The AgBiotech Controversy

Alan McHughen, D.Phil.,
University of California
Riverside, Ca USA

alanmc@ucr.edu

Are GM foods in US supermarkets?

a. Yes
b. No

Do ordinary tomatoes contain genes?

a. Yes
b. No

Would a tomato with a fish gene taste "fishy"?

a. Yes
b. No

If you ate a GM fruit, might it alter your genes?

a. Yes
b. No

Can animal genes be inserted into a plant?

a. Yes
b. No

Give an example of GM food on the market

a. There are none
b. All foods are GM
c. Tomato
d. Wheat
e. Squash
f. Papaya

Survey results (% Correct)

Are GM foods in US supermarkets?	48 %
Do ordinary tomatoes contain genes?	40
Would a tomato with a fish gene taste "fishy"?	42
If you ate a GM fruit, might it alter your genes?	45
Can animal genes be inserted into a plant?	30
Give an example of GM food on the market	79% Tomatoes

Need for public science literacy

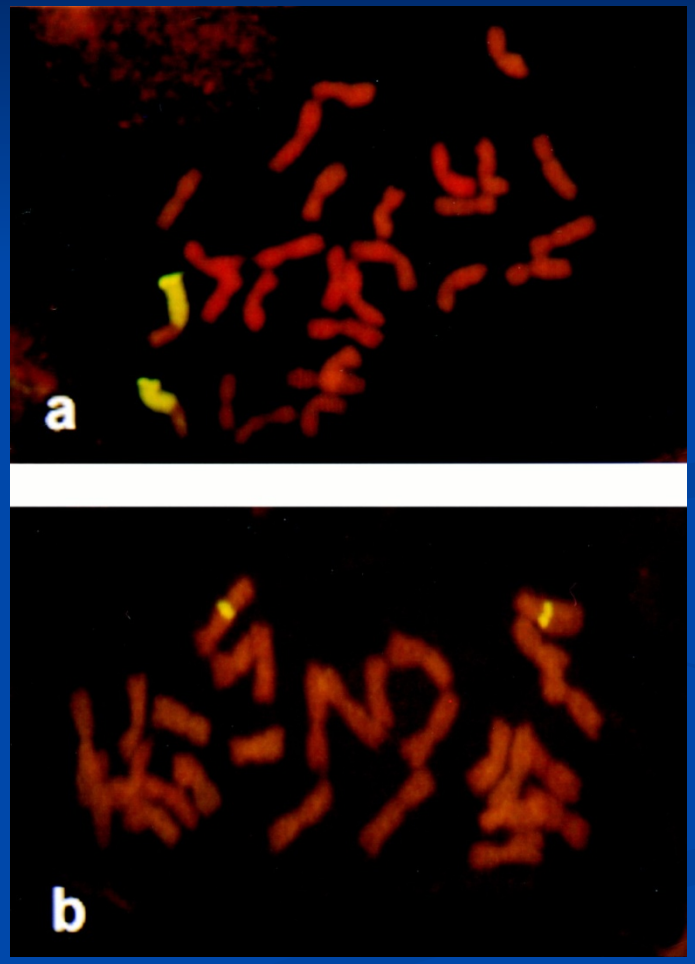
- Public perceptions are often based on:
  - Invalid assumptions
  - Failure to apply critical thinking
  - Lack of context (e.g. chemicals).

From a billboard in Nebraska*, Courtesy of Syngenta*

Where do people get information?

- Common misconceptions abound…
  - "GE (rDNA) is unnatural because it breaks the nature's species barrier that precludes genes moving from one species to another"
  - "DNA is a complex protein"
  - "GMOs commercialized with 3 mos to 3 yrs field testing and no long-term safety and environment studies."

What species barrier?
Approx 38% of wheat has rye DNA



Friebe et al., Crop Science 39:1692-1696 (1999)

File to support registration of new crop variety- conventional breeding

A long history of Biotechnology fearmongering

Documented benefits of biotech crops

- Farmers
  - Increased yields (especially in developing countries)
  - Decreased chemical input costs
  - Cleaner fields, less dockage
  - Less fuel used
  - Less tillage
  - Fewer adverse health effects (esp. China).

But Global Controversy

- Biotech crops are grown on over 250 million acres in 22 countries around the world.
- But many countries refuse to allow cultivation of biotech crops
- Or consumption of foods from biotech crops
- Or both.

Why do farmers grow GM crops?

- Philippines (Bt corn)
  - ~30% increase in yield
- South Africa (Bt cotton, Bt maize)
  - ~77% higher returns (smaller farm = higher benefit)
- China (Bt cotton)
  - 8-10% Higher yields
  - Reduction in farm labor poisonings
- India (Bt cotton)
  - ~70% drop in pesticide exposure
  - Shift in pesticide way from older, mote toxic ones
  - Increased yields

Left: GE Bt corn hybrid ‘D’; Right: regular hybrid corn ‘D’ with bacterial rot

courtesy Gary Munkvold, Iowa State Univ.

GE Bt corn Hybrid ‘D’

Regular corn plus pesticide

Regular corn, no pesticide

Documented benefits of biotech crops

- Consumers
  - Safer food (less mycotoxin in maize, esp Africa/Asia)
  - Safer food (greater regulatory scrutiny)
  - Less pesticide
  - Environmental benefits.

Documented benefits of biotech crops

- Environment
  - Less pesticide burden
  - Safer pesticides
  - Improved soil from less tillage
  - Less fuel usage
  - Increased biodiversity

  - Sources: NCFAP, Plant Biotechnology, June 2002; November 2004
  - Canola Council of Canada, An agronomic and economic assessment of transgenic canola, 2001
  - Munkvold, G.P., Hellmich, R.L., and Rice, L.G. 1999. Comparison of fumonisin concentrations in kernels of transgenic Bt maize hybrids and non-transgenic hybrids. Plant Dis. 83:130-138.

Biotech opportunities

- Health and Nutrition
  - Removal of allergens
  - Removal of anti-nutritional substances
  - Removal of pathogens and contaminants
    - Mycotoxins in Bt corn
  - Signal for pathogens (with nanotech)
  - Enhance nutrient content
    - "Golden rice" with β -carotene
    - India's "Protato" with increased protein.

Biotech opportunities

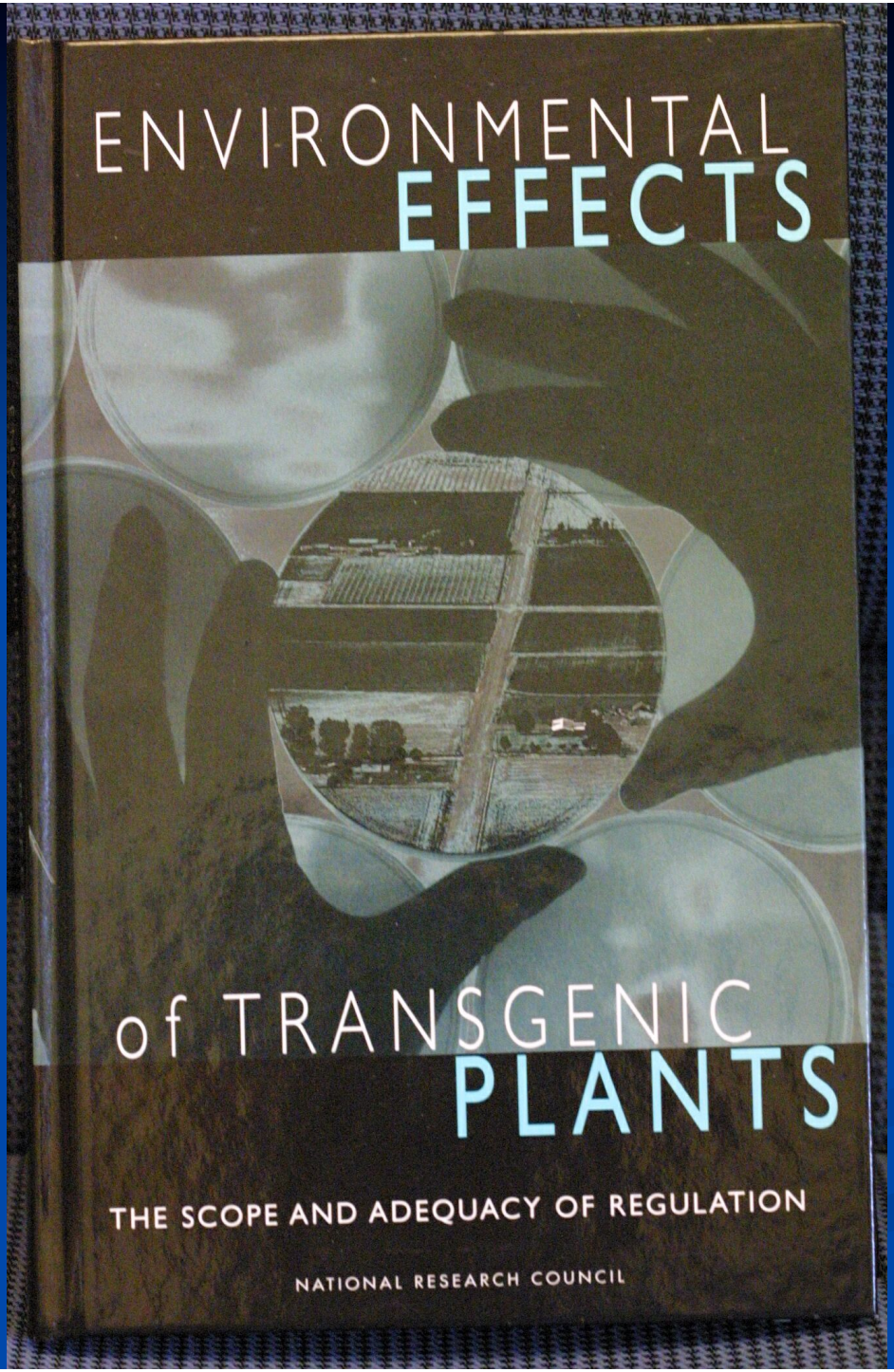
- Environment
  - Reduced pesticide load
  - More food/feed on less land
  - Better resource efficiency
    - Water use
    - Climate change adaptations.

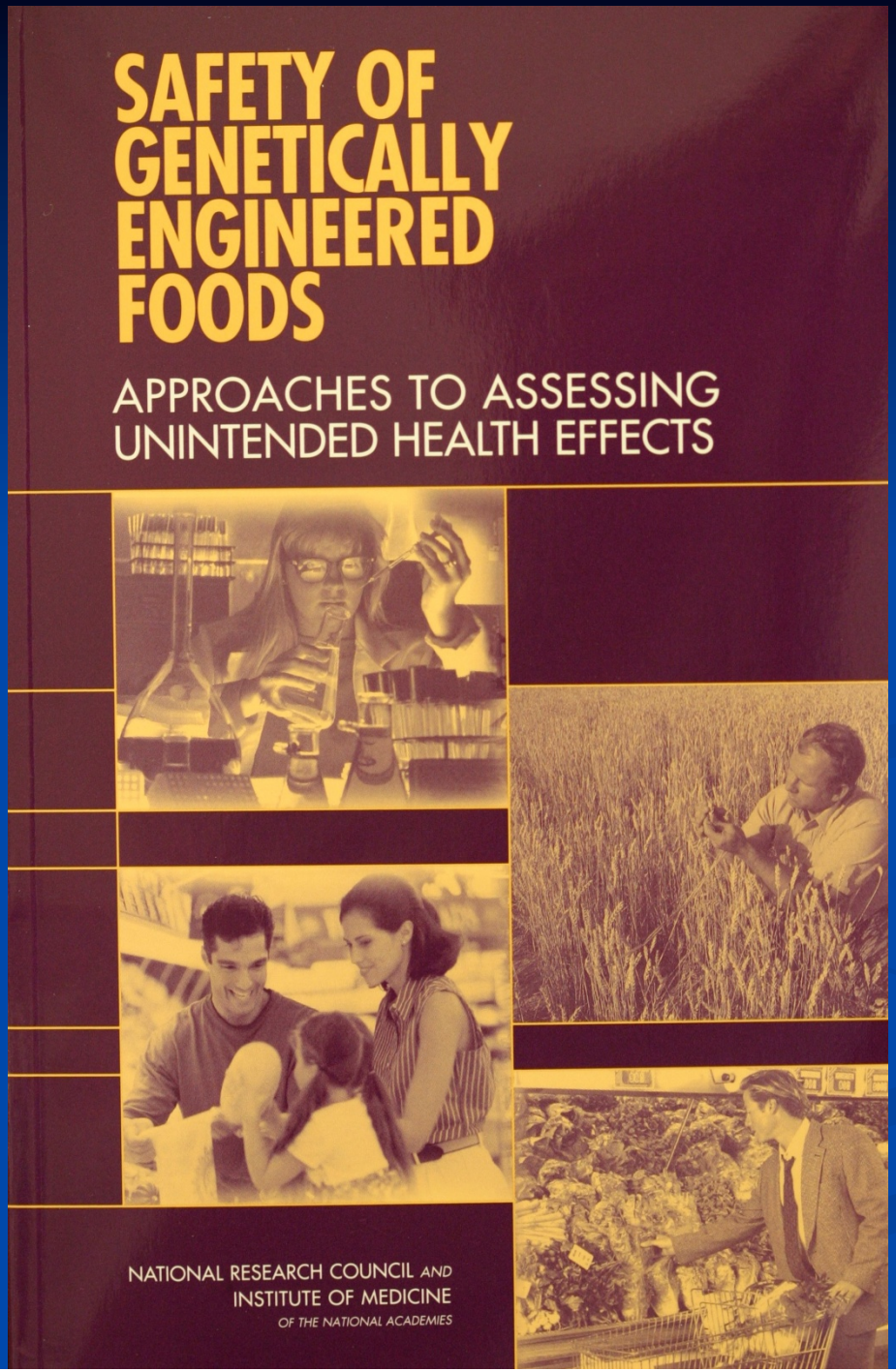
Biotech opportunities

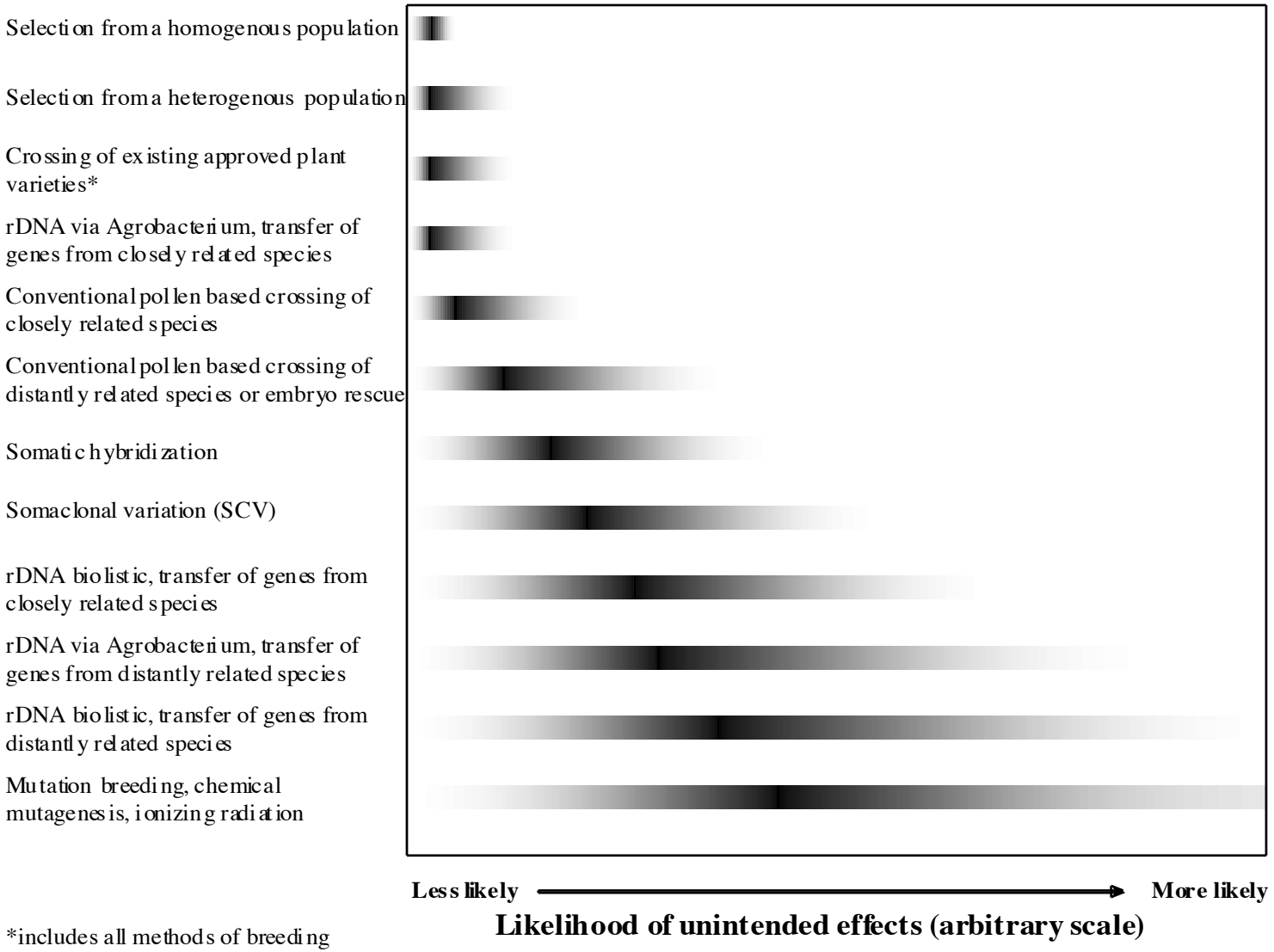
- Sustainable development
  - Sustainability in poorer countries
    - Philippines
    - South Africa
  - Diversification at home and abroad
    - Specialty crops
    - Improvement of local crops.

Have you heard…

- **GMOs are hazardous because…**
- GE breaks the "species barrier"; Nature never allows genes from one species in another
- GE involves random insertions into genome
- GE crops and foods are untested and unregulated
- Once released, GMOs can never be recalled
- Future "unintended consequences" and hazards.


ENVIRONMENTAL
EFFECTS
of TRANSGENIC
PLANTS
THE SCOPE AND ADEQUACY OF REGULATION
NATIONAL RESEARCH COUNCIL


SAFETY OF GENETICALLY ENGINEERED FOODS
APPROACHES TO ASSESSING UNINTENDED HEALTH EFFECTS
NATIONAL RESEARCH COUNCIL AND
INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES



*includes all methods of breeding

NAS/IOM findings

- There are NO documented adverse health effects from eating GE foods.
  - Allegations of harm are unfounded
- Genetic engineering is NOT inherently hazardous.

Paradigm shift: The disconnect

- Process vs product
  - Fear derived from **process**
  - Hazard comes from **product**
- Absolute vs relative
  - To some, GE is absolutely novel and incomparable to previous hazards or technologies.
  - To scientific community, GE is an extension of previous gene manipulation technologies.

Traditional approach to Risk

- *Component*
- Risk Assessment
- Risk Management
- Risk Communication

- *Responsibility*
- Scientists
- Regulators
- No one, everyone, ???

Who should be responsible for risk communication?

a. Scientists

b. Government

c. Industry

d. NGOs

Modern approach to Risk Assessment

- *Science driven*
- Real risk
- Substantial equivalence
- Objective
- Relative
  - "Prove it as safe as…"
- Product

- *Values driven*
- Perceived risk
- Precautionary Principle
- Subjective
- Absolute
  - "Prove it safe."
- Process

Science vs. Non-science

- Non-scientific approach
  - Starts with conclusion, searches for evidence to support it (*cherry picking*)
  - Discredits alternative views
  - Often lacks context
- Scientific approach (*n.b. not all scientists*)
  - Collects and analyses all available evidence before (perhaps) reaching conclusion
  - Actively seeks alternative interpretations
  - Is his/her own greatest critic
  - Applies **Critical thinking skills.**

Consequences of poor public understanding of science

- Public opinion drives policy
- Ignorance of science results in bad science policy
- Topical political issues demand good science:
  - Stem cell research, Nanotechnology, Climate change, GM foods, Pharmaceuticals, Pesticides, Cell phones, Biodiversity, Fuel cell technology, Biological weapons, Evolution in schools, etc.

Examples of poor scientific literacy

- World: Cartagena Protocol 9/11/2003
  - "…prevents or reduces the risks (of LMOs) to biological diversity, taking also into account risks to human health ."
- Philippines: effect of Bt cornfields
- Zambia: GM food is 'poison"
- Africa (south): cure for HIV/AIDS
- Africa (north): GM foods and CIA

Problem of context

- "Fear uncouples rational and critical thinking"
  - E.g. use of pesticides in agriculture
    - "Natural" products are invariably safe.
      - Synthetic chemicals are invariably hazardous
    - Toxicology doesn't matter:
      - **all** chemicals are equally hazardous
    - Amount doesn't matter:
      - **any** amount is too much.

From a billboard in Nebraska*, Courtesy of Syngenta*

Fear and loathing: the context of risk

- Roanoke (Va) *Times (9/20/2004)*: "Mellisa Williamson, 35… worries about the effect on her unborn child from the sound of jackhammers.'
  - Is Ms Williamson (or other similarly concerned parents) likely to feed GMO babyfood to her child?

Pregnant Mellisa worries about noise

(What's wrong with this picture?)

STEPHANIE KLEIN-DAVIS | The Roanoke Times

Scientific fact as common currency

- Science is a search for *TRUTH*
  - Science evaluates all available evidence before (maybe) reaching a conclusion
  - Non-science starts with a conclusion, then seeks supporting evidence (and rejects contrary evidence)
- Value neutral
  - But access may influence values
- Facts are not subject to democracy or whim of fashion/ popular opinion.
  - Indiana considered rounding Pi to 3.0
  - Mendocino County redefined DNA as a protein.

Science vs Nature?

- Science is the knowledge of Nature
  - Technology *might* be used to fight Nature
  - Technology *might* be used to support Nature
    - Human blood transfusions
    - Air conditioning, irrigation, water purification, etc.
- *Homo sapiens* population >6.5 billion +
  - Holding capacity of Earth: 3-4 billion humans
    - What do we do?

Should science/technology be used to fight climate change?

a. Yes
b. No

Future Prospect

- Applications of biotechnology will increase,
  - Especially in Agriculture
  - Also in Medical, Industrial, etc.
- Outcome for society at large
  - Division between science literate and illiterate?
  - Informed vs ignorant?
  - The ignorant still get to vote!

Should people ignorant of issues be allowed to vote?

a. Yes

b. No

Conclusions

- Biotechnology is a tool with no greater potential risks than other breeding methods
- But does provide much greater opportunity for good
- Each application of Biotechnology must be individually and properly evaluated
- Biotechnology may serve objectives of environmental, agronomic, and economic sustainability
- Biotechnology is not a panacea but also cannot be categorically rejected or ignored.

Conclusion

- Scientists provide information
  - And context (e.g., that nature also transfers genes)
- Society, not scientists, makes decisions
  - But must have accurate information
- Scientists have professional responsibilities
  - To conduct work in an ethically sound manner
  - To inform, but not advocate, policy.