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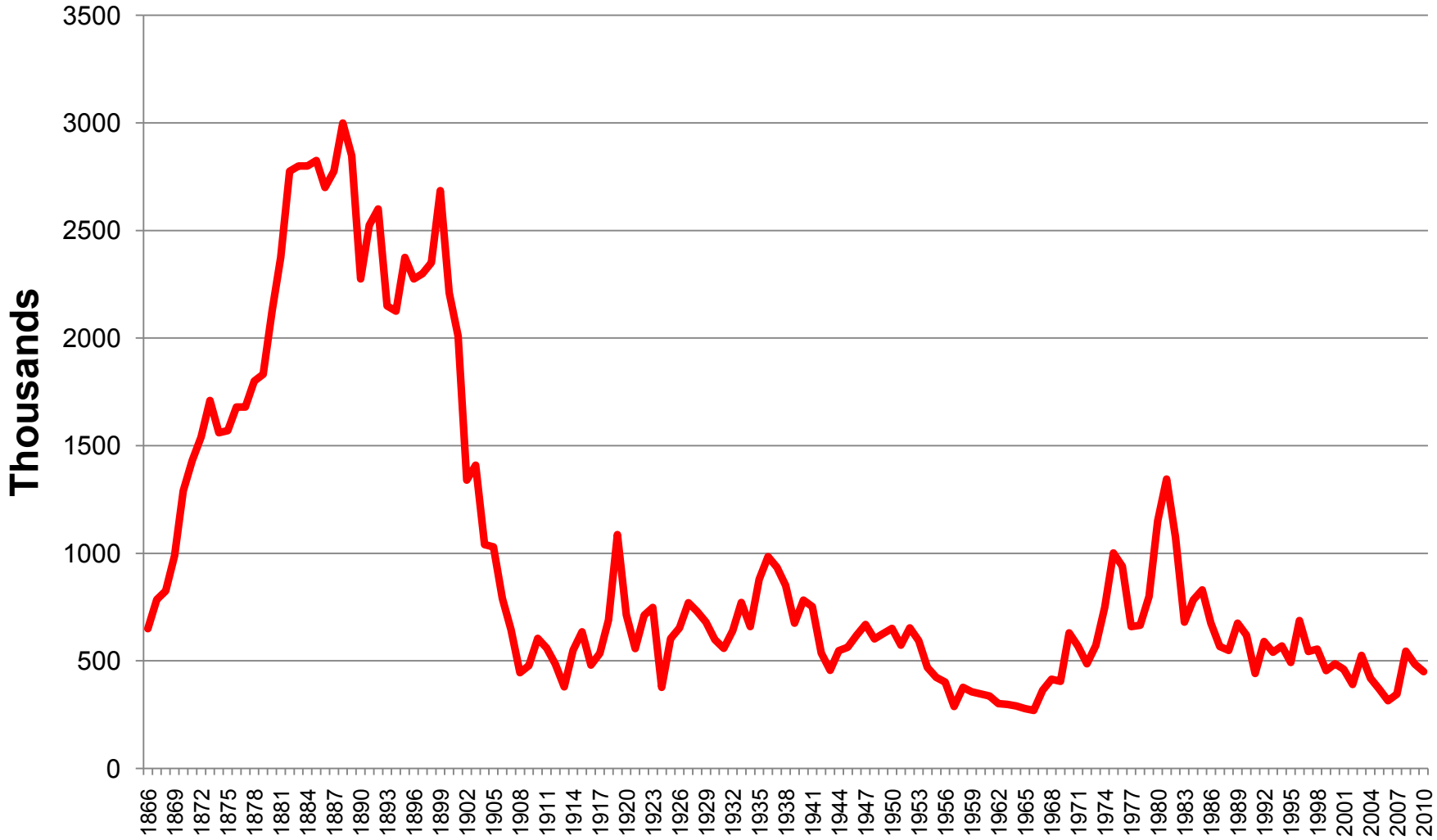
# Breeding Wheat for California

## RSI – Resource Seeds, Inc. becomes Syngenta Cereals - Southwest

# Overview

- Producing wheat grain in California
- Breeding wheat for that production
- Syngenta – how can it benefit California wheat & wheat breeding?

# Harvested Wheat Grain Acreage in California



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# Cost of Growing Wheat in California

| | Sacramento Valley | San Joaquin Valley |
|---|---|---|
| | $ / Acre | |
| Operating Costs | 351 | 488 |
| Overhead | 176 | 277 |
| Total | 527 | 765 |

Source: University of California Cooperative Extension

Wright et al. 2008 Sample Costs to Produce Wheat for Grain – 2008 San Joaquin Valley – South Irrigated

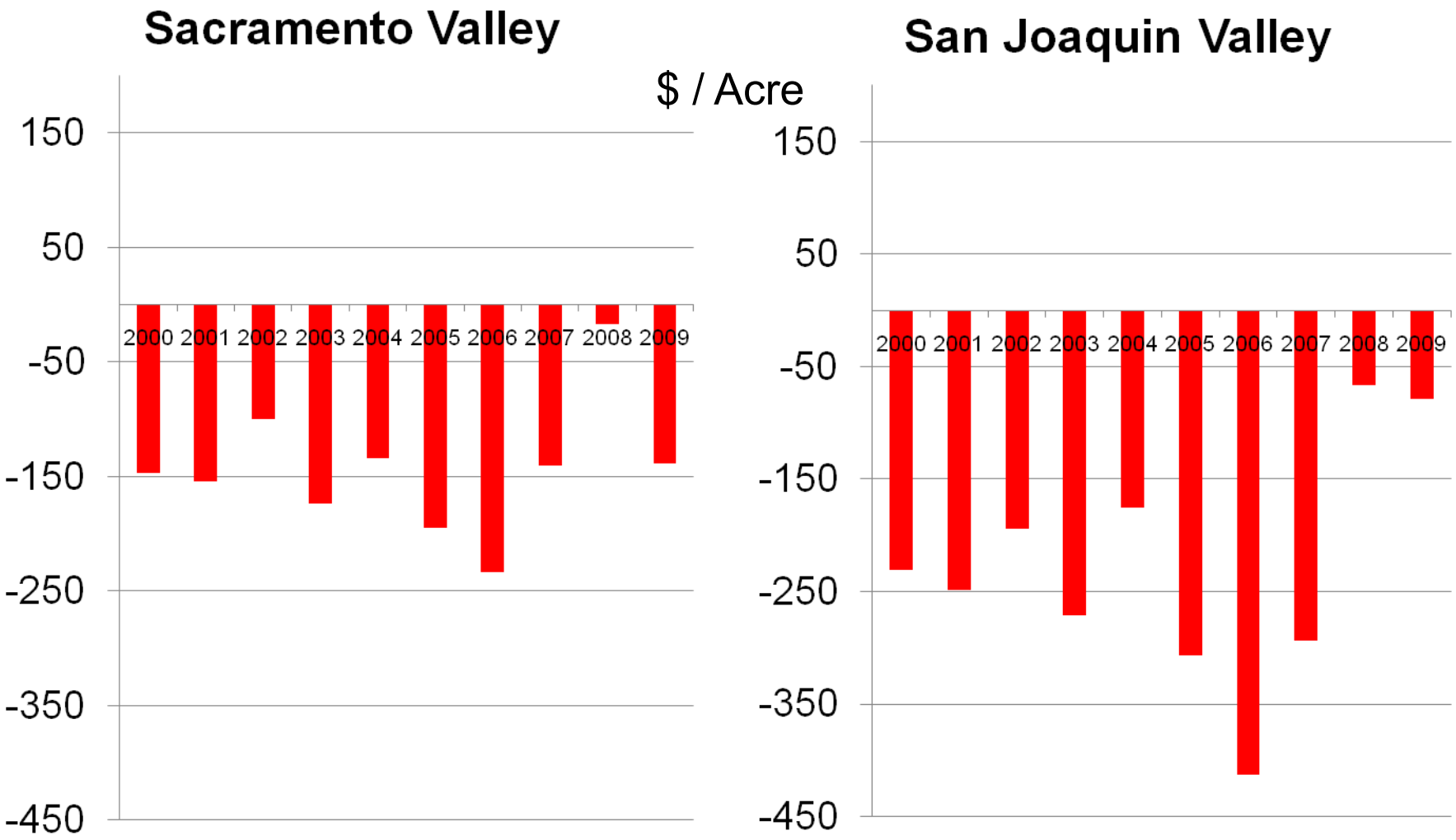
Munier et al. 2009 Sample Costs to Produce Wheat - 2009 Sacramento Valley - Irrigated

# Economic Time Series:

| | Tons / Acre | | Prices Received $ / Ton | | Prod. Cost Index |
|---|---|---|---|---|---|
| | Sac Valley | SJ Valley | Sac Valley | SJ Valley | US |
| 2000 | 2.26 | 2.04 | 86 | 119 | 117 |
| 2001 | 2.28 | 2.10 | 87 | 115 | 121 |
| 2002 | 2.31 | 2.34 | 109 | 126 | 121 |
| 2003 | 1.86 | 1.84 | 102 | 128 | 125 |
| 2004 | 2.46 | 2.67 | 103 | 136 | 133 |
| 2005 | 2.19 | 2.16 | 100 | 124 | 142 |
| 2006 | 1.70 | 1.74 | 121 | 114 | 151 |
| 2007 | 2.54 | 2.27 | 132 | 161 | 163 |
| 2008 | 2.45 | 2.69 | 218 | 260 | 189 |
| 2009 | 2.33 | 2.48 | 167 | 264 | 181 |

Sources: CASS County Ag. Commissioners USDA

# Profitability of Growing Wheat Grain based on Time Series



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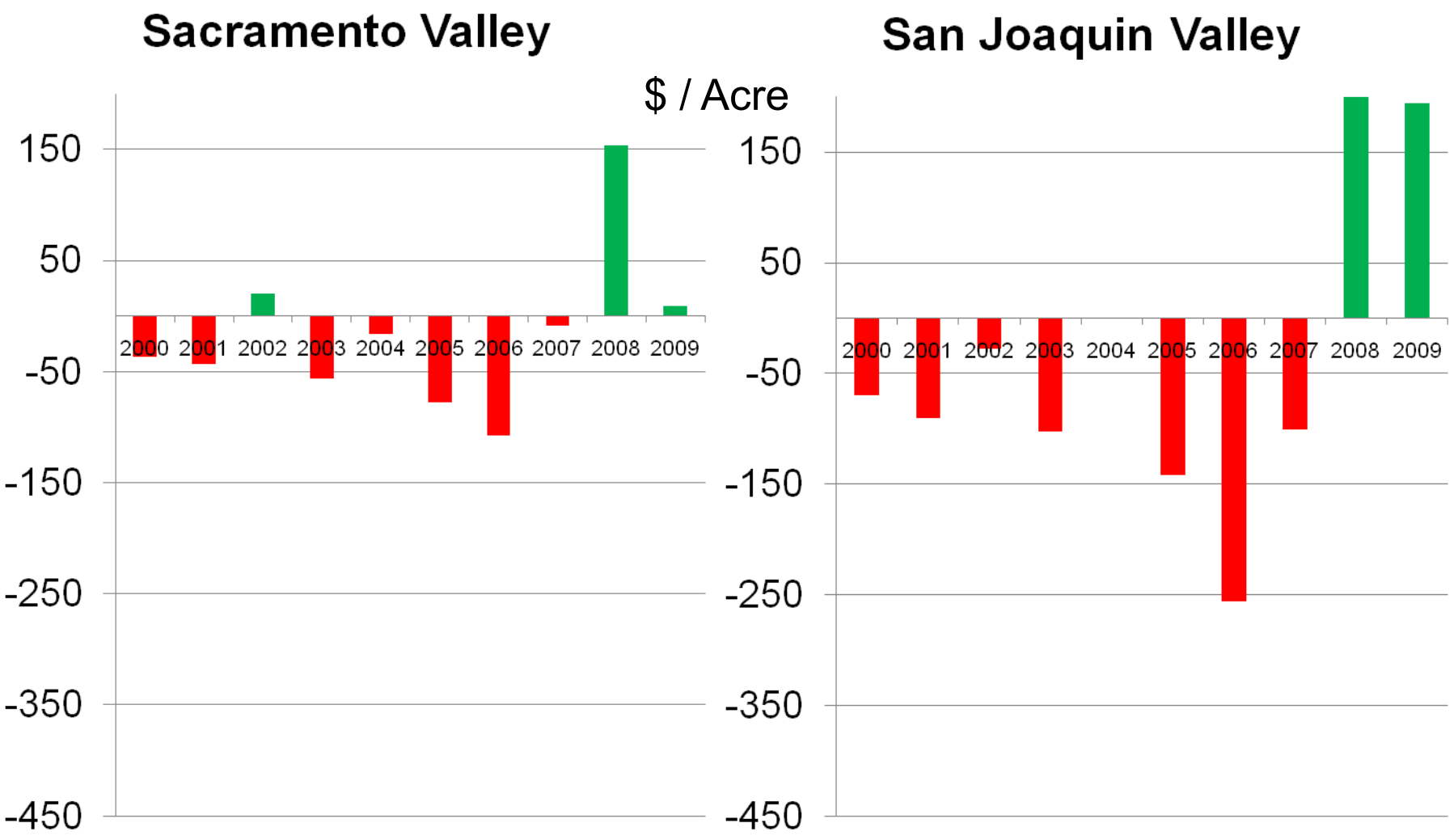
# Profitability of Growing Wheat (w/ gov prog/straw, ↑yield)



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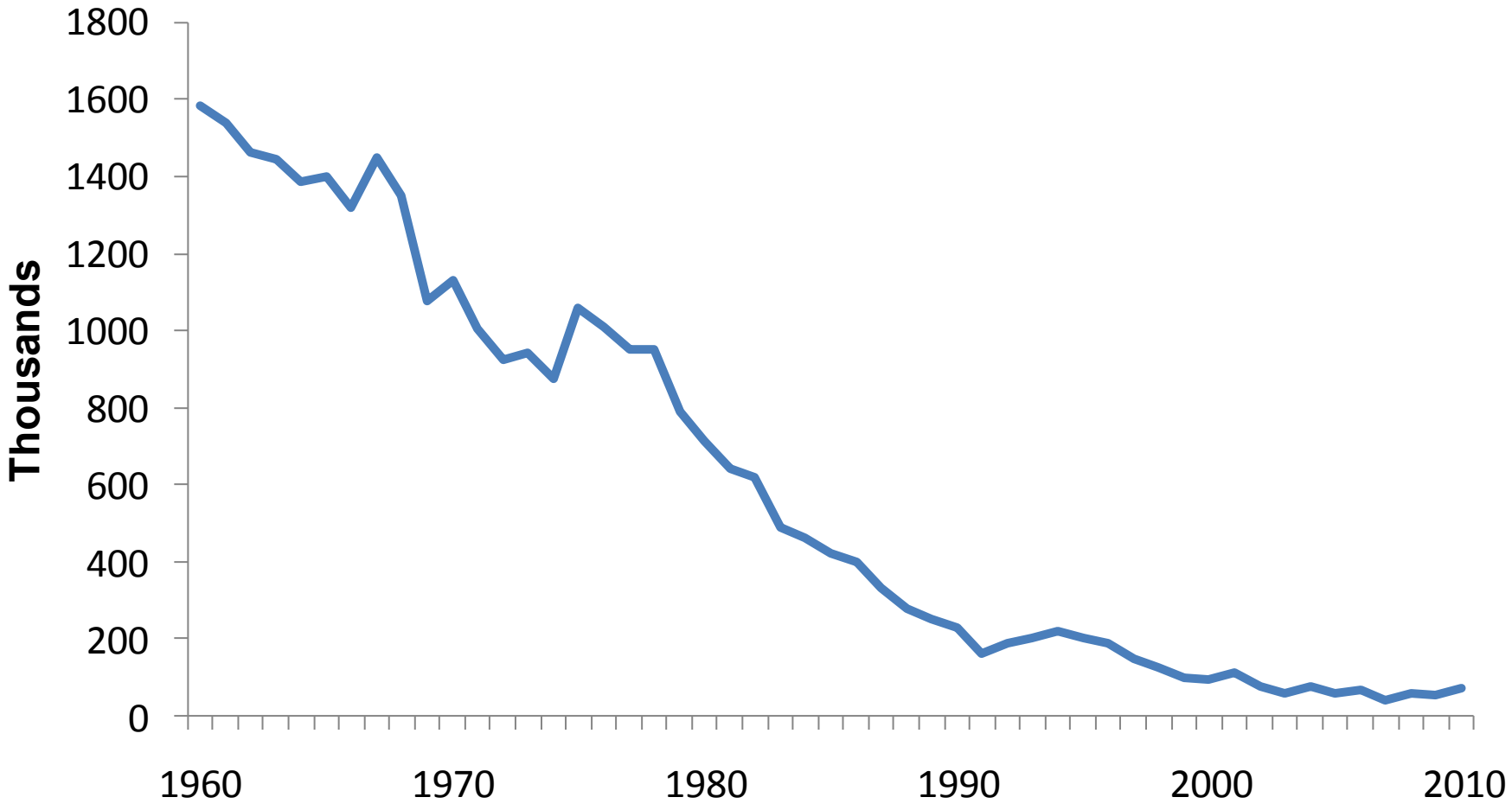
# Wheat's Place in California - Part of a Cropping System

- Rotational benefits
- Soil structure and organic matter
- Income diversification and risk management

# Harvested Acreage of Barley Grain in California



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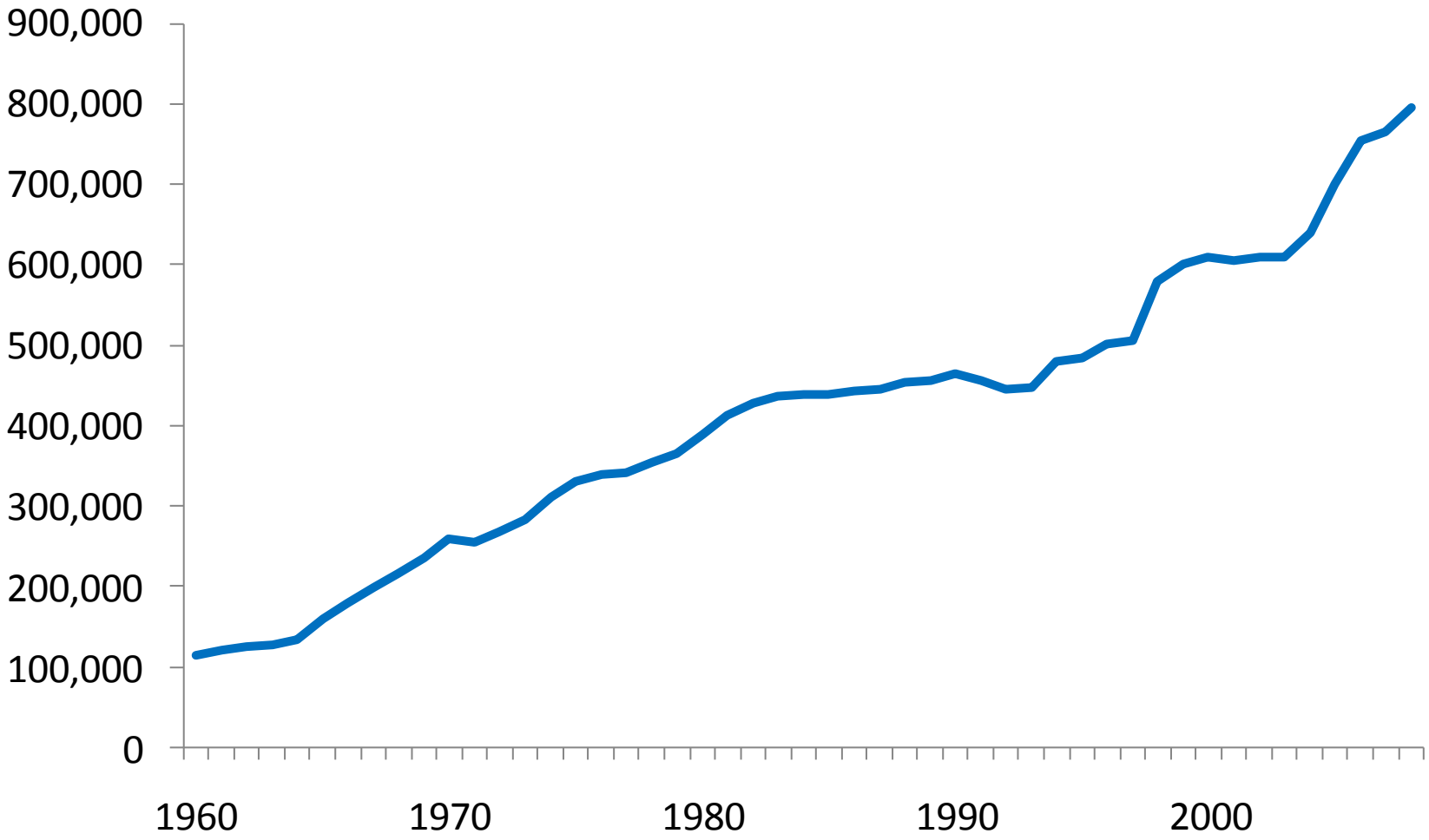
# Acreage of Almonds in California



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# Trios ™ Triticale for Rotational Benefits and Soil OM



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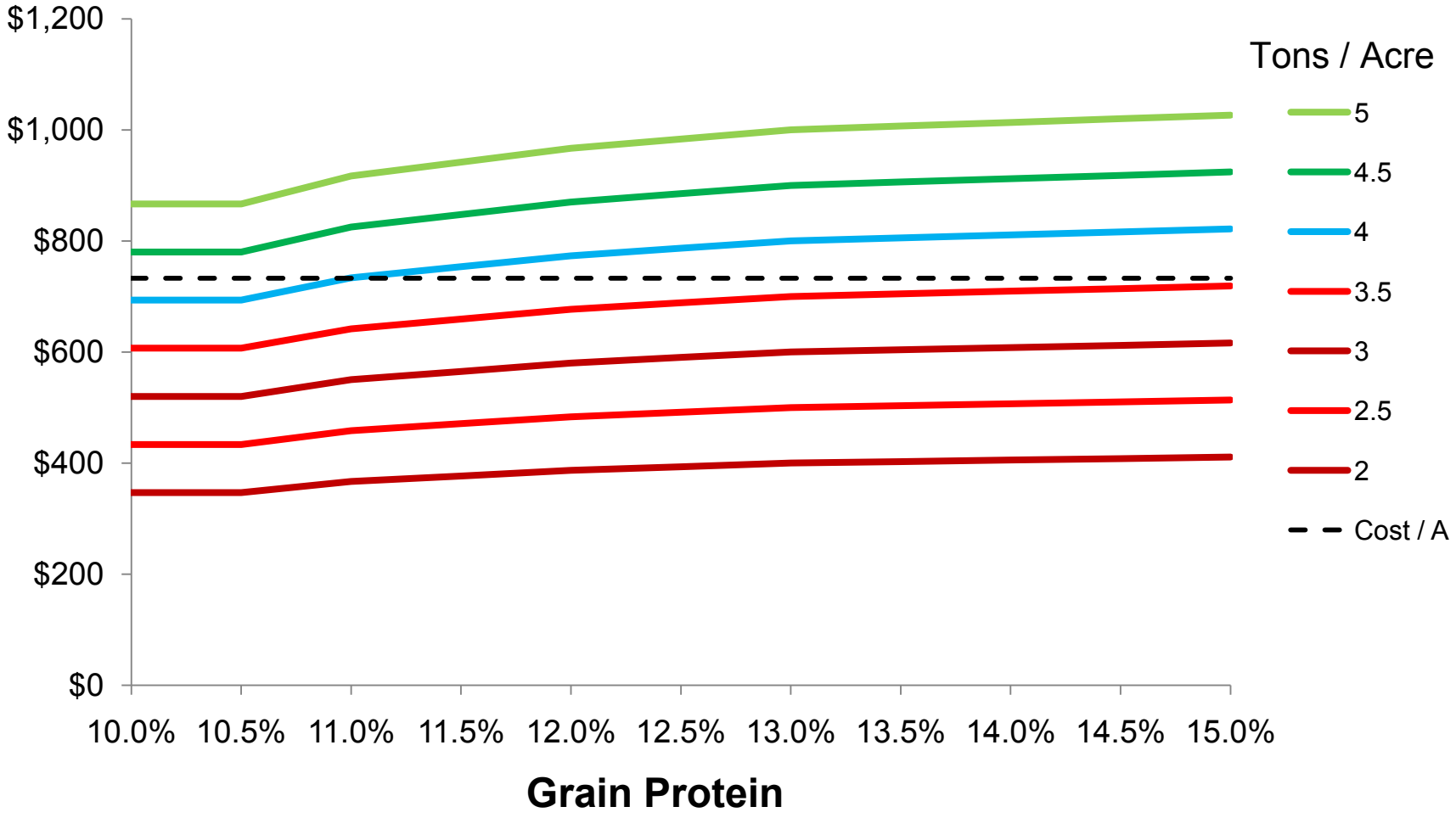
# Sustaining Wheat Production in CA - Challenges for Wheat Breeding

- Increase the profitability of producing wheat grain

# Wheat Grain Revenue per Acre based on Yield & Protein



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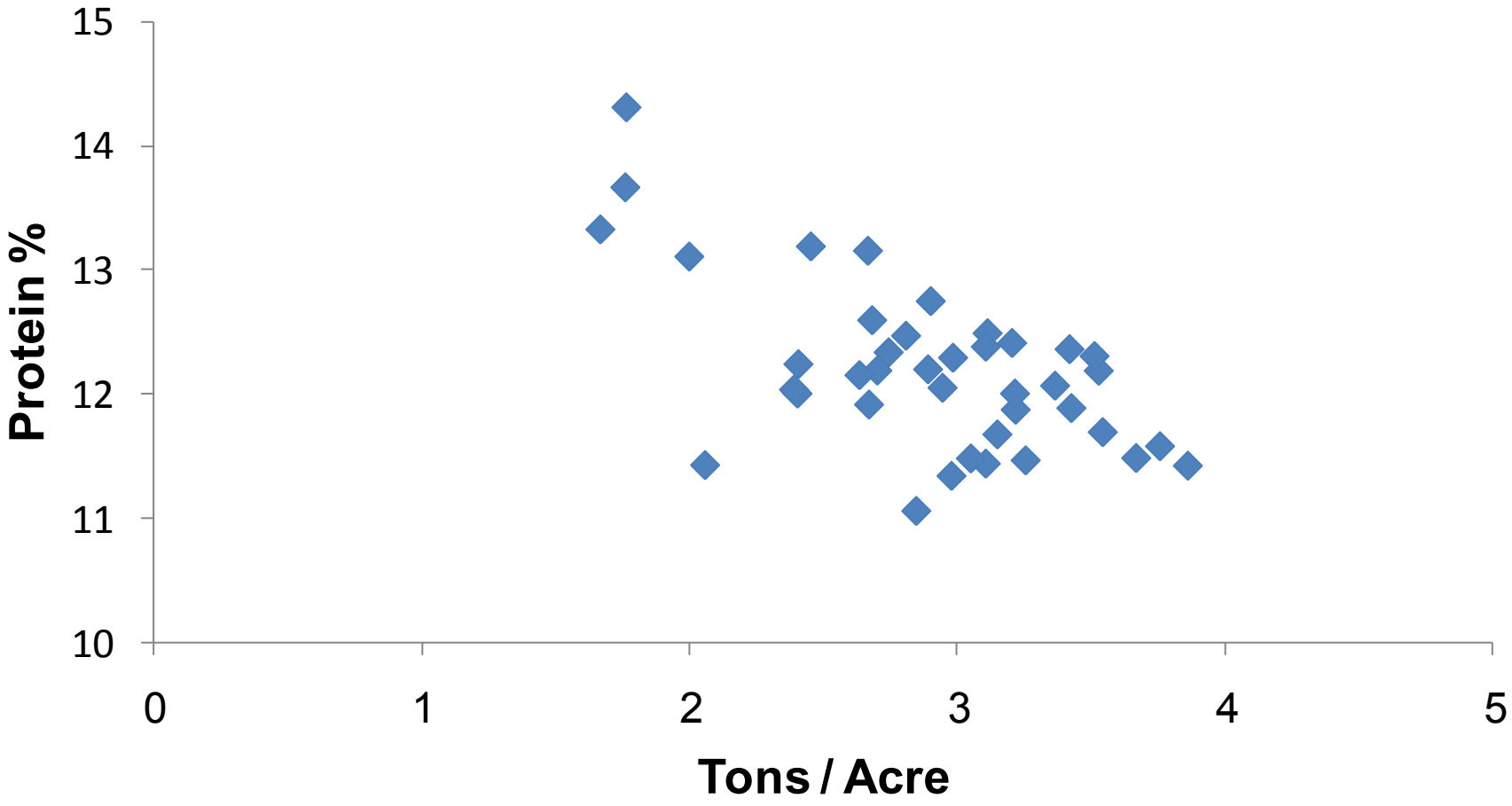
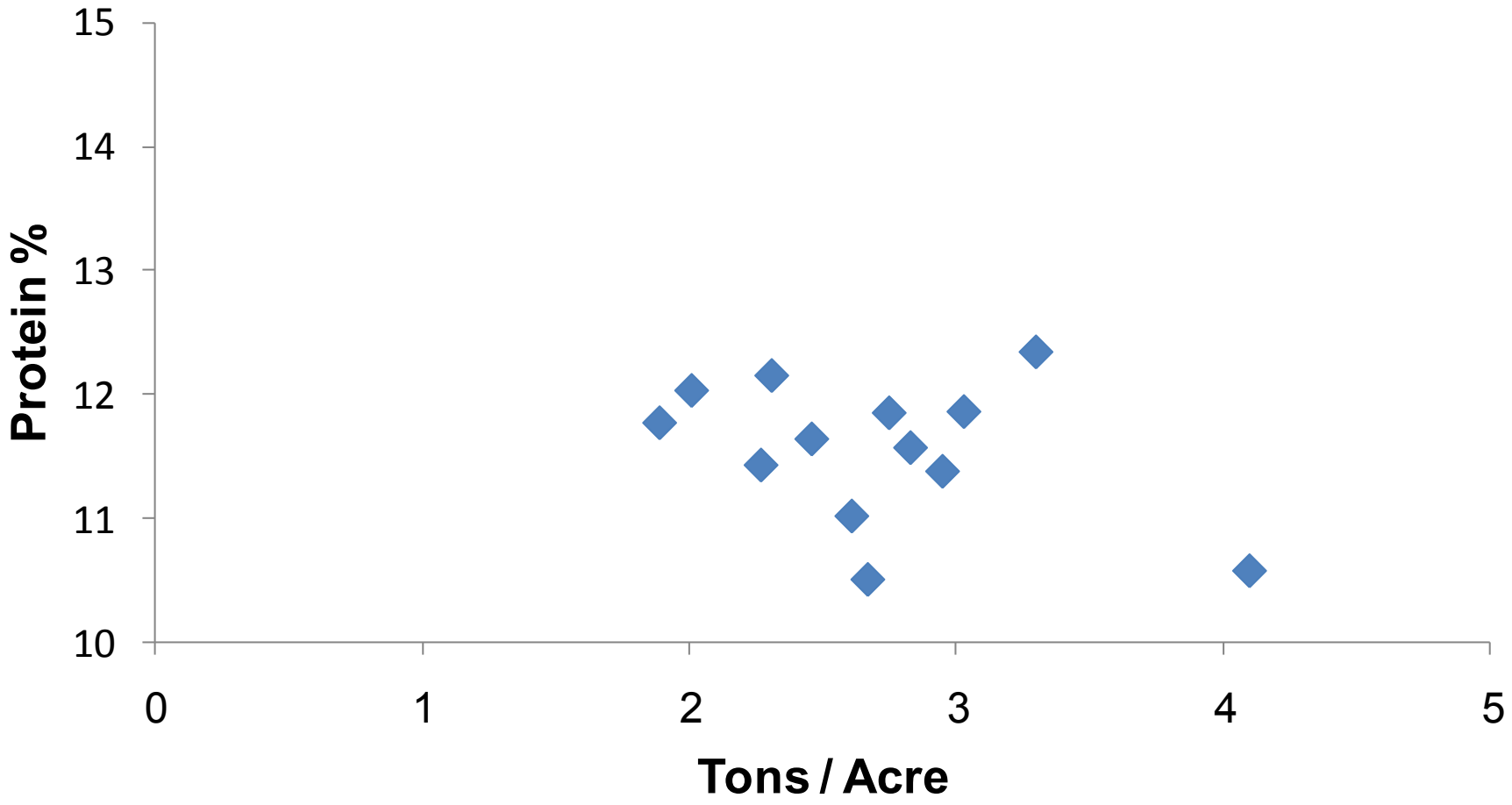
# Relationship between Yield & Protein in Variety Selection




Source: 2008 UC Regional Performance Tests .
Grain yield and protein of 40 wheat varieties and experimental lines averaged over 6 locations

# 2008 Collaborator Entries: To Release or Not Release?




Source: 2008 UC Regional Performance Test, Kings Co.
Grain yield and protein from yield trial for varieties entered into 2008 Wheat Collaborator Program at same location



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# Nitrogen Content of Wheat at Harvest

| % Protein: | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|
| Tons / Acre | | LBS of Nitrogen per Acre in the Plant at Harvest[1] | | | | |
| 2 | 100 | 110 | 120 | 130 | 140 | 150 |
| 3 | 150 | 165 | 180 | 195 | 210 | 225 |
| 4 | 200 | 220 | 240 | 260 | 280 | 300 |
| 5 | 250 | 275 | 300 | 325 | 350 | 375 |

Footnote: 1. assumes 70% of N in grain; 30% in remainder of plant

# N Fertilizer Requirements for Wheat Grain Yield & Protein

| % Protein: | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|
| Tons / Acre | | LBS of Nitrogen Fertilization Needed per Acre[1, 2, 3] | | | | |
| 2 | 128 | 147 | 167 | 187 | 207 | 226 |
| 3 | 226 | 256 | 286 | 315 | 345 | 374 |
| 4 | 325 | 365 | 404 | 444 | 483 | 523 |
| 5 | 424 | 473 | 523 | 572 | 621 | 671 |

Footnotes:

1. assumes N uptake efficiency = 40% preplant N, 70% mid and late season application
2. assumes 30% of “at harvest N need” met with preplant application 3. 70 lbs start residual N

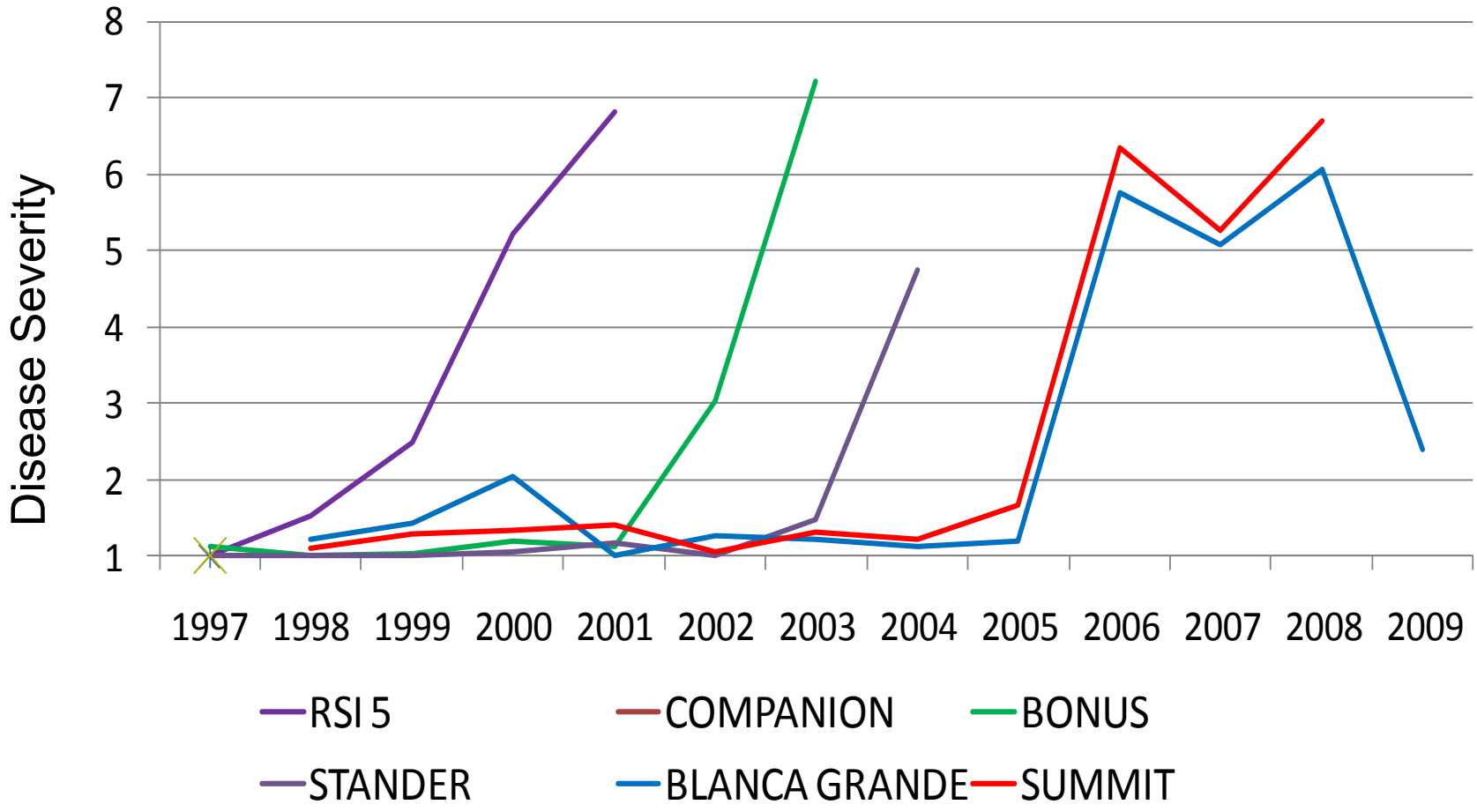
# Sustaining Wheat Production in CA - Challenges for Wheat Breeding

- Increase the profitability of producing wheat grain
  - Yield, protein, and nitrogen fertilization
    - Genetic markers to characterize N response
    - Nitrogen use efficiency
    - Management systems encouraging higher N use

# Sustaining Wheat Production in CA - Challenges for Wheat Breeding

- Increase the profitability of producing wheat grain
- Combat stripe rust and other diseases to increase average income and reduce risk.

# Stripe Rust Ratings in UC Regional Performance Tests



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# Managing Stripe Rust in California

- Sources of resistance
- Breeding resistance varieties
- Use of fungicides
- Stewardship of resistance genes and fungicides


Bringing plant potential to life



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**Employees** over 25,000
in more than 90 countries

**2009 Sales** $ 10,992,000

**R&D investments 2009**
$ 960 million

www. syngenta.com



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# Syngenta Cereals & CA Wheat

- Breadth and depth of expertise, germplasm, and technology

# Cereal Grains at Syngenta: Unmatched Breadth & Depth

**Seeds**

- Global #2 – market share 13% *
- Unique geographic breadth
- First commercial hybrid barley

**Genetics & traits**

- Accelerated breeding: markers & DH
- Leading wheat gene map & genomic tools
- GM capability

**Seed Care**

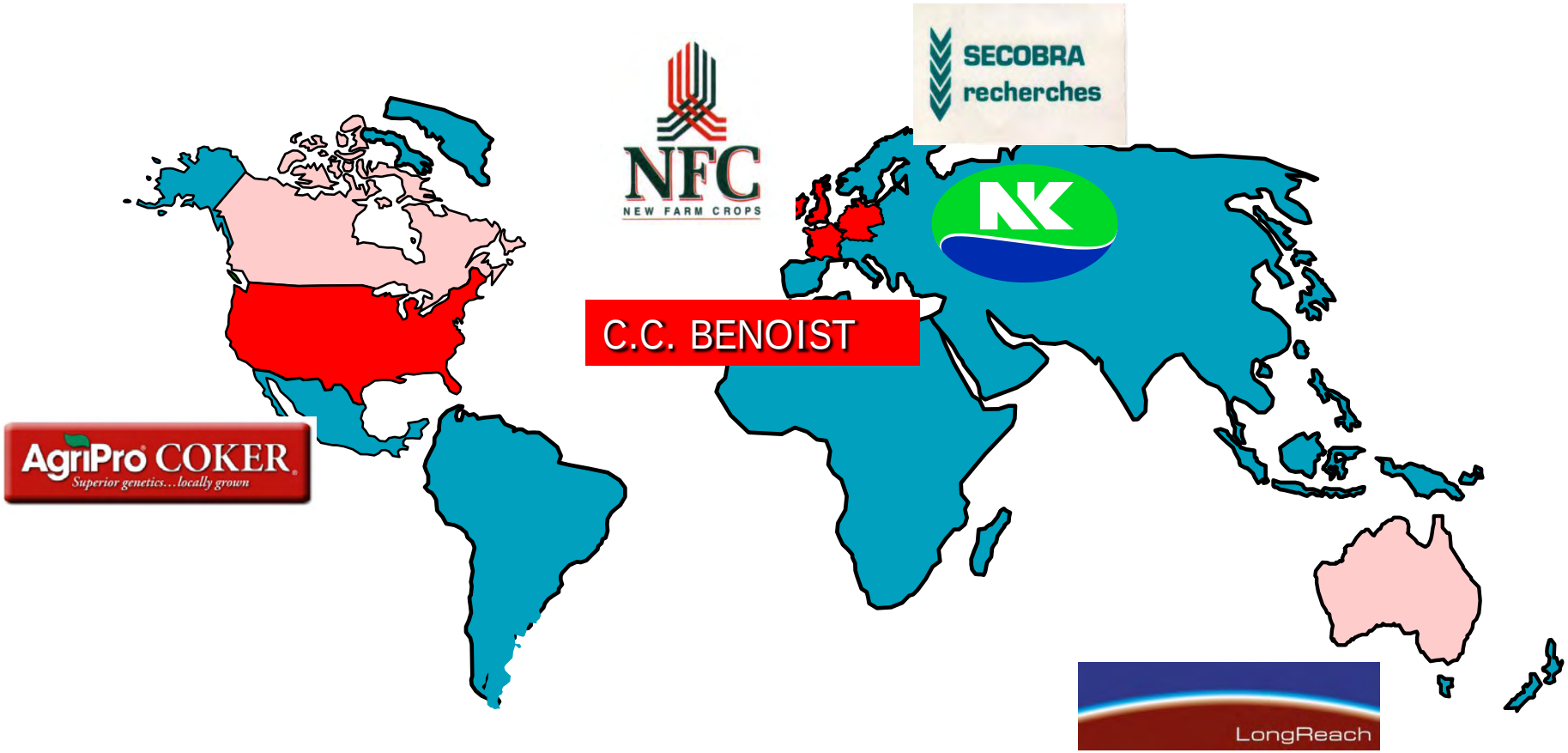
- Seed protection & seedling vigor

**Crop Protection**

- Global #1 – market share 19%
- Fungicides, herbicides, insecticides, PGR & Invinsa stress protection
- Global reach

* share of wheat & barley royalty market

# Syngenta Cereals Breeding Programs



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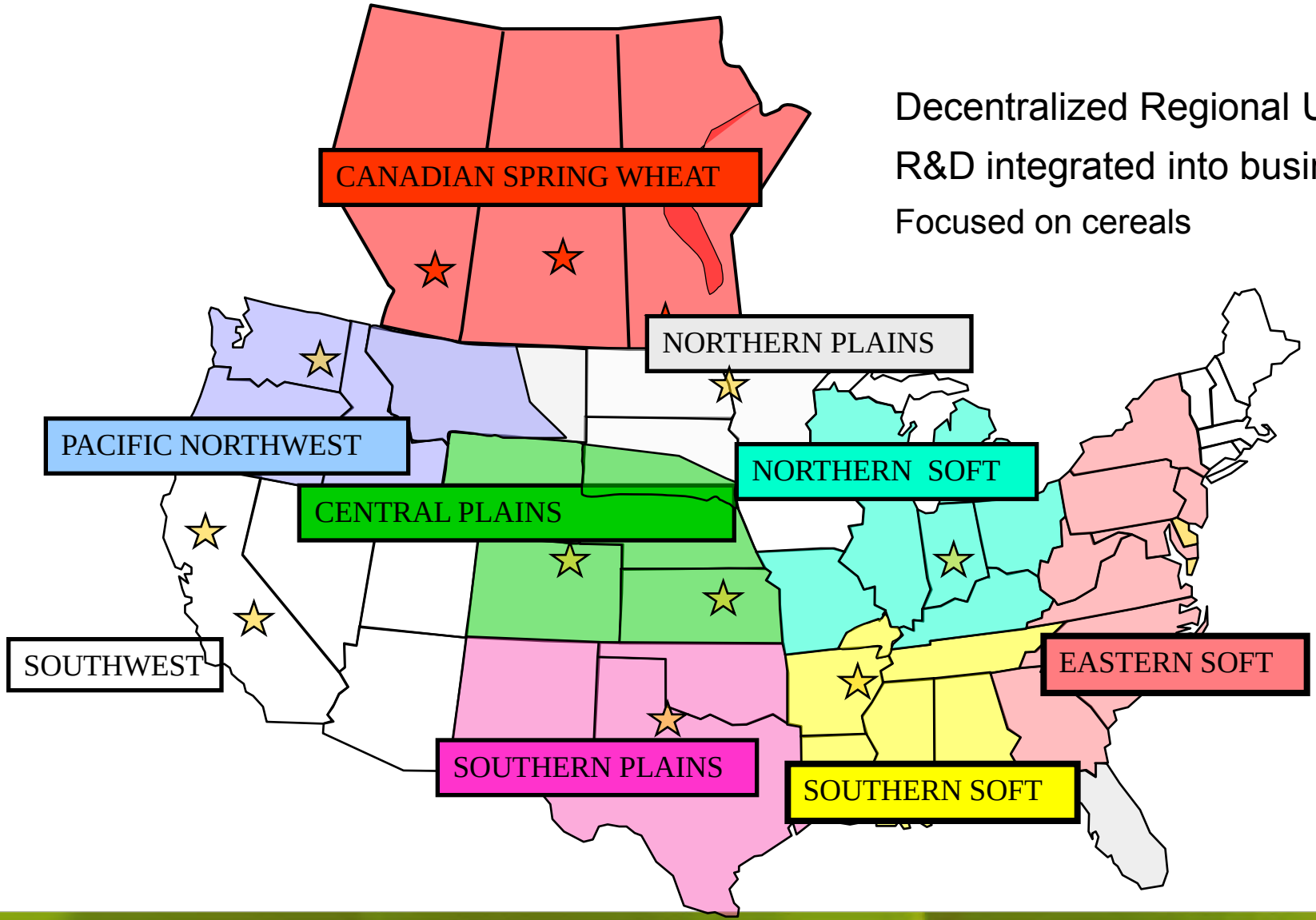
# Syngenta Cereals - NAFTA




Decentralized Regional Units

R&D integrated into business

Focused on cereals



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# Genetic Relationship
# Durum, Common Wheat, & Triticale

| Progenitor or Related Species | | Durum | Common Wheat | Triticale |
|---|---|---|---|---|
| | | Genomic Structure | | |
| Einkorn | AA | AA | AA | AA |
| *Aegilops speltoides* | BB | BB | BB | BB |
| *Aegilops tauschii* | DD | | DD | |
| Rye | RR | | | RR |


28

# Double Haploid Systems at Syngenta Cereals

### *Traditional Breeding*

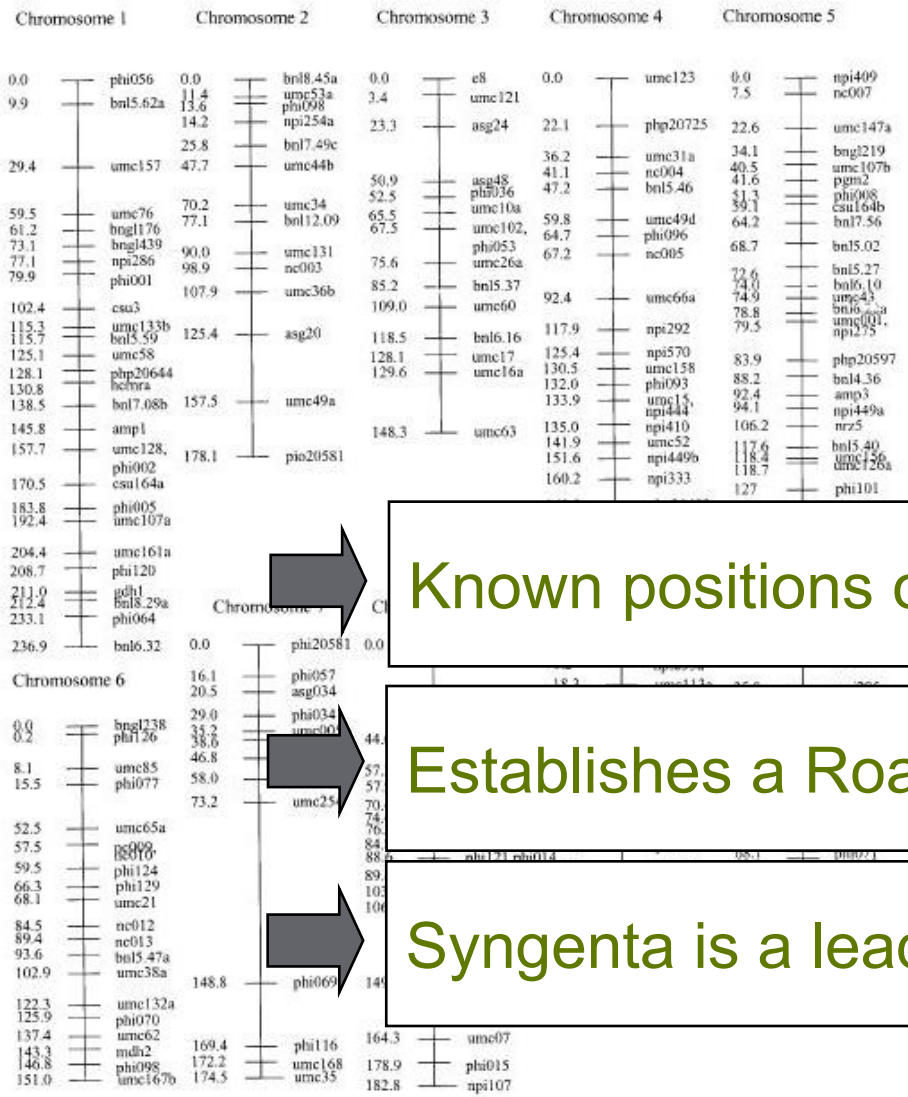
| Season | Generation | Activity |
|---|---|---|
| 1994 | F0 | Cross |
| 1995-1996 | F1 | Advance Generation |
| 1996-1997 | F2 | Advance Generation |
| 1997-1998 | F3 | Advance Generation |
| 1998-1999 | F4 | Advance Generation |
| 1999-2000 | F5 | Advance Generation |
| 2000-2001 | F6 | yield 1 |
| 2001-2002 | F7 | yield 2 |
| 2002-2003 | F8 | yield 3 |
| 2003-2004 | F9 | yield 4 |
| 2004-2005 | F10 | yield 5 |
| 2005-2006 | F11 | Release |

### *Double Haploid Breeding*

| Season | Generation | Activity |
|---|---|---|
| 1994 | F0 | Cross |
| 1995-1996 | F1 | make DH |
| 1996-1997 | F20 | Increase DH |
| 1997-1998 | F20 | yield 1 |
| 1998-1999 | F20 | yield 2 |
| 1999-2000 | F20 | yield 3 |
| 2000-2001 | F20 | yield 4 |
| 2001-2002 | F20 | Release |

- Faster to market
- Faster cumulative gain

# Marker Assisted Selection at Syngenta Cereals




**Genetic Marker Maps are becoming *essential* in wheat**

Known positions on chromosomes

Establishes a Road Map to traits and genes

Syngenta is a leader for markers in cereals



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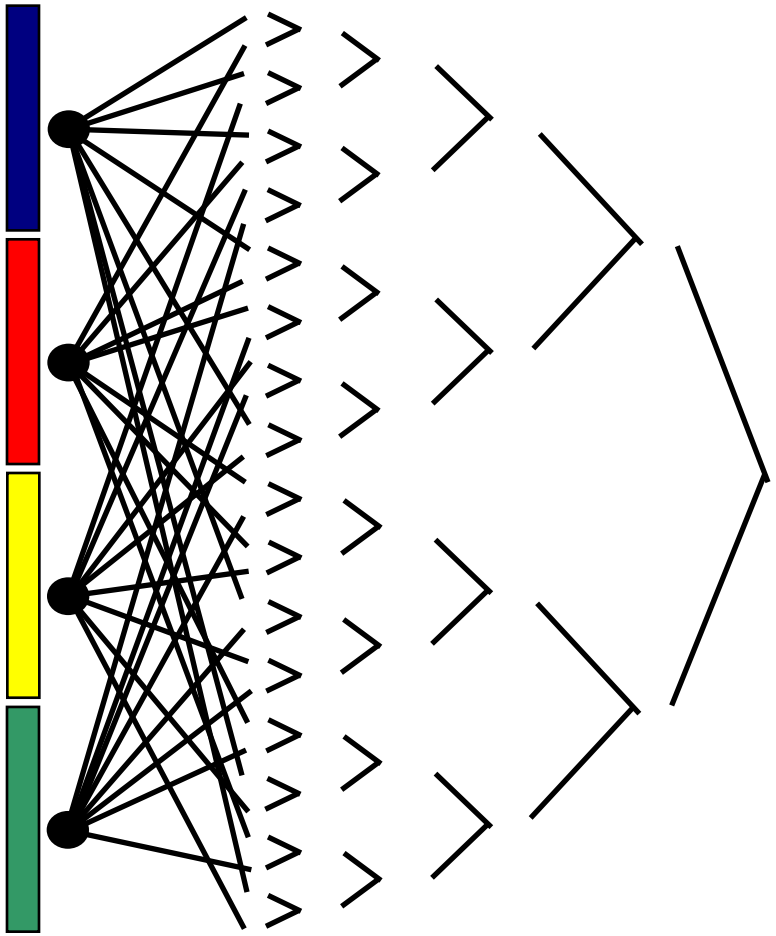
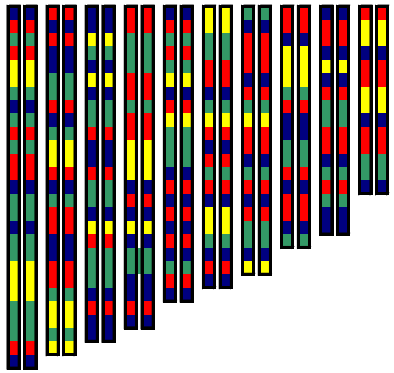
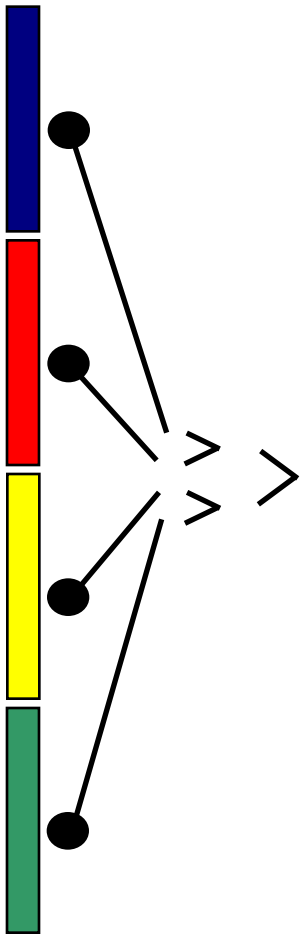
# Conventional Breeding for Complex Traits

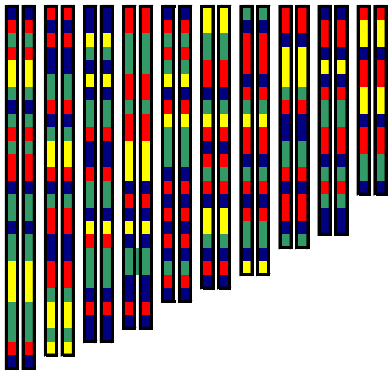




12 years ...

# Marker Assisted Selection for Complex Traits





Increased genetic gain per unit of time

Maximized exploitation of germplasm

Carry complex or difficult to screen traits

**6 years ...**

# Syngenta Cereals & CA Wheat

- Breadth and depth of expertise, germplasm, and technology

- Collaboration with CIMMYT – International Maize and Wheat Improvement Center

# Public-Private Partnership with CIMMYT to Develop & Advance Technology in Wheat

"Global wheat production is increasing at only 0.9% each year. This is a very critical issue as global demand is growing at 1.5% or more annually."

Hans-Joachim Braun
CIMMYT

"Syngenta and CIMMYT are both committed to transforming wheat production worldwide."

John Atkin
Syngenta

# Public-Private Partnership with CIMMYT to Develop & Advance Technology in Wheat

- Joint R&D across broad range of traits and technologies
- Syngenta's genetic marker technology, advanced traits
- CIMMYT's access to wheat genetic diversity, global partnership network

# Public-Private Partnership with CIMMYT Implications for California Wheat

- Historical tight link between CIMMYT and California wheat breeding and varieties
- Broaden the genetic base of resistance to stripe rust and other diseases
- Markers for tracking resistance genes
- Production systems combining seed and crop management
- Hybrid wheat

# Syngenta Cereals & CA Wheat

- Breadth and depth of expertise, germplasm, and technology
- Collaboration with CIMMYT
- Hybrid wheat

# Syngenta Hybrid Wheat Initiative

- Cost-effective production of hybrid seed – refined and validated in hybrid barley in Europe
- Molecular marker technology
- Expertise from AgriPro and Monsanto programs in 1990s





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# Syngenta Hybrid Wheat Initiative
# Implications for California Wheat

- Heterosis
  - Tolerance to abiotic and biotic stress
  - Grain yield
  - Forage yield
- Efficient, flexible system for combining desirable traits

# Syngenta Cereals & CA Wheat

- Breadth and depth of expertise, germplasm, and technology
- Collaboration with CIMMYT
- Hybrid wheat
- “Systems” approach and capabilities

# Syngenta “Systems” for Crop Production

- “Whole crop”, multi-product program to optimize production and resource use
- Efficient resource use, environmental stewardship, and increased profitability for sustainable production of wheat and other crops

# Syngenta "Systems" for Crop Production Implications for California Wheat

- Integrated program for managing stripe rust and other diseases at the field, farm, and area-wide levels
- "Whole crop" program to optimize production and use of land, water, and fertilizer, and increase profitability
- Benefit the environment and meet regulations
- Help sustain wheat, annual cropping, and farming in California

# 40 Years of Superlative Products for California

Bob Matchett

Oly Cantu