

Agricultural Biotechnology

Popular Misconceptions

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Clicker question

- Industrial agriculture (since *ca.* 1948) resulted in increased US farm productivity of approx.
 - A) 17%
 - B) 170%
 - C) 570%
 - D) 770%

Clicker question

- Farmers in 2000 occupied what % of US labor force?
 - A) <2%
 - B) 2 – 17%
 - C) 17 – 37%
 - D) 37 – 47%

Clicker question

- Farmers in 1900 occupied what % of US labor force?
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 - C) 17 – 37%
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Most people have romantic notions of farming and food production



Modern agriculture is actually...



■ Intense but Sustainable Production Oriented US Agriculture

- Increased productivity since 1948 = 170%
- 1900 US agriculture workforce = 41%
- 2000 US agriculture workforce = <2%

http://www.ers.usda.gov/media/259572/eib3_1_.pdf

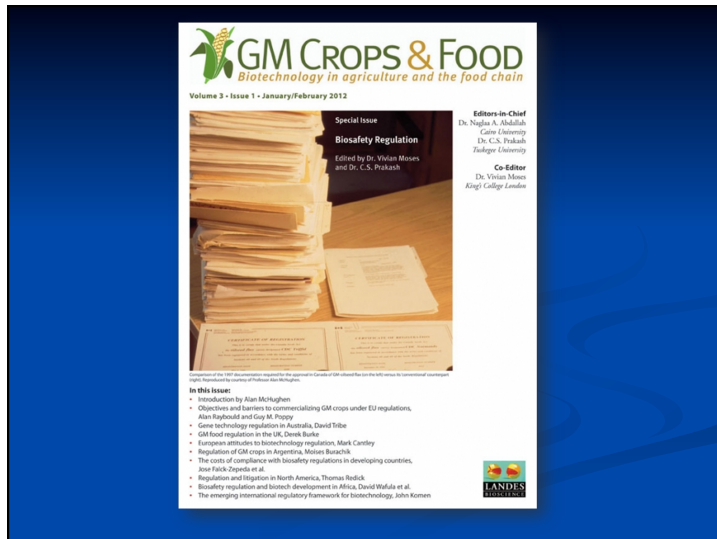
<http://www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx>

Some Popular Misconceptions

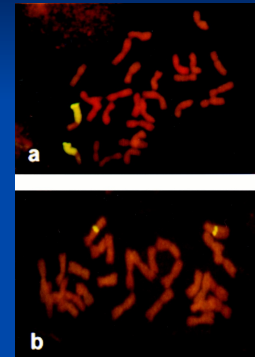
- GMOs are untested and unregulated
- GE violates Mother Nature's "species barrier"
- GMOs are all Patented by big companies
- GE foods cause tumors in test animals
- GE crops cause an increase in pesticide use
- Organic farmers may get GE contamination
- rDNA is 'fundamentally different' from traditional crossing, and so they must be more hazardous
- GMO crops and foods are banned in Europe.

Variety release requirements: genetically engineered crops

- USDA (APHIS) - environmental issues
- HHS (FDA)- food and feed safety
- EPA- pesticide usage issues



Approx 38% of bread wheat varieties in US carry fragments of rye DNA



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

Europe *did* have GM foods



Misconceptions lead to policies that are humorous or symbolic

- Mendocino County, California bans GE crops
 - and reclassifies DNA as protein
- GMO foods cause sterility in 350K couples in Serbia (http://english.ruvr.ru/2012_12_27/Are-GMOs-sterilizing-Serbia/)
- Philippine judge rules Bt Corn responsible for marriage breakdown and grants divorce
 - Because the husband walked through a Bt cornfield
 - And turned gay.

Or Tragic

- Zambia 2002 GM food: “poison”
- Terminator gene in Indian Bt Brinjal
- B-Carotene enhanced “Golden” rice.

Misconceptions in Prop 37 debate

- “People have a right to know what’s in their food!”
- GE food labeling “Won’t cost a dime”
- GE Labels would apply to imported foods
- GE Labels apply to foods of unverifiable source
 - Under US law, food labels must be “truthful and not misleading”, which requires **verification**.
 - But what about...

Corn oil in EU... made from GE maize ???



Refined sugar in the USA

- Cane sugar: ca. 50%
- Sugar beet: ca. 50%
- In both cases, refined sugar is sucrose: $C_{12}H_{22}O_{11}$
- No GE sugar cane on the US market
- 95% sugar beet GE; so almost half sugar eaten is GE
- No current label to specify cane vs beet source
- Cannot verify GE sugar in foods; **Label is useless.**

What about these products?

- GE Soybean with inserted Soybean gene
- Soybean with bacterial gene
- Tofu from Soybean with bacterial gene
- Oil from Soybean with bacterial gene
- Lecithin from Soybean with bacterial gene
- Soybean from wild-type ('null') segregant
- Fruit from branch grafted onto rDNA roots
- Bread from wheat with rye genes.

Biotech beef tomatoes? from Holland?



Sodium free?



Diet Water?



“Truthful and not misleading”?



Purpose of science

- Science: Latin *Scientia* = *To know*; knowledge
- A search for truth, especially of nature
- Science provides information:
 - Proved certain and therefore known,
 - Accepted but uncertain
 - Not accepted but possible
- Science cannot prove a negative
 - But can exculpate in specific cases.

“The” Scientific Method*

- No foregone/desired conclusion
- Testable hypothesis
- Falsifiable
- Verifiable
- Repeatable
- Predictive powers
 - Not *post hoc* explanations, but *pre hoc* predictions
- Critical analyses required

*There's more than one!

Process of Science

- Hypothesis (idea) driven
 - ‘Moon is made of green cheese’
- Observations
 - Moon is not green
- Model building
- Model testing/probing/challenging
- Refining the model to accommodate new info.

Testing Hypotheses/ Building Models

- Acquire evidence
- Compile structure based on evidence
- More evidence
- Consolidate structure
- More evidence
- Expand detail to structure
- Increase confidence in accuracy of model.

Progress of knowledge

- Experiments/observations accumulate and either
 - Support and strengthen model, or
 - Challenge, divert model
- Rarely, if ever, is the growing model destroyed entirely
- Ultimately, compare model to reality
 - “Does it fly?” “Are there missing features?”

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.**

Clicker question

- Worldwide, how many people died of hunger while I was speaking today?
 - A) ~ 200
 - B) 200 – 700
 - C) 700 – 1000
 - D) < 1,000

Ethical considerations for a sustainable future using GMOs

- Nuffield Council on BioEthics, 1999, 2004, 2010
 - Health
 - Environment
 - Corporate Domination of Food Supply
 - Threat to 'Traditional' Farming?
 - "Unnaturalness"?
- Is it Ethical NOT to use *any* tool— with appropriate safeguards— to relieve human suffering and environmental degradation?

The GMO Train... hop aboard or get run over...?



Should people ignorant of issues be allowed to vote?

A. Yes

B. No