

Wiring Diagrams for Better Crop Design and Breeding

An introduction to new “Wiring Diagrams” describing the important traits underpinning wheat grain yield has just been published in *Nature Foods* by an international group of IWYP scientists (Reynolds MP, Slafer GA, Foulkes JM, Griffiths S, Murchie EH, Carmo-Silva E, Asseng S, Chapman SC, Sawkins M, Gwyn J, Flavell RB, 2022. A wiring-diagram to integrate physiological traits of wheat yield potential. *Nature Food* DOI=10.1038/s43016-022-00512-z).

Several decades of knowledge on the roles of source and sink traits in determining grain yield, generated by crop physiologists and plant geneticists, has been assembled into this new tool designed to aid wheat research and breeding. The Wiring Diagram (WD) now published, and the series of WDs soon to be added to the literature in separate detailed review papers, describe the key traits and their interactions using a set of “wires” that illustrate trait interactions at different crop growth stages. The overall aim was to generate a deterministic physiological and genetic framework over plant development of the traits determining the yield of the wheat crop. The specific objectives for developing this new visual tool were to:

- Identify the core set of traits that determine grain yield in wheat breeding pools
- Synthesize currently known trait interactions over the development of the crop
- Identify known or anticipated trade-offs among traits and processes at different crop development stages
- Identify connections among traits that may not have been previously apparent from the literature
- Identify traits amenable for efficient exploitation and tracking in breeding programs
- Provide a framework for mapping genetic control of traits and identifying new sources of genetic variation
- Develop new and additional integrative research hypotheses to identify current gaps and future opportunities
- Provide a framework for the addition of more detailed Wiring Diagrams based on, for example, biochemical pathways, metabolite and hormone flow and gene expression

The sets of WDs are intended to make it easier to conceptualize and design changes in specific components of the crop with better understanding of the consequences of the changes on field performance and thus facilitate the generation of more impactful innovations in wheat breeding.

It is anticipated that the new wheat WDs will be adopted as a community-owned resource for wheat research and breeding design. By illustrating current knowledge gaps, the WDs can be used to prioritize investments in R&D as well as a teaching tool for the next generation of crop physiologists, geneticists and breeders. To remain relevant, the WDs will require updating as new knowledge becomes available and could be digitally linked to other types of data underpinning crop development such as transcriptomics and metabolomics. The WDs could also be customized for specific environments and to other crop species where there is a sufficient knowledge base.

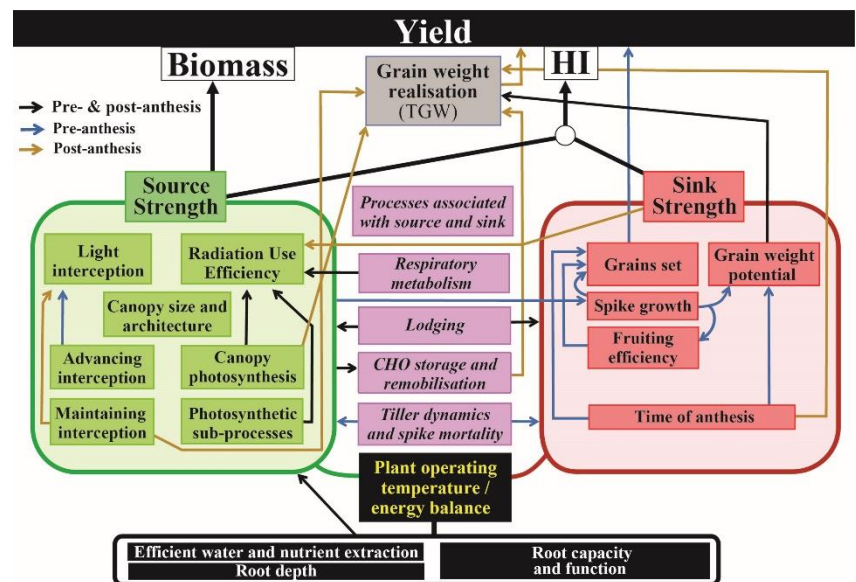


Figure 1. Example of the Wiring Diagram for wheat yield illustrating the relationships among trait categories at different developmental stages.