Optimising Nitrogen Inputs for Cereals

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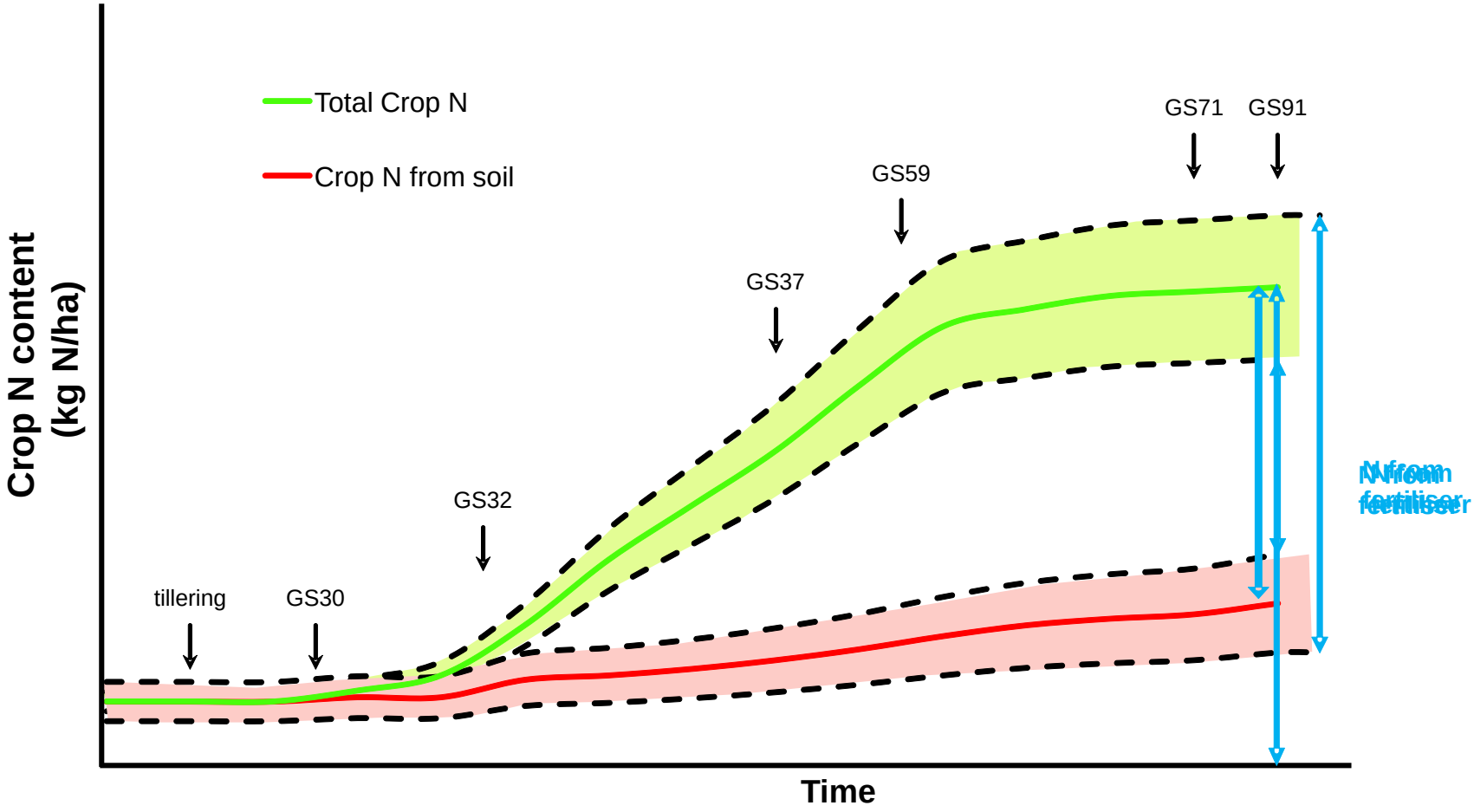
Outline

- Background
- Conceptual framework
- Nitrogen rates
- Splitting and timing
- Fertiliser N types

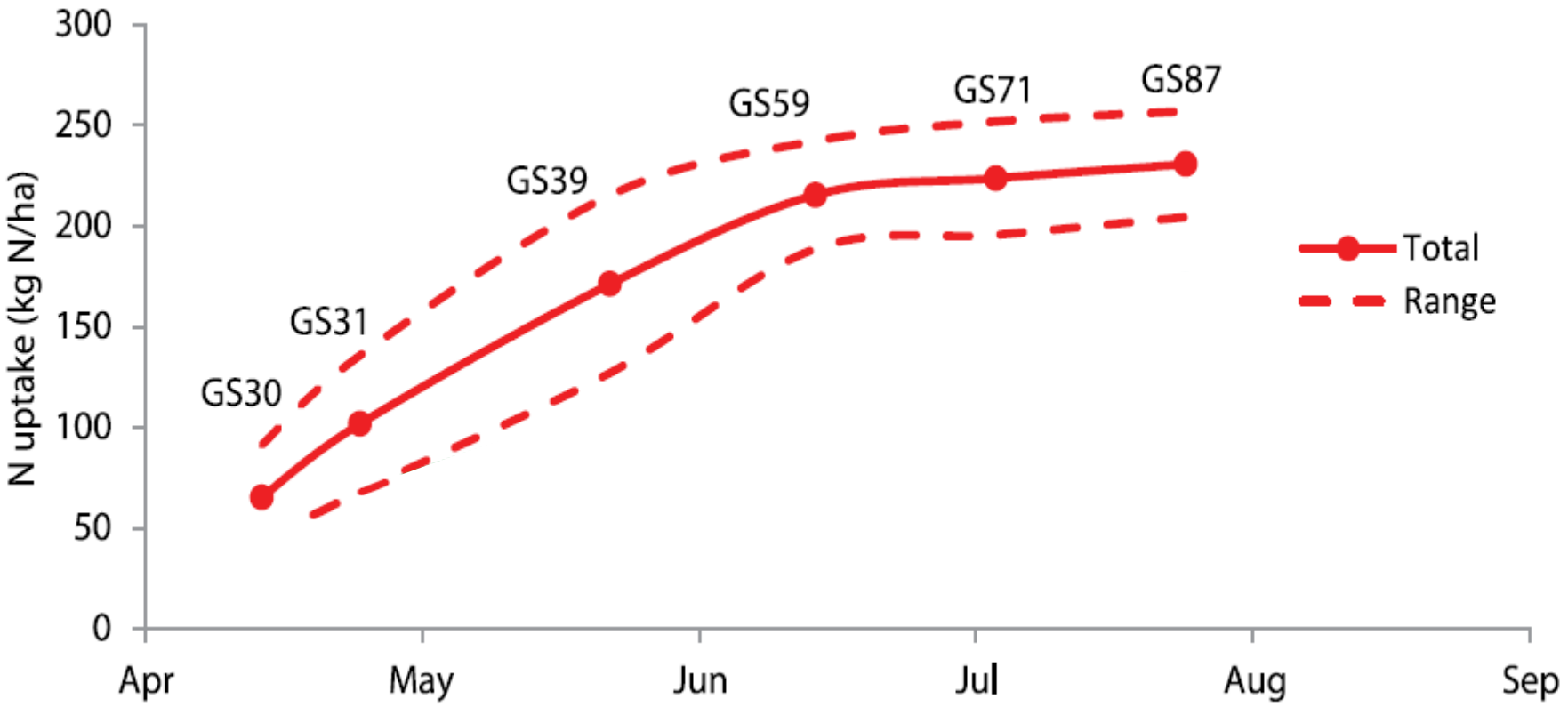
Background

- Nitrogen a large cost in cereal production
- Nitrogen has potential to cause environmental issues
  - Leaching
  - GHG emissions
- Agronomic efficiency will help minimise environmental impact
- Nitrogen often gives bigger visual effects than economic effects
- Grower decisions revolve around
  - Rate
  - Timing
  - Fertiliser type

Seasonal pattern of N uptake by a cereal crop



N uptake by winter wheat crops



Source: Winter wheat guide

Fertiliser N requirement

- Fertiliser N requirement = $\frac{\text{Crop N demand – soil N supply}}{\text{\% recovery of fertiliser}}$

- Predicting Crop N demand
  - Yield and N demand not a straightforward relationship
  - historic yields incorporate site and management effects – no seasonal effect
  - Future use of sensors/crop models

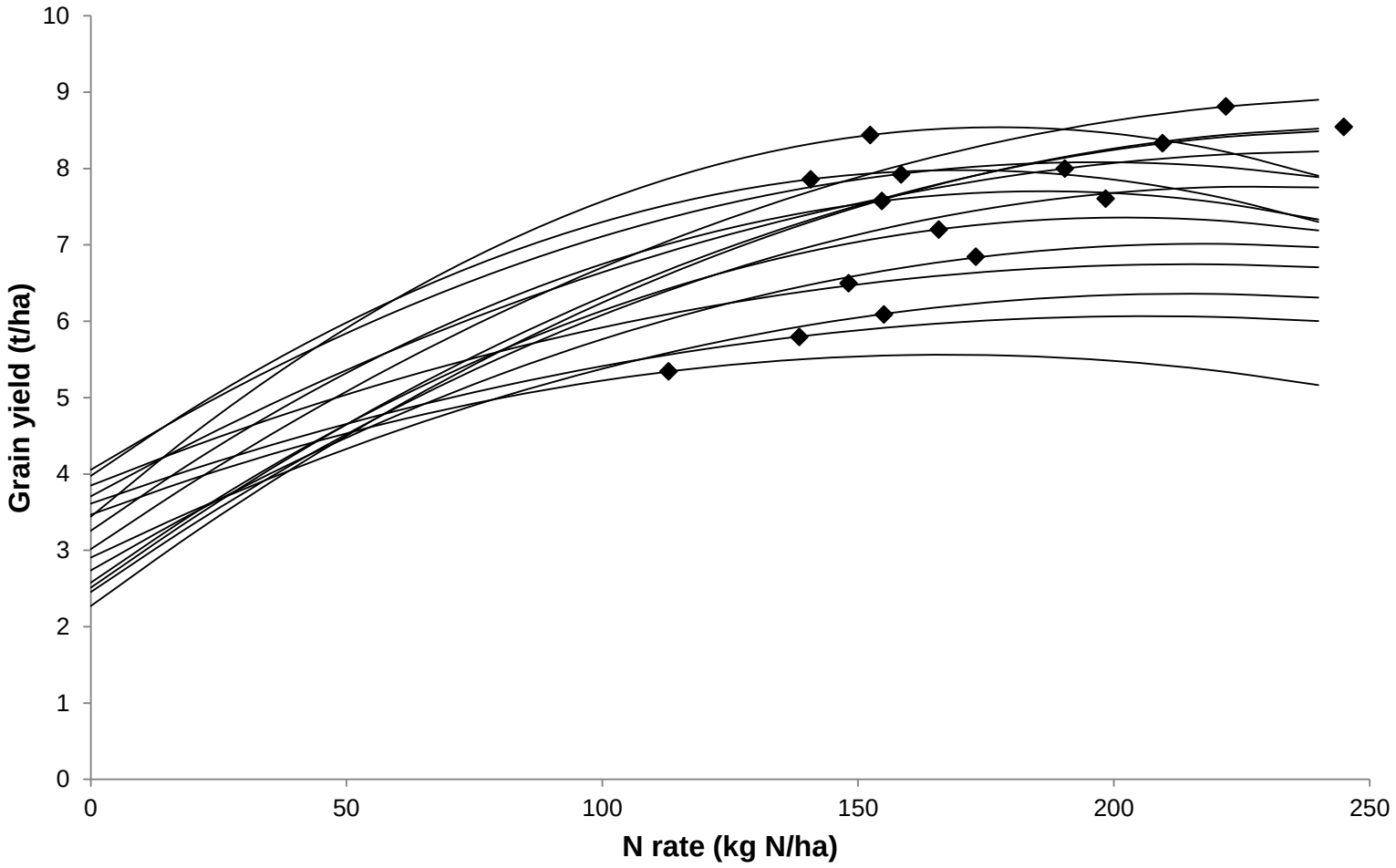
- Predicting Soil N supply
  - Soil N index
  - crude indicator – not very site specific
  - Soil measurement could help but expensive/ laborious

- Predicting % recovery fertiliser N
  - No reliable prediction
  - Use standard value?

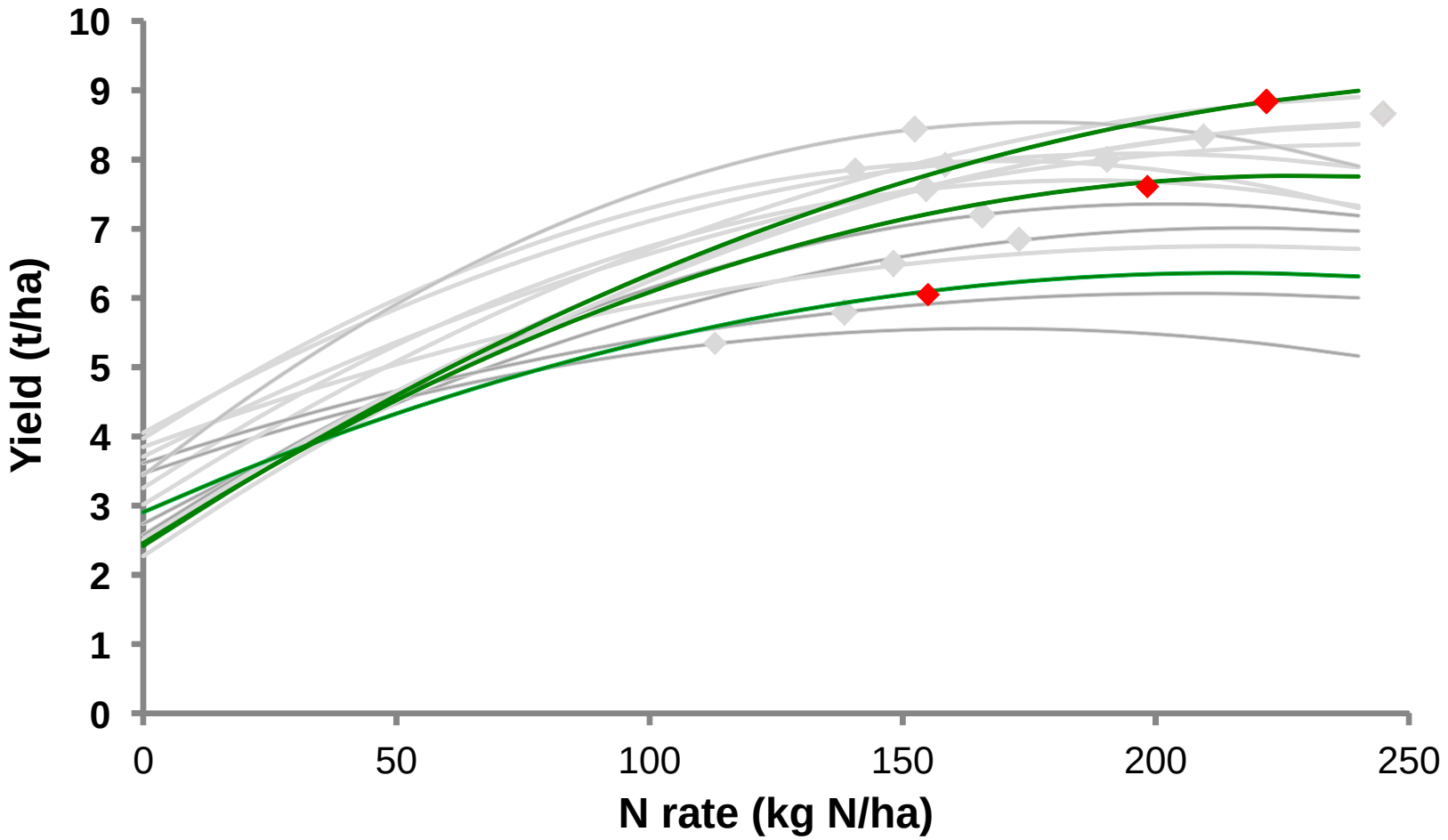
Determining N rates

- Current Irish recommendations based on empirical approach
- Series of N response trials at representative sites
- Calculate rate that maximises return on fertiliser investment
- Use average rate with adjustment for yield and soil N supply

Effect of N rate on spring barley yield



Effect of N rate on spring barley yield – same site over years



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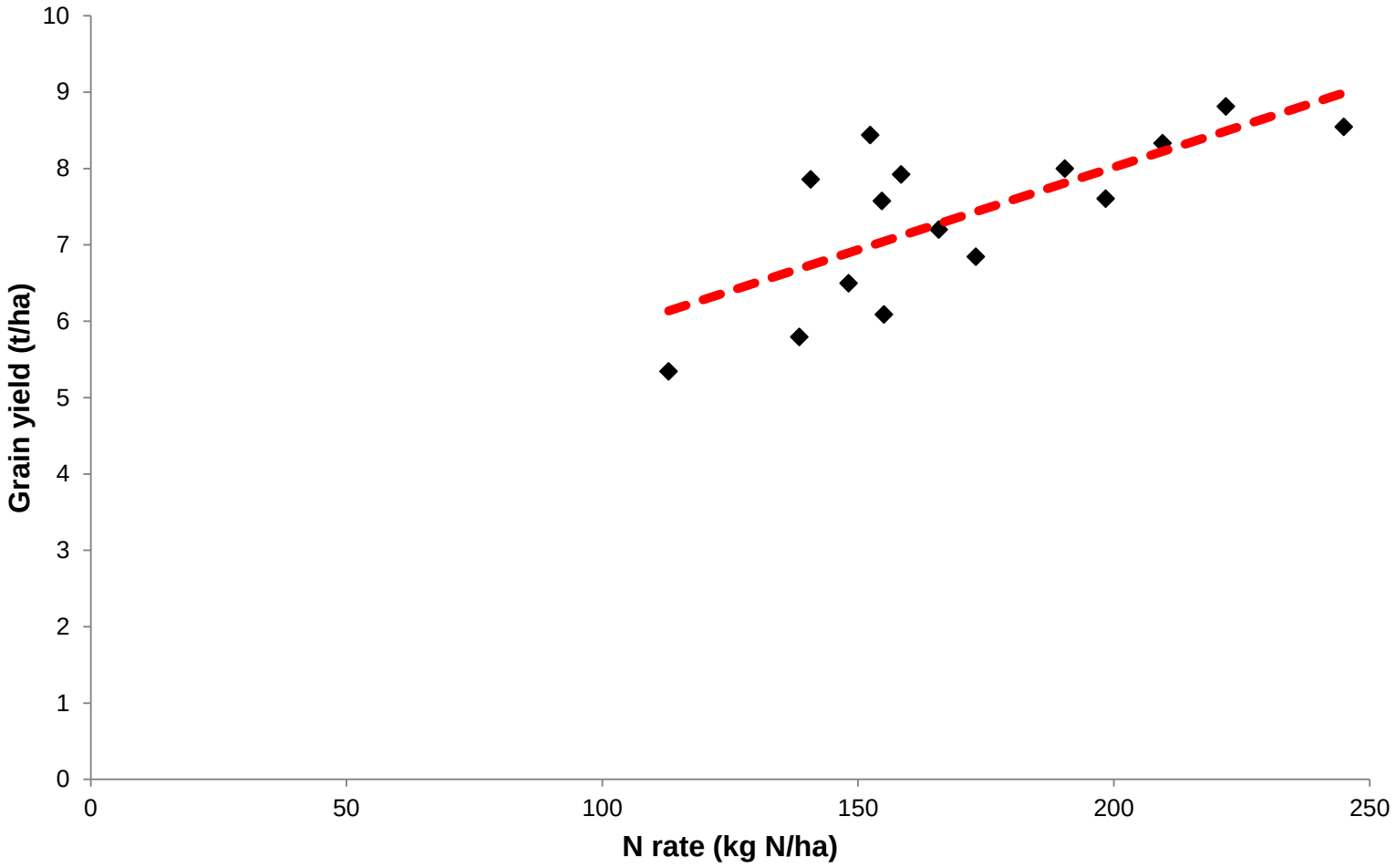

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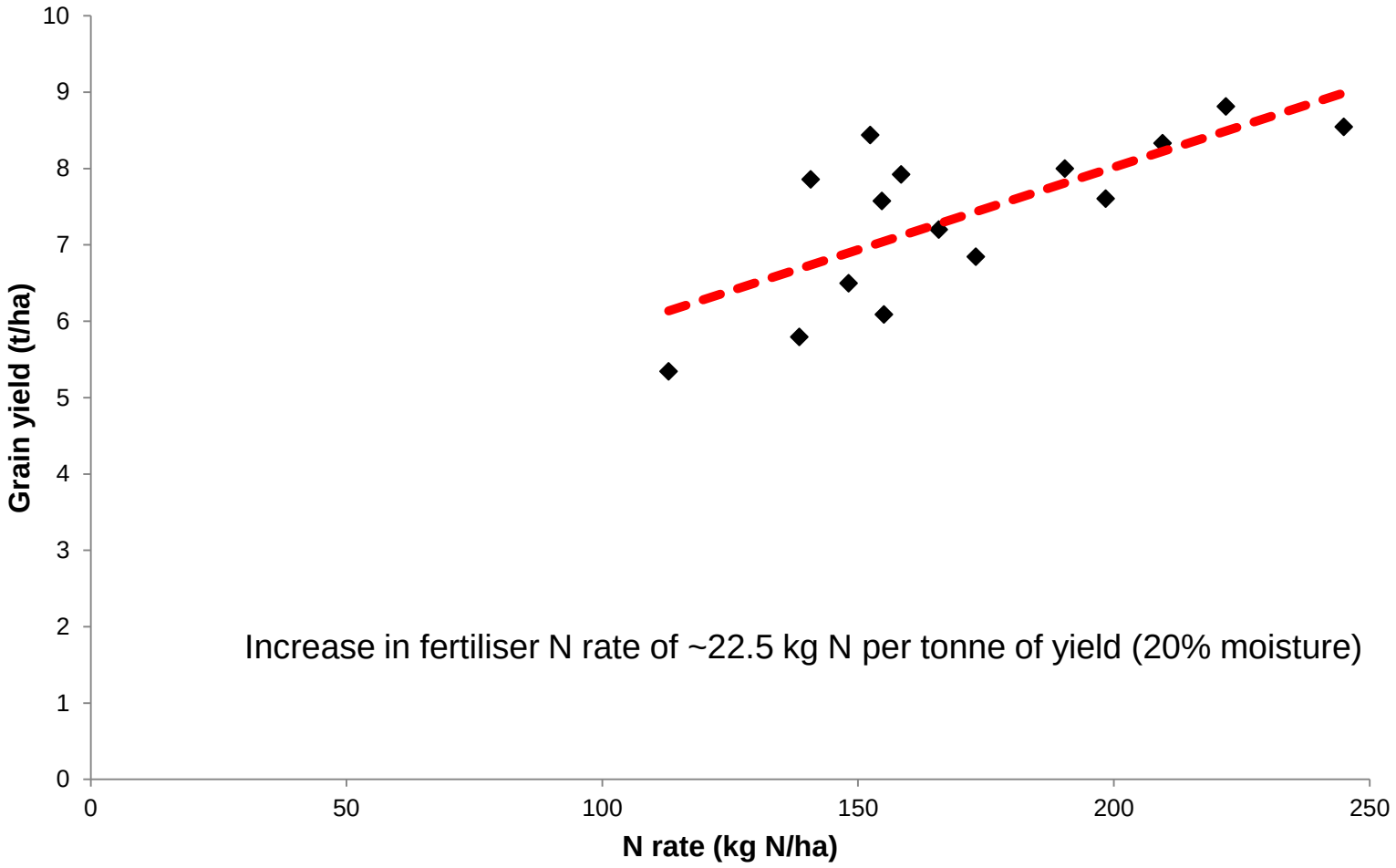
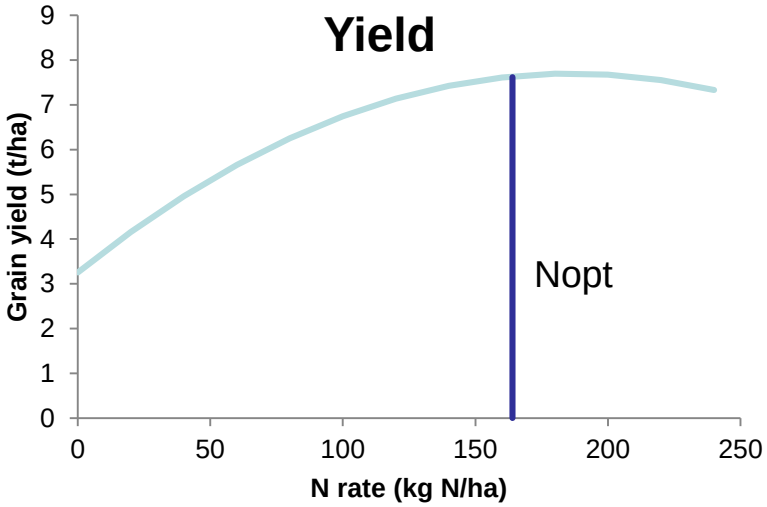
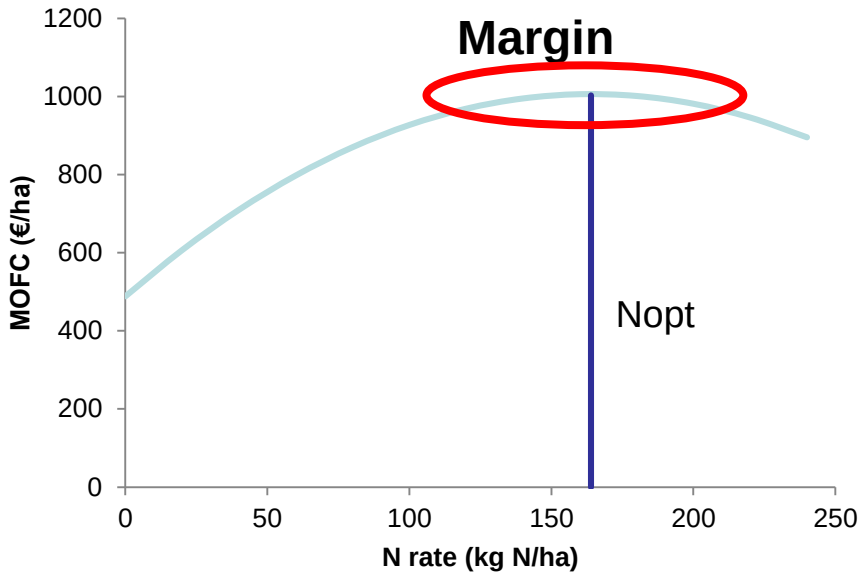


How accurate do we need to be?



Small errors around optimum have only small economic effect



N rates

- Optimum N is very variable and difficult to predict
- Taking Soil N Supply and Yield into account is important
- Small errors are not very economically significant

Timing of N

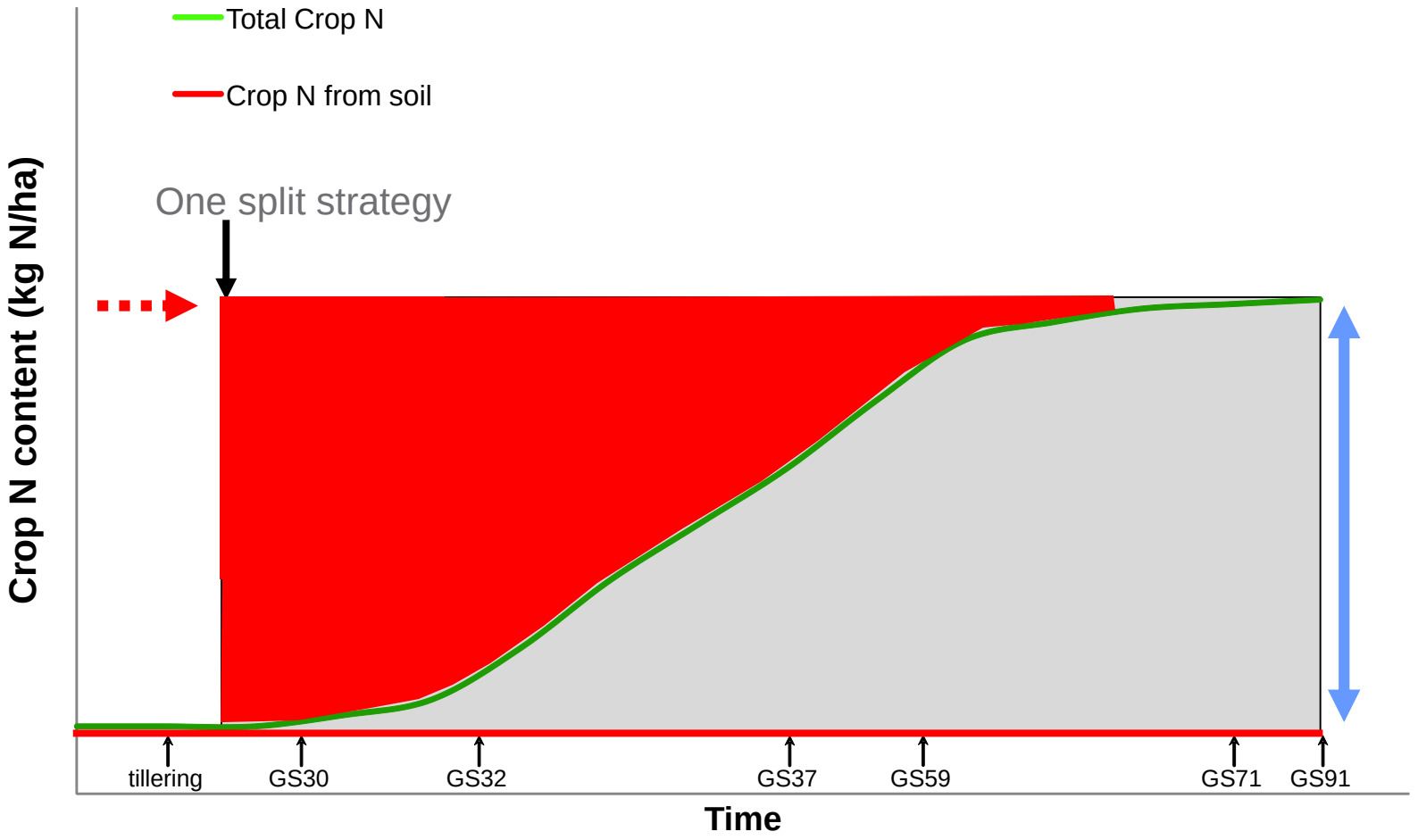
Objective

- Ensure sufficient N present to meet crops demand through season

But……

- Available N in soil can be subject to loss and/or lock-up
- Try to avoid large excesses for long periods

Seasonal pattern of N uptake by a cereal crop



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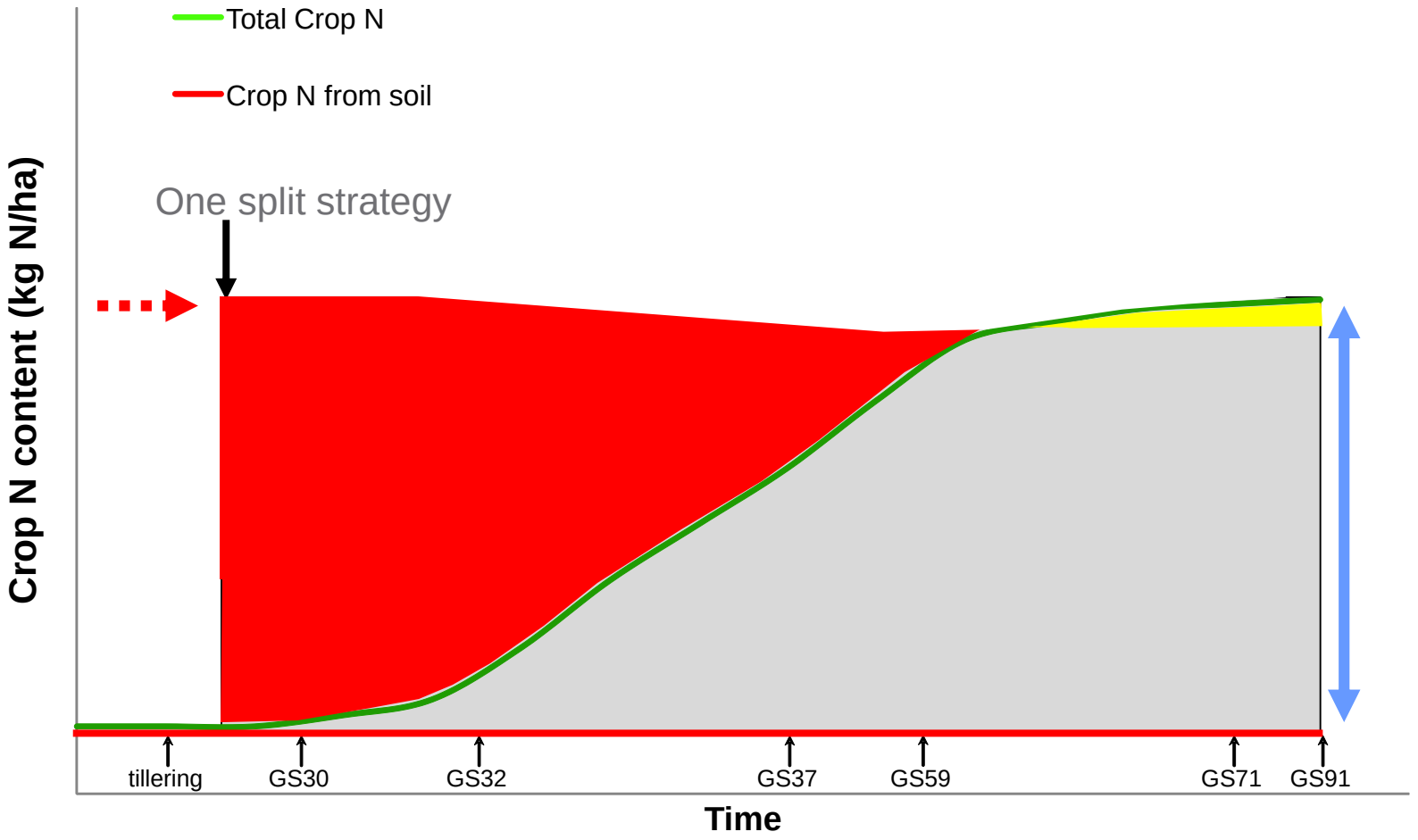

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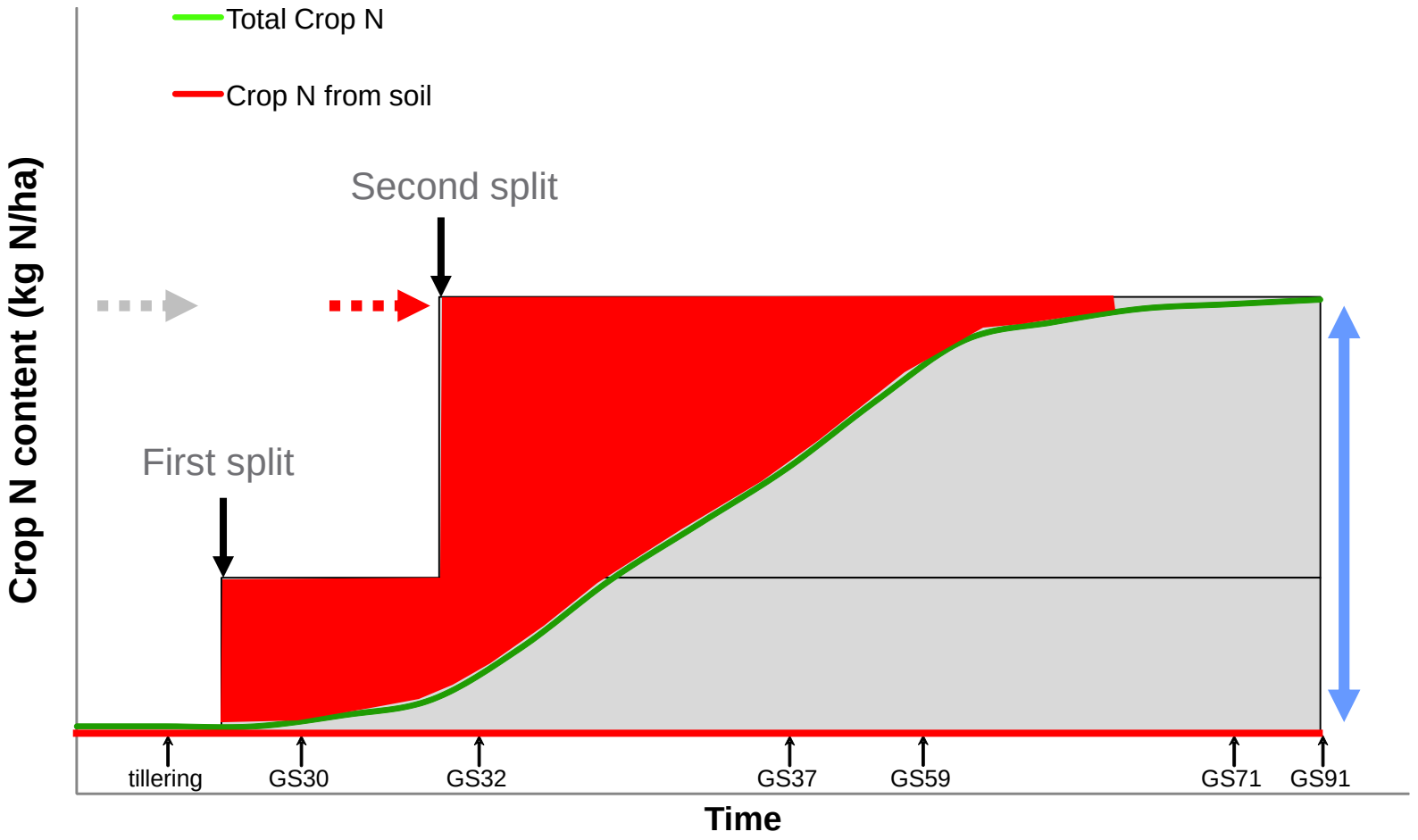

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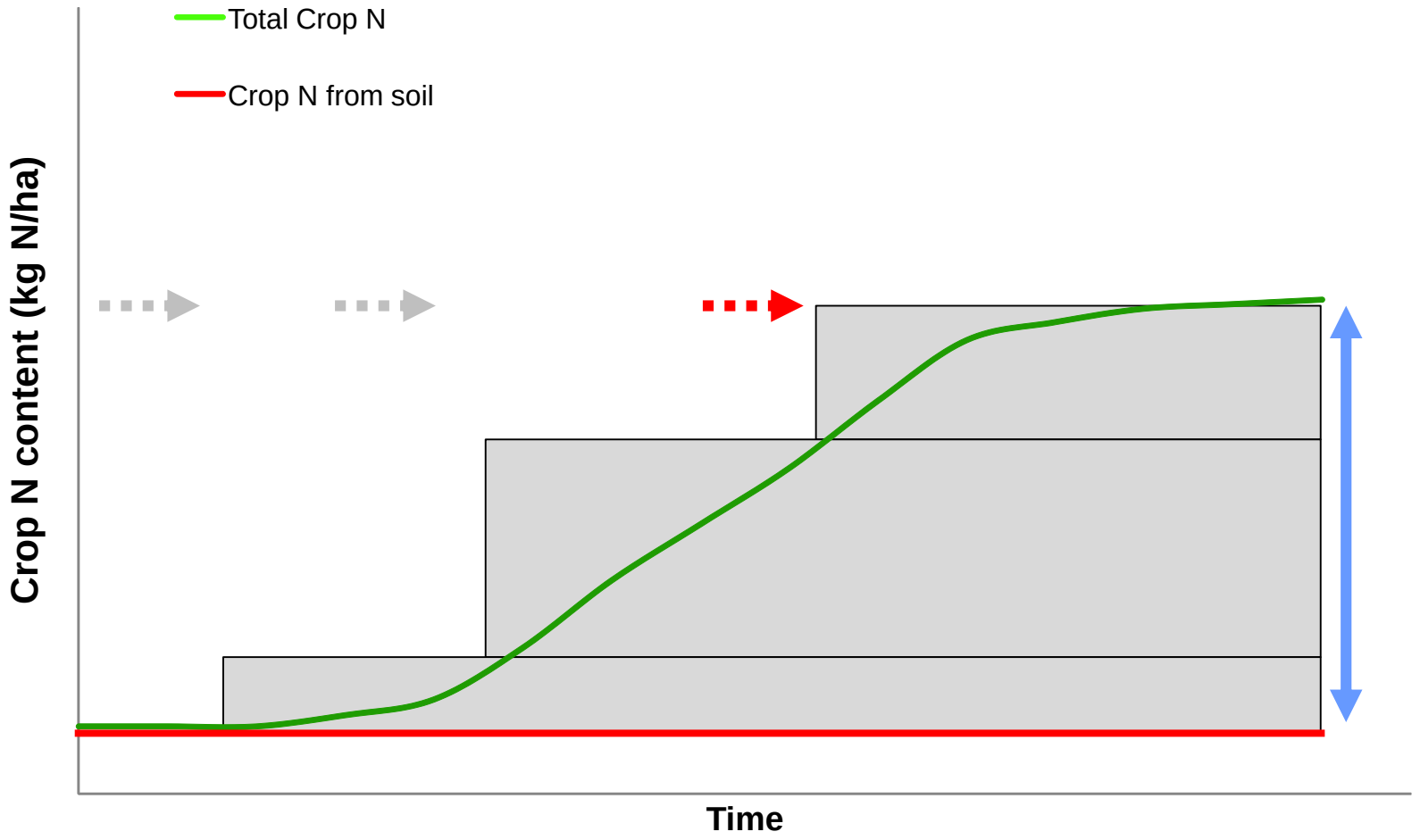
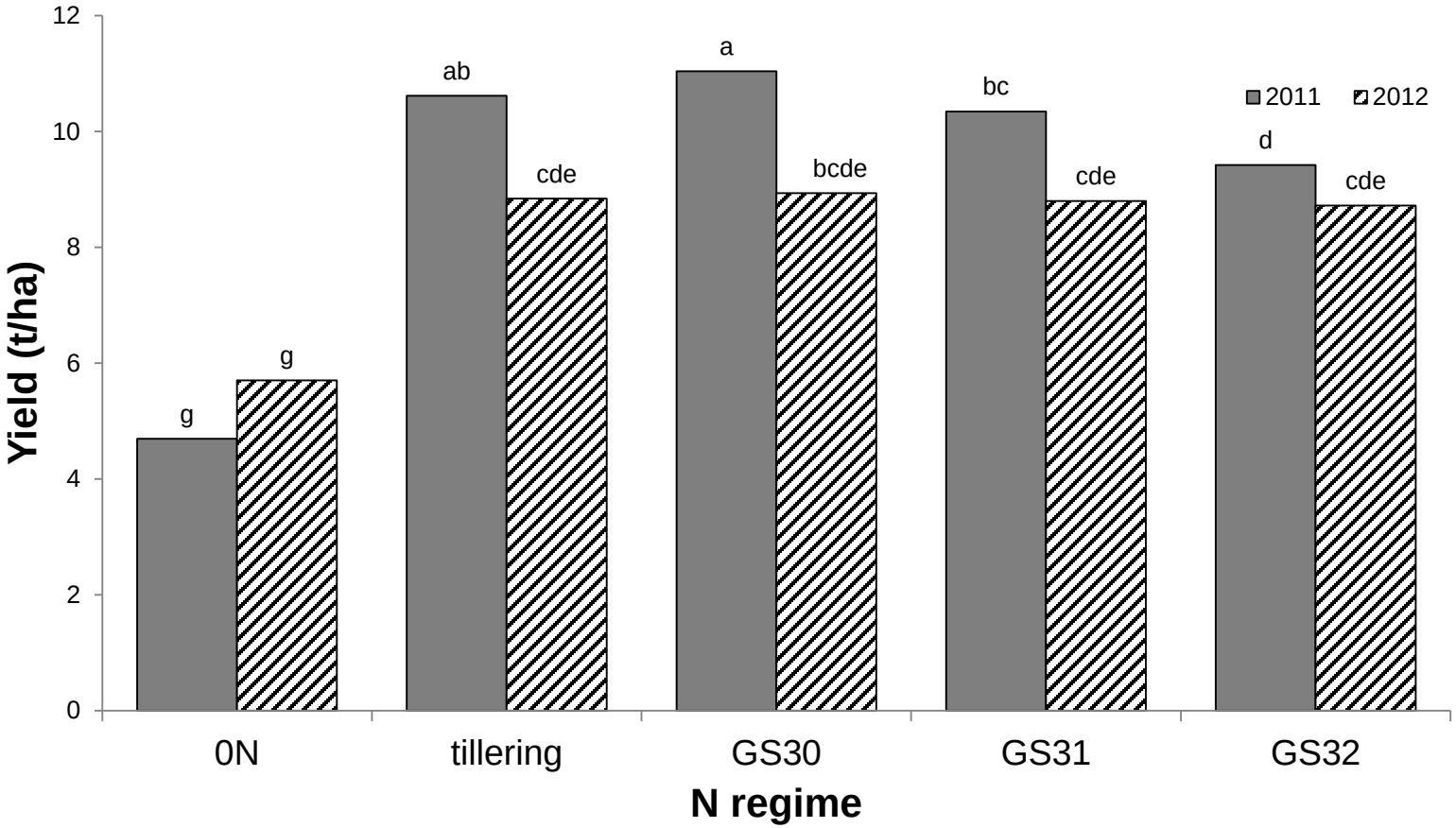


Winter wheat – recent work

- Does timing of first N affect yield?
  - First split applied at
    - tillering,
    - GS30,
    - GS31,
    - GS32
  - Same total amount applied to all treatments

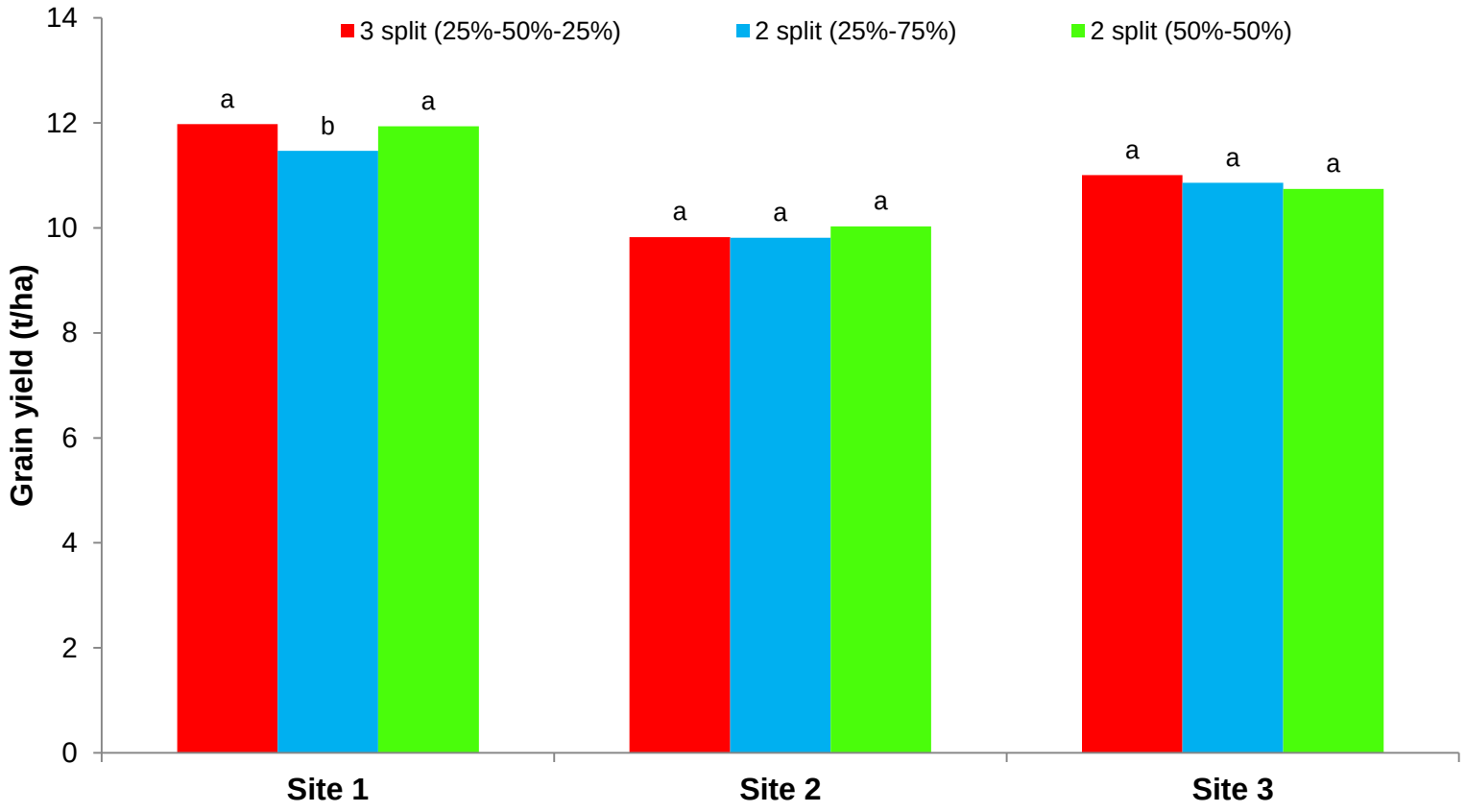
- Does number and size of splits affect yield?
  - Two or three split strategies compared
    - 25%:75%
    - 50%:50%
    - 25%:50%:25%
  - Each at a range of N rates

Effect of first N timing on winter wheat



Efretuei *et al*. 2016

Effect of splitting on N response in winter wheat



Effect of splitting on N response in winter wheat

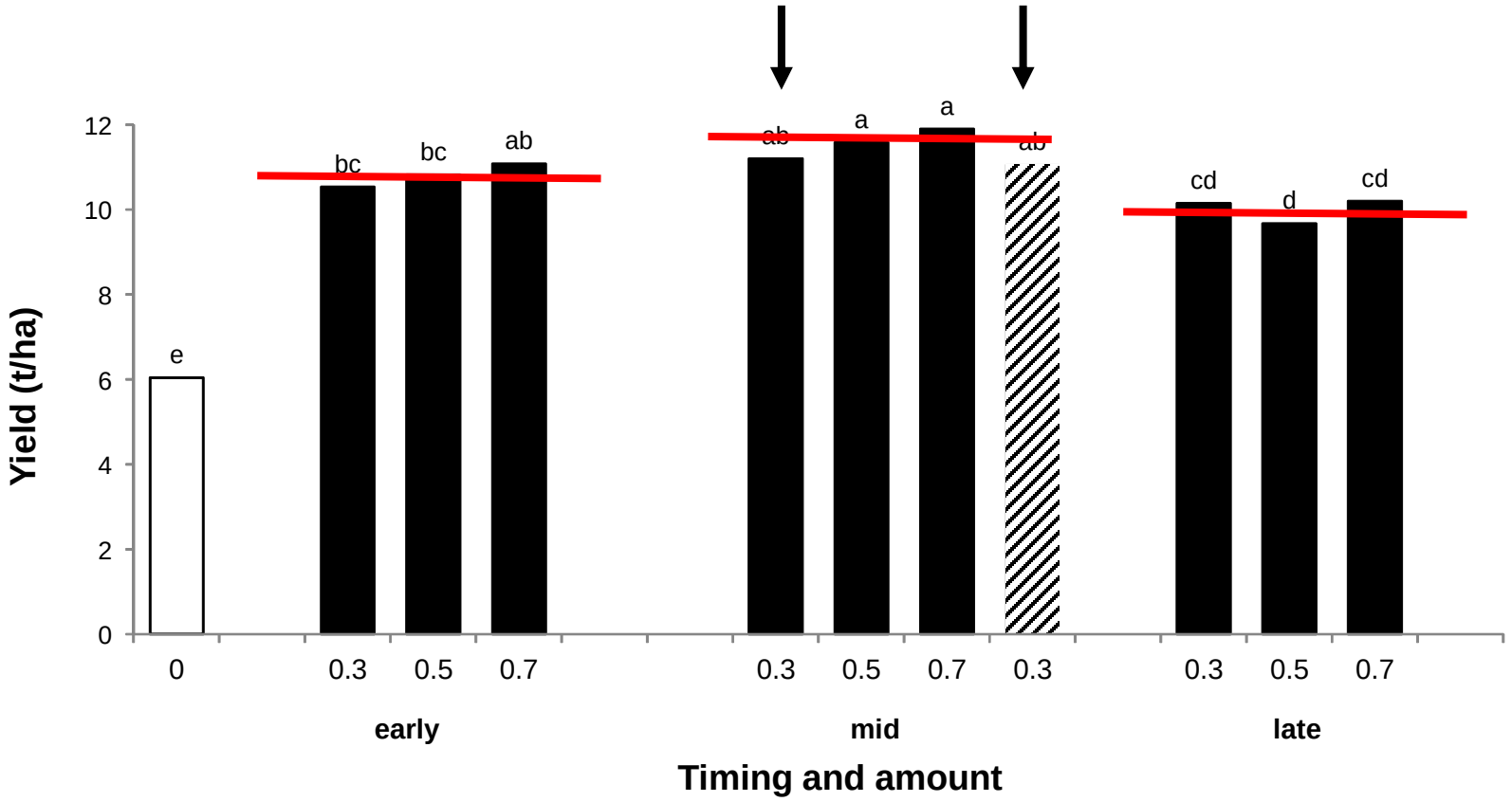
- Number and relative size of splits not very critical
- Large splits mean nitrogen is in soil for longer
  - Vulnerable to loss and/or lock-up
- Third splits
  - Reduce risk of loss
  - Avoid large second splits
  - Offer potential to fine-tune N inputs based on crop growth – precision ag
  - Should be considered where in excess of 150 kg N/ha is being applied

Winter barley nitrogen - recent work

- UK work indicated more N in first split advantageous
- French work suggested small benefit of delaying first N
- What about Ireland?
- 3 timings of first N
    - Early - Late Feb/early March
    - Mid – mid-March
    - Late – Late March/early April
- 3 proportions of total in first split
    - 30%
    - 50%
    - 70%
- 2 split vs 3 split strategy

Timing of first N on winter barley

2015 (medium soil)



N management in winter barley

- No yield advantage to very early N applications in winter barley
  - Usually no yield loss either – grower has flexibility
  - Aim to have first split on by GS30 (but not before late Feb)
  - Avoid large early splits – no benefit to >30%
  - Aim to have at least ~ 75% of total on at GS 31 (ie total of 1st and 2nd split)

- No yield benefit of third split in trials but
  - Reduces risk of loss
  - Avoids large second splits
  - Offers potential to fine-tune N inputs based on crop growth – precision ag
  - Should be considered where in excess of 150 kg N/ha is being applied

- Apply 3rd split between GS32 and GS37

Fertiliser type – CAN vs urea

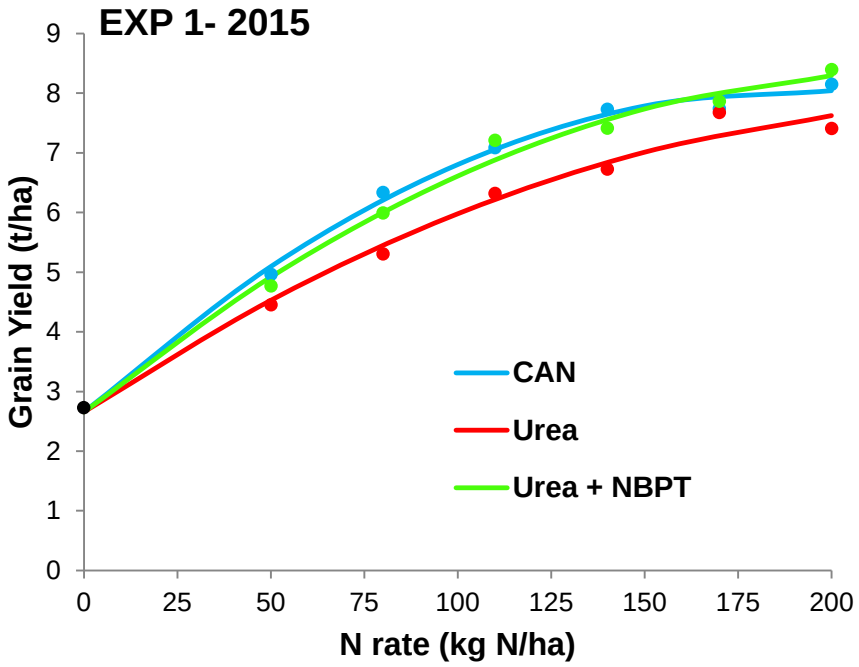
- CAN – the predominant form in Ireland for arable crops
- Urea – less common, particularly on arable crops

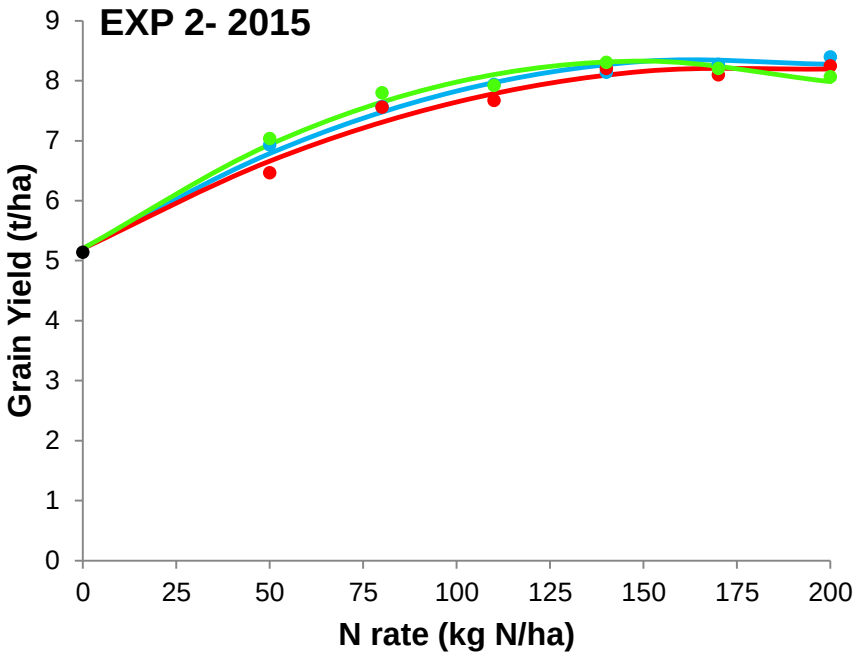
- Urea advantages
  - Lower cost per unit N
  - More concentrated form of N fertiliser

- Urea disadvantages
  - Lower density than CAN – more difficult to spread evenly at wide bout widths
    - Careful set-up of machine required
    - Urea blends require particular attention
  - Potential loss of N via volatilisation
    - Risk of loss higher at high pH, drying conditions
    - Stabilised (NBPT treated) urea negates risk

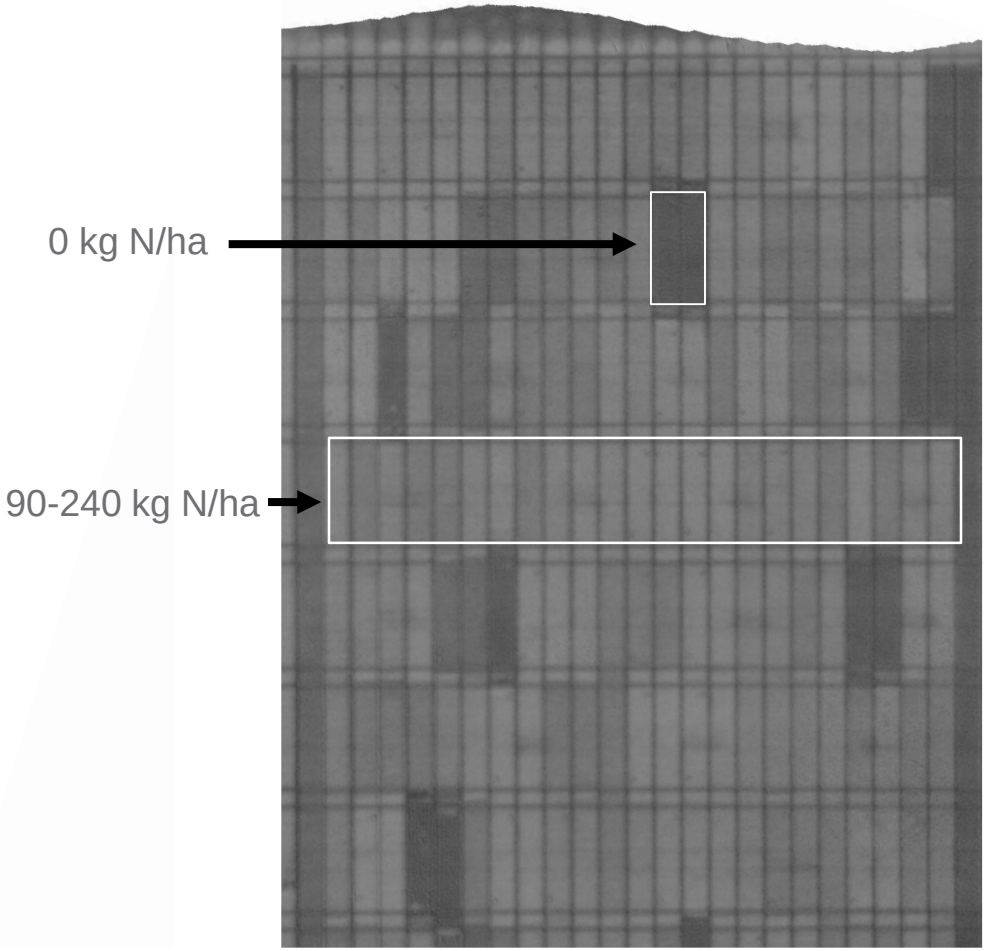
Comparison of CAN, urea and stabilised urea on spring barley

Most common scenario





Future directions – crop requirement



Potential for reflectance sensor data to guide N Inputs

Can be satellite, drone or tractor mounted

Need robust algorithms that work in Irish conditions

Likely to be only of use for late season applications

Teagasc
Agriculture and Food Development Authority

Future directions – soil N supply

- Better prediction of SNS needed
- Further evaluation of mineral N measurements required
  - Could regional measurements be useful?
  - Can a robust and reliable soil sensor be designed?
  - Potential of unfertilised areas within crops?

Summary

- Estimating crop requirement is difficult
- Estimating soil N supply is difficult
- Precise estimation of fertiliser N requirement is difficult
- Empirical work indicates N allowances for crops are satisfactory
- Timing/splitting of nitrogen for cereals is flexible