



Cultivating GMO Crops: Destination Unknown

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One Health One Planet Symposium

Phipps Conservatory and Botanical Garden

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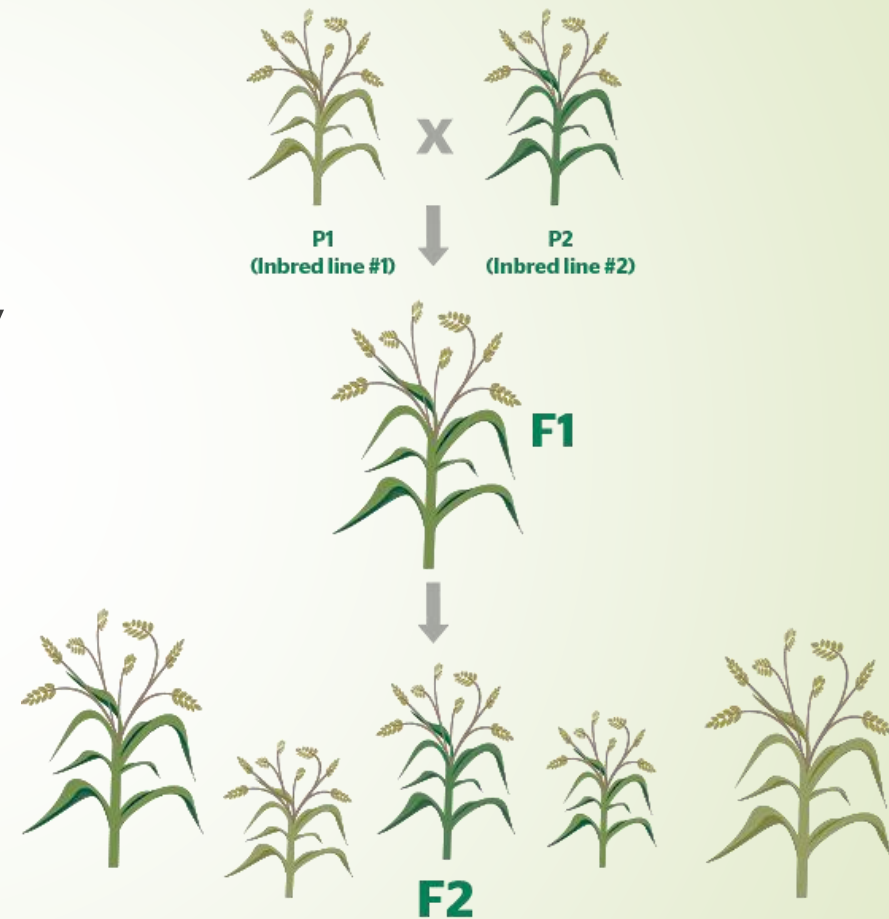
From Gatherers to Farmers

- Selective breeding
- Gregor Mendel's principles of inheritance
- Choose traits desired and cross pollinate



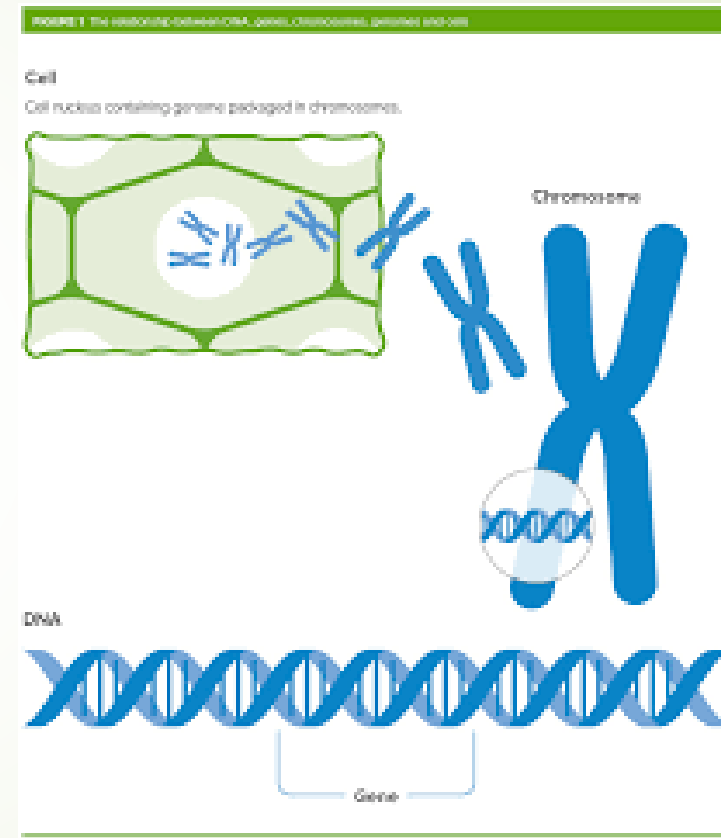
Hybridization

- Cultivate varieties with different traits by sequential selecting and breeding
- Cross fertilization between representatives of **same species**



Genetically Modified Organisms

- Combining traits across species- even across phyla
- Insert a strand of DNA with the desired trait (from a bacterium or virus vector)
- Into the genome of the target plant
- Grow in tissue culture to produce new plants whose seeds carry the new trait



Applications of GMO

- **Medical and pharmaceutical**
 - Animal models of human genetic diseases like hemophilia
 - Creating “edible vaccines” for diseases like Hepatitis, HIV and malaria
 - Biosynthesis of pharmaceuticals such as human insulin



1978

Genentech produced the world's first genetically engineered human insulin. They engineered bacteria that produced human insulin whereas previous methods for obtaining insulin involved taking it from animals.

Applications of GMO

➤ Bioremediation-

Creating genetically modified bacteria to:

- Clean up pollution such as mercury
- Remediate Persistent Organic Pollutants (PCB, PAH, pesticides)
- Clean up oil spills



*Alabaster Corporation
Bio-remediation of oil spill*

Applications of GMO

- **Agricultural Uses**
 - Pest management
 - Nutritional enhancement



M.Buiatti, P.Christou, G.Pastore. "The Application of GMO in Agriculture and Food Production for Better Nutrition- Two Different Scientific Points of View"
Genes Nutr. May 2013. **8(3)**:255-270
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3639326/#__ffn_sectitle

US leading user of GMO in crops



<https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx>

Roundup Ready!



Arguments For Agricultural GMO

- Enhance food quality
- Enhance agricultural productivity (yields)
- Enhance nutrition
- Create “drug factories” for producing edible vaccines and pharmaceuticals



“Golden Rice” enhanced with vitamins

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4346933/>

10/01/18

Arguments For Agricultural GMO

- Reduce environmental footprint of agriculture
 - Reduce fossil fuel use for tilling and harvesting
 - Conserve water
 - Use “less” pesticides



Glyphosate sprayed just before harvest for crop drying

<https://www.ag.ndsu.edu/cpr/plant-science/glyphosate-as-a-pre-harvest-aid-in-small-grains-07-17-14>

Arguments Against GMO



GMO Monoculture crops



Organic farming

- Effects untested, unknown will take decades to manifest
- GMO escape and transfer to wild populations
- Loss of biodiversity and habitat destruction

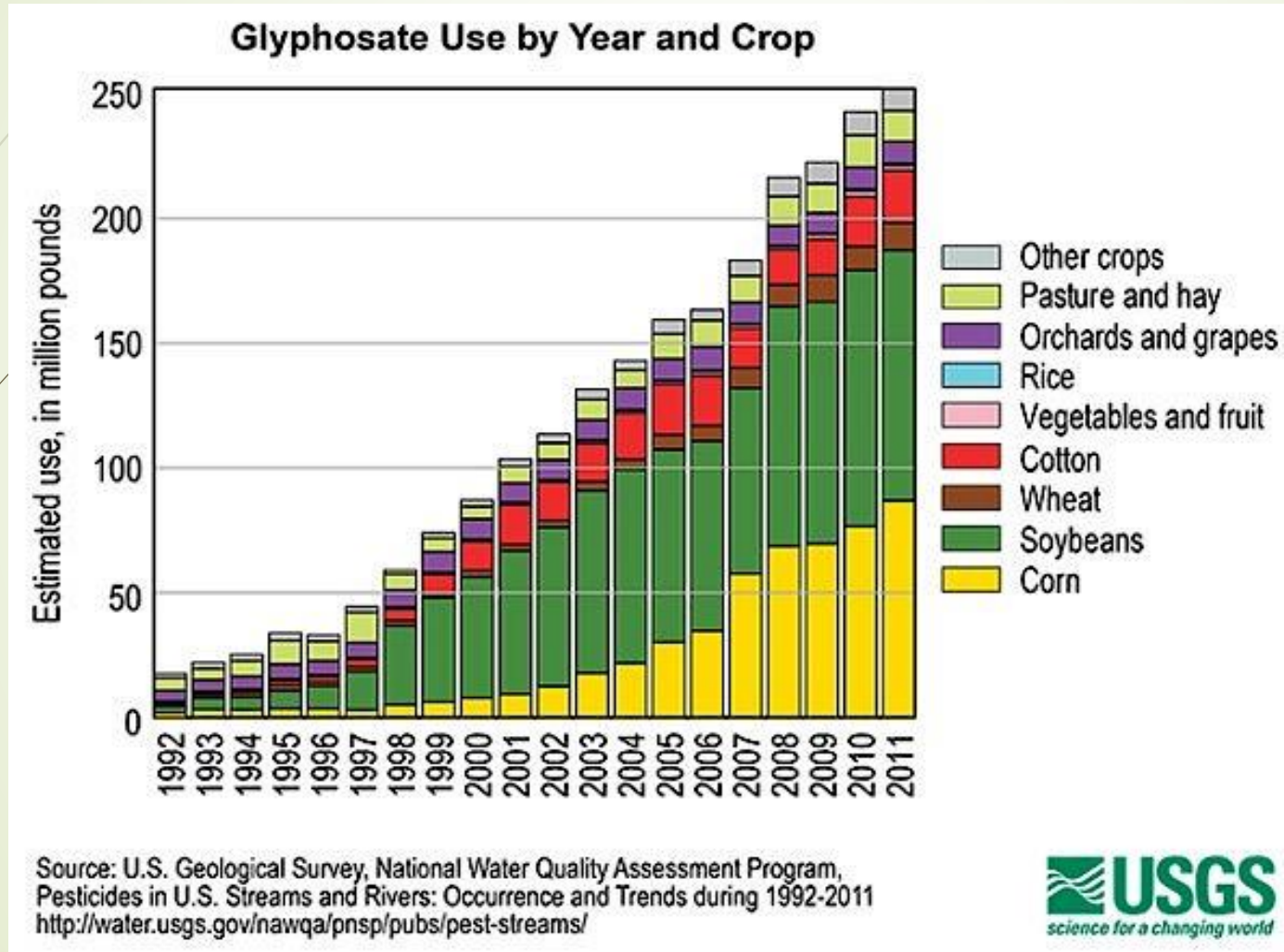
Arguments Against GMO



Palmer amaranth is one of the most prolific glyphosate resistant weeds in the US, producing up to a million seeds per plant. (Superior Ag Resources photo/Tom Sinnot)

- Increased use of chemicals in agriculture & persistence in harvested foods
- Unintended transfer to other organisms (for example *E.coli* in your intestines)
- "Super Weeds"

GMO crops increase pesticide use



- Monsanto introduced GMO Roundup Ready crops in 1995

Ecological Effects

- **Essential Pollinators:** Nearly 90 per cent of all wild flowering plants and **75 % of food crops** depend on animal pollination
- **Biodiversity reduction:** Herbicide spraying destroys non-crop plants reducing habitat
- **Pollinator toxicity:** – Neonicotinoids, sub-lethal and indirect effects of GM crops on pollinators are poorly understood and not usually accounted for in risk assessments.

<http://www.fao.org/news/story/en/item/384726/icode/>



Economic Impact of losing Pollinators



Insect pollinators
contribute \$29
billion to U.S. farm
income

www.patriciademarco.com



Glyphosate residues in finished foods

- FDA has expanded testing for residues of herbicides: **glyphosate**, **2,4-D** and **dicamba** because of projected *increased use* of these weed killers on new genetically engineered crops
- FDA chemist, N. Chamkasem, found “over-the-tolerance” levels of glyphosate at 6.5 parts per million in corn. The legal limit is 5.0 parts per million.



EWG tested granola, oatmeal and cereals - 45 of 47 samples found Glyphosphate at higher levels than safe

<https://www.ewg.org/childrenshealth/glyphosateincereal/#.W7JPRy-ZOL>

<https://usrtk.org/pesticides/fda-foia-documents-regarding-glyphosate-residue-testing/>

EPA finds no harm to humans- rescinds restrictions in 2017

- The EPA's assessment found "no meaningful risks to human health when the product is used according to the pesticide label."
- "There is potential for effects on birds, mammals, and terrestrial and aquatic plants."



<https://www.epa.gov/pesticides/epa-releases-draft-risk-assessments-glyphosate>

Effects on Health and Worker Safety

- numerous negative health effects have been associated with chemical pesticides
- dermatological, gastrointestinal, neurological, carcinogenic, respiratory, reproductive, and endocrine effects
- Exposure through ingestion, inhalation, contact
- Bio-accumulation in fat tissue

Alewu B, Nosiri C. Pesticides and human health. In: Stoytcheva M, editor. Pesticides in the Modern World – Effects of Pesticides Exposure. InTech; (2011). p. 231–50.

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The Ethical Dilemma

Who has the right to decide for the countless legions of people who were not consulted?

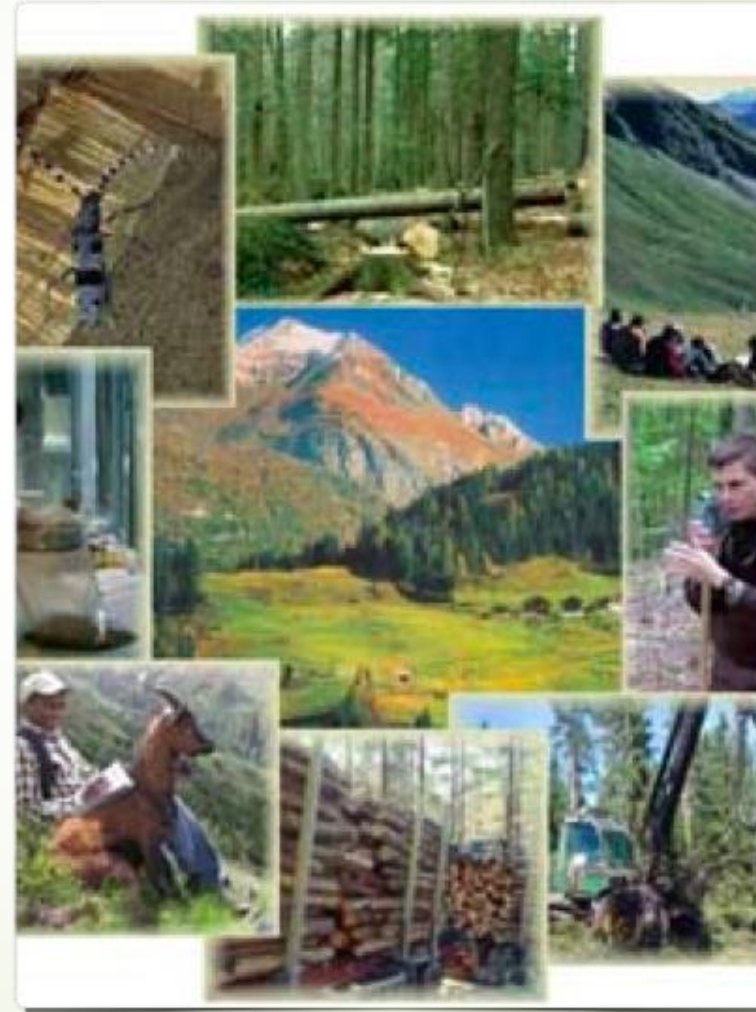
- Preserving the Ecosystem Services of the Earth
- Precaution Principle
- Intergenerational Equity



Interconnected Web of life

“...man does not live apart from the world; he lives in the midst of a complex, dynamic interplay of physical, chemical, and biological forces, and between him and this environment are continuing, never ending interactions.”

Rachel Carson



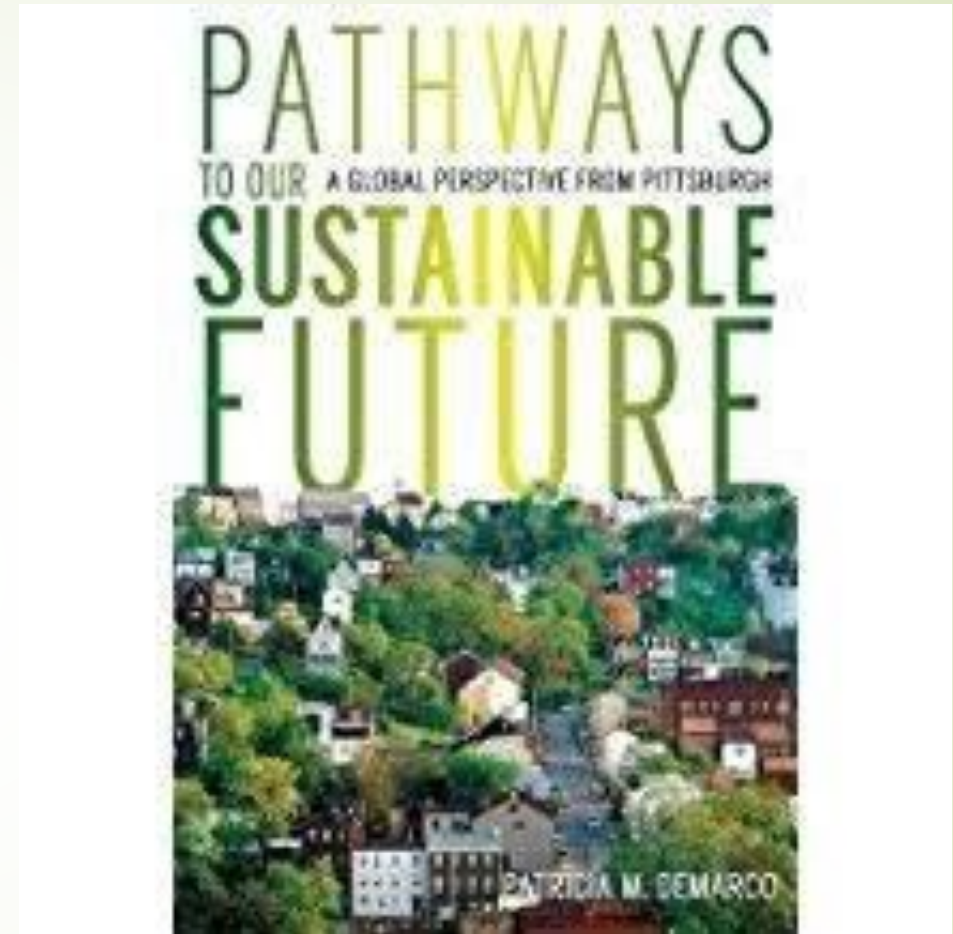


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Resources for further study:

Batista, Rita, and Maria M. Oliveira. "Facts and Fiction of Genetically Engineered Food. Trends in Biotechnology 27.5 (2009): 277-86. Web. 18 Nov. 2013.

Maghari, Behrokh M. "Genetically Modified Foods and Social Concerns." Avicenna Journal of Medical Biotechnology 3.3 (2011): 109-17. Web. 18 Nov. 2013.

Singh, Om V., Shivani Ghai, Debarati Paul, and Rakesh K. Jain. "Genetically Modified Crops: Success, Safety Assessment and Public Concern." Appl Microbiol Biotechnol 71 (2006): 598-607. Web. 18 Nov. 2013.

Further resources

- ▶ <https://www.baumhedlundlaw.com/toxic-tort-law/monsanto-roundup-lawsuit/roundup-cancer-study/>
- ▶ <https://www.activistpost.com/2018/08/monsanto-taken-to-the-cleaners-in-jury-verdict-dwayne-johnson-v-monsanto.html>
- ▶ <https://www.wakingtimes.com/2018/08/10/monsanto-was-just-fined-289-million-by-san-francisco-jury-for-failing-to-warn-of-known-cancer-risk/>
- ▶ <https://www.nytimes.com/2018/04/23/well/eat/are-gmo-foods-safe.html>
- ▶ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3558185/>
- ▶ <https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx>
- ▶ <https://usrtk.org/pesticides/fda-foia-documents-regarding-glyphosate-residue-testing/>