RESEARCH AND INNOVATION POLICIES FOR

SUSTAINABLE PRODUCTIVITY GROWTH IN AGRICULTURE

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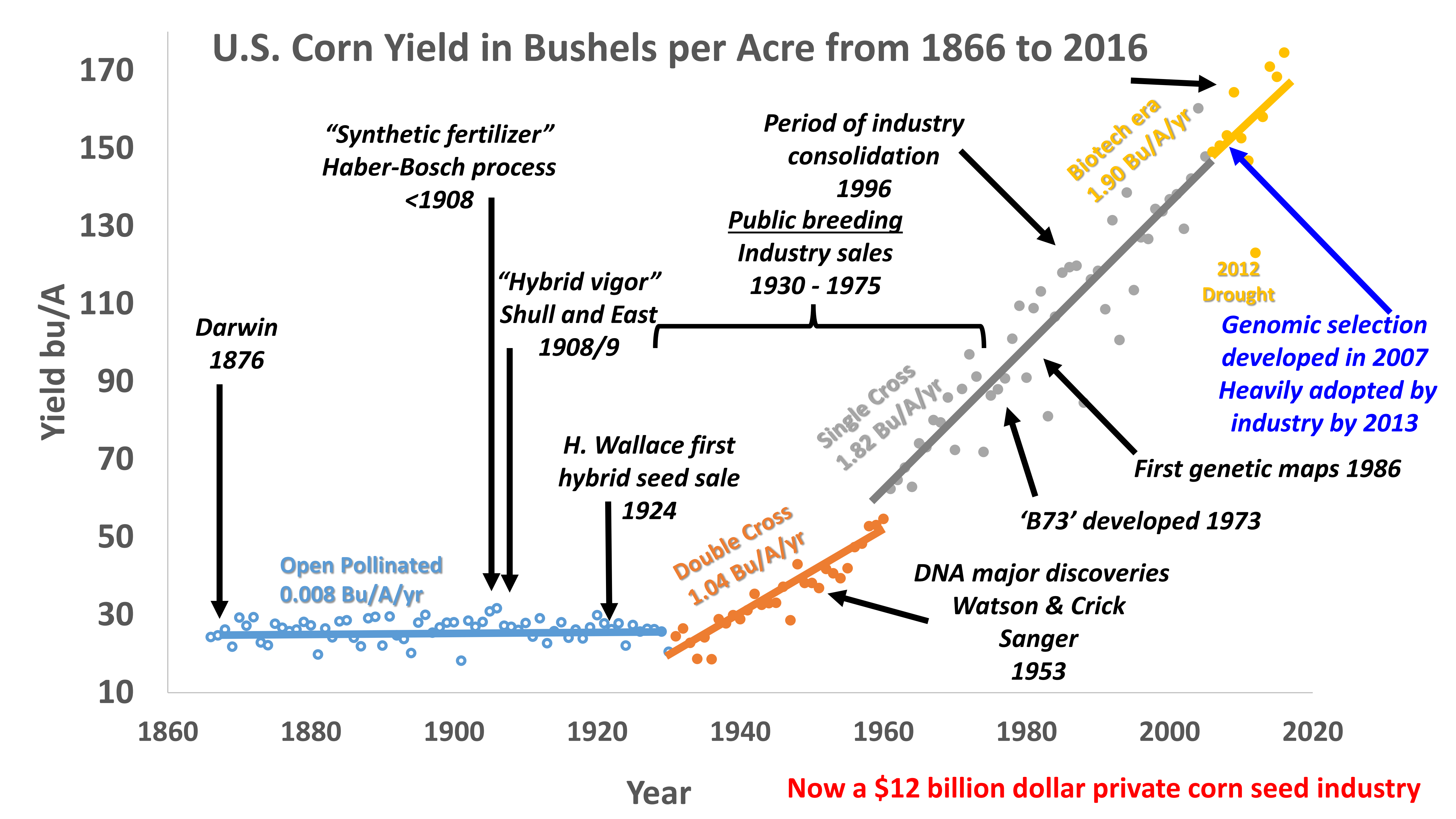


U.S. Corn Yield in Bushels per Acre from 1866 to 2016
Yield bu/A
170
150
130
110
90
70
50
30
10
1860
1880
1900
1920
1940
1960
1980
2000
2020
Year
Darwin 1876
"Synthetic fertilizer" Haber-Bosch process <1908
"Hybrid vigor" Shull and East 1908/9
H. Wallace first hybrid seed sale 1924
Period of industry consolidation 1996
Public breeding
Industry sales 1930 - 1975
Open Pollinated 0.008 Bu/A/yr
Double Cross 1.04 Bu/A/yr
Single Cross 1.82 Bu/A/yr
Biotech era 1.90 Bu/A/yr
2012 Drought
Genomic selection developed in 2007 Heavily adopted by industry by 2013
First genetic maps 1986
'B73' developed 1973
DNA major discoveries Watson & Crick Sanger 1953
Now a $12 billion dollar private corn seed industry

Pace of Change is Slow in Plant Breeding

Nokia 2330
http://www.mymobiles.com/

7 years

Samsung S6
http://www.mymobiles.com/

1 new variety

Agricultural Research	Role (naïve)	Metrics of Success (naïve)
Private (basic)	Discover new technologies	Patents, stock value
Private (startup)	Translate new technologies to sellable product. Sell product to established company.	Growth, market share, "buzz"
Private (established applied)	Sell product to end user (farmers); well funded incremental research	Product sold, market share, stock value
Non-profit / Private Research Institute	Conduct novel research (mostly basic)	Depends: publications, grant $
University Researcher	Conduct novel research (basic through applied), train students	Many: Publications, patents, varieties; students trained, classes taught; international recognition, presentations; grant $
University Extension	Assist farmer, conduct farmer relevant applied research	Number of contact hours, extension publications, $ brought in, training
ARS / ERS government research	Provide long-term big-picture research on agriculture and ag. economics	Many: research products used (industry, congress, etc.), publications
NASS government research	Provide unbiased and operational data routinely	Trusted, on-time data publications of facts

Basic Scientific Discovery → **Validation and Translational Research** → **Applied Product** → **Commercialization** → **Sell to End User**

Agricultural Research	Time horizon (naïve)
Private (basic)	Short; 1-3 years
Private (startup)	Until VC runs out Very short; 1-3 years
Private (established applied)	Short; 1-3 years Some longer, most < 5-7 years
Non-profit / Private Research Institute	Medium; 3-5 years
University Researcher	Varies: 1-7 years
University Extension	Very short: 1-2 years
ARS / ERS government research	Varies: typically 5 year cycles
NASS government research	Constant: Short yearly deadlines Readjust year to year

Realities that make agriculture different:

Biology
Outdoors
Complex and unpredictable
Regionally specific

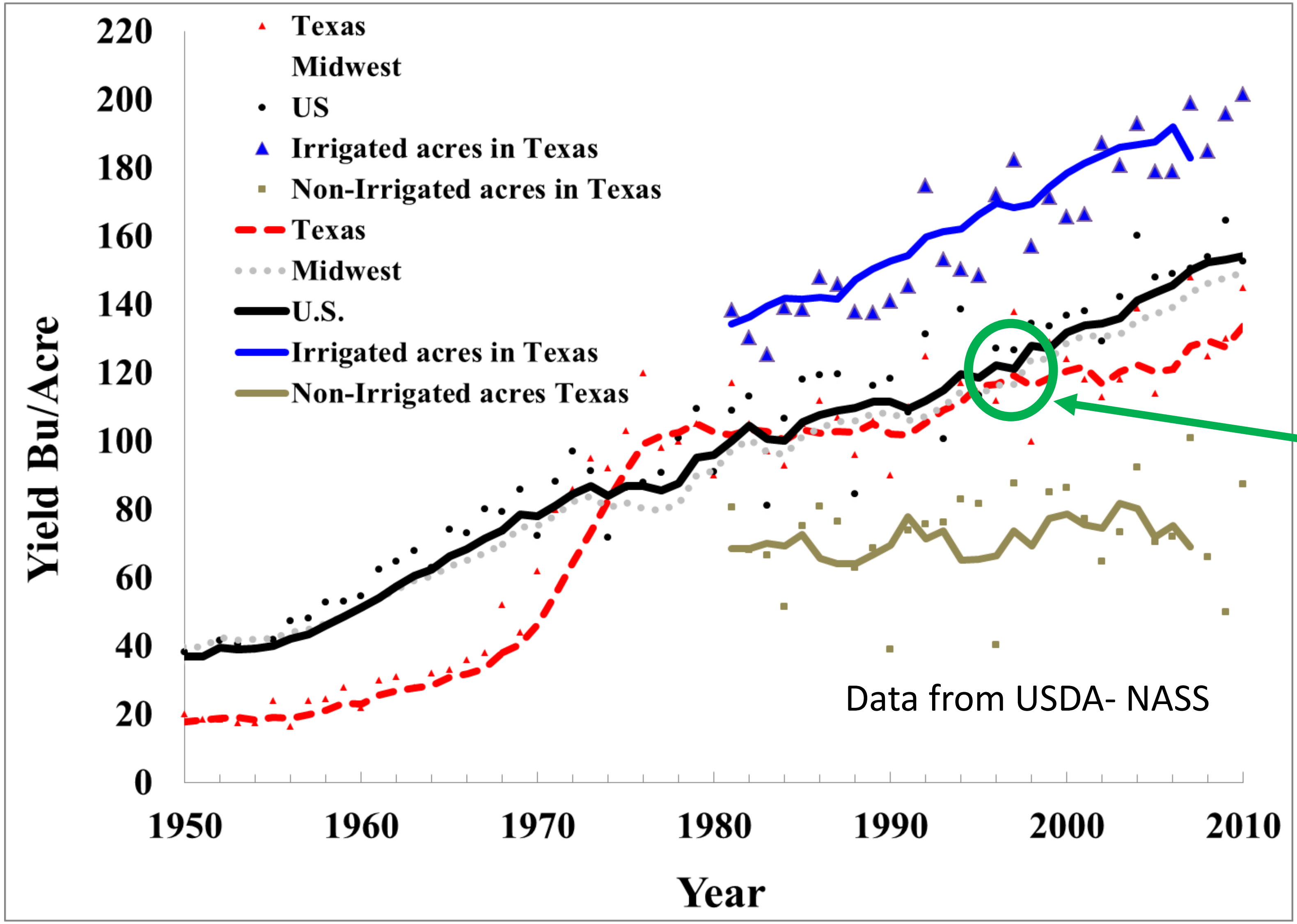
Can not scale up immediately or beyond appropriate regions.

Thus…Timescale
Agricultural research progress often requires a much longer time horizon than other industries

Makes speeding things up very attractive

Justification: Increase yield, food stability and sustainability

Gains in maize yield ~50% due to genetic improvement, ~50% due to agronomy – Duvick 1995



Agronomy includes site specific management & precision agriculture

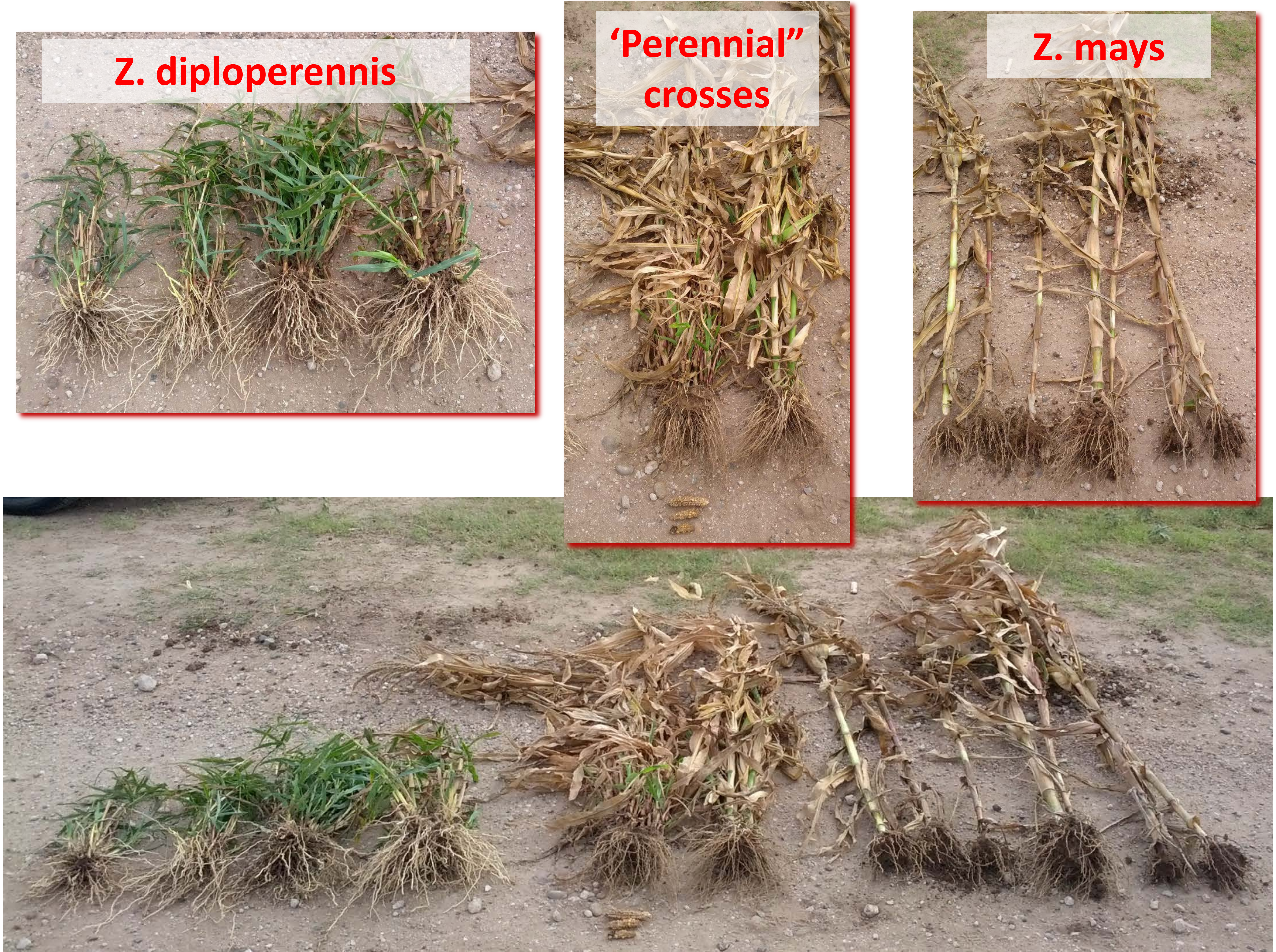
Industry consolidation research in just the best environments

Barrero et al. 2013, Field Crops Research

Plant breeding and Education Prog.

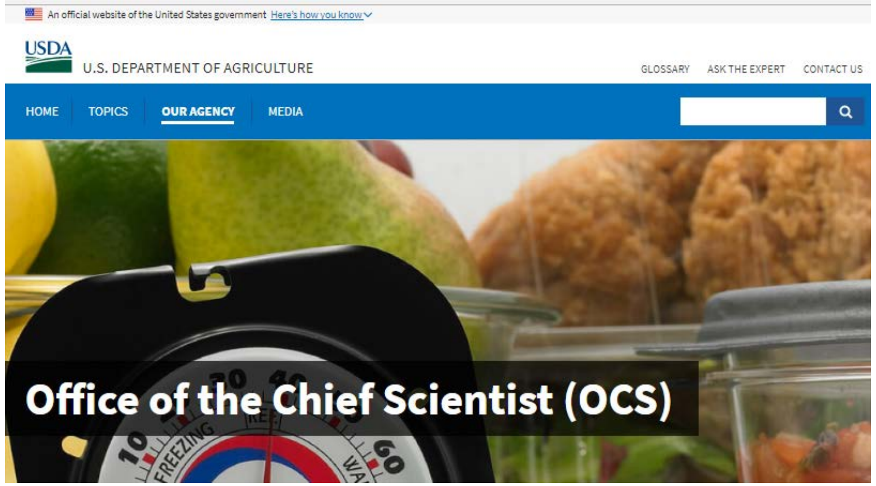
USDA United States Department of Agriculture
National Institute of Food and Agriculture


Wild species
Zea
Corn
X
Wild species
hybrid
Zea mays
(Corn)
Commercial
Hybrid
New lines selected from crosses


Z. diploperennis
'Perennial" crosses
Z. mays

March 2, 2017 listening session "Visioning of United States Agricultural Systems for Sustainable Production"

- Discuss strengths, weaknesses, opportunities and threats in the long-term future (to 50 years) of U.S. agricultural production systems; especially focusing on how to leverage new technologies and scientific knowledge.
- 86 in person participants, 58 by phone, and 50 by Web



https://www.usda.gov/our-agency/staff-offices/office-chief-scientist-ocs

Relevant Big-Picture Topics

- Major systematic issues are not being addressed due to a lack of integration across agricultural species and disciplines (i.e. silos, and not holistic systems);

- Missing opportunities because research lacks longer-term (>7 years) funding and longer-term performance metrics (e.g. breeding perennial grain crops)