

AIM Soil Improvement Projects 2022

Ryan Barrett, P. Ag., CCA
Prince Edward Island Potato Board



Living Lab Atlantic – PEIPB Projects:



BMP1: Fall Cover Crops in the year before potatoes (following tillage)

BMP2: Fall Cover Crops following potato harvest

BMP3: Full-Season Soil Building Crops in the year before potatoes



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Why Fall Cover Crops?

- Prevent Soil Erosion
- Reduce N Losses from Soil
- Build Soil Carbon
- Weed Suppression
- Disease Suppression
- Feed the Soil Microbiome
- Increase Yields?



Preventing Soil Erosion

- Left side: Barley cover crop that largely winter killed but grew enough to hold soil. Right side: No cover
- While we had limited number of sites with erosion measurement, we generally saw **25-33% decrease in accumulated topsoil with use of a fall cover crop.**



Reduce N Losses from Soil

- By having a cover crop following harvest or legume plow-down, you can keep nitrates from leaching.
- Also prevents loss of N as nitrous oxide (powerful GHG)
- Covers before potatoes:
39% reduction in NO_3 at 6"
- Covers after potatoes:
31% reduction in NO_3 at 6"
- Both based on 3 years of data, 20+ fields in each trial.

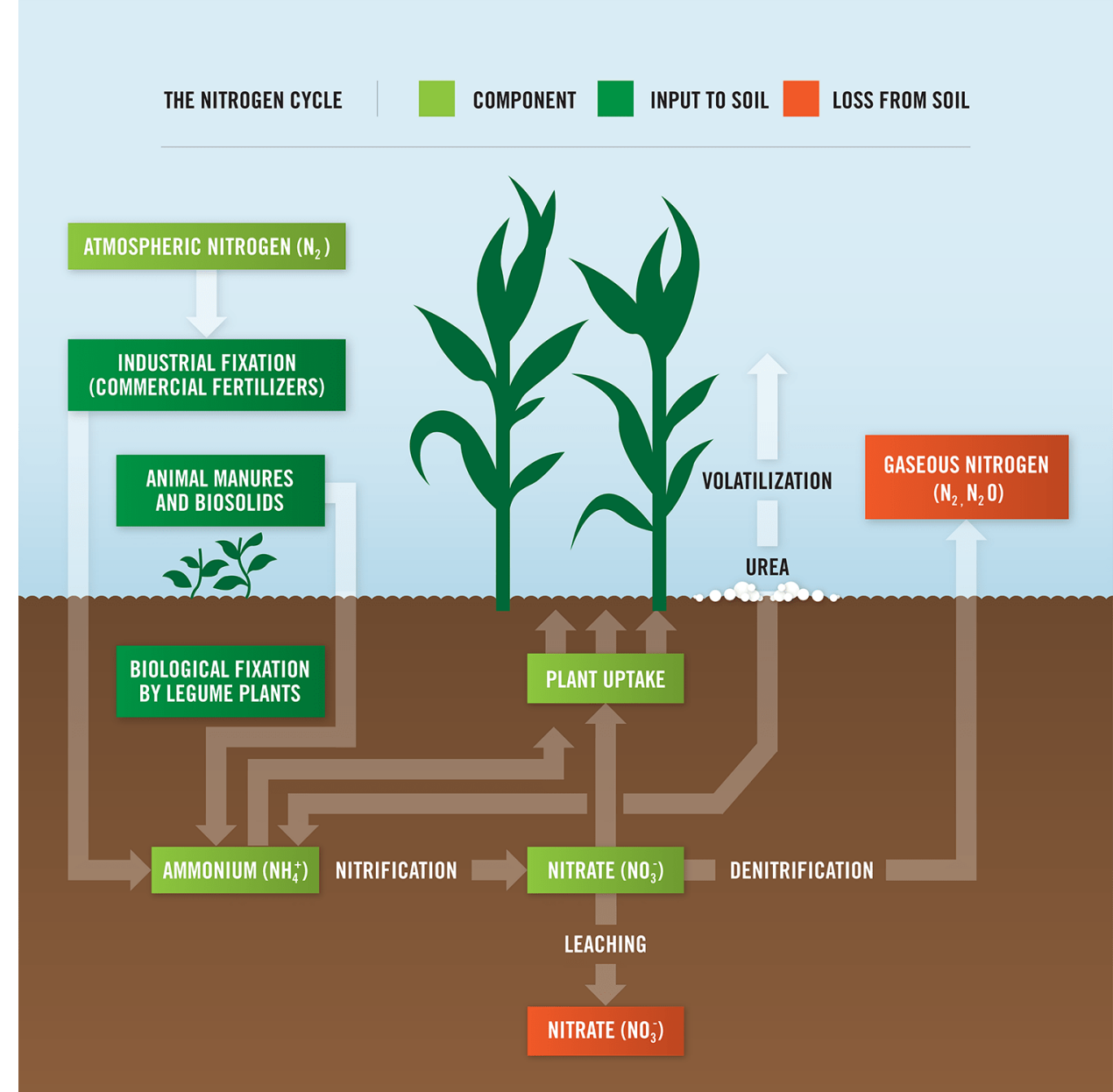


Image: <https://kochagronomicservices.com/>

Increasing Yields?

- Other studies in other areas have shown increased crop yields following cover crops, but response differs by area, cropping system, etc. Wanted to assess under PEI conditions and rotations.
- Can we get all of the long-term benefits of cover cropping while also getting some immediate payback on the costs of cover cropping?

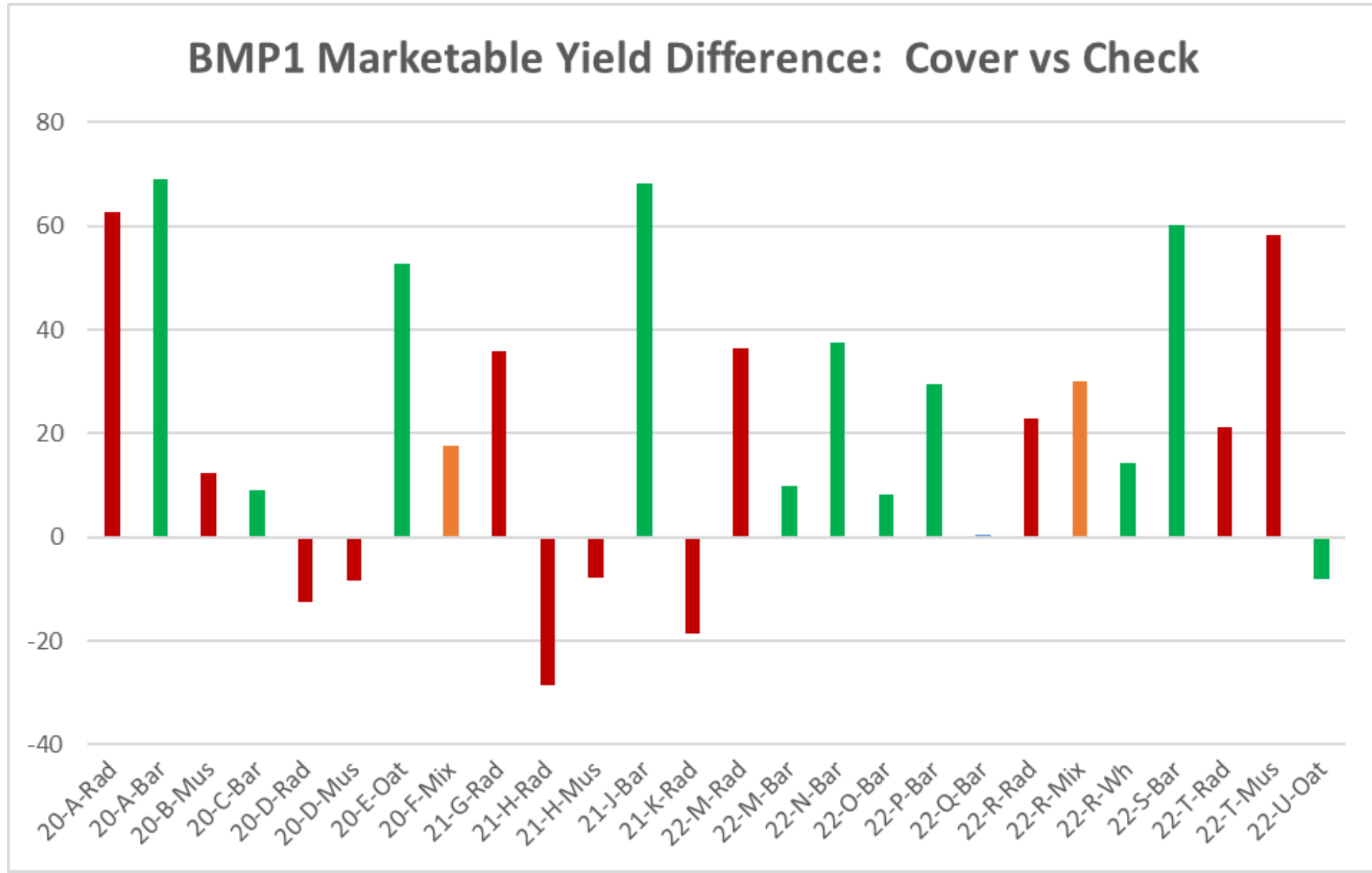


Increasing Yields following Cover Crops

	Total Yield cwt/ac	Total Defects %	Smalls %	> 10 oz %	Specific Gravity	Market. Yield cwt/ac	Crop Value \$/acre
Cover	352.7	4.8	6.9	16.9	1.088	316.6	4601
No Cover	318.5	4.1	8.5	15.9	1.086	284.7	4065
Diff:	34.2	0.7	-1.6	1.0	0.002	31.9	\$536
p value	0.002	0.490	0.049	0.651	0.268	0.006	0.005

Comparison in bold: Statistically significant at $p < 0.05$

Increasing Yields following Cover Crops



Increasing Yields following Cover Crops

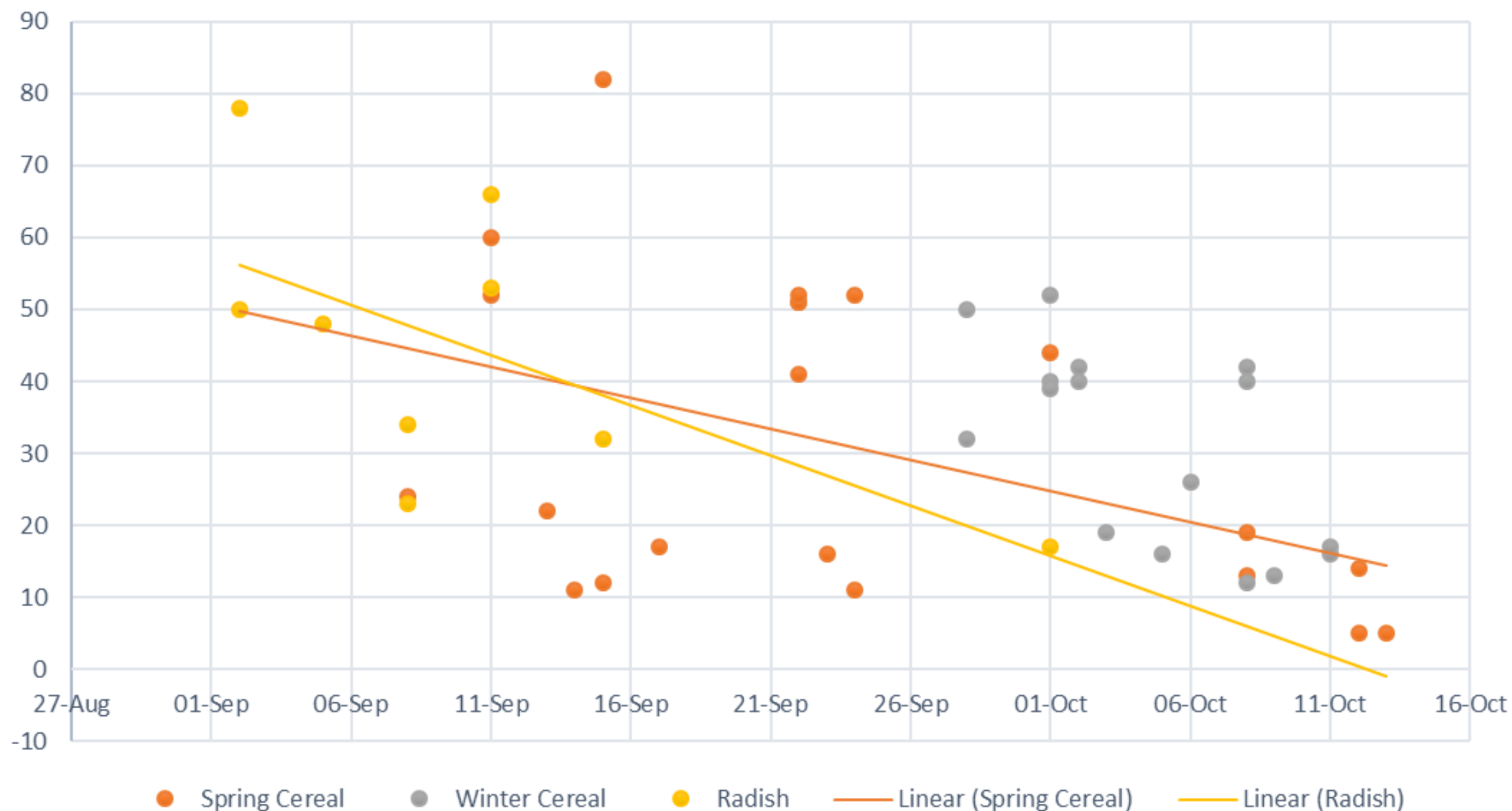
- Over 3 cropping cycles, we saw a **32 cwt/ac yield improvement** (11% increase) when planting a cover crop in the fall ahead of potatoes compared with no cover.
- Historically, majority of PEI fields were tilled in late fall ahead of potatoes. By moving up tillage to late summer/early fall, we can:
 - Increase potato yields
 - Terminate legumes earlier, accelerating N release
 - Prevent soil and nitrate losses
 - Move tillage operations up to a less busy time?

Lots of Cover Crop Options...how to choose?

- What crop am I following?
- What crop am I planting next year?
- Establishment window
- Available equipment
- Seed and establishment cost



Percent Green Cover by Crop Type - Mid/Late November



Mid-August to Early September:

- Oilseed/Daikon Radish
- Brown Mustard
- Spring Cereals (Barley, Oats, etc)
- Winter Canola (cash crop)
- Winter Barley (cash crop)
- Oats & Peas (grazing option)
- Annual Ryegrass (grazing option)
- Kale (grazing option)
- Mixes of brassicas and cereals



Early September to Early October:

- Daikon Radish (until Sept 10)
- Spring Cereals
 - Barley
 - Oats
 - Spring Wheat
- Winter Cereals
 - Winter Wheat
 - Winter Barley (September ideally)
 - Winter Triticale (hybrid of rye & wheat)
 - Fall Rye
- Winter Peas? In mix?



After the first week of October:

- Winter Wheat (differs by region)
- Fall Rye (until October 15-18 in most years)
- Barley and Oats don't consistently establish after the first week of October in most years. High seeding rates don't make up for the cool soil temperatures. Will also die quickly if they don't have time to establish more than 8-10 inches



Full-Season Soil-Building Crops

- Majority of PEI potato acres are preceded by a forage crop. Some are harvested for hay/silage, many are just mulched.
- Used to be mostly red clover...now there is increasing diversity of choice
- What is the best choice, looking at multiple factors:
 - Pests & Diseases
 - Soil Compaction
 - N fixation
 - Building soil OM/soil health



Full-Season Soil-Building Crops

- “Soil Building Crops” versus Annual Ryegrass:

- **+25 cwt/ac, +\$407/acre**

- 13 fields over 3 years. Significant at $p = 0.10$

- “Soil Building Crops” versus Red Clover:

- +6 cwt/ac, +\$22/acre

- 5 fields over 3 years. No sig. diff.

- In these fields...Red Clover established the year previous by underseeding, so “control” treatments had less soil disturbance than the “treatment” crops.



Full-Season Soil-Building Crops

- None of the individual crops we looked at were statistically better than the check crops for most metrics (yield, soil health, soil OM)
- Root lesion nematodes were highest following red clover, lowest following mustard, radish, and pearl millet.
- We may need more samples or more rotations to see true effects of these crops. However, increased tillage frequency may counter-act some of the value of these crops. Options for no-till seeding may hold value in exploration
- From our research, **it's less important what you grow than how often land is tilled** and if a green manure crop is grown vs a cash crop.

SS/Mustard vs Ryegrass: Chelton

	Total Yield cwt/ac	Total Defects %	Smalls %	> 10 oz %	Specific Gravity	Market. Yield cwt/ac	Crop Value \$/acre
SS-Mus	410.5	2.3	5.2	22.3	1.082	383.6	5567
Ryegrass	364.6	1.4	4.2	15.2	1.078	346.9	4937
Diff	45.9	0.9	1.0	7.1	0.004	36.7	630

Nothing statistically different
Variety: Caribou, table

Pearl Millet vs Check (Clover or Timothy)

	Total Yield cwt/ac	Total Defects %	Smalls %	> 10 oz %	Specific Gravity	Market. Yield cwt/ac	Crop Value \$/acre
Millet	424.3	1.5	4.3	18.3	1.088	403.5	6085
Check	395.4	2.5	5.0	22.5	1.086	373.4	5650
Diff	28.9	-1.0	-0.7	-4.2	0.002	30.1	435
P value	0.177	0.234	0.471	0.402	0.557	0.155	0.218

Nothing statistically different, but trending in right direction

Varieties: Alverstone, Mountain Gem

Nematode levels lower following Pearl Millet

Highest levels of Active Carbon following C4 grasses

Full-Season Soil-Building Crops

- From research that we've done, benefits from **using mustard as a biofumigant crop are not consistent**. Only seems to show payback on really compromised fields and Vert-susceptible varieties
- In multi-year trial, potatoes following **alfalfa out-yielded** red clover by 43 cwt/ac and ryegrass by 57 cwt/ac. Increased N, reduced nematodes, decreased compaction.



Full-Season Soil-Building Crops

- We've seen **no evidence that ultra-diverse mixtures improve yields or soil health** more than a single species or a simple 2-3 species mixture. This is supported by meta-analyses over hundreds of trials.
- Pick crops that fit your rotation, fit your region, won't become a weed issue, don't require too much extra management cost, and won't multiply pests/diseases ahead of potatoes.
- Take advantage of crops that may have both soil-building characteristics as well as economic value (ie. mustard for seed, alfalfa for hay, etc)

Find the crop that works for you!

Biggest Issue:	Crop Options:
Compaction	Alfalfa, Daikon Radish, Sudangrass, Pearl Millet
Wireworm	Brown Mustard, Buckwheat (don't have to be tilled in)
RL Nematodes	Pearl Millet (the best), Sudangrass, Radish/Mustard, Alfalfa
Fixing Nitrogen	Alfalfa, Red Clover, White Clover, Annual Clovers/Faba Beans
Building Soil OM	Whatever you can grow with the most biomass with the least amount of tillage! Root biomass more important than above-ground biomass!

Looking ahead:

- We want to look at how much **N credit** we can truly expect following legumes like alfalfa and red clover, and how that is affected by termination date and presence of a cover crop.
- What effect can **rotational grazing** have on soil health and soil OM? Research underway with two farms, expanding in 2023.
- What are the **cumulative effects of cover cropping and reduced tillage** on soil organic matter over 1-2 rotations?

Acknowledgements:

AIM Funding Partners:



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Living Labs Partners:



DALHOUSIE
UNIVERSITY

FACULTY OF AGRICULTURE

Thank You!

Ryan Barrett, P. Ag., CCA-AP

Research & Agronomy Specialist

PEI Potato Board

Tel: (902) 439-9386

Email: ryan@peipotato.org



@rbarrettPEI

www.peipotatoagronomy.com

Please scan code with your mobile device to receive CEUs immediately.



Once scanned, the app will automatically sign you in.

SpudChat

