SOIL PHOSPHORUS AND NITROGEN FIXATION ON ORGANIC DAIRY FARMS IN ONTARIO

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Background

- Low soil test phosphorus has been observed on many organic dairy farms in Ontario
- Many organic farms export more P than is imported to the farm – therefore there is risk that soils will become further depleted
- Worldwide, phosphate rocks are relatively scarce:
  - The age of abundant, cheap phosphate fertilizers will soon come to a close

Background, Con't.

- Nitrogen fixation by legumes is the cornerstone of soil fertility and crop productivity on organic dairy farms
- We know that P deficiency affects plant productivity, persistence of legume forages, and N fixation
- But…
  - Healthy biological activity of soils work in favor of P uptake
    - Mycorrhizae fungi and P solubolizing bacteria

Background

- Is low soil P becoming an issue for organic dairy farms?
  - What are the critical levels?
  - Is N fixation being affected?
  - What can be done to improve P availability where needed?

Objectives

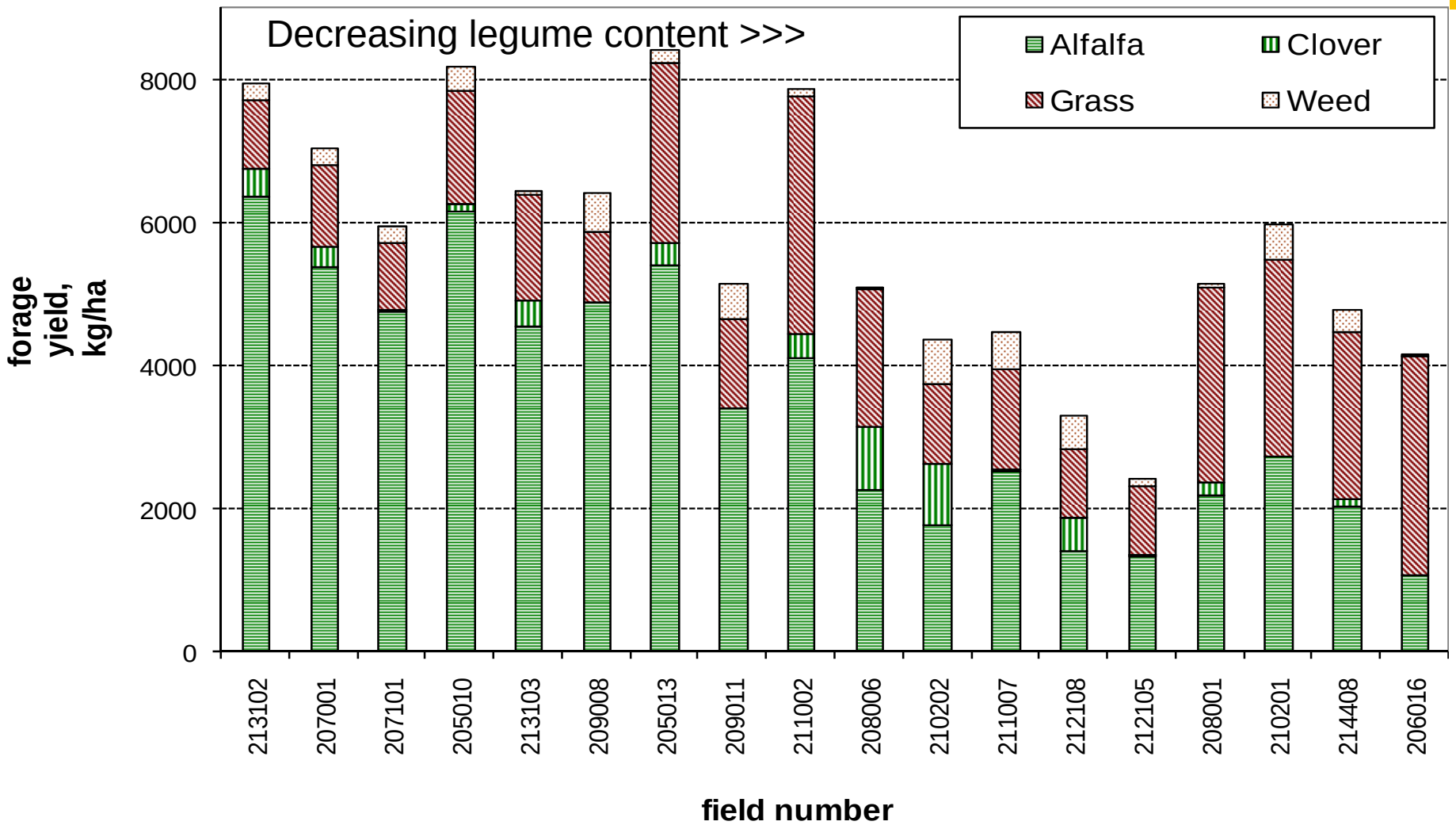
- To draw a relationship between soil test P, forage productivity and N fixation of legume forage stands on organic dairy farms in Ontario and Nova Scotia.
- To test the effect of added P on legume productivity and N fixation and to evaluate the effectiveness of some new organic P sources on legume P uptake and N fixation in greenhouse culture.
- To evaluate the role mycorrhizae fungi and/or other biological factors in increasing the supply of P to organically grown crops.

Year 1

- Samples collected from 28 fields on 14 organic or transitional dairy farms – 10 in Ontario and 4 in Nova Scotia
- 7-25 samples per field
- Determine yield of each major plant type
- Analyze for nitrogen and N isotopes to determine N fixation
- Soil samples at each point
- Over 1900 separate plant samples!

Collecting forage samples in Ontario, June 2008.

Yield patterns and distribution, 2008



Protein content

- High quality forage; average of 62% legume, mostly alfalfa

	Crude protein
Cut 1	19.9%
Cut 2	21.5%
Cut 3	21.8%

Field data summary

field	% legume	Soil test P	# cuts	total forage yield,	cut 1 protein	cut 2 protein	cut 3 protein	N fixation, kg/ha	Legume N yield, kg/ha	non-legume N yield
209008	85%	10	2	7954	26.0%	17.2%		150	229	33
207101	81%	15	3	7047	23.0%	27.5%	23.5%	150	229	39
213103	81%	4	3	5951	18.8%	24.7%	20.0%	100	163	29
205010	77%	11	2	8184	19.9%	19.1%		140	210	46
205013	76%	7	2	6460	20.6%	25.4%		160	199	38
209011	76%	15	2	6426	22.9%	19.1%		80	172	42
207001	68%	8	3	8423	17.7%	21.2%	19.4%	130	196	59
208006	66%	11	2	5151	22.6%	16.2%		80	122	45
213102	56%	6	3	7887	21.0%	31.4%	24.5%	110	171	113
211007	62%	7	2	5111	19.2%	17.8%		70	114	38
208001	60%	5	2	4389	18.7%	20.7%		60	93	46
212105	57%	22	2	4477	20.7%	20.3%		60	99	48
214408	57%	6	2	3314	24.4%	21.7%		40	80	43
206016	56%	8	2	2449	19.0%	24.0%		40	56	30
210202	46%	18	2	5150	15.4%	21.1%		60	90	58
211002	46%	8	2	5988	18.8%	19.1%		70	107	75
212108	45%	N/A	2	4787	18.2%	21.1%		50	82	68
210201	26%	11	2	4167	11.7%	18.7%		30	43	48
ON average	62%	10	2.2	5740	19.9%	21.5%	21.8%	90	136	50

Nitrogen

- Average of 186 kg /ha N was harvested in samples
- Average of 50 kg N harvested in grass and weeds
- Average of about 100 kg/ha fixed by legumes, not counting growth that was missed
- The balance of N would come from manures, residues, etc.

Crop N fixation, kg/ha

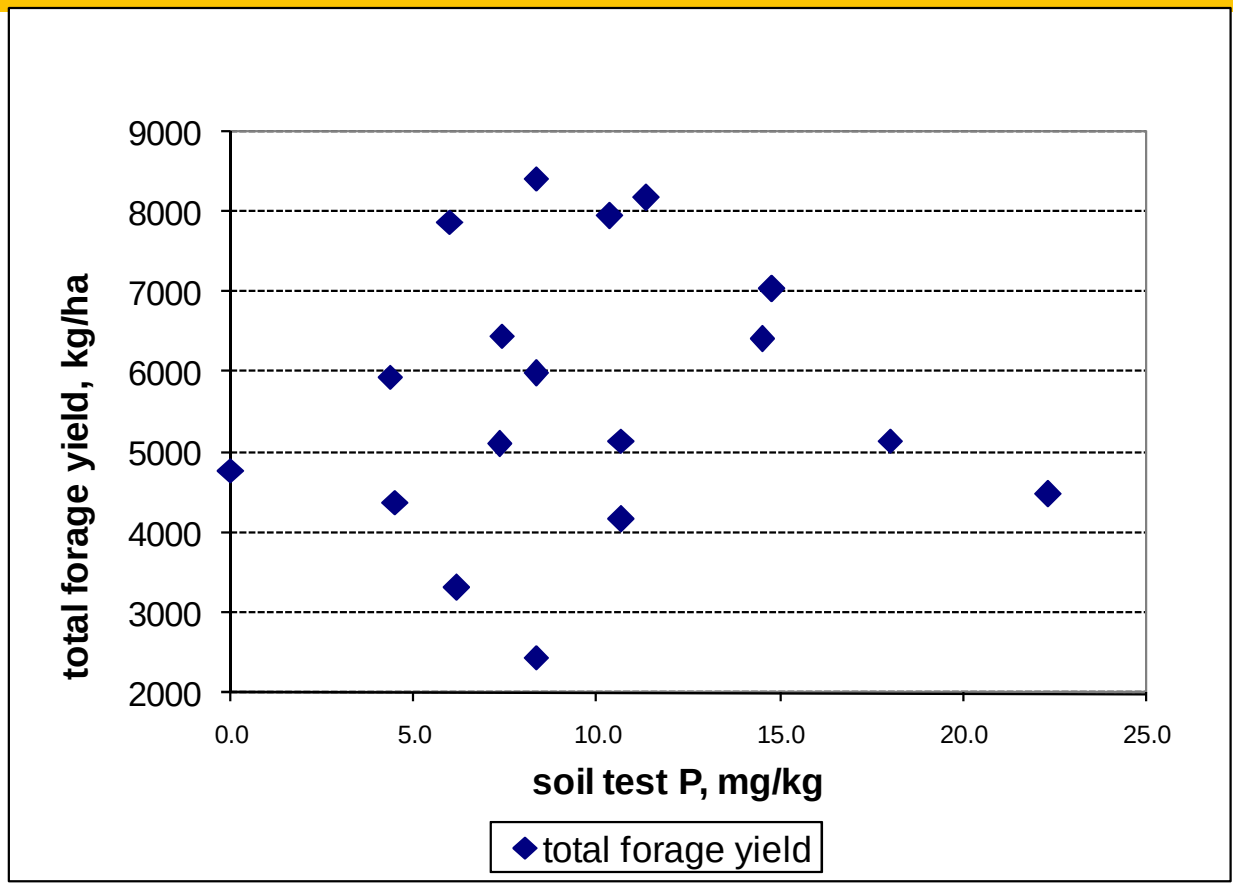
	Ave.	High	Low
Cut 1	**40**	**90**	**10**
Cut 2	**40**	**90**	**10**
Cut 3	**5**	**30**	**0**
Total	**85**	**160**	**30**

N fixation and yield were proportional to legume content.

Legumes are the main drivers of total yield and of protein yield

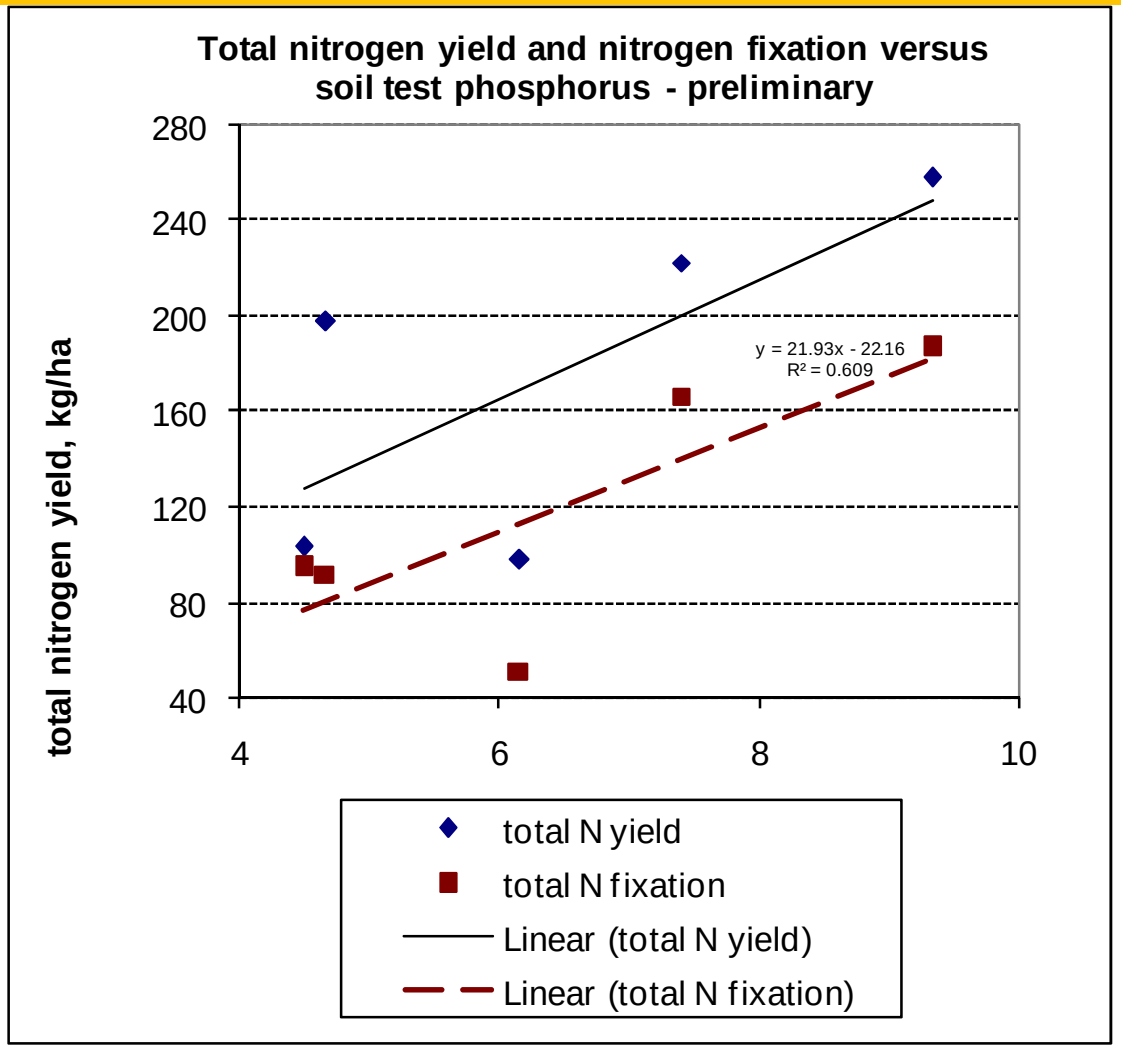
Phosphorus

- No apparent pattern is emerging yet
- A limited number of samples have been completed; more obvious patterns may emerge
- But…



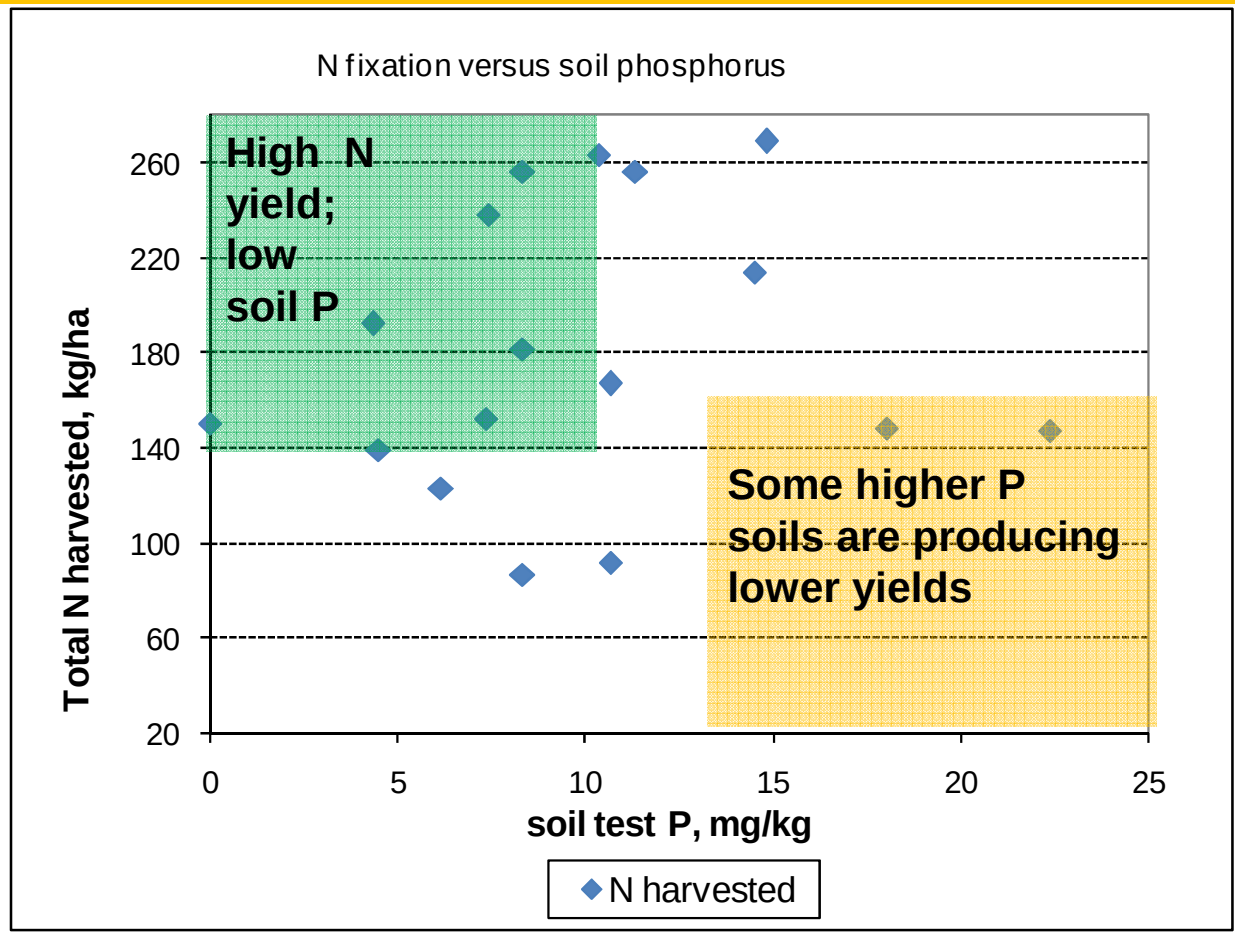
Phosphorus

- We completed more data points for a few fields
- A pattern may emerge, but it's too soon to say



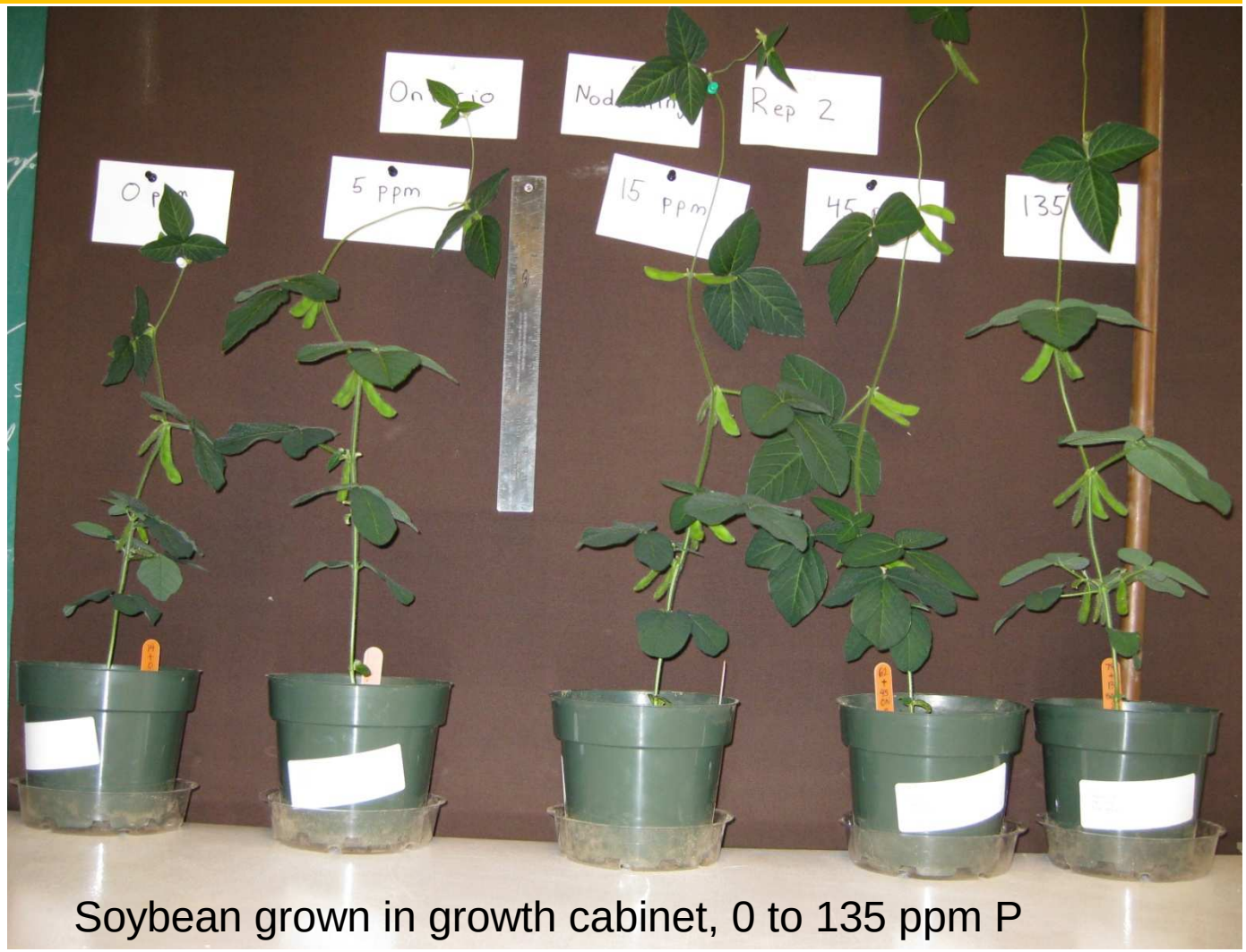
Phosphorus and N fixation?

- Some fields with low soil test P are producing a lot of forage; others not so good
- Many factors
  - Stand age; disease; other inputs



Phosphorus and N fixation

- P has an effect on soybeans
- Yield data collected; no analysis yet



Soybean grown in growth cabinet, 0 to 135 ppm P

Biological Factors in P uptake

- Mycorrhizae grow on crop roots, sending out thousands of tiny threads that help absorb phosphorus. Mycorrhizae also produce enzymes that help break down organic phosphorus
- Past studies have shown that mycorrhizae become more abundant when soil P is low.
- Field studies to evaluate the role and value of mycorrhizae and other biological factors in low-P soils under organic management in Ontario are being planned for 2009-2010
- More to tell in another 2 years.

Summary

- Yield and N fixation depend on the legumes
- There were fairly strong stands of legumes - over 60% on average
- There was a wide range of productivity and N fixation on farms
- Soil P was fairly low on many fields, but the effect of this on N fixation is not yet clear
- P effects were seen in soybeans
- Soil P may be one of the reasons for differences in stand performance
- Mycorrhizae and other factors will be explored further