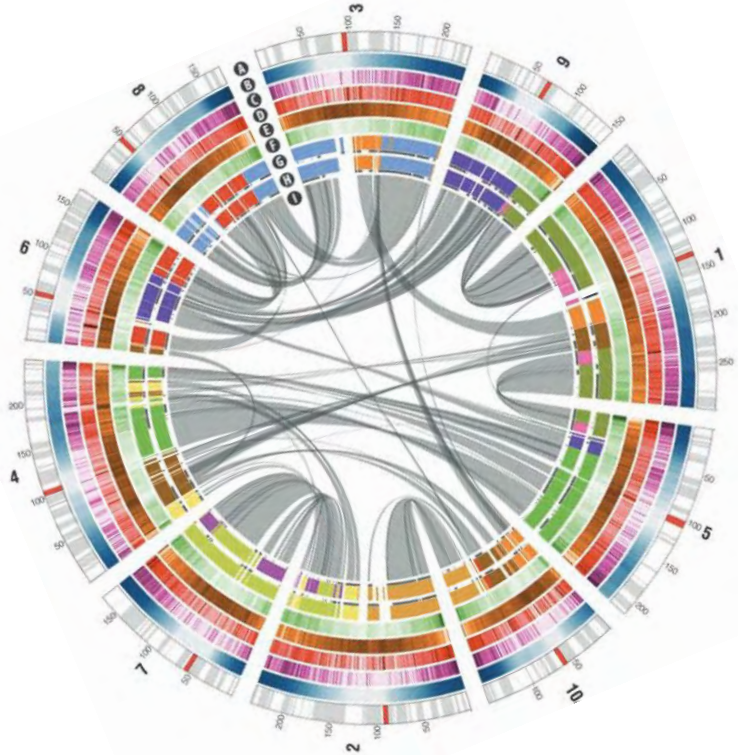
Translating Our Understanding of the Genome to Predictions of Performance in the Field



Zea mays genome

www.sciencemag.org/content/326/5956/1112

?

www.nrcornfest.org

Triceratops genome

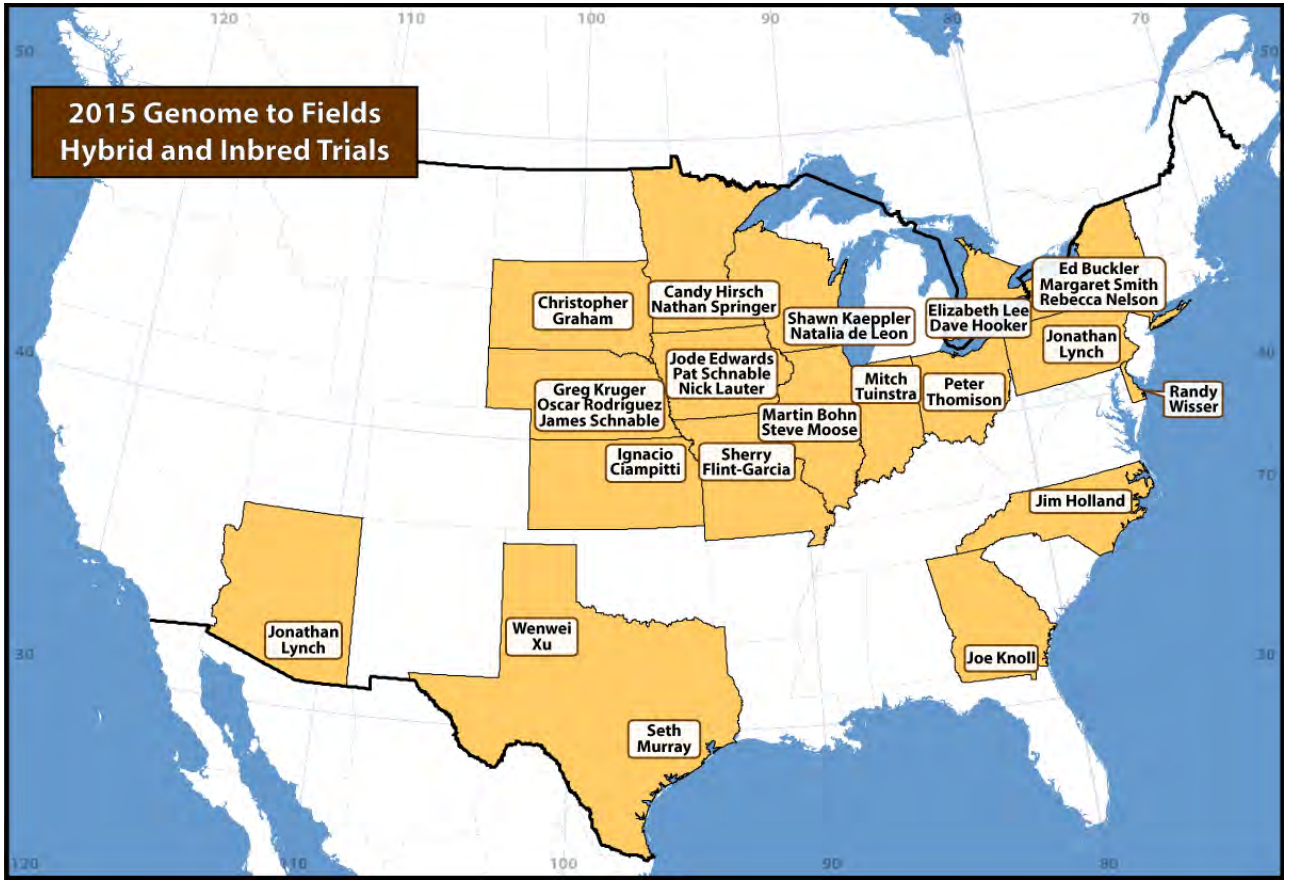
www.jurassicworld.com

Images cropped by Jonathan Gent

www.amazon.com

Genomes to Fields

Pat Schnable (Iowa State Univ)
Natalia de Leon (Univ of WI)
Ed Buckler (USDA/Cornell)
Shawn Kaeppler (Univ of WI)
Jonathan Lynch (Penn State Univ)
Nathan Springer (Univ of MN)
David Ertl, Iowa Corn Growers



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Genomes to Fields

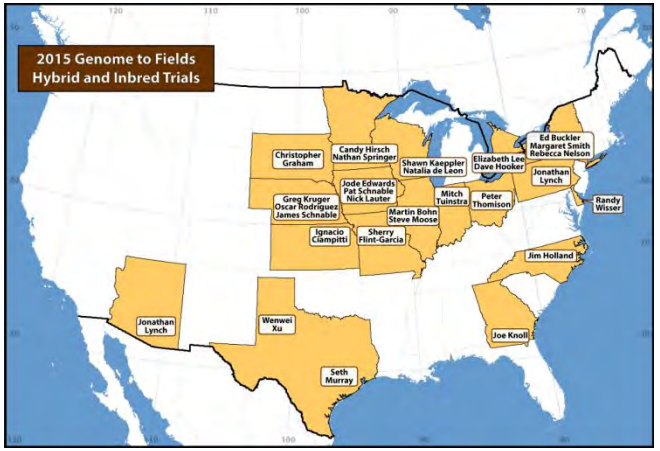
Germplasm: 853 hybrids generated from 374 inbreds crossed by 4 testers

GBS genotype data collected for all lines

Evaluated across 22 environments (avg=243 hybrids per location) for two years

Weather stations located within fields at all locations

Collect core data on plant morphology, ear morphology, agronomic traits and productivity



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Why am I up here?

Genomes to Fields

Disclaimer: Presentation reflects my thoughts; not those necessarily shared within the G2F project

A project that is still “growing up”

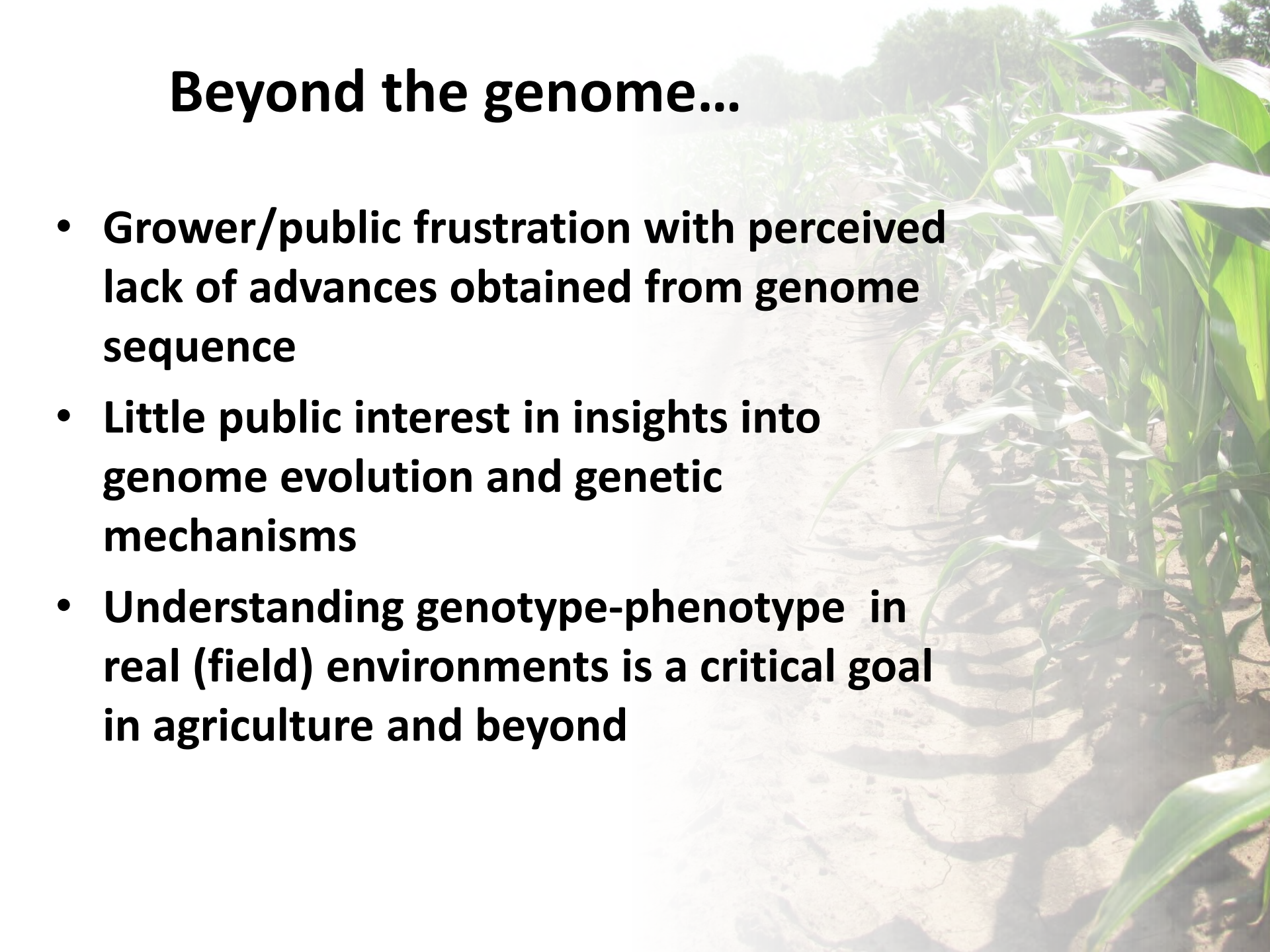
How do we provide food security for a growing population in a changing environment?

- Past answers:
  - Molecular markers for breeding
  - GMOs
  - Genome sequencing
  - ?? Phenotyping

Understanding how heritable information influences important traits

Beyond the genome…

- Grower/public frustration with perceived lack of advances obtained from genome sequence
- Little public interest in insights into genome evolution and genetic mechanisms
- Understanding genotype-phenotype in real (field) environments is a critical goal in agriculture and beyond



Keys to useful genotype-phenotype

- Genotype
  - Good data standards and technology
  - Primary limitations are legal
- Phenotype
  - What to measure?
  - How to standardize measurement and data reporting?
- Environment
  - Climate variables relatively easy to measure
  - Fine scale variation (soil, microbiome) more difficult to account for

Building a “living telescope” for agriculture

- Changing our models
  - Projects focused on particular traits, germplasm or environments struggle to integrate across disciplines or collect data at necessary scale for true relevance
  - Should we consider an attitude / approach similar to models used for astronomy and physics?

Hubble telescope (wikipedia)

http://phys.org/news/2016-01-cern-agricultural-science.html

Advantages of a “living telescope” model

- Flexibility to address emerging problems
- Shared access to unique resources
- Potential to force standardization
- Provides scale that is attractive for interdisciplinary collaboration (Engineering, Comp Sci, etc)
- Generate collaborative training environment

Issues with a “living telescope” model

- Requires culture shift at many levels
- How do we fund?
- Who gets credit? (and access to data)
- How to decide what to point the telescope at?
  - Species
  - Germplasm/traits
  - Environments
- How to balance resource development, germplasm improvement and important scientific discoveries?

Concluding thoughts

- **Using high-throughput phenotyping to enable genotype-phenotype prediction in field environments provides grand challenge for plant sciences and agriculture**
- **Will require culture shifts at various levels**
- **Needs new funding**
- **Important to walk fine line between expressing the excitement for the potential while not over-selling the outcomes**

Genomes To Fields Collaborators

Project planning, data management, phenotyping initiatives, and Executive Committee members

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- Ed Buckler (ARS)
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- James Clohessy (Cornell)
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