Incorporating breeding and genetics as part of enhancing, harmonizing and applying models

- Why is this action item important/ why should it be addressed?
  - Genetics and plant breeding are technological ways of adapting to climate change
  - Cultivars will be developed with tolerance to high temp, drought, salinity, diseases, insects, etc., and we need models that can include these technologies.
  - Modeling has been underused due to data access, perceptions of inaccuracy... that have recently been less severe.
  - Progress in breeding is less than desired. Models can assist with complex responses of G to E x M.
  - De-complex G x E x M
  - To use models more effectively for projecting climate change impacts
  - Models are one of many efficient tools to harmonize complex data to derive some actionable item/ decision. How else one could harmonize such issues, so I consider use of models as one of the tools.
  - Genetics are rapidly advancing and new possibilities for adaptation will likely result.
  - Breeding gains could be further maximized with these efforts.
  - Increase fundamental understanding of crop physiology.
  - Availability of genetic, weather and soil data has greatly improved, making it more realistic/practical to employ models in breeding.
  - May be able to help with abiotic stress tolerance
  - Increase efficiency of testing
  - Accurately constructing artificial selection environment for abiotic stress tolerance.
  - Increase gain from selection
  - Large gap between agronomic models and phenotype and genotype models.
  - Population increase
  - Feed the 10 billion with less natural resource extraction
  - Complex issue, needs lots of input from various experts.
  - Not currently being done, but could be effective.
  - Improve our image – Borlaug with Google Glasses – Plant breeding is cool.
  - Stakeholders have issued for more involvement from breeders
  - Need to engage private sector breeders in this effort.
  - Modeling climate change effects to target traits
  - Modeling changes of genetic effects on other organisms in system

- What needs to be addressed within this action item?
  - Get the agronomist involved in to make more understanding between crop modeling and genetic scientist.
  - Develop collaborative projects between breeders and modelers.
  - Need to identify plant breeders and geneticists that would like to integrate their work into crop models.
  - Develop team of breeders and crop modelers to incorporate genes into models.
  - Identify one or ensemble of models to do item listed in question one. How this could be achieved? What geographical locations to consider based on a priority.
  - Efficient ways to collect, store, and analyze data.
  - How are models updated as more information is generated.
- Votes
  o Unknown subject 1 = 10 votes
  o Unknown subject 2 = 6 votes
- Data- Additional added sheet
  o Steps
    ▪ Identify case studies to start with
    ▪ Standardize data collection and description
    ▪ What type of population do you use
    ▪ Collect data on management
  o When
    ▪ Soon
  o Resources
    ▪ People- $$
    ▪ Time and talent
    ▪ Genotyping
  o Communication
    ▪ Enhance
  o Success
    ▪ Prediction of traits (quantitative) (low h2)
    ▪ Useful to breeder

- Collaboration – Additional added sheet
  o Needed for Progress?
    ▪ Teams for collaboration in Wheat and Maize
    ▪ Identify modelling and breeding scientists willing to collaborate
    ▪ Private sector – public partnerships (Identify pre-competitive space)
  o By When? How long?
    ▪ Sustainable funding- NSF
    ▪ Several years to breakdown silos
  o Resources
    ▪ Genetic resources
    ▪ Mapping populations
    ▪ I/U CRC
    ▪ Funding
    ▪ Access to public wheat data sets (T3)
  o What would success look like?
    ▪ Current progress in yield 0.7%/yr
    ▪ TPOC for collaboration 1.4%/yr
- Additional Sheet
  o Genetics – 6 votes
    ▪ Need better understanding of genetic control of traits used in models
    ▪ Reduce error in yield trials with environmental covariation
    ▪ Gene based information that can be “translated” physiological processes that can be modeled
    ▪ Accessibility of data and germplasm. Freedom to operate
- Need efficient data pipeline to link data from breeding work with models G, E, M, and P.
  - Money – 6 votes
    - Determine how to influence funding agencies to recognize value of collaboration efforts between modeling community, climate scientists and breeders/crop physiologists/agronomists.
    - Obtain financial resources for model improvement
  - Phenomics – 8 votes
    - Continuing education in spatial statistics relevant to TAIS topic
    - Need to identify what characteristics we should be looking for in future plants
    - Simplify selection
    - Commitment by breeders and agronomists to standard phonological descriptors
    - Need much better physiological data for lines. (Use phenotyping tools)
- Uncategorized Notes
  - Predictive recommendation for use of cultivars
  - Need models that are easily modified to consider traits of value for breeding
  - Some best practices for environment monitoring of trial sites
  - Improve data capture tools
  - Automate image/sensor data capture
  - Build predictive models for yield limiting factors
  - What information needs to be collected to develop models.