BBSRC bioscience for the future

Germplasm Resources Unit

..... a national capability supported by the BBSRC at the John Innes Centre

John Innes Centre

DFW Breeders Toolkit: Arming the Commercial Breeding Industry with Novel Alleles for the Future

Simon Orford

Germplasm Resources Unit

John Innes Centre

DFW

30th November 2017

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Germplasm Resources Unit

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Presentation Overview

- 1 – The Germplasm Resources Unit (GRU) and its role in Designing Future Wheat

- 2 – The DFW Breeders Toolkit.

Its concept, what it will deliver to the Breeding Industry and its challenges

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Germplasm Resources Unit

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National Capability Grant

In 2012 the GRU successfully obtained a BBSRC NCG

- A centralised Resource Unit for DFW BTK
- Increased visibility: New GRU Website, greater participation at plant conferences and YouTube channel
- Greater public access to resources and information.
- Modernisation of the way GRU handles requests and stock control (shopping cart, cost recovery).
- Greater capacity for stock regeneration (JIC Hort services /Field services)
- Improved quality control and audit trails.
- Direct accountability to the Research Council and steering com

GRU Collections

3615 Pea

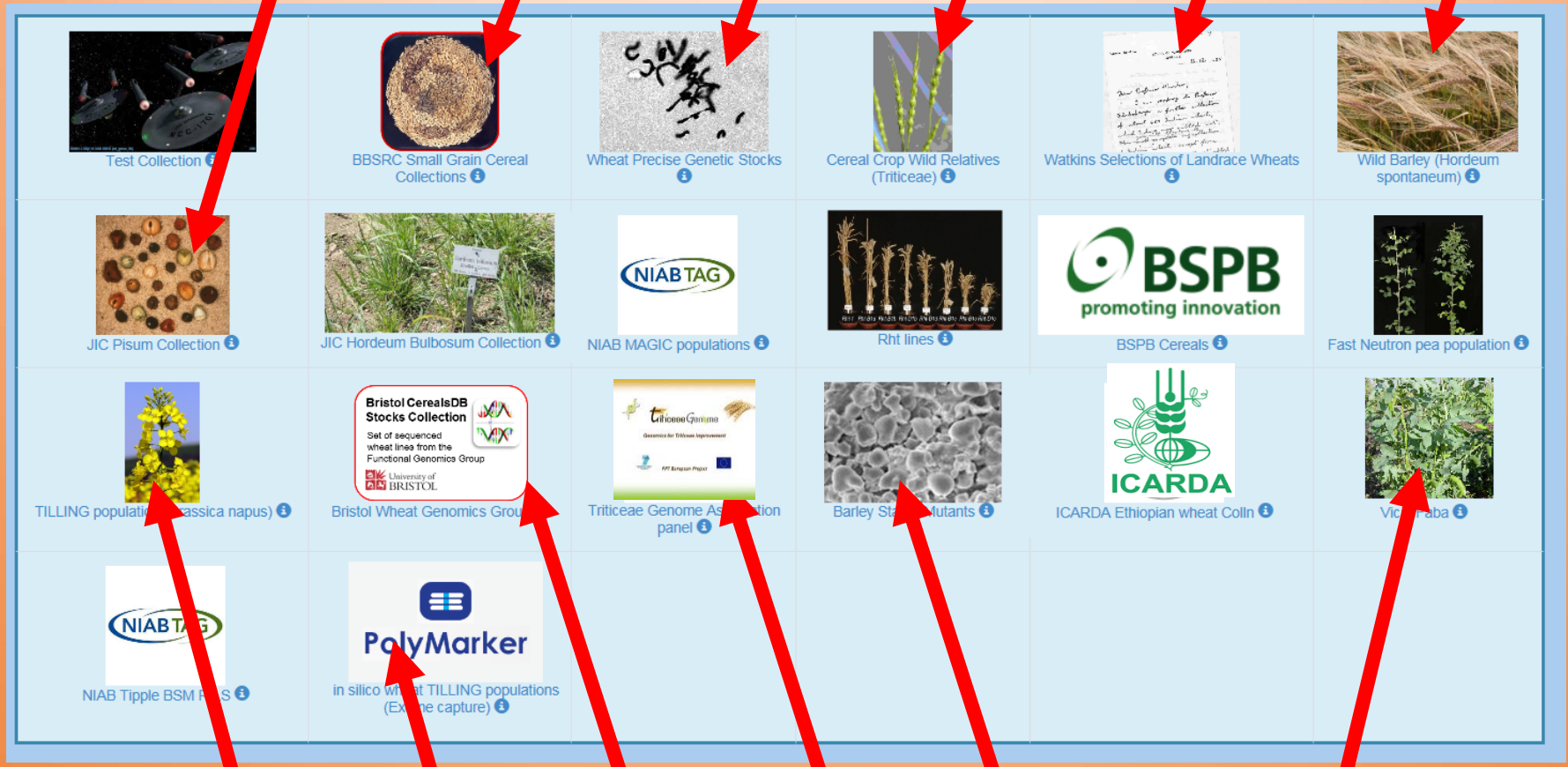
2663 Oat
9786 Wheat
10978 Barley

3246 Wheat

966 *Triticeae* & *Aegilops*

~1200 Wheat

~13000 Barley



~6000 Oil Seed Rape

2739 Wheat

60 Wheat

376 Wheat

80 Barley

~300 Beans

Storage at 1.5°C and 10% RH

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Derived Germplasm Specialist

Incorporating a range of resources into the GRU – 'SeedStor'

- Ensuring a range of GRU Resource tools (Derived - mapping, tilling populations, Near Isogenic Lines) are maintained, utilised and freely available
- Enabling academia and industry to get what it wants out of the GRU with Quality Control guidelines (identity, viability…)
- Operating as the DFW Breeder Toolkit centralised location
- Ideal opportunity to announce new appointment

Germplasm Resources Unit

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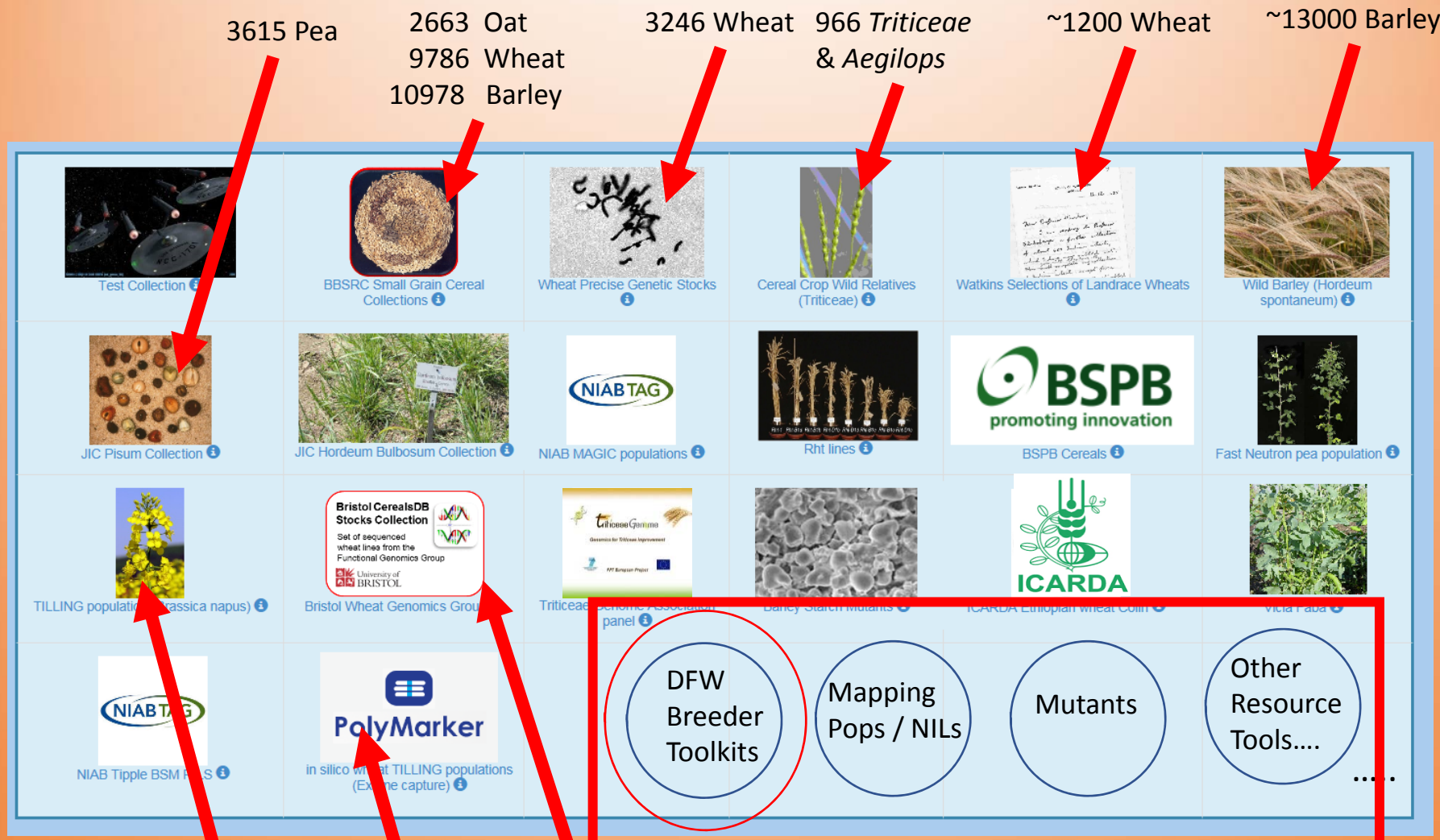
Newly appointed GRU Manager

Noam Chayut

GRU Collections



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Germplasm Resources Unit

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Designing Future Wheat (DFW)/ Breeders Toolkit Partners

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ROTHAMSTED RESEARCH

Limagrain United Kingdom

LSPB

BAYER

University of BRISTOL

DFW

RAGT SEEDS

Earlham Institute

Elsoms

Quadram Institute Science • Health • Food • Innovation

EMBL-EBI

syngenta

KWS

NIAB

The University of Nottingham

DSV

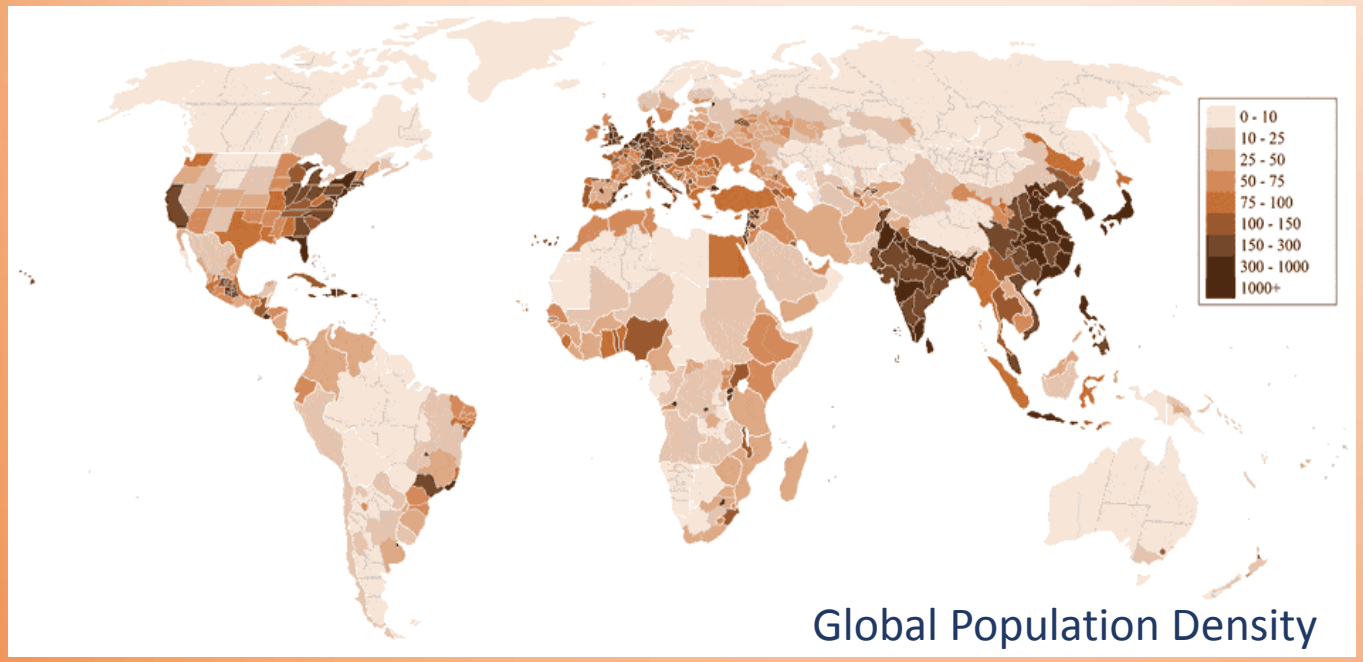
What is Driving us?

Unpredictable climate,

Increasing legislation,

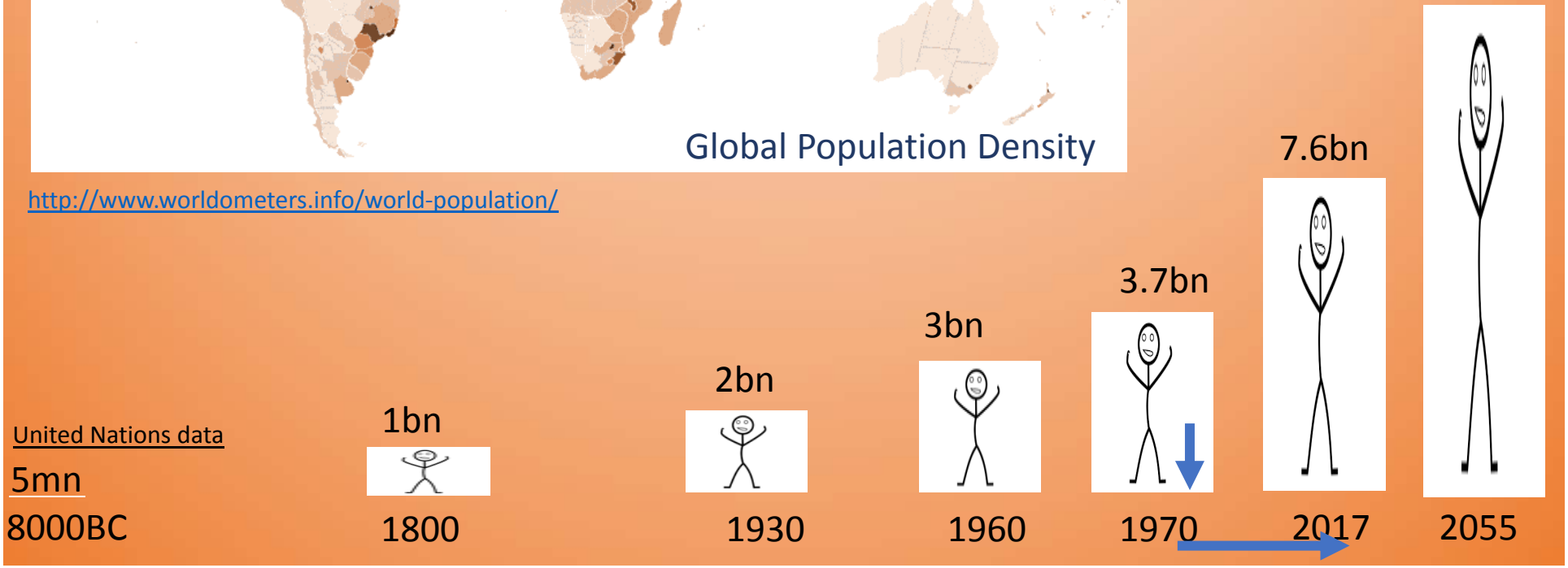
Environment concerns

Changing lifestyle



Global Population Density

http://www.worldometers.info/world-population/



The DFW The Breeders Toolkit – The Concept

- Delivery and interface role for Researchers and their work at Rothamsted, Nottingham University, NIAB and JIC to the Breeding Industry
- Applied aspect of getting valuable generated resources offering agronomic advantages (comparable, trackable and testable) out into the real world of breeding
- Genetically trackable research on to the big stage

Breeders Toolkit Concept

DFW Research

Testable, comparable trackable alleles with agronomic improvements

Breeders Gene Pool

Breeders Toolkit Concept

Varietal Inclusion

DFW

Breeders Gene Pool

Breeders Toolkit Concept

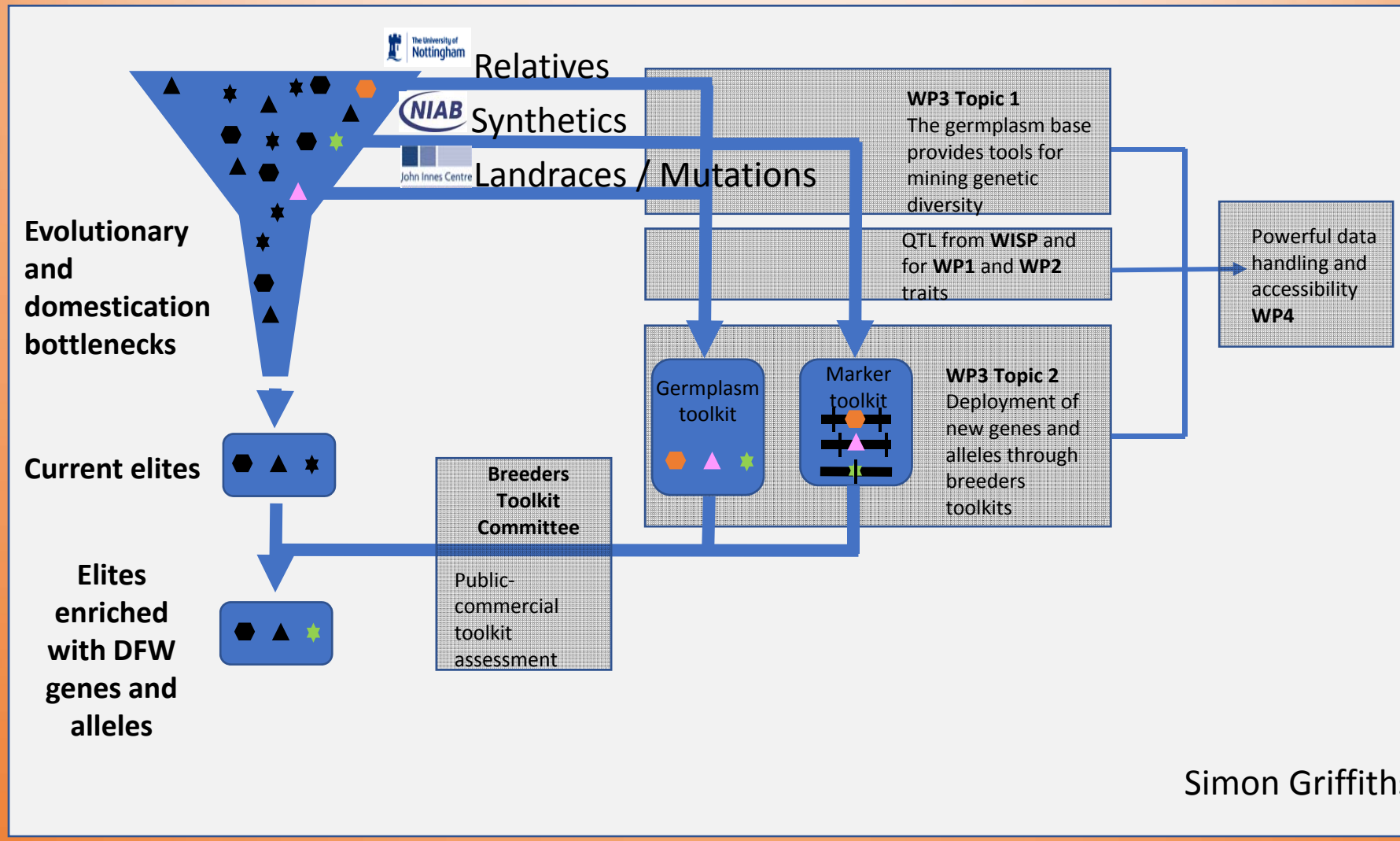
Varietal Inclusion

DFW

The Breeders Toolkit

Breeders Gene Pool

DFW strategy to long term food security – The Work Packages in DFW



Simon Griffiths

Breeders Toolkit Deliverables

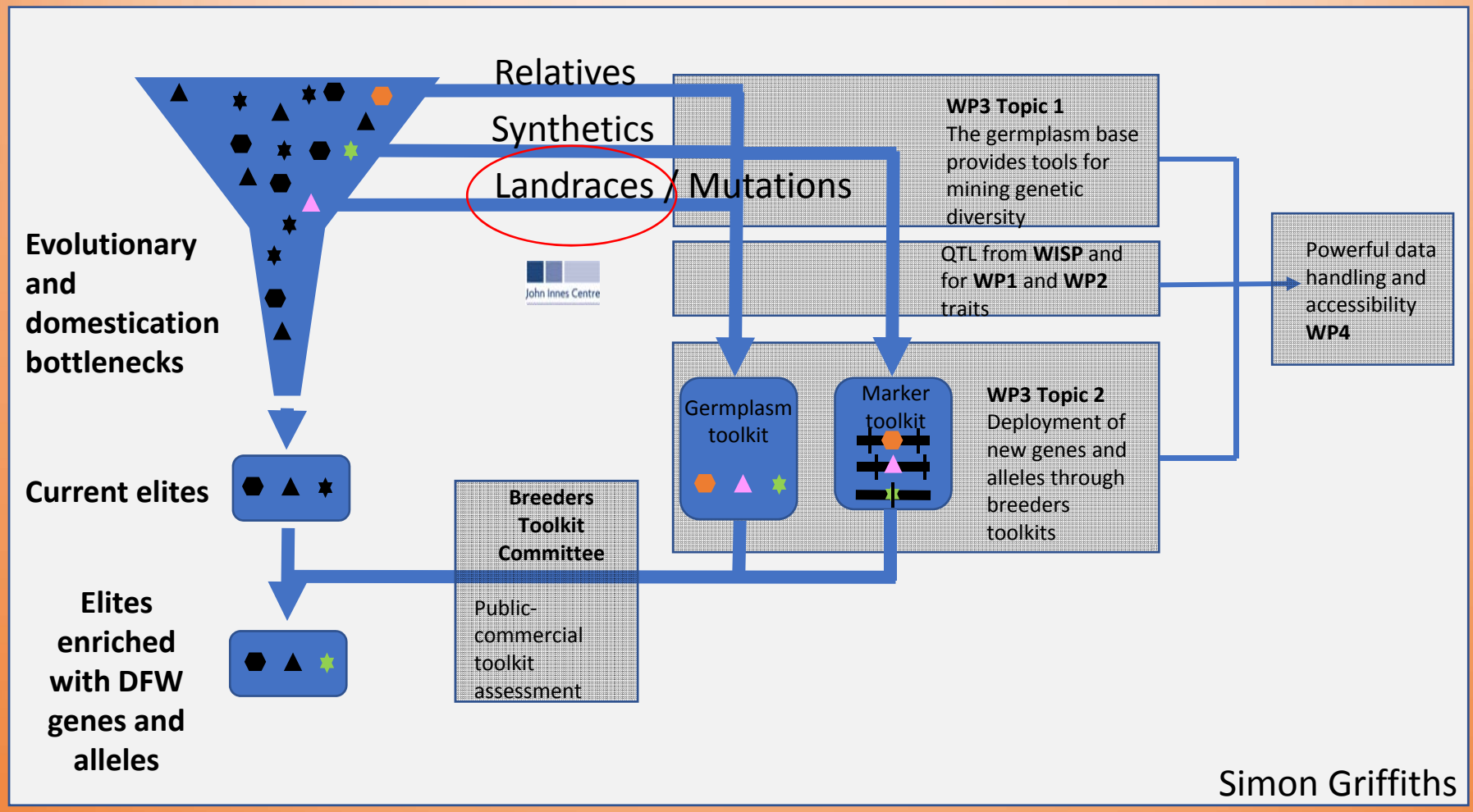
Multi site field trial quantity test material

Precise material for breeder's crossing

Origin	NIL stream	QTL / Gene	Landrace/ Mutant sib	Paragon/ Wildtype sib	Markers used for selection
WISP landrace	PW141-16	2D-EM	12W	10P	BS00003804 BS00069899 BS00021912
WISP landrace	PW034-19	2B-EM	12W	11P	BS00064155 BS00074661
EMS (Uauy group)	TILLING line T4-2235	GW2-A1 a	mutant (A)	wildtype (G)	TaGW2_A_F_specific TaGW2_A_R_wildtype TaGW2_A_R_mutant

Marker information to track inclusion

The Mining of Landrace Alleles Approach



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A. E. Watkins Landrace Diversity

Example of sturdy/high biomass

With PGR: Heights 55 – 150cm

Ear emergence 77 – 109 days

Extensive array of ear types

A global snapshot of wheat evolution

Core set established to capture this

Not so sturdy

Immense diversity discovered – what next?

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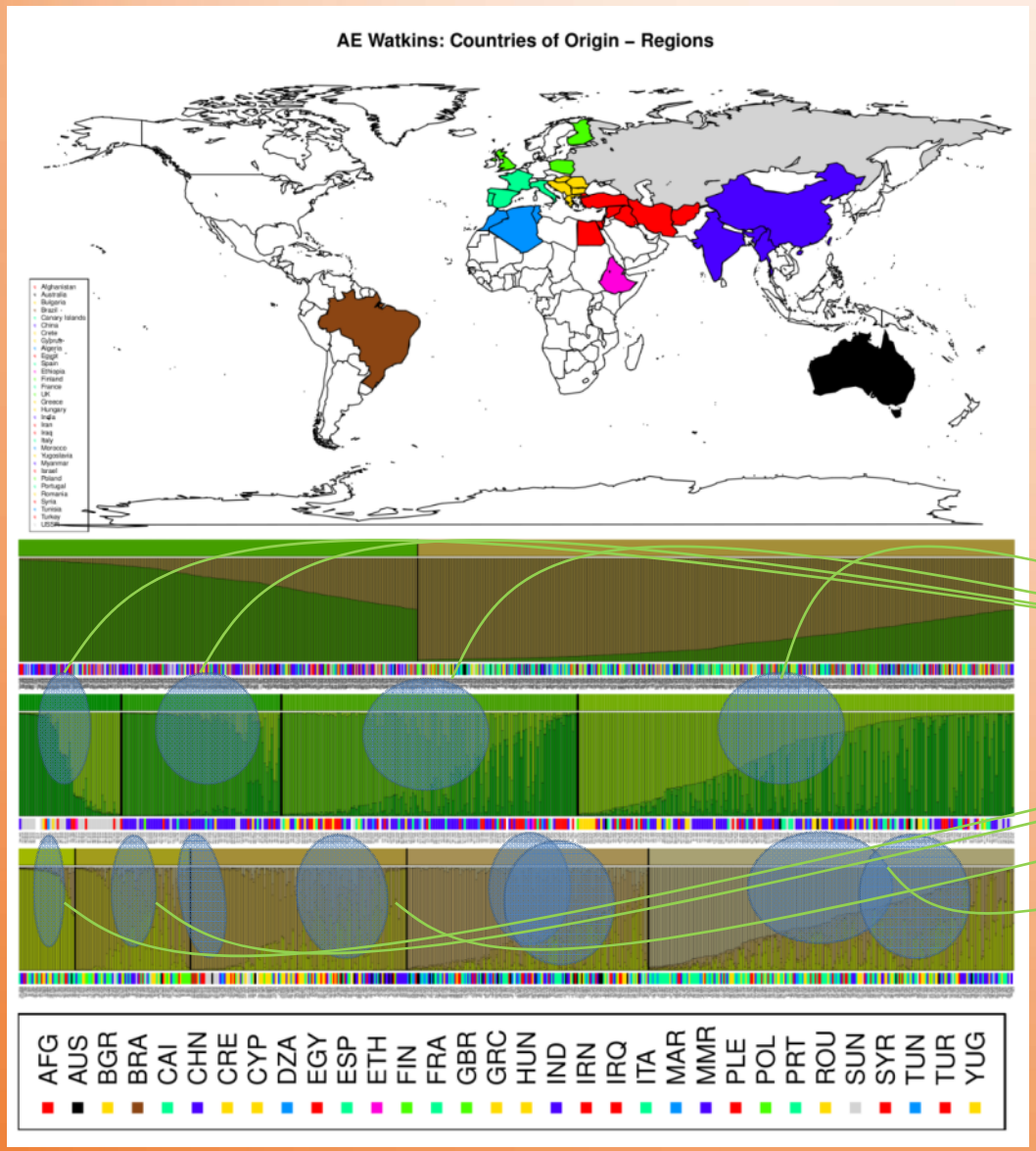
Genetic structure information allows us to produce a core set



1050
Entire
Collection

120
Core

Development of 85 Segregating Populations

(S) Denotes season

Season 1 – Novel F1 cross to Paragon UK Spring bread wheat

F1 plant (3 plants) bulked 1L pot 100-500 seeds each (S2)

F2 – F3 Single tiller (S3)

F3 – F-4 Single tiller (S4)

F4 – F5 tray to 1L pot (S5)

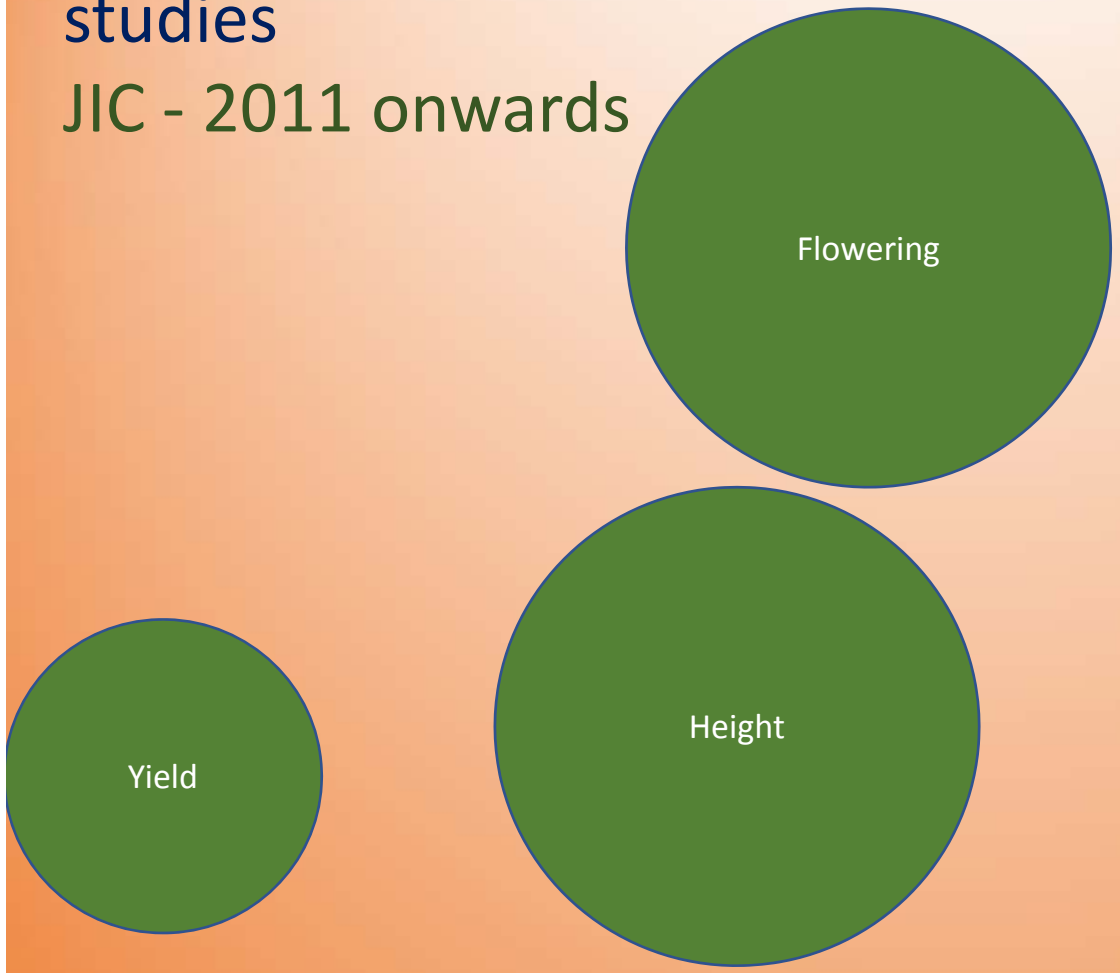
First field entry bulking and trait candidates (S6)

Further field testing eg 'use efficiencies'

GRU Resource tools

Landrace mapping populations studies

JIC - 2011 onwards



Early Landrace mapping efforts focussed data for the Griffiths Group ‘major three’

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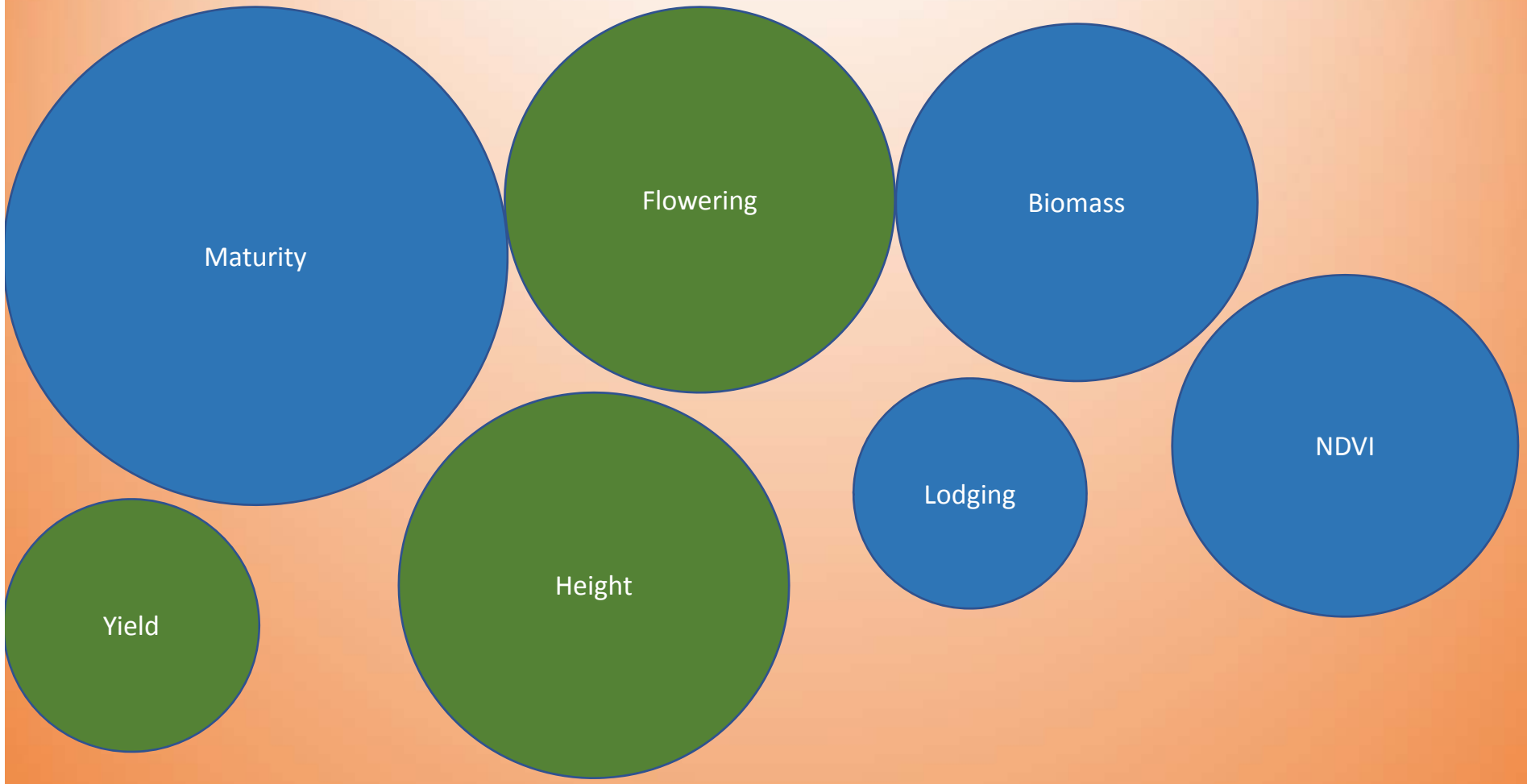
Mapping populations studies

Rothamsted, Nottingham and JIC 2012 onwards



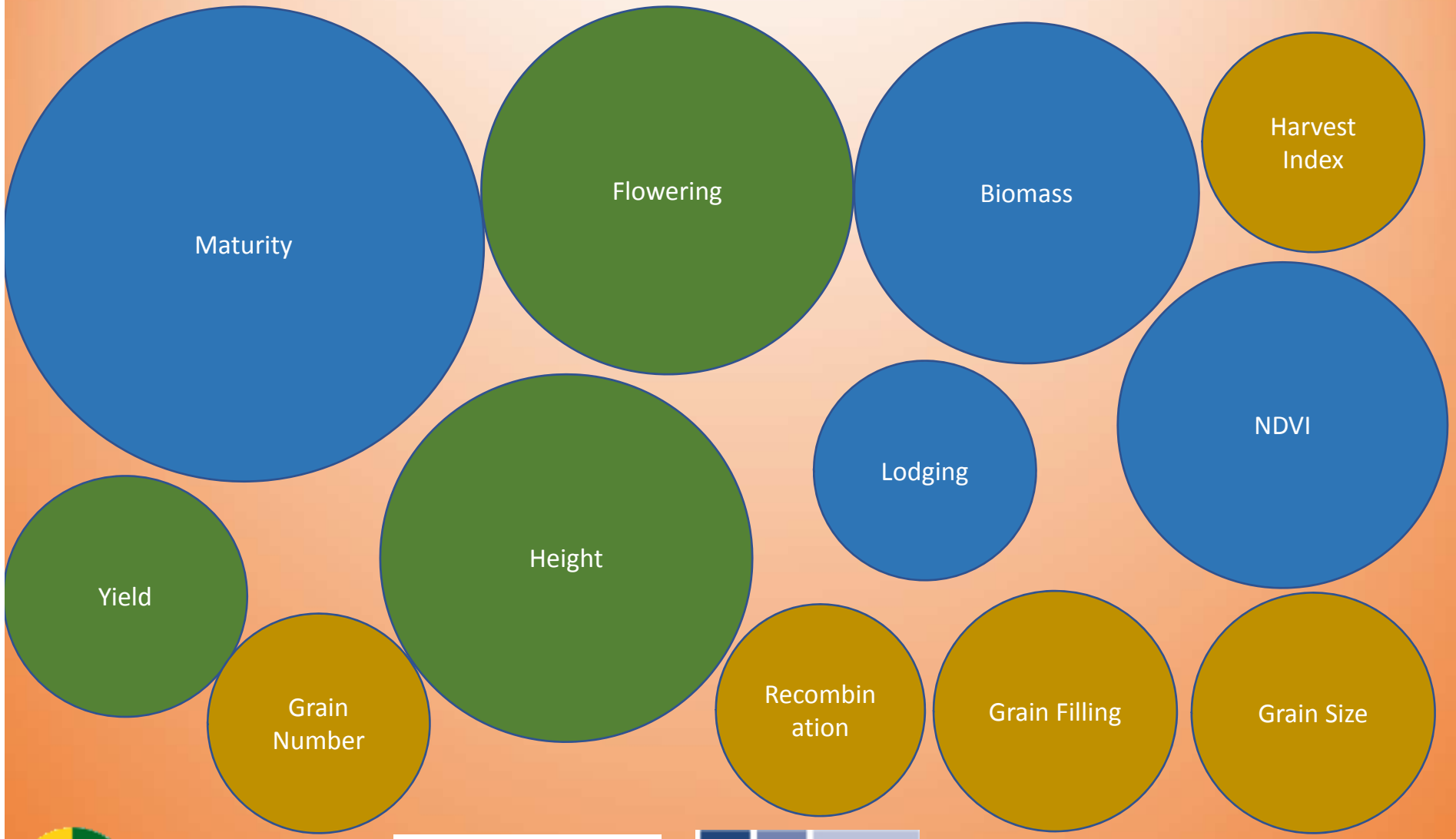
ROTHAMSTED RESEARCH

The University of Nottingham

John Innes Centre

Mapping populations studies

RReS, Nottingham, and JIC 2013 onwards



ROTHAMSTED RESEARCH

The University of Nottingham

John Innes Centre

Development of 168 Watkins NILs for future Toolkit nomination

John Innes Centre

NIL Development Pipeline

*(S) Denotes season

Field GHouse

F1 production with Recurrent parent following field trait validation (S6)

Back-cross 1 to recurrent parent (S7)

Select het + back-cross 2 (S8)

Select hets + self pollinate (S9)

Select homs + self pollinate (S10)

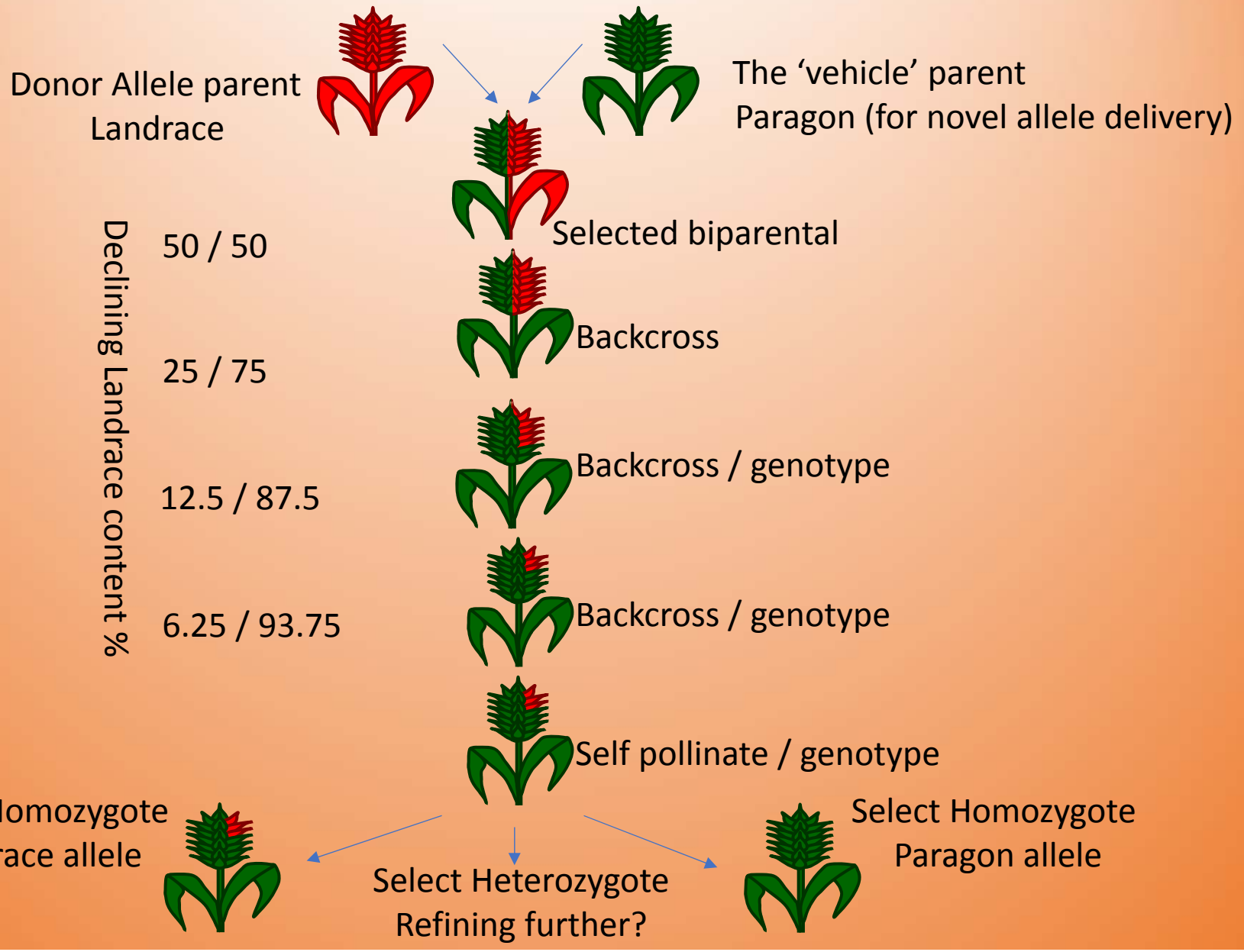
Field validation of additive effect 1m (S11)

Field validation of additive effect 6m 3reps (S12)

Breeder Selection?

F4 – F5 tray to 1L pot *(S5)

NILs Development - Concept



WISP BTK Trial Sites 2016 and 2017 Drilling

Complete BTKNIL1 series

Tested and selected alleles

RAGT

Elsoms

LS Breeding

Nottingham University

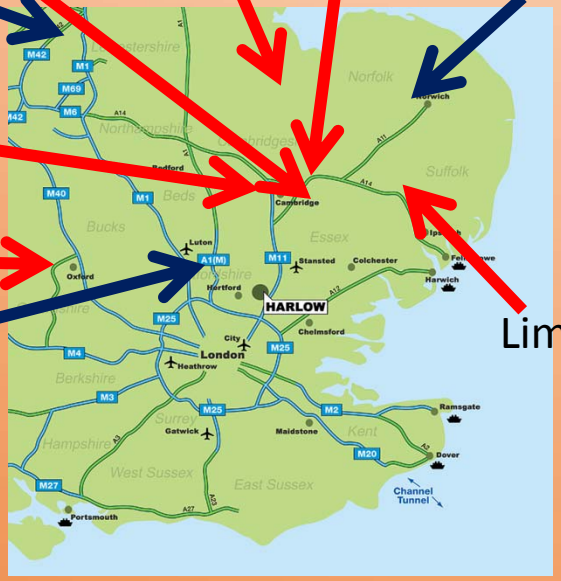
JIC

KWS

DSV

LimaGrain

RRes



Syngenta – Orgerus

2017 Bayer – Milly La Foret

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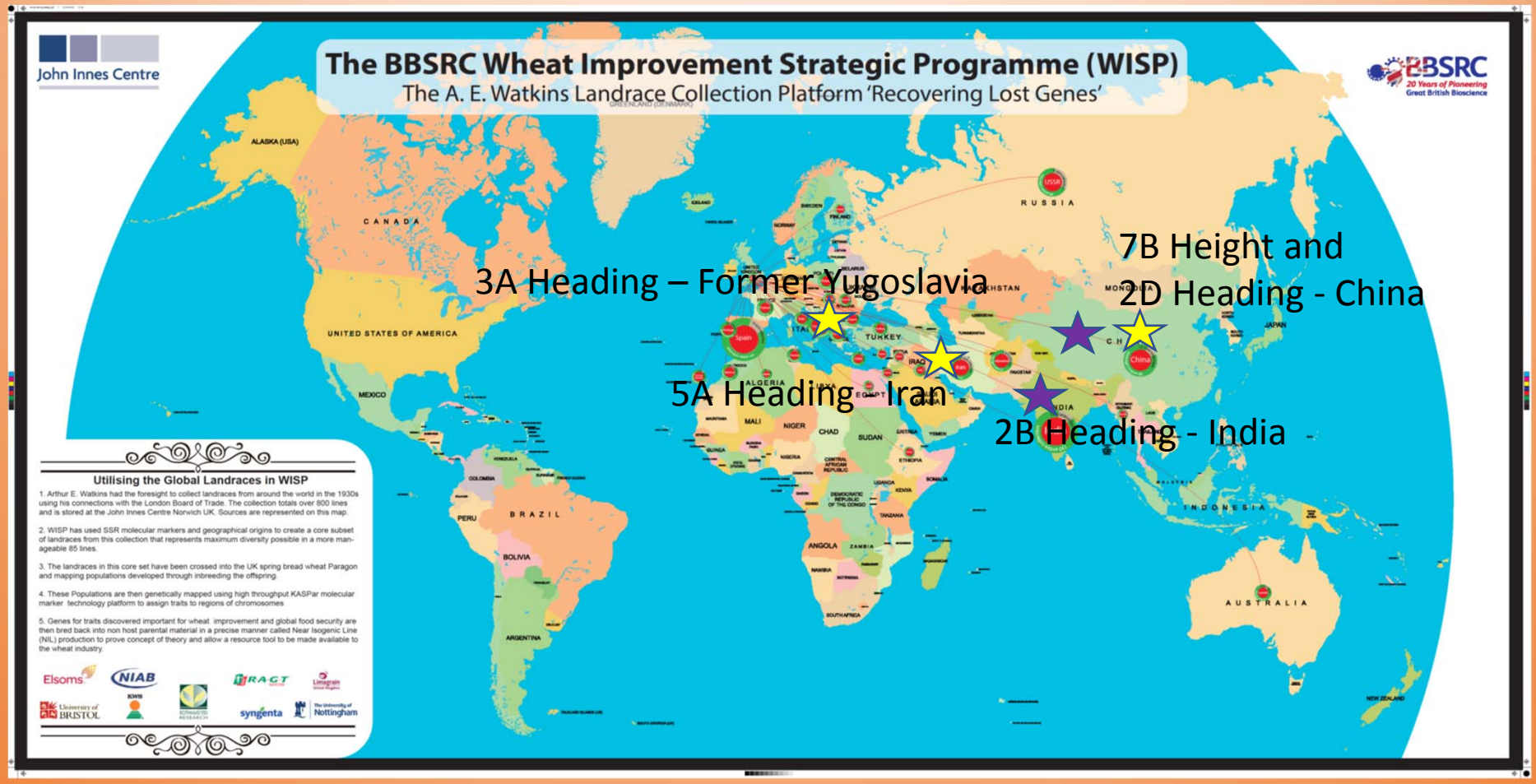
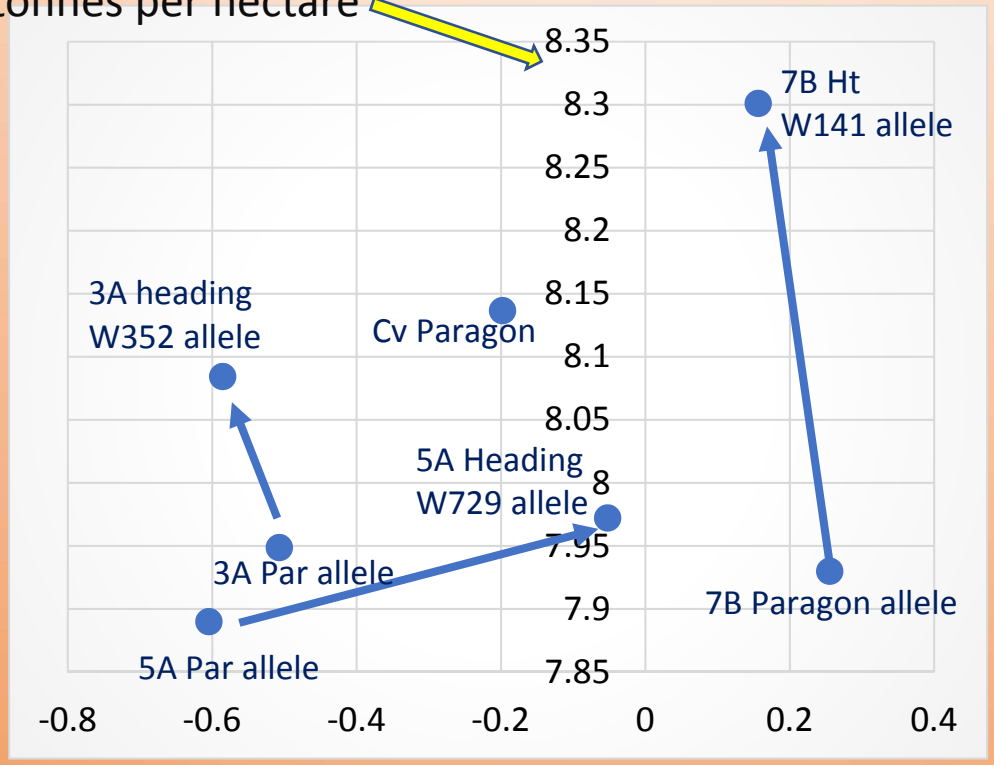
Agronomic advantage
BTK Breeder Selections 2016 / 2017



The first alleles to get to the breeders including Kronos mutant grain width (Uauy)

Three site performance of the 2016-17 Landrace Toolkit

YIELD
in tonnes per hectare



Multi site stability
/ Multi Interaction
AMMI

Breeder Trial Site Tour

Elsoms

LSPB

Limagrain

DSV

KWS

RAGT

RRes

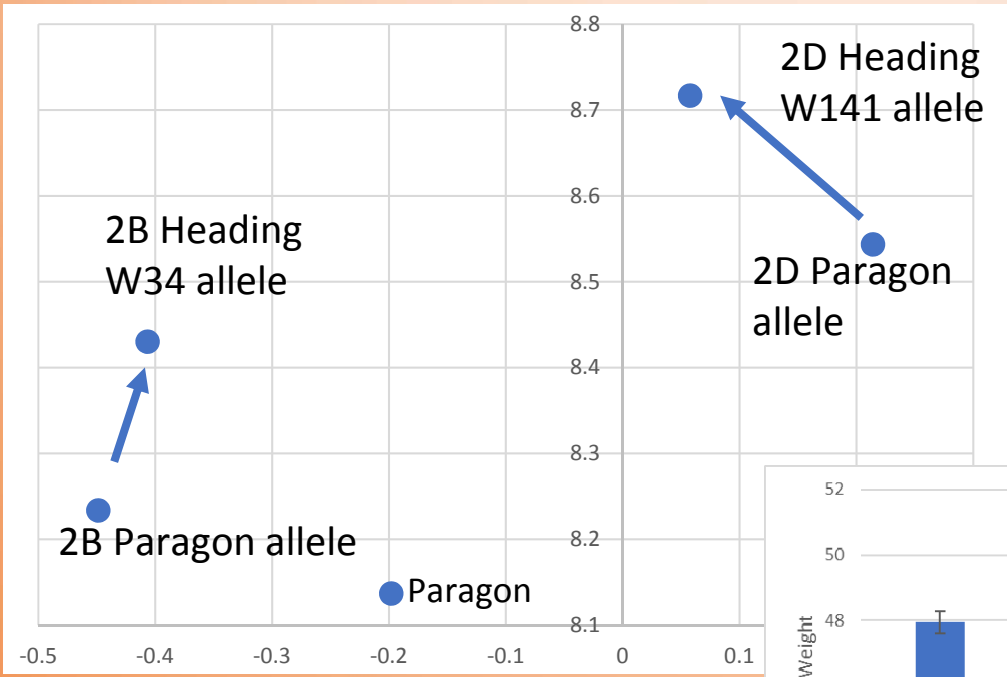
NIAB and Syngenta

Visits to the trial sites
4-6th July 2017

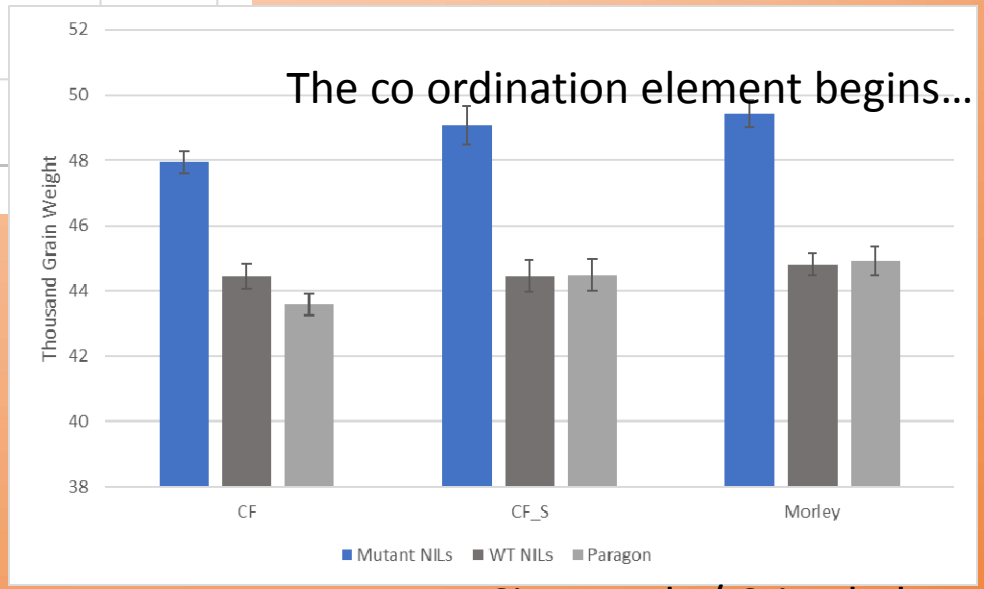
Helps to understand and gain an appreciation of what we are asking of the Breeding industry and what we can expect of their role

A unique chance to speak one to one in the ideal setting to voice thoughts and concerns

Landrace and Mutant selections for 2017-18 Toolkit



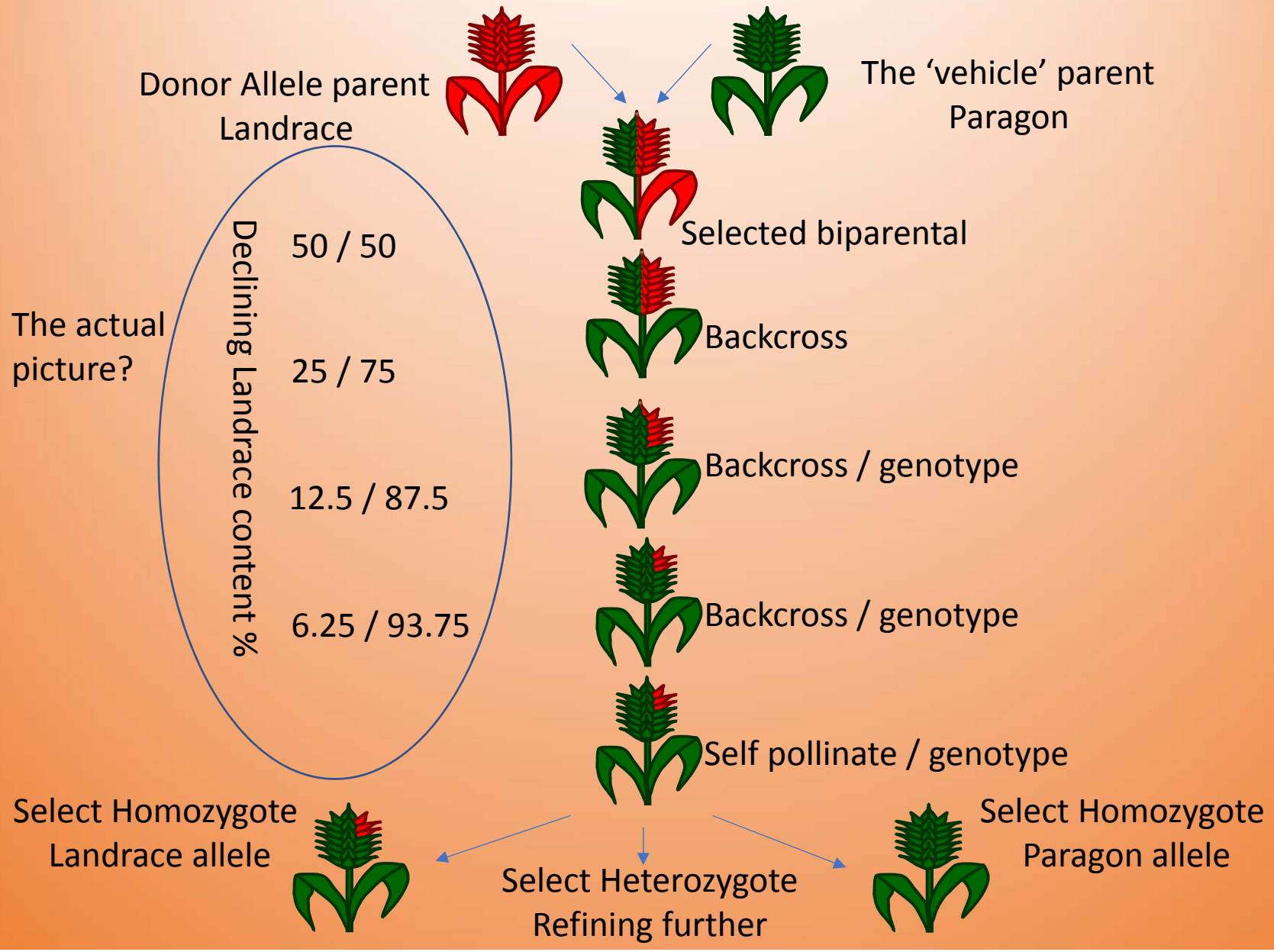
Simon Griffiths WISP generated



James Simmonds / Cristobal Uauy

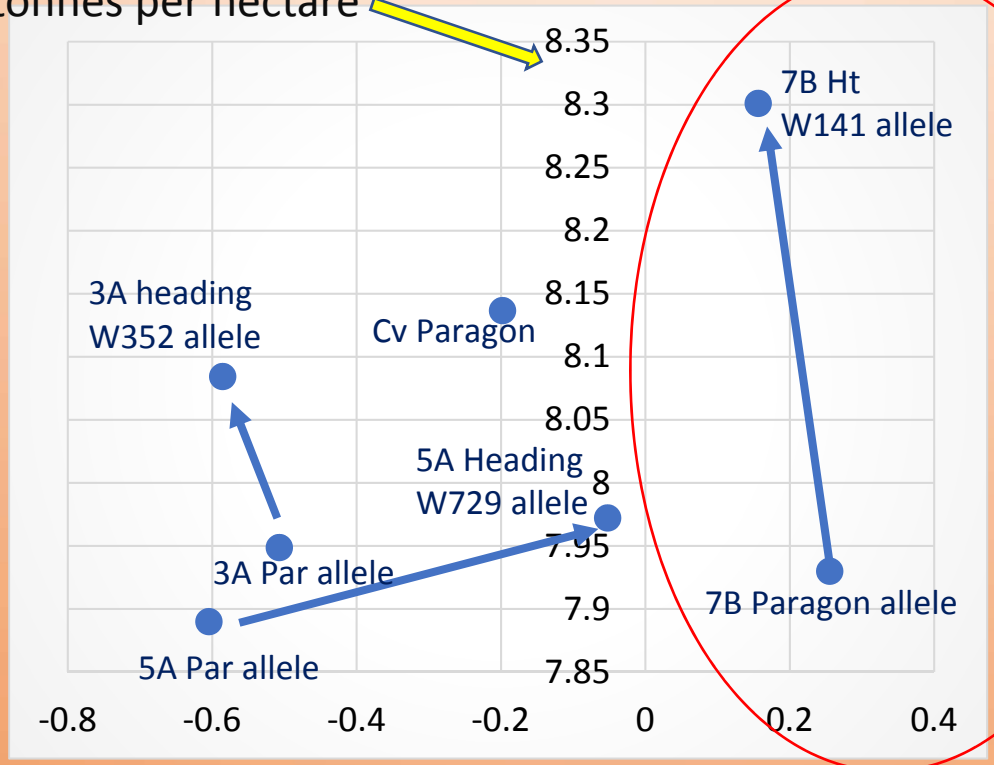
Genetic Marker data included

NILs Development – What is really happening



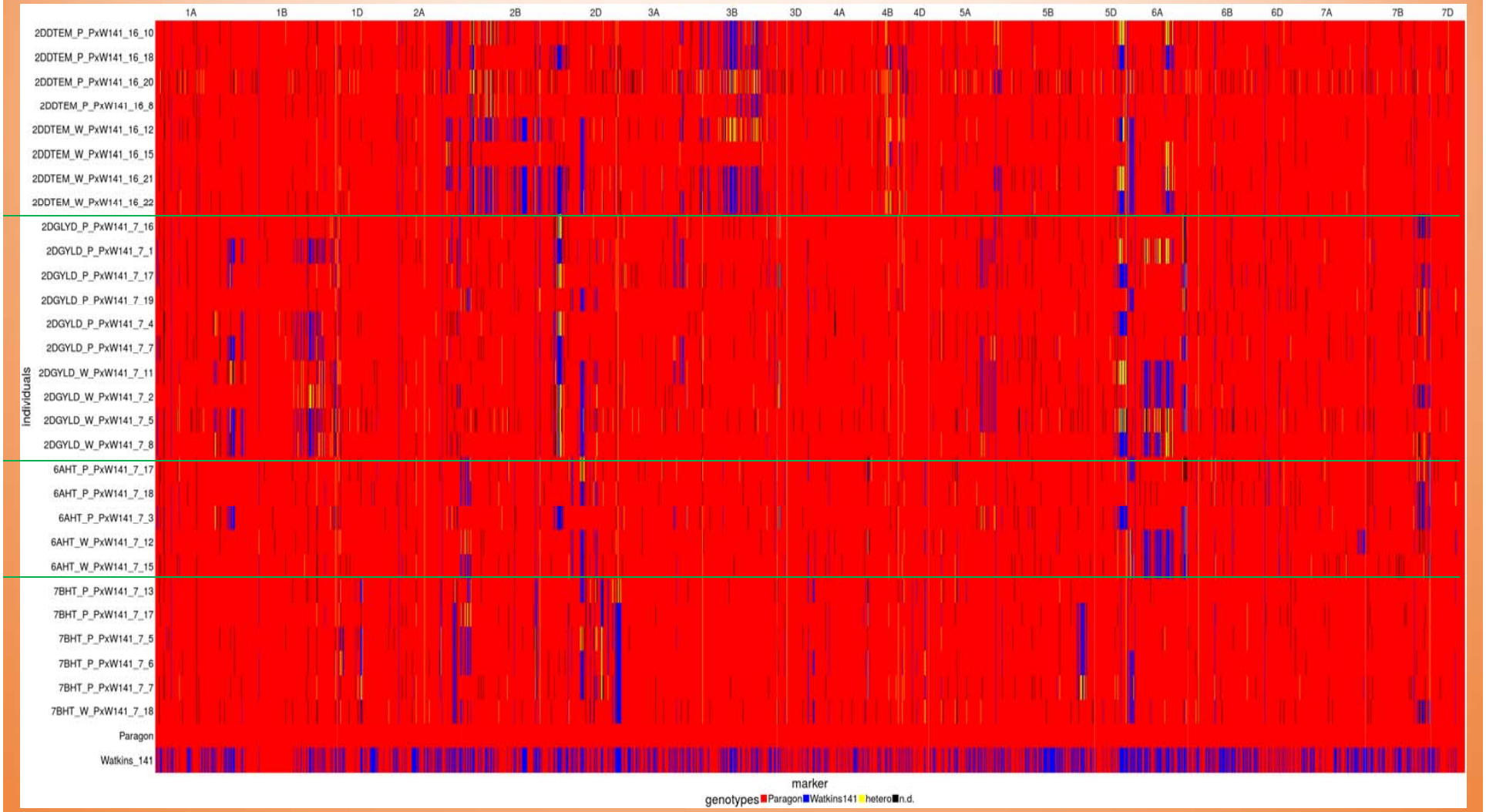
Three site performance of the 2016-17 Landrace Toolkit

YIELD
in tonnes per hectare



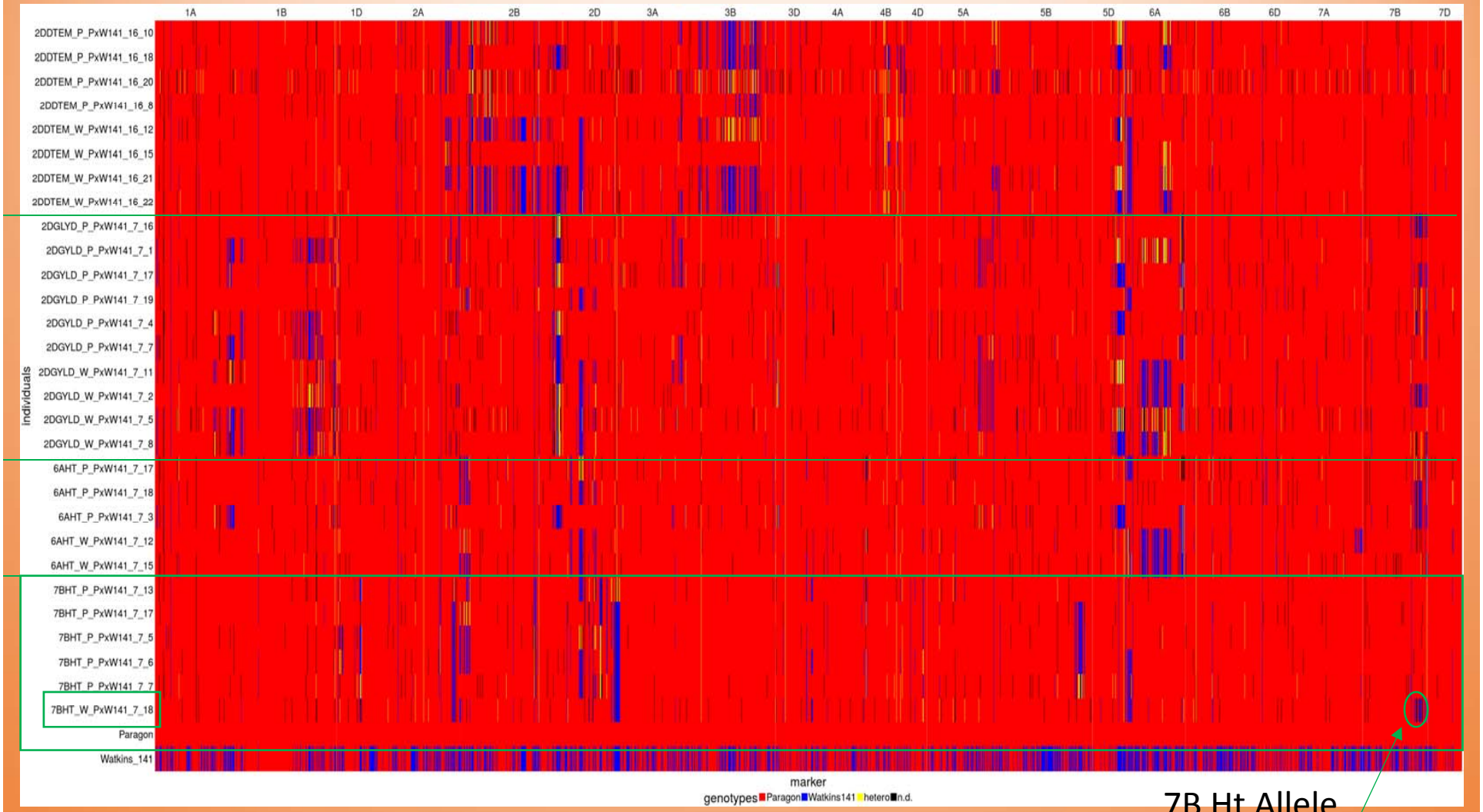
Multi site stability
/ Multi Interaction
AMMI

Actual 35k array genotyping outcomes of NIL Development



*Including non-polymorphics

Luzie Wingen



7B Ht Allele
Watkins 141

*Including non-polymorphics

Luzie Wingen

BTK Selection Committee positions

Chair

DFW Project Manager

KWS

RAGT

LSPB

LimaGrain

Syngenta

Bayer

DSV

Elsoms

Work Package Representatives

Bristol

NIAB

Nottingham

GRU BTK Co

DFW Breeder Toolkit Selection Committee Annual meeting to agree
Loci for backcrossing,
Lines for academic-commercial multi site assessment,
What traits to measure and how

The Challenges

- To operate as BTK Central. Implementing RRes, NIAB and Nottingham University Toolkit lines into GRU and beyond. The DFW structure and its many parts – co ordination

- Ensuring the material is to an adapted standard. Agronomic improvement within 10% height window of background material with the agronomic advantage. Keeping all Breeders onside throughout

- Having the seed arrive with GRU bulked to the quantity required in the correct time window (mid September).

- Annual (Feb2017) Assessment meeting for selecting future candidates and selections for the BTK panel. Thorough and fair assessment

Who is involved…

GRU
Mike Ambrose
Liz Sayers
Richard Horler

RRes
Malcolm Hawkesford
Andrew Riche

JIC Field
Cathy Mumford
Chris Allen
Richard Samworth
Kevin Crane
Stevie Johnson
Luke Dewing

Breeders
Stephen Smith
Chris Burt / Richard Summers
Matt Kerton
David Schafer
Phil Tailby / Ed Flatman
Mike Kerns / Celine Zimmerli
David Feuerhelm / Pauline B-Basler
Jacob Lage

NIAB
Alison Bentley
Fiona Leigh
Richard Horsnell
Phil Howells

DFW
Graham Moore
Simon Griffiths
Cristobal Uauy
Julie Ellwood

JIC Horticulture
John Lord
Lionel Perkins
Lewis Hollingsworth

JIC Genotyping / Analysis
Michelle Leverington-Waite
Sarah Collier
Rajani Awal
Richard Goram
Luzie Wingen

Bristol
Keith Edwards
Sacha Przewieslik-Allen
Amanda Burridge
Gary Barker
Paul Wilkinson
Mark Winfield

Nottingham
Ian King
Julie King
Matt Tovey
John Alcock
Jonathon Atkinson
John Foulkes

Wheat is one of the most important global crops and is grown on more land than any other commercial crop. It currently provides 20% of total calories consumed by humans daily worldwide - Designing Future Wheat

Breeder Toolkit Projected Future Supply

DFW Start

DFW by 2022 and beyond

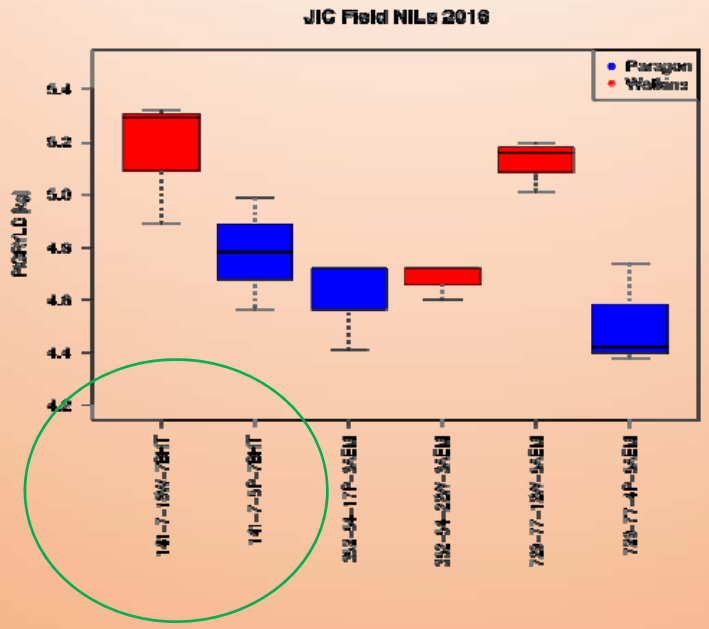
BTKNIL Future Supplies														
		Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by
Action	Achieved by	S2015	W2015/16	S2016	W2016/17	S2017	W2017/18	S2018	W2018/19	S2019	W2019/20	S2020	W2020/21	S2021
Bi parental x recurrent	GH F1 (cross)		BTKNIL3 x		BTKNIL4 x	BTKNIL5 x		New cohort of 30 BTKNIL6 x	New cohort of 30 BTKNIL7 x					
F1 x recurrent	GH BC1 (cross)			BTKNIL3 x		BTKNIL4 x	BTKNIL5 x							
BC1 x recurrent (MAS: Hets)	GH BC2 (cross + MAS)				BTKNIL3 xs		BTKNIL4 xs	BTKNIL5 xs						
self (MAS: Hets)	GH BC2 F2 (MAS)					BTKNIL3 s		BTKNIL4 s	BTKNIL5 s					
final selection (MAS: Homs)	GH BC2 F3 (MAS)						BTKNIL3 s		BTKNIL4 s	BTKNIL5 s				
Drill	Field 1m (25g x 10))	BTKNIL1				BTKNIL2		*		*BTKNIL3 BTKNIL4		BTKNIL5		
Drill	Field 6m - Yield Trial **Field 12m Seed Production**			BTKNIL1		BTKNIL1		BTKNIL2				BTKNIL3 BTKNIL4		BTKNIL5
500g (x18) availability for supply														

1m NIL plots harvested summer 2021 BTKNIL6 (BTK7 one Year more)

6m rep data summer 2022

90 streams in crossing programmes in any one season

Refining a Near Isogenic Line



Sow Heterozygotes from the BC2F3 (Homs to field trial)
Nearly 600 screened

Chairperson

- Commercial
  - KWS
  - RAGT
  - LS
  - Limagrain
  - Syngenta
  - Bayer
  - DSV
  - Elsoms
- ISP
  - WP1 Rep
  - WP2 Rep
  - WP3 Rep
  - WP4 Rep
- WP3 Germplasm/marker producers
  - Bristol
  - NIAB
  - Nottingham
  - JIC

Annual meeting to agree:

- Loci for backcrossing
- Lines for adademic-commercial multi site assessment
- What traits to measure and how

















DFW Breeder Toolkit Selection Committee
Responsible for agreement on selections
for breeder multi trial site testing

Chairperson

- Commercial
  - KWS
  - RAGT
  - LS
  - Limagrain
  - Syngenta
  - Bayer
  - DSV
  - Elsoms
- ISP
  - WP1 Rep
  - WP2 Rep
  - WP3 Rep
  - WP4 Rep
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  - Nottingham
  - JIC

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Acknowledgements

(after 6years of development)

- Fiona Leigh, Richard Horsnell, Alison Bentley, Phil Howells
- Andrew Riche, Malcolm Hawkesford
- John Foulkes, Ian King, Matt Tovey, Julie King
- Wheat Breeders List all and individual representatives
- JIC / GRU Team – Genotypers, Rajani, Hort and Field services Cathy
- Griffiths team

BTKNIL1 Field Trials JIC 2016/17 JIC

1	soi		64	65	1	2	4	3	5	6	9	8	7	113	14	10	15	22	20	26
2	67	72	p	49	50	52	48	47	45	soi		51	46	43	44	42	21	24	30	28
3	75	68	soi	73	93	94	97	100	101	103	95	96	98	99	102	71	66	77	soi	
4	34	37	33	p	41	32	40	31	35	18	13	soi	23	16	11	74	69	76	70	
5	36	38	39	63	soi	62	53	54	56	55	57	58	59	60	61	80	78	90	p	
6	12	19	17	25	27	29	88	92	84	91	83	87	82	soi	89	86	81	85	79	
7	P	24	20	26	21	30	soi	1	2	4	3	5	6	8	7	p	9	64	65	
8	28	15	22	14	10	50	49	44	42	46	43	47	45	52	48	soi	51	67	72	
9	66	71	102	103	95	96	98	99	soi	p	p	101	93	94	97	100	73	68	75	
10	74	69	76	70	77	p	23	18	13	16	11	31	33	41	p	32	40	soi	35	
11	89	88	53	54	60	61	62	63	55	56	soi	57	58	59	34	36	37	38	39	
12	90	92	84	91	83	87	82	86	81	85	79	80	78	12	19	17	25	27	29	
13	9	5	6	soi	8	7	4	3	1	2	64	65	soi	18	13	23	p	16	11	
14	15	22	21	30	20	26	24	28	44	42	46	43	47	45	52	48	49	51	50	
15	14	10	p	p	29	soi	12	19	17	25	27	77	76	70	soi	74	69	71	66	
16	67	72	68	75	73	31	35	36	34	32	40	33	41	37	38	39	80	78	90	
17	93	94	97	100	101	102	103	soi	p	95	96	98	99	58	85	79	soi	87	82	
18	61	p	60	62	63	54	59	55	53	56	57	89	88	92	84	91	83	86	81	

Trial design accounts for comparable NILs to be tested as direct neighbours

Repeat from H2016 (Morley)

BTKNIL2 Field Trials 2016/17

	Rack1					Rack2					Rack3					Rack4					Rack5					Rack6					
	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	
1	par	par	par	par		PW141-21-3	4	W	2A GFP		PW141-41-2	21	P	5B NDVI		PW141-80-3	16	W	5A MATU		PW292-25-6	1	P	2A MATU		PW292-93-7	8	P	1B MATU		1
2	PW34-12-13	10 (L.S)	P	1A HT		PW141-31-2	5	P	3B MATU		par	par	par	par		PW292-9-5	7	P	4B GFPTT		PW292-25-6	18	P	2A MATU		par	par	par	par		2
3	PW34-12-13	21	W	1A HT		soi	soi	soi	soi		PW141-41-2	2	W	5B NDVI		PW292-9-5	14	P	4B GFPTT		par	par	par	par		PW292-93-7	11	P	1B MATU		3
4	PW34-63-2	13	P	4A GFP		PW141-31-2	6	P	3B MATU		PW141-41-2	4	W	5B NDVI		soi	soi	soi	soi		PW292-25-6	3	W	2A MATU		PW292-93-7	16	P	1B MATU		4
5	PW34-63-2	15	W	4A GFP		PW141-31-2	9 (L.S)	P	3B MATU		PW141-41-2	10	W	5B NDVI		PW292-9-5	15	P	4B GFPTT		soi	soi	soi	soi		PW292-93-7	17	P	1B MATU		5
6	Soi	Soi	Soi	Soi		PW141-31-2	14	P	3B MATU		PW141-41-2	11	W	5B NDVI		PW292-9-5	18	P	4B GFPTT		PW292-25-6	13 (L.S)	W	2A MATU		PW292-93-7	13	W	1B MATU		6
7	PW34-66-6	4	P	7A LODG		PW141-31-2	15	P	3B MATU		PW141-41-2	12	W	5B NDVI		PW292-9-5	6	W	4B GFPTT		PW292-67-1	7	P	3B MATU		soi	soi	soi	soi		7
8	PW34-66-6	8	P	7A LODG		PW141-31-2	21	P	3B MATU		soi	soi	soi	soi		PW292-9-5	8 (L.S)	W	4B GFPTT		PW292-67-1	1	W	3B MATU		PW352-3-7	9	P	2D MATU		8
9	PW34-66-6	9	P	7A LODG		par	par	par	par		PW141-41-2	13	W	5B NDVI		PW292-9-5	10	W	4B GFPTT		par	par	par	par		PW352-3-7	16	P	2D MATU		9
10	par	par	par	par		PW141-31-2	4	W	3B MATU		PW141-41-2	14	W	5B NDVI		par	par	par	par		PW292-67-1	3	W	3B MATU		PW352-3-7	19	P	2D MATU		10
11	PW34-66-6	14	P	7A LODG		PW141-31-2	12	W	3B MATU		PW141-41-2	17	W	5B NDVI		PW292-20-1	18 (P.S)	P	7A ADTT		PW292-67-1	11	W	3B MATU		par	par	par	par		11
12	PW34-66-6	20	P	7A LODG		PW141-36-3	19	P	7A DTMA		par	par	par	par		PW292-20-1	1 (L.S)	W	7A ADTT		PW292-67-1	14	W	3B MATU		PW352-3-7	3	W	2D MATU		12
13	PW34-66-6	3	W	7A LODG		PW141-36-3	14	W	7A DTMA		PW141-41-2	20	W	5B NDVI		soi	soi	soi	soi		PW292-67-1	16	W	3B MATU		PW352-3-7	6	W	2D MATU		13
14	PW34-66-6	10	W	7A LODG		PW141-36-10	3	p	7A DTMA		PW141-58-7	20	P	7D AGDM		PW292-20-1	4	W	7A ADTT		soi	soi	soi	soi		PW352-3-7	21	W	2D MATU		14
15	PW34-66-6	19	W	7A LODG		soi	soi	soi	soi		PW141-58-7	10	W	7D AGDM		PW292-22-9	16	P	3A COMSTR		PW292-67-1	18	W	3B MATU		PW352-5-1	10	P	1B GRYLD		15
16	PW34-66-6	22	W	7A LODG		PW141-36-10	13	p	7A DTMA		PW141-58-7	7	W	7D AGDM		PW292-22-9	19 (L.S)	P	3A COMSTR		PW292-69-4	10 (L.S)	P	6B DTAD		PW352-5-1	13	W	1B GRYLD		16
17	Soi	Soi	Soi	Soi		PW141-36-10	22	p	7A DTMA		PW141-80-3	9	P	5A MATU		par	par	par	par		PW292-69-4	6	W	6B DTAD		soi	soi	soi	soi		17
18	PW141-21-3	10	P	2A GFP		PW141-36-10	1	w	7A DTMA		soi	soi	soi	soi		PW292-22-9	1	W	3A COMSTR		PW292-69-4	14	W	6B DTAD		PW352-5-1	16	W	1B GRYLD		18
19	PW141-21-3	11	P	2A GFP		par	par	par	par		PW141-80-3	21	P	5A MATU		PW292-22-9	7	W	3A COMSTR		PW292-69-4	19	W	6B DTAD		PW352-23-1	5	P	1A MATU		19
20	PW141-21-3	3	W	2A GFP		PW141-36-10	4	w	7A DTMA		PW141-80-3	6	W	5A MATU		PW292-22-9	8	W	3A COMSTR		par	par	par	par		PW352-23-1	7	P	1A MATU		20

BTKNIL2 Field Trials JIC 2016/17

	Rack7					Rack8					Rack9					Rack10					Rack11					Rack12						Rack13					Rack14			
.	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	genotype	plant	allele	trait	data	.	.	genotype	plant	allele	trait	data	genotype	plant	allele	trait
1	PW352-23-1	21	P	1A MATU		soi	soi	soi	soi		PW352-26-4	19	P	2A GFR		PW352-26-5	19	W	2A DTMA		PW468-12-4	16	P	1A LODG		soi	soi	soi	soi		1	1	PW468-84-4	8	P	5A NDRE		PW729-55-3	6	P	6B AGDM
2	PW352-23-1	1	W	1A MATU		PW352-23-4	14 (LS)	P	1A NDVI		PW352-26-4	20	P	2A GFR		soi	soi	soi	soi		PW468-12-4	8	W	1A LODG		PW468-77-3	11	W	7B AGDM		2	2	cv par	cv par	cv par	cv par		PW729-55-3	8	P	6B AGDM
3	PW352-23-1	2	W	1A MATU		PW352-23-4	17	P	1A NDVI		cv par	cv par	cv par	cv par		PW352-26-5	20	W	2A DTMA		cv par	cv par	cv par	cv par		PW468-77-3	13	W	7B AGDM		3	3	PW468-84-4	2	w	5A NDRE		soi	soi	soi	soi
4	cv par	cv par	cv par	cv par		PW352-23-4	18	P	1A NDVI		PW352-26-4	2	W	2A GFR		PW352-26-5	21 (V.L.S)	W	2A DTMA		PW468-12-4	19	W	1A LODG		PW468-77-3	14	W	7B AGDM		4	4	PW468-84-4	5	w	5A NDRE		PW729-55-3	12 (LS)	P	6B AGDM
5	PW352-23-1	6	W	1A MATU		PW352-23-4	20	P	1A NDVI		PW352-26-4	3	W	2A GFR		PW352-26-5	22	W	2A DTMA		PW468-21-2	7	P	2D DTAD		PW468-77-3	17	W	7B AGDM		5	5	PW468-84-4	22	w	5A NDRE		PW729-55-3	13	P	6B AGDM
6	soi	soi	soi	soi		PW352-23-4	6	W	1A NDVI		PW352-26-4	4	W	2A GFR		PW468-10-1	2 (LS)	P	2A NDVI		PW468-21-2	10	P	2D DTAD		PW468-77-3	19	W	7B AGDM		6	6	PW729-36-4	4 (V.L.S)	P	2B MILDS		PW729-55-3	15	P	6B AGDM
7	PW352-23-1	9	W	1A MATU		cv par	cv par	cv par	cv par		PW352-26-4	14	W	2A GFR		PW468-10-1	21 (V.L.S)	P	2A NDVI		soi	soi	soi	soi		PW468-84-1	15	P	2B MATU		7	7	soi	soi	soi	soi		PW729-55-3	1	W	6B AGDM
8	PW352-23-1	11	W	1A MATU		PW352-23-4	7	W	1A NDVI		PW352-26-4	15	W	2A GFR		cv par	cv par	cv par	cv par		PW468-21-2	14	P	2D DTAD		PW468-84-1	1	W	2B MATU		8	8	PW729-36-4	7	P	2B MILDS		cv par	cv par	cv par	cv par
9	PW352-23-3	6	P	4B MATU		PW352-23-1	13	W	1A MATU		soi	soi	soi	soi		PW468-10-1	5	W	2A NDVI		PW468-21-2	22	P	2D DTAD		PW468-84-1	16	P	5D MATU		9	9	PW729-36-4	16	P	2B MILDS		soi	soi	soi	soi
10	PW352-23-3	9	P	4B MATU		PW352-26-2	8	P	5D MATU		PW352-26-4	18	W	2A GFR		PW468-10-1	17 (LS)	W	2A NDVI		cv par	cv par	cv par	cv par		PW468-84-1	17	P	5D MATU		10	10	PW729-36-6	22	P	MATU PEAK 2B MILDS		PW729-55-3	21	W	6B AGDM
11	cv par	cv par	cv par	cv par		PW352-26-2	10	P	5D MATU		PW352-26-4	21	W	2A GFR		PW468-12-2	2	P	1A MATU		PW468-21-2	1	W	2D DTAD		cv par	cv par	cv par	cv par		11	11	PW729-36-4	2	W	2B MILDS		PW352-23-1	12	W	1A MATU
12	PW352-23-3	16	P	4B MATU		PW352-26-2	19	P	5D MATU		cv par	cv par	cv par	cv par		PW468-12-2	9	P	1A MATU		PW468-21-2	11	W	2D DTAD		PW468-84-1	14	W	5D MATU		12	12	PW729-36-4	5	W	2B MILDS		PW352-23-3	2	P	4B MATU
13	PW352-23-3	18	P	4B MATU		soi	soi	soi	soi		PW352-26-4	22	W	2A GFR		PW468-12-2	15	P	1A MATU		PW468-21-2	12	W	2D DTAD		PW468-84-1	22	W	5D MATU		13	13	PW729-36-4	8	W	2B MILDS		soi	soi	soi	soi
14	PW352-23-3	19 (LS)	P	4B MATU		PW352-26-2	2	W	5D MATU		PW352-26-5	1	P	2A DTMA		PW468-12-2	19	P	1A MATU		PW468-21-2	15	W	2D DTAD		soi	soi	soi	soi		14	14	cv par	cv par	cv par	cv par		PW352-23-3	3	P	4B MATU
15	PW352-23-3	21	P	4B MATU		PW352-26-2	15	W	5D MATU		PW352-26-5	11	P	2A DTMA		soi	soi	soi	soi		PW468-77-3	3	P	7B AGDM		PW468-84-4	4	P	5A COMGRWT		15	15	PW729-36-4	11	W	2B MILDS		PW729-55-5	15	P	4A MATU
16	soi	soi	soi	soi		PW352-26-2	21	W	5D MATU		PW352-26-5	2	W	2A DTMA		PW468-12-2	18	W	1A MATU		PW468-77-3	9	P	7B AGDM		PW468-84-4	12	P	5A COMGRWT		16	16	PW729-36-4	19	W	2B MILDS		PW729-55-5	19	P	4A MATU
17	PW352-23-3	4 (LS)	W	4B MATU		cv par	cv par	cv par	cv par		PW352-26-5	8	W	2A DTMA		PW468-12-4	2	P	1A LODG		PW468-77-3	16	P	7B AGDM		PW468-84-4	1	W	5A COMGRWT		17	17	PW729-36-6	8	P	2B MILDS		PW729-55-5	6	W	4A MATU
18	PW352-23-3	8	W	4B MATU		PW352-26-4	10	P	2A GFR		PW352-26-5	10	W	2A DTMA		PW468-12-4	5	P	1A LODG		soi	soi	soi	soi		PW468-84-4	6	P	5A NDRE		18	18	soi	soi	soi	soi		cv par	cv par	cv par	cv par
19	PW352-23-4	2	P	1A NDVI		PW352-26-4	13	P	2A GFR		soi	soi	soi	soi		PW468-12-4	9	P	1A LODG		PW468-77-3	20	P	7B AGDM		PW468-84-4	7	P	5A NDRE		19	19	PW729-36-6	7	W	2B MILDS		PW729-55-5	7	W	4A MATU
20	PW352-23-4	3 (LS)	P	1A NDVI		PW352-26-4	17	P	2A GFR		PW352-26-5	17 (LS)	W	2A DTMA		cv par	cv par	cv par	cv par		PW468-77-3	10	W	7B AGDM		cv par	cv par	cv par	cv par		20	20	PW729-36-6	9	W	2B MILDS		PW729-55-5	11	W	4A MATU

6A	HT
3A	DTEM
5A	HT
	3A DTEM
6A	HT
6A	HT
2D	DTEM
1B	DTEM
2D	GYLD
	7B HT
	5A DTEM

Set 1 (11)

Complete trials H15 (1m)
+ H2016 + H2017 (6m)

H = Field harvest year
W = Winter glasshouse
S = Summer glasshouse

7A DTMA- Peak
7A DTMA- Whole
4B MATU
7D AGDM
5A MATU - peak
5A MATU - Whole
4B GFPTT
7A ADTT
3A COMSTRWT DTAD
2A MATU
3B MATU
6B DTAD
1B MATU DTEM
1A HT
4AGFP/GFPTT
7D LODG
2D MATU
1B GRYLD
1A MATU
1A NDVI
4B MATU
2A GFR
5D MATU
2A NDVI R Bottom
2A NDVI R Top
1A LODG
1A MATU
2D DTAD
7B AGDM
2B MATU
5A NDRE
5A COMGRWT
5D MATU
2B MILDS MATU peak
2B MILDS MATU whole
4A MATU
6B AGDM
2A DTMA

Set 2 (33)

BC2 F3 self selects – field trials
H17 drilled to 1m 27/10/16

4D	PIGRYLD
7A	DTEM
4D	PIGRYLD
1A	BIOYLD
1D	GRYLD
2A	BIOYLD
5A	crossover
5A	DTEM
4B	TGRWT
6B	GRYLD
2B	HI
6B	NDVI
7A	AGBM
7D	HT
1B	GFP
2D	Ht
3A	NDVI
3B	DTAD
6A	BIOYLD
6D	TGRWT
1B	NDVI
2A	DTAD
3A	GRpsqm.
7A	GRpsqm
7B	DTAD
1B	NDVI
1B	HT
3A	GRpsqm.
3D	AGBM
5A	GRpsqm.
5B	Ht
7A	crossover
2B	NDVI
3A	DTAD
3A	NDVI
4D	GRpsqm.
5A	GFR
7A	COMSTRWT
4A	TGRWT
3A	TGRWT
6A	TGRWT
6B	DTEM
5A	TGRWT
1B	GRpsqm
6A	HI
5B	TGRWT
2D	Ht
3A	Ht
4D	Ht
6A	GRYLD

Set 3 (47)
Selections BC2 F2 S2017

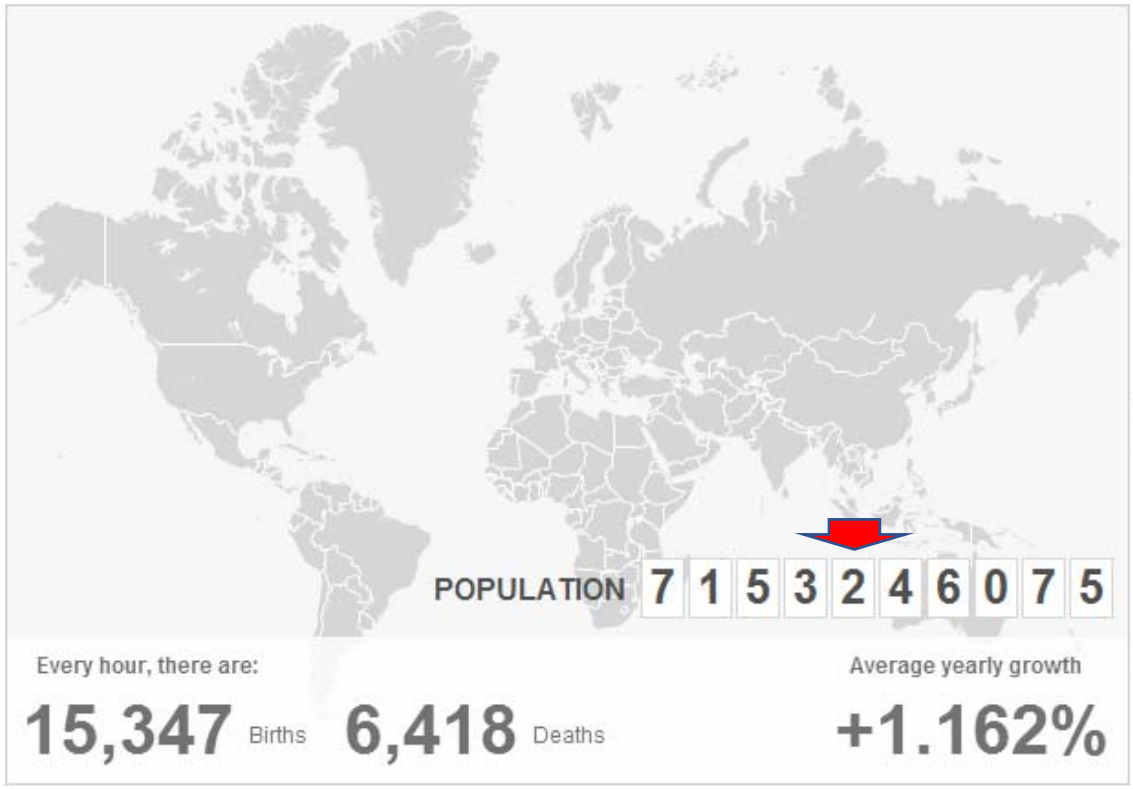
overview

- 5 year post – never been clearer objectives
- The developer / custodian but not the originator (G Moore and S Griffiths way back)
- The coal face of science. The centre forward knocking into the breeders net
- Importance of the practicalities for Breeder interaction. Awareness needed of
- Benefits of the summer tour for the above success
- GRU – In and Out. New Manager, GRU team – Liz on core

John Innes Centre

Expanding World

When I was born on the 25/09/1970 I was the 3,713,169,044th person alive on Earth and the 77,858,327,550th person to have lived since history began



The solution…..?

Development of 168 Watkins NILs for future Toolkit nomination

6A	HT
3A	DTEM
5A	HT
	3A DTEM
6A	HT
6A	HT
2D	DTEM
1B	DTEM
2D	GYLD
	7B HT
	5A DTEM

Set 1 (11)

7A DTMA- Peak
7A DTMA- Whole
4B MATU
7D AGDM
5A MATU - peak
5A MATU - Whole
4B GFPTT
7A ADTT
3A COMSTRWT DTAD
2A MATU
3B MATU
6B DTAD
1B MATU DTEM
1A HT
4AGFP/GFPTT
7D LODG
2D MATU
1B GRYLD
1A MATU
1A NDVI
4B MATU
2A GFR
5D MATU
2A NDVI R Bottom
2A NDVI R Top
1A LODG
1A MATU
2D DTAD
7B AGDM
2B MATU
5A NDRE
5A COMGRWT
5D MATU
2B MILDS MATU peak
2B MILDS MATU whole
4A MATU
6B AGDM
2A DTMA

Set 2 (33)

4D	PIGRYLD
7A	DTEM
4D	PIGRYLD
1A	BIOYLD
1D	GRYLD
2A	BIOYLD
5A	crossover
5A	DTEM
4B	TGRWT
6B	GRYLD
2B	HI
6B	NDVI
7A	AGBM
7D	HT
1B	GFP
2D	Ht
3A	NDVI
3B	DTAD
6A	BIOYLD
6D	TGRWT
1B	NDVI
2A	DTAD
3A	GRpsqm.
7A	GRpsqm
7B	DTAD
1B	NDVI
1B	HT
3A	GRpsqm.
3D	AGBM
5A	GRpsqm.
5B	Ht
7A	crossover
2B	NDVI
3A	DTAD
3A	NDVI
4D	GRpsqm.
5A	GFR
7A	COMSTRWT
4A	TGRWT
3A	TGRWT
6A	TGRWT
6B	DTEM
5A	TGRWT
1B	GRpsqm
6A	HI
5B	TGRWT
2D	Ht
3A	Ht
4D	Ht
6A	GRYLD

Set 3 (47)

1A	DTEM
1A	DTEM
1B	DTAD_n2
1B	DTAD_n2
2A	PIGRYLD.adj
2A	PIGRYLD.adj
2A	PIGRYLD.adj
2A	PIGRYLD.adj
2B	PIGRYLD.adj
2B	PIGRYLD.adj
2B	DTAD_n2
2B	DTAD_n2
2D	Ht_n2
2D	Ht_n2
2D	DTEM.adj
2D	DTEM.adj
3A1	Ht_n2
3A1	Ht_n2
3A1	DTAD_n2
3A1	DTAD_n2
3B	DTEM
3B	DTEM
5A	PIGRYLD.adj
5A	PIGRYLD.adj
5A	PIGRYLD.xycor
5A	PIGRYLD.xycor
5A1	Ht_n1
5A1	Ht_n1
5B	DTEM
5B	DTEM
5B2	DTAD_HN
5B2	DTAD_HN
5D	DTAD_HN
5D	DTAD_HN
6A	Ht_n1
6A	Ht_n1
6A1	Ht_n1
6A1	Ht_n1
6B	PIGRYLD.adj
6B	PIGRYLD.adj
6B1	Ht_n1
6B1	Ht_n1
7B	DTEM
7B	DTEM

Set 4 (44)

1A Initation stem elongation
1D Ht
1D Ht
1D Ht
2A EARWT
2A GRLG
2A GRLG
2A GS31
2A Ht
2A maturityy
2AGRSA
2B Anthesis
2B Initation Stem elongation
3A EARLG
3A Ht
3D Height
4A eSPTNBpEAR
4A Ht
4D DTEMfM
4D GRWD
5A GFR
5A sSPRNBpEAR
5A sSPRNBpEAR
5B sSPTNBpEAR
6A GRpfSPT
6B GRLG
6B Ht
7A fSPRNBpEAR
7A fSPRNBpEAR
7B Heading
7D DTEMfM
7D Heading
7D Iniation to booting

Set 5 (33)

JIC data

BTKNIL1
Set 1 (11)

6A	HT
3A	DTEM
5A	HT
	3A DTEM
6A	HT
6A	HT
2D	DTEM
1B	DTEM
2D	GYLD
	7B HT
	5A DTEM

Complete (trials H15(1m) + H2016 + H2017 (6m)

WISP generated QTL data
RRes and Nottingham

BTKNIL2
Set 2 (33)

7A DTMA- Peak
7A DTMA- Whole
4B MATU
7D AGDM
5A MATU - peak
5A MATU - Whole
4B GFPTT
7A ADTT
3A COMSTRWT DTAD
2A MATU
3B MATU
6B DTAD
1B MATU DTEM
1A HT
4AGFP/GFPTT
7D LODG
2D MATU
1B GRYLD
1A MATU
1A NDVI
4B MATU
2A GFR
5D MATU
2A NDVI R Bottom
2A NDVI R Top
1A LODG
1A MATU
2D DTAD
7B AGDM
2B MATU
5A NDRE
5A COMGRWT
5D MATU
2B MILDS MATU peak
2B MILDS MATU whole
4A MATU
6B AGDM
2A DTMA

Field trials 2017/18 drilled to Yield and Seed Production

BTKNIL3
Set 3 (47)

4D	PIGRYLD
7A	DTEM
4D	PIGRYLD
1A	BIOYLD
1D	GRYLD
2A	BIOYLD
5A	crossover
5A	DTEM
4B	TGRWT
6B	GRYLD
2B	HI
6B	NDVI
7A	AGBM
7D	HT
1B	GFP
2D	Ht
3A	NDVI
3B	DTAD
6A	BIOYLD
6D	TGRWT
1B	NDVI
2A	DTAD
3A	GRpsqm.
7A	GRpsqm
7B	DTAD
1B	NDVI
1B	HT
3A	GRpsqm.
3D	AGBM
5A	GRpsqm.
5B	Ht
7A	crossover
2B	NDVI
3A	DTAD
3A	NDVI
4D	GRpsqm.
5A	GFR
7A	COMSTRWT
4A	TGRWT
3A	TGRWT
6A	TGRWT
6B	DTEM
5A	TGRWT
1B	GRpsqm
6A	HI
5B	TGRWT
2D	Ht
3A	Ht
4D	Ht
6A	GRYLD

Selections BC2 F3 production W2017 / 2018

Breeder Toolkit Current Supply

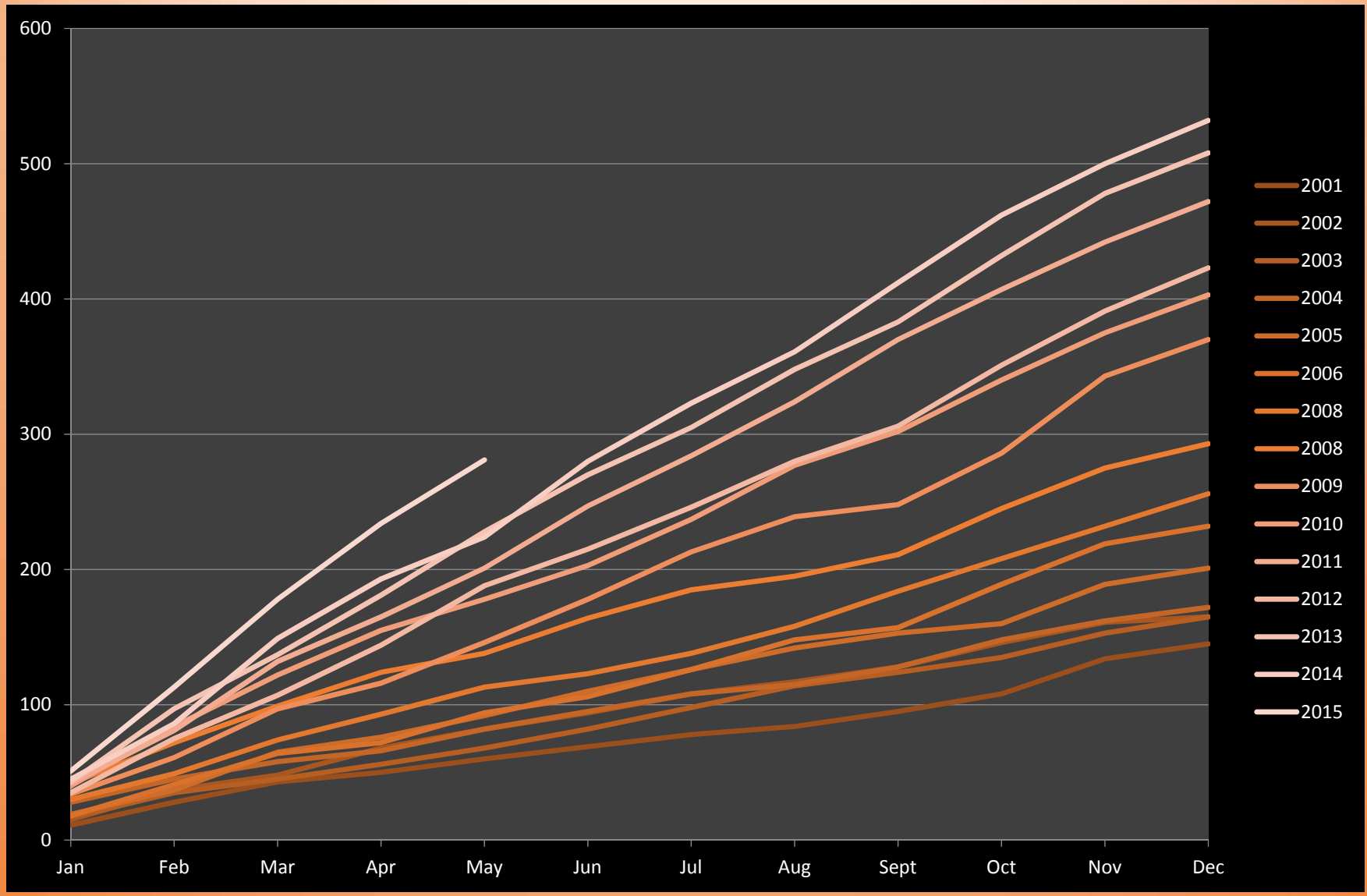
BTKNIL Future Supplies														
		Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by	Produced by
Action	Achieve	S2015	W2015/16	S2016	W2016/17	S2017	W2017/18	S2018	W2018/19	S2019	W2019/20	S2020	W2020/21	S2021
Bi parental x recurrent	GH F1 (cross)		BTKNIL3 x		BTKNIL4 x	BTKNIL5 x								
F1 x recurrent	GH BC1 (cross)			BTKNIL3 x		BTKNIL4 x	BTKNIL5 x							
BC1 x recurrent (MAS: Hets)	GH BC2 (cross + MAS)				BTKNIL3 xs		BTKNIL4 xs	BTKNIL5 xs						
self (MAS: Hets)	GH BC2 F2 (MAS)					BTKNIL3 s		BTKNIL4 s	BTKNIL5 s					
final selection (MAS: Homs)	GH BC2 F3 (MAS)						BTKNIL3 s		BTKNIL4 s	BTKNIL5 s				
Drill	Field 1m (25g x 10))	BTKNIL1				BTKNIL2		*		*BTKNIL3 BTKNIL4		BTKNIL5		
Drill	Field 6m (500g x 18)			BTKNIL1		BTKNIL1		BTKNIL2				BTKNIL3 BTKNIL4		BTKNIL5
500g (x18) availability														
for supply														
25g (x10) availability for														
supply														

Breeders Toolkit Deliverables

Origin	NIL stream	QTL / Gene	Landrace/ Mutant sib	Paragon/ Wildtype sib	Markers used for selection
WISP landrace	PW141-16	2D-EM	12W	10P	BS00003804 BS00069899 BS00021912
WISP landrace	PW034-19	2B-EM	12W	11P	BS00064155 BS00074661
EMS (Uauy group)	TILLING line T4-2235	GW2-A1 a	mutant (A)	wildtype (G)	TaGW2_A_F_specific TaGW2_A_R_wildtype TaGW2_A_R_mutant

Trait classes of the 1272 landrace QTL identified at RReS, Nottingham, and JIC

Monthly Total Requests per Year



BBSRC bioscience for the future

Germplasm Resources Unit

..... a national capability supported by the BBSRC at the John Innes Centre

John Innes Centre

SeedStore (β-3.5) | SeedStor Home | Public Search Interface | JIC Staff Access | Control Panel | GRU Help | GRU Search

Regeneration Tasks

- Stage 1 - Update Regeneration Flags
- Stage 2 - Generate Regeneration Lists
- Stage 3 - Retrieve Stocks
- Stage 4 - Plant Stocks
- Stage 4b - Germination Rates
- Stage 5 - Phenotyping
- Stage 6 - Record new Stocks
- View Regeneration Records
- Regeneration Flag Report

Seed Stock Regeneration Module

This module provides the functionality to allow seed stock regeneration.

SeedStor will limit the number of accessions shown to 980 per page (This is due to PHP limit of 1000 form elements by default)

On Going Regeneration Processes

	Year	Sub Collection	Location	Regeneration Status (Failed / Success / Ongoing)	Ongoing Status
1	2015	BBSRC_Wheat	Field	**F:** 0, **S:** 0, **O:** 347	**Selected:** 347, **Retrieved:** 0, **Planted:** 0, **Threshing:** 0
2	2015	BBSRC_Wheat	Glasshouse	**F:** 0, **S:** 0, **O:** 243	**Selected:** 243, **Retrieved:** 0, **Planted:** 0, **Threshing:** 0
3	2015	BBSRC_Barley	Glasshouse	**F:** 0, **S:** 0, **O:** 276	**Selected:** 276, **Retrieved:** 0, **Planted:** 0, **Threshing:** 0
4	2015	BBSRC_Barley	Field	**F:** 0, **S:** 0, **O:** 696	**Selected:** 696, **Retrieved:** 0, **Planted:** 0, **Threshing:** 0
5	2015	BBSRC_Oat	Glasshouse	**F:** 0, **S:** 0, **O:** 146	**Selected:** 146, **Retrieved:** 0, **Planted:** 0, **Threshing:** 0

SeedStore (α-3.1)

SeedS

The John Innes Centre.

Search Pane 36 records found. Toggle Search and Sort Pane

Filtering Active, only displaying results that match the filter criteria: (JobStatus='Open' OR JobStatus='Pending')

Active Job Requests

Add Create a new Job Request

Job ID: 5100 — **Client:** Rasheed, Awais; **Last Client Contact:** Job Acknowledged: 27/May/2015.; **Status Comment:** New job 27-May-2015; **Title:** Triticeae reference set and Watkins collections. — **Primary Staff Contact:** Mr Mike Ambrose

Job ID: 5099 — **Client:** Wulff, Brande; **Last Client Contact:** Job Acknowledged: 27/May/2015.; **Status Comment:** New job 27-May-2015; **Title:** Export of Triticum turgidum to Tunisia. — **Primary Staff Contact:** Mr Mike Ambrose

Job ID: 5098 — **Client:** Meldrum, Josiah; **Last Client Contact:** Job Acknowledged: 21/May/2015.; **Status Comment:** New job 21-May-2015; **Title:** Invitation to Hodmedod open day at Waklyns. — **Primary Staff Contact:** Mr Mike Ambrose

GRU slides courtesy of Richard Horler

The Breeders Toolkit

- Delivery role passing between Researchers at JIC and other Academia Centres to the Breeding Industry
- Applied aspect of getting valuable generated resources (comparable and testable) out into the real world of breeding – '*The Breeder Toolkit'* (BTK)
- Trackable research on to the big stage

Varietal inclusion….

Breeders Gene Pool

Research - DFW

The Breeders Toolkit

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Varietal inclusion….

Breeders Gene Pool

The BTK role

Research - DFW

DFW

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Varietal inclusion….8years?

Breeders Gene Pool

5years?

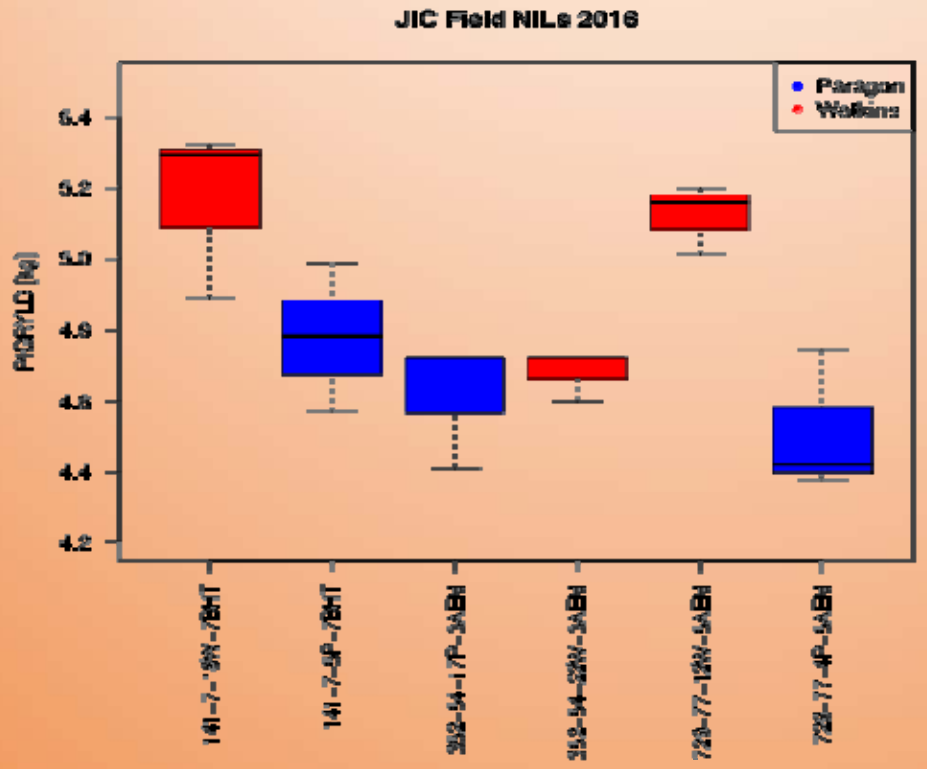
The BTK role

Research - DFW

JIC Specific - Global Landrace Resource
A. E. Watkins Collection Origins

Over 800 accessions collected in the 1930s using London Board of Trade from 32 countries.
Collection = 1050 / Core Set 85

From WISP/DFW yield trial data 2016 and 2017



First positive signs of Landrace alleles bringing agronomic advantage

500g of this seed for three alleles (x2) are provided + Paragon = 21 plots (and marker data)

Enabling three rep 6m yield plot assessment

Breeders Toolkit Concept

Va

Breeders Gene Pool

The Breeders Toolkit

A.E Watkins Landraces
Genetic and Geographic Diversity

Over 800 accessions collected in the 1930s using London Board of Trade from 32 countries.
Entire Collection - 1050 (WATDE)
Core Set 119 (WATDC) of which 85 mapping populations are developed and mapped at F4