Building Climate Smart Agriculture for the 21st Century & Beyond

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Agriculture Marches On:

- **Industrial Revolution: Mechanization**
  - Large areas – *Fast!*

- **“Green Revolution”**
  - Crop genetics focus – *Continues!*

- **Information Revolution: Precision agriculture**
  - Spatial & temporal variability
    - Yields & limiting factors

- **What’s next??**

Challenges to *intensify* production still exist….and……now……
Climate Change & Agriculture: Effects & Adaptation* Key Messages

- Climate change poses new challenges
- Climate more of a decision-making criteria – adds greater uncertainty
- All agricultural systems will be affected to some degree
  - Yield reductions, production cost increases
- Soil, water, ecosystem services will be affected
- Extreme events impact significant
- Decision-making for adaptation is complex
  - Economics, policy, abiotic & biotic effects, physical & social scales, risk management.....

Research: Genetics + Management Practices
Research to Build Agricultural Resilience: Vulnerability

- Understand Potential *Exposures*
  - Focus on extremes as well as mean changes
- Understand *Sensitivities*
  - Define critical thresholds & interactions
- Enhance *Adaptive Capacity*
  - Resilient systems: *Climate-ready crops & production systems*

*Vulnerability = (exposure + sensitivity - adaptive capacity)*

(IPCC)
G x E x M: Departure From Classic G x E Interaction

- Genetics x Environment x Management

- Genetics: Variety, breed, or animal haplotype
  “Potential”
- Environment: Stress effects on agriculture
  “What cannot be controlled”
- Management: Production practices
  “What can be controlled”
An Alternative to Science Reductionist Approach

- Highlight the effects of *climate variability on the environment factor*
- Highlight opportunities for *management to optimize performance of genetic resources under varying environmental conditions*
- Enhances problem solving
  - Which is the limiting factor: G? E? M?
  - What can we do about it?
- *Producers view*

Yield Gap Analysis
Challenge: Increase Yields Sustainably

• Satisfy human needs* for food, feed, and fiber, & contribute to biofuel
• Enhance environmental quality & the resources base
• Sustain economic viability of agriculture
• Enhance the quality of life for farmers, farm workers, & society as a whole

* Quantity & Quality
G x E: Phenotypic data

• Link animal/crop/variety development & choice with
  – *Current* environment
  – *Projected changes* of environment
  – Means & *extremes* of environment
  – Abiotic & biotic stresses

Sustainability:
• Yield/Production
• Economics
• Environment
• Quality of life
G x M: What genotypes respond well to management practices?

- Link crop/variety development & choice with:
  - Soil management practices
  - Water management
  - Pest & pathogen management
  - Timing of planting
  - Cover crops & crop rotations
  - Erosion & conservation management
  - Nutrient management

Sustainability:
- Yield/Production
- Economics
- Environment
- Quality of life
G x M: What genotypes respond well to management practices?

- Link animal breed or haplotype choice with
  - Nutrition
  - Health
  - Pest & pathogen management
  - Housing
  - Production system
  - Nutrient management

Sustainability:
- Yield/Production
- Economics
- Environment
- Quality of life
**E x M: How do we separate management effects from environment?**

- Link choice of management & environment
  - Reduced emissions, runoff
  - Efficient input application
    - Method
    - Temporal & spatial decisions
    - Production system/Housing

**Sustainability:**
- Yield/Production
- Economics
- Environment
- Quality of life
Sustainable Agriculture & Soil Quality/Soil Health

- Soil Health management for
  - Crop yield
  - Ecosystem functions
  - Reduced risks to health

- Soil Health: physical, chemical, biological

  What organisms? What are their functions/roles?
Management: Fertilizers

- Inorganic
- Organic
- Liquid
- Encapsulated/slow release
- Innoculants
- Paired Innoculant-crop combinations
- Other soil-biology oriented: biotic fertilizers

Promising signs for sustainability....

Why do these work?
How do these work?
How do we fully realize the genetic potentials of new crop varieties for sustainable agriculture?

- Mounting evidence points to benefits of managing soil biology component of soil health

- Crop Genetics + Management Practices
  - Nutrient Management Focus on Soil Biology

The Next Revolution for Agriculture?
Adaptation: Decision Support via Decision Trees?

What are the model, forecast, and data needs at each decision point?
A Way Forward

- **Genetics x Environment x Management**
  - Interactions
  - Cross/Trans Disciplinary
  - Matches producer decision-making
  - Yield gap focus

- **Management: soils**
  - Soil biology

Collaborations are essential……