Using Nitrogen as a tool for building optimal cereal crops for high yields and the right quality

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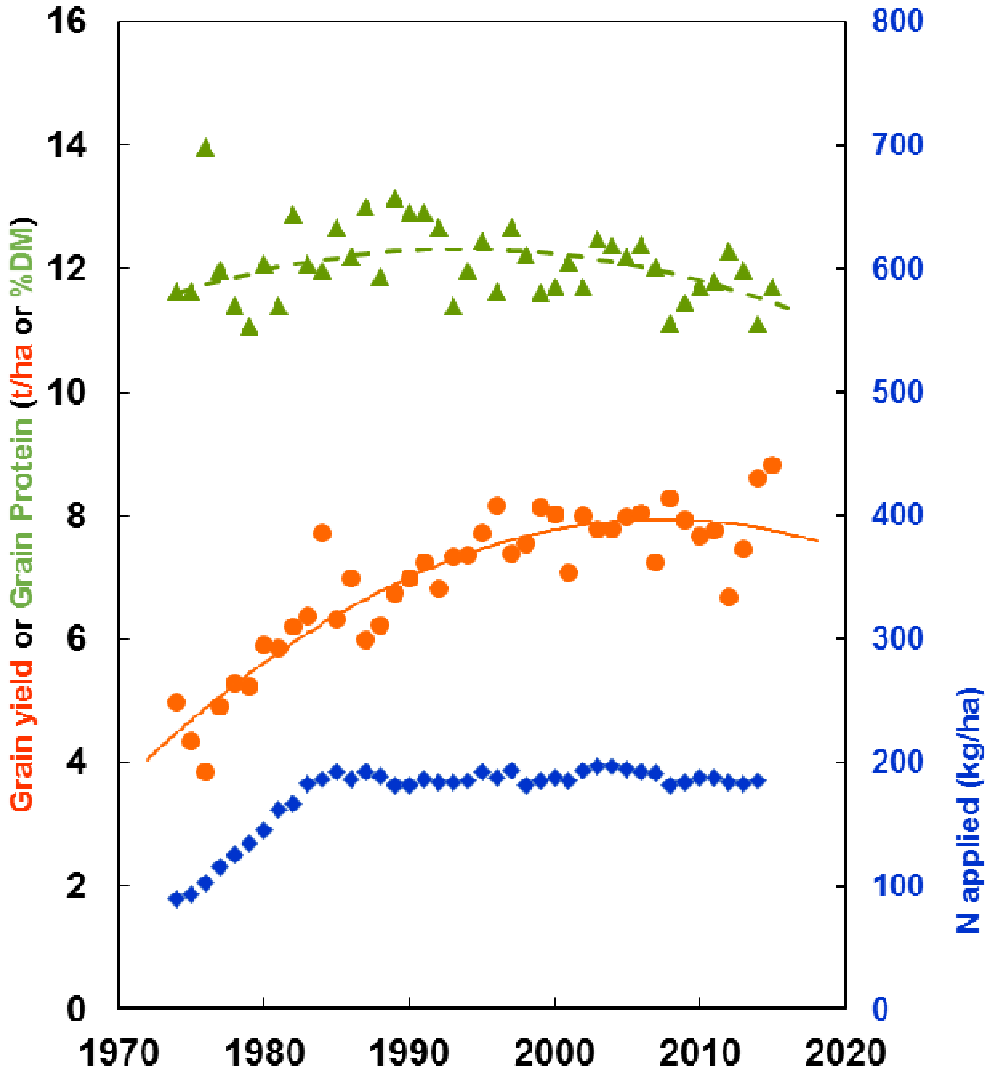
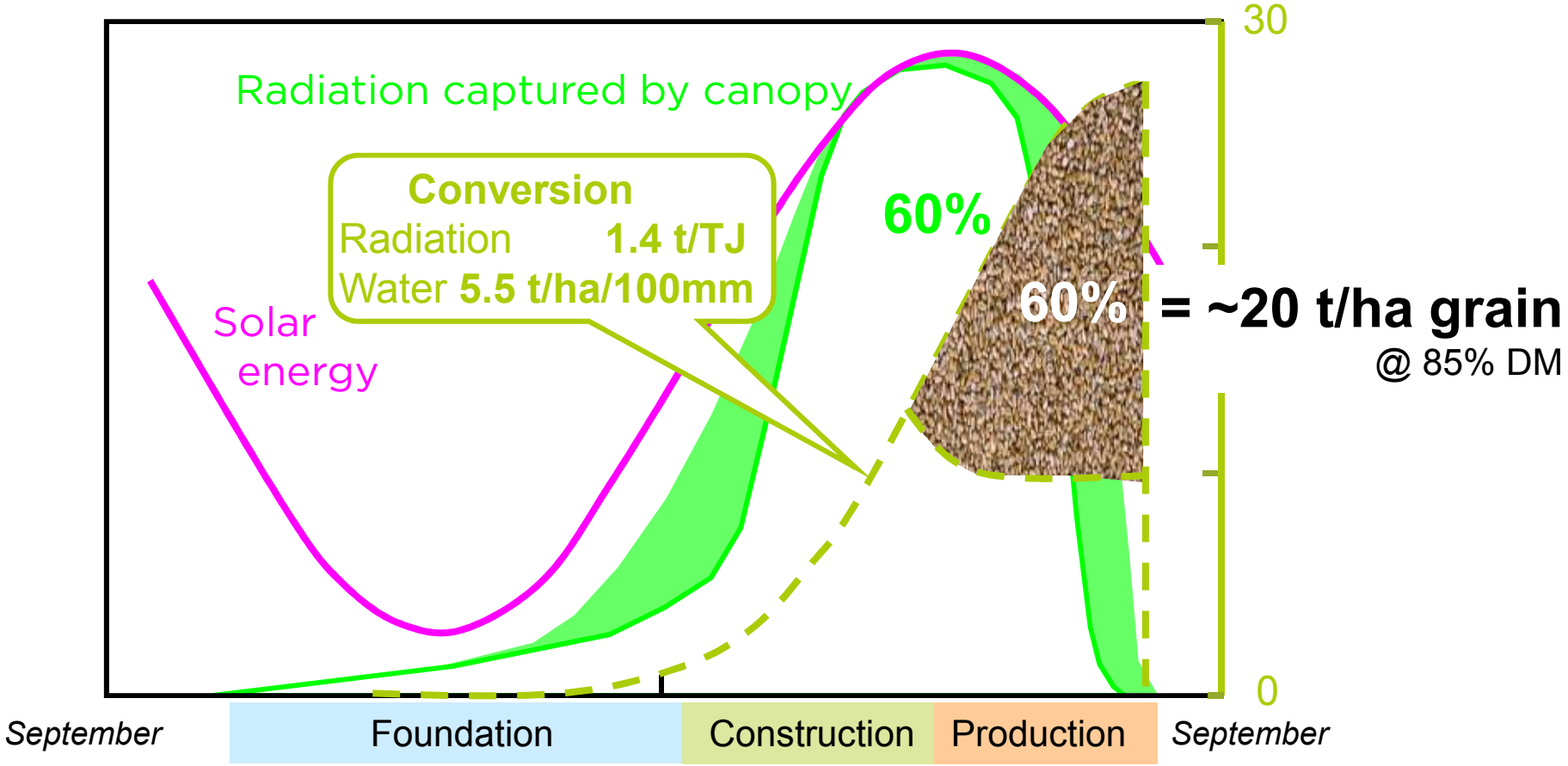
UK Wheat yield & N rates



Estimating *bio-physical potential* cereal yields

… based on *Yields of Farmed Species* (2005) Chapter 11: 'Wheat'



NEW World Record Yield*, 2015

- **Grain cv. Reflection** **16.5 t/ha**
  - @ 15% MC & 11.5% protein
  - Grain N 'offtake' 282 kg/ha
- **Incident Solar Radiation:** **36 TJ/ha**
- **Summer Water Supply:** **470 mm**
  - 200 mm summer rain
  - 270 mm soil water
- **Nitrogen Fertiliser:** **330 kg/ha**
  - plus soil N (after OSR)
- **ESTIMATED POTENTIAL** **21.0 t/ha**

Yield achieved : 79% of potential

Tim Lamyman, Worlaby, near Louth, Lincs, UK

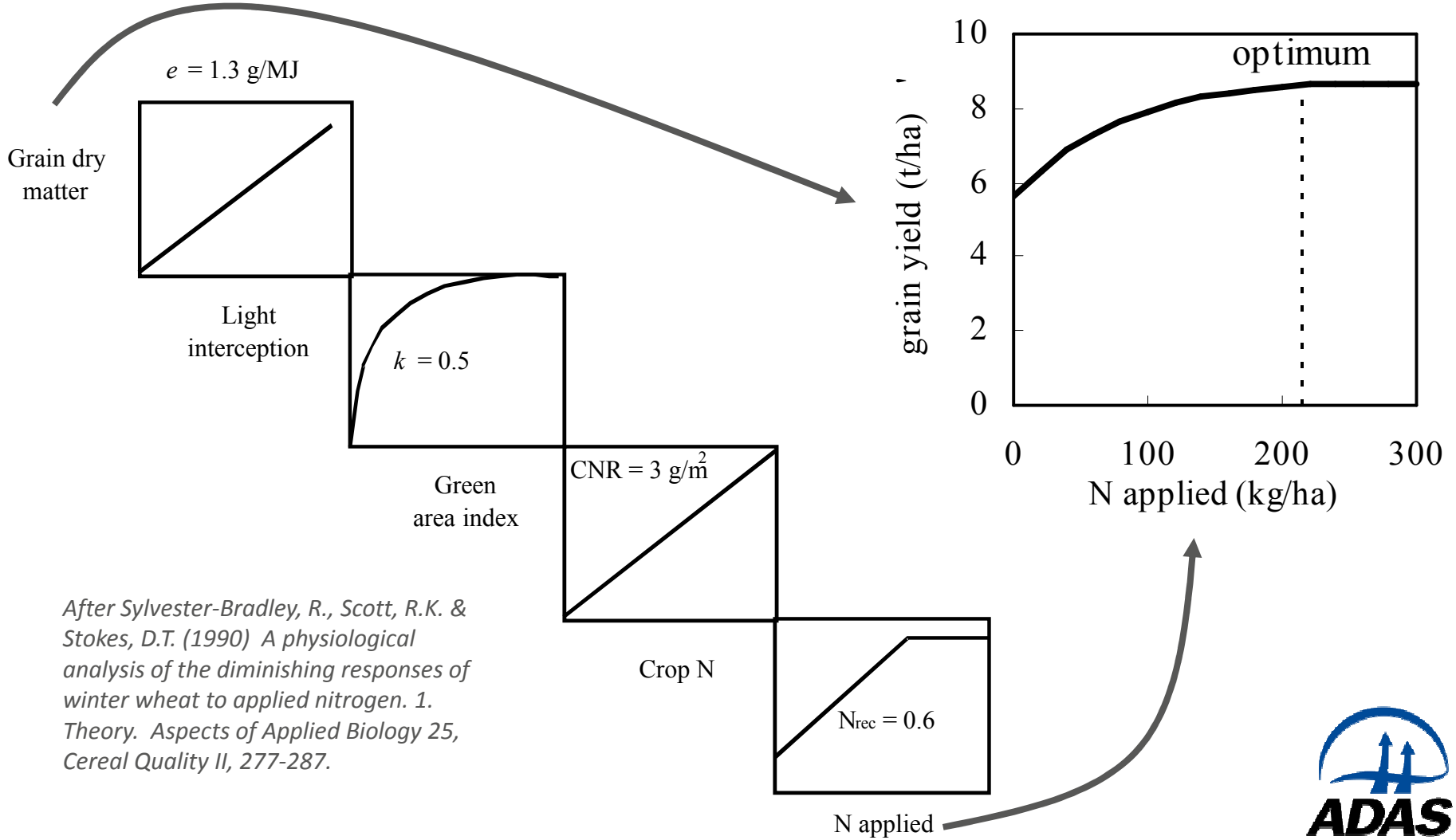
* Whether this or a very similar yield by Rod Smith, Beal Farm, Haggerston, Northumberland will be accepted by the Guinness Book of Records remains to be seen.

Tim Lamyman, Louth, Lincs.

Sponsored by Hutchinsons

	Bench-mark	***Entry***
Ears / m^2	*460*	**711**
Grains / ear	*48*	**49**
TGW @ 15% MC	*50*	**47**
Sp Wt, kg/hl	*NA*	**81**
Grain protein %	*11.6*	**11.5**
Biomass, t/ha	*18.4*	**26.2**
Harvest Index	*51%*	**54%**
N 'uptake', kg/ha	*279*	**282**
Yield, t/ha (rank)	*11.0*	**16.5 (1st)**
Yield % Potential		**79% (2nd)**

Theory of Crop N requirement

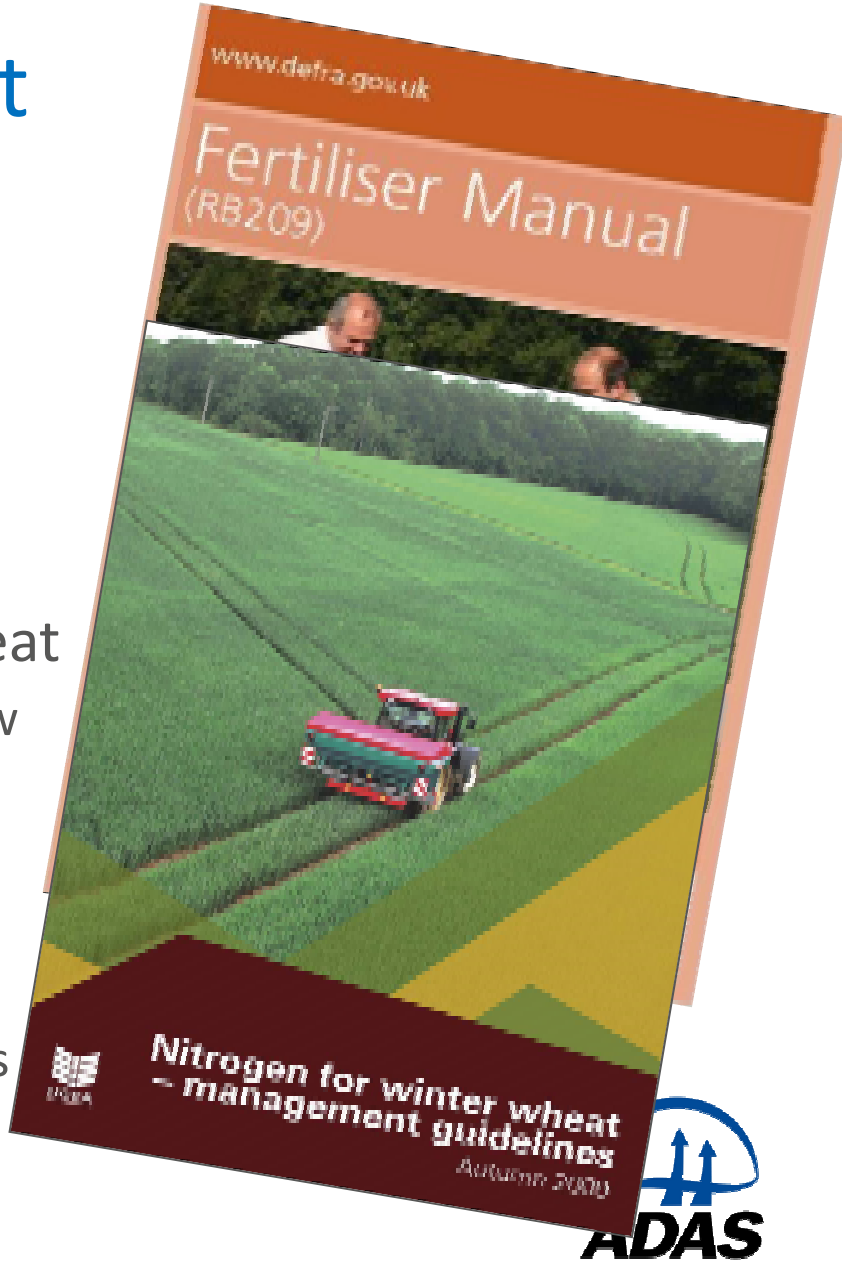


After Sylvester-Bradley, R., Scott, R.K. & Stokes, D.T. (1990) A physiological analysis of the diminishing responses of winter wheat to applied nitrogen. 1. Theory. Aspects of Applied Biology 25, Cereal Quality II, 277-287.

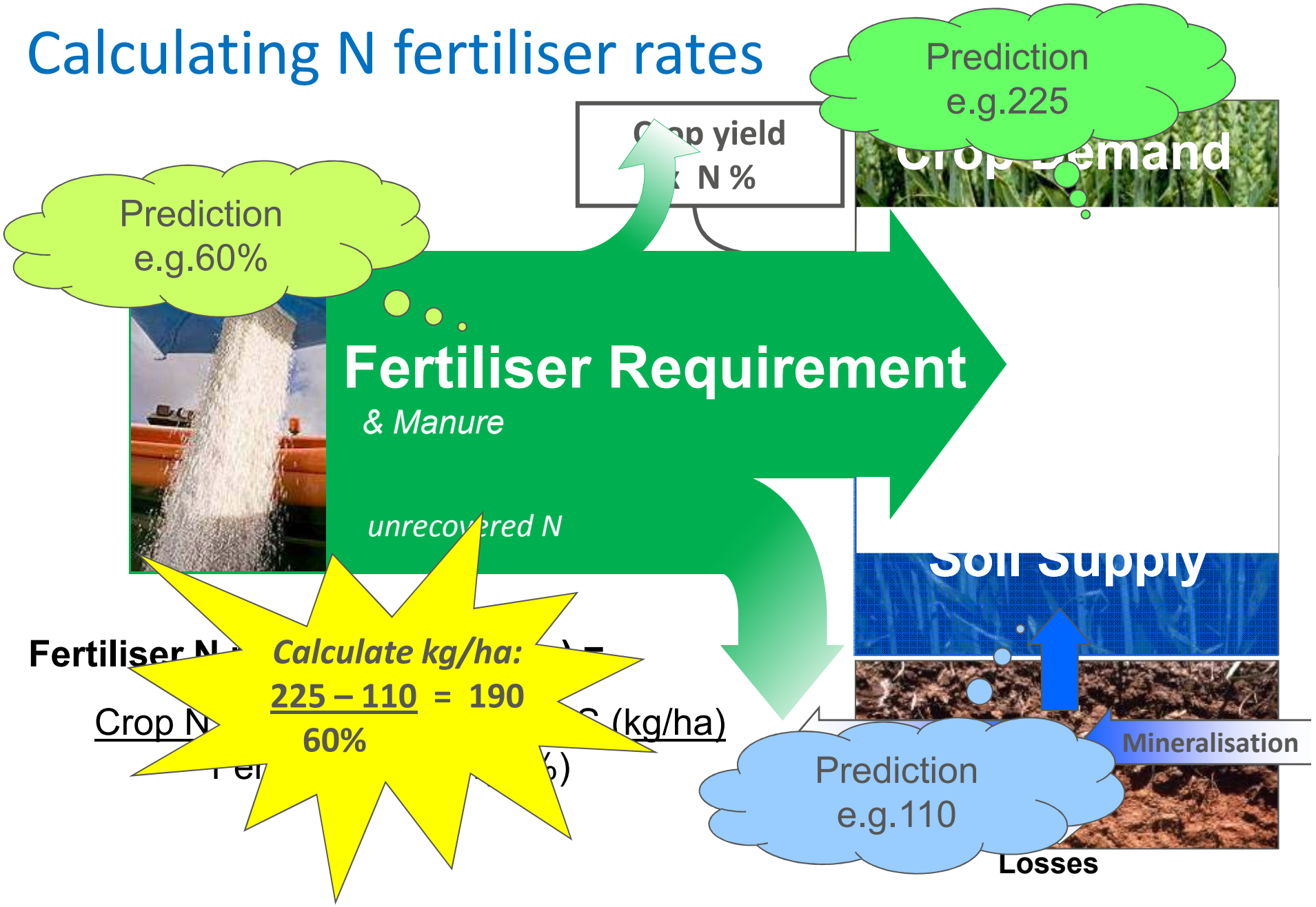
Estimating N requirement

- Traditional: Fertiliser Manual (RB209)
  - Look up tables
  - Accounts for Soil N Supply & soil type

- Newer: N Management Guide for wheat
  - Account for greater yield potential of new varieties
  - Greater price volatility
  - Adjust for local conditions
  - Simpler SNS index tables
  - Detailed soil N measurement instructions



Calculating N fertiliser rates



Crop fertiliser N requirement

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

Crop N Demand

- **Rule of thumb**
  - nabim Groups 1&2: **25 kg N/t**
  - nabim Groups 3&4: **23 kg N/t**

- Detailed calculation

$$= \frac{\text{grain yield (t/ha)} \times \text{grain N (kg/t)}}{\textbf{N harvest index}}$$

Farm average over years

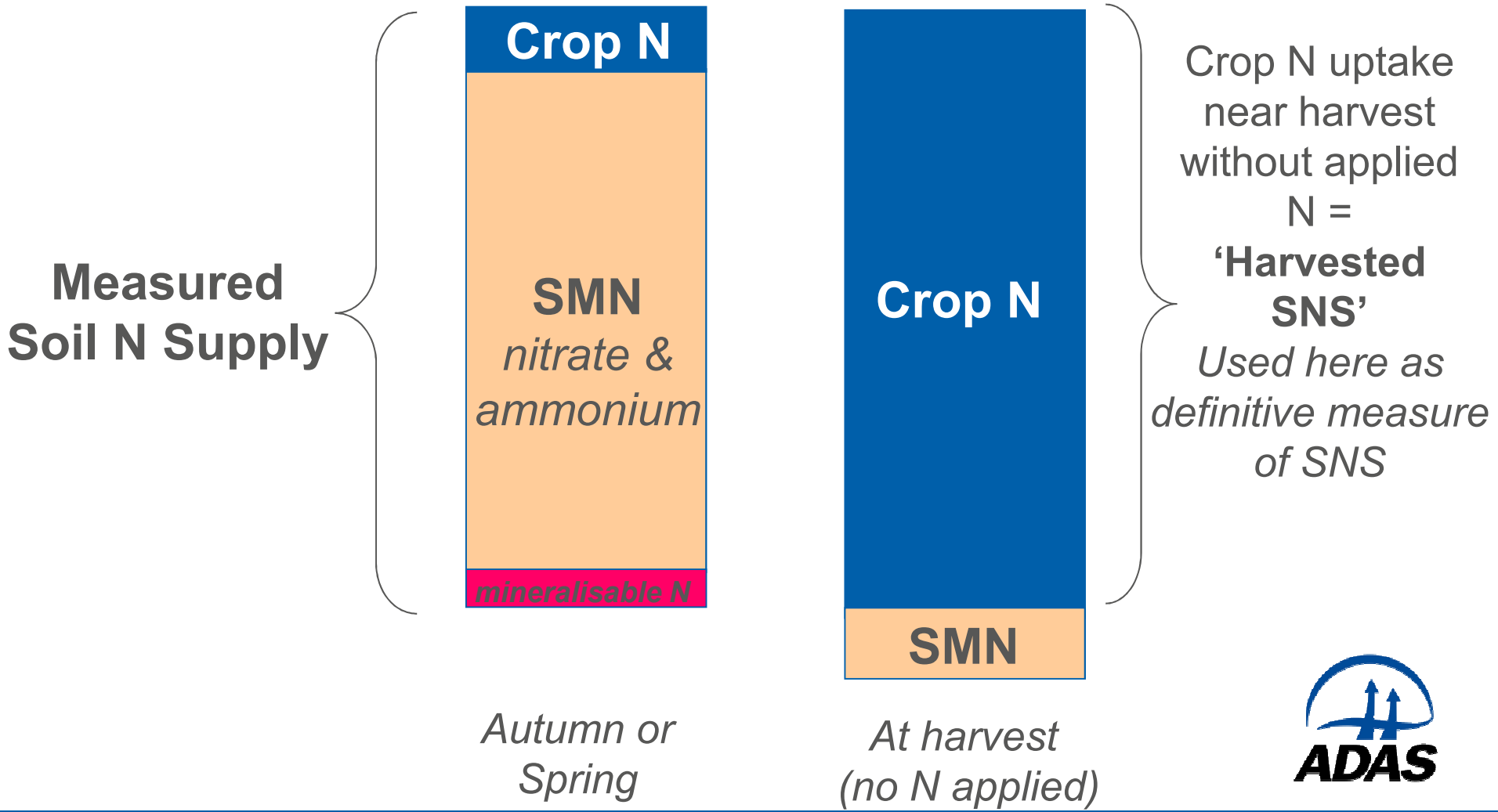
= 0.7 or **70%**

From farm protein average for feed varieties over years

Crop fertiliser N requirement

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

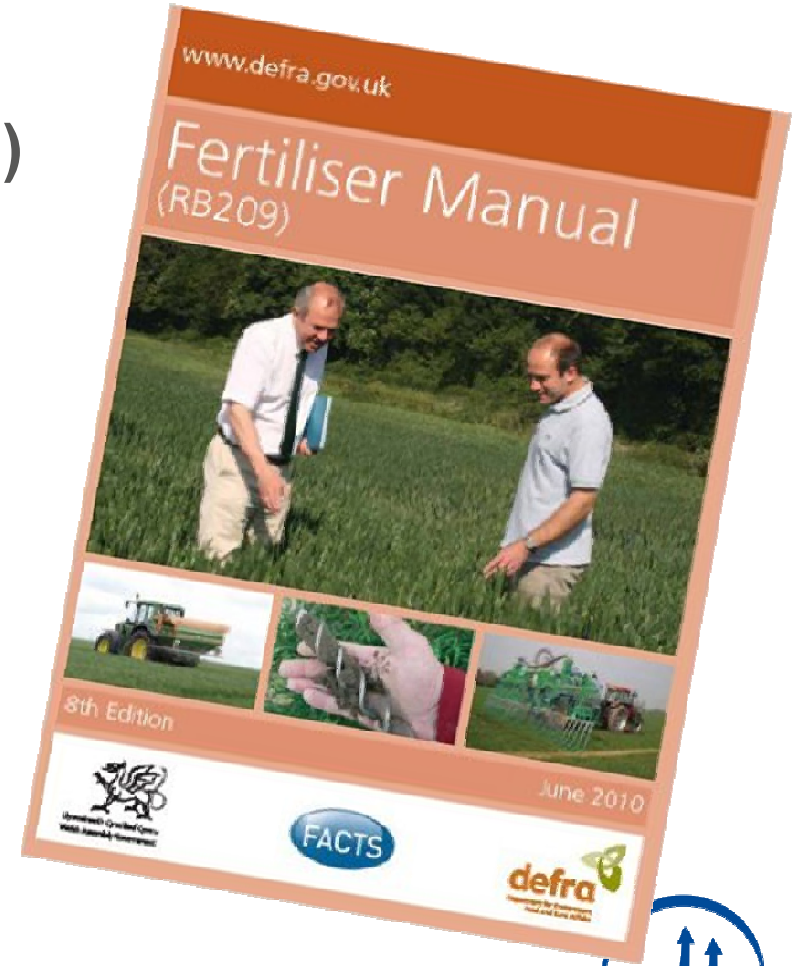
Soil N Supply (SNS)



Estimating SNS

Field Assessment Method (FAM)

- Look up tables
- Soil type
- Over winter rainfall
- Previous Crop
- Previous manuring



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Estimating SNS

When to measure soil mineral N (SMN)?

- where SNS uncertain & possibly high (>160 kg/ha)
- on deep retentive (clay / silt) soils in low rainfall areas,
- as part of a wider monitoring approach applied to large areas across a farm, especially new blocks of land.

Best practice for measuring SNS

- Autumn sampling
  - Better than spring sampling, except shallow soils
  - 0-60cm … as good as 0-90cm
- Spring sampling
  - 0-90cm best
  - mineralisation analysis helps
- Sample handling & storage
  - Don’t freeze, don’t mix, keep cool
  - SMN increases with storage … ***get samples to lab quickly***

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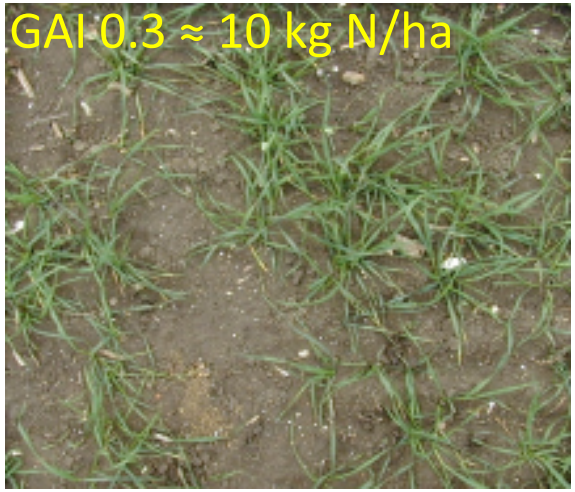
How to estimate crop N: Cereals

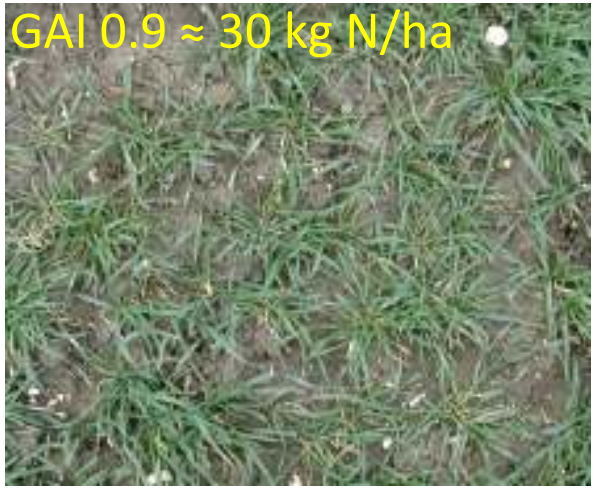
- **Count shoots before GS31**
  - 500 shoots/m^2: 5-15 kg N/ha
  - 1000 shoots/m^2: 15-30 kg N/ha
  - 1500 shoots/m^2: 25-50 kg N/ha

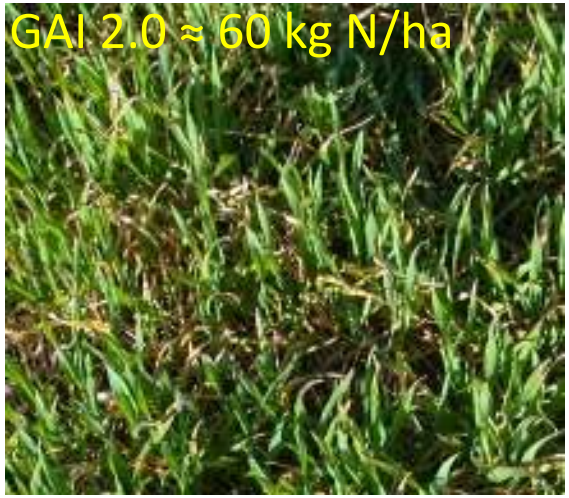
- **Fraction of soil covered by crop**
  - Third: 10 kg N/ha
  - Half: 30 kg N/ha
  - Two thirds: 60 kg N/ha

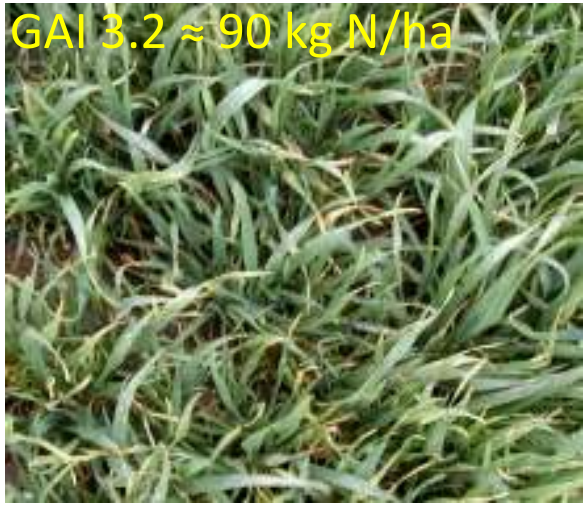
- **Digital photo (wheat)**
  - 30 kg N/ha per unit of GAI
  - Upload l photo on www.pgrplus.basf.com

Wide range of crop N contents









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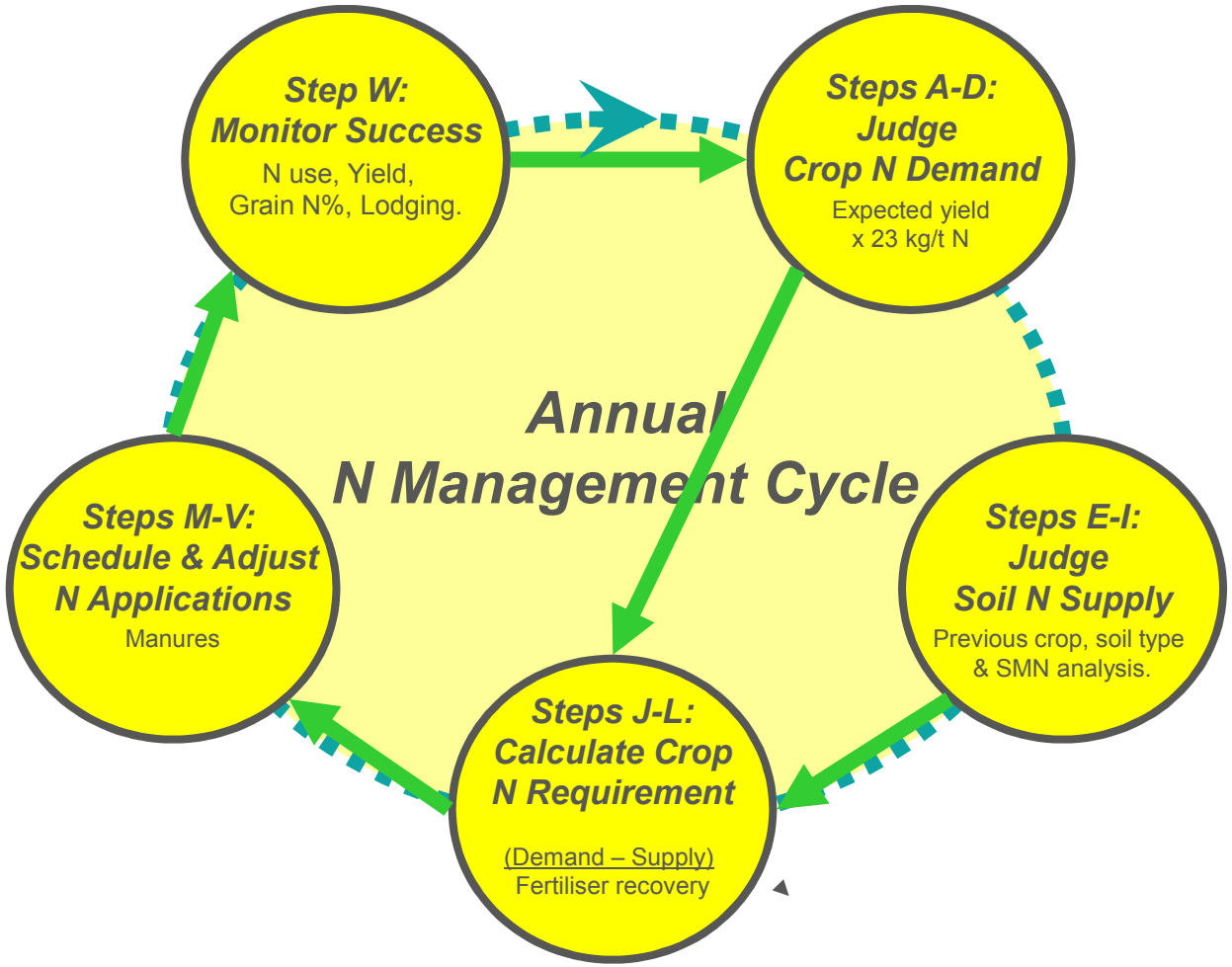
Crop fertiliser N requirement

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

60%

Steps in N Management Guidelines



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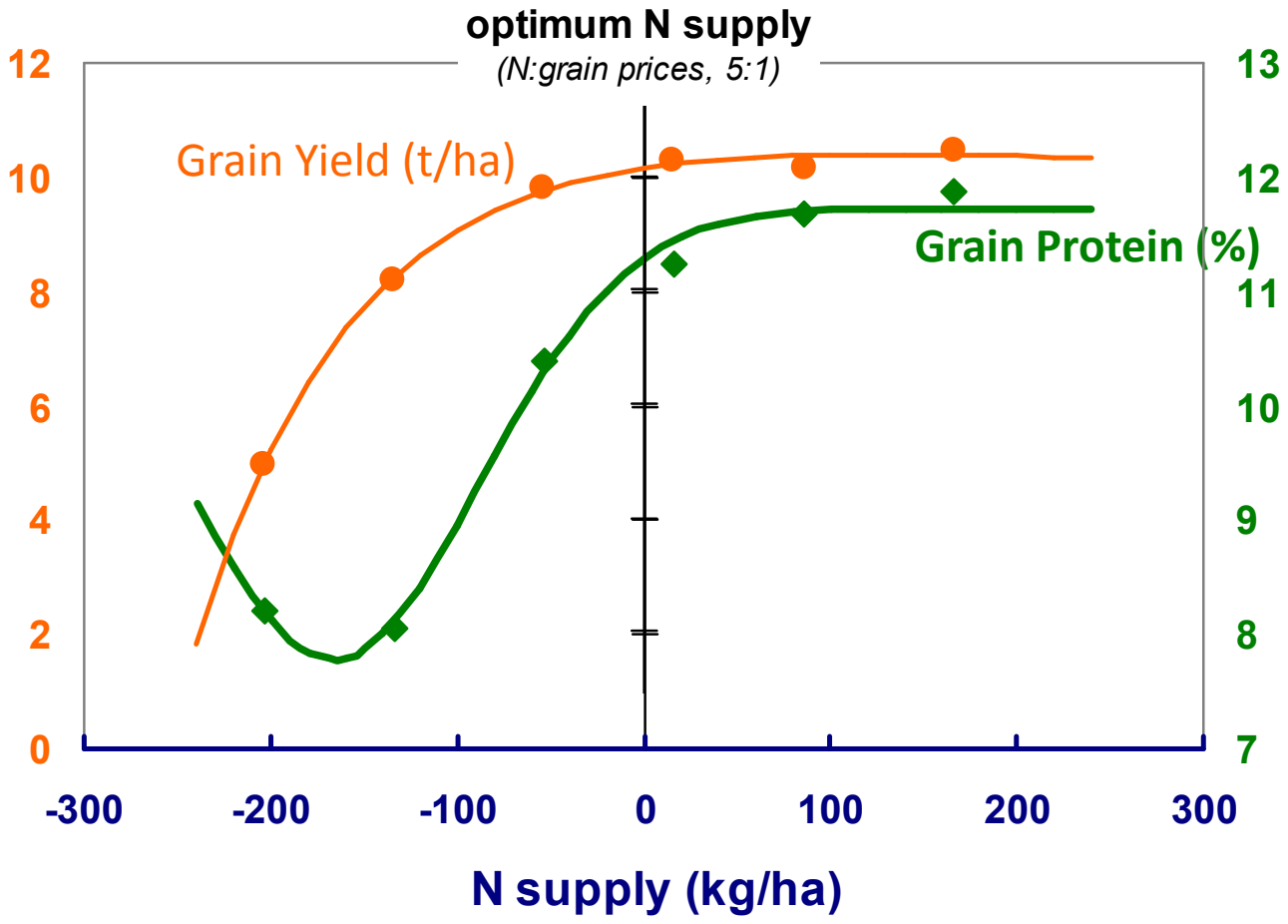
Monitor & Review *… vital for good management*

- **N errors are inevitable**
  - They are usually unseen
  - Small errors seldom matter
  - Beware of big errors
  - Errors can accumulate
    - if not corrected
    - not light or shallow soils
- Checklist provided
  - Key check is grain protein
- Action
  - Double-check odd fields
  - Adjust strategy gradually.

Table 16. Check-list for an example field

Check	Result		
Did you use more or less N than intended?	less ✓	same	more
How did N use compare with Table 12?	less	same ✓	more
How do grain prices compare to those budgeted?	more	same	less ✓
How did N prices compare to those budgeted?	less ✓	same	more
Colour of crop in late May?	pale	normal ✓	dark
Estimated weed infestation in May?		little ✓	lots
Crop height and lodging, ignoring overlaps?	short	none ✓	some
Was grain yield more, or less, than expected?	more ✓	same	less
Was grain protein of feed varieties?	under 10% ✓	11%	over 12%
What about other grain analyses?	low ✓	normal	high
Summary position of ticks		✓	
Likely difference from optimum N use	**too little**	**on target**	**too much**

Use grain protein to indicate success



Rules of thumb

11% optimum for feed

10% – 50 kg N/ha short

12% - 50 kg N/ha over

NB Danish protein is less

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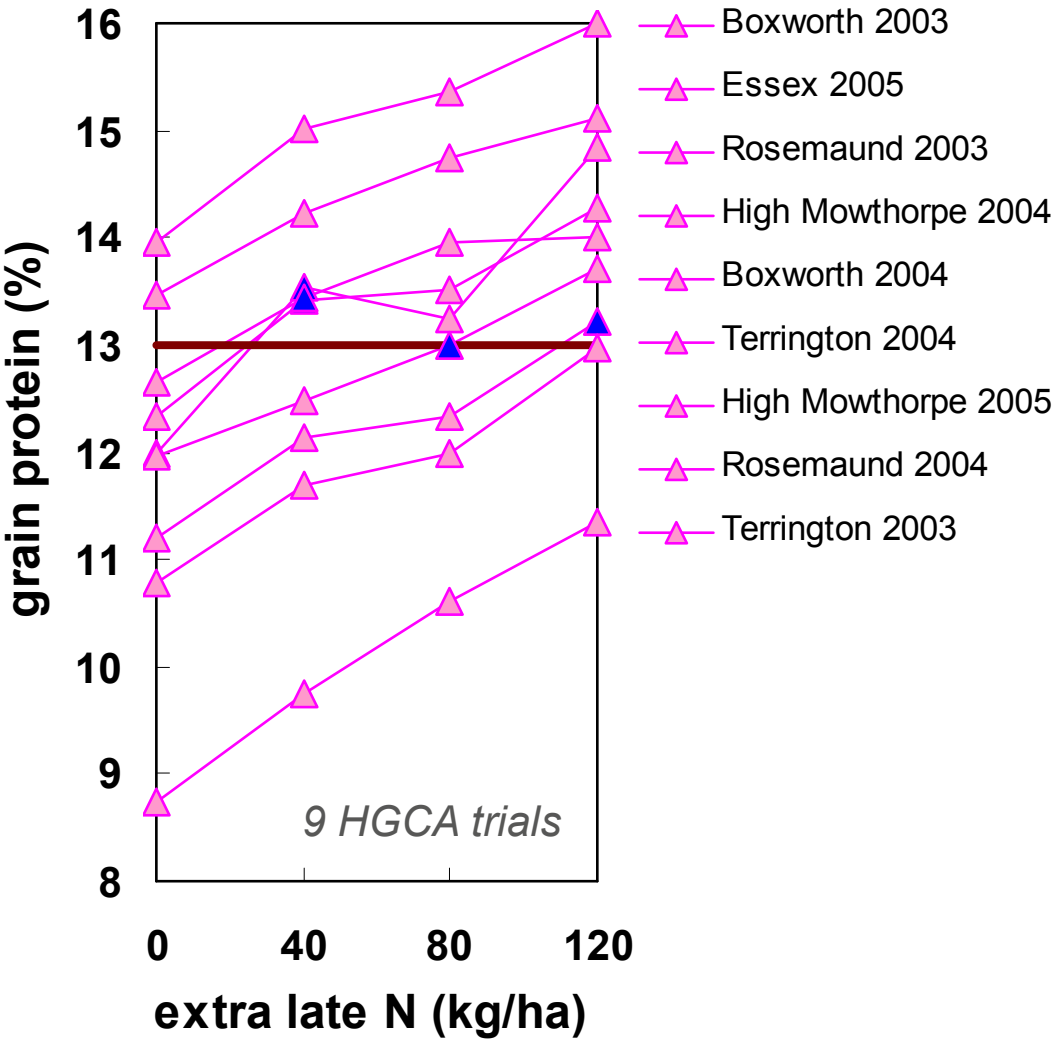
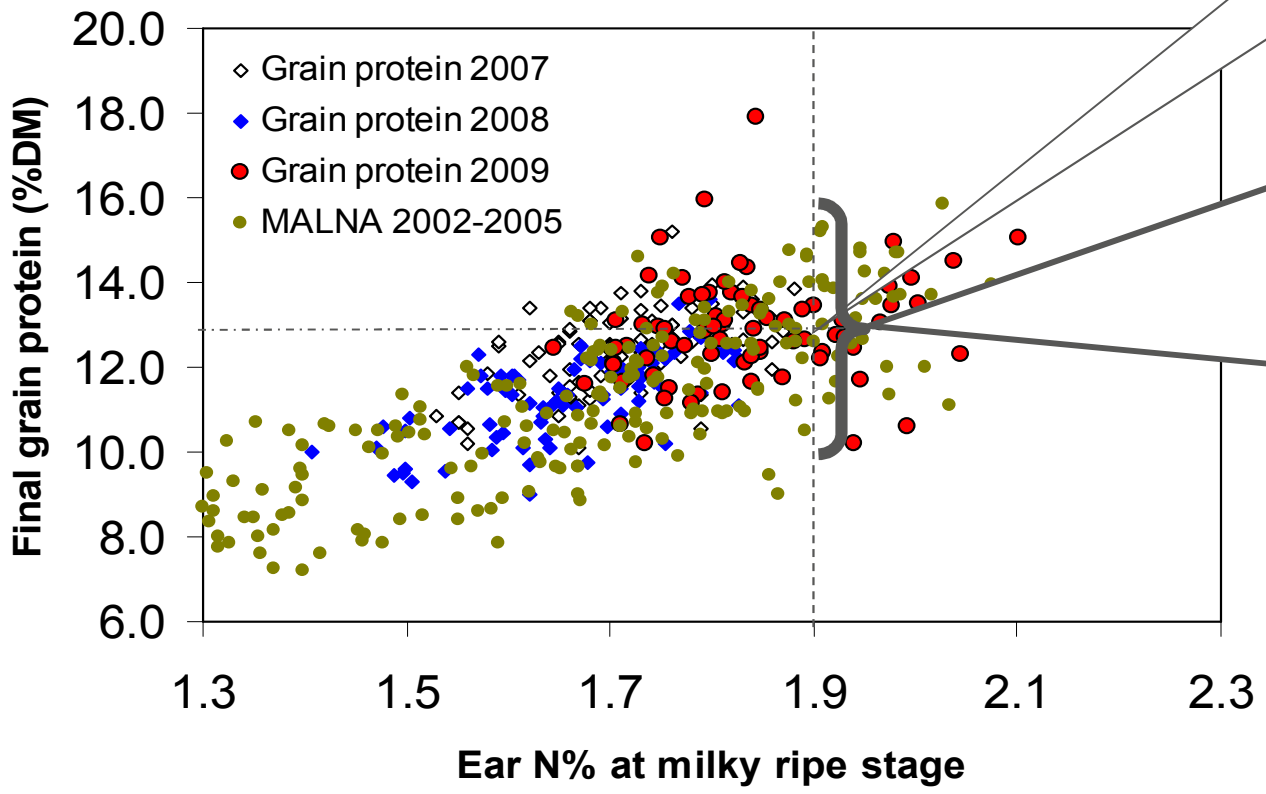
Bread varieties: extra N for protein



Monitoring ear N – results



Ear N at 1.9% indicates 13% grain protein

Big Variability

- ***Mainly due to sampling limitations***
- ***May be reduced by modelling***
- **Conclusion:** ***Ear analysis best used by cooperatives for regional policy.***

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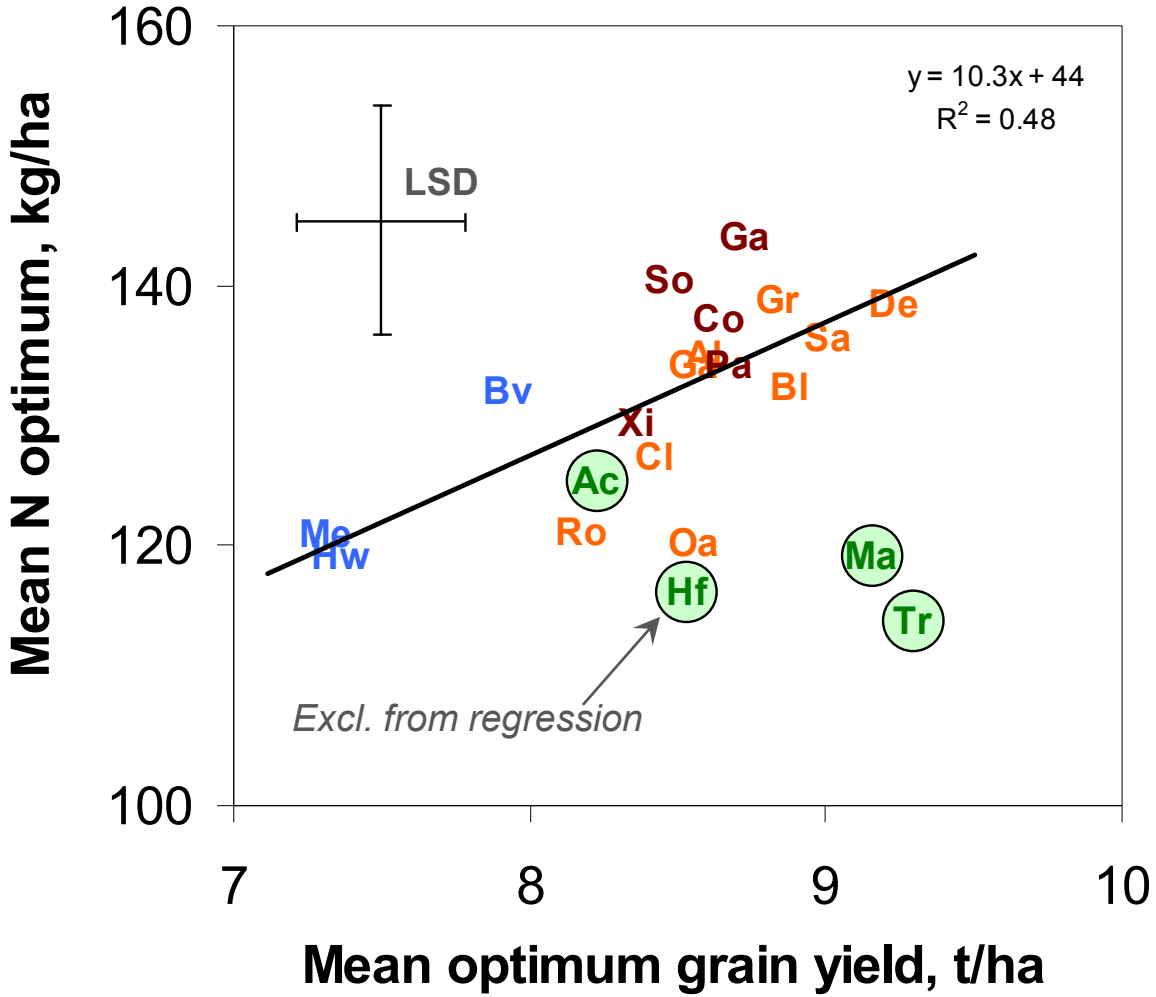
Varietal differences in N requirement (5 years)



Four groups:

- L-Y L-O
  - Old cvs
- M-Y H-O
  - New bread cvs
- H-Y H-O
  - New feed cvs
- H-Y L-O
  - Mariboss & Triticale

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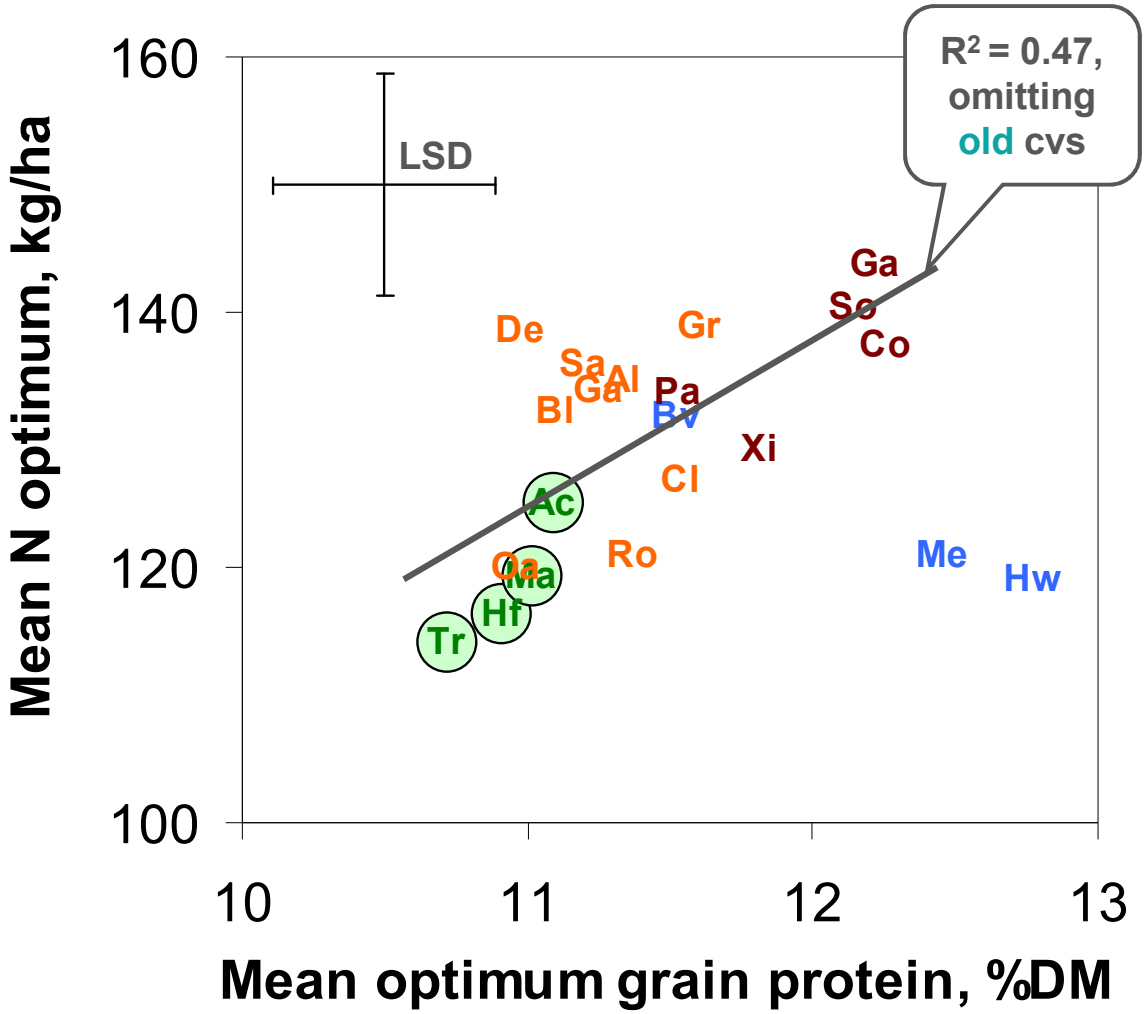
Grain Protein



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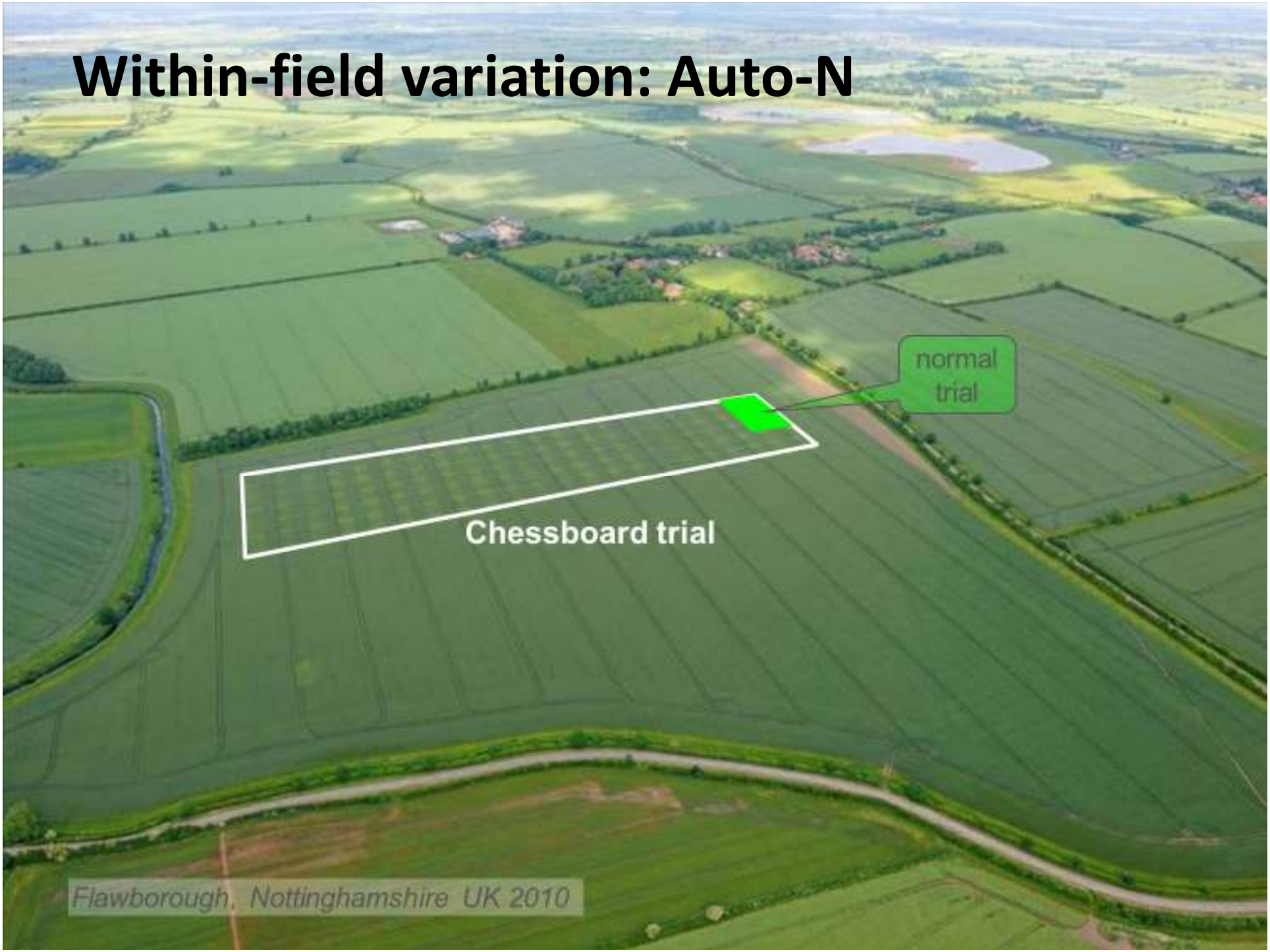
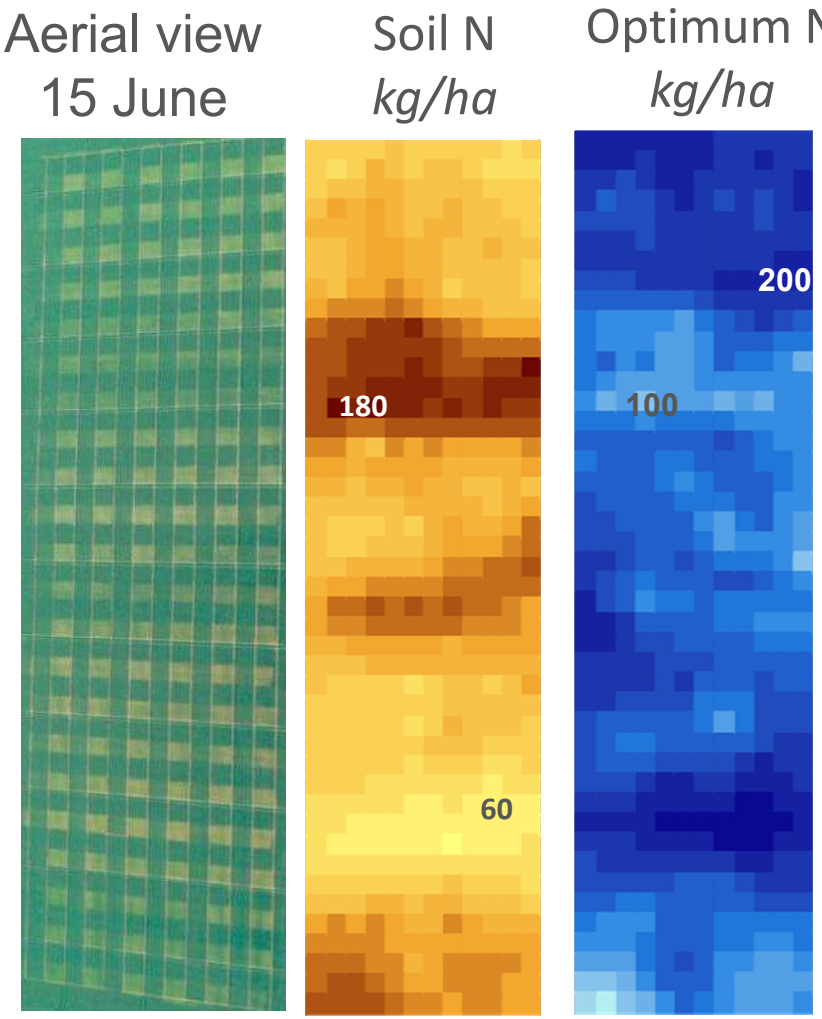
Within-field variation: Auto-N



Within-field variation: Auto-N



- Large variation in optimum N
- Differences of 100-200 kg N/ha
- In some fields, N optimum can be partly explained by variations in:
  - SNS
  - crop N demand (yield)

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Summary – Winter Wheat

- Record yielding crops usually have high biomass and many ears
- Will need early N to maximise tillering & shoot retention, and late N to delay senescence and prolong grain filling
- Fertiliser requirement depends on: crop N requirement, SNS, fertiliser recovery
- Possible that > 300 kg N/ha needed when yield potential high
  - Don't apply more than 100 kg N/ha in one split
  - Allow 2-3 weeks between splits
  - Include tillering application and a late one (GS33-39)
- Principles apply for estimating intra-field variation of fertiliser
- Varietal differences in N requirement
  - Higher yielding varieties generally had higher N requirement
  - Grenado, Mariboss & Hereford had good yields and low N optima
  - Low grain protein indicates low N requirement

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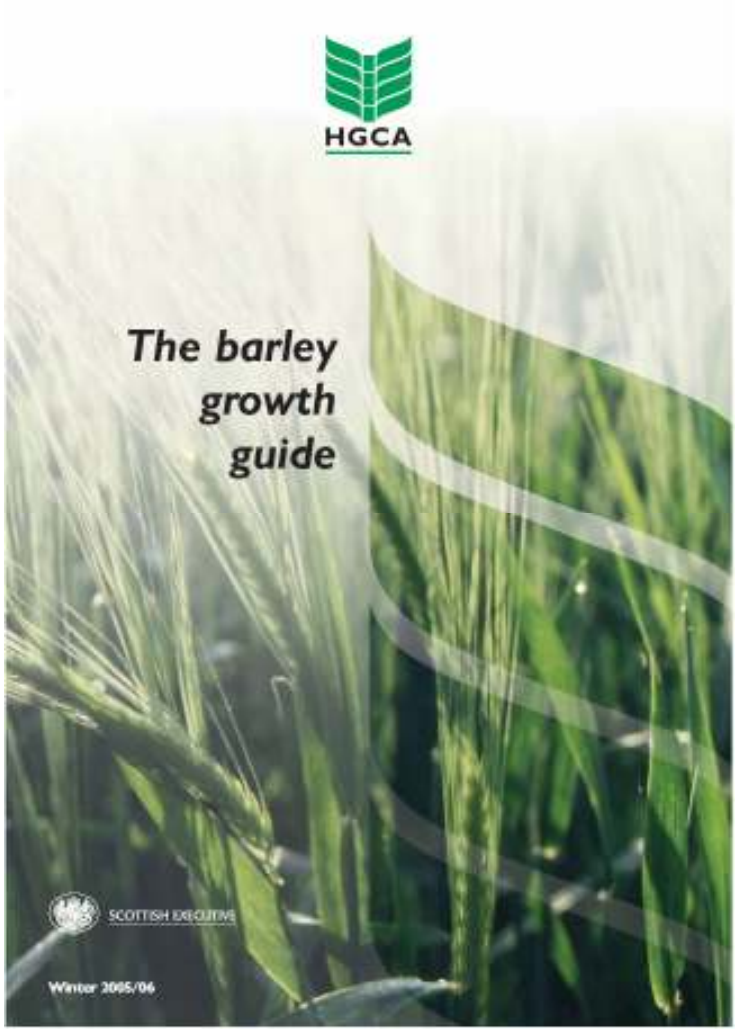

Winter Barley

CF® syngenta

AHDB CEREALS & OILSEEDS

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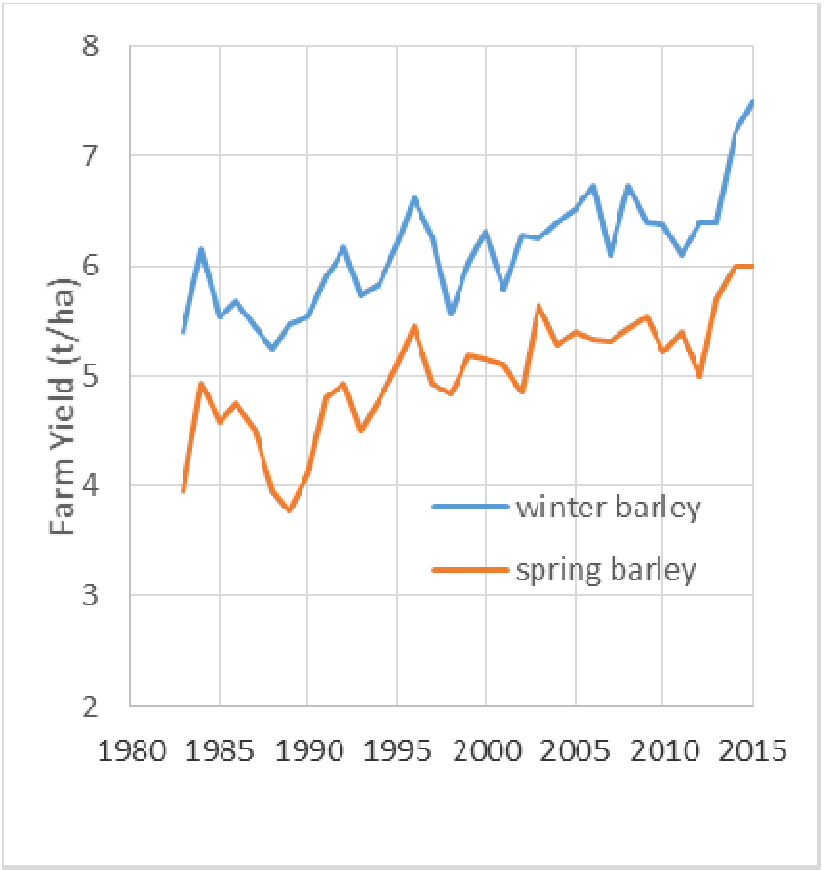
Introduction

- Farm winter barley record: **12.2 t/ha**
  - Scottish Borders, 1989
- UK 2015 >13 t/ha
- Trial yields > **12 t/ha** for winter barley and > **10 t/ha** for spring barley
- Winter barley N rate: 141 kg N/ha
- Spring barley N rate: 102 kg N/ha



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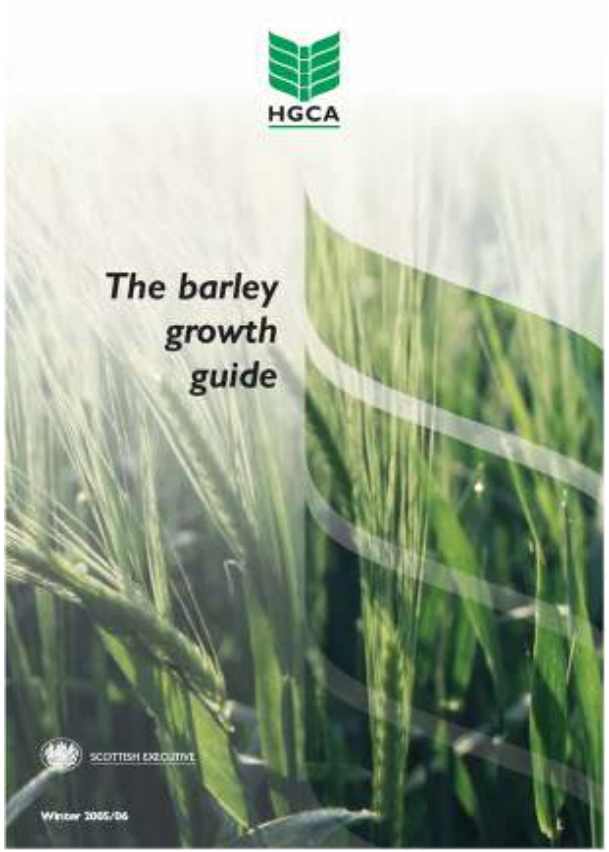
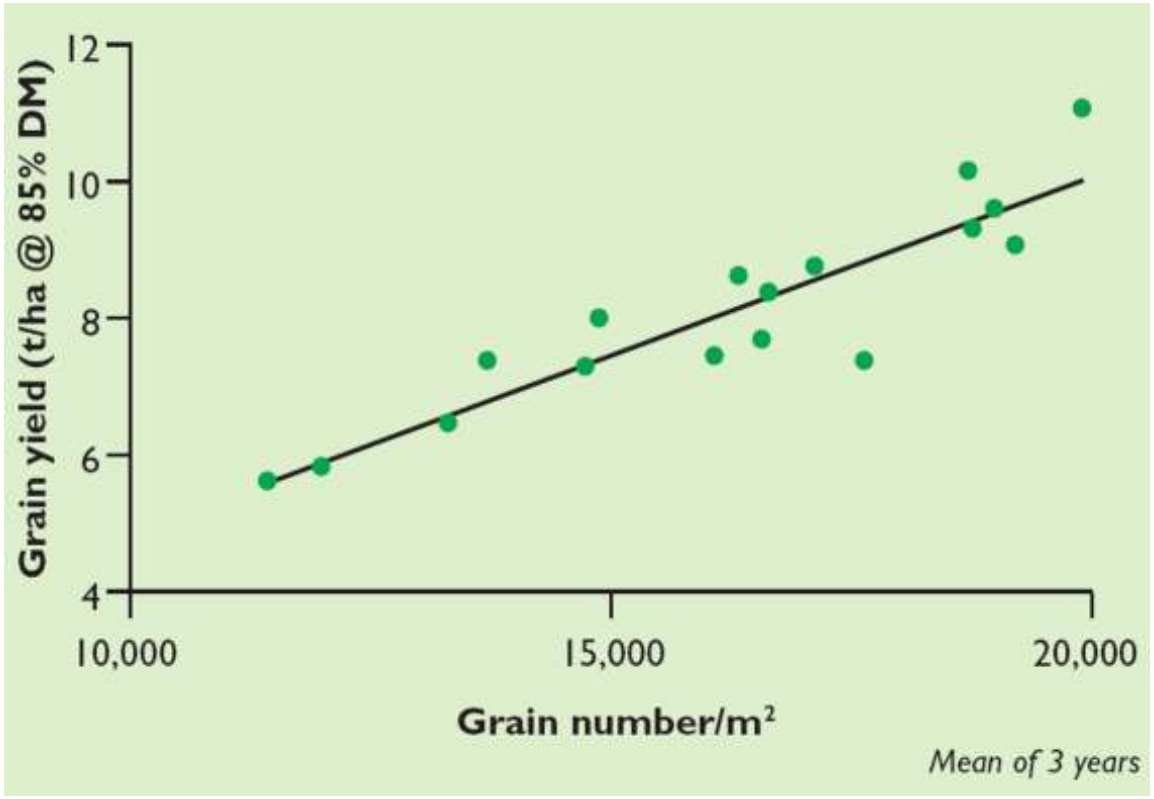
Increase seeds/m^2 to maximise yield





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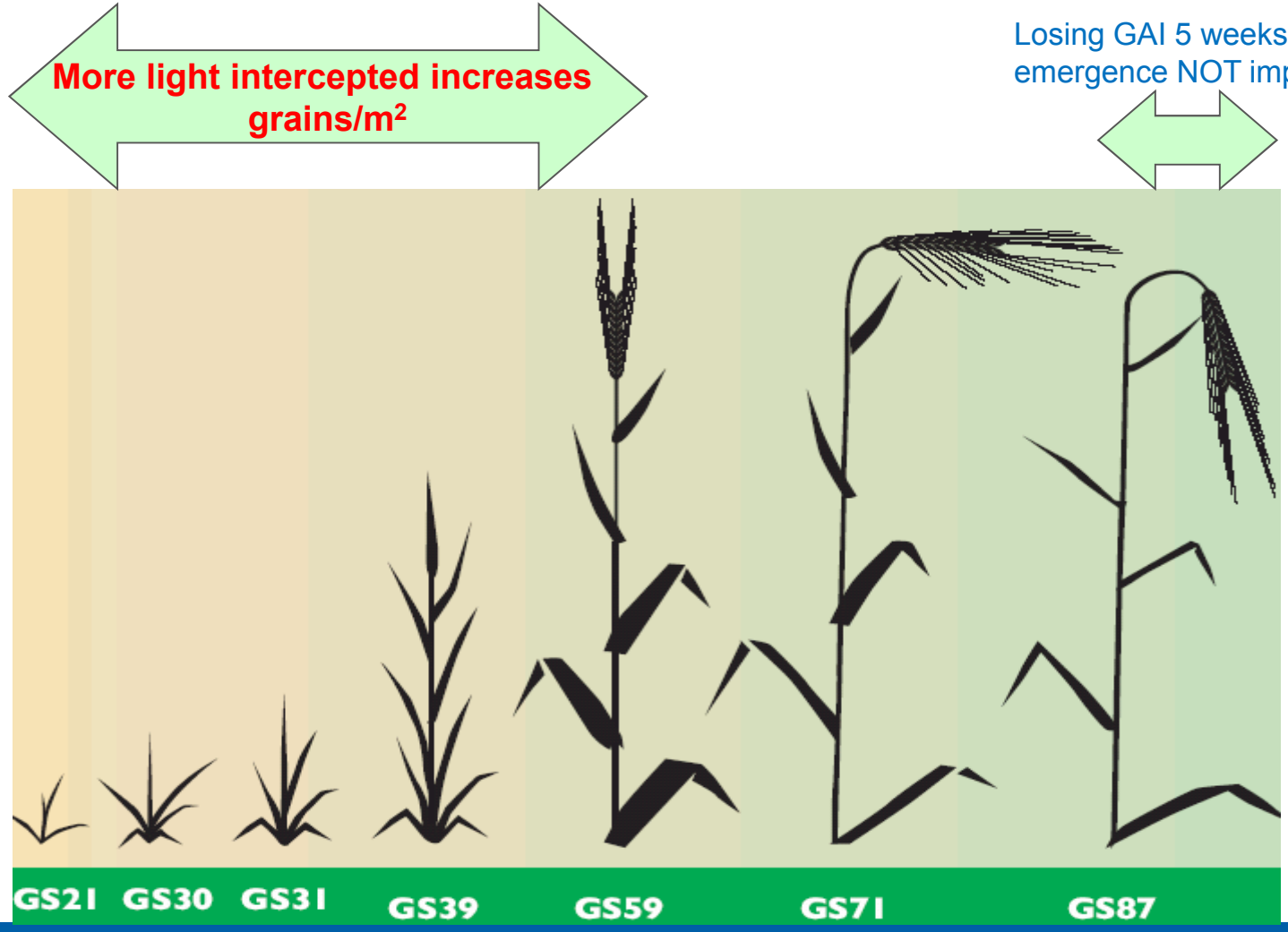
Maximise light interception between plant emergence & flowering



Optimum N timing & rate for winter barley

- RB209 recommends 25-30% N applied before early stem extension
- Current practice for 30-40% N applied before early stem extension
- RB209 may underestimate the N requirement of high yielding modern varieties

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Review of historic data

N Timing

- 25 experiments (2004–12)
- "More than 30% of the total N applied before 1st April vs 30% or less of the total N applied before 1st April"
- "More than 50% of the total N applied before 1st April vs 30% or less of the total N applied before 1st April"

N timing experiment – HM 2015

Total Rosemaund High Mowthorpe	Autumn 30/10/14 2/10/14	1st split GS 25-29 27/02/15 08/03/15	2nd split GS30 26/03/15 11/04/15	3rd split GS31 13/04/15 02/05/15	**Total**
1) RB209	0	40	0	170	**210**
2) Medium	0	70	70	70	**210**
3) Early	0	130	80	0	**210**
4) Autumn	30	100	80	0	**210**

SMN: 29 kg/ha; AAN: 24 kg/ha

Varieties

Volume: Hybrid

SY Venture: 2-row malting

KWS Meridian: 6-row feed

KWS Cassia: 2 row feed

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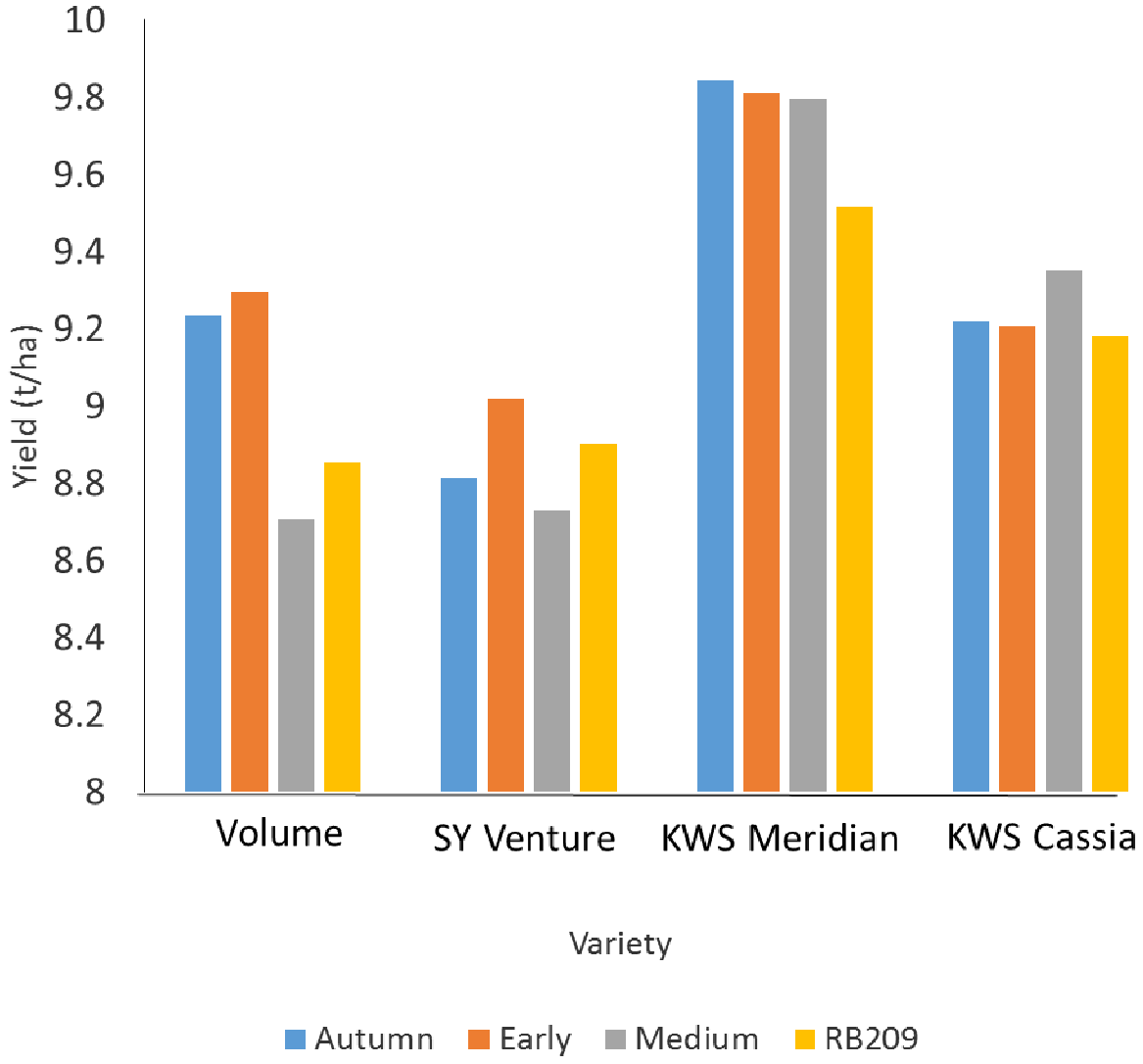
N timing yields (HM 2015)



Treatment	Yield (t/ha)
1) RB209	9.11
2) Medium	9.15
3) Early	9.33
4) Autumn	9.27

Treatment	*P*	LSD
N Timing	0.031	0.165
Variety	<0.001	0.165
N Timing x Variety	0.062	0.329

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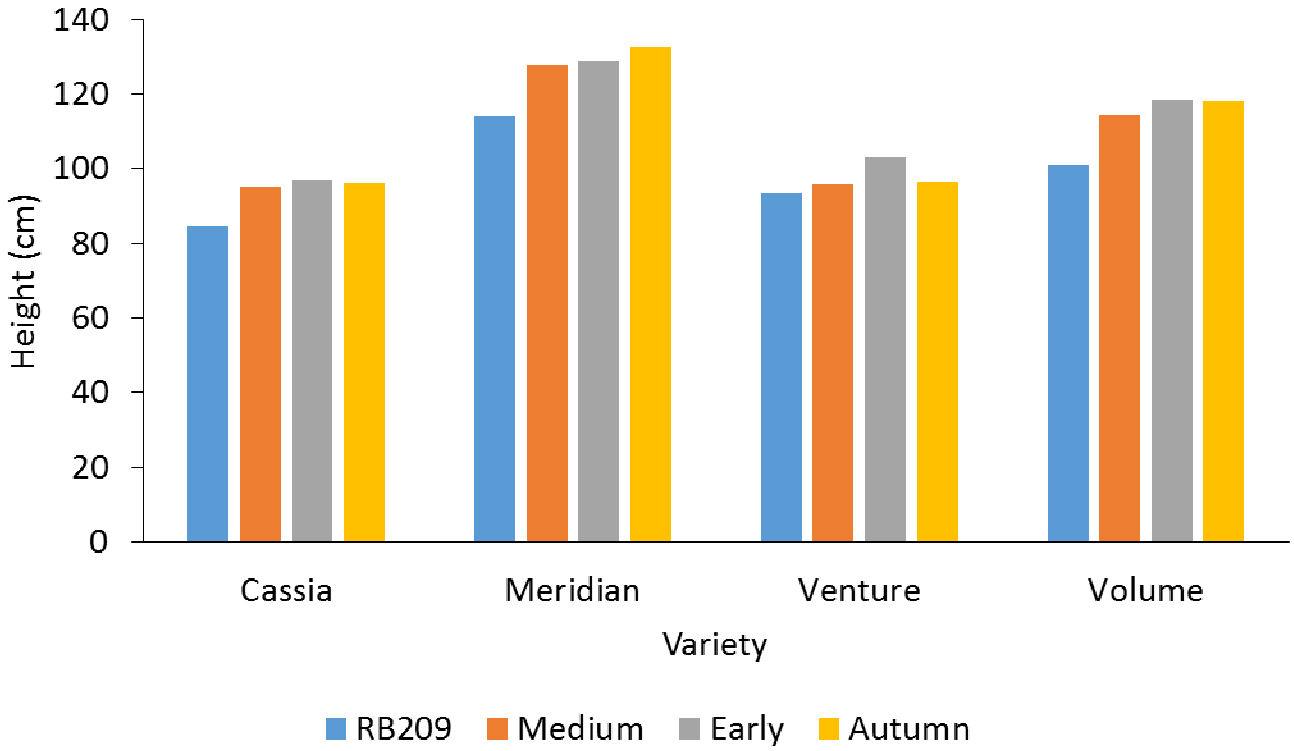
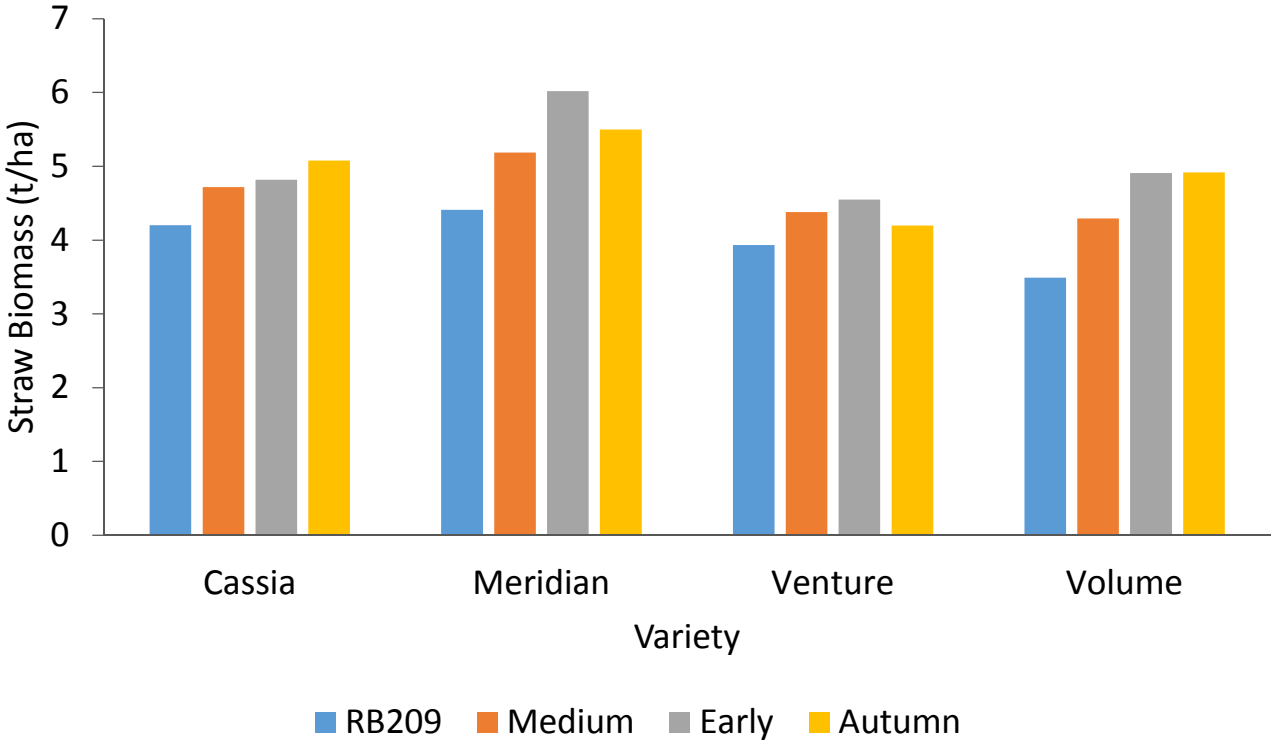
Crop height



Treatment	Height (cm)
1) RB209	98.2
2) Medium	108.1
3) Early	111.8
4) Autumn	110.7

Treatment	*P*	LSD
N Timing	<0.001	1.498
Variety	<0.001	2.631
N Timing x Variety	0.015	4.70

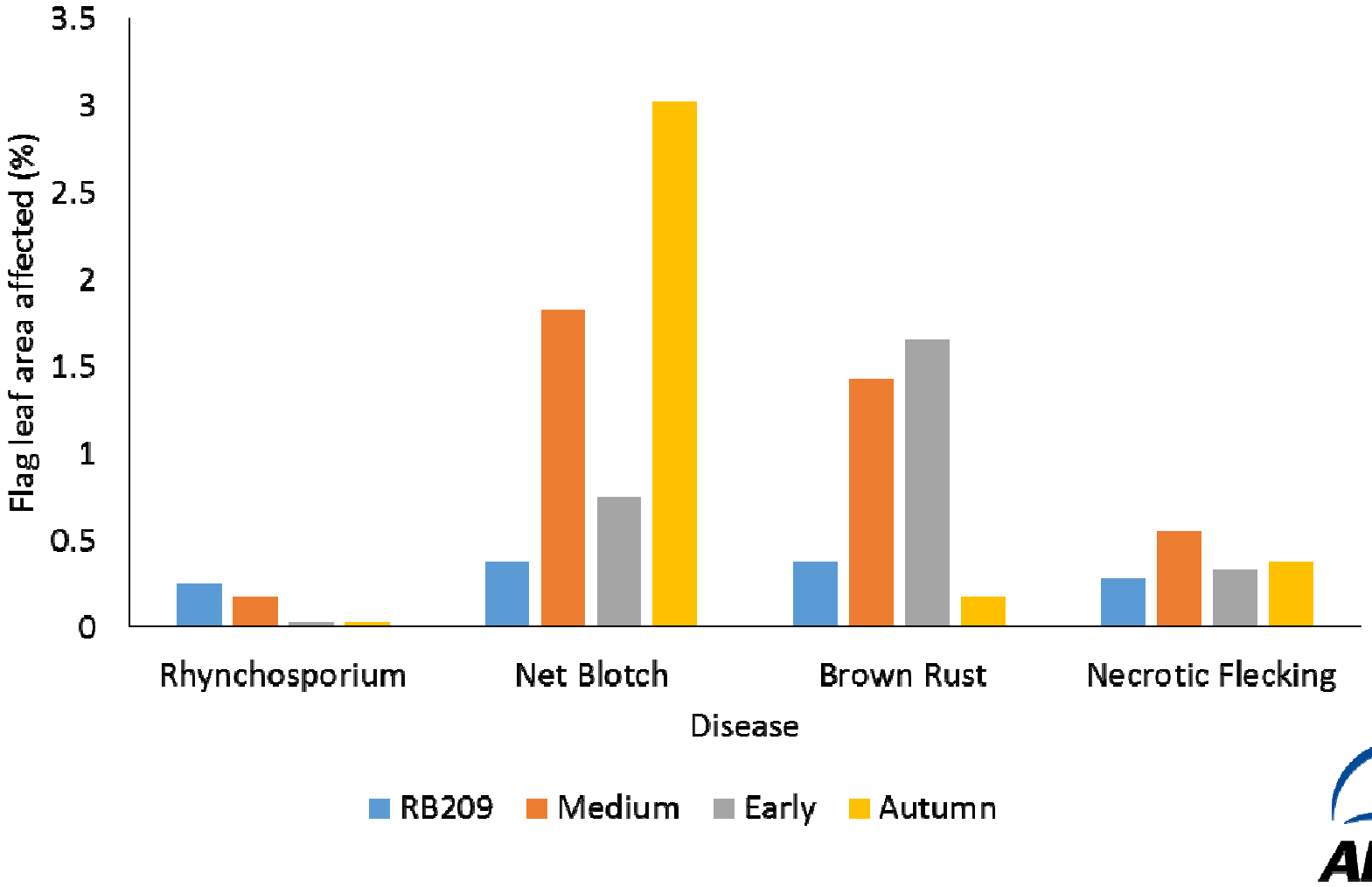
Straw yield



Treatment	Straw Biomass (t/ha)
1) RB209	4.06
2) Medium	4.67
3) Early	5.07
4) Autumn	4.87

Treatment	*P*	LSD
N Timing	0.031	0.261
Variety	<0.001	0.261
N Timing x Variety	0.109	0.522

Disease



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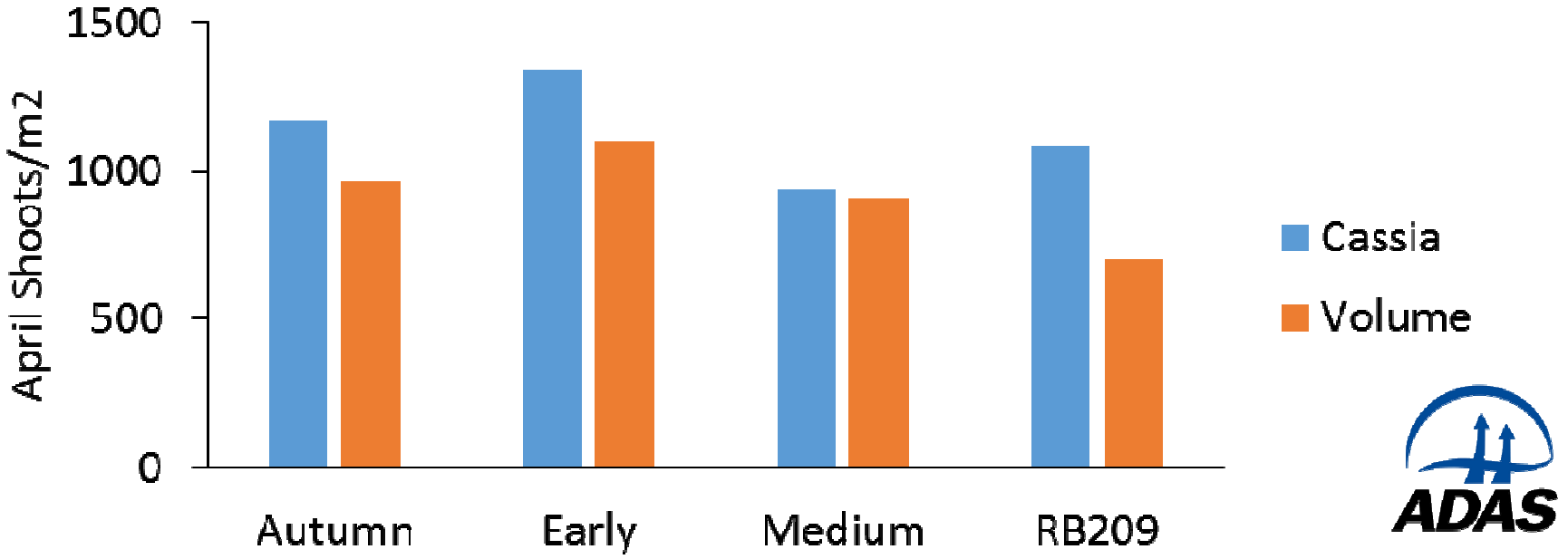
Physiological effects of early N

- More shoots/m^2 in April/May
- No improvement in maintaining tiller number
- Significantly greater GAI in April & May
- Significantly more light interception GS37 & GS57

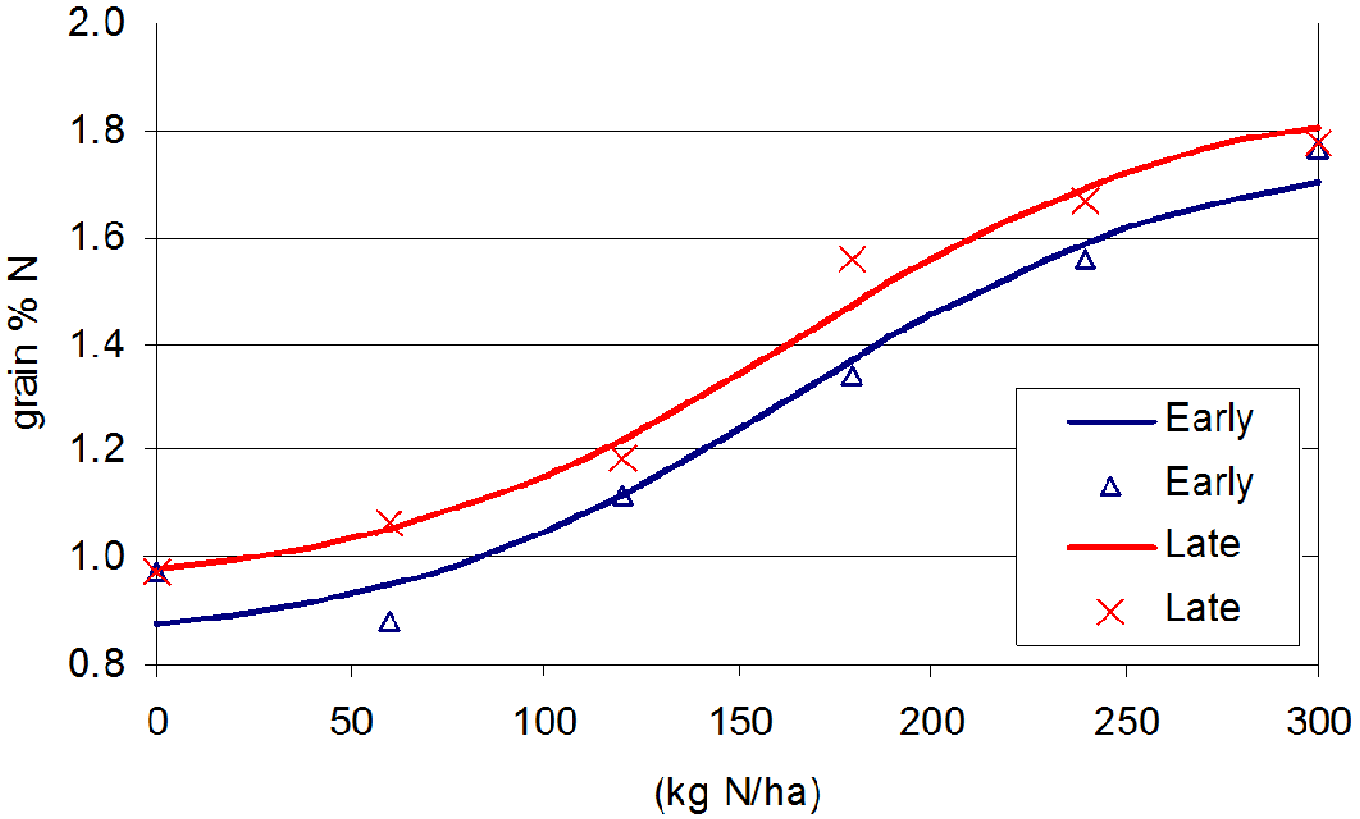


Effect of earlier N on winter barley

Early N

RB209

Effect of earlier N on grain N%

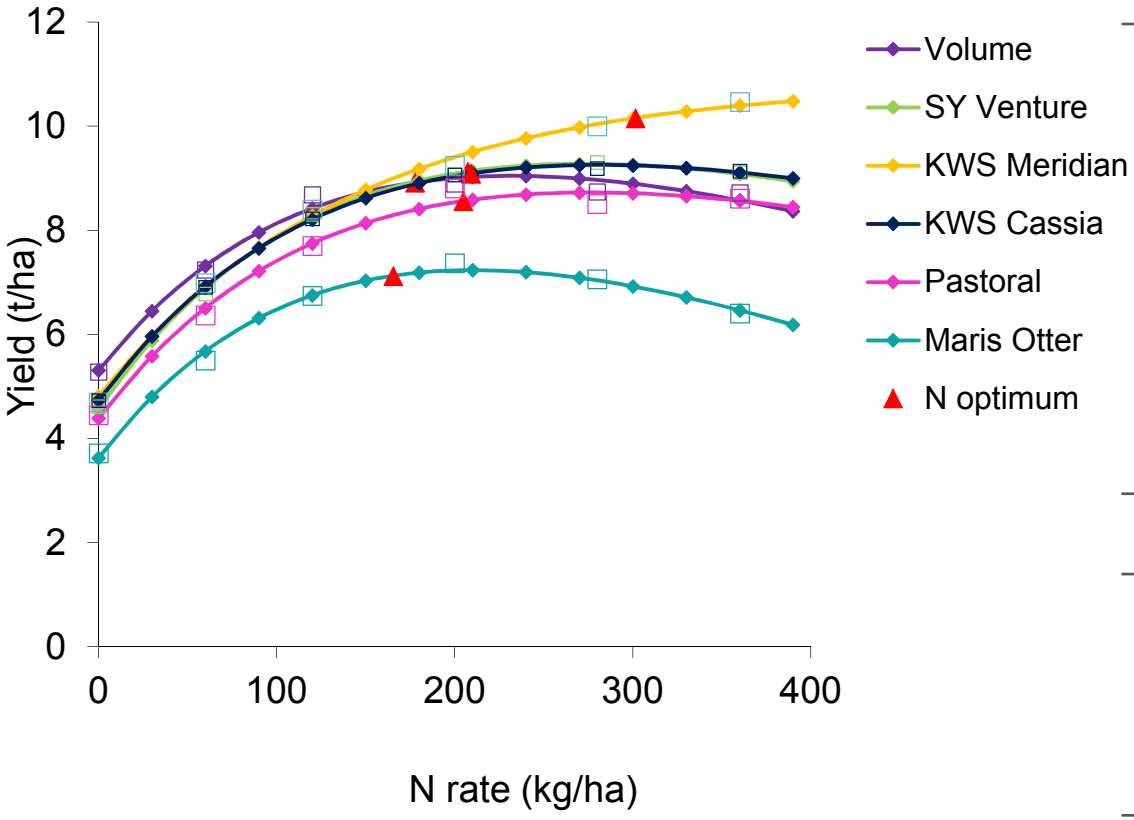


N rate experiments

6 N rates: 0 – 360kg/ha

Varieties:
- Volume (Hybrid)
- Venture (2-row malting)
- Cassia (2-row feed)
- Meridian (6-row feed)
- Maris Otter (2-row malting ‘old’ Intro 1966)
- Pastoral (2-row malting ‘old’ Listed 1989)

N rate experiment (HM 2015)



Variety	Optimum N rate (kg/ha)	Yield at Optimum (t/ha)
Volume	182	8.94
SY Venture	212	9.15
KWS Meridian	314	10.22
KWS Cassia	214	9.12
Pastoral	210	8.59
Maris Otter	169	7.14

Treatment	*P*	LSD
Variety	<0.001	0.251
N Rate	<0.001	0.251
Variety x N Rate	<0.001	0.6147

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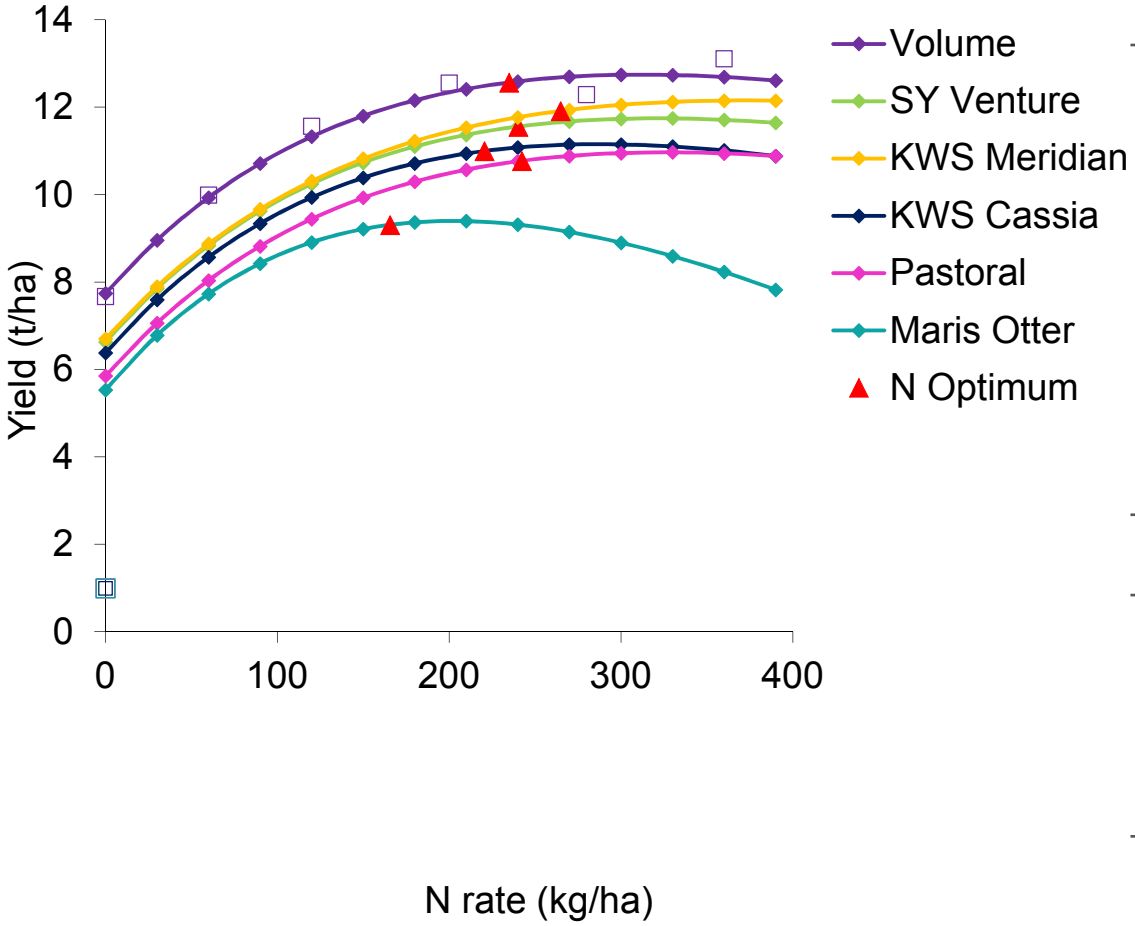
Rate trial yield (RM 2015)



Variety	Optimum N rate (kg/ha)	Yield at Optimum (t/ha)
Volume	241	12.59
SY Venture	246	11.58
KWS Meridian	272	11.95
KWS Cassia	226	11.02
Pastoral	248	10.80
Maris Otter	169	9.32

Treatment	*P*	LSD
Variety	<0.001	0.358
N Rate	<0.001	0.358
Variety x N Rate	0.017	0.877

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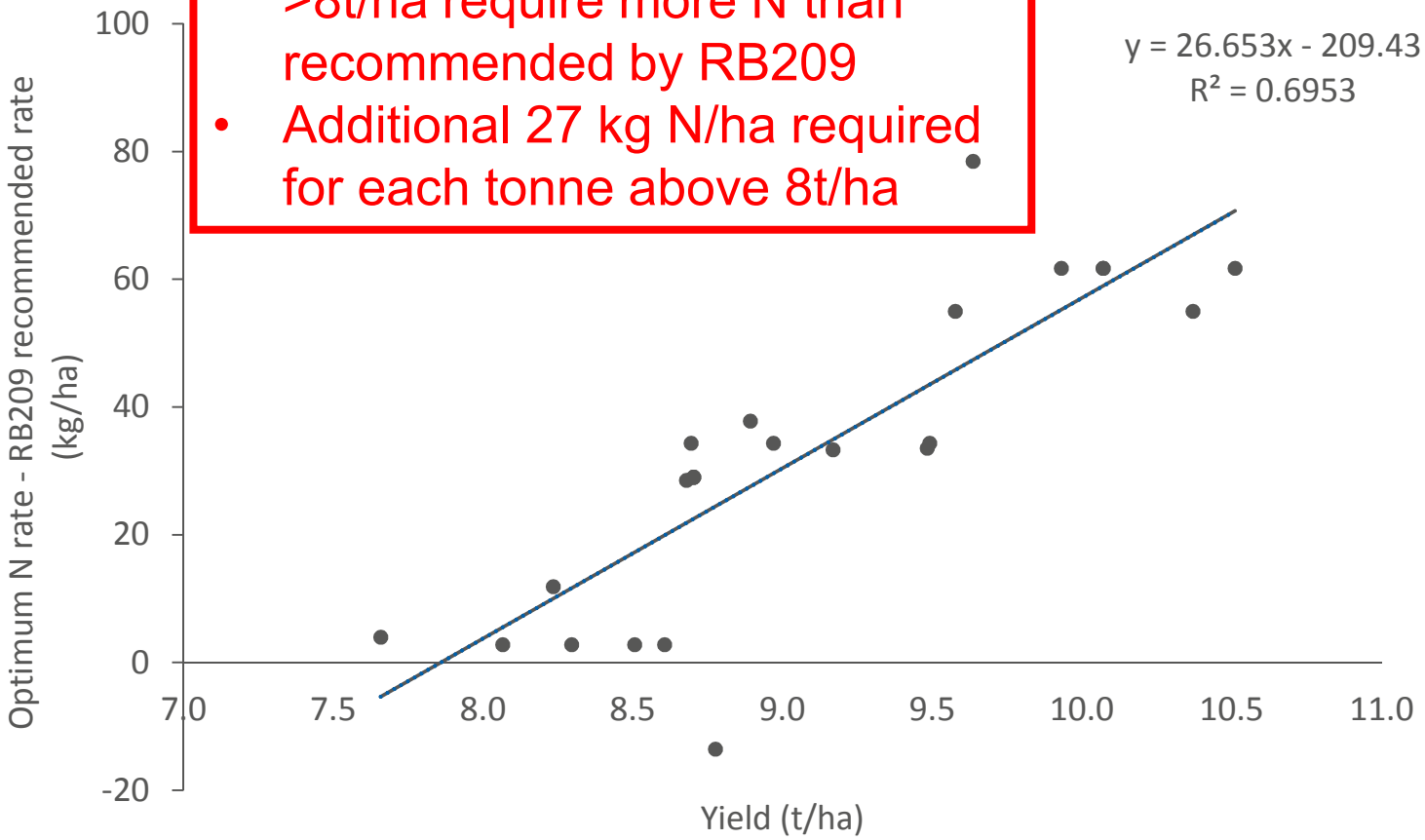
Optimum N rate

- Crops with yield potential of >8t/ha require more N than recommended by RB209
- Additional 27 kg N/ha required for each tonne above 8t/ha



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Conclusions – Winter Barley

- 0.5t/ha yield benefit from applying 50% of N before stem extension.
  - 10cm taller and at 1-2 t/ha more straw
  - But greater lodging risk
- Earlier N reduces grain N% by 0.1%
- Each additional 1t/ha over 8t/ha requires +27kg/ha N
- >12 t/ha possible for winter barley

Thank You

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