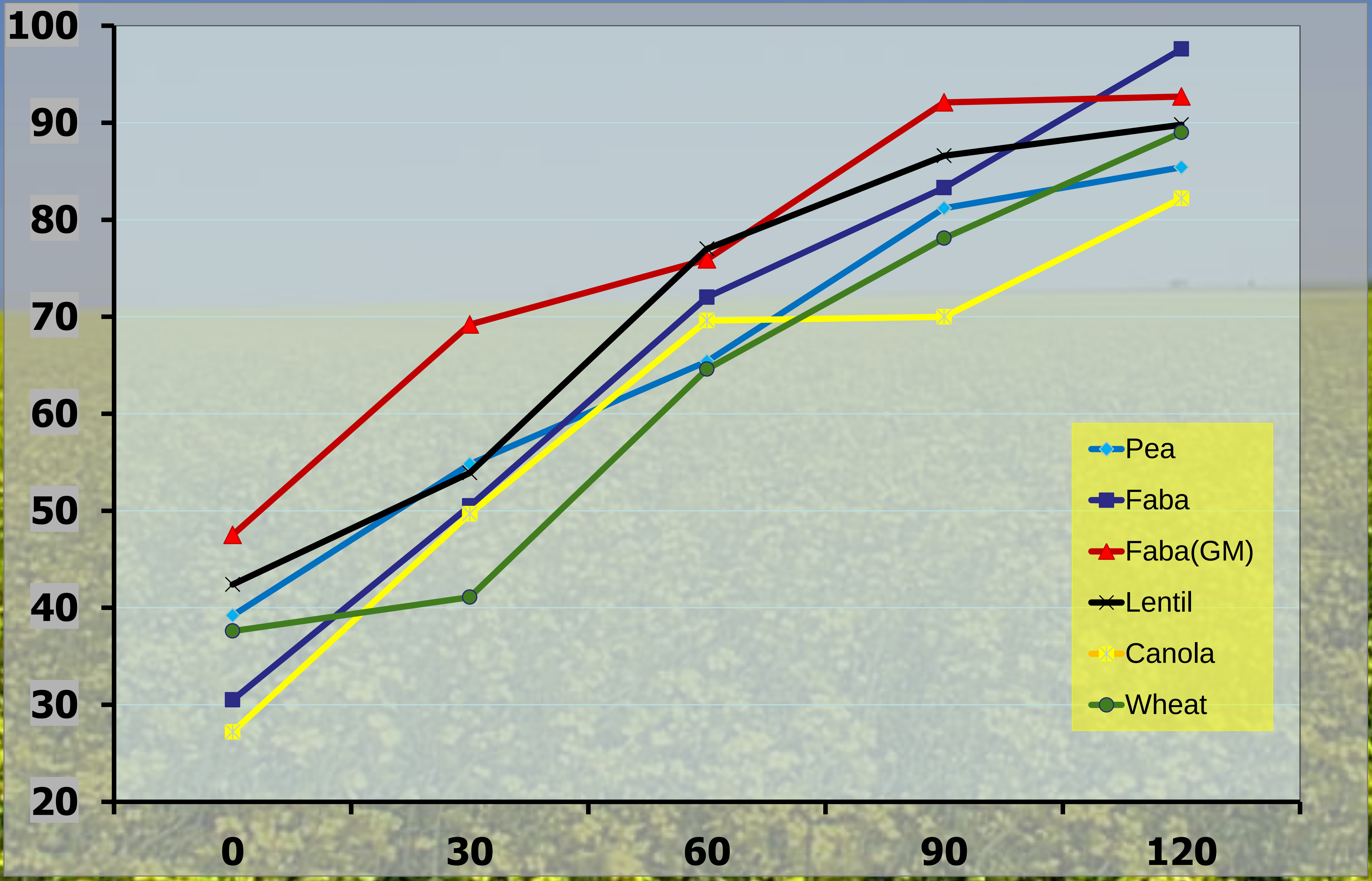
Year 2 – 2010 Canola
Grain Yield (bus/acre)



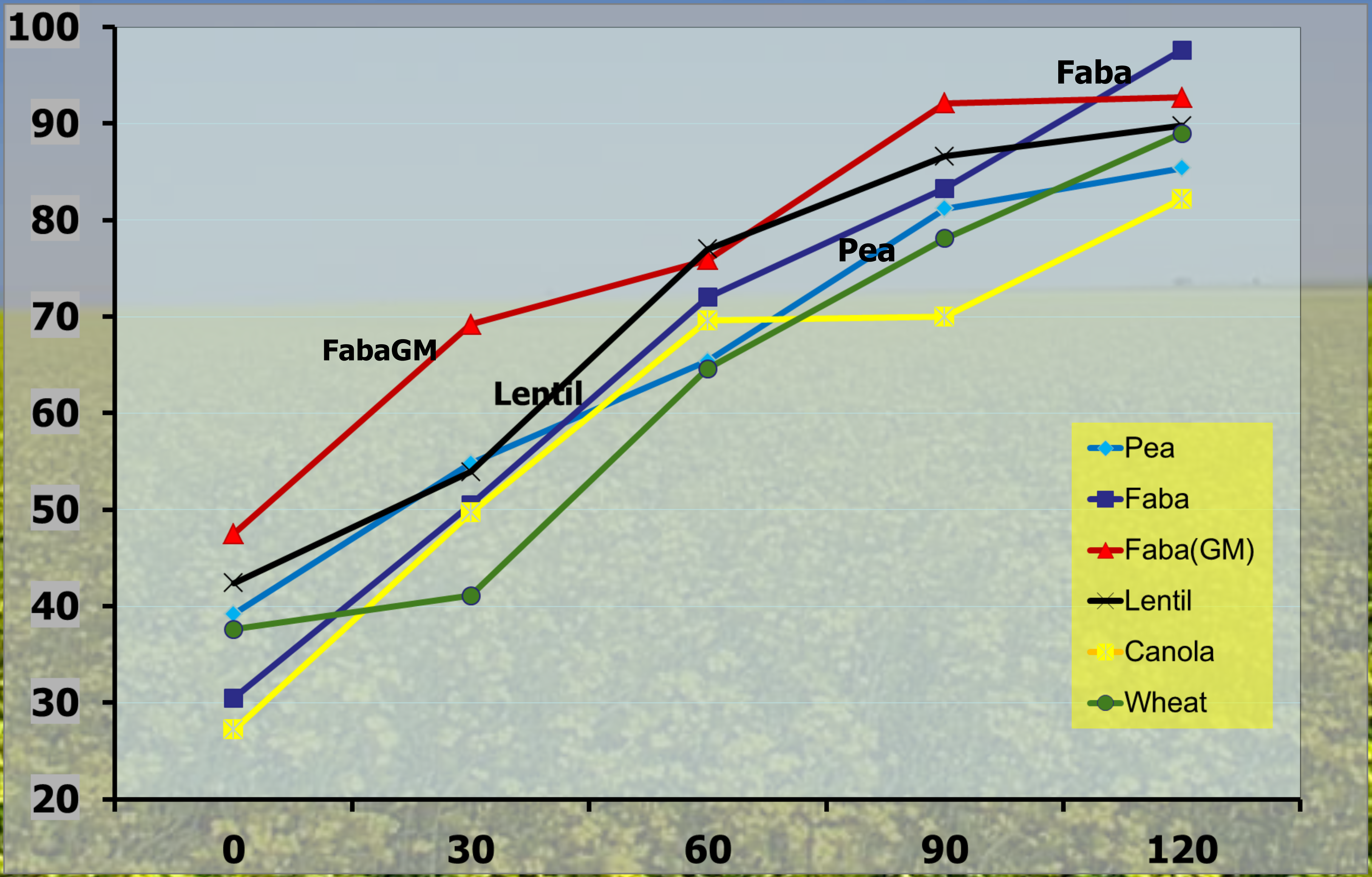
Year 2 – 2010 Canola
Grain Yield (bus/acre)



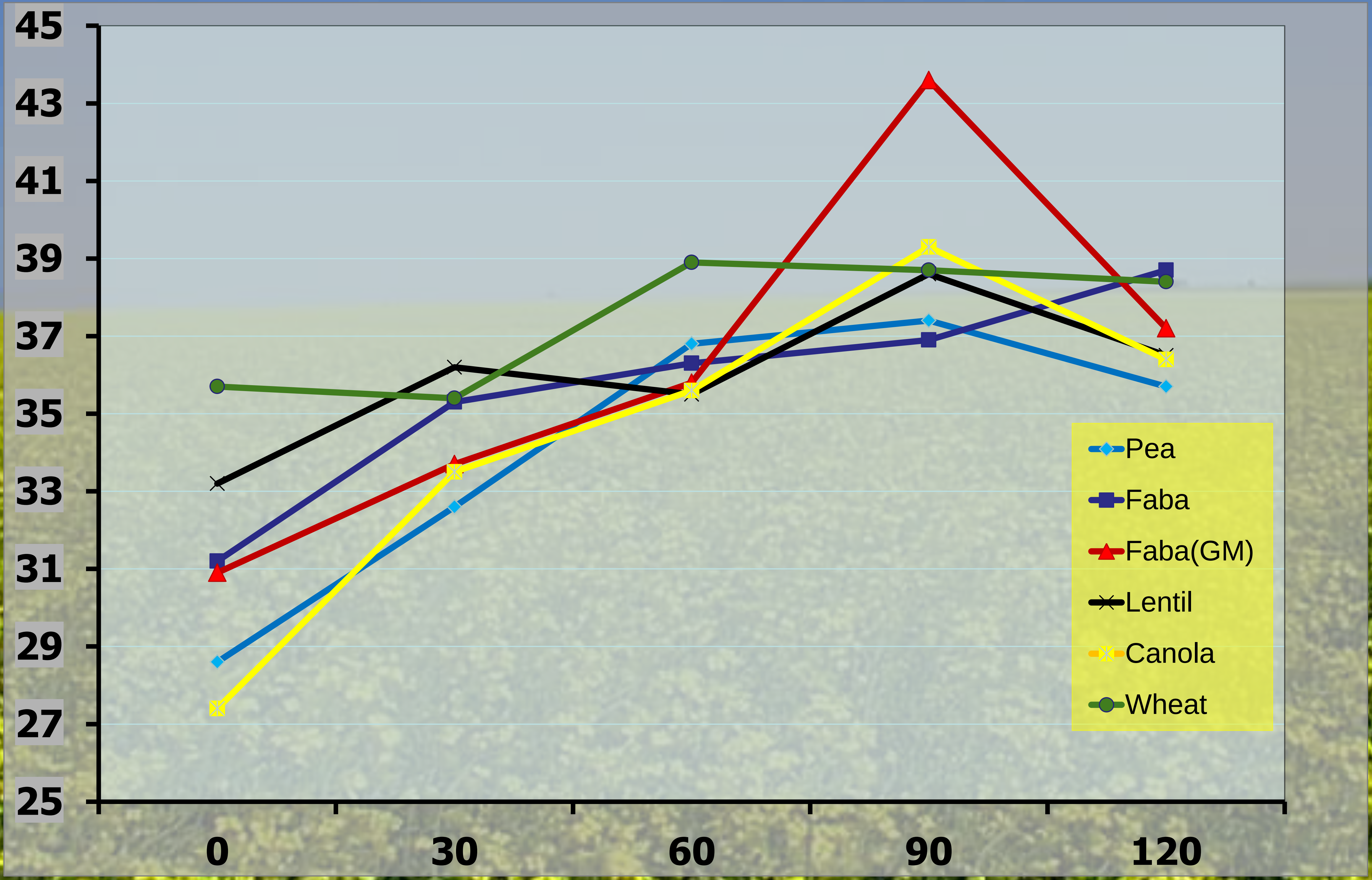
Year 3 – 2011 Barley
Grain Yield (bus/acre)



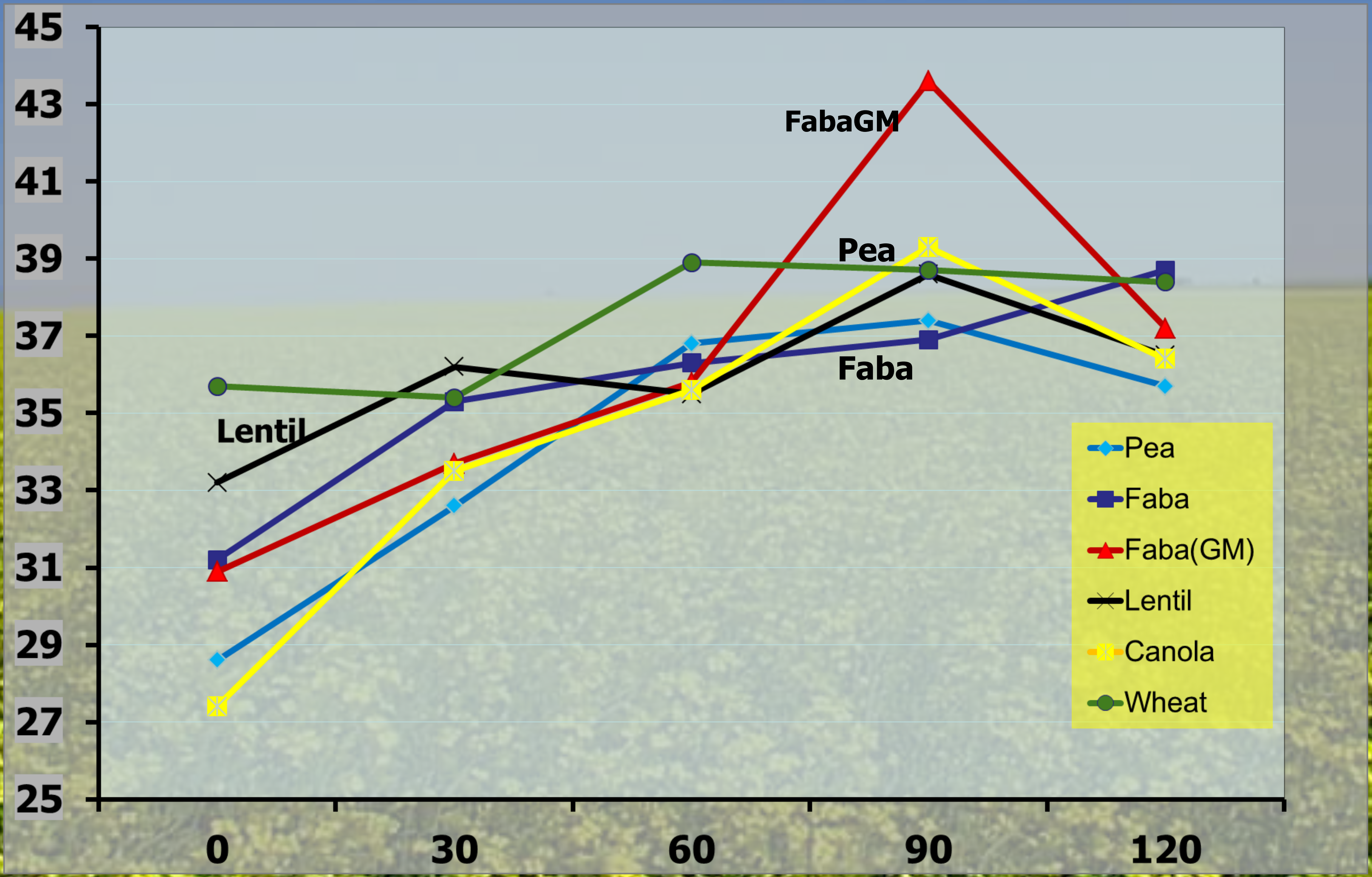
Year 3 – 2011 Barley
Grain Yield (bus/acre)



Year 4 – 2012 Canola
Grain Yield (bus/acre)



Year 4 – 2012 Canola
Grain Yield (bus/acre)



Soil Nitrate – N (0-60cm) (kg/ha)

2009 Crop	Date of Sampling			
	Fall 2009	Spring 2010	Fall 2010	Fall 2011
Field Pea	26.6	57.2	14.8	17.6
Fababean	31.2	27.2	8.8	16.0
Fababean GM	21.7	48.2	15.0	19.6
Lentil	40.6	54.3	15.6	21.9
Canola	11.2	32.9	11.3	19.3
Spring wheat	20.8	33.6	14.1	17.0

Soil Nitrate – N (0-60cm) (kg/ha)

Time of Sampling	N Fertilizer Rate (kg/ha)				
	0	30	60	90	120
Fall 2009	21.0	16.3	19.1	17.1	16.6
Fall 2010	13.3	14.2	14.1	16.3	18.6
Fall 2011	18.6	21.2	21.1	20.4	19.3

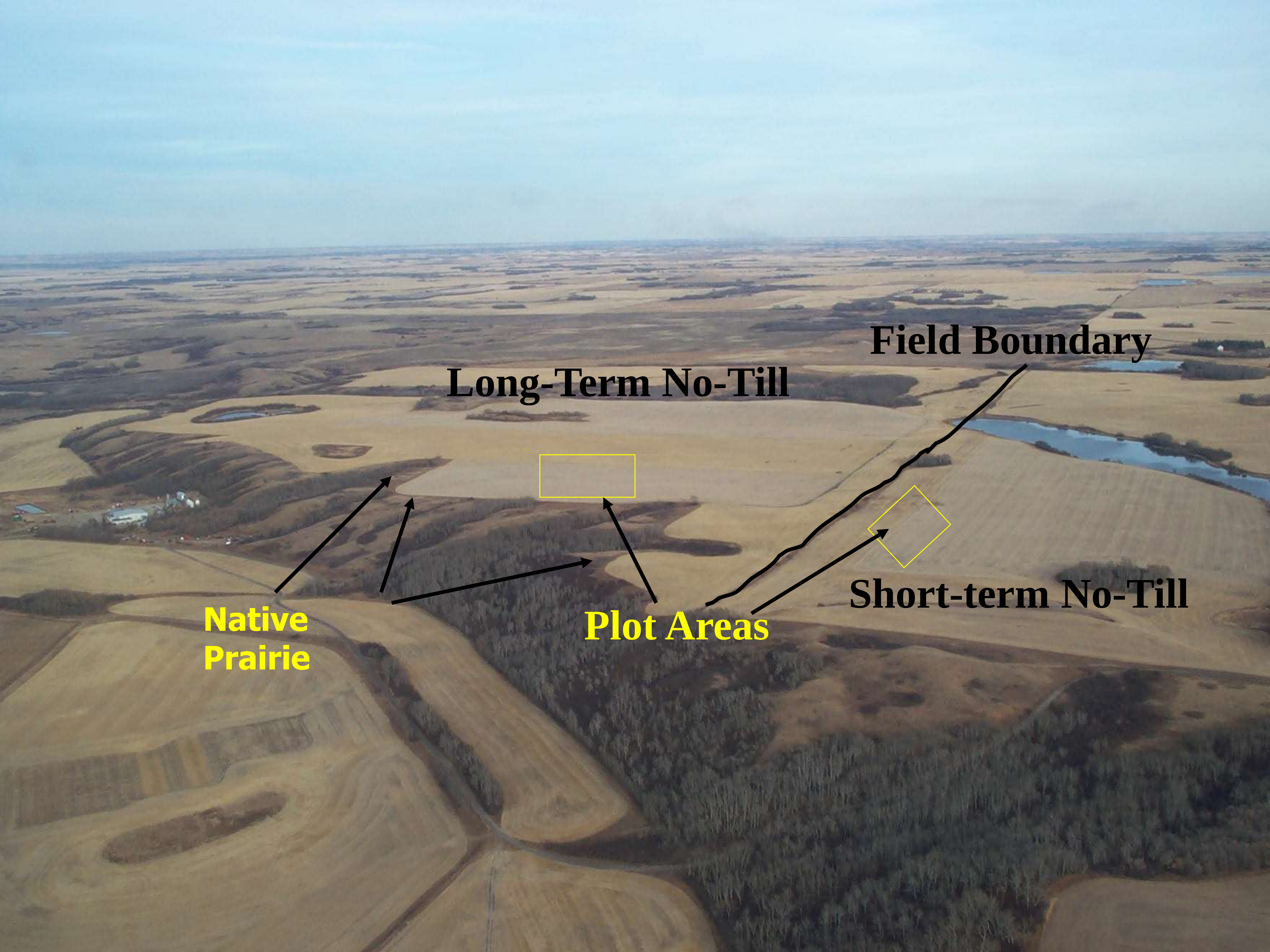
General Conclusions

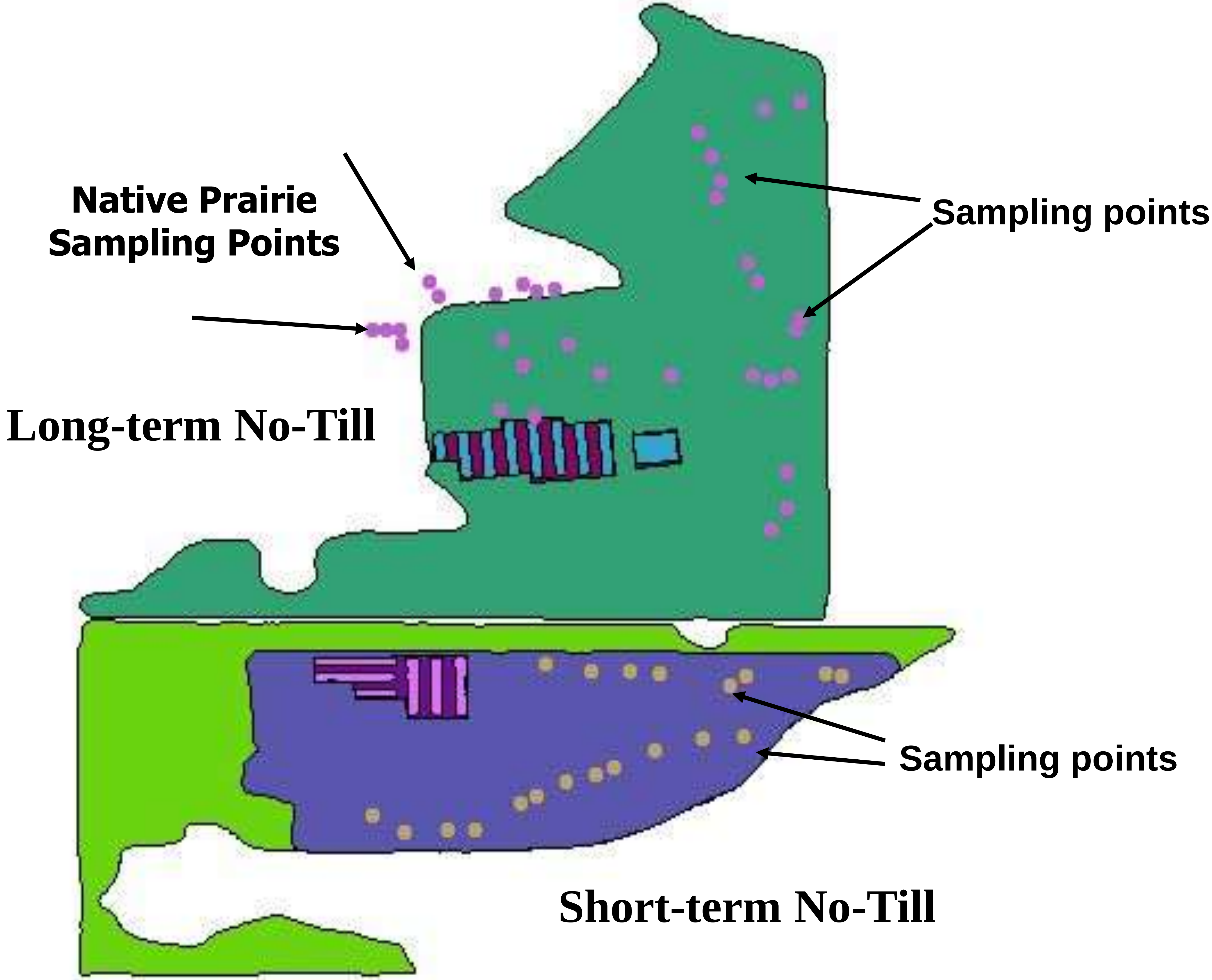
- Growing fababean as a green manure crop increased grain yields for the next two consecutive years
- Growing lentil for seed had a very similar effect
- Economics of taking land out of grain production to grow a green manure crop is questionable
- Can we do the same thing with N fertilizer?


How much improvements in soil quality and crop production can we expect with long-term no-till and N fertilizer?


Long-term No-Till
(1978 -2012)
vs
Short-Term No-Till
(2001-2012)

Characteristics	Long-Term No-till	Short-Term No-till
Soil Type	Oxbow loam (Typic Haplocryoll)	Oxbow loam (Typic Haplocryoll)
Soil Rating	Class 5	Class 5
No-till History	1978-present	2001-present


Field Boundary
Long-Term No-Till
Native
Prairie
Plot Areas
Short-term No-Till


Native Prairie
Sampling Points
Sampling points
Long-term No-Till
Sampling points
Short-term No-Till

Treatments

Long-term No-Till vs Short-term No Till

N Rate (kg/ha)	Seed-Placed P (1 rate)	Side-Banded P (1 rate)
0	√	√
30	√	√
60	√	√
90	√	√
120	√	√

Question #1

Seed-placed P vs Side-banded after 10 years of comparison?

Seed-Placed P vs Side-Banded P

(bus/ac)

Crop	Seed Placed P	Side Banded P	Difference
Spring Wheat	38.5	40.0	3.9%
Canola	22.8	22.5	ns

Seed-Placed P vs Side-Banded P

Plants per meter square

Crop	Seed Placed P	Side Banded P	% Difference
Spring Wheat	302	312	+3.4%
Canola	126	155	+23%

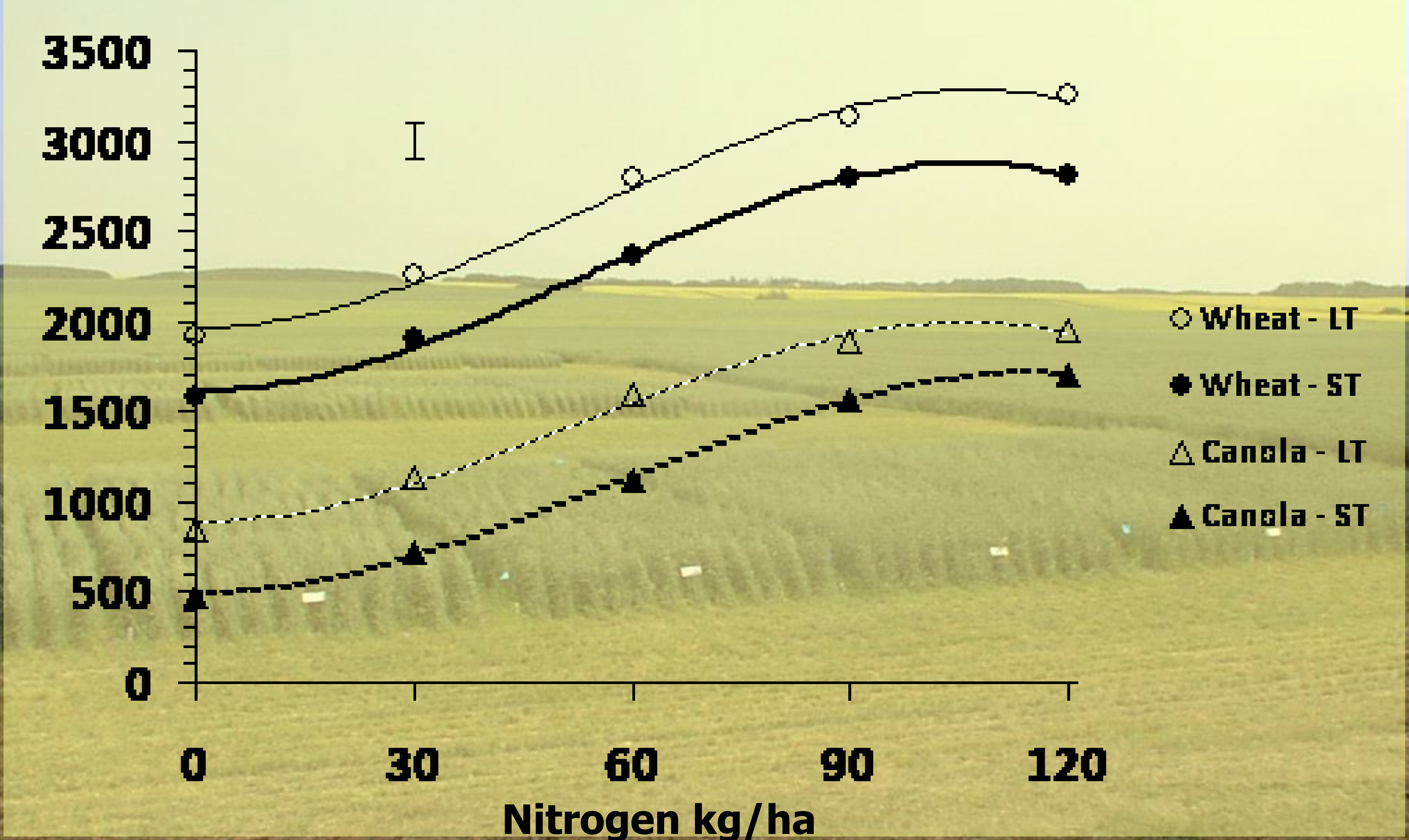
General Conclusions about P Placement

- **Maybe we are too focused on Seed-placed P vs Side-band P.**
- **The focus should be placed on getting the seeding done in a timely manner.**

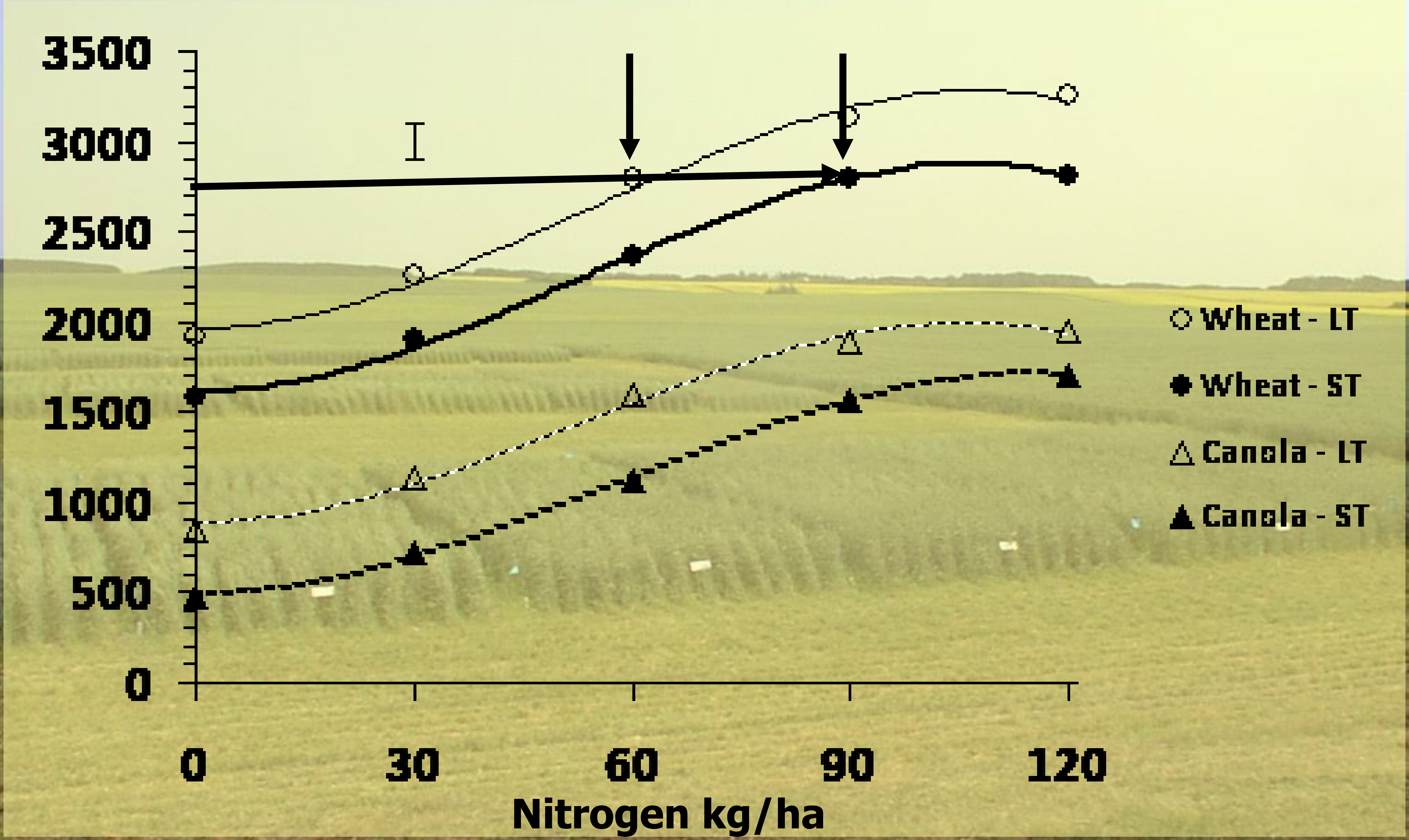
Question #2

What is N response for wheat and canola under LT and ST No-till?

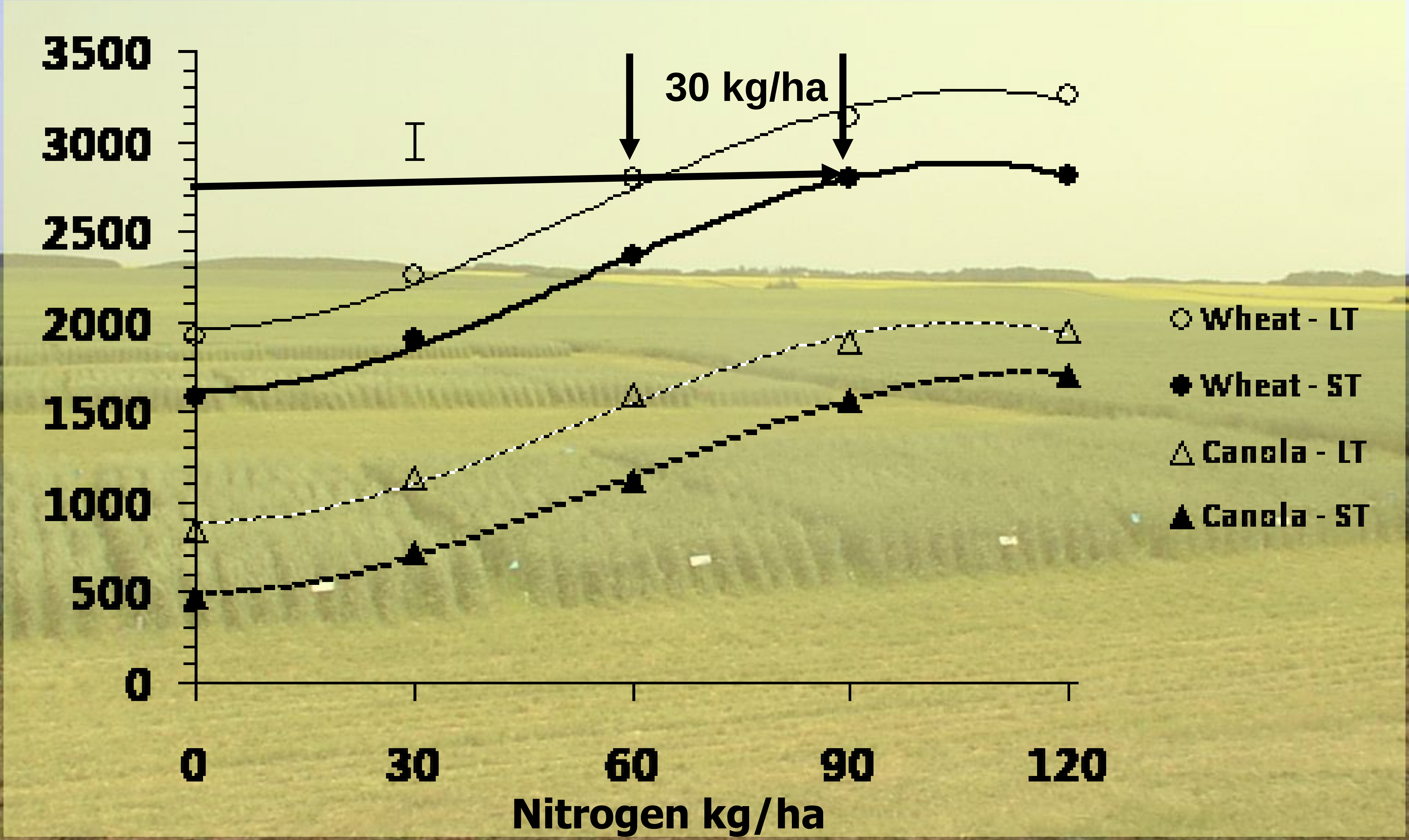
Spring Wheat and Canola (2002-2009) Average Grain Yield (kg/ha)



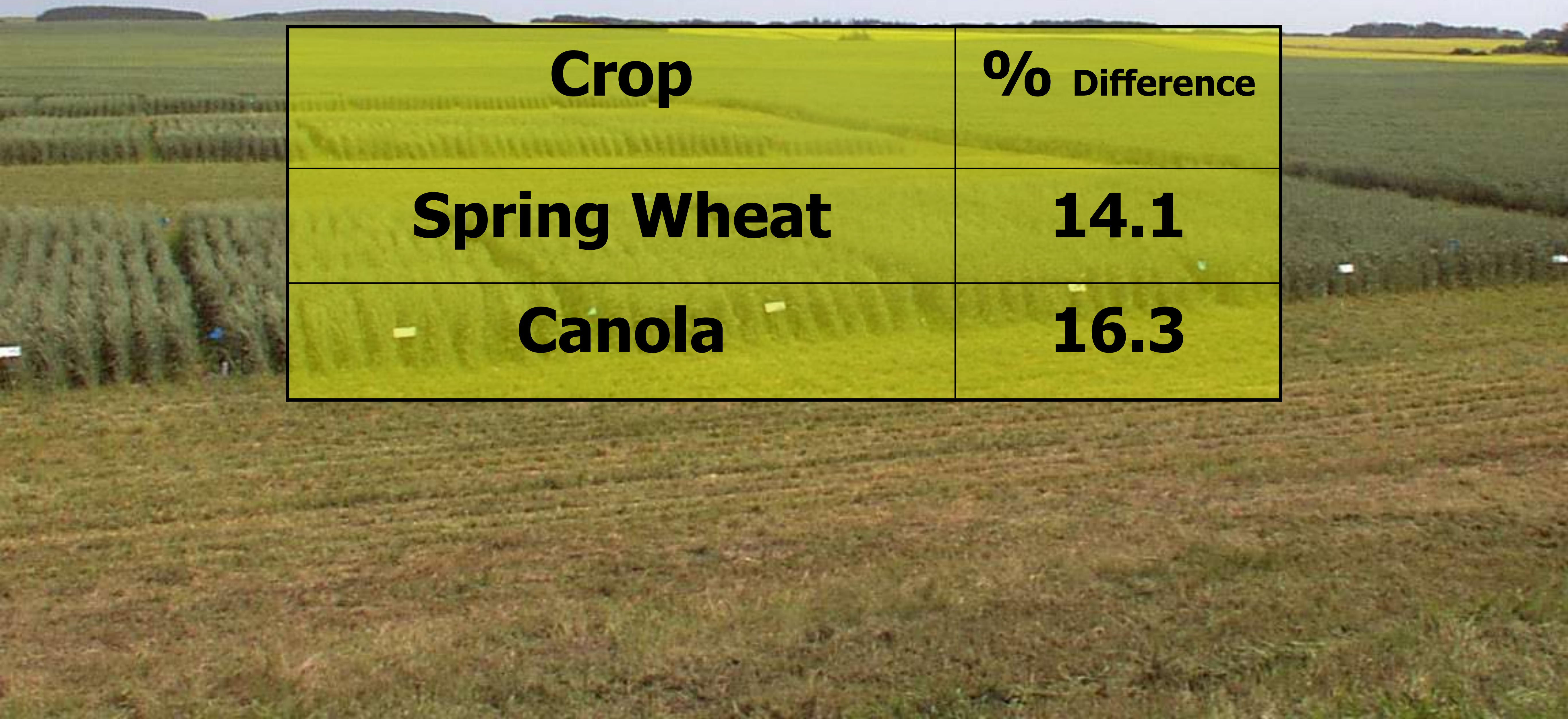
Spring Wheat and Canola (2002-2009) Average Grain Yield (kg/ha)



Spring Wheat and Canola (2002-2009)
Average Grain Yield (kg/ha)



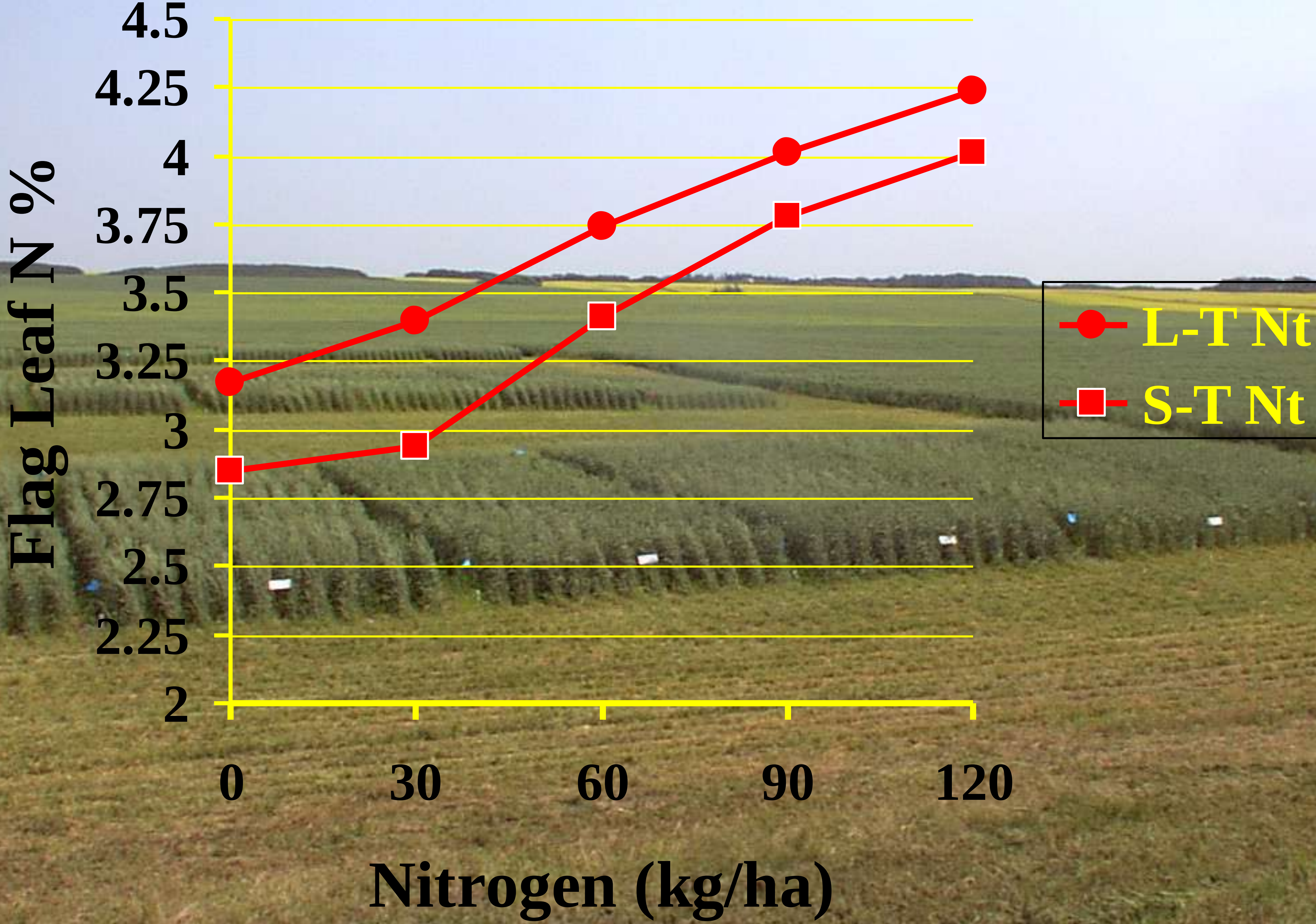
Summary of Findings
Long-term benefits of No till
% difference between LT and ST

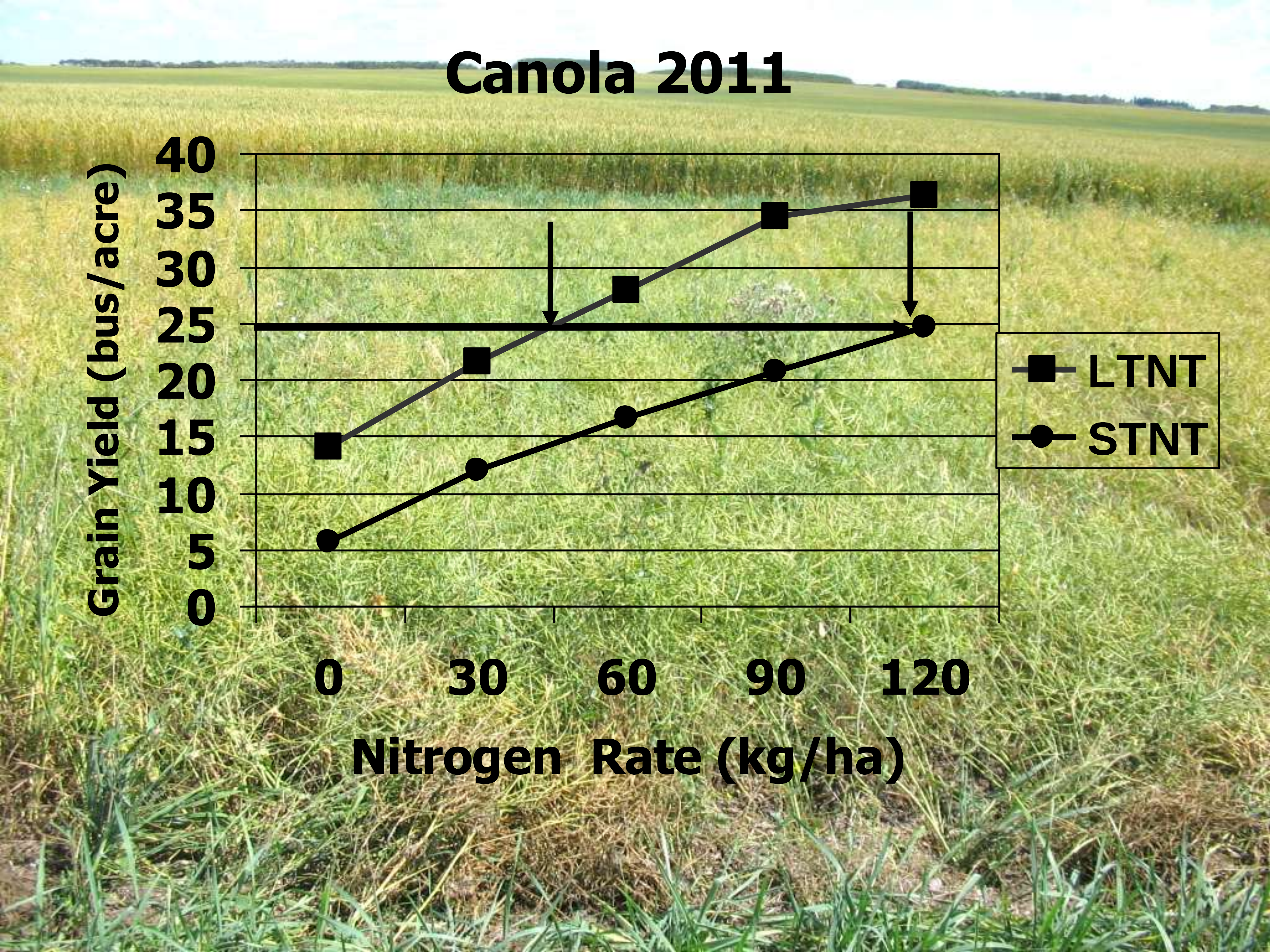


Crop	% Difference
Spring Wheat	14.1
Canola	16.3

Spring Wheat Flag Leaf N %

Average of 5 Years (2002-2011)




Canola 2011
Grain Yield (bus/acre)
40
35
30
25
20
15
10
5
0
0
30
60
90
120
Nitrogen Rate (kg/ha)
LTNT
STNT

Question #3

Can higher than recommended fertilizer N rates increase the rate of soil improvement?

N Responses

Long-term No-Till vs Short-term No Till

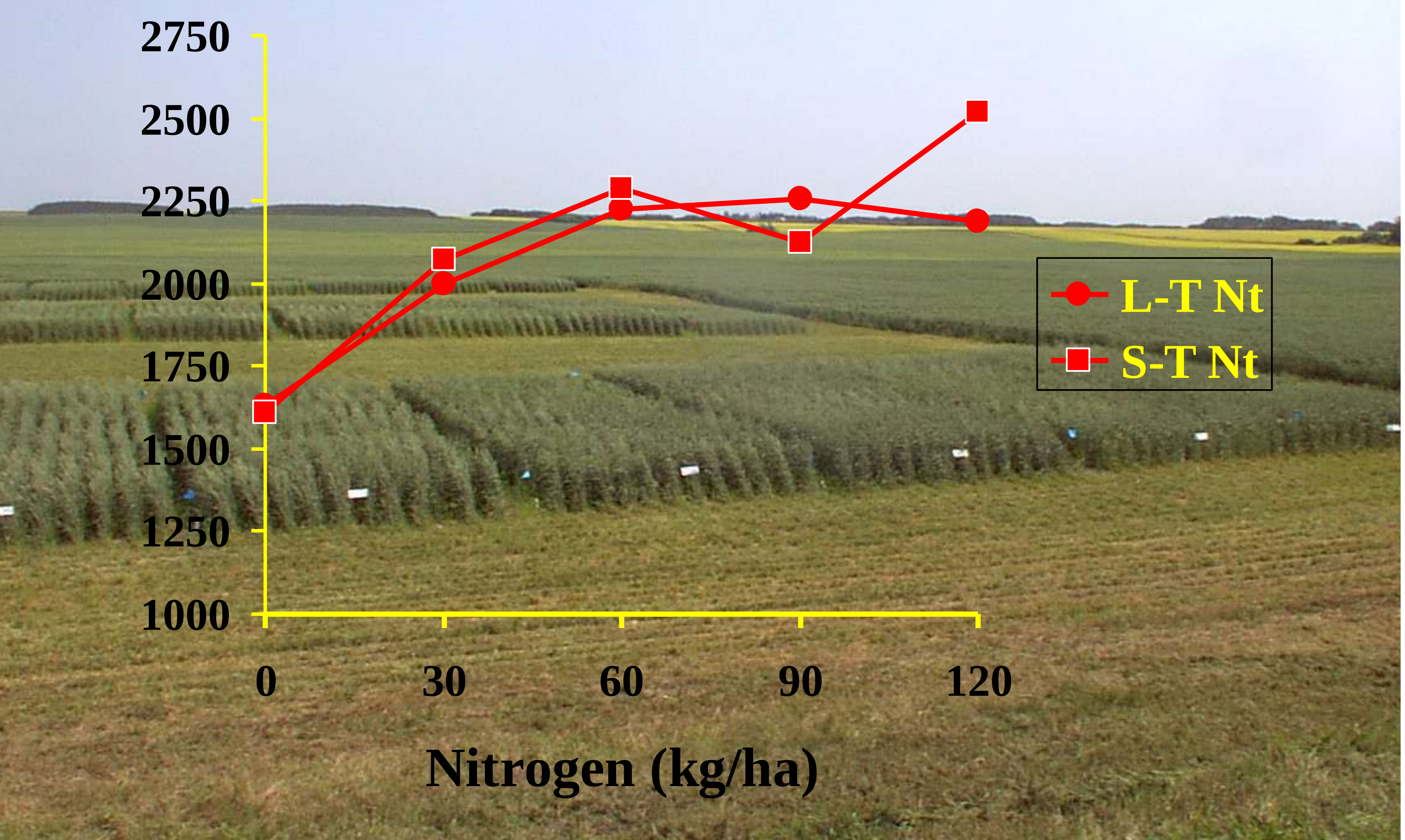
N Rate (kg/ha)	Seed-Placed P (1 rate)	Side-Banded P (1 rate)
0	√	√
30	√	√
60	√	√
90	√	√
120	√	√

N Responses

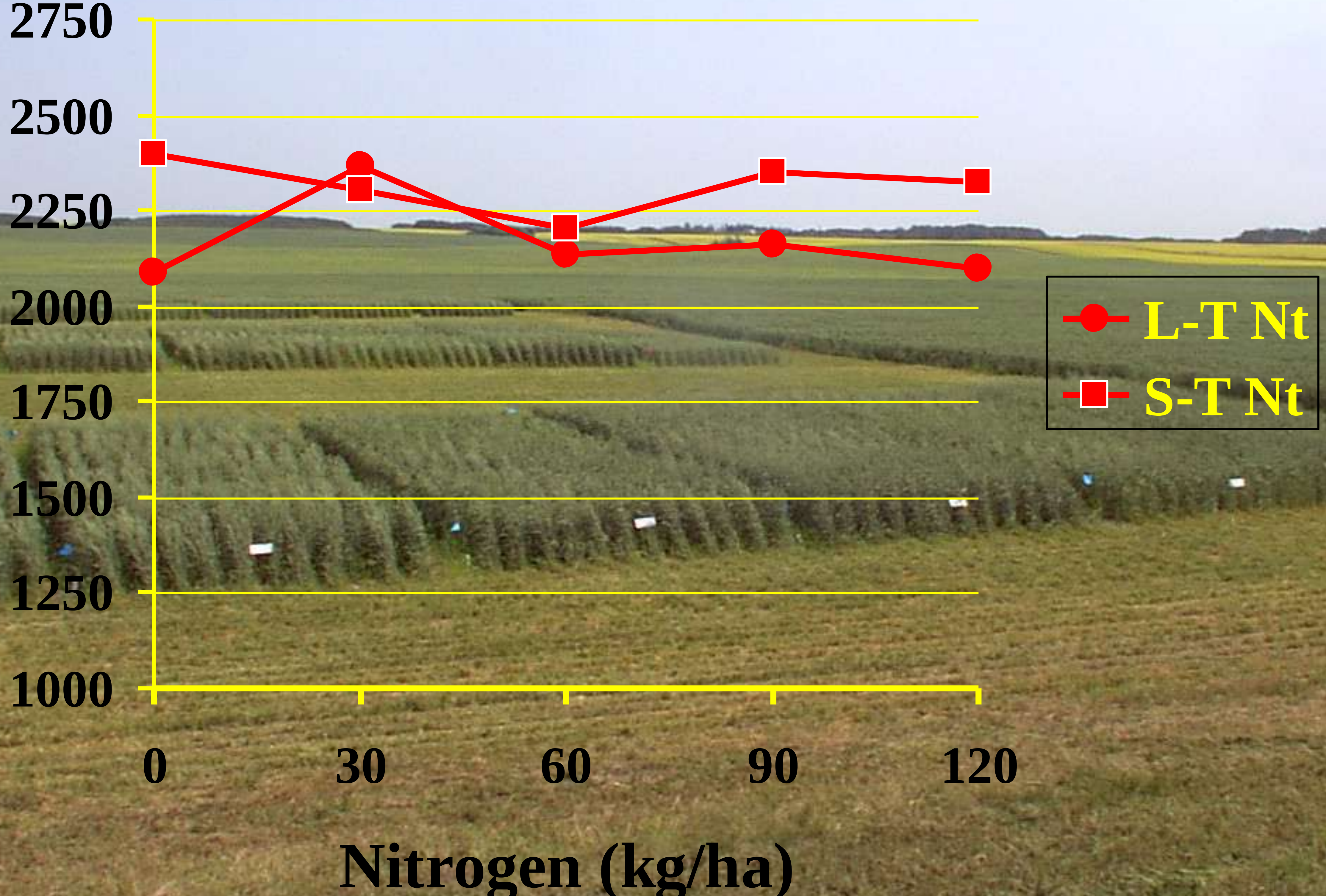
Long-term No-Till vs Short-term No Till

N Rate (kg/ha)	80 kg/ha +Side Banded P (1 rate)	Side-Banded P (1 rate)
0	√	√
30	√	√
60	√	√
90	√	√
120	√	√

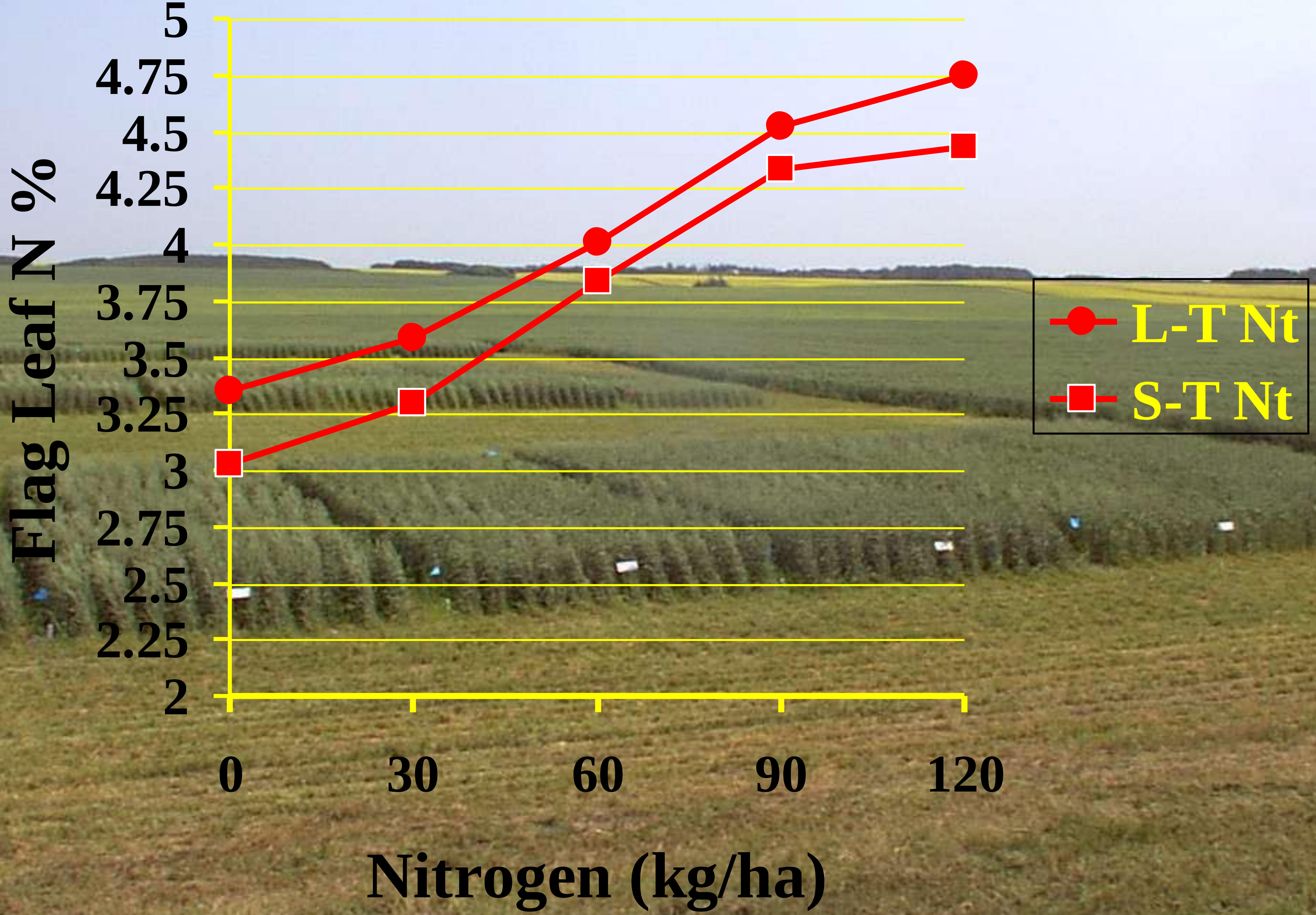
Spring Wheat (2012)
Grain Yield (kg/ha)



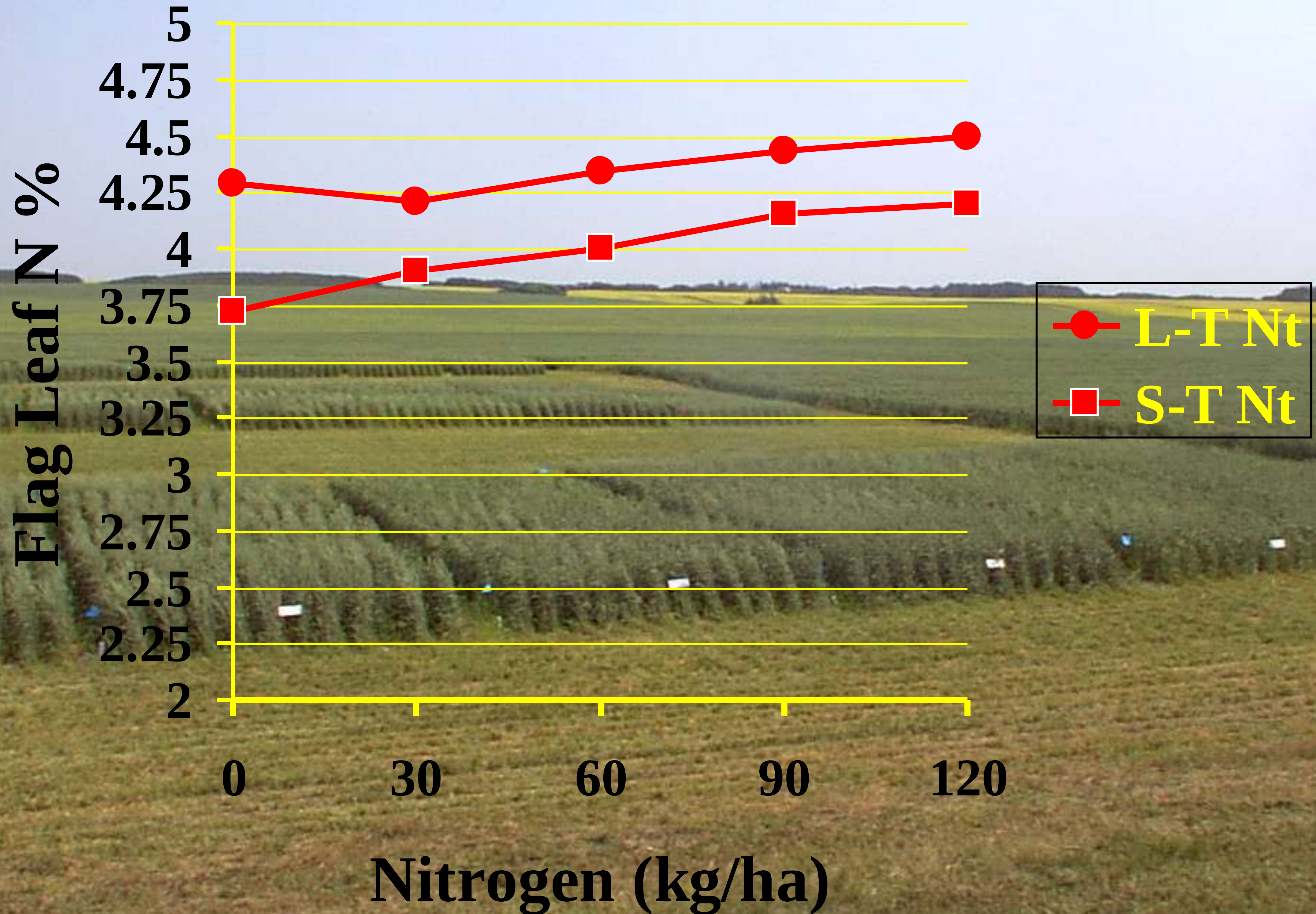
Spring Wheat (2012)
Grain Yield (kg/ha)
Constant N Rate (80 kg/ha)



Spring Wheat (2012)

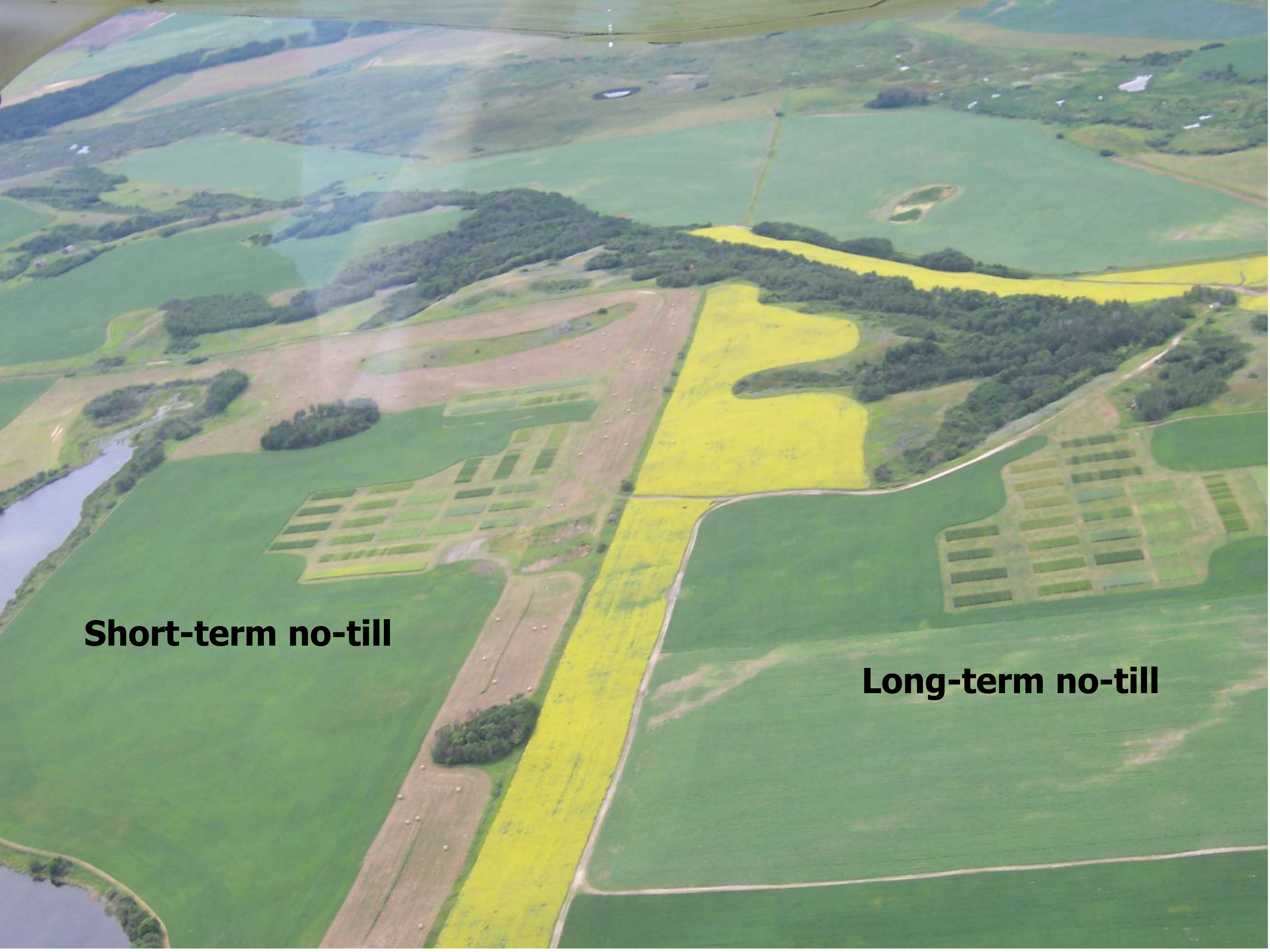


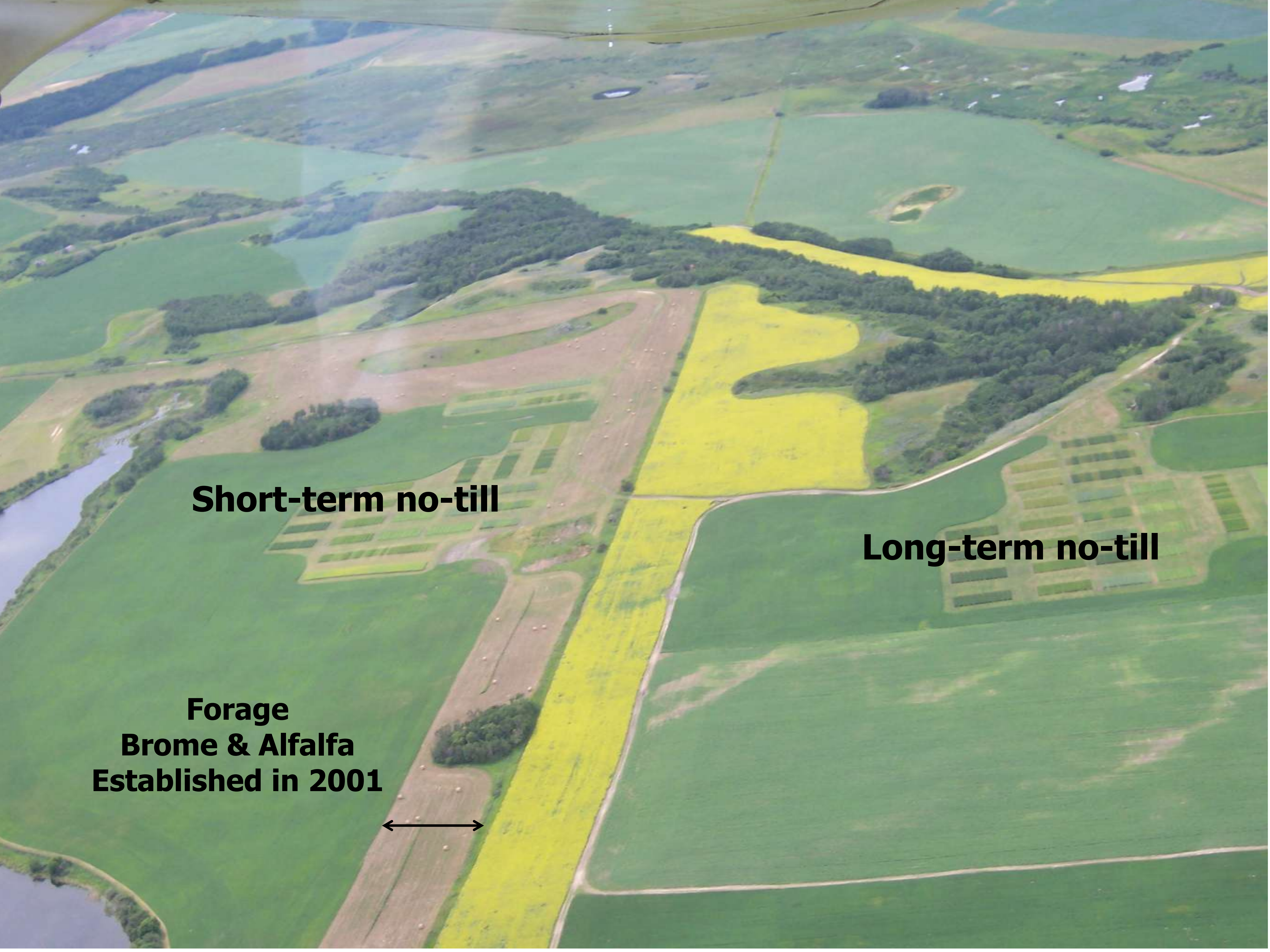
Spring Wheat (2011)
Constant N Rate (80 kg/ha)

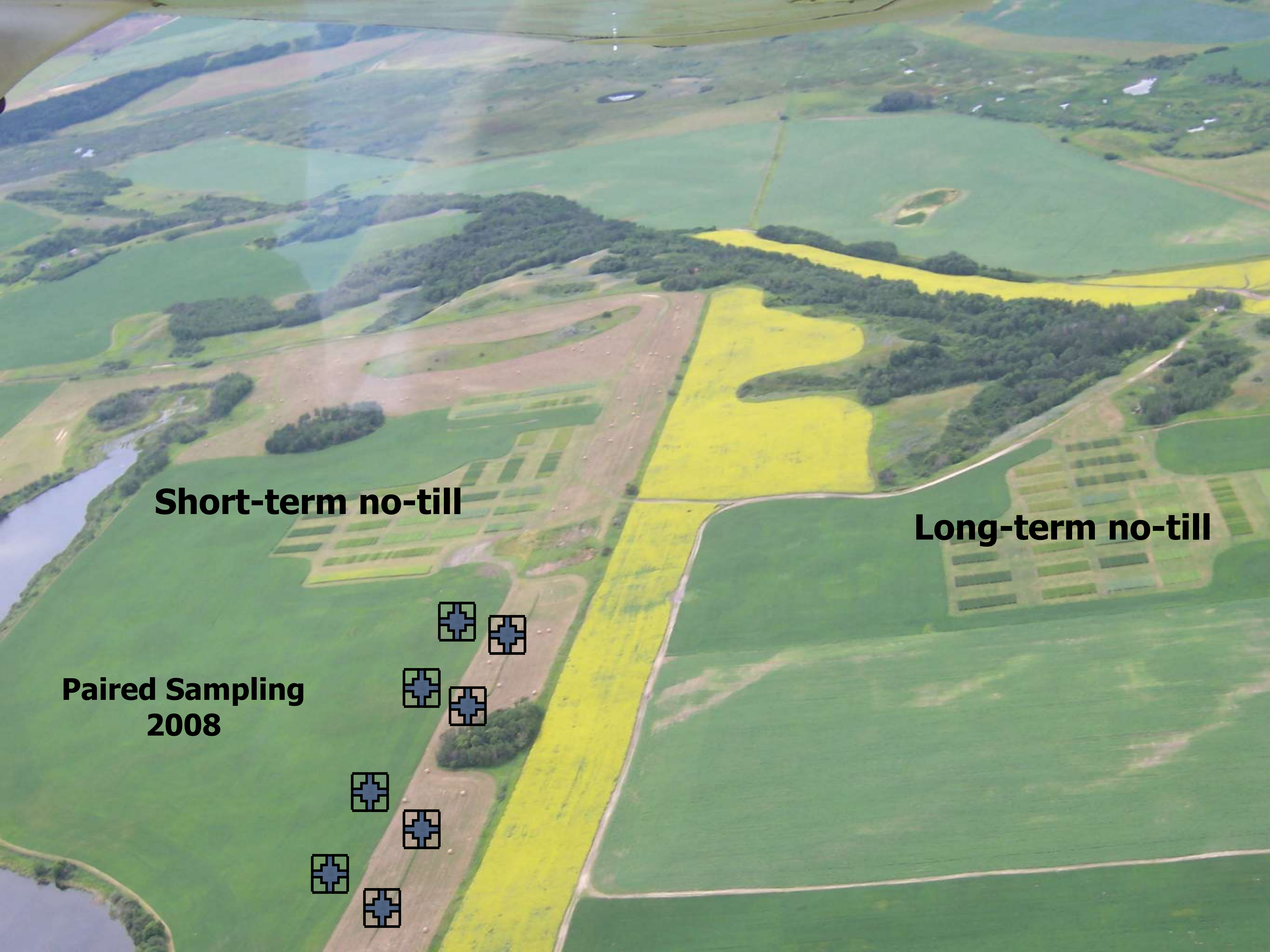


Question #3

Other ways to improve soil fertility and productivity?


Short-term no-till
Long-term no-till


Short-term no-till
Long-term no-till
Forage
Brome & Alfalfa
Established in 2001


Short-term no-till
Long-term no-till
Paired Sampling
2008

Results – Soil Organic Carbon (SOC) 2001-2008 (after 9 years)

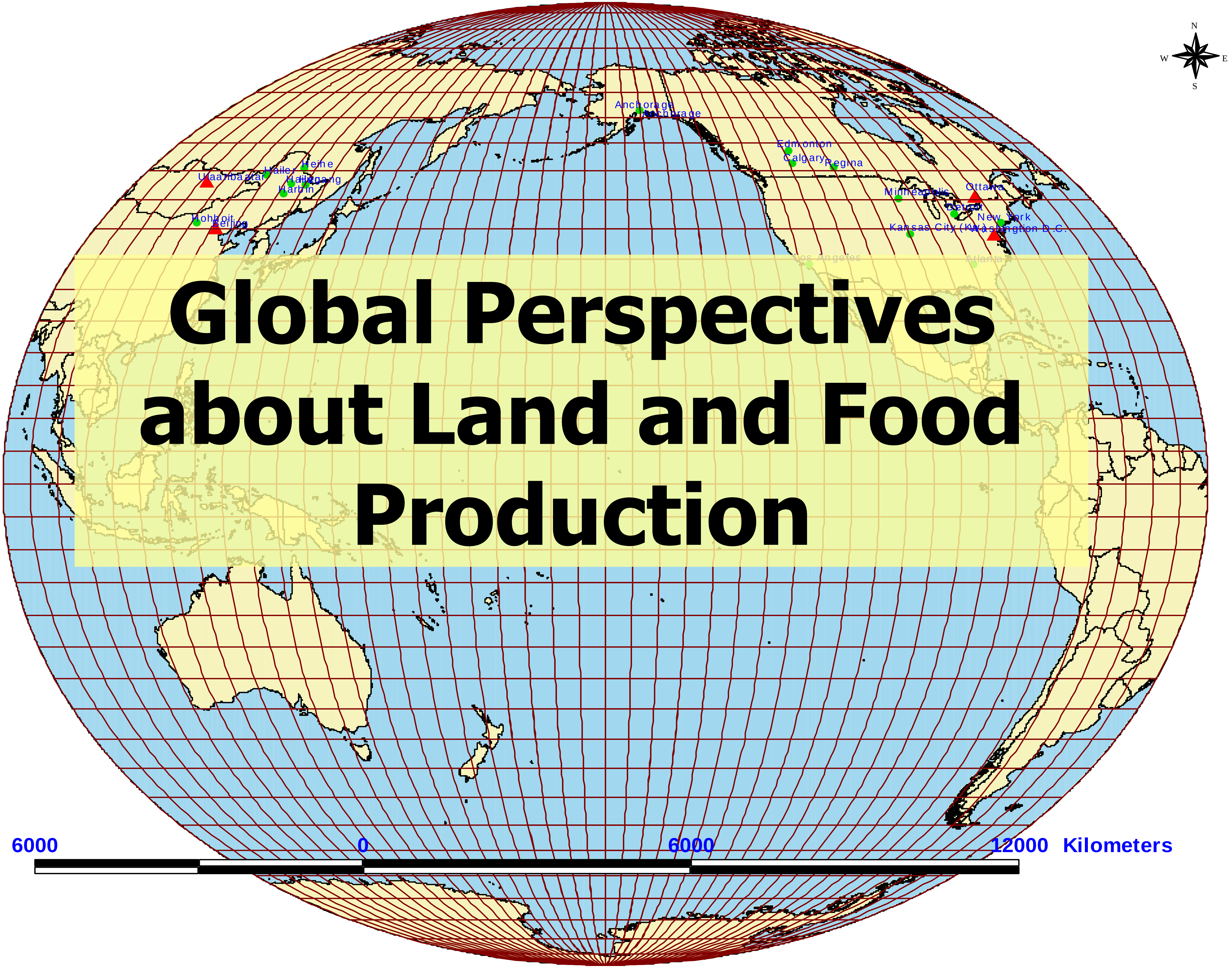
Landscape Position	Management System	SOC (Mg/ha)
Level –Gently Sloping	STNT (Continuous Cropping)	45.1
	STNT (Forage)	53.3
	Difference %	+18%
Knoll	STNT (Continuous Cropping)	22.8
	STNT (Forage)	27.9
	Difference %	+22%

Conclusions

- Since the conversion to no-till, we estimated the yield gains at 0.7% per year on this soil.
- The higher rates of nutrient cycling with LTNT is reflected in the higher N content of the flag leaves.
- Continuous cropping + Proper fertilizer rates + No-till = Increased productivity.
- Forages vs no-till continuous cropping.

Why do need to maintain a strong focus on overall soil and crop management?

Global Perspectives about Land and Food Production



Global Arable Land Area
A few facts

- 1562 million hectares
- 3859 million acres
- 586 million has in developed countries
- 966 million ha in developing countries

Global Arable Land Area (per capita)

- 1.10 ac (0.45 ha) per person in 1960
- 0.60 ac (0.26 ha) per person in 1999
- 0.50 ac (0.20 ha) per person in 2009
- 0.34 ac (0.14 ha) per person in 2050
- 0.34 ac = 14,800 ft^2 or 100′ x 148′

Global Food Production
A few facts

- 2012 Global Grain Production was 2850 Mt
- Cereals 2100 Mt
- Root Crops 140 Mt
- Sugar Crops 194 Mt
- Pulses 48 Mt
- Oilseeds 361 Mt

Global Food Production
A few facts

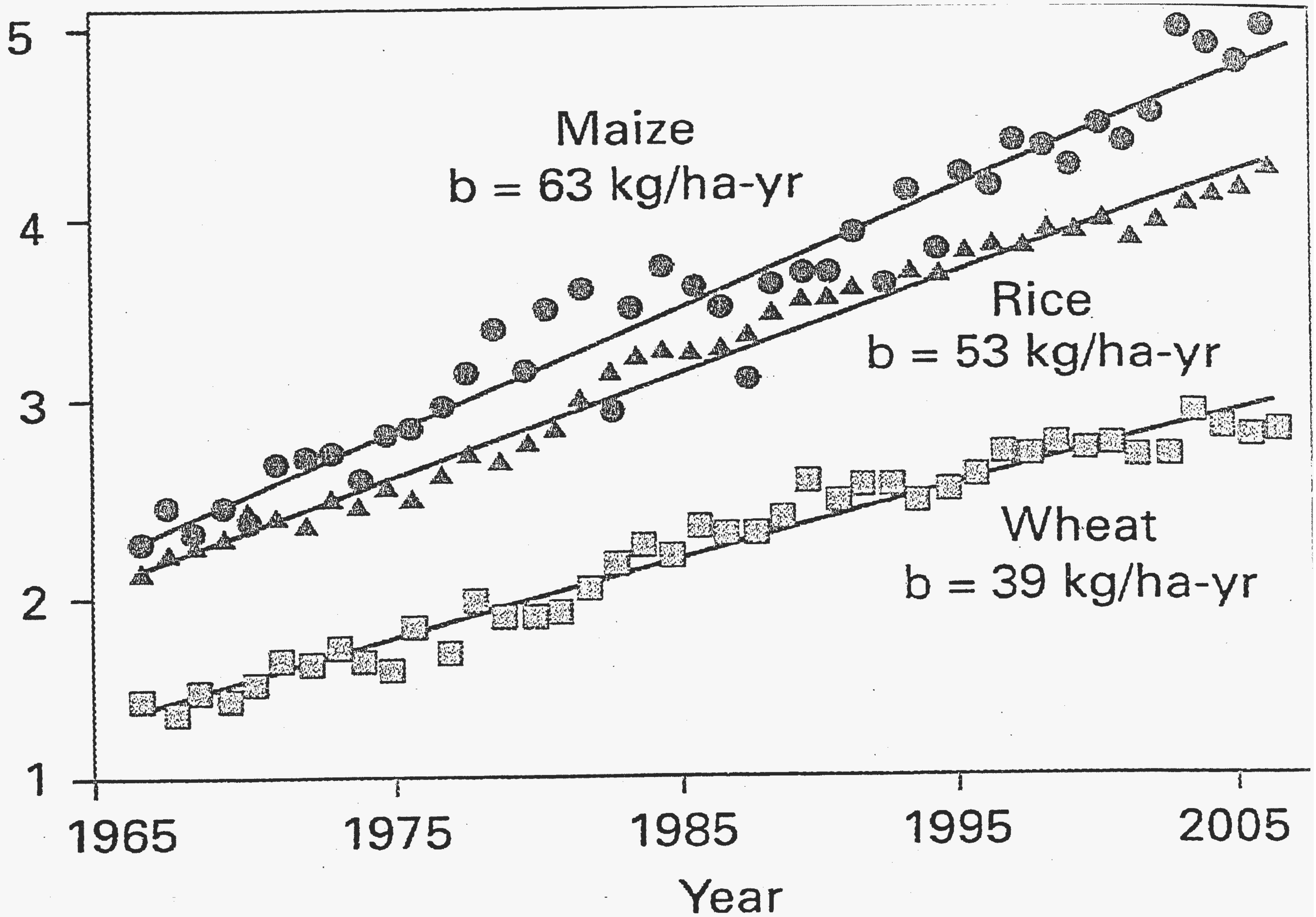
9 Billion People by 2050 will require a 70% increase in grain production

Equivalent to 2000 Mt of grain

Increase from 2850 to 4850 Mt per year

Assuming no increase with current yield levels means an extra 1.1 B ha or 2.7 B acres to attain production that level of production

Rates of Crop Yields 1965-2005



Global Food Production
A few assumption

- Assuming the current rates of yield increase for the next 37 years = 980 Mt of the 2000 Mt required by 2050.
- Balance has to come from greater yield gains, cropping intensity but from a limited increase in arable land.

Food vs Biofuel Debate

- 2009 36-41 Mha used for biofuel.
- 2020 60-166 Mha (4% - 11% of total arable land)
- Standard Nutritional Unit: 500 kg or 1102 lbs per person per year.
- 500 kg grain is equivalent to 140 l gasoline or 1.2 fills of a ¾ tonne truck.
- Biofuels only makes sense if the feedstock is cellulose but this has implications on soil fertility

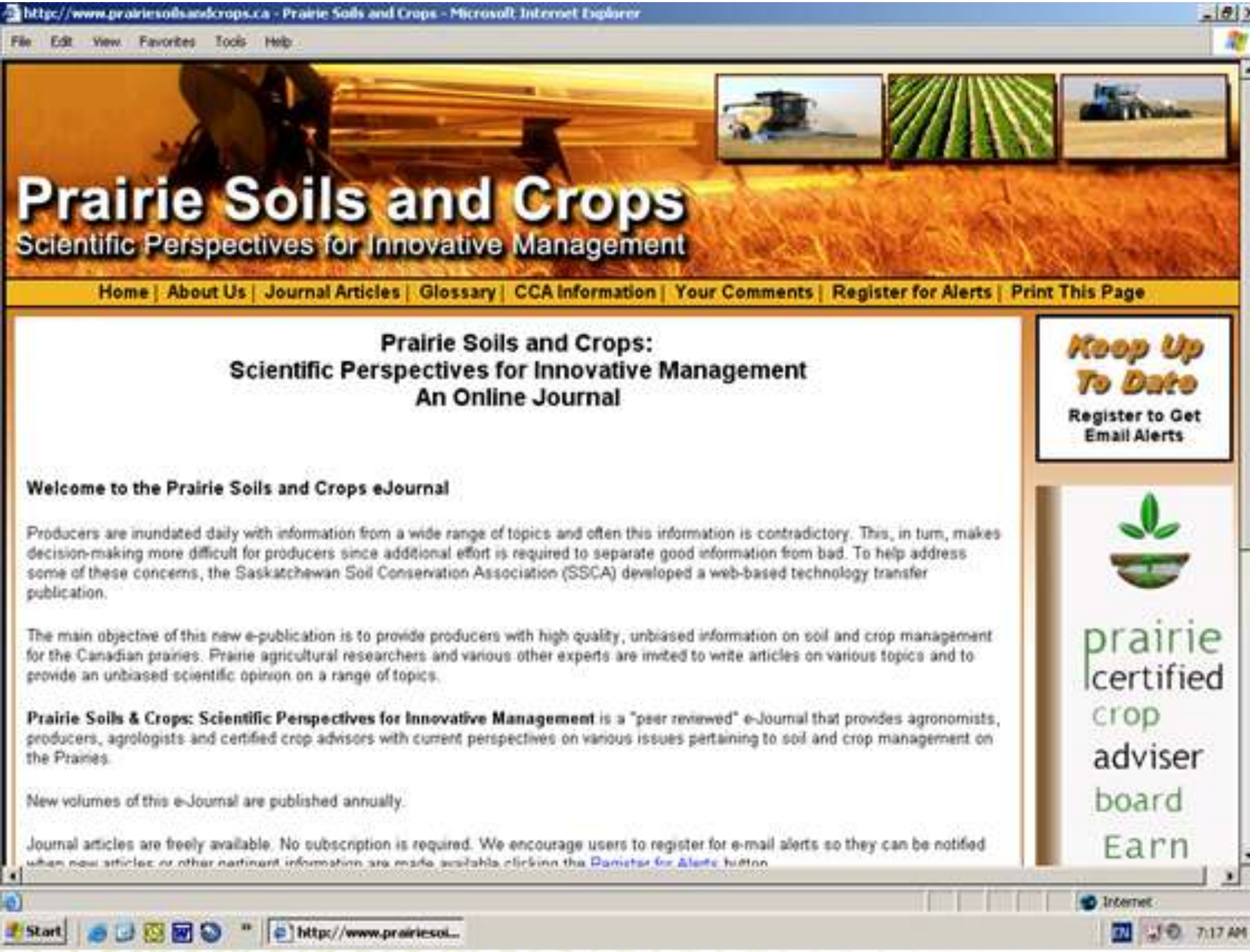
How do we make up the shortfall?

- Only small increases from irrigation
- Only small increases in arable land
- Food Waste – 30-40%
  - Developing Countries 25-35% at farm gate
  - Developed Countries 12-16% at farm gate and 18-24% with final preparation and consumption
- Innovation and technology

Future Challenges

- Where will the future increases in grain yield come from?
- Wheat yields are leveling in Northern Europe
- Corn yields under irrigation in the USA are leveling off.
- Changes in diet to reduce food wastage in order to meet the requirements of 2050
- Ability of producers to implement new technology

e-Journal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Prairie Soils and Crops:
Scientific Perspectives for Innovative Management
An Online Journal
Welcome to the Prairie Soils and Crops eJournal
Producers are inundated daily with information from a wide range of topics and often this information is contradictory. This, in turn, makes decision-making more difficult for producers since additional effort is required to separate good information from bad. To help address some of these concerns, the Saskatchewan Soil Conservation Association (SSCA) developed a web-based technology transfer publication.
The main objective of this new e-publication is to provide producers with high quality, unbiased information on soil and crop management for the Canadian prairies. Prairie agricultural researchers and various other experts are invited to write articles on various topics and to provide an unbiased scientific opinion on a range of topics.
Prairie Soils & Crops: Scientific Perspectives for Innovative Management is a "peer reviewed" e-Journal that provides agronomists, producers, agrologists and certified crop advisors with current perspectives on various issues pertaining to soil and crop management on the Prairies.
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Thank-you