

**A COMMERCIAL PERSPECTIVE OF DEVELOPING SOYBEAN
VARIETIES USING TRAIT-MARKER ASSOCIATIONS AND MARKER
ASSISTED SELECTION**

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DuPont Pioneer is a global supplier of agricultural products with significant commercial soybean breeding and product development activities in North and South America. The goal of soybean product development scientists at DuPont Pioneer is to create high-yielding varieties that increase productivity and profitability of producers. To accomplish this task, scientists are enabled by an extensive set of breeding tools and an expansive array of native and transgenic trait options. Traits in development range from yield enhancement and crop protection to improved output traits that create benefits for consumers and value added opportunities for food processors and growers. In addition to transgenic trait options, advances in trait-marker associations and marker assisted selection have enabled breeders to better access and harness native variation for trait improvement. These technologies in combination with an expansive network of yield testing locations across North and South America have resulted in a pipeline of products that our producers have learned to expect from a commercial soybean breeding program. An overview of current soybean product development processes in the context of a commercial seed company will be presented.



A Commercial Perspective of Developing Soybean Varieties Using Trait-Marker Associations and Marker Assisted Selection

Soybean Breeding and Genetics

Steve Schnebly, Sr. Research Manager
DuPont Pioneer Soybean Product Development



Improving agricultural productivity

Innovative solutions helping growers worldwide meet the food & agriculture challenges of the 21st century

Food Production Goals



Increase food production by 70% by 2050 to feed estimated 9 billion people

Rise in Global Middle Class



Middle class expected to double by 2020

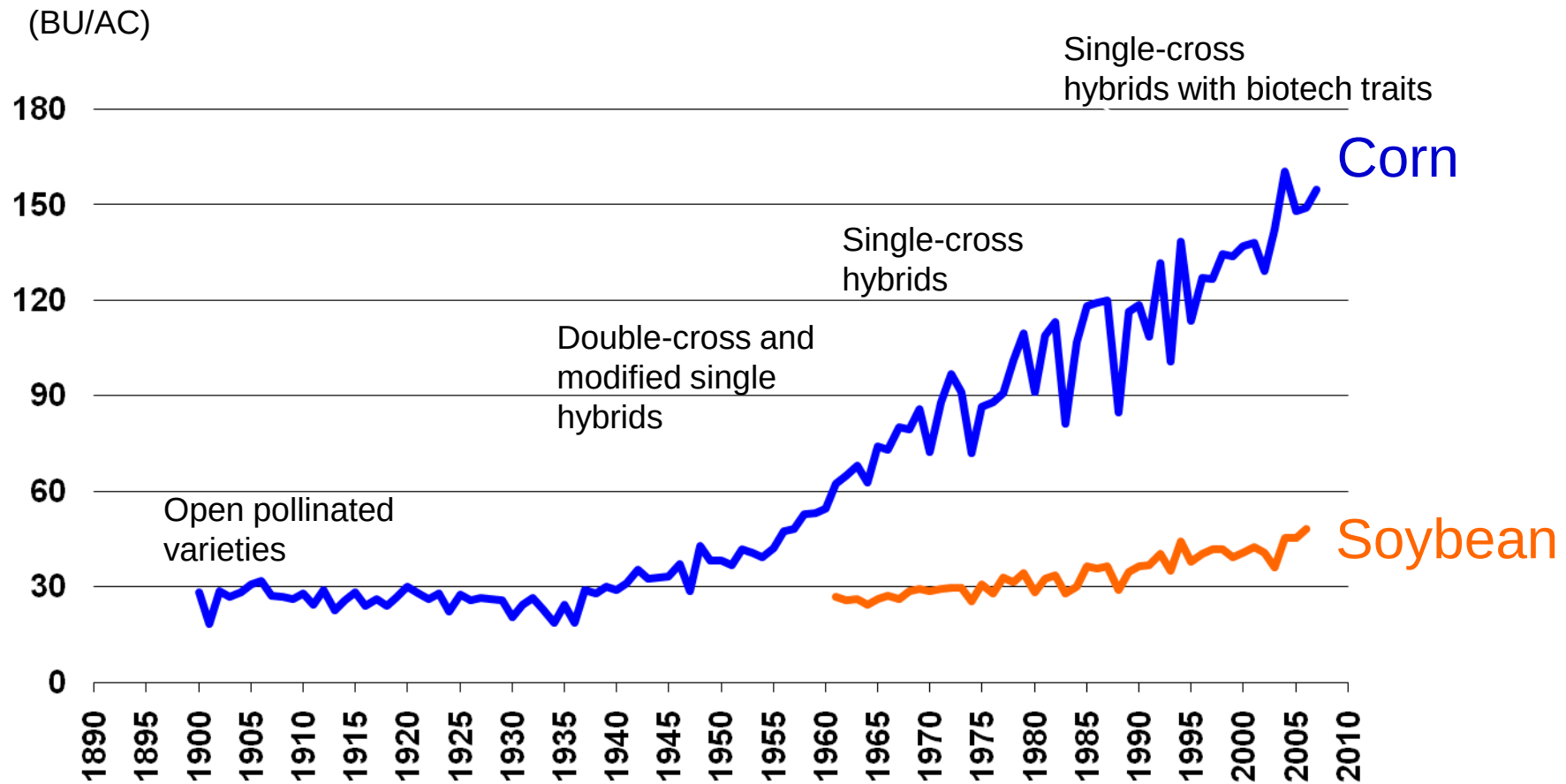
2001-2011 Global Crop Consumption



Corn +38%	Sunflower +74%
Soybean +41%	Rice +11%
Canola +68%	



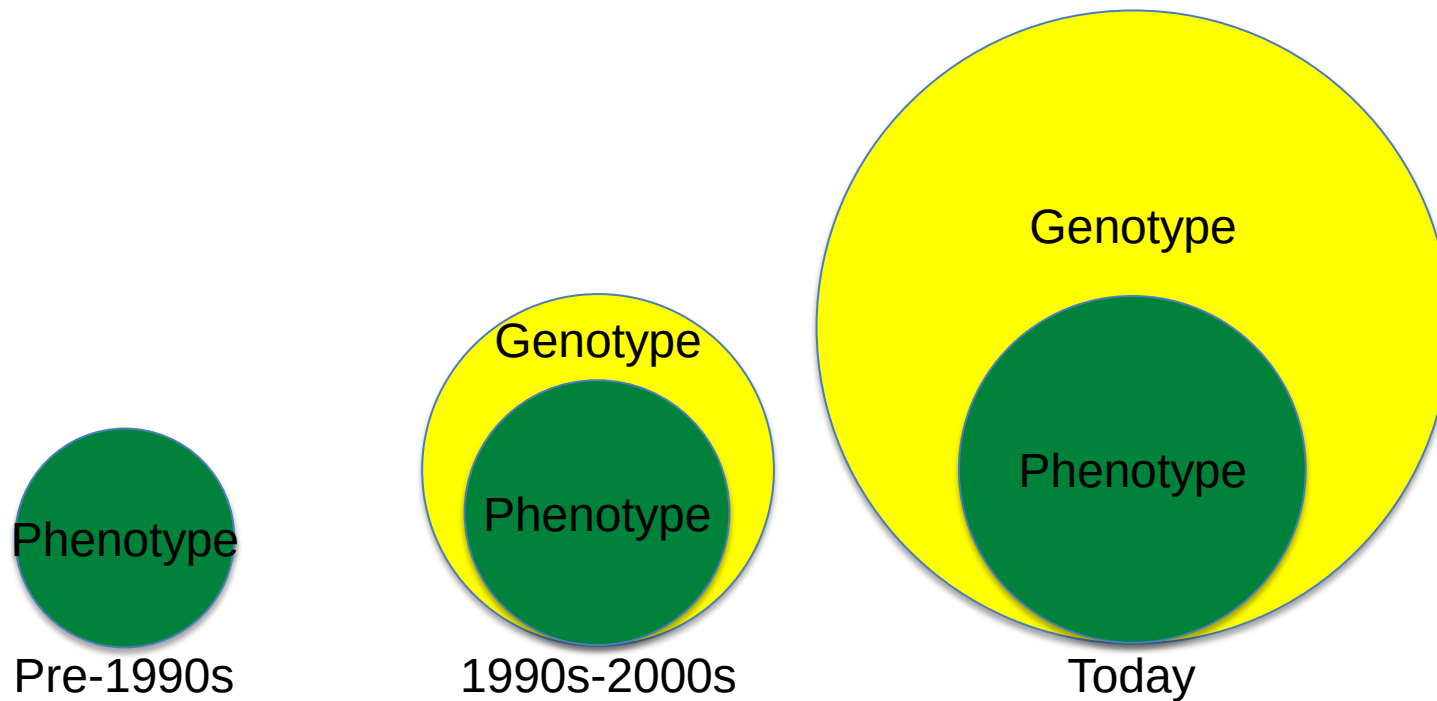
Innovation has Driven Historical U.S. Yield Improvement



Source: USDA, IRRI and FAO



Evolution of Plant Breeding



- Phenotype is no less important and is still vital to developing new products
- New advances in genotyping now allow for a virtual mountain of genotypic information
- AYT tools are how we leverage that information into better products

Reducing technology to practice in developing markets

Leverage technologies across crops and geographies



Breeding
Molecular markers
Biotech trait development
Agronomic research

Applied research

Local product advancement
Address needs of small and large farmers
Provide education
Offer agronomic services

Regulatory and IP frameworks encourage local investment

Molecular marker technologies have revolutionized product development

SCN
markers
discovered

1994

Introduced Y
Series

2005

2008

2013

Implemented
AYT™
system

T Series
launch



Accelerated Yield Technology (AYT™) system: Novel integration of molecular breeding technologies into the product development process

DUPONT

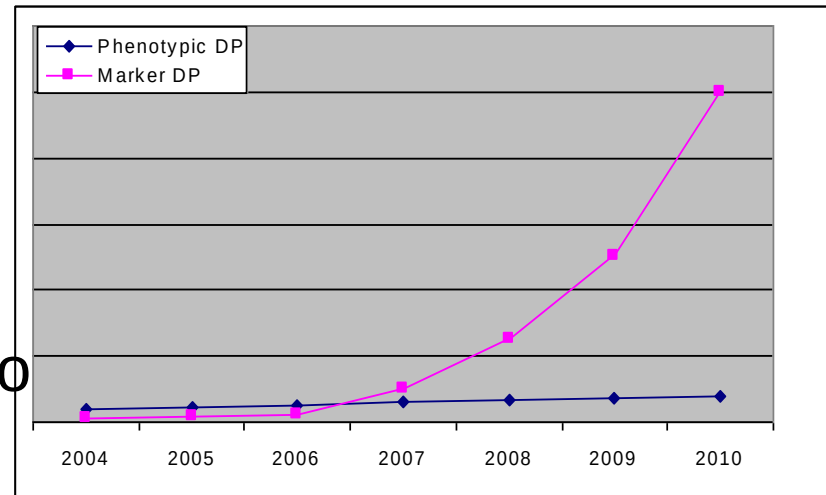
PIONEER.

Enabling Technologies-IM Systems

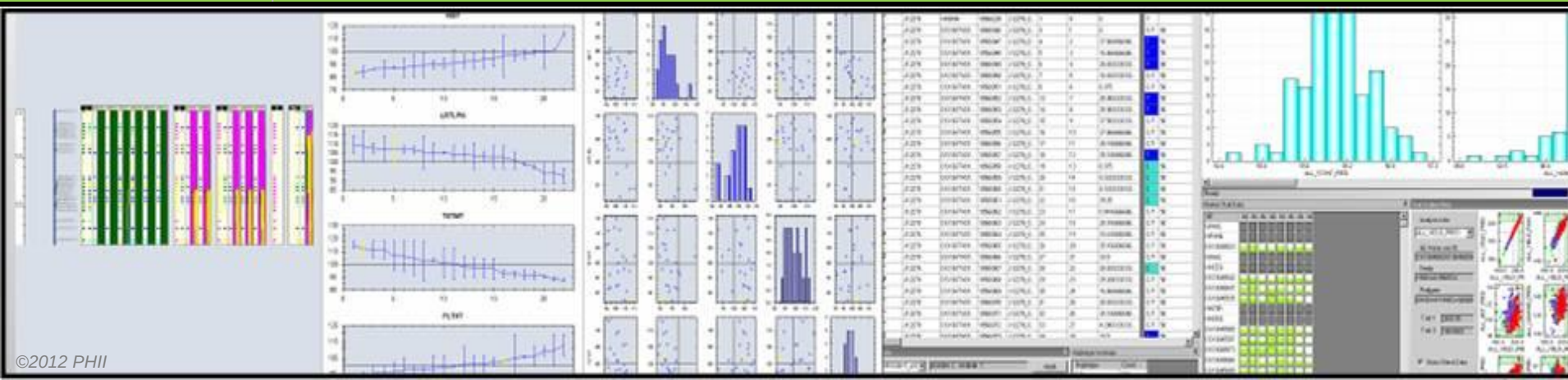
BREEDING



- Molecular breeding creates millions of associated data points
- Pioneer has developed proprietary IM systems to manage data



Inbreds Populations Traits Selection Germplasm



Accelerated Yield Technology (AYT™)

■ Forward Breeding for Native Traits:

- Currently have over 50 traits available for MAS

■ Context Specific Mapping (CSM) for Yield:

- Yield is our most important trait, CSM allows us to select for it
- Results in more winning lines being selected earlier in the pipeline

■ Whole Genome Predictions:

- Predictions for quantitative traits, making forward breeding more effective
- Allows early generation screening
- Allows selection progress to be made when phenotypic data is unavailable due to environment

Native defensive traits protect yield

Charcoal Rot



Soybean Cyst Nematode



Iron-Deficiency Chlorosis



Chinese Soybean Aphid

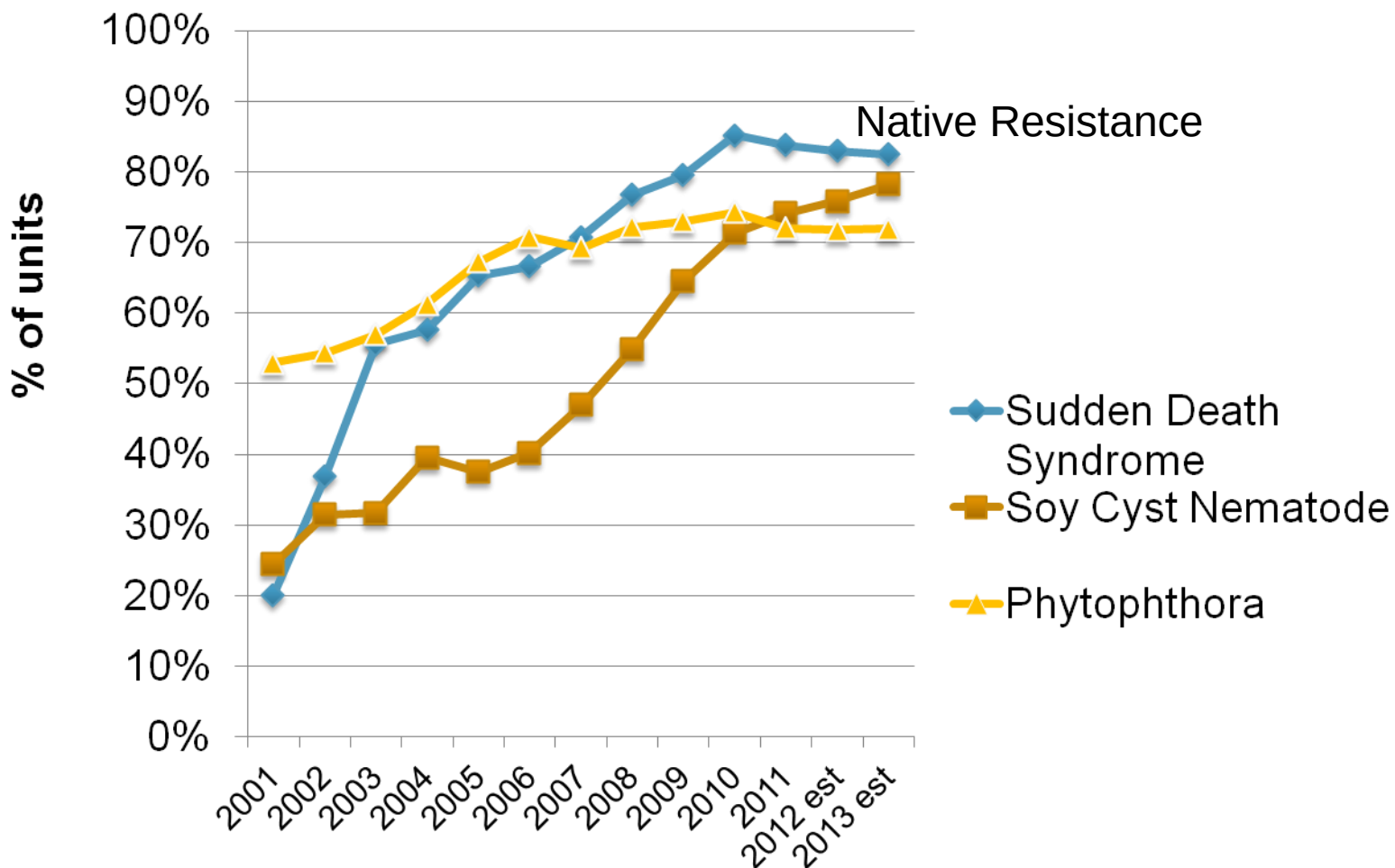


Asian Soybean Rust



Sudden Death Syndrome

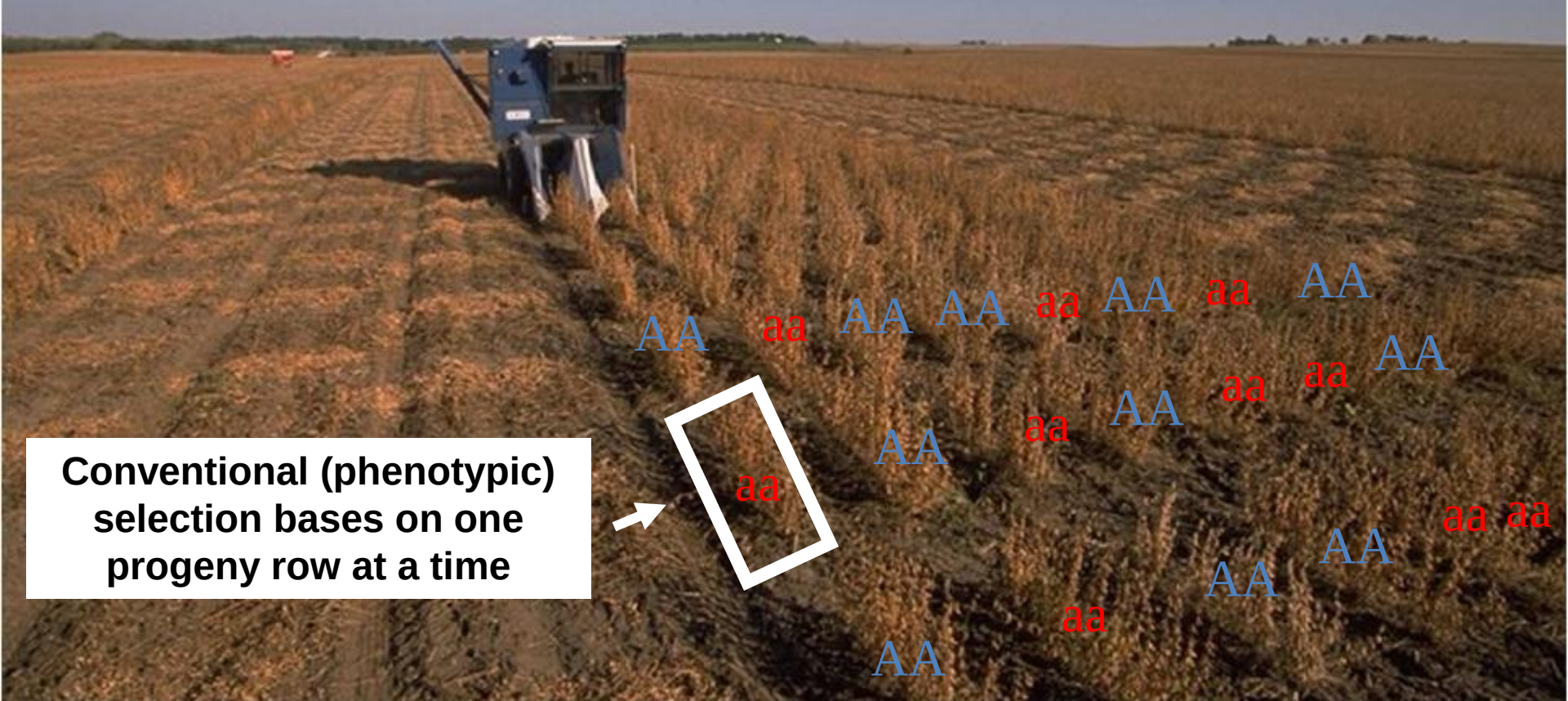
Continuous growth in soybean product line-up



Context-specific Mapping (CSM)

More marker coverage = more power to detect yield QTL

Large populations, multiple environments = more power



**Conventional (phenotypic)
selection bases on one
progeny row at a time**

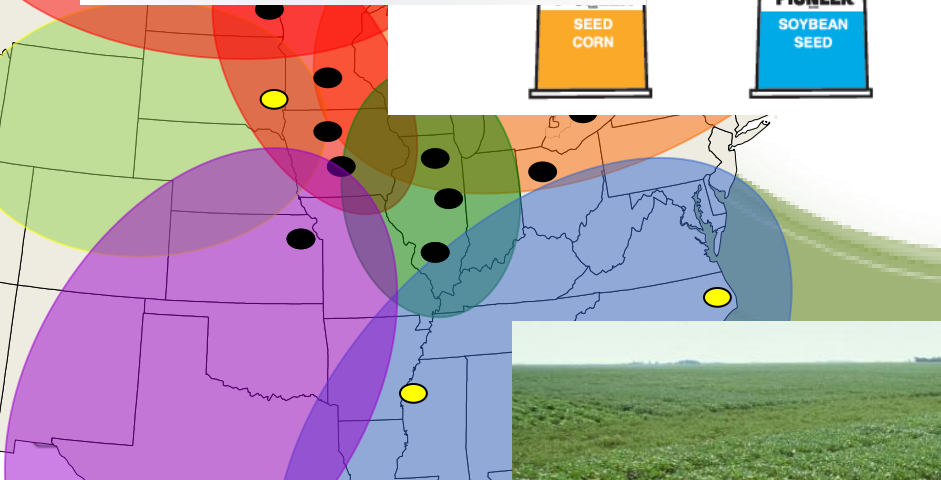
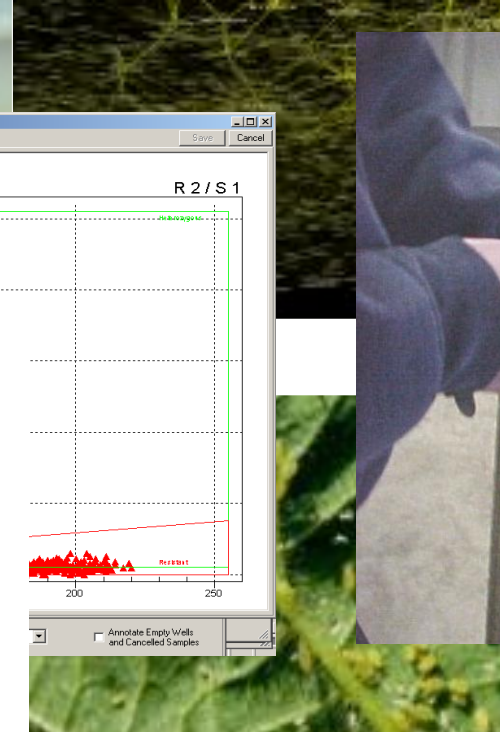
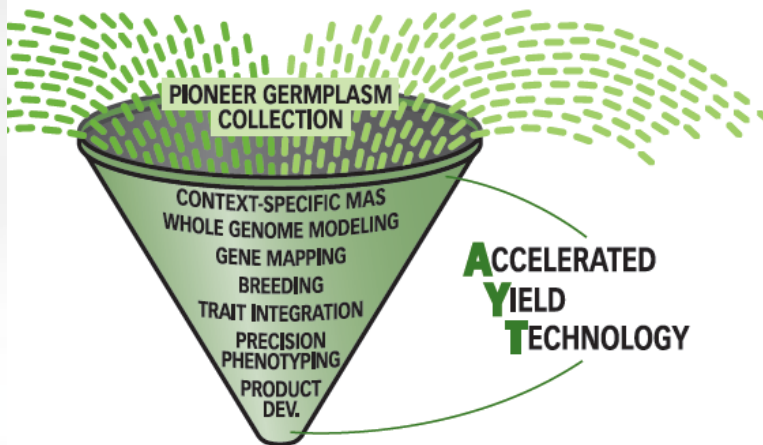
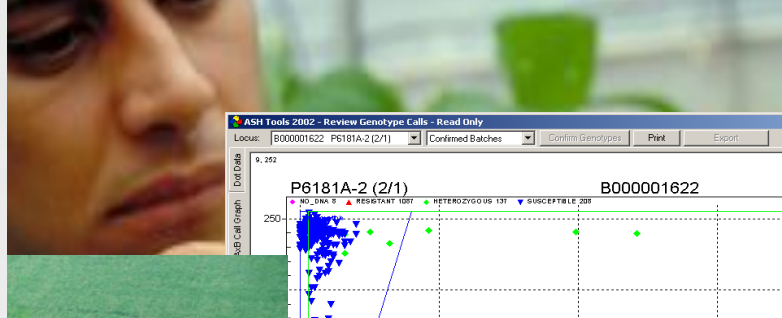
AYT system
'averages out' the
field error to expose
the true winners

Select winners by
Target Genotype

AA bb DD ...



DM



PLENISH™ HIGH OLEIC SOYBEANS

Biotech soybeans with consumer benefits

Status:
Limited Launch**

BENEFIT TO GROWERS

- Highest oleic content in soy (heart-healthy monounsaturated fat)
- Soy-based trans fat solution with 20% less saturated fat than commodity soybean oil
- Enhanced functionality for food preparation
- Industrial application benefits
- Yields on par with Pioneer® brand elite commercial varieties

Soybean Oil Comparison

PLENISH™ HIGH OLEIC



Linoleic

Linolenic

Sats

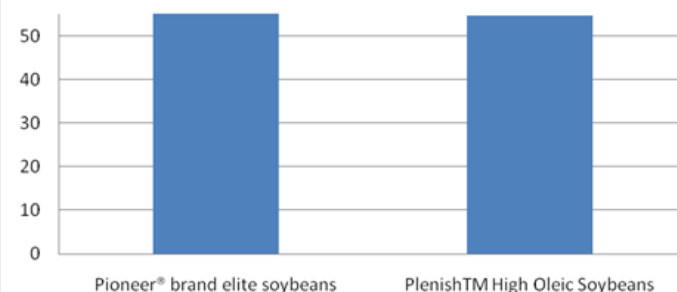
Oleic

COMMODITY



Research Results*

Plenish™ High Oleic Soybean Yield Comparison



Grower Benefits : Increased Value/Acre | Expanded Soy Markets



*Source: Pioneer research plot yield data depicting an average yield on Pioneer® brand commercial varieties with the Plenish™ high oleic trait compared to average yield of Pioneer® brand elite soybean checks in 2011.

**This program is in limited launch. Full commercialization upon full regulatory approval.

MULTIPLE MODE HERBICIDE TOLERANCE - SOYBEANS

Flexible, broad-spectrum weed control options

OBJECTIVE

- Transgenic approach expanding soybean herbicide tolerance to provide more durable weed control options
- Flexible tool; wide application window and range of environmental conditions

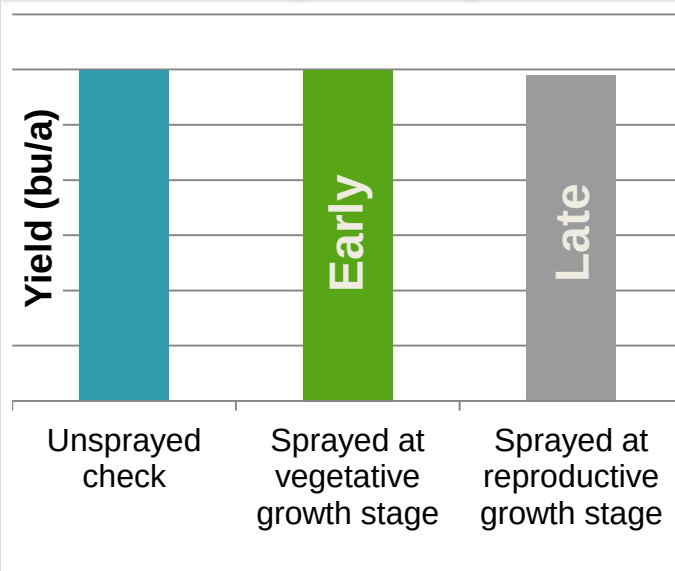
PIONEER RESEARCH

- Combination of germplasm and novel genes to develop the next generation of traits including:
 - Dow AgroSciences Enlist™ trait
 - Bayer LibertyLink® trait
 - Glyphosate tolerance traits
- Full pipeline of leads being evaluated

Status:

Phase 2, Early Development

Roundup Ready® gene + Enlist™ trait stack: No yield impact spraying at early or late growth stages



Grower benefits: Flexibility | Convenience | Weed Resistance Management

*2X rate of 2,4-D and glyphosate applied to lead event at vegetative and reproductive stage. Data across 3 locations, 6 reps/location in 2011.

® Roundup Ready is a registered trademark used under license from Monsanto Company. The Enlist trait and Enlist Weed Control System are technologies owned and developed by Dow AgroSciences. Enlist is a trademark of Dow AgroSciences LLC. Components of the Enlist Weed Control System have not yet received regulatory approvals; approvals are pending. The information presented is not an offer for sale. ©2012 Dow AgroSciences LLC Ignite®, LibertyLink® and the Water Droplet Design are trademarks of Bayer. Pioneer® brand soybean varieties with multiple mode herbicide tolerance will not be offered for sale or distribution until completion of field testing and approval by regulatory authorities. ®, SM, TM Trademarks and service marks of Pioneer Hi-Bred. ©2012 PHIL



LEPIDOPTERAN PROTECTION – SOYBEANS

Provide efficacy against soy lepidopteran pests

Status:

Phase 1, Proof of Concept

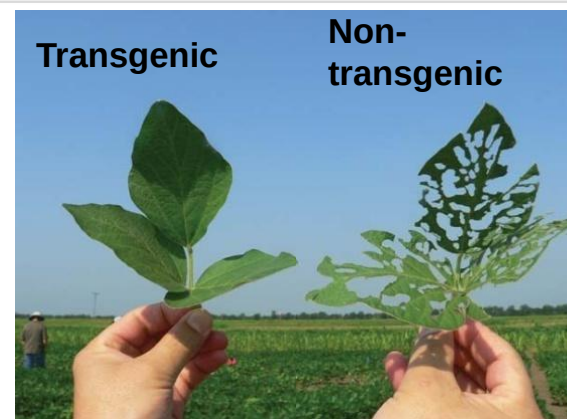
OBJECTIVE

- Provide efficacy against a broad spectrum of soy lepidopteran pests:
 - Velvetbean caterpillar, soybean looper, armyworm species, corn earworm
- Protect against multiple insect generations throughout growing season
- Products with long-term durability

PIONEER RESEARCH

- Approach complements non-transgenic Pioneer® brand soybean varieties already in product line up
- Several lead transgenic events demonstrate control of insects and reduced insect damage
- Rich pipeline of leads
- Conducting regulatory trials

Comparison of transgenic and non-transgenic varieties*



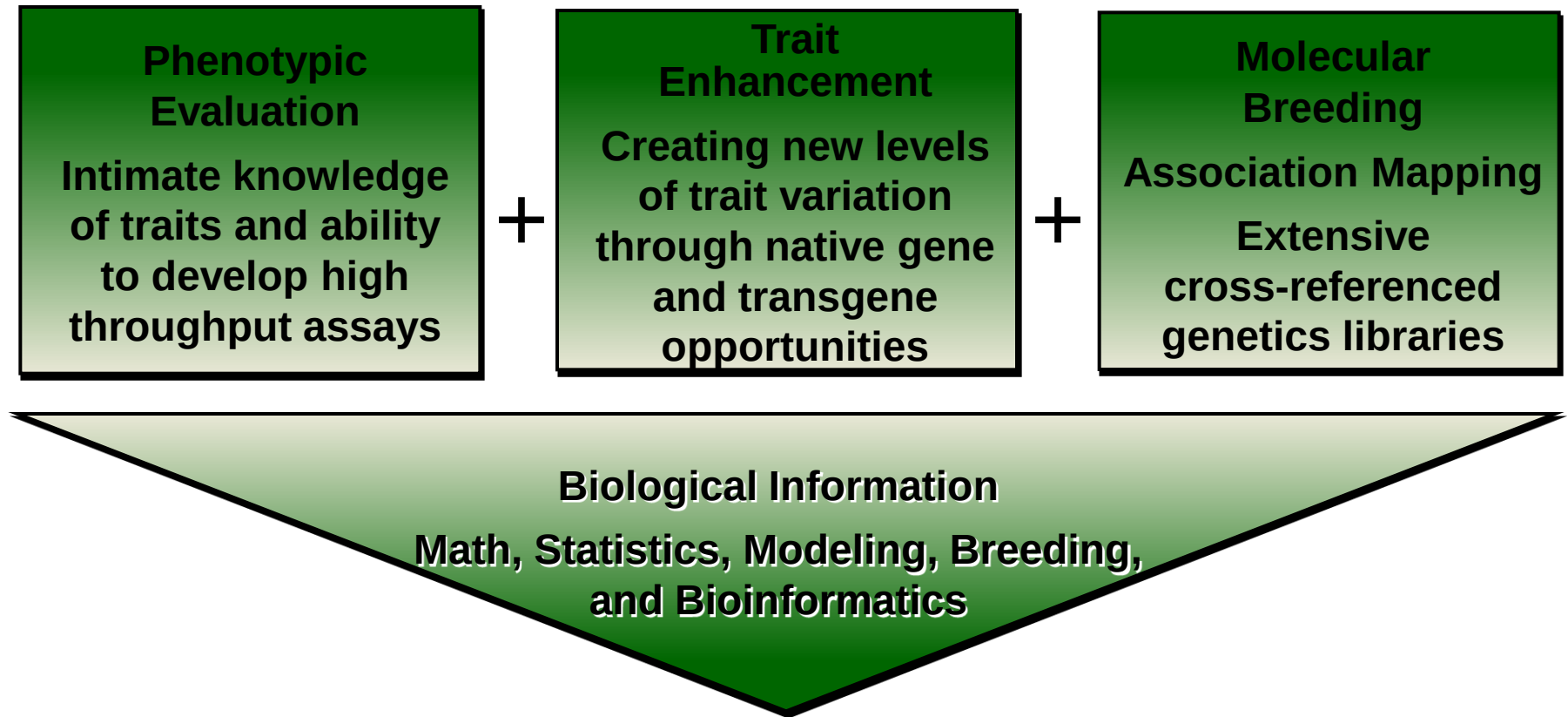
Grower Benefits: Harvestable Yield | Input Cost Control | Risk Management



*Soybean leaves extracted from a Pioneer artificially infested test plot.

Pioneer® brand soybean varieties with the transgenic Lepidopteran protection trait will not be offered for sale or distribution until completion of field testing and approval by regulatory authorities.

Summary - Breeding for Maximum Genetic Gain



**Increased Rate of Genetic Gain
for Desired Traits**



Thank you

