“Edición Genética Y GMO: ¿Iguales O Diferentes?

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About ITIF

- Independent, nonpartisan research and education institute focusing on intersection of technological innovation and public policy, including:
  - Innovation and competitiveness
  - IT and data
  - Telecommunications
  - Trade and globalization
  - Life sciences, agricultural biotech, and energy
- Mission to formulate and promote policy solutions that accelerate innovation and boost productivity
- Ranked by University of Pennsylvania as top science and technology think tank in United States and number two in world
“A truly extraordinary variety of alternatives to the chemical control of insects is available. All have this in common: They are *biological* solutions, based on understanding of the living organisms they seek to control. ...Some of the most interesting of the recent work is concerned with ways of forging weapons from the insects’ own life processes.”

--Rachel Carson, Silent Spring, 1962
Chapter 17, para 3
What is a “GMO”?  

“organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination”

UN WHO at http://www.who.int/foodsafety/areas_work/food_technology/faq-genetically-modified-food/en/

Definition describes something that does not exist. (Sweet potatoes, monarch butterflies, every living thing)
¿Odias los cultivos genéticamente modificados? Recuerda que por milenios el ser humano ha modificado genéticamente la naturaleza.

Mediante cruce y selección el ser humano ha modificado a nivel genético y morfológico muchas especies vegetales y animales de interés, este mejoramiento genético tradicional es un proceso ciego y azaroso que puede conllevar efectos negativos. Actualmente la ingeniería genética nos permite mejorar cultivos y animales en un ambiente controlado de laboratorio, con modificaciones génicas mínimas y precisas, además de evitar el surgimiento de características negativas.
Corn/maize

Teosinte

Modern Corn
¿SABÍAS QUE LA MARIPOSA MONARCA ES UN ORGANISMO TRANSGÉNICO NATURAL”?

En su ADN tiene genes provenientes de una avispa, y 2 de los genes adquiridos podrían tener un papel protector frente a patógenos que afectan a la mariposa (Gasmi et al, 2015).
SUPERFICIE MUNDIAL DE CULTIVOS BIOTECNOLÓGICOS/GM

Millones de hectáreas (1996-2014)

- Hectáreas totales
- Industrializados
- En desarrollo

Un record de 18 millones de agricultores en 28 países, cultivaron 181,5 millones de hectáreas (448 millones de acres) en 2014, un incremento sostenido del 3-4% o 6,3 millones de hectáreas (16 millones de acres) más que en 2013.

Source: Clive James, 2014.
Figure 7
Farmers’ reasons for adopting genetically engineered crops

HT soybeans
- Increase yields: 60%
- Decrease pesticide input cost: 20%
- Save management time and make other practices easier: 15%
- Other: 5%

HT corn
- Increase yields: 71%
- Decrease pesticide input cost: 7%
- Save management time and make other practices easier: 9%
- Other: 13%

Bt corn
- Increase yields: 77%
- Decrease pesticide input cost: 7%
- Save management time and make other practices easier: 10%
- Other: 6%

Bt cotton
- Increase yields: 79%
- Decrease pesticide input cost: 12%
- Save management time and make other practices easier: 5%
- Other: 4%

HT cotton
- Increase yields: 77%
- Decrease pesticide input cost: 12%
- Save management time and make other practices easier: 5%
- Other: 6%

Bt crops have insect resistant traits; HT crops have herbicide tolerance traits.
Economic & Environmental Impacts

- $17.7 billion in AV in 2014—150.3B since 1996
  - soybeans +158MT
  - maize +322MT
- Pesticide use -503 M kg
- CO2 reductions ~ -11.88 million autos for 1yr
- EIQ = -18.7%

Source: http://www.pgeconomics.co.uk/pdf/2013globalimpactstudyfinalreport.pdf
WHAT’S THE BENEFIT OF GENETICALLY MODIFIED CROPS?

IN 2014 ALONE, CROP BIOTECHNOLOGY ALLOWED FARMERS TO GROW MORE ON LESS LAND.

WITHOUT BIOTECH, FARMERS WOULD HAVE NEEDED 44.7 MILLION MORE ACRES OF LAND TO PRODUCE THE SAME AMOUNT OF CROPS. THAT’S ALMOST EQUIVALENT TO ALL THE FARMLAND IN IOWA AND WISCONSIN.

18 MILLONES DE AGRICULTORES BENEFICIADOS
Se debe destacar que 90% de los mismos fueron agricultores pequeños de escasos recursos en países en vías de desarrollo.

22% DE MAYOR RENDIMIENTO
Los rasgos de resistencia a insectos y enfermedades, y tolerancia a herbicidas, permitieron reducir las pérdidas por plagas y malezas y ahorrar en insumos agrícolas.

LA SUPERFICIE DE CULTIVO AUMENTÓ 100 VECES
Se incrementó desde 1,7 millones de hectáreas en 1996 a 197 millones en 2015. Esto se debe a la preferencia de los agricultores por los beneficios de esta tecnología.

37% DE REDUCCIÓN EN USO DE PESTICIDAS
Los cultivos transgénicos resistentes a insectos y/o tolerantes a herbicidas, permiten ahorrar fitosanitarios al reducir plagas y tener un mejor control de malezas.

68% DE MAYORES GANANCIAS
Al aumentar los rendimientos y ahorrar en insumos como pesticidas y combustibles, los agricultores tienen un mayor margen de ganancias y más tiempo para dedicar a nuevas actividades en el campo.

CONSERVACIÓN DE 152 MILLONES DE HECTÁREAS DE BIODIVERSIDAD
Al ser más productivos, los cultivos transgénicos permiten producir más alimentos usando menos tierras. Esto contribuye a salvar pastizales, bosques y selvas.

* Revisa más información en nuestro artículo: http://www.chilebio.cl/?p=5923
What Is “Gene Editing” (“New Breeding Techniques”)?

- ZFN = Zinc Finger Nucleases
- TALENS = Transcription activator-like effector nucleases
- ODM = Oligonucleotide directed mutagenesis
- MEGA = meganucleases
- RdDM = RNA dependent DNA methylation
- RNAi/PTGS = small, interfering RNAs/Post translational gene silencing
- CRISPR-Cas9 = Clustered regularly interspaced short palindromic repeats
- (Gene drives/reversal drives...)

ITIF INFORMATION TECHNOLOGY & INNOVATION FOUNDATION
The History of CRISPR

- CRISPR discovered in 1987 (Yoshizumi Ishino)
- An unusual repeating DNA sequence (24-48bp) that was accidentally cloned
- Similar repeating sequences found in all bacteria, archaea examined
- It is an adaptive immune system for defense against viruses
- “RNA derived from… CRISPR loci direct large ribonucleoprotein complexes (cas) to destroy invading bacteriophage and plasmids”
- Identifies viral DNA and cuts it
Where Do We Find CRISPR In The Wild?

- There are at least 45 families of CAS genes/proteins

- “Libraries of tens of thousands of guide RNAs are available…”

How CRISPR Works

- The CRISPR portion is the post office wall full of mug shots
- The CAS moiety is the U.S. Marshall
How CRISPR really Works…

HAVE YOU SEEN THIS WIZARD?

APPROACH WITH EXTREME CAUTION!

DO NOT ATTEMPT TO USE MAGIC AGAINST THIS MAN.

Any information leading to the arrest of this man shall be duly rewarded.

Notify immediately by owl the Ministry of Magic.
Copyediting genomes at will...

- “My initial gut reaction was 'Oh my god, this is terrible. It's so scary... But when you give it more thought and weigh it against the environmental changes that we have already made and continue to make, it would be a drop in the ocean.”
  
  — Micky Eubanks, Texas A&M

- “A dream come true for plant breeders…”
  
  — A. Gal-On
Gene Editing Publications

![Gene Editing Publications Chart](chart_image)
Why Is CRISPR Important? What Can We Do With It?

- Researchers have tweaked CRISPR so it can be used to target any specific DNA sequence (via “guide RNAs” – make your own!)

- It enables researchers to manage any DNA sequence of choice by changing, deleting, or inserting specific nucleotides or nucleotide sequences

- If you can imagine a change you’d like to make to a DNA sequence, CRISPR allows you to make it.
Gene Editing Timeline

- Herbicide resistance in var. crops
- Blight-resistant rice
- Powdery mildew-resistant wheat
- Herbicide resistant canola
- Soybean with reduced trans-fats
- Non-browning mushroom
- Virus-resistant cucumber
- High yield waxy corn
- Potatoes with altered starch
- High yield rice
- Gluten-free wheat
- Non-allergenic apples and peanuts
- Improved abiotic behaviour

- 2012: TALENs used to fight leukemia in two infant girls
- 2015: Hornless milk cows
- 2016: CRISPR clinical study to cure lung cancer in China
- In vitro CRISPR trials to cure HIV
- CRISPR clinical trials to cure var. cancer in the US
- Tuberculosis-resistant cattle
- Farm animals with var. resistances against virus and bacterial diseases
- Cancer treatment
How Researchers Already Have Used CRISPR

- Genetically “poll” dairy cattle
- Gene therapy: curing tyrosinaemia in mice; ß-thalassaemia
- Make programmable transcription factors to turn genes on/off
- Disease resistance or HT in canola, wheat, rice, soy, potato, sorghum, tomato, mice, goats, pigs, sheep, cattle
- Drought tolerant crops (corn, rice, sugar cane, soy, tomatoes, barley, wheat…)
- Vitamin enriched oranges; micronutrient enhanced grains; oil-profile modified oilseeds
- Enhance product quality in mushrooms, apples, potatoes, tomatoes
- CRISPR gene drives (2015) targeting mosquitoes, ticks, invasive plants, weeds
- PERV deletion in pigs
- CRISPR used to gene edit human embryos (2015)
- T-cell augmented cancer therapy clinical trial (2016)
What Else Could We Do?

- Cure HIV
- Cure genetic diseases like CF, MD, Huntington's... (OMIM = 23,714)
- Cure cancer (restore p53-mediated tumor suppression)
- Improved N fixation; Nitrogen fixation in non legumes; enhanced photosynthesis (C3 plants to C4)
- Make mosquitoes immune to malaria/Dengue/Yellow Fever/Zika
- Drive mosquito species to extinction
- Rescue endangered species (Hawaiian honeycreepers; alala)
- Eradicate invasive species
- What else can you think of?
GMOs vs CRISPR: Same or different?

- Some have tried to draw a bright line between GMOs & CRISPR
- Earliest CRISPR uses were simple edits, usually deleting one or several nucleotides (letters) to produce “knock outs”
- Using CRISPR to import exogenous DNA is increasingly common; now almost routine in animals, becoming easier in plants.
- In the near future we will be able to do with CRISPR whatever we could with GMOs
- What technique we use is less important than what we do
- All techniques are used to improve plants, animals, diagnose and treat disease, use resources more efficiently and sustainably
- Risks derive from results (phenotypes) and are not specific to any particular technique
Further Reading

- L. Val Giddings, *Gene Editing, GMOs, and Fear Based Marketing.*
- Lluís Montoliu, The CRISPR page at CNB.
- Jennifer Doudna, “CRISPR systems in prokaryotic immunity” and “How CRISPR lets us edit our DNA.”
Thank You!

Val Giddings  |  @PrometheusGreen
With such great stories, why are we still in a hole?
“Our purpose is not to be scientifically correct, that’s the corporation and robber-baron’s job. Our job is to move the needle and affect radical change.”

--Greenpeace organizer responding to charges that Greenpeace’s “science” continues to build on misrepresentations and blatant falsehoods...
Resolute v Greenpeace

- …“hyperbole,” “heated rhetoric,” and “non-verifiable statements of subjective opinion” that should not be taken “literally”

- …”“a fundamental disregard for scientific reality.”

Read more at: http://www.nationalreview.com/article/445373/greenpeace-environmental-groups-grandstand-harass-company-finally-sues-them
WHY FACTS DON’T CHANGE OUR MINDS: New discoveries about the human mind show the limitations of reason. By Elisabeth Kolbert
It’s how you tell the story

- People don’t follow facts to a conclusion
- People align with their tribe
- Then look for facts to buttress alignment
- Challenging facts is felt as an attack on their identity & values
- More effective to establish & build on emotional rapport
People don’t care how much you know until they know how much you care...
“Something’s just not right—our air is clean, our water is pure, we all get plenty of exercise, everything we eat is organic and free-range, and yet nobody lives past thirty.”
¿Sabías que la insulina para los diabéticos es producida en organismos transgénicos?

Antes se extraía de animales muertos, gracias a la ingeniería genética ahora se puede producir de una manera limpia y eficiente.

Informate en nuestra página web y redes sociales
Reducing Food Allergy Risks

La tecnología GM podría ayudar a desactivar la proteína que causa el 90% de las alergias de maní!
Disease resistant fruit

**Papaya hawaiana susceptible al virus de la mancha anillada (PRSV)**

**Papaya hawaiana transgénica resistente al virus de la mancha anillada (PRSV).**

Actualmente el 80% de la papaya de Hawai es transgénica, ya que el virus casi extinguió la papaya convencional en los años 1990’s.
Sugar from Sugar Beets: the Greenest Option

No source of sugar is more sustainable than GM sugar beets.
Bt Brinjal in Bangladesh

With traditional varieties, I would lose 40% of my crop to pest damage.

With Bt brinjal, I don't need to use pesticide and the crop doesn't get any pest damage.

I have given almost everything away because I am sharing with neighbors!
Bt cotton in India

"Before GM cotton, we sprayed our fields almost every alternate day with pesticides and still we could barely control the boll worms. Lucky for me, my farm became a testing ground for GM cotton in 2003."

Balwinder Kang, farmer, India
Figure 12
Insecticide use in corn and cotton production, 1995-2010

Cotton, pounds per planted acre

Corn insecticides (right axis)

Cotton insecticides (left axis)

Bt maize protects against Asian corn borer
Bt protects against African stem borer
Bt maize & pesticide use

Bt corn uptake and insecticide use in U.S. corn fields

- Insecticide use (kg/ha)
- Percent hectare Bt corn

Percentage of area where Bt corn is grown

INFORMATION TECHNOLOGY
& INNOVATION FOUNDATION
Un agricultor hondureño sostiene dos mazorcas de maíz. El de arriba está genéticamente modificado para resistir una plaga local, mientras que el de abajo no.
Bt maize, aflatoxin, and cancer
"The fact that our nation’s more than 300,000 farmers have adopted GMO technology on more than 90 percent of their corn acres demonstrates the effectiveness they see in their fields every day."

NATIONAL CORN GROWERS ASSOCIATION
The data are absolutely clear. Why does so much fear remain?
STOP MONSTANTO FROM INJECTING TOXIC PESTICIDES INTO OUR FOOD!*

*Actually, this plant is being injected with Bt, which is allowed in organic farming.
"I daresay the environmental movement has done more harm with its opposition to genetic engineering than with any other thing we've been wrong about... We've starved people, hindered science, hurt the natural environment and denied our own practitioners a crucial tool."

There are so many misconceptions. The first is a fundamental one, that being that there is a debate [about safety] at all.

Kevin Folta @ http://randomrationality.com/2013/03/18/qa-the-lowdown-on-gmos-with-kevin-folta/
Worldwide scientific consensus on “GMO” safety

- [Link](http://www.geneticliteracyproject.org/2013/10/08/with-2000-global-studies-confirming-safety-gm-foods-among-most-analyzed-subject-in-science/#.UwP6KfIdWSr)
- [Link](http://gmopundit.blogspot.ca/p/450-published-safety-assessments.html)
- [Link](http://realfoodorg.wordpress.com/2014/02/13/about-those-industry-funded-gmo-studies/)
Worldwide scientific consensus on “GMO” safety


MÁS DE 275 ACADEMIAS CIENTÍFICAS Y ENTIDADES TÉCNICAS RECONOCEN LA SEGURIDAD DE LOS CULTIVOS TRANSGÉNICOS

INFÓRMATE CON LOS QUE SABEN

La mayor cantidad de estas instituciones científicas se encuentran en Europa.

Las Academias de Ciencias de EE.UU, Latinoamérica, África, China, India, Rusia y otros países también apoyan esta tecnología.

Fuente: https://goo.gl/Q5VC3O Elaborado por ChileBio
If you’re worried about food safety...

GENETIC MODIFICATION IS A PLANT BREEDING METHOD, NOT AN INGREDIENT!
¿¡¡TRANSGÉNICOS!!?

Alcohol: 3,3 millones de muertes/año
Tabaco: 6 millones de muertes/año
Obesidad: 3 millones de muertes/año

Transgénicos: 0 muertes/año

CUIDATE DE LO QUE REALMENTE TE HACE DAÑO
“it is absolutely true that there’s a scientific consensus on GMO safety.”

-- George Monbiot
What proponents really want:

- [http://www.geneticliteracyproject.org/2013/10/31/genetic-literacy-project-infographic-is-labeling-really-about-our-right-to-know/#.UwP6r_IdWS0](http://www.geneticliteracyproject.org/2013/10/31/genetic-literacy-project-infographic-is-labeling-really-about-our-right-to-know/#.UwP6r_IdWS0)
We are going to force them to label this food. If we have it labeled, then we can organize people not to buy it.

---Andrew Kimbrell, “Center for Food Safety”
“The burning question for us all then becomes how - and how quickly - can we move healthy, organic products from a 4.2% market niche, to the dominant force in American food and farming? The first step is to change our labeling laws.”

Ronnie Cummins.

https://www.commondreams.org/view/2012/08/02-0
This isn't about freedom of choice. It's about destroying biotechnology and getting it off the shelves.

-- Bruce Chassy, Assoc.
  Director, University of Illinois Biotechnology Center.
"People buy organic because they think it's better for the environment; it's not. It's safer; it's not. It tastes better; it doesn't. It's more nutritious; it isn't. And these are all misconceptions that have been deliberately promoted -- according to these authors -- by organic farmers and organic proponents despite the fact that scientific evidence doesn't support any of these claims."

-- Dr. Steven Novella

What Does the USDA Organic Seal Mean?

- IT DOESN’T MEAN FREE OF ALLERGENS
- IT DOESN’T MEAN HEALTHIER
- IT DOESN’T MEAN MORE NUTRITIOUS
- IT DOESN’T MEAN PESTICIDE FREE
- IT DOESN’T EVEN MEAN THE PRODUCT IS SYNTHETIC PESTICIDE FREE

IT JUST MEANS YOU PAID MORE
If the only way to sell your product is to scare people with lies about your competitors’ products, that speaks volumes about the uselessness of your product.

Show your support for American farm families. Sign the petition. goo.gl/zNRzhs

fb.com/TheChowGabe