Genetically Modified Organisms

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Outline

- ➤What is a GMO
- ➤ Deregulated Plant in U.S.
- ➤Top 10 GMO crops in U.S.
- ➤ Break down of the traits
- ➤Why GMO
- >Why farmers use GM Crops
- ➤ Concerns
- ➤ Evidence
- **≻**Conclusion



What is a Genetically Modified Organism?

 A genetically modified organism (GMO), also known as a transgenic organism, is any organism whose genetic material has been altered using genetic engineering techniques. (Wikipedia)

*An organism or microorganism whose genetic material has been altered by means of genetic engineering. (Dictionary.com)

 A genetically modified organism (GMO) is any organism the genetics of which have been altered through the use of modern biotechnology to create a novel combination of genetic material. (Monsanto Dictionary)

*Organisms whose genetic material has been artificially manipulated in a laboratory through genetic engineering, or GE. This relatively new science creates unstable combinations of plant, animal, bacteria and viral genes that do not occur in nature or through traditional crossbreeding methods. (NONGMO Project)



APHIS regulates GMOs

- ➤ Release to environment
- ➤Importation
- Doesn't regulate already contained experiments
 Field
 Laboratory

- Regulates under the Plant Protection Act:

 > Authorizes the Secretary of Agriculture to "prohibit or restrict the importation, entry, exportation, or movement in interstate commerce of any plant or plant product."



APHIS grants authorization in 3 ways

- Notification
- ▶Permitting
- ➤ Determination of Nonregulated Status



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- ► Lower risk plants
- >Not classifies as noxious weeds, or weeds in the release area
- > Have to meet certain criteria
- ▶ Plant must be stably integrated
- Expression of genetic material must not result in plant disease
- >If notification denied, applicant can pursue a permit







Permit

- >Applicant must submit information
- on:
- >Donor organism
- ➤ Recipient organism
- Expression of genetic material and biology of system used to produce the plant
- ➤ More restrictive; higher risk plants ➤ Loci of gene alteration
 - > Purpose
 - >Quantity to be produced
 - > Process to prevent release
 - ➤Intended destination
- If a permit is granted, APHIS designs conditions to ensure both the regulated plant remains controlled and the APHIS can maintain regulatory oversight.

Determination of Non-regulated Status

Plants have been tested and have shown to not pose a risk may be eligible for determination of non-regulated status

Petition must include:

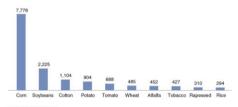
- Detailed biological information
- Published and unpublished data
- $^{\circ}$ Any other information from APHIS permit conditions

GMO Deregulated Plants

CROP	DEREGULATED	MODIFICATION	CROP	DEREGULATED	MODIFICATION
Tomato	1992	Fruit ripening	Rice	1999	нт
Squash	1994	VR	Flax	1999	нт
Cotton	1994	HT	Tobacco	2002	Nicotine reduced
Soybean	1994	HT	Plum	2007	VR
Rapeseed	1994	Oil profile	Rose	2011	Flower color
Potato	1995	PT	Alfalfa	2011	HT
Corn	1995	нт	Sugar Beet	2012	нт
Papaya	1996	VR	Canola	2013	HT
Chicory	1997	Male sterile	Apple	2015	Non-browning
Beet	1998	HT	i		

VR=Virus Resistance HT=Herbicide Trait PT= Pests Trait Source: USDA

Figure 2 Number of releases approved by APHIS: Top 10 crops (includes permits and notifications)*



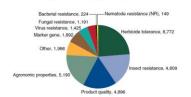
*As of September 24, 2013.

Authorizations for field releases of GE plant varieties are issued by USDA's Animal and Plant Health Inspection Service (APHS) to allow benchoology providers to pursue field testing.

Source: Information Systems for Biotechnology (ISB), 2013).

Source: USDA

Figure 3 Number of releases approved by APHIS by GE trait (includes permits and notifications)*



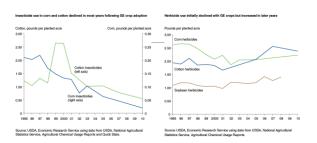
*As of September 24, 2013.

*All of September

Source: USDA

Why GM?

- ➤ Desirable Traits
- With conventional breeding this can take up to 15 years
 Abiotic/biotic stresses
- > Drought, temperature, salinity, insects and pathogens
- ➤ Genetic incompatibility
- >Improve nutrient/nutritional content
- ► Lysine rich corn, Golden Rice, Oilseed Rape vs. Canola
- ➤ Recombinant medicines and industrial products
 ➤ Monoclonal antibodies, vaccines, plastics and biofuels



Concerns?

Overall, risk to the environment or human health

- > Hybridize with non-GM plants through pollen (canola)
- ➤ Pests will become resistant (refuge in a bag)
- ➤ Conditions required to grow GM crops will interfere with wildlife habitat (biodiversity)
- >Adverse effects on human health
- ➤ Carcinogen, toxic, allergens

Source: Key et al. 2008

Hybridize with non-GM plants through pollen- Canola (*B. napus*)



- Pollenmediated, intraspecies gene flow from canola to its wild relatives.
- B. rapa L. (rapeseed), Raphanus raphanistrum L. (wild radish), Sinapis arvensis L. (wild mustard), and Erucastrum gallicum (common dogmustard)
- \triangleright B. rapa = ~7% in commercial fields and ~13.6% in the wild
- ightharpoonup GE B. napus \Longrightarrow three wild varieties was shown to be low (<2 to 5 x 10⁻⁵)
- >Genes could move via wild volunteers
- >Most outcrossing occurred in the first ten meters from the field
- > Rate of outcrossing was influenced by factors relating to the field, plant, pollen, and environment influenced the rate

Pests will become resistant

Refuge in a bag

- Mandatory refuge requirements planting sufficient acres of the non-Bt crop near the Bt crop—were needed to reduce the rate at which targeted insect pests evolved resistance
- Such refuges slow the rate at which Bt resistance evolves by allowing target insects that are susceptible to the Bt toxin to survive and reproduce

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As on example, th	e images above represent	20% refuge requirem	ersts.		

Conditions required to grow GM crops will interfere with wildlife habitat	
➤ A lot of bird species returned to cotton fields as soon as GM cotton replaced conventional insecticides.	
Before GM cotton, birds were eating insecticide- laden insects and dying as a result.	
Safe or no?	
A project to develop genetically modified peas by adding a protein from beans that conferred resistance to weevils was abandoned after it was shown that the GM peas caused a lung allergy in mice.	
SCIENCE EMOTION	
Safety testing of GM plants is effective by having and if this caused allergic identified allergenic reaction then all GMOs potential before the probably due. The product was released on process is unpredictable	
the market. and dangerous.	

Unsafe

Crop	Animal Species	Main Adverse Effect	Author
Corn (MON 863)	Rats	Dose related weight variation, hepatorenal toxicity, increase triglycerides in females and diminished urine phosphorus in males.	Seralini et.al (2007)
Corn (NK 603, MON 810, & MON 863)	Rats	Hepatorenal toxicity, other adverse effects were found in heart, spleen, adrenal glands, and hemopoietic system.	de Vendomois et al. (2009)
Rice expressing GNA lectin	Wistar Rats	No adverse effects but a range of differences between groups (biological, clinical, pathological). Design of study was not able to conclude the safety of the diet.	Poulsen et al. (2007)
Soybean (CP4 EPSEP gene)	Mice	Several proteins belonging to hepatocyte metabolism, stress response, calcium signaling and mitochondria were differentially expressed.	Mathesius et al. (2009)
Soybean (SUPRO 500E)	Wistar rats	No adverse effects in nutritional performance. Altered pancreas function.	Malatesta et al. (2007)

Safe

*Corn: 12 out of 15 studies reported no adverse effects or nutritional differences

- 90 days to 13 weeks
 Rats, Chickens, and mice

*Rice: 3 out of 4 studies reported no adverse effects or nutritional differences

90 days to 26 w
 rats

Soybeans: 7 out of 9 studies reported no adverse effects or nutritional differences
 28 days to 104 weeks
 Rats, mice, chickens,



Conclusion

- ➤ APHIS regulates GM pipeline.
 ➤ 3 phases: notification, permit, deregulation
 ➤ The US has had deregulated plants since 1992
- ➤ Corn typically has the most interest, followed by soybeans and cotton
- ${\blacktriangleright} \text{Speed up the breeding process or overcome incompatibility issues}$
- >Traits should be conserved to avoid resistance issues
- ➤ Safe
 ➤ WHO declares that GM products currently on the market have all gone through risk assessment and passed.
 ➤ Majority of the scientific community deems GMO Crops safe
 ➤ On the market for 19 years

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