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Nutrient carry-over following a dry season: more, less or the same?

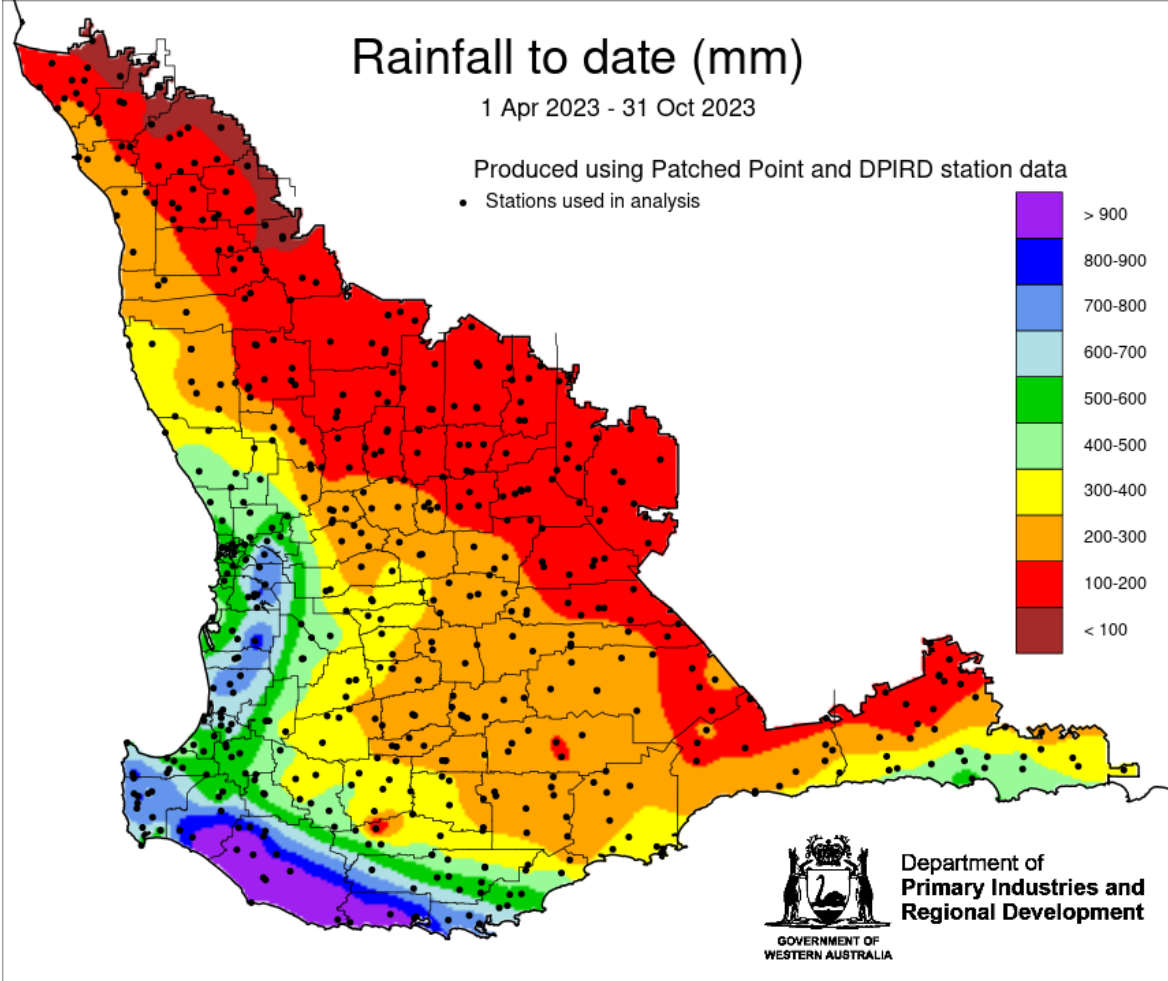
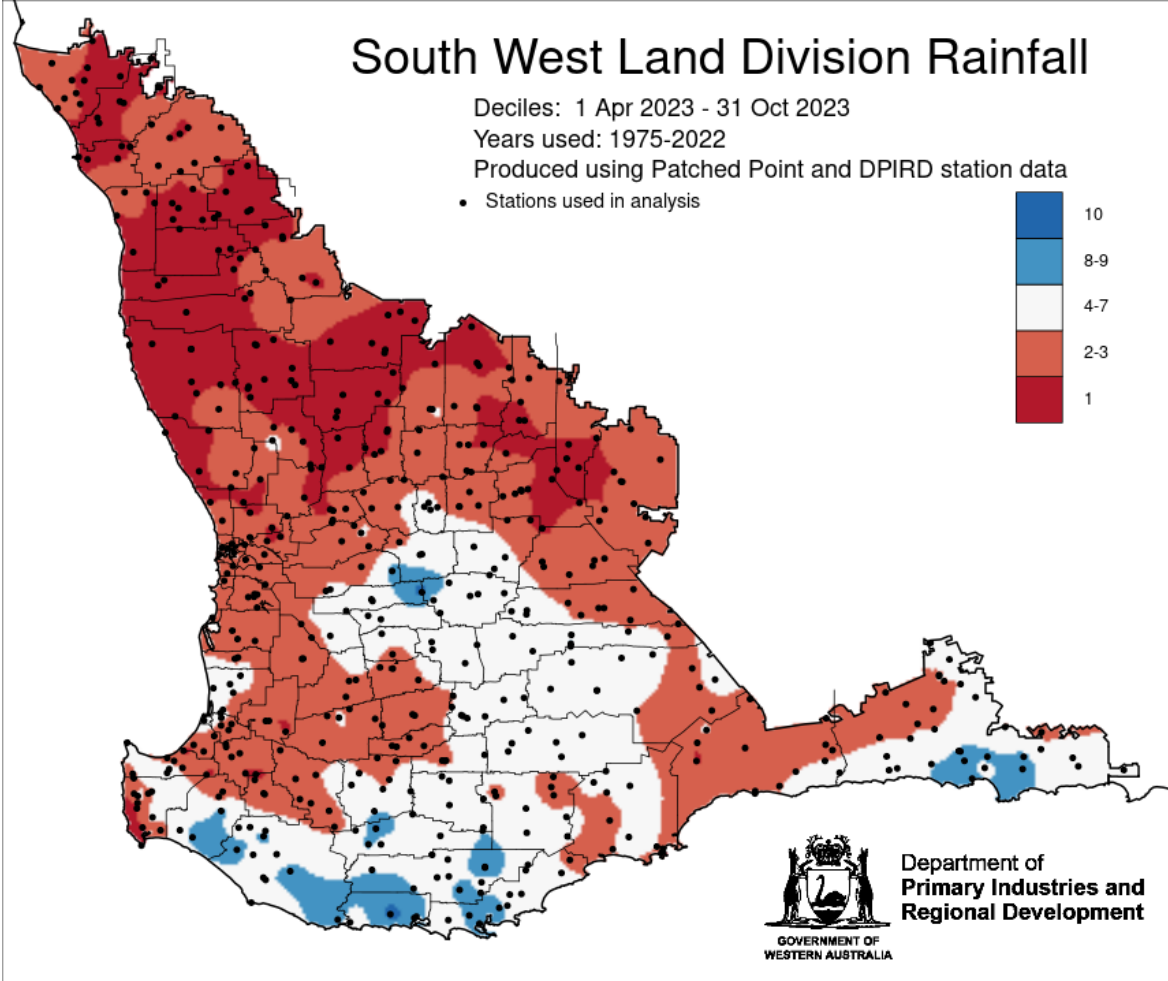
Craig Scanlan

Grains Industry Day 2023

Nutrient carry-over following a dry season: more, less or the same?

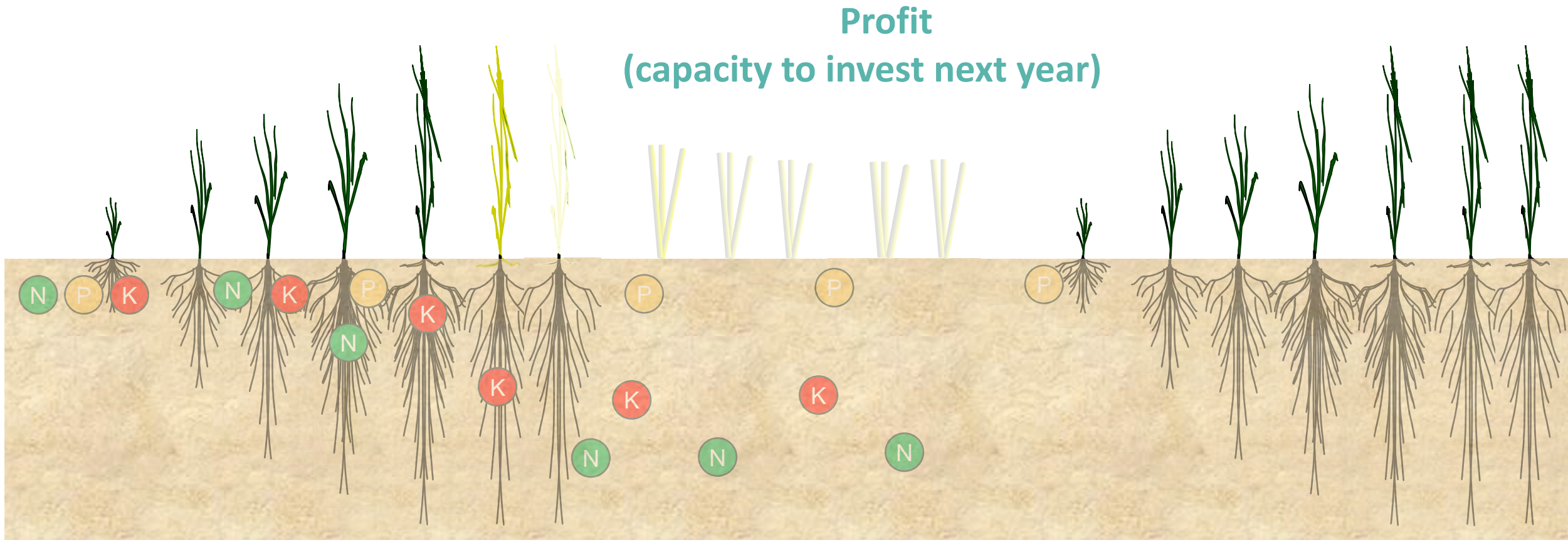
- More:
 - Positive P and K balances from 2023 fertiliser application are likely
- Less:
 - N leaching losses compared to years > 300 mm annual rainfall
 - K leaching losses on sands
- Same:
 - Wheat yield response to fertiliser N
 - Nitrogen balance after non-legume crops
 - Nitrogen balance after lupins (harvest index main effect)
 - Mineral N after fallow

Growing season rainfall was below decile 3 for most of the south west land division.



Maps by Merredith Guthrie, DPIRD.

Why does rainfall this year matter for next year?



**Residual effects of fertilisers
(yield response to fertiliser next year)**

Example nutrient balances for 'good' and 'poor' years

Wheat @ 3.5 t/ha and 9% protein

	N	P	K
Compound at sowing	10	11	10
N banded	15		
N post-sowing	45		
Total applied	70	11	10
Removed in grain	56	10	14
Balance	14	1	-4

Wheat @ 1 t/ha and 12% protein

	N	P	K
Compound at sowing	10	11	10
N banded	15		
N post-sowing	15		
Total applied	40	11	10
Removed in grain	21	3	4
Balance	19	8	6

** values are kg of nutrient per ha.

Nutrient balances in crop production are small relative to nutrient stocks.

	N balance (kg N/ha)	K balance (kg K/ha)	P balance (kg P/ha)
Good	14	-4	1
Poor	19	6	8

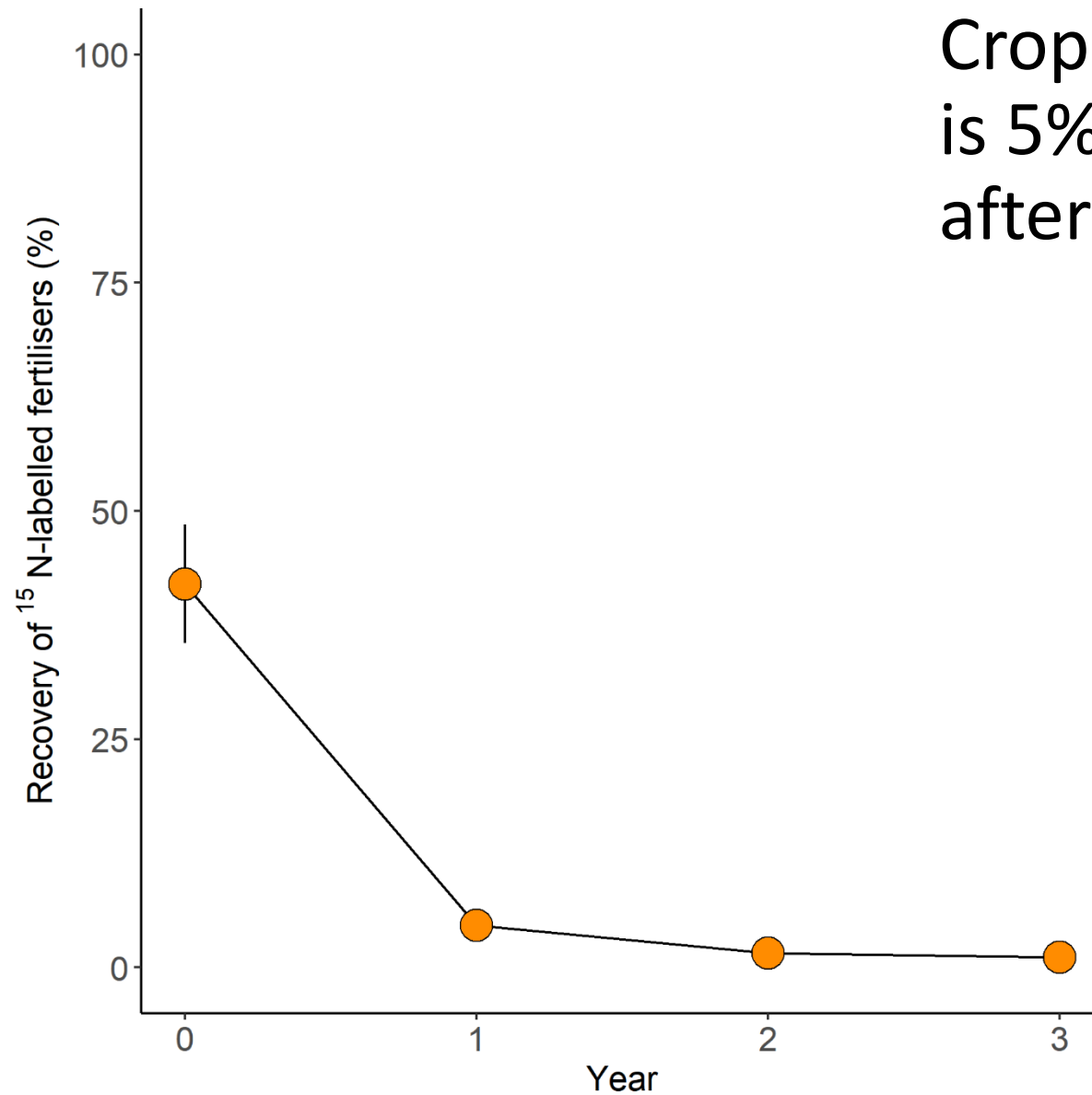
Depth (cm)	Bulk density (g/cm ³)		OC%	Soil organic N (kg N/ha)	Available N (kg N/ha)**		Colwell K (mg/kg)	Colwell K (kg K/ha)		Colwell P (mg/kg)	Colwell P (kg P/ha)
0-10	1.5		1.1	1227	30 to 40		90	135		29	44
10-20	1.7		0.5	638			42	71		14	24
20-30	1.5		0.3	321			44	66		6	9
30-40	1.5		0.2	246			50	75		5	8
40-50	1.5		0.2	235			55	82		4	7

Soil chemical data median values from 40 field trials (UMU1801-006/UWA1801-002RTX)

Bulk density 0-30 cm from Soil Quality data (soilquality.org.au)

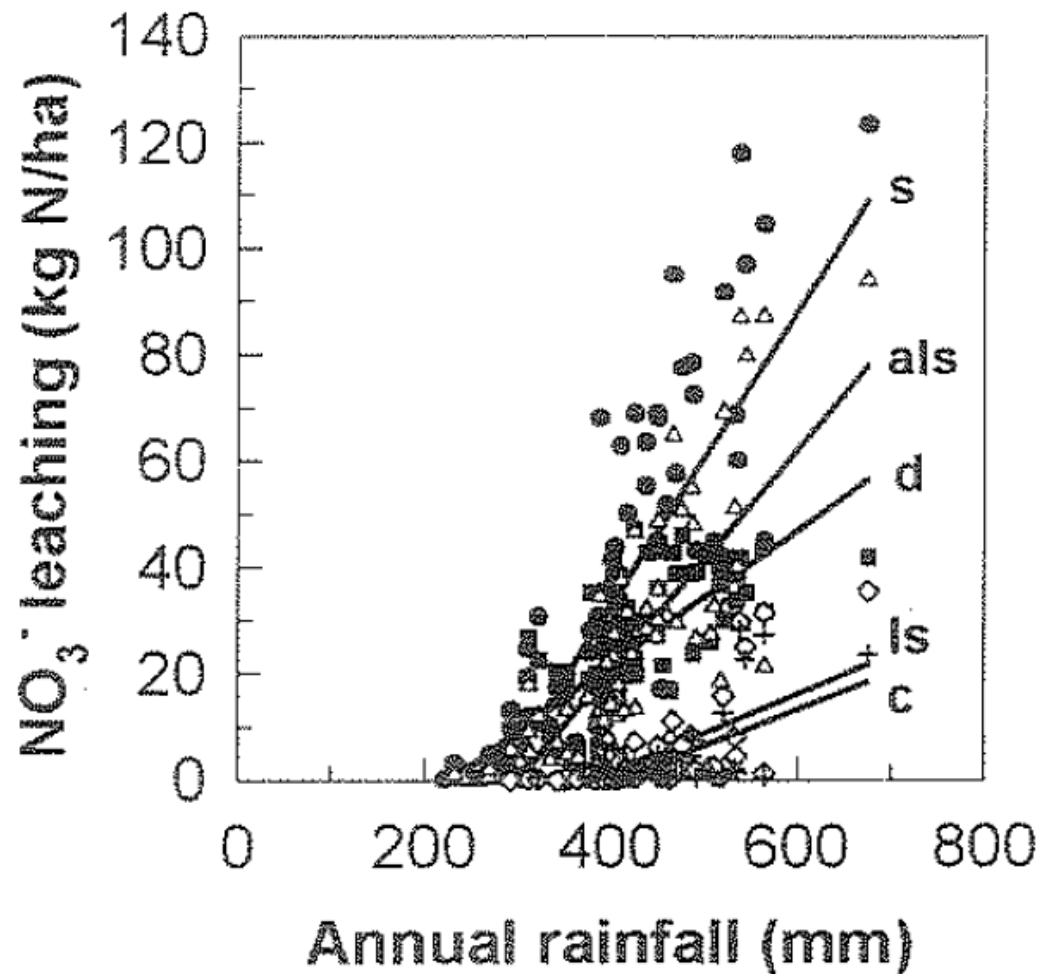
** Annual budgeting approach - assumes 2.5 to 3% of SON is plant-available in a growing season.

Crop recovery of fertilizer N is 5% or less in the years after application



Summary data from 83 studies.
Error bars are standard error.

Source: Smith and Chalk (2018), Field Crops Res.
<https://doi.org/10.1016/j.fcr.2017.12.006>

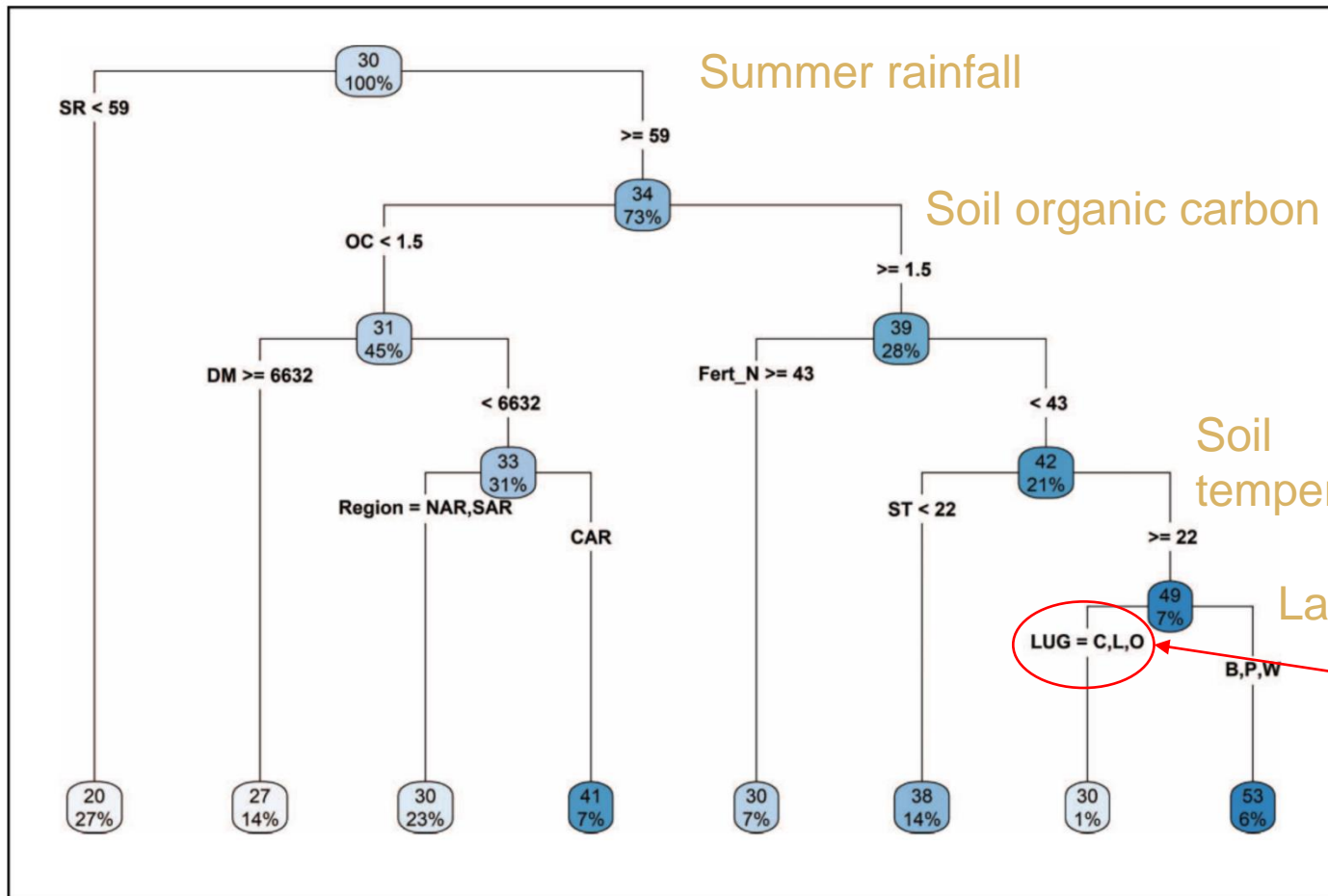


Simulation modelling showed a threshold of about 300 mm annual rainfall for nitrate leaching.

s = deep sand
als = acid loamy sand
d = duplex
ls = loamy sand
c = clay.

** Soil mineral N was reset at 100 kg N/ha on 1st April for each simulated year.

Is higher soil mineral N likely in paddocks that were fallowed in 2023?



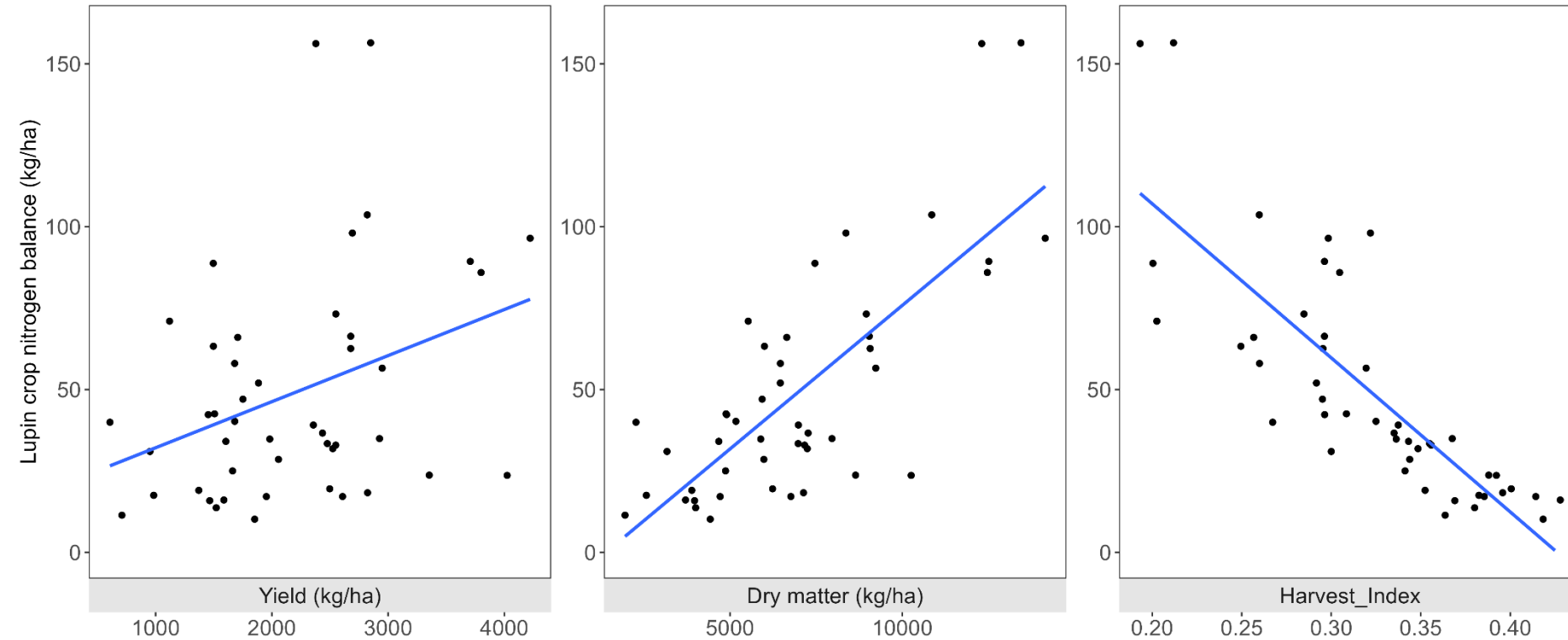
Summer rainfall, soil organic carbon and soil temperature were the main factors affecting soil mineral N in the following autumn.

Land use had a minor effect.

Land use group.
O includes fallow years.

Increasing soil mineral N in following autumn

Lupin grain yield is not closely related to nitrogen balance, but ...



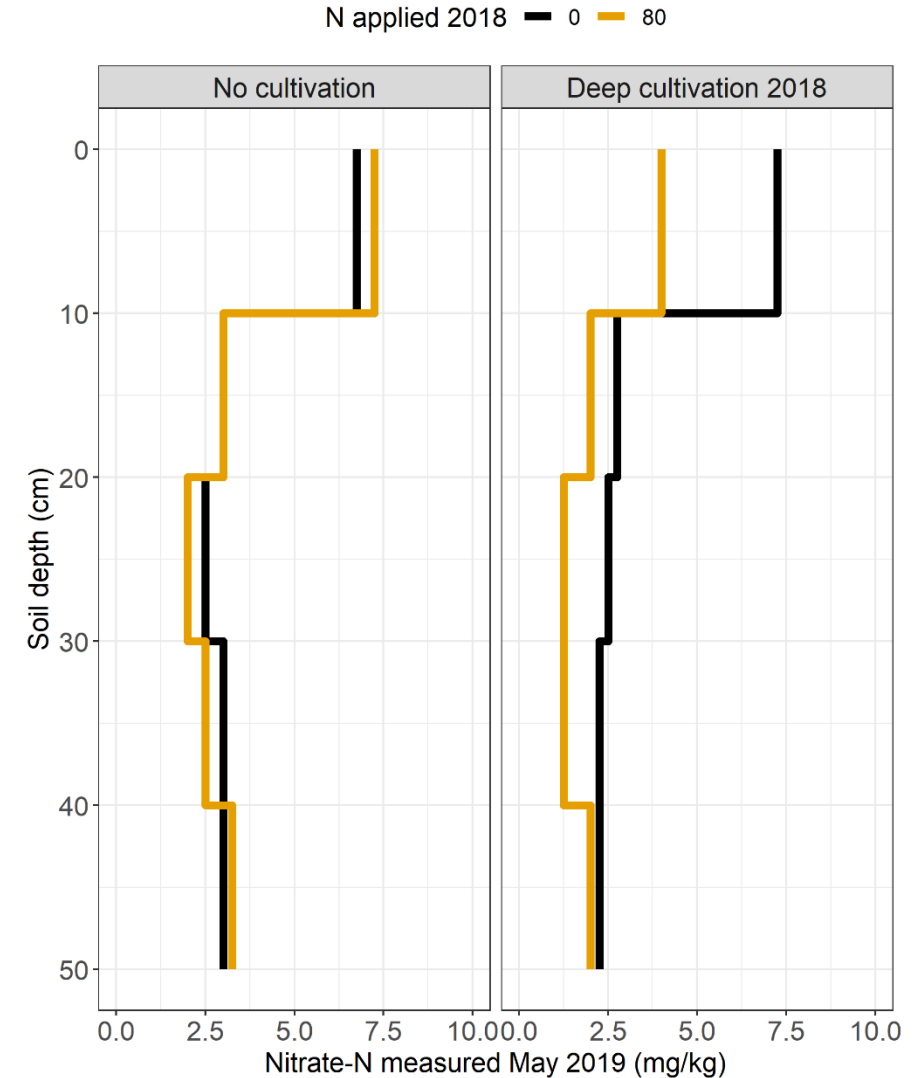
....it's likely to be less than 40 kg N/ha when lupin grain yield is less than 1 t/ha.

Residual effects of deep cultivation and nitrogen fertilizer: a 2-year study.

Differences in nitrogen balance were large in 2018, but small differences in soil nitrate profiles May 2019.

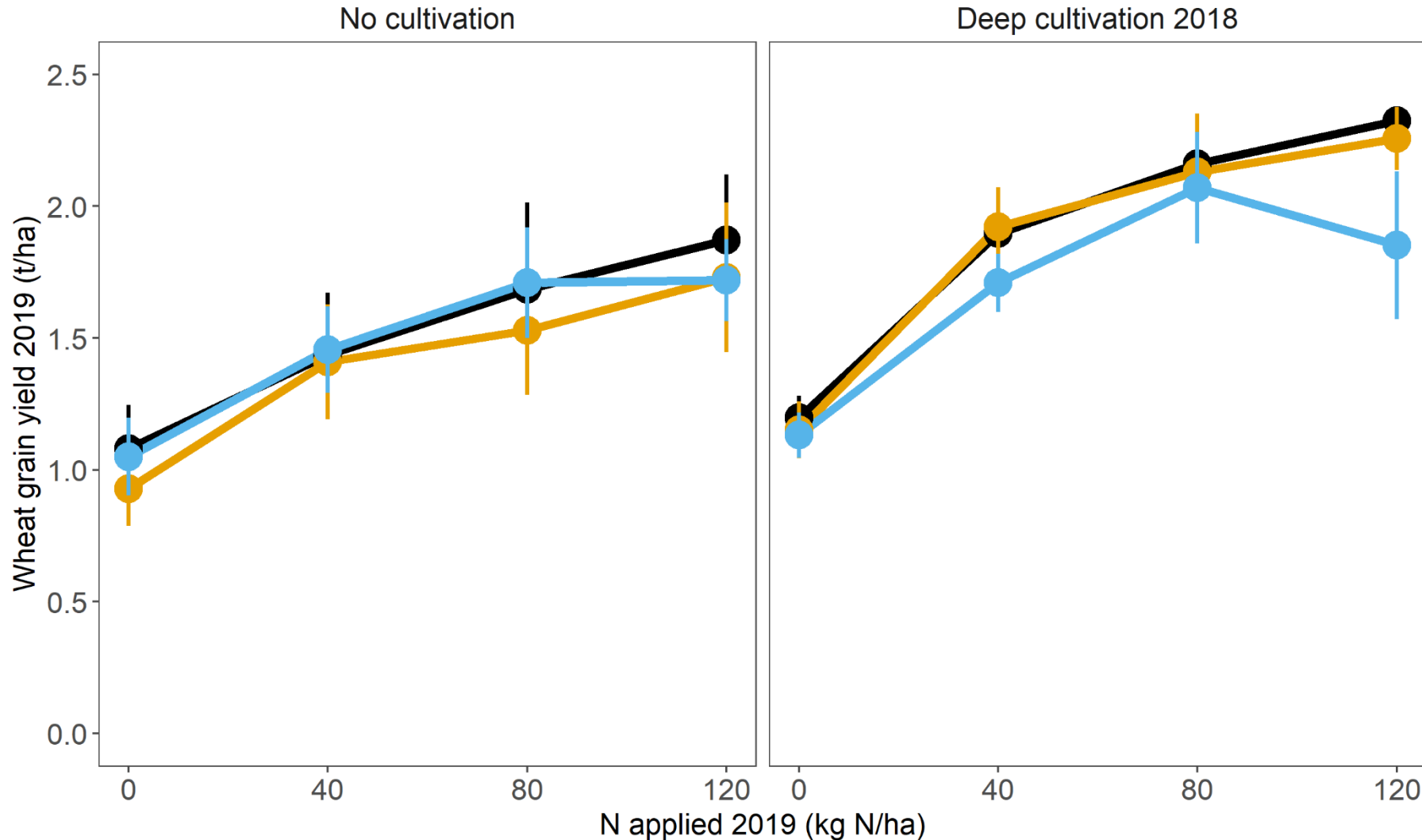
Nitrogen balance (kg N/ha) [*N applied* – *N exported in grain*] for tillage and nitrogen treatments in 2018.

	0 kg N/ha applied	80 kg N/ha applied	Difference between N treatments
No cultivation	-45	31	77
Deep cultivation 2018	-49	23	72



Residual effects of deep cultivation and nitrogen fertilizer: a 2-year study.

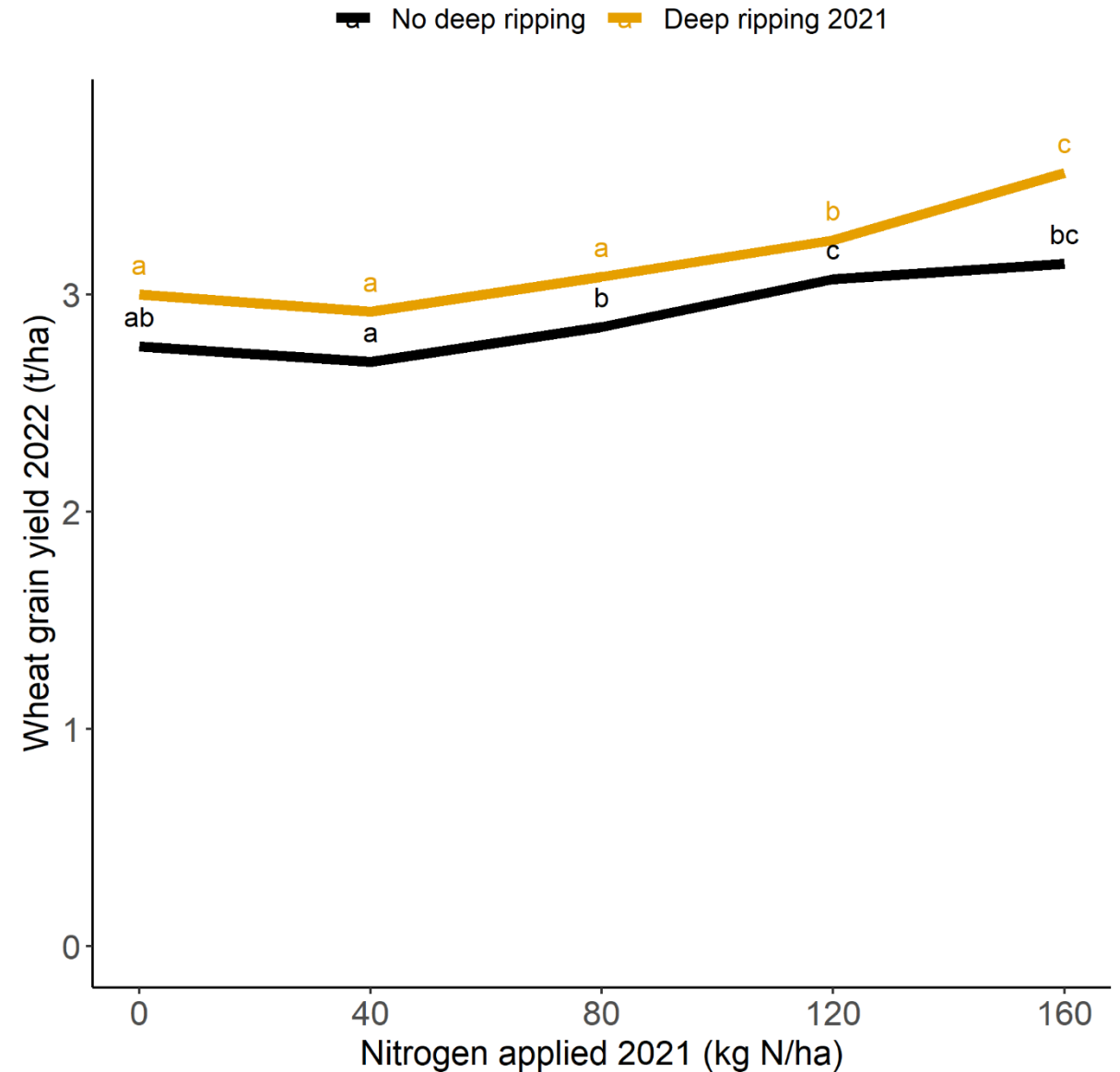
N applied 2018 (kg N/ha) ● 0 ● 40 ● 80



Residual effect of deep cultivation was detected, but not for nitrogen.

Residual effects of nitrogen fertiliser were detected, but only where > 80 kg N/ha was applied in the previous year.

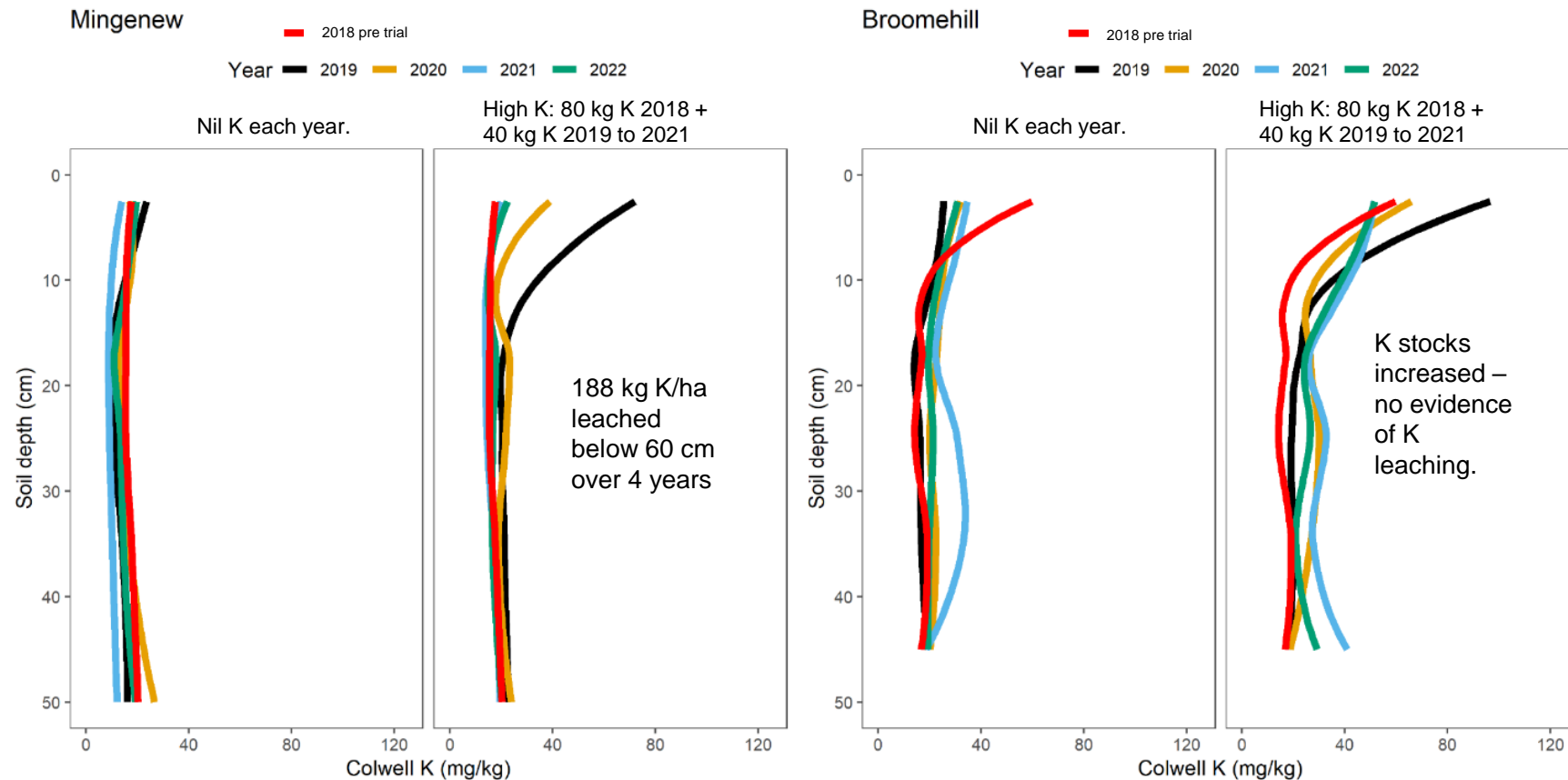
- Data from a 2-year trial on deep ripping and nitrogen interactions.
- 60 kg N/ha applied to all plots in 2022.



Source: Nutrient re-distribution and availability in ameliorated and cultivated soils in the Western Region (DAW1801-001RTX)

Potassium leaching losses can be significant on deep sands.

Most of the K applied over 4 years to a deep sand at Mingenew leached below 60 cm but most was retained on a duplex soil at Broomehill.



CEC (cmol + /kg)
 0-10 cm: 2.4
 10-20 cm: 1.1
 > 20 cm: < 0.6

CEC (cmol + /kg)
 0-10 cm: 21
 10-20 cm: 10
 > 20 cm: 5

Source: Increasing profit from N, P and K fertiliser inputs into the evolving cropping sequences in the Western Region (UMU1801-006RTX, UWA1801-002RTX)

Maximising use efficiency of nutrients in 2024.

- Key outcomes from recent projects:
 - Agronomic efficiency (kg grain per kg of N) N higher after removing compaction with deep ripping
 - Amelioration of soil water repellence increases yield potential but not agronomic efficiency of N
 - Small increases in response to K with split applications
 - Yield response to K greater after removing compaction with deep ripping
 - Lupin residues increase K supply to following crop
 - Yield response to lupin residue and K application were additive.

Nutrient carry-over following a dry season: more, less or the same?

- More:
 - Positive P and K balance from 2023 fertiliser application is likely.
- Less:
 - N leaching losses compared to years > 300 mm annual rainfall.
 - K leaching losses on sands
- Same:
 - Wheat yield response to N expected where 80 kg N/ha or less applied in 2023.
 - Nitrogen surplus after non-legume crops
 - Nitrogen balance in lupins (harvest index main effect)
 - Mineral N after fallow (rainfall, organic carbon and soil temperature main effects)



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Acknowledgements

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GRDC Project: Increasing profit from N, P and K fertiliser inputs into the evolving cropping sequences in the Western Region (UMU1801-006RTX, UWA1801-002RTX).

GRDC Project: Nutrient re-distribution and availability in ameliorated and cultivated soils in the Western Region (DAW1801-001RTX)



Thank you

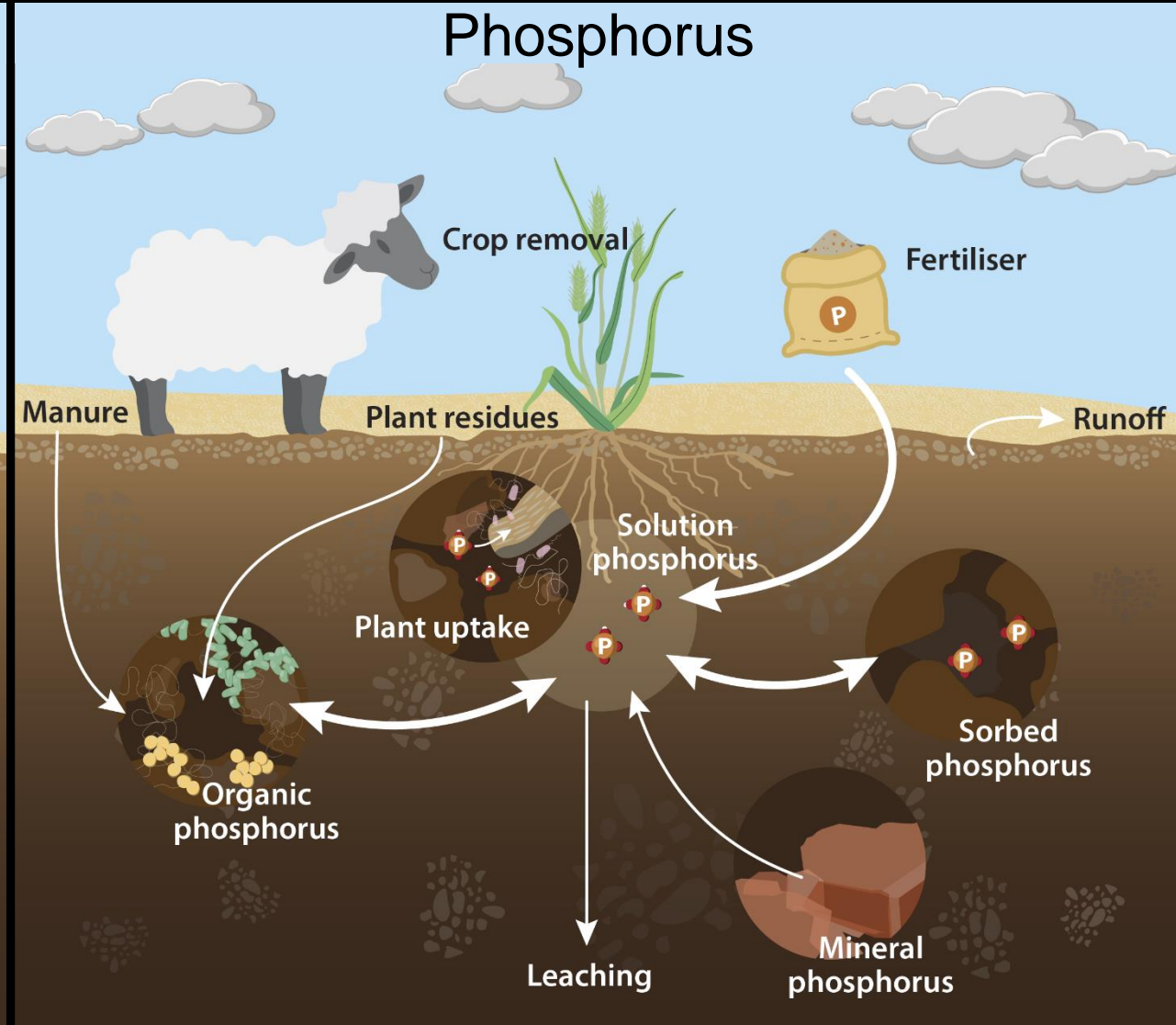
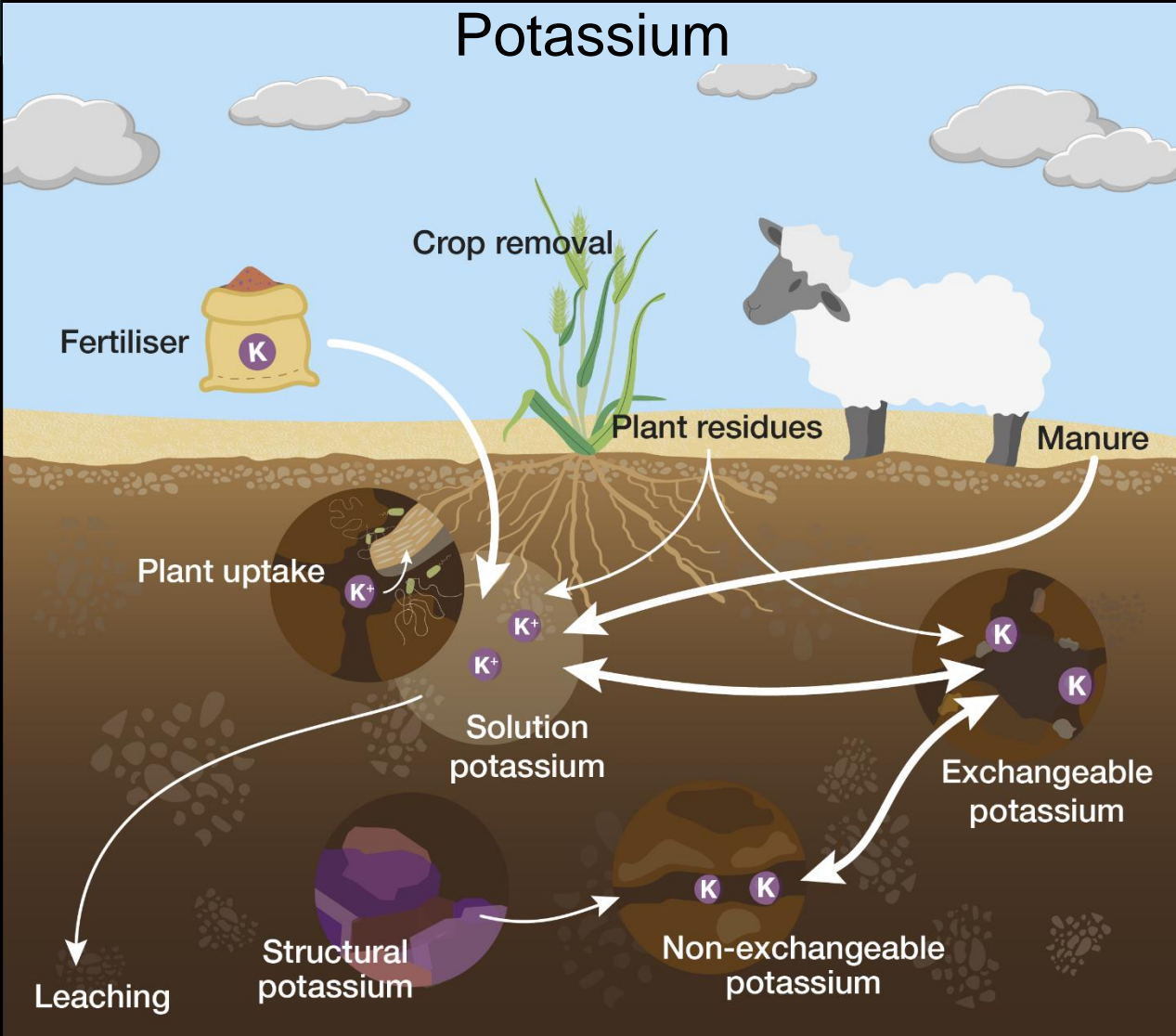
dpiird.wa.gov.au    

Important disclaimer

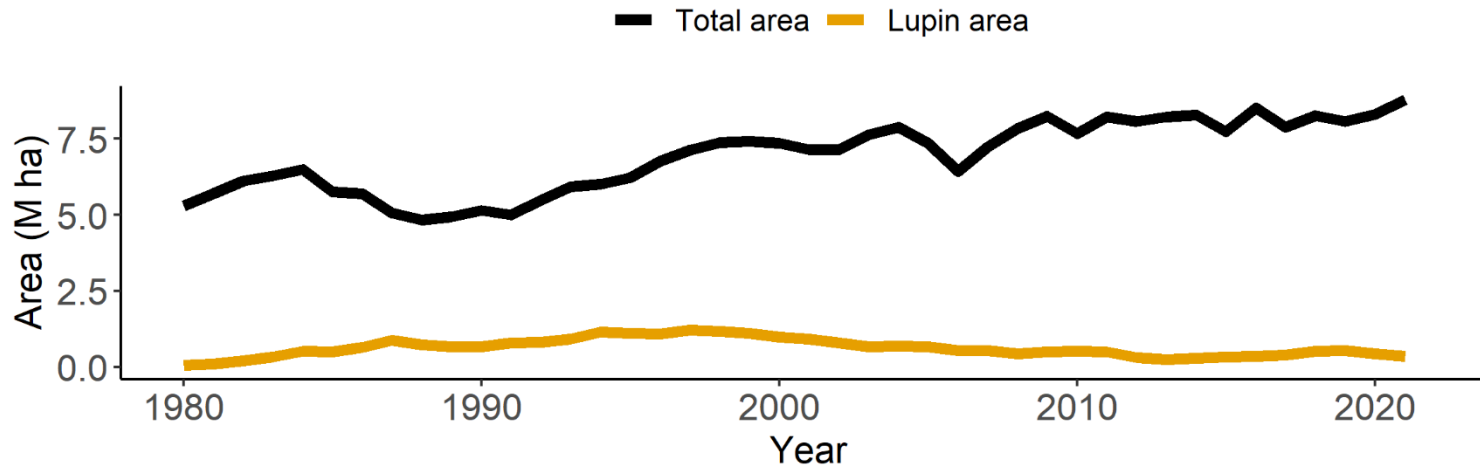
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What happens to fertilisers in soils?



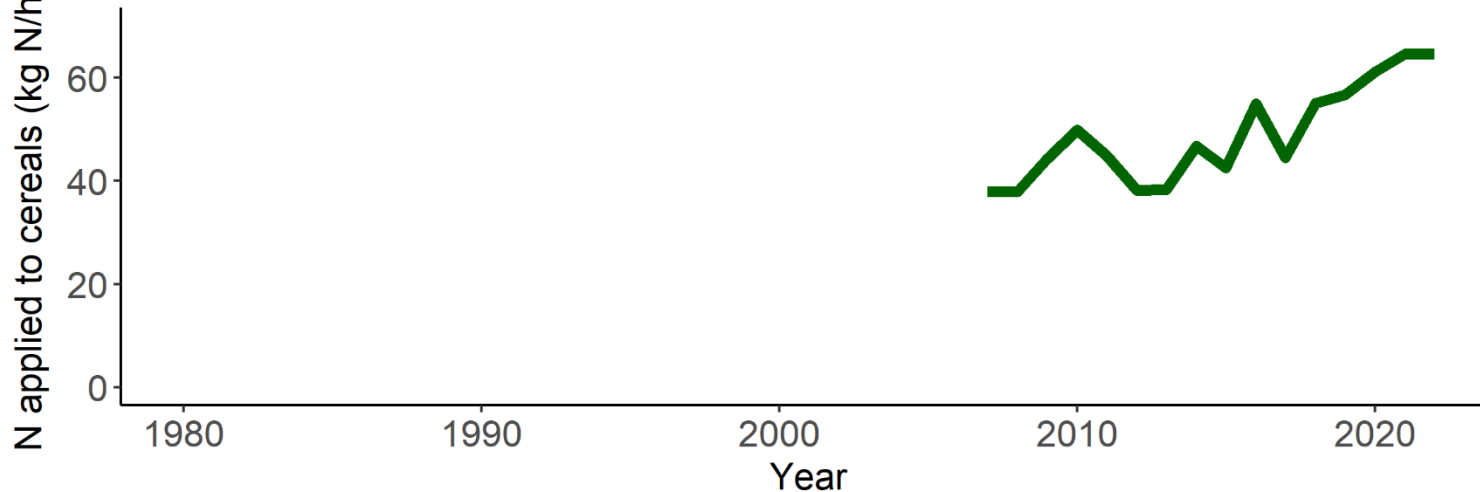
Planted area in Western Australia



Two important trends for N decisions in 2024:

- percentage of area planted to lupin less than 5% in recent years.
- average N rate for cereals has been increasing

Average N rate applied to cereals in Western Australia



Rundown of soil K in WA is evident in industry data.

Agzones of Western Australia

