IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future

Current IWYP Research Portfolio

NIFA–IWYP Project Director Meeting

PAG - San Diego, CA, 15 January 2017

Mark Sawkins, PhD – IWYP Program Manager

Current IWYP Research Projects

Research for New NIFA IWYP Projects to Link With

IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future

- IWYP Funded Projects from 1st Call
  - 8 Projects; 7 countries; ca. 60 research scientists
- IWYP Aligned Projects
  - Engage formally with relevant research funded outside of IWYP
  - Expands the IWYP research base
  - Be inclusive as possible and potentially gain some "early wins"
  - 6 projects; 5 countries; ca. 10 research scientists

Realizing Increased Photosynthetic Efficiency to Increase Wheat Yields

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- University of Essex
  - **CHRISTINE RAINES**
  - Tracy Lawson
- Lancaster University
  - Elizabete Carmo–Silva
  - Martin Parry
- University of Illinois
  - Stephen Long
- Rothamsted Research
  - Huw Jones

- Manipulation of the Calvin Cycle has the potential to improve photosynthesis and increase crop yields
- Exploit the extensive knowledge of Calvin Cycle genes and photosynthesis gained from model species to produce wheat plants with enhanced photosynthetic performance and increased yield

Molecular Dissection of Spike Yield Components in Wheat

IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future

- John Innes Centre
  - **CRISTOBAL UAUY**
- University of California, Davis
  - Jorge Dubcovsky
  - Stephen Pearce
- CIMMYT
  - Karim Ammar

- Limited knowledge of the genes controlling wheat yield is hampering efforts to improve wheat yields using genetically directed solutions
- Discover, characterize and manipulate genes regulating the early stages of spike and carpel/grain development and that govern spike yields (grains per spike and grain weight)

Improving Wheat Yield by Optimizing Energy Use Efficiency

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- Australian National University
  - **BARRY POGSON**
  - Owen Atkin
  - Justin Borevitz
  - Robert Furbank
- University of Western Australia
  - Harvey Millar
  - Nicolas Taylor
- University of Adelaide
  - Matthew Gilliham
- CIMMYT
  - Matthew Reynolds

- Greater than 85-90% of the energy captured by plants is used in 'futile cycles' and high-cost cellular processes
- There is untapped genetic variation in Energy Use Efficiency (EUE). This variation will be sought in wheat and its genetic basis described so that the trait can be selected via molecular markers

Increasing Carbon Capture by Optimizing Canopy Resource Distribution

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- University of Sydney
  - **THOMAS BUCKLEY**
  - Richard Trethowan
  - Helen Bramley
  - Andrew Merchant
  - David Fuentes
  - Peter Sharp
- University of California, Davis
  - Matthew Gilbert
- Agharkar Research Institute
  - Satish Mishra
  - B K Honrao
  - A M Chavan

- Wheat yield is limited by carbohydrate supply to the filling grain, which in turn depends on whole canopy photosynthesis
- Identify variation in the efficiency of canopy photosynthate distribution coupled to yield and deliver the resulting knowledge, germplasm markers and tools to wheat breeding programs

Next Generation Genetic Approaches to Exploit Phenotypic Variation in Photosynthetic Efficiency

IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future

- Earlham Institute
  - **ANTHONY HALL**
  - Neil Hall
- Lancaster University
  - Martin Parry
  - Elizabete Carmo-Silva
- Australian National University
  - Robert Furbank
  - John Evans
- CIMMYT
  - Matthew Reynolds
  - Sivakumar Sukumaran

- Phenotype photosynthetic characters from diverse lines of wheat in combination with next generation genetic approaches
- Identify markers and genes associated with each trait and use the markers to incorporate the traits into elite lines

AVP1, PSTO1 and NAS – Three High Value Genes for Higher Wheat Yield

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- University of Adelaide
  - **STUART ROY**
- Rothamsted Research
  - Sigrid Heuer
- University of Melbourne
  - Alex Johnson
- Arizona State University
  - Roberto Gaxiola
- Cornell University
  - Ravi Valluru
- University of California, Riverside
  - Julia Bailey-Serres

- AVP1, PSTOL1 and NAS have been shown to improve plant biomass production and grain yield
- Exploit and build synergy between these high value genes and enable molecular breeding of the traits they control by identifying the corresponding wheat orthologs
- Modification of the genes using CRISPR/cas also envisaged

THE UNIVERSITY of ADELAIDE · ROTHAMSTED RESEARCH · THE UNIVERSITY OF MELBOURNE · ASU ARIZONA STATE UNIVERSITY · Cornell University · UC RIVERSIDE UNIVERSITY OF CALIFORNIA

A Genetic Diversity Toolkit to Maximize Harvest Index by Controlling the Duration of Developmental Phases

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Research to Deliver Wheat for the Future

- The John Innes Centre
  - **SIMON GRIFFITHS**
  - Scott Boden
- University of Bristol
  - Keith Edwards
- Universidad de Buenos Aires
  - Daniel Miralles
- CSIRO
  - Scott Chapman
- CIMMYT
  - Susanne Dreisigacker
- University of Lleida
  - Gustavo Slafer

- Better understand and optimize plant and crop phenology to maximize grain yields and provide breeders' decision tools to inform the fine tuning of the best phenology trait combinations to maximize yields in particular environments, as well as coarse tuning of heading date for stress avoidance and agronomic fit

High-Throughput Phenotypic Exploration of Novel Genetic Variation for Breeding High Biomass and Yield in Wheat

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Research to Deliver Wheat for the Future

- University of Nottingham
  - **ERIK MURCHIE**
  - Ian King
  - Julie King
  - John Foulkes
  - Kevin Pyke
- University of Bristol
  - Keith Edwards
- Lancaster University
  - Martin Parry
  - Ian Dodd
  - Elizabete Carmo-Silva
- University of Essex
  - Christine Raines
  - Tracy Lawson

- Explore wheat lines carrying chromosomal segments from wild relatives for variation in biomass production and photosynthetic efficiency, using novel high throughput screening techniques and to investigate the genetic basis of the variation
- Transfer into elite lines to increase photosynthetic efficiency

CIMMYT Aligned Projects

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Research to Deliver Wheat for the Future

- CIMMYT
  - **MATTHEW REYNOLDS**
  - Wheat Physiology Team

1. Exploring Genetic Diversity for Biomass and Traits Related to Canopy Photosynthesis
2. Exploring Genetic Diversity for Harvest Index and Identifying Improved Selection Approaches
3. Developing a High Throughput Screen for Source Sink Balance to Tap Photosynthetic Potential

1. Identify germplasm with increased biomass and photosynthetic capacity that can be used in prebreeding activities
2. Characterize elite materials to identify genetic resources with promising expression of HI and related traits and develop new screening protocols
3. Select lines that show both good grain set and good grain-filling characteristics as indicators of a favorable Source Sink Balance

AP - Genetic Improvement of Photosynthetic Efficiency and Capacity to Improve Grain Yields

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- NRC
  - **RAJU DATLA**
- AAFC
  - Jas Singh
  - Richard Cuthbert
- University of Saskatchewan
  - Curtis Pozniak
- CIMMYT
  - Matthew Reynolds
  - Gemma Molero
- Lancaster University
  - Martin Parry

- Explore genetic diversity for photosynthetic efficiency in Canadian wheat in comparison to improved CIMMYT lines
- Discover new targets of photosynthetic capacity and efficiency and develop markers for deployment in a MAS breeding approach

AP - Altering Canopy Architecture to Increase Crop Photosynthesis and Yield

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- CSIRO
  - **RICHARD RICHARDS**
  - Others in research team

- Field results in Australia over two years have demonstrated a yield advantage of up to 25% for lines with a desirable canopy architecture
- Evaluate the performance of erect leaf lines against floppy leafed lines on raised and flat bays at the IWYP Hub
- Backcross erect leaved elite line (donor) with three floppy elite CIMMYT lines (1 high biomass and 2 disease resistant)

CSIRO

AP - Chasing Wheat Yields in Challenging Environments

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- ARC – Small Grains Institute
  - **SCOTT SYDENHAM**
  - Annelie Barnard
  - Others in research team

- Screening of germplasm for known markers correlated to yield components
- Detailed phenotyping for yield components, roots and drought at the Plant Accelerator
- Crosses made of selected germplasm with S. African wheat cultivars
- Advanced to F_3 and evaluated in field

ARC • LNR
Excellence in Research and Development

IWYP Research and Aligned Projects

IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future


Realizing Increased Photosynthetic Efficiency to Increase Wheat Yield


Molecular Dissection of Spike Yield Components in Wheat


Improving Wheat Yield by Optimizing Energy Use Efficiency


Next Generation Genetic Approaches to Exploit Phenotypic Variation in Photosynthetic Efficiency


Maximizing Harvest Index by Controlling the Duration of Developmental Phases


AVP1, PSTO1 and NAS - Three High Value Genes for Higher Wheat Yield


High-Throughput Phenotypic Exploration of Novel Genetic Variation for High Biomass and Yield in Wheat

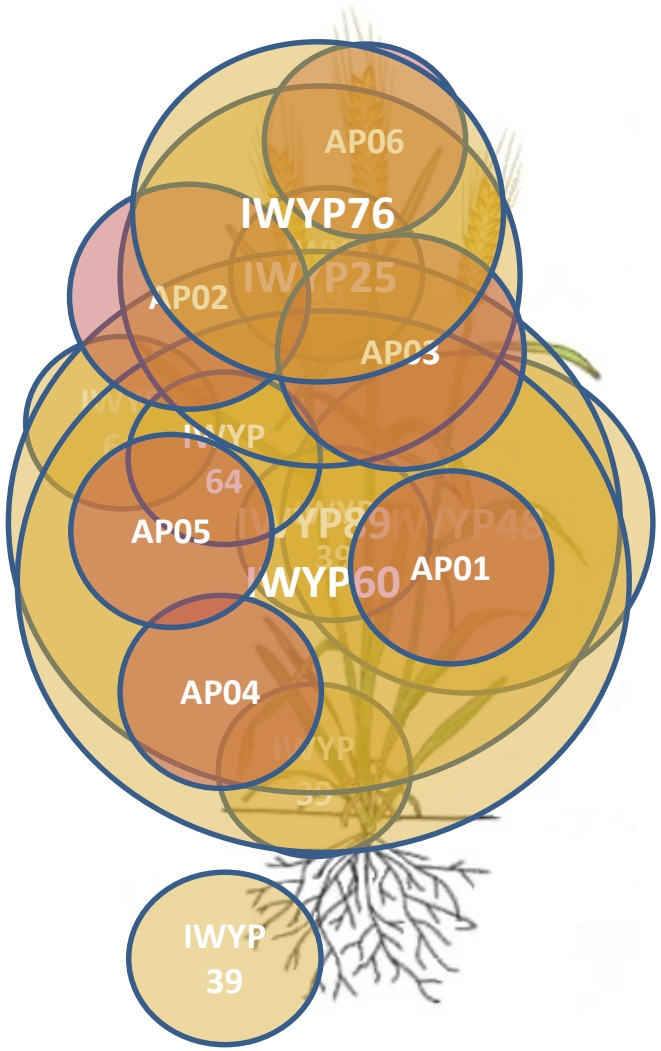

Increasing Carbon Capture by Optimizing Canopy Resource Distribution


CIMMYT Aligned Projects


Genetic Improvement of Photosynthetic Efficiency and Capacity to Improve Grain Yields


Altering Canopy Architecture to Increase Crop Photosynthesis and Yield


Chasing Wheat Yields in Challenging Environments



NIFA – IWYP Research Projects

IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future

Influence of Nitrogen Form on Wheat Carbon Fixation, Grain Yield and Protein Yield

Validation, Characterization and Deployment of QTL for Grain Yield Components in Wheat

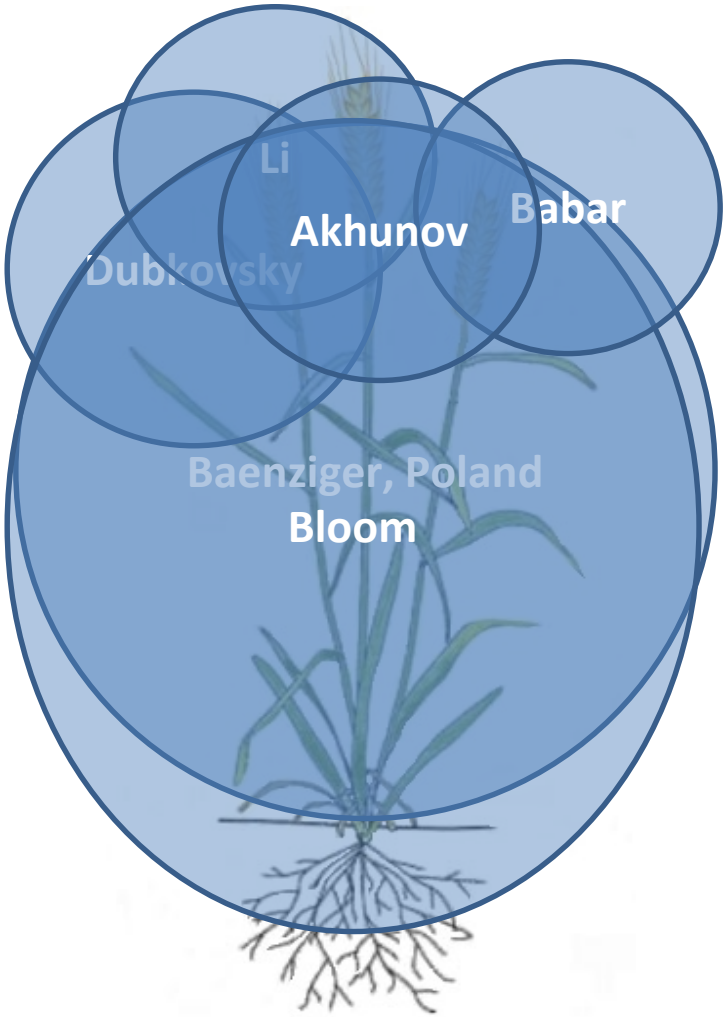
Advancing Harvest Index in Wheat through Genomic Enabled Physiological Breeding

Genome Editing for Improving Wheat Yield and Yield Related Traits

Wheat Yield Prediction and Advanced Selection Methodologies through Field-Based HT Phenotyping with UAVs

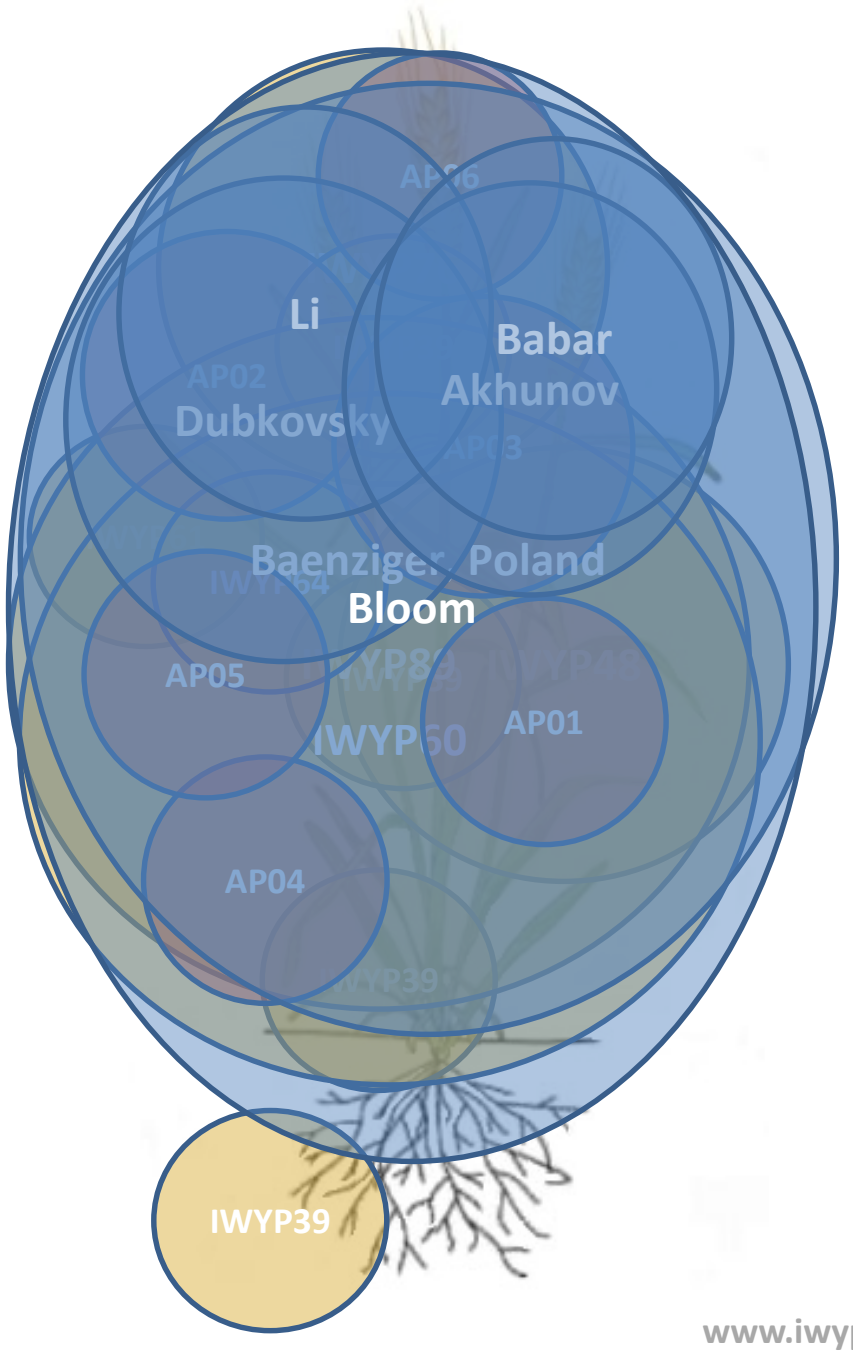
Developing the Tools and Germplasm for Hybrid Wheat

CRISPR-Based Genome Editing of Grain Size Regulators for Novel Variation to Increase Wheat Genetic Yield Potential



Pursuit of the optimum wheat plant

- 1st IWYP Call strong focus on “source” traits
- NIFA-IWYP Call more focus on “sink” traits
- Current projects are complementary in terms of targets, traits and underlying mechanisms



Conclusion

IWYP International Wheat Yield Partnership

Research to Deliver Wheat for the Future

- Many opportunities for linking / integrating your research with existing IWYP Research Projects
  - Generate added value by making discoveries not originally envisioned
  - Community of Practice – sharing experiences, learning from each other, resource for troubleshooting
- IWYP Hub is a unique validation and development feature to deliver research discoveries into breeders hands
- Many benefits of active participation in the IWYP Program
  - Willing to share ideas and data, be open, communicative, attend meetings etc.
- Excellent entry point is during the IWYP Program Conference in March, Obregon, MEX
- Contact details for our IWYP Website Member Space
  - Access to information / data / news
  - Member directory
- Summary / abstract of research to post on IWYP website