

Pulses Session

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Is your N fertiliser rate following a pulse crop the same/more/less compared with following OSR?

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The Effects of Pulses on Rotational Nutrition

YEN Conference January 2025

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24/01/2025

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Agenda

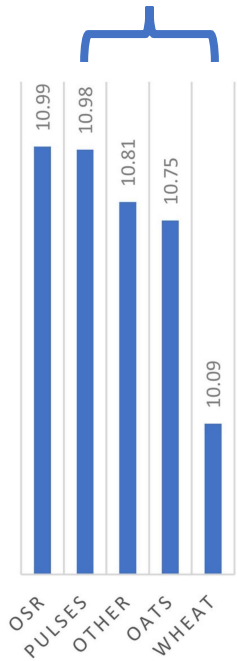
- What do we know about the impact of pulse crops on subsequent crops?
- Main focus N - How does RB209 account for this?
- What approach does the average farm currently take?
- What can we learn from other recommendation systems?
- What other refinement to N rates is available?
- Conclusions



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Pulse pre-crop effects



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IRORZ IQJ SUH FURSV

1 HIFW

- 3 1 VSDUIQ' FRP SDUFGWRWU SUH FURSV
- 3 URYLMRQRI UFMGXMRVIO
R 8 SWNHRIP IQHDDJ HGSUH FURS
1 UFMGXHGLUFWOE
IRORZ IQJ FURS
R 3 UP IQJ RIVRIORU DQF1
P IQHDDJ DMRQWHRICID
DCCLMRQRISUH FURSUHMGXHV

1 RQ 1 HIFW

- 3 HMRQGGVHMEUHDNV
- 0 REIQJ DMRQIRQ 1 QXWHEW
- 0 RGLIFDMRQIRVRIQ IFUREIDDFWYDW \
- 6 RIORFRQGMRQIQ
- \$ EIQWVRVSSRUWLIHFQWUP
P DQJ HP HQWUFWFHV
- 5 HGFHGRICZ DMLXVHCQU FOP DMV

- Analysis of 1061 wheat yields from the YEN data set shows that crops following pulses yield on average 0.9 t/ha higher than those following a first wheat.
- Effect is likely due to a changes in N provision to the system as well as non-N related effects.
- Sylvester-Bradley et al., (1991) and Preisell et al., (2015) hypothesise that non-N related effects can make cereal crops more nitrogen use efficient, suggesting that higher yields may also be possible with less N per unit yield.

How does RB209 Field Assessment method account for this?

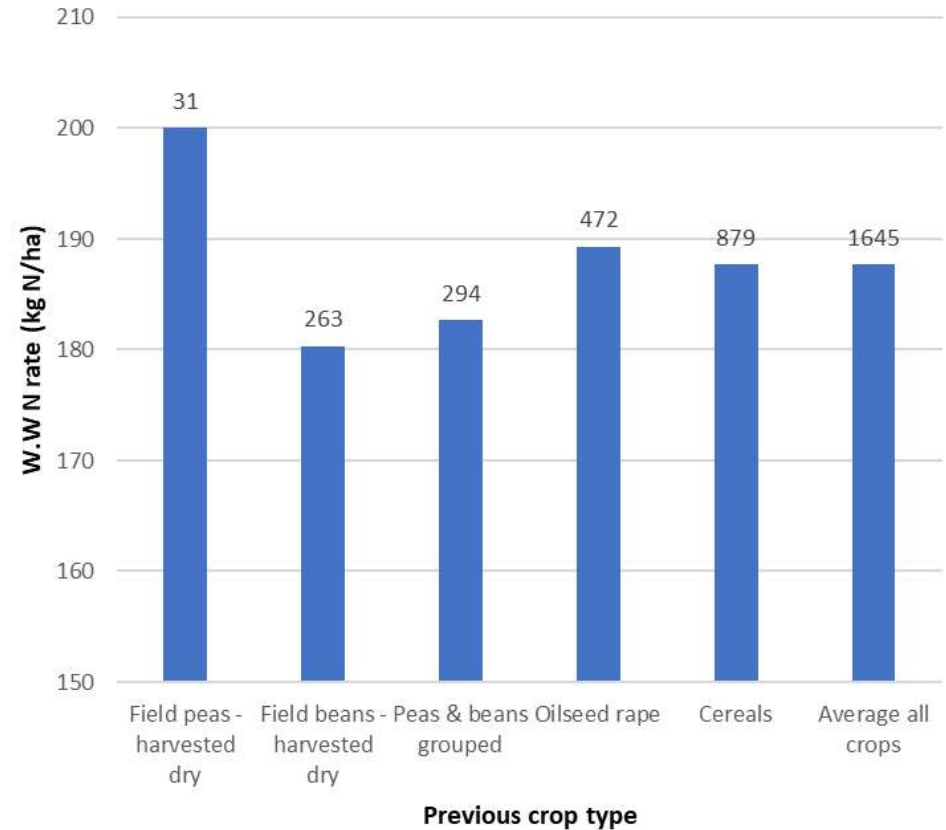
- Pulse pre-crop returns an SNS index of 1 higher than cereal pre-crops for most soil types. Using expected yield as a modifier, either:
 - Assume same YP compared to a cereal pre-crop. Resulting N rate of 30 kg N/ha less.
 - or,
 - Consider YP may increase ~0.5-1 t/ha. As where “yields above 8 t/ha can be realistically expected, increasing the recommended rate by 10 kg N/ha for each 0.5 t/ha additional yield, up to a maximum of 13 t/ha” can be justified. Resulting N rate of ~5-10 kg N/ha less.



What does the average UK farm do?

1061 wheat YEN crops between 2013-2023.

	Oats	OSR	Other Pulses	Wheat	P-value	
Yield (t/ha)	10.75	10.99	10.81	10.98	10.09	<0.001
N fertiliser applied (kg/ha)	231	237	233	238	242	0.73
Grain protein (%)	11.37	11.44	11.52	11.57	11.44	0.72
Grain N offtake (kg/ha)	182	188	184	189	173	0.001



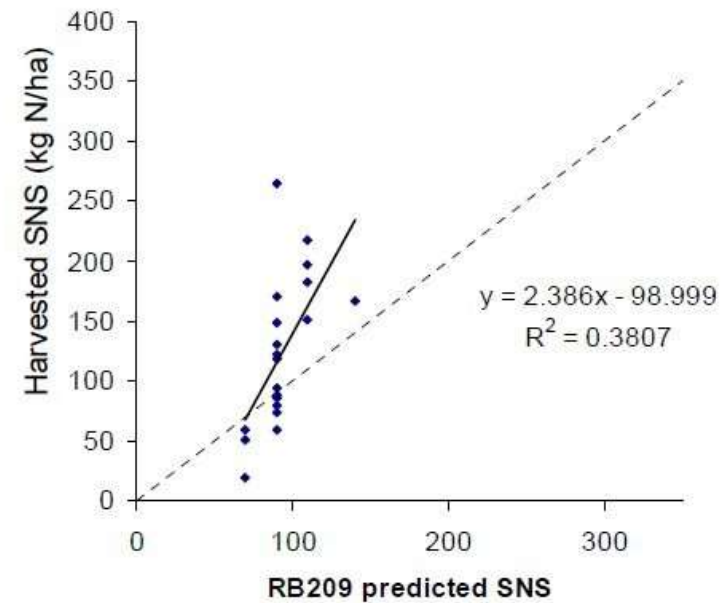
N rates applied to winter wheat following different pre-crops as surveyed by the BSFP between 2020 and 2022. Numbers above bars = number of data points.

Value of pulse crops in rotation - summary

- Pulses (and legumes) are likely change following crop N requirements by changing N in the system and altering following crop yield potential.
- Therefor maximizing N and non-N benefits could lead to more efficient nutrition across the rotation.
- By using yield as modifier in the field assessment method a farmer can choose a range of approaches to N rates following pulses.
- Both the Cereal YEN and BSFP suggest farmers most commonly choose to apply similar N rates following pulses, likely targeting a higher yield potential.
- Grain N analysis suggests following cereal crops are not uptaking too much N (but more work required to understand risk of N losses from system).

Can we get even more value out of pulse crops by better understanding their effect on SNS?

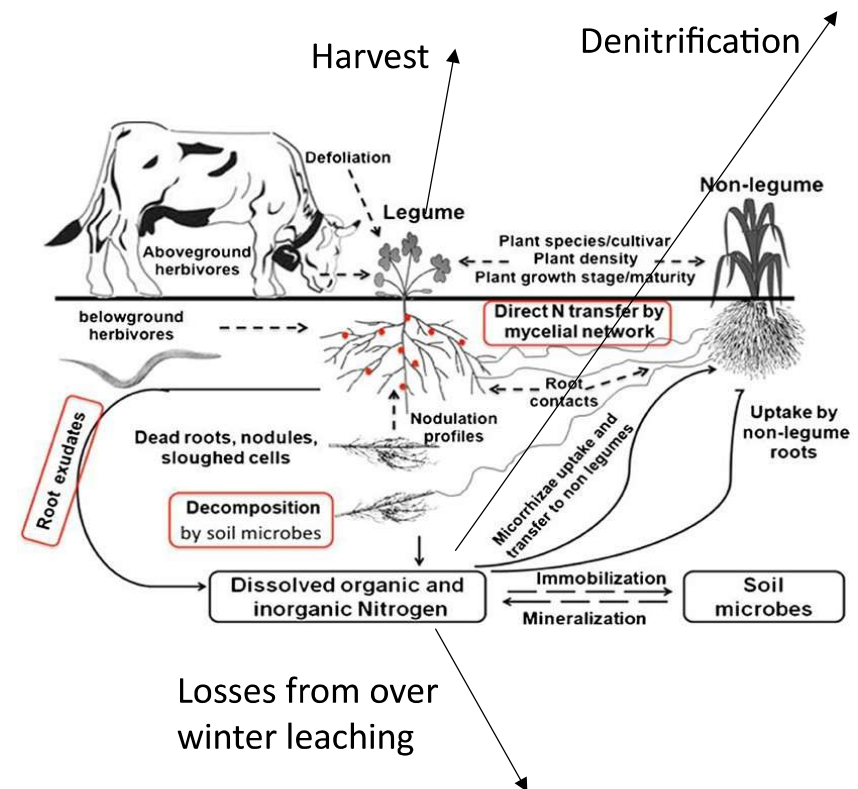
- Analysing historic data could be at risk of highlighting actual practice, rather than potential savings.
- The AHDB SNS best practice report suggests that bean residues could be underestimated in some cases.
- SNS is taken up with 100% efficiency whilst fertiliser taken up with 60% efficiency, so modest differences in SNS translate to larger differences in fertiliser requirement.



(AHDB Report 490)

Can we get even more value out of pulse crops by better understanding their effect on SNS?

- Size of N impact to following crop is dependent on many things of which many are hard to estimate:
 - total N uptake (from BNF and soil N)
 - the proportion N in the residues
 - the mineralisability (C:N) of the residues
 - losses (leaching and gaseous)
 - ability of following crop to access (and then utilize) N
- RB209 accounts for yield potential & likelihood of losses, but not currently amount of N residue.



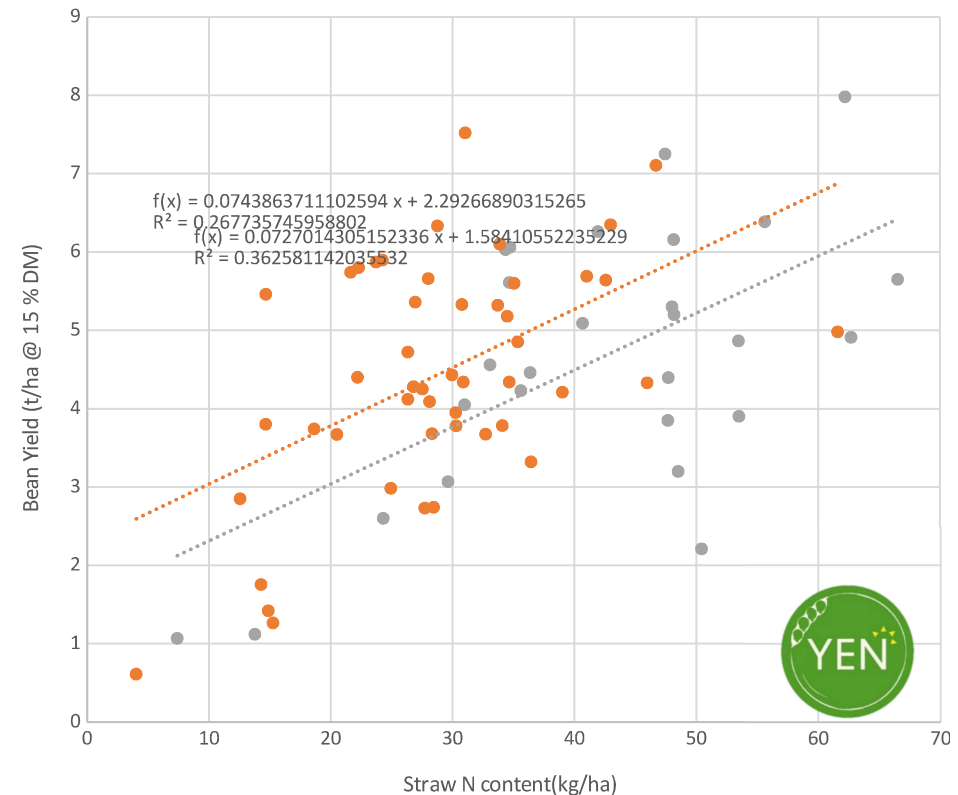
Examples of potential N residue fates. Adapted from Thilakarathna, et al. "Agronomy for Sustainable Development 36 (2016): 1-16.

Estimating N supply from bean residues

- Pulse YEN above ground material analysis highlights that differences in N residue between crops can be large.
- 1 t/ha yield of beans may be equivalent to ~10-13 kg/ha above ground straw and pod N residue
- There may be some plateauing in high yielding bean crops due to an increased Nitrogen Harvest Index
- Assumes that BNF is relatively proportional to biomass (Anglade et al., 2015)
- You can check for active nodules.



Image courtesy of PGRO



Bean YEN 2029-2023 crop yield vs straw N content. Grey = winter beans, Orange = Spring beans

What other approaches to recommendation systems are there?

- **Canada** – rules of thumb based on biomass for legume cover crops
 - Approach from Martens & Hoepfner (2004). Can. J. Plant Sci.
 - Extrapolation from N response trials.
- **Australia** – rules of thumb based on yield and estimation of HI
 - Based off historic data ~25 pulse pre-crop trials
 - Approach within Peoples et al., (2017). Soil Research. 55. 10.1071/SR16330.
- **France** – complex models including for pulse and legume service crops
 - Uses biomass as main input, but accounts for rainfall, starting SMN, residue C:N and date of termination for cover crops
 - Guinet, Nicolardot and Voisin, (2020) for pulses
 - Constantin et al., (2024) for cover crops

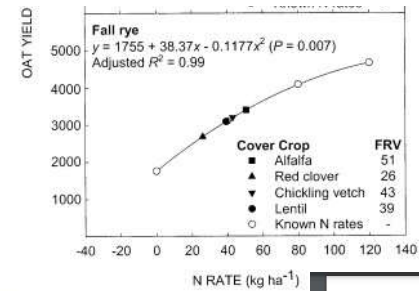
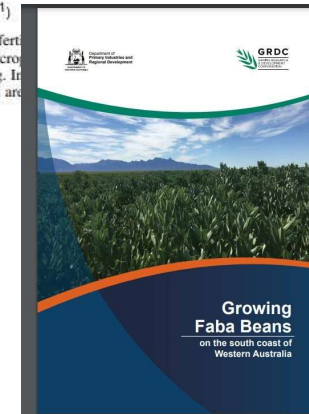
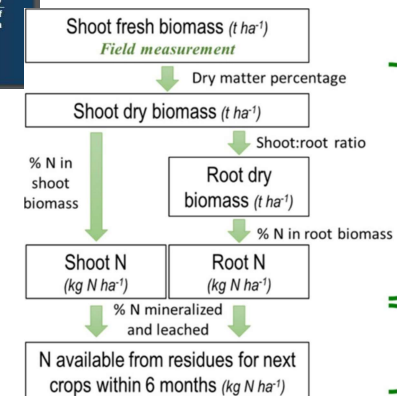


Fig. 1. Oat grain yield response curves and fertilizer values (kg N ha⁻¹) of four relay- and double-cropping winter wheat and fall rye at Winnipeg. In this system, the symbols for red clover and lentil are overlapping one another.

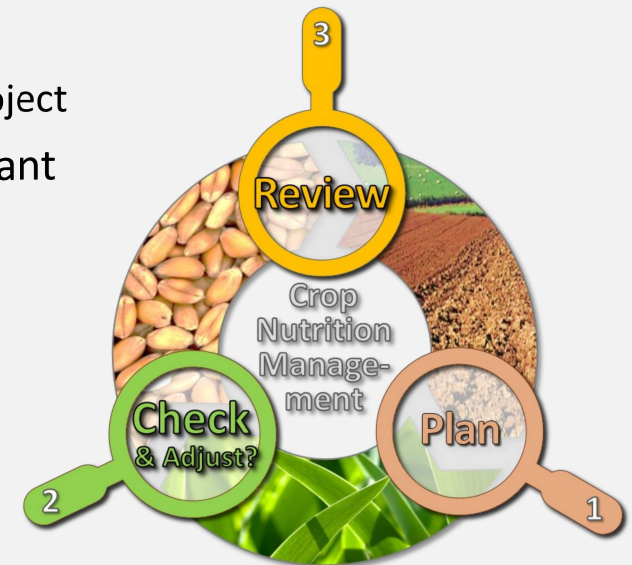
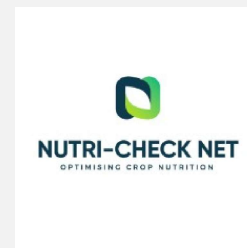


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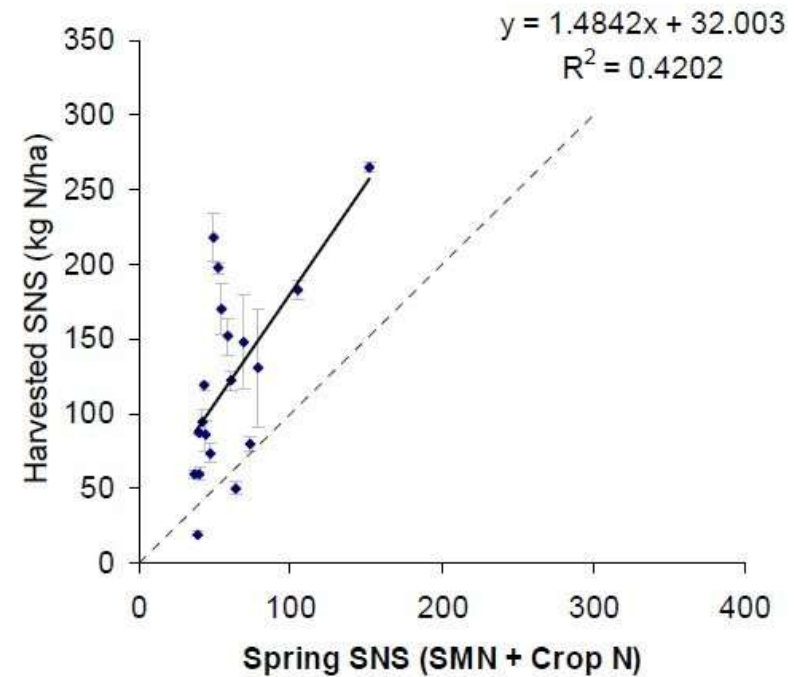
Are there other approaches to recommendation systems?

- Several recommendation systems developed in different ways and with varying complexities and levels of validation
- Most use an estimation of legume biomass as the main input
- Could be scope to incorporate an amendment into RB209 recommendations, but note that return on effort for small refinements may be low
 - More conceptual development to be done as part of NCS and LegumES project
- Planning, Checking and Adjusting and Reviewing is likely to be important



What other refinement to N rates is available?

- Tools may be of use – see NUTRI-CHECK NET Platform
- Be aware that SNS from SMN of beans in the spring may underestimate bean N provision by about 20-25 Kg N/ha.
 - Checking and adjustment may therefore be useful for later N splits.
- For legume fallows, testing of SMN may be of use until more work is completed.
- MINNO project highlighted that it's likely that green residues turn over more quickly in the soil and so spring SMN could be less likely to underestimate provision .



(AHDB Report 490)

Conclusions

- Pulses (and legumes) likely change following crop N requirements by changing N in the system and altering following crop yield potential
 - Therefor maximizing N and non-N benefits could lead to more efficient nutrition across the rotation
- Residue amounts from pulses can vary widely and might be a good indicator of N benefits
 - Need to understand BNF and amount of N taken off with the seed though – you can check nodules and consider harvest index when accounting for N provision
 - More work is required to create UK rules of thumb, but if the previous legume crop was particularly large of small then further refinement may be merited
- Concepts of Planning, Checking and Adjusting, and Reviewing are likely to be important
 - Note that SMN may underestimate N residues from beans by about 20-25 Kg N/ha
 - Checking before later N splits after beans, e.g through tissue testing, could be useful
 - NUTRI-CHECK NET will be a good resource to find different tools

Get involved in testing and developing



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- Focuses on pulse cash crops (mainly beans) and feeding to livestock.
 - Carbon baseline with FCT to help understand wider benefits/trade offs of pulses.
 - Pulse Pioneer split field trials to compare pre-crop effects with financial support available.
- Focused on all legumes across cropping systems and wider Ecosystem Services (ES) such as other pre-crop effects.
 - Participatory Farmer Call to be launched to monitor farmer's choice legume arable systems ES over two seasons. Financial support available.

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Thank you!



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