Sustainable Vegetable Systems

Andrew Barber

SVS Programme Manager

AGRILINK

Sustainable Vegetable Systems

Ministry for Primary Industries
Manatū Ahu Matua

Potatoes NEW ZEALAND

Horticulture New Zealand
Ahumāra Kai Aotearoa

Plant & Food Research
Rangahau Ahumāra Kai

Vegetable RESEARCH+ INNOVATION

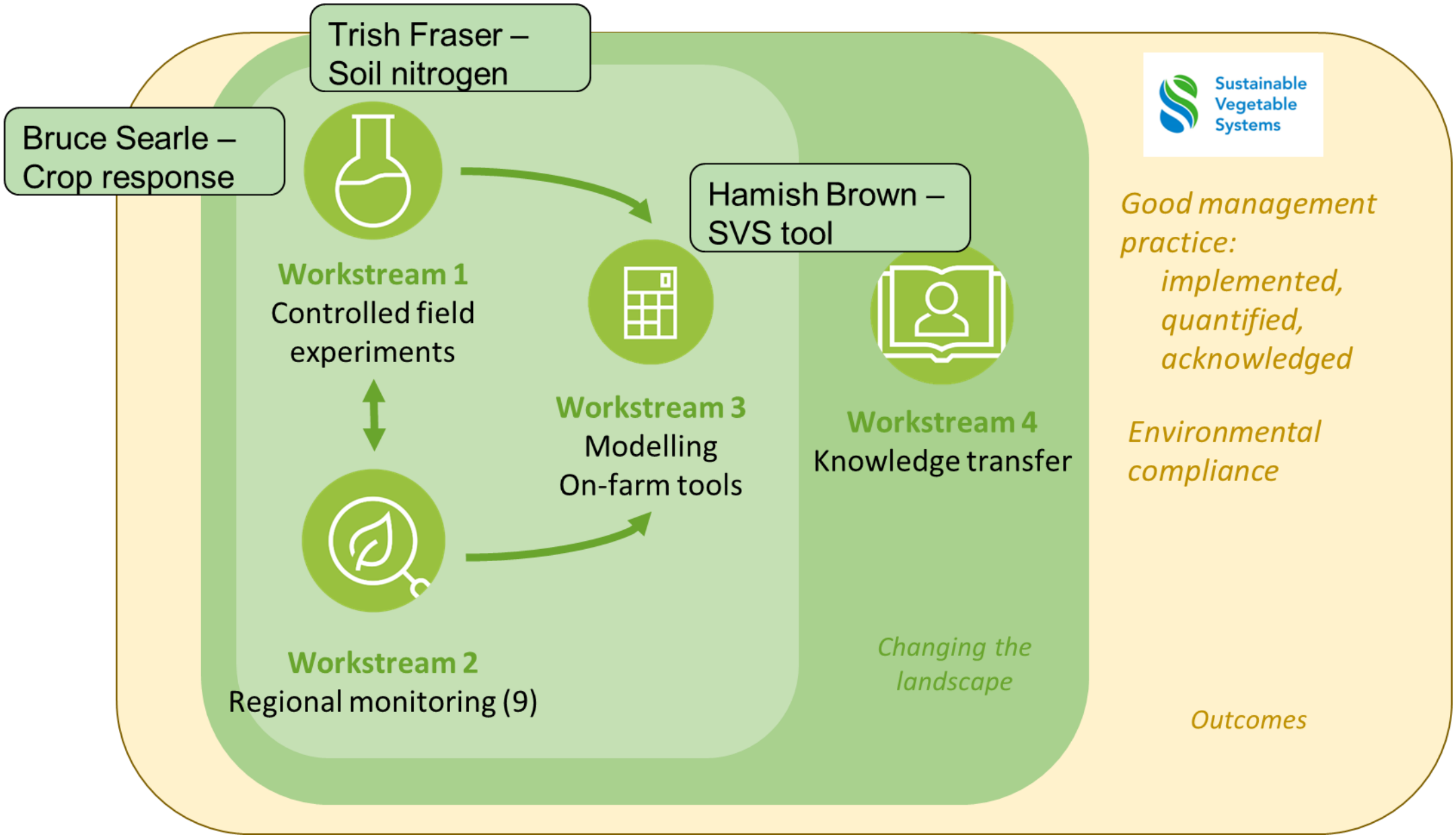
Turning the invisible visible

Sustainable Vegetable Systems

- Drivers
  - Nitrogen optimisation – cost, yield, and quality
  - Regulatory – replacing nitrogen leaching numbers with practices

- SVS is delivering a nitrogen budget tool

- Integrating soil nitrogen tests into fertiliser decision making
  - Measured over modelled wins every time


Trish Fraser – Soil nitrogen
Bruce Searle – Crop response
Hamish Brown – SVS tool
Workstream 1
Controlled field experiments
Workstream 3
Modelling
On-farm tools
Workstream 4
Knowledge transfer
Workstream 2
Regional monitoring (9)
Changing the landscape
Sustainable Vegetable Systems
Good management practice:
implemented, quantified, acknowledged
Environmental compliance
Outcomes

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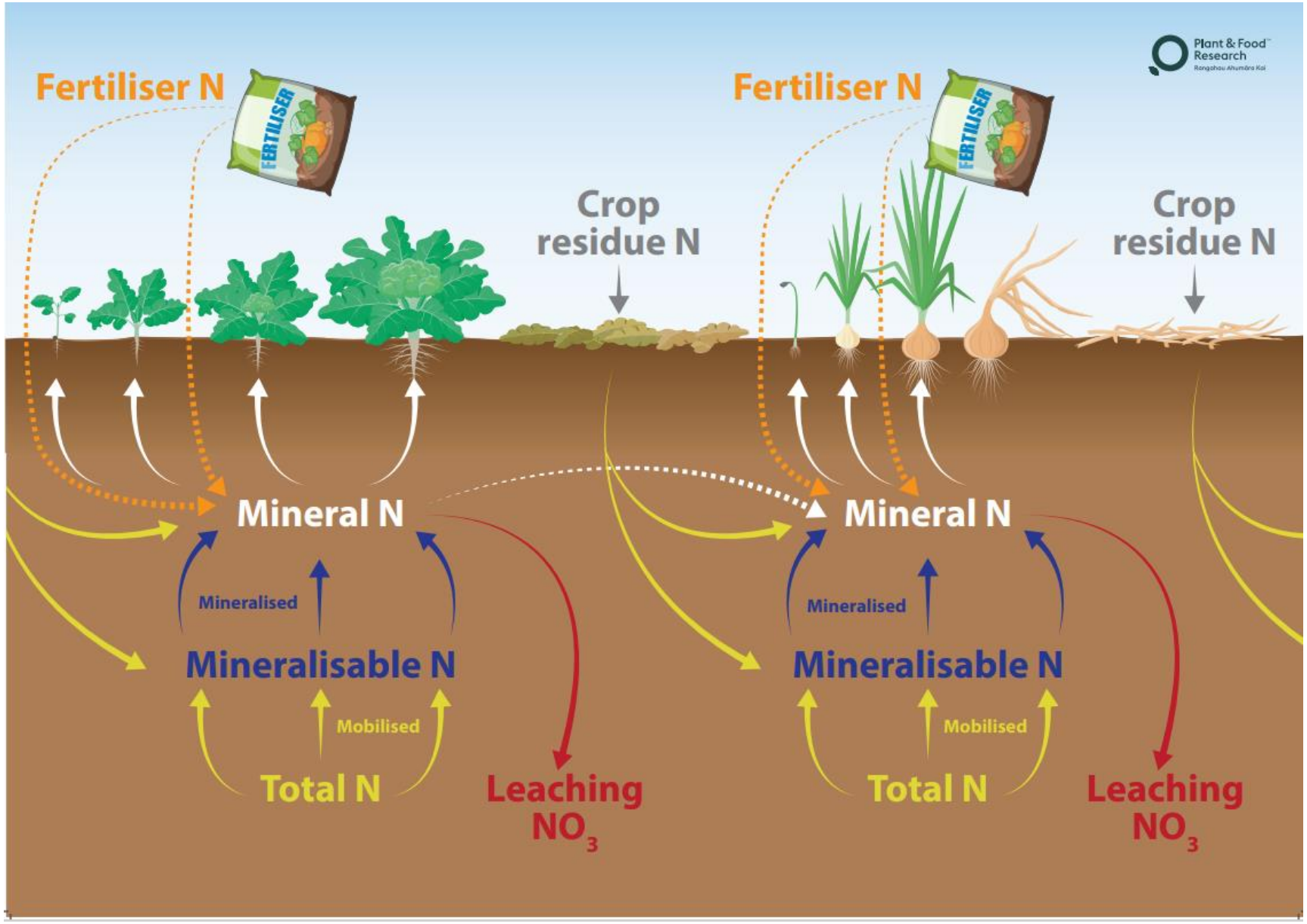
Soil and crop nitrogen dynamics in vegetable cropping systems

Bruce Searle and Trish Fraser

The New Zealand Institute for Plant and Food Research Limited

Nitrogen cycling in a vegetable rotation



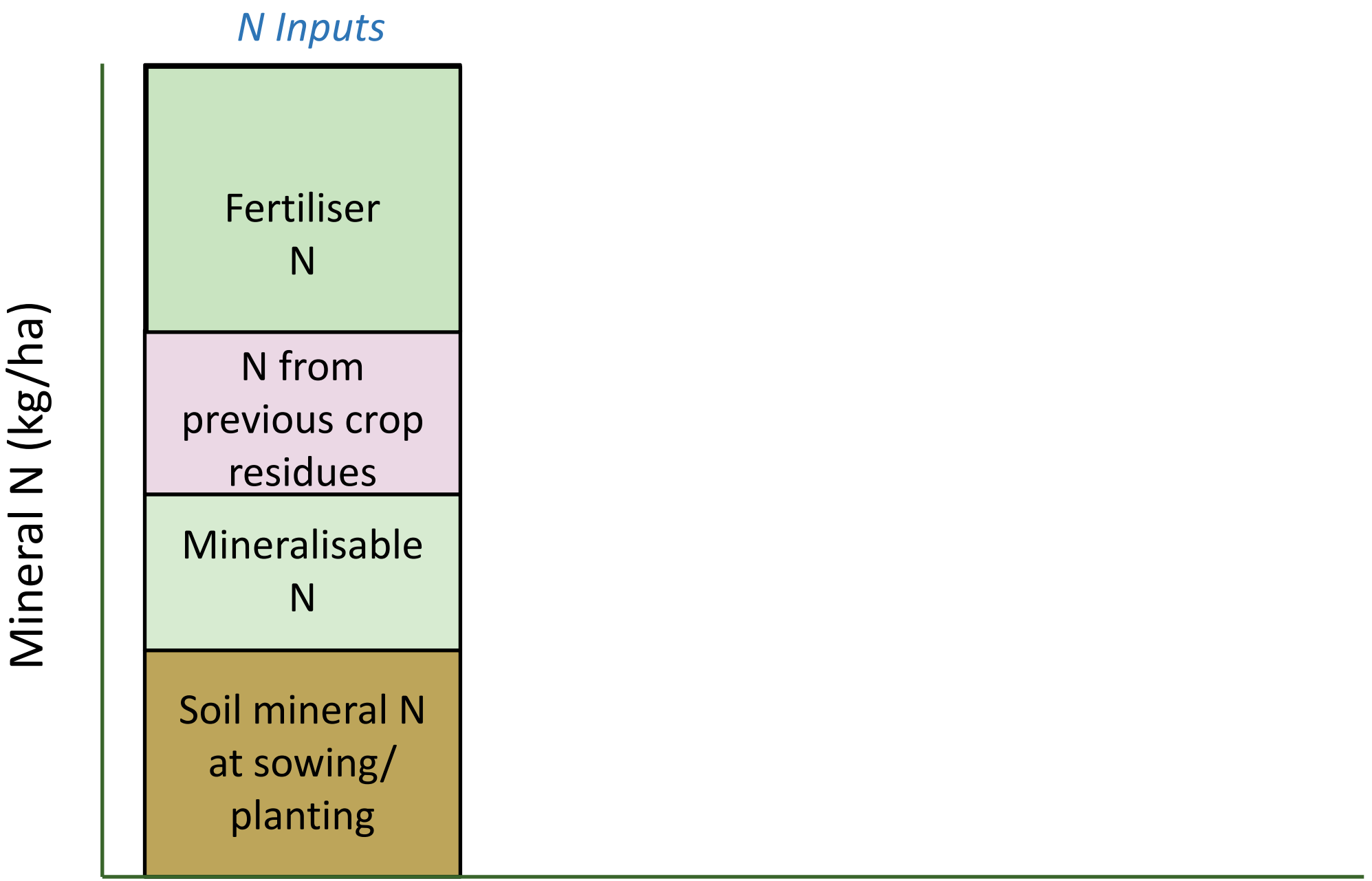
Issues:

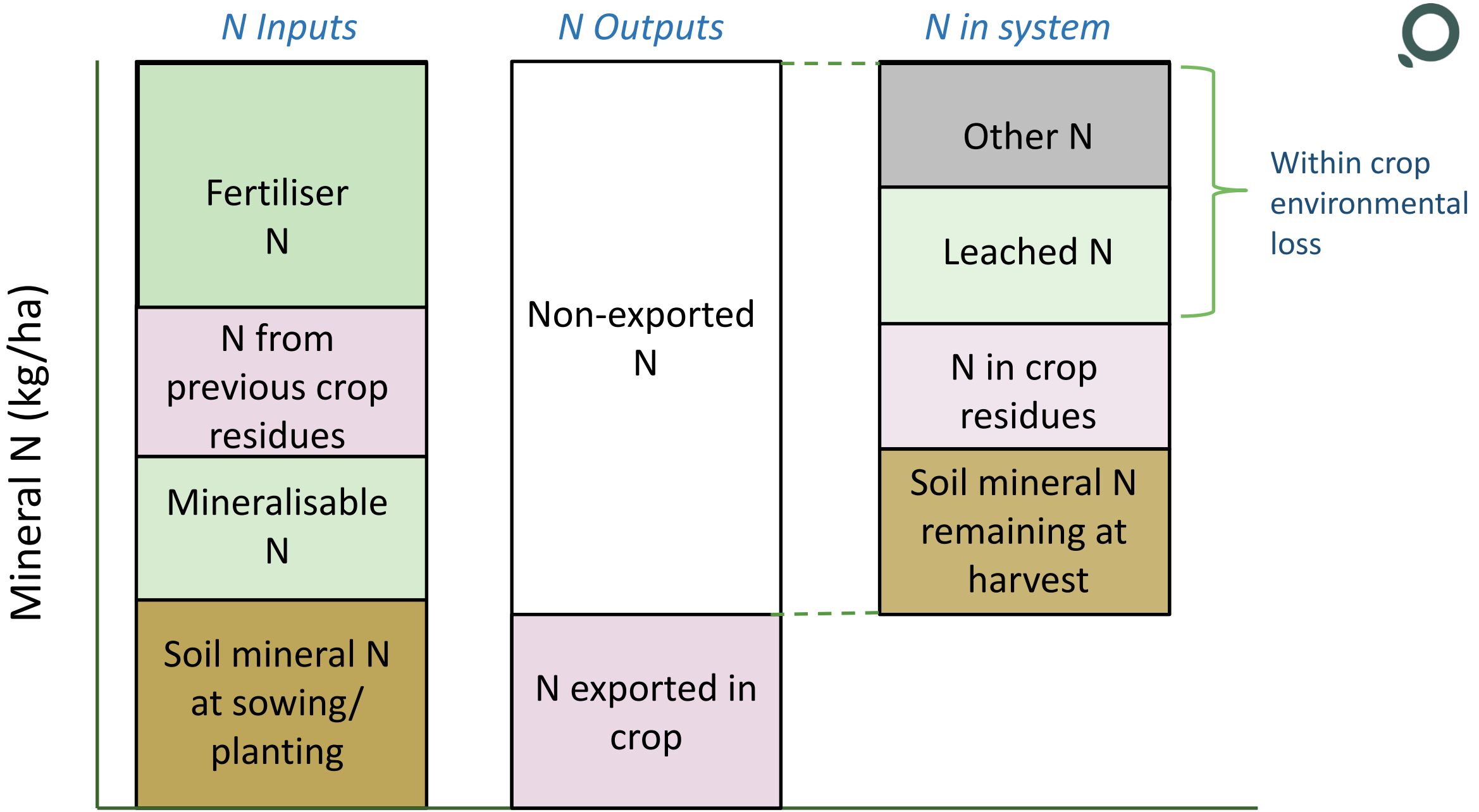
When nitrogen gets misplaced in the environment, water bodies and the atmosphere can become polluted.

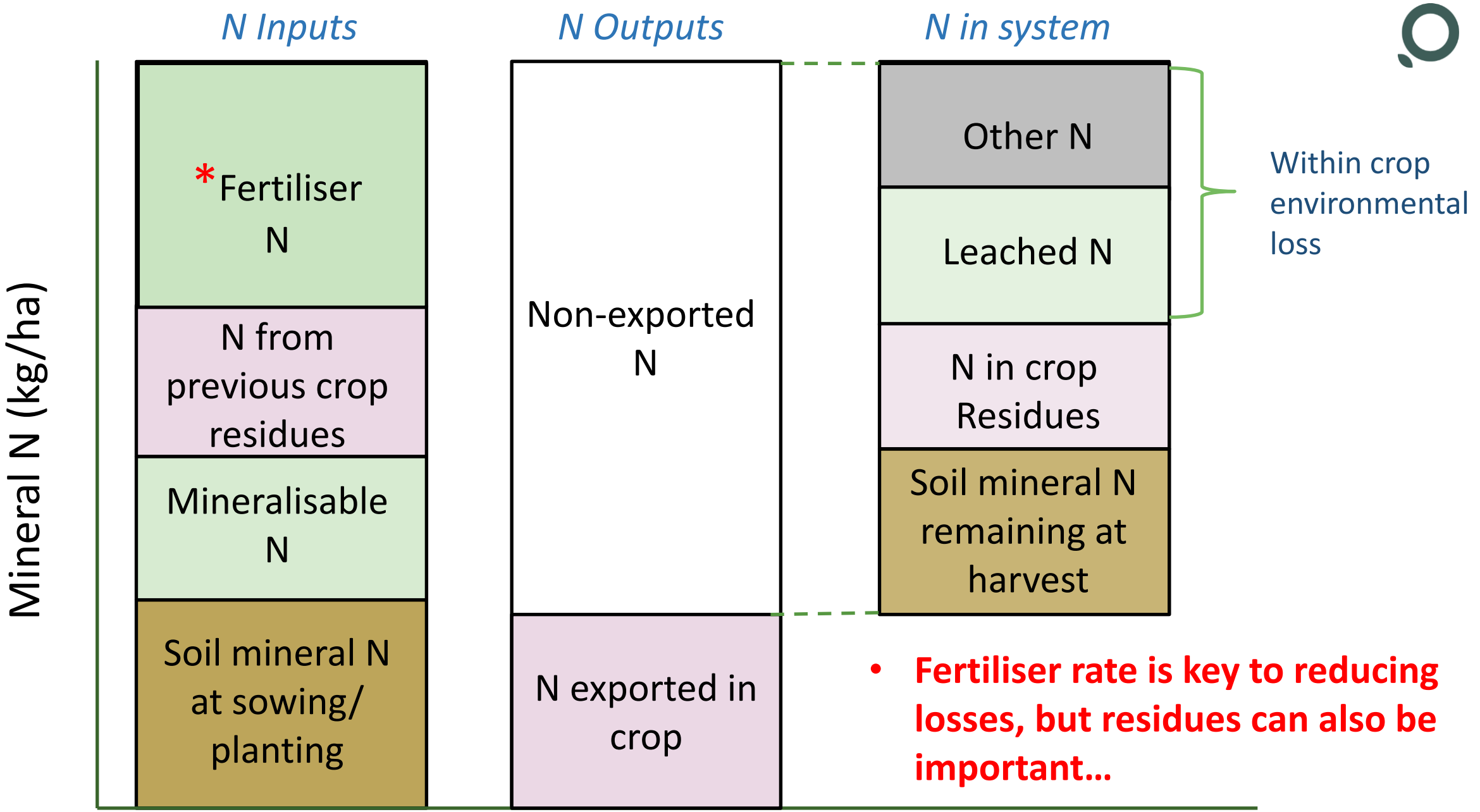
This is also an undesirable economic loss for the farmer/grower.

Aim:

Help improve current practices through provision of mitigation strategies to reduce nitrogen losses - whilst sustaining productivity.


N Inputs
Mineral N (kg/ha)
Fertiliser N
N from previous crop residues
Mineralisable N
Soil mineral N at sowing/ planting

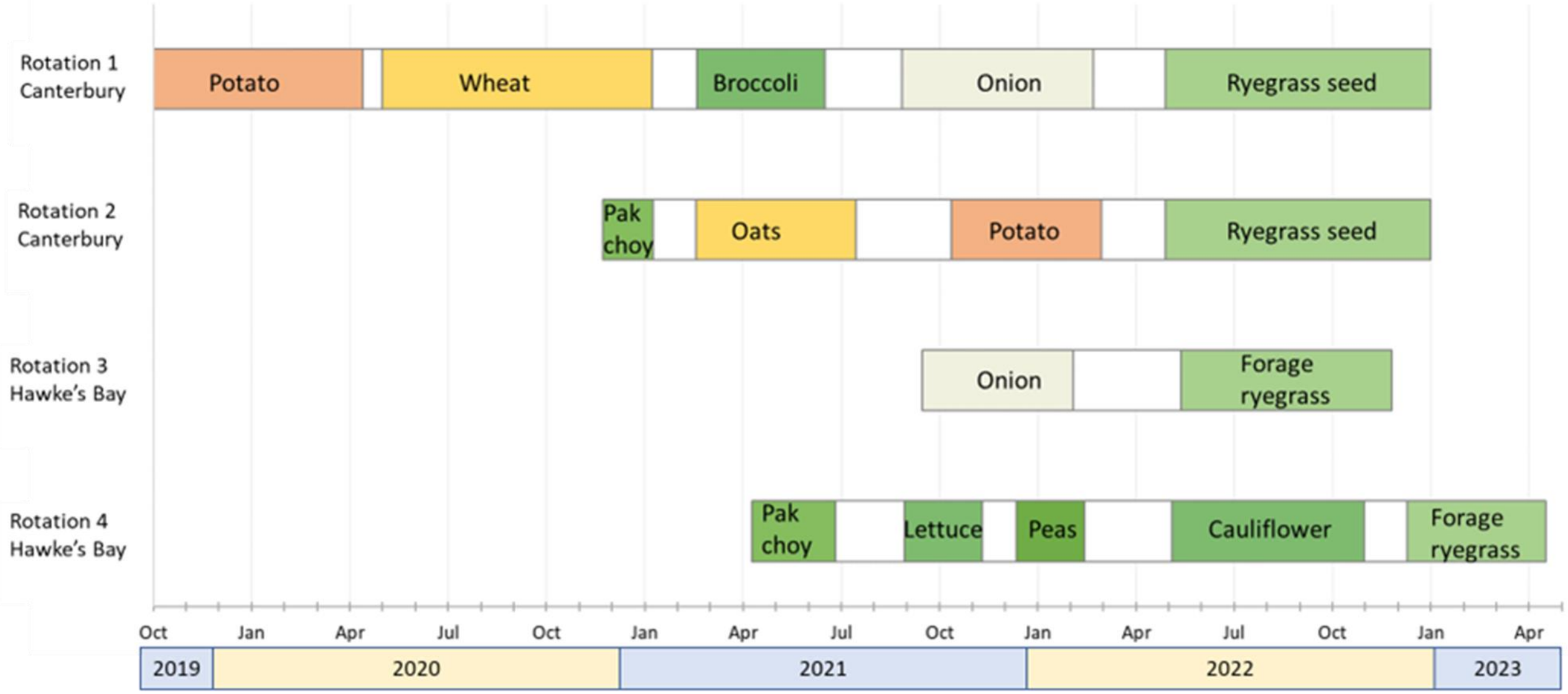

N Inputs
N Outputs
N in system
Mineral N (kg/ha)
Fertiliser N
N from previous crop residues
Mineralisable N
Soil mineral N at sowing/ planting
Non-exported N
N exported in crop
Other N
Leached N
N in crop residues
Soil mineral N remaining at harvest
Within crop environmental loss



- **Fertiliser rate is key to reducing losses, but residues can also be important…**

Workstream 1

Rotations in Workstream 1



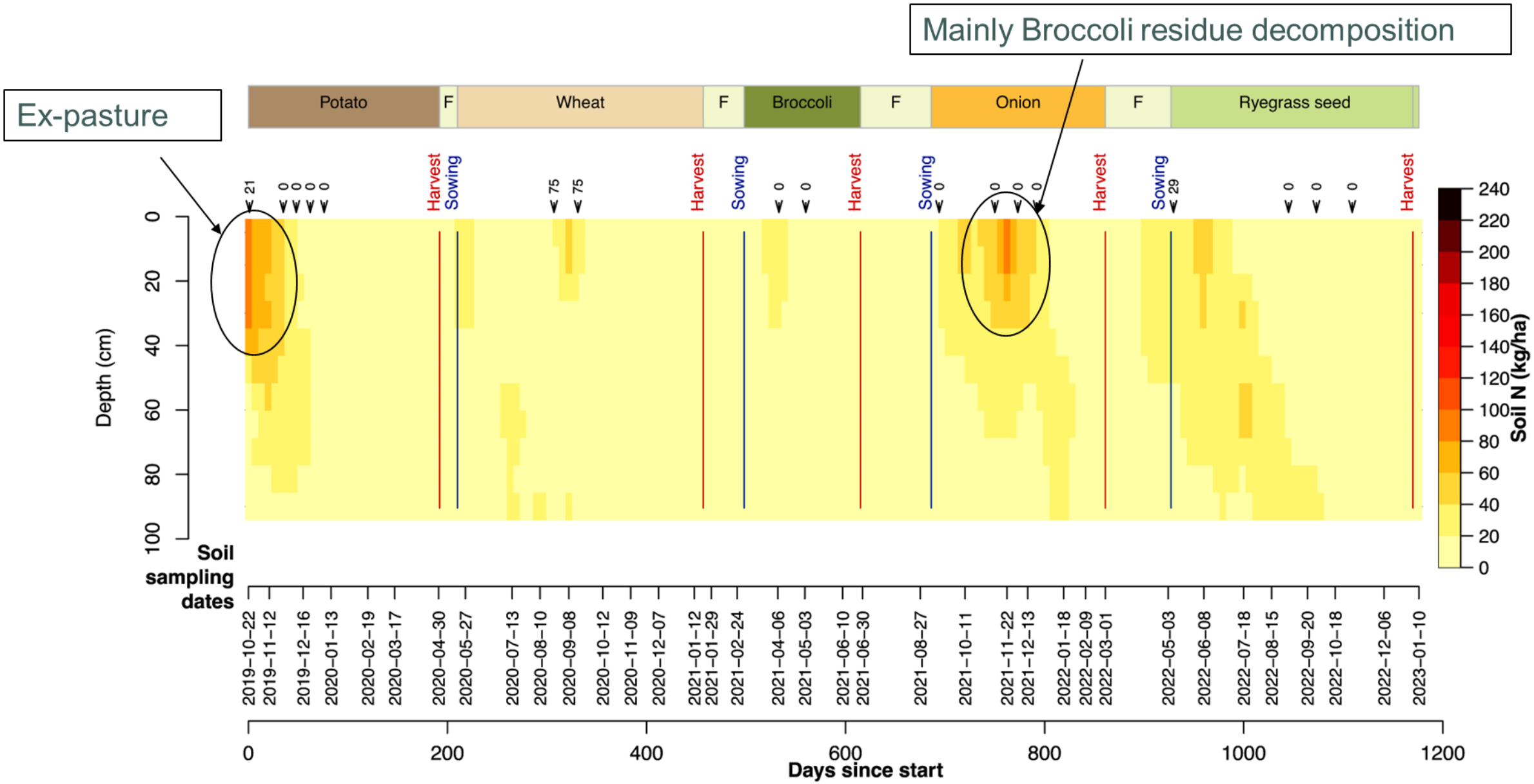
Rotation 1

	Potato	Wheat	Broccoli	Onion	Rye grass
	‘Russet Burbank’	‘Catherine’	‘Nobel’	‘Tilbury’	‘Nui’
Sow date	22 Oct 2019	19 May 2020	3 Mar 2021	7 Sep 2021	6 May 2022
Nitrogen rate (kg/ha)					
N1	21	150	0	0	29
N2	121	150	30	60	74
N3	221	150	60	120	119
N4	421	150	120	240	209

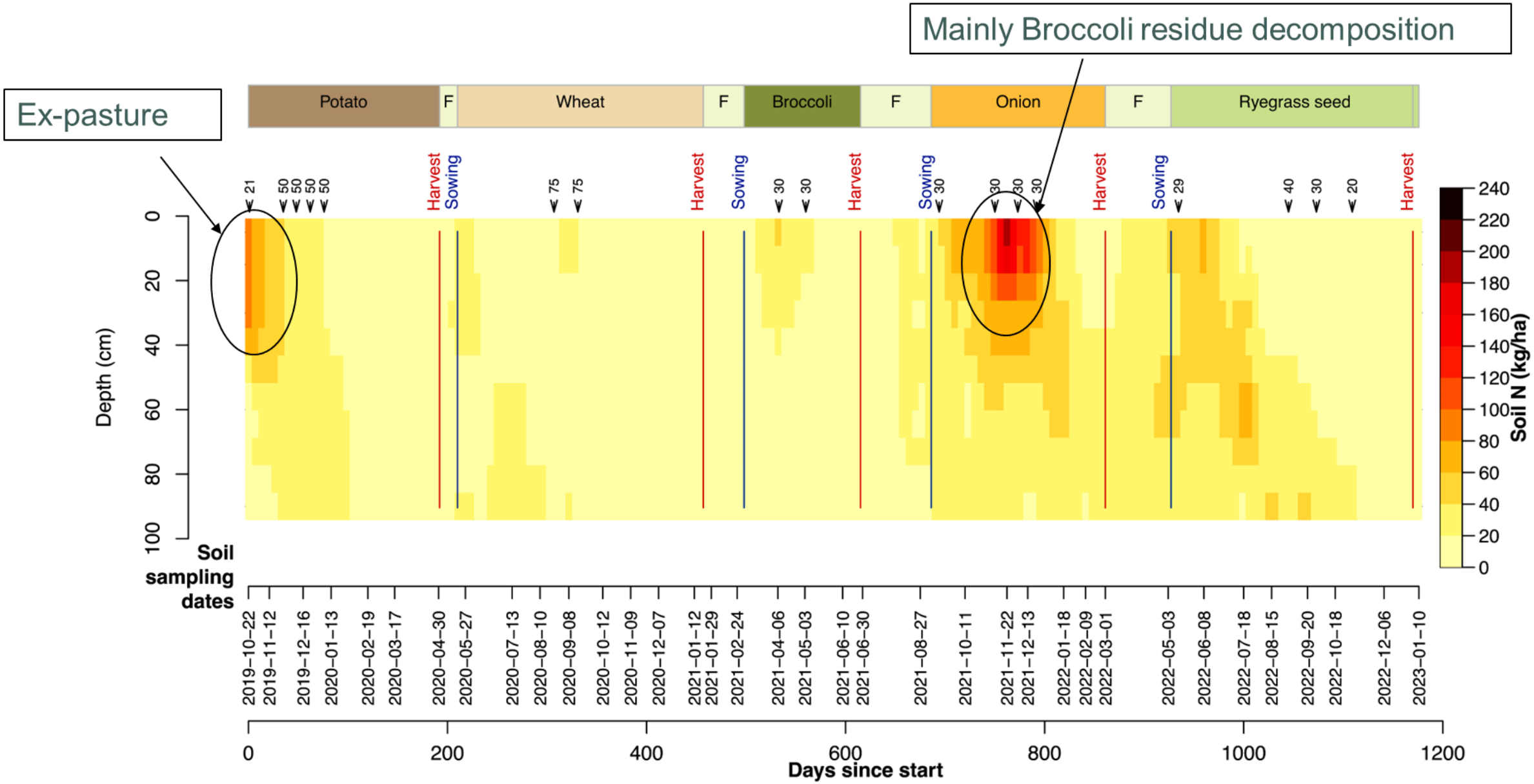
Rotation 2

	Pak choy	Oats	Potatoes	Ryegrass
	‘Shanghai’	‘Milton’	‘Agria’	‘Nui’
Sow date	7 Dec 2020	2 Mar 2021	22 Oct 2021	6 May 2022
Nitrogen rate (kg/ha)				
N1	0	0	0	0
N2	30	0	103	60
N3	60	0	206	120
N4	140	0	412	240

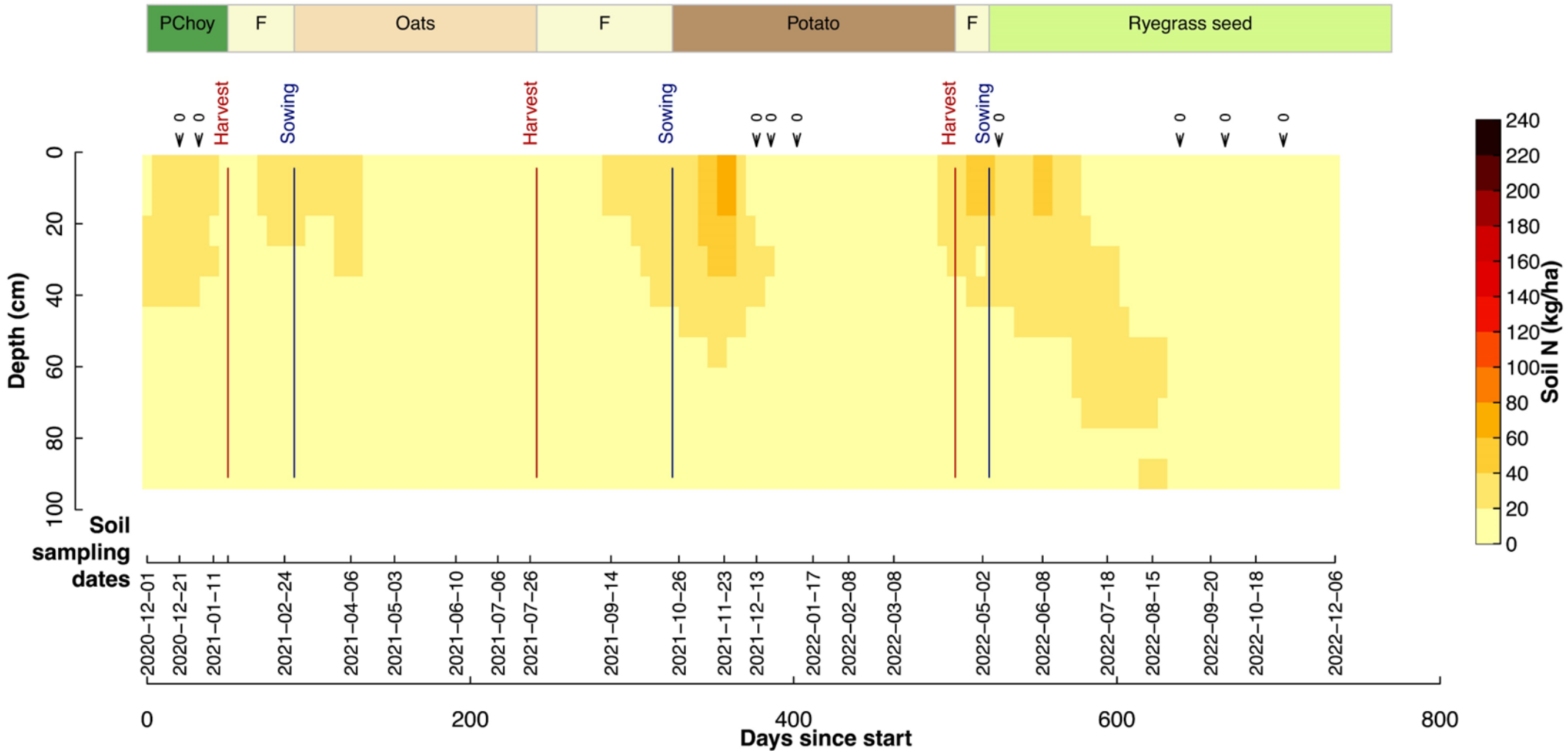
Soil mineral N in Rotation 1 – N1 treatment



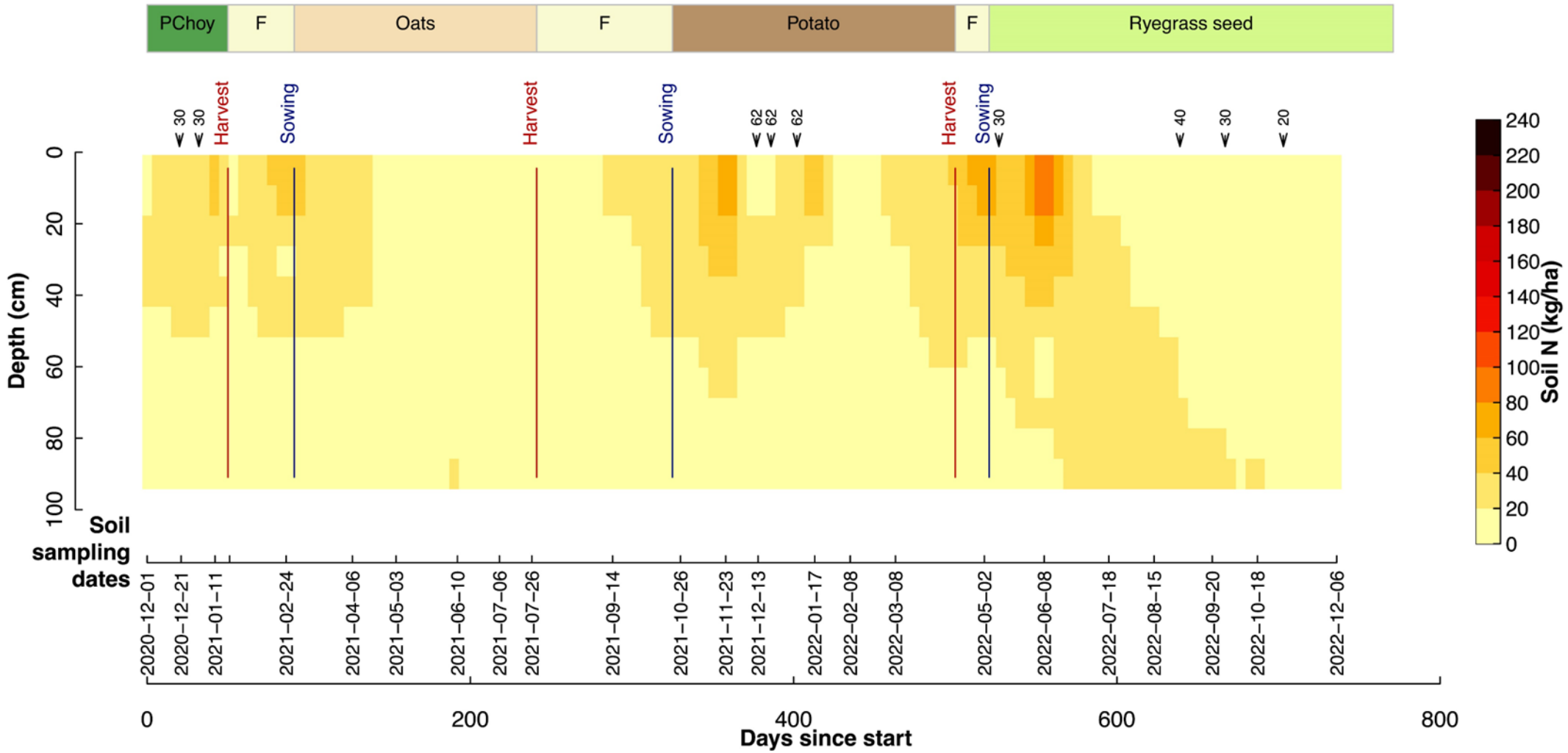
Soil mineral N in Rotation 1 – N3 treatment



Soil mineral N in Rotation 2 – N1 treatment

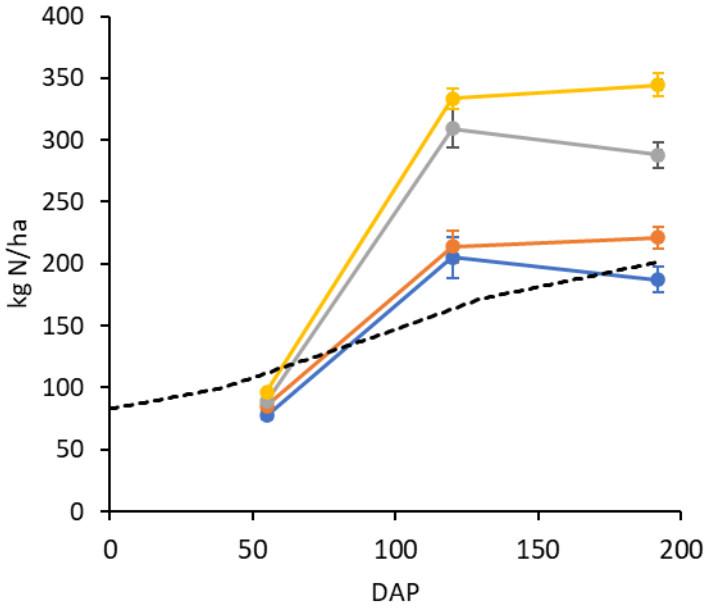


Soil mineral N in Rotation 2 – N3 treatment

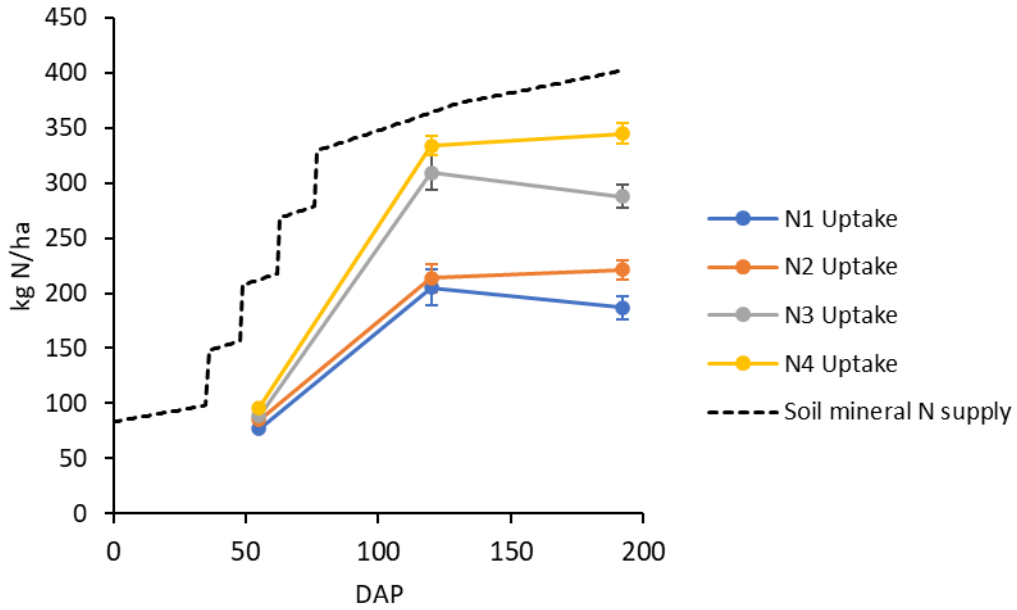


Potato N uptake

Rotation 1 – N1



Rotation 1 – N3

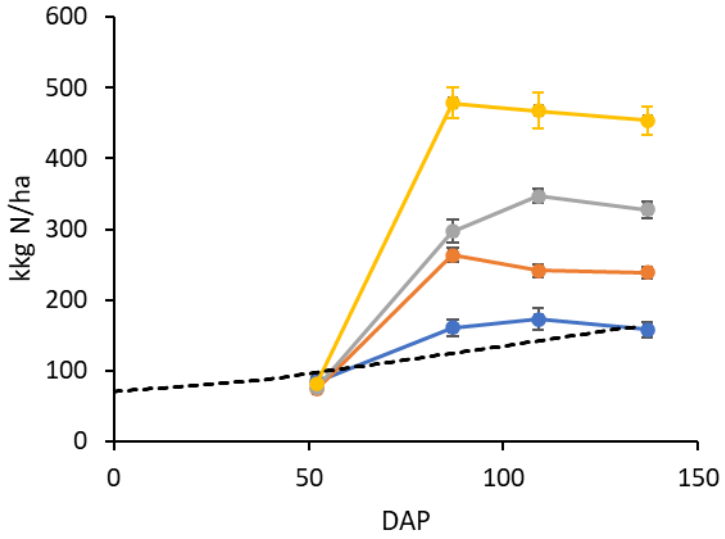


Yield t/ha

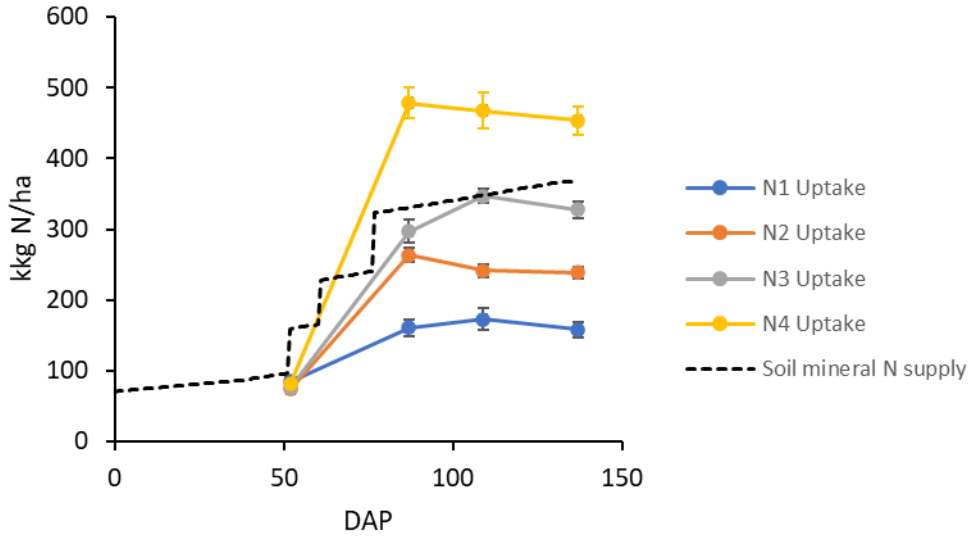
77.4
72.0
63.8
56.3

Potato N uptake

Rotation 2 – N1

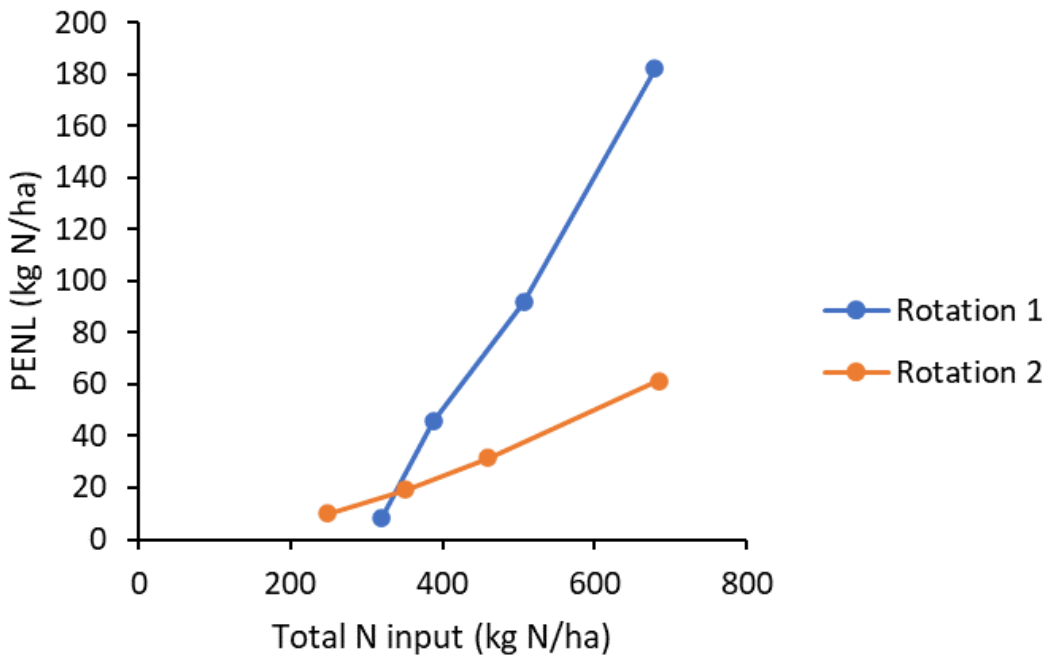


Rotation 2 – N3



Yield t/ha

89.8
80.1
76.2
64.1


200
180
160
140
120
100
80
60
40
20
0
PENL (kg N/ha)
0
200
400
600
800
Total N input (kg N/ha)
Rotation 1
Rotation 2

Conclusions

- Data obtained from different rotations to understand crop- soil N dynamics
- Potato crops had similar N inputs, but different N balances.
- Difference in N balance partly driven by yield, partly by supply amount and timing
- Applying the appropriate amount of N to match desired yield optimises returns and minimises losses

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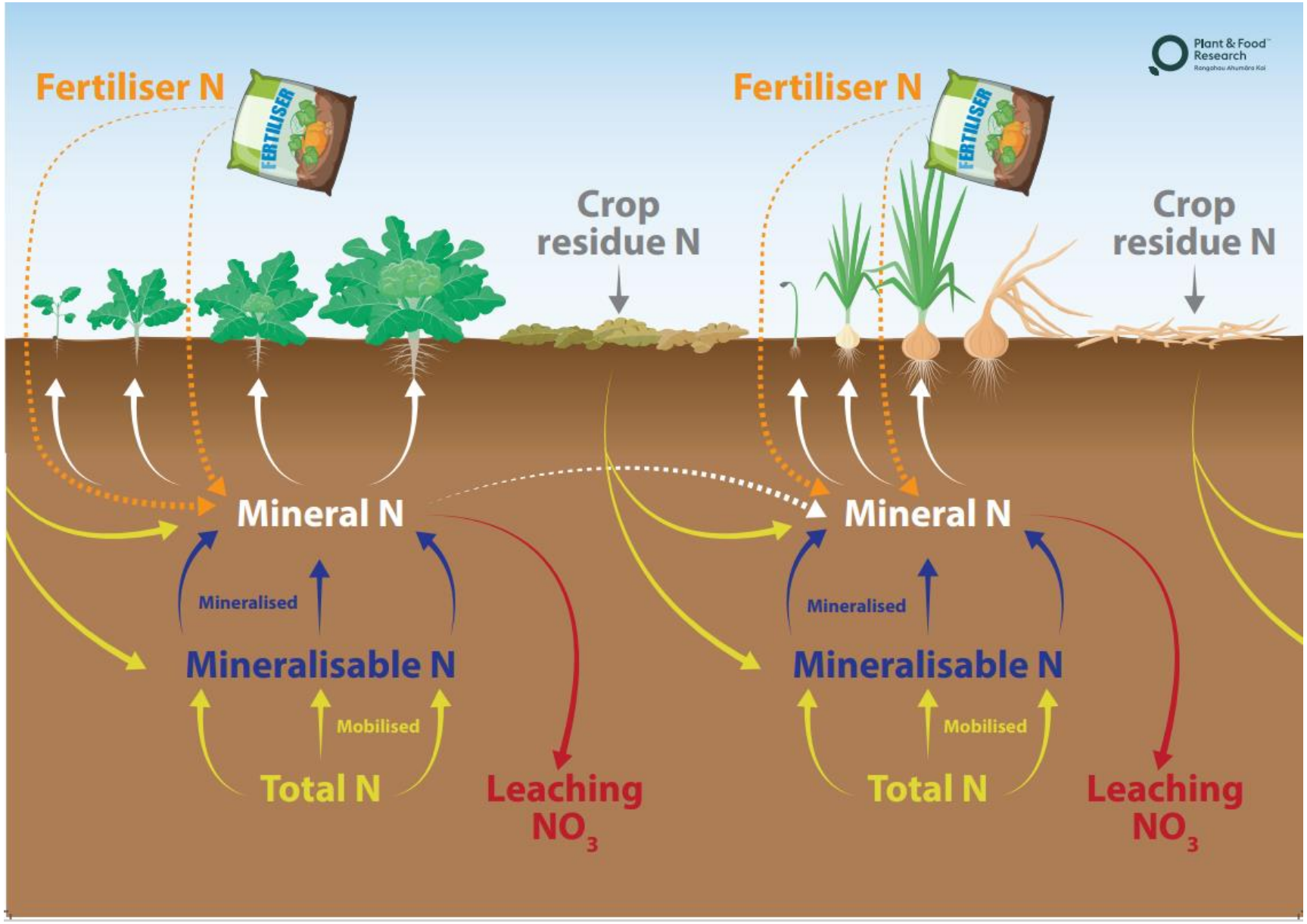
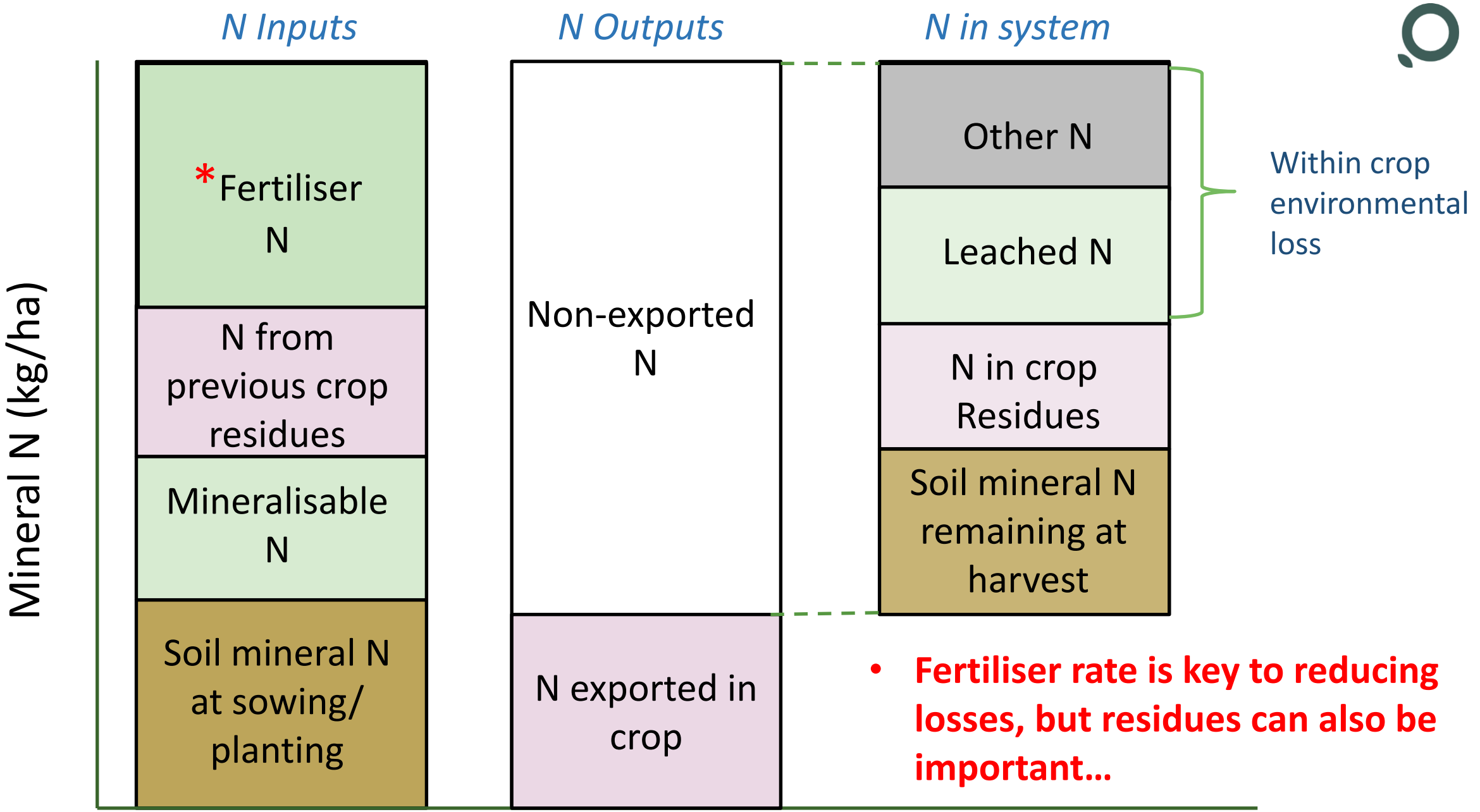
Residues in vegetable cropping systems

Trish Fraser and Bruce Searle

The New Zealand Institute for Plant and Food Research Limited

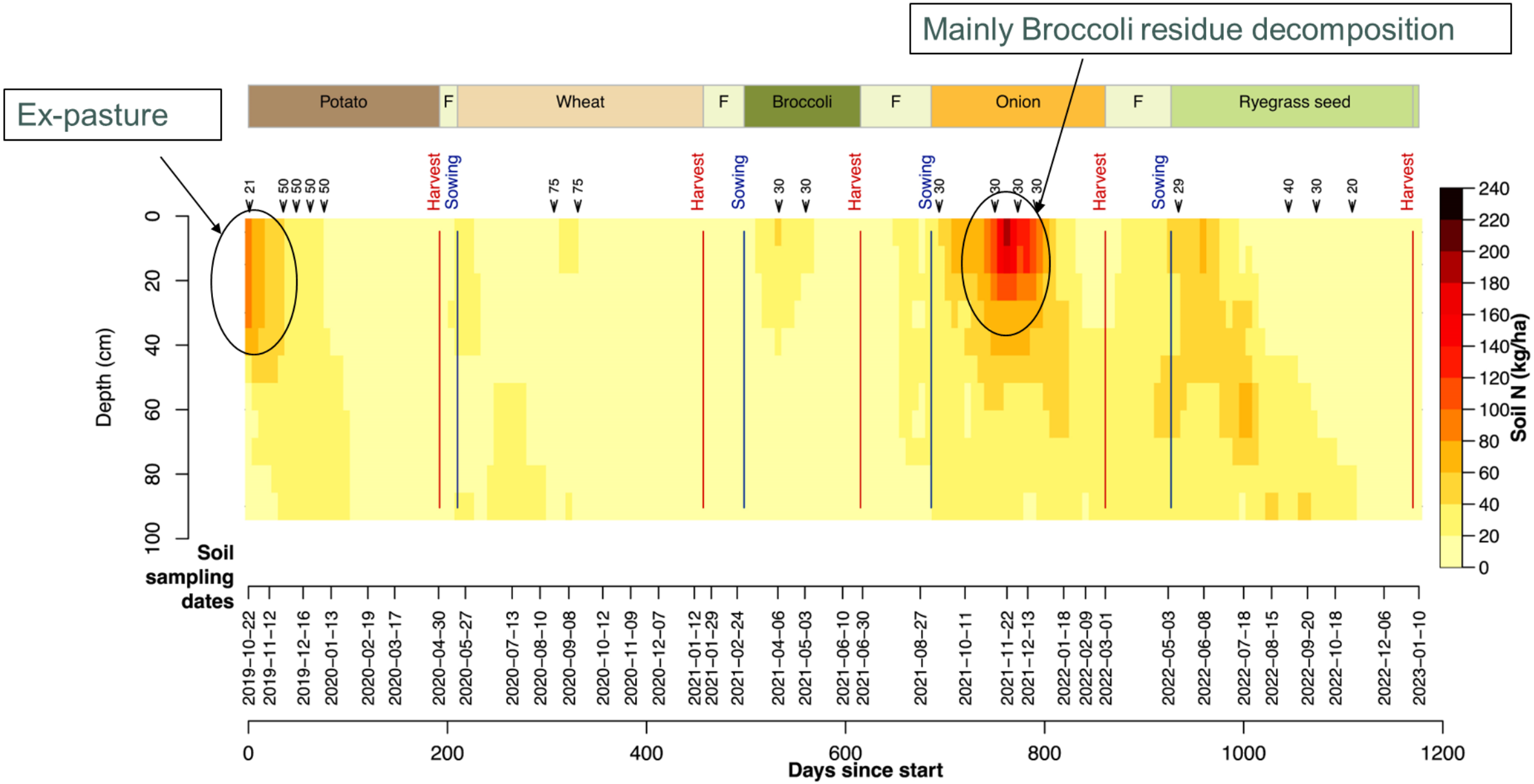
Nitrogen cycling in a vegetable rotation





- **Fertiliser rate is key to reducing losses, but residues can also be important…**

Soil mineral N in Rotation 1 – N3 treatment

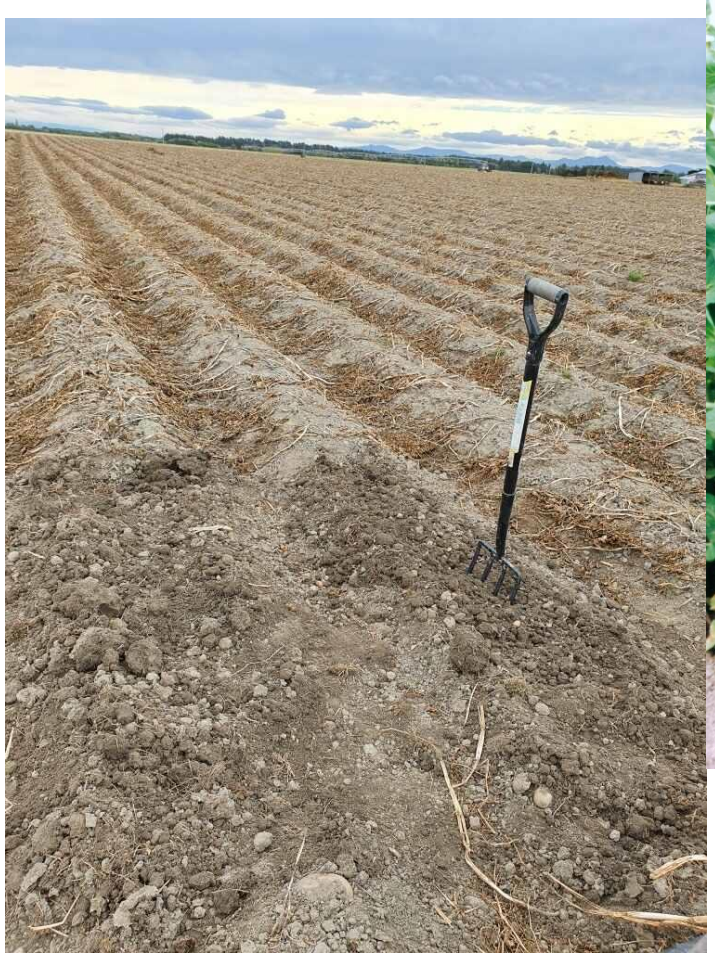


Literature review conducted focussing on N in crop residues

- Sharp JM, Khaembah EN, Fraser PM, Gee M. February 2023. A literature review of arable and vegetable crop residues, with emphasis on nitrogen status and factors affecting residue decomposition and nitrogen release.

- Gathered information on nitrogen concentration in residue components and factors affecting the subsequent supply of N from crop residues to the next crop

Amounts of crop residue left behind vary considerably by crop

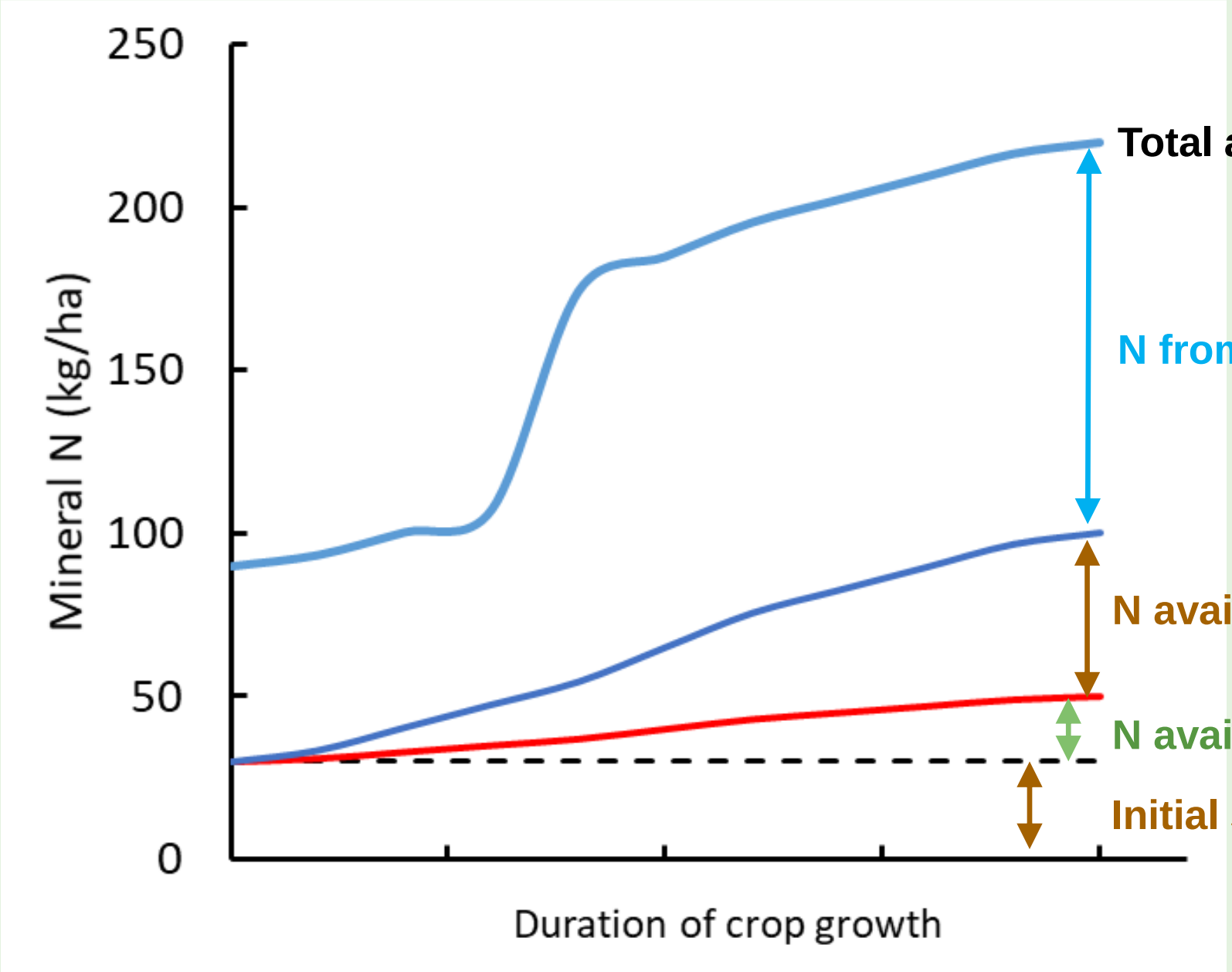


Potato: avg HI = 0.89

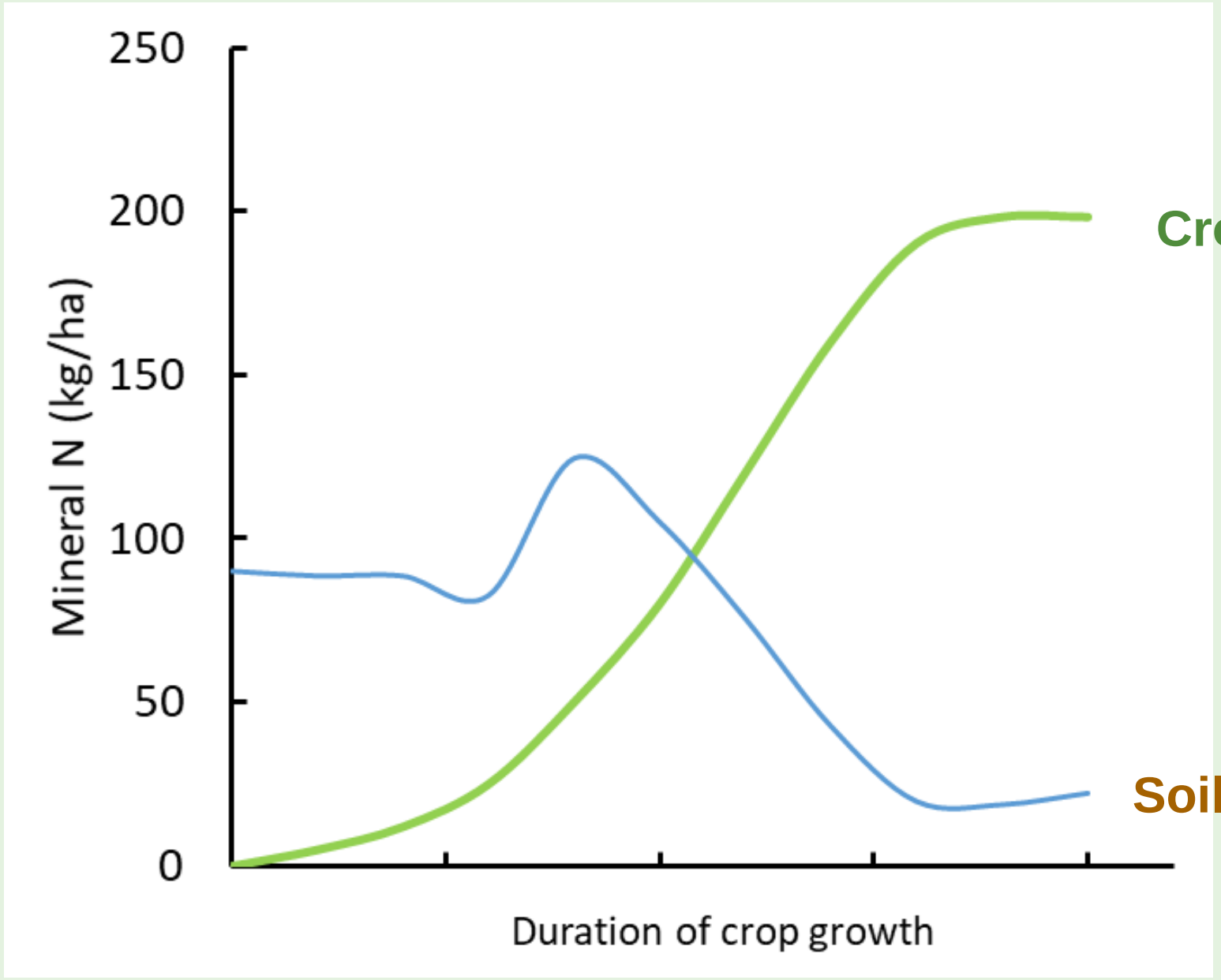
Peas : avg HI = 0.52

Cabbages (avg HI = 0.73

N movement is very dynamic

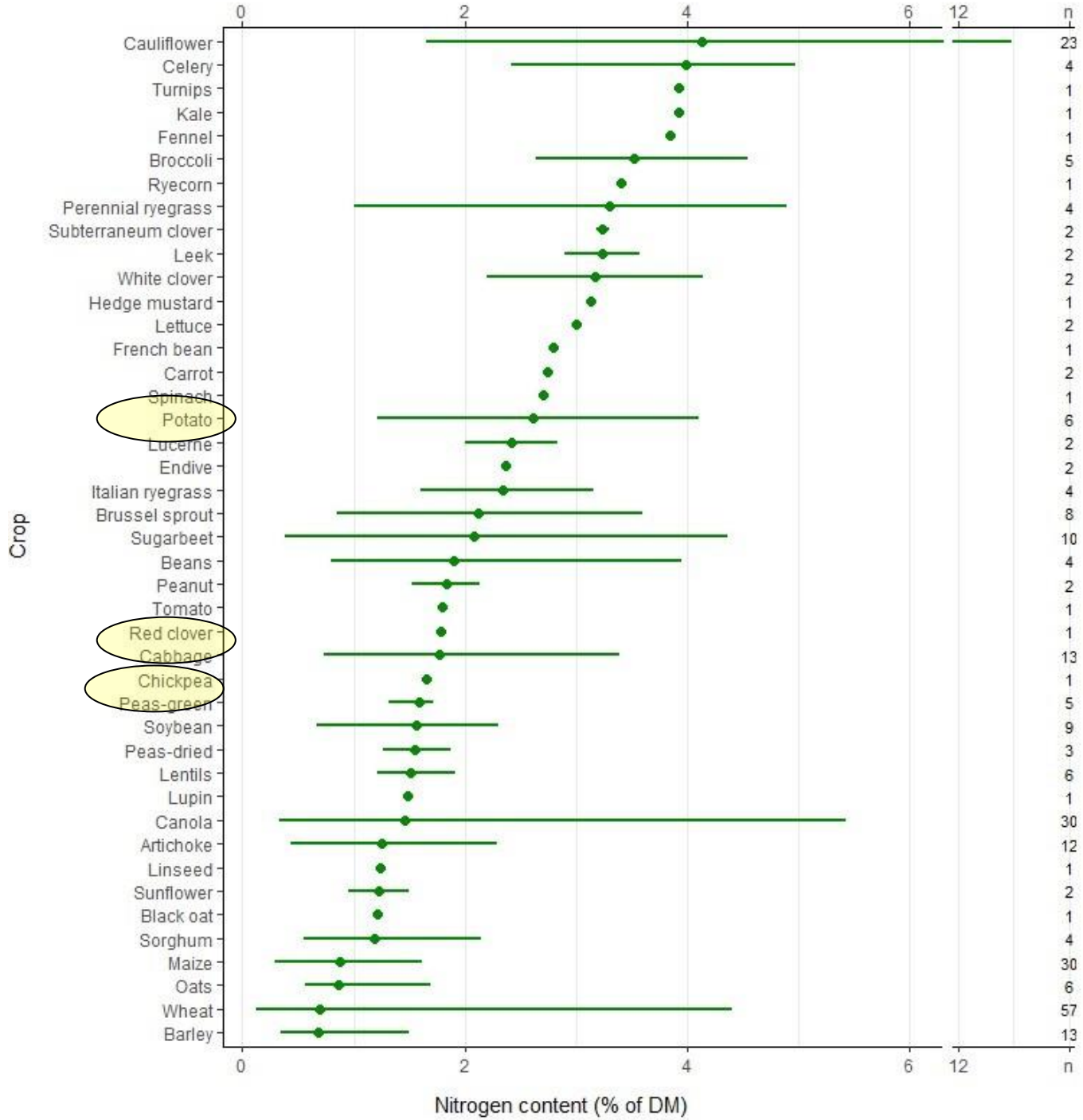


N movement is very dynamic

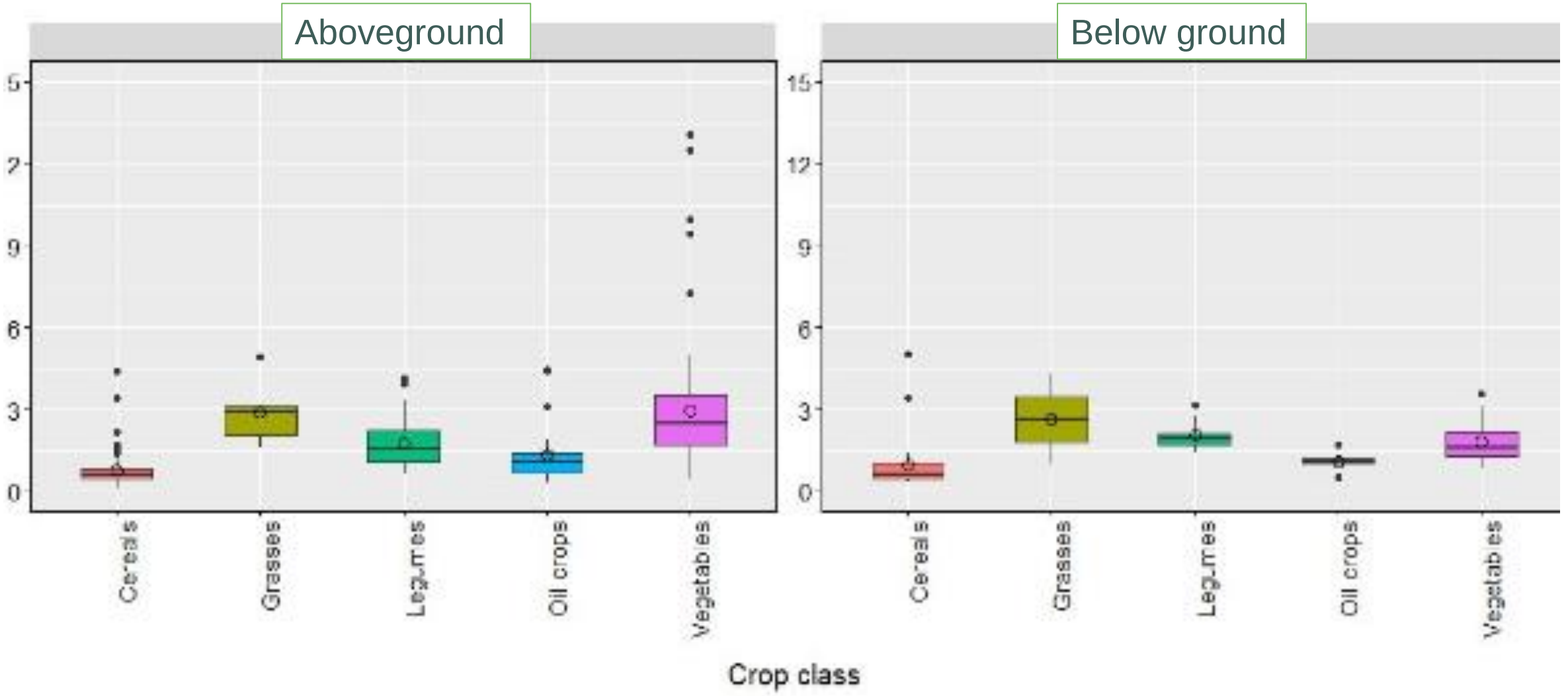


Average % N in crop residue found in different crops in temperate systems

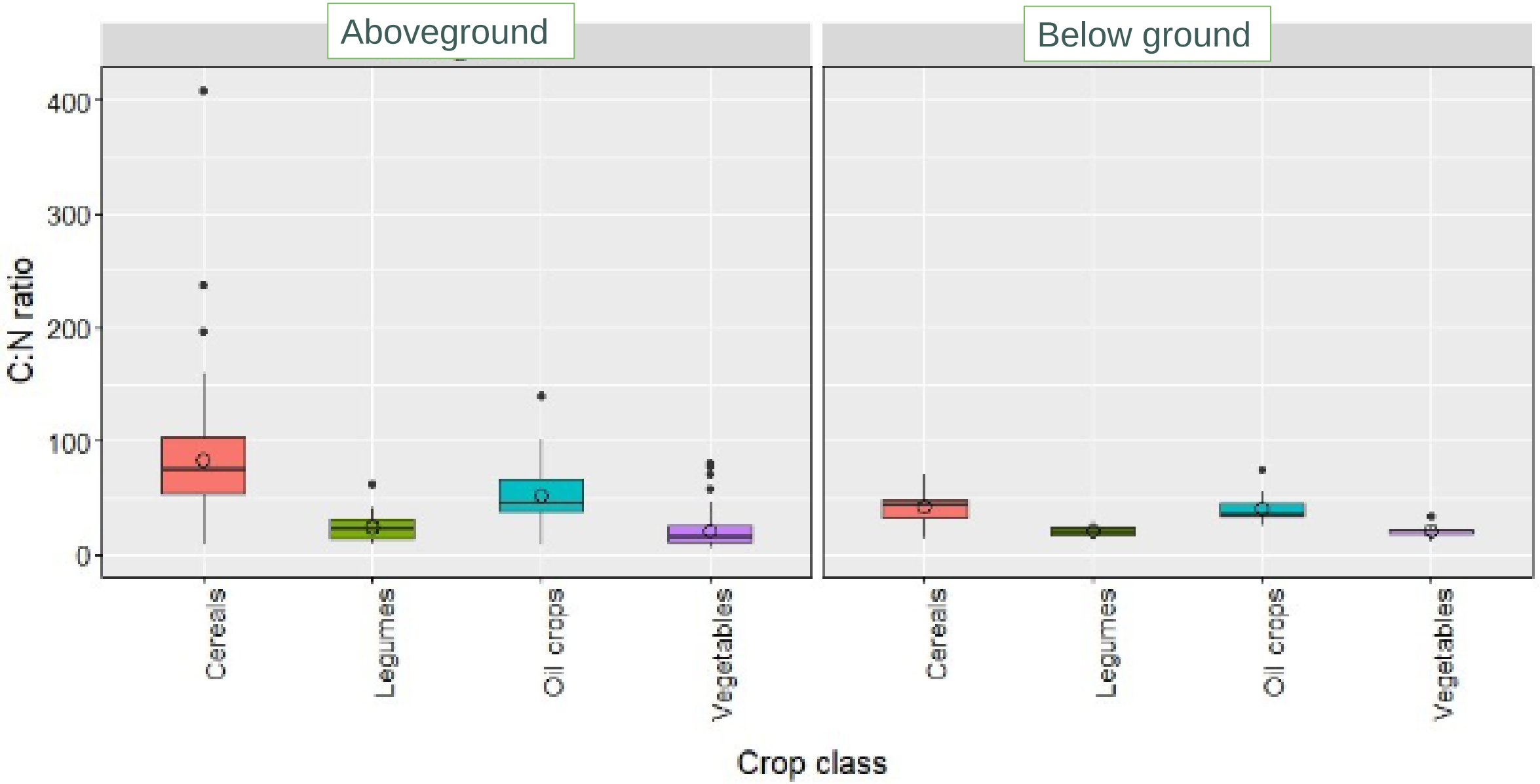
- *Review highlighted:* Average % N in crop residue found in different crops in temperate systems
- Mostly above ground residues investigated,
- *Importance of using local biomass in calculations, as yields for a number of crops are often higher in NZ*



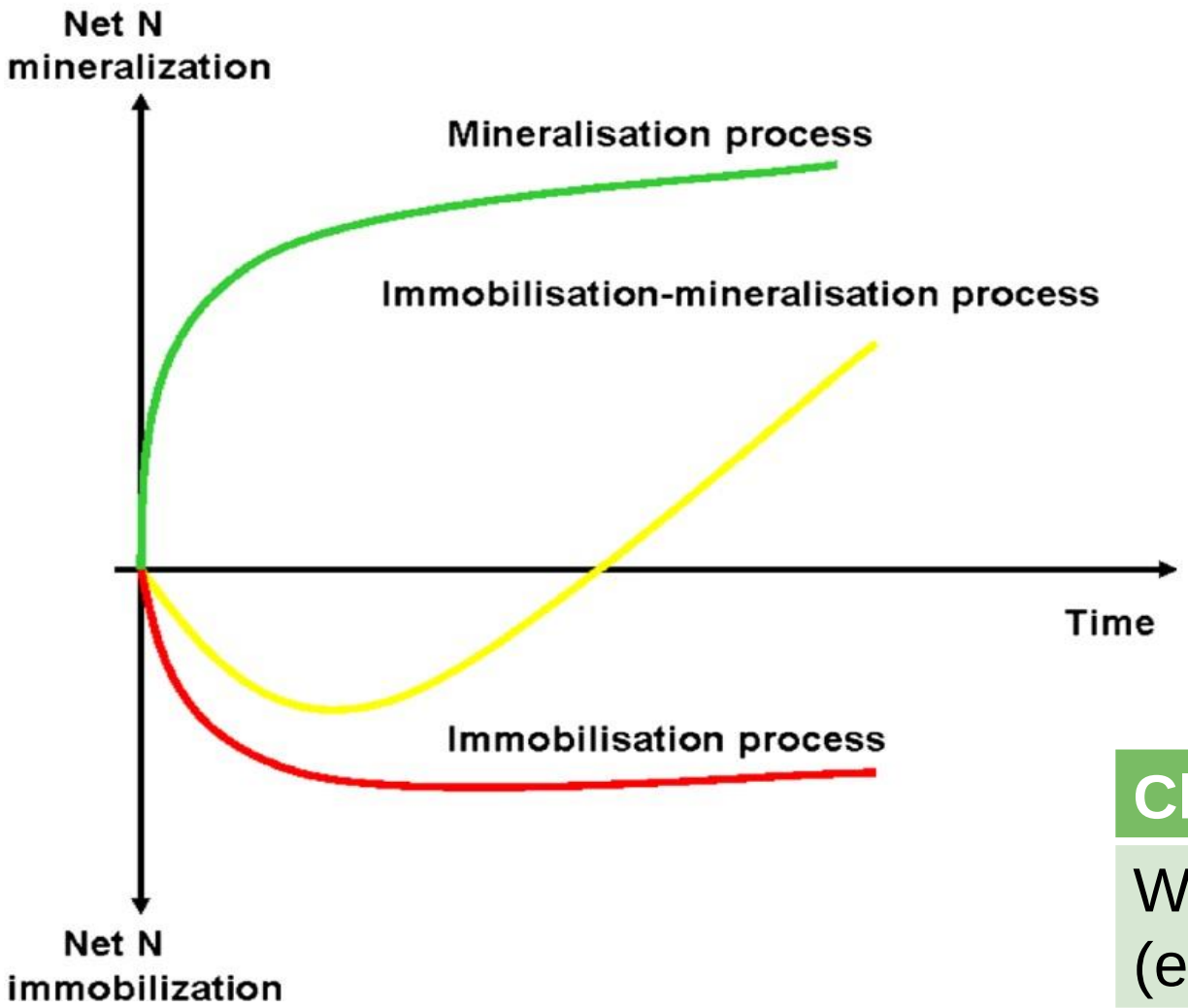
Lit review - Average nitrogen concentrations in residues



C:N ratio of residues

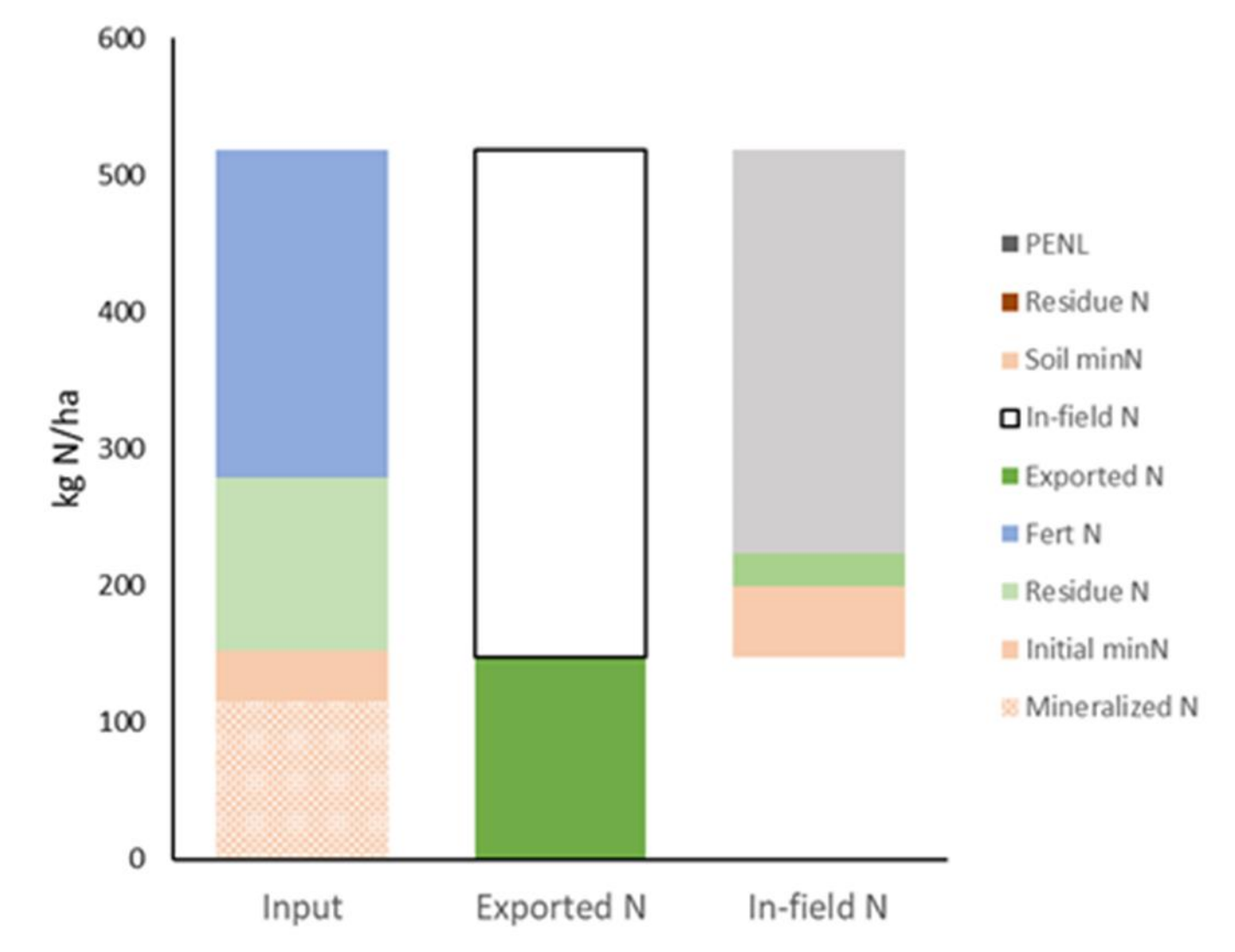


Residue decomposition



Chemical constituent	Breakdown rate
Water soluble materials (eg sugars)	Days
Cellulose/hemicellulose	Months
Lignin	Years

N balance


600
500
400
300
200
100
0
kg N/ha
Input
Exported N
In-field N
PENL
Residue N
Soil minN
In-field N
Exported N
Fert N
Residue N
Initial minN
Mineralized N

Conclusions

- Nitrogen in vegetable systems is very dynamic.
- Ideally follow “4R’s approach”
  - **R**ight fertiliser
  - **R**ight place
  - **R**ight time
  - **R**ight amount
- Need to know - crop N uptake (modelled) and soil N (measured) to help make this decision.
- Applying the appropriate amount of N to match desired yield optimises returns and minimises losses

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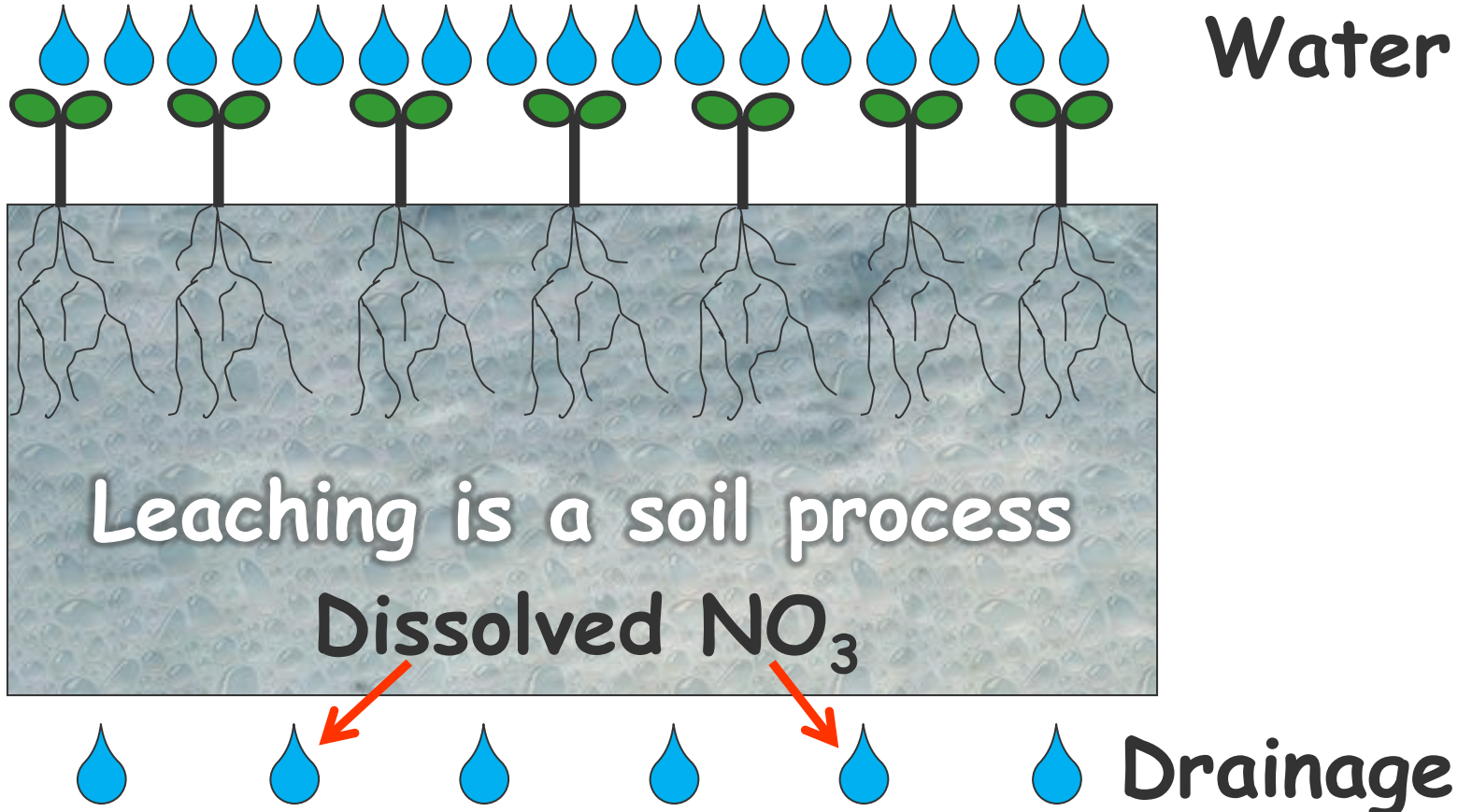
Nitrogen Management Tool(s) for Minimised Leaching

Hamish Brown, Systems modeller

Some leaching is unavoidable



$$N_{Leached} = \boldsymbol{N}_{\boldsymbol{mineral}} \times a\left(\frac{\boldsymbol{drainage}}{PAW}\right)^{b}$$

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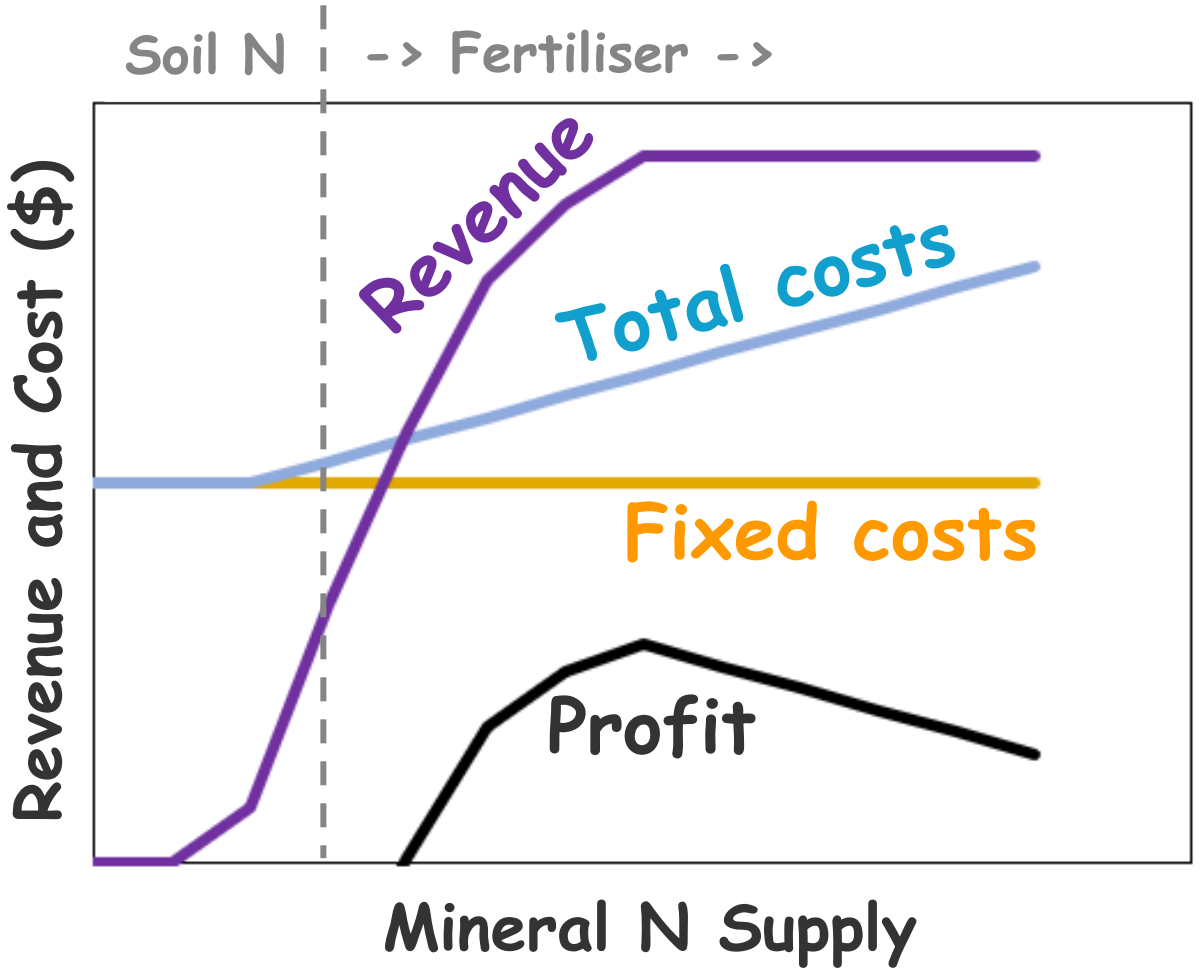
Some leaching is unavoidable

- Drainage is unavoidable

- Mineral N is essential



How to minimize leaching risk in crop production

Easy in theory !!!

- Avoid surplus N in the soil

- Ensure enough N for economic crop growth

Difficult in Practice !!!

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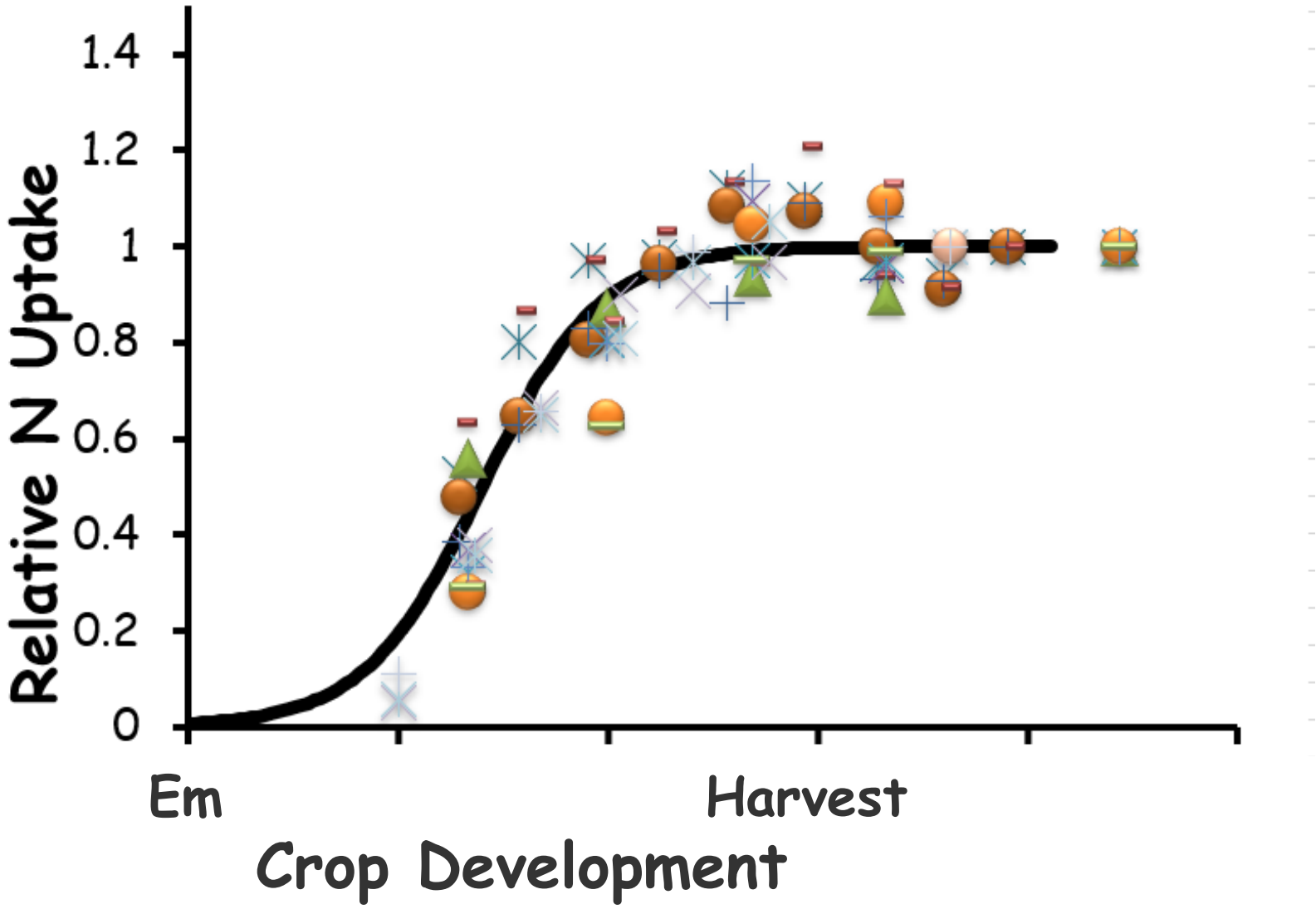
How much is enough soil N ?

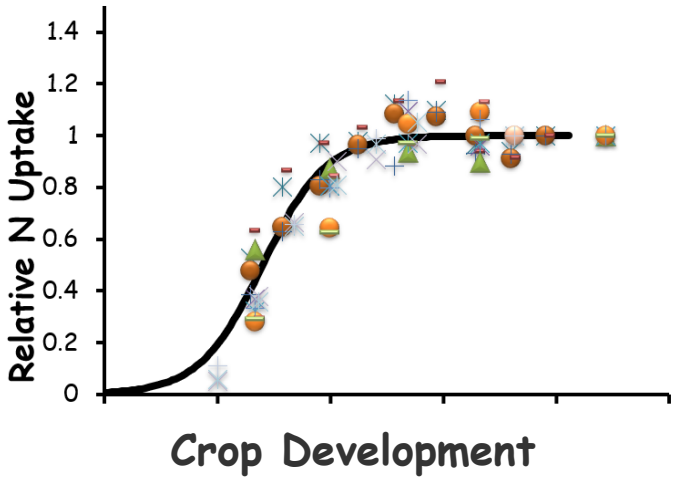
Start with

Total uptake

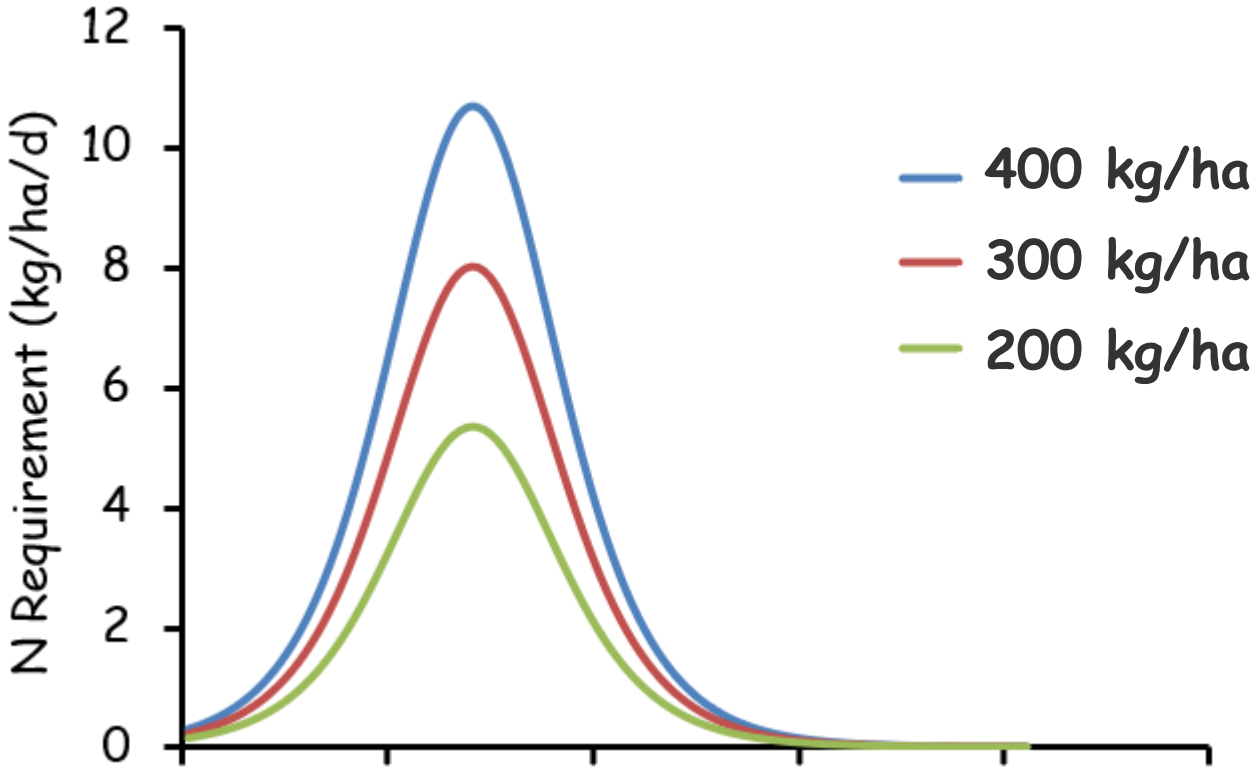


How much is enough soil N ?

Total uptake

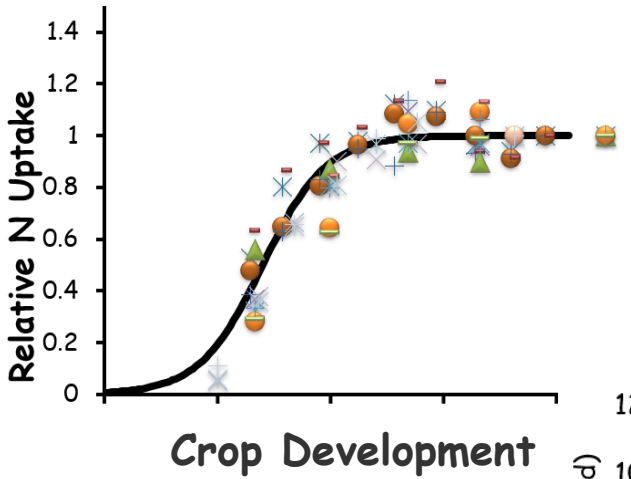


Then work out Daily uptake

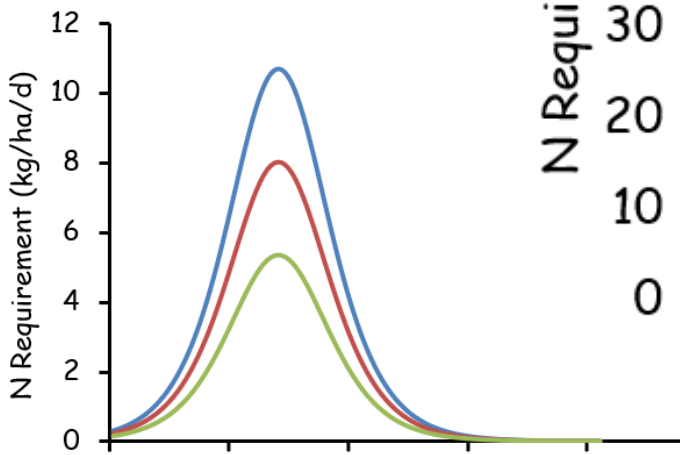


How much is enough soil N ?

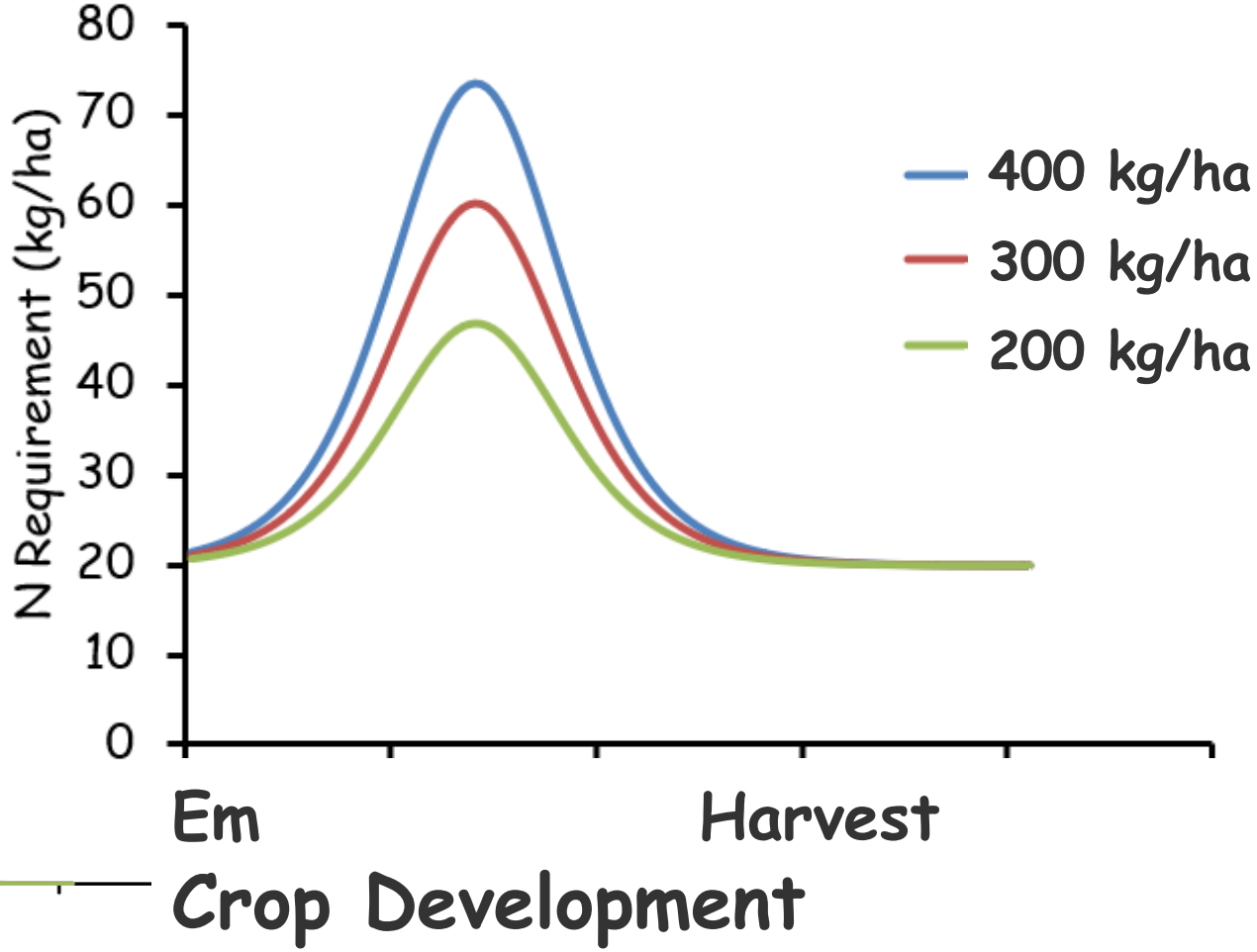
Total uptake



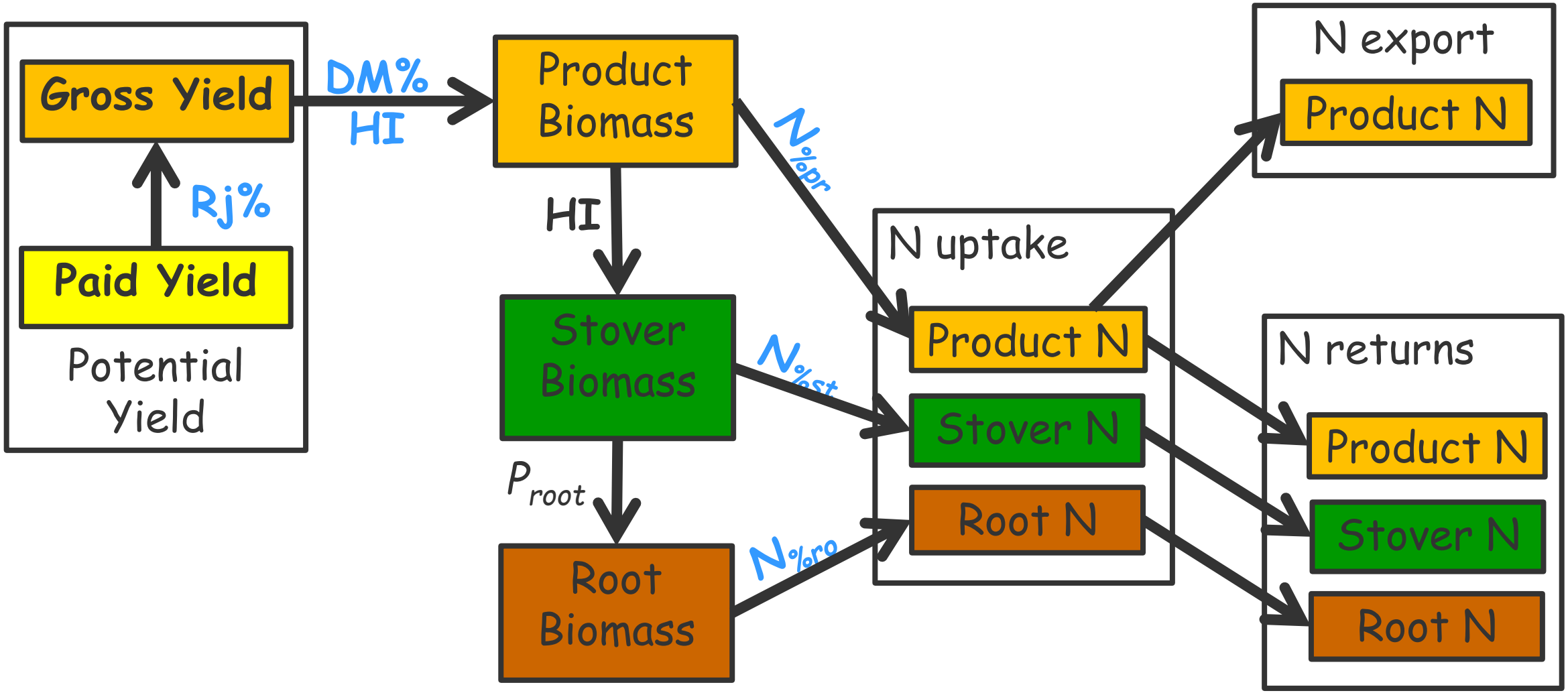
Daily uptake



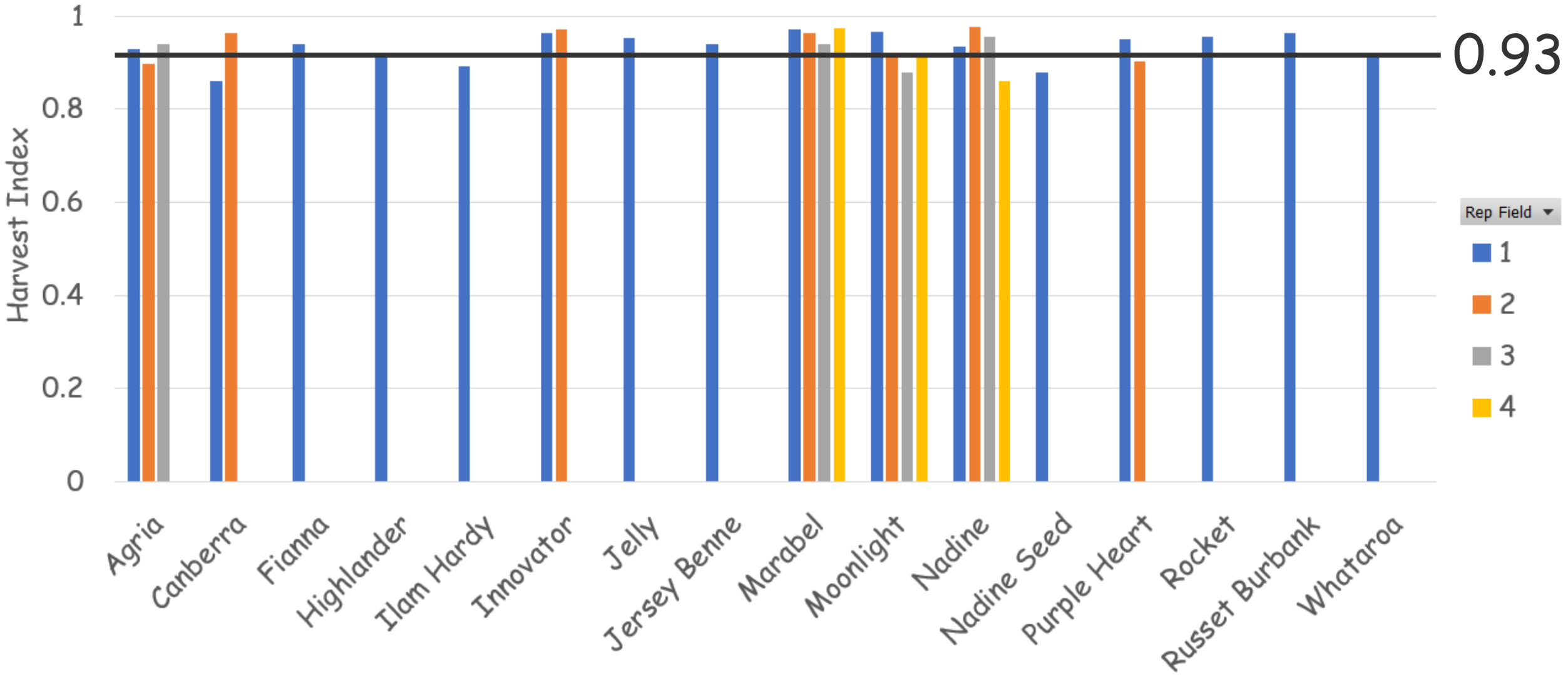
Finally work out Soil N required



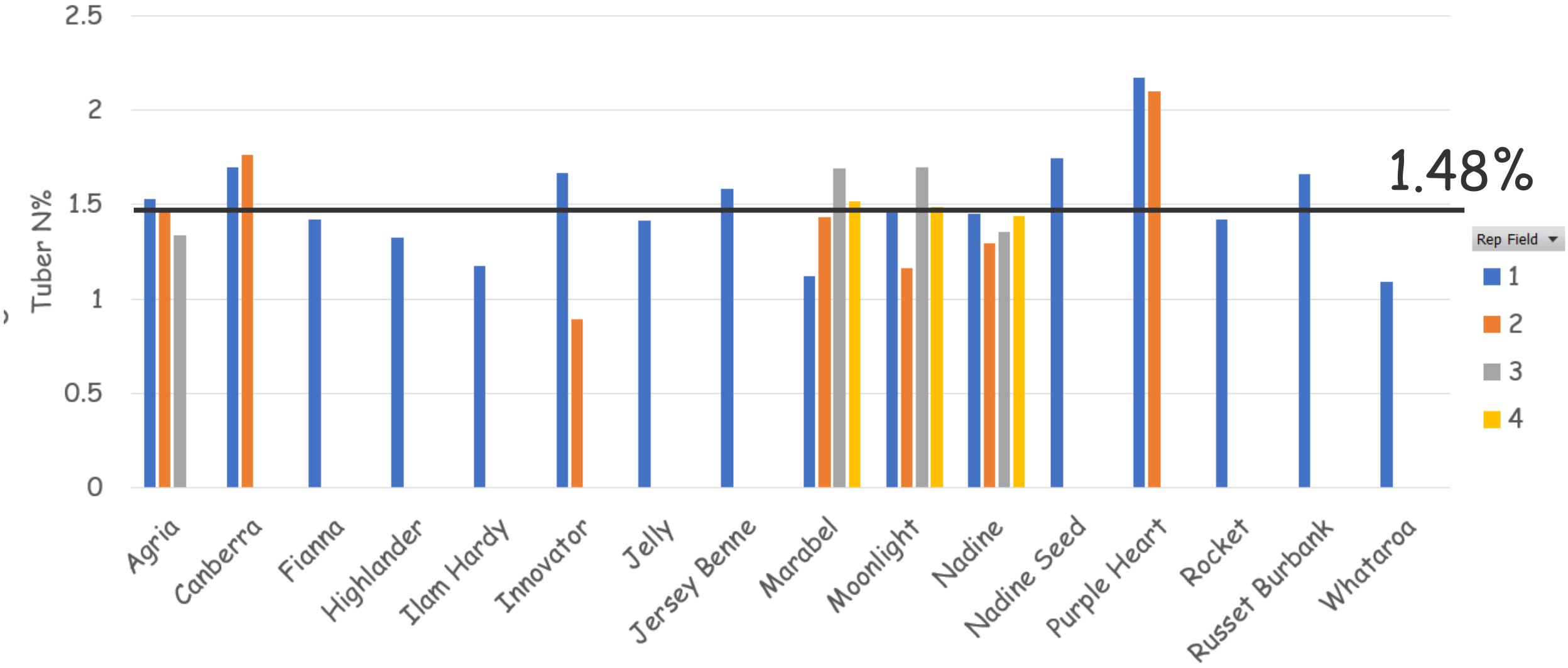
Calculating total Crop N uptake



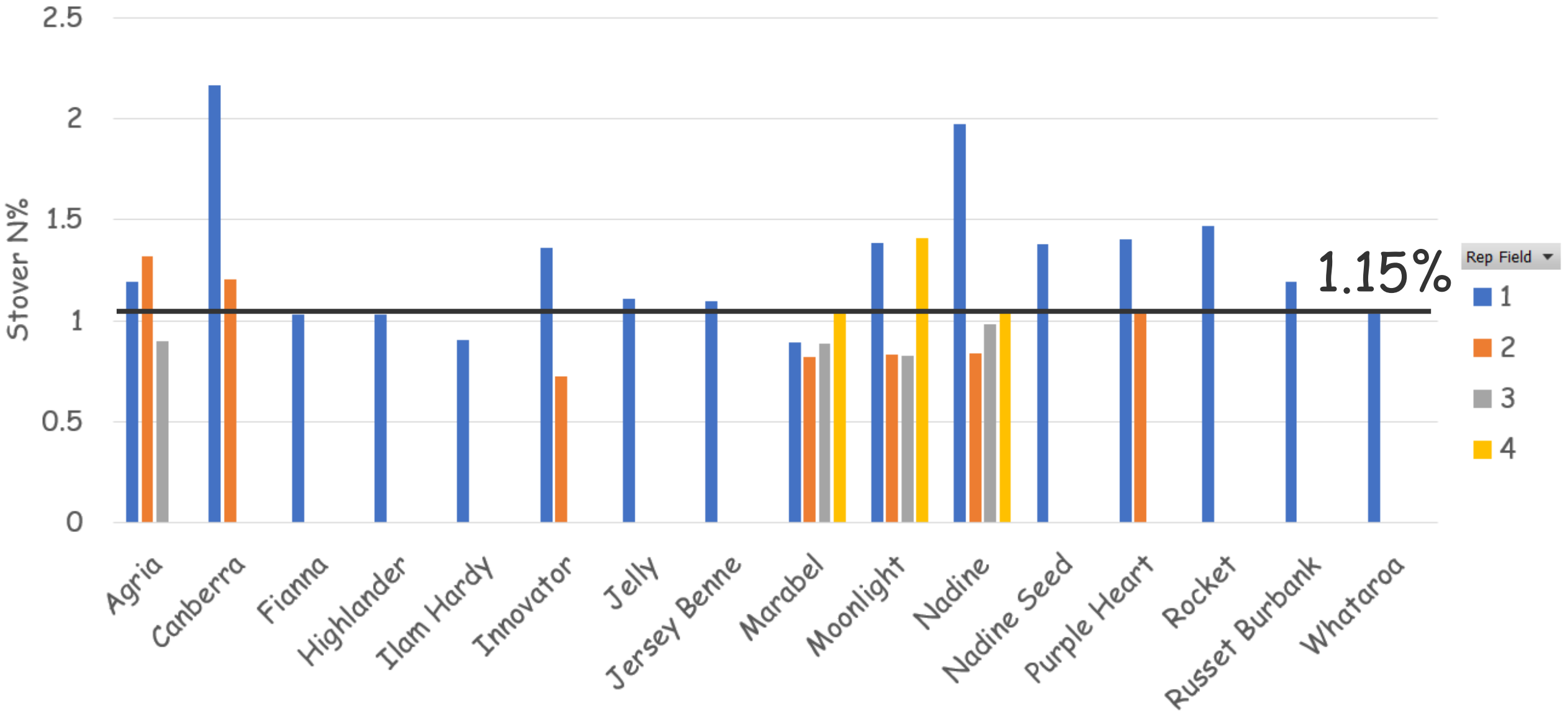
Harvest Index



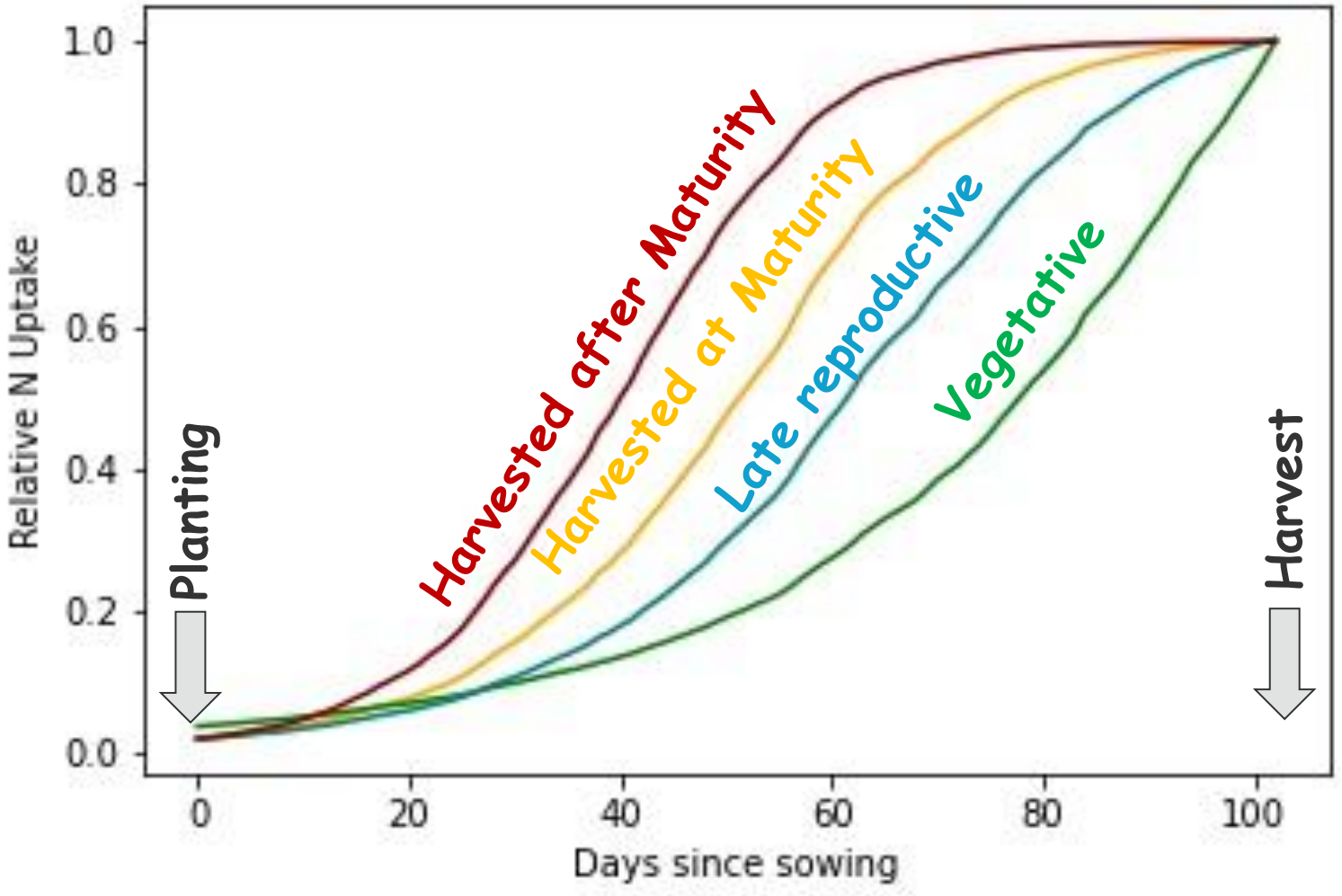
Tuber N%


2.5
2
1.5
1
0.5
0
Tuber N%
1.48%
Rep Field
1
2
3
4
Agria
Canberra
Fianna
Highlander
Ilam Hardy
Innovator
Jelly
Jersey Benne
Marabel
Moonlight
Nadine
Nadine Seed
Purple Heart
Rocket
Russet Burbank
Whataroa

Stover N%


2.5
2
1.5
1
0.5
0
Stover N%
1.15%
Rep Field
1
2
3
4
Agria
Canberra
Fianna
Highlander
Ilam Hardy
Innovator
Jelly
Jersey Benne
Marabel
Moonlight
Nadine
Nadine Seed
Purple Heart
Rocket
Russet Burbank
Whataroa

Different use classes



Longevity
Group 1 – Short haulm
Group 2 – Medium haulm
Group 3 – Long haulm
Group 4 – Very long haulm

Nitrogen Input Planning Tool

Sustainable Vegetable Systems

N-sight tool | Manage enterprises & crops

Select a nitrogen balance scenario

Back2 - Potato General - 24/08/2023

Prior Crop | Current Crop | Next Crop

Crop Grown

Crop Type: Vegetable

Crop: Potato

Variety: General

Basic Crop Info

Planting date: 15/10/2023

Growing Days: 183

Crop finish date: 15/04/2024

Population: -

Yield: 64

Unit: t/ha

Additional Crop Info

Established stage: Seed

Harvest stage: Late Repr...

Paddock loss (%): 0

Dressing loss (%): 0

Moisture content (%): 78

Residue treatment: None rem...

Residue incorporation: Full (Plough)

N fertiliser applied or planned — Add

Side dressings: 1

Date	Amount (kgN/ha)

Soil mineral N Test Results — Add

Date	Nitrogen kg N/ha(to 30 cm)

Potential Mineralisable Nitrogen

PMN test result: 0

PMN result type: PMN

Sample depth (cm): 0-30cm

Bulk density (g/mm³): 1.19

Rain & Irrigation

Amount of rain prior to planting: Typical

Amount of rain during crop: Typical

Irrigation Applied: None

Enterprise & Paddock

Enterprise: Please sel...

Paddock: Back2

Nearest weather station: Pukekohe

Soil order: Brown

Soil texture: Clay loam

Submit changes

Level: Basic — Select input level to unlock defaults

Download PDF | Download CSV

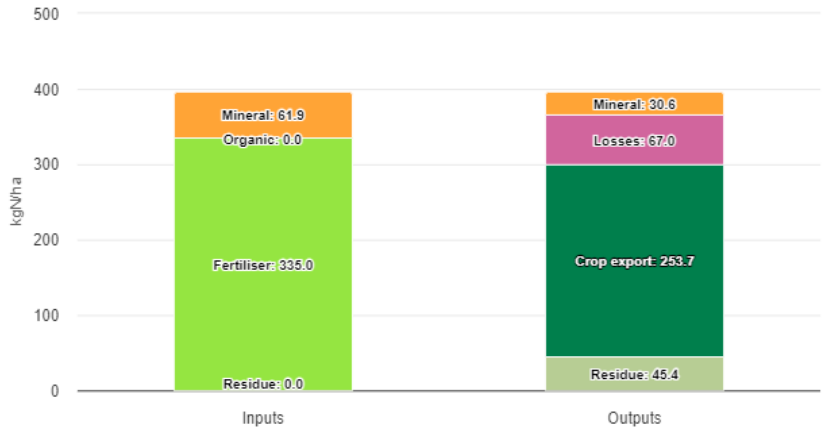
Total N fertiliser guidance: 335 (kgN/ha)

Nitrogen Schedule

Date	Amount (kgN/ha)
12/12/2023	335

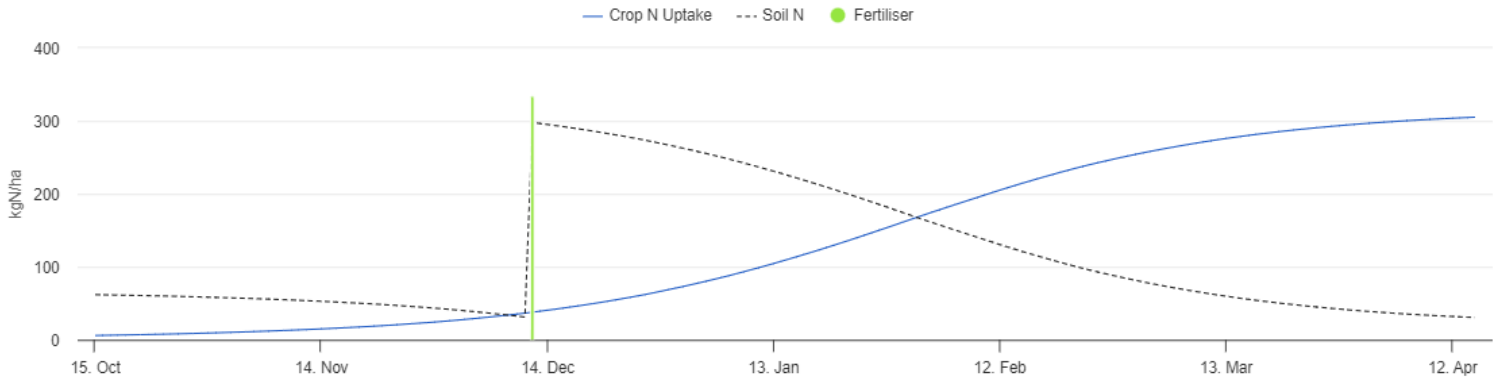
● Applied/Planned ● Recommended

Current Crop Nitrogen Balance



Current Crop N Uptake and Soil N

Displays patterns of Crop N uptake and soil mineral N content during the current crops growth period. The tool recommends an N application whenever soil N drops to 30kg/ha and aims to leave this much N in the soil when the crop is harvested.



Nitrogen Input Planning Tool

Sustainable Vegetable Systems

N-sight tool | Manage enterprises & crops

Select a nitrogen balance scenario

BackBlock - Carrot General - 17/08/2023

Prior Crop | Current Crop | Next Crop

Crop Grown

Crop Type: Vegetable

Crop: Potato

Variety: General

Basic Crop Info

Planting date: 15/10/2023

Growing Days: 183

Crop finish date: 15/04/2024

Population: -

Yield: 64

Unit: t/ha

Additional Crop Info

Established stage: Seed

Harvest stage: Late Repr...

Paddock loss (%): 0

Dressing loss (%): 0

Moisture content (%): 78

Residue treatment: None rem...

Residue incorporation: Full (Plough)

N fertiliser applied or planned + Add

Side dressings: 2

Date	Amount (kgN/ha)

Soil mineral N Test Results + Add

Date	Nitrogen kg N/ha(to 30 cm)
05/12/2023	95

Potential Mineralisable Nitrogen

PMN test result: 20

PMN result type: PMN

Sample depth (cm): 0-30cm

Bulk density (g/mm³): 1.22

Rain & Irrigation

Amount of rain prior to planting: Typical

Amount of rain during crop: Typical

Irrigation Applied: None

Enterprise & Paddock

Enterprise: Please sel...

Paddock: BackBlock

Nearest weather station: Pukekohe

Soil order: Brown

Soil texture: Clay

Submit changes

Level: Crop Rotation | Select input level to unlock defaults | Download PDF | Download CSV

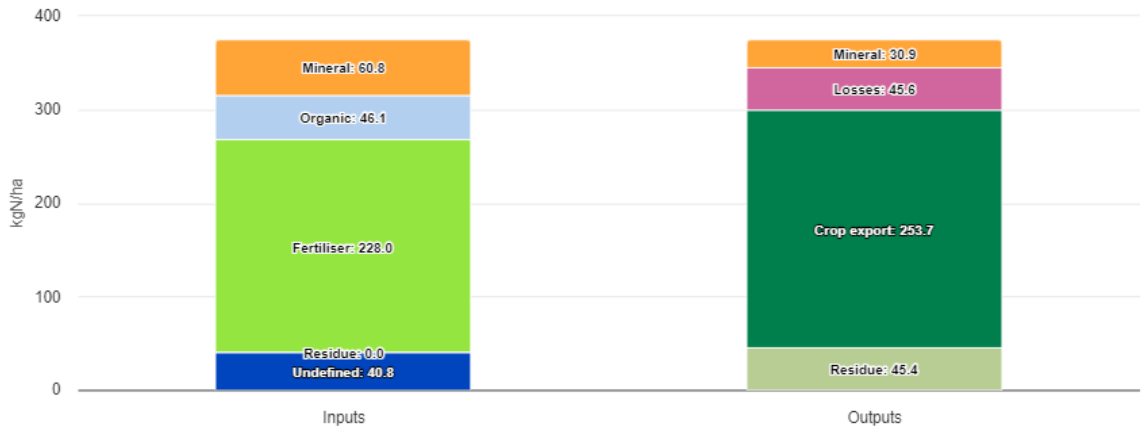
Total N fertiliser guidance: 228 (kgN/ha)

Nitrogen Schedule

Date	Amount (kgN/ha)
14/01/2024	114
12/02/2024	114

● Applied/Planned ● Recommended

Current Crop Nitrogen Balance



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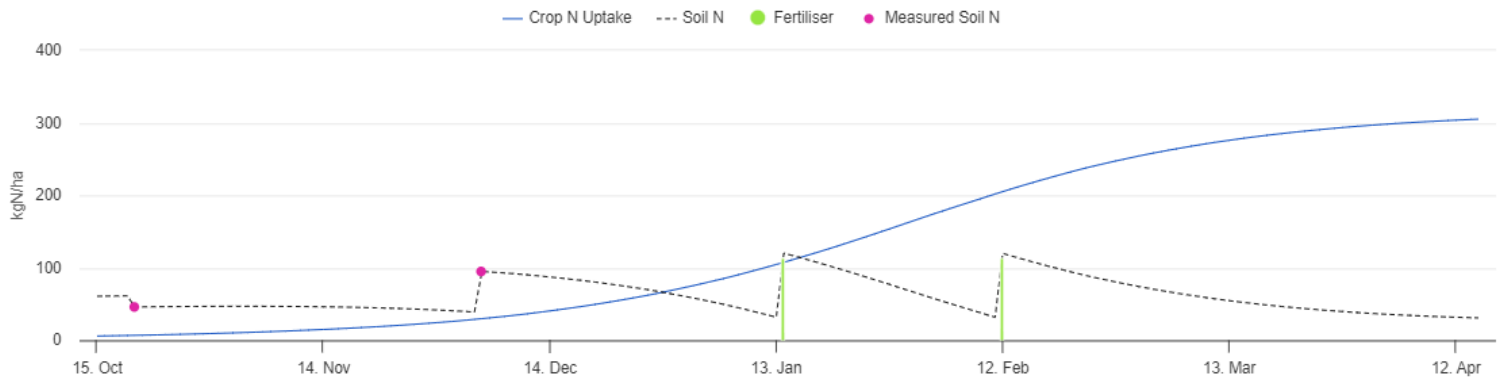


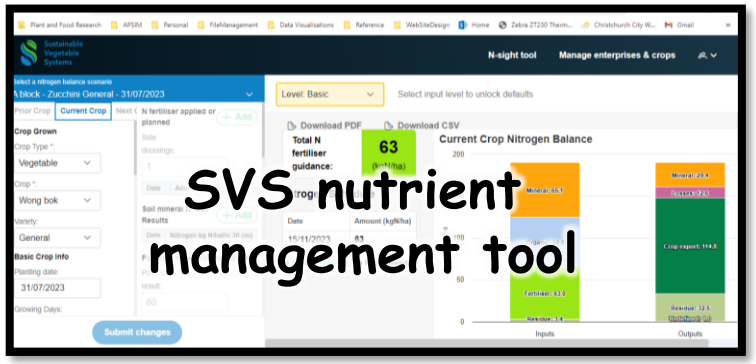
Soil test results

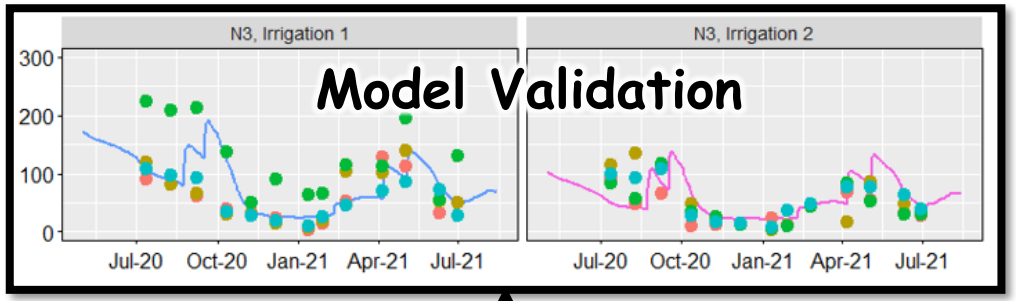
Crop Information

Fertiliser Requirements Estimated

Fertiliser timing and amount match crop requirements

Lit review





APSIM
AGRICULTURAL PRODUCTION SYSTEMS SIMULATOR

Process abstraction

Process model testing

Testing System

N balance improvement
Leaching, Gaseous losses,
Residues, scheduling, coeffs

Configuration

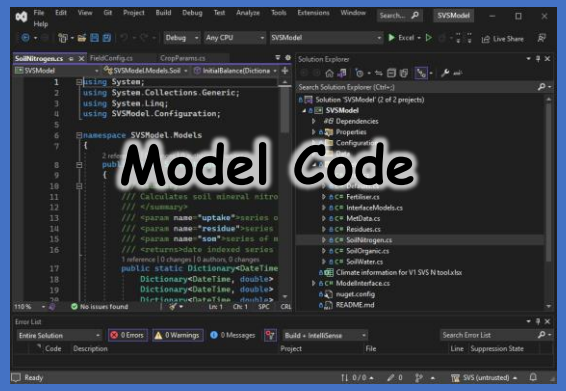
Nitrogen balance

Evaluate

Coefficients

Pull request

Data analysis



Test data

API

NuGet

Plant & Food Research
Rangahau Ahumāra Kai

Thank you

Plant & Food Research
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Thank you

A smart green future. Together.

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