

Rooting out Fiction to See the Facts of Today's Wheat



Brett Carver



Whole Grains
BREAKING BARRIERS

A Consumer, Scientific and Culinary Conference

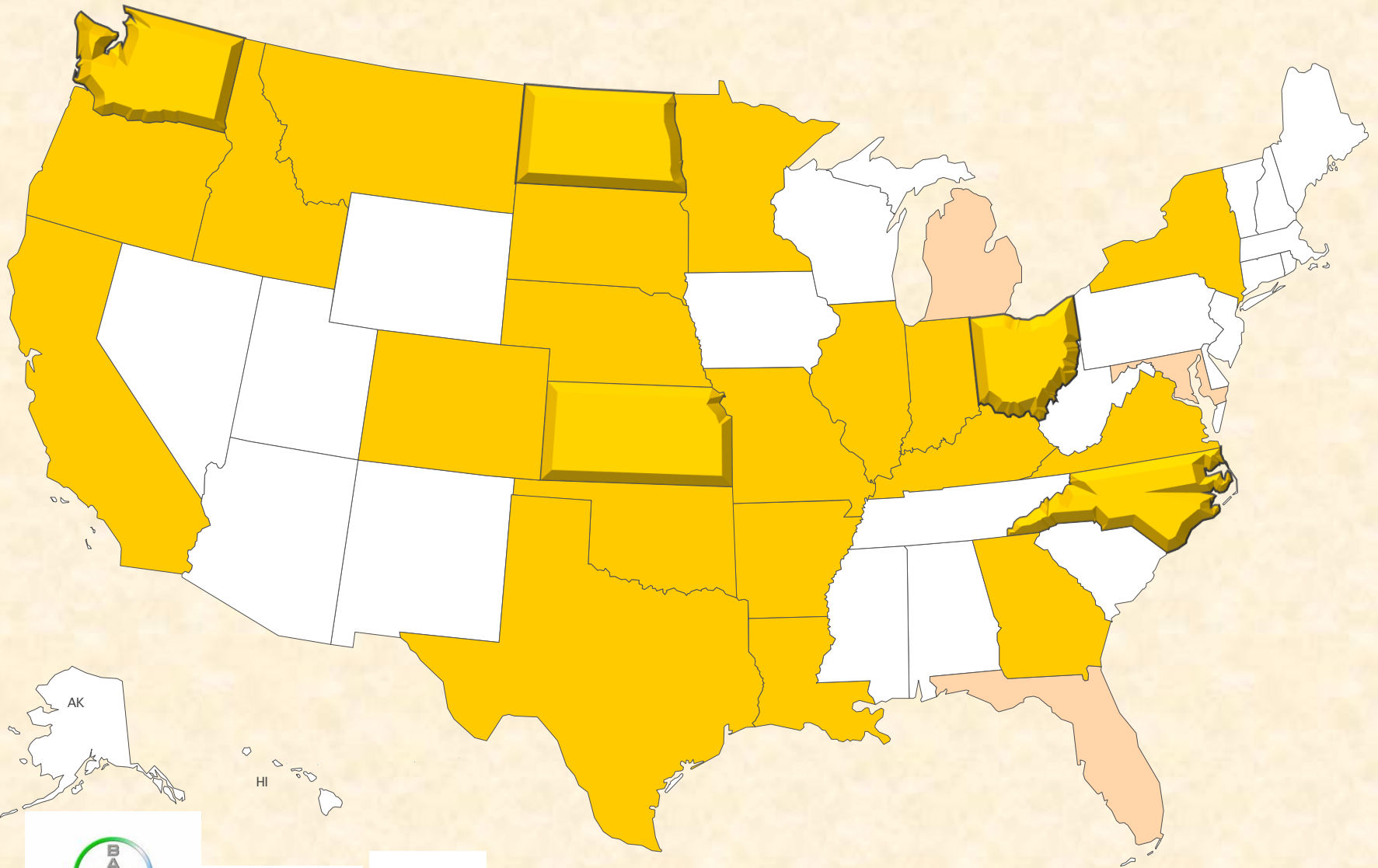
Boston, Massachusetts
November 9-11, 2014

ORGANIZED BY OLDWAYS AND THE WHOLE GRAINS COUNCIL

My Pledge



Our wheat comes from an LGU near you....





Myth 1

- Today's wheat is not our grandfather's wheat

Myth 2

- Modern wheat is on gluten overdrive

Consider This

- Today's bread wheat: ~ 8,000 years old
 - Durum wheat is even older than that
- Modern wheat breeding: <100 yr old
- Evolution and domestication vs. breeding



Forces of wheat evolution-domestication

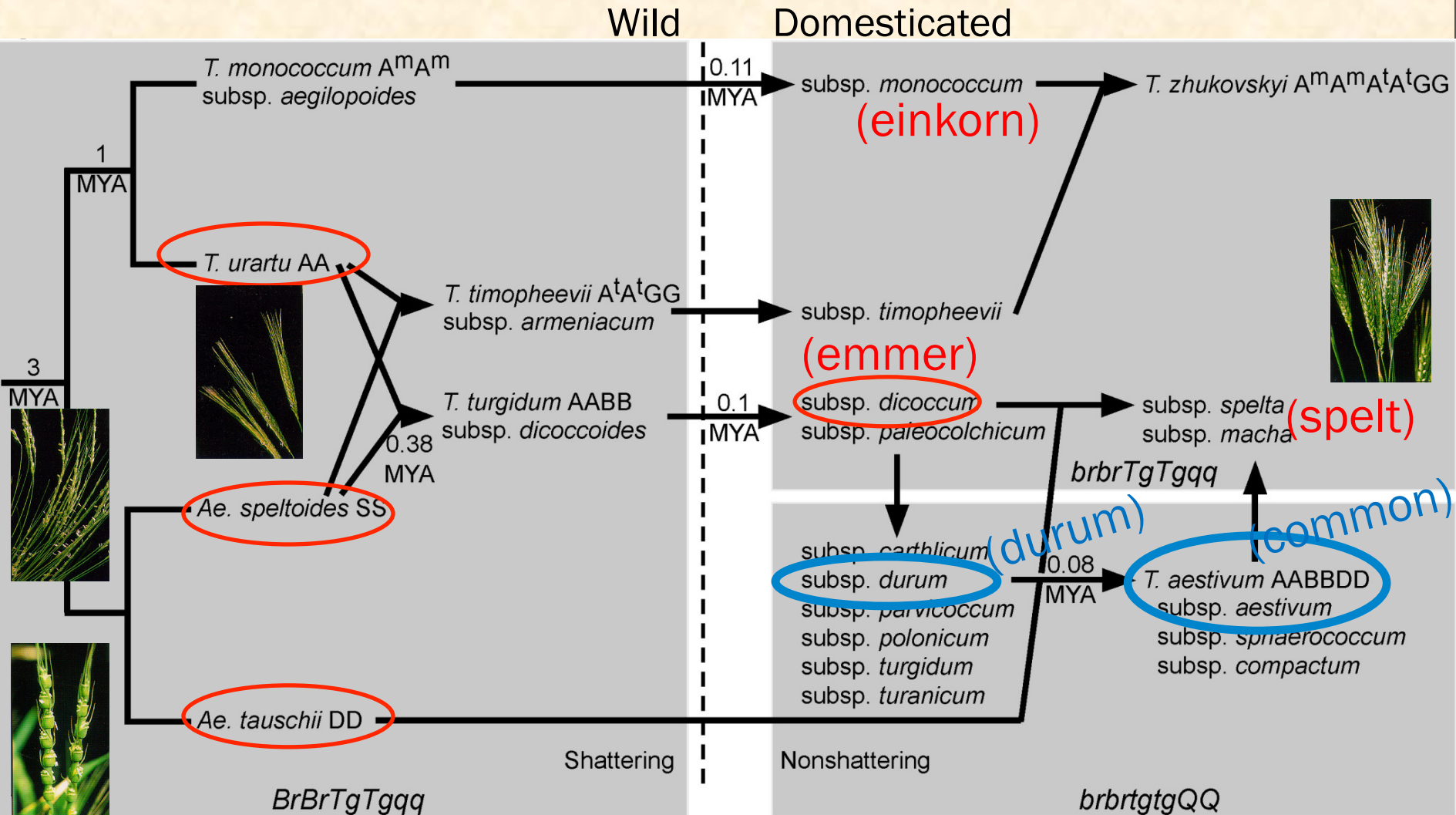
- ▶ Gene flow
- ▶ Gene fixation (loss)
- ▶ Chromosome rearrangements
- ▶ DNA sequence deletion
- ▶ DNA insertion/amplification
- ▶ DNA silencing

Obvious

Not so obvious

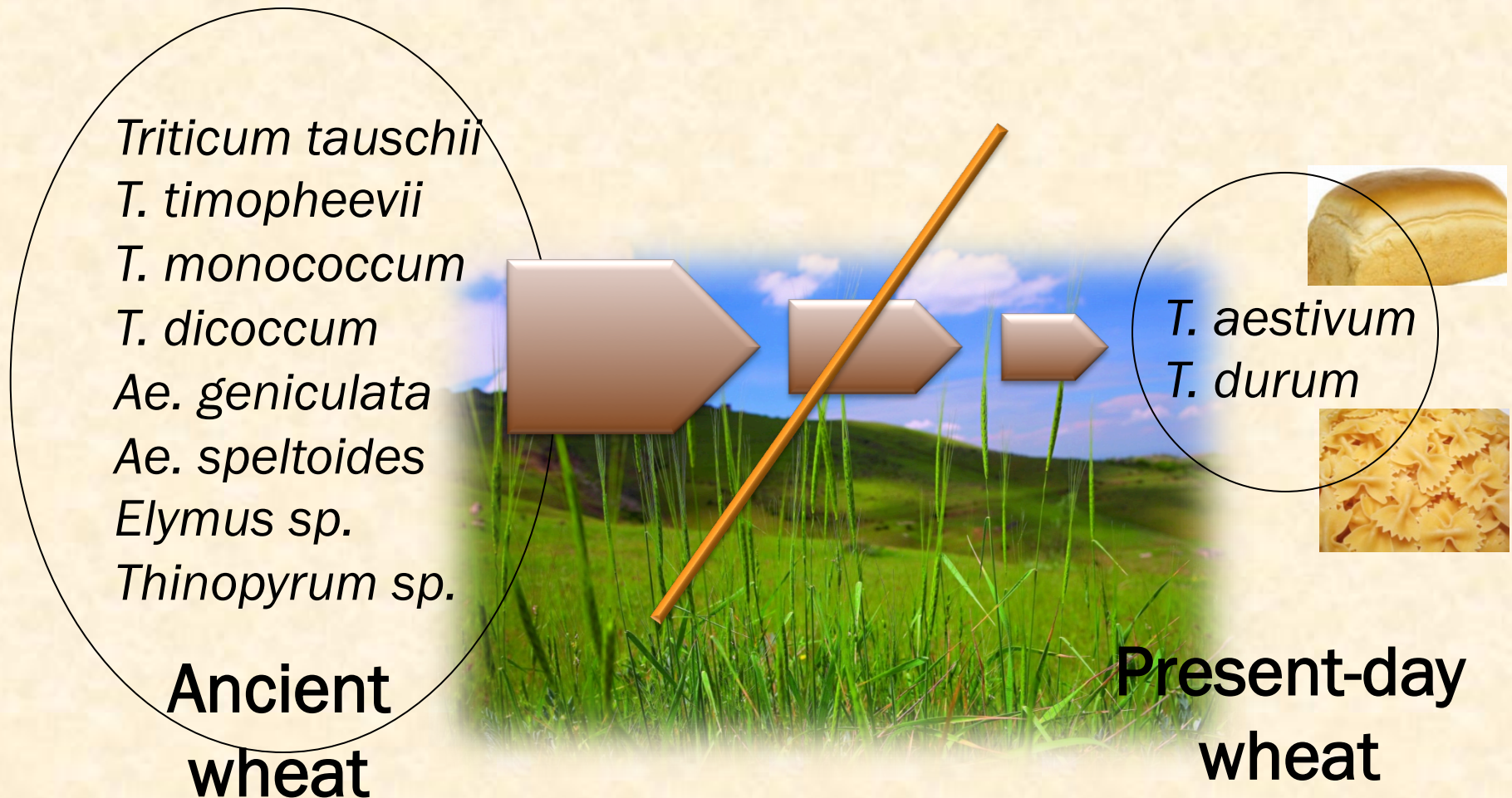
Did genetic change start with modern wheat breeding?

Where our wheat came from...



Hallmark of modern-day wheat breeding

Continuous flow of ancestral wheat germplasm





How is Today's Wheat Different?

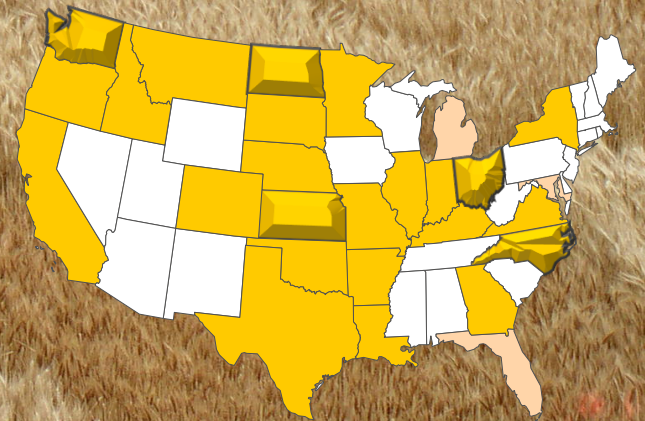
- Triple the *genetic yield potential*
 - Worldwide, 0.5% per year since 1940s

Wheat Head Size in 90 Years



How is Today's Wheat Different?

- Triple the *genetic yield potential*
- Better local adaptation (disease resistance)
- Often shorter and earlier maturing
- More plant mass accounted for by grain



How is Today's Wheat NOT Different?

- Same genome(s)
- Same chromosome complement
- Genes are “native”; no GM in commercial production
- Gene sequences still highly conserved – 98% identity, tauschii vs.aestivum
- Protein content and composition



Myth 1

- Today's wheat is not our grandfather's wheat

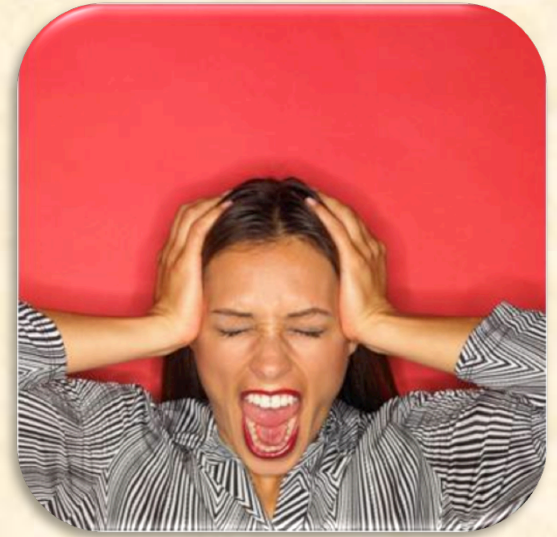
Myth 2

- Modern wheat is on gluten overdrive

- “Modern wheat choices likely exacerbate the problem of celiac disease. Today’s farmers prefer protein-rich varieties that produce greater yields.” *National Geographic*, 2012



- “Blame for the increase of celiac disease sometimes falls on gluten-rich, modern wheat varieties, increased consumption of wheat, and the ubiquity of gluten in processed foods.” *New York Times*, 2013



- “Modern wheat has more carbs than ancient wheat”. *Space Coast Daily.com*, July 2014



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A REPORTER AT LARGE | NOVEMBER 3, 2014 ISSUE

AGAINST THE GRAIN

Should you go gluten-free?

BY MICHAEL SPECTER



Just after Labor Day, the Gluten and Allergen Free Expo stopped for a weekend at the Meadowlands Exposition Center. Each year, the event wends its way across the country like a travelling medicine show, billing itself as the largest display of gluten-free products in the United States. Banners hung from the rafters, with welcoming messages like “Plantain Flour Is the New Kale.” Plantain flour contains no gluten, and



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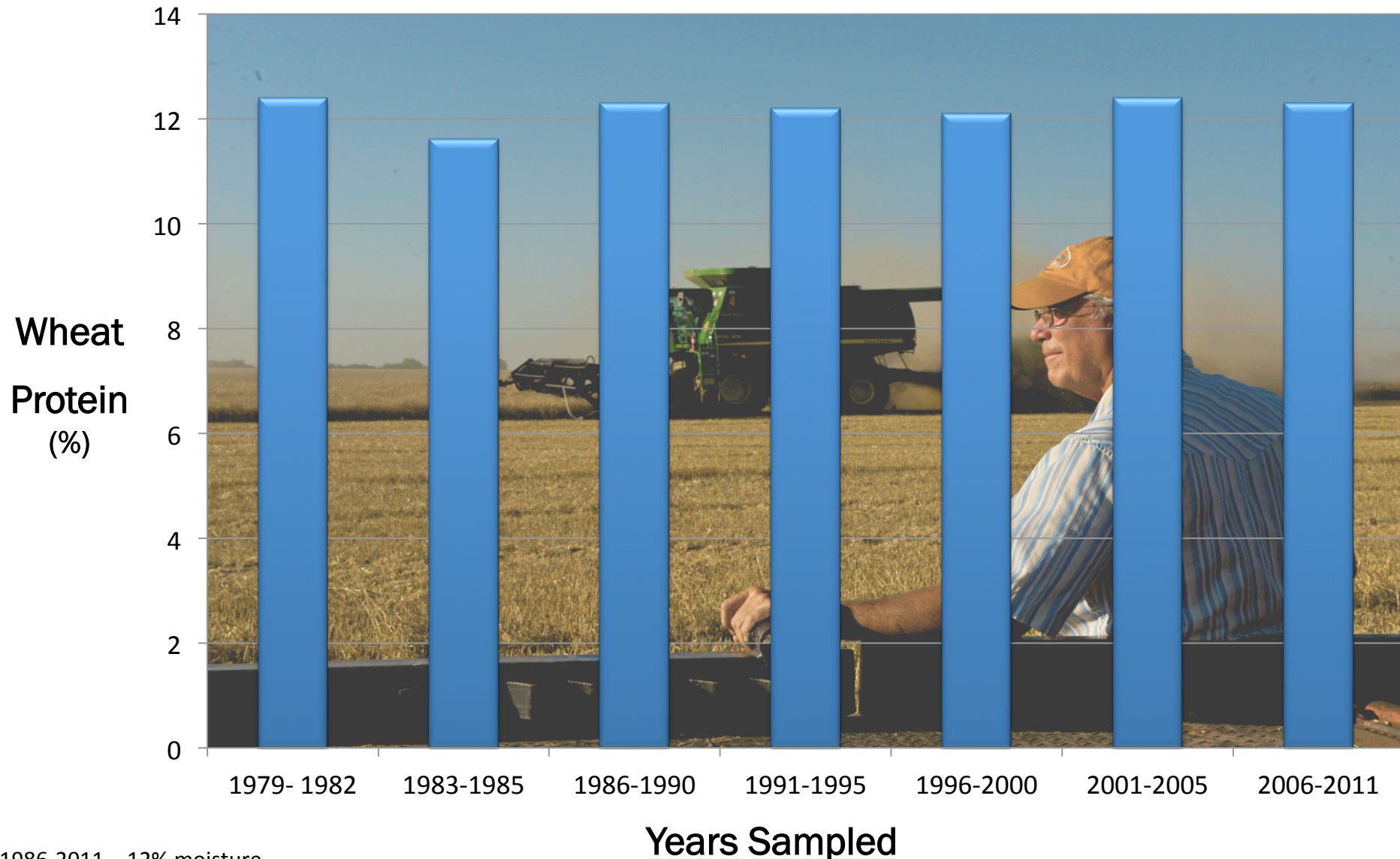
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BY MICHAEL SPECTER

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*“The wheat grain is not a lot different than it was fifty years ago.”
“Chemically, the contents just have not changed much.”
-Dr. Joseph Murray, Mayo Clinic, professor of medicine*

US Wheat Associates: On-Farm Protein



1986-2011 – 12% moisture
1979-1985 – “as is” moisture

Bread Wheat Varieties

Protein Content (%) Changes Over Time

	Hard Red Winter		Hard Red Spring
	Southern Plains	Northern Plains	Northern Plains
Pre-1940s	11.7		
1960s	11.5		
1970s	11.3		
1980s	11.5		
1990s	11.8		
2000s	—		
Change	0		
Source	BF Carver Euphytica, 2001		

Side-by-side comparisons within each region across multiple years

Bread Wheat Varieties

Protein Content (%) Changes Over Time

	Hard Red Winter		Hard Red Spring
	Southern Plains	Northern Plains	Northern Plains
Pre-1940s	11.7	13.4	
1960s	11.5	12.6	
1970s	11.3	12.7	
1980s	11.5	12.4	
1990s	11.8	12.2	
2000s	—	12.1	
Change	0	Downward	
Source	BF Carver Euphytica, 2001	PS Baenziger Euphytica, 2005	

Side-by-side comparisons within each region across multiple years

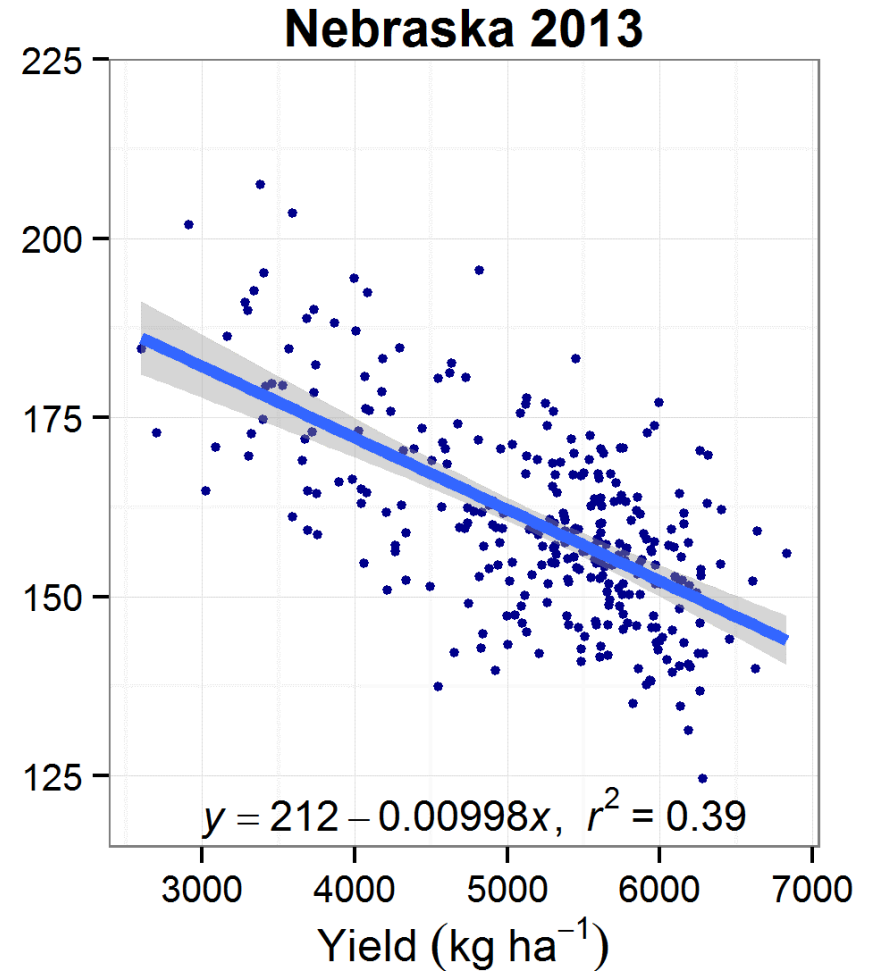
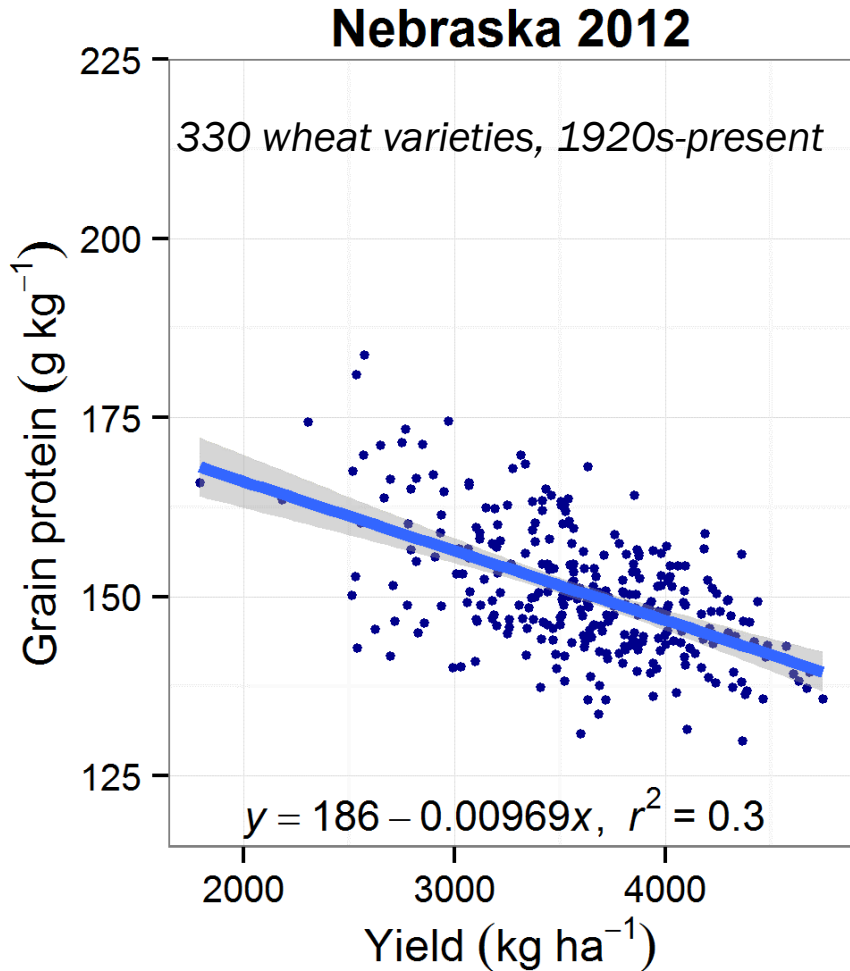
Bread Wheat Varieties

Protein Content (%) Changes Over Time

	Hard Red Winter		Hard Red Spring
	Southern Plains	Northern Plains	Northern Plains
Pre-1940s	11.7	13.4	14.9
1960s	11.5	12.6	—
1970s	11.3	12.7	14.8
1980s	11.5	12.4	14.5
1990s	11.8	12.2	14.7
2000s	—	12.1	15.1
Change	0	Downward	0
Source	BF Carver Euphytica, 2001	PS Baenziger Euphytica, 2005	M Mergoum Cereal Chem., 2008

Side-by-side comparisons within each region across multiple years

Up with yield, down with protein



What We Know About Wheat Protein

- Stable over eras; genetic challenge to move up
- That which forms gluten—about 75-80%
- Environment has twice the effect on wheat protein content than genetics!

% of Total Wheat Protein	
Gluten	75-80
Gliadin	30-40
Glutenin	40-45
LMW	20-30
HMW	5-10

More About Wheat Gluten

- Gliadin content highly sensitive to environment; glutenin content less sensitive
 - Distinct differences – same vty, different locations
- Gliadin/glutenin ratio in US bread wheat – no systematic change
- Breeders tend not to select for specific protein components; functionality is key
- Varieties vary widely in expression pattern for Celiac responsive epitopes (33-mer peptide)



Presence of celiac disease epitopes in modern and old hexaploid wheat varieties: wheat breeding may have contributed to increased prevalence of celiac disease

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Abstract Gluten proteins from wheat can induce celiac disease (CD) in genetically susceptible individuals. Specific gluten peptides can be presented by antigen presenting cells to gluten-sensitive T-cell lymphocytes leading to CD. During the last decades, a significant increase has been observed in the prevalence of CD. This may partly be attributed to an increase in awareness and to improved diagnostic techniques, but increased wheat and gluten consumption is also considered a major cause. To analyze whether wheat breeding contributed to the increase of the prevalence of CD, we have compared the genetic diversity of gluten proteins for the presence of two CD epitopes (Glia- α 9 and Glia- α 20) in 36 modern European wheat

varieties and in 50 landraces representing the wheat varieties grown up to around a century ago. Glia- α 9 is a major (immunodominant) epitope that is recognized by the majority of CD patients. The minor Glia- α 20 was included as a technical reference. Overall, the presence of the Glia- α 9 epitope was higher in the modern varieties, whereas the presence of the Glia- α 20 epitope was lower, as compared to the landraces. This suggests that modern wheat breeding practices may have led to an increased exposure to CD epitopes. On the other hand, some modern varieties and landraces have been identified that have relatively low contents of both epitopes. Such selected lines may serve as a start to breed wheat for the introduction of 'low CD toxic' as a new breeding trait. Large-scale culture and consumption of such varieties would considerably aid in decreasing the prevalence of CD.

Communicated by J. Snape.

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Introduction

X Environmental factors
X Genetic sampling
X Statistical rigor

Monitor gluten changes with breeding in true breeding populations

BREEDING PROGRESS



Base (unimproved)
germplasm

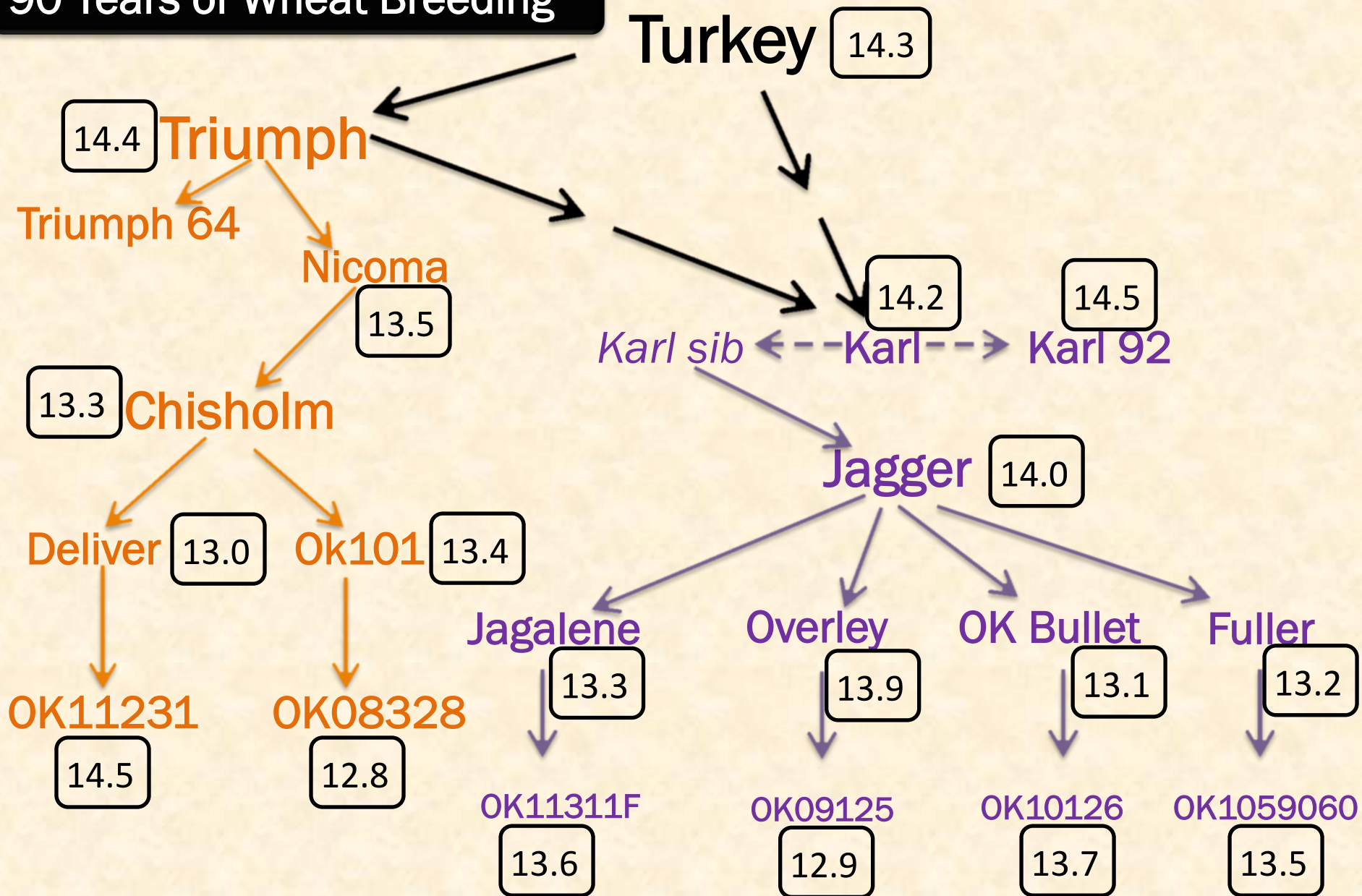


Improved descendents



Improved current
descendents

90 Years of Wheat Breeding



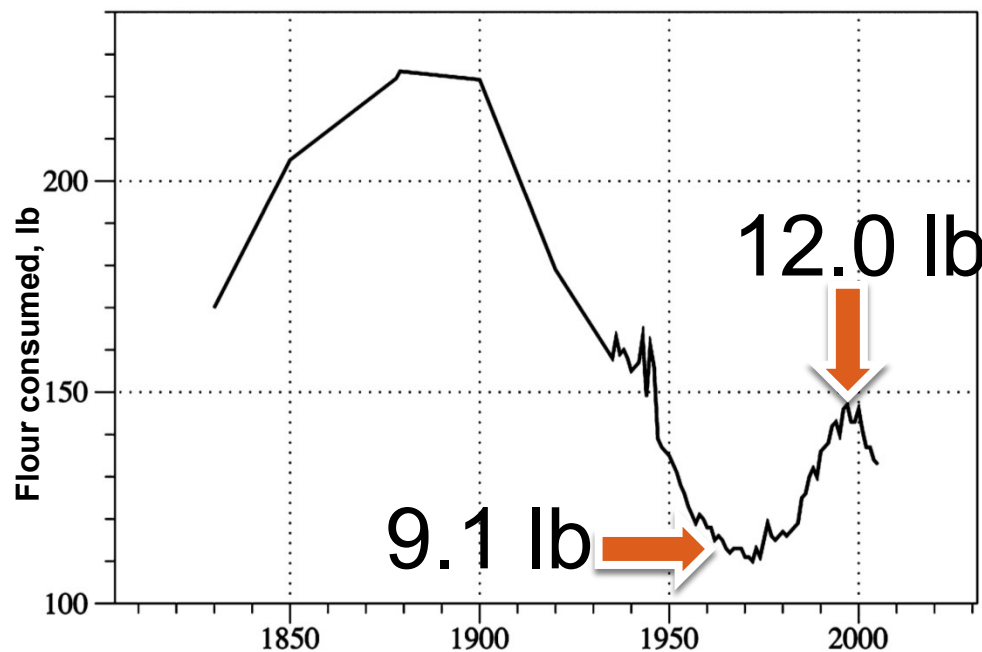
Wheat protein data, 2014, Stillwater, OK

Gluten consumption

D. Kasarda, *J Agric Food Chem* 2013

Vital gluten improves
whole wheat product
performance

1977 0.3 lb
vs
2012 0.9 lb



Key Messages

- Modern wheat – a melting pot of ancestral genetics, and natural
- No systematic increase in gluten content or composition with breeding
- Environment greatly influences protein expression, and functionality
- Specific gluten proteins not the main attraction in breeding
- Nothing obvious, yet, about gluten components and diet response





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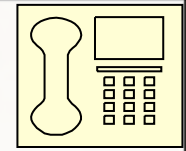
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