

## WYN STRATEGY DOCUMENT (draft)

### THE WHEAT YIELD NETWORK: A STRATEGY FOR 2014-24

In November 2012, funding agencies and organisations from 20 countries agreed to work together to develop a strategic approach to supporting research that would lead to increasing the genetic yield potential of wheat<sup>1</sup>. This collaborative approach, the Wheat Yield Network (WYN), builds on the Wheat Yield Consortium established by CIMMYT and contributes to the global Wheat Initiative<sup>2</sup>.

1 <http://www.bbsrc.ac.uk/web/FILES/Resources/wheat-yield-network.pdf> .

2 <http://www.wheatinitiative.org/>

#### Need and rationale for the WYN

1. The WYN represents a new and more coordinated approach to address the challenge of raising the genetic wheat yield potential of wheat by up to 50%. Globally, wheat is the most important staple crop providing 20% of daily calories and protein. By 2050 wheat demand is expected to increase by 70%. To meet this demand, annual potential wheat yield increases must grow from the current level of below 1% to at least 1.7%.

2. The WYN goal of increasing the genetic yield potential of wheat by up to 50% is exceptionally challenging, it requires a strategic and collaborative approach to enable the best scientific teams from across the globe to work together in an integrated programme. Whilst a number of large global and national programmes exist, most are focused on combatting stresses and diseases thereby protecting current yields, few are focused on increasing the wheat yield potential *per se*. The outputs will provide new genetic resources to allow wheat breeders throughout the world to draw on this new „raw material“ to produce higher yielding varieties adapted to local conditions.

3. Recent developments in scientific methodologies and new technologies have led to an unprecedented increase in our understanding of many aspects of plant science. When combined with the urgent need to increase wheat yields, it is now timely to address the challenge of increasing wheat yields by developing an integrated programme focused on the genetics underpinning yield potential traits. The renewed interest from the private sector in wheat research underlines the need for, and timeliness of, this programme.

#### The WYN's Vision

4. The WYN encompasses an applied programme that will deliver genuine outcomes in terms of novel germplasm and new elite genotypes to breeders. The WYN represents an integrated, multi-disciplinary, research programme involving a combination of public and private funded research and in-kind support, where possible aligned with current relevant programmes.

5. The WYN will address the challenge of increasing the genetic wheat yield potential by a targeted approach including the identification and subsequent validation of sources of genes and /or combinations of genes that have the potential to influence wheat yield. Studies will be conducted to understand the genetic and physiological basis of increasing yield potential through the development of new models and wheat ideotypes in relevant breeding germplasm.

6. Many of the most powerful innovations for plant breeding have come from branches of science outside plant biology. Research outputs from other plant species may also

provide valuable information for wheat improvement. The WYN will survey the outputs from other relevant programmes and form new research linkages when appropriate.

#### WYN Programme Scope

7. The WYN will focus on genetic wheat yield potential. Specific areas of research will initially focus on increasing grain yield through fixation of more carbon into biomass via photosynthesis and transferring more carbon into seeds during senescence, while protecting the plants from lodging.

8. **Increasing the efficiency of carbon fixation:** Photosynthetic capacity, efficiency and carbon fixation into useful biomass are known bottlenecks to raising productivity potential. The photosynthetic rate in crop canopies is correlated with biomass yield and grain yield in a multitude of environments, provided that other constraints do not become limiting. Even small increases in the efficiency of net photosynthesis could translate into large increases in biomass and potentially grain yield, since carbon assimilation by the crop canopy is integrated over the entire growing season. Mobilisation of starch to the grain and grain development are key factors as changes to biomass will require a modified partitioning in order to maintain the same harvest index. Photosynthesis in the spike during grain development is also significant.

**9. Biological routes to increase photosynthetic capacity, efficiency and biomass:** Increasing ear photosynthesis, optimizing canopy photosynthesis, introducing chloroplast CO<sub>2</sub> pumps, increasing RuBP regeneration, improving the thermal stability of RuBisCo activase to sustain full activation of RuBisCO, and even replacing wheat RuBisCo with that from other species with different kinetic properties are all potential routes that should be investigated. Any such innovations will need to be coupled with resistance to lodging and optimal harvest indices to ensure high grain yield gains. An additional understanding of underpinning developmental biology for grain development may also be necessary to maximise potential yield gain.

**10. Exemplar projects:** To deliver the ultimate aims of the WYN will require a combination of discovery and applied projects, each orientated towards the overall end goal of developing new models and ideotypes for wheat lines with improved yield potential. Six key project areas have been proposed which will be combined into an integrated programme:

- A. Discovery of genetic variation in wheat that boosts the fixation of carbon into biomass for subsequent transfer to grains
- B. Deployment of proven transgenes to boost carbon fixation and biomass production
- C. Maximising grain yields from enhanced carbon capture and biomass through optimising plant phenology
- D. Building elite lines for dispersal to other breeding programmes
- E. Taking advantage of discoveries coming from relatives of wheat and other species
- F. Breakthrough enabling technologies to transform wheat breeding.

**11. Cutting Edge Technologies:** Where appropriate the WYN should employ novel, cutting-edge, technologies and build on recent advances in plant sciences. New tools and technologies will make it possible for the genetic analysis of complex traits to be performed in more powerful and successful ways. For example: new sequencing technologies have enabled genotyping and identification of novel QTLs to be performed much more rapidly and efficiently. Moreover, advances in phenomics and analysis of physiological traits have increased the feasibility of field-scale assessment of physiological traits.

**12. Building on outputs from other programmes:** During the lifetime of the WYN, a hexaploid wheat genome reference sequence will be delivered. The comparative mapping of variant genotypes onto this reference sequence will enable better selection of parental diversity and the ability to explore and define different haplotype segments to provide markers for following preferred genetic variation in breeding programmes. Moreover, comparative genomics using results from barley, rice and maize will be very informative for wheat. Transgenes are increasingly being identified that may influence relevant traits in crop plants.

**13.** The power of modern bioinformatics and computational biology is allowing many of the aforementioned approaches and methodologies to be accomplished much more quickly and at a greater scale than has previously been possible. Progress in such innovations and systems of analysis are game-changing for plant breeding and will need to be monitored and integrated into the WYN programme.

#### **A collaborative approach to funding and delivering the WYN**

**14.** The overarching WYN goal is extremely challenging and complex and cannot be easily tackled by individual groups. Funders and research organisations will develop innovative mechanisms and funding scenarios to allow the deployment of resources to enable the best teams to work together towards an integrated programme which will include the components described below.

**15.** It is important to emphasise that the WYN Governance and Management Structure (e.g. the WYN Science and Impact Executive Board and the Scientific Leadership Committee) will allow the results and outputs from the different scientific strands, and projects funded by different streams, to be integrated together as a cohesive programme. The WYN Programme Director will be crucial in enabling, coordinating and delivering such integration.

□ **A dedicated WYN Platform:** The WYN Platform will be responsible for building the innovations into elite adapted germplasm for distribution, with the required supporting breeding tools, to other public and private programs through its existing networks and collaborations. It will also need to adopt state-of-the-art marker assisted breeding and bioinformatics year-on-year to play this role effectively. Specific funding will be required to sustain the Platform's research activities and management and coordination practices.

□ **Competitive Calls:** To support the most competitive research in defined areas to create the necessary breakthroughs via innovative, discovery research projects. Such projects, assessed by fit for purpose peer review processes, will form the overall WYN programme and research pipeline.

□ **In-Kind support:** Mechanisms will be developed to enable researchers, research providers, funding organisations and the private sector already seeking relevant breakthroughs to become part of the WYN, if necessary, after peer review. Such in-kind support could enable researchers supported by existing mechanisms to contribute towards WYN research programmes, or enable access to research facilities.

□ **Aligned Programmes:** A number of large programmes exist that are complementary to the overall aims of the WYN. These include: WHEAT3 (a CGIAR Programme); Breedwheat4; (France) WISP5 (UK); Triticeae CAP 6(USA) and the Wheat Initiative7. Mechanisms will be developed to enable relevant outputs from ongoing research programmes to be shared with the WYN, and *vice versa*, thereby adding value by helping to maximize the outputs and impacts.

3 <http://wheat.org/>

4 <http://breedwheat.fr/>

5 <http://www.wheatisp.org/>

6 <http://www.triticeaecap.org/>

7 <http://www.wheatinitiative.org/>

□ **Private Sector participation within the WYN:** Significant benefit would be realised by participation of the private sector within the WYN. Increasing the genetic potential by 50% in the next 20 years is a common goal shared by all wheat breeders. This challenge is likely to be achievable only by sharing the challenge, the discovery processes necessary and many applications. Depending on the size and company type, companies will have different interests within the overall WYN pipeline and will have different resources to deploy. Opportunities and methods of engagement will be created to enable company involvement within the WYN. Where possible, early engagement will be sought to enable a shared vision to be developed.

It is anticipated that specific areas of interest for the private sector could include: bringing transgenic varieties to market when it becomes desirable; co-operation in the efficient making of hybrids and exploitation of novel traits/improvements in more markets.

□ **Data Sharing and Management:** The WYN will be built on the principles of sharing of data, research material, equipment and facilities both within and between projects in order to reach breakthroughs as rapidly as possible. There will be integration at the level of aims and objectives, approaches and outputs. Funding will be made available to enable the effective sharing of resources and data management to meet the WYN's goals. The Scientific Leadership Committee and WYN Programme Director (see below) will have responsibility for ensuring data sharing and management. Intellectual Property issues will be addressed before projects are initiated to the agreement of all parties.

□ **Training and Skills:** Innovative mechanisms will be developed to enable WYN researchers, postdoctoral research assistants and students to learn new techniques and experience different research environments within the overall framework of the WYN.

□ **Capacity building:** Establishing the WYN will assist in building critical mass in the area of yield potential. It is anticipated that researchers from other areas of plant science, other areas of bioscience, as well as other scientific disciplines will be excited by the challenge and the scale of this ambitious programme thereby increasing the skill base for future generations of wheat research.

□ **Governance and Management:** The WYN will develop and employ robust and fit for purpose governance and management practices that enable coordination, collaboration and cooperation whilst encouraging flexibility, openness and inclusivity. Key Governance and Management bodies include:

- **Science and Impact Executive Board (SIEB):** Comprised of Funders (including the private sector), Research Providers and Scientific Experts (academia and industry). SIEB has decision-making responsibility and provides strategic direction and scientific oversight to the WYN.

- **Scientific Leadership Committee (SLC):** Chaired by the WYN Programme Director, the Scientific Leadership Committee serves as an internal management and advisory body. It will integrate outputs of competitively awarded research grants with the WYN Platform and other WYN research activities. The SLC reports to the SIEB through the WYN Programme Director.

- **WYN Programme Director:** The WYN Programme Director will have responsibility for directing and integrating the science projects into a streamlined and cohesive programme and reporting to the Science and Impact Executive Board.

### WYN Funding Strategy

16. Deriving maximum impact from the WYN necessitates a long-term commitment of between 5 to 10 years. Since it is unlikely that many organisations will be in a position to commit to a 10 year programme, the WYN will comprise a number of specific project areas (see above) that are initiated at different time-points throughout the 10 year period. Discrete project areas will also enable funders and research providers to deploy their resources more effectively and will help to minimise overall risk.

17. A long term research and development and accompanying funding strategy will raise the overall profile of the WYN, thereby promoting interest and attracting potential investment from funders, including the private sector, and research providers. It should also serve to attract the participation of the best research teams.

18. The WYN research pipeline and associated funding requirements are illustrated in the diagram overleaf.

