Breeding programs to mitigate climate change and environment pressures on crops

Dave Bubeck, Research Director – Seed Product Development, Corteva Agriscience

UPOV - Seminar on the role of plant breeding and plant variety protection in enabling agriculture to mitigate and adapt to climate change

October 11, 12, 26; 2022

File under Seed Corn Requests

G. D. Station A.
Ames, Iowa
March 7, 1926

H.A. Wallace
Des Moines
Iowa

Dear Mr. Wallace

At the corn show last February, you said that if I would write to you along in March you might be able to let me have some inbred corn to cross and enter in the Corn Yield contest. So I am writing you in hopes that you will have some to spare.

I am a sophomore Farm Crops and Soils student at Ames, so naturally very much interested in corn. Do it best when crossing corn to use the paper sack method, so as to cross on both parents; or just cut the tassels off of one strain? I am going to school at Ames, but would want any corn sent home to Beaconsfield, Iowa. You can either send it C.O.D or let me know what the postage is.

Thanking you in advance, I remain,

Yours truly
Raymond Baker

March 10, 1926.

Mr. Raymond Baker,
G.D. Station A,
Ames, Iowa.

Dear Mr. Baker:

I think I can send you some inbred strains of corn all right, but before sending them I would like to know just what kind of a plot you have. Do you have a half acre which is at least 500 feet away from any other corn, where there would not be much chance for pollen from other corn coming in on it? If so, I would suggest that you use the detasseling method. I would send you one sort to use as a male parent and thirty or forty other sorts to use as female parents. I would want you to plant about twenty hills each of these different female parents. We would then take four pounds of each of these different combinations and enter them in the Iowa Corn Yield Contest in the spring of 1927. We can enter these combinations in the name of Baker and Wallace if you so desire.

If you take on this project, you will of course have to arrange to plant the corn with some care so you know in which row each of the different strains is planted, and then in July you will have to arrange to pull the tassels out every day, and in late September or early October you will have to harvest the different sorts and label them. It is quite a little job.

Write me further on the matter as to just how you want to go ahead with this proposition. If you happen to be coming down to Des Moines at any time, let me know in advance and drop around to the office.

Sincerely yours,

HAWallace
HH

Beaconsfield, Iowa
July 15, 1926

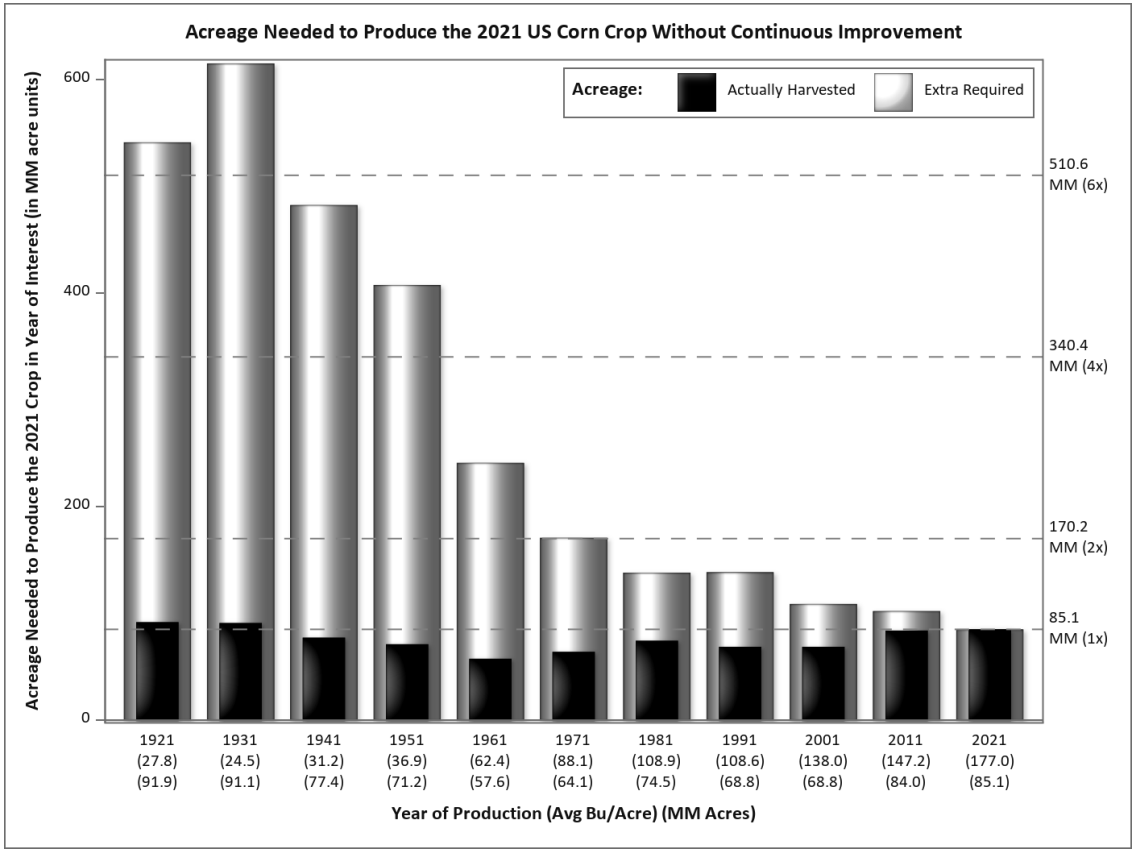
Mr. H.A. Wallace
DesMoines, Iowa

Dear Mr. Wallace:

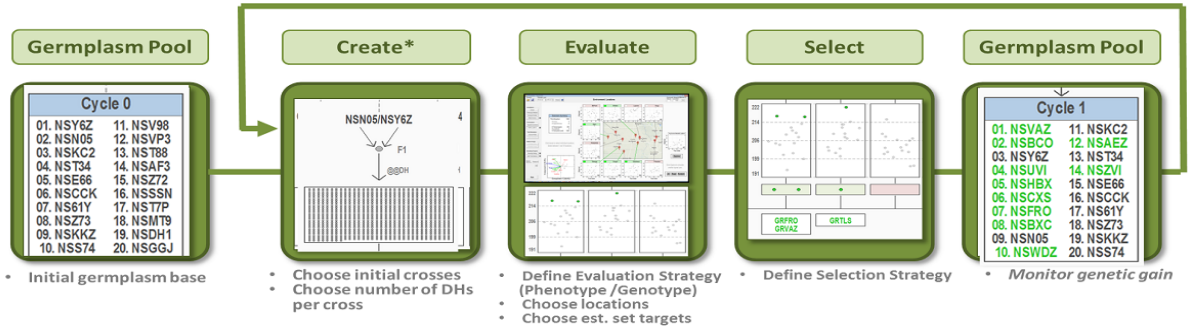
Our corn is doing fine, and I am having a lot of fun pulling out the tassles. I have already pulled out about half the tassels. Some of the mother parents are so tall (over 8 ft) that I need a step-ladder to reach the tassels.

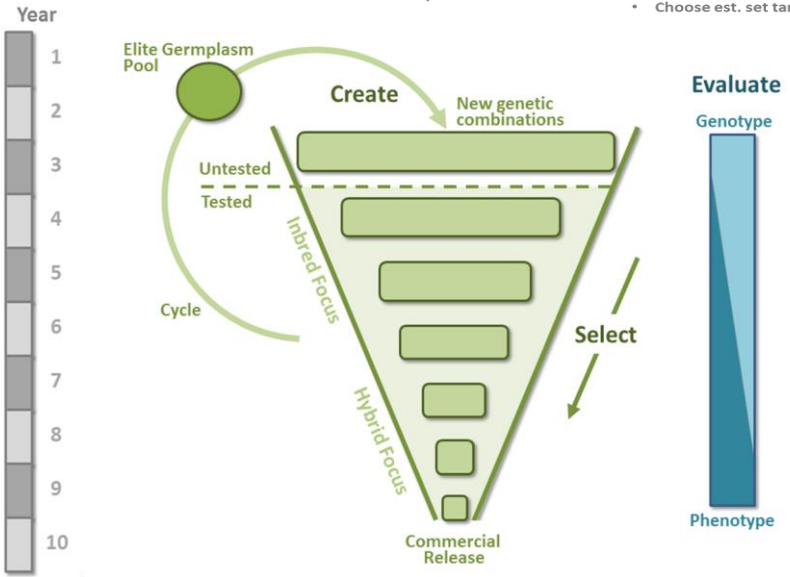
RAYMOND BAKER

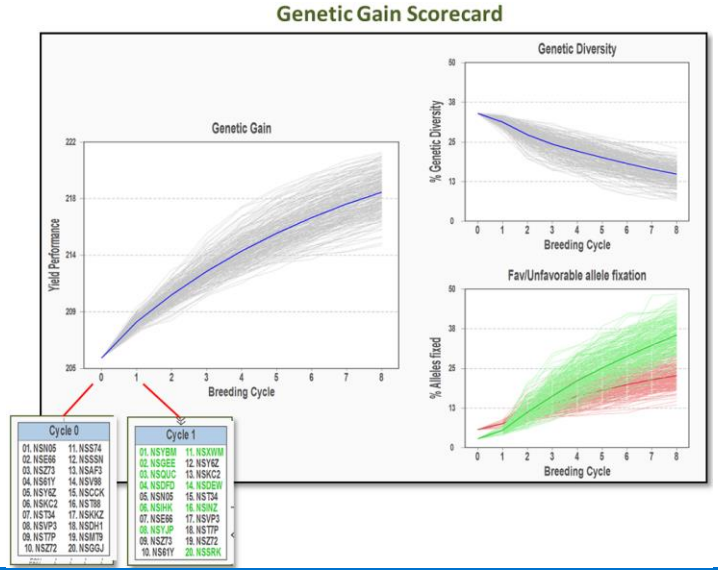
Acreage impact of corn breeding and improved management practices



The Breeding Pipeline - Conduct pre-commercial product testing in target environments for multiple years

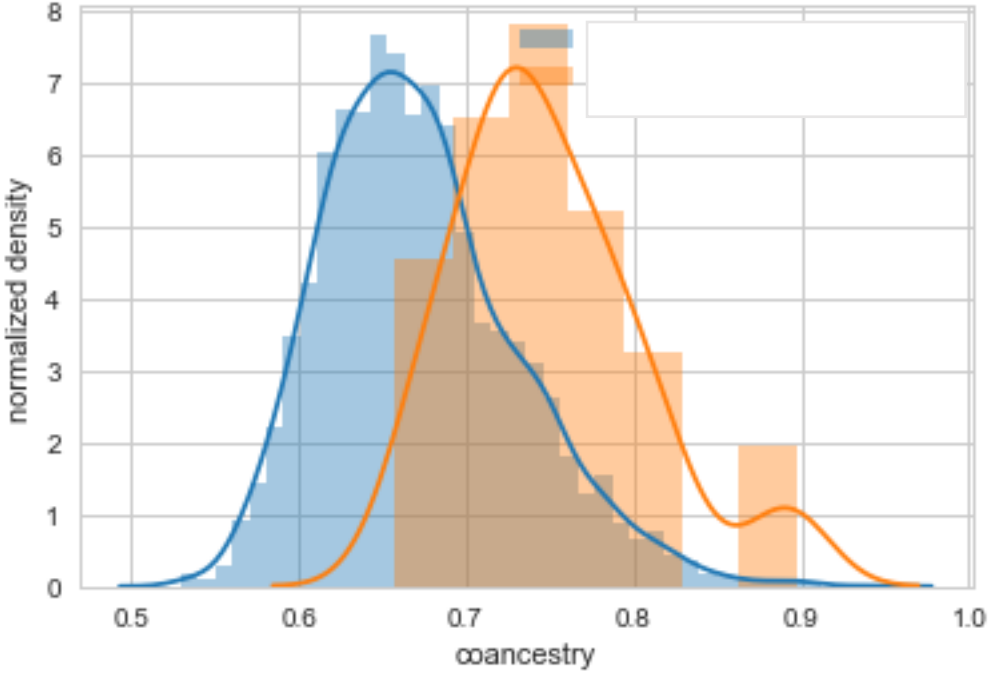


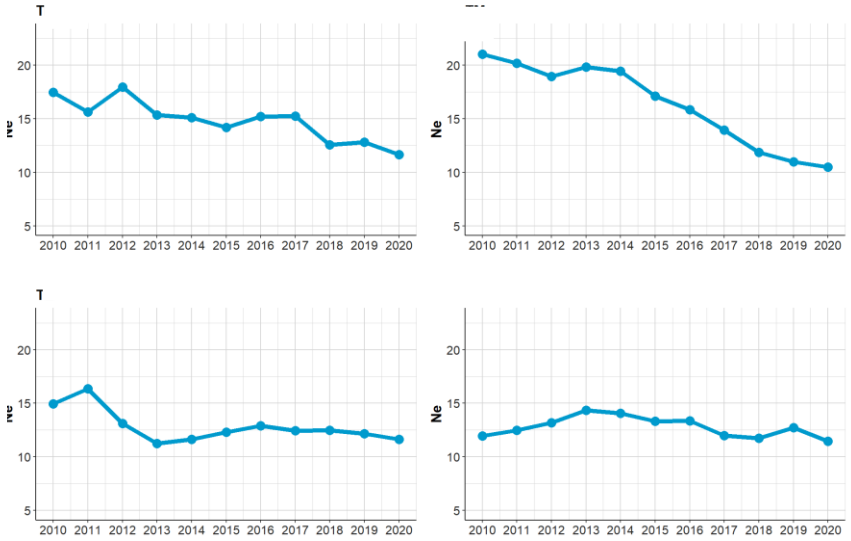




Genetic variation – trends over time

- Genetic variation is essential to achieve breeding goals
- Co-ancestry based – pedigree and/or genotype
- Allelic diversity – driven by population sizes in breeding programs





Maize Breeding – highly complex trait selection needs

Genetic gain for any of these traits requires favorable variation and response to long-term selection, adding patience and adjusting breeding goals as the environmental pressures change over time

Agronomics

Yield

- Test weight
- Grain moisture
- Grain dry-down
- Stalk lodging
- Root lodging
- Plant height
- Ear height
- Brittle snap
- Drought tolerance
- Emergence
- Stand establishment
- Early growth
- Cold tolerance

Pest Resistance

- Gray leaf spot
- Northern leaf blight
- Southern leaf blight
- Stewart's wilt
- Rusts
- Smuts
- Anthracnose
- Diplodia
- Giberella
- Fusarium
- Diplodia
- Bacterial wilt

End-Use Traits

- Mycotoxin Production in Grain
- Starch, Protein, & Oil
- Extractable starch
- Total fermentables
- Gross energy
- Digestible energy
- Food-grade Traits
- Silage quality traits

Native Genetics and CRISPR approach to Disease Control

100% A

Lower quality plant
Disease resistant

Disease Resistance

100% B

Higher quality plant
Disease sensitive

=

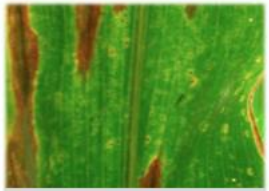
100% high quality plant
+
Improved resistance to Disease

No unintended donor genetics

Accelerating Native Genetics for Disease Control

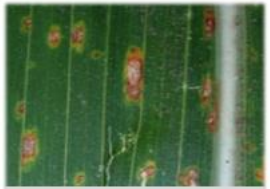
Plant Disease is a Major Challenge for Growers

In 2021, North American corn growers lost more than 318 MM bu[1] due to:



Northern Leaf Blight

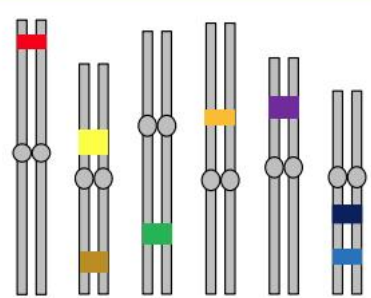
Southern Rust



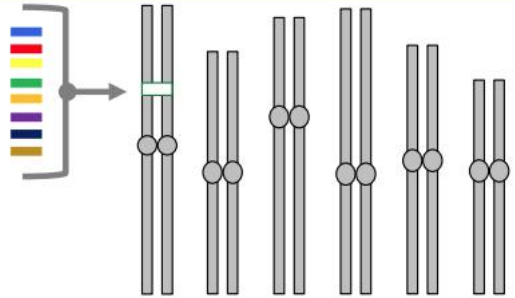
Gray Leaf Spot

Anthracnose Stalk Rot

Our Patent-Pending Approach



Many Genes, Many Locations, Imprecise Gene Information



Many Genes, Single Location, **Precise** Gene Information

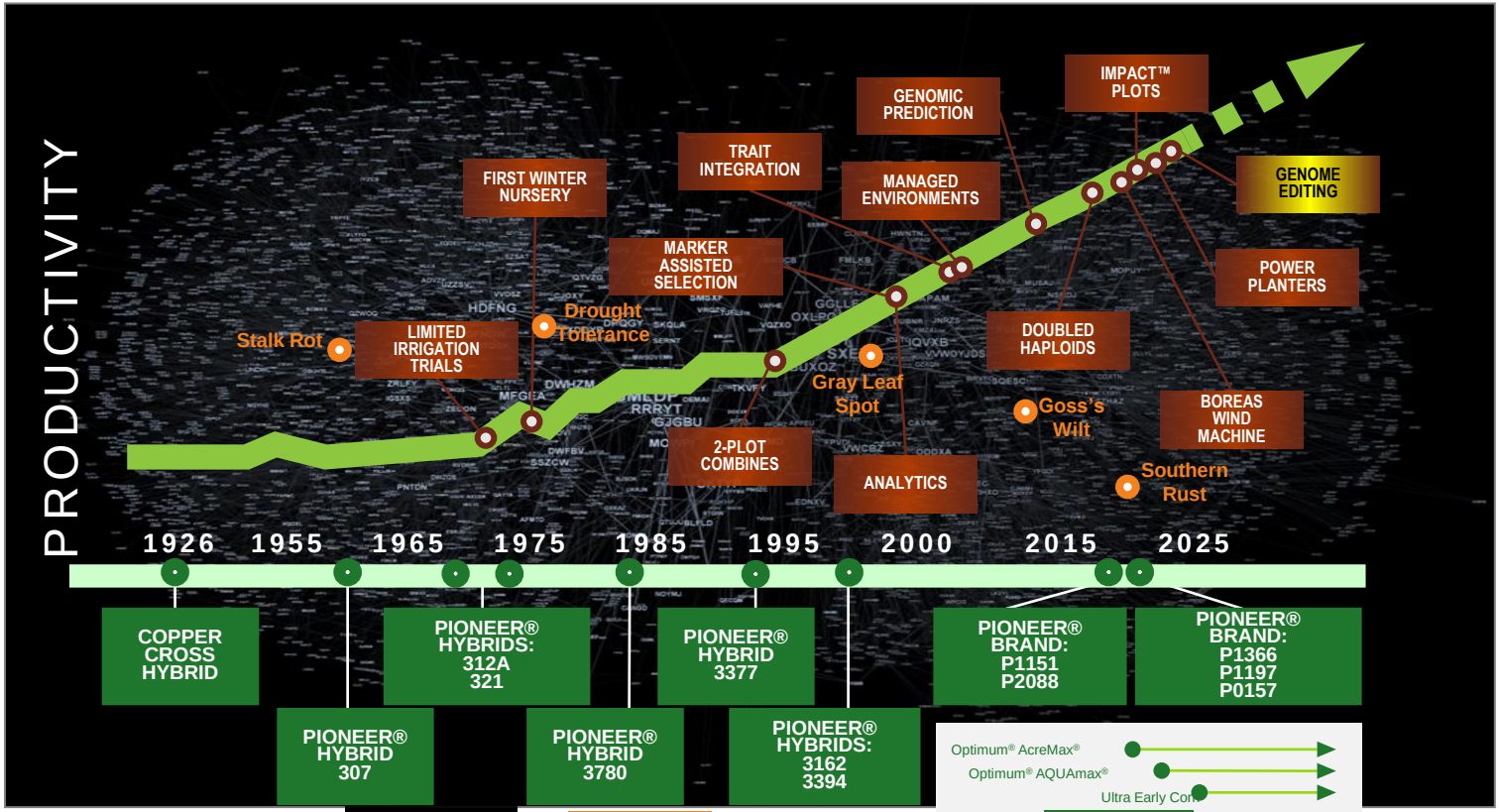
- Builds off germplasm advantages and improves genetic gain
- New breeding techniques unlock additional power of native genetics
- Multiple disease targets
- Multiple native genes for each disease target improves resistance and adds durability
- Simplified genetics assembled through gene editing accelerates plant breeding

LATE DECADE

Genome editing and future potential – what if we could…go beyond plant breeding techniques and exceed current range of variation

- Chromosomal rearrangements (CR's) and potential to change phenotypes and "unlock" genetic variation (https://www.nature.com/articles/s41477-020-00817-6)
- Effective control of genomic recombination elements
- Enable co-location of native traits, unleashing major portions of the genome for improved maintenance of genetic diversity and additional favorable trait selection
- Multiple and simultaneous edits across numerous traits

Will Genome Editing reside on this chart in 2070?



Key Points

- Conduct plant breeding and pre-commercial product testing in the target environments for multiple years
- Genetic variation is essential to achieve breeding goals and mitigate climate change
  - Account for inevitable diversity decline over time
  - Leverage science and technology to create new favorable variation
- Plant breeding requires long-term selection, patience and adjusting breeding goals as the environmental pressures change over time
- Genome editing methods have potential for creating additional and needed variation to accomplish future environmental needs to feed a growing population
- Increased progress to minimize or eliminate biotic and abiotic stresses enables increased heritability and selection efficiency for grain yield improvement

Thank you!