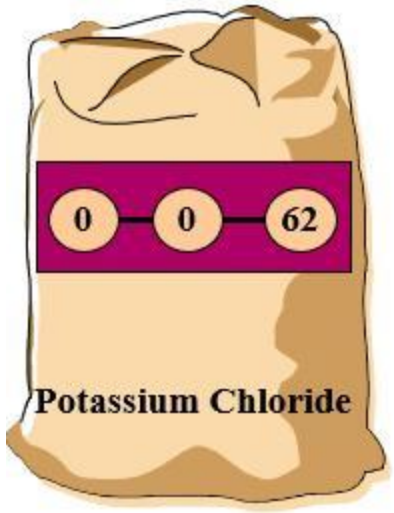
Potassium = K

4R Fertilizer Management



Lyle Cowell
Senior Agronomist
Nutrien Canada

Who am I?

Lyle Cowell
Senior Agronomist, Canada
lyle.cowell@nutrien.com
Telephone: 306-873-7105

Nutrien

What Creates Yield Potential?

1. Sunshine
2. Adequate water
3. Adequate nutrients
4. Genetic potential

Everything else? Protects above.

A note on letters

K = Potassium (Kalium)

KCl = Potash (Potassium Chloride)

K_2O = Expression of fertilizer K Content

As is 0-0-62% K_2O

Today is about K, but don’t forget Cl

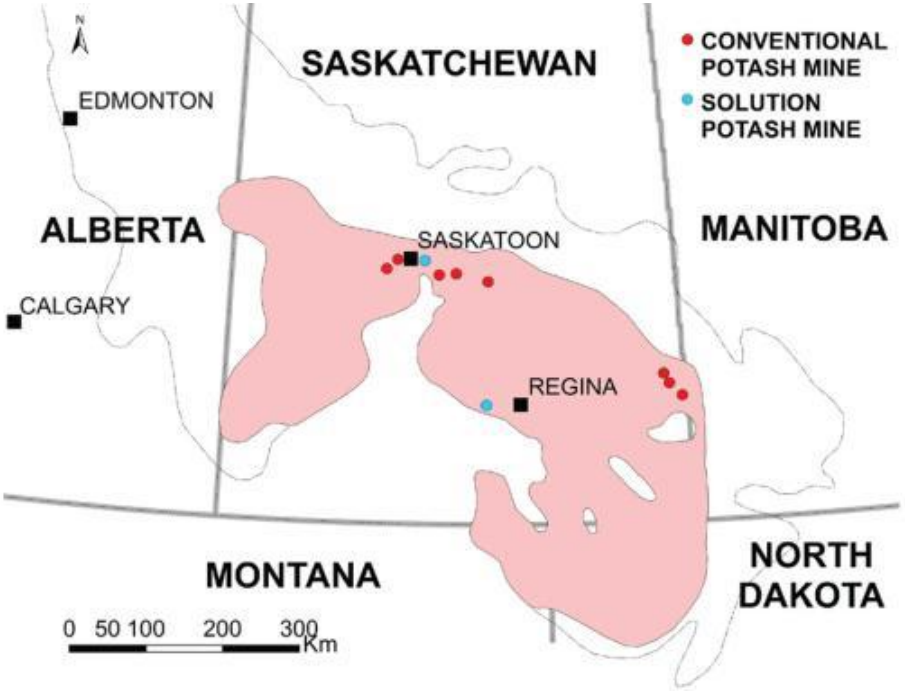
Where in the World is Potash Found?

2021, Natural Resources Canada

	Production (MT KCl)	Reserves (BT K_2O)
Canada	23	1.1
Russia	14	0.4
Belarus	13	0.75
China	7	0.35
Germany	3	0.15
Israel	3	?

Over 30% of both

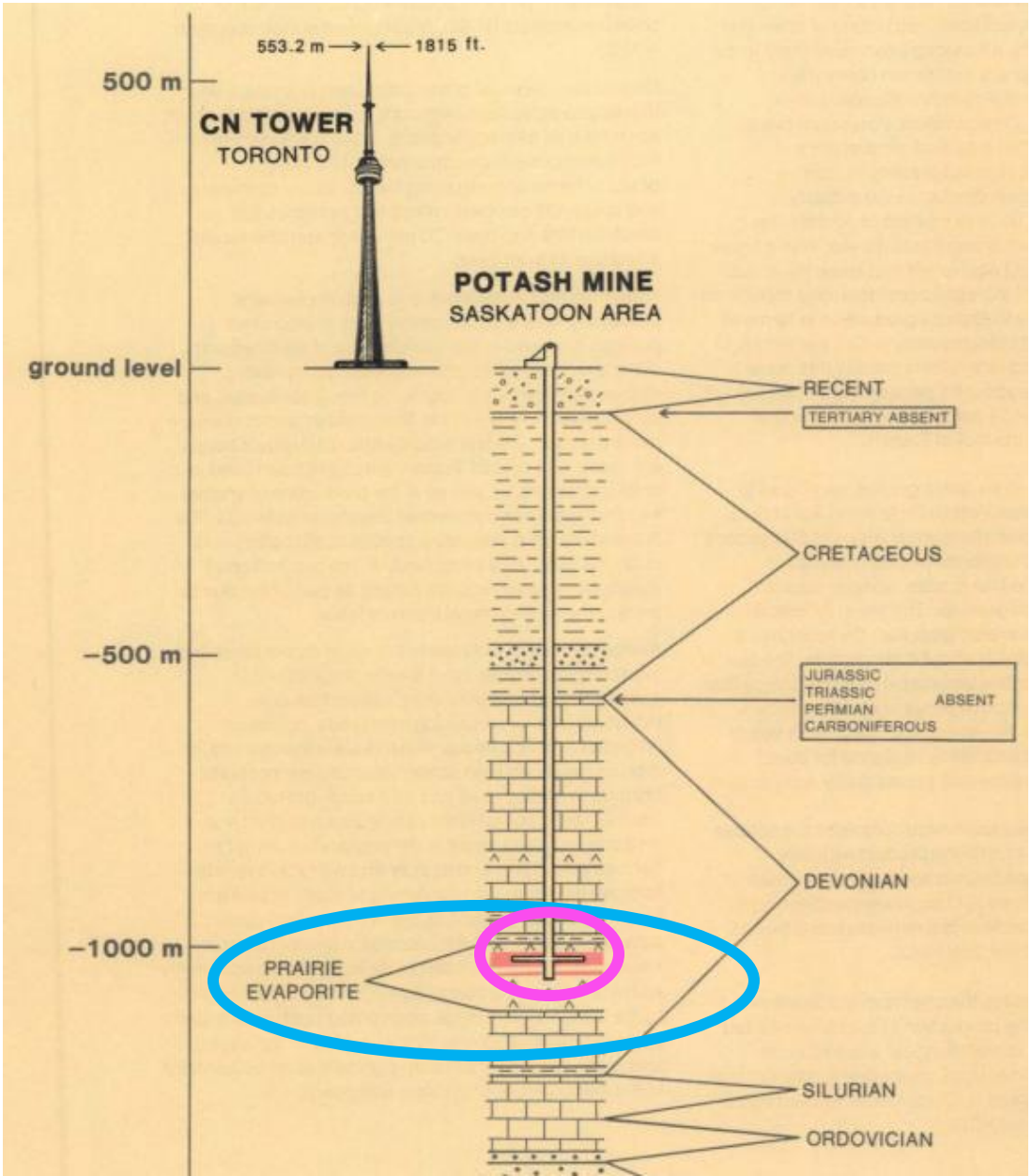
Where are the potash mines?



10 operating mines in Saskatchewan with capacity of about 24M tonne per year

6 Nutrien: Rocanville, Allan, Lanigan, Cory, Vanscoy, Patience Lake (solution) with capacity of 14M tonne per year

Depth to Potash



About 1000 m deep and beds 30 m thick

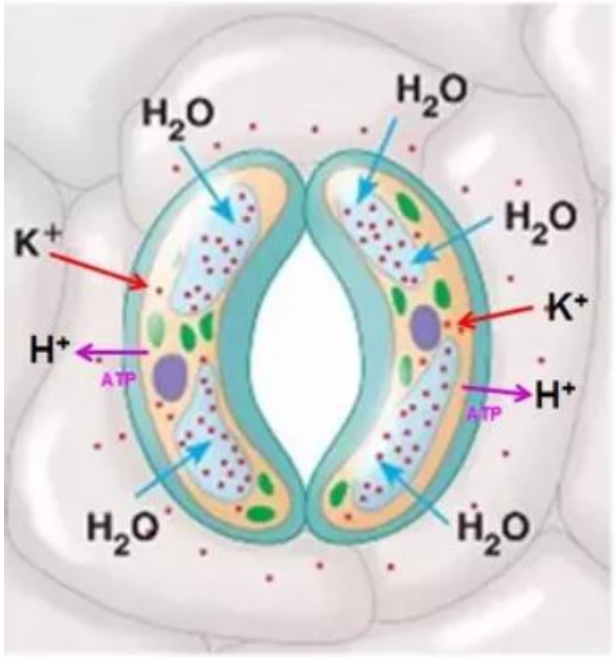
These are geologically disconnected from our surface soils by 400 M years. Devonian Era.

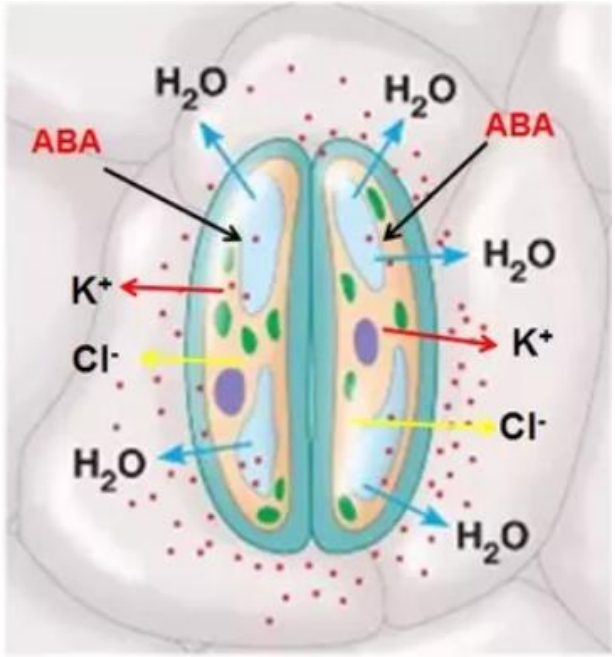
‘Soil’ K has no connection to Geological K!!!

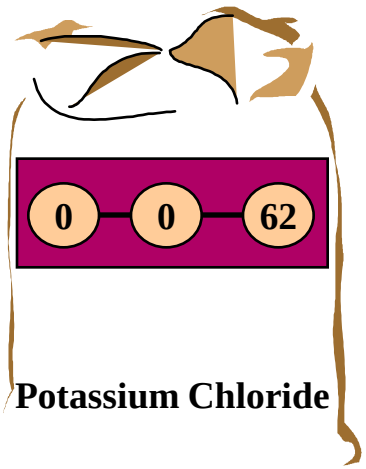
Potassium – Why is it Needed?

- **internal cell pressure – water balance**
- enzymatic activation….of many enzymes
- starch formation and more

Overall, a complex multifunctional nutrient.

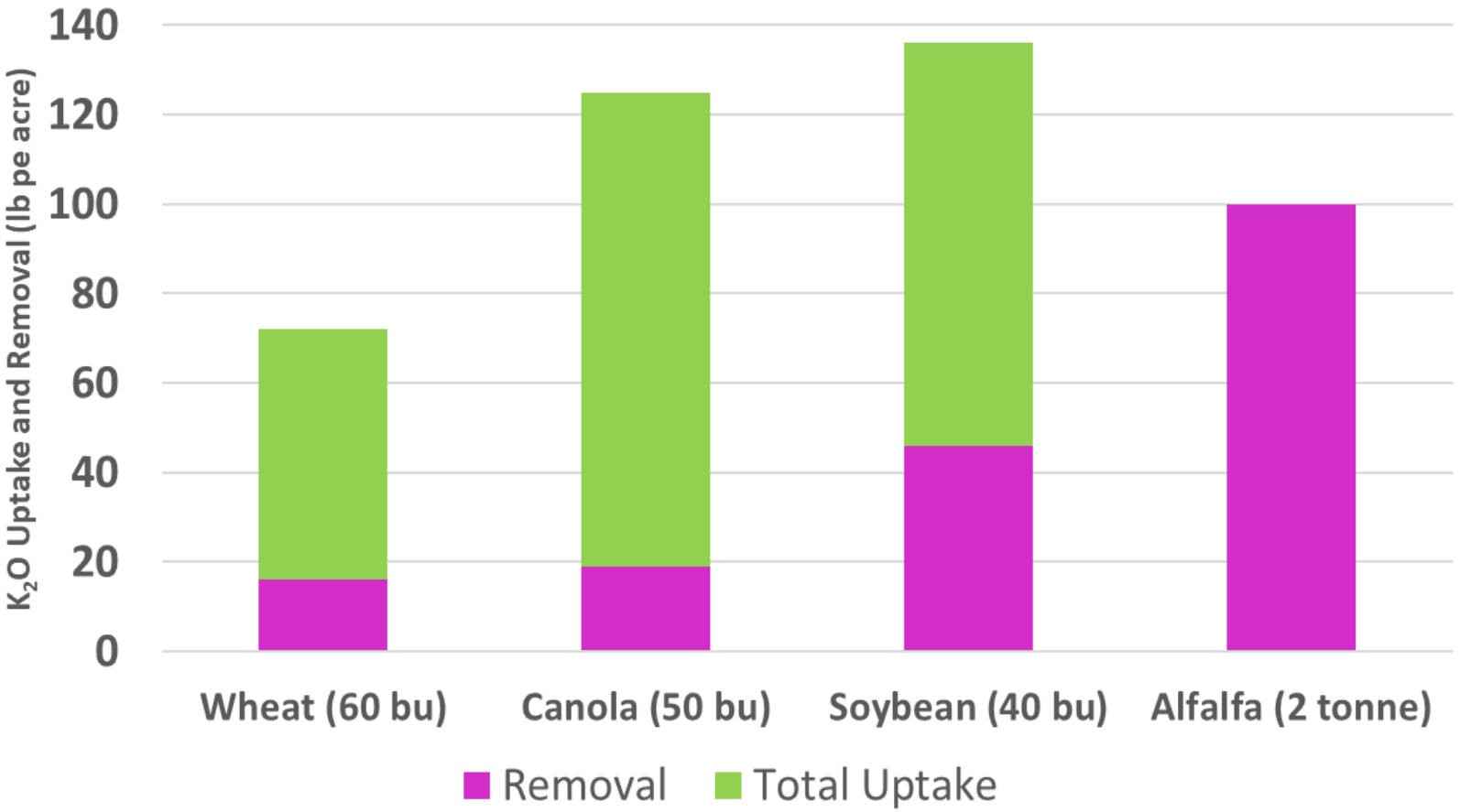






Uptake of K is very high. Removal is not.

Prairie Nutrient Removal Calculator https://prairienutrientcalculator.info/



All Crops need K!!

It is not just ‘barley’.

Sensitivity to deficiency? Or appearance of symptoms?

If we only focus on barley, the rotation becomes deficient.

Don’t oversimplify this – all crops need a lot of K

Rotational Removal of Potassium

Crop	Removal of K_2O
HRS wheat (60 bu)	16
Canola (50 bu)	19
Barley (80 bu)	22
Pea (40 bu)	26
4 year removal	**83**

Crop	Removal of K_2O
Durum (50 bu)	17
Lentil (25 bu)	18
Durum (40 bu)	14
Lentil (30 bu)	21
4 year removal	**70**

Crop	Removal of K_2O
Alfalfa (2 tonne)	100
Alfalfa (2.5 tonne)	125
Wheat (40 bu) straw	45
Canola (35 bu)	13
4 year removal	**283**

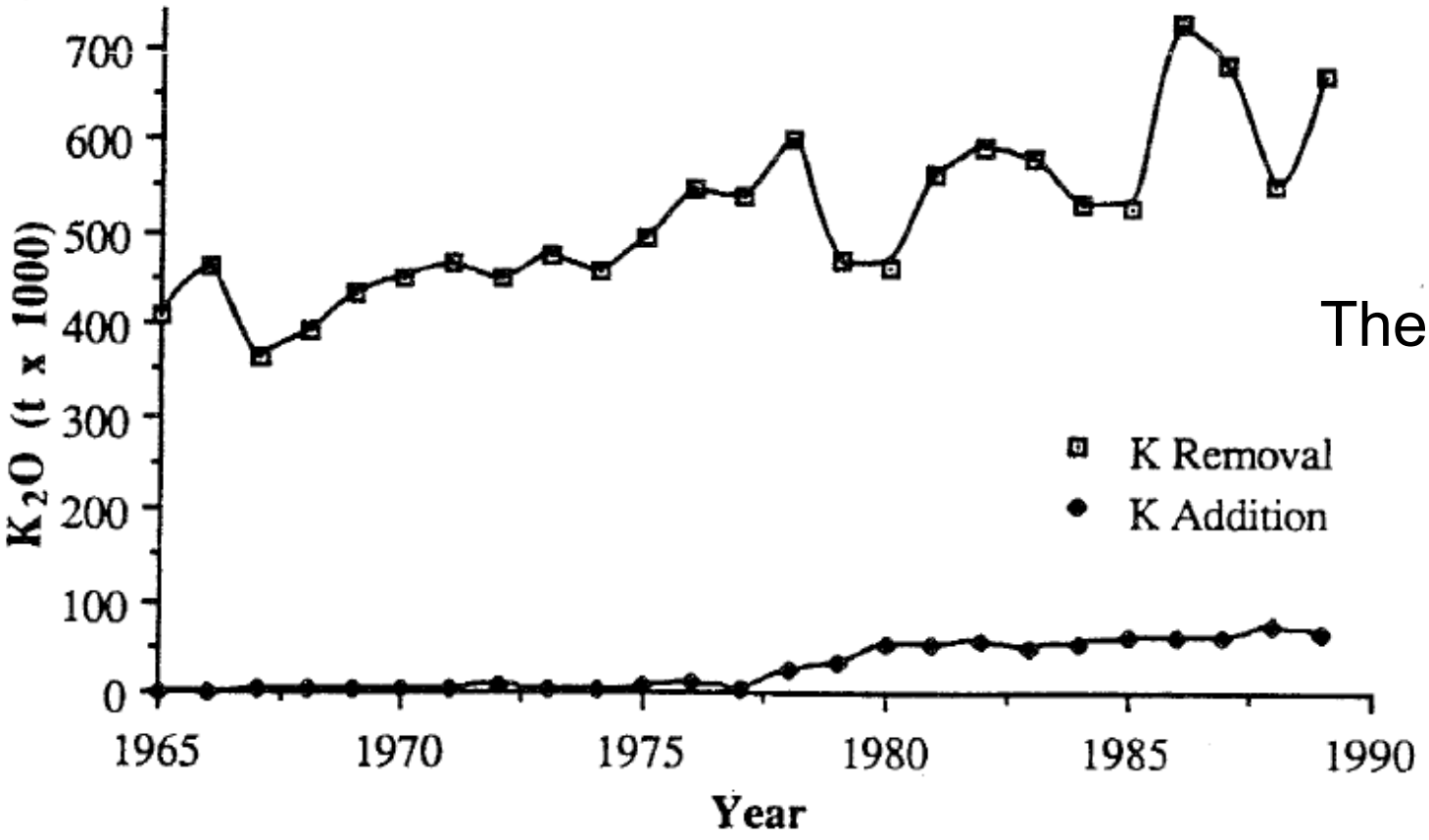
Crop	Removal of K_2O
Soybean (35 bu)	40
Corn (140 bu)	35
Soybean (45 bu)	51
Corn (160 bu)	40
4 year removal	**166**

Rennie and McKercher, 1965

'A 20 bu crop of wheat will take up 17 lb of K per acre, the majority contained in the straw….about 7 lb of K removed by grain….at this rate of loss of K the A horizons contain sufficient K to meet all crop requirements for 30 to 100 years.'

Now, 60 years later with much higher annual yields?

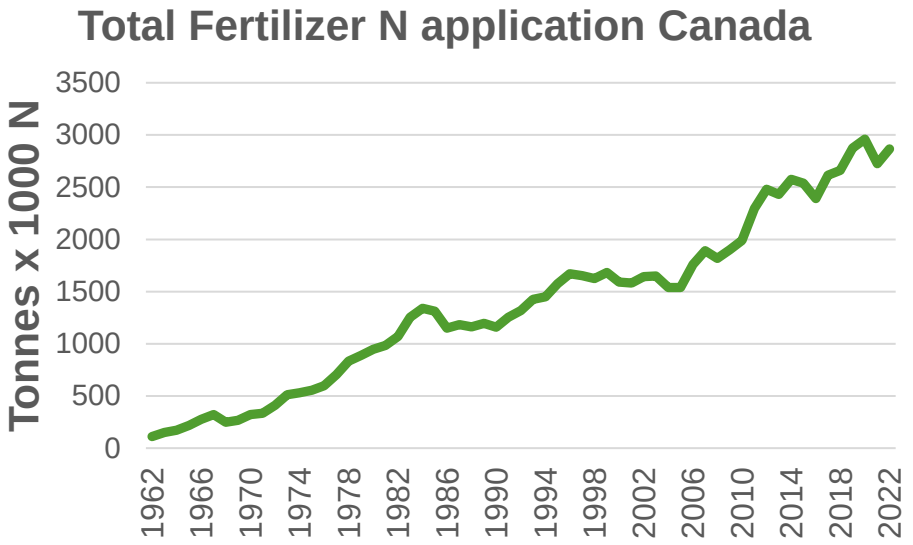
Historical removal of K

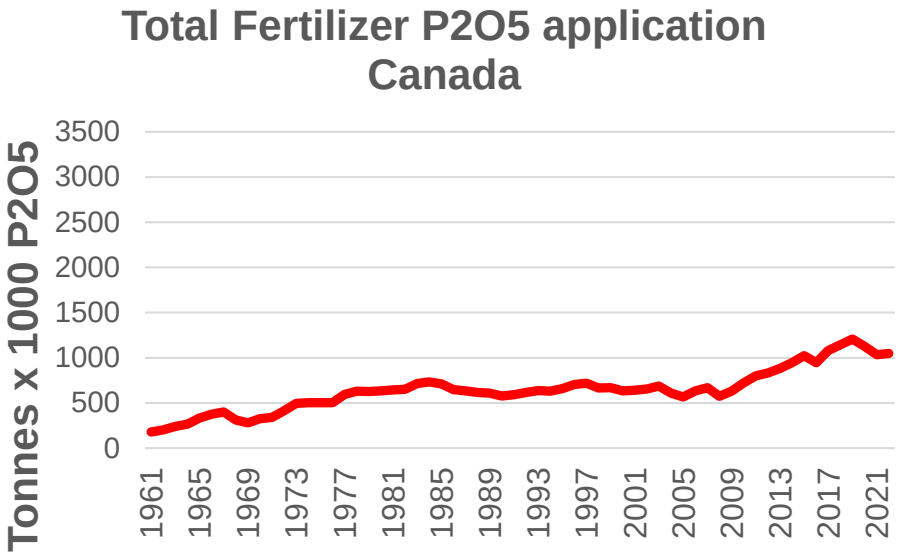


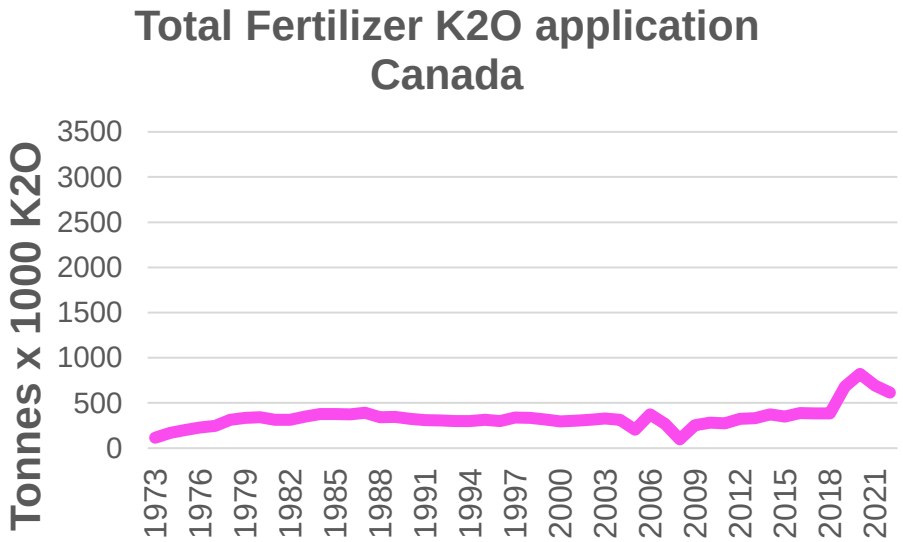
The ‘Red Book’

We have likely removed 1000 lb per acre of our best soil K

Canadian Application of Fertilizer Nutrients

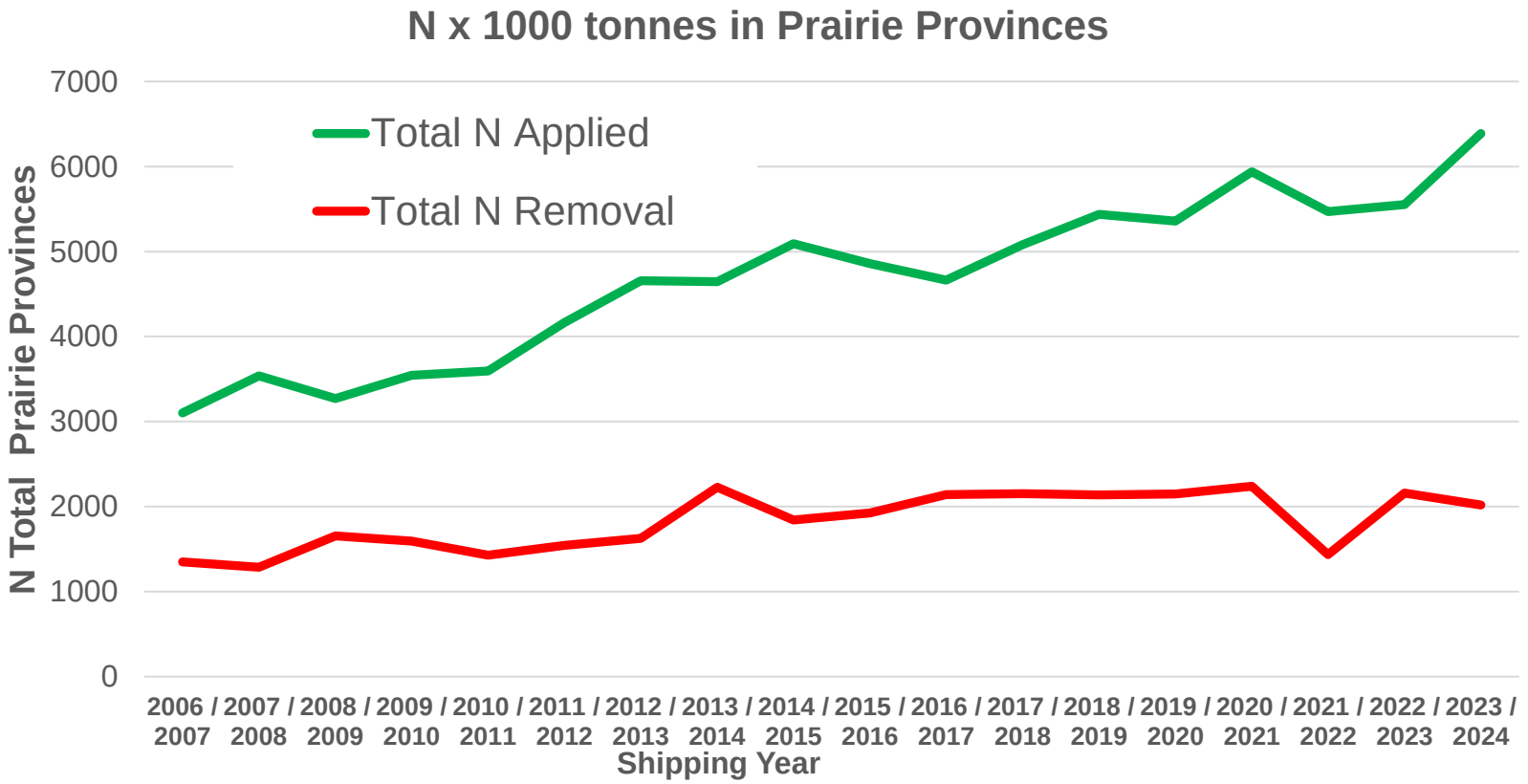






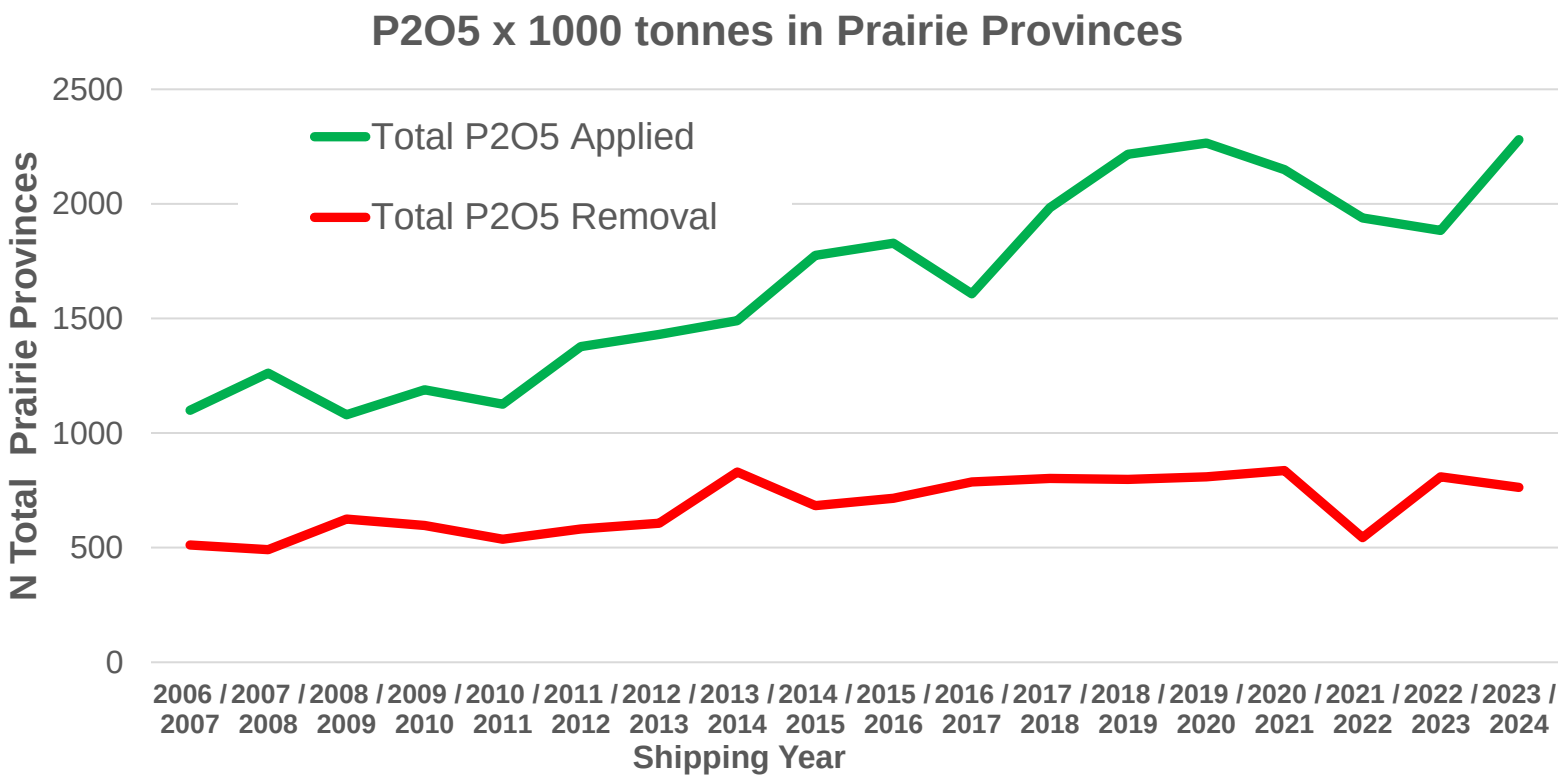
https://www.ifastat.org/databases/plant-nutrition

Prairie Province Nitrogen Addition and Removal



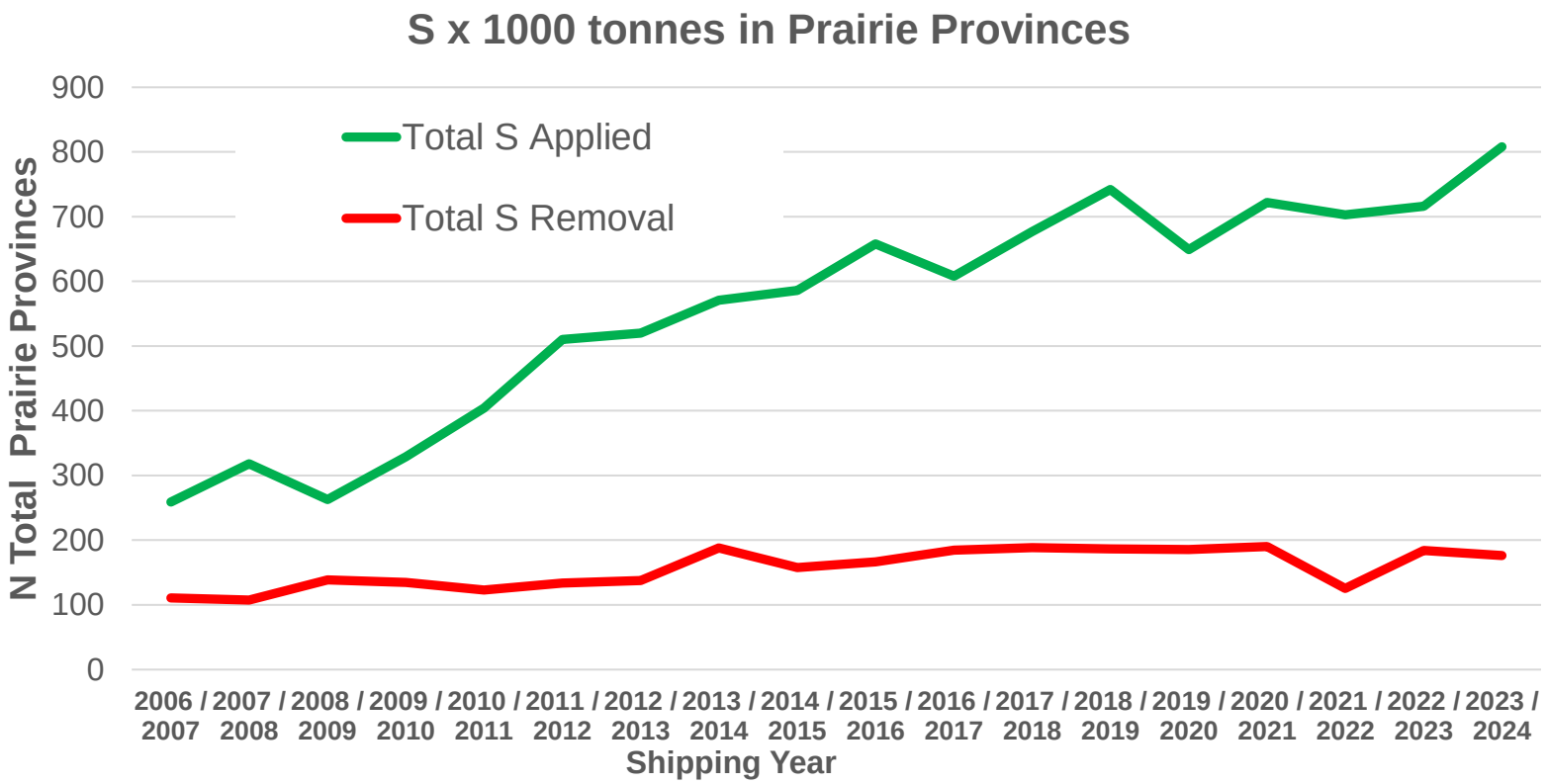
2006 → 2024

Prairie Province Phosphorus Addition and Removal



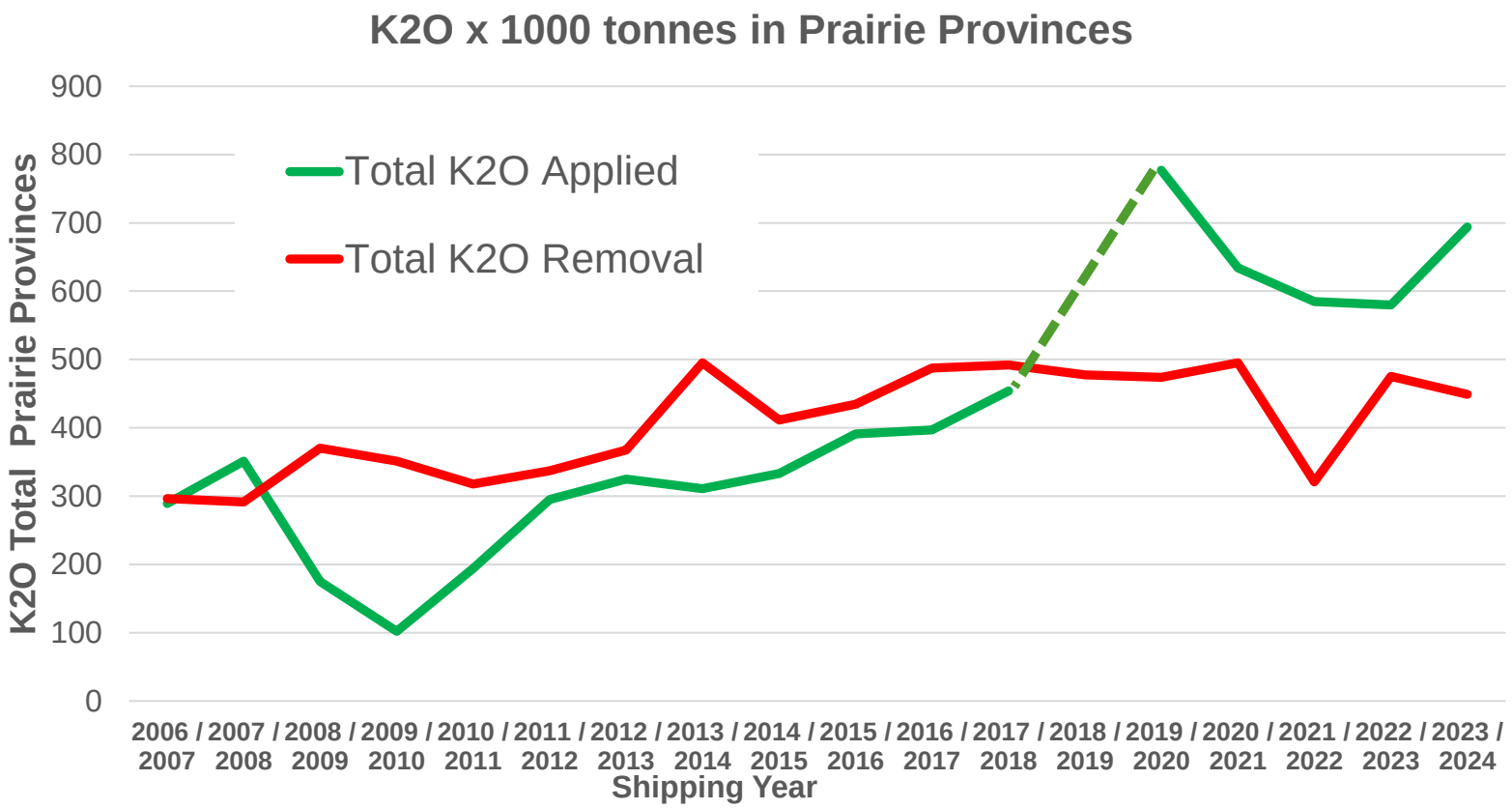
2006 → 20224

Prairie Province Sulphur Addition and Removal



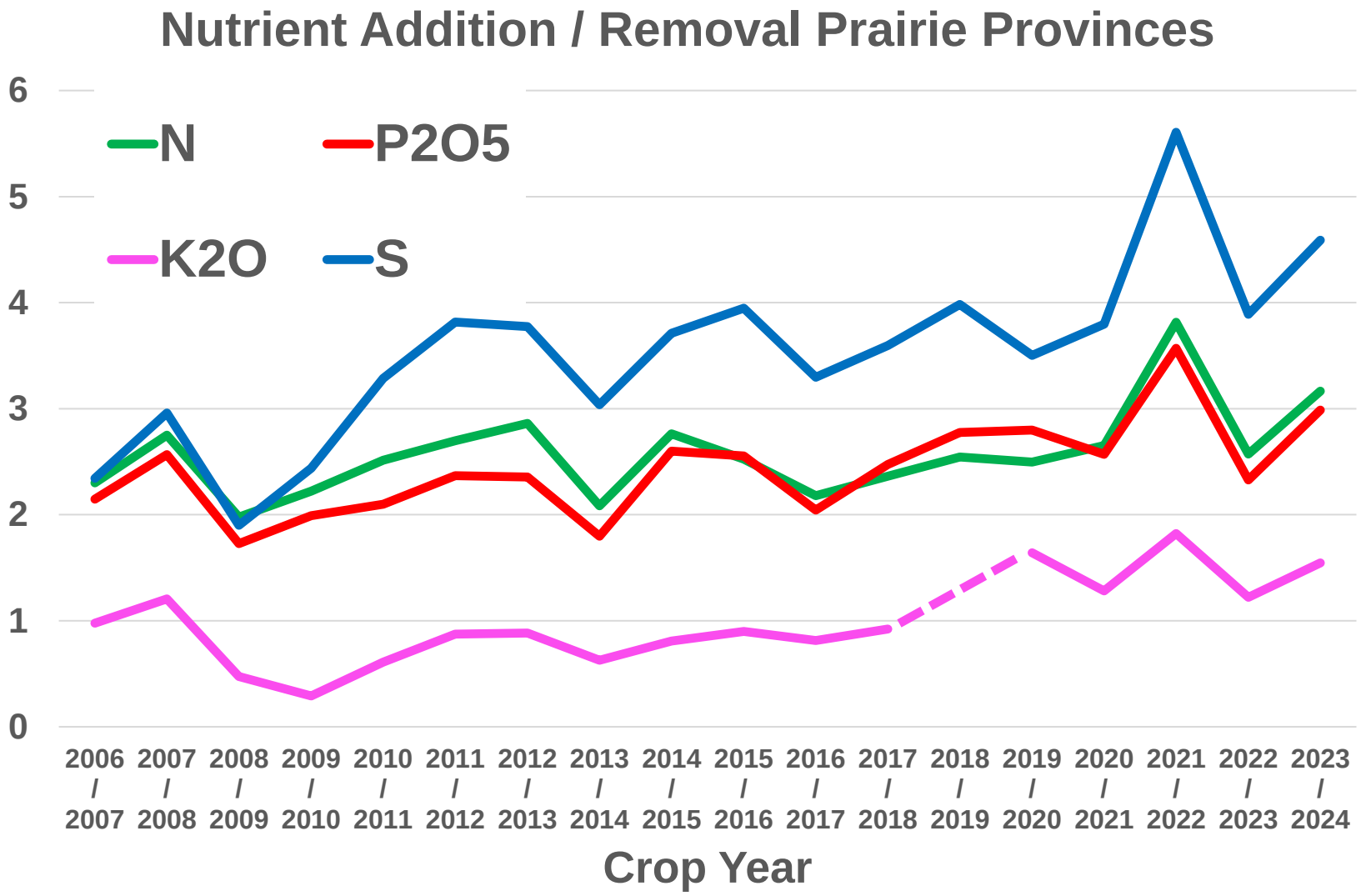
2006 → 20224

Prairie Province Potassium Addition and Removal

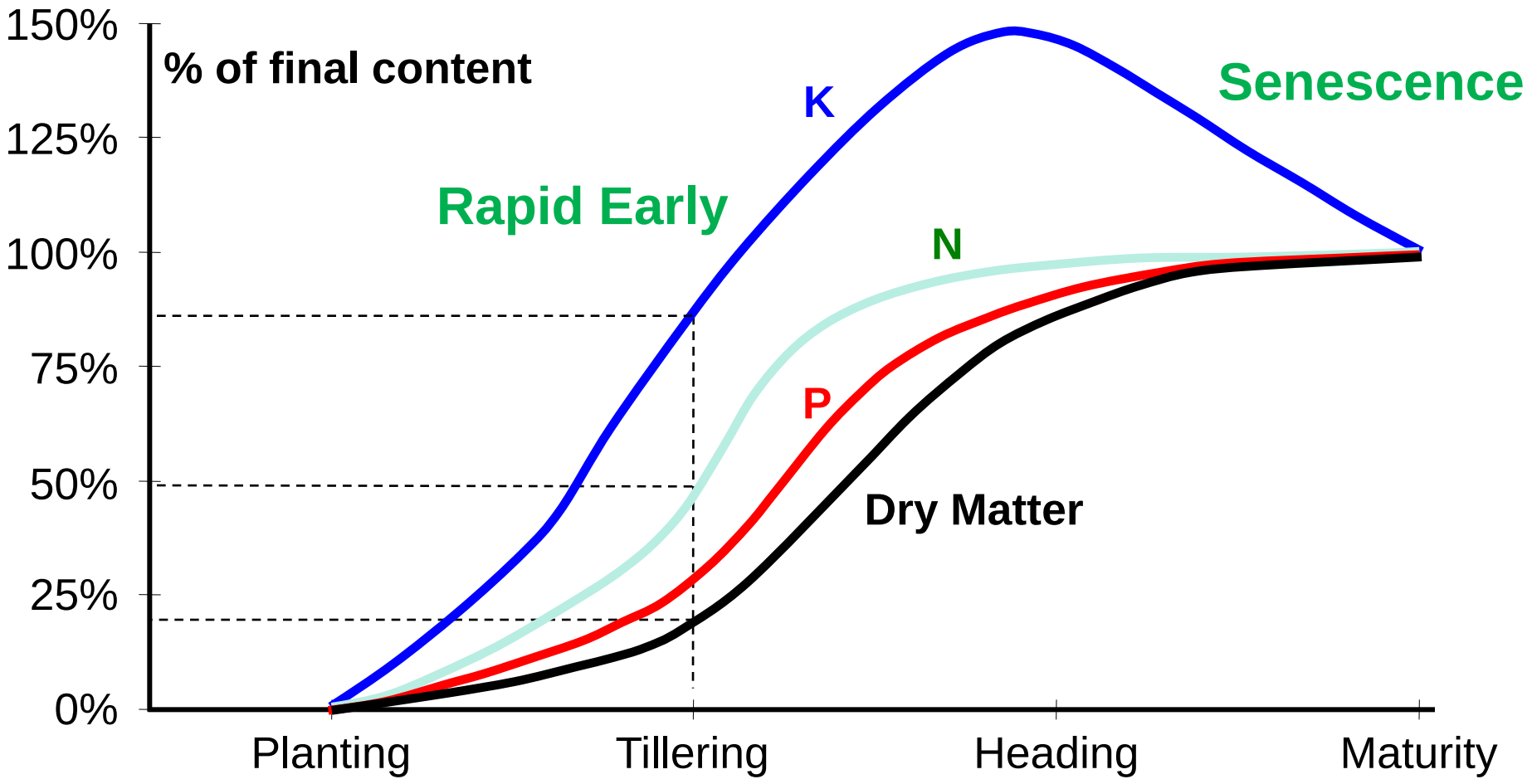


2006 → 20224

Addition and Removal Ratios



When do crops need K??



Fundamentals of K in Soil

1. It is taken up by plants as a soluble cation (K^+)
2. Cations cannot move very far in soil as they are attracted to clay and organic matter
3. Potassium is therefor both soluble but not very mobile
4. Most movement and uptake will be via diffusion
5. Dry soil. Compacted soil. Cold soil. Slower Diffusion
6. Clay type and concentration of other cations

Sand

You can probably fix this easily

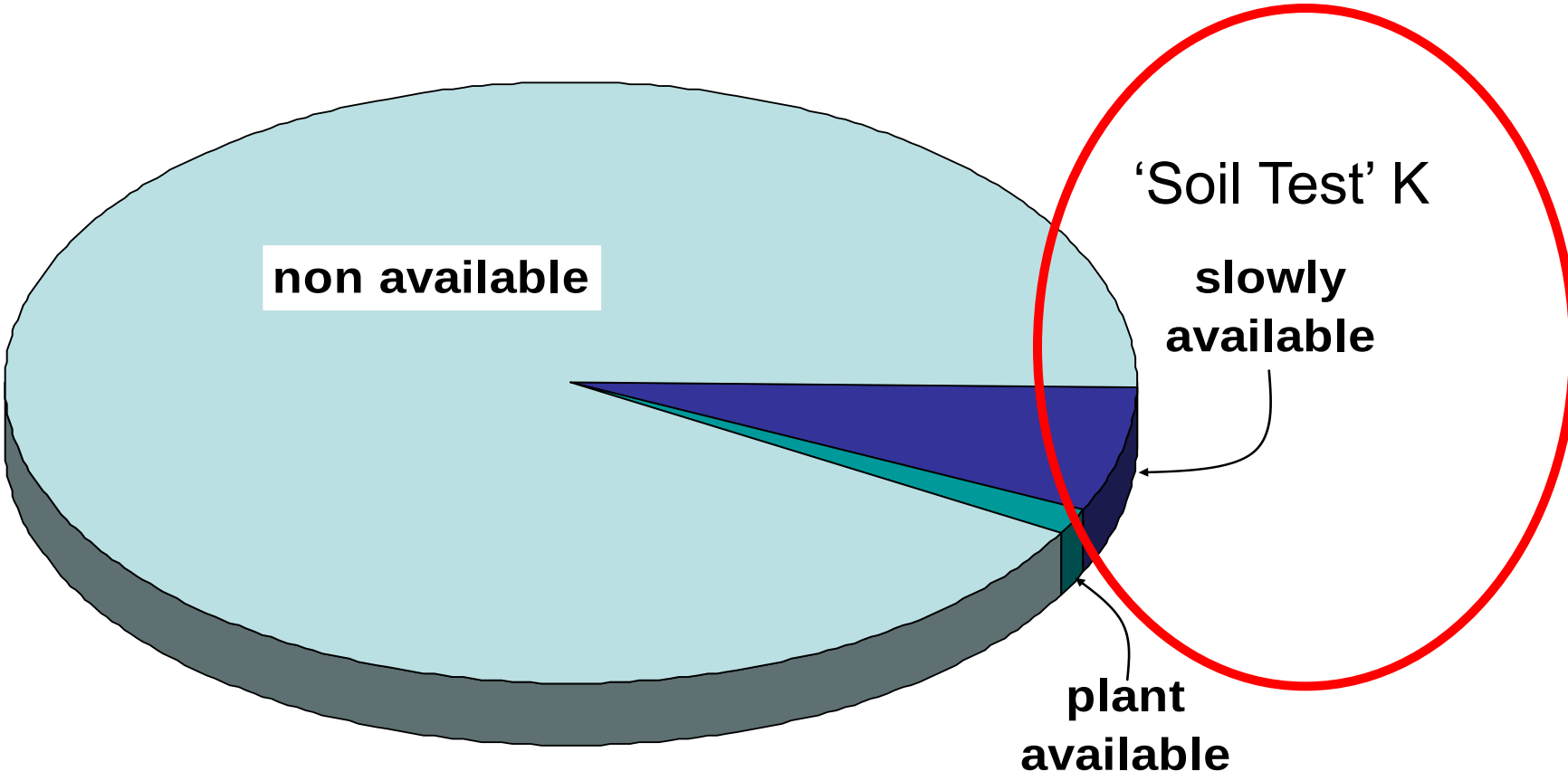
Peat

Harder to fix – depends on type and depth of peat

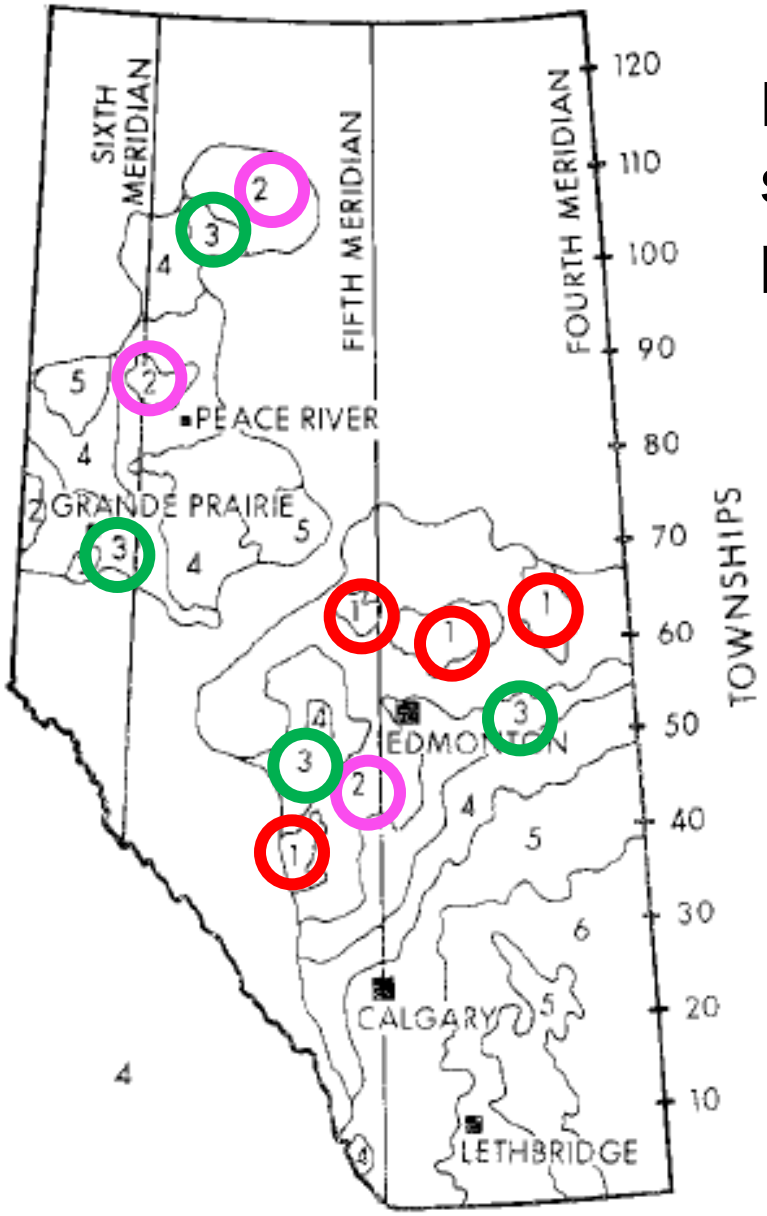
Relative Amounts of Soil Potassium

Soil has a lot of K.

Soil does not have a lot of available K at each moment.



Mapping of Alberta Soil Test Data. 1970.

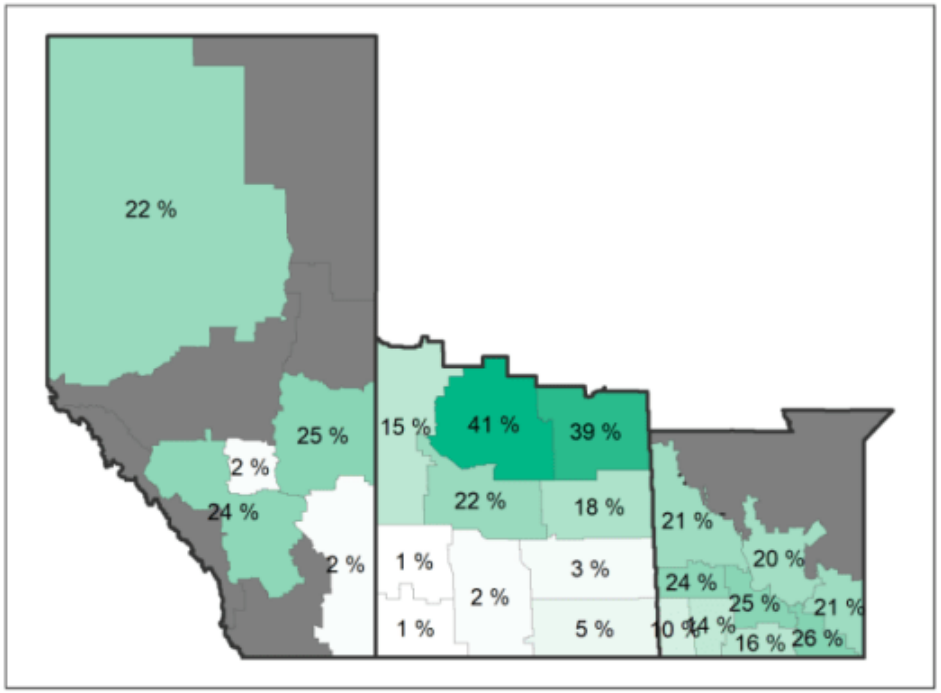


Based on **63,000 6" topsoil samples** from 1962-1969 at AB provincial lab

'1' = 201 to 300 lb K
'2' = 301 to 400 lb K
'3' = 401 to 500 lb K
'4' = 501 to 600 lb K
'5' = 601 to 800 lb K
'6' = 801 to 1000 lb K

D. Cameron and J. Toogood. CJSS 50, pp 1-7.

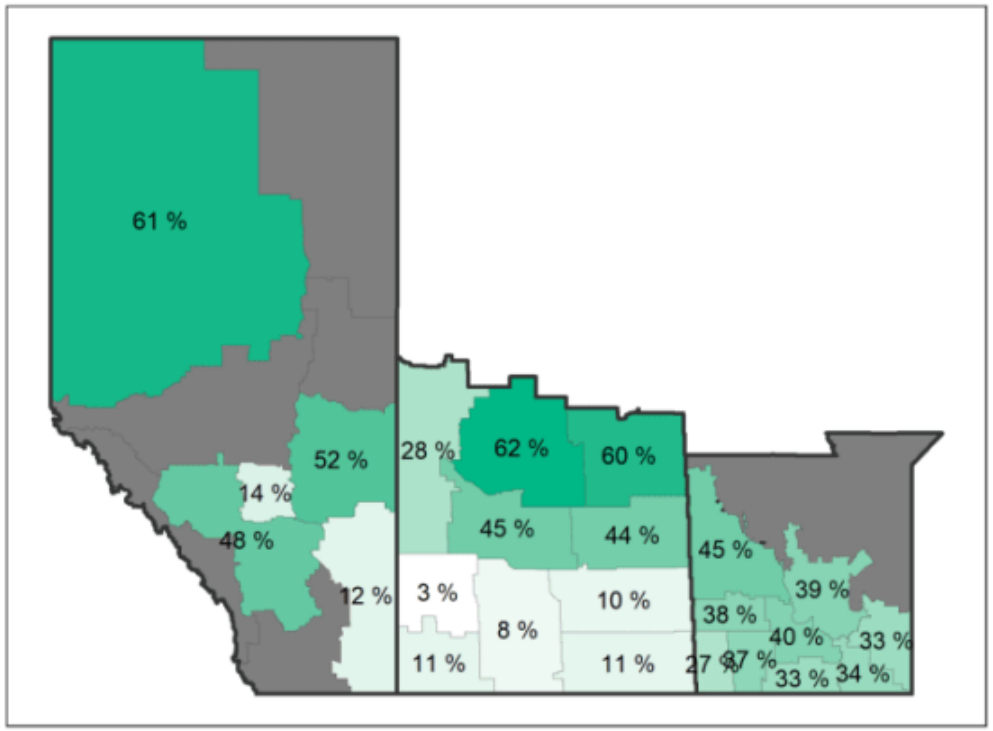
Soil samples with soil test potassium below 150 ppm in 2024



Data not shown where n< 100
AGVISE Laboratories, Inc.

150 ppm = 260 lb per acre for 6” sample

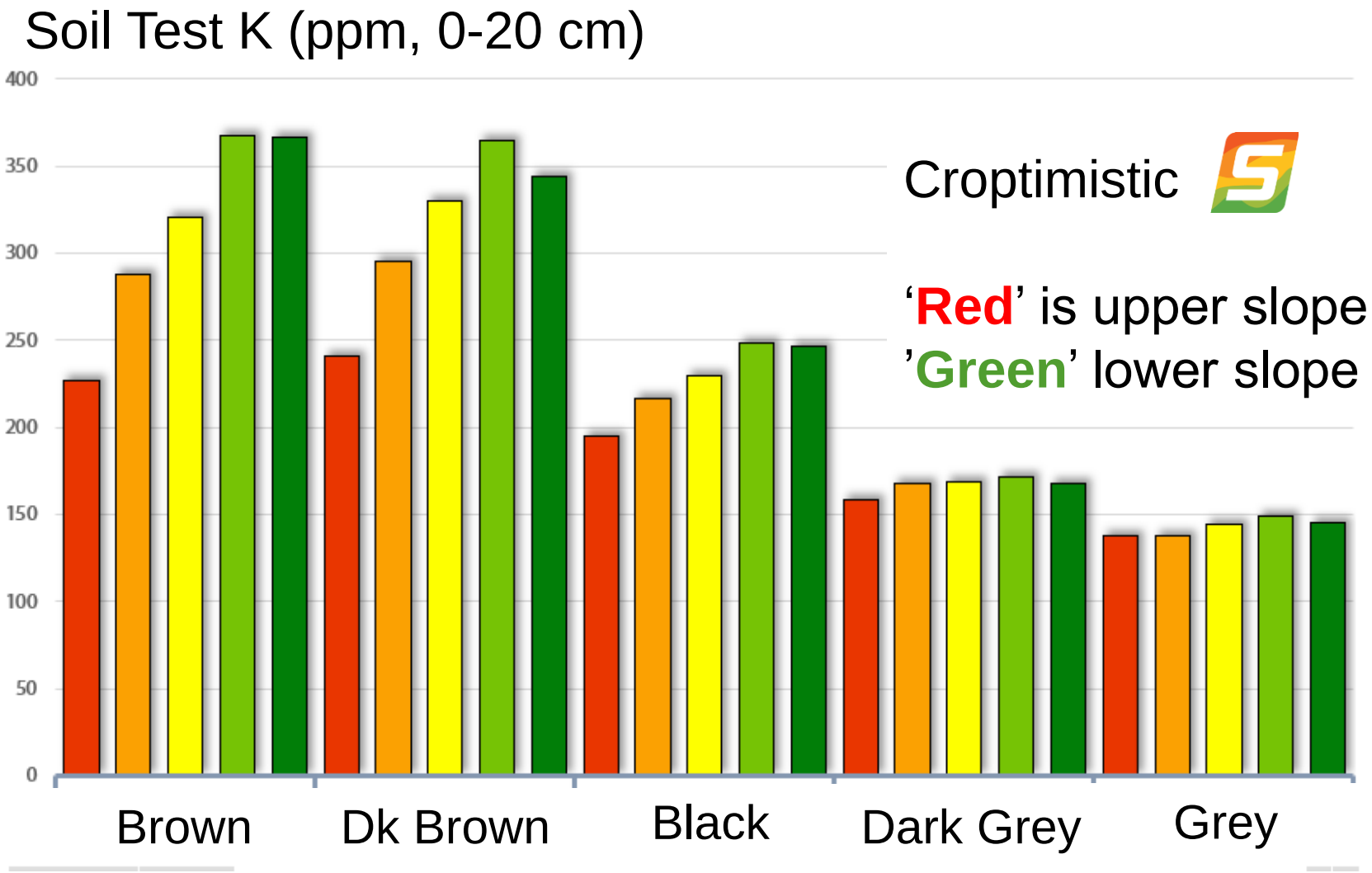
Soil samples with soil test potassium below 200 ppm in 2024



Data not shown where n< 100
AGVISE Laboratories, Inc.

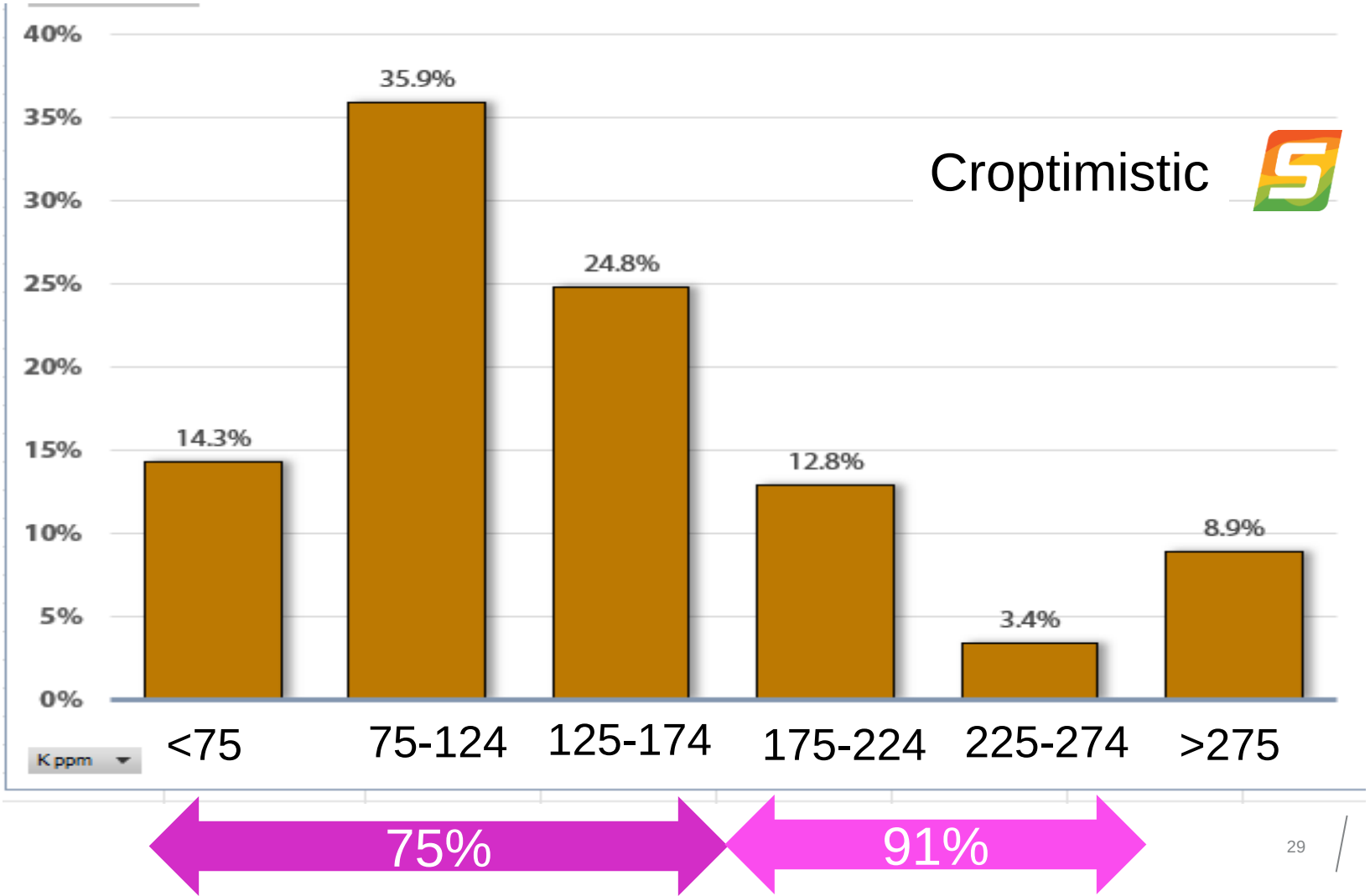
200 ppm = 350 lb per acre for 6” sample

Soil K x Soil Zone and Landscape Zone



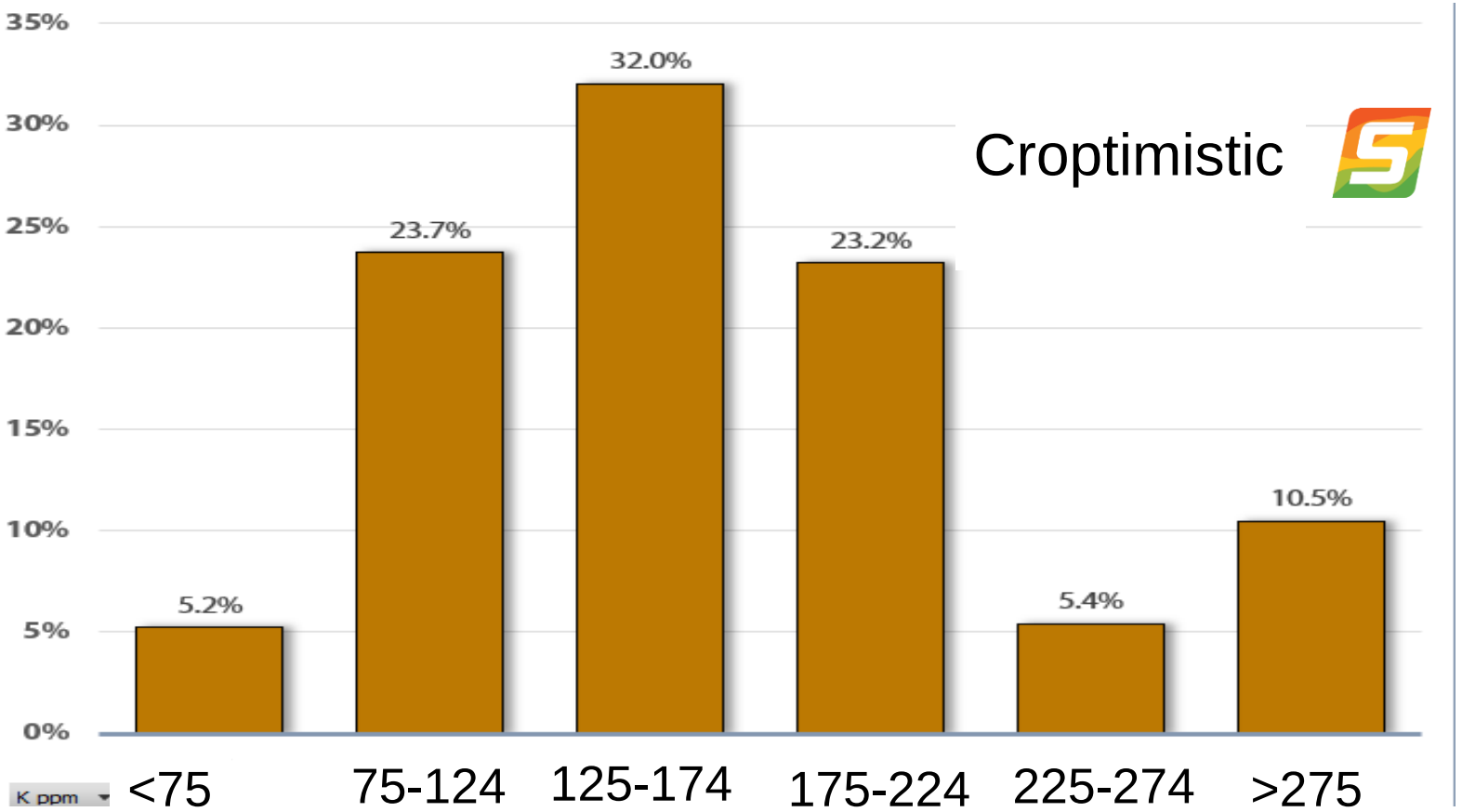
Soil K x Grey Wooded Soils

Soil Test K Variance in Grey Wooded Soil Zone (ppm, 0-20 cm)



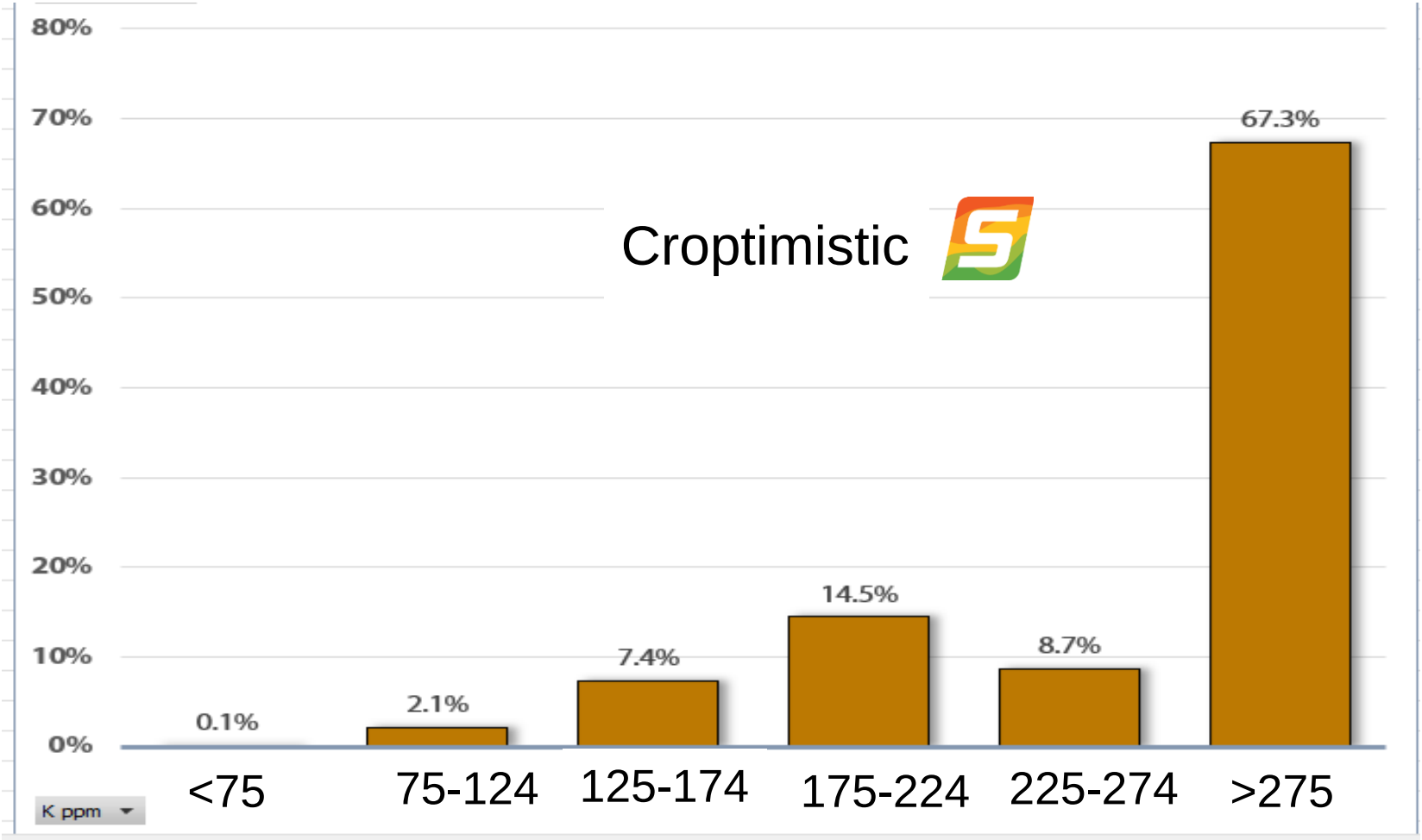
Soil K x Dark Grey Soils

Soil Test K Variance in Dark Grey Soil Zone (ppm, 0-20 cm)



Soil K x Dark Brown Soils

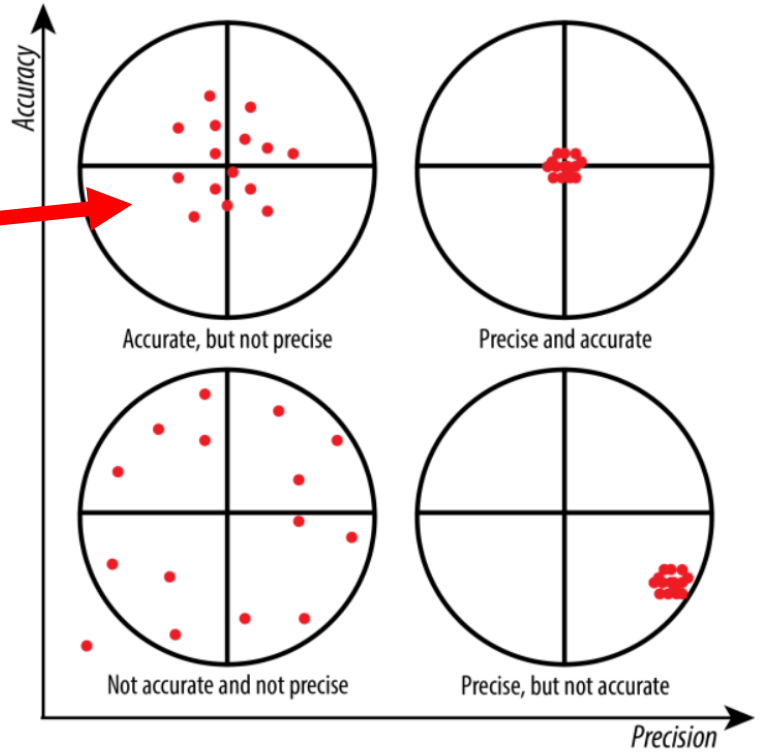
Soil Test K Variance in Dark Brown Soil Zone (ppm, 0-20 cm)



Expect Soil Tests to Predict K Response but not Size of Response

(Good) soil test correlations are something like this

Yields are not only affected by nutrition, so to target a specific yield can be daunting.



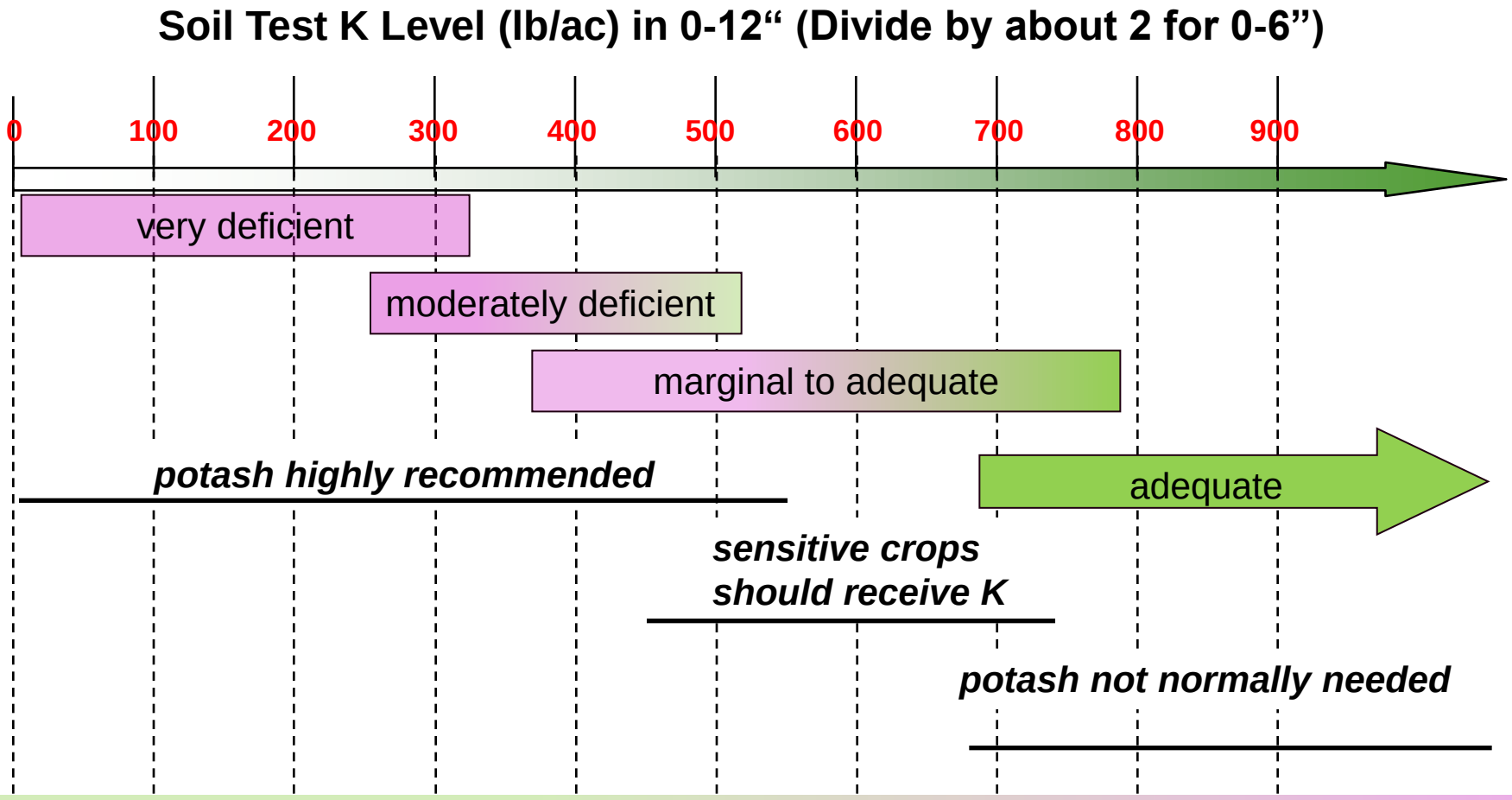
Again – soil tests of K are only an index

Critical level in soil?

- Varies x soil sample depth (higher if shallow)
- Varies x soil CEC (clay buffering)?
- Species variance which has not been measured?
- Yield goal and environmental potential?
- Recent history of removal or application of K

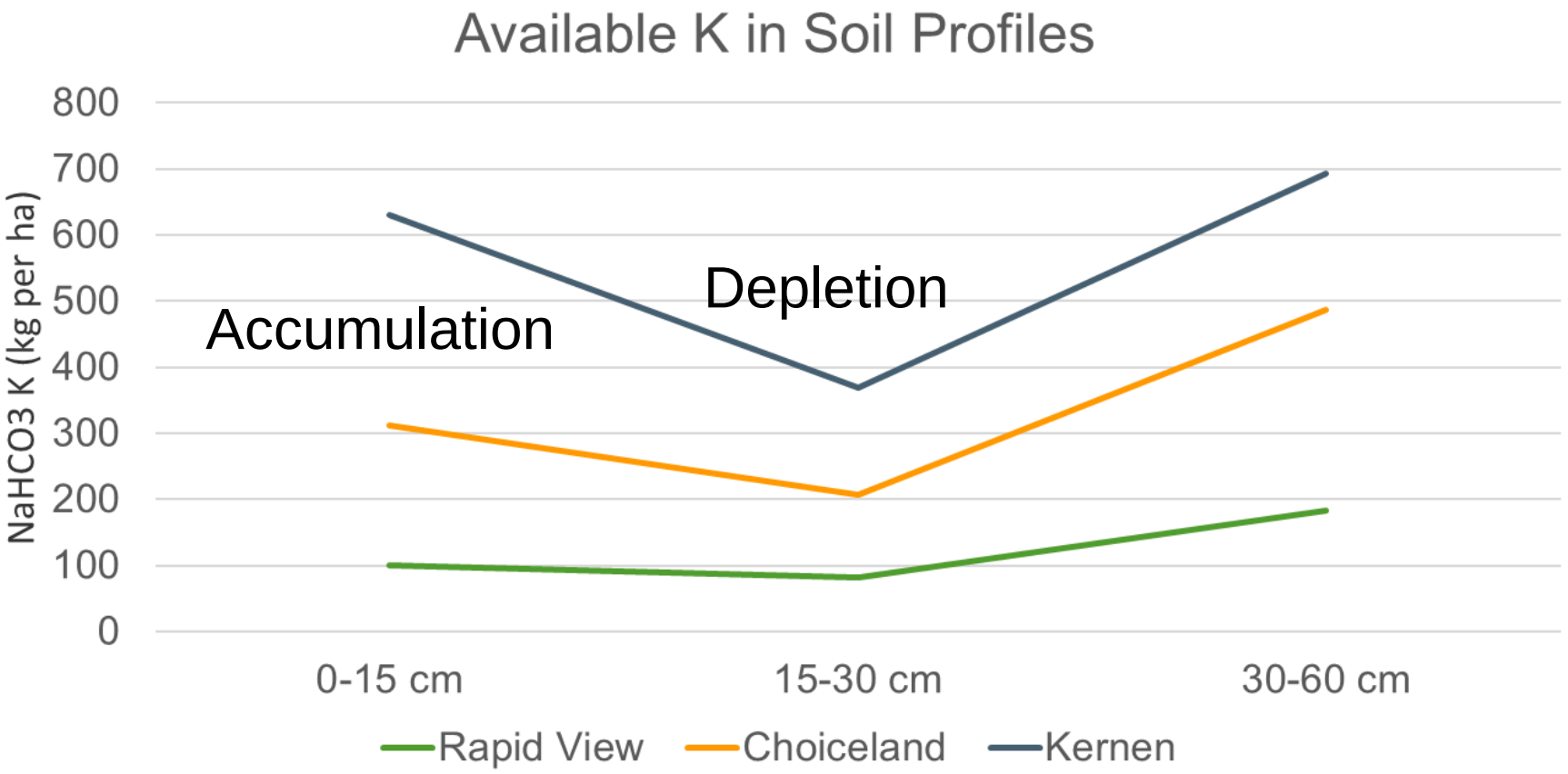
Its not straight forward.

Soil K Ratings and Recommendations
ONLY an INDEX



Critical point? About 300 lb per acre for 0-6” soil sample and 500 lb per acre for a 0-12” soil sample

The Pattern of Available K x Soil Sample Depth.



Accumulation in surface soil, depletion in subsoil – K test level and nutrition will vary by rooting depth (Les Henry, unpublished)

Potential Reponses? An Alberta Example.

Yield increase of barley to added potassium (K) fertilizer at increasing available soil K levels

Soil K (0-6”) lb per acre	% Sites Yield Response	% Yield Increase from K Fertilizer
<50	100	>1000
51-100	75	242
101-150	66	47
151-200	24	30
201-250	18	34
>250	3	11

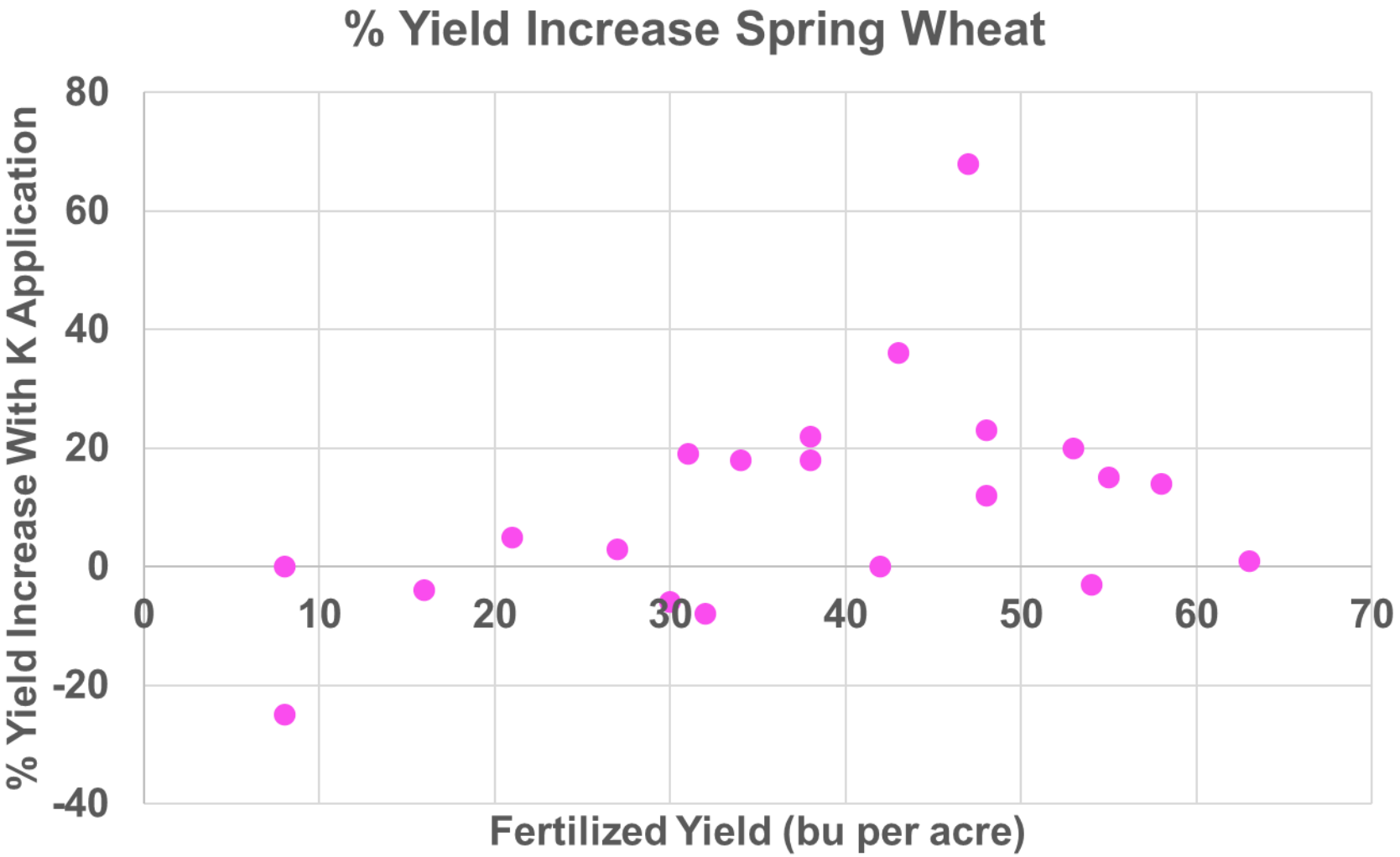
Potassium Fertilization in Central Alberta. D. Walker, Lacombe Ag Canada (from Better Crops Magazine, IPNI, 1978).

Quite large responses even in range of low frequency of response

Innovative Acres Field Trials

- Field research in 1980s across Sask, Dept Soil Science USask
- Side by side field trials with paired samples at 10 positions per trials in 1985 and 1986
- Soil test K measured to 15 cm
- 26 successful trials in barley, spring wheat and winter wheat
- Significant yield increase at 14 sites
- 22% yield increase at responsive sites
- ‘despite an absence of visual responses in field’

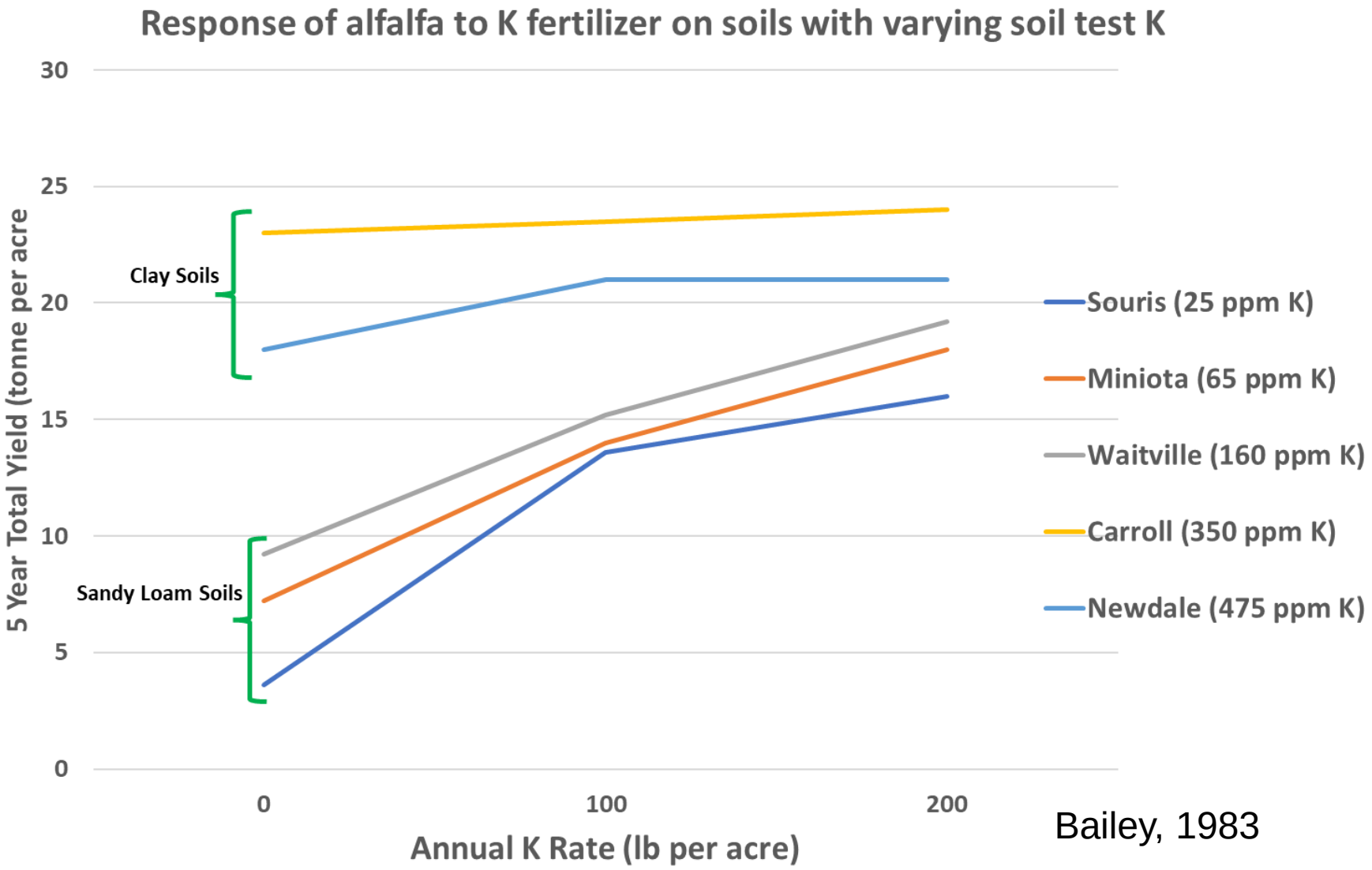
The higher the yield, the more likely a K response



A note on forages

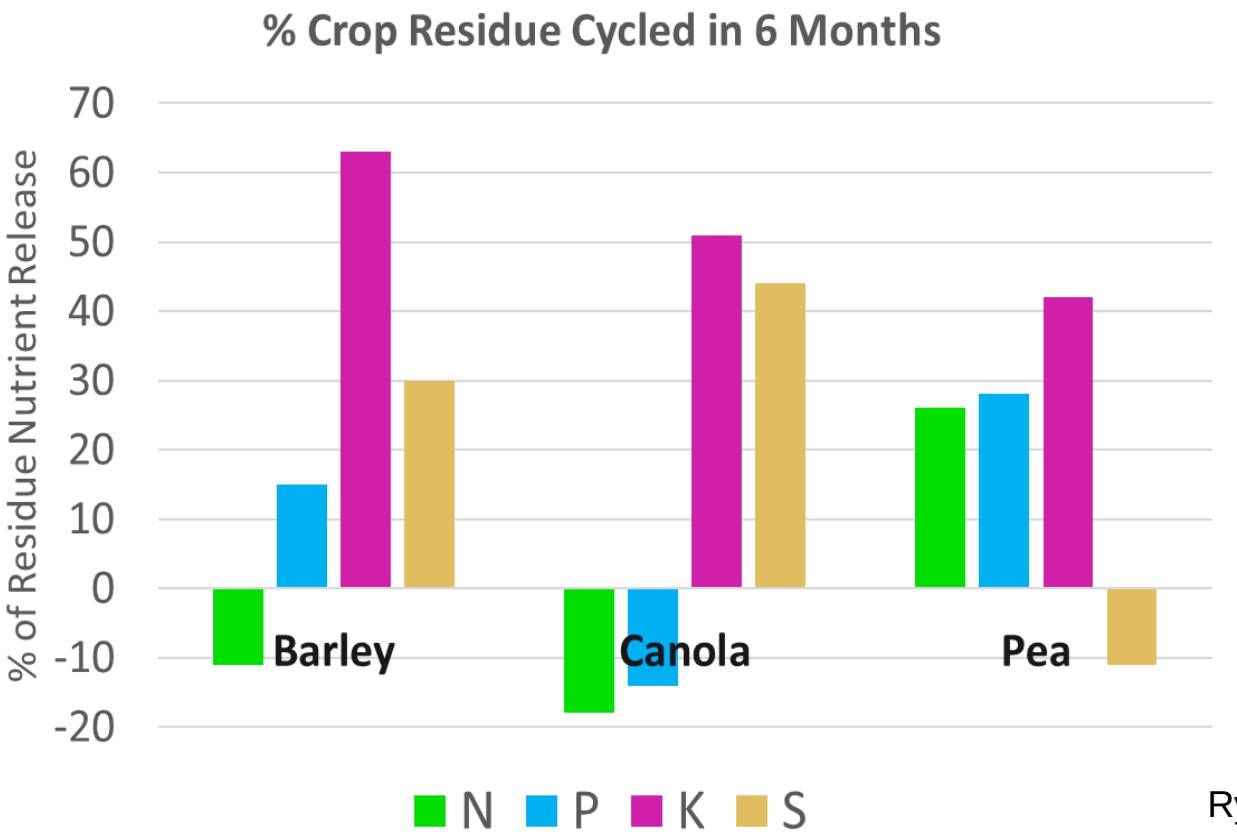
- Very high rates of removal by hay, sileage and straw
- Forages are more often seeded on potassium deficient soil – sand, peat, eroded, marginal land….some which can be very productive with forage

Forage response to added K can be impressive



Bailey, 1983

Back up here a minute – what about the crop residue K ?

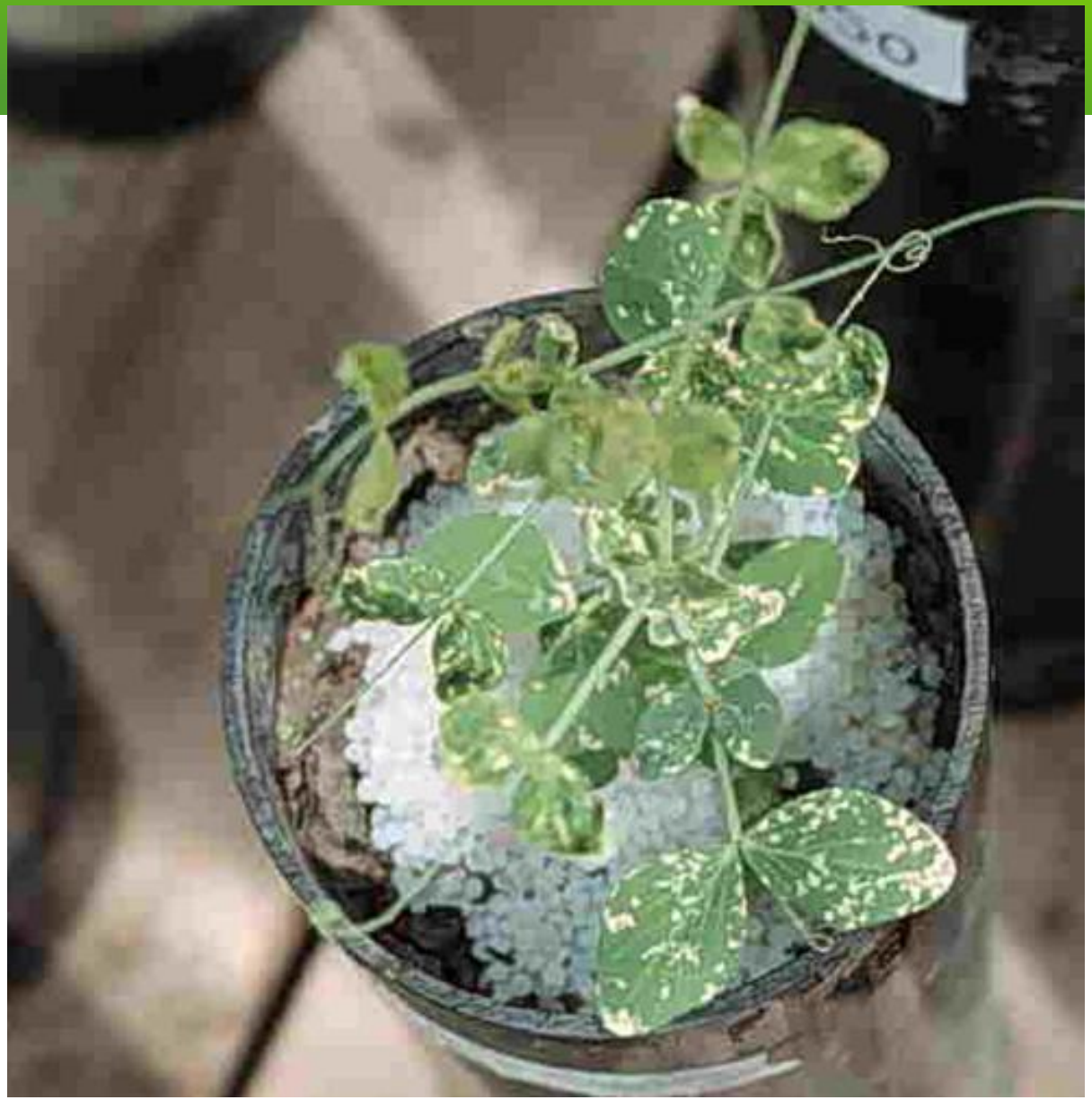


Ryan Hangs, USask

Overall, residue is always a good source of K to the next crop

Diagnosing Potassium Deficiencies

- symptoms occur in the older, lower leaves
- tip and marginal necrosis of leaves
- white spots on alfalfa leaves
- uneven and slow growth
- weak stalk ➔ stem breakage (not ‘lodging’)
- poor seed development



Broadleaf crops – spotted necrosis on some species

Potassium in Canola (rare!)

Remember – its in the straw

What happened here??

Barley

Remember – its in the straw

What happened here?

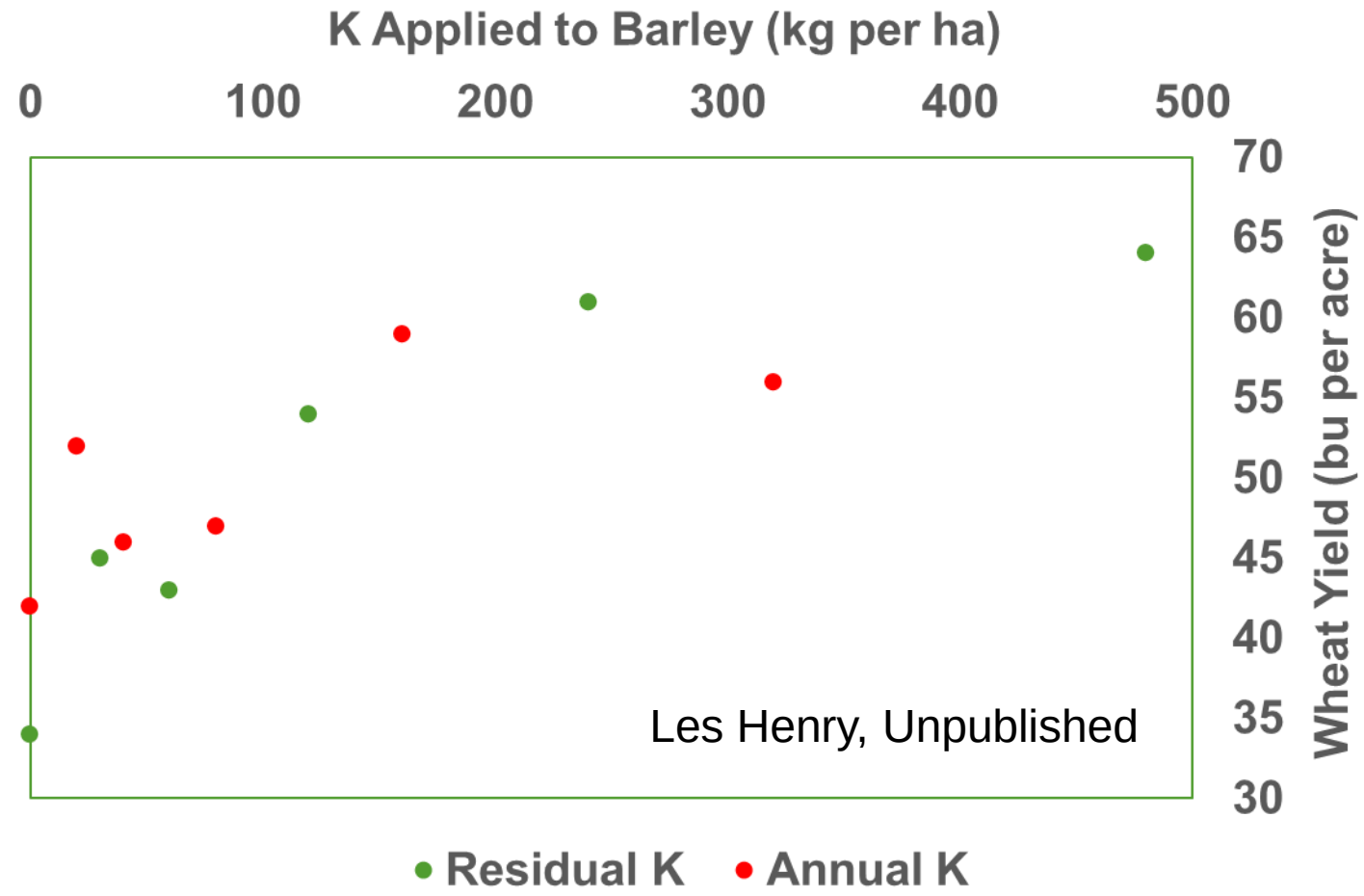
The opportunity of comparative tissue tests!

General K application thoughts

1. K is a cation
2. K moves in soil mainly by diffusion
3. Crops need K early

- First choice, apply a safe rate near the seedrow
- Second choice, Broadcast or Band K
- Foliar K is just not gonna work

Response to Annual or Single K Application



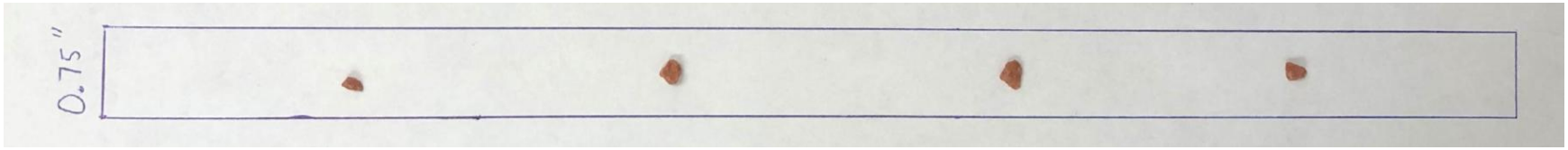
Annual K rate is the accumulative rate of 1980-81
For example, the 80 kg per ha is 2 x 40 kg per ha

A note on seedrow potash

15 lb K2O/acre as 0-0-60
10” Equivalent Row Spacing, at 0.75 inch row width

- Significant space between granules!
- Poor access for all seeds?

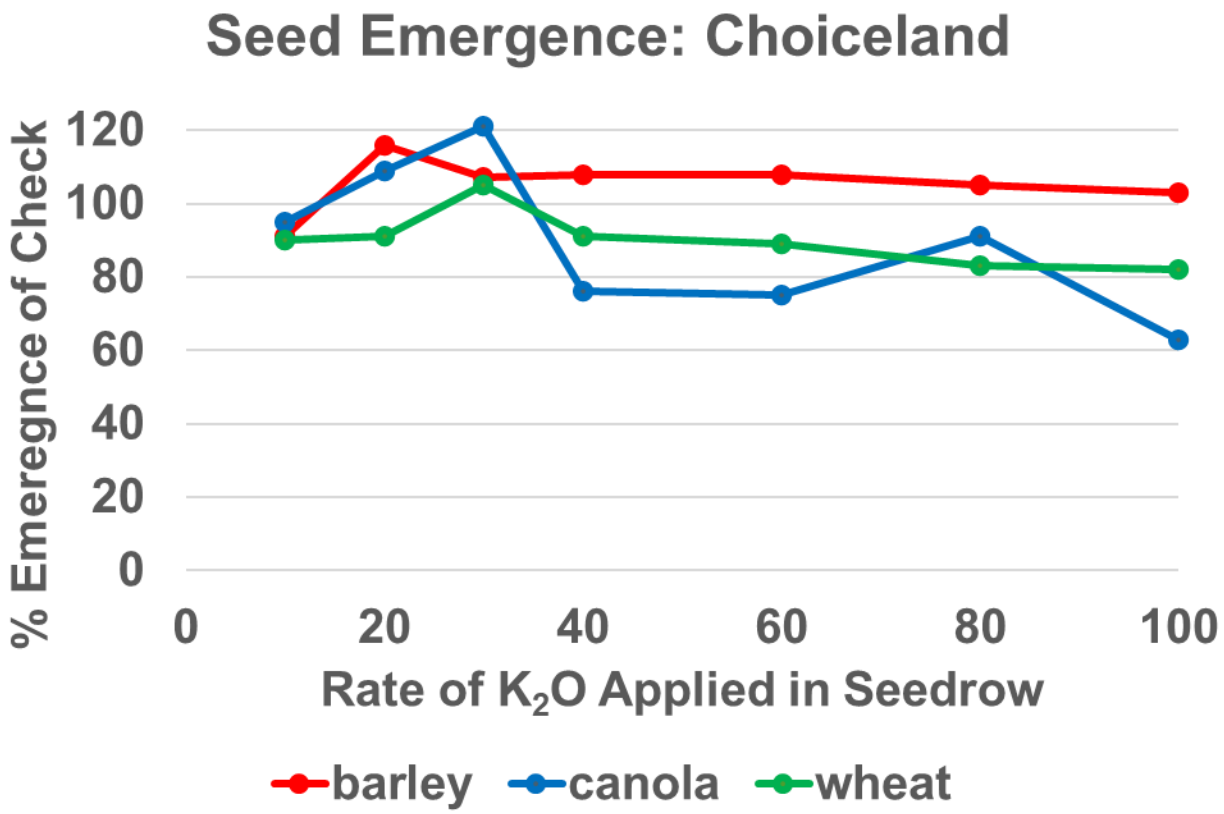
0.75”



1 Foot of Row

Seedrow Safety of Potash

- Double disc press drill on 7.5” spacing. SBU <10%?
- Replicated 4 x
- At all sites, little or no reduction to seedling emergence



0 K Plant Counts

Wheat = 17.8
Barley = 11.5
Canola = 9.1

‘*Seed placement of potash fertilizer can be safe at relatively high rates, especially on soils with a high exchange capacity. For soils with a lower exchange capacity current guidelines are probably warranted though severe reduction in plant populations or head counts were not found at even high rates of seed placed K’*

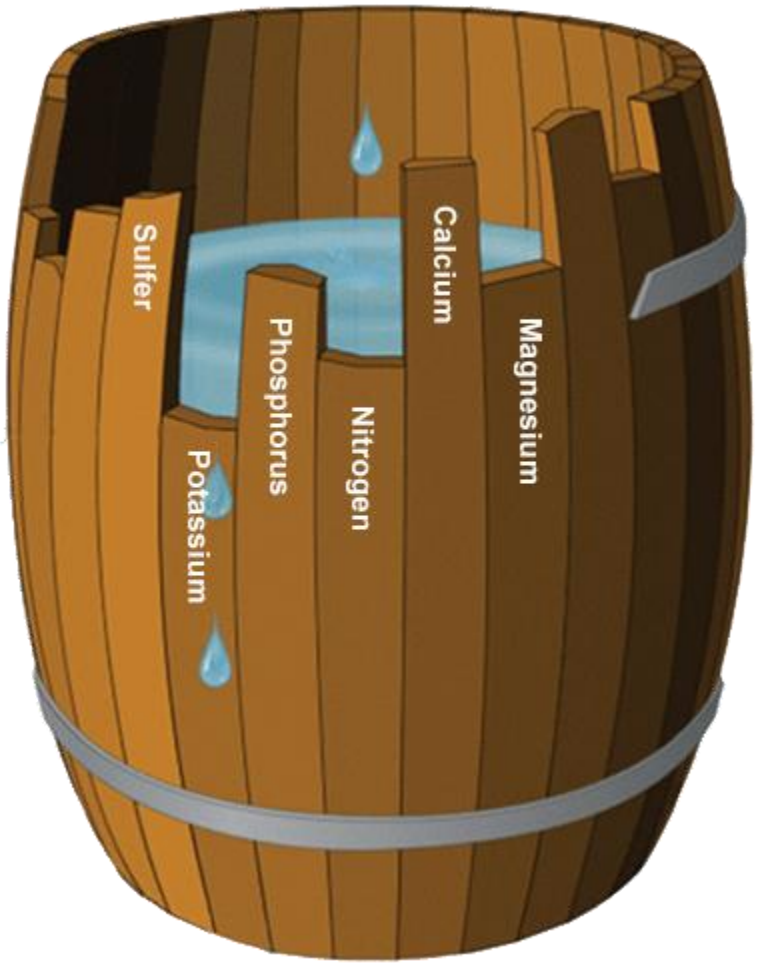
Les Henry, unpublished

BUT USE CAUTION!!!!

Ask yourself?

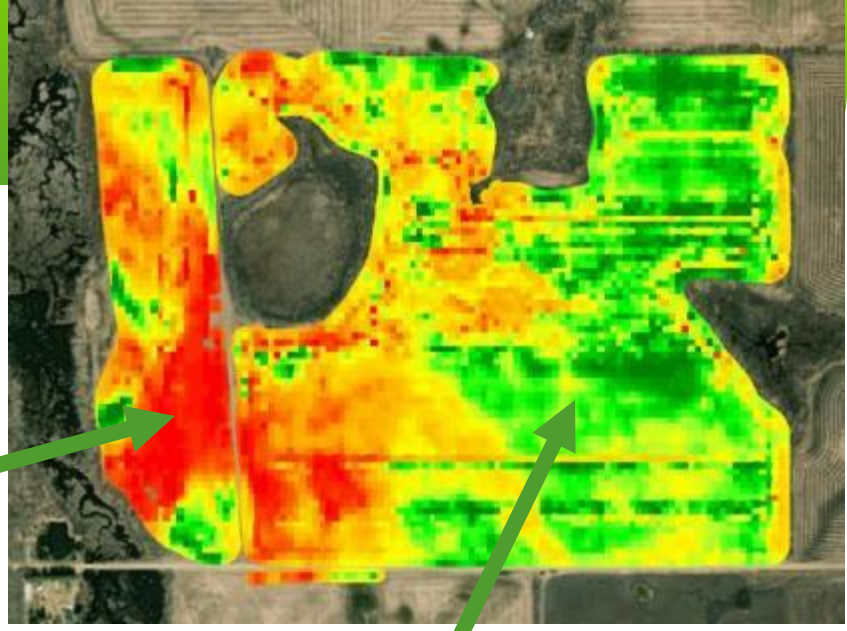
On your farm, what
soils x crops are most likely to
respond to potassium?

Where is the lowest Leibig bar.

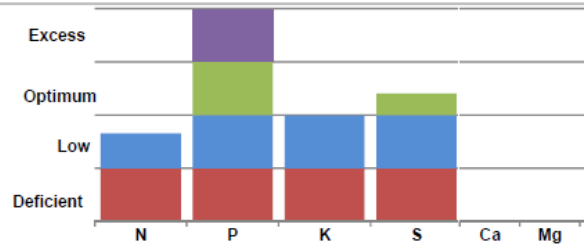


VR K. It makes sense.

Separate Sampling and Management

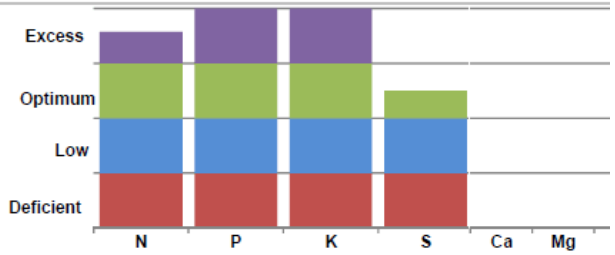


		Soil Nutrients					
		Macros			Secondary		
		NO3-N	P	K	SO4-S	Ca	Mg
Lab ID	Depth	lbs/ac	lbs/ac	lbs/ac	lbs/ac	mg/kg	mg/kg
231030M027	0-12	50	149	298	38		
Available Total		50	149	298	38		



		Soil Characteristics					
		OM	Estimated N Release	pH 1:1	Sol Salts 1:1	Lime Req.	
Lab ID	Depth	%	lbs/ac	-	dS/m	tonne/ha	C
231030M027	0-12	1.6	18	6.5	0.4		

		Soil Nutrients					
		Macros			Secondary		
		NO3-N	P	K	SO4-S	Ca	Mg
Lab ID	Depth	lbs/ac	lbs/ac	lbs/ac	lbs/ac	mg/kg	mg/kg
231012M045	0-12	106	405	1900	40		
Available Total		106	405	1900	40		



		Soil Characteristics					
		OM	Estimated N Release	pH 1:1	Sol Salts 1:1	Lime Req.	
Lab ID	Depth	%	lbs/ac	-	dS/m	tonne/ha	Ca
231012M045	0-12	4.5	40	6	0.3		

Remember….

- Crops need a lot of K, but seed removal is small
- Focus on rotational removal and supply
- Beware of forage removal
- Soil tests are a very good indicator
- Sandy soils (and peat) most likely to benefit
- Seedrow and BC application can ‘work’

What we need??

- Better soil test x response data
- Better understanding of annual vs single application
- Safe rates of potash in a seedrow
- Better understanding of species K response
- Better understanding of VR K potential

What to do with $10?

20 lb per acre of K_2O per year would resolve most risk of K deficiency in western Canada.

This is less than $10 per acre.

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Thanks!

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