WGIN and nitrogen

Dissecting NUE

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WGIN Stakeholder Meeting

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Wheat Genetic Improvement Network

defra
Department for Environment Food and Rural Affairs

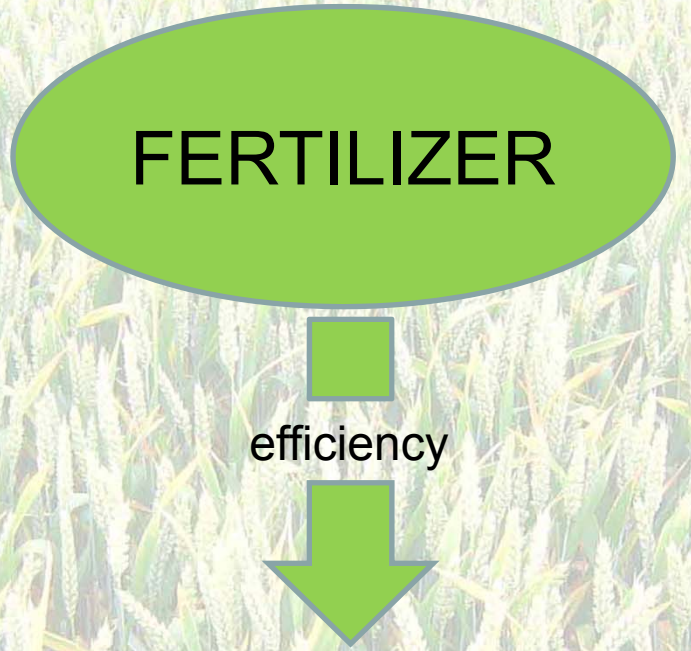
ROTHAMSTED RESEARCH

Talk overview

- Why N, why NUE?
- Dissecting NUE
- Examining genetic diversity (WGIN project, since 2003)
  http://www.wgin.org.uk/
- Even more diversity!
- Exploiting diversity and environment to dissect pathways and identify novel genes

Why do we care about nutrient (nitrogen) efficiency in wheat?

Financial costs
Conventional farmers
Fertilizer producers
Organic growers
Millers
Bakers



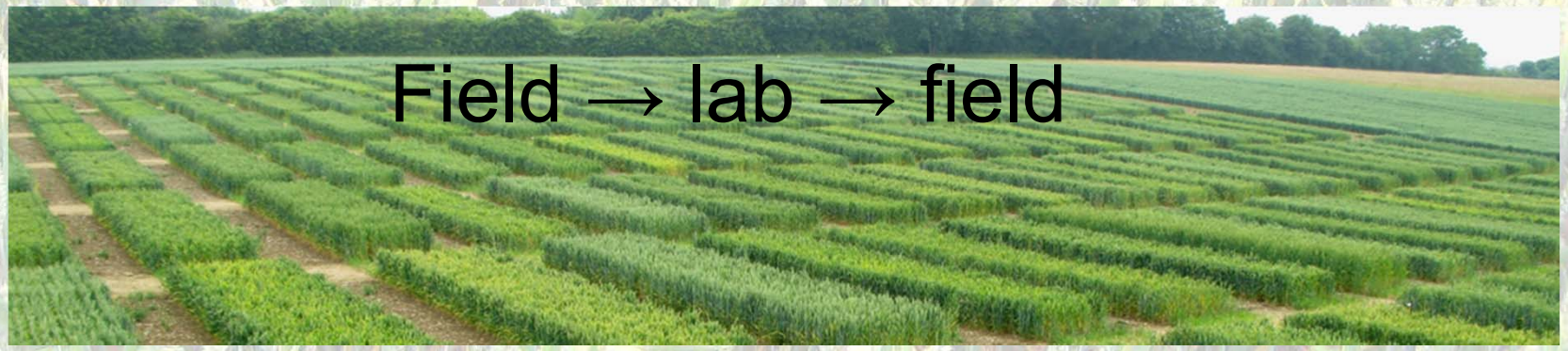
Sustainability
Non renewable (P?)
Energy costs for production
Carbon footprint

Food security
Increase yields
Challenging environments
Challenging climate
World agriculture

Environmental costs
Government/legislation
Public concerns
Carbon footprint

Many ways to dissect NUE

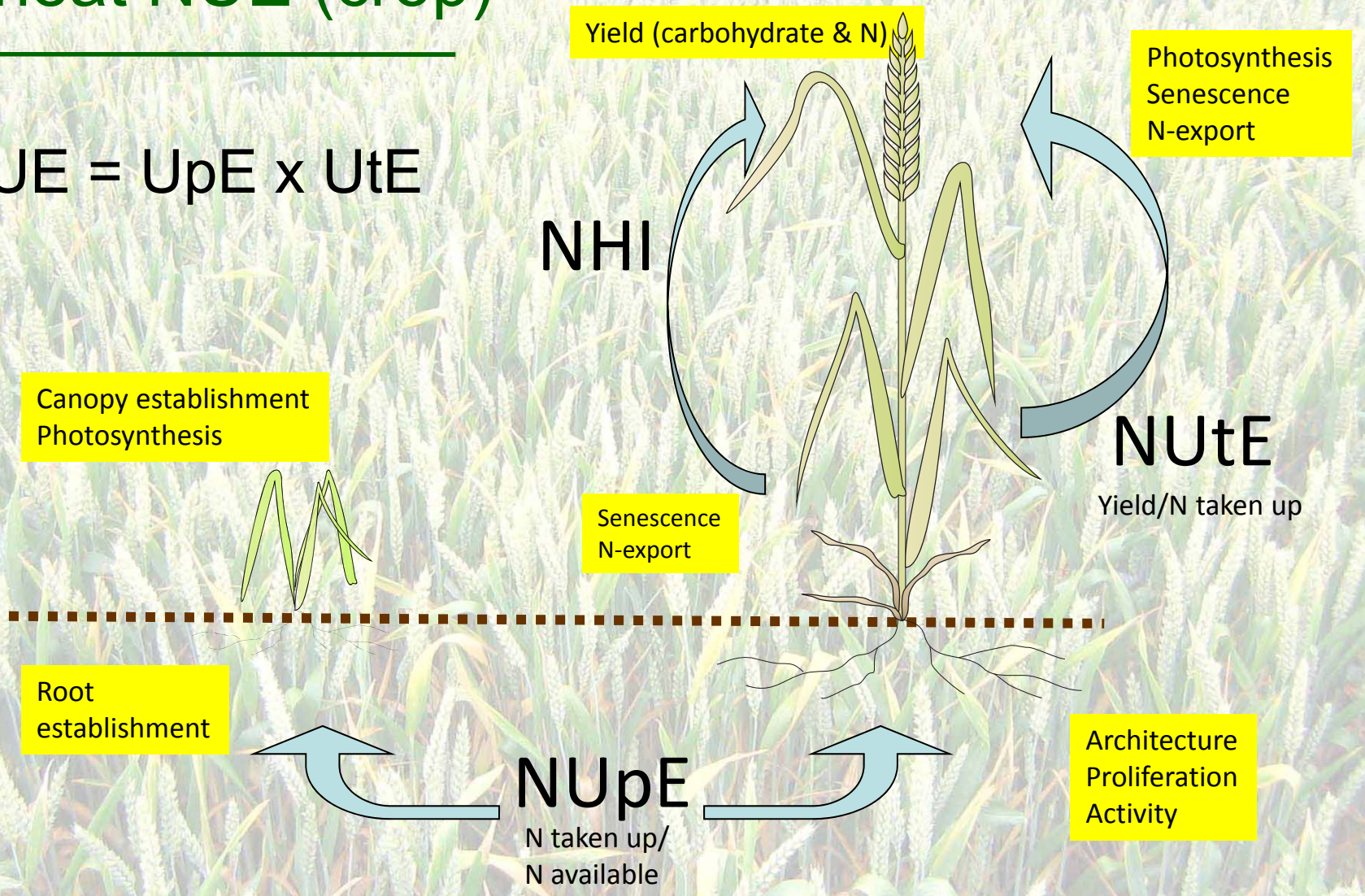
- Crop
- Plant
- Metabolic pathways
- Genes



Avalon x Cadenza, Rothamsted 2010

Wheat NUE (crop)

NUE = UpE x UtE



Resolving traits (physiology/biochemistry)

acquisition	**canopy**		**yield**
Root architecture Activity Sink strength Translocation	Establishment Extent Activity Longevity Senescence	Leaf N N export Stature HI NHI	Carbohydrate N content (1.1-2.8%)

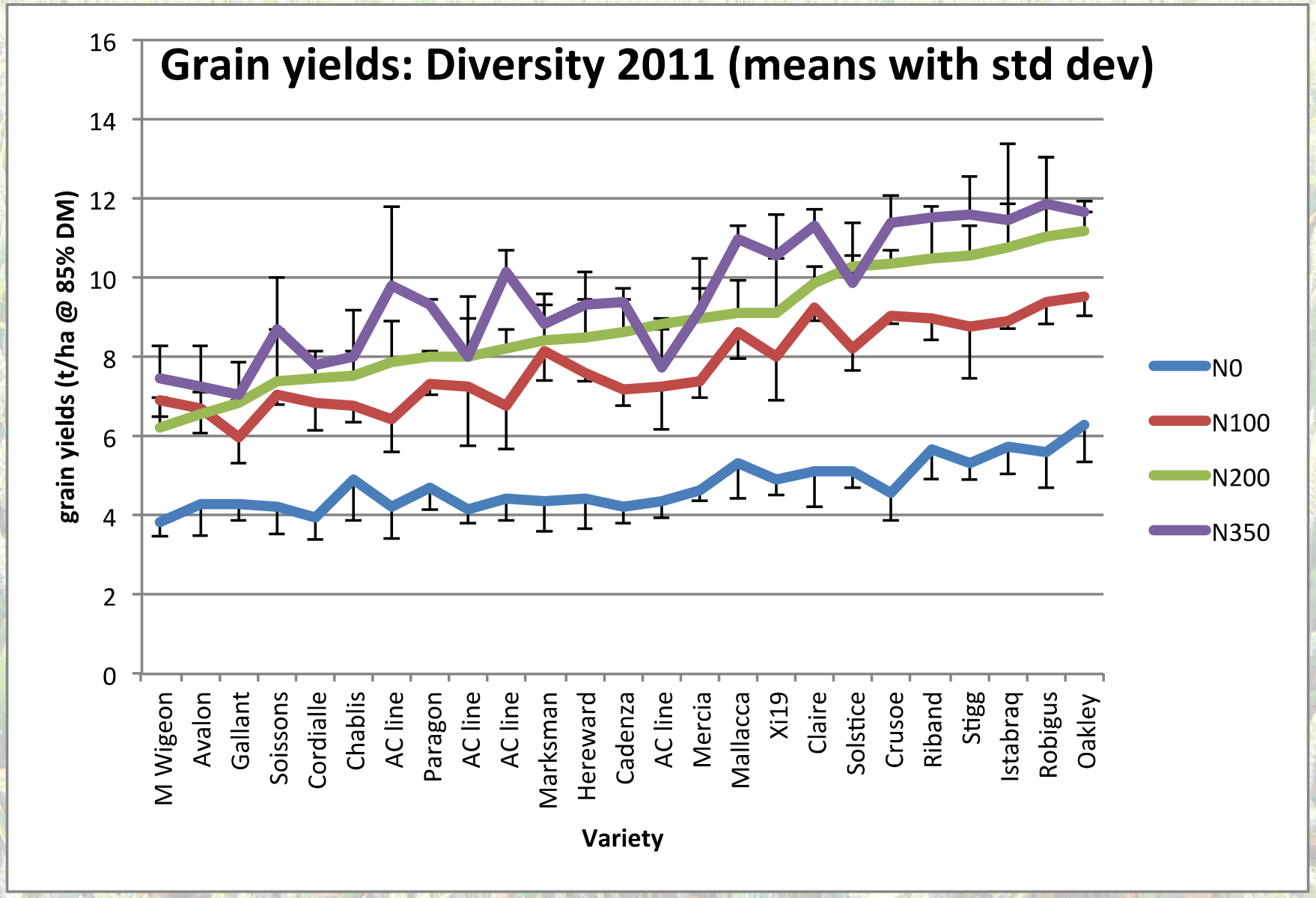
For all component traits:
Multiple pathways, enzymes, genes and control sites/forms of regulation involved

The WGIN Diversity trials

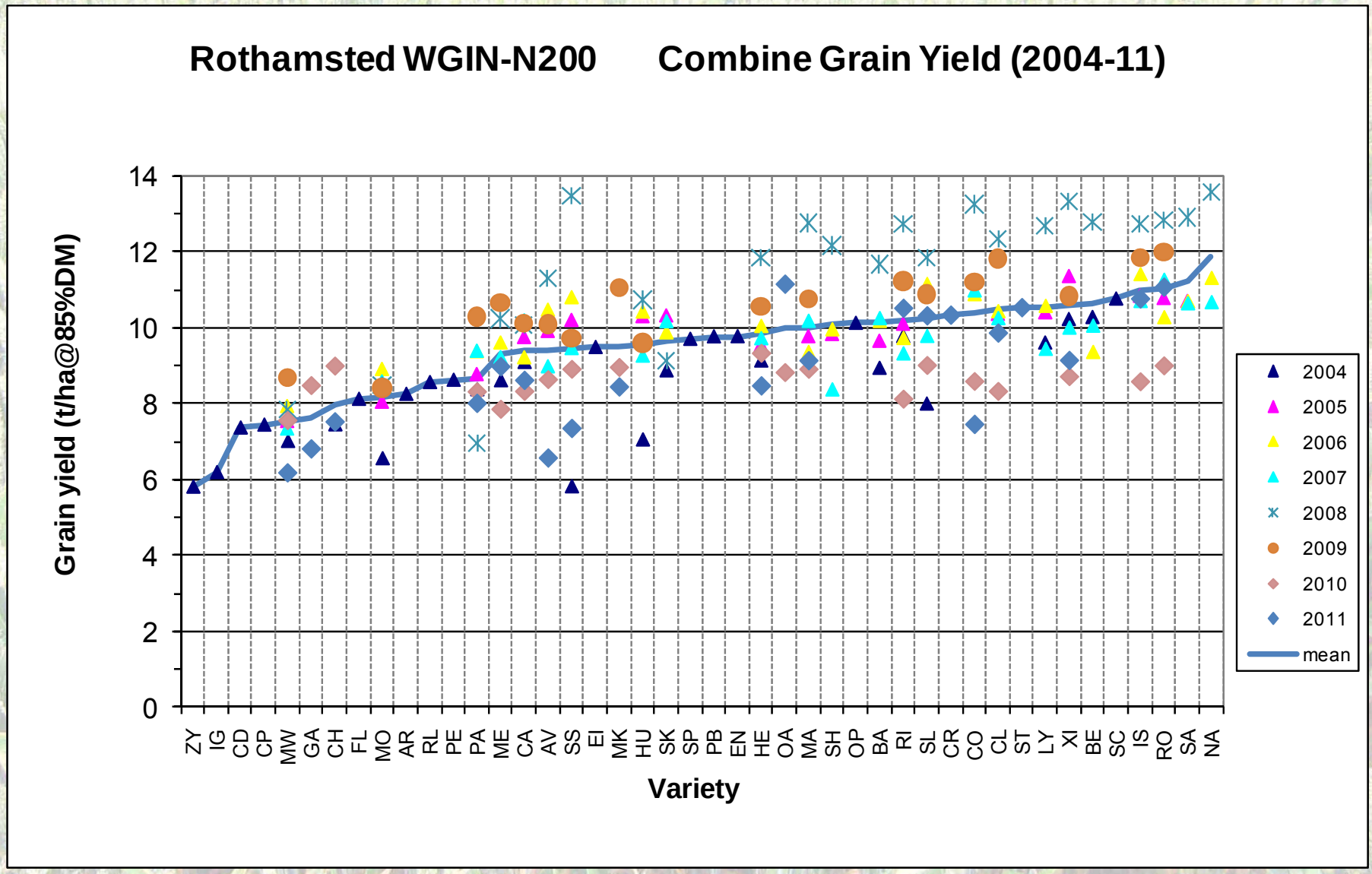
WGIN Diversity trial history

Trial	Year	Varieties (core of 9)	N-levels	kg N/ha
1	2004	32	4	0,50,200,350
2	2005	20	2	0,200
3	2006	24	3	0,100,200
4	2007	24	4	0,100,200,350
5	2008	24	4	0,100,200,350
6	2009	24 (include 6 x A x Cs)	4	0,100,200,350
7	2010	25 (include 6 x A x Cs)	4	0,100,200,350
8	2011	25 (include 4 x A x Cs)	4	0,100,200,350
9	2012	25 (include WUE/take-all lines)	4	0,100,200,350
10	2013	25 (include WUE/take-all lines)	4	0,100,200,350

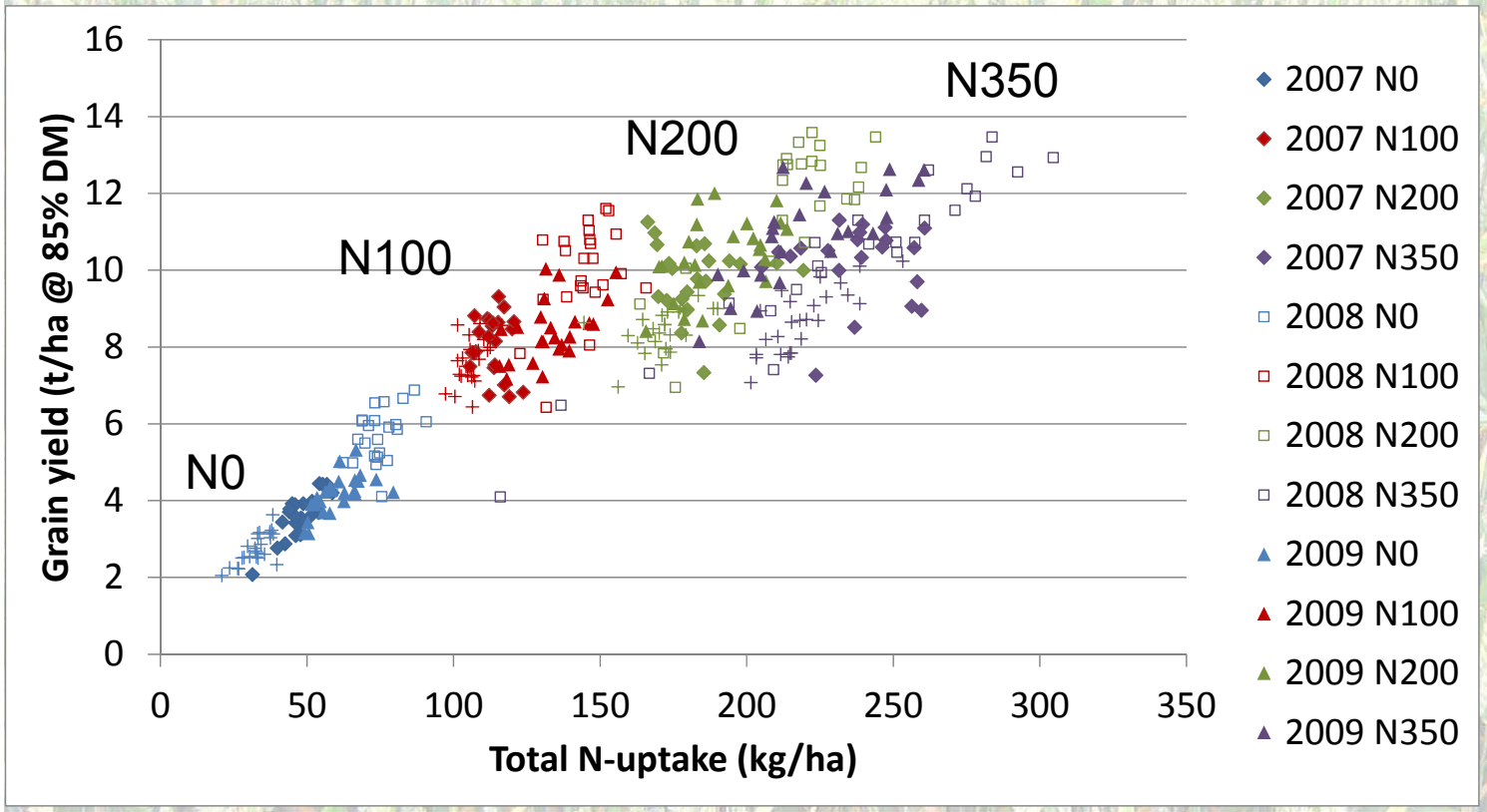
N-responses


Grain yields: Diversity 2011 (means with std dev)
grain yields (t/ha @ 85% DM)
16
14
12
10
8
6
4
2
0
M Wigeon
Avalon
Gallant
Soissons
Cordialle
Chablis
AC line
Paragon
AC line
AC line
Marksman
Hereward
Cadenza
AC line
Mercia
Mallacca
Xi19
Claire
Solstice
Crusoe
Riband
Stigg
Istabraq
Robigus
Oakley
Variety
N0
N100
N200
N350

Year to year variation

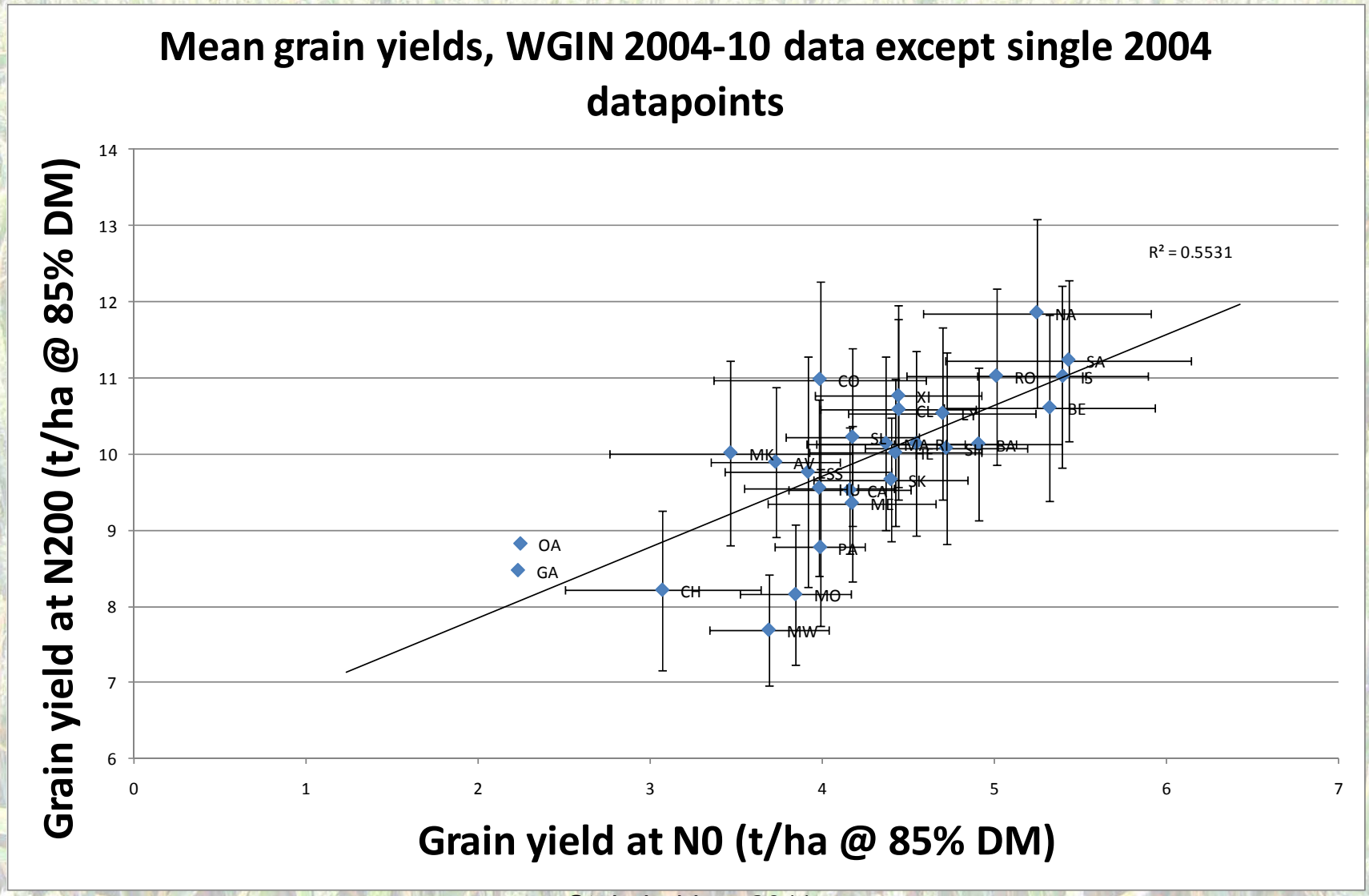


Grain yield and N uptake



- Plateau of yield although uptake increases with increasing N-supply
- Factors other than uptake limiting yield
- Grain yield less strongly related to N-uptake
- Clustering (weak relationship between yield and N-uptake) at any one N-supply and year

Performance at high compared to low N



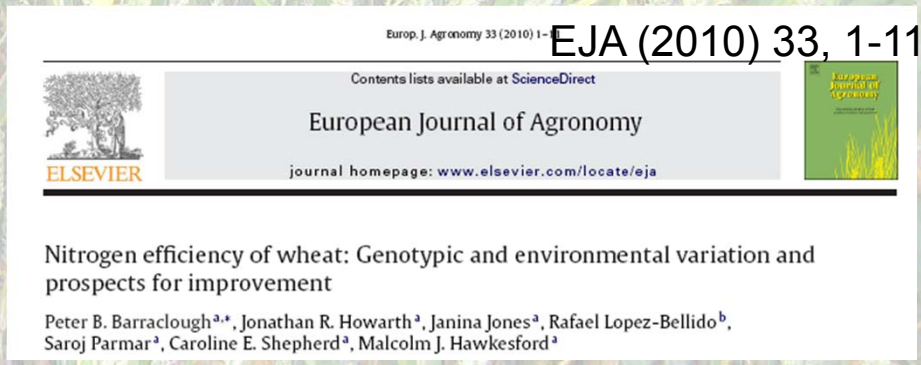
Variety Performance at 200 kg-N/ha (2004-08)

Variety	Code	Nabim	Years	Yield	%N	Uptake	Utilisation
Avalon	AV	1	5				
Flanders	FL	1	1				
Hereward	HE	1	5				
Hurley	HU	1	5				
Malacca	MA	1	5				
Mercia	ME	1	4				
Maris Widgeon	MW	1	5				
Shamrock	SH	1	4				
Solstice	SL	1	5				
Spark	SP	1	1				
Xi 19	XI	1	5				
Cadenza	CA	2	5				
Cordiale	CO	2	3				
Einstein	EI	2	1				
Lynx	LY	2	5				
Rialto	RL	2	1				
Scorpion	SC	2	1				
Soissons	SS	2	5				
Beaver	BE	3	4				
Claire	CL	3	4				
Riband	RI	3	5				
Robigus	RO	3	4				
Istabraq	IS	4	4				
Napier	NA	4	3				
Savannah	SA	4	4				
Paragon (spring)	PA	1	5				
Chablis (spring)	CH	2	1				
Arche	AR	F	1				
Batis	BA	G	5				
Caphorn	CP	F	1				
Cappelle Desprez	CD	F	1				
Enorm	EN	G	1				
Isengrain	IG	F	1				
Monopol	MO	G	5				
Opus	OP	G	1				
PBis	PB	G	1				
Petrus	PE	G	1				
Sokrates	SK	G	5				
Zyta	ZY	P	1				

Upper-Q
Inter-Q
Inter-Q
Lower-Q

Individual varieties show specific attributes

Summary of variety performance (quartile rankings) based on 2004-07 WGIN datasets



EJA (2010) 33, 1-11

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Even more diversity?

Wheat pre-breeding Lola :

Rothamsted and Nottingham Biomass/NUE trials 2011 and 2012

‘Donor material’ coming Watkins and Gediflux collections, SHWs (NIAB) and more mapping populations

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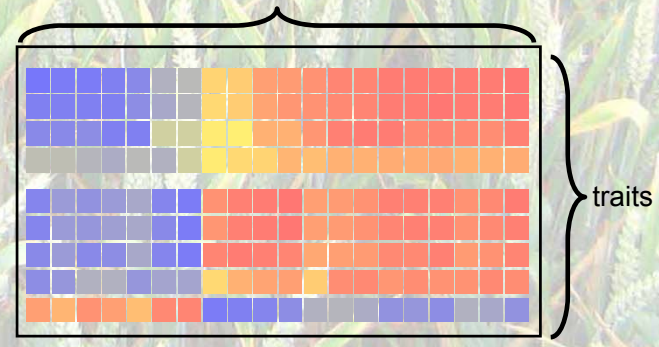
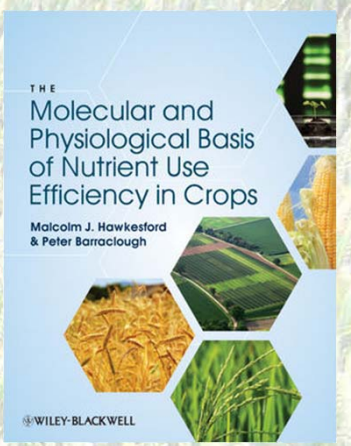
Summary

- NUE is a complex trait
- Many ways to dissect NUE
- There is substantial genetic diversity in modern elite wheat but potentially a lot more in more exotic germplasm
- Germplasm screening combined with transcriptomics is a powerful tool for novel gene identification
- Key target traits? Roots, canopy longevity and grain N



Thanks



- Group and field team: Peter Barraclough, Peter Buchner, Andrew Riche, Saroj Parmar, Yongfan Wan, Jonathan Howarth, Adinda Derkx, Caihong Bai, Astrid Grün + many summer students
- WGIN and LOLA Pre-breeding teams
- RRes Farm staff

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