



## Development of an appropriate variety testing methodology for assessing nitrogen requirements

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# HGCA Recommended List<sup>®</sup> winter wheat 2010/11

## YIELD, AGRONOMY AND DISEASE RESISTANCE

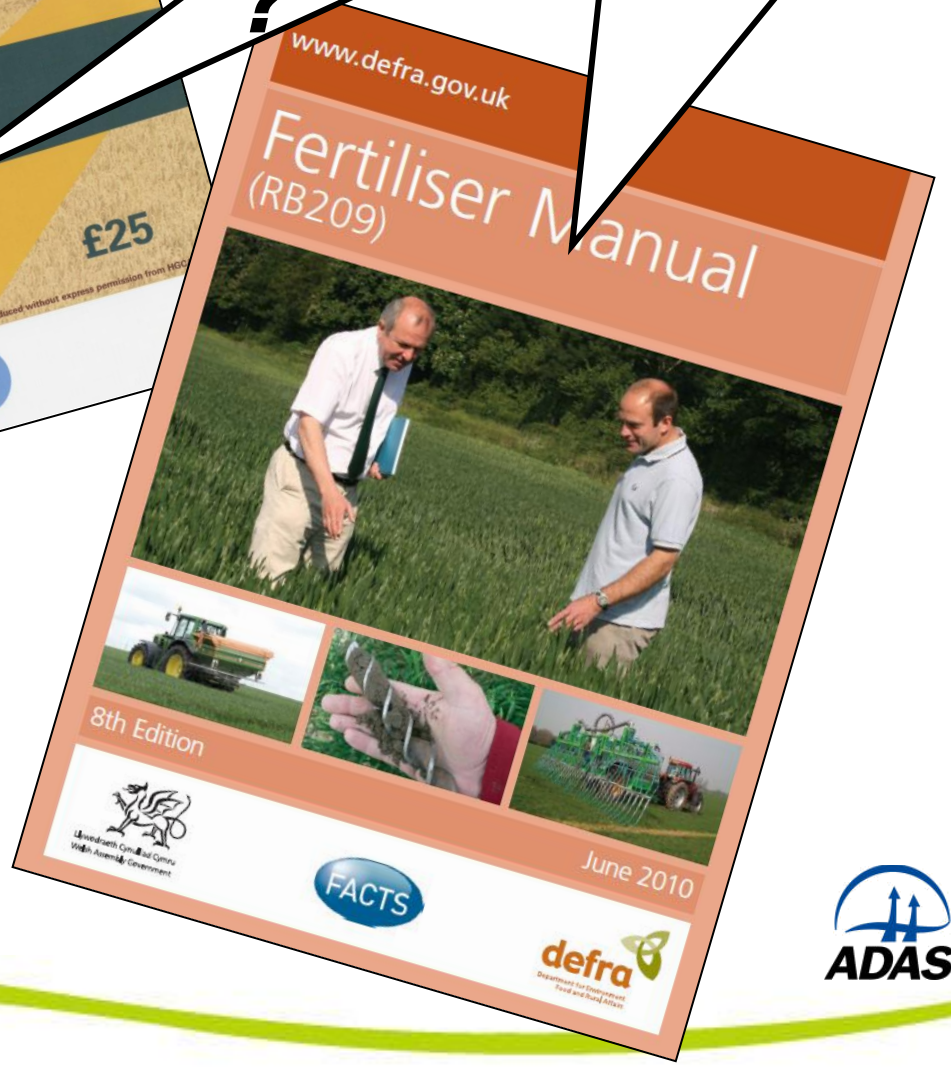
	P2		*	C	*	P1		P2	P2	P1	C	*	P2	P1
	Gallant	Xi19	Solstice	Hereward	KWS-Sterling	Panorama	Ketchum	Kingdom	Cordiale	Einstein	Battalion	Marksman	Oplus \$	Invicta
<b>RECOMMENDED</b>	nabim Group 1				nabim Group 2									nabim Group 3
End-use group	nabim Group 1				nabim Group 2									nabim Group 3
Scope of recommendation	UK	East	UK	UK	UK	UK	UK	E&W	UK	UK	UK	E&W	Sp	UK
<b>Fungicide treated grain yield (% treated control)</b>														
United Kingdom (10.6 t/ha)	99.7	99.3	96.5	87.8	101.9	101.6	101.1	99.6	98.4	98.3	98.1	96.8	96.7	102.7
Dry (East) region (10.6 t/ha)	100	100	96	89	102	102	101	99	99	98	99	98	97	103
Wet (West) region (10.6 t/ha)	101	97	97	86	102	101	102	102	97	98	98	97	97	103
North region (10.7 t/ha)	96	[98]	95	-	[100]	99	99	[94]	96	99	95	91	92	[100]
<b>Untreated grain yield (% treated control in comparable trials)</b>														
United Kingdom	78	77	76	73	79	85	84	77	77	81	84	84	82	85
<b>Agronomic features</b>														
Resistance to lodging without PGR	7.1	4.3	8.0	8.3	6.7	8.1	5.6	6.4	7.7	6.0	6.9	6.9	8.6	7.2
Resistance to lodging with PGR	7.1	6.0	8.6	8.4	8.3	8.9	6.6	7.6	8.3	7.2	8.3	8.1	9.1	7.5
Height without PGR (cm)	86	97	97	89	80	92	95	92	83	89	88	88	92	93
Ripening (days +/- Solstice, -ve = early)	-2	0	0	0	0	+1	0	-1	-2	0	0	-2	+2	+3
Resistance to sprouting	[6]	[7]	7	[5]	-	[7]	[6]	-	6	6	5	[5]	[6]	-
<b>Disease resistance</b>														
Mildew	5.6	6.3	4.2	5.2	6.5	7.2	8.0	5.8	6.2	6.2	7.6	7.0	4.9	5.7
Yellow rust	4.1	9.0	3.9	5.0	9.0	8.9	3.9	6.4	6.1	5.4	5.7	5.3	6.0	7.6
Brown rust	4.1	5.5	2.9	-	-	-	-	-	-	-	-	-	-	7.3
Septoria nodorum	[5]	5.2	5.3	-	-	-	-	-	-	-	-	-	-	[7]
Septoria tritici	4.1	4.9	5.1	-	-	-	-	-	-	-	-	-	-	6.3
Eyespot	6.1	5.0	4.9	3.9	6.0	5.2	5.4	4.9	5.3	6.0	7 @	7 @	5.3	5.4
Fusarium ear blight	[6]	6.0	6.0	5.5	[6]	[7]	[8]	[7]	6.0	5.9	5.0	5.0	[6]	[6]
Orange wheat blossom midge	-	-	-	-	-	-	-	-	-	-	-	-	R	-

**14 criteria for crop protection**  
*but none for nutrition !!*



**N 'requirements'**  
= *economic optima*

?



# HYLO Project – Literature Review – Conclusions

- **‘N Use efficiency’ is not the right target**
  - Nor any other ratio, or index
  - N efficiency is an additional target to high yield
- **New target: Optimum N, kg/ha**
  - Determined from multi-level N trials
  - Precision of optimum N is poor, so many trials needed
  - Need to find *new methods* or *indicative crop traits*
- **Genetic variation exists**
  - Especially between species .. e.g. triticale vs. wheat
  - But cultivar effects are poorly researched

... best tested with a series of ‘HYLO’ experiments ...

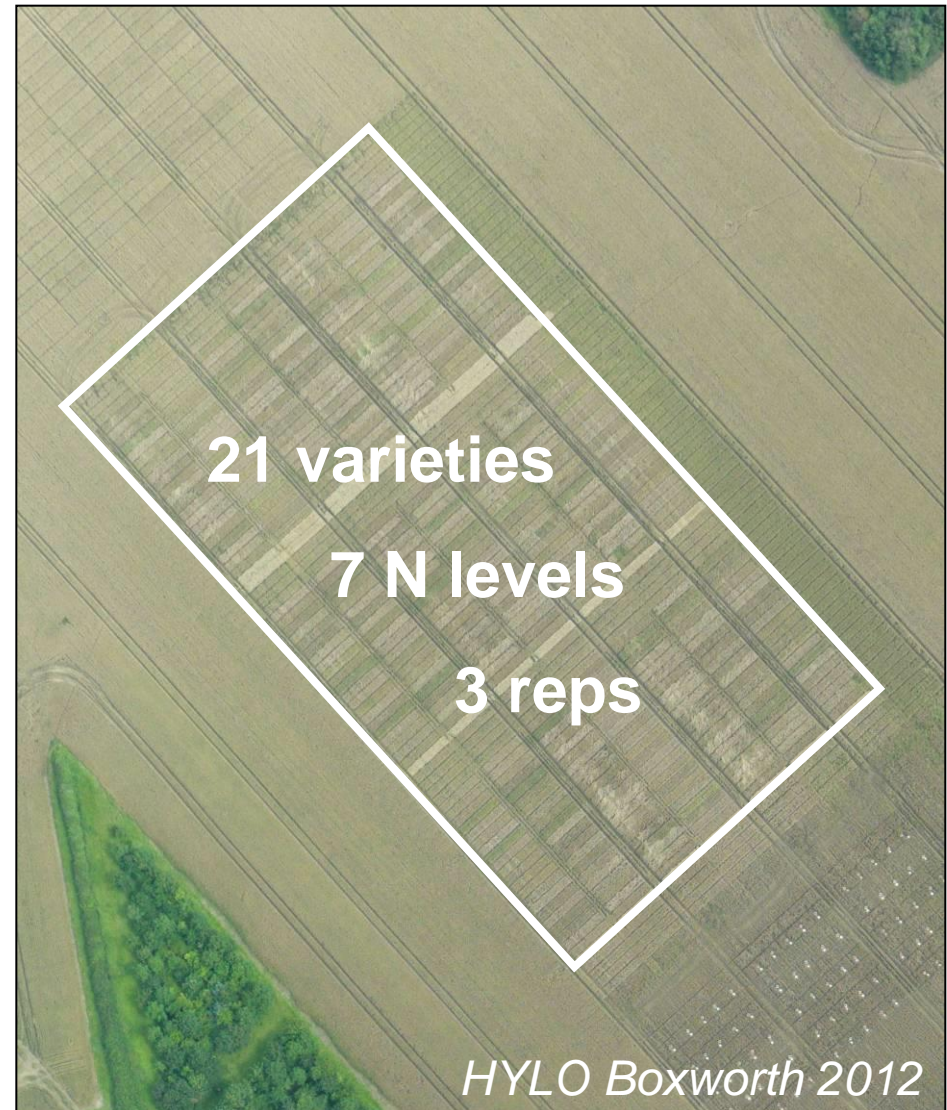


1. Sylvester-Bradley, R. & Kindred, D.R. (2009). Analysing nitrogen responses of cereals to prioritize routes to the improvement of nitrogen use efficiency. *Journal of Experimental Botany* **60**, 1939-1951.
2. Kindred, D.J. & Sylvester-Bradley, R. (2010). Routes to reducing the N requirements of high yielding wheat crops. *Aspects of Applied Biology* **105**, *Water and nitrogen use efficiency in plants and crops*, 97-106.



# HYLO experiments

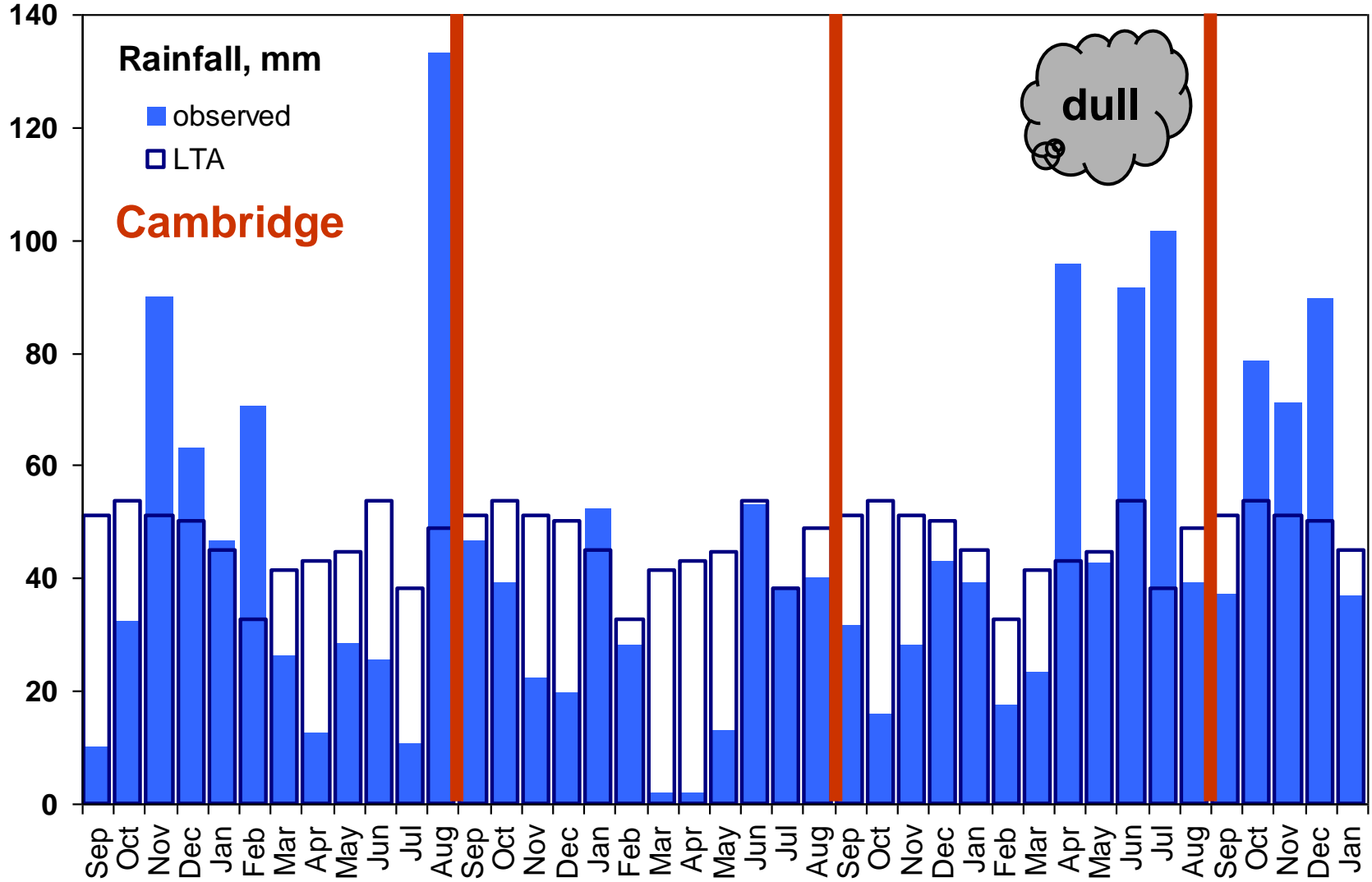
- **21 x 7 x 3 = 441 plots**
  - Large experiments .. >1 ha
  - Triticale had guard plots
- **5 sites**
  - 2 in 2011 & 3 in 2012
- **Fitted N responses**
  - Linear plus Exponential curve
    - ...  $Y = A + B.R^N + C.N$
    - ... Common R for all varieties
- **Spatial patterns tested and 'removed'.**



# Weather data

2010-2011

2011-2012



# 21 varieties

Old

Feed

Bread

HYLO ?

Ac	Acropolis
Al	Alchemy
Bv	Beaver
Bl	Beluga
Cl	Claire
Co	Cordiale
De	Denman
Ga	Gallant
Ga	Gatsby
Gr	Grafton
Tr	Grenado
Hf	Hereford
Hw	Hereward
Ma	Mariboss
Me	Mercia
Oa	Oakley
Pa	Panorama
Ro	Robigus
Sa	Santiago
So	Solstice
Xi	Xi 19

old NL

Feed

old feed

Gp 3 feed

Gp3

Gp 2

new feed

Gp 1

Gp 4 feed

Feed

Triticale

Danish

Gp 1

Danish

old bread

Gp 4 feed

Gp 2

Gp 3

new feed

Gp 1

Gp1

Low protein, high Y-0

High Y-0 (GG)

Low protein, high Y-0

High yield, feed

Low yield, feed

High protein yield

Low protein, high Y-0

High yield, bread

High yield, high biomass

High protein, hard

Low Nopt, tall

Low protein, high Y-0

High protein, low yield

Low protein, high Y-0, tallish

Low yield, low Nopt (WGIN)

High yield, low protein

High yield, bread

Low protein, high Y-0

High yield, low protein

High yield, bread, widely grown

High yield, high Nopt (WGIN)

# Measurements

- **Grain yield ... & Optimum N** – by combine
- **Protein** – by NIR
- **N Harvest Index & N uptake** – from grab samples

## Other possible indicators:

- **Canopy reflectance** – by 'Crop Circle'
- **Light interception** – by Sunscan
- **Canopy temperature** – by infra-red
- **Height** – by manual measurement
- **Senescence** – by visual score, one date
- **Lodging** – by visual score, one date





# Grain yields and N optima

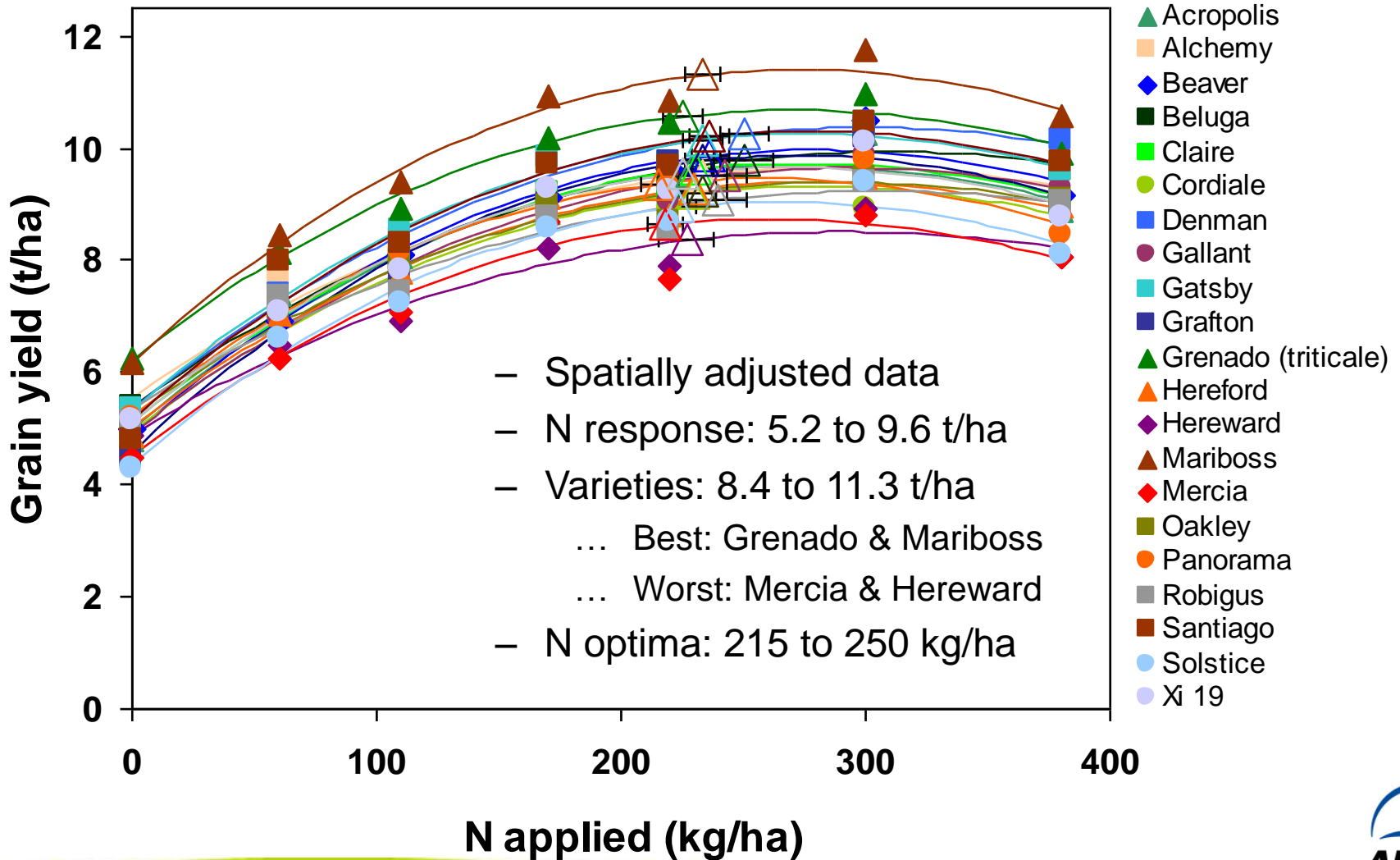


*HYLO experiment at ADAS Rosemaund*

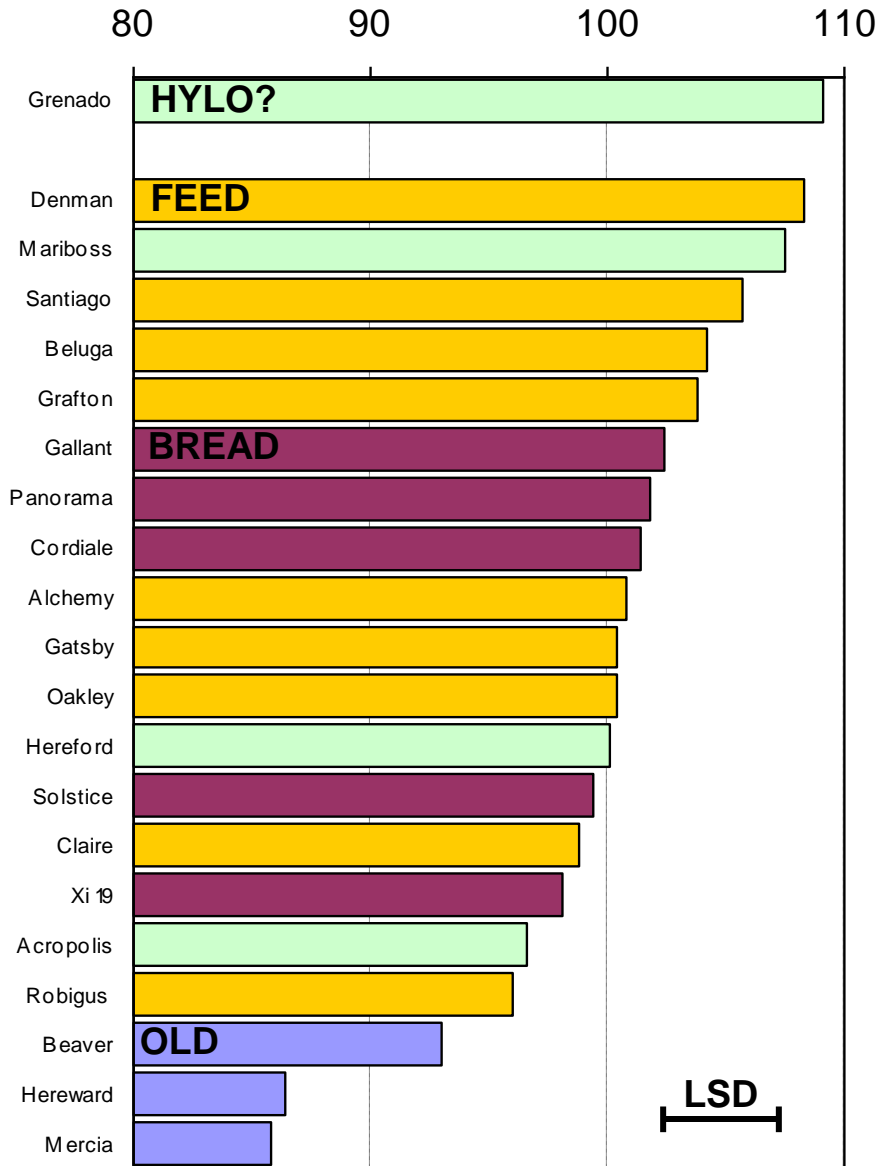
*January 2012*



# Yields at Terrington 2011 ... common 'r' 0.99875



## Mean Optimum Grain Yield (% mean 8.53 t/ha)

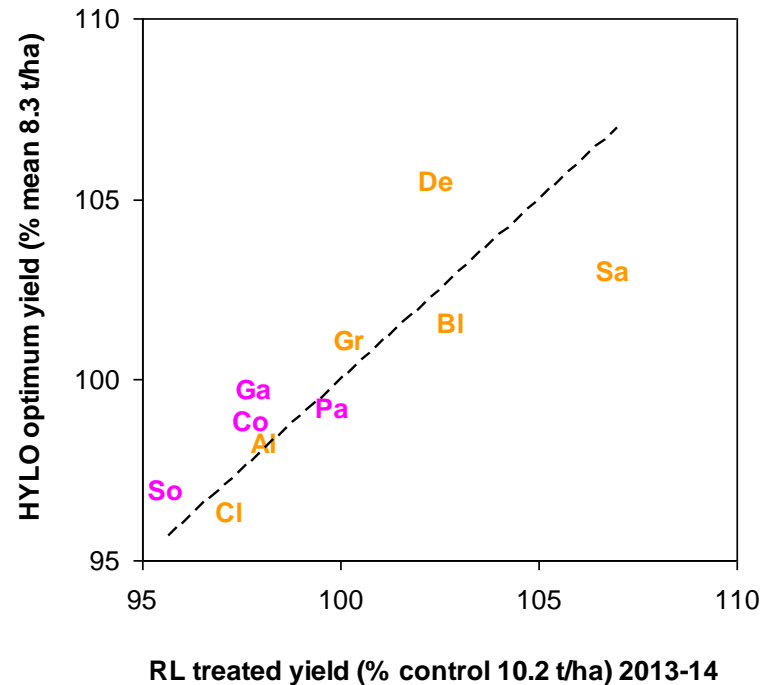


## Five-site analysis

### ■ Optimum Grain Yield

- Variety Probability = <math><0.001</math>
- Range 7.3 to 9.3 t/ha
- LSD 0.57 t/ha

### ■ Compared to RL 2013-14

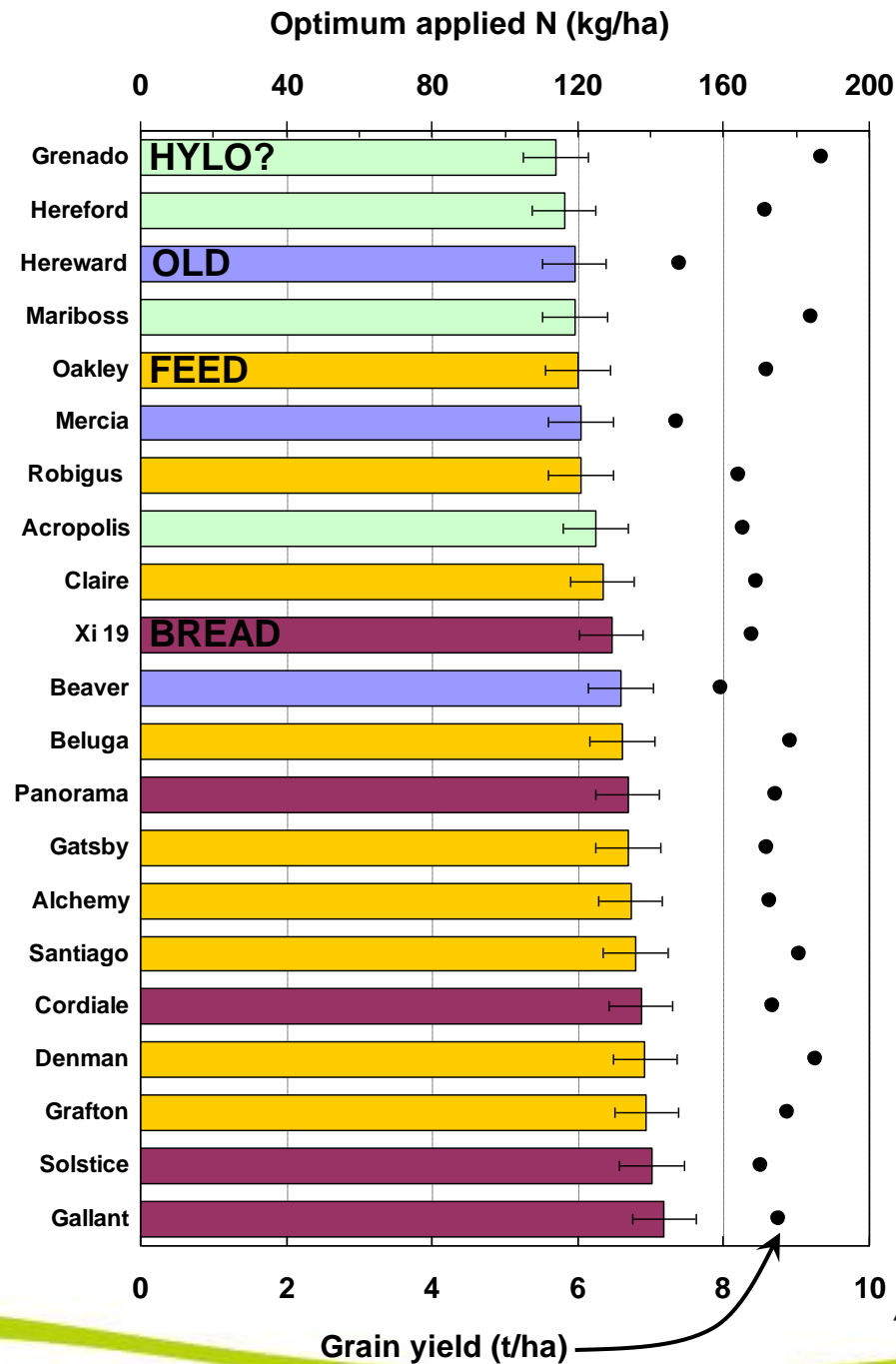




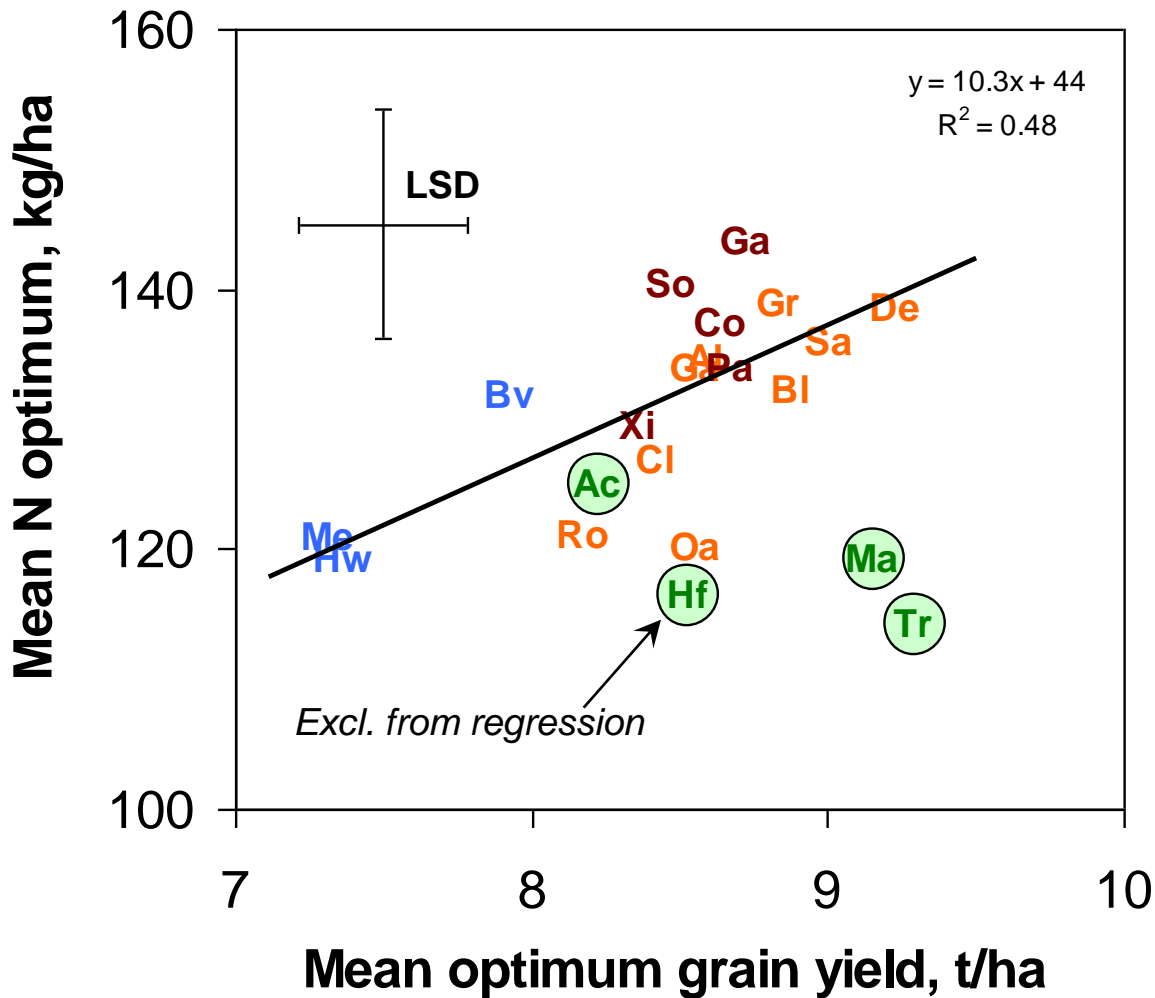
# Five-site analysis:

## ■ N optimum

- Variety Probability = 0.016
- Range 114 to 144 kg/ha
- LSD 17.6 kg/ha



# Five-site analysis – yields and N optima



## Four groups:

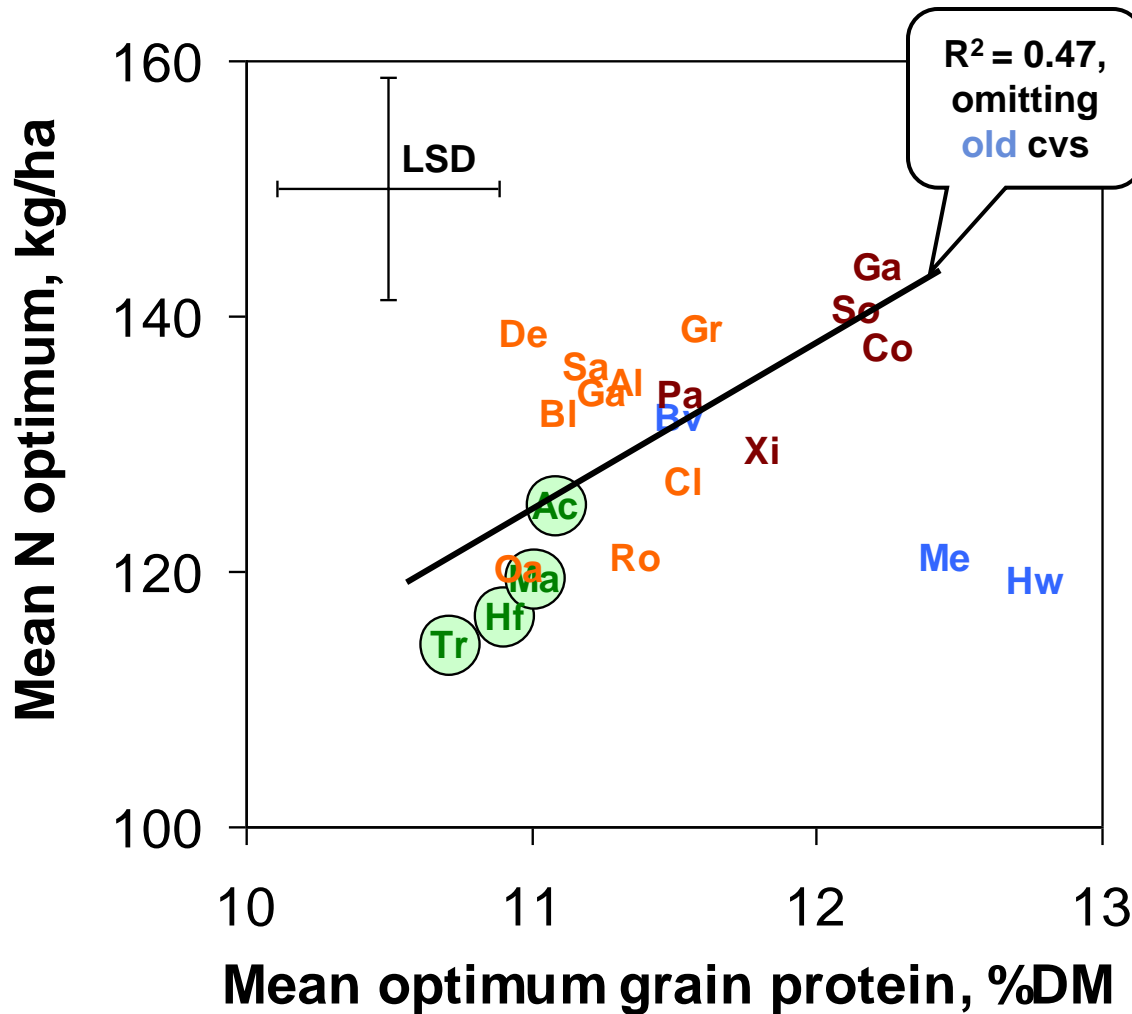
- **L-Y L-O**
  - Old cvs
- **M-Y H-O**
  - New bread cvs
- **H-Y H-O**
  - New feed cvs
- **H-Y L-O**
  - Mariboss & Triticale

# Grain Protein





# Grain Protein – Five-site analysis & summary



## ■ Protein responses

- Affected by 'odd' weather
- Some poor model fits
- Evidence of cross-over, but often parallel

## ■ Opt. grain proteins

- Variety effect
  - ...  $P = <0.001$
- LSD 0.78 %
- Range 10.7 to 12.8 %DM
- Vary according to type
- Low protein varieties have low optima.
  - ... despite higher yields

# Other Measurements

- **Leaf chlorophyll** ... *'SPAD' in May & June*
  - No significant variety effect
- **Canopy reflectance** ... *'Crop Circle' in May*
  - $P=0.001$ . Hereford low, Grenado high
- **Light interception** ... *by Sunscan in June*
  - $P=<0.001$ . Hereford low, Grenado & Mariboss high
- **Canopy temperature** ... *by infra-red*
  - No significant variety effect
- **Height** ... *in late June*
  - $P=<0.001$ . Grafton low, Grenado high
- **N harvest index**
  - $P=0.02$ . Cordiale & Denman high, Grenado low
- **Senescence** ... *visual score in July*
  - $P=0.006$
  - Cordiale & Gallant early, Alchemy & Mariboss late.



# Summary .... despite 2 odd years

## ■ Inter-site consistency in variety effects

- Grain yield ... significant differences ... as expected from HGCA RL
- ALSO ... Optimum N .. range 30 kg/ha N
  - ... Grenado, Mariboss & Hereford generally had good yields and low N optima
  - ... Oakley was best of RL varieties .. also had lowest protein
  - ... Mercia & Hereward had low N optima ... & low yields

## ■ Conclusion for wheat breeders & testers

- HYLO wheat varieties do exist ... & can be detected
- But not amongst Recommended List varieties ... esp. breadmaking types
- Low grain protein may be indicative ... other traits not convincing

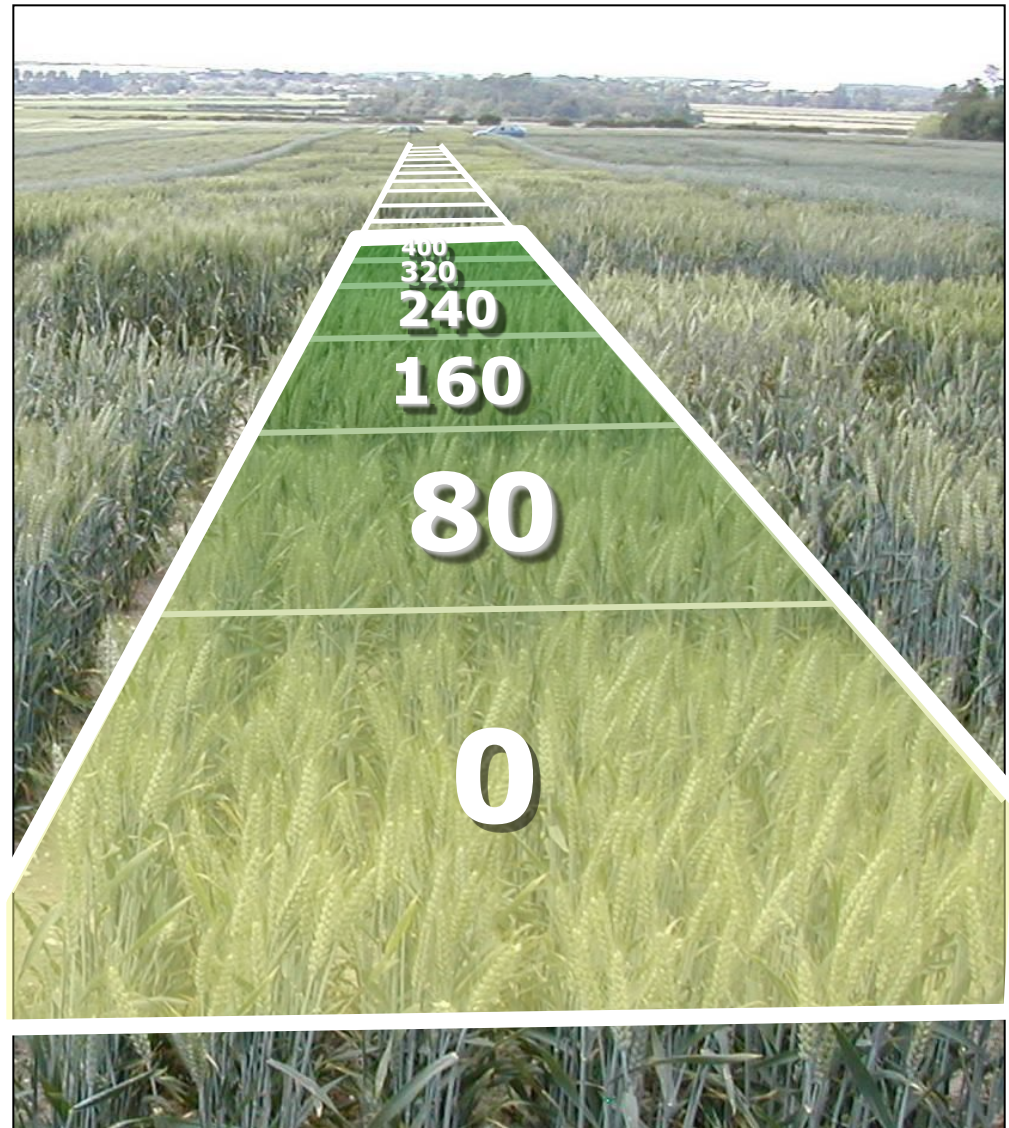
## ■ Further work

- New trial methodology ...
- (Complete analysis of Oilseed Rape experiments).



# Idea for improved trial design: 'Opti-plots'

- **Aim:**
  - Direct determination of N optima on all RL candidates
  - Without increasing seed requirements
- **Smaller plots**
  - Systematic N treatments ?
  - Special machinery ?
  - New statistics ?
- **TSB Agronomics project**
  - Testing Optiplots 2014-2016.





# Thank you

