Local corn debris management: What does it contribute to head blight and mycotoxin reduction?

Gary C. Bergstrom
Cornell University
Department of Plant Pathology and Plant-Microbe Biology

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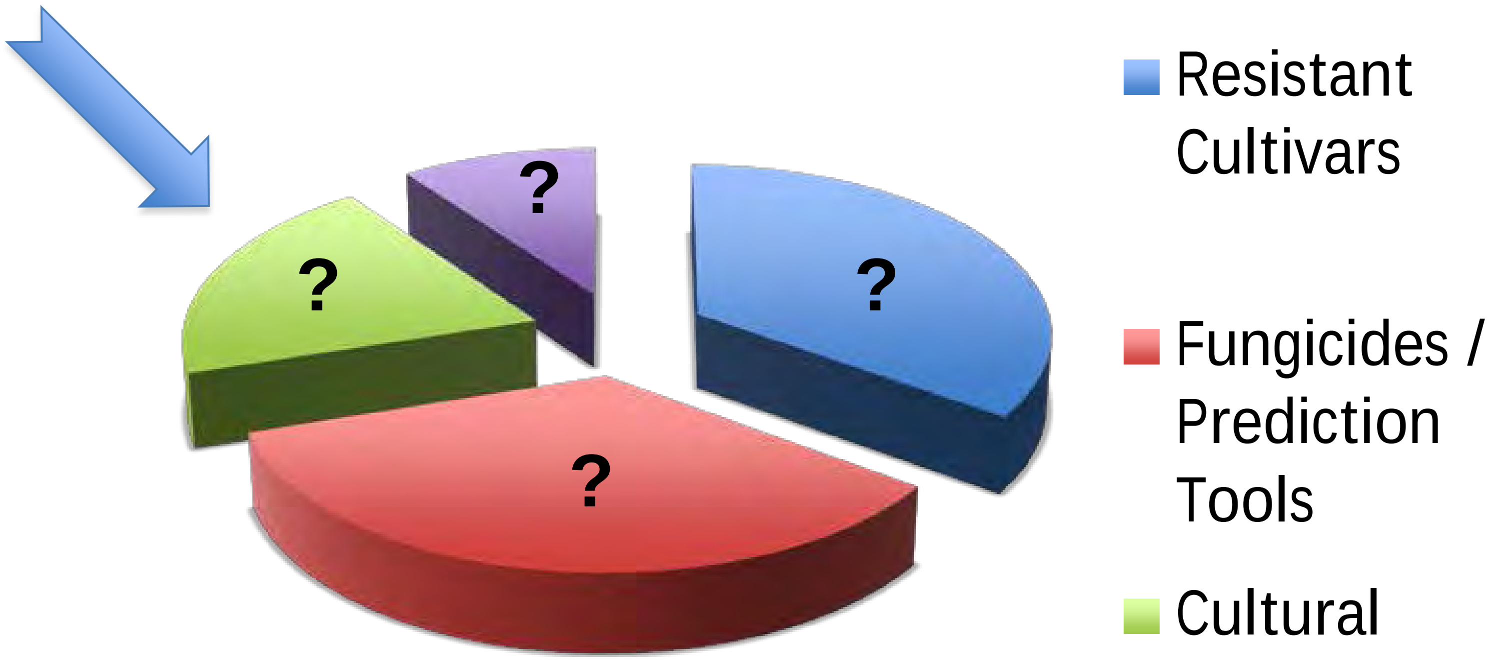
Effects of Local Corn Debris Management on FHB and DON Levels in Seventeen U.S. Wheat Environments in 2011 to 2013

Poster # 51

Co-authors:
Jaime A. Cummings & Katrina D. Waxman (Cornell Univ.)
Carl A. Bradley (Univ. of Illinois)
Stephen N. Wegulo (Univ. of Nebraska)
Ann L. Hazelrigg (Univ. of Vermont)
Donald E. Hershman (Univ. of Kentucky)
Martin Nagelkirk (Michigan State Univ.)
Laura E. Sweets (Univ. of Missouri)

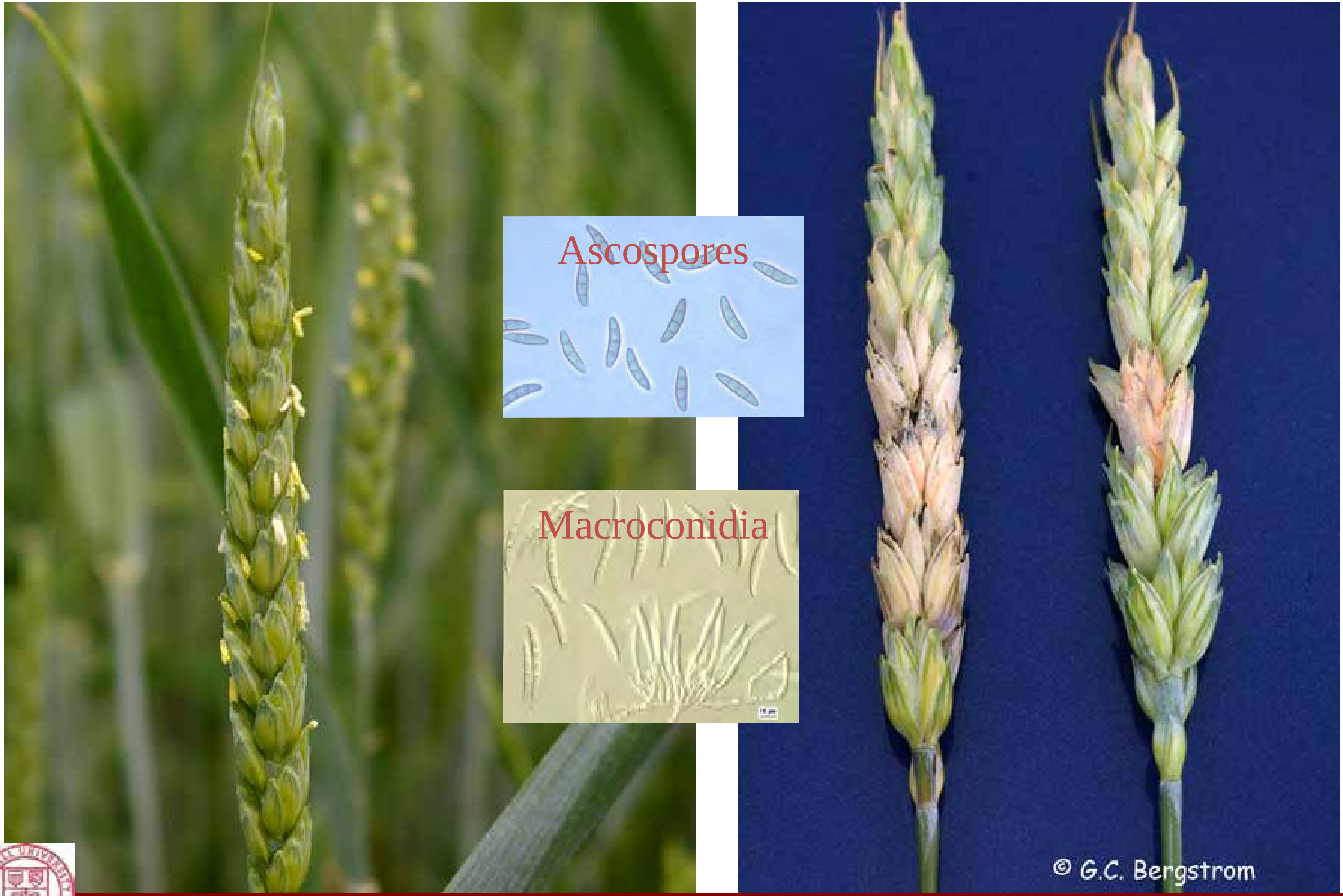
What is / can be the contribution of cultural control to integrated management of FHB/DON?



How big is the ‘cultural’ slice of the management pie?

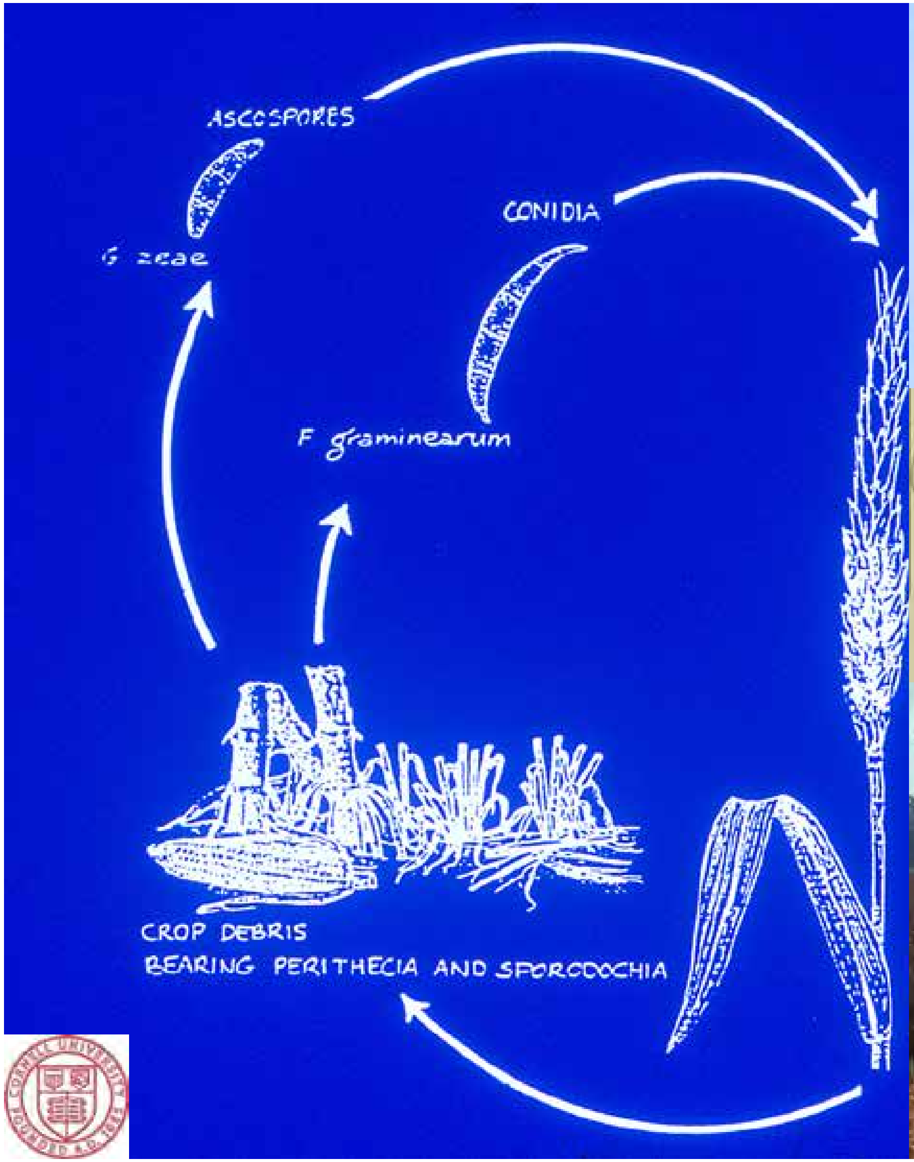
What gap is left in the absence of cultural control?

Cultural control of Fusarium head blight is based on …



avoiding or limiting exposure of cereal spikes to spores.

Cereal residues: principal source of spores for FHB



Conventional thinking about inoculum

•Airborne ascospores are the principle inoculum for infection of florets

•Splash dispersal limited to within 1-3 m of inoculum sources

•Inoculum sources are mainly local (within-field and near-field), based on steep horizontal gradients of disease or spore capture from area sources of inoculum

•Inoculum potential can be adequately predicted based on local weather favoring perithecial development and discharge

•Inoculum management (tillage, residue treatment, rotational sequence) in individual fields will likely result in significant reduction in FHB and DON

•Long distance dispersal occurs, but is of minor significance for annual epidemics

Management of overwintered cereal residues: Regional impact and benefits in individual cereal fields

Debris management strategies for FHB

- Avoid growing wheat and barley in proximity to cereal debris
  - Crop Rotation: follow non-host crops
  - Underseeded crops as splash barrier

- Remove or destroy cereal debris
  - Tillage: bury debris by moldboard (nearly complete) or chisel (partial or reduced) plowing
  - Burning of residue
  - Chopping, splitting, or other size reduction

- Treat debris to reduce *Fusarium* survival/sporulation
  - Green manures, organic acids, C/N sources, soil, clay, lime, microbial inoculants

- Reduce *Fusarium* content in debris of resistant cereals

Fusarium graminearum spore production on overwintered corn stalks

Data from: E.B. Khonga and J.C. Sutton. 1988. Can. J. Plant Pathol. 10:232-239.

Potential for local and long-distance dispersal

Perithecia per residue piece

	Above soil	On soil surface	Buried
+1 yr June	57	175	0
+2 yr June	42	1	-
+3 yr June	0	-	-

Potential for local rain-splash dispersal

Macroconidia per residue piece

	Above soil	On soil surface	Buried
+1 yr June	550,000	80,000	0
+2 yr June	30,000	0	0

Spatial patterns of FHB incidence

Mostly random, non-uniform, non-aggregated

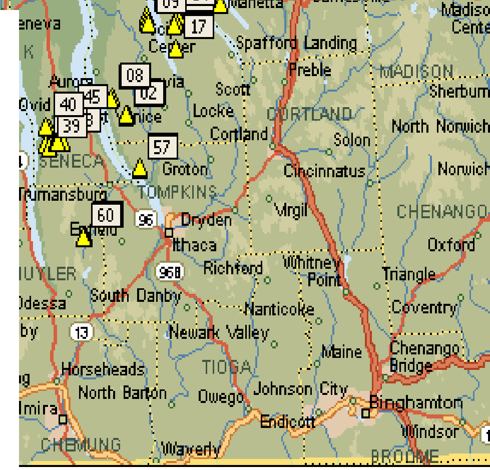
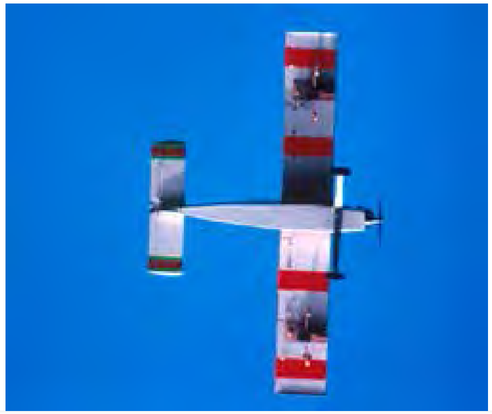


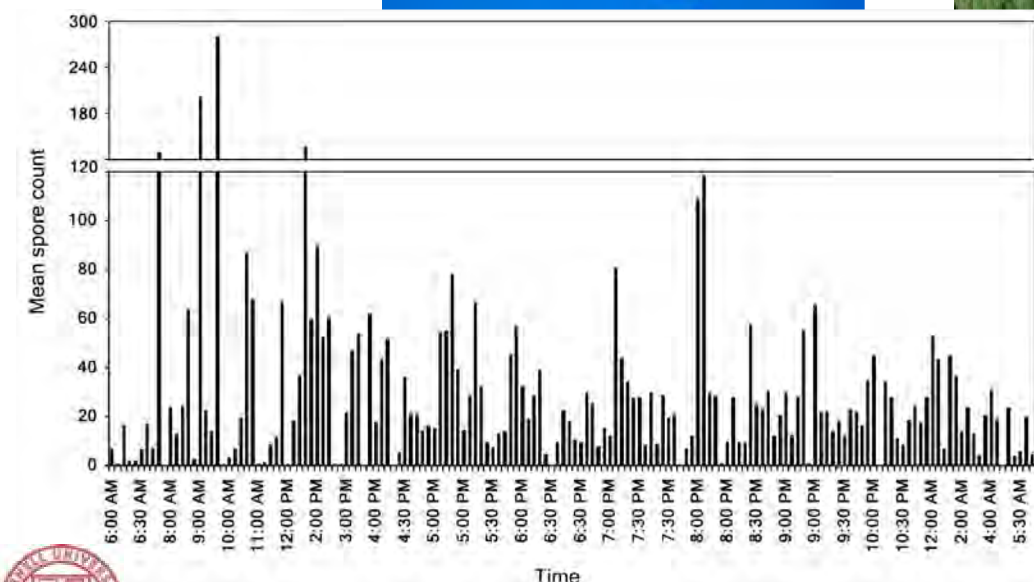
Table 3. Spatial patterns of Fusarium Head Blight (FHB) incidence in 70 New York winter wheat fields with different cropping histories, 2000 to 2002.

Previous crop	Number of fields with random FHB	Number of fields with aggregated FHB	Total Fields
Vegetable (bean, cabbage, pea)	25	2	27
Soybean	3	1	4
Oat	31	1	32
Sorghum	1	0	1
Corn	4	2	6
Total	64	6	70

Del Ponte, Shah, and Bergstrom. 2003. Online. Plant Health Progress doi:10.1094/PHP-2003-0418-01-RS.

Horizontal transport of spores over km distances in the planetary boundary layer





Maldonado-Ramirez et al. 2005. Agric. Forest Meteorol. 132:20-27
Schmale et al. 2012. Aerobiologia 28:1-11.

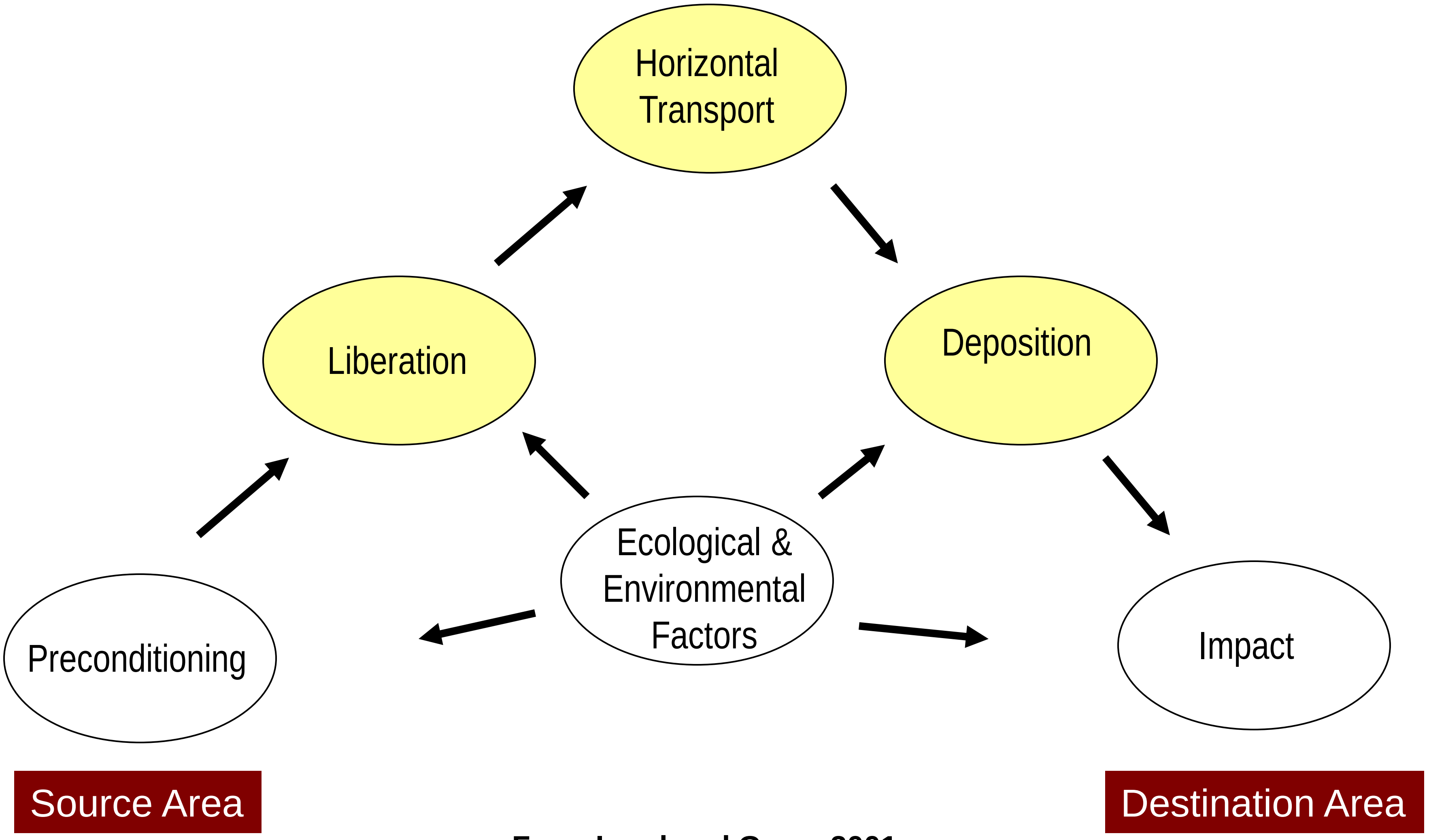
Deposition of spores:

Landing of viable spores of *F. graminearum* by gravitational settling or by rainfall

Similar magnitude over variable landscapes

Schmale, Shields, and Bergstrom. 2006. Can. J. Plant Pathol. 28:100-108.

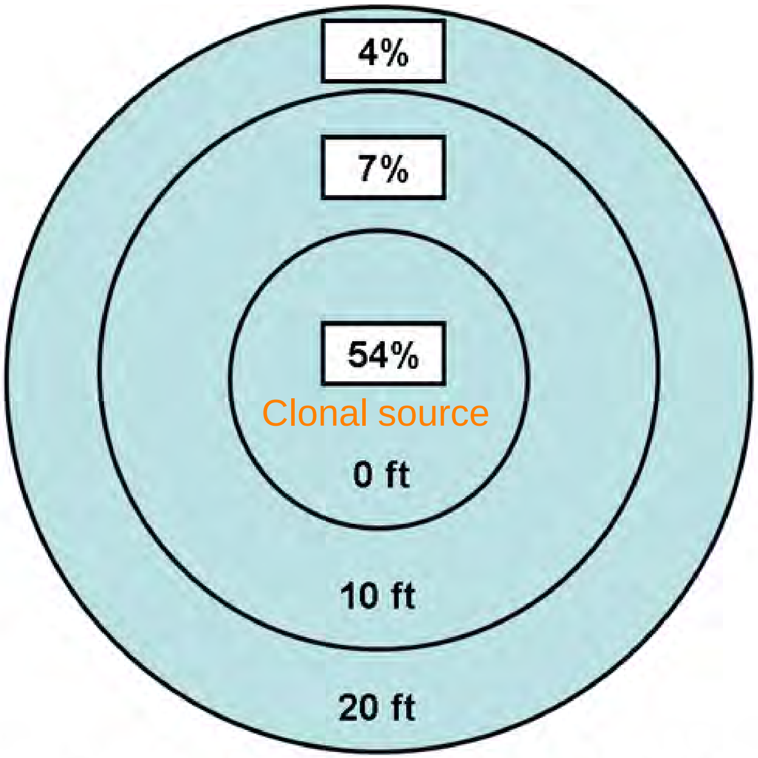
Ascospores may be deposited close to or distant from their source



From Isard and Gage, 2001.

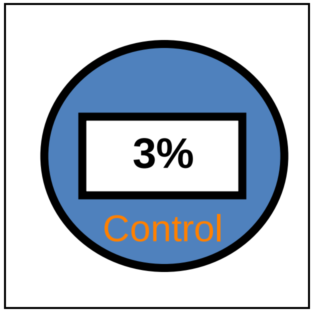
Keller et al. 2013. The aerobiology of *Fusarium graminearum*. Aerobiologia DOI 10.1007/s10453-013-9321-3 [Review]

Local distance infection by released clones of *F. graminearum*



Percentage of Infected Heads from Clonal Source

100 ft



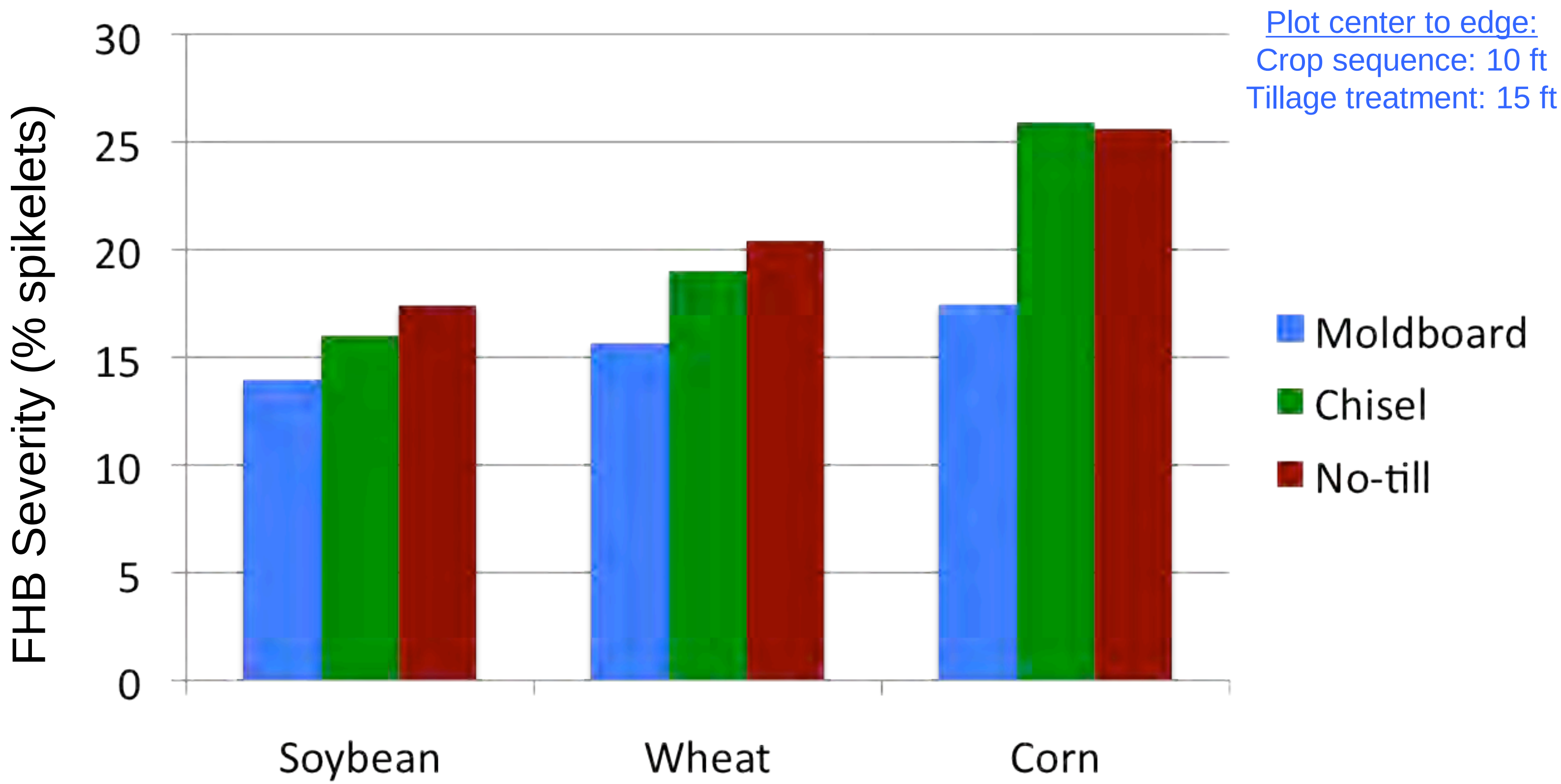
% Clones

Suggested a 3 to 6 meter (10 to 20 feet) interplot to avoid significant interplot interference from inoculum-bearing cereal residue

Keller, Waxman, Bergstrom, and Schmale. 2010. Plant Disease 94: 1151-1155.

Effects of previous crop and tillage on FHB severity in wheat

Data from: R. Dill-Macky and R.K. Jones. 2000. Plant Dis. 84:71-76.

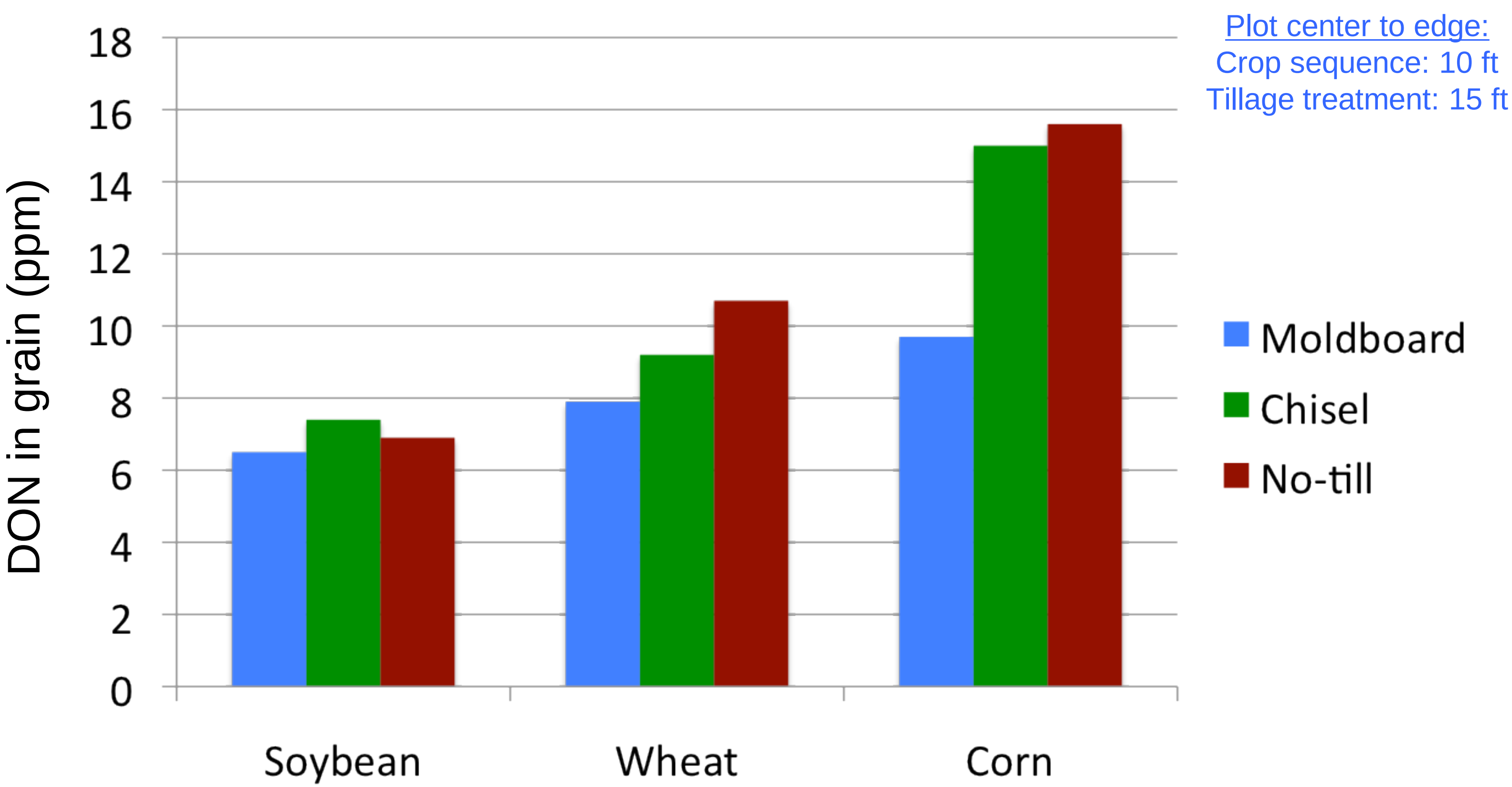


- Disease reduction benefit of tillage of 24% after wheat and 32% after corn

- Disease reduction benefit of soybean rotation of 15% compared to wheat and 32% compared to corn

Effects of previous crop and tillage on DON in wheat

Data from: R. Dill-Macky and R.K. Jones. 2000. Plant Dis. 84:71-76.

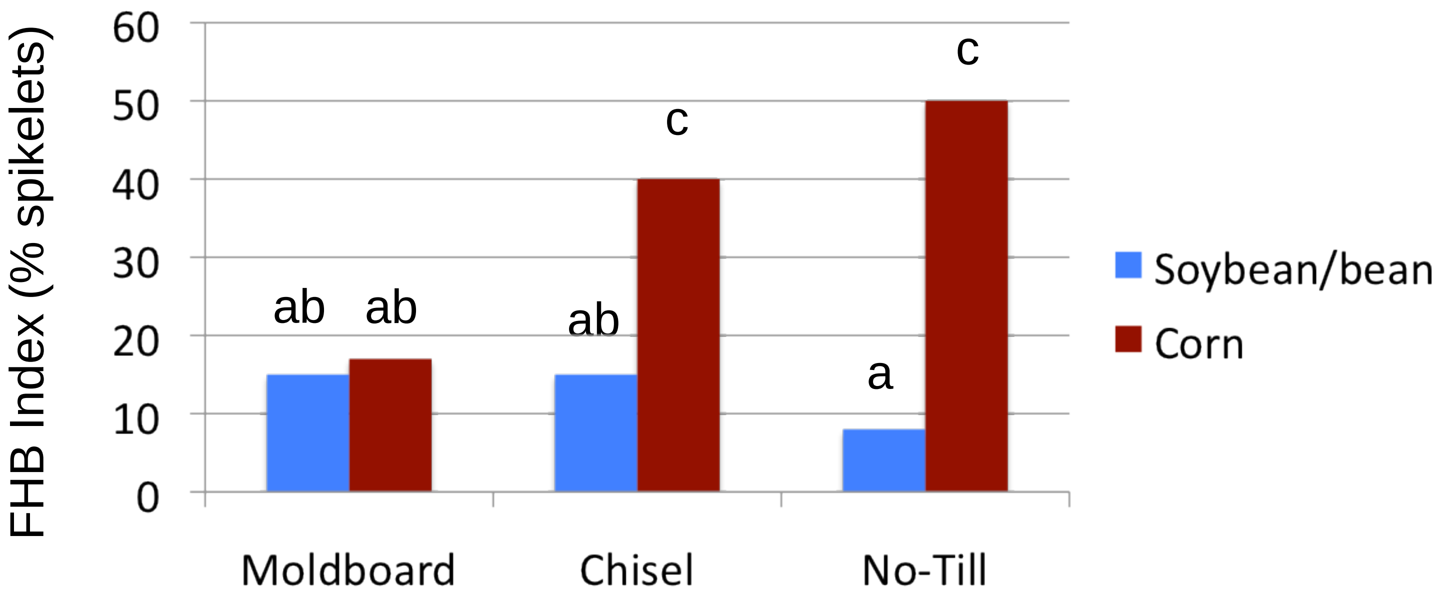


•Mycotoxin reduction benefit of tillage of 26% after wheat and 38% after corn

•Mycotoxin reduction benefit of soybean rotation of 36% compared to wheat and 56% compared to corn

Association of previous crop and tillage practice on FHB in large (>20 acre or 8 hectare) wheat fields in SW Ontario

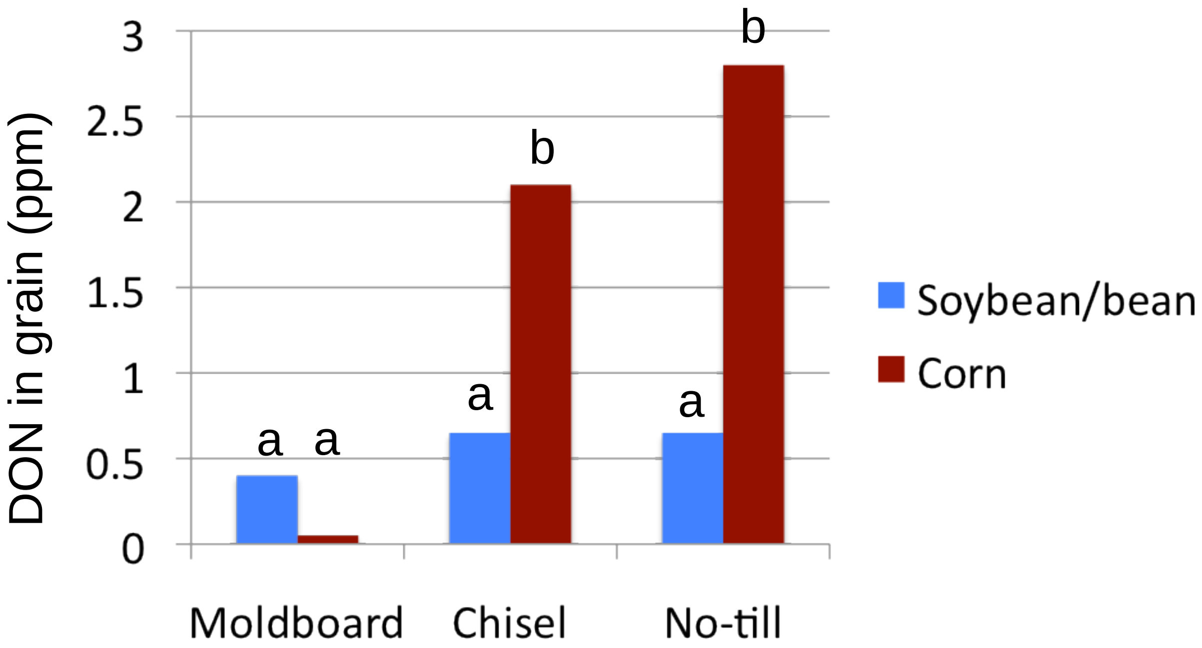
Data from: A.W. Schaafsma et al. 2005. Can. J. Plant Pathol. 27:217-224



FHB levels were not significantly different for comparisons of previous crop or of tillage practice in small (1-5 acre) or medium-sized (10-15 acre) fields. Of the total fields surveyed, 68% were after soybean or white bean and 25% after corn. Chisel tillage (46%) was predominant, followed by moldboard tillage (29%) and no-till (25%).

Association of previous crop and tillage practice on DON in large (>20 acre or 8 hectare) wheat fields in SW Ontario

Data from: A.W. Schaafsma et al. 2005. Can. J. Plant Pathol. 27:217-224



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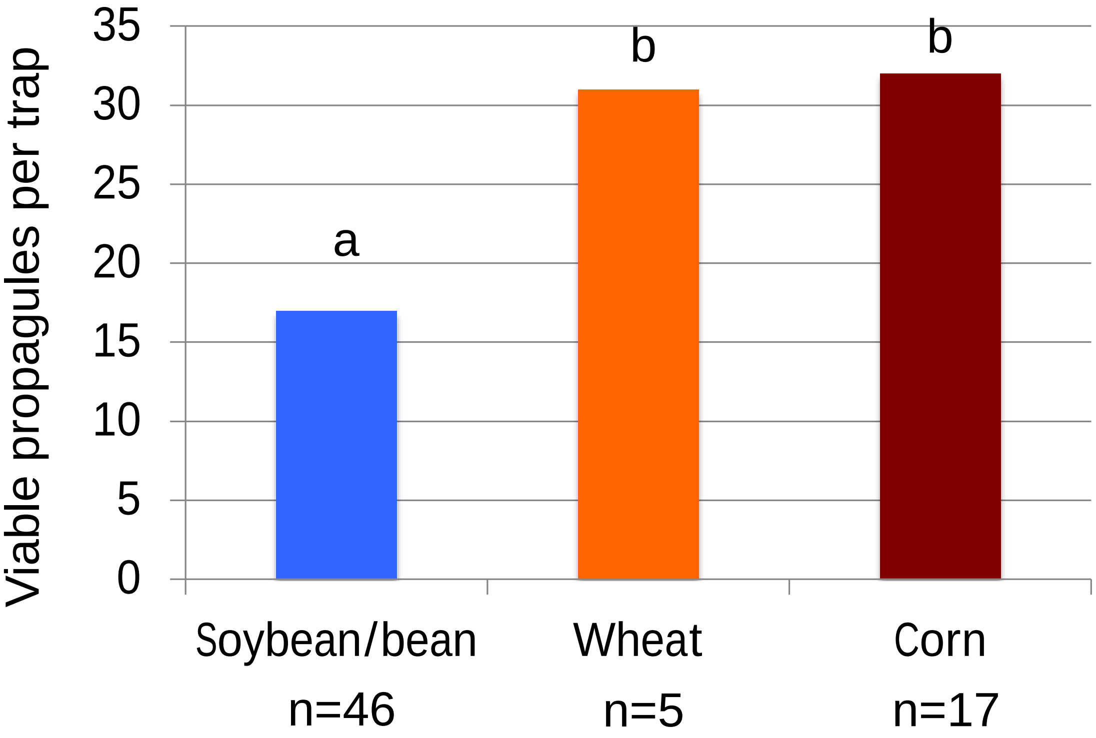
Association of previous crop with viable airborne *Fusarium graminearum* spores above wheat fields in SW Ontario

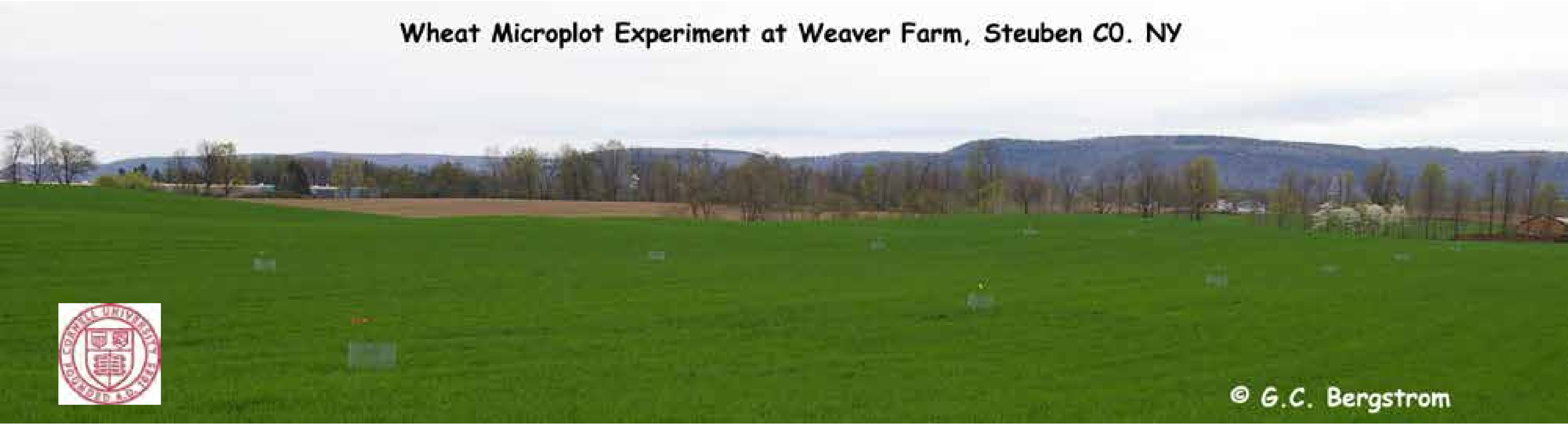
Data from: A.W. Schaafsma et al. 2005. Can. J. Plant Pathol. 27:217-224



Corn microplot experiments:
What are the mycotoxin consequences of having corn residues in your wheat field?

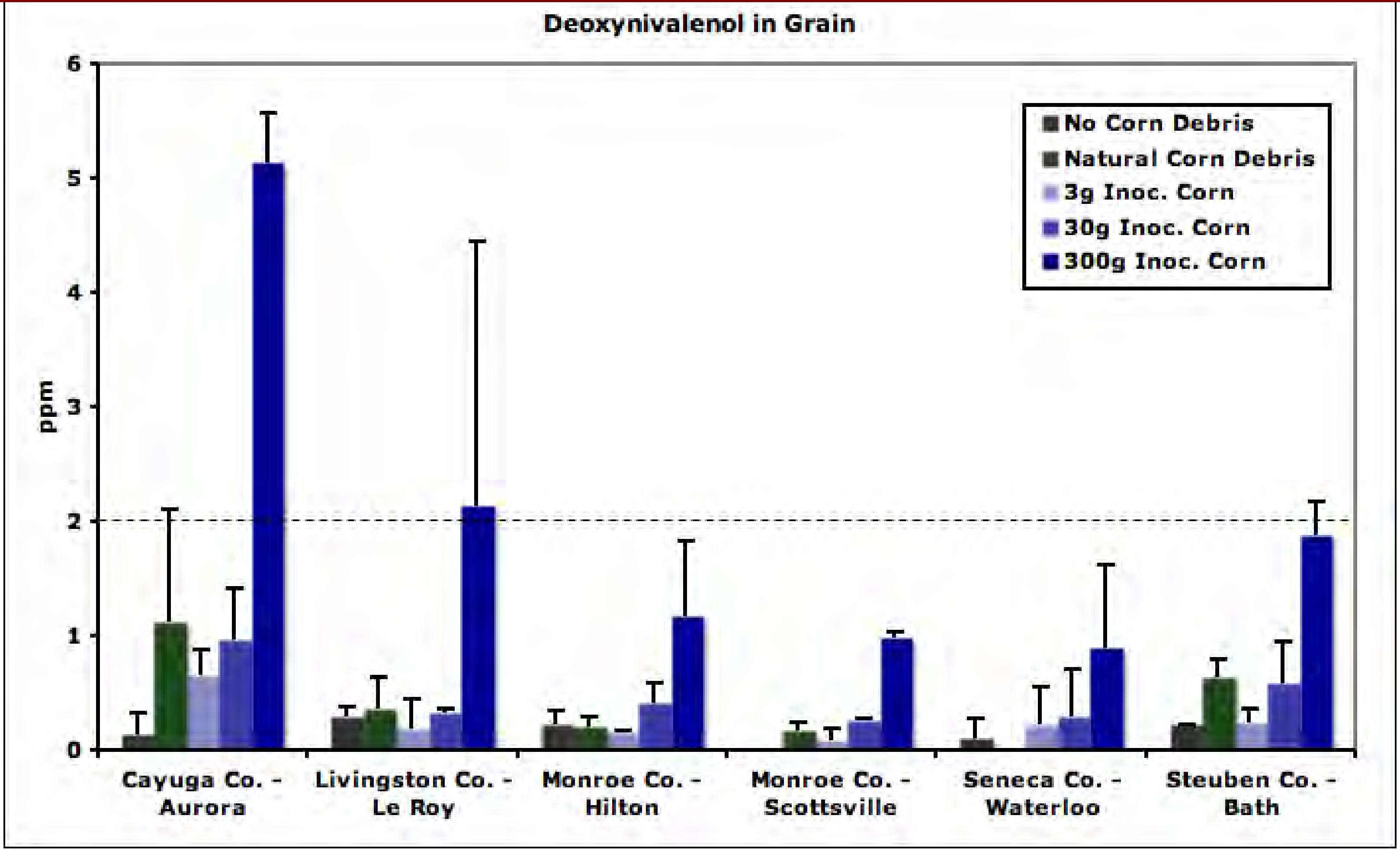
Naturally overwintered, local corn stalks

Lab-inoculated corn stalks



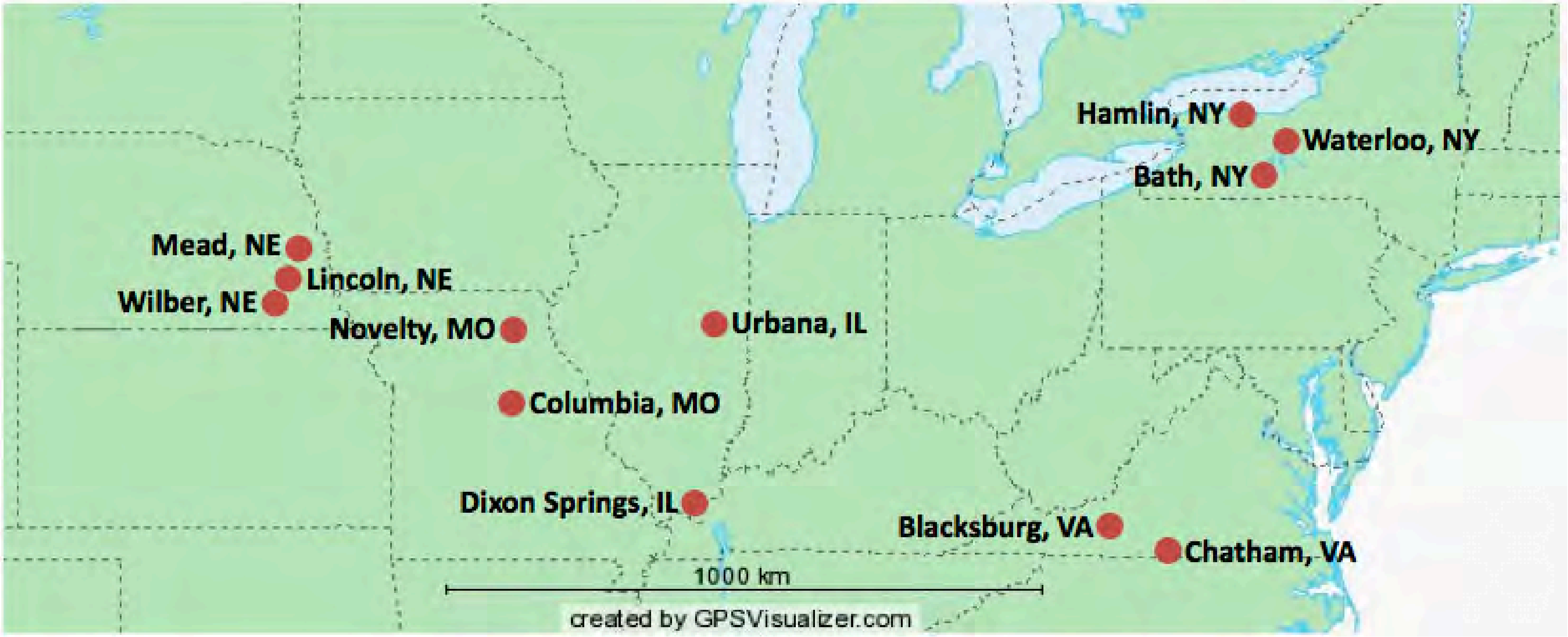
Pilot corn debris microplot experiments in commercial wheat fields in New York in 2007-08

Pilot corn debris microplot experiments in six commercial wheat fields in New York in 2008



Spikes above natural corn stalks and above clonal inoculum of one-tenth or one-hundreth strength generally showed higher infection and DON than spikes above no corn debris, but not statistically significant differences.

Twenty-one corn debris microplot experiments in winter wheat fields in five states (2009-2010)

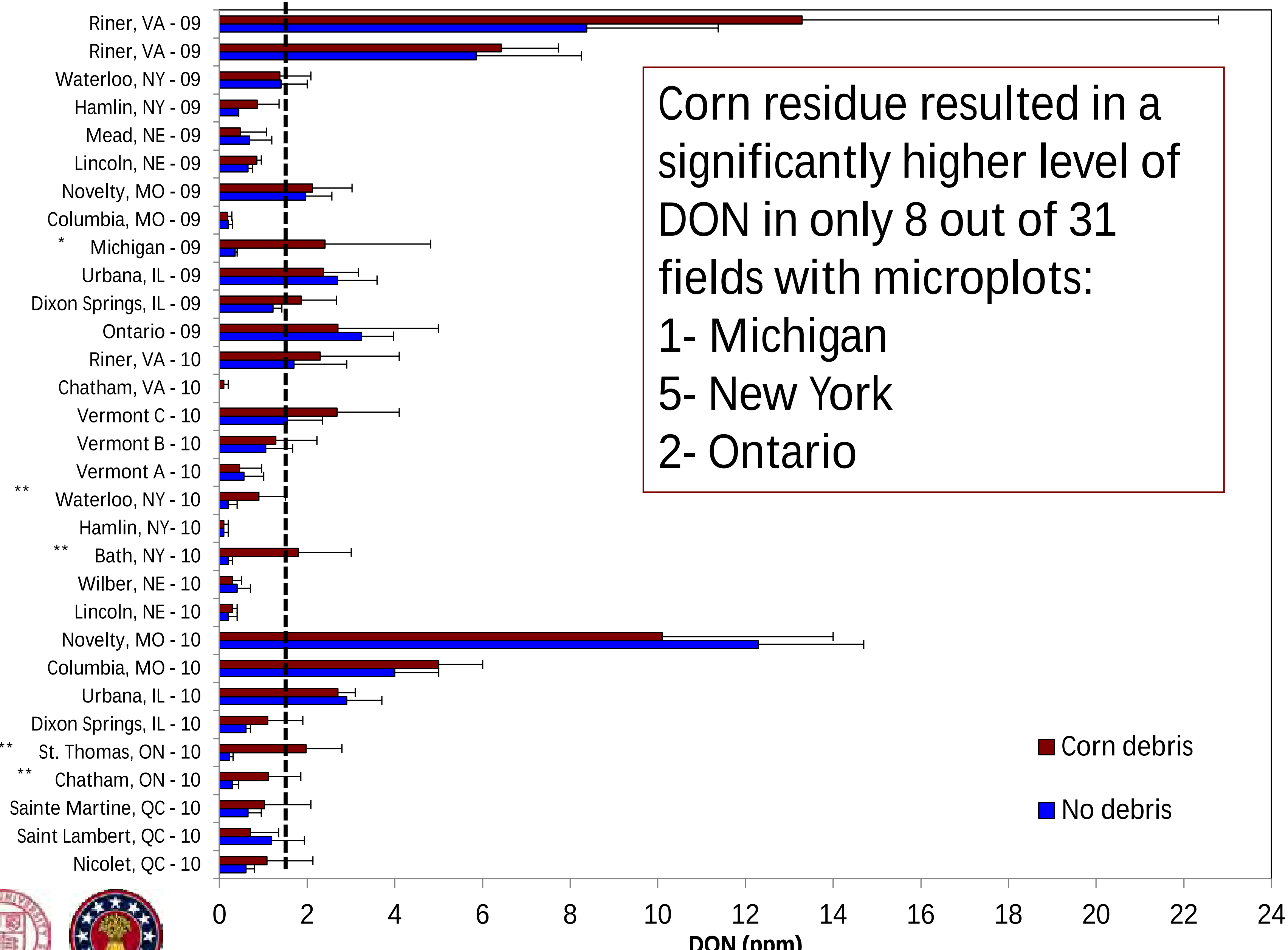


Collaborators: Carl Bradley, David Schmale, Laura Sweets, Stephen Wegulo

Plus nine satellite experiments in Michigan, Vermont, Ontario, and Quebec

Collaborators:
Ann Hazelrigg, Martin Nagelkirk, Albert Tenuta, Pierre Filion, Sylvie Rioux

DON Concentration in Mature Grain



Corn residue resulted in a significantly higher level of DON in only 8 out of 31 fields with microplots:

1- Michigan

5- New York

2- Ontario

Effects of Local Corn Debris Management on FHB and DON Levels in Seventeen U.S. Wheat Environments in 2011 to 2013

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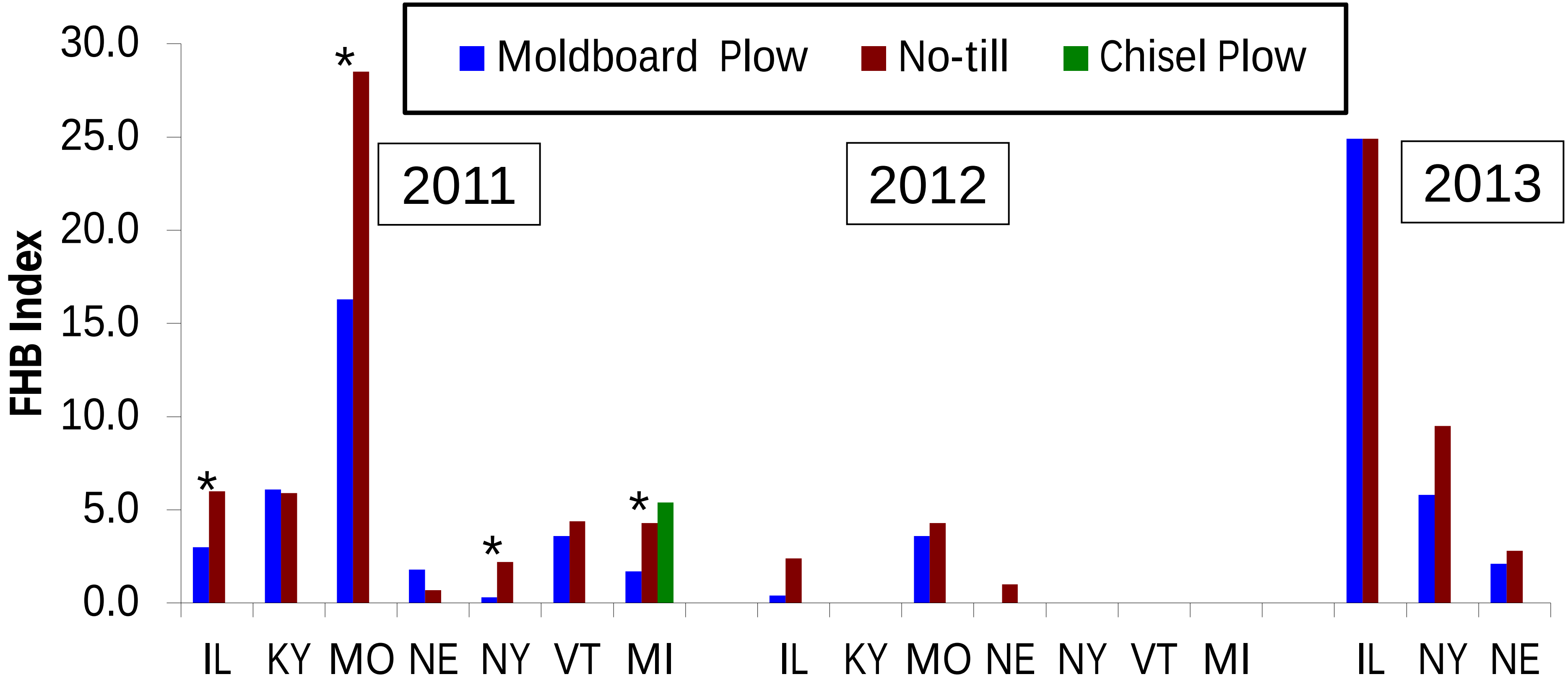
Commercial-scale wheat after corn strip trials (no-till vs moldboard-plowed) in seven states (2011 - 2013)

Collaborators: Carl Bradley, Ann Hazelrigg, Don Hershman, Martin Nagelkirk, Laura Sweets, Stephen Wegulo

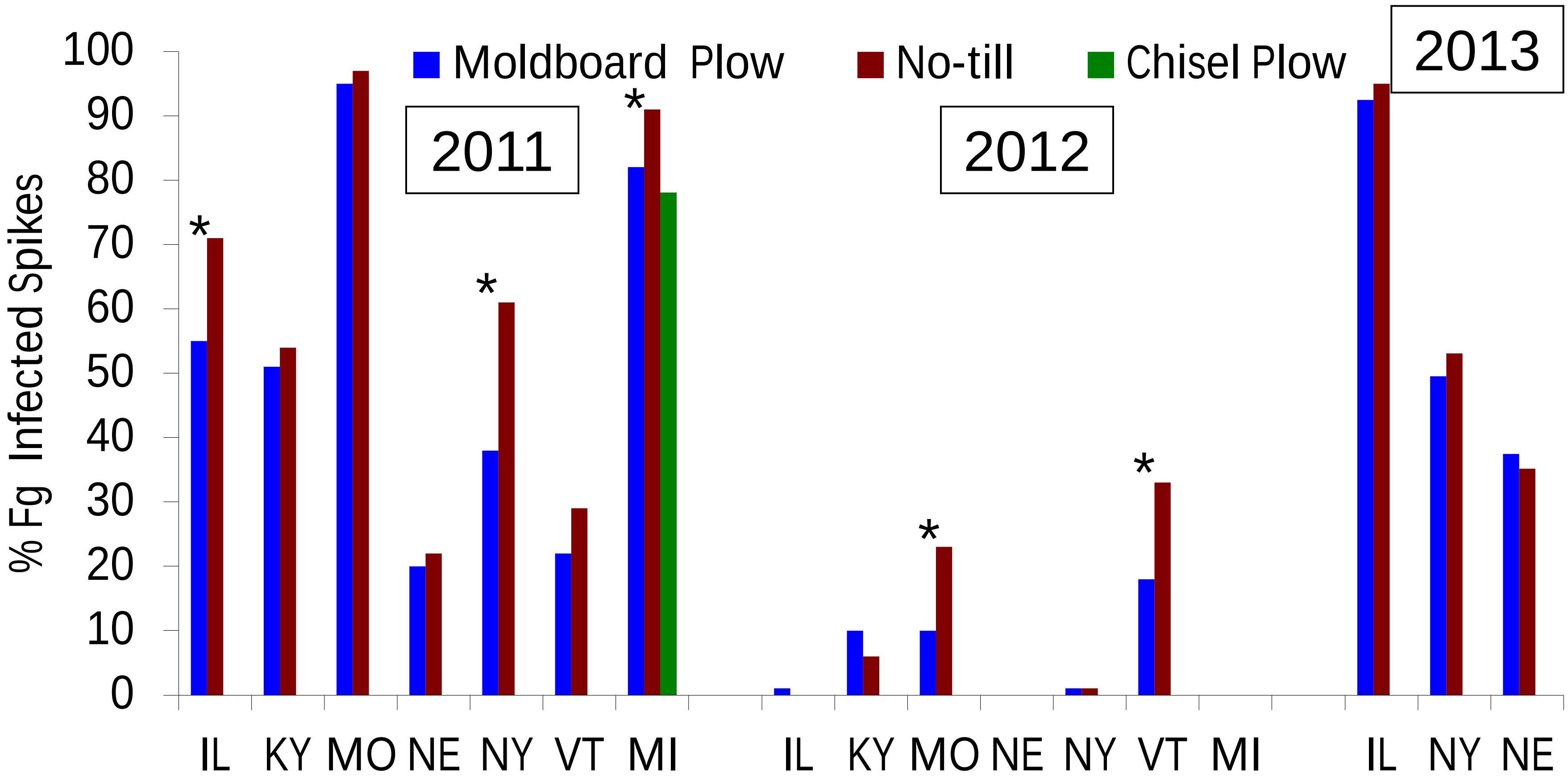
Commercial-scale wheat after corn strip trials (no-till vs moldboard-plowed) experimental design

Average increase in FHB Index of 1.6 associated with no-till corn residue in wheat strips



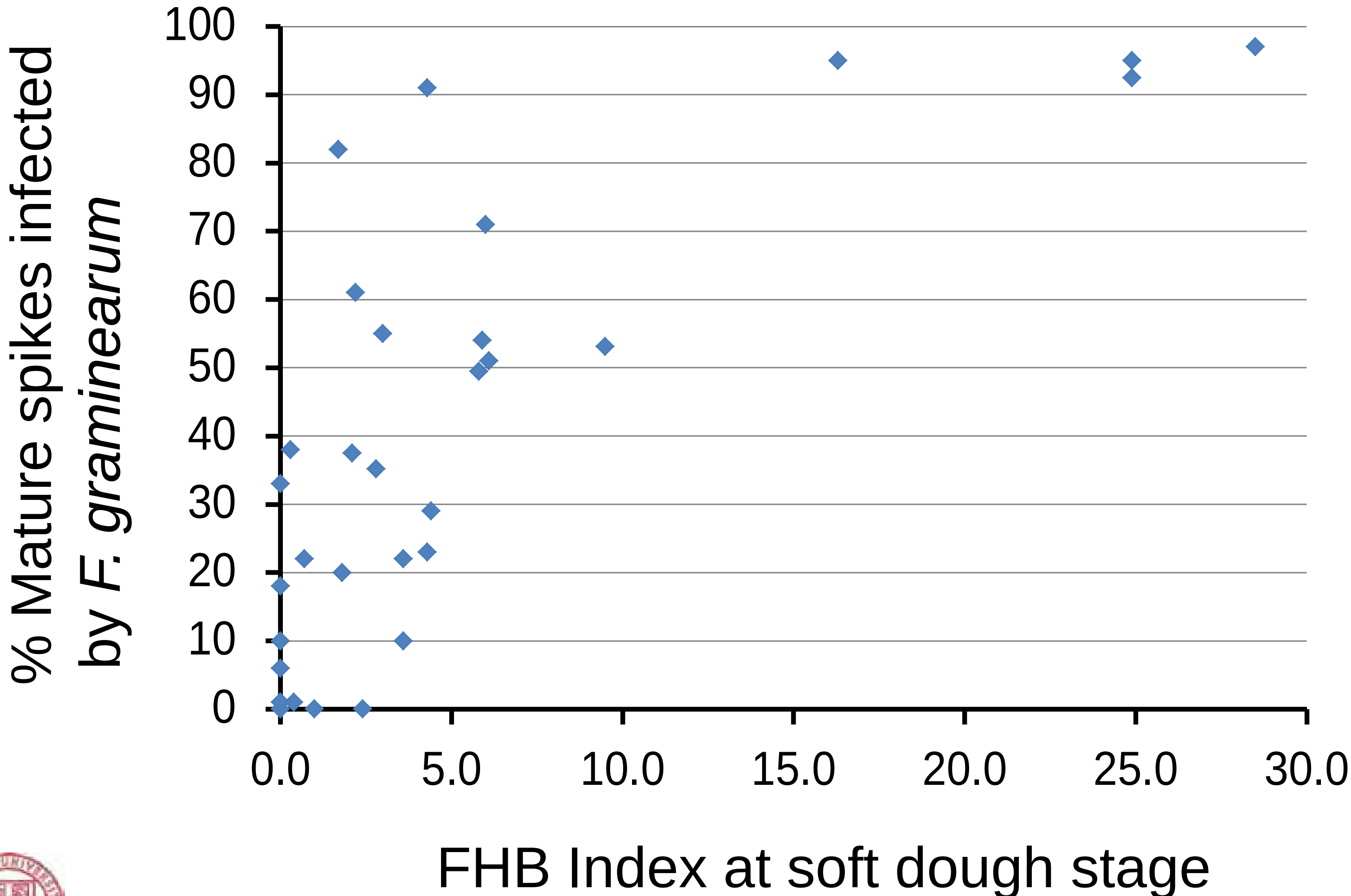
Significant increase in FHB Index in IL, MO, NY, MI in 2011; none in 2011 or 2012.

Average increase in infection incidence of mature spikes of 5% associated with no-till corn residue in wheat strips

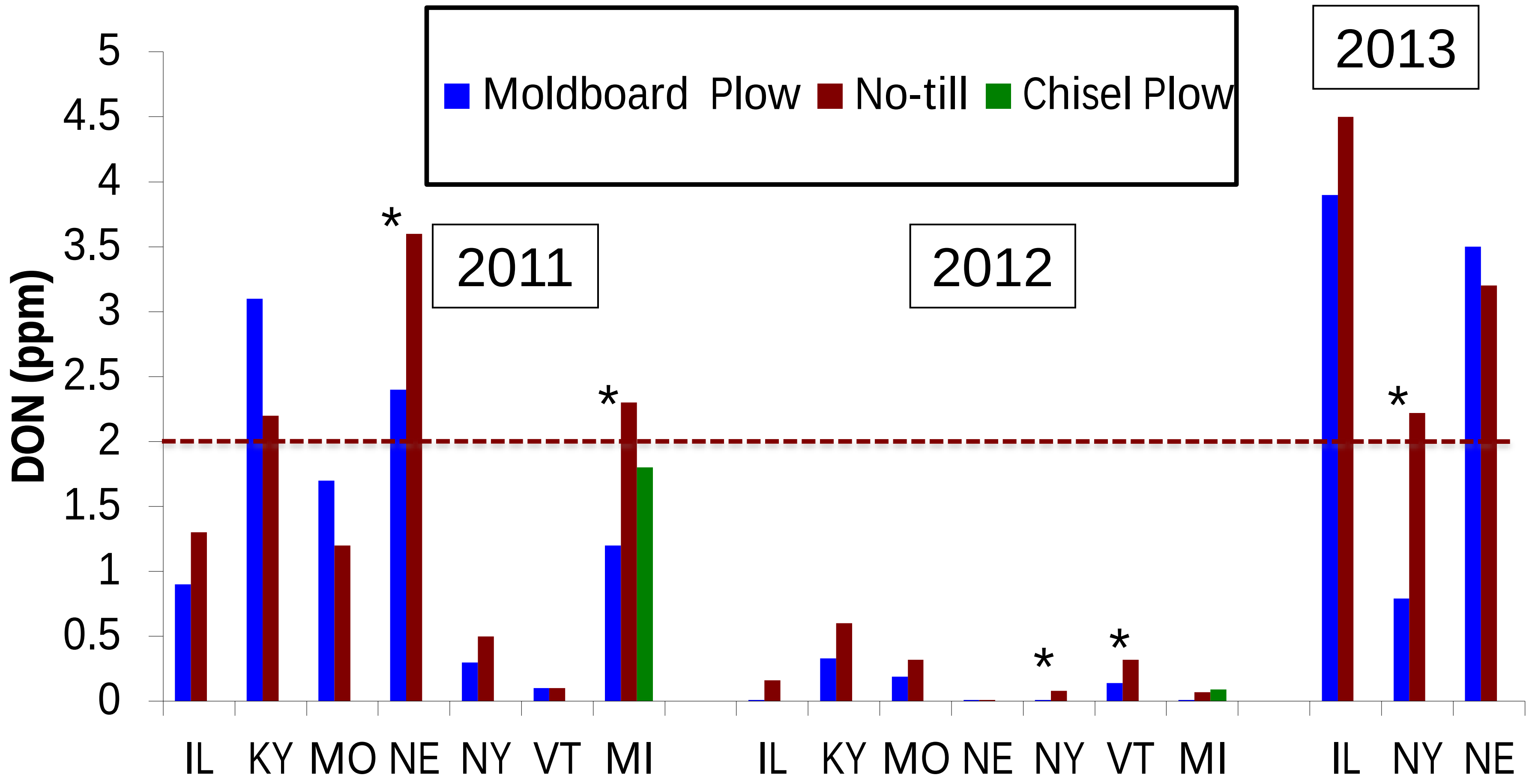


Significant increase in recovery of *F. graminearum* from spikes in IL, MI, VT in 2011 and MO, VT in 2012

Association of FHB Index at soft dough with infection incidence of mature spikes

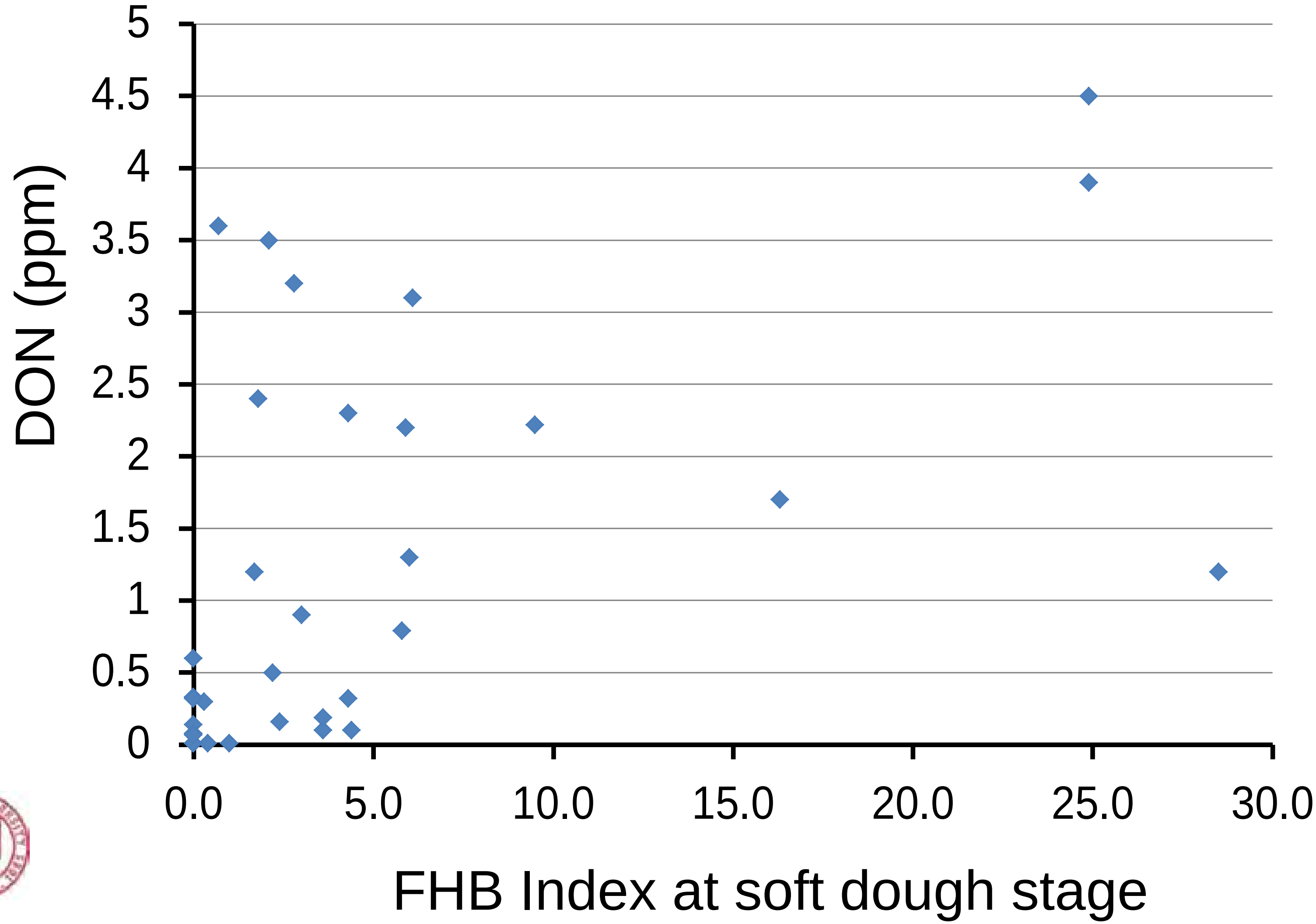


Average increase in DON of 22% (0.24 ppm) associated with no-till corn residue in wheat strips

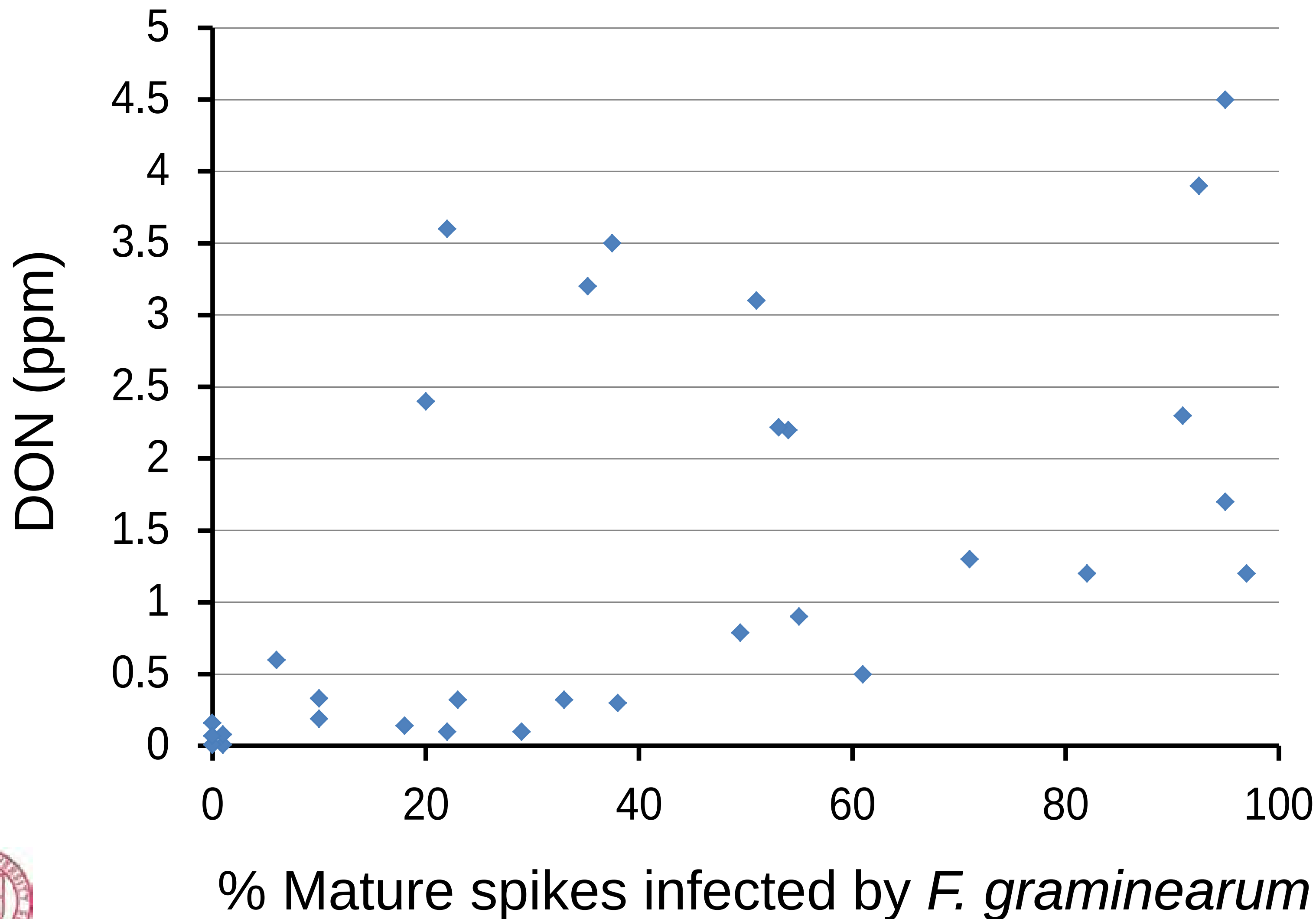


Average 17% (0.38 ppm) increase when background level > 0.50 ppm

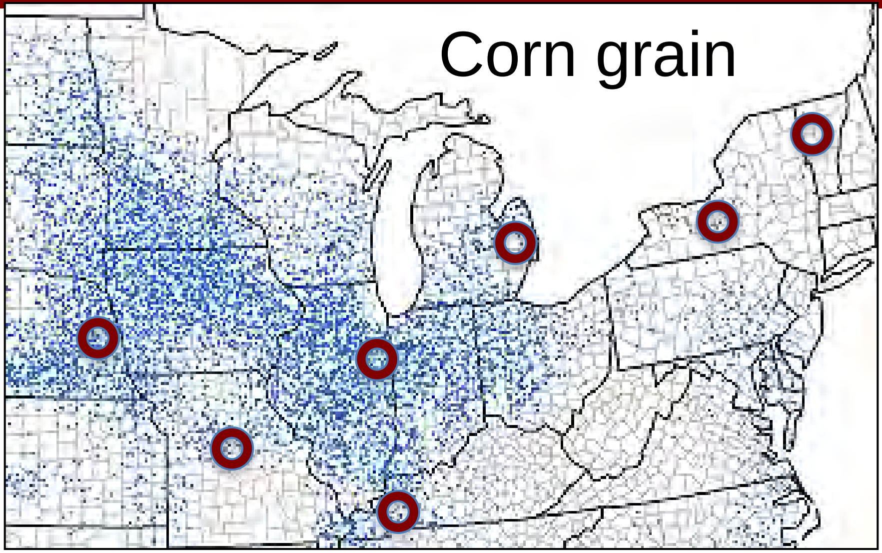
Association of FHB Index at soft dough with DON in harvested grain

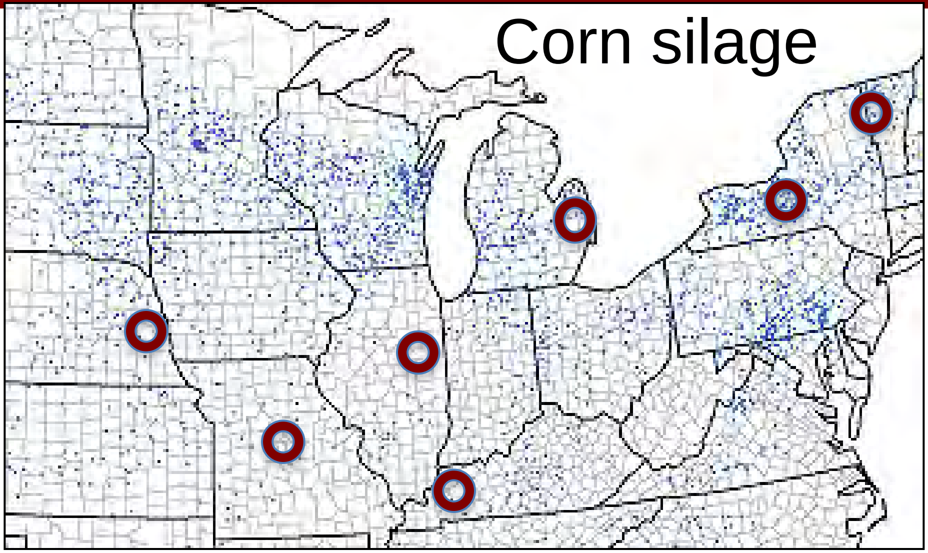


Association of infection incidence in mature spikes with DON in harvested grain

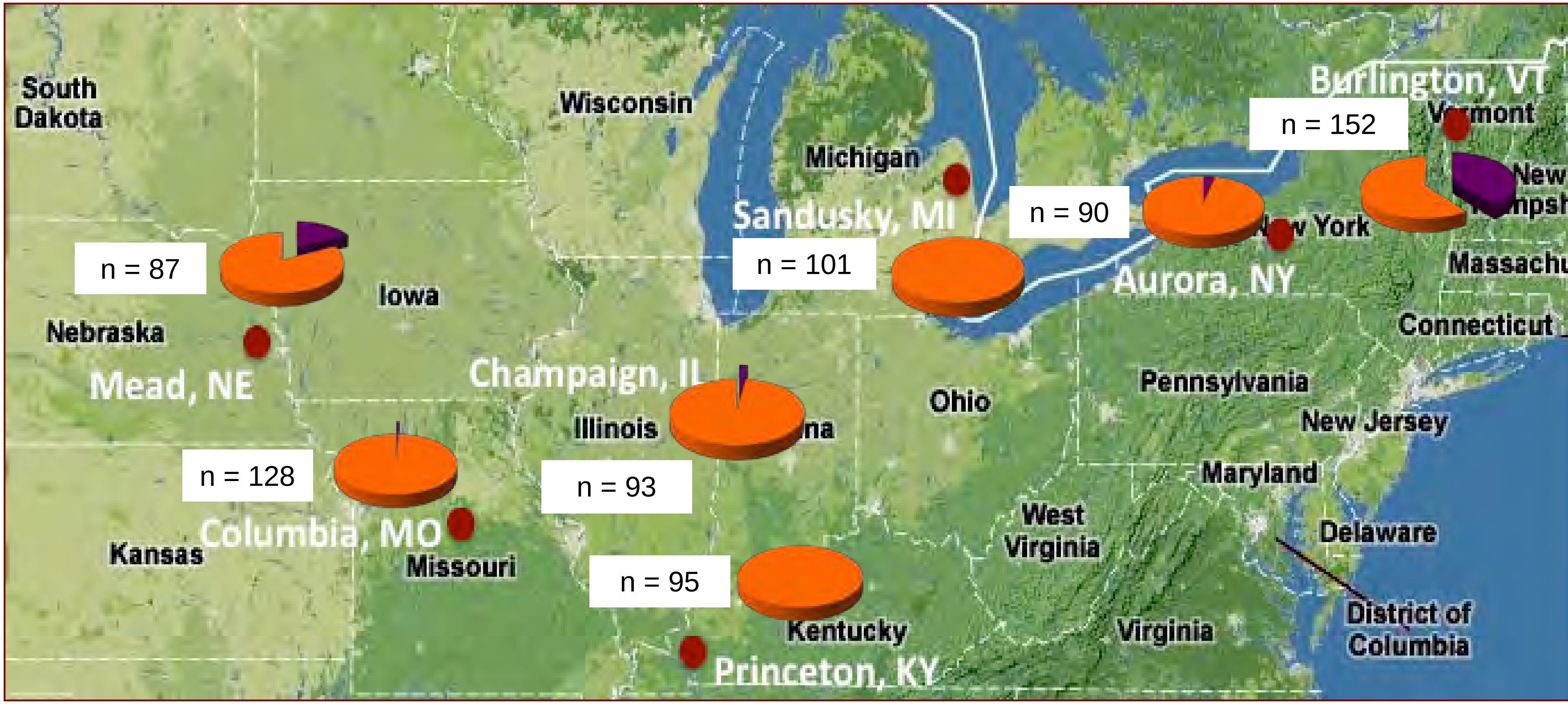


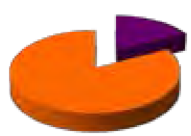
Environments typical of north-central and northeast regions where wheat is grown in proximity to / rotation with corn





Proportion of trichothecene genotypes of *Fusarium graminearum* in 2011 and 2012

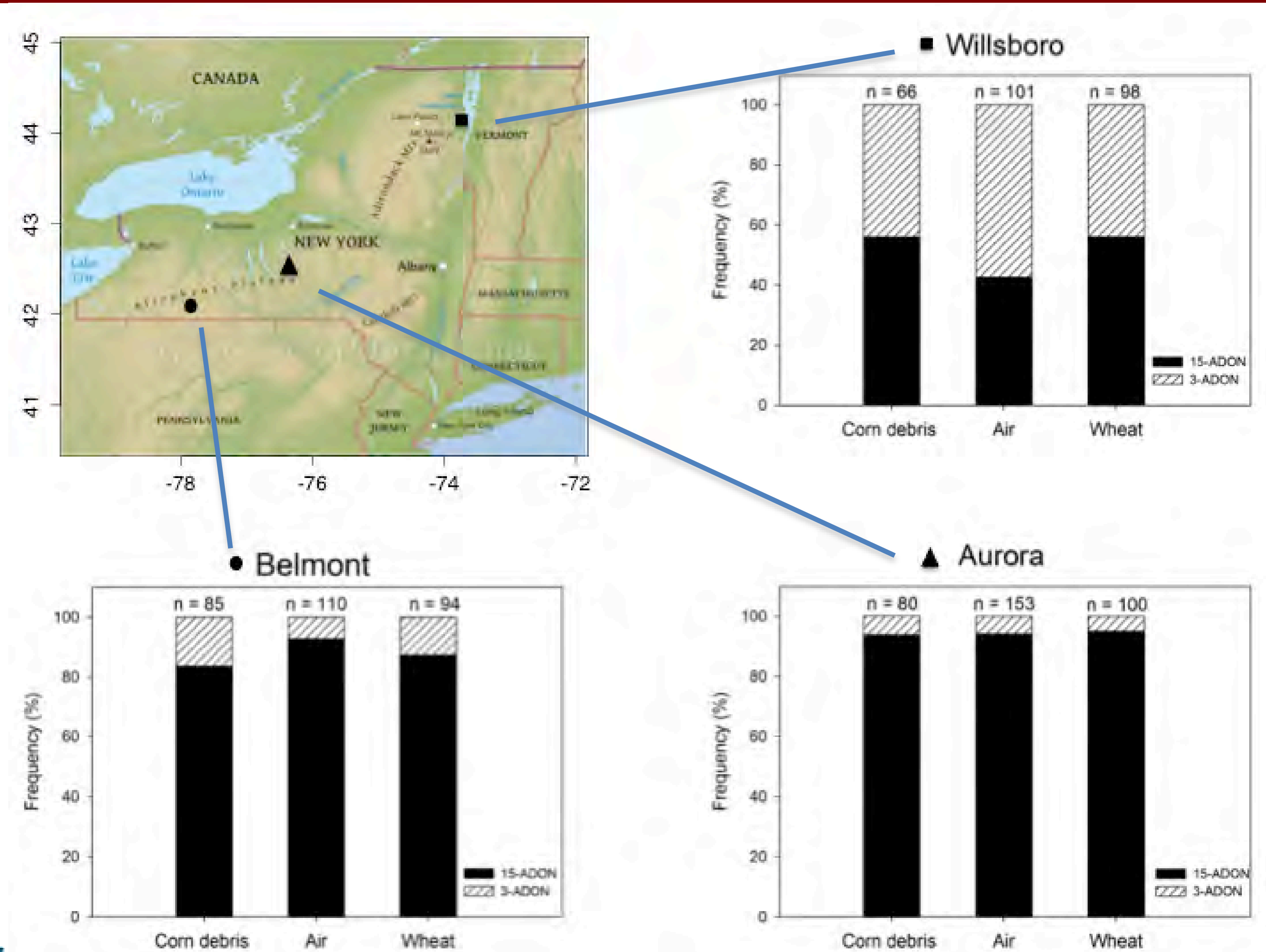




3-ADON
15-ADON

Bergstrom et al. unpublished

Trichothecene genotype frequency by niche in New York in 2013



Kuhnem and Bergstrom See Poster No. 29

Boosted Regression Trees to Predict FHB Epidemics*

Study based on 527 FHB observations from 15 states over 26 years

"**The BRT models showed that** both TYPE (spring or winter wheat) and **CORN (+/- corn residue in plots) had very low relative influence** and consequently were dropped during model simplification**, indicating the overarching influence of weather on FHB epidemics regardless of** spring or winter wheat, or **local inoculum pressure from infested crop debris**.*"

*Shah, D.A., E. De Wolf, P.A. Paul, and L.V. Madden. 2014. Predicting Fusarium head blight epidemics with boosted regression trees. Unpublished, personal communication.

Incidence-severity relationship and spatial analysis of Fusarium Head Blight epidemics in southern Brazil

“Based on sampling and analysis of **160 production wheat fields** over three years, there was **no influence of previous summer crop** (local inoculum) on **FHB intensity or disease spatial pattern**. The **predominant random pattern** of FHB incidence in the fields is probably associated with **airborne inoculum**.”

Piérri Spolti (PhD Student)
Denis Shah
José Maurício C. Fernandes
Gary C. Bergstrom
Emerson M. Del Ponte

UFRGS
UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

Effect of tillage on DON in wheat following corn or wheat in Argentina

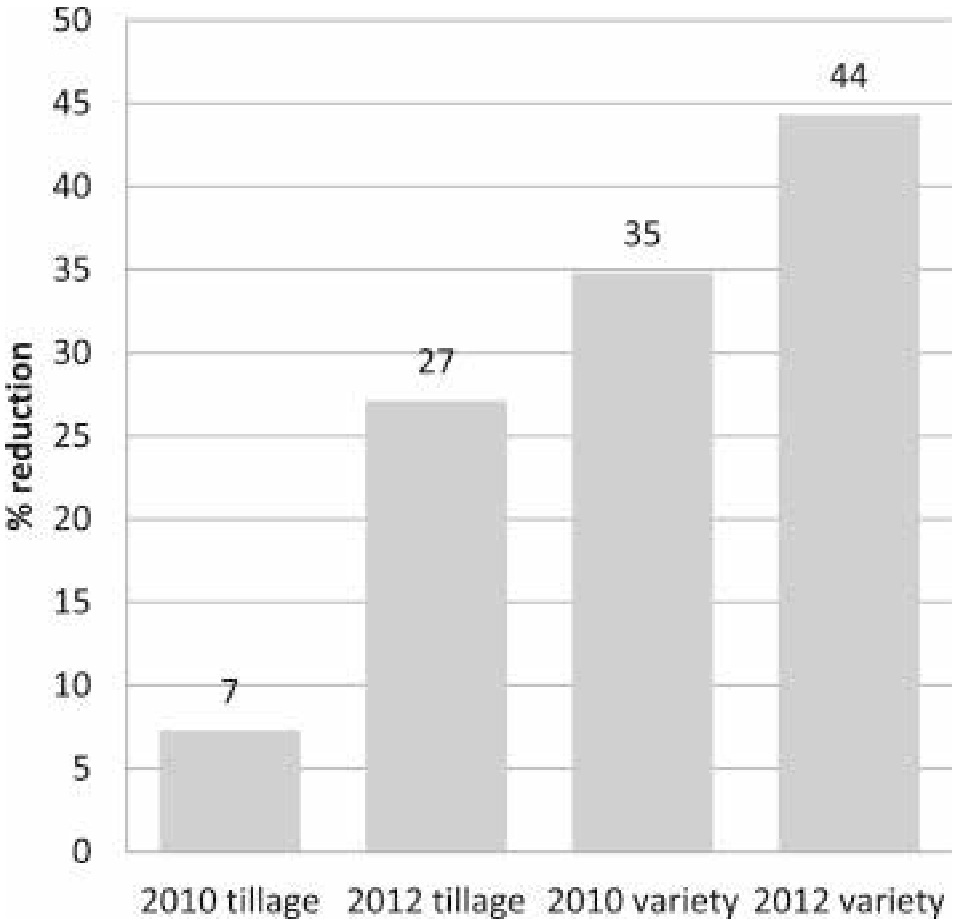
Tillage treatments as main plots:
12 x 54 m

	Year 1 Wheat after corn	Year 2 Wheat after wheat	Year 3 Wheat after wheat
Conv. tillage	3.5 b	10.3 a	nd
No tillage	4.9 a	13.7 a	nd

“The results obtained would suggest that favourable weather conditions are likely to be more important than tillage practice and fertilizer treatments.”

Lori et al. 2009. Fusarium head blight in wheat: Impact of tillage and other agronomic practices under natural infection. Crop Protection 28:495-502.

Reduction in DON due to tillage after corn in Belgium 2010-12



2010: Low FHB
2012: High FHB

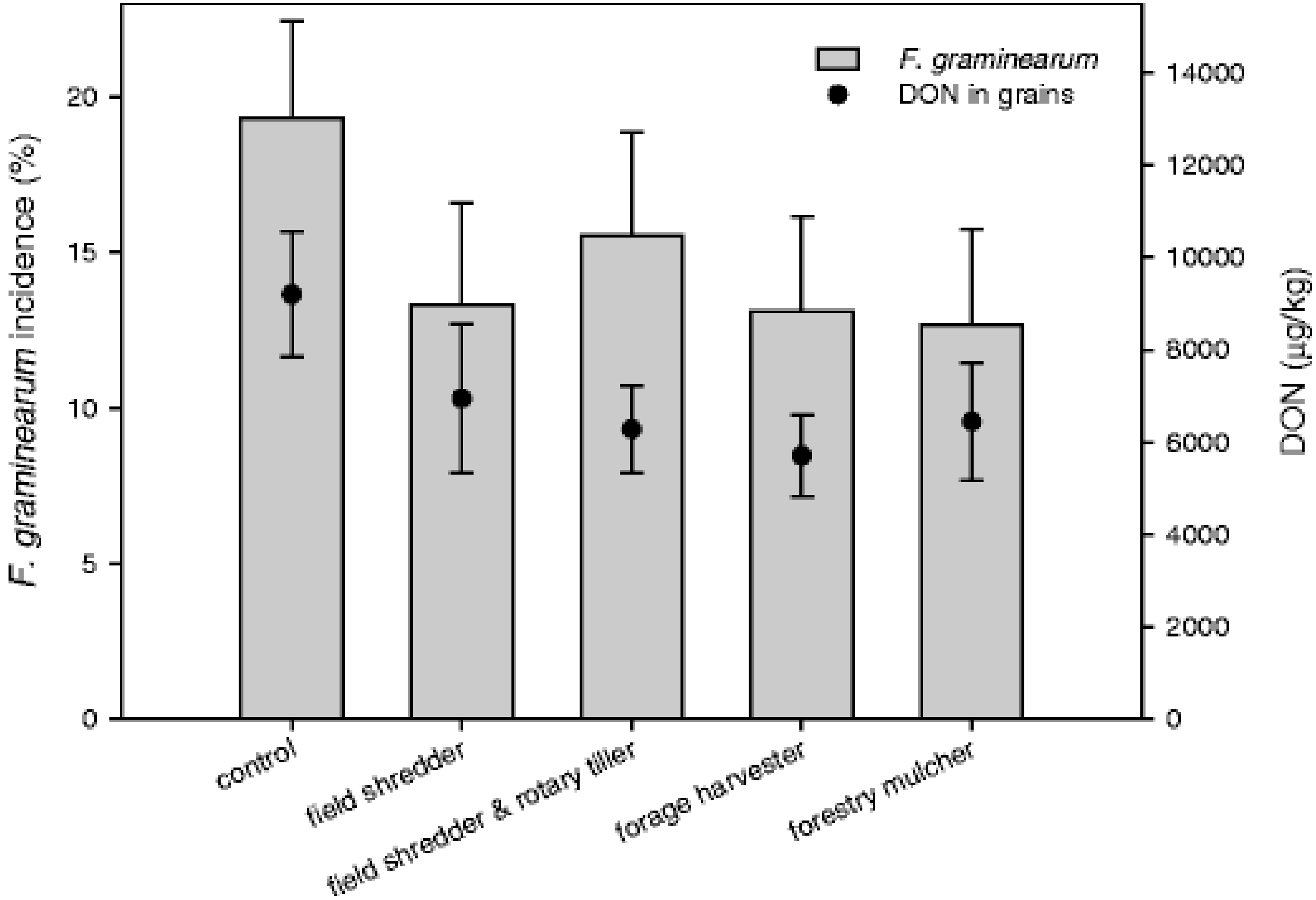
Landschoot et al. 2013. Influence of maize-wheat rotation systems on Fusarium head blight infection and deoxynivalenol content in wheat under low versus high disease pressure. Crop Protection 52:14-21.

Reduction in DON in wheat after corn due to corn residue treatments in Switzerland

14 sites

18 m x 20 m plots

21-38 % reduction in DON



Vogelgsang et al. 2011. On-farm experiments over 5 years in a grain maize/winter wheat rotation: Effect of maize residue treatments on Fusarium graminearum infection and deoxynivalenol contamination in wheat. Mycotoxin Res. 27:81-96

Reduction in DON in wheat after corn or sorghum due to tillage in Italy

9 sites

7 m x 2 m subplots

Avg 68% reduction in DON with plowing, S variety, no fungicide compared to no-till, S, no fungicide.

Avg 30% reduction in DON with plowing, MR variety, no fungicide compared to no-till, MR variety, no fungicide

Tillage > MR wheat varieties > Triazole at heading

Blandino et al. 2011. Integrated strategies for the control of Fusarium head blight and deoxynivalenol in winter wheat. Field Crops Res. 133:139-149.

Conclusions about management of inoculum sources for FHB

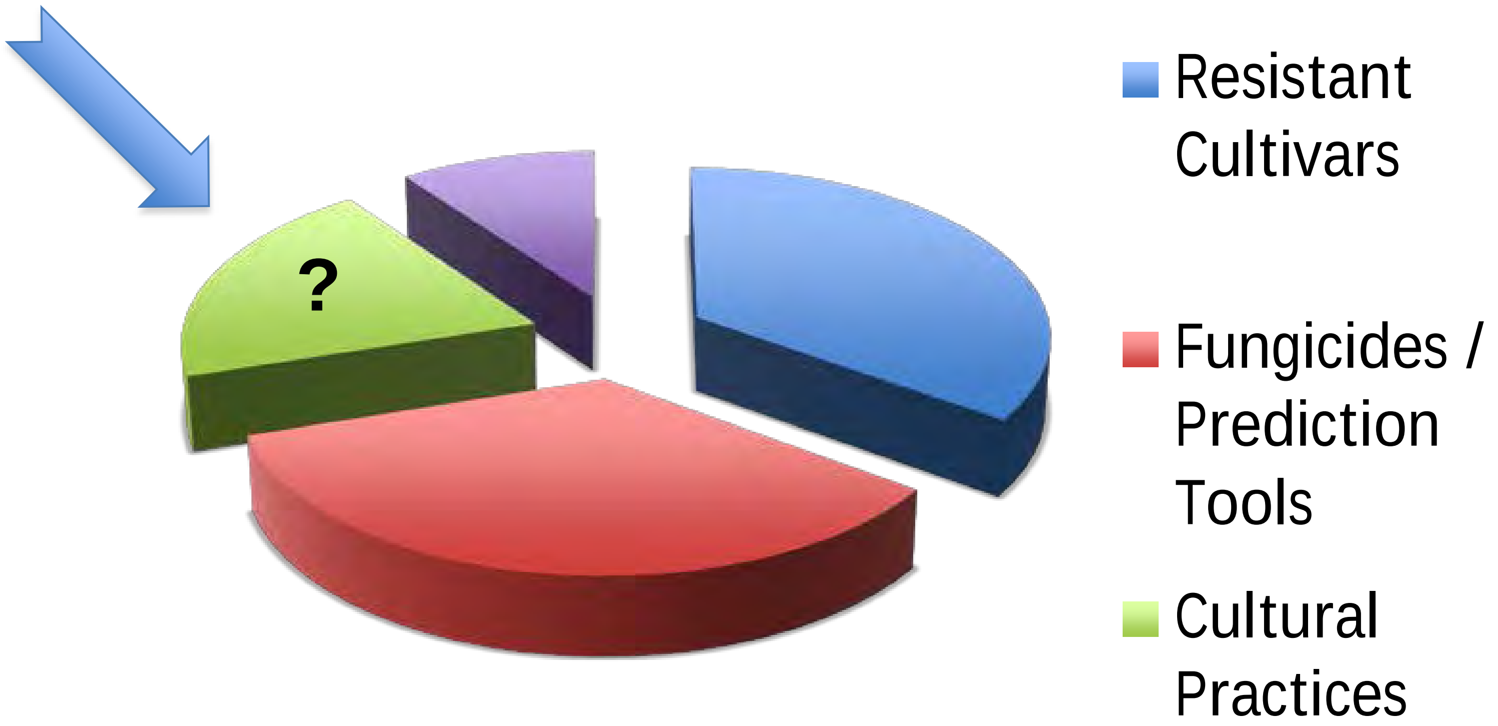
- **Spores liberated from within-field debris may provide a significant fraction of inoculum for a given field, though often less than 30% (most important in FHB-limiting environments)**

- **Regional, atmospheric spore populations generally provide more inoculum than within-field sources (especially under FHB-conducive environments)**

- **Inoculum (debris) management strategies in individual fields may result in incremental reductions of FHB/DON, and thus contribute to integrated management**

What is the contribution of cultural control to integrated management of FHB/DON?

No single answer for all environments and cropping systems.



For wheat within corn-growing regions in the north central and northeastern U.S., generally less than 30% contribution to DON reduction.

Where cereals must be planted into cereal residues, greater emphasis must be placed on other disease management strategies, especially resistant varieties and fungicides!

Questions and Comments