

CLIMATE-SMART  
**Agriculture**  
2015



Global Science Conference

March 16-18, 2015  
Le Corum, Montpellier France

# Building Climate Smart Agriculture for the 21<sup>st</sup> Century & Beyond

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March 16-18, 2015

# *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 as a living entity”*

*Indicators & indices?*

## ◎ *Soil Health: physical, chemical, biological*

*What organisms? What are their functions/roles?*

# Management: Fertilizers

- Inorganic
- Organic
- Liquid
- Encapsulated/slow release
- Inoculants
- Paired Inoculant-crop combinations
- *Other soil-biology oriented: biotic fertilizers*

*Promising signs for sustainability...*

*Why do these work?  
How do these work?*

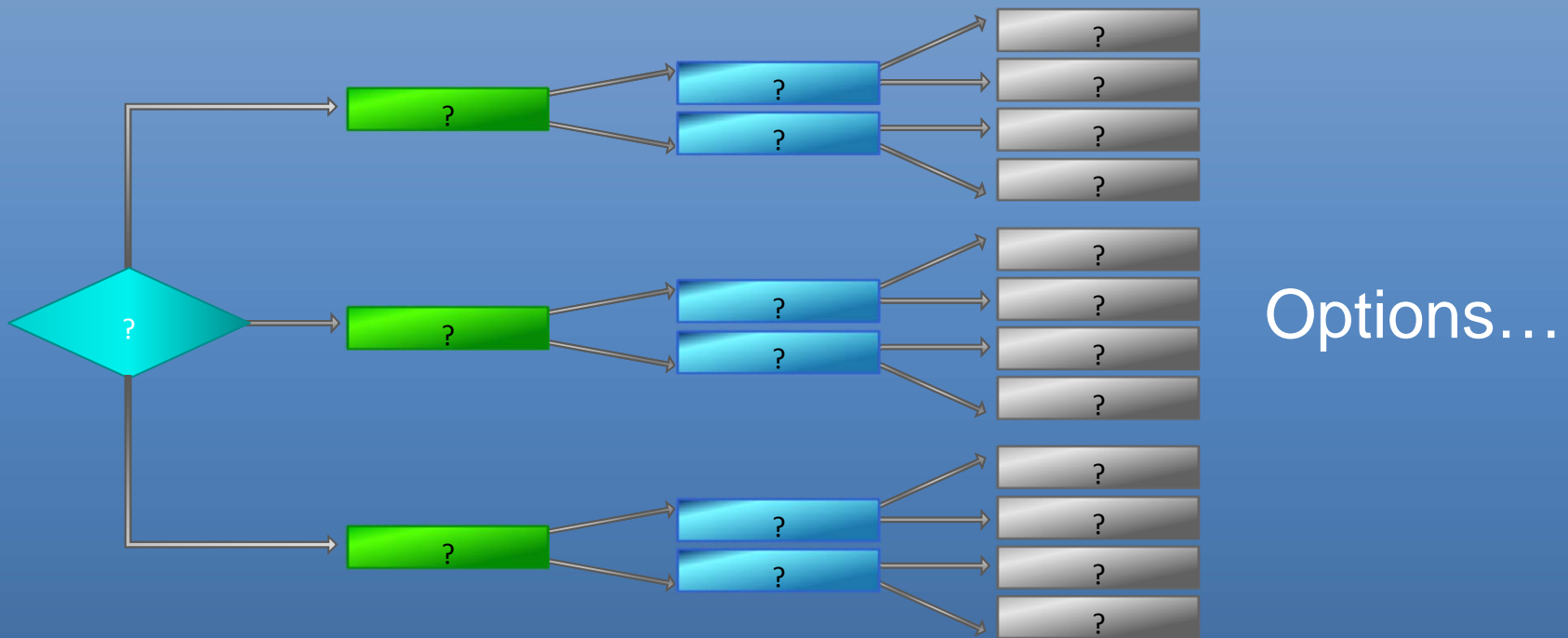
## *How do we fully realize the genetic potentials of new crop varieties for sustainable agriculture?*

◎ *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.....*



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