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Maize GE – Benefits & Bugbears in the U.S.

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Links to this presentation can be found under "Presentations & Papers"

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A word not common to my vocabulary…

Bugbears?

- Special kind of bug or problem which can show up in the development of a system.
  - These problems are difficult to track down because they aren't caused by any one part of the system.
  - These problems are caused by subtle consequences of the way the whole system interacts.
- Tend to show up very late in the development cycle because that's the first time the system is essentially complete.
- Expensive to fix because they tend to require fundamental changes in the way the system works.

Source: http://www.dunkworks.com/research/bugbears/ot2000.html

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An Alternative Definition, Also Appropriate?

Bugbears?

- Giant, hairy cousins of goblins who frequent the same areas as their smaller relatives.
  - Large and very muscular, standing 7' tall.
  - A nose much like that of a bear with the same fine sense of smell.
  - Prefer to ambush their foes.
  - Two main goals in life: survival and treasure.

Source: http://home.onego.ru/~adnd/pages/mm/MM00025.htm

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The GE Debate:

Benefits & Bugbears…

- The transgenic debate is emotional for opponents & proponents alike.
  - Proponents often overstate the size of the benefits in their blind fervor to support biotechnology.

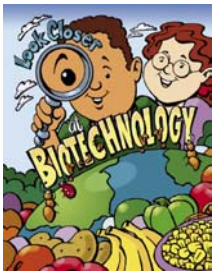

Image source: http://www.whybiotech.com/html/pdf/ActBook.pdf

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The GE Debate:

Benefits & Bugbears…

- The transgenic debate is emotional for opponents & proponents alike.
  - Proponents often overstate the size of the benefits in their blind fervor to support biotechnology.
  - Opponents often overstate the size of the bugbears in their blind fervor to stop biotechnology.

Image source: http://ge.greenpeace.org/campaigns/intro?campaign%5fid=3942

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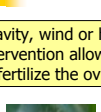
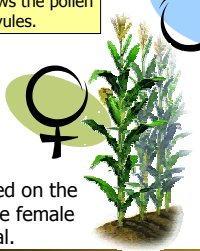
'Natural' Corn Plant Sex

Gravity, wind or human intervention allows the pollen to fertilize the ovules.

Pollen produced in the tassel anthers contains the male genetic material.





Ovules produced on the ears contain the female genetic material.

This 'natural' sex has been going on for thousands of years!

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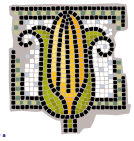
So, let's admit that…

Maize is a GMO!



- Genetic modification of maize has been occurring for thousands of years.
  - Center of origin = Mexico, central America
  - Earliest plant breeders = women
  - Genetic modification the old-fashioned way: Hard work!

- Now, genetic modification is possible using fancier tools than ever before.
  - Including the transfer of genes from other living species into maize.

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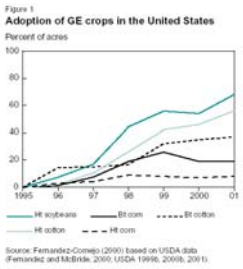
Adoption of transgenics…

- Certain transgenic crop types have been adopted very rapidly by U.S. farmers. Why?
  - Very few additional management changes are required by the farmer to adopt this technology.



Source: www.ers.usda.gov/publications/aer810/

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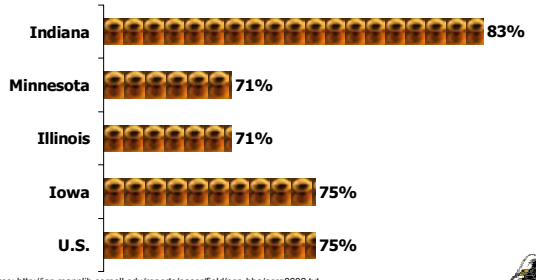
U.S. transgenic soybean acreage, 2002



Source: http://jan.mannlib.cornell.edu/reports/nassr/field/pcp-bba/acrg0602.txt

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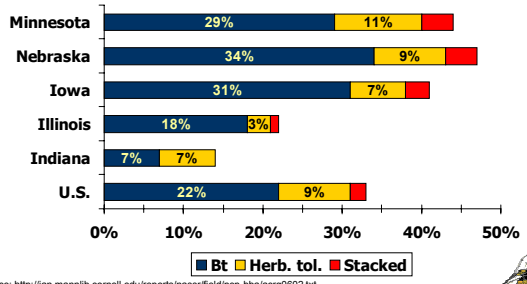
U.S. transgenic maize acreage, 2002



Source: http://jan.mannlib.cornell.edu/reports/nassr/field/pcp-bba/acrg0602.txt

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Indiana is a bit odd…

- Among the **highest** percentage of acres planted to transgenic **soybean**.
- Second **lowest** percentage of acres planted to transgenic **maize**.

Why the discrepancy between Indiana's two major crops for the adoption of transgenic varieties?

Perception of Benefits & Bugbears

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To adopt or not to adopt?

- The answer lies with the balance between agronomic costs, agronomic or economic benefits and market uncertainties associated with transgenic crop varieties.

For example:
High cost + little benefit + uncertain market =
substantial economic risk

High cost + some benefit + feed own livestock =
little economic risk

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Indiana farmers:

Transgenic HT soybean…

- Benefits
  - Effective weed control program.
  - Less crop injury
  - Simplified weed control program.
- Bugbears
  - Higher priced seed
  - HT soybean varieties yield less than non-HT

Result? Benefits overcome Bugbears

Consumer & market acceptance almost a non-issue.

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Indiana farmers:

Transgenic HT maize…

- Benefits
  - Effective control of problem weeds.
  - Simpler post-emergence program.
- Bugbears
  - Higher priced seed
  - Additional, residual, herbicide usually required for optimum weed control program.
  - Yield potential vs. best non-HT hybrids on the market still uncertain.
  - Indiana food processors refuse to buy HT maize grain.
  - Pollen drift can create transgenic contamination of adjacent non-HT fields.

Result? Bugbears overwhelm Benefits

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Indiana farmers:

European corn borer:

Transgenic Bt maize…

- Benefits
  - Effective control of targeted pest.
  - Simplified pest control program.
- Bugbears
  - Higher priced seed
  - Targeted insect is not a serious economic pest in eastern U.S. Corn Belt.
  - Often yields less than best non-Bt hybrids on the market.
  - Indiana food processors often refuse to buy Bt grain.
  - Pollen drift can create transgenic contamination of adjacent non-Bt fields.

Result? Bugbears overwhelm Benefits

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Indiana farmers:

Corn rootworm:

Transgenic Bt maize…

- Benefits
  - Targeted insect is a major economic pest in Indiana.
  - Effective control of targeted insect.
  - Simplified pest control program.
- Bugbears
  - Higher priced seed, including add'nl seed treatment.
  - Yield potential vs. best non-Bt hybrids on the market yet unknown.
  - Indiana food processors will likely refuse to buy Bt grain.
  - Pollen drift can create transgenic contamination of adjacent non-Bt fields.

Bugbears (especially market concerns) will still be hard to defeat.

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GE Crop Regulation:

Who are the watch dogs?

- USDA's Animal and Plant Health Inspection Service (APHIS)
  - The agency regulates the field testing of genetically engineered plants and certain microorganisms.
  - Was the agency involved with 2002 Prodigene® regulation breach.

In other words, APHIS determines whether these products are safe to release into the "real world".

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GE Crop Regulation:

Who are the watch dogs?

- The U.S. Department of Health and Human Service's Food and Drug Administration (FDA)
  - Governs the safety and labeling of drugs and the nation's food and feed supply, excluding meat and poultry.

In other words, FDA determines whether food made from these products is safe for human consumption.

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GE Crop Regulation:

Who are the watch dogs?

- The U.S. Environmental Protection Agency (EPA)
  - Ensures the safety and safe use of pesticidal and herbicidal substances in the environment and for certain industrial uses of microbes in the environment.

In other words, EPA determines whether TGs that express pesticidal traits are safe for the environment.

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GE Crop Regulation:

Who are the watch dogs?

- The U.S. Dept. of Health and Human Service's National Institutes of Health
  - Guidelines for the laboratory use of genetically engineered organisms.
    - Generally voluntary, but mandatory for any research conducted under Federal grants
    - Widely followed by academic and industrial scientists around the world.

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Consumer concerns?

- Issues commonly raised include …
  - Fears of unidentified food safety risks from transgenic modifications
    - Toxins
    - Carcinogens
    - Dietary preferences
      - Not a risk, but a matter of choice
    - Allergens
      - Soybean & Brazil nut genes
      - Kraft taco shell recall & StarLink™ Bt maize

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So, what about StarLink Insect Protection ?

- StarLink™ maize hybrids contained the Cry9C insecticidal gene from *Bacillus thuringiensis*
  - Stability of protein to heat and gastric digestion were greater than those of other Bt genes
    - Was the reason for allergen uncertainty on the behalf of EPA regulators.
    - Was the reason for non-approval of StarLink™ maize for human food use.

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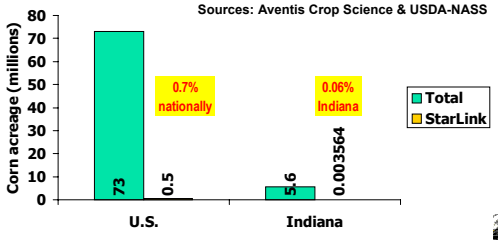
Perspective on StarLink Insect Protection

- Very small % of total maize acres



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Consumer concerns?

- Issues commonly raised include …
  - Fears of unidentified environmental risks from transgenic modifications
    - Off-target injury or death to nonpests
      - Monarch butterflies & Bt maize pollen
    - Selection pressure for pesticide-resistance
      - Glyphosate resistance in Australian *Lolium rigidum*
    - Gene escapes (cross-pollination) to weedy relatives of crops
      - Canola (rapeseed) & weedy mustards

Image source: www.nre.vic.gov.au

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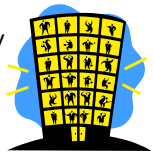
Consumer concerns?

- Issues commonly raised include …
  - Fears of corporate monopolies in agricultural production
    - Control of global food supply
    - Elimination of small farmers



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Marketplace response?

- Grain importers, buyers & processors have responded to consumer concerns by limiting which transgenic varieties they will purchase.
  - European Union has an accepted list
    - Includes RR soy & most Bt maize, but not RR maize, StarLink Bt or rootworm Bt maize.
  - Acceptance by processors & public is less certain for the immediate future
    - Frito-Lay, Gerber, Staley, McDonalds

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Thoughts courtesy of: Dirk Maier, Purdue Ag. Engr.

StarLink lessons for future

- Biotech firms **should not be allowed** to market a biotech variety until:
  - The variety has been approved by regulatory agencies and accepted by the grain industry for **all end uses**, including feed, industrial, food and pharmaceutical;

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  - Reliable and inexpensive **testing technology** is available for use at the first point of sale (such as strip-test kits for elevator use); and

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StarLink lessons for future

- Biotech firms **should not be allowed** to market a biotech variety until:
  - The variety has been approved by regulatory agencies and accepted by the grain industry for all end uses, including feed, industrial, food and pharmaceutical;
  - Reliable and inexpensive testing technology is available for use at the first point of sale (such as strip-test kits for elevator use); and
  - **Tolerance levels** based on detectable limits have been established in order to give the U.S. grain handling, exporting and processing industry the ability to meet customer demands **with respect to the presence of approved but undesired transgenic crop traits** in their end-products.

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Future transgenics?

- Broad acreage will likely continue to be defensive traits (e.g., pest resistance).
  - Possibly industrial use traits, also.
- Food crops may not be best choice for non-food transgenic traits.
  - E.g., HIV-vaccine production using tobacco rather than maize.
- Niche markets for human health products
  - Required production acreage likely small.
  - Likely controlled by parent company in a vertically integrated system (seed >> pill).

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Hungry for More?

- Check out one of these fine Web sites…

Welcome to … KingCorn.org
The Corn Growers' Guidebook

Corny News Network
Biotech Issues
www.kingcorn.org/cafe/biotech.html