

Contemporary Food Fights: Communicating about Biotechnology with the Public



Peggy G. Lemaux
University of California, Berkeley





Comfortable doing research in a laboratory...





Comfortable teaching in a classroom...



Comfortable doing public outreach...

...but what about this role?

County GMO Ordinances

GrowGmoFree.ORG

Paid for by The Committee for Humboldt Green Genes (#1264406) (707)826-1031 (707)442-3481 (707)923-1116 PO Box 4841, Arcata, CA 95518

NO on Q
It's Bad for Farmers.

No On "D"

Families & Farmers For
A Healthy Environment

YES Q

HEALTHY FARMS AND FAMILIES

ucbiotech.org



IT ALL STARTED IN
MENDOCINO
COUNTY



**March 2004 MENDOCINO
MEASURE H -2,579 signatures obtained**

- “unlawful for any person, firm, or corporation to propagate, cultivate, raise, or grow genetically modified organisms in Mendocino County” (excludes microorganisms)
- “DNA or deoxyribonucleic acid means a complex protein that is present in every cell of an organism...”
- The ban does not pertain to properties within city limits, or lands managed by State, Tribal and Federal agencies.
- At election time, no GE organisms were known to be in production in Mendocino County.

...entist argument
...udicrous

In our opinion
Remember there are two sides to every story.

To the Editor:
The comparison in the article regarding the loss or omission of organic certification if an organic crop is contaminated with GMO pollen is ludicrous! If an organic crop is contaminated with GMO pollen, it becomes a GMO crop. I don't want to see organic food that is not certified organic, but I do want to see organic food that is not contaminated with GMO pollen. Heck, I'd even take organic food from last year that was contaminated with GMO pollen. And I will grow organic food that is not contaminated with GMO pollen. I will grow organic food that is not contaminated with GMO pollen. I will grow organic food that is not contaminated with GMO pollen.

We endorse Measure H!



CRAIG BELL

YES
on the ballot

Mendocino considers ban of genetically engineered plants

NORTH COAST

Letters to the Editor, Flyers, Mailings Were Everywhere...

GM

By GLENDA
The Daily Journal

County supervisors voted to place on the March ballot an initiative that would prohibit the growing of genetically modified organisms in Mendocino County.

Supervisors' only other choices were to adopt the initiative as a county ordinance or to send it to the ballot.

The initiative was authored by Mendocino Organic Network, a coalition of farmers and consumers who are concerned about genetically modified organisms. Organic farmers could no longer certify their crops as organic, Cooperidge said.



TONY CRAVER

■ **Protect our health!**

What were they writing about?

More on GMO

To the Editor:
I've been reading with interest the arguments in support of banning genetically modified organisms in Mendocino County. Unfortunately, the arguments lack a certain amount of forethought. We all know that by cross-pollination, the pollen from one plant can fertilize another. This is why we have hybrid vigor in farm products that have been bred genetically. Now we have a process by means of laboratory engineering. We have used this new science



TONY CRAVER

- **Protect our environment!**
- **Protect our private property!**

Keep Mendocino County GMO FREE!

Join us!

...this band of
...ations includes the
...ic engineering of food
...they just happen to be
...ers of the herbicides
...high their patented GMO
...ed to use exclusively.
...ed to use a Novartis
...on the Northwest Science
...nental Policy Center in
...2003 study
...and Environmental Policy
...Idaho, which - ... concludes that the
...million acres of GM corn, soybeans
...cotton planted in the US since 1994
...increased pesticide use (herbicides
...insecticides) by about 50 million
... (emphasis is mine).
...So I ask you, dear reader, why
...interest might the CPHA have?
...Mendocino County initiative.

Understood

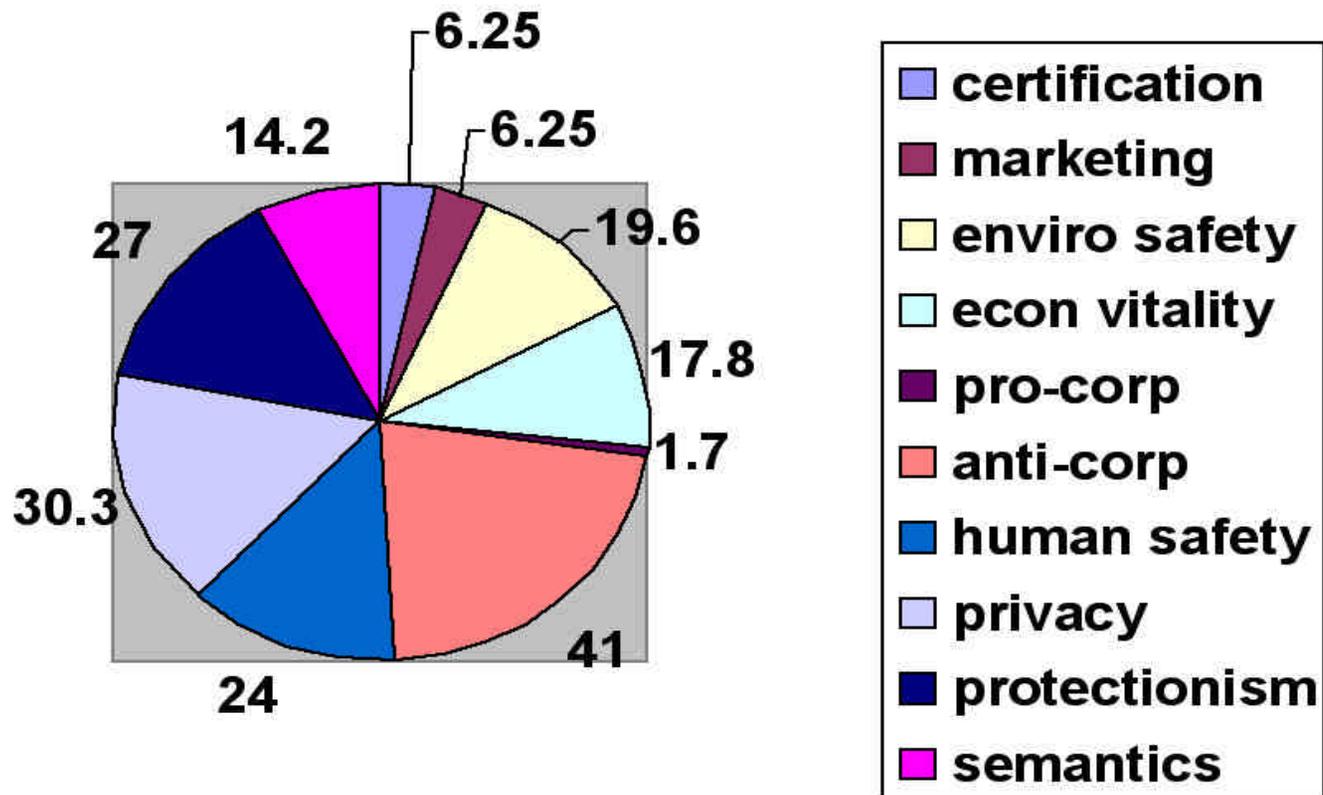
...of Marie
...en, GMO crop

...the arguments from the
...measure H, but without sex
...text for measure H, I wa
...validity of their argument

...argument for measure H wa
...one planted a field of GM
...the pollen that would
...crop onto a neighbor's
...d the
...the neighbor's
...organic certification.
...little research to find
...I talked to Ray Green, the
...organics for the State of Californi



CHARACTERIZATION OF MEASURE H ELECTION RELATED MATERIALS IN MENDOCINO COUNTY



Giusti *et al.* (2004) Focus on Genetically Engineered Crops and Foods - A Case Study from Mendocino County's Public Debate.

The discourse was driven in many cases by alarming assertions and facts that are not derived from, nor supported by science

“When my son was 6 month (sic) old and receiving chemotherapy for leukemia, he was also receiving soy lipids intravenously because he had lost the ability to eat or drink. The longer he received the lipids, the higher the dose of chemo. When I asked why, I was told that the soybeans used were genetically modified to be “Round Up Ready,” they were putting food into my son’s veins that could withstand the chemicals they were using to kill the leukemia blood cells, making the chemo less effective. In order to keep my son alive nutritionally, the higher doses of chemo almost took him away ”

Jenny Shattuck-Hale, Ukiah Daily Journal, 2/20/04

**EXCERPTS FROM ORGANIC CONSUMERS ASSOCIATION
LETTER DISSEMINATED BEFORE NOV. 2 ELECTION**

Dear Friends,

While the rest of the country focuses on one presidential candidate or another, Measure D represents Biodemocracy in action. Rarely do we have the opportunity to change the

Contamination is spreading so quickly that we have little time to waste before our entire food supply is lost forever...

statewide ban on GE crops. California's future is organic!

Yours in organics,

Organic Consumers Association

www.organicconsumers.org

WHY DO WE NEED TO PASS THIS “GE-FREE” INITIATIVE

A “GE Free Sonoma County” will be good for our farmers, good for our environment, good for business, good for public health, and good for our democracy!



We need to protect the right to farm. Those farmers who choose to farm without GE crop varieties must have the right to do so...

livestock or fish will lose access to important international markets. We also want to

We need to protect our...environmental, public health and economic future...until there is public, peer-reviewed science available, with multigenerational studies on all the long-term impacts of these very new technologies...

We need to protect the public health of the people of Sonoma County... Such exposure could occur through GE pollen inhaled or plants eaten, or by increased exposure to toxic herbicides and pesticides used to kill the new “super weeds” and “super bugs”...





Feeding the Future

www.feedingthefuture.org

Dear Friend of California's Family Farmer,

While the fundamentals of farming are well known, the actual practice

...special interest groups - professing to have the best interests of family farmers at heart - are challenging the innovation that has made California farmers the leaders in progressive agriculture.

As farmers, we understand that some people are unsure of

As farmers, we understand that some people are unsure of biotechnology...Some activists, however, utilize scare tactics in an effort to ban biotechnology and deny everyone the benefits of the best science and the most extensive research in the world today.

making our planting decisions. We are confident in the future of

Family farmers want to continue to utilize scientific expertise when making our planting decisions. We are confident in the future of biotechnology and support the regulatory process that approves these crops on a case-by-case basis.

BILL PAULI
President
California Farm Bureau Federation



November 2004, Fresno

Passed: Board of Supervisors 5 For; 0 Against

- Whereas, biotechnology has the potential to greatly improve the health, nutrition and

County of Fresno affirms the right for farmers and ranchers to choose to utilize the widest range of technologies available to produce a safe, healthy, abundant and affordable food supply, and that the safe, federally regulated use of biotechnology is a promising component of progressive agricultural production.

and ranchers to choose to utilize the widest range of technologies available to produce a safe, healthy, abundant and affordable food supply, and that the safe, federally regulated use of biotechnology is a promising component of progressive agricultural production.







Main Menu

Information

- Sales
- Information-Genetic Engineering in California Agriculture
- ANR Programs On-Air
- UCTV Program Times & Time

Sales Information-Genetic Engineering in California Agriculture



Peer-Reviewed Educational Video

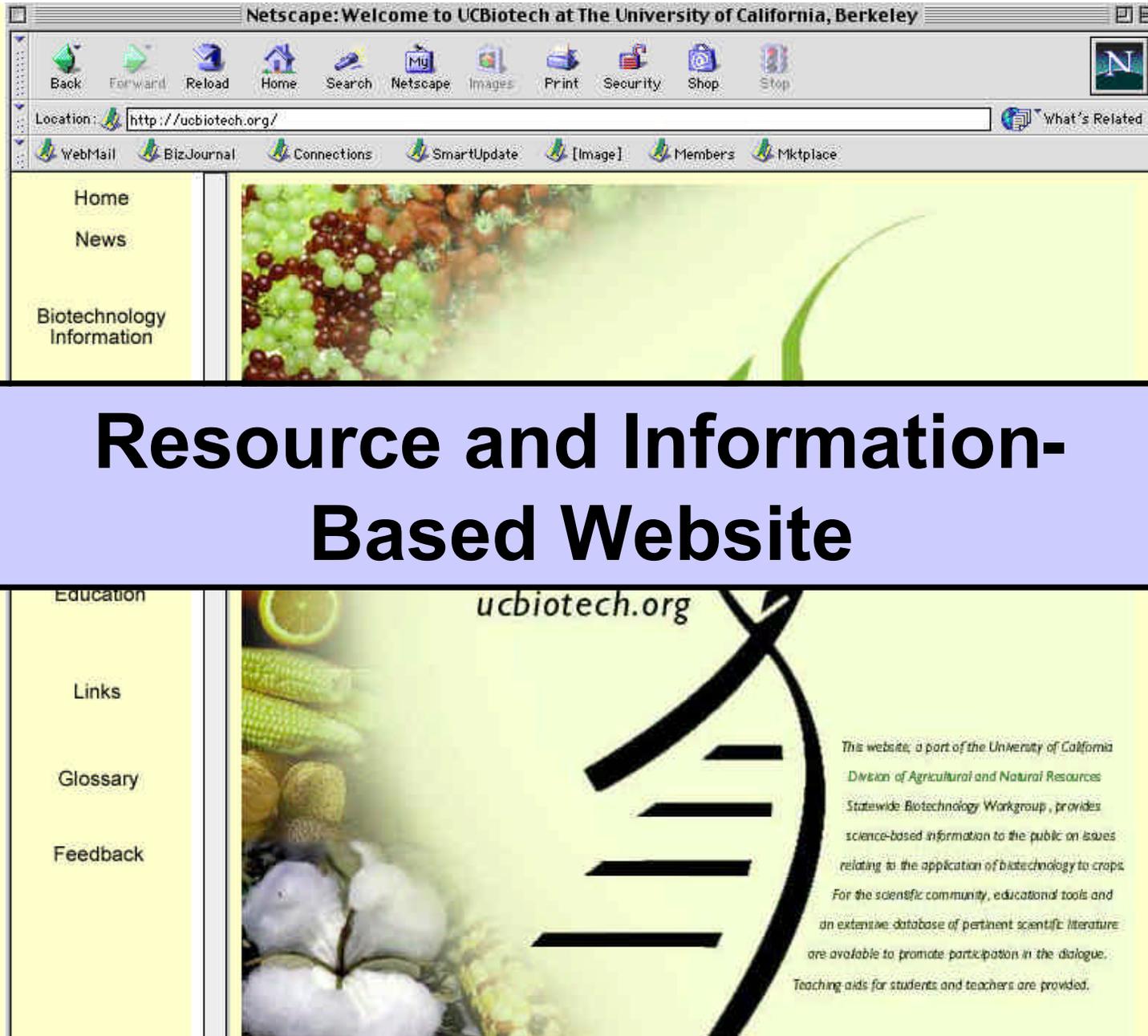
Production Team

your credit card information.

A 30-minute, peer-reviewed video explaining the science behind genetic engineering, its uses in food crops and animals, where and why the technology is being used by California farmers, and some of the science-based concerns pertaining to the use of genetic engineering.

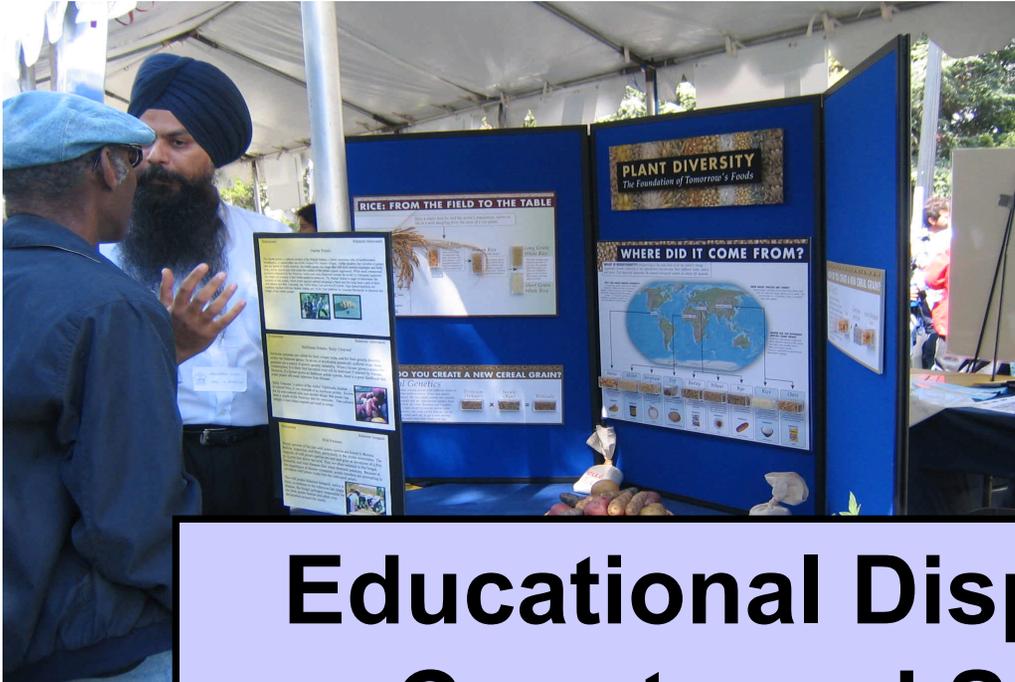
If you want to view the movie

mms://STREAM.ucanr.org/Windows Media/UCTV_04_06.asf



Resource and Information-Based Website





Educational Displays for City, County and State Events





Informational Workshops for County Officials and Staff



PUBLICATION 8153

UNIVERSITY OF CALIFORNIA
Division of Agriculture
and Natural Resources
<http://anrcatalog.ucdavis.edu>



Genetic Engineering and Pollen Flow

NORMAN C. ELLSTRAND, PH.D., Professor of Genetics and Director,
Biotechnology Impacts Center, University of California, Riverside

INTRODUCTION

Pollen grains are the vehicles that transport a plant's male cells or gametes. For most plants that produce pollen, it is transported by wind and insects plus many species are able to self-pollinate some or most of their own female cells or eggs. Typically, the

Science-based, Peer-reviewed FACT Sheets on the Issues

What are the consequences when traditionally bred crops cross with wild relatives?

The vast majority of the attention has focused on engineered crop genes in natural populations. For guidance about future problems with engineered crops, we can ask whether traditionally improved crops have hybridized with wild relatives, and if so, whether those hybrids have caused any problems. Most cultivated species naturally hybridize with some wild relative or relatives somewhere in the world (Ellstrand 2003a). In some cases, such as coffee, those wild relatives are geographically restricted. On the other hand, one or more wild relatives of rice are usually found where rice is cultivated worldwide. The vast majority of cases involving hybridization of cultivated plants and their wild relatives has been of little consequence. However, such hybridization, on occasion, has created two classes of problems:

The evolution of new or more difficult-to-control weeds. In particular, the evolution of a new weed beet in Europe – a hybrid of sugar beet and an innocuous wild species - has resulted in well over a billion dollars of damage to Europe's sugar industry in terms of reduced yields and increased management costs (Ellstrand 2003a). In California, hybridization between rye and a wild relative has been implicated in the evolution of a new weedy rye variety that has hurt the wheat and rye industry in the northeastern part of that state (National Research Council 1989).





Science-based educational presentations

What do we present?



Genetically engineered foods or GMOs





This is not the first agriculturally based controversy



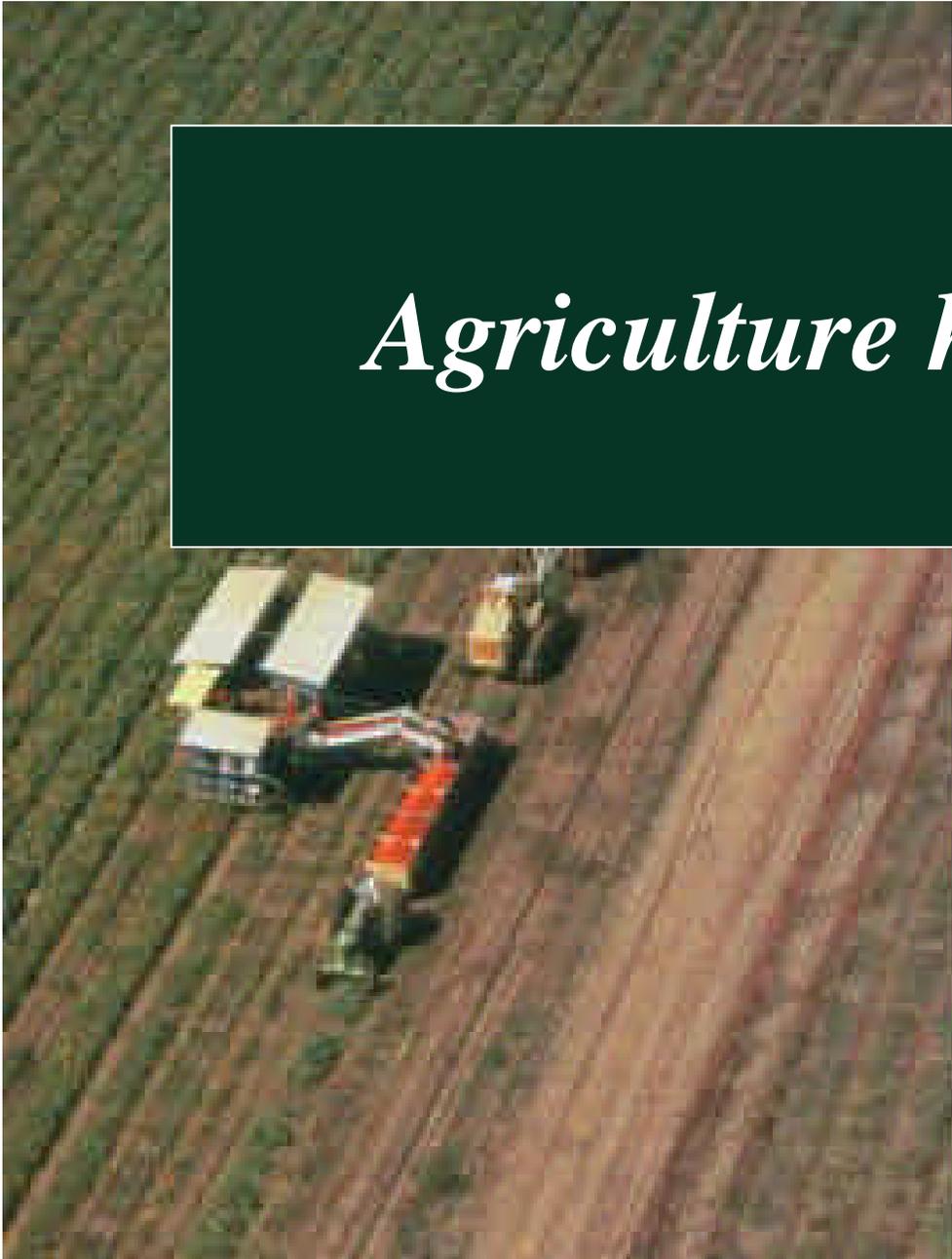
Pasteurization

Other technologically based controversies

Nuclear Power

Risk: *Determined quantitatively*

Safety: *Acceptable risk*

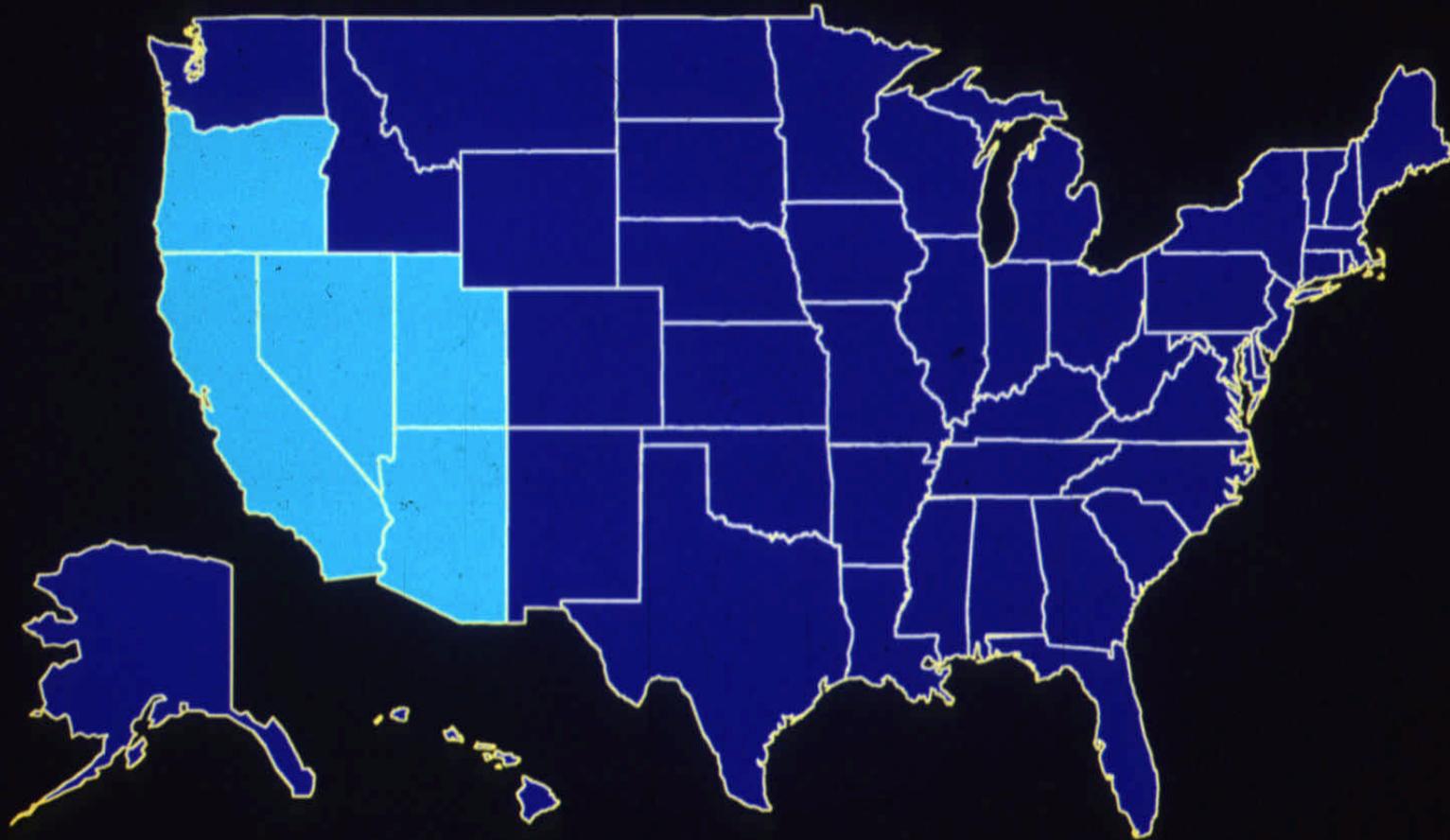


Agriculture has changed



Modern Corn and Ancient Teosinte Relative

U.S. Cultivated Land



■ 1987 Acreage

ANALOGIES FOR DEMONSTRATING GENETICS

COMPARE NUCLEOTIDES IN WHEAT
TO LETTERS IN BOOKS



1.5 million pages

COMPARE GENES IN WHEAT
TO POP-IT BEADS



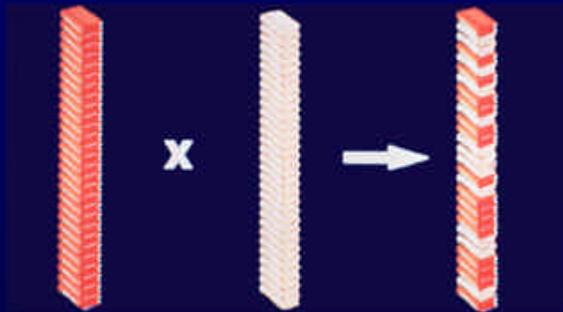
String of beads = quarter of a mile

CLASSICAL BREEDING

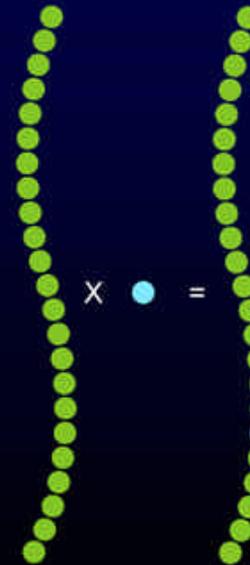
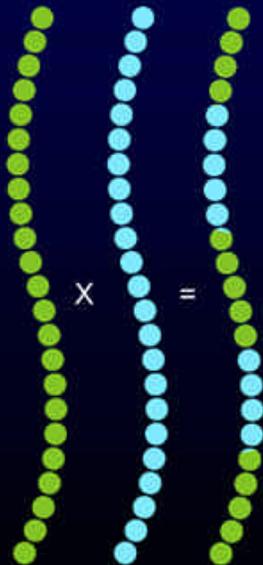
VS

GENETIC ENGINEERING

USING BOOK ANALOGY



USING POP-IT BEADS



TERMS USED

GM/GMO

Genetically Modified Organism

GE/GEO

Genetically Engineered Organism

LMO

Living Modified Organism

rDNA

Recombinant DNA

Biotechnology

What Is in a Recombinant DNA Construct?

On
switch

Gene of interest:
herbicide, stress or
disease tolerance



Herbicide tolerance

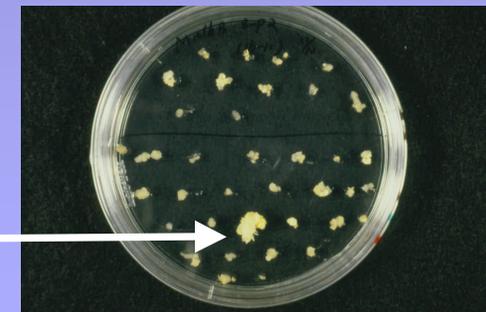
Off switch

On
switch

Marker gene:
antibiotic or
herbicide
resistance

Off switch

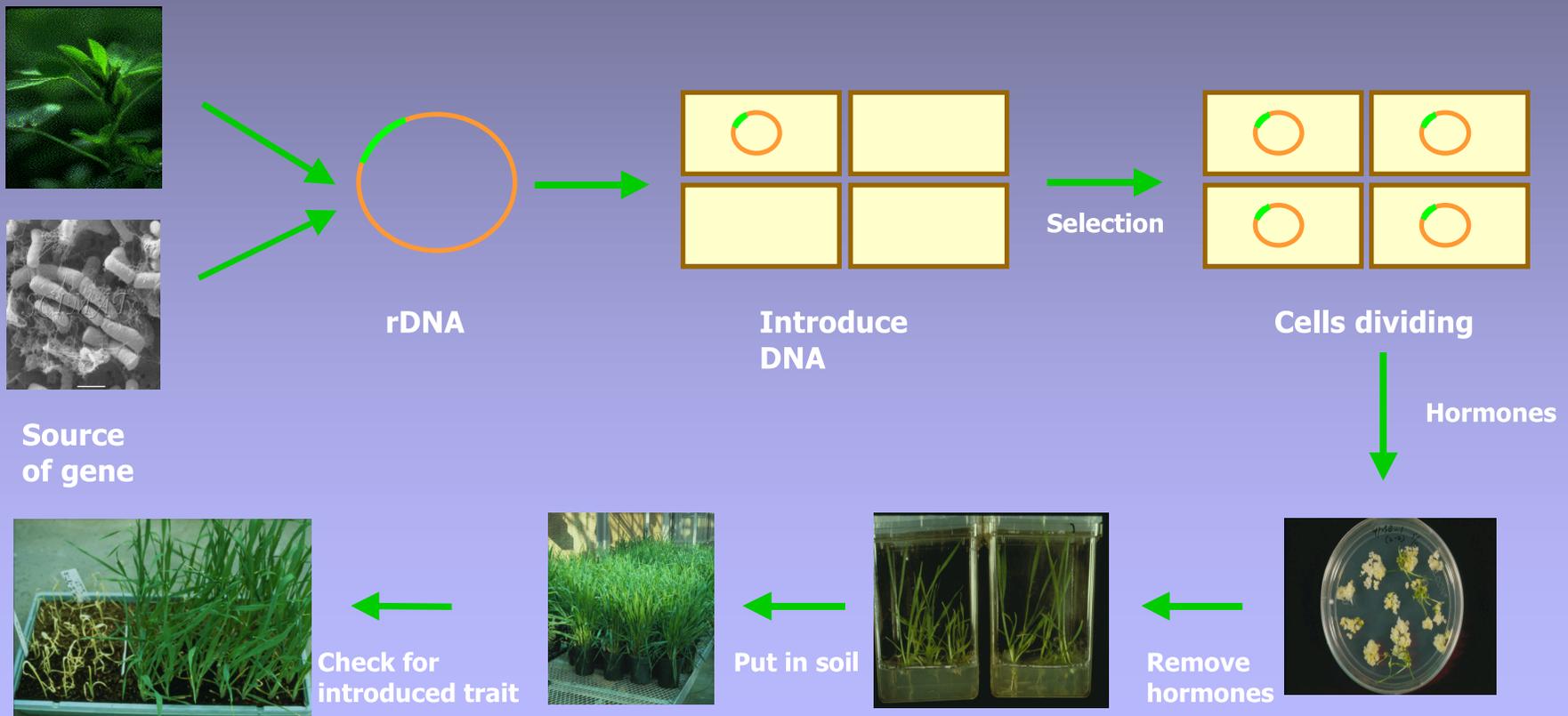
Surviving tissue



Selection plate

Genetic Engineering

- Create rDNA with gene from same or different organism
- Transfer DNA to plant cell; allow plant cells to divide under selection
- Cue cells to reform plant - every cell will have new DNA
- Confirm introduced DNA and expression of foreign protein in plants



Classical Breeding

compared to

Genetic Engineering

Uses plant machinery in plant

Gene exchange is random
involving entire genome

When/where genes expressed
not controlled by breeder

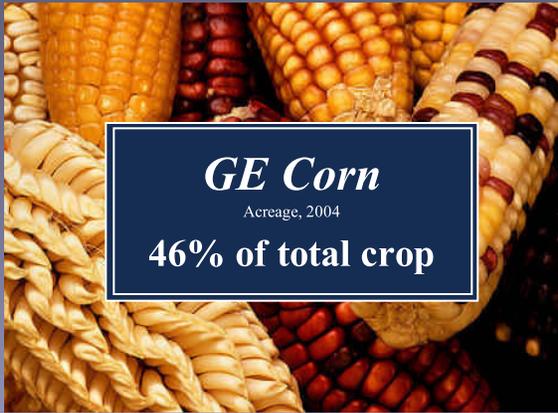
Only between closely related or
within species

Uses plant machinery in laboratory

Gene exchange is specific,
single or a few genes

When/where gene expressed
can be controlled precisely

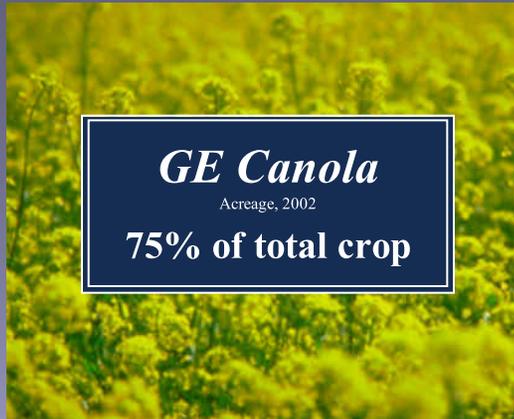
Source of gene from any
organism



GE Corn

Acreage, 2004

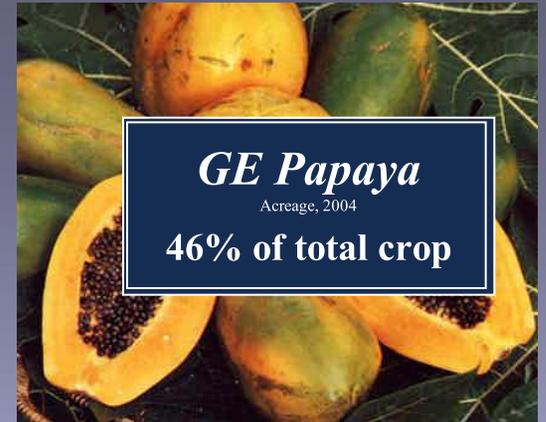
46% of total crop



GE Canola

Acreage, 2002

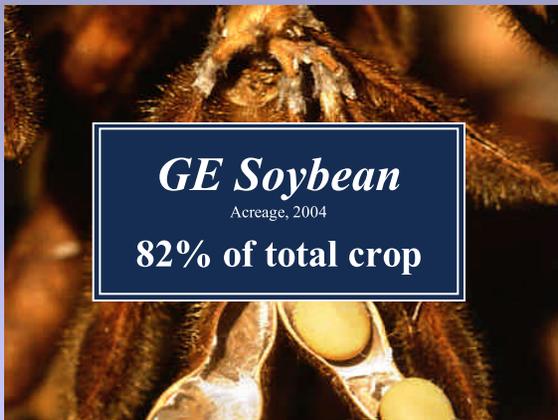
75% of total crop



GE Papaya

Acreage, 2004

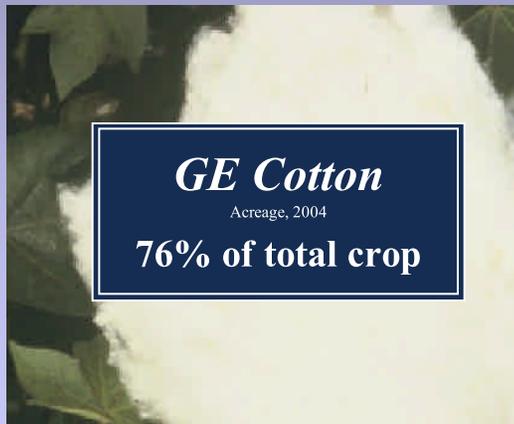
46% of total crop



GE Soybean

Acreage, 2004

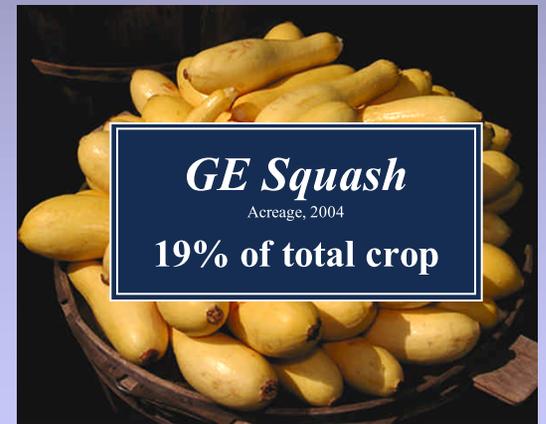
82% of total crop



GE Cotton

Acreage, 2004

76% of total crop



GE Squash

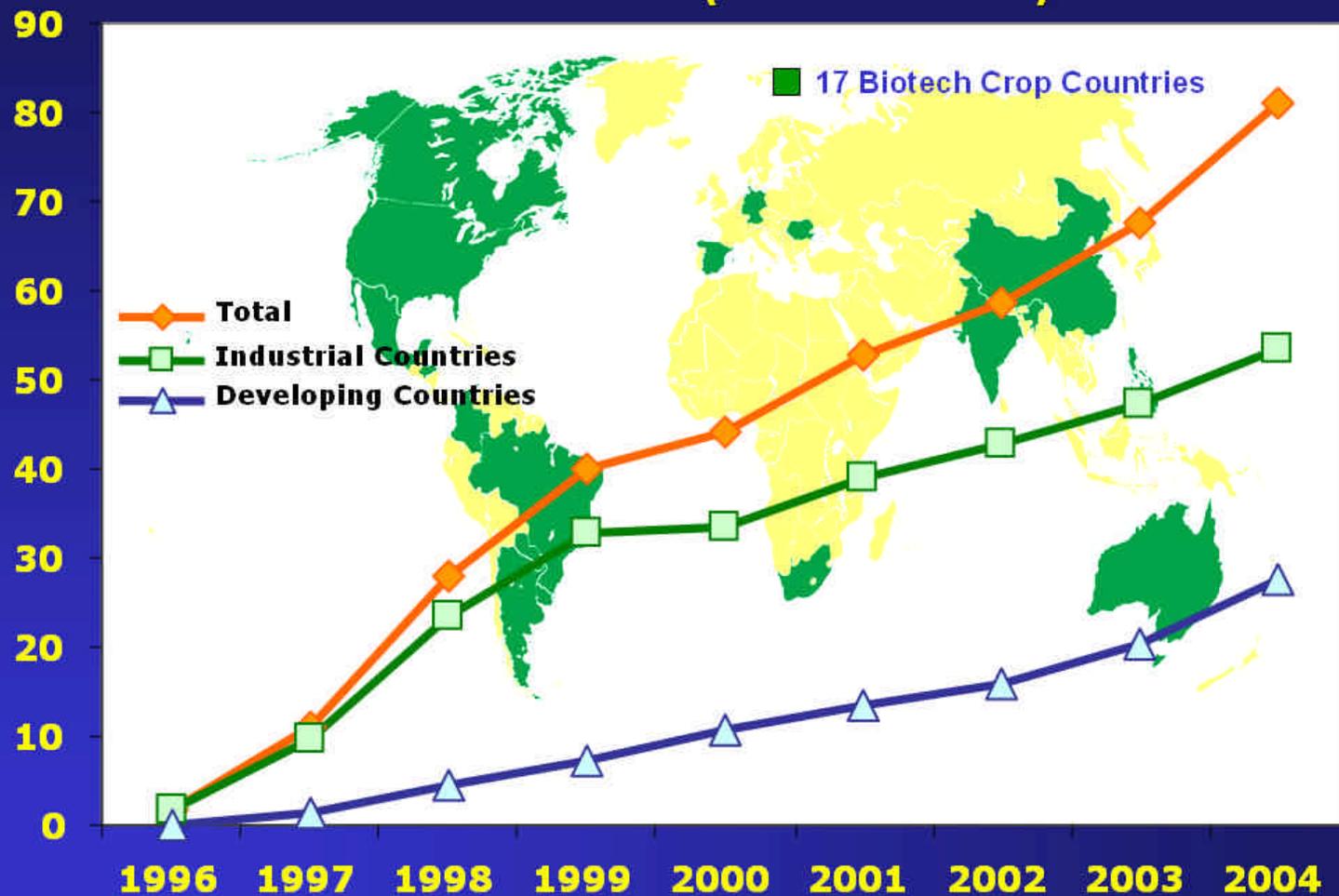
Acreage, 2004

19% of total crop

SOURCE: NCFAP; USDA, USA Today



Global Area of Biotech Crops Million Hectares (1996 to 2004)



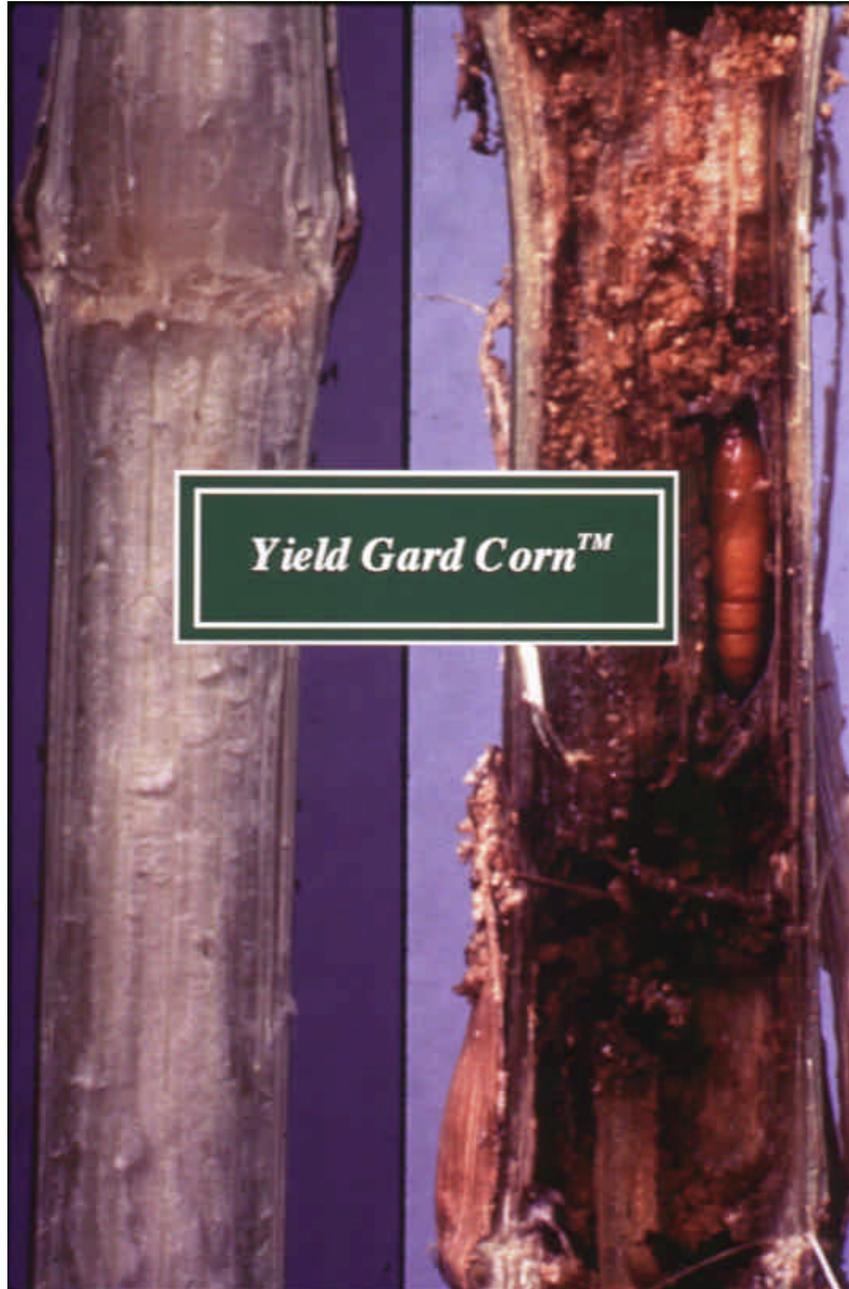
Increase of 20%, 13.3 million hectares or 32.9 million acres between 2003 and 2004

Source: Clive James, 2004

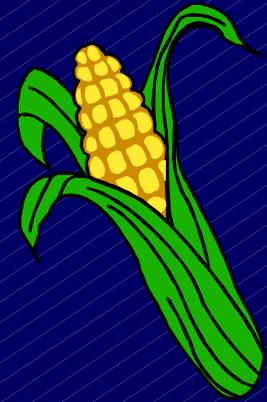


Estimated 75% of Processed Foods Contain GE ingredient





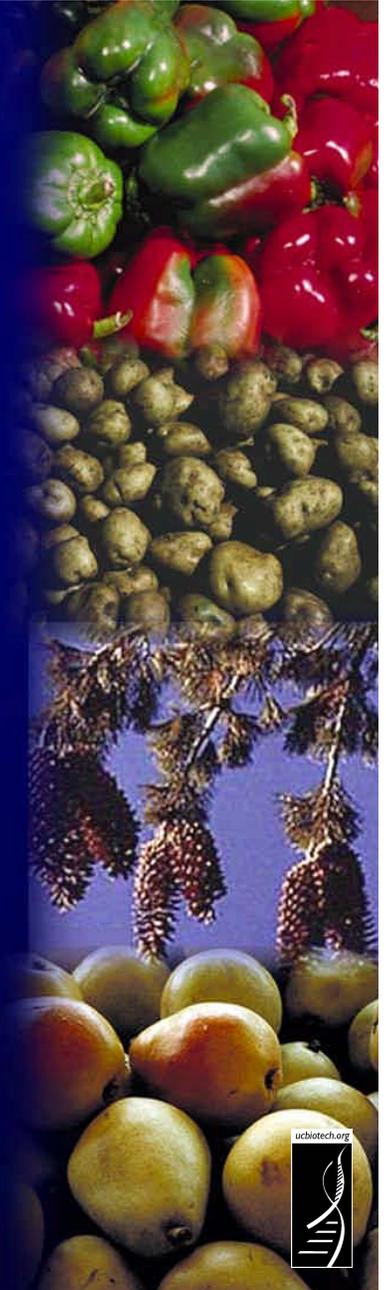
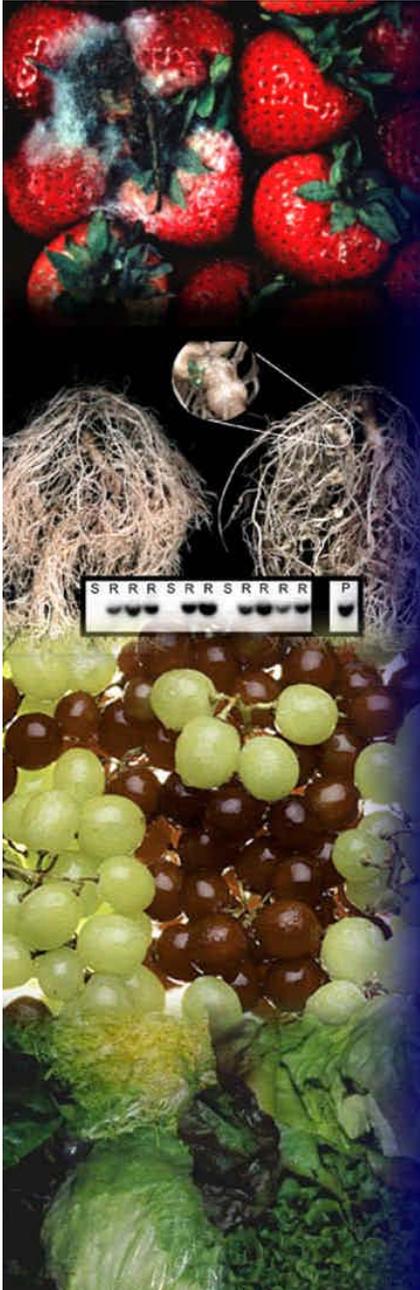
Insect-Resistant Crops (Bt)



- + Increases yield; profits variable.
- + Decreased pesticide use
- + Reduced mycotoxin content in corn
- Can produce Bt-resistant insects.
- Produces insect toxin throughout plant.
- Can transfer Bt gene to wild relatives.

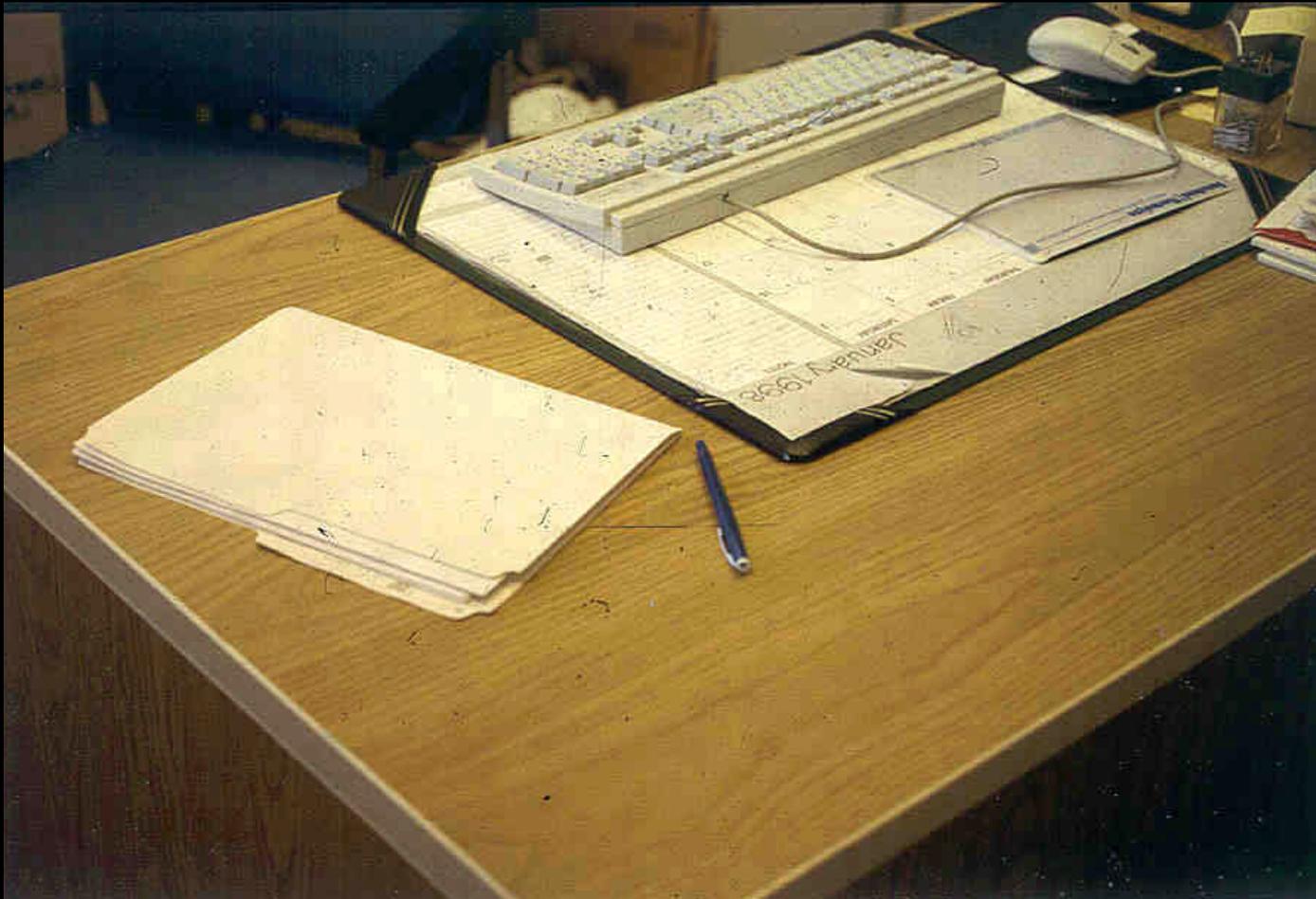
Sample of possible engineered fruits and vegetables

- Strawberries resistant to molds
- Tomatoes not attacked by root nematodes
- Grapes resistant to Pierce's Disease
- Drought tolerant lettuce
- Peppers resistant to bacterial diseases
- Potatoes no longer susceptible to blight
- Sugar pine resistant to white pine blister rust
- Frost-tolerant pears



Variety release requirements: Conventional cultivars

- Agronomic performance
- Proximate analysis
- Antinutritive factors



Variety release requirements: Transgenic cultivars

- Agronomic performance
- Proximate analysis
- Antinutritive factors
- *Plus:*

Plus:

Molecular/Biochemical Analysis

- Molecular characterization of inserted DNA,
- Southern and restriction analyses
- PCR for several fragments,
- Various enzyme assays
- Copy number of inserts
- Size of each fragment,
- Source of each fragment
- Utility of each fragment
- How fragments were recombined
- How construct was delivered into flax
- Biological activity of inserted DNA
- Quantitative analyses of novel proteins (western analyses)
- Temporal activity of inserted genes
- Spatial activity of inserted genes
- Complete amino acid analysis
- Detailed amino acid analysis for valine, leucine and isoleucine
- Toxicity (not warranted)
- Allergenicity (not warranted)

Biological Analysis:

- Pathogenicity to other organisms
- Dormancy
- Outcrossing
- Potential for horizontal gene transfer
- Seed production
- Flowering time,
- Flower morphology
- Analysis of relatives
- Stability of genes over generations
- Survivability in natural environment
- Survivability in agricultural environment in presence of herbicide
- Survivability in agricultural environment in absence of herbicide
- Interaction with other organisms
- Interactions with novel organisms
- Changes to persistence/invasiveness
- Any selective advantage to GMO
- Selective advantage to sexually compatible species
- Plan for containment and eradication in event of escape



CONTROVERSY



STARLINK CORN ISSUE

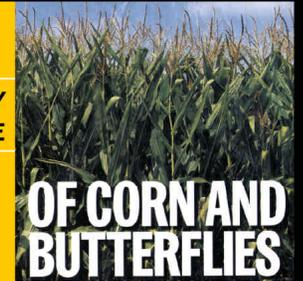
POSSIBLE FOOD SAFETY RISKS AND BENEFITS

- + Increased nutritional quality of food
- Decreased nutritional quality of food
- + Removal of existing allergens
- Creation of new allergens



Controversy often accompanies the introduction of new technologies, and the application of biotechnology to agriculture is no different. The boundary between risks and benefits is often not distinct; the application of the technology can involve both positive and negative aspects. Considering the appropriateness of the technology involves weighing the two sides and making a decision on the appropriateness of the particular application.

MONARCH BUTTERFLY ISSUE



OF CORN AND BUTTERFLIES

POSSIBLE ENVIRONMENTAL SAFETY RISKS AND BENEFITS

- + Reduced pesticide use
- Increased use of specific pesticides
- + Positive effects on beneficial insects
- Adverse effects on beneficial insects

Nonexhaustive List of Issues with GMO Foods

- *Food Safety*
- *Environmental*
- *Socioeconomical/Ethical*

Nonexhaustive List of Issues with GMO Foods

Food Safety Issues

- Create new allergens
 - Activate naturally occurring toxins or create new ones
 - Removal of existing allergens and antinutritionals
-
- Adversely affect the nutritional quality of foods
 - Enhance the nutritional quality of foods
-
- Vegetarian and religious issues with GMOs
 - Labeling
 - Increased antibiotic resistance in intestinal flora
 - Horizontal transfer of DNA from plants to humans through foods
 - Unknown, unanticipated risks from GMO consumption
 - Trust in regulatory agencies

Regulatory Systems in the U.S. (existing regulations)

GE Foods and Crops: Unregulated?

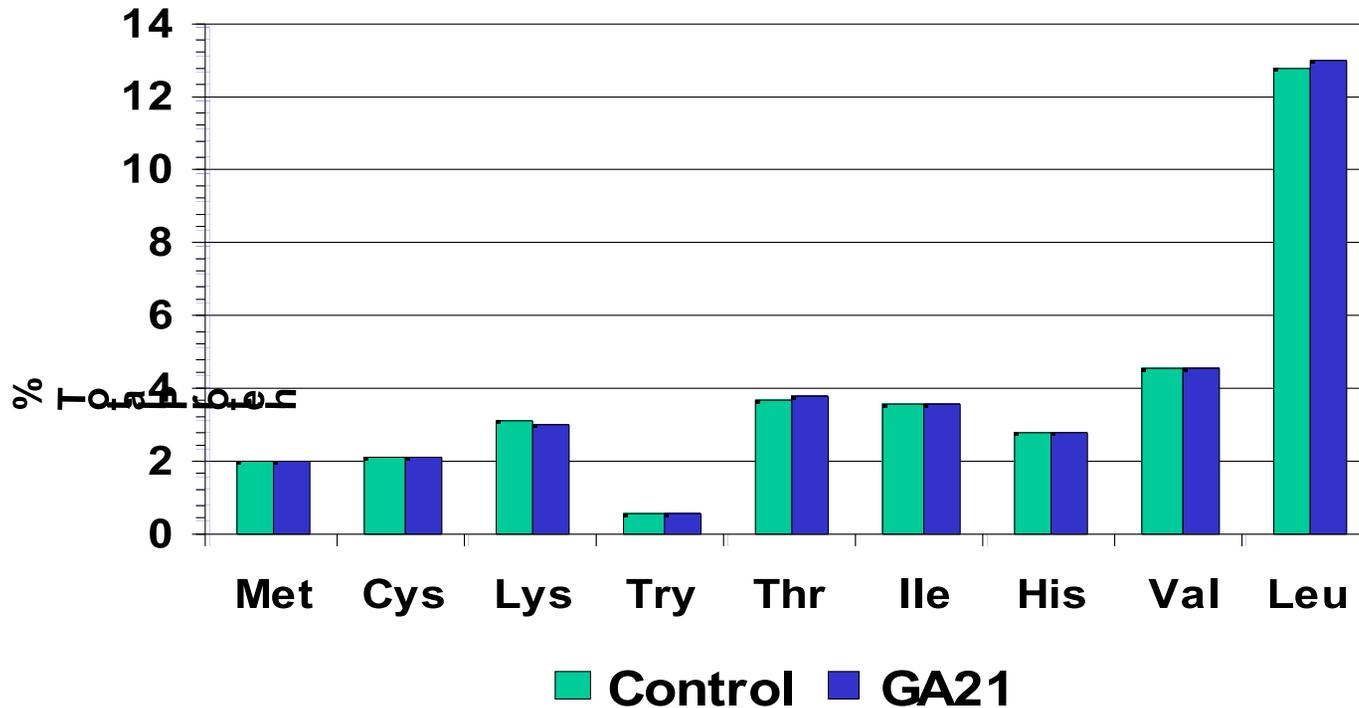
- ◆ Field testing
 - permits
 - notifications

- ◆ Determination of non-regulated status

- ◆ Food safety
- ◆ Feed safety

- ◆ Herbicide registration

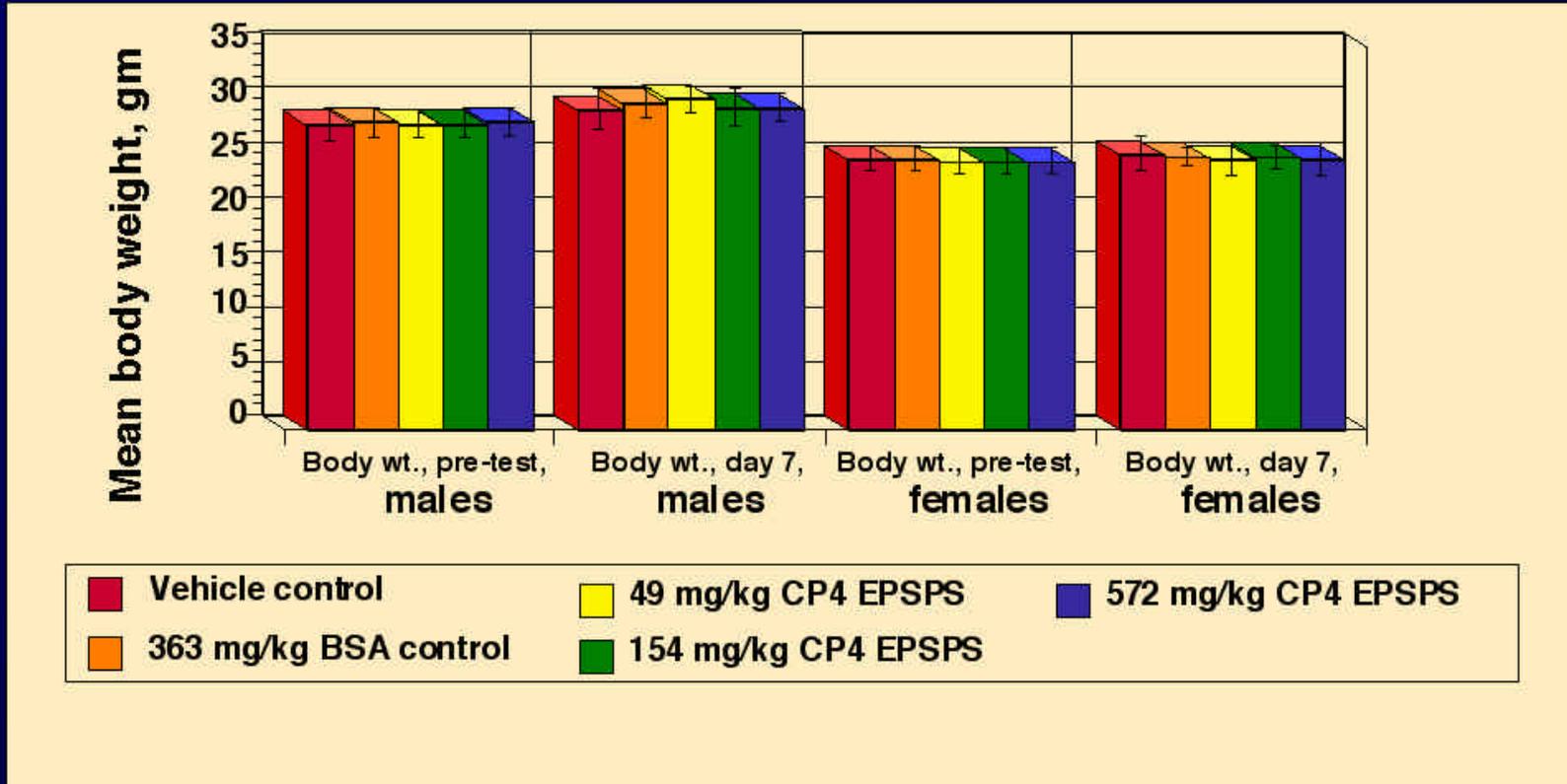
Compositional Equivalence: Amino Acids



These results have been generated on event GA21. Data showing similar amino acid composition have been generated on the other corn events.

Toxicity Assessment: Roundup Ready/CP4 EPSPS protein

No deleterious effects at highest dose (572mg/kg)



*Starlink corn raises allergy and
containment concerns*



*Kraft Food recalls all taco shells sold
nationwide under Taco Bell Brand*

SOURCE: Washington Post, September 19, 2000





*Large Scale Grain Movement by Rail Can
Cause Mixing of Grain*



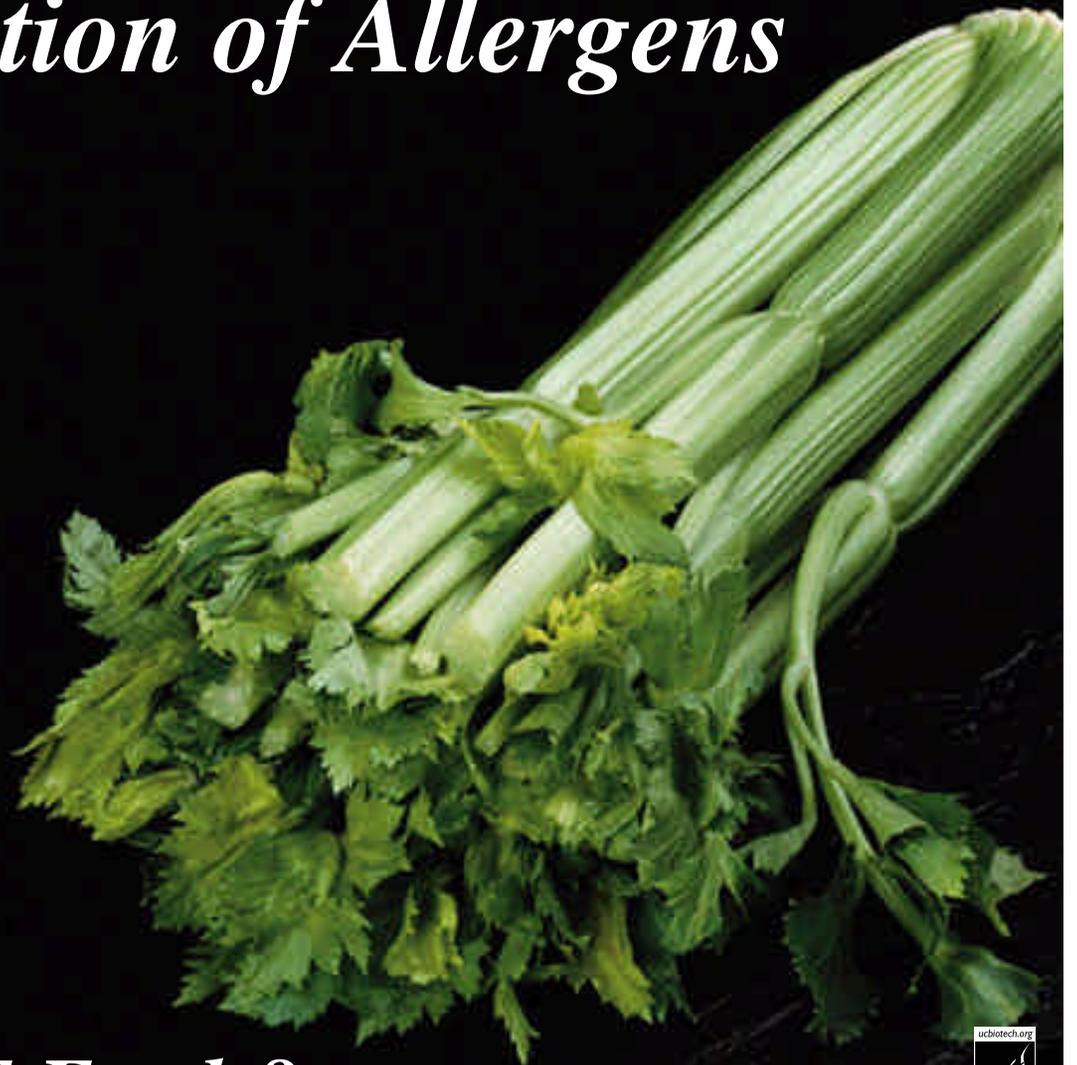
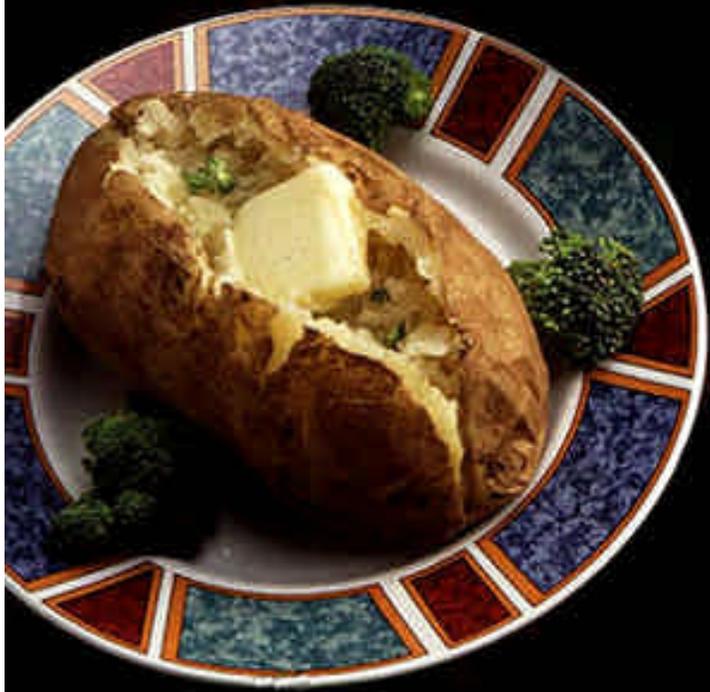
Classically bred foods can cause allergy problems also

Kiwi Allergies



**Long-term Food Safety Studies:
Should They Be Done, How
and on What Foods?**

Inadvertent Creation of Allergens



Is This Confined to GE Foods?

*Rat feeding studies on
snowdrop lectin potato*



*Were Pusztai studies conclusive and were
they pertinent to other GE crops?*

Nonexhaustive List of Issues with GMO Foods

Environmental Issues

- Unintended adverse consequences for beneficial insects
 - Unintended beneficial consequences for beneficial insects
- Soil residuals of bio-engineered pesticides
 - Soil residuals of nonengineered pesticides used in the absence of engineered varieties
- Degradation of the environment because of GMOs, *e.g.*, residuals, chemical dependence
 - Degradation of the environment because of current agricultural practices, *e.g.*, tilling, fertilizers, pesticides
 - Improved environmental situation with GMOs, *e.g.*, reduced phytic acid, phyto and bioremediation
- Herbicide-resistant weeds as a result of GMOs, “superweeds”
 - Herbicide-resistant weeds from conventional practices in absence of GMOs

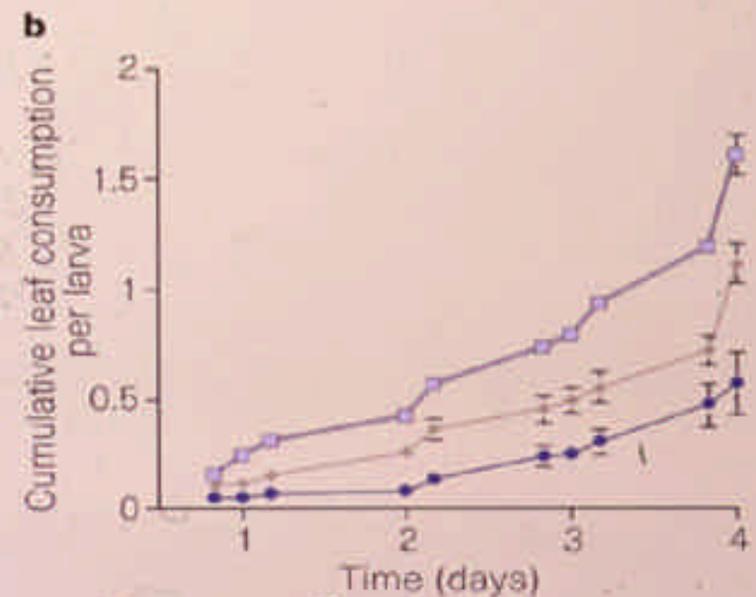
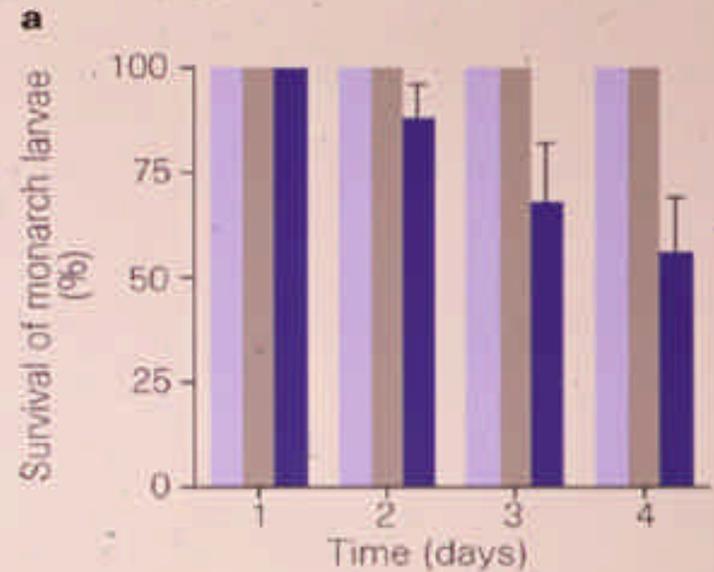
Effect on Bystanders?

- Monarch butterfly study



Losey et al. 1999

- Criticisms:
 - pollen dosage?
 - lab study



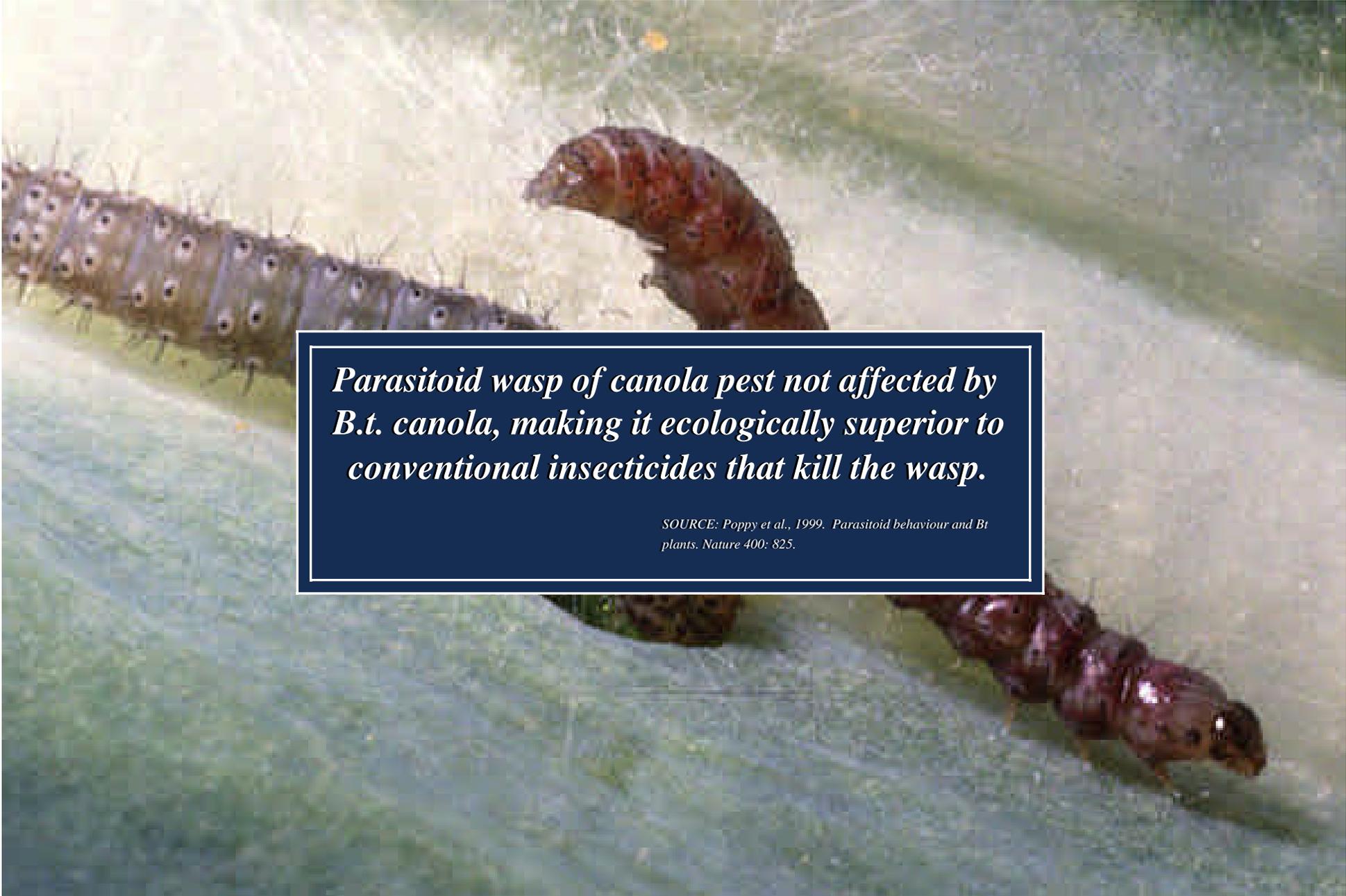


September 8, 2001

Data on Genetically Modified Corn Reports Say Threat to Monarch Butterflies Is 'Negligible'

By ANDREW POLLACK

Genetically modified corn poses a "negligible" risk to monarch butterflies, according to a package of six papers that will soon be published in a scientific journal. The papers, the most comprehensive peer-reviewed publications on this issue, could lay to rest one of the biggest controversies over genetically modified crops.



Parasitoid wasp of canola pest not affected by B.t. canola, making it ecologically superior to conventional insecticides that kill the wasp.

SOURCE: Poppy et al., 1999. Parasitoid behaviour and Bt plants. Nature 400: 825.

Movement of genes between crop species and wild relatives



Charlock



Buchan weed



Canola



Wild radish



Brassica tournefortii



*Gene flow from rice to
weedy red rice*





- Planted soybeans in field previously used for transgenic corn.
- USDA discovered "volunteer" corn plants growing among soybeans. Instructed ProdiGene to remove corn plants.
- Soybeans harvested before all corn was removed, mixed with 500,000 bushels of soybeans.
- Soybeans destroyed, ProdiGene paid \$250,000 civil fines, reimbursement for lost crops; \$1 million higher regulatory fees.

A photograph of a cornfield in Mexico. The foreground is filled with tall, green corn plants. In the background, there is a rolling hill covered in green vegetation and trees. The sky is a pale, hazy blue. A yellow rectangular box with a thin black border is centered over the image, containing the title and source information.

Genetic Modification Taints Corn in Mexico

SOURCE: New York Times, October 2, 2001

Gene flow in Mexican Maize: consequences for genetic diversity?



How did pollen and gene flow occur in Mexico?

Is this the first time gene flow has occurred into Mexican landraces of maize?

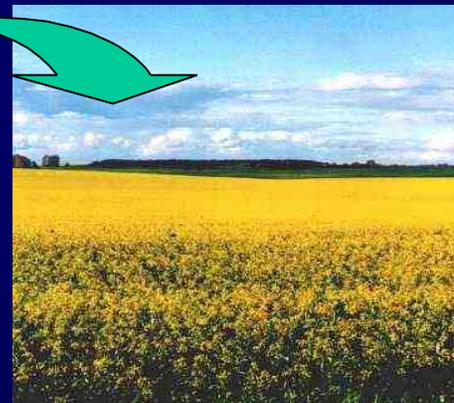


What implications does transgene flow have for wild and domesticated maize?

*Consequences of pollen spread
from GE crops to organic crops in the field*



GM canola



non-GM canola





Will an organic farmer automatically lose accreditation if his/her crop is found contaminated with a GE crop?

No.

“As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods, as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation.”

SOURCE: AMS National Organic Program Q&A



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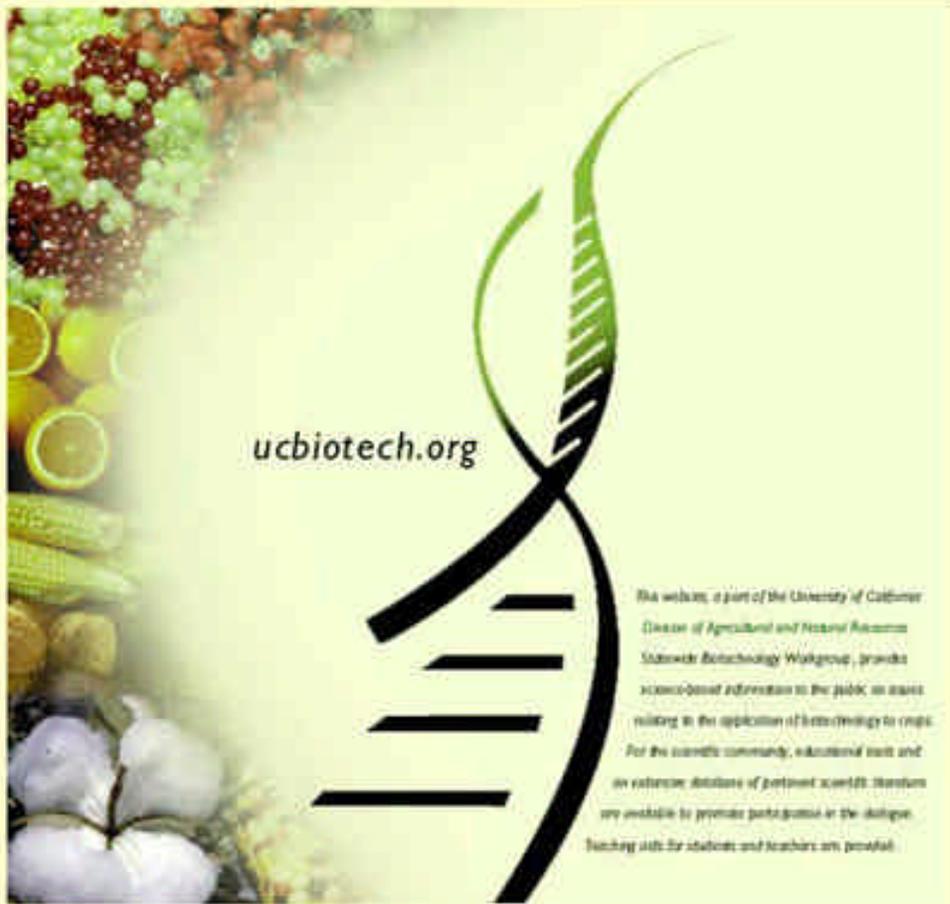
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*The website, a part of the University of California
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Statewide Biotechnology Workgroup, provides
science-based information to the public on issues
relating to the application of biotechnology to crops.
For the scientific community, educational needs and
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BIOTECHNOLOGY INFORMATION

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Plant Biotechnology Group

In-depth understanding of biotechnology and its issues is a necessary factor in informed dialogue and making wise decisions about the use of this technology and its products. This section has commonly raised issues associated with a variety of topics relating to biotechnology and agriculture. The issues are paired with responses, which contain links to relevant scientific references. The content of the Issues and Responses section and the choice of literature cited is the sole responsibility of Peggy G. Lemaux and Petra Frey at the University of California, Berkeley, in collaboration with the Plant Biotechnology Group, ETH, Zurich, Switzerland and Dr. Alan McHughen, Cooperative Extension Specialist, University of California, Riverside.

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Do Bt plants affect beneficial insects?

The effect of Bt plants on non-target insects has been studied using a broad range of different insects, both in the laboratory and in the field. In one of these studies Bt176 corn pollen and a control corn pollen were fed to lady beetle larvae, where 69% of the larvae survived on Bt pollen and 61% of the larvae survived on the control pollen [Pilcher, 1997]. Another group tested the effect of Bt 176 corn on aphids feeding on leaves and the effect this would have on their natural predators, the green lacewings. They could not find any significant effect of the Bt corn on aphid larvae development or green lacewing mortality [Lozza, 1998]. A further study tested the predation and parasitism of the European corn borer, using the same Bt176 corn variety, in the field. Also in this case, the predation and parasitism was the same on Bt and on non-Bt corn [Orr, 1997]. No significant negative effect of the Bt corn could be found in any of these studies. The results of two recent studies, however, showed that monarch butterfly larvae could be adversely affected by pollen from certain varieties of Bt corn (Bt 11 [Losey, 1999] and Bt176 [Hansen Jesse, 2000]). These laboratory studies demonstrated that monarch larvae were more likely to die when fed milkweed leaves dusted with pollen from Bt corn than when fed leaves dusted with pollen from conventional corn. Both of these laboratory studies used Bt pollen at very high concentrations that are not encountered beyond the edge of a field [Betz, 2000]. An analysis of the results from a field-study of effects on swallowtail larvae, where mostly lower pollen

