

**ADVISORY COMMITTEE ON ANIMAL FEEDINGSTUFFS**

**63rd Meeting of ACAF on 26 February 2014**

Presentation Paper  
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Pre-breeding and wheat resynthesis

**Secretariat  
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## Pre-breeding and wheat resynthesis



Dr Phil Howell  
NIAB TAG Pre-breeding group

## Pre-breeding and wheat resynthesis

- What do we mean by pre-breeding?
- Origins of wheat and resynthesis
- Tetraploid / hexaploid crossing
- Results to date
- Relevance to animal feed supply chain
- Next steps



## Pre-breeding

- Pre-breeding sits in the (big!) gap between “high science” (universities, research institutes) and the market (breeders, growers, end-users)
- Primarily, it involves moving new genes & traits into adapted backgrounds
- The aim is not to directly breed new varieties, but to produce adapted lines which commercial breeders can then incorporate into their programmes
- This requires a different mindset - most of my NIAB selections would have got me the sack as a breeder for Syngenta!

# New sources of genetic diversity

## Mutants eg Smart Carbs



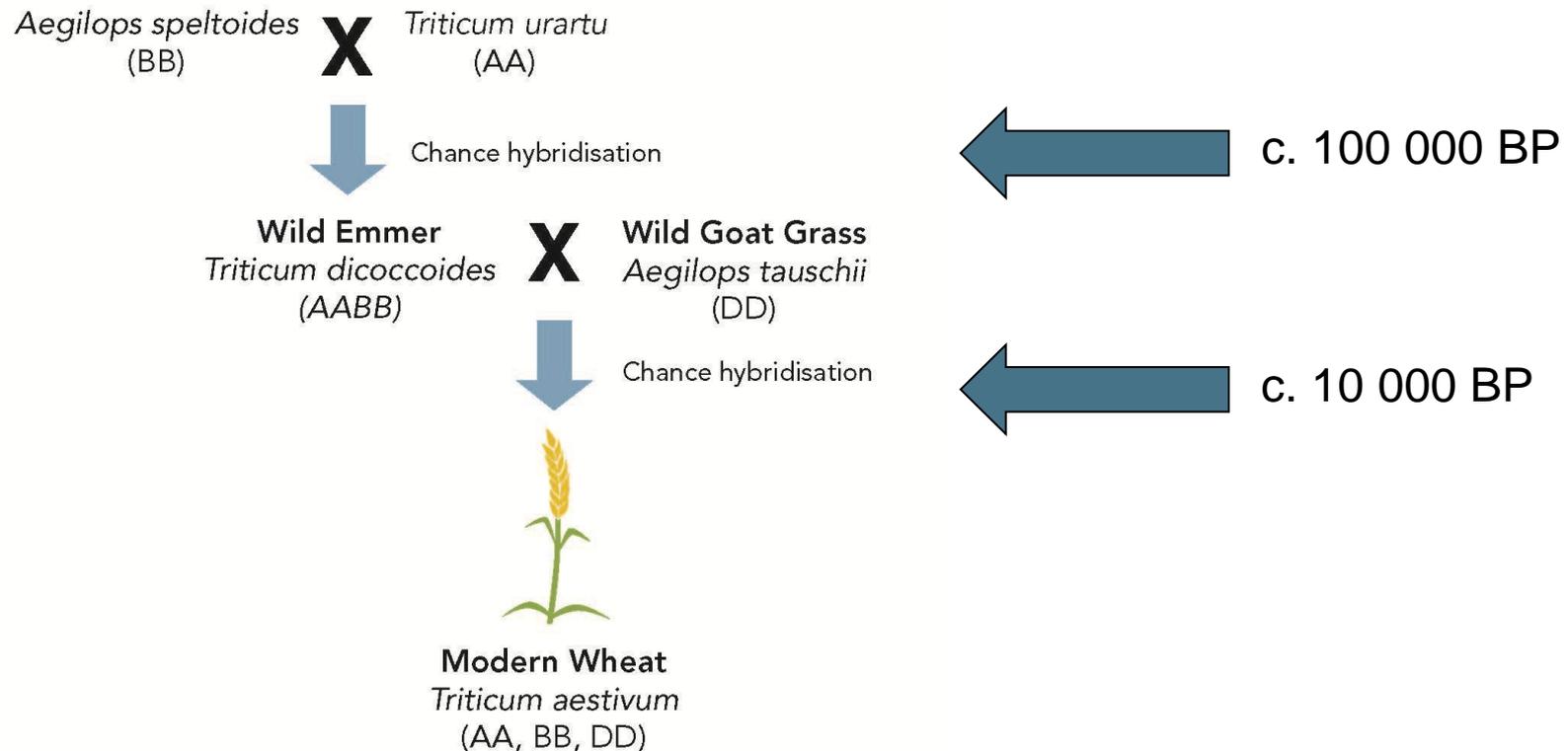
Related species



Resynthesis

# Origins of modern wheat

## Modern Wheat

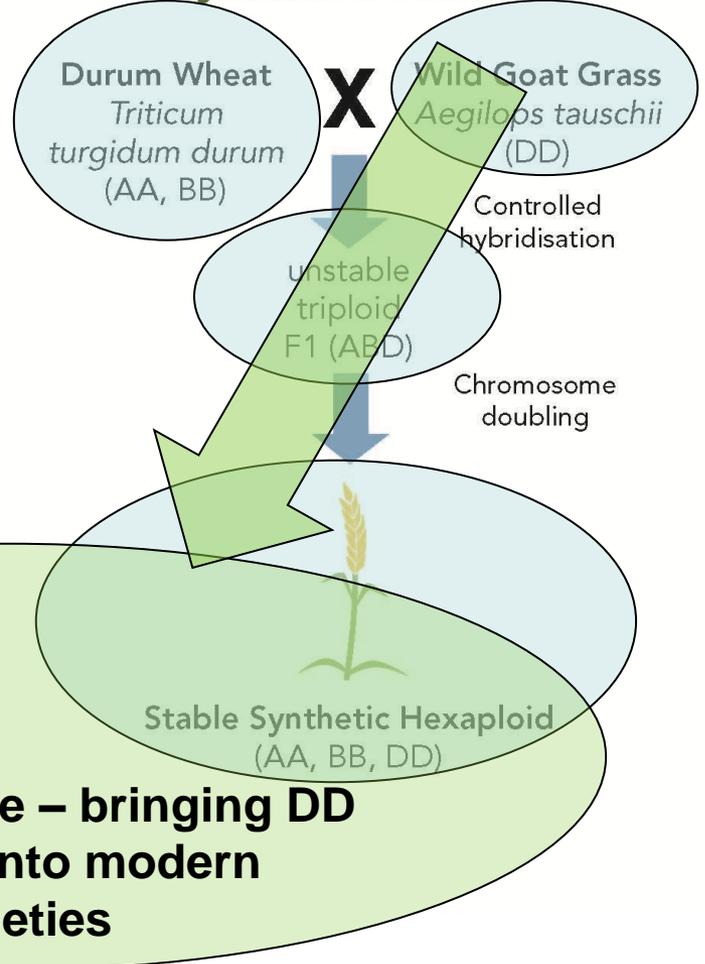


# Resynthesised wheat (SHWs)

Modern Wheat



Synthetic Wheat



**Fully crossable – bringing DD variation into modern varieties**

# Tetraploid / hexaploid direct crossing



Robigus,  
Paragon  
*Triticum aestivum*  
(AA, BB, DD)

**X**

Wild Emmer  
*Triticum dicoccoides*  
(AA, BB)



pentaploid F1  
(AA, BB, **D**)

**X**

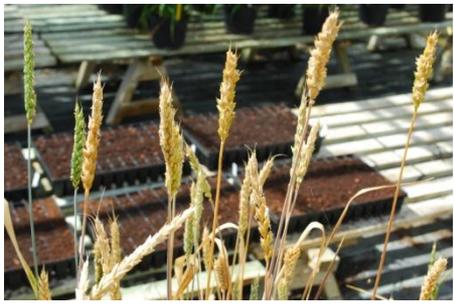
Robigus,  
Paragon



Cultivated Emmer  
*Triticum dicoccum*  
(AA, BB)



Segregating backcross generation  
(AA, BB, **D**); (AA, BB, DD)



Inbred BC1F5 generation  
(**AA, BB**); (AA, BB, DD)



Durum Wheat  
*Triticum durum*  
(AA, BB)



## Positive results so far.....

- High yield potential in SHW-derived selections
  - Best yields >30% above adapted parent
- Room for further improvement:
  - eg 110% yield but 119% biomass: can we tweak harvest index further?
  - Even if yield only = best elites, likely to be for different reasons: are these additive?
- High yields may be maintained better at lower N than elites
- We have also seen increases in yield components:
  - Very large grains
  - Increased grain number



## Grain quality

- Relatively little quality testing so far
- Samples from 2011-12 trials showed “normal” ranges of protein content, HFN, specific weight etc in predictive quality tests
- Samples from 2012-13 trials currently passing through the labs
- Best candidates from 2013-14 will go on to milling and baking tests
- Currently no plans for specific animal feeding studies
- The trials appear perfectly palatable to certain animals!



## Is there a feed wheat ideotype?

Most wheat feeding studies come from non-ruminants (primarily pigs/poultry)

- Soft wheat is broadly preferred to hard wheat (energy conversion)
- Reducing GI viscosity is key:
  - 1BS/1RL (“rye”) translocation is detrimental - secalins
  - Non-starch polysaccharides (NSPs) esp arabinoxylans
  - Xylanase-inhibitor proteins (XIs) can counteract enzymes added to reduce feed viscosity
  - Gluten “dough balls” can cause lethal intestinal blockages: affected by protein content, gliadin/glutenin profile and degree of milling
- Ideotype = “rye-negative”, soft, low NSP, low XI, low protein, weak gluten ?
- More studies needed to refine this and test hypotheses

## Do our pre-breeding lines fit this ideotype?

- Hard/soft: some SHWs carry novel gene variation which may give hardness and softness outside the usual range ✓?
- 1BS/1RL: not carried by any of the donor or recipient lines ✓
- NSPs and XIs: unknown, not a standard screening test ?
  - NIRS calibrations for NSPs?
- Protein content: routinely screened within breeding process ✓
- Gluten profile: Routinely screened within breeding process ✓
  - Both SHWs and tetraploids can carry unusual sub-units with unknown functionality ?
- Overall viscosity: not a standard screening test ?
  - NIRS calibrations? RVA screening standard in France

## Is this new?

- The first resynthesised wheat was reported in the 1946 in the US
- CIMMYT began a large resynthesis programme in the late 1980s; other work in eg China and Australia is also underway
  - 1/3<sup>rd</sup> of new lines distributed through CIMMYT's global nurseries have resynthesised wheat in their pedigree
  - 25% of the Chinese wheat acreage (~5m ha) is reported to be planted with SHW-derivatives
- Closer to home:
  - 40 varieties on the 2014-15 UK Recommended List
  - Wheat used for animal feed will be mainly drawn from the 31 Gr3 and Gr4 varieties
  - 2/3<sup>rd</sup> of these have pedigree links to *T. dicoccoides* derivatives, mainly through the variety 'Robigus'
  - Unaware of any alarm bells regarding their feeding suitability
  - No SHW-derivatives have been commercialised to date in N Europe



## Next steps

- Existing material (BBSRC Follow-On Fund, all SHW-derived)
  - 3 breeder partners already have full access for crossing
  - Exhaustive testing, entry into NL trials, commercial release?
- New material (WISP material; SHW-derived and THEX)
  - Primary sift, transfer to commercial breeders
  - Longer-term pre-breeding to explore beneficial traits
- “Breed for Feed”
  - Biosciences KTN sponsored a meeting in May 2013 for the animal feed supply chain (plant breeders, feed compounders, meat producers etc)
  - Feed Supply Chain Working Group formed to address the challenges of animal feed from UK crops from all sides
  - Hoping to bid for funding from the imminent Agritech Catalyst call

# Funding

- NIAB's pre-breeding is funded from several sources
  - BBSRC
  - HGCA
  - Breeders
  - EU
  - Technology Strategy Board
  - NIAB Trust



Technology Strategy Board  
Driving Innovation