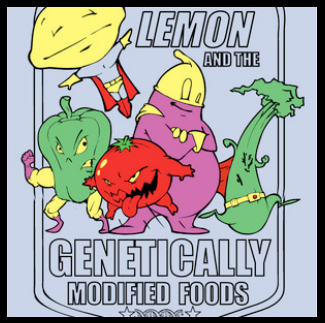


Genetically Modified Organisms

Ethical and economical issues regarding the growth, cultivation, and use of GMOs

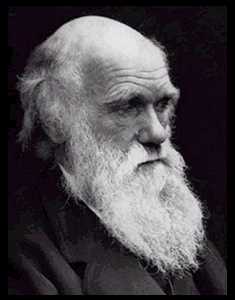
Randy Pares
Elaine Bersaba
Mel Bersaba
Tyler Jackins
Jason Molt

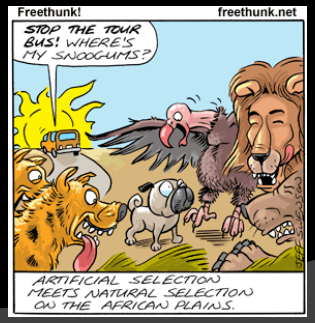
What are GMOs?

- Genetically Modified Organisms
  - An organism whose genetic characteristics have been altered using the techniques of genetic engineering.
- Used by many people for a variety of purposes
- Medical research, pharmaceutical drugs, experimental treatment, agriculture

GMOs – A Brief

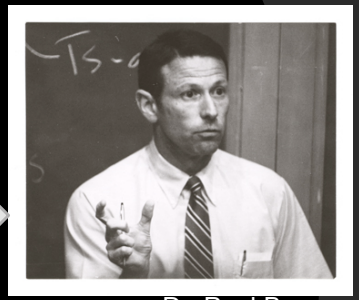
- Charles Darwin - Natural Selection
- Gregor Mendel - Theory of Heredity
- Outcome: Artificial Selection and Hybridization





GMOs – A Brief History,

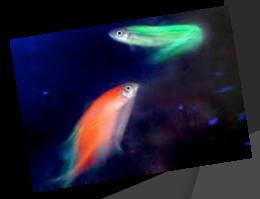
- Fast-Forward to the 1970's
  - 1973 – First GMO, E. coli expresses extraneous Salmonilla
  - 1975 - Asilomar Conference
  - 1978 - First genetically engineered bacteria to produce insulin



Dr. Paul Berg

The 90's and Toda

- 1993 - Flavr Savr Tomato
- Today - GloFish, Apriums, EnviroPig Golden Rice, iGEM, etc.



iGEM

Uses of GMOs

- Agricultural products (meat, dairy, fresh produce)
- herbicide-resistant crops
- insect-resistant crops

US GM Crops

Soy	91%
Corn	73%
Cotton	87%
Canola (Canada)	80%

Purpose of GE on plants

- Resistance to diseases and pathogenes (bacteria, fungi, viruses, insects…)
- Resistance to novel herbicides
- Protection against abiotic stress – salinity, drought, frost…
- Functional food (cancer protecting tomato, …)
- Improved nutritional value in different food products
- Increased amount of vitamins in products (golden rice – provitamin A), vaccines in plants
- Improved aroma, taste and structure of agricultural products
- Improved fiber quality (cotton)

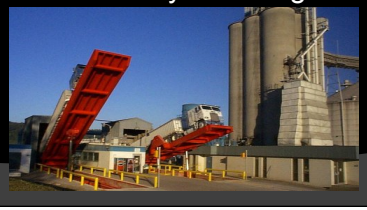
GMOs: Why the Controversy?

Long Term Effects still UNKNOWN…
GMOs → Profoundly impacts the global agricultural economy

Production

Processing

Commodity Handling



Consumer Products

Uses of GMO- Advantages

- **Economical benefits in the case of sugar beet**
  - use of selective herbicide decrease income for 5-15%
  - GMO plant needs LESS watering, instead 4-6 just 2-3
  - seeds costs more
  - less machine cultivation
  - less fuel used -> less emission of CO_2 in the atmosphere

Advantages Cont.

- Herbicide (weed killer) tolerance
- Insect resistance
- Virus resistance
- Quality improvement, Higher Crop yield
- Less use of herbicides

Reasons to Avoid GMOs

- Human Health Concerns
- Nobody can say GMOs are safe
- No specific tests which analyze long term safety of GM foods, no independent research and post-marketing follow-up analysis.

Agency scientists warned of:

- Allergens
- Toxins
- New diseases
- Nutritional problems

Other Risks

- **Pollination**
  - transfer of pollen and genes by insects even in the area of more km from field with GMO
- Pesticides go hand in hand with GMO's
- Increased use of pesticides and herbicides → superweeds
- Artificially created selection pressure could lead to a dominance of GMO

GM plant become weed – high herbicide tolerance – difficulties with control of growth

Animal Health Concerns

- Massive worker bee die-offs due to inc. use of pesticides
- GMOs negatively impacting other insects – food for larger animals
- Glyphosate (herbicide) impacts composition of soil
- Engineered plants which express toxic substances present risks to other organisms

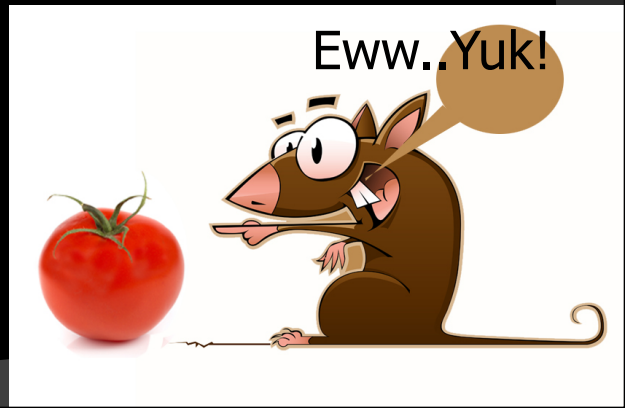
demonstrating that glyphosate adversely impacts the composition of soil thereby causing adverse impact in nematoes (earthworms) and other beneficial soil bacteria. Finally, plants engineered to express toxic substances could present risks

- **GM plants could "contain unexpected high concentrations of plant toxicants."**
- **"The possibility of unexpected, accidental changes in genetically engineered plants justifies a limited traditional toxicological study."**

FDA Toxicology Group

1st GM Crop: FlavrSavr Tomato

Rats refused to eat the tomato



After 28 days

Industry study

- **7 of 20 force fed rats developed stomach lesions**
- **Another 7 of 40 died within 2 weeks**

2 lines of GM tomato made; one associated with high rates of lesions and deaths

FDA did not block introduction of tomato and company voluntarily marketed one not associated with the rat problems

When given a choice, many animals avoided GM foods

Mice avoided GM corn

Non-Genetically Modified

Genetically Modified

Is this a G.M.O.?

Golden Rice

Pathway for β-carotene biosynthesis.

•Added two daffodil and one bacterial genes.

Is this a G.M.O.?

Corn (*Z. mays*)

There has not always been corn.

- **Likely corn ancestor: "Balsas Valley Teosinte"**

Is this a G.M.O.?

Your dog

Compounded product thousands of years of artificial selection.

Cisgenic vs. Transgenic

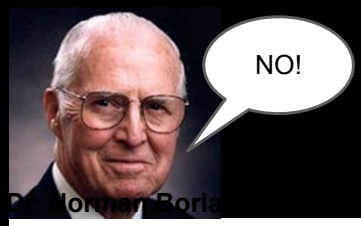
Cisgenic: Transfer of genes from one organism to another sexually compatible species by natural means.

Transgenic: Transfer of genes from one species to another artificially.

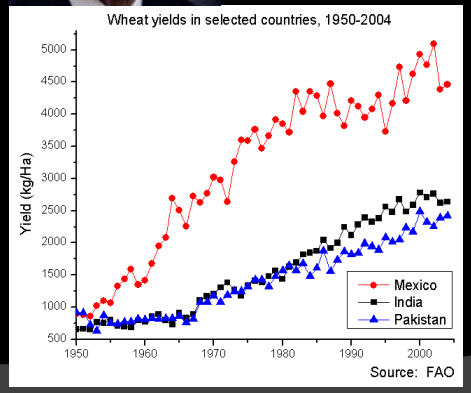
Ethical Question: Is it

- **Opposition:**
  - **Argument of unforeseeable consequences**
    - **Don't know what it will do**
  - **Argument of sacred genetics**
    - Mankind shouldn't have the ability to change mother nature

Ethical Question: Is it



Dr. Norman Borla



Support:

Argument of Inevitability

Argument of Risk vs. Benefit

Dr. Borlaug helped create genetically modified wheat that could grow better in countries who strongly depended on the crop. He is credited for saving the lives of billions of people through the discovery.

Two primary traits

1) Herbicide tolerance

2) Pesticide production (eg. Bt toxin)

* There are also crops with both traits

ECONOMICAL BENEFITS OF GMO

- Reduces average cost of production
- No need for farmers to use insecticides
- Increase in revenue due to higher yield or quality of genetically engineered crops

Economical Concern

- Biotech companies monopolizing agriculture

- Example of company: Monsanto's near-monopoly on Bt corn

- Monsanto increased prices for farmers.

Monsanto

The GM genocide: Thousands of Indian farmers are committing suicide after using genetically modified crops By Andrew Malone

A farmer and child affected by GM debt in India

- In 2008, UK Daily Mail estimated that 125,000 indebted farmers committed suicide.
- The Bt cotton sold by Monsanto didn't offer a reliable harvest and therefore many farmers were unable to pay back the loans that they took to buy the expensive GM seeds.
- The price difference is staggering: £10 for 100 grams of GM seed, compared with less than £10 for 1,000 times more traditional seeds.

Another Economical concern

- Internationally, many countries – in particular the European Union – have expressed a reluctance to accept GM food and feed grains, in contrast to the quick adoption of GM agriculture by US farmers.
- The result of this is some countries have been hesitant to use GM, knowing their customers may not buy their products.

- Editorial
  The Lancet
  Vol 360, Number 9342
  October 26, 2002
- 14 million people are affected by hunger in southern Africa
- USA donated GM maize
- In 2002, Zambia food rots in warehouses because government believes its unsafe.

President Levy Mwanawasa has even called GM maize "poison", saying he is not prepared to "use our people as guinea pigs".

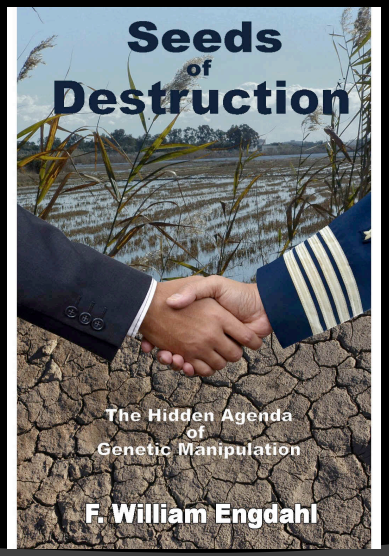
In some areas, citizens have rioted and looted to get to the food.

Another Economical Concern

- Others argue that non-GM food marketers, especially organic food producers are looking for ways to justify charging more for their ‘GM-free’ products.

Seeds of Destruction

The Hidden Agenda of Genetic Manipulation by F. William Engdahl

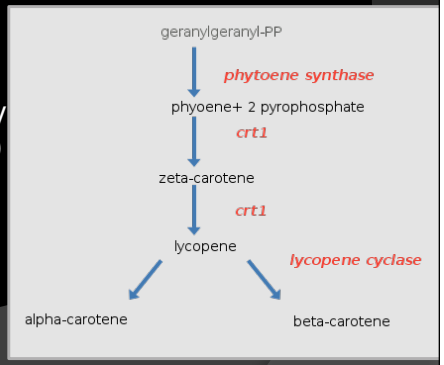


What is so frightening about Engdahl's vision of the world is that it is so real. To achieve world domination, they no longer rely on bayonet-wielding soldiers. All they need is to control food production.

(Dr. Arpad Pusztai, biochemist, formerly of the Rowett Research Institute Institute, Scotland)

Examples: Golden Rice

- Developed to combat vitamin A deficiency, which affects one in three children under 5
- Beta-carotene is a precursor of vitamin A and is produced in the non-edible parts of the rice plant
- Rice plants were genetically engineered to produce the proteins required to synthesize beta-carotene
- The genes that code for these proteins are controlled by a promoter specifically found in the endosperm (edible portion)



Flavr Savr Tomatoes

- First genetically engineered tomato
- Slows down rotting by interfering with polygalacturonase, which breaks down pectin in the cell walls
- Increases the shelf-life of the tomato, making it more economically friendly for farmers
- This allows the tomato to be picked when it ripens, enhancing the flavor lost during artificial ripening

Bt Cotton

- Produced to limit the amount broad-based insecticides used to minimize costs
- The bacterium *Bacillus thuringiensis* (Bt) produces a toxin that is a natural insecticide
- Bt toxin is toxic to moth, butterfly, beetle, and fly larvae
- It is not harmful to humans
- The gene that encodes for the Bt toxin was inserted into the cotton genome to protect itself more naturally