



## WHEAT GENETIC IMPROVEMENT NETWORK (WGIN) 1<sup>ST</sup> STAKEHOLDERS MEETING

3 November 2003 at Rothamsted Research

### MINUTES

#### **SUMMARY OF DISCUSSION AND QUESTIONS FOLLOWING THE PRESENTATIONS GIVEN BY Dr DONAL MURPHY-BOKERN (Defra) and Prof PETER SHEWRY (RRes)**

What does sustainability mean to Defra? Defra uses the term 'Sustainable Development' rather than 'sustainability'. On the ground in relation to this research, it means increasing the environmental and economic performance of arable farmers. It's about minimising pesticide use and impacts and improving the nutrient economy of the cereal-based food chain. It may mean breeding wheat to serve as a more efficient animal feedstuff or for non-food uses. The recent farm scale evaluations have raised fundamental questions about the impact of crop production practice on biodiversity and there may be a role for crop breeding in addressing the resulting challenges.

The political paradigm includes social, environmental and economic elements. The aim is to deliver progress on all three at the same time. For the UK, social and economic progress has been achieved in the last century but at the expense of the environment. We now need to square the 3 circles together. This research is about harnessing genetics to improve the economic and environmental performance of agriculture.

What are the Satellite projects about? Unlike the WGIN core project, which is ongoing and does not have true boundaries, the satellite projects will be specific and time bound. The satellite projects will be concerted efforts to address specific issues. They may involve desk top scoping studies. This is already occurring for nitrogen used efficiency. The idea is, through the stability and scope for excellence provided by the core project, to attract BBSRC support into in the satellite project areas via responsive mode grants.

The core project science will deliver (a) to the wheat breeders and other end-users, (b) to Defra and its policy development and (c) good science and the tools required in the future.

Intellectual property management – This should be achieved by the implementation of Baker (1). IP ownership is with the research providers concerned. However, the patent culture can hinder exploitation, so we need to be mindful of this. IP commercialisation should foster exploitation. Where IP commercialisation hinders exploitation, then Defra will use the get-out clauses in Baker to ensure that exploitation is fostered through retaining ownership.

"Genetics" is now a controversial word. Could Defra publicise via its genetic improvement programme what genetics and plant breeders actual have done and continue to do for the public good? This would apply across all the crop networks and the Networks could be used to remind the wider public of the role of public sector in harnessing genetics and breeding for the public good pursued through partnerships with breeders.

What should be done about developing technologies that the public does not like? There is a need to educate the public during the development of the technology and then as the new products enter the market to undertake a survey of the now 'well-educated' public.

WGIN is not about GM crops. Some of the hostility to new breeding technology is based on the perception that plant breeding is controlled by a few private sector multi-national companies. The Networks are an opportunity to remind ourselves and the wider public of the public service role that plant breeders' activities have had in the past and that plant breeding continues to have a strong public dimension. Breeders work with the public sector to deliver the crops the consumer/ general public wants to see grown.

Allocation of resources to trait evaluation – There were no preconceived ideas about the funds to be allocated to traits. Defra applies the market failure rationale to its funding and that is the main consideration. If a trait is needed to deliver on policy and public research will help overcome market barriers, then it is a candidate for funding.

The core project versus the LINK projects - Can Defra sponsored LINK projects stand alone? Yes. However, by accessing the resources within the core project we would expect there should be a natural advantage to the LINK project team that is recognised by the project partners and the PMC. This will be a self regulating mechanism. If for example in 3 years time, there are 5 LINK projects supporting the genetic improvement of wheat and none of them use the core resources, then Defra will need to look carefully at the core research activities.

Time frame to deliver - All government spending is set in three-four year spending review cycles. WGIN will yield benefits very soon because it is building on resources already in place because of previous investment by BBSRC, Defra and the other funding agencies. Success in terms of helping the wheat breeders will be measured in two+ years.

What is the relationship between WGIN and the BBSRC crop science review? Donal Murphy-Bokern and Peter Shewry are both on the BBSRC crop science review committee chaired by Prof. Chris Gilligan (University of Cambridge). Therefore, the review team are well aware of the interactions such as this project between Defra and BBSRC.

The balance within the WGIN - There are 3 roles: the needs of industry, Defra policy, and the science. The science underpins the other two and is certainly not undertaken independently.

The Defra Arable Research programme is mostly about policy delivery. WGIN is much longer term than research that feeds directly into policy making. It is about spotting the technologies required to support delivery of policy years for now. In this type of research, we have failed if we find ourselves initiating research after the policy requirement become obvious.

## DISCUSSION SESSIONS

### THE WGIN CEREAL RESEARCH PLATFORM

Dr Kim Hammond-Kosack (RRes) and Dr Robert Koebner (JIC)

### VIEWS FROM UK WHEAT BREEDERS

Bill Angus (Nickersons) and Philip Howell (Syngenta)

### WGIN RESOURCES IN THE CORE PROJECT

Chair: Professor John Snape (JIC)

What resources should be in this open source programme?

What are the useful end-points of this research to the user community?

#### Markers and Mapping Populations

The discovery of a molecular marker tightly associated to a specific trait, may NOT be a useful end-point. There is a need to validate the marker in elite germplasm and to provide the trait to the breeders in a current genotype. Industry does not have the resources to take a lab marker tested in an experimental population into an elite genotype (line) and then test this in the next generation of commercial germplasm. This has been a key learning from the Australian experience, where seven years of public sector science has delivered about 10 genes and linked molecular markers that can be used by the wheat breeding industry. In Australia, all the wheat breeding is now undertaken by private companies (2).

Molecular markers are expensive at the moment, but hopefully the price will go down in the future. Is WGIN looking at ways to reduce the cost per datapoint? The SNPs discovery with the WGIN programme is an example.

#### Germplasm

No comments received

#### Diversity screen

How much needs to be done? At JIC, phenotyping of the BBSRC maintained wheat collection by Mike Ambrose is ongoing. There is field scale phenotyping during the annual seed multiplication of 1200 lines. A web accessible database will soon be available that describes the traits within the wheat collection maintained at JIC.

Annually, HGCA scores 150 traits that are aimed at end-user needs. RL trial data is a valuable resource owned by HCGA and I understood that HGCA would make it available. Can you clarify if this was the case?

Annually, each wheat breeding company assesses a miscellaneous genotype collection for traits readily visible at their location, for example resistance to a specific disease because of a local epidemic. It is possible that each of the breeding companies could take each year 30-50 of the BBSRC accessions held at JIC and evaluate them for various traits. The strength of the wheat breeders lies in field based evaluations. This would also be an active partnership, early on in WGIN programme.

It was my understanding at the meeting that breeders showed interest in providing a contribution to phenotyping, can you please make this more clear?

Is evaluation of older hexaploid germplasm very useful? A novel trait found in older material would be accessible via marker assisted selection into elite germplasm.

In the USA, there is a \$5 million programme just started on EST based SNPs as molecular markers. The JIC wheat marker project will link in with this larger programme.

### Mutagenesis and PCR Tilling

Why mutagenise a hexaploid? Will you see recessive mutations? Evidence from mutagenesis programmes suggests that many wheat genes are not triplicated, and recessive phenotypes are detected, and in any case recessive phenotypes will be detected by the reverse genetics approach

Why not choose barley as the diploid to test for gene function instead of diploid wheat? Barley is a non-host, ie not susceptible to many of the pathogens that attack wheat. For example, Septoria leaf blotch, yellow and brown rust and wheat powdery mildew. It is also not possible to test bread making quality traits in barley.

To use the PCR Tilling you need to already have a candidate gene that has been shown to affect the phenotype (3). It is not possible to go directly from the trait to the PCR Tilling technique? PCR Tilling is technically difficult and therefore funds were made available within WGIN to send 2 people from RRes to the lab in Seattle, USA to be trained in the Tilling technique.

How much biochemical testing of genotypes will take place? There is very little in the core WGIN programme. However, the grain from the field trials will be archived and this will be made available for use by other researchers.

Could the programme use interference RNAi to silence genes and look for phenotypes? This activity will take place in the Defra funded BRAC project.

### **WGIN TRAITS**

Chair: Dr Mike Gooding (Reading)

How should traits be prioritised? The traits priority list needs to be generated first and only then will it be possible to determine which mapping populations will be suitable for the WGIN programme. Should WGIN be developing new mapping populations, or should it just extend existing mapping populations so that the programme is able to deliver within the time frame? It's important that target traits are identified before selection of suitable parents for mapping populations.

A good activity for WGIN would be to produce and distribute a summary page of what trait evaluation is ongoing now and where is this happening. Then all the stakeholders can see where the gaps are and what is already ongoing. This should be one of the wider networking activities.

Pre-harvest sprouting – John Flintham (JIC) is at the pre-concept note stage for a LINK project on sprouting and is seeking academics and industrial partners. This trait is always amongst the priorities. Does pre-harvest sprouting fit with Donal's initial remarks about the focus is on sustainability traits. Yes, because if grain destined for breadmaking sprouts, then it is sold instead for animal feed and this causes excess nitrogen to enter the animal feed chain.

Ergot caused by the flower attaching fungus pathogen *Claviceps purpurea*. This is an increasing problem in the UK and there is variation in susceptibility between varieties. Possible causes (a) change in pesticide use leading to change in the grass weed species that are found around the field margins, (b) cultivar partial infertility lengthening the flowering

time and hence susceptibility period, (c) high N favours ergot and (d) issues with current seed certification standard and the levels permitted in the retail delivered seed means that this disease is entering into new geographical regions via the infected/ contaminated seed route, either wheat or grass weed grains. Rosemary Bayles at NIAB is at the pre-concept note stage with a LINK project and is seeking academics and industrial partners.

Disease resistance/insect resistance – These two traits affect the entire UK wheat crop, whereas grain quality traits only cover specific sub-sectors, eg, for breadmaking. There is a need to understand why there is market failure. To prevent market failure there is a need to understand the mechanism of the trait.

Septoria leaf blotch - In the 1980/1990s the wheat breeders placed less emphasis on breeding wheat lines with a high level of resistance to Septoria leaf blotch. This was because of the range of effective fungicides available. Now the situation has changed with the arrival and widespread occurrence of strobilin fungicide resistant in Septoria isolates in 2003.

Fungicides vs insecticides – fungicides are more environmentally benign when compared with insecticides. When insecticides are applied in the autumn to control the virus BYDV, the insect biodiversity is less than when insecticides are applied in spring and summer.

Food safety problems - We do not want health scares with wheat. The two pathogens that are likely to cause the greatest food safety problems are Fusarium ear blight (FEB) and ergot. In North Dakota, USA, barley can no longer be grown for the brewing industry because of the annual severity of the Fusarium ear blight. For FEB, there is a need to find new resistance sources unrelated to the Chinese source.

Nitrogen use efficiency - There is not much variation in NUE in modern wheat. John Folkes (University of Nottingham) is undertaking a 1 year desk study along with RRes and NIAB into NUE as a Defra funded Satellite project (AR0714 - A study of the scope for the application of crop genomics and breeding to increase N economy within cereal and rapeseed food chains). Over the past 20 years, there has been a more efficient use of nitrogen on the same amount of land due to the efforts of agronomists. Protein yield/ hectare has rising whilst the nitrogen levels applied per hectare have decreased.

### Grain protein quality

A. For breadmaking. Trait analysis is already ongoing with a funded Defra LINK project involving JIC and RRes.

There is a need to think about the use of crops that do not make the breadmaking grade. Formerly, this has meant selling the grain for animal feed.

Future work at RRes using BBSRC and hopefully EU monies will focus on (a) the effect of the environment on the stability of processing quality and (b) delivering nutritional benefit to the consumer.

B. For animal feed – there is a lot more interest in feed-processing quality. We are now looking at protein and polysaccharide composition and consistency of the product to create animal protein. Animal feeds are typically 50 % wheat based.

C. For industrial use – Defra has funded research on industrial uses of wheat, namely through LINK projects. This shows there is industrial interest and therefore the currently niche markets are likely to increase in importance. Examples were given of two LINK projects of relevance, on the use of cereal starch as dry lubricant and cereal grain to produce foams that can have several applications, namely for the car industry. These are currently niche markets, and it is envisaged that they will increase in the future.

Hybrid wheat – Why not try to do this in WGIN? It has proven beyond the financial means of even the multinationals. Wheat is largely self-fertile, in hybrid wheat production, the male sterile parent would suffer from no/low fertilisation rates and, hence, problems with ergot. Wheat is a global commodity and it is not a crop that you should expect to get a large return.

#### References

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2. Australian J. Agricultural Research (2001) Volume 52, pages 1079n onwards, describes in detail the Australian wheat breeding experience.
3. A review of the PCR Tilling technique. Henikoff S and Comai I (2003) Single-nucleotide mutations for plant functional genomics. Annu. Rev. Plant Biol. 54: 375-401.

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