International Wheat Yield Partnership
Research to Deliver Wheat for the Future

IWYP SCIENCE BRIEF

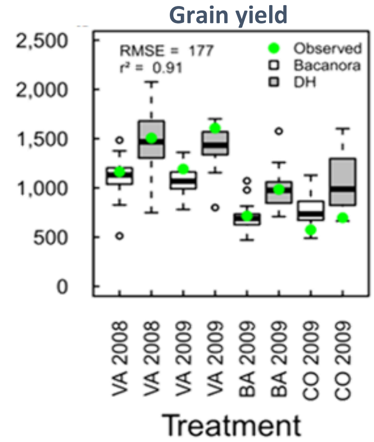
NUMBER 19 SEPTEMBER 2021

Supported by

Tailoring Crop Models to Identify Yield Increasing Traits for Different Environments

Incorporating promising plant traits into breeding material might take several breeding cycles before being available in commercial cultivars and thus their actual benefits may not be realized for decades, during which time the climate will be continually changing. Crop simulation models that reproduce different growing conditions in the field could estimate the impact of specific traits across environments *ex ante*, well before any of these traits are available in commercial cultivars. A project "**Traits for increasing wheat grain yield**", led by Senthold Asseng at the Technical University of Munich, with other colleagues in Germany, the USA, France, New Zealand, and Mexico, is combining crop simulation models with field experiments (**Figure 1**) to quantify the impact of different agronomic traits, estimating the amount of yield changed, and the impact of specific trait combinations on wheat grain yield potential. Different simulated trait impact scenarios (**Figure 2**) were created to guide breeding towards the most effective traits and trait combinations for future wheat across the world.

Figure 1. Observed (green circles) and simulated (box plots) grain yields for wheat variety Bacanora and a double haploid (DH) line at Valdivia, Chile (VA), Buenos Aires, Argentina (BA), and Ciudad Obregon, Mexico (CO). Box plots show the 90th, 75th, 25th, 10th percentiles, median, and outliers (open circles) of simulations based on a multi-model ensemble that can efficiently reproduce observed yield.



What solutions have been identified?

- Improved physiological traits, particularly increased radiation use efficiency (RUE), can be scaled to most irrigated and high-rainfall regions (**Figure 3**) and have the potential to increase current global wheat yield by over 30%.

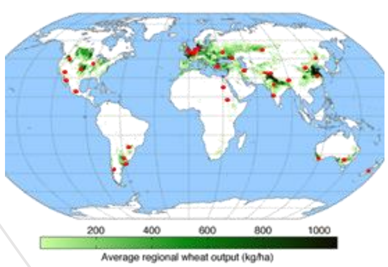


Figure 2. Average regional wheat yield (green areas) and the 34 representative irrigated or high-rainfall locations used in simulation (red dots).

Anticipated Impact of this Research

- A multi-model ensemble of wheat crop models that incorporated measured yield-enhancing traits efficiently reproduced the observed yield and biomass in different environments. Extrapolating the observations with crop simulation models to the global level shows that improved traits can increase current global wheat yield by over 30% in high-yielding environments, providing a yardstick for yield gap analysis and breeding adaptation strategies. The extrapolation involves certain assumptions, such as no significant trade-off with below ground biomass and that adaptation of reproductive growth to each environment is achieved simultaneously with RUE.

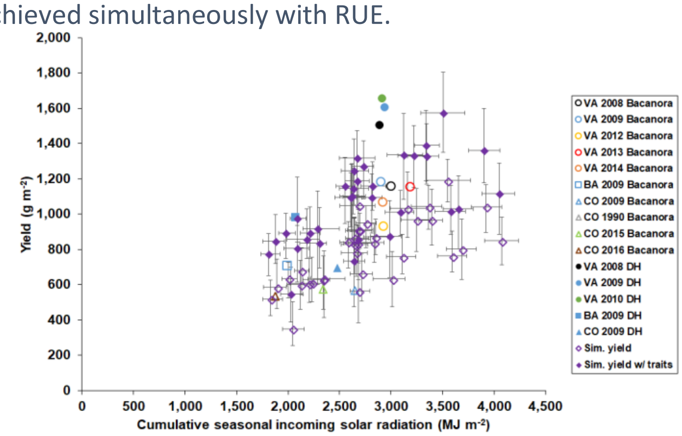


Figure 3. Observed yields for wheat cultivar Bacanora and the double haploid (DH) line in Chile (VA), Argentina (BA), and Mexico (CO) and simulated yields (◇) of multi-model ensemble medians of 26 wheat crop models for 34 representative high-rainfall or irrigated locations with (◆) and without (◇) modified cultivar traits vs. cumulative incoming solar radiation. While some variation was observed in yield among locations, simulated yields considering new cultivar traits were able to reproduce the observations made in the different environments, highlighting the importance of traits such as RUE for higher yield potential.

IWYP115: S. Asseng, Technology University Munich (lead); C. Fraisse & M.D. Babar, University of Florida; P. Martre, INRAE, Montpellier; F. Ewert & H. Webber, Leibniz-Zentrum für Agrarlandschaftsforschung; M. Reynolds, CIMMYT; H. Brown, Plant and Food Research, NZ. https://iwyp.org/funded-projects/.