IOWA STATE UNIVERSITY
Department of Agronomy

Changes in corn hybrids over the last 40 years

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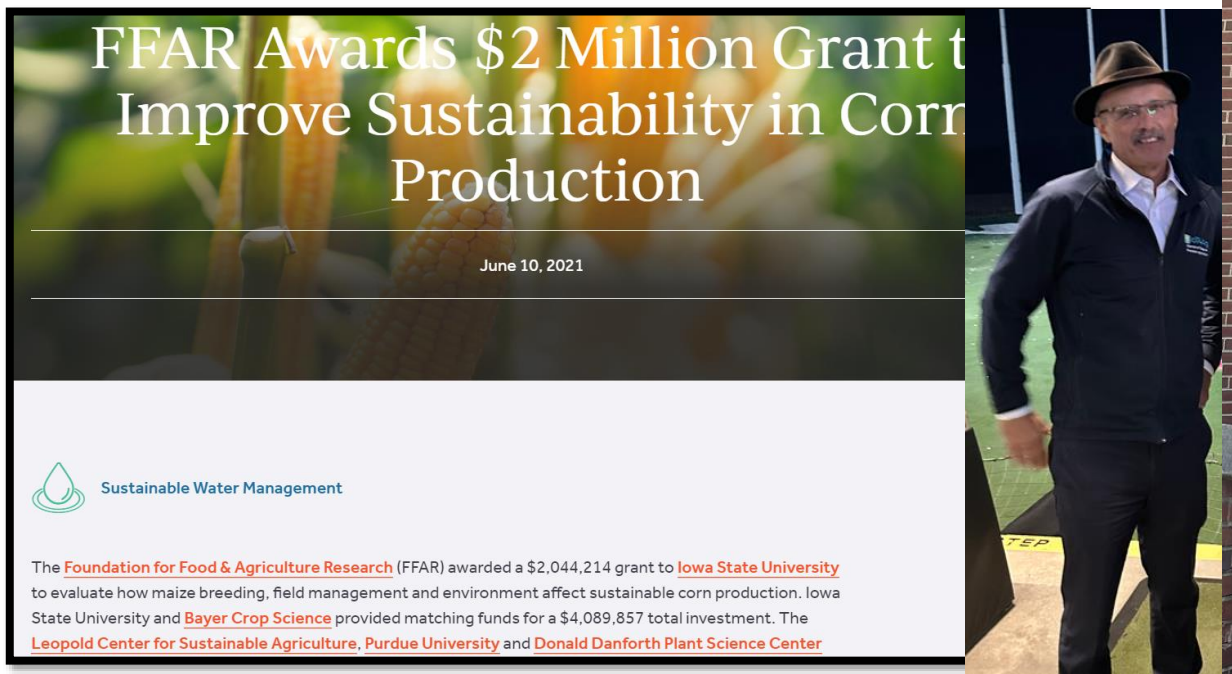
The corn ERA project – a public/private partnership

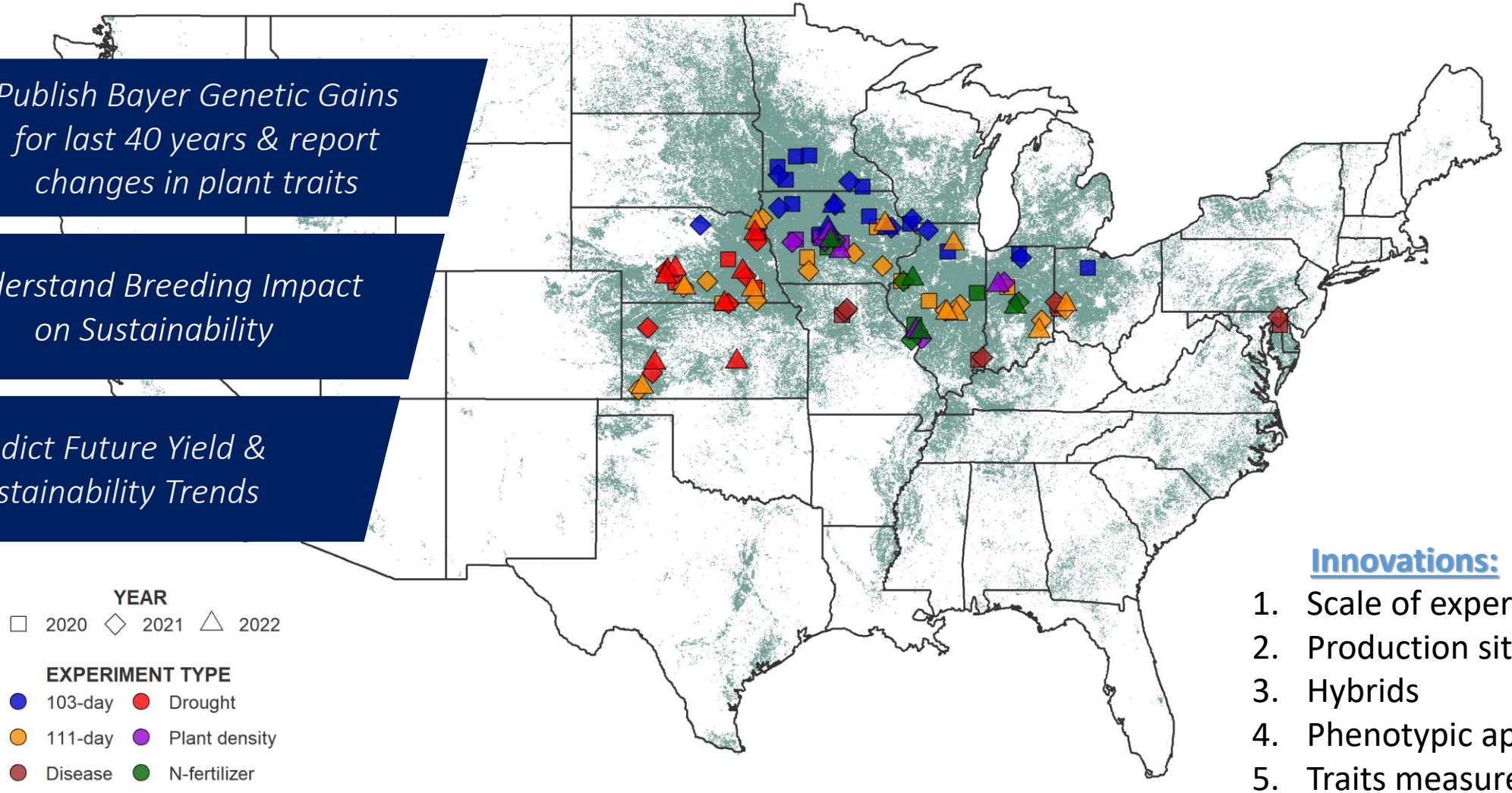


Objectives and experiments

Publish Bayer Genetic Gains for last 40 years & report changes in plant traits

Understand Breeding Impact on Sustainability

Predict Future Yield & Sustainability Trends



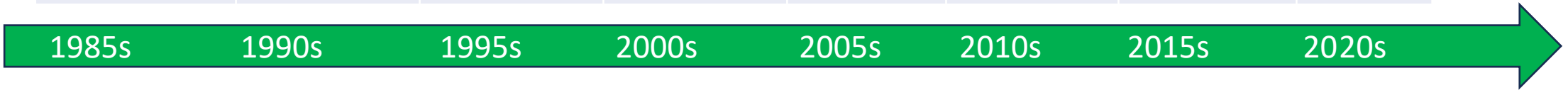
Innovations:

1. Scale of experimentation
2. Production situations
3. Hybrids
4. Phenotypic approaches
5. Traits measured

Thanks to the Bayer Testing Team!

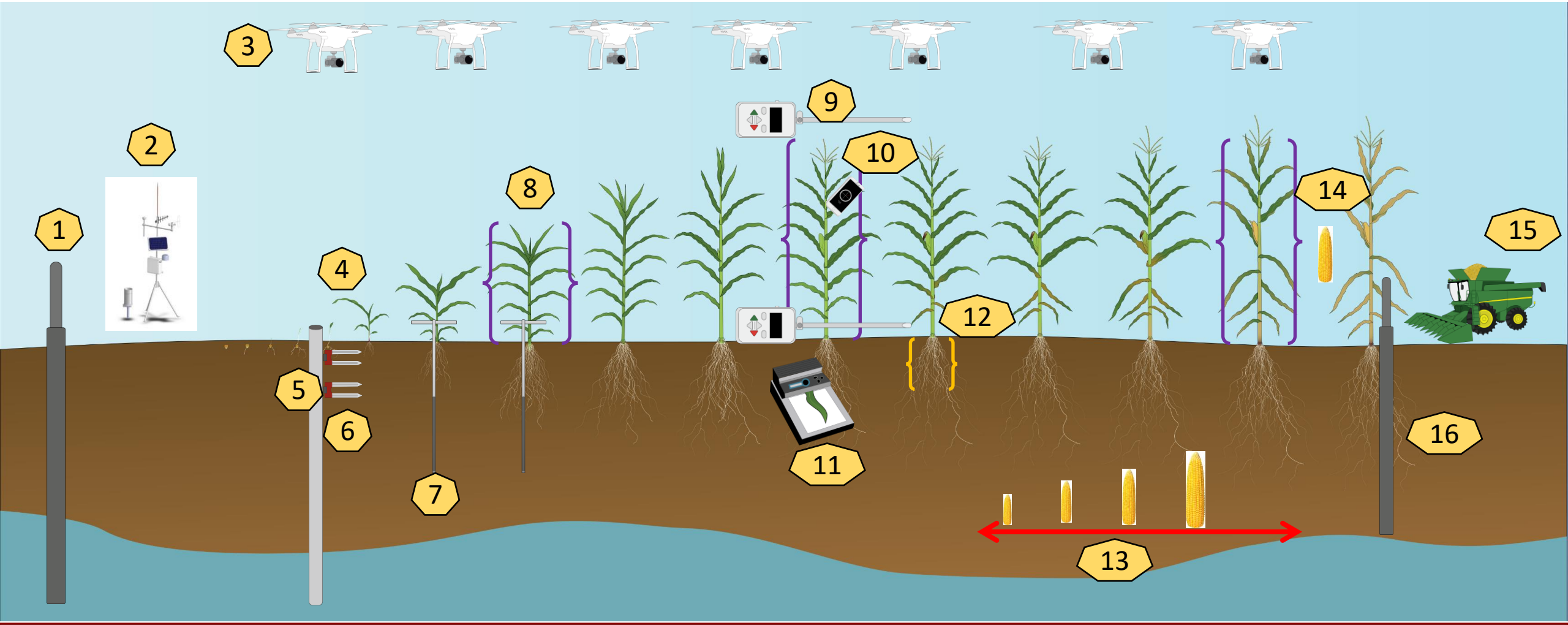
82 hybrids evaluated

111-day	T1100	LH212+LH204	DK626	RX708	RX715	DKC62-54	213-19VT2P	DKC62-53
	LH119+LH59	DK614	DK604	RX740	DKC63-78	DKC63-87	DKC63-33	DKC63-57
	LH74+LH51	DK623	DK618	DKC60-19	DKC61-69	DKC62-97	DKC60-67	213-93STX
	LH132+LH109	DK591	RX730	DKC60-08	DKC63-42	DKC61-88	DKC61-54	DKC59-81
	LH132+LH59	LH195+LH167	LH198+LH185	LH245+LH287	DKC61-21	DKC62-08	DKC60-88	DKC61-40
	LH82+LHE136						DKC63-55	
103-day	T1000	LH222+LH172	LH227+LH172	LH227+LH295	DKC52-43	DKC53-56	DKC51-19	DKC55-85
	DK524	DK535	DK527	DK537	DKC53-11	DKC55-09	DKC52-04	204-25STX
	LH74+LH59	LH74+LH61	LH198+LH176	DK520	DKC54-50	DKC55-24	DKC55-20	DKC53-25
	DK547	LH202+LH163	DK546	DK539	DKC52-21	DKC53-78	DKC52-84	DKC52-34
	LH82+LH74	DK512	DK521	DKC51-43	DKC52-59	H5222VT3	DKC54-38	DKC52-16



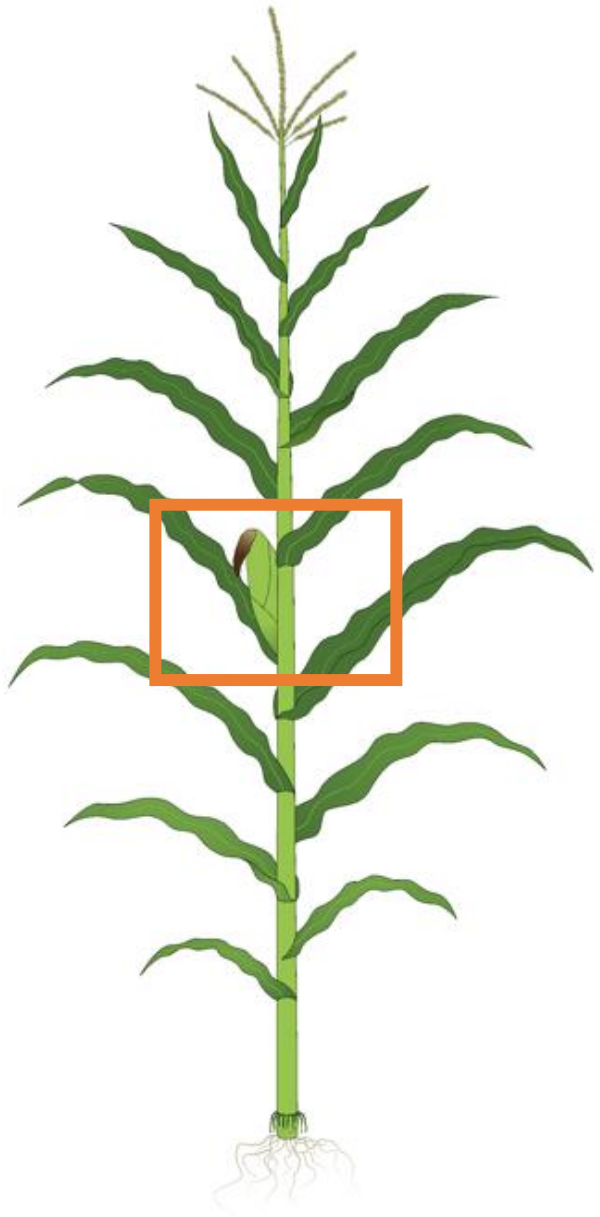
Year of Release

Measurements from roots to grain: 200+ plant traits



Biomass partitioning

> 40,000 maize plants used for research

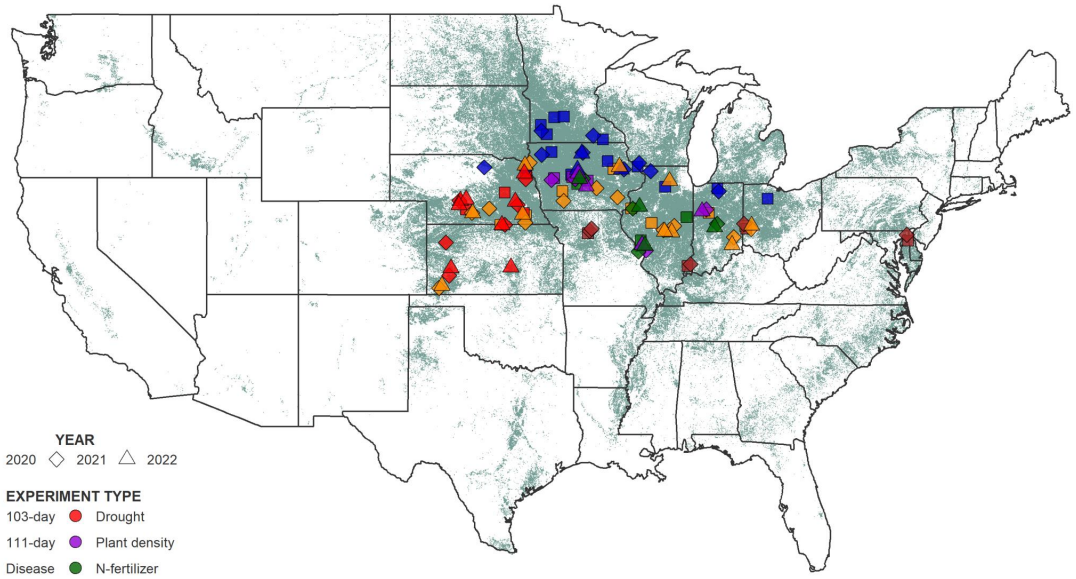


Topics:

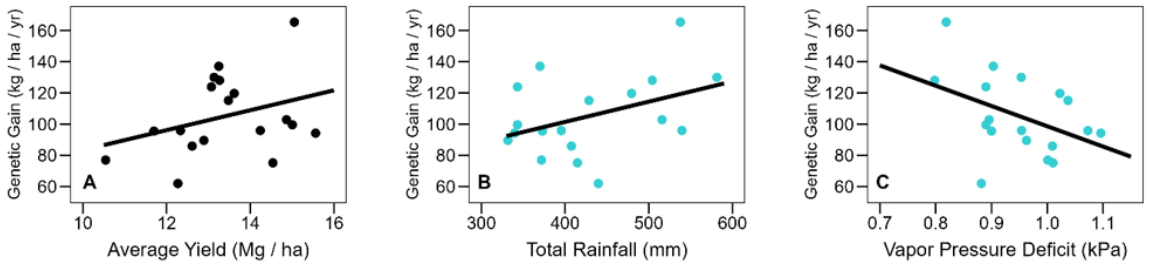
- Grain
- Biomass
- roots
- Leaves
- Water use
- Nitrogen use
- Protein
- Macro-micro nutrients

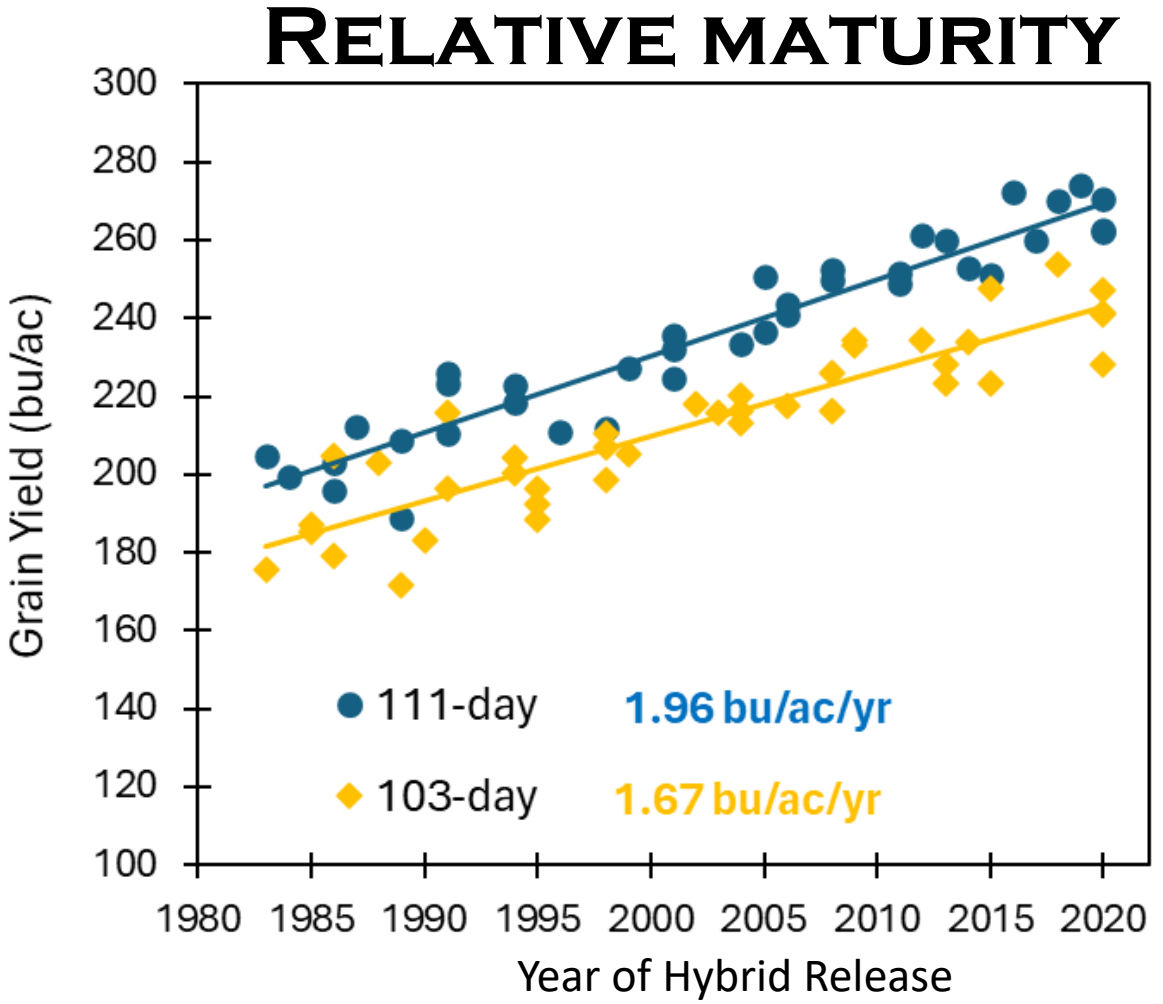
Maize grain yield genetic gains

44 site-years; plant density of 33,000 seeds/acre



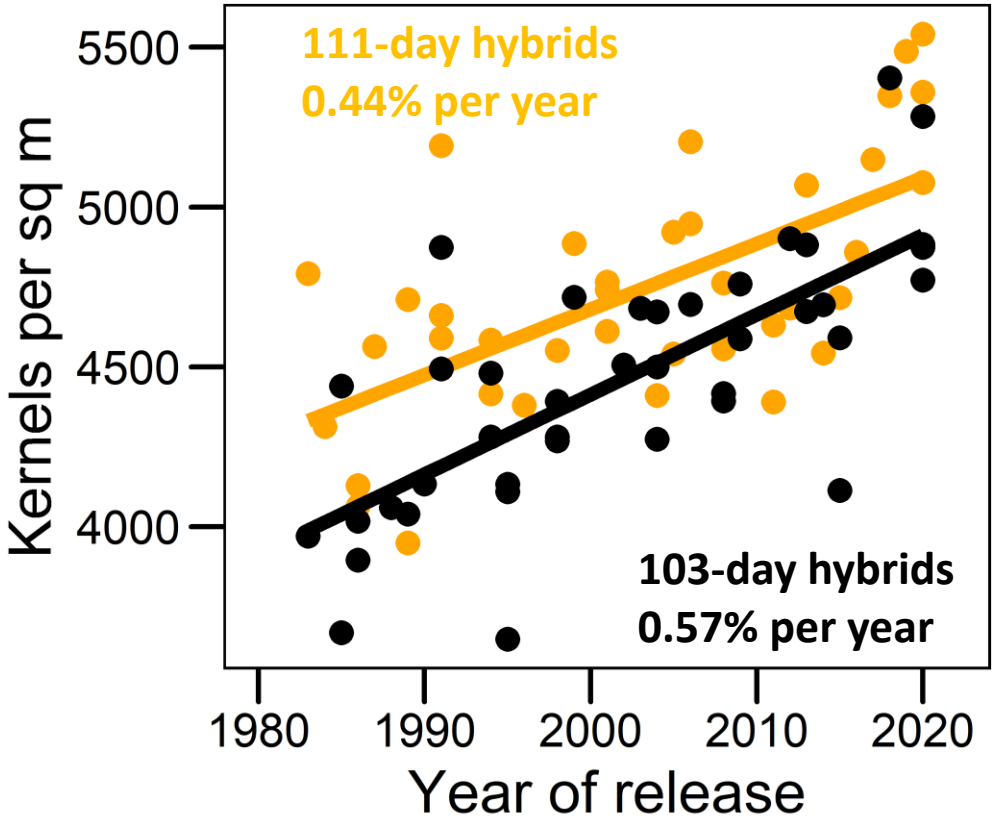
103-day hybrids

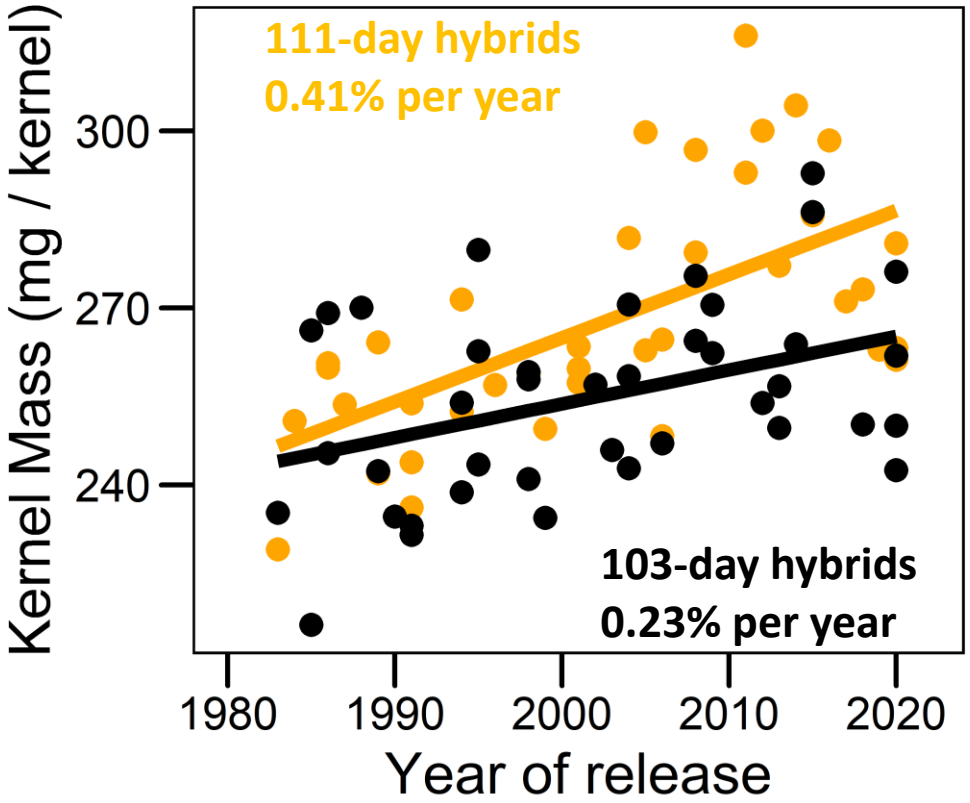




King et al.
In preparation for submission

Grain Yield = Kernel number * Kernel weight * plant density





King et al.
In preparation for submission

ELSEVIER

Field Crops Research

Volume 303, 1 November 2023, 109123

Maize kernel weight genetic gain is achieved through different mechanisms depending on the hybrid maturity

Brenda L. Gambin [a], Juan I. Di Salvo [a], Cintia Sciarresi [a], Slobodan Trifunovic [b], Jim Narvel [b], Xiaobo Zhou [b], Kendall Lamkey [a], Sotirios V. Archontoulis [a]

[a] Department of Agronomy, Iowa State University, Ames, IA, USA

[b] Bayer Crop Science, Chesterfield, MO, USA

- ✓ **111-day hybrids: longer grain fill duration**
- ✓ **103-day hybrids: higher grain growth rate**

ELSEVIER

Field Crops Research

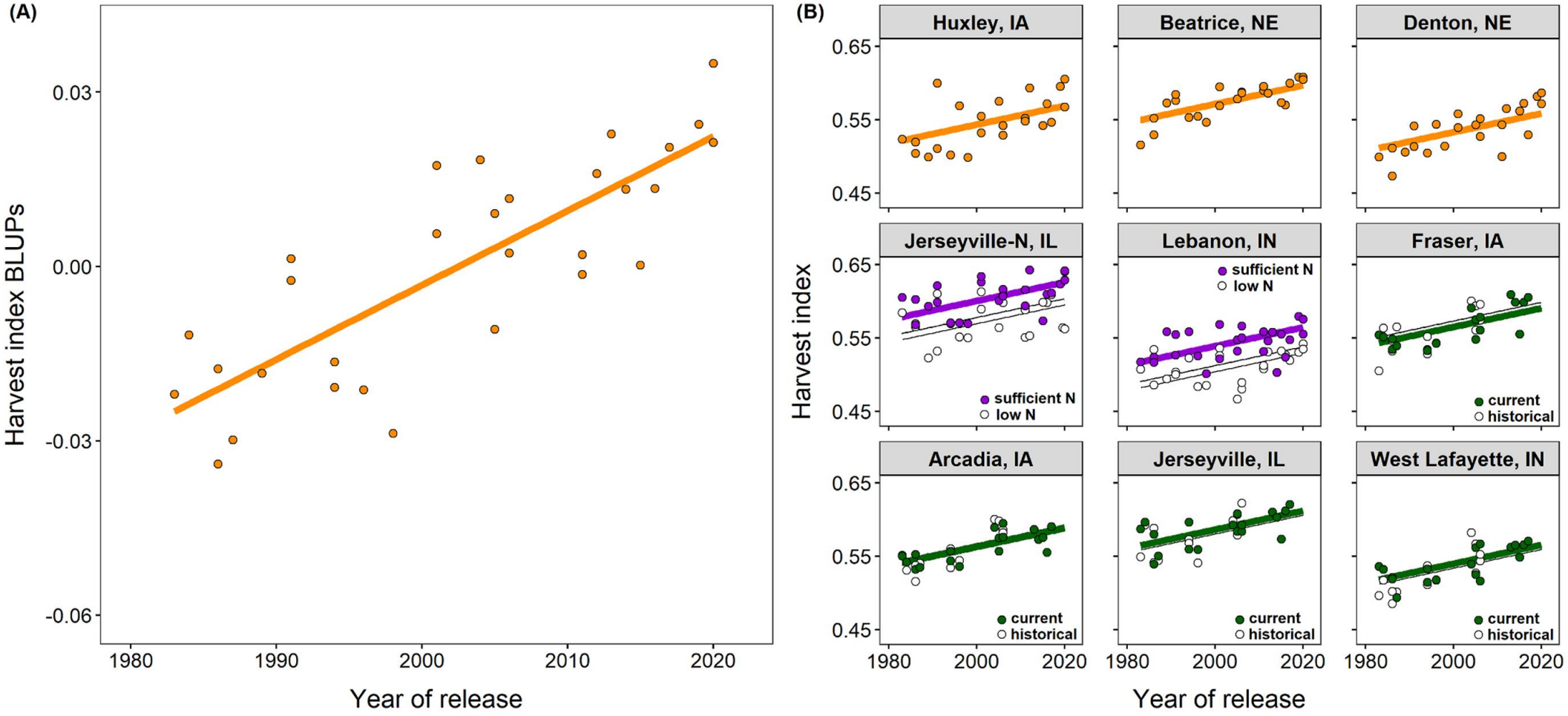
Volume 300, 1 September 2023, 108991

Harvest index has increased over the last 50 years of maize breeding

Alejo Ruiz [a], Slobodan Trifunovic [b], Douglas M. Eudy [b], Cintia S. Sciarresi [a], Mitchell Baum [a], Gerasimos J.N. Danalatos [a], Elvis F. Elli [a], Georgios Kalogeropoulos [a], Kyle King [a], Caio dos Santos [a], August Thies [c], Lia Olmedo Pico [d], Michael J. Castellano [a], Patrick S. Schnable [a], Christopher Topp [c], Michael Graham [b], Kendall R. Lamkey [a], Tony J. Vyn [d], Sotirios V. Archontoulis [a]

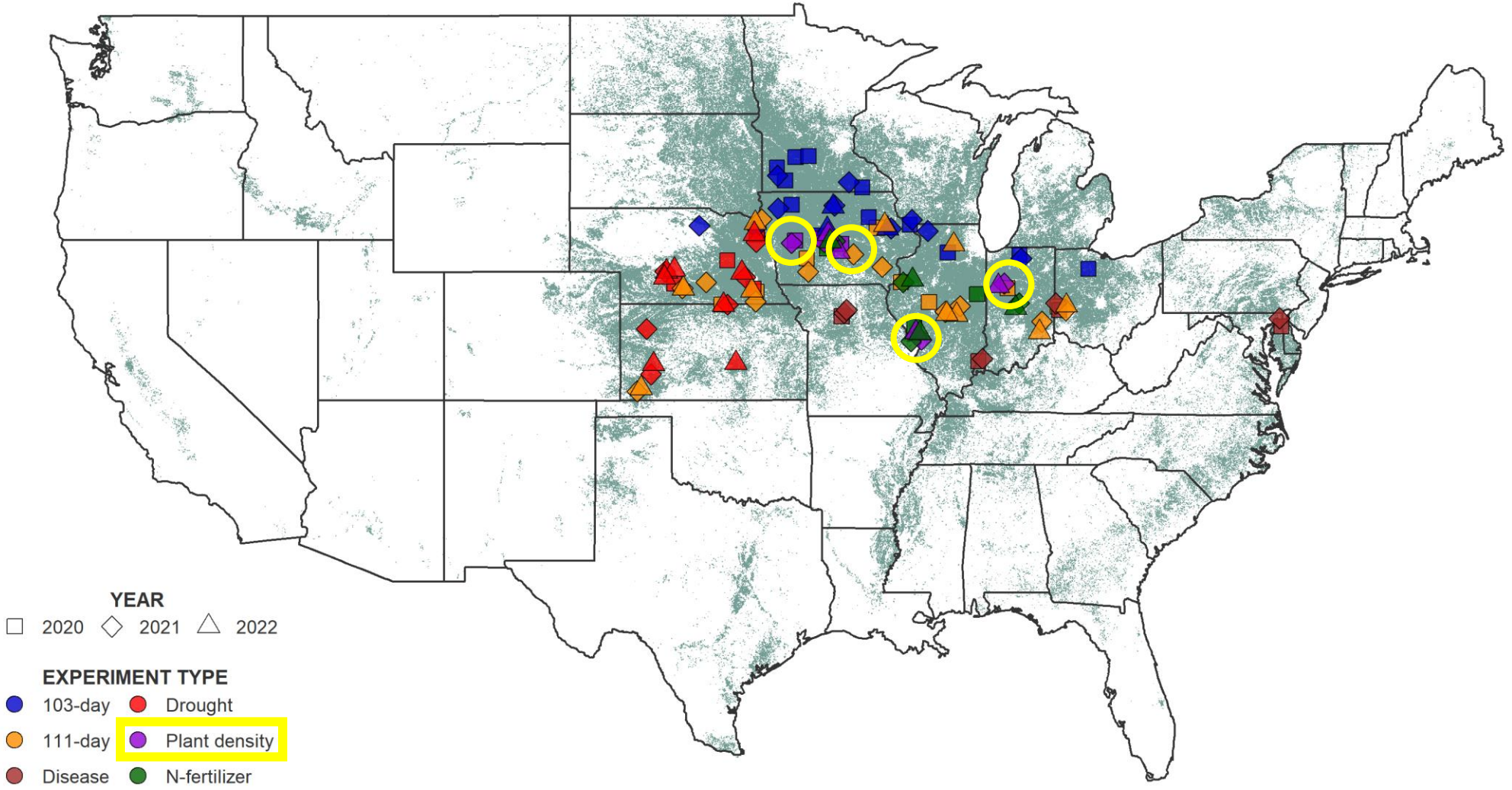
[a] Iowa State University, Department of Agronomy, Ames, IA, USA
[b] Bayer Crop Science, Chesterfield, MO, USA
[c] Donald Danforth Plant Science Center, Olivette, MO, USA
[d] Purdue University, Department of Agronomy, West Lafayette, IN, USA

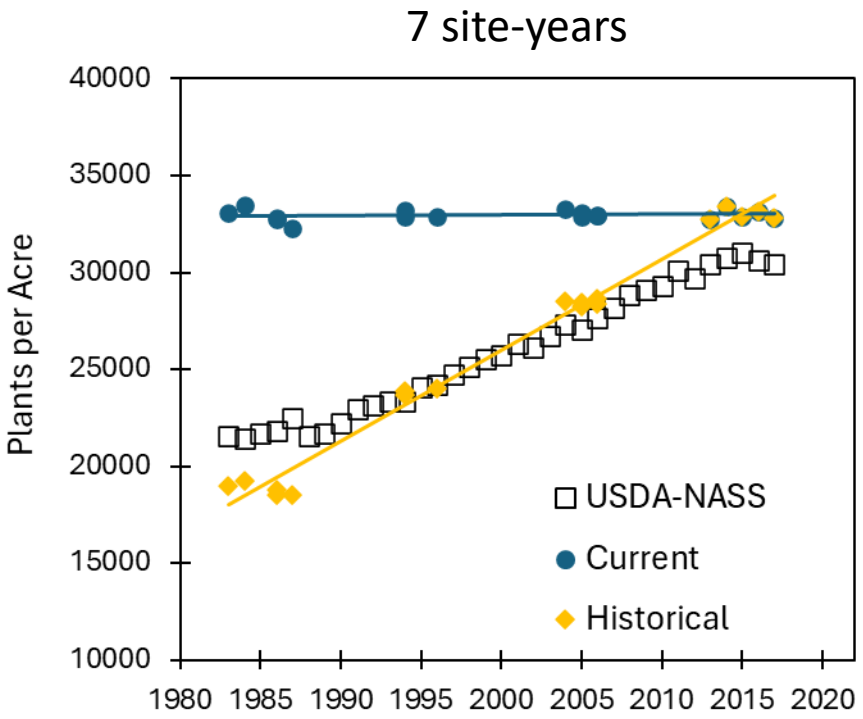
The HI increase is attributed to breeding, not management.
The HI increase accounted for 15% of the US Corn yield increase.

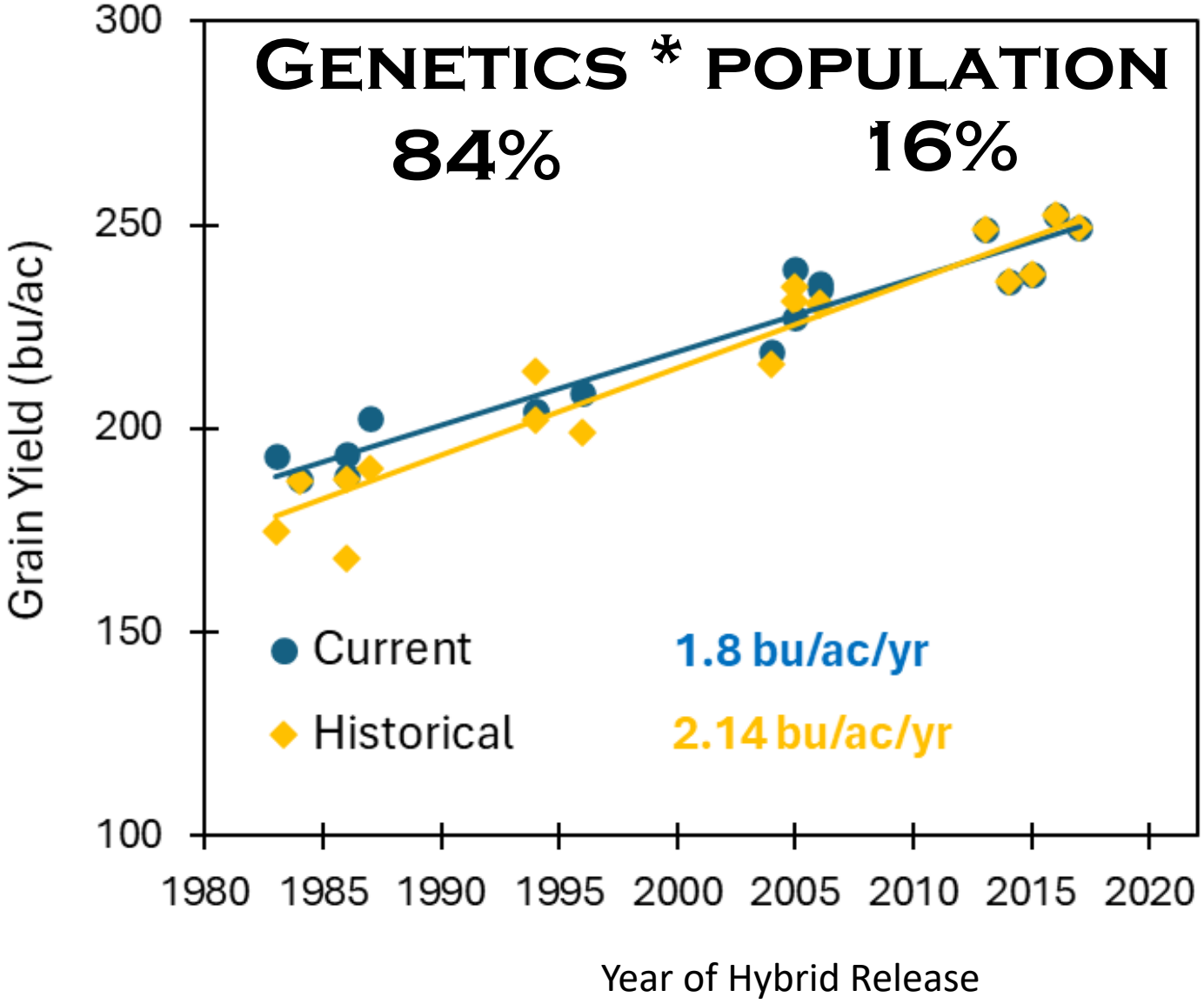


Ruiz et al. 2023
Field Crops Research

Plant density versus genetics

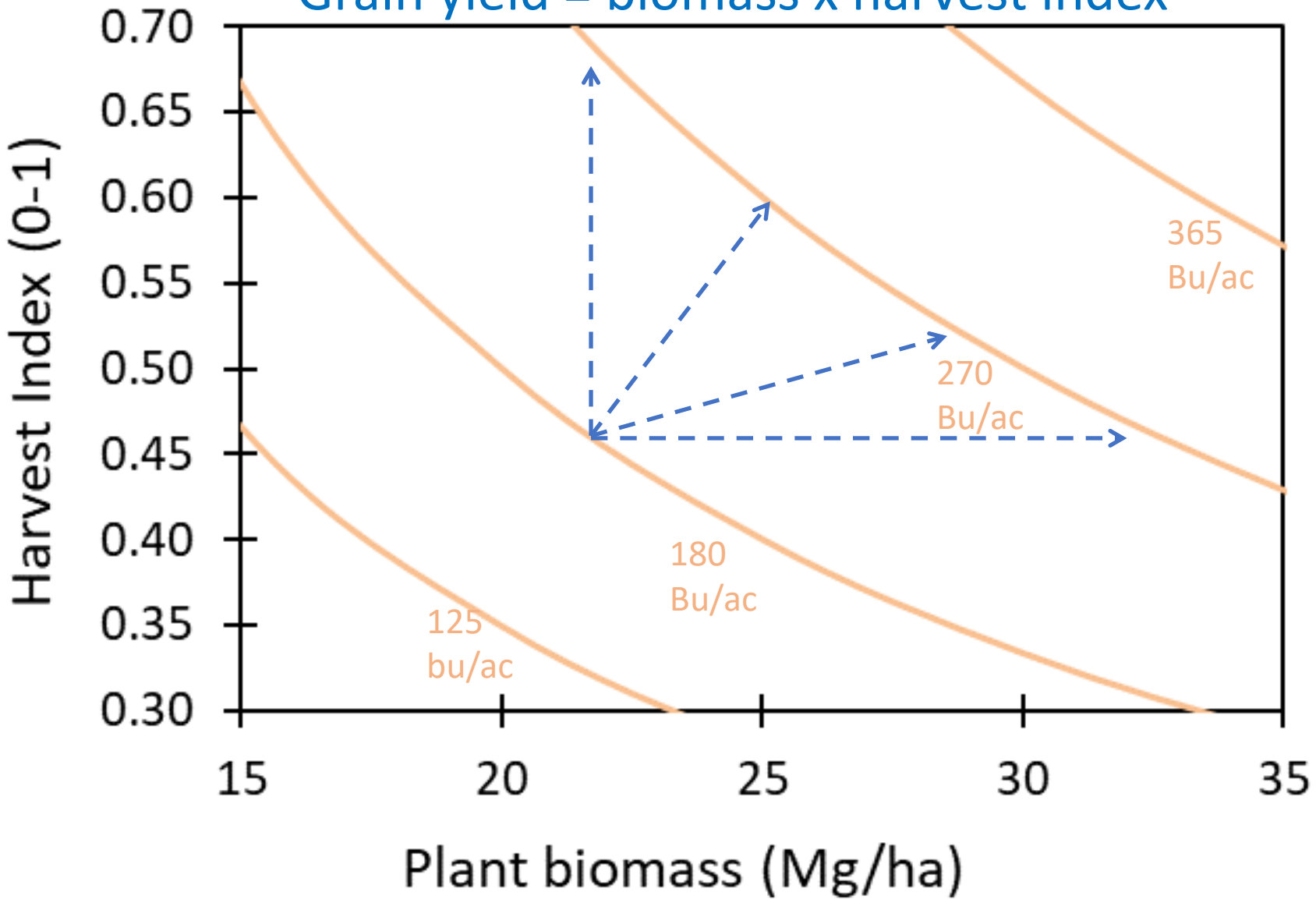






Archontoulis et al. In prep

Grain yield = biomass x harvest index



Archontoulis et al.
In preparation for submission

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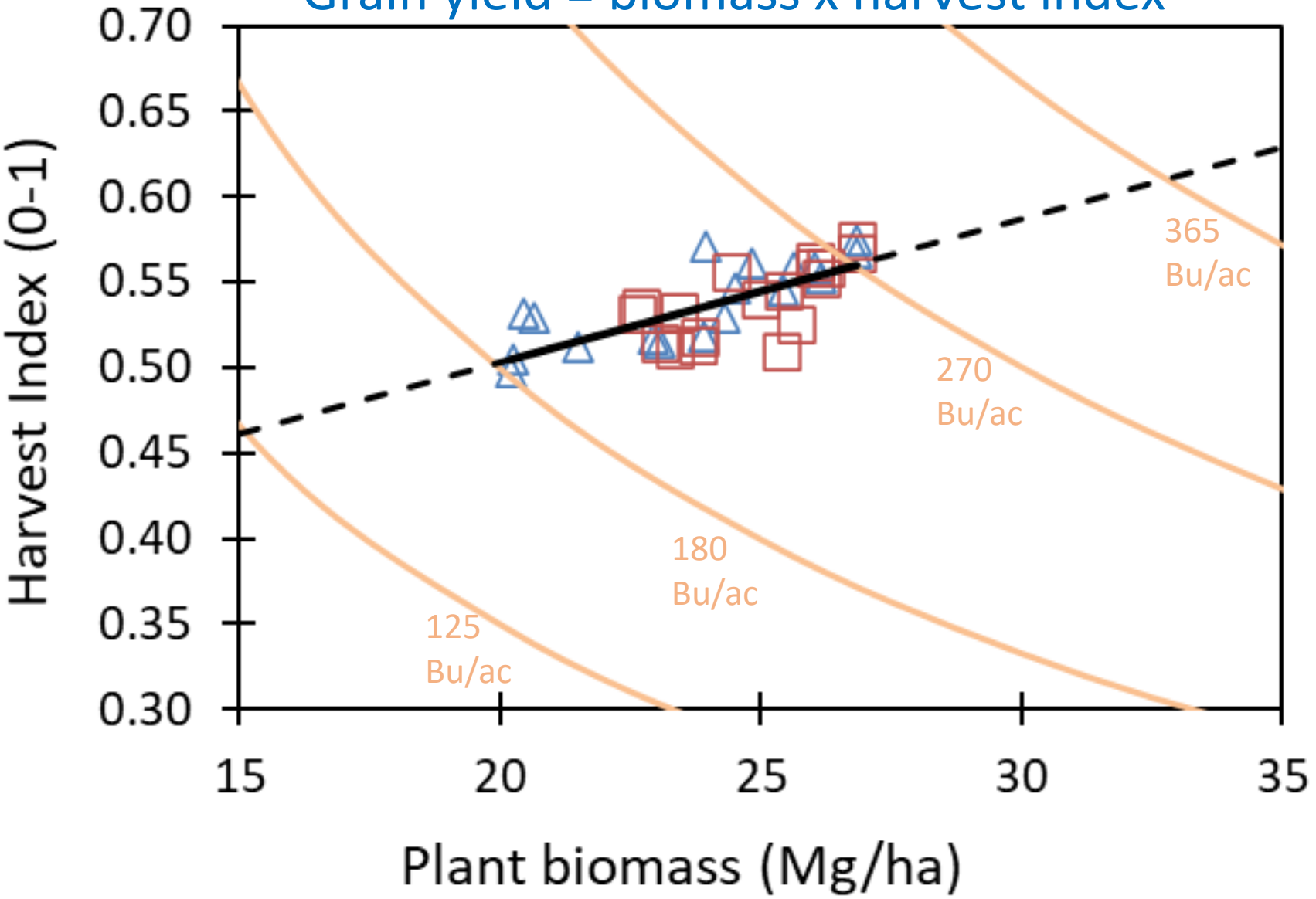
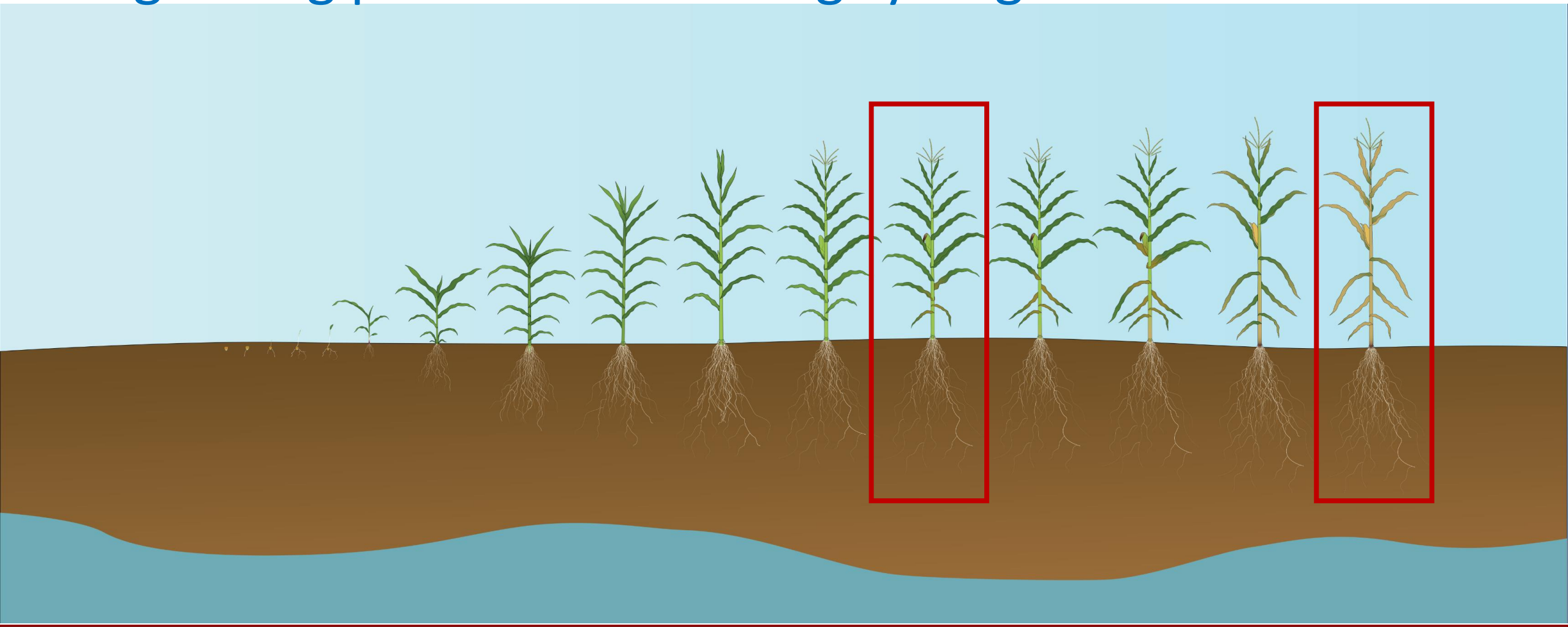


Reason:
2/3 biomass
1/3 HI

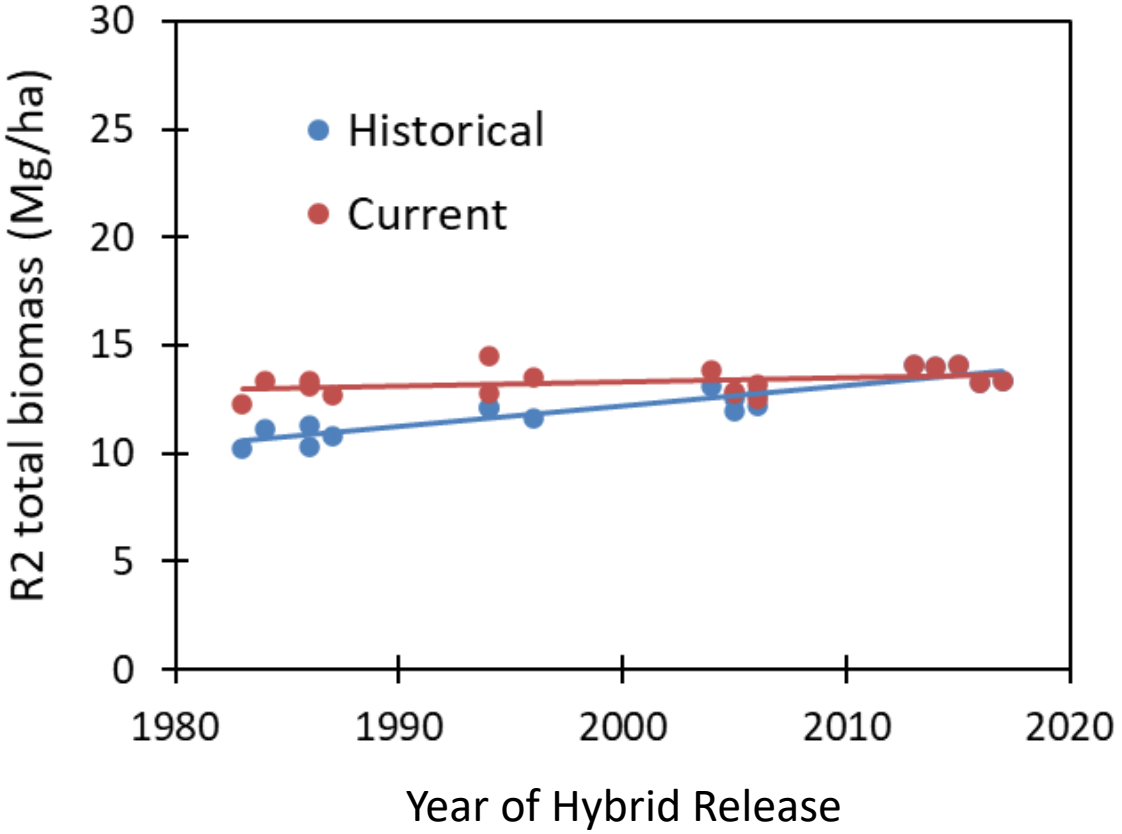
Breeding and plant density effects change during the growing period while having synergies and trade-offs



Biomass production

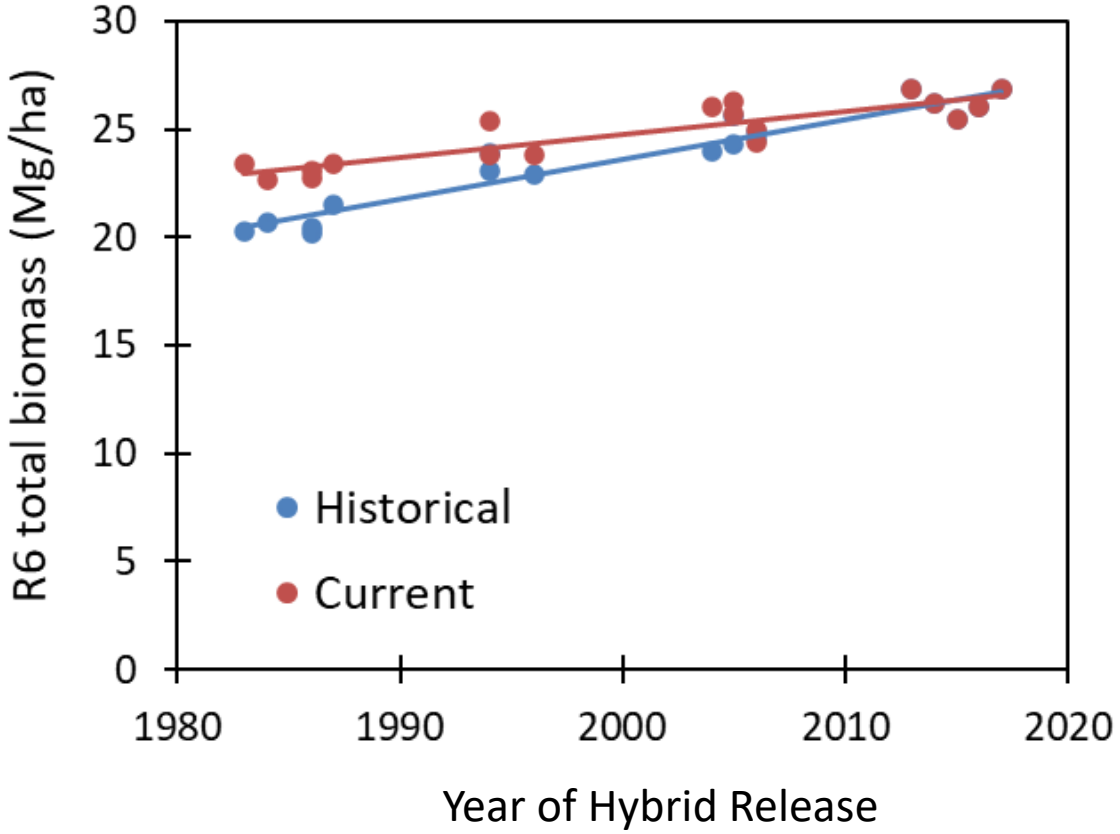
Newer hybrids + increase in plant density produce 30% more biomass

R2-stage



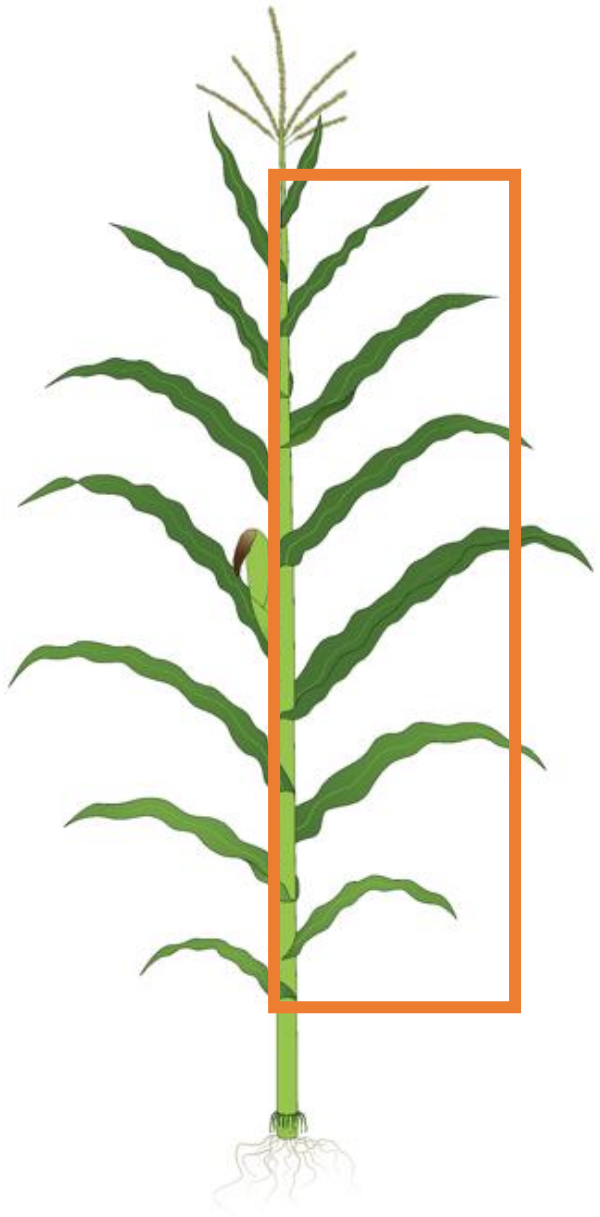
20% genetics, 80% density

R6-stage



58% genetics, 42% density

Archontoulis et al. In prep



...ived: 7 December 2022 | Accepted: 7 June 2023

DOI: 10.1002/csc2.21044

Crop Science

ORIGINAL ARTICLE

Crop Breeding & Genetics

Accelerated leaf appearance and flowering in maize after four decades of commercial breeding

Caio L. dos Santos[1] | Fernando E. Miguez[1] | Kyle A. King[1] | Alejo Ruiz[1] | Cintia Sciarresi[1] | Mitchell E. Baum[1] | Gerasimos J. N. Danalatos[1] | Mickala Stallman[1] | Emily Wiley[1] | Lia Olmedo Pico[2] | August Thies[3] | Laila A. Puntel[4] | Christopher N. Topp[3] | Slobodan Trifunovic[5] | Douglas Eudy[5] | Clarice Mensah[5] | Jode W. Edwards[6] | Patrick S. Schnable[1] | Kendall R. Lamkey[1] | Tony J. Vyn[2] | Sotirios V. Archontoulis[1]

...ceived: 12 July 2023 | Accepted: 24 September 2023 | Published online: 15 October 2023

DOI: 10.1002/csc2.21111

Crop Science

ORIGINAL ARTICLE

Crop Ecology, Management & Quality

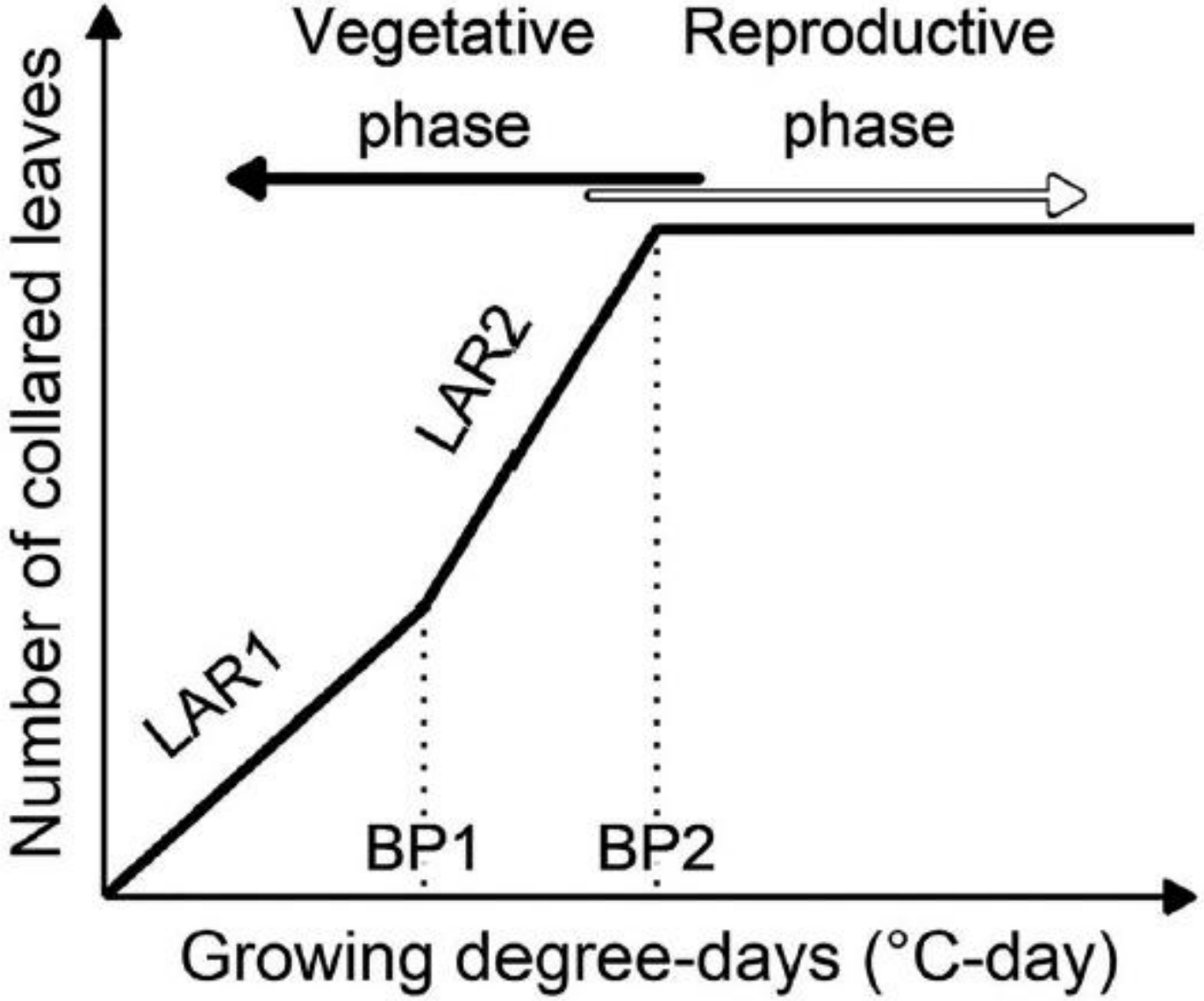
Maize leaf angle genetic gain is slowing down in the last decades

Elvis F. Elli[1,2] | Jode Edwards[3] | Jianming Yu[1] | Slobodan Trifunovic[4] | Douglas M. Eudy[4] | Kevin R. Kosola[4] | Patrick S. Schnable[1] | Kendall R. Lamkey[1] | Sotirios V. Archontoulis[1]

Leaf number

Newer hybrids:

- ✓ Produce leaf faster
- ✓ Close canopy faster
- ✓ Same number of leaves
- ✓ Reach silking earlier
- ✓ Grain fill starts earlier

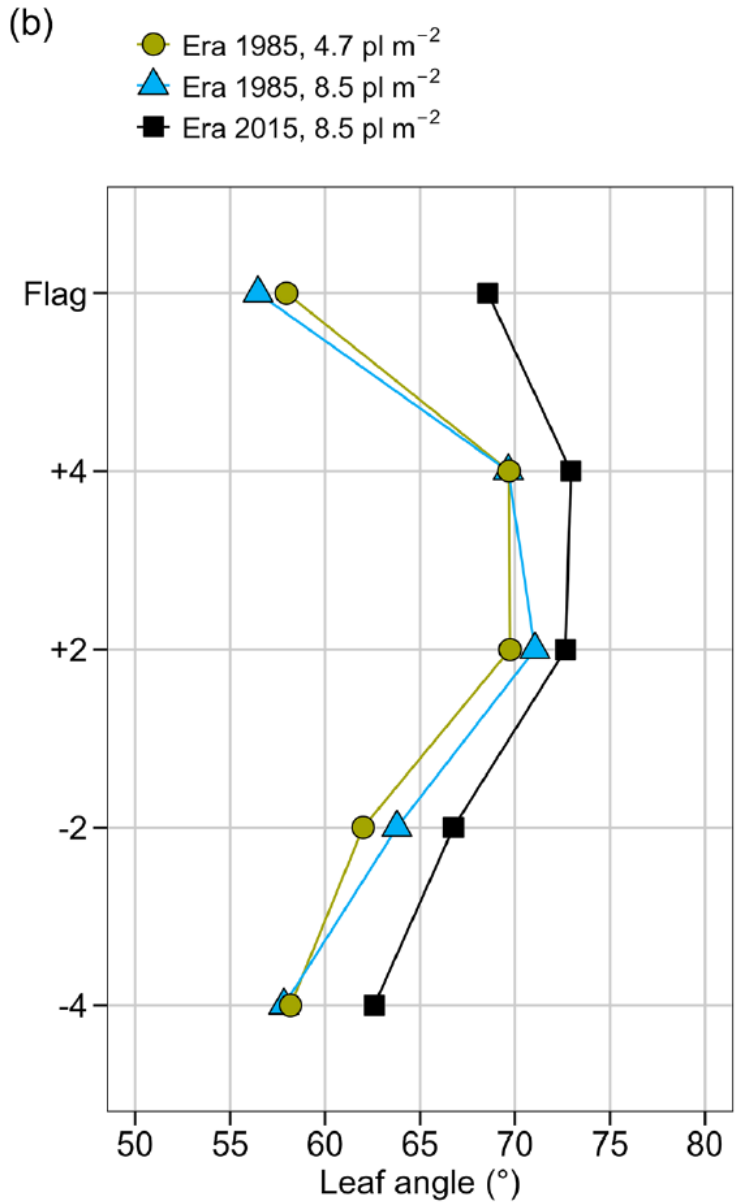


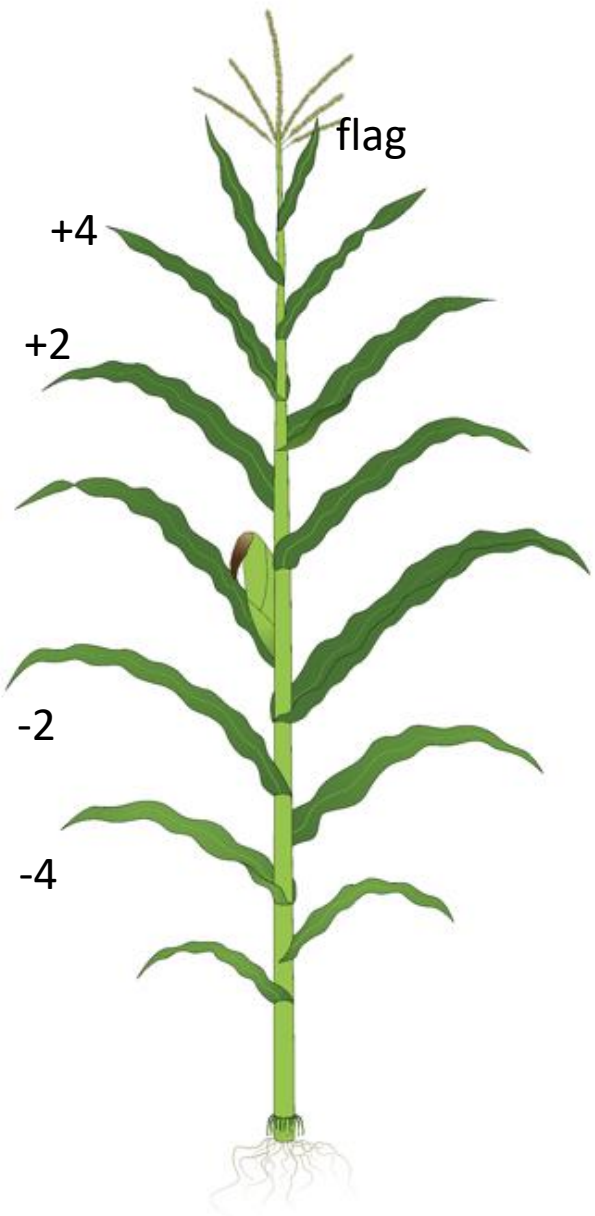
Dos Santos et al 2023
Crop Science

Leaf angle

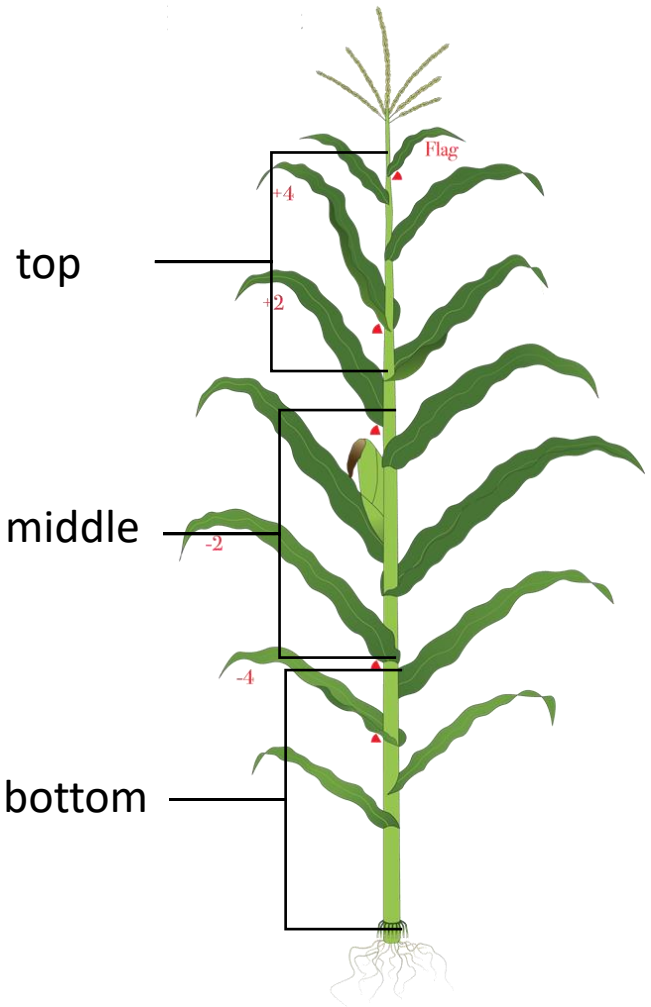
Newer hybrids:

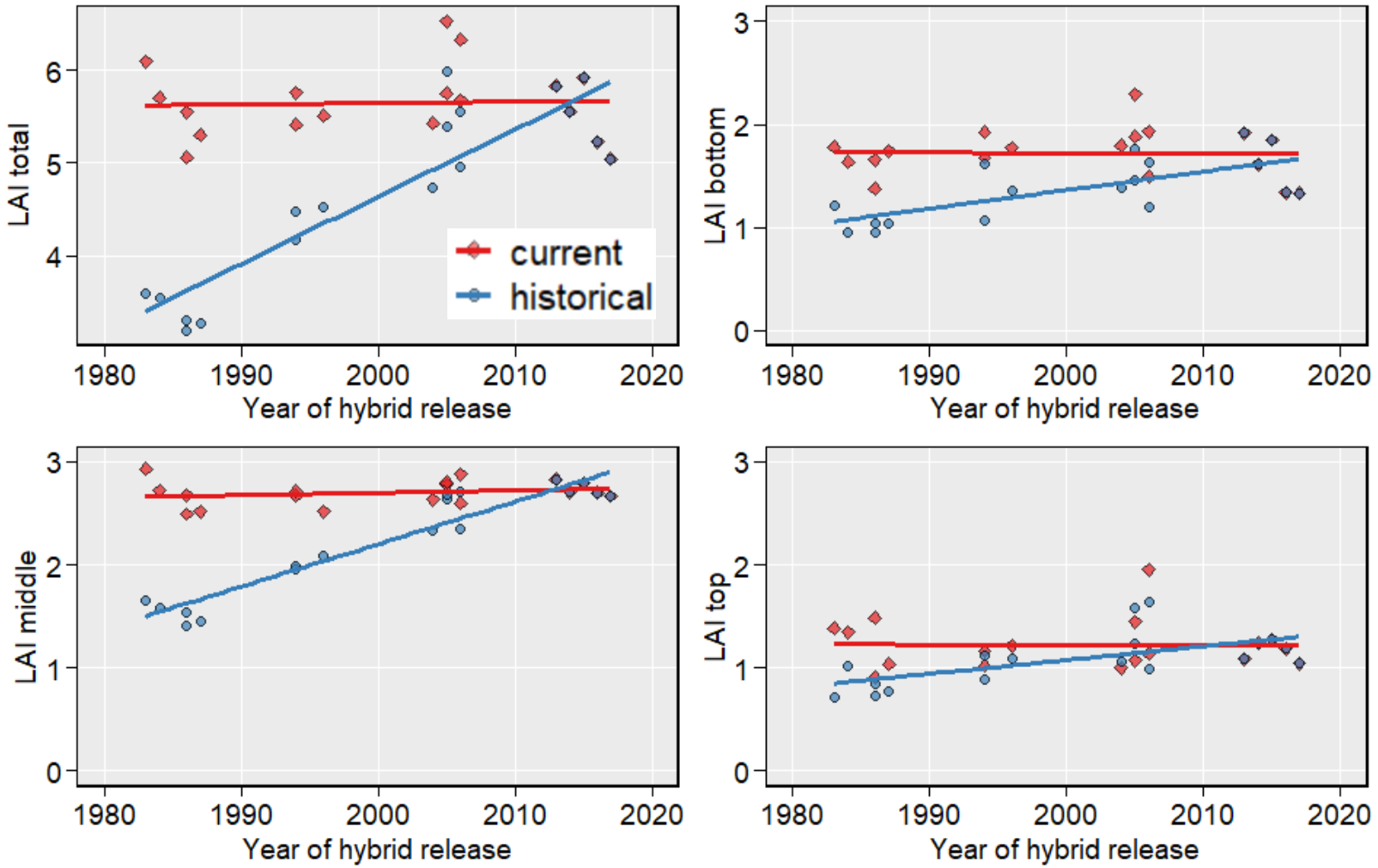
- ✓ 6º more erect leaves on average
- ✓ Larger changes in the top leaves
- ✓ Breeding affected top and bottom leaves, density the middle leaves
- ✓ Changes in leaf angle are slowing down, did we reach an optimum?
- ✓ Small correlation between leaf angle and yield





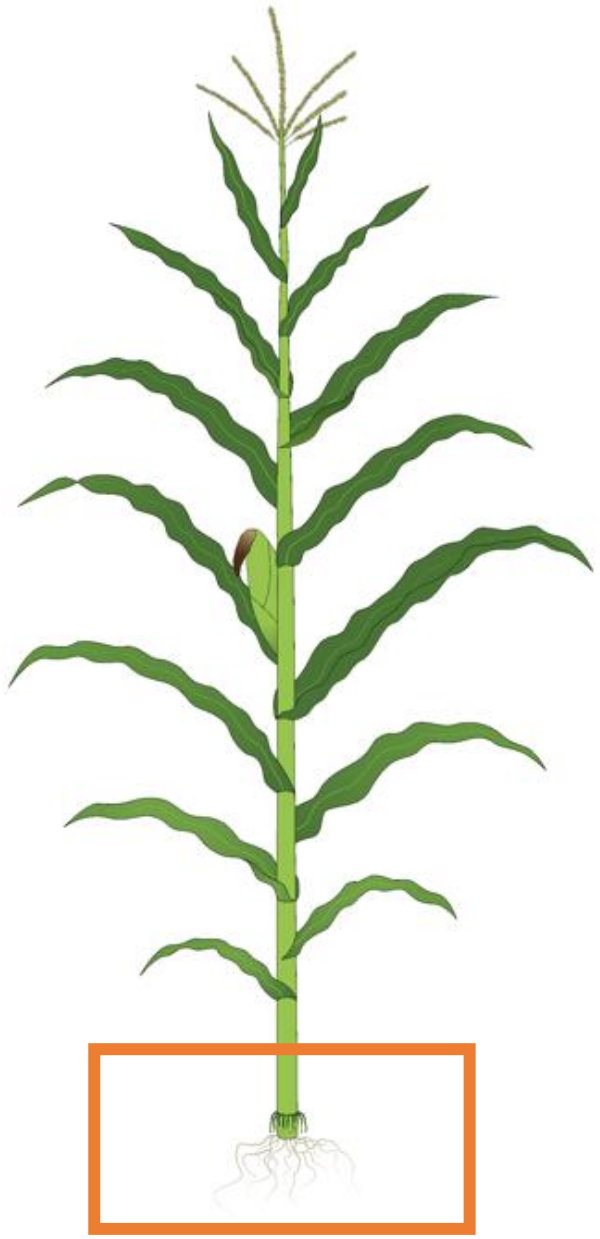
Leaf area





- ✓ Plant density larger impact on leaf area index than breeding
- ✓ Larger increase in the middle leaves
- ✓ Optimum LAI to maximize yields: 4.5 to 5.5

Kalogeropoulos et al
In prep



2 PhD students

Cintia Sciarresi, ISU
Gus Thies, Danforth Center

Root Measurements

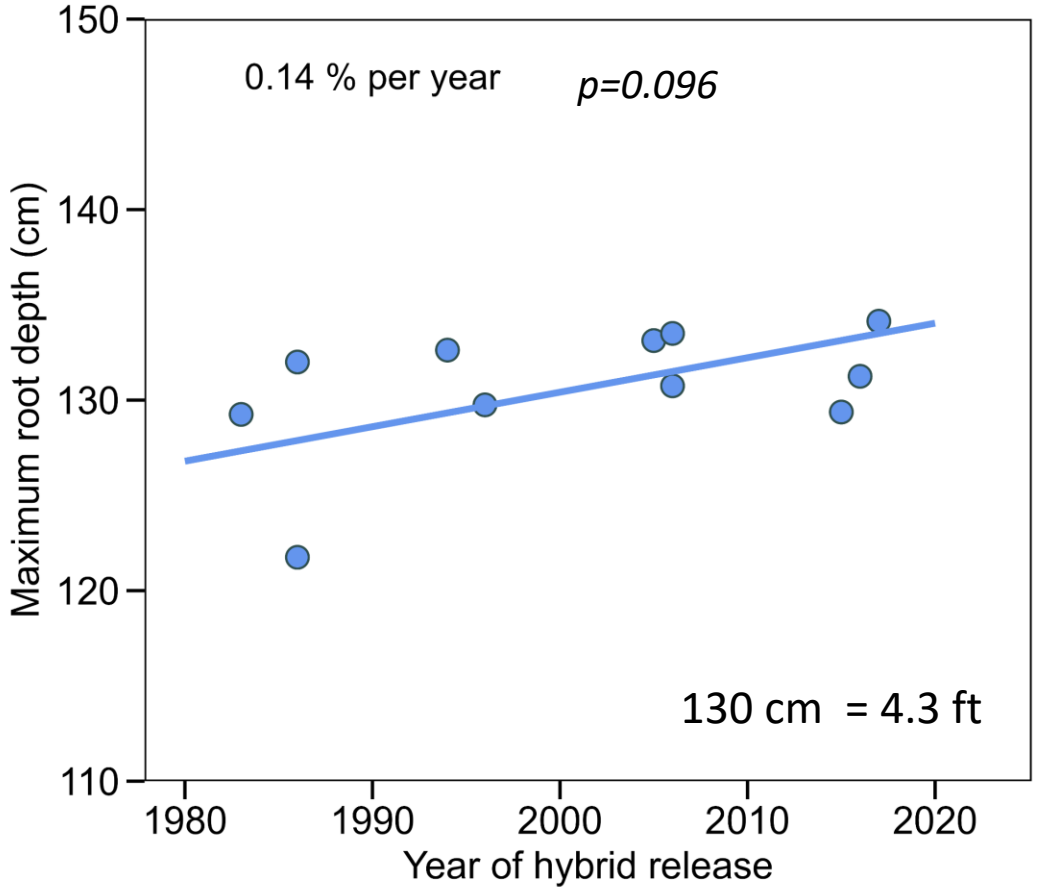
1. Depth
2. Carbon
3. Nitrogen
4. Length
5. Distribution
6. Crowns

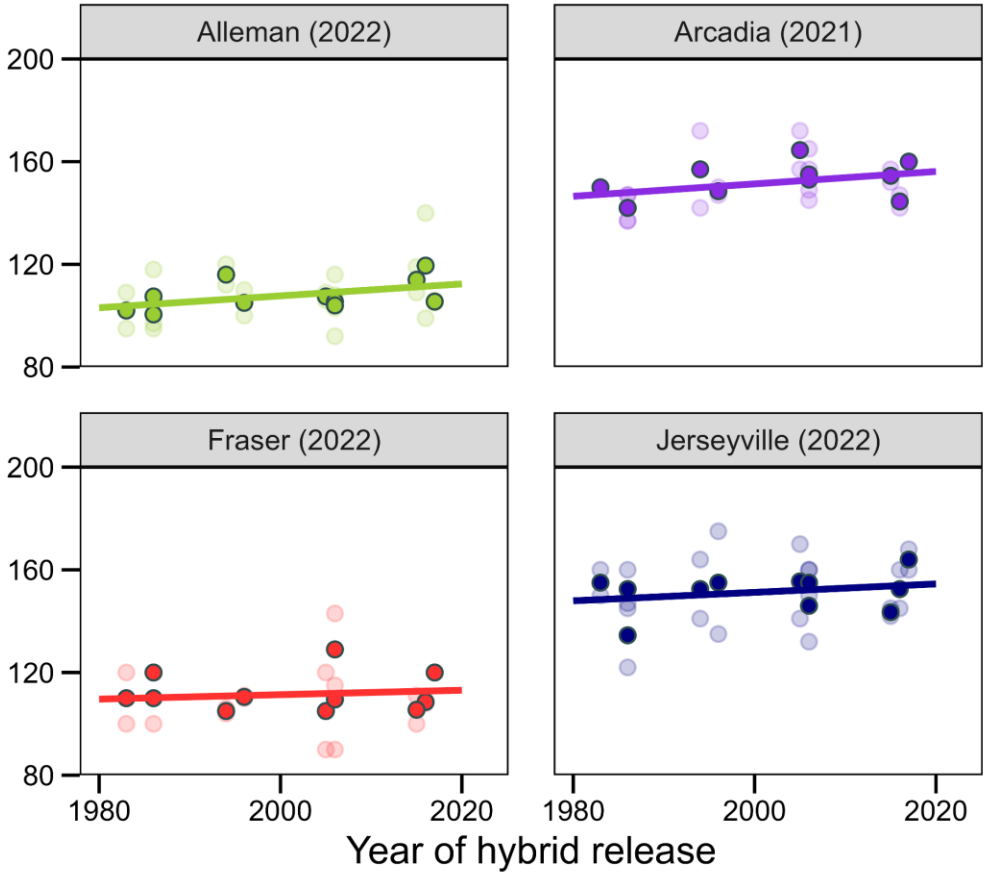
Up to 7 ft depth
IA, IL, IN


Cintia Sciarresi
PhD student

Newer hybrids grow roots faster and deeper

4 site-years; 11 hybrids; for every new leaf produced after V5, the root depth is increasing by 3 inches

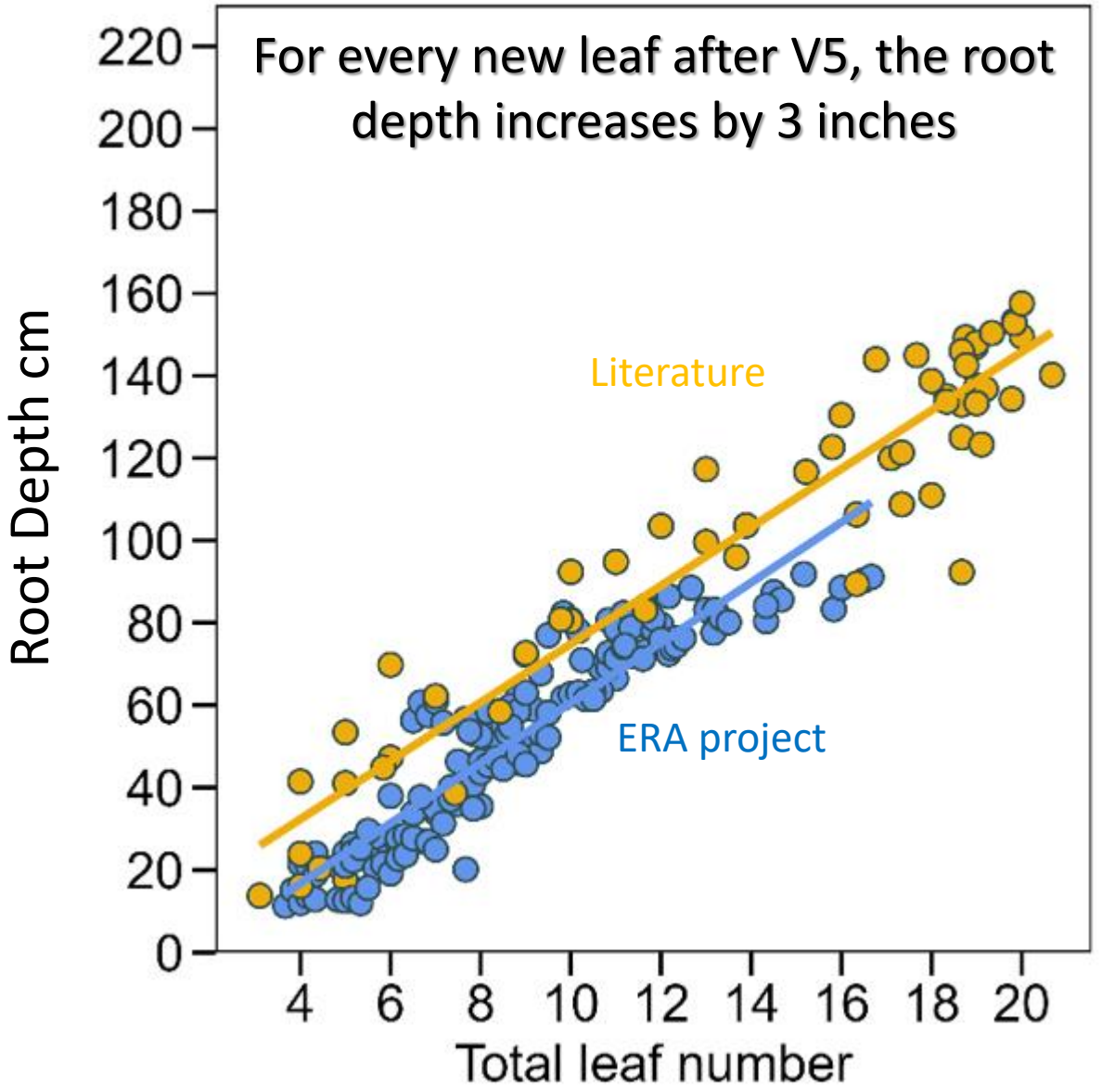


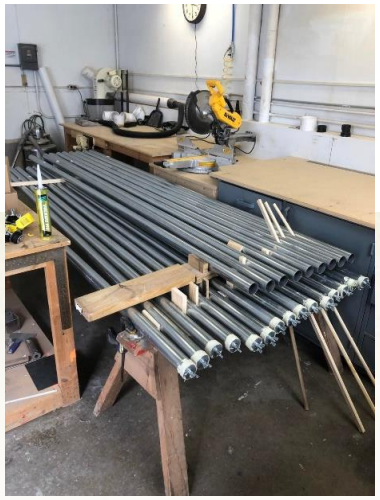


Sciarresi et al. 2023 (Crop Science in review)

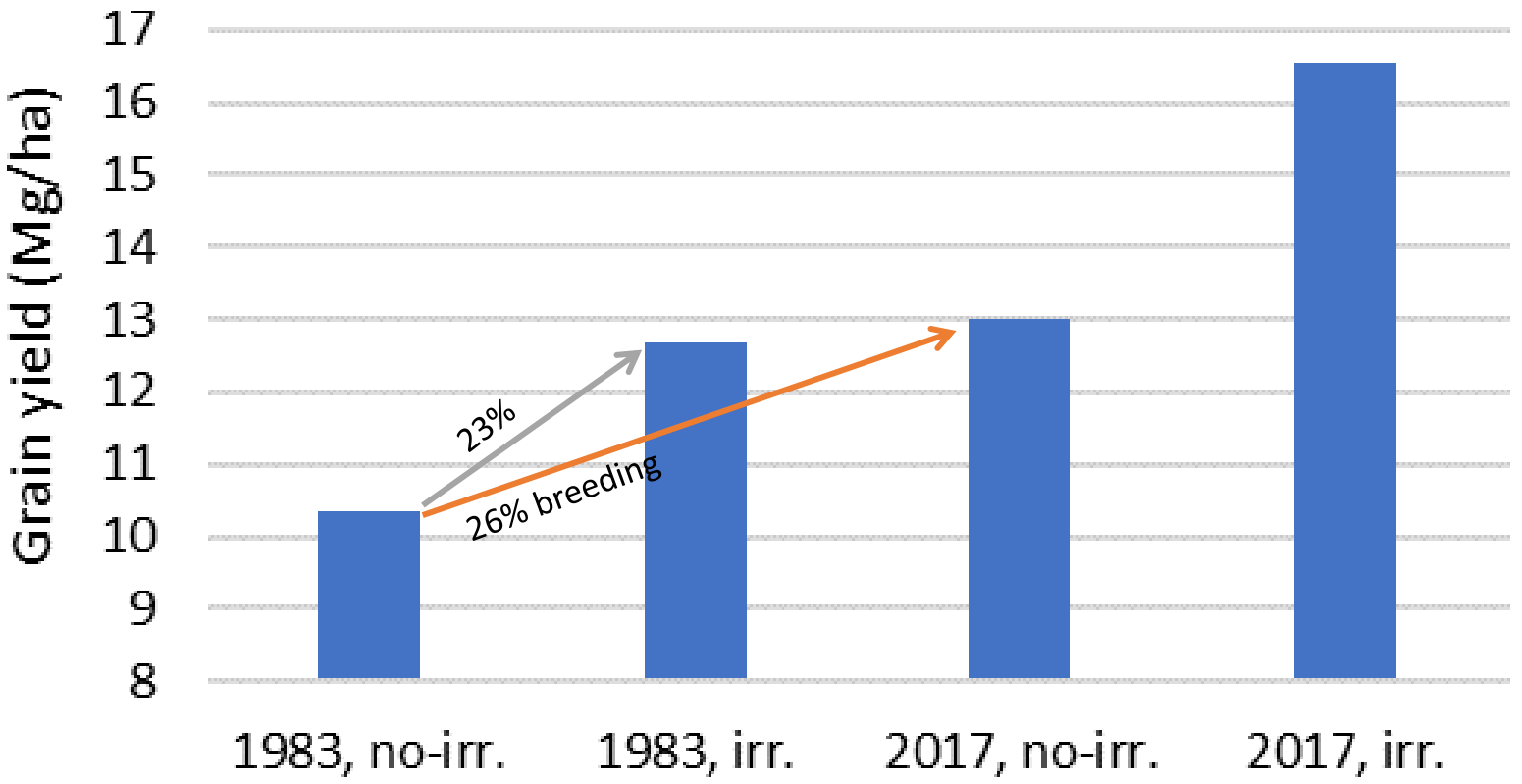
Root research highlights

- ✓ New hybrids grow root faster and deeper
- ✓ Root mass genetic gain is 10-fold lower compared to grain yield
- ✓ The higher the grain yield the higher the root carbon
- ✓ 84% of the total root mass in the top 2 feet
- ✓ <u>Large environment effects on root traits</u>





Neutron Probe technique
5 site-years


Grain yield (Mg/ha)
17
16
15
14
13
12
11
10
9
8
23%
26% breeding
1983, no-irr.
1983, irr.
2017, no-irr.
2017, irr.

Agricultural efficiency and sustainability
Carbon – Nitrogen – Water

Maize breeding aids sustainability

2 PhD students, 1 data analyst

Kyle King
Katy Darrah-Wiedemeier
Antonella Ferela

~ 10,000 samples from 80 hybrids and 70 experiments (site-year)

Data: Protein, oil, starch, ethanol, N, P, K, S, Mg, Cu, Mn, Zn, B

Grain quality research summary:

	Concentration in the grain	Total amount produced /exported
	% per year from 1980 to 2020	
Protein	-0.32	+0.51
Oil	-0.02	+0.81
Starch	+0.04	+0.86
P	-0.23	+0.60
K	-0.26	+0.56
S	-0.24	+0.59

Katy Darrah-Wiedemeier et al
In prep

Take home messages:

- ✓ The corn plant is changing
- ✓ Different avenues to increase grain yield
- ✓ Maize breeding improved Water-Nitrogen Use Efficiencies
- ✓ Grain quality is highly impacted by management
- ✓ Public – Private Collaboration enabled us to achieve more

Iowa State University – Bayer Interaction
Huxley, Iowa, July 22, 2022