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USDA DROUGHT TOLERANCE RESEARCH OVERVIEW

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Drought Research in ARS
An Overview: *soybeans and maize*

AgForum

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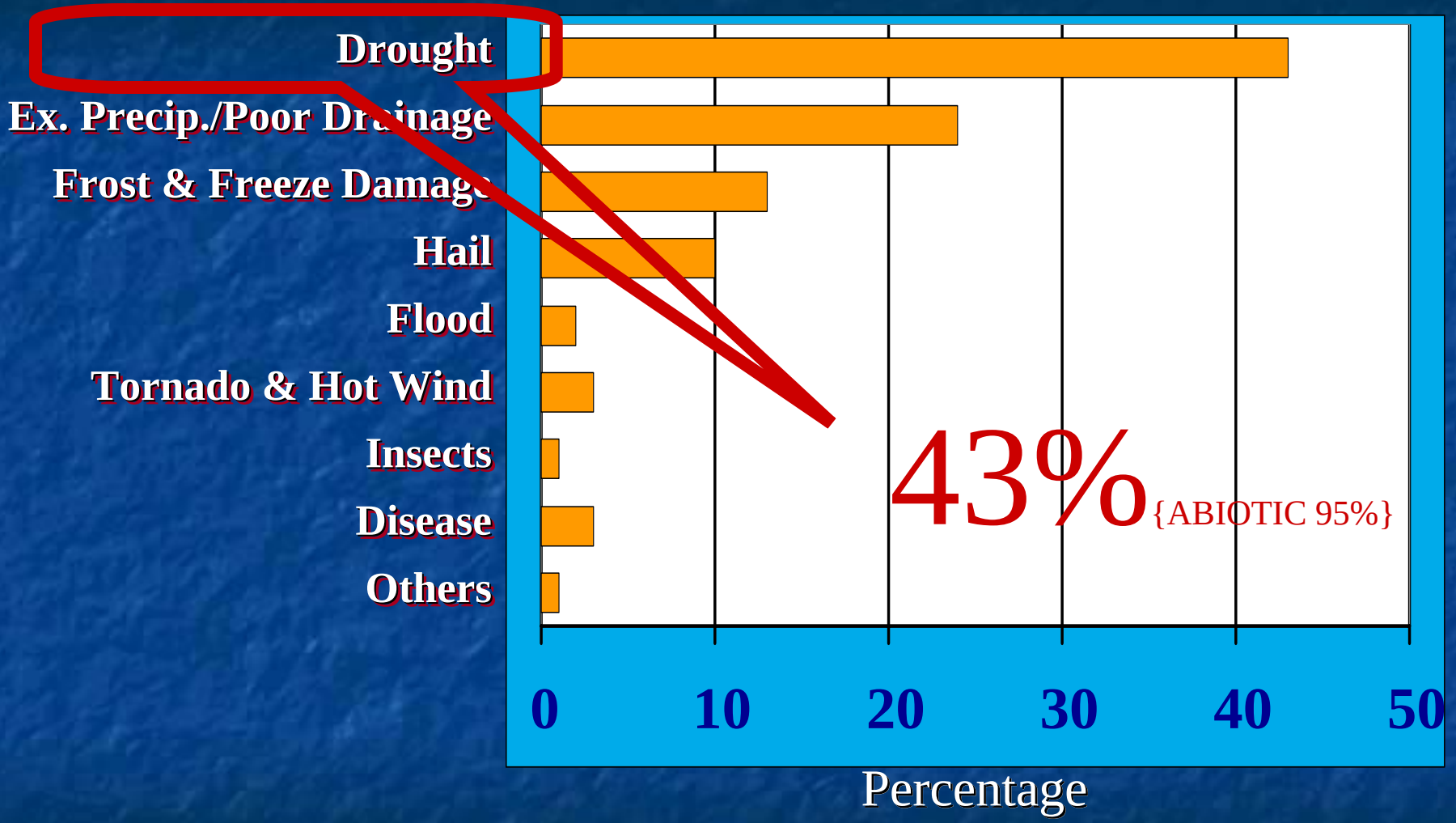
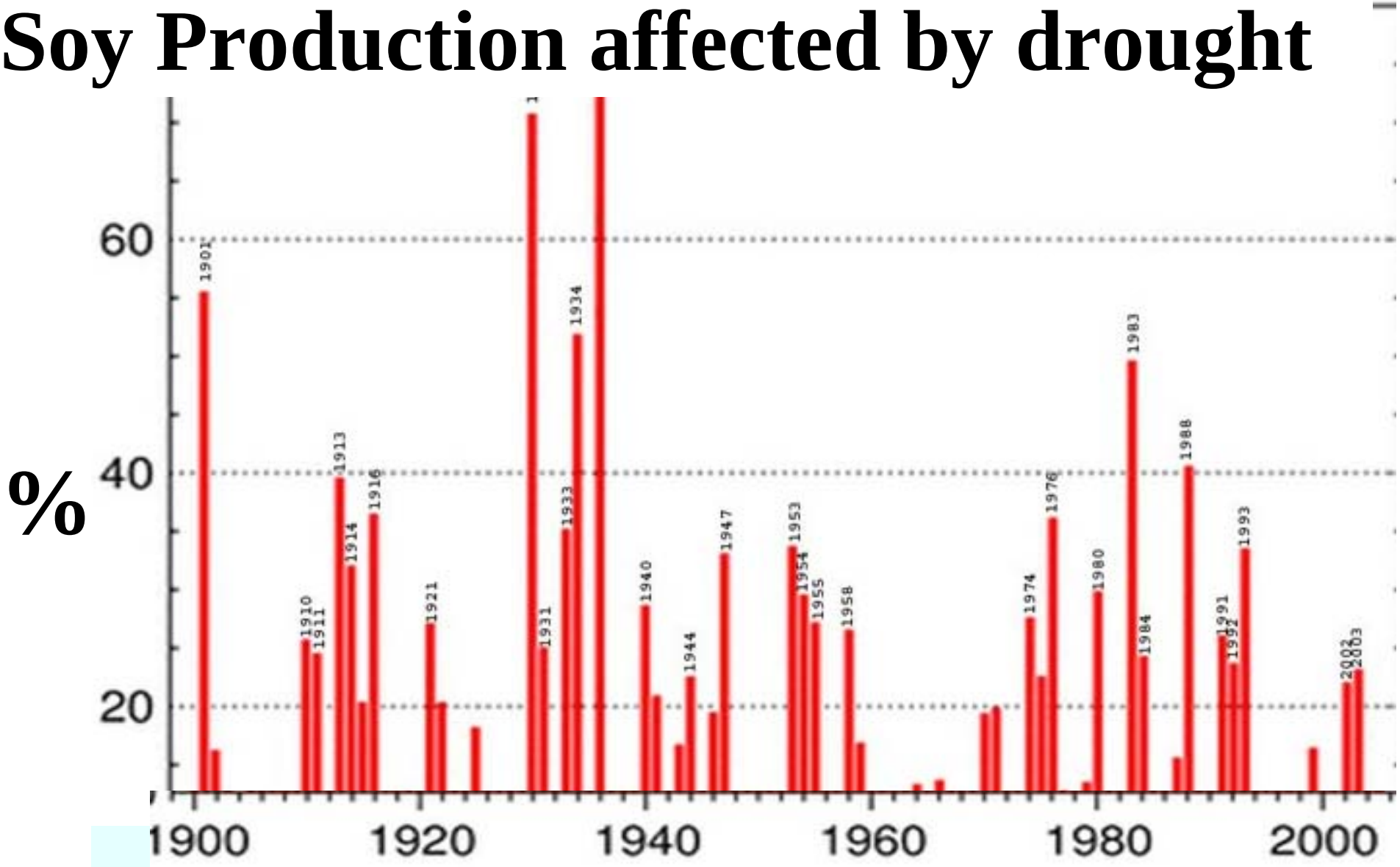
Average Percentage of Indemnities by Hazard, all crops, 1948-1996*



(*USDA Agricultural Statistics (1998))

Soy Production affected by drought



YEAR 1900 - 2005

Courtesy NOAA

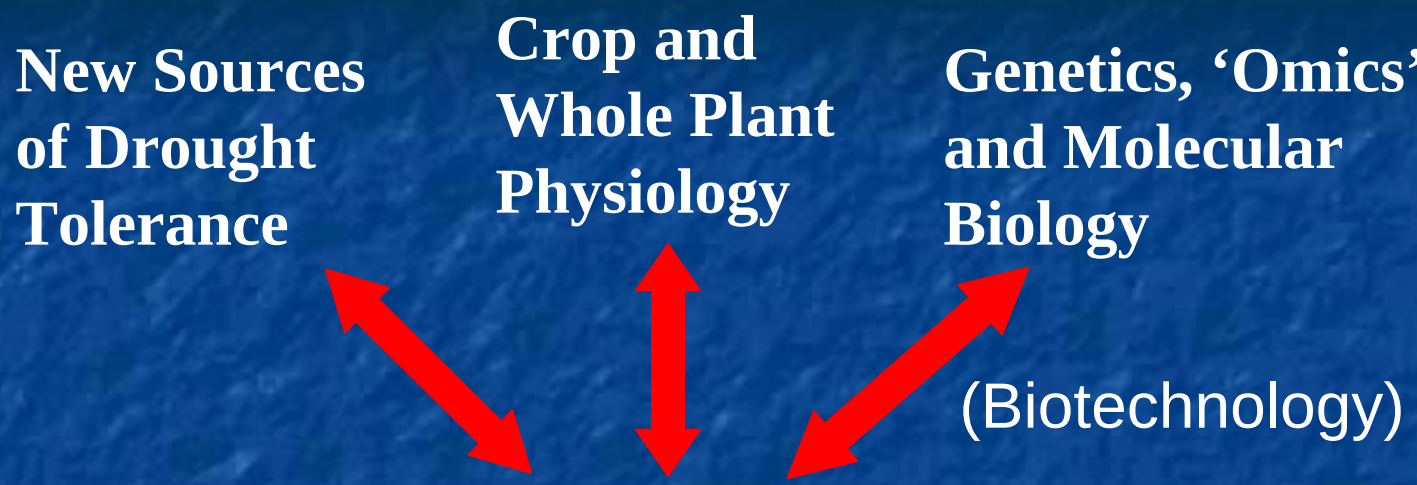
Breeding for Improved Drought Tolerance

- 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

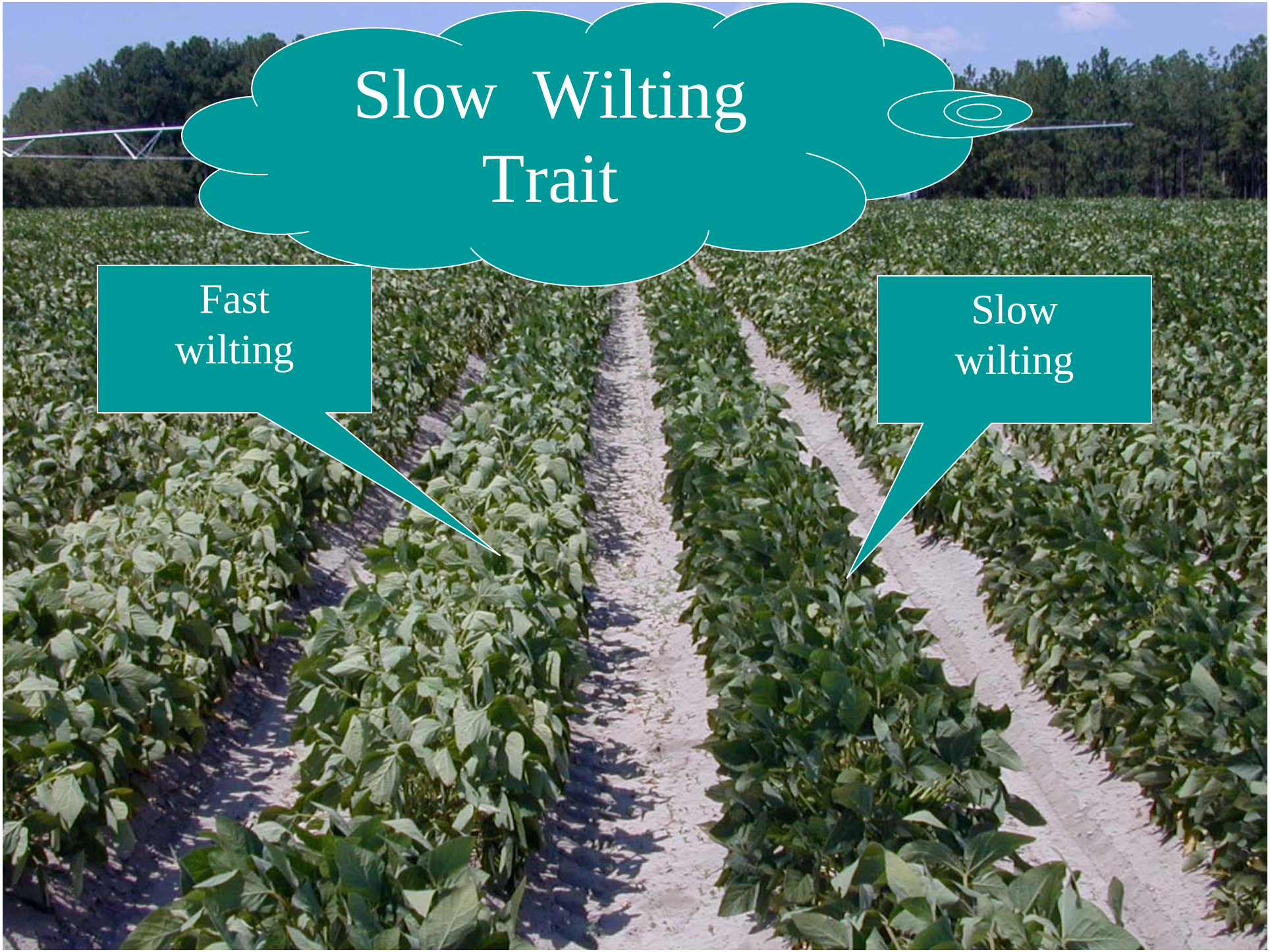


Field Breeding

Better Varieties

Soybean: *Glycine max*

Germplasm
to
Genes


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

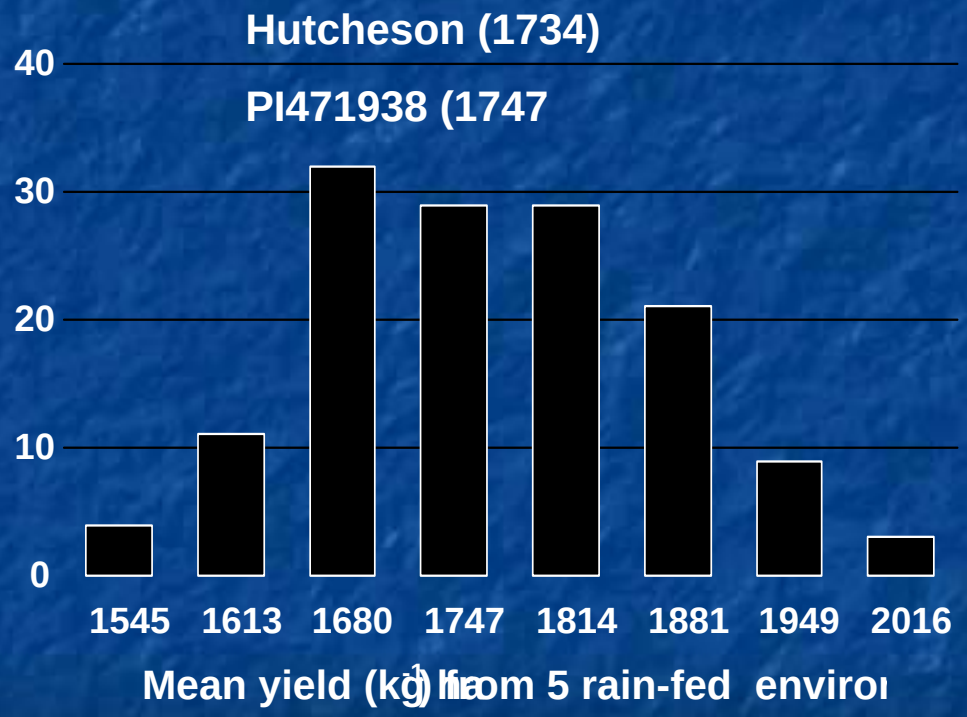
DNA MARKER RESULTS

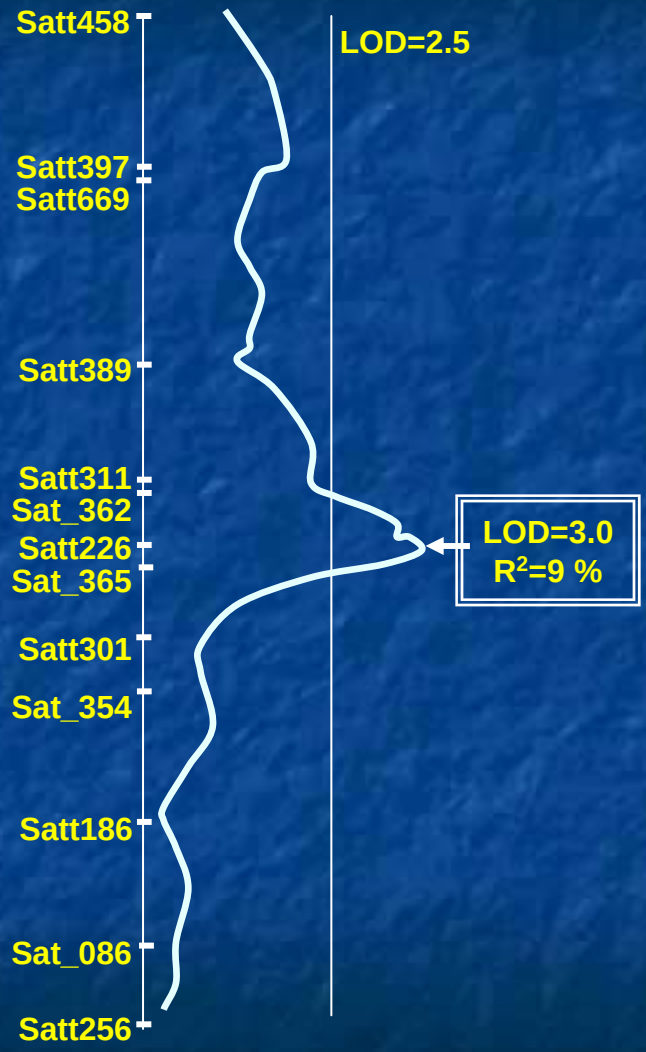
4 Slow Wilting Genes

identified thus far

More expected soon

QTL's for Yield under Drought: From PI 471938



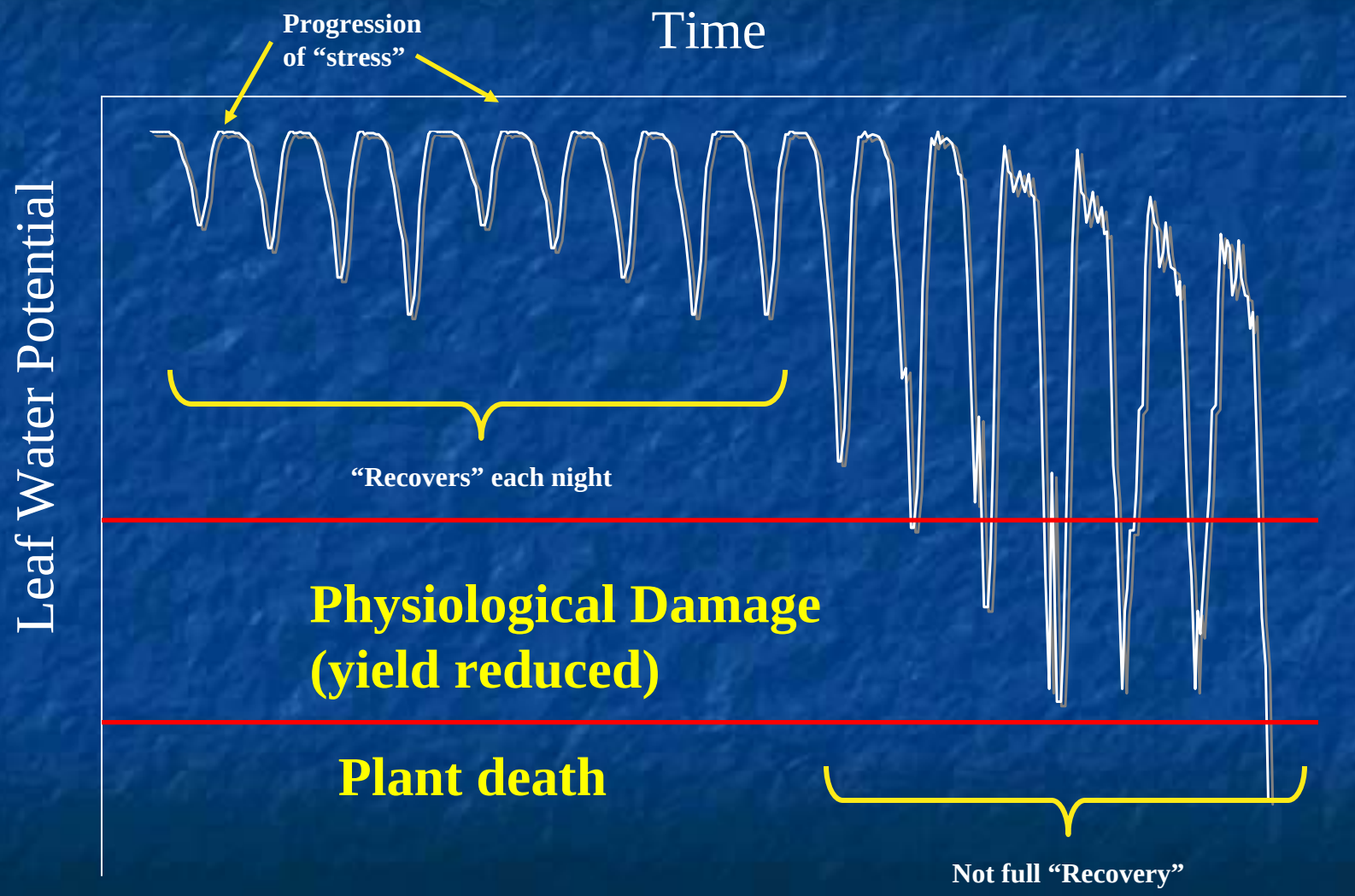


Maize

Zea mays

Genes
to
Germplasm

Water Stress Cycle



Drought and Desiccation Tolerance

Drought tolerance = tolerance of sub-optimal water availability

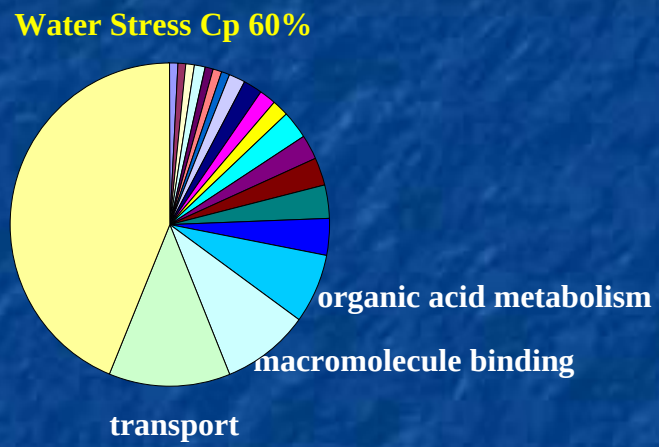
Desiccation tolerance = tolerance of complete drying to equilibrium with the air

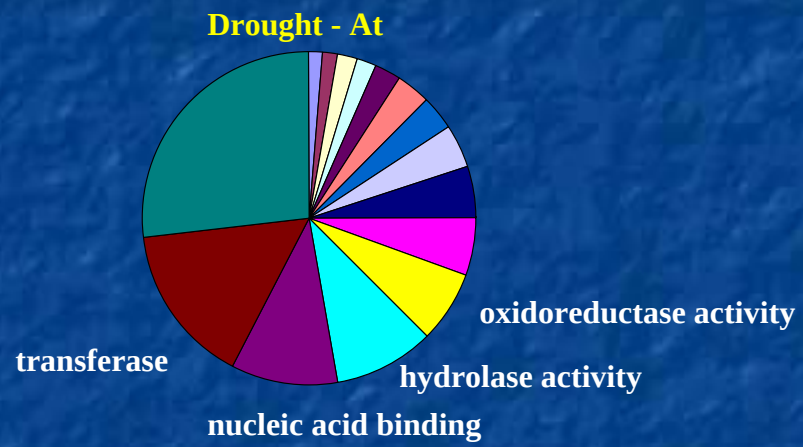
Drought tolerance mechanisms include ways of maintaining cell water content, such as osmotic regulation and stomatal closure, whereas desiccation tolerance consists of ways to survive the complete loss of water.

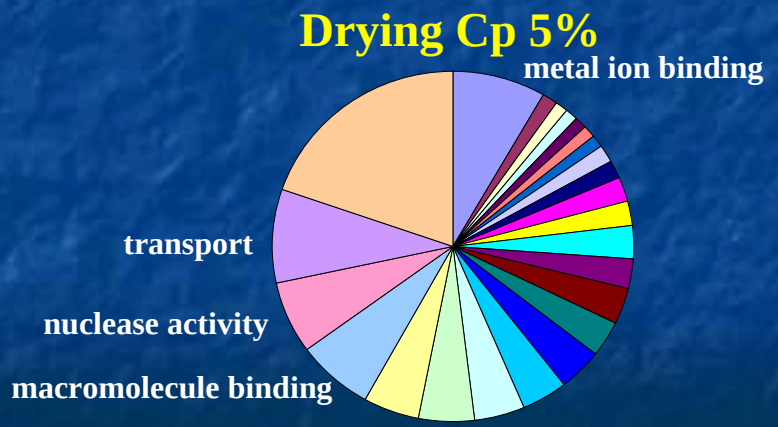
Sporobolus stapfianus

Craterostigma plantagineum

Induction by water stress vs Desiccation



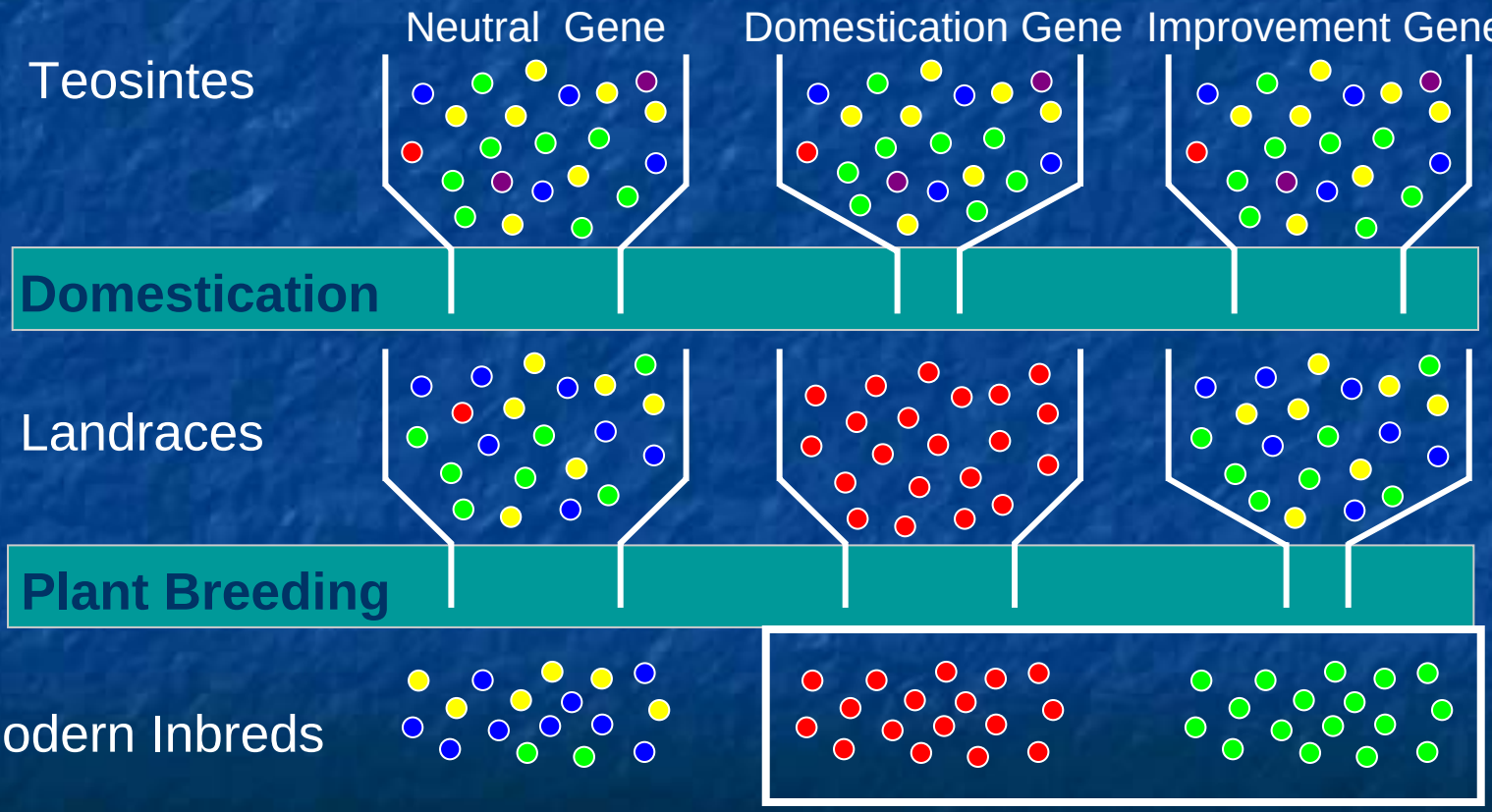




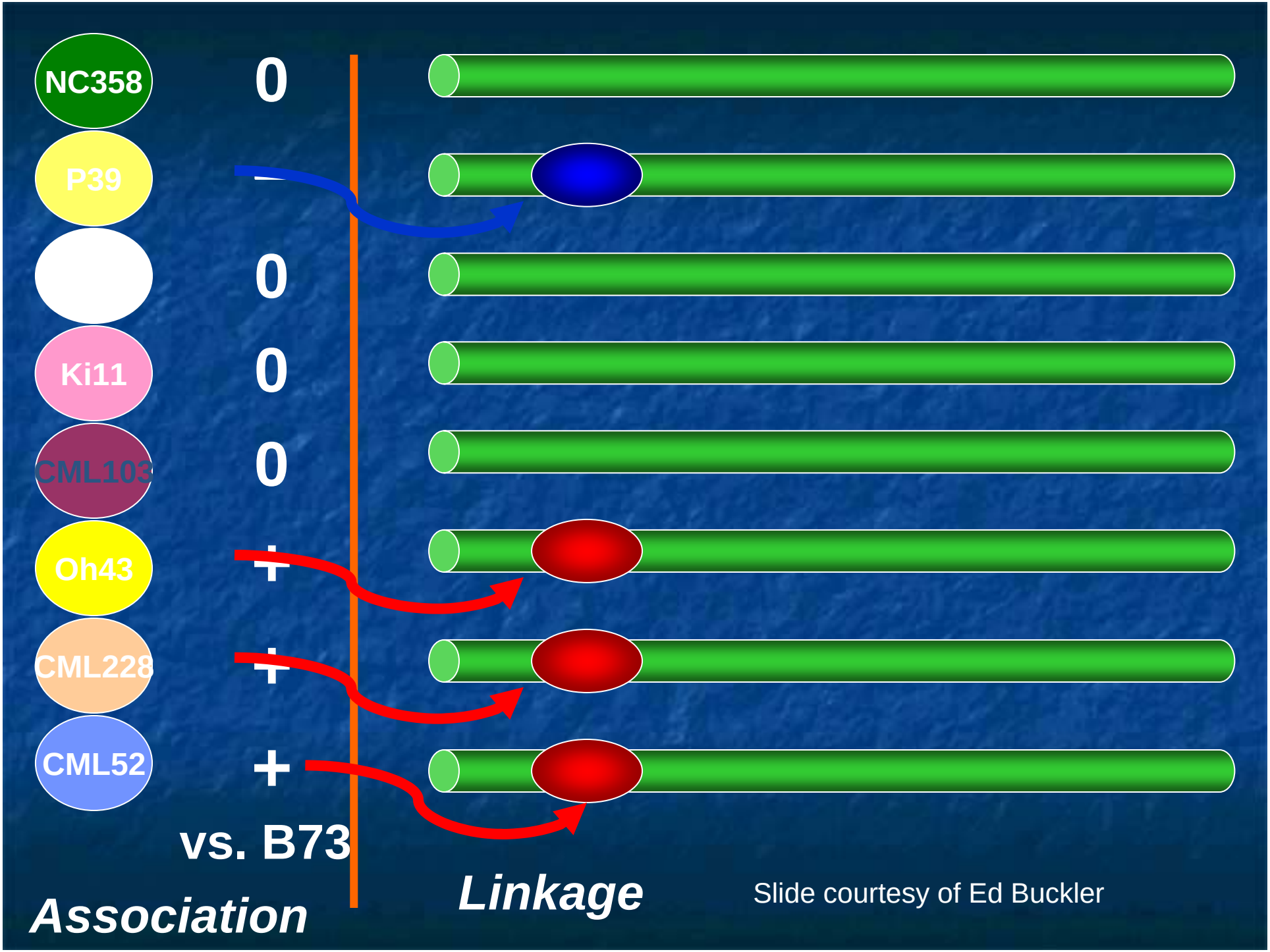
Genes Ascribed to Drought Tolerance

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

Domestication and plant breeding reduced maize genetic diversity



Slide courtesy of Masanori Yamasaki

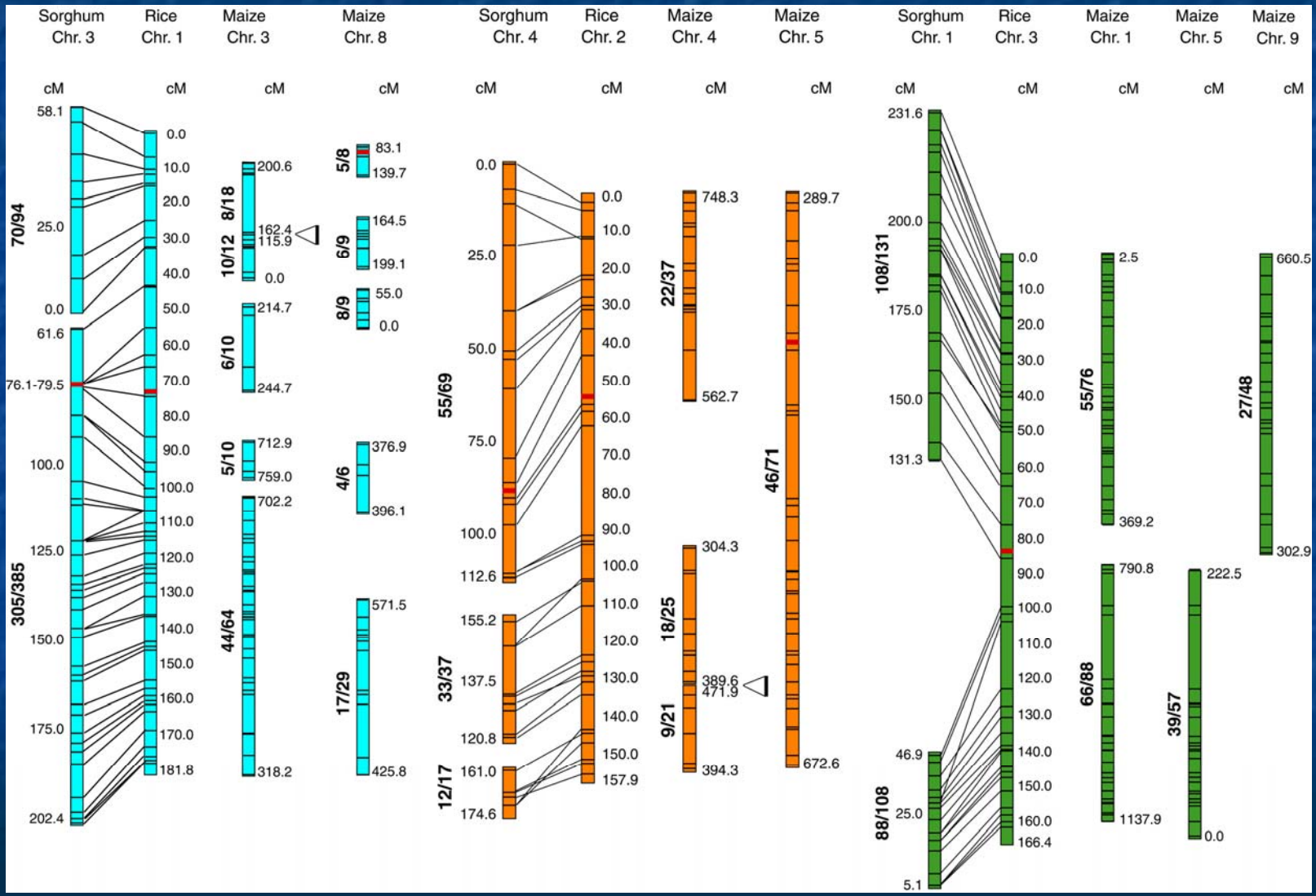

NC358
P39
Ki11
CML103
Oh43
CML228
CML52
0
–
0
0
0
+
+
+
vs. B73
Association
Linkage
Slide courtesy of Ed Buckler

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


Sorghum Chr. 3
Rice Chr. 1
Maize Chr. 3
Maize Chr. 8
Sorghum Chr. 4
Rice Chr. 2
Maize Chr. 4
Maize Chr. 5
Sorghum Chr. 1
Rice Chr. 3
Maize Chr. 1
Maize Chr. 5
Maize Chr. 9
cM
70/94
305/385
76.1-79.5
8/18
10/12
6/10
5/10
44/64
5/8
6/9
8/9
4/6
17/29
55/69
33/37
12/17
22/37
18/25
9/21
46/71
108/131
88/108
55/76
66/88
39/57
27/48

Integrated Approach

The Key for Crop Improvement in Drought Tolerance