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2015 National Fusarium Head Blight Forum
St. Louis, MO 6 Dec 2015

Managing mycotoxin issues in corn and small grains: parallels and contrasts

Corn & small grain comparisons

- Issues
  - Major mycotoxigenic fungi & mycotoxins
  - Production & use of corn vs. small grain cereals
  - Impacts of mycotoxins – N. America, globally
- Management strategies
  - Breeding
  - Risk assessment models
  - Crop protection chemicals
  - Genetic engineering

Major pathogens & mycotoxins

- Corn
  - *Aspergillus flavus* - aflatoxins
  - *Fusarium verticillioides* & others - fumonisins
  - *Fusarium graminearum* & others – deoxynivalenol & derivatives, zearalenone, *other trichothecenes*

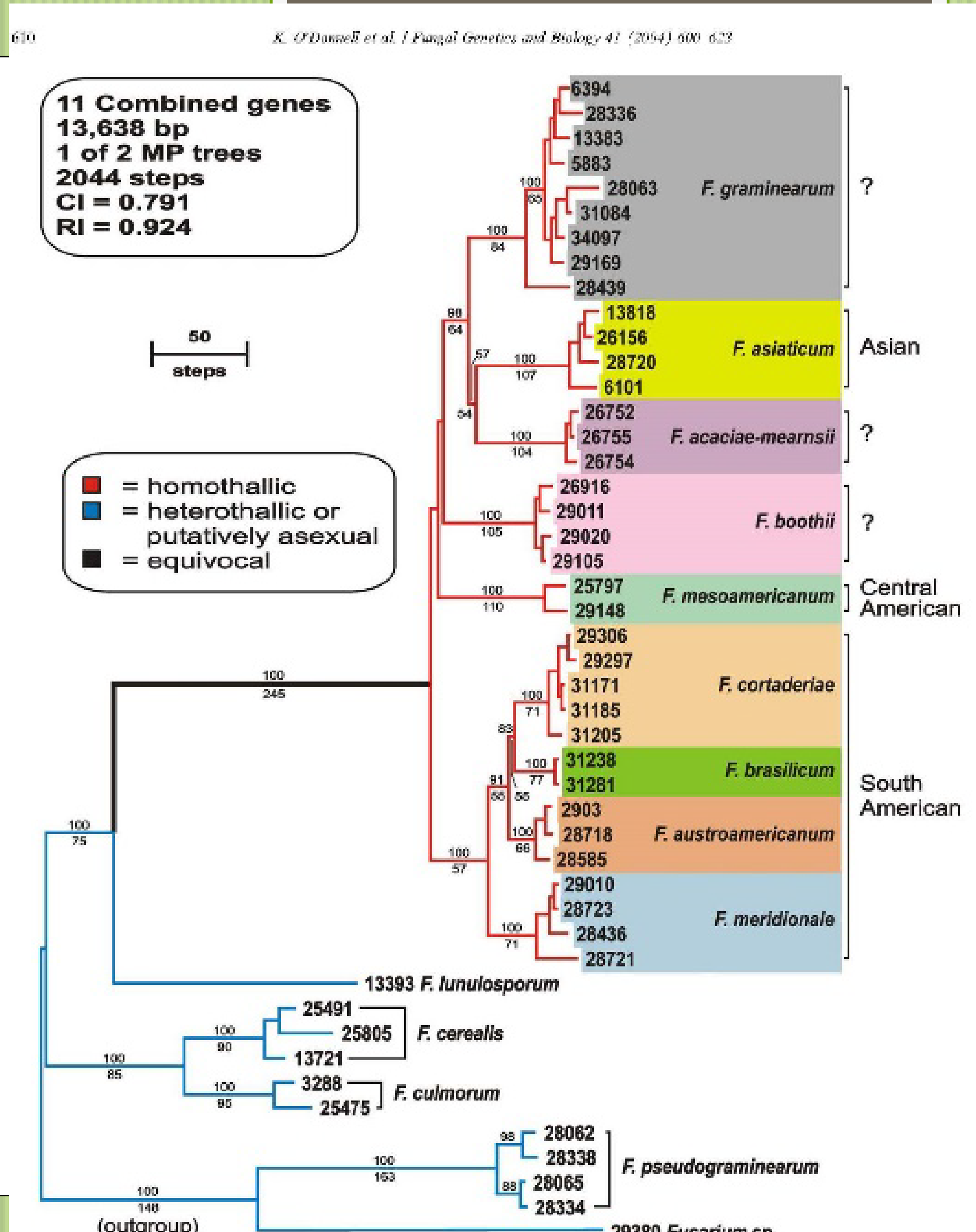


Major pathogens & mycotoxins

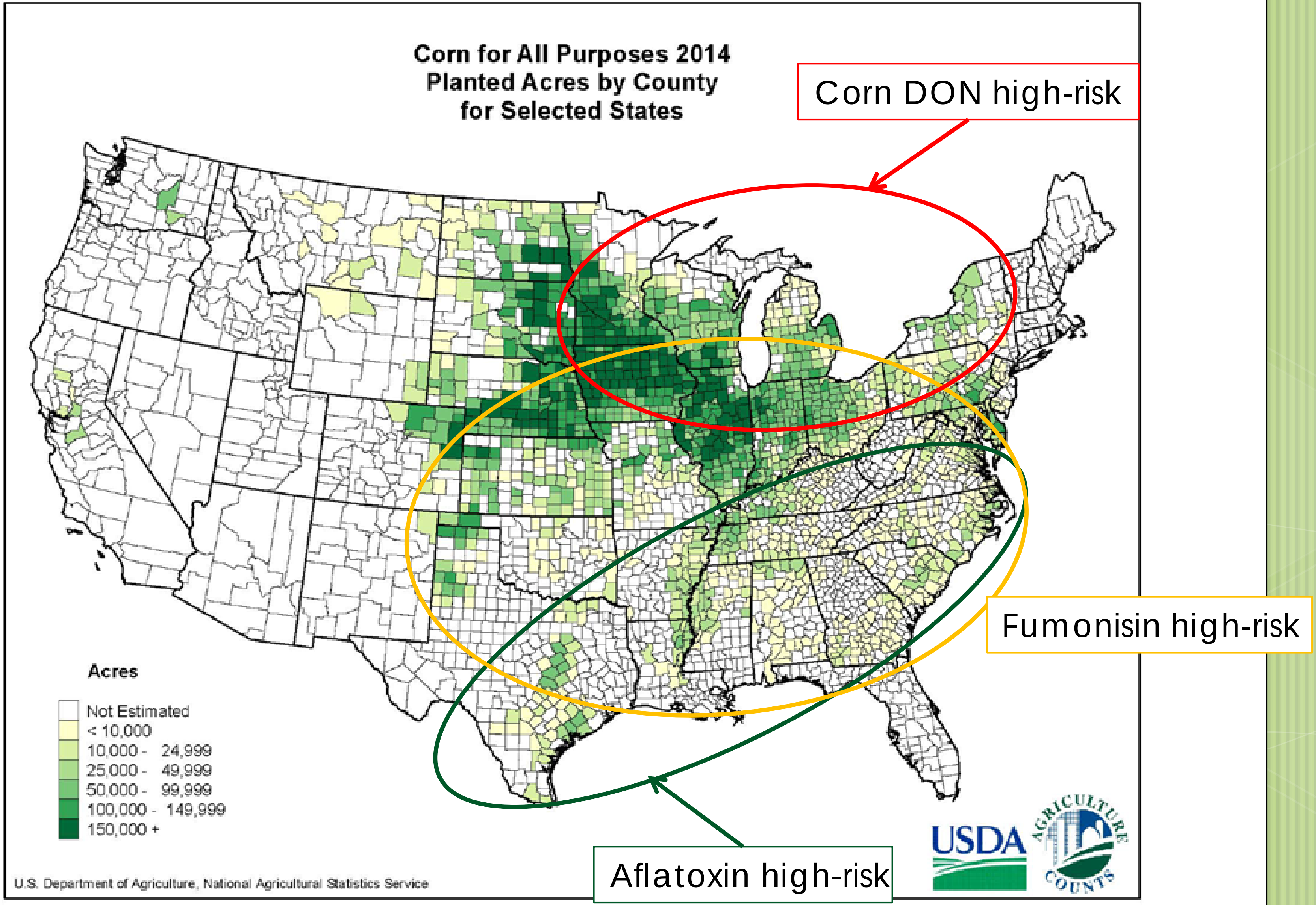
- Wheat and barley
  - *Fusarium graminearum* & others – deoxynivalenol & derivatives, zearalenone, <u>other trichothecenes</u>
  - *Penicillium verrucosum* – ochratoxin A



Fusarium graminearum species complex



Disease distribution differs between corn and small grains due to differences in disease cycles



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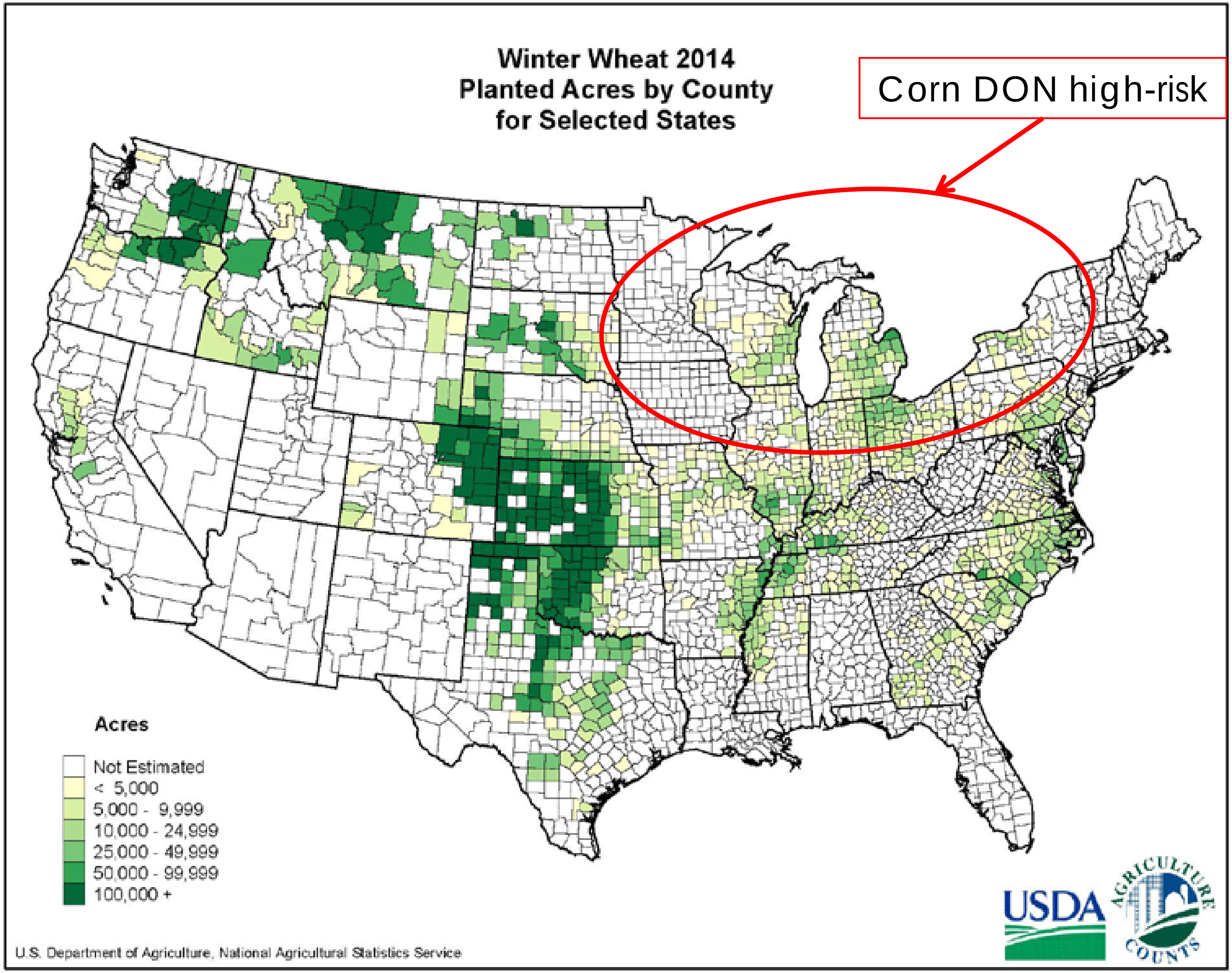

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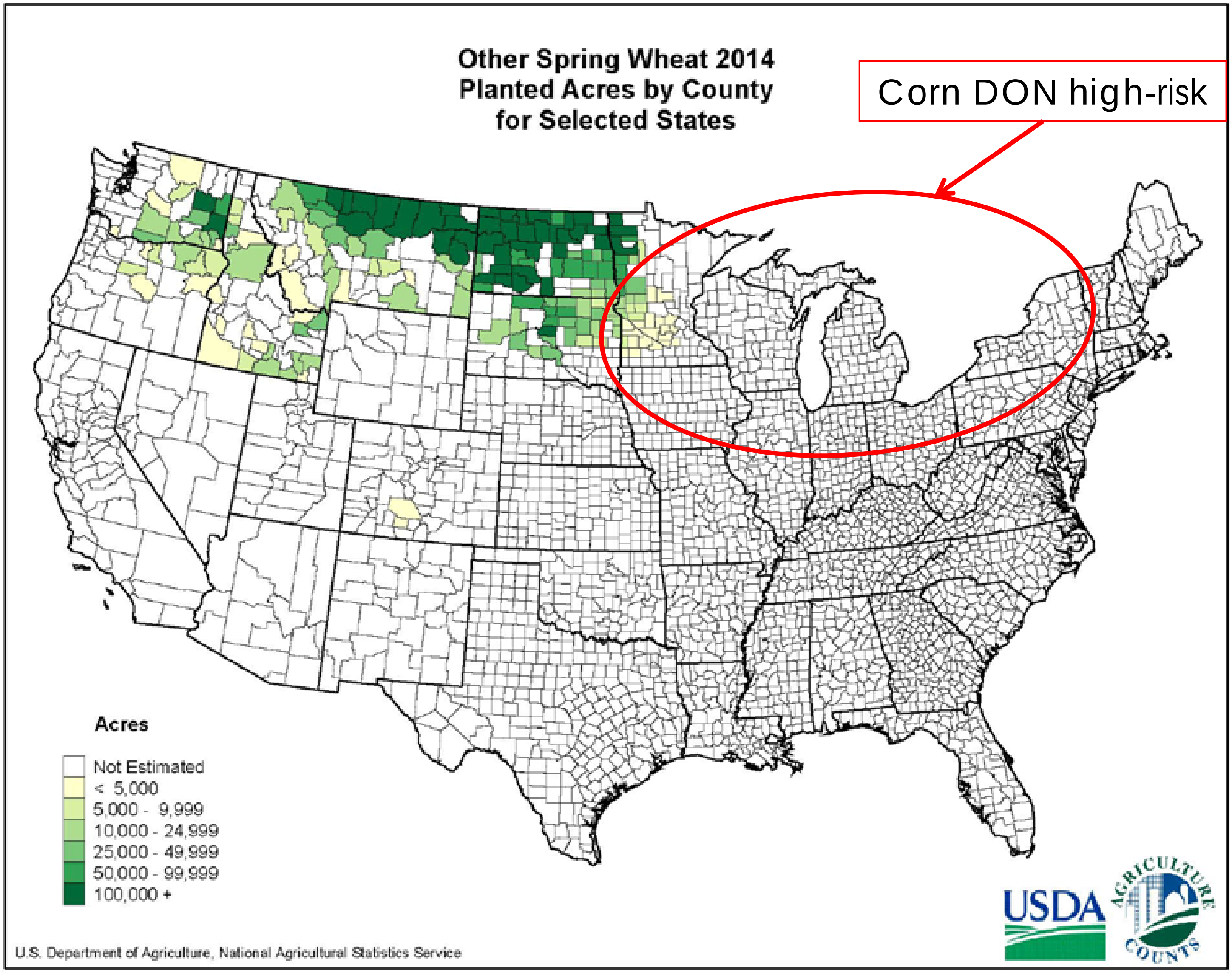

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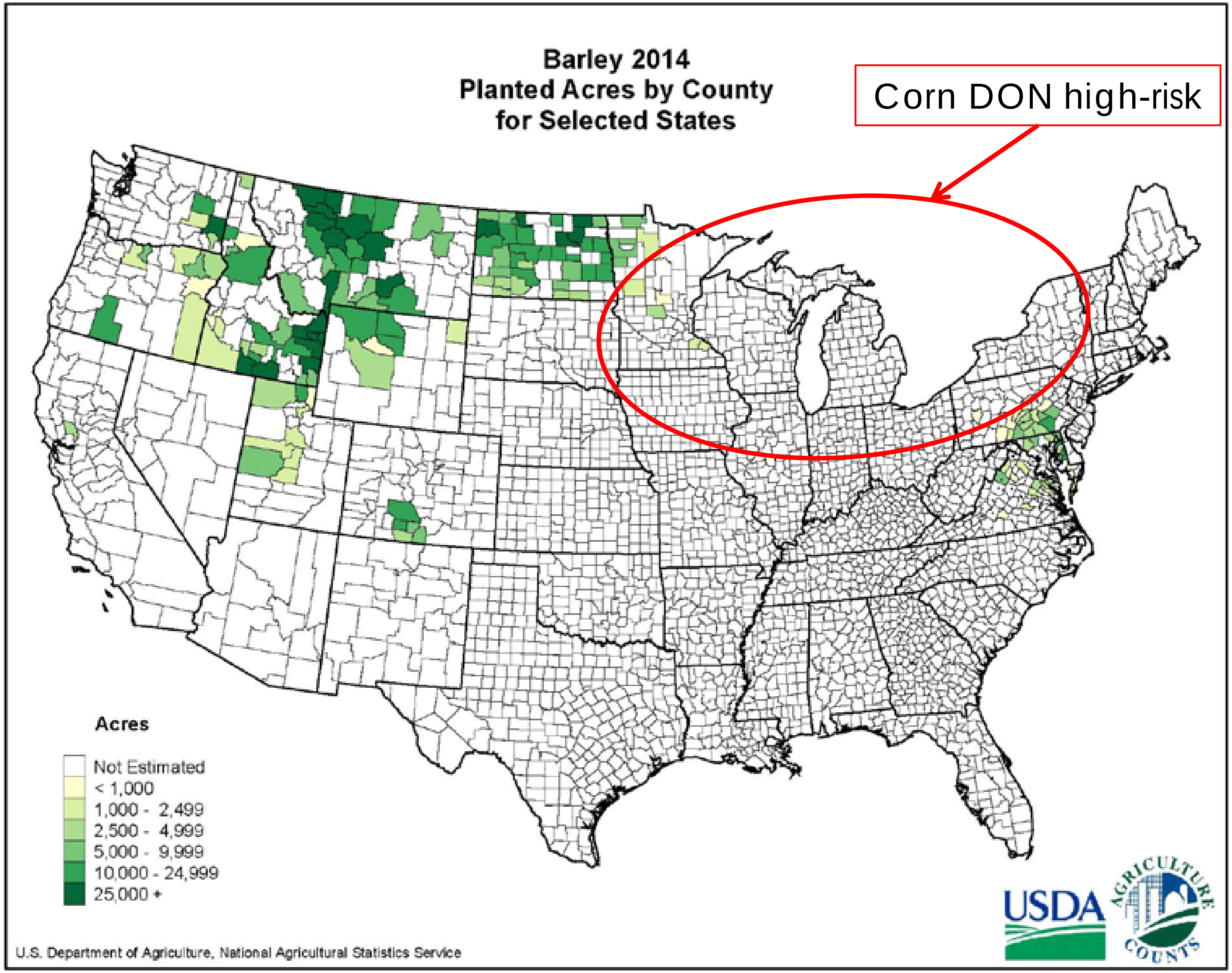
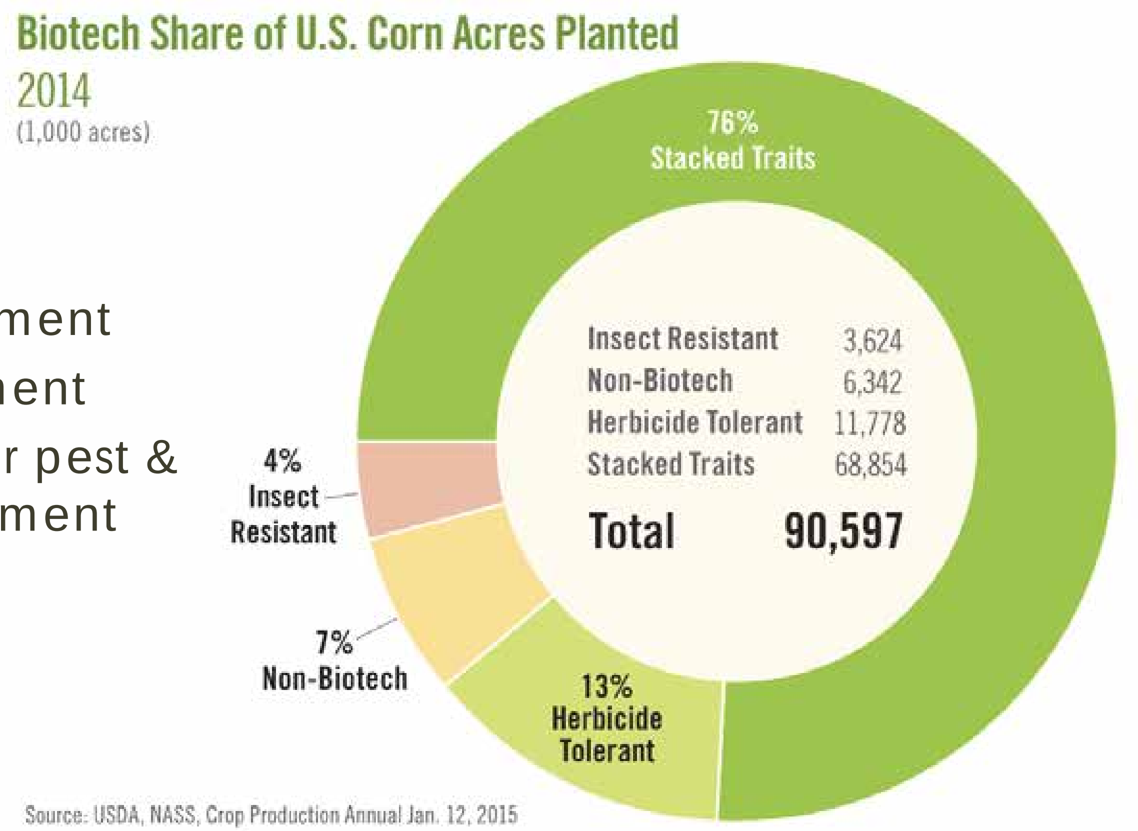


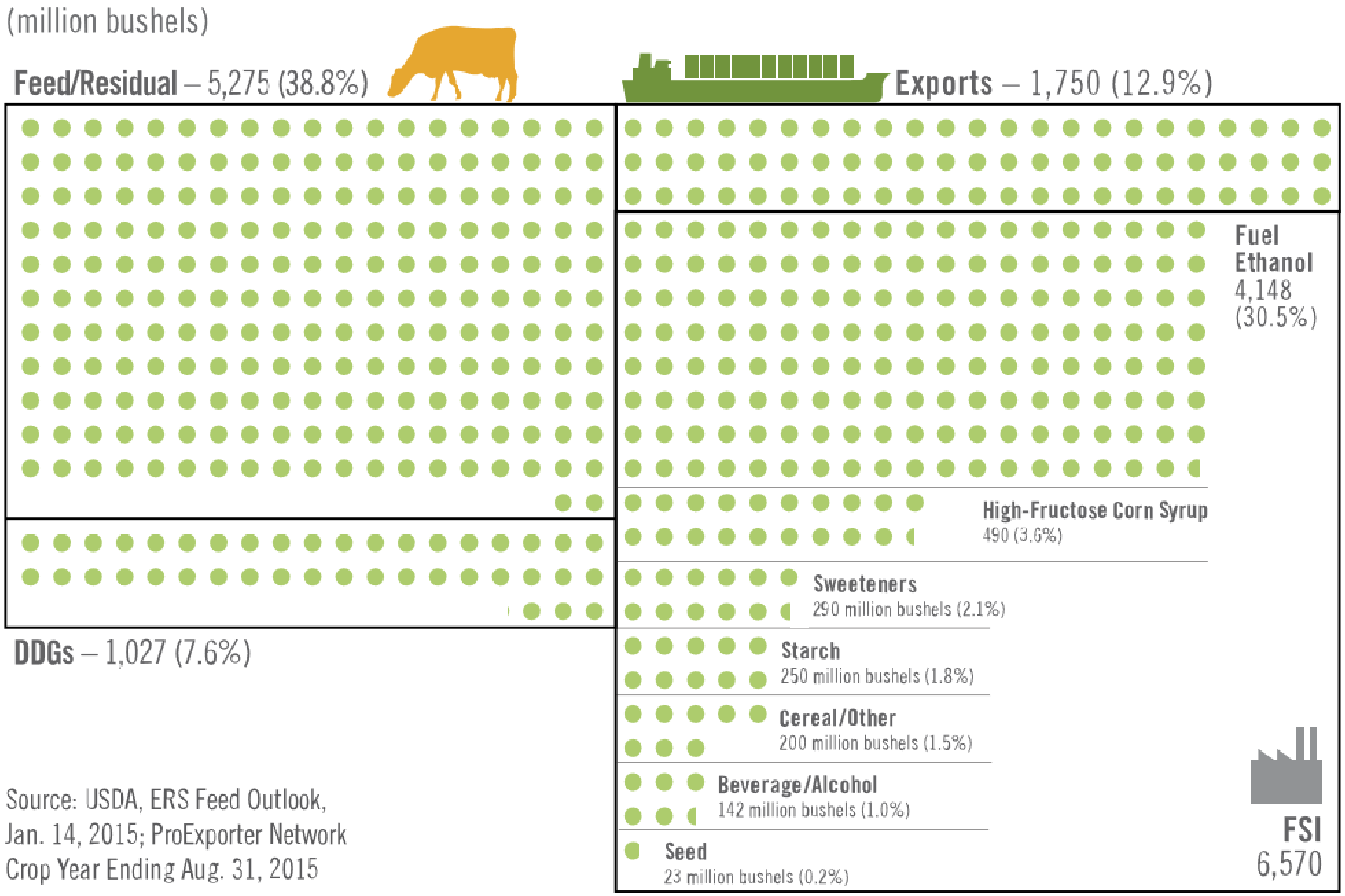
Corn is a hybrid, transgenic crop

- Implications for:
  - Seed cost
  - Cultivar development
  - Research investment
  - Available tools for pest & disease management



www.worldofcorn.com

Corn Usage by Segment 2014



Source: USDA, ERS Feed Outlook, Jan. 14, 2015; ProExporter Network Crop Year Ending Aug. 31, 2015

Mycotoxins in DDGS

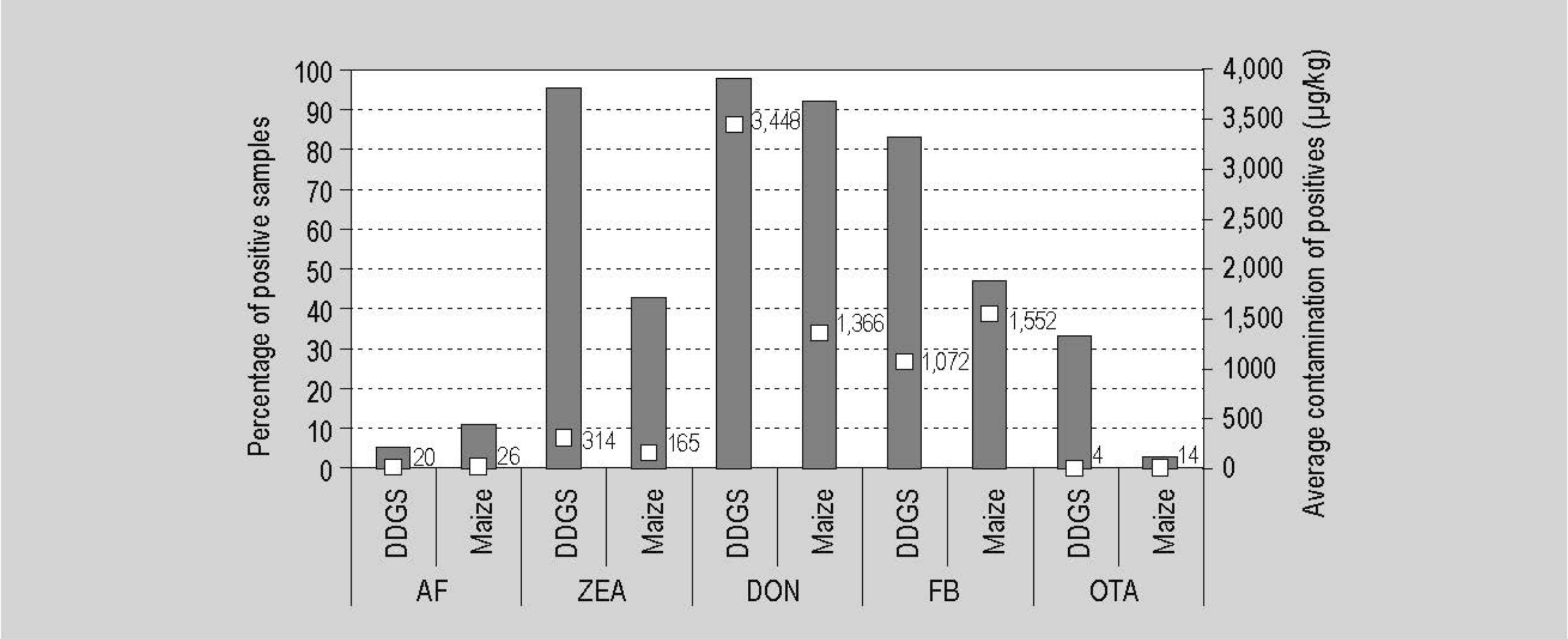


Figure 3. Comparison of the prevalence of and average contamination with aflatoxins (AF), zearalenone (ZEA), deoxynivalenol (DON), fumonisins (FB) and ochratoxin A (OTA) in dried distillers' grains and solubles (DDGS) and US maize in 2010.

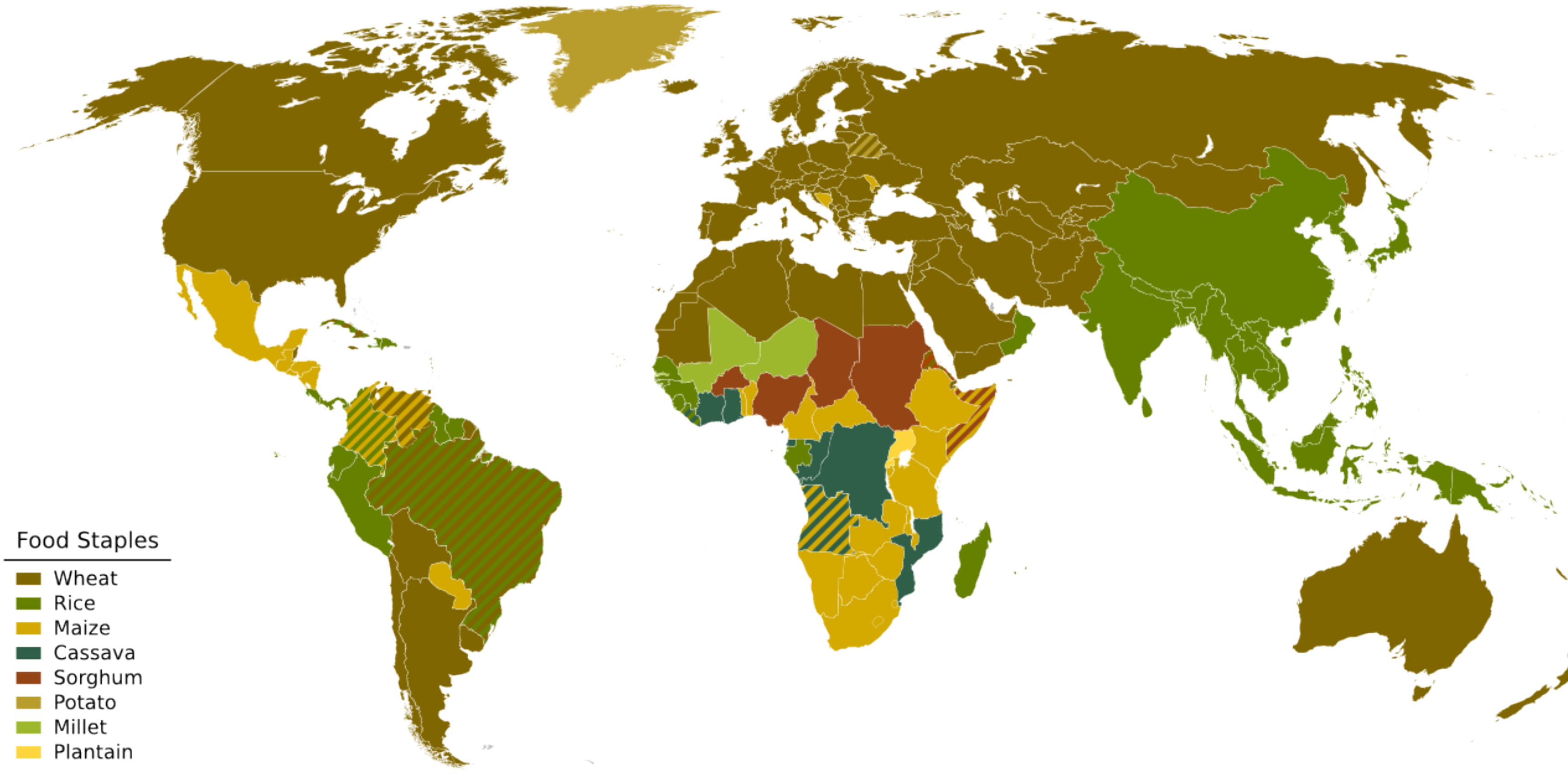
Schatzmayr and Streit, 2013

Mycotoxin impacts

- Corn – N. America
  - Aflatoxins – significant market impacts
  - Fumonisins – livestock production impacts, some market impacts, limited human health impacts
  - DON and zearalenone – market impacts (DDGS), livestock production impacts
- Corn – Low-income countries
  - Significant human health impacts (aflatoxins, fumonisins)
- Wheat – N. America
  - DON and zearalenone – significant market, food industry impacts
- EU
  - Significant market impacts, also on countries exporting to EU
    - $600 M USD annual costs to African countries in lost exports

G. Munkvold
2015 Fusarium Head Blight forum

Global staple foods



Mycotoxin impacts

- Corn is not routinely tested at the point of sale
  - Exceptions - aflatoxin problem areas, outbreak years; EtOH plants, corn for food use
  - Price docking for aflatoxins

Contamination	Kansas	Texas
20 ppb	$.05	$.30
100 ppb	$.45	$.60
150 ppb	$.95	$.60
200 ppb	-	$.90
300 ppb	-	$1.65

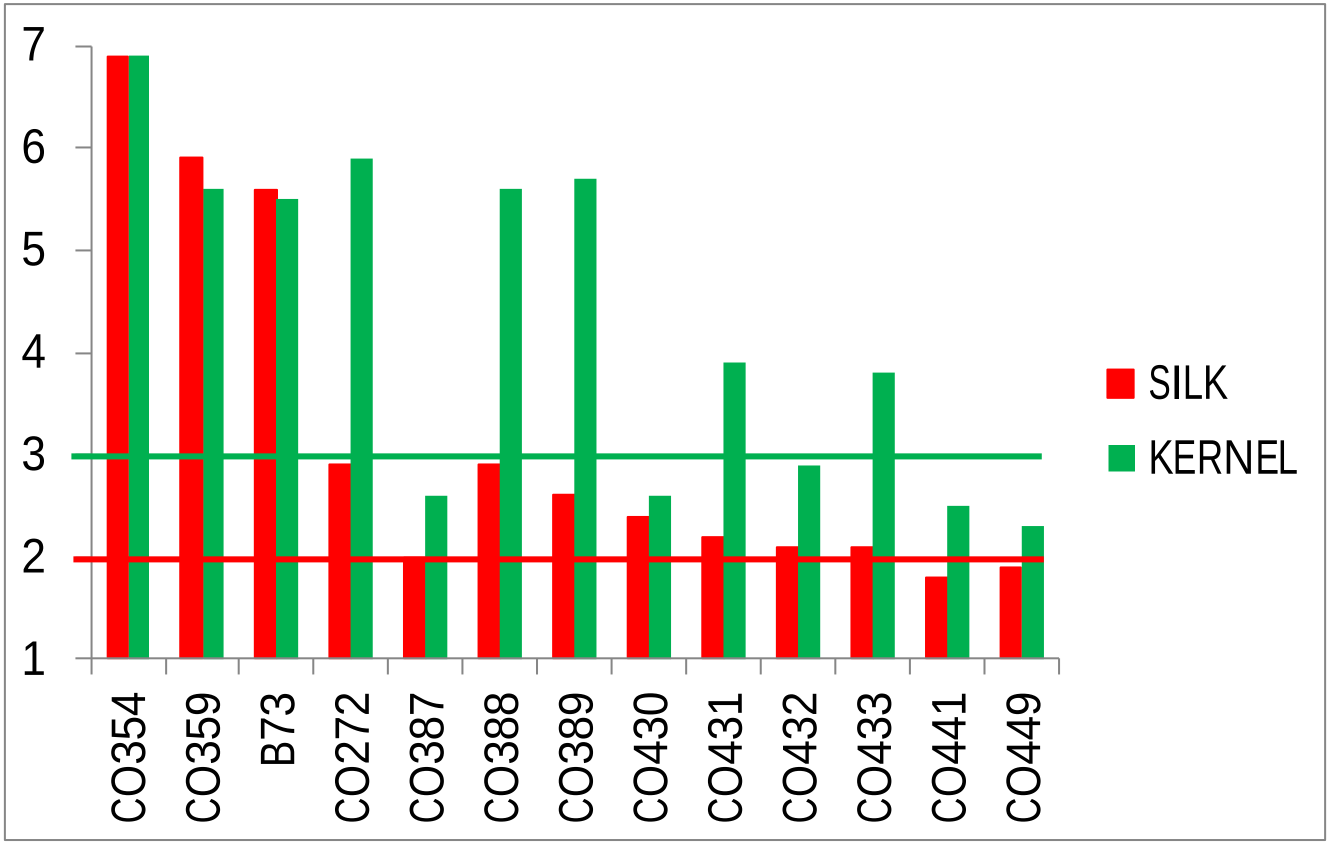
  - In most states the policy is to reject grain > 20 ppb
- Food Safety Modernization Act could change practices

Mycotoxin management strategies

	Corn	Small grains
Breeding	++	++
Insect management	++	-
Risk assessment models	+/-	+
Fungicides	-	++
Biocontrol	+/-	?
Cultural practices	+	+
Genetic engineering	++*	++**

*Insect resistance, drought tolerance
**Potential disease-resistance traits

Available Gibberella ear rot resistance – Agriculture & Agri-Food Canada releases



Courtesy Lana Reid, AAFC

Commercial hybrid CO441 AAFC testcross hybrid

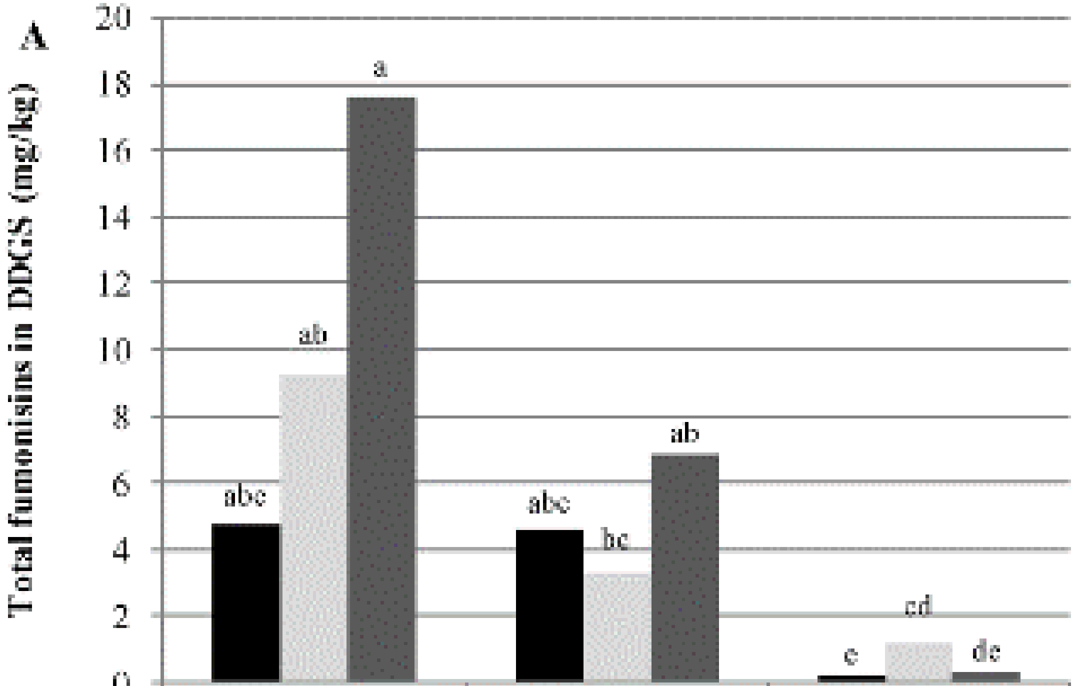
Courtesy Lana Reid, AAFC

Fusarium verticillioides -
Susceptible and resistant hybrids

Courtesy Mark Mancl, DuPont Pioneer

Challenge: incorporating resistance into high-yielding, agronomically desirable hybrids

Mycotoxins are lower in grain and DDGS from Bt corn



	NoBt	Cry1Ab	Cry1Ab x Vip3Aa
Natural	4.72	4.62	0.17
ECB	9.19	3.31	1.18
CEW	17.64	6.90	0.32

Bt hybrid

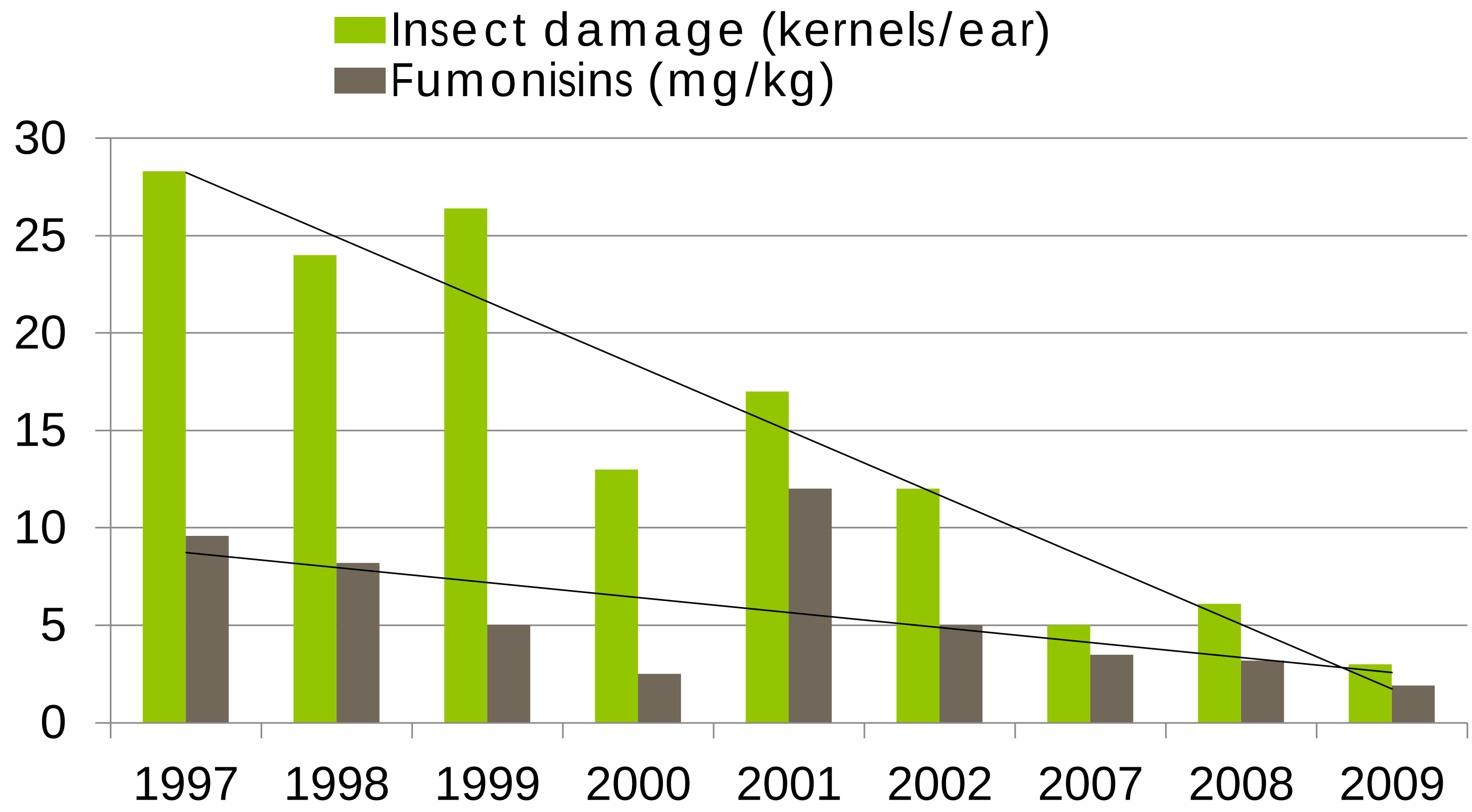
Conventional hybrid

Bowers and Munkvold, 2014

Seed Science Center

Plant Pathology and Microbiology
Iowa State University

Insect feeding damage and fumonisins in non-Bt maize plots in Iowa experiments



Munkvold & Hellmich

Seed Science Center

Fungicide use for corn ear rots

- Challenges:
  - Multiple pathogens & infection pathways
  - Canopy architecture
  - Timing
- Needs:
  - Better systemic activity
  - Different application technology
  - Risk assessment models
    - Have been developed but not widely implemented

Limay-Rios et al., 2013

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Fungicide application for ear rot / mycotoxin management

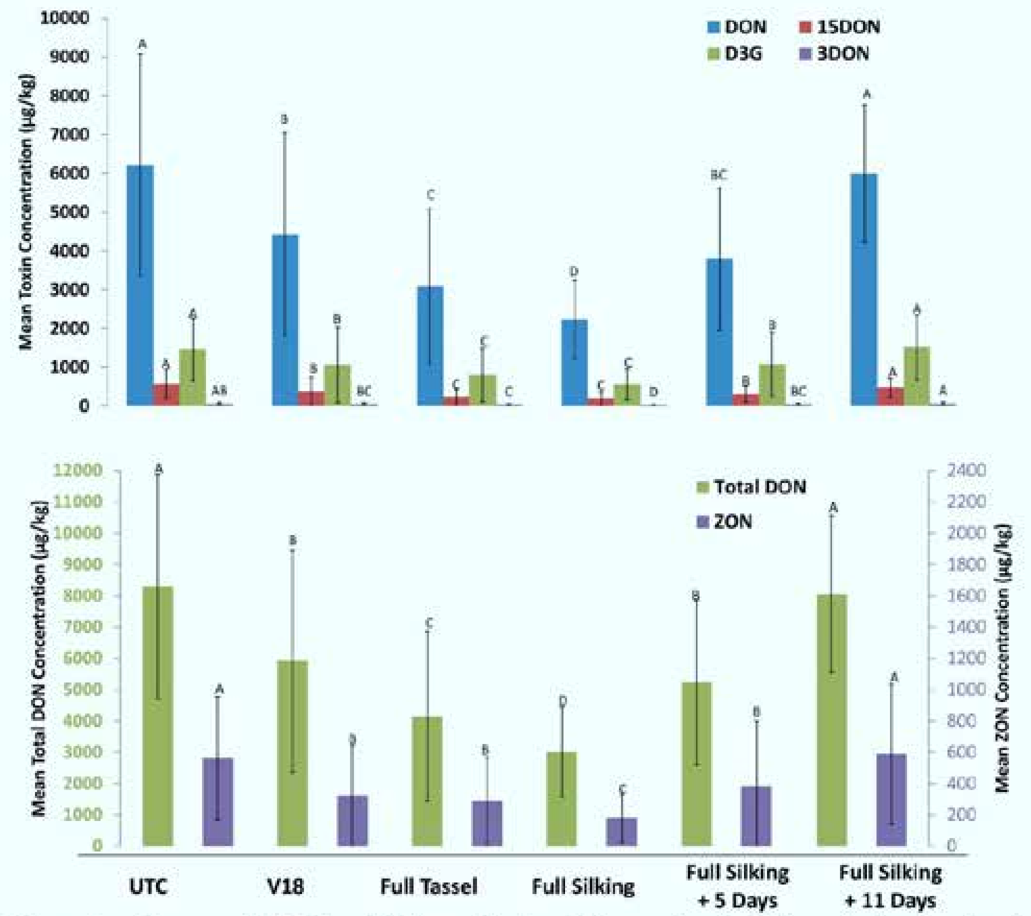

Fig 3, Effect of prothioconazole (200g a.i./Ha) application timing on levels of deoxynivalenol, related compounds and zeralenone (µg/kg) found in maize grain harvested from misting and field trials in 2010 and 2011 (P<0.01).

Limay-Rios and Schaafsma, 2013

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Fungicide application for ear rot / mycotoxin management

Limay-Rios and Schaafsma, 2013

Atoxigenic *A. flavus* in corn

TREATMENT	AFLATOXIN (PPB)*
NONE	52.7
AFLA-GUARD	13.3

*68 LOCATIONS. 75% REDUCTION

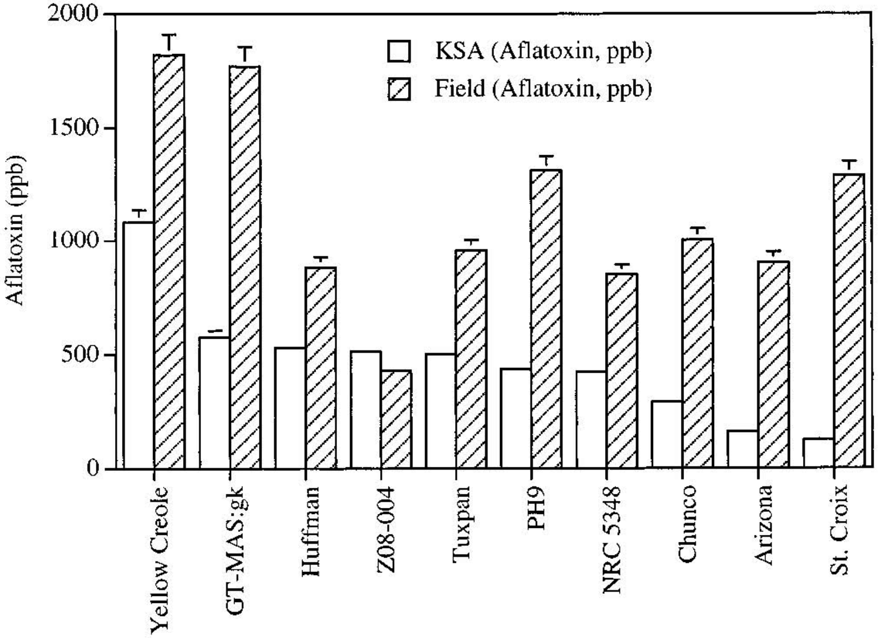
2010 Field Trials, Texas
(T. Isakeit, TAMU)

IITA project in Africa
- first year, 99% of treated fields had aflatoxins below 2 ppb

Photo courtesy IITA

Drought tolerance and aflatoxins

- Drought-tolerant maize introduced in 2012, 2013
  - DuPont Pioneer - Optimum® AQUAmax™
  - Syngenta - Agrisure Artesian™
  - Monsanto - Genuity® DroughtGard™
- 5-10% yield advantage under drought stress (OH St. Univ., TX A&M Univ.)



Tubajika and Damann, 2001

Summary

- Differing pathogens & disease cycles dictate strategies & priorities in mycotoxin management
  - Corn - insect management, drought tolerance, biocontrol
  - Wheat - risk assessment models, fungicides
  - Both – genetic resistance
- Different use patterns influence impacts, available tools, and post-harvest measures
  - Corn – livestock impacts, blending, feed additives
    - Public health interventions in developing countries
  - Wheat – food impacts, testing costs, quality management in food production
  - Genetic engineering acceptance!