



# Drought Research in ARS

## An Overview: *soybeans and maize*

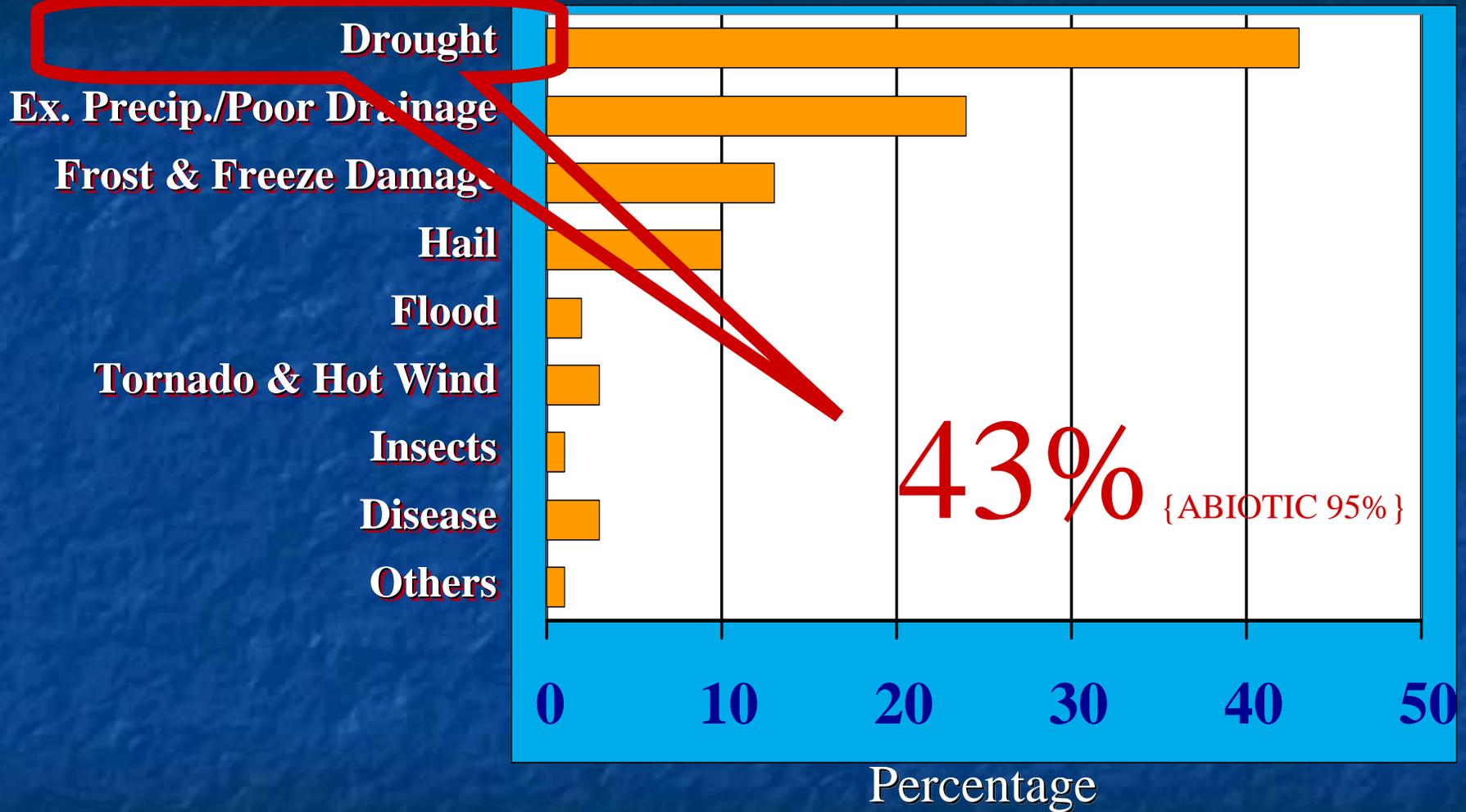
AgForum

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# ARS Contributors

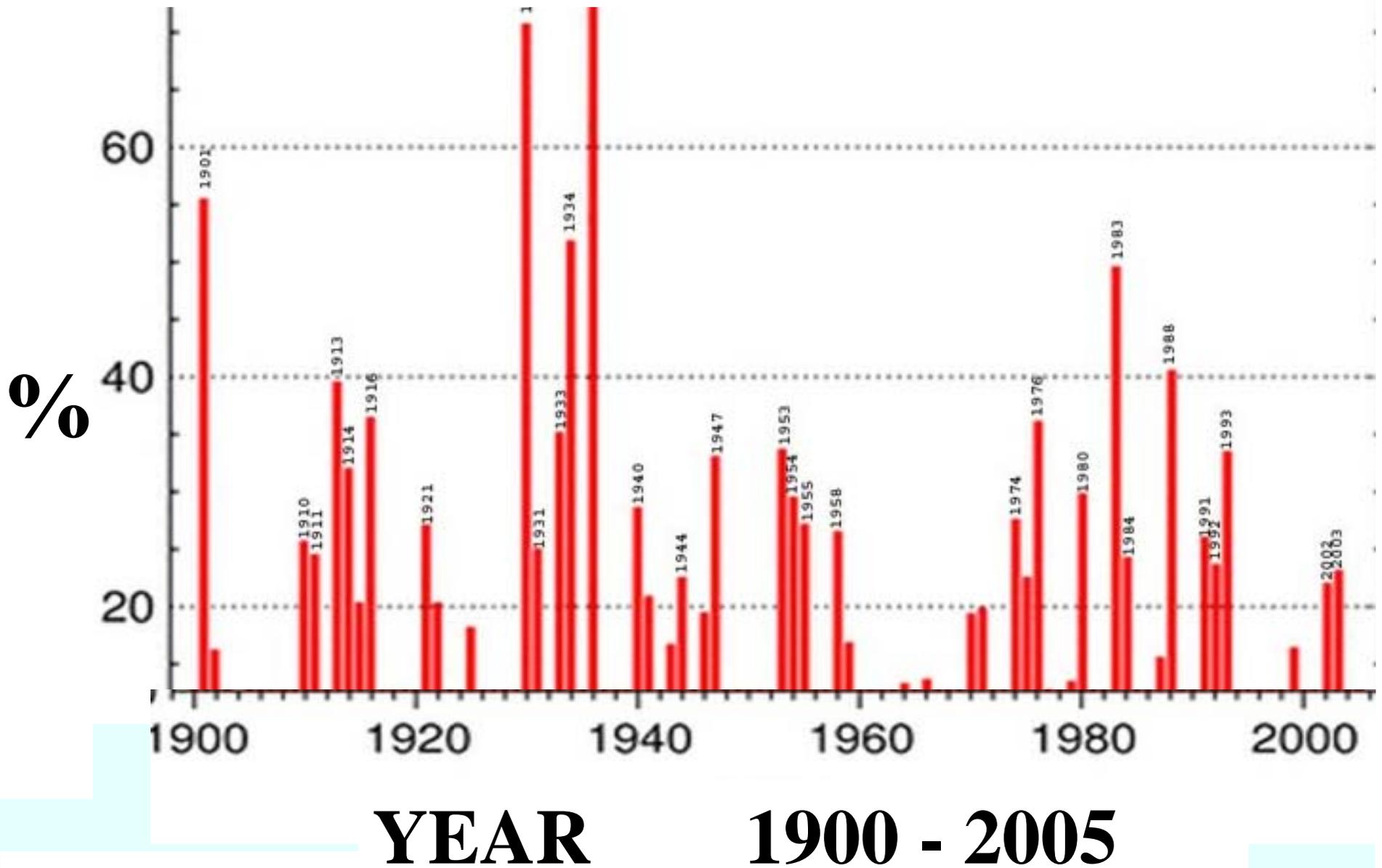
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# Average Percentage of Indemnities by Hazard, all crops, 1948-1996\*



(\*USDA Agricultural Statistics (1998))

# Soy Production affected by drought



Courtesy NOAA

# Breeding for Improved Drought Tolerance

- Screening for drought tolerance using laboratory or glasshouse-based assays is notoriously difficult and not always correlated to observed tolerance in the field

# Drought Tolerance: Complex Phenotype

- Field Performance!
- Plant Architecture
- Morphology
- Cellular
- Sub-cellular
- Genetic



# Integrated Program

**New Sources  
of Drought  
Tolerance**

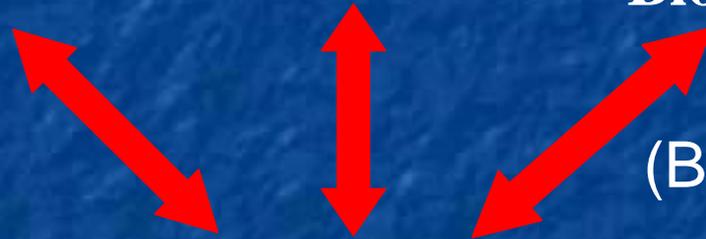
**Crop and  
Whole Plant  
Physiology**

**Genetics, 'Omics'  
and Molecular  
Biology**

(Biotechnology)

**Field Breeding**

**Better Varieties**





Germplasm  
to  
Genes

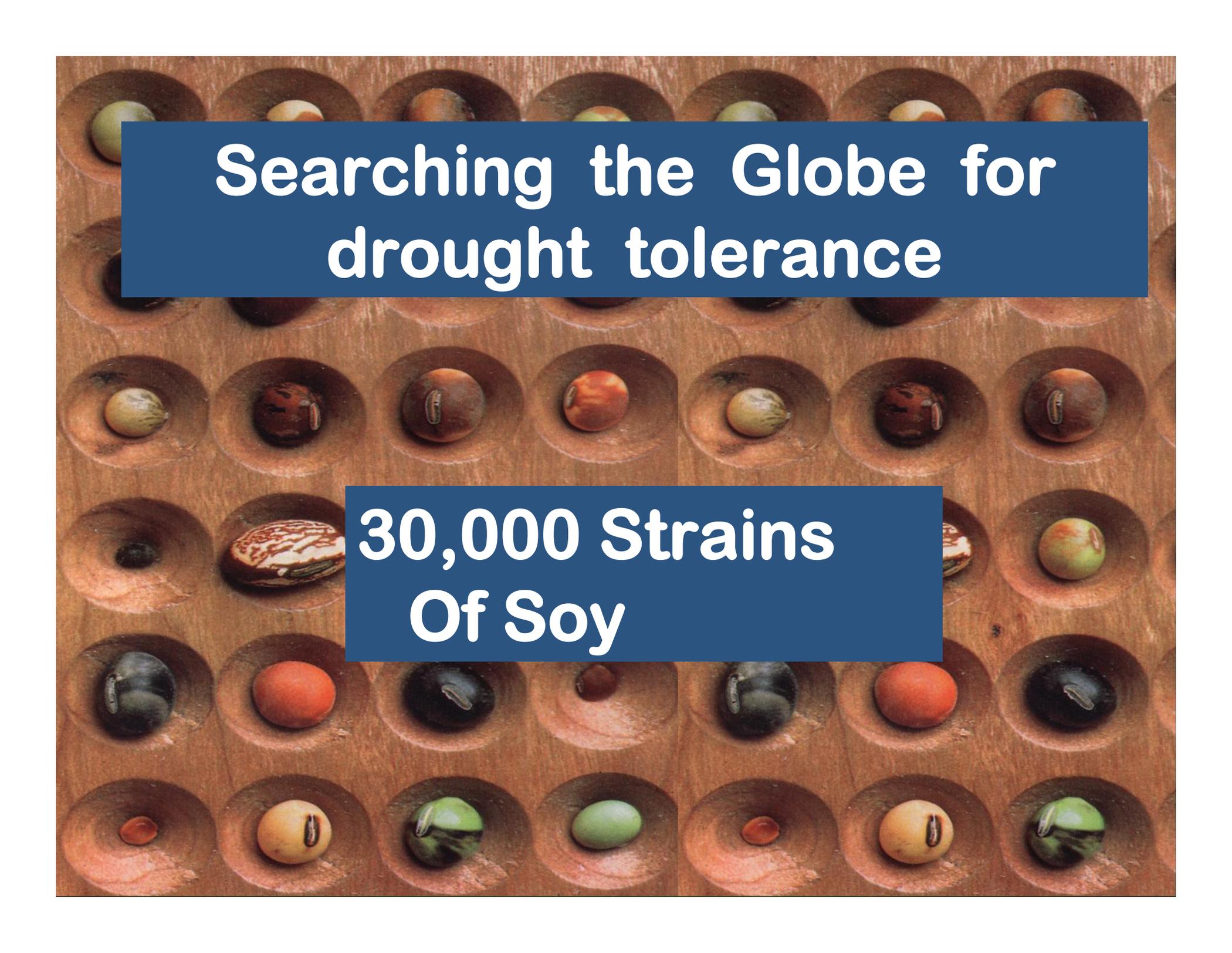
Soybean: *Glycine max*



# Slow Wilting Trait

Fast  
wilting

Slow  
wilting



# Searching the Globe for drought tolerance

30,000 Strains  
Of Soy

# Slow Wilting Discovery

Carolina

**6 Asian types**

Minnesota

**6 (more) Asian types**

Nebraska

**10 (more) Asian types**

Arkansas

**2 U.S. types**

# OTHER ADVANCES

Slow wilting related to yield under stress

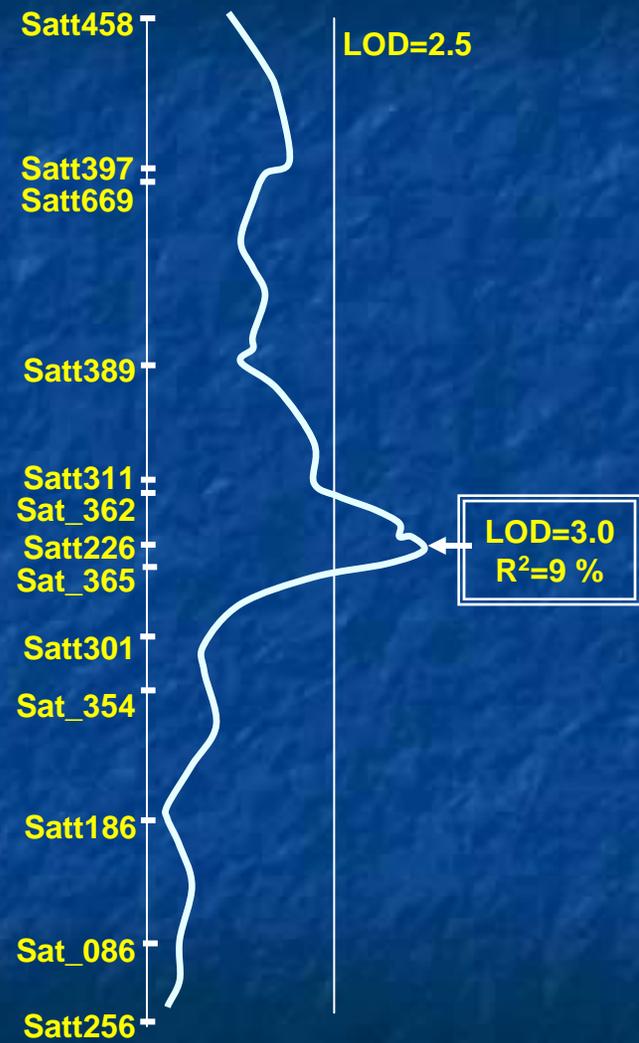
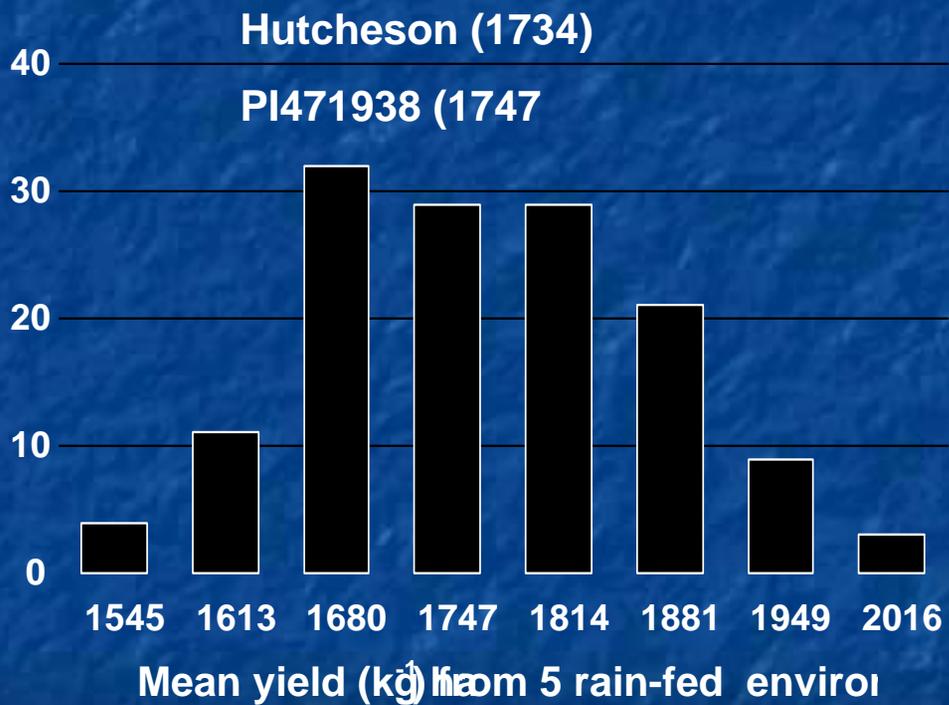
## DNA MARKER RESULTS

4 Slow Wilting Genes

identified thus far

More expected soon

# QTL's for Yield under Drought: From PI 471938



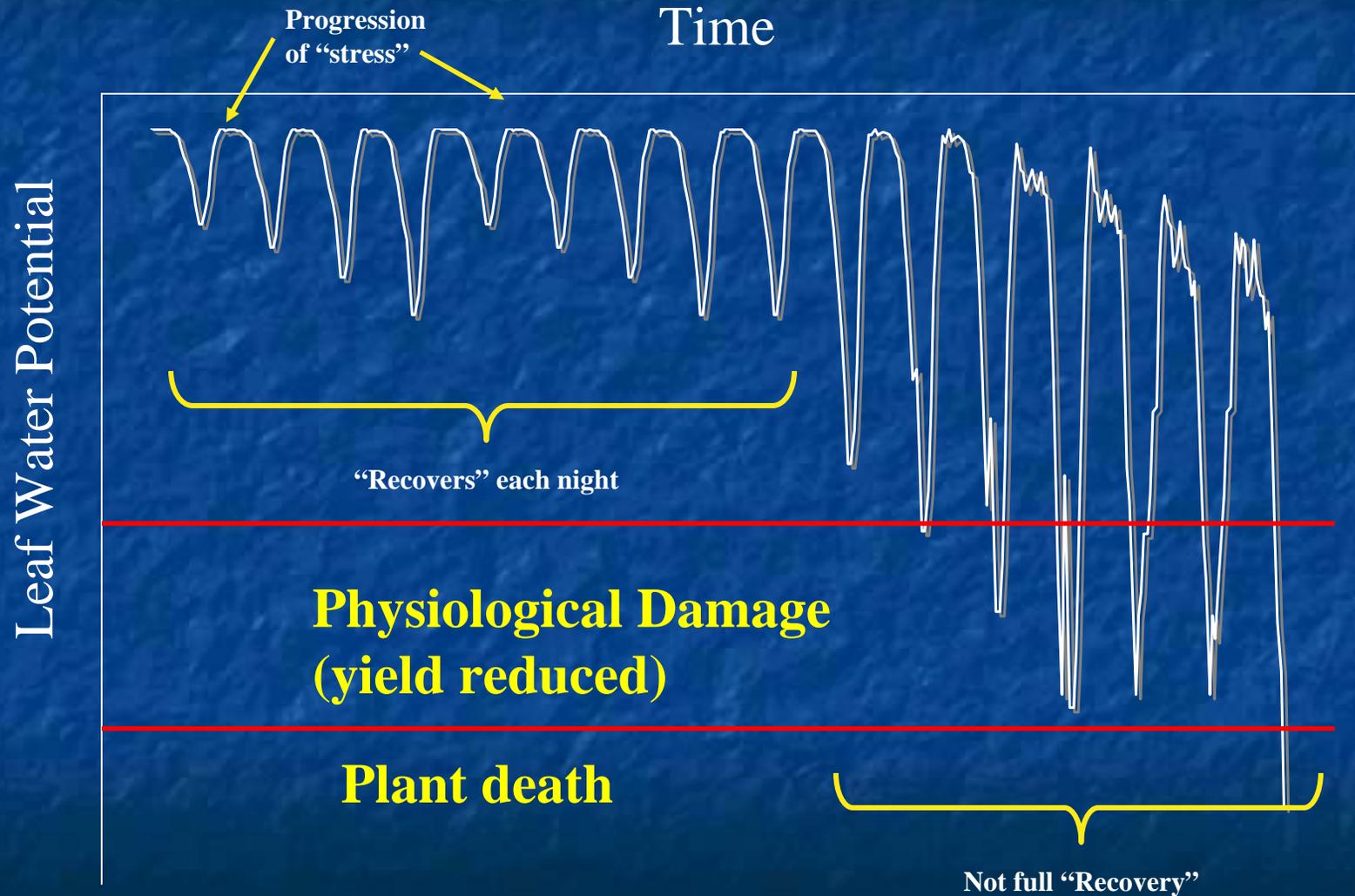
Maize

*Zea mays*



Genes  
to  
Germplasm

# Water Stress Cycle



# Drought and Desiccation Tolerance

**Drought tolerance = tolerance of sub-optimal water availability**

**Desiccation tolerance = tolerance of complete drying to  
equilibrium with the air**

Drought tolerance mechanisms include ways of maintaining cell water content, such as osmotic regulation and stomatal closure, whereas desiccation tolerance consists of ways to survive the complete loss of water.

*Sporobolus stapfianus*

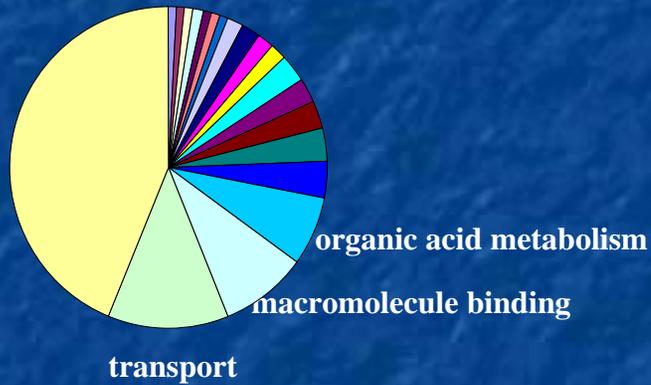


*Craterostigma plantagineum*

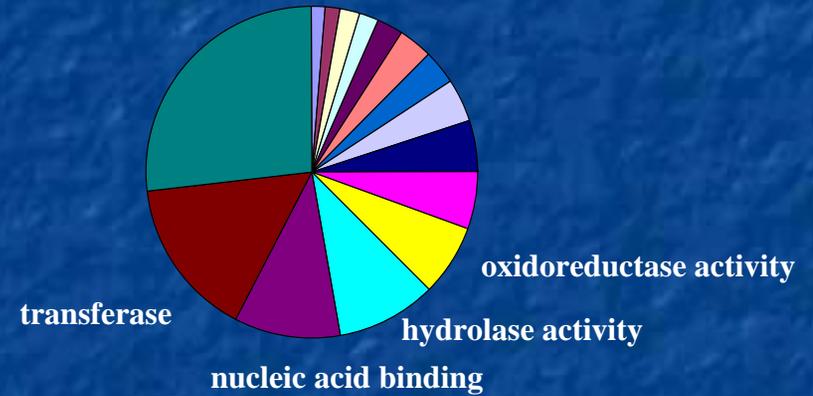


# Induction by water stress vs Desiccation

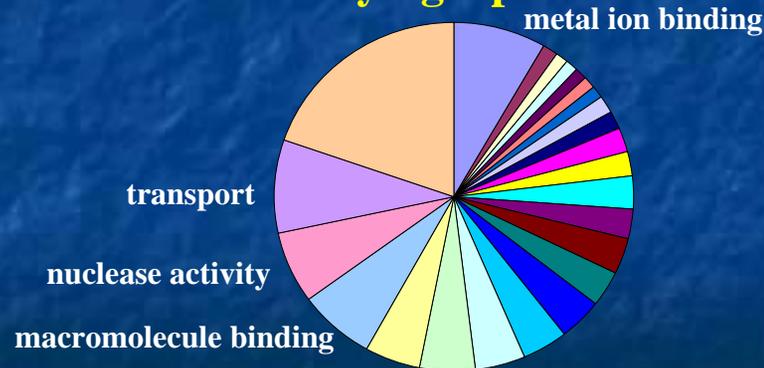
Water Stress Cp 60%



Drought - At



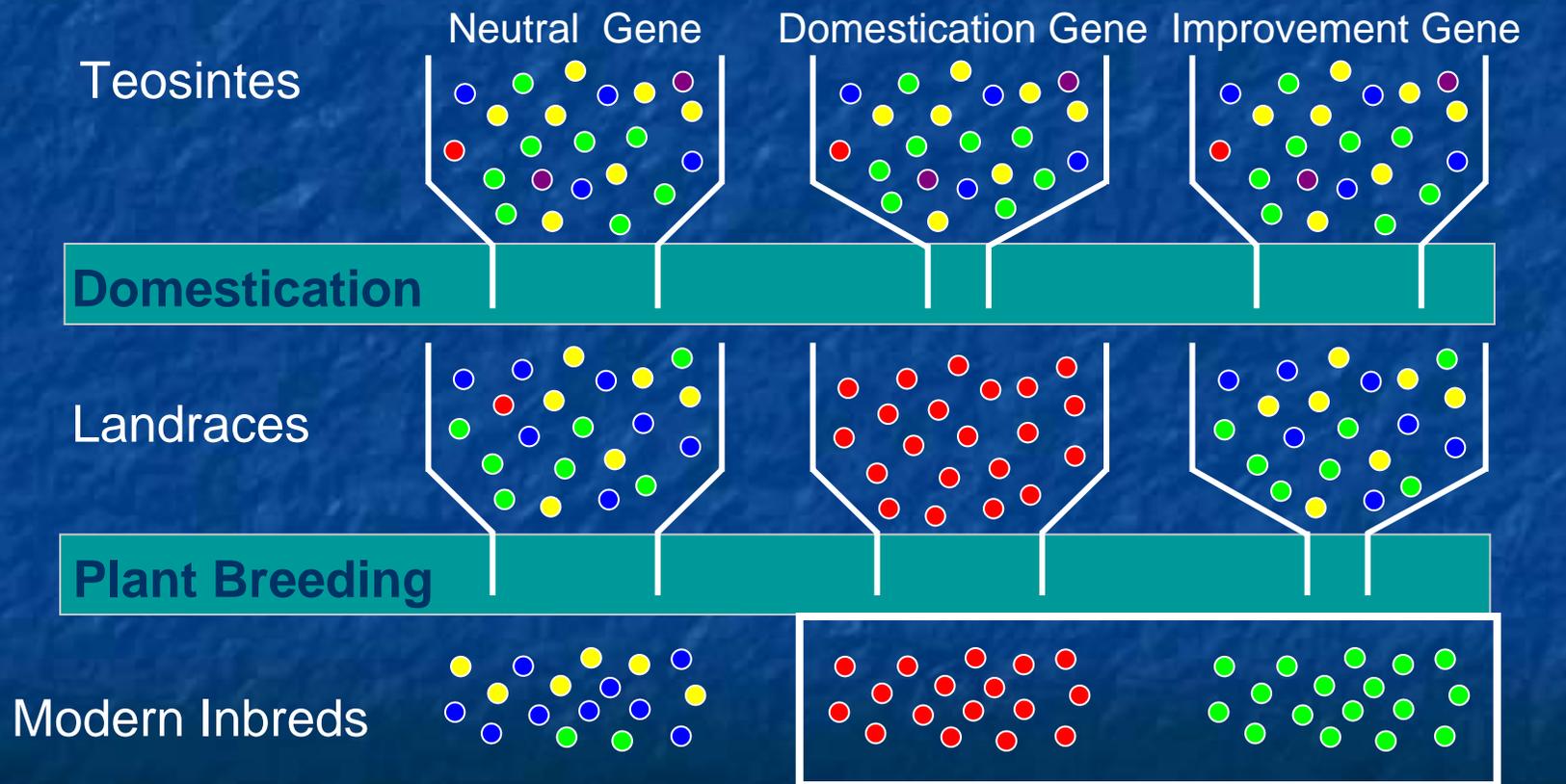
Drying Cp 5%



# Genes Ascribed to Drought Tolerance

# Selection Screens: Another way to identify genes that have contributed to agronomic traits

## Domestication and plant breeding reduced maize genetic diversity



**Very low sequence diversity**

Slide courtesy of Masanori Yamasaki

NC358

0

P39



0

Ki11

0

CML103

0

Oh43

+



CML228

+



CML52

+



vs. B73

Association

Linkage

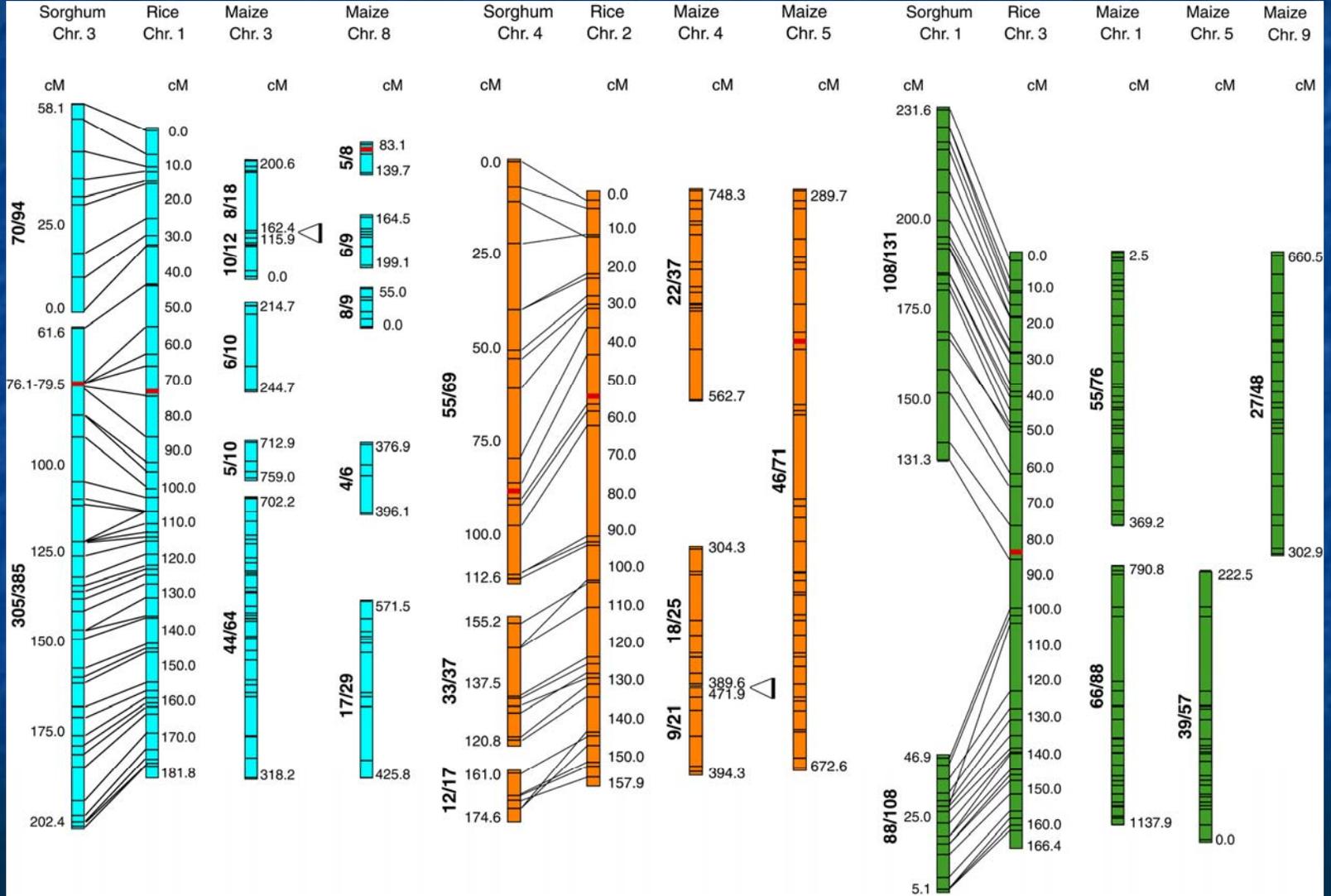
Slide courtesy of Ed Buckler

# Syntenic Relationships

Sorghum - Rice - Maize

# Drought Tolerance in Sorghum

- Two forms of drought tolerance have been observed in sorghum:
  - Pre-flowering
  - Post-flowering (the 'Stay-Green' trait)
- Each is identified by the lack of specific symptoms of water-deficit stress imposed at a particular plant growth phase



# Integrated Approach

The Key for Crop Improvement in  
Drought Tolerance