Growing Genetically Engineered (GE) and Conventional Crops Side by Side

Mark Westgate

What makes it possible...

- Pollen drift is a natural and predictable phenomenon in corn production
  - — As such, it can be managed to achieve production goals.
- Extensive cooperation among regulatory agencies (APHIS, EPA, FDA) for deregulation, registration, and review of commercial GE crops
  - — No examples of safety problems to date
  - — Product management remains a key issue

    e.g. StarLink developed for commercialization without established tolerance levels in food

Coordinated Framework of Agricultural Standards and Regulations

- Federal "Safety Net"
  - All crops subject to science-based regulation with individual products or categories eligible for exemption over time based on experience and data
  - "Precautionary approach" adopted by U.S. in 1986
  - Ensure that biotechnology-derived crops are as safe to grow as conventional crops
  - For crops intended for food or feed, ensure they are as safe to eat as conventional crops

Coordinated Framework
Agency positions…

- USDA
  - Is it safe to agriculture?
- EPA
  - Is it safe to the environment?
- FDA
  - Is it safe to eat?

Regulatory determinations thus far…

- GE crops in commercial use in the U.S. have gained regulatory clearance
- Considered safe to eat
- Waiver of food tolerances

International Food Information Council
March, 2005

Biotech is not a primary food safety concern

Q: What, if anything, are you most concerned about when it comes to food safety?

Handling/Preparation	42%
Disease/Contamination (food-borne illness)	28%
Ingredients (chemicals, preservatives, fats)	23%
Packaging (expiration dates, packaging)	14%
Chemicals/Pesticides	7%
Biotechnology	< ½ %

(Open-ended; Multiple responses allowed, n = 1000)

International Food Information Council
March, 2005

Biotech is not avoided as a food ingredient

Q: If (you purposefully avoided some foods), what foods or ingredients did you avoid or eat less of?

Sugar/Carbohydrates	58%
Fats/Cholesterol	37%
Animal Products	34%
Salt/Spices	14%
Snack Foods	11%
Biotechnology	< ½ %

(Open-ended; Multiple responses allowed, n = 478)

Complicating factors

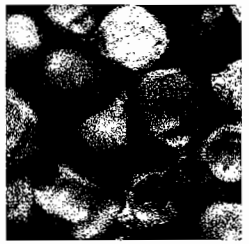
- Unintended occurrence of GE crops for which there is no food tolerance or exemption
  - Crops under experimental evaluation, not intended for commercial release
  - StarLink corn, Prodigene, Bt10
  - No recourse but to eliminate from food channels
- Asynchronous approval by importing countries
  - Products must be channeled away from markets where approvals are not in place
- Grower preference
  - Adventitious presence in organic, non-GE crops

BIGMAP: Biosafety Institute for Genetically Modified Agricultural Products

Iowa State University
Dr. Manjit Misra, Director

- Created to provide science-based analysis of the risks and benefits of genetically modified plant and animal products.
- Develops methods to help growers take advantage of new products to spur economic growth, while safeguarding valuable agricultural resources.
- Provides guidance and education about GMAPs to help safeguard consumers and the environment.

BIGMAP Structure to Assess Risks of GE Corn

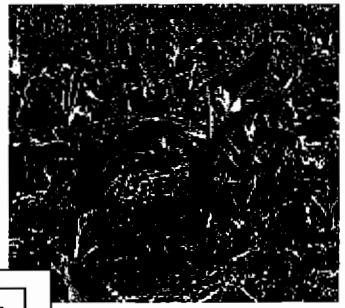


Transformation

Environmental Contamination: Wildlife (Plant & animal), Water/soil Quality, Native Species and other Crops, etc

Plant Generation

Seed Purity, Planting, cultivating, volunteer crop, Pollen Drifting, Harvesting & Drying, Conditioning & Storage



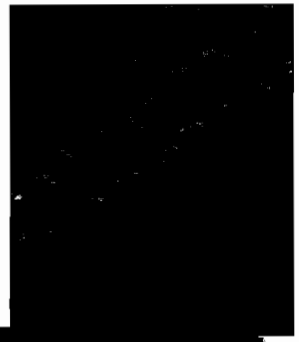
Seed Production

Crop Production

Food Contamination: Food derived directly from plants (corn flake) and/or meat products (thru

Grain Harvest, Storage and Transportation

Similar to above



Supporting services Statistics, Economics Impact, Social Impact

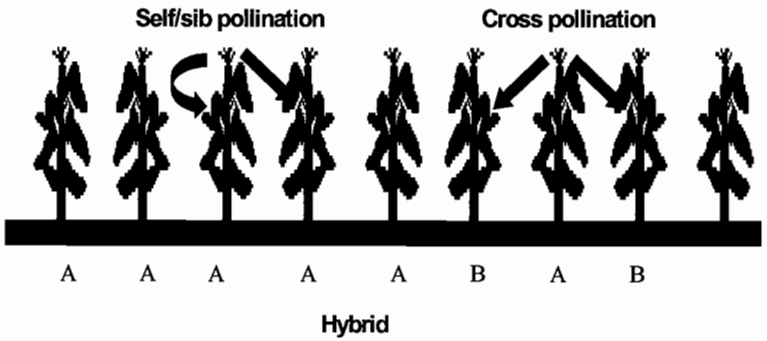
Food Processing

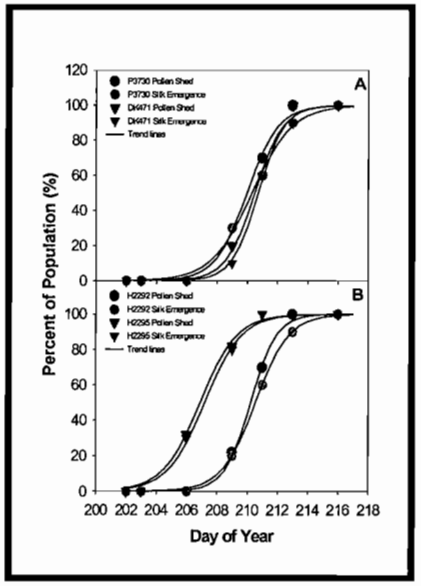
Extraction, purification, Formulation

Finished Products

IOWA STATE UNIVERSITY
College of Agriculture

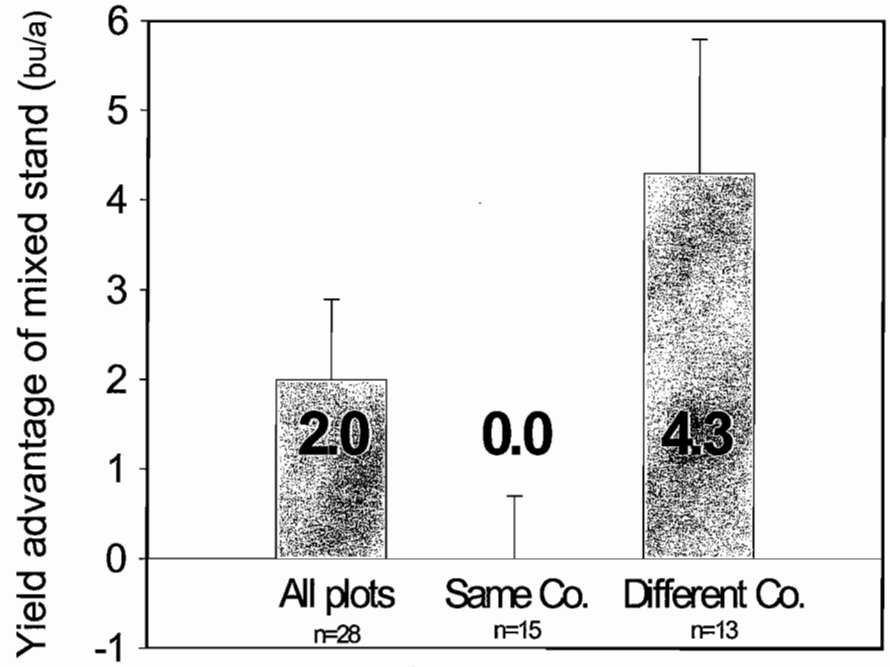
Pollen drift is a good thing for corn yield





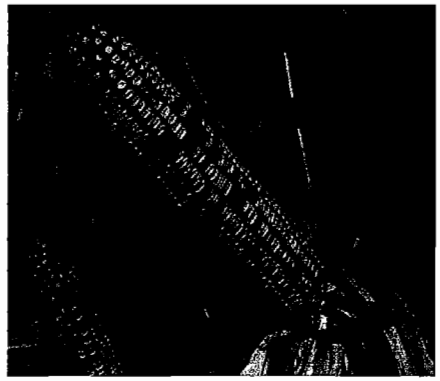
Close synchrony between hybrids is required

Cross pollinated plants can yield more

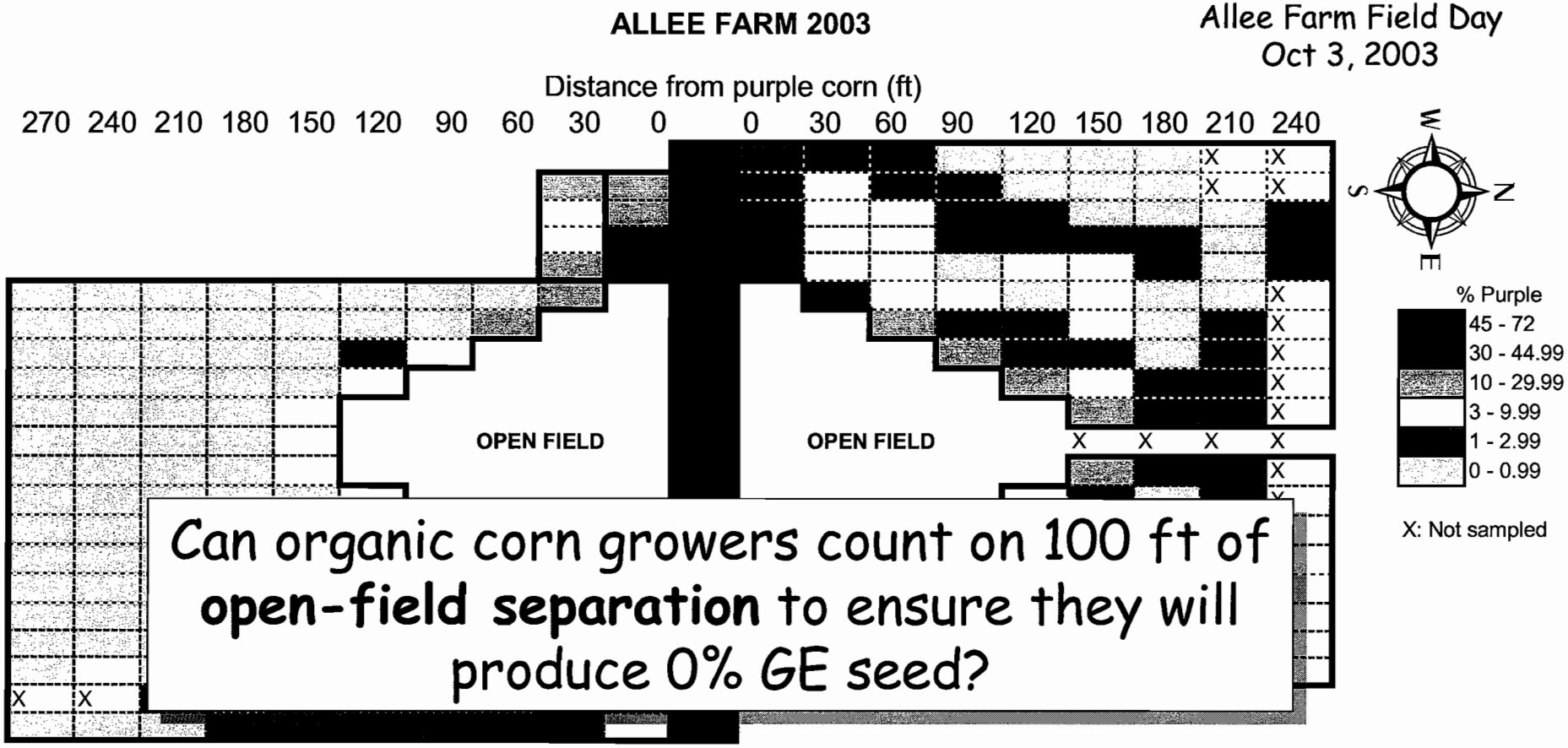


Yield: Ave = 165 bu/a. Range = 130 - 217 bu/a
Plot size: Ave = 1.0 a. Range 0.4 - 2.6 a.

The challenge for corn producers:
Intended vs Unintended Pollination



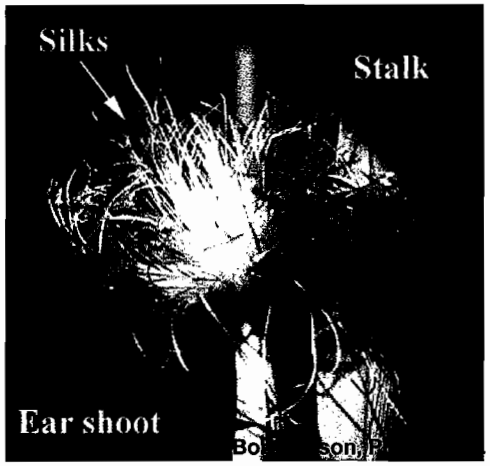
Allee Farm Field Day
Oct 3, 2003

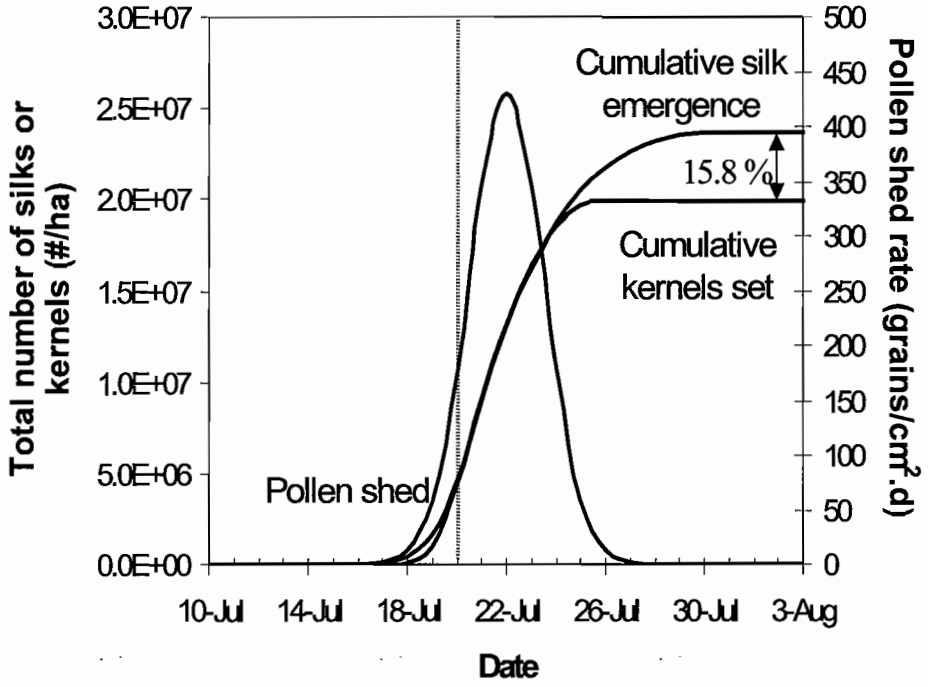


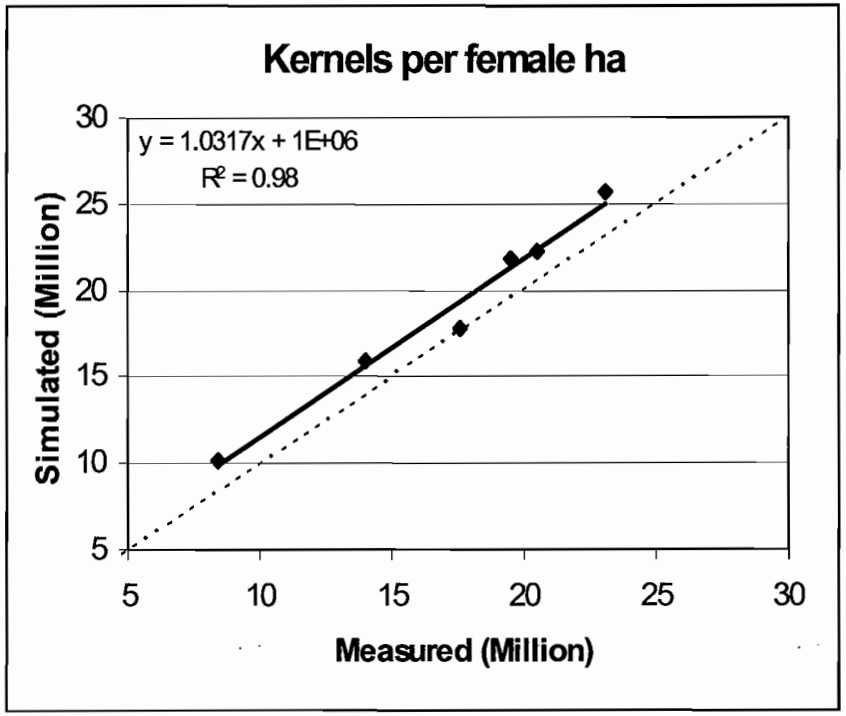
Biological & Physical Components of Pollination in Corn

- Biological (source)
  - Pollen shed characteristics (Timing, intensity, viability)
- Physical (delivery system)
  - Topography (Distance, elevation, wind breaks, border rows)
  - Atmospheric conditions (Wind speed, wind direction, stability index, mixing height, air temperature, relative humidity)
- Biological (receiver field)
  - Pollen shed characteristics
  - Synchrony with female and adventitious pollen source
  - Pollen vigor

The Biological Component "Very Predictable"

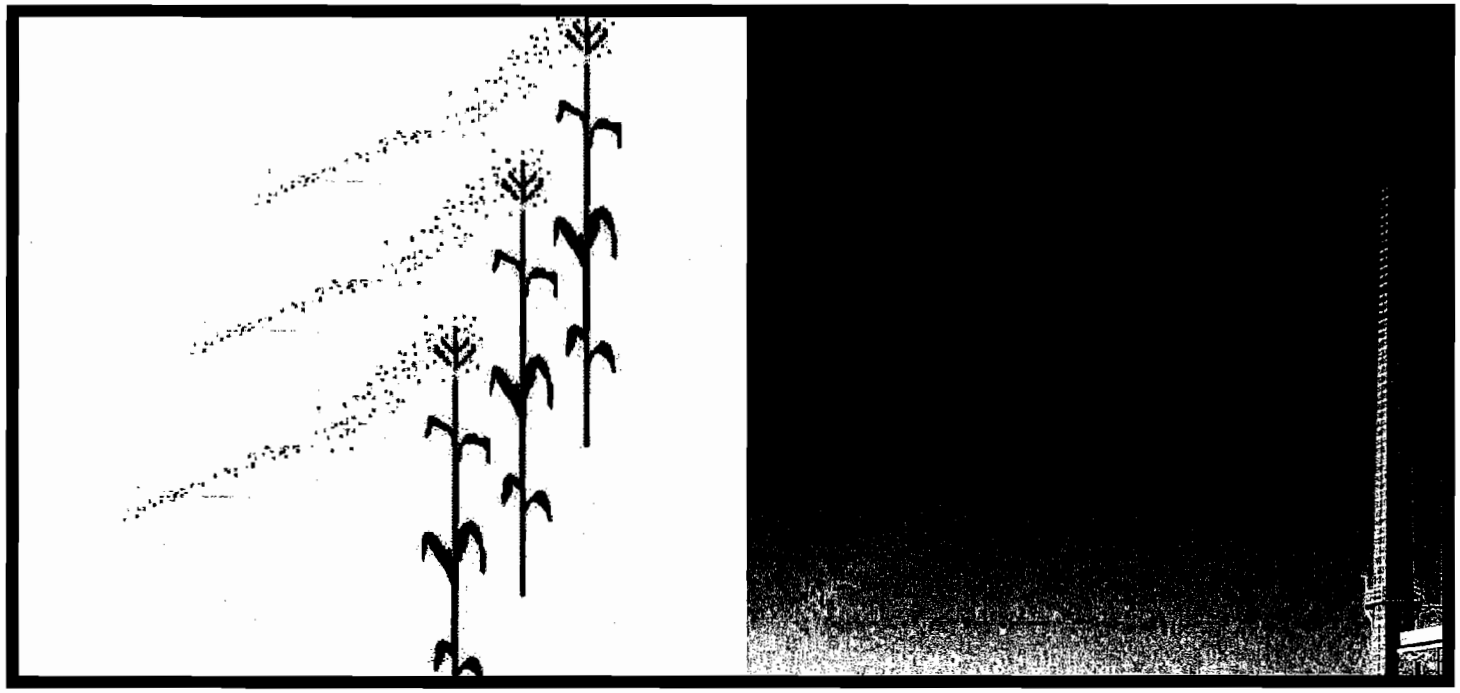




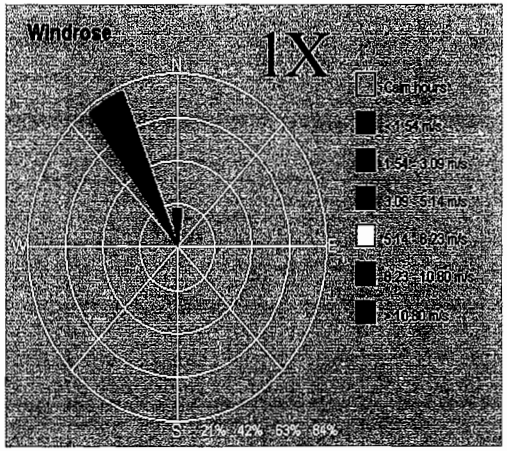


The Physical Component
"Modeling Pollen Dispersal"

Pollen movement into surrounding areas is determined primarily by the physical nature of the transport system

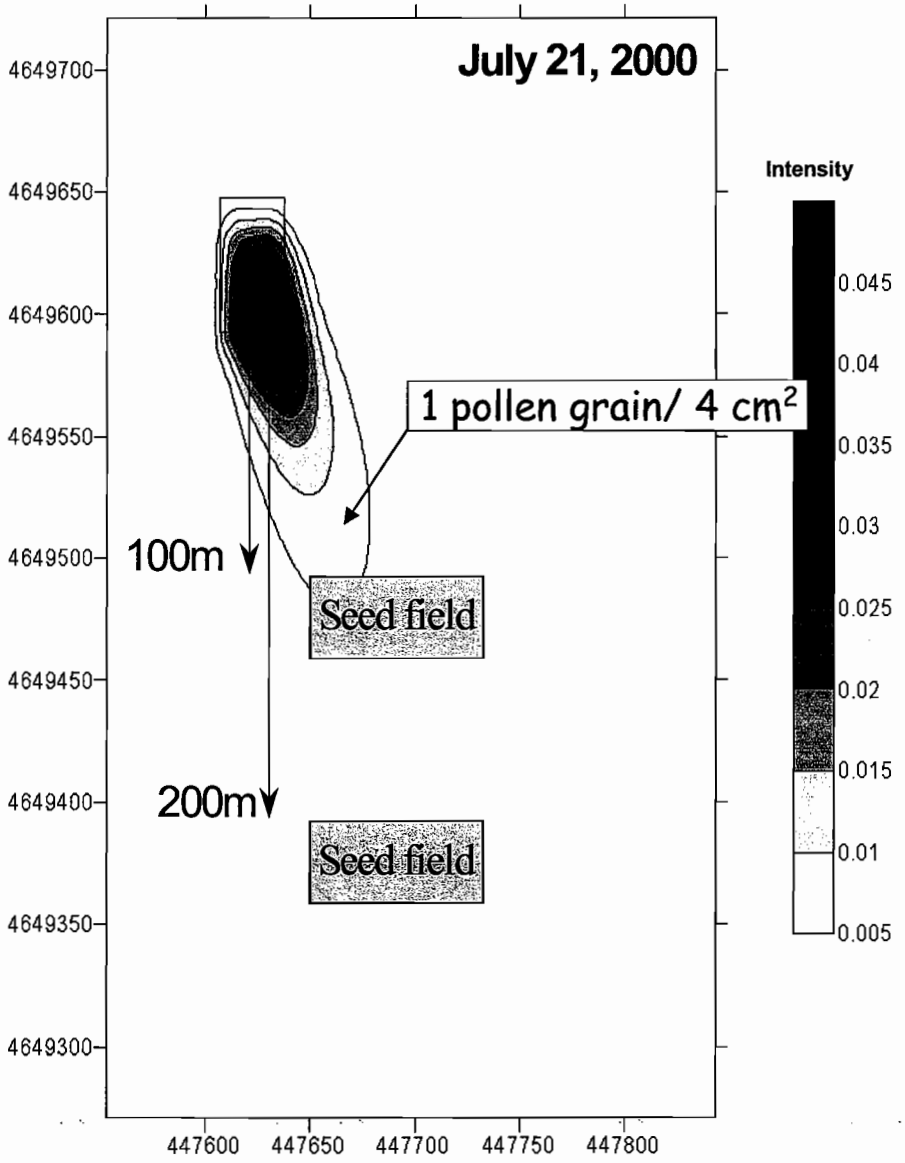


We can estimate the amount of pollen carried away from a source area



Wind at 7 mph (3 m/s) was sufficient to cause pollen drift to a seed field 330 ft (100 m) away.

at 1 pollen grain/ 4 cm^2
potential contamination ~ 0.28%
or ~ 3 kernels per 1000 exposed silks

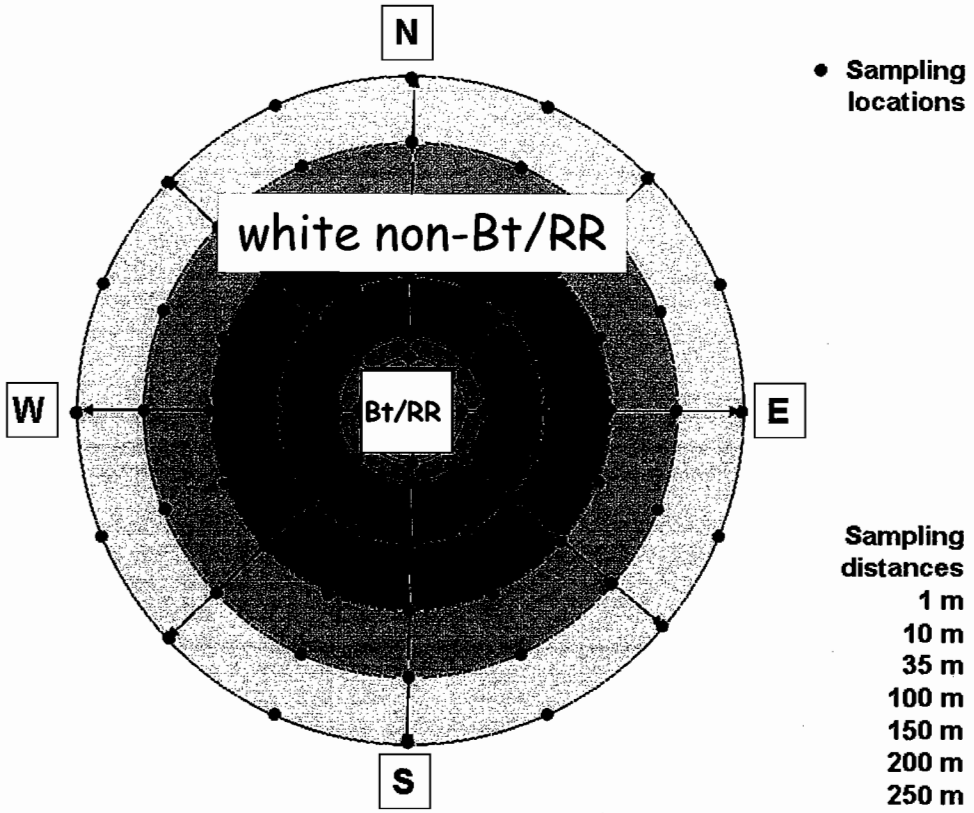


Is planting intervening corn a more effective way to isolate non-GE corn from the neighbor's Bt/RR/LL/etc. corn?

2-ac field of Bt/RR yellow corn surrounded by 80 ac of non-GE white corn

Floral synchrony and intensity measured at 45 locations.

Percent yellow/Bt/RR seeds measured at 90 locations, up to 30,000 seeds each.



2003 and 2004

Results from 2003...

Average percentages of yellow, RR grain in the adjacent field.

	Transect							
Distance	NW	N	NE	E	SE	S	SW	W
(m)	----------Outcrossing (%) ----------							
1	20.7	26.1	20.9	25.7	47.1	43.5	45.1	9.8
10	3.0	1.8	2.4	3.1	3.9	3.1	2.9	0.2
35	0.2	0.2	0.2	0.9	0.9	0.4	0.6	0.0
100	0.003	0.05	0.05	0.01	0.05	0.06	0.04	0.005
150	0.001	0.02	0.03	0.002	0.03	0.04	0.004	0.0
200	0.004	0.005	-----	0.006	0.01	0.01	0.011	0.0
250	0.000	-----	-----	-----	0.003	-----	0.002	0.003

At 35 m, 0.9% or less of the seeds were yellow/RR
At 100 m, less than 0.1% of the seeds were yellow/RR

Results from 2004...

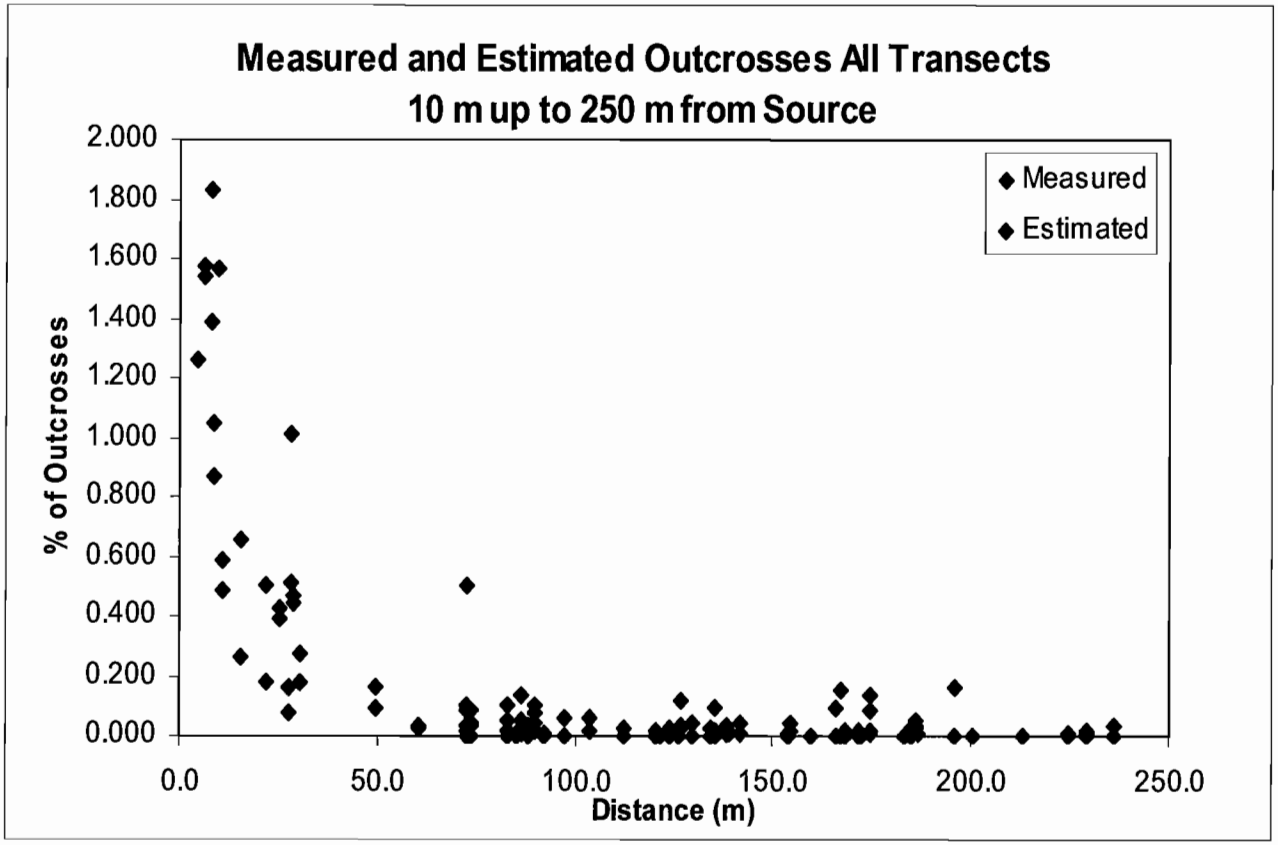
Average percentages of yellow, RR grain in the adjacent field.

	Transect							
Distance	NW	N	NE	E	SE	S	SW	W
(m)	---------- Outcrossing (%) ----------							
1	8.9	9.9	19.4	18.4	21.2	30.6	15.4	12.3
10	2.1	4.0	2.9	1.8	4.4	2.1	1.2	1.0
35	0.5	0.5	0.5	0.3	0.7	0.4	0.4	0.2
100	0.05	0.06	0.05	0.01	0.09	0.03	0.05	0.03
150	0.04	0.03	0.06	0.06	0.01	0.02	0.02	0.01
200	0.01	0.01	0.04	0.00	0.01	0.01	0.01	0.12
250	0.08	0.01	-----	-----	0.00	0.02	0.04	-----

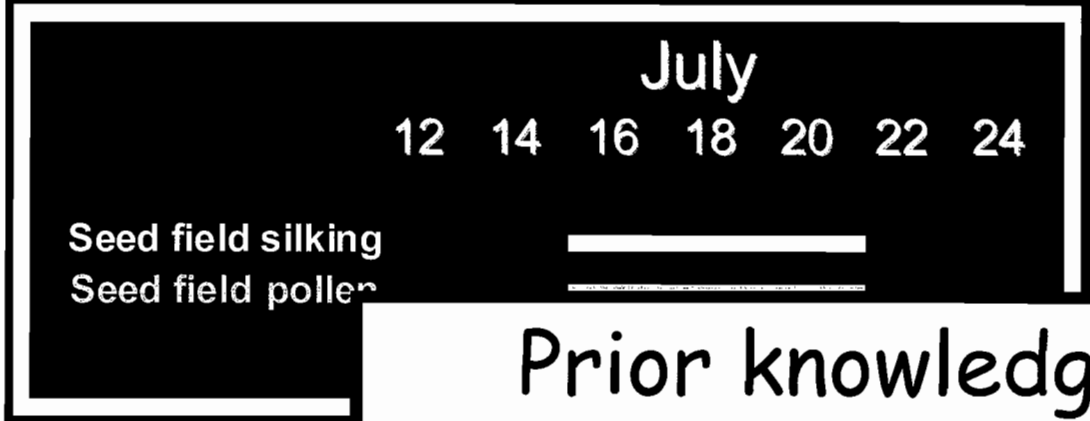
At 35 m, less than 0.9% of the seeds were yellow/RR
At 100 m, less than 0.1% of the seeds were yellow/RR

The pattern of Bt/RR presence in the surrounding field could have been predicted!

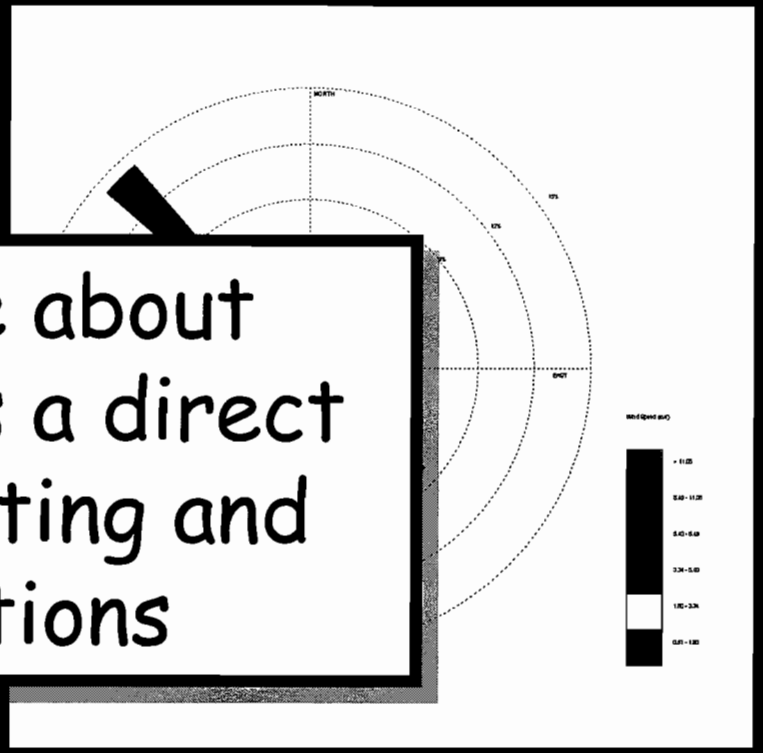
(...because pollen dispersal and the pollination process are predictable)



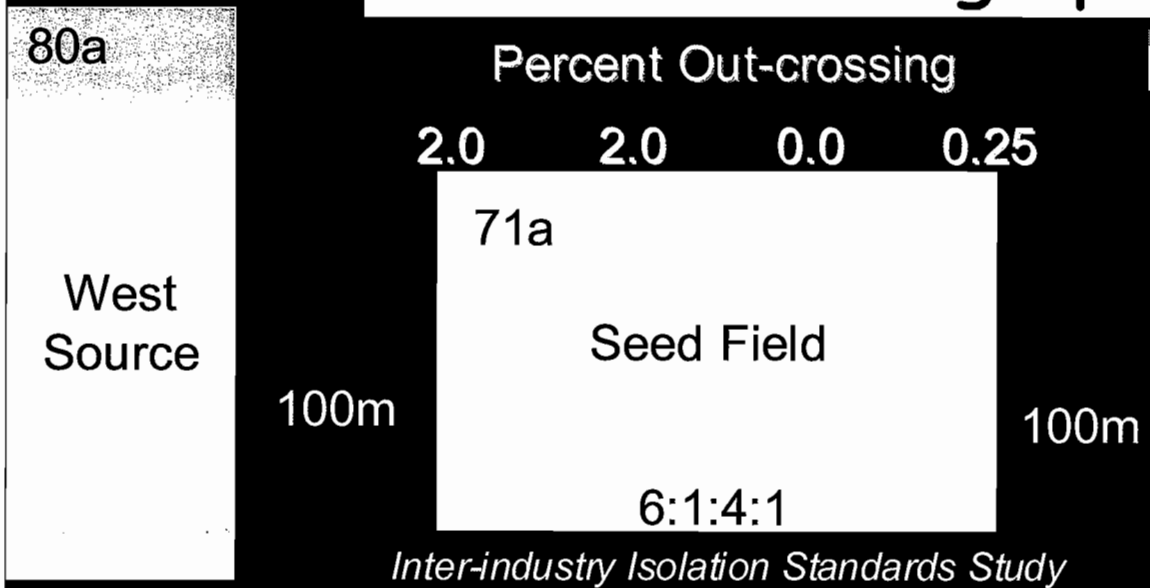
Durant, IA :1998



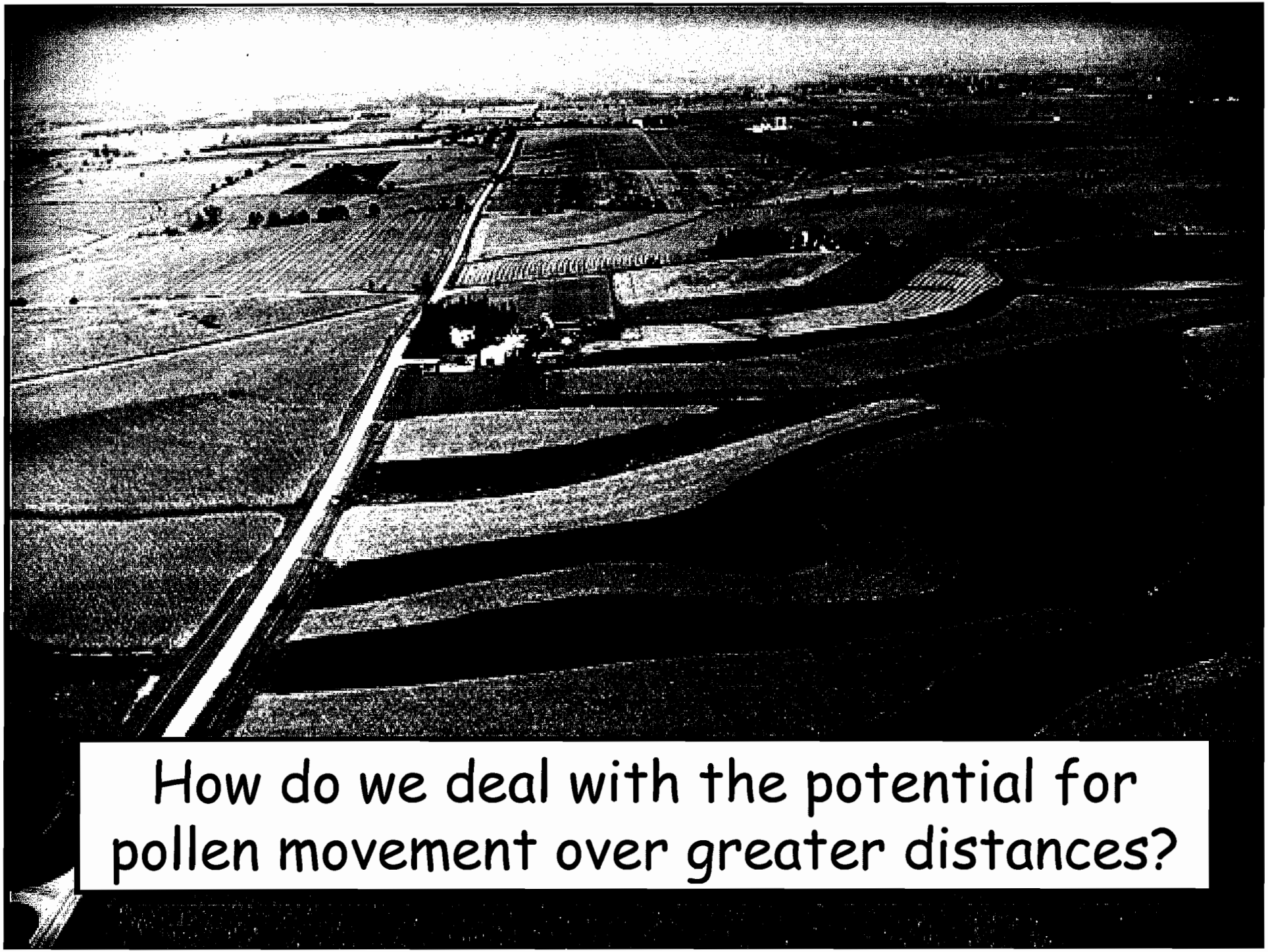
WindRose for Durant, IA
15-21 July 1998: 0800 – 1400 h



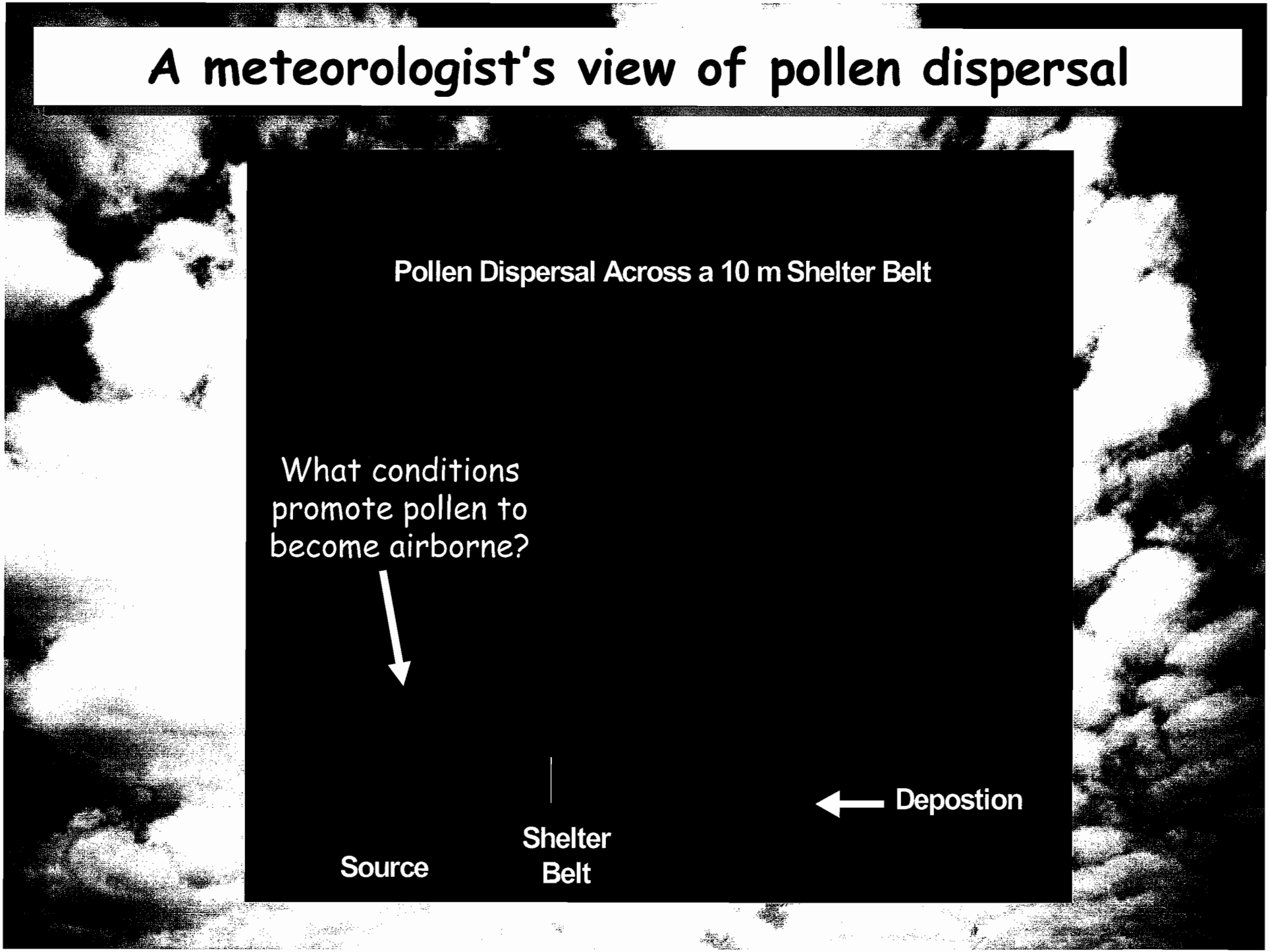
Prior knowledge about genetic purity has a direct impact on harvesting and marketing options



Inter-industry Isolation Standards Study


How do we deal with the potential for pollen movement over greater distances?

A meteorologist's view of pollen dispersal



The physical shape of the corn canopy itself effects the potential for pollen dispersal

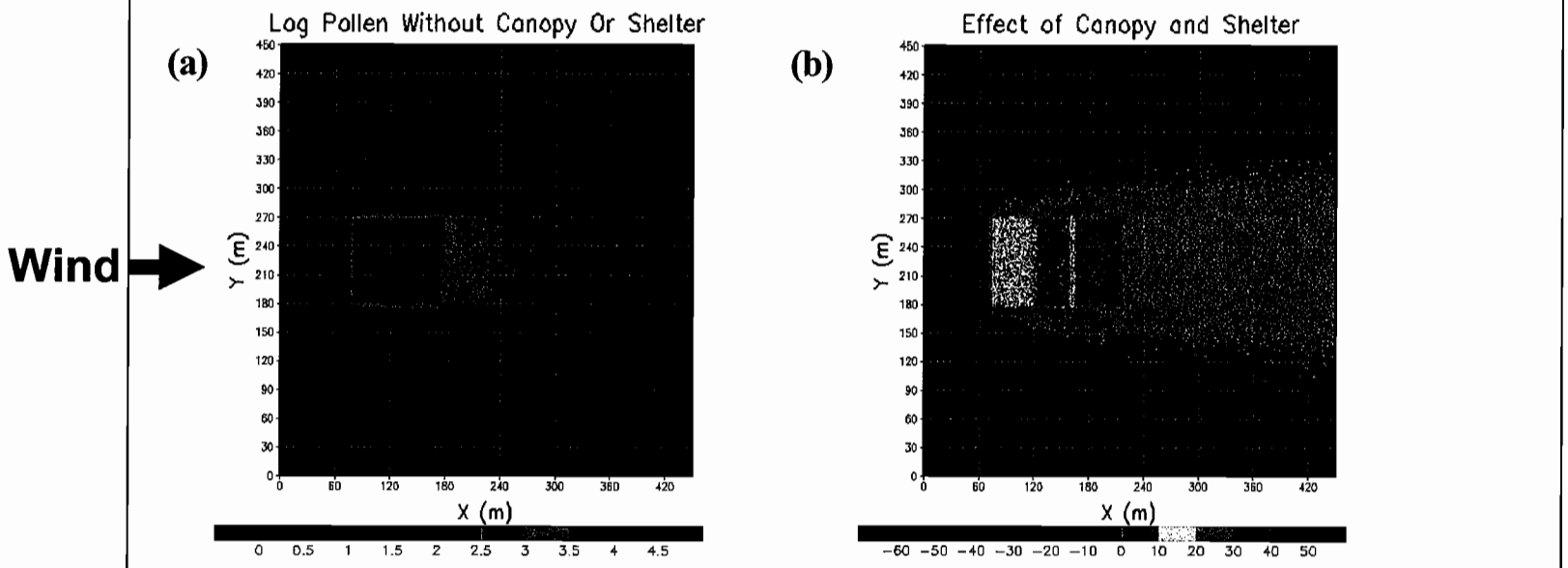


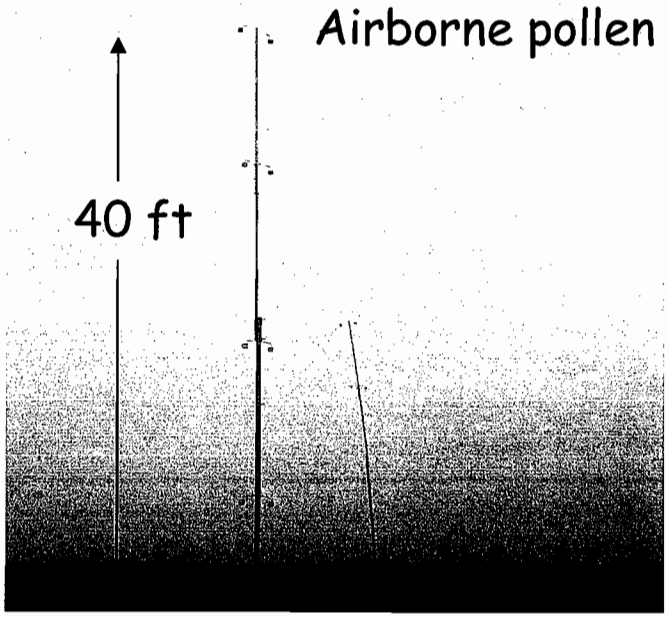
Figure 1: (a) Base-10 logarithm of pollen deposition (grains per square meter) from a 1 ha test plot without considering effect of canopy height or surrounding by a shelter; (b) Change in base-10 logarithm of pollen deposition when including the effect of canopy height and a surrounding shelter of 3 m height.

2005 Field study to document (and modify) pollen dispersal
-- to be used to validate long-distance pollen transport model

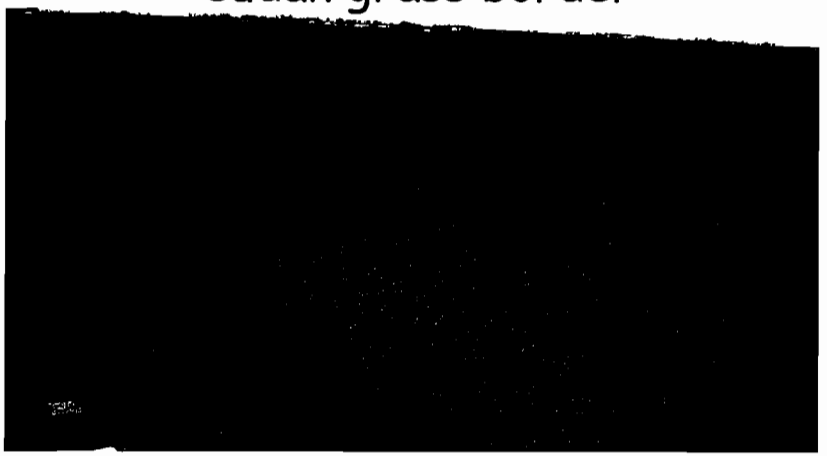
Two corn plots each isolated within a 640 acre of soybeans

near Rockwell City, IA

in cooperation with
Horan BioProduction, LLC



Corn plots with/without sudan grass border



Pollen deposition with distance

What Can Be Done Today?

- Barriers to Pollen Movement
  - Physical (glass house, nets, caves)
  - Biological (sterility, terminator genes)
  - Mechanical (detasseling, hand pollination)
  - Spatial (isolation distance)
  - Temporal (delayed planting)

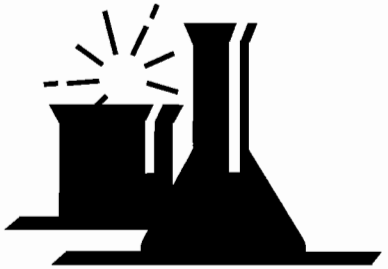
Slide courtesy of Kendall Lamkey

Minimizing the potential for product impurity requires a combination of management activities

- ✓Test the seed to be planted for genetic purity
- ✓Use distance, time, and intervening corn to isolate the crop from other pollen sources
- ✓Document wind patterns during pollination
- ✓ Cooperate with your neighbors

The bottom line…

"100% pure" cannot be proven.



Low, but acceptable levels of product impurity (transgene content) need to be identified and promoted.

As always, your call or email is welcome:

Mark Westgate
Department of Agronomy
515-294-9654

westgate@iastate.edu