IWYP International Wheat Yield Partnership
Research to Deliver Wheat for the Future

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Implementing "deep learning" to boost efficiencies in wheat breeding

Plant breeding programs must evaluate thousands to tens-of-thousands of candidate lines to identify and deliver the best high-yielding new varieties to farmers. Novel evaluation tools are needed to accelerate this process to meet the growing demands for food, feed and fibre. One promising approach is to utilize the rapidly advancing technology of unmanned aerial vehicles (UAVs). A NIFA-IWYP Project "**Wheat Yield Prediction and Advanced Selection Methodologies Through Field-Based High-Throughput Phenotyping with UAVs**", led by Jesse Poland at Kansas State University, with colleagues at CIMMYT and George Washington University, aims to accelerate genetic gain in wheat breeding programs through the implementation of field-based high-throughput phenotyping (HTP) to precisely identify traits of interest at the scale of large wheat breeding programs.

What Solutions have been Identified?

- Deployment of UAVs equipped with multispectral, hyperspectral and high-resolution imaging.
- Development of image extraction and analysis processing pipelines.
- Collection of hyperspectral data for phenotypes in field grown plots followed by analyses using high-dimensional prediction models.
- Construction of Integrated genomic and physiological models for yield prediction, including novel statistical modeling of hyperspectral data.
- Development of an improved UAV image analysis approach using ortho-rectified plot-level imaging.
- Development of multiple instance deep learning models fusing image data (multispectral, thermal, canopy height) and genomic information for yield prediction.
- Implementation of deep learning for scoring phenotypic traits such as percent heading and presence of awns from high-resolution images (extracted from UAV captured videos).
- Delivery of validated HTP approaches to predict grain yield by measuring traits such as plant height, biomass, spike number, lodging, vegetation index, canopy temperature and ground cover.

What has been transferred to the wheat improvement pipelines?

- Automated image processing pipeline for extraction of orthorectified plot-level images (Wang, X., et al. 2020. Frontiers in Plant Sciences. github.com/xwangksu/traitExtraction)
- Video processing pipeline for extraction of images (single frames) of individual field plots from high-definition video (Wang, X., et al. 2019. International Society for Optics and Photonics. github.com/xwangksu/plotIdentify)

UAV collecting high resolution video over wheat breeding

Image extracted from high-resolution video frame

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