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Communicating with the general public about GMOs and genome edited organisms

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<http://animalscience.ucdavis.edu/animalbiotech>

10. Frankenfish Aren't Animals, They're "Animal Drugs"

1 of 11



Obama's FDA is regulating genetically engineered salmon, a genetically modified organism (GMO) that is the first of its kind, not as an animal, but as an animal drug.

Van Eenennaam 9/13/2022

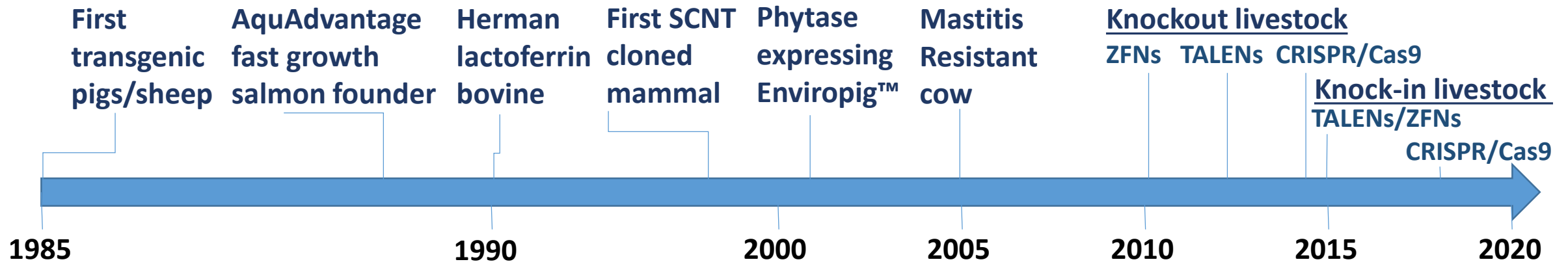


Definition of Animal Genomics and Animal Biotechnology

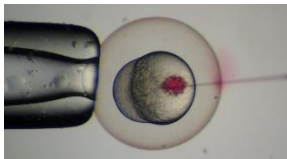
Animal **genomics** is the scientific study of structure, function and interrelationships of both individual genes and the genome in its entirety. Utilization of genomic information in breeding is often referred to as genomic selection (**GS**).

Animal **biotechnology** is the application of modern molecular techniques to animals. Genetic engineering (**GE**) and cloning are two older forms of animal biotechnology, and genome editing (**GnEd**) is a more recent entrant.

In my view these two fields – genomics and biotechnology - face entirely different public acceptance issues.



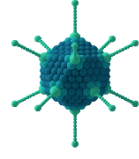
Microinjection of DNA into early stage zygotes



Precomplexing DNA with sperm



Retroviral delivery into zygotes



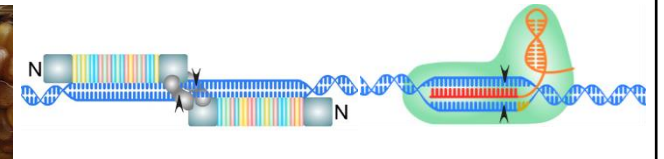
SCNT of genetically engineered cells



Transposon-mediated integration



Genome editing-based genomic alterations (ZFNs, TALENs, CRISPR/Cas9)

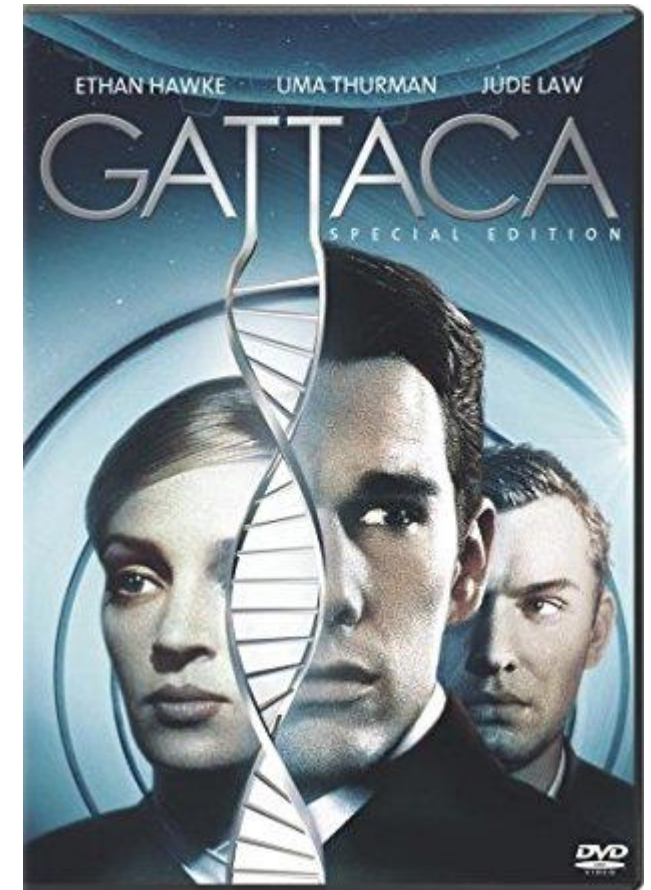
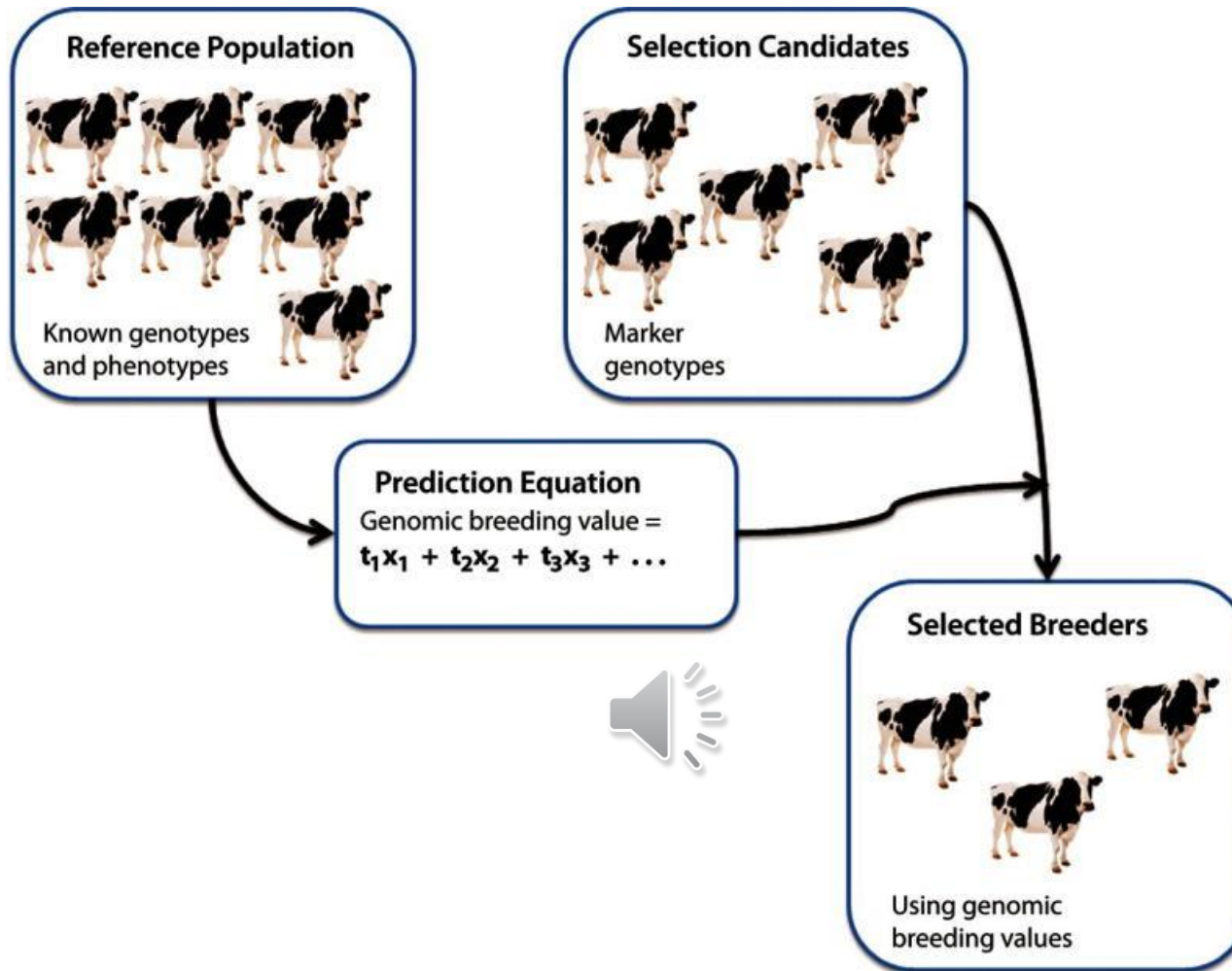


Three things that trigger whether a breeding method will become controversial

1. There is an extra (often lengthy and expensive) regulatory step uniquely associated with commercializing products developed using that breeding method above and beyond that associated with conventional/traditional breeding and selection programs
2. There is/are a competing business interests that can spread misinformation and monetarize fear to extract value (rent seeking) for their product that avoids that breeding method
3. There is some way to track/differentiate products produced with or without that breeding method to enable value-added marketing



The narrative around genomic selection



I predict there will be no public acceptance issues with genomic selection (GS)

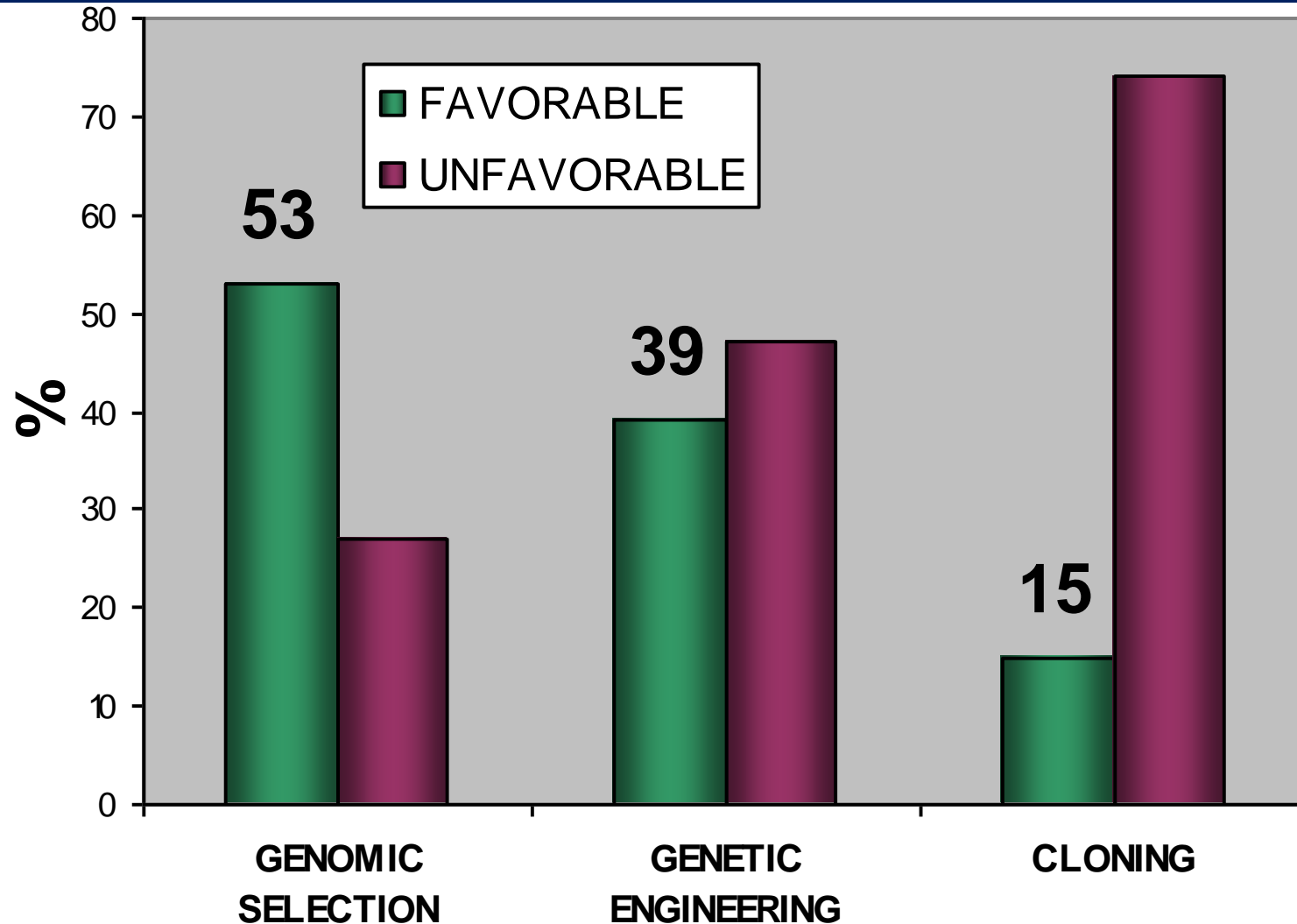
- There is no money to be made opposing GS.
- There is no GS labeling required from the products from GS bulls.
- There is no additional regulatory layer to the use of genomic testing
- There are no large multinational companies controlling its use that can serve as a proxy for evil (e.g. Monsanto).

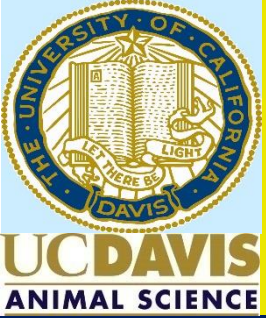


NON
GENOMIC
SELECTION
PROJECT



Public Attitudes Towards Specific “Animal Biotechnologies” (IFIC, 2005)





The Center for Food Safety was founded by Andrew Kimbrell - spun out of Jeremy Rifkin's Foundation on Economic Trends



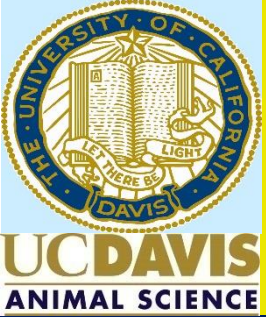
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ABOUT RBGH

For nearly twenty years, rbGH (recombinant bovine growth hormone), has been a staple in the dairy products consumed by Americans.

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“The Center for Food Safety” IS NOT THE U.S. FDA’s Center for Food Safety and Applied Nutrition (CFSAN)



 An official website of the United States government [Here's how you know](#) ▼



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Content current as of:
09/19/2018

The Center for Food Safety and Applied Nutrition, known as CFSAN, is one of six product-oriented centers, in addition to a nationwide field force, that carry out the mission of the Food and Drug Administration (FDA). FDA is a scientific regulatory agency responsible for the safety of the nation's domestically produced and imported foods, cosmetics, drugs, biologics, medical devices, and radiological products.

The Center provides services to consumers, domestic and foreign industry and other outside groups regarding field programs; agency administrative tasks; scientific analysis and support; and policy, planning and handling of critical issues related to food and cosmetics. Most Center staff members work in the Center's headquarters in College Park, Maryland. The Center also operates research facilities in Laurel, Maryland, Bedford, IL, and in Dauphin Island, Alabama.

Cloning – on CFS radar



https://www.centerforfoodsafety.org/issues/302/animal-cloning/about-cloned-animals

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ABOUT CLONED ANIMALS



Using genetic technologies to clone food animals is a relatively new science that remains understudied and imprecise. However, defects in these animals are common, and scientists warn that even small imbalances could lead to hidden food safety problems in cloned milk or meat. There are few studies on the risks of food from cloned animals, and no long-term food safety studies have been completed.



Cloning – effectively banned in the European Union



Dolly the cloned sheep kills a lamb — and EATS it!

By MIKE FOSTER / *Weekly World News*

EDINBURGH, Scotland — A frightened scientist says Dolly the cloned sheep has killed a young lamb — and eaten it!

What's more, the world's first cloned mammal has exhibited other strange behavior, such as chasing a young child, biting a keeper and staring menacingly at razzled scientists.

"When you do something to anger her, she looks at you with these intense

eyes full of hate," said a researcher involved in the cloning project.

Dolly's eerie antics — including the "cannibalism" episode



two months ago. "A keeper was giving her a bath, which she doesn't seem to enjoy very much," recalled the researcher. "When his back was turned, she bowled him over, then nipped his face, drawing blood."

"Another time I brought my 8-year-old daughter to see Dolly in her pen. She was thrilled and was looking forward to



Cloning – happening routinely in the United States for those with money



Trans Ova Livestock Cloning

Cloning livestock empowers you to leverage the value of your most profitable animals

At Trans Ova Genetics, we have been devoted to livestock reproductive technology for 40 years. This includes the entire toolbox of assisted reproductive technology including embryo transfer, in vitro fertilization, sexed semen, genetic preservation, and cloning. Our team of devoted scientists, caring veterinarians and expert professionals are the leaders in livestock cloning with literally thousands of cloned cattle, pigs, sheep, and goats produced since our first cloned calf was born in 1998.

The production of your cloned calf, piglet, lamb and kid is diligently nurtured by a dedicated team of trained professionals who have years of experience in a successful program. With 40 years of experience delivering healthy animals to our clients, they are unparalleled in the world of cloning technology.

Cloning Resources

[Cloning >](#)

- Cattle
- Sheep
- Pigs
- Goats

Does food from cloned animals and their offspring have to be labeled?

In January 2008, the FDA released their Final Risk Assessment that stated that the products from cloned animals and their offspring are safe, that there is no difference in food produced from cloned animals and their offspring, thus there is no reason to require labeling on all products. The offspring of cloned animals are conventionally bred and are not cloned animals themselves.

Cloning has been able to proceed in countries where:

- Clones are not regulated differently to conventional breeding
- Products from clones are not required to be labeled (as they are in impossible to differentiate from products from non-cloned animals)
- Lacking mandatory labeling requirements and in the absence of a plausible path to harm, it was just not possible to create a cost-effective “absence-labeling” campaign as was done with rBST
- If there is a direct benefit, at least in the mind of the person cloning their pet dog or bucking bull or 4-H club lamb, then people are willing to overcome their hesitations regarding cloning despite low (15%) approval rating.



Genetic Engineering – on CFS radar



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GE FOODS

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ABOUT GENETICALLY ENGINEERED FOODS



The genetic engineering of plants and animals is looming as one of the greatest and most intractable environmental challenges of the 21st Century.

Currently, up to 92% of U.S. corn is genetically engineered (GE), as are 94% of soybeans and 94% of cotton [1] (cottonseed oil is often used in food products). It has been estimated that upwards of 75% of processed foods on supermarket shelves – from soda to soup, crackers to condiments – contain genetically engineered ingredients.



FRANKENFOOD



Orange Juice
May Soon
Contain
Pig Genes

GMOs

5 DANGERS + THE AUTISM/ALLERGY CONNECTION



Genetically Modified Oranges gene spliced with Frogs

Coming soon to a grocery store near you.



One New Apple Product
Your Family Doesn't Need.



Just say "know" to
genetically engineered apples.

400% increase

in allergies since GMOs were introduced.



Coalition Powered by Green America
GMO INSIDE!

#SimilacNoGMO



Will **Roundup** rob
him of someday having
babies of his own?

Gerber uses RoundUp Ready GMOs in its Good Starts for American babies. But a new study published in the journal *Free Radical Medicine & Biology* implicates Roundup in male infertility at concentration levels well within the EPA's "safe levels" for food.

That's NOT a Good Start, Gerber!

Pro-GMO organizations argue that in a world where food is scarce, they are helping to feed the hungry. Feeding people untested lab modified food (GMOs) is like one giant science experiment gone bad! You can feed rice mixed with a little rat poison to a starving African child each day and claim, "I am feeding this child!" The ability to stave off starvation does not counteract the poisonous side-effects!

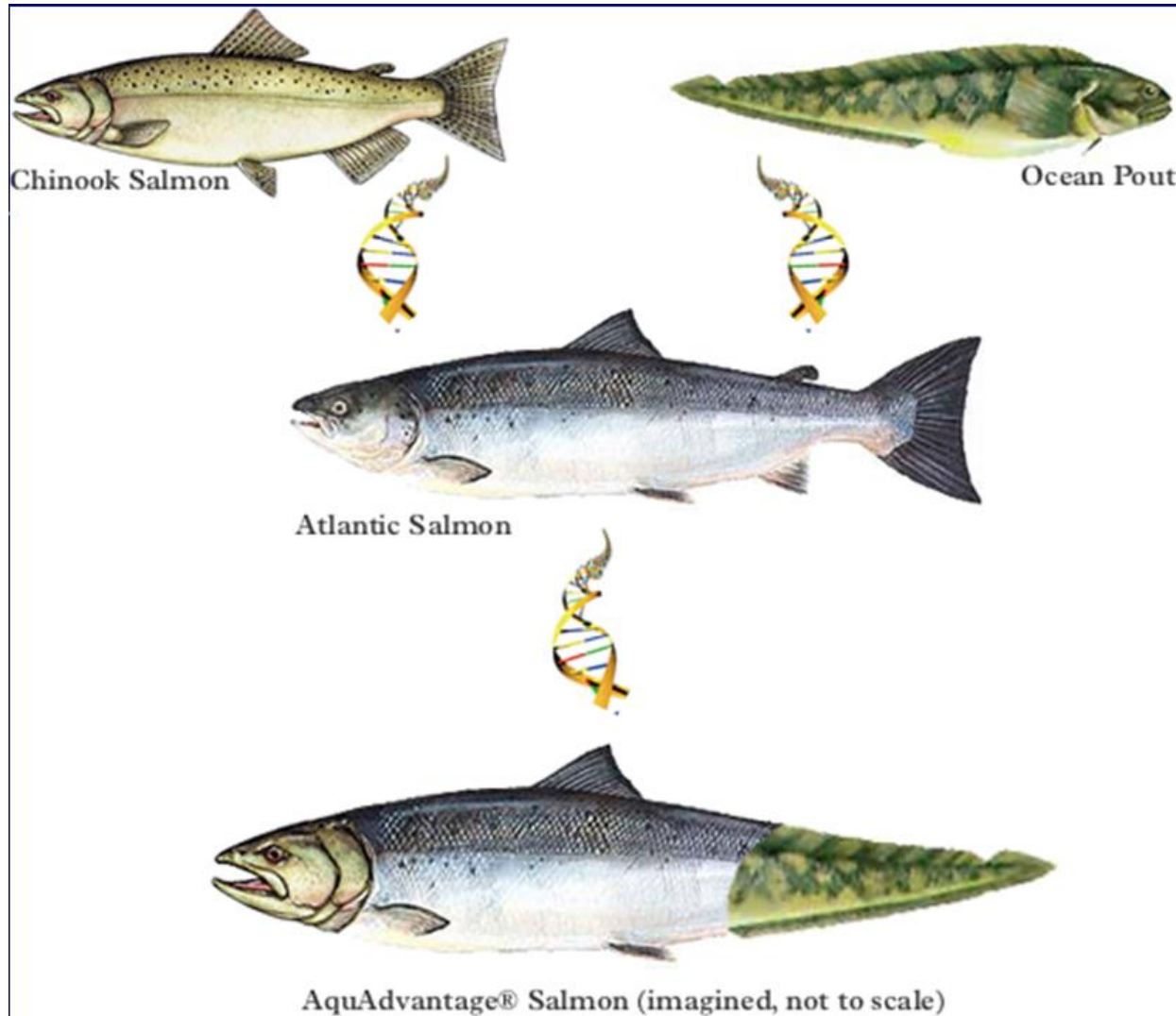
homecuresthatwork.com



United Nations Photo



Retrieved from “AquAdvantage” image search on web



Séralini et al. (2012) Two year study on rats given NK603 genetically engineered corn (GMO) and/or Roundup (R) (retracted; then republished in Environmental Sciences Europe)

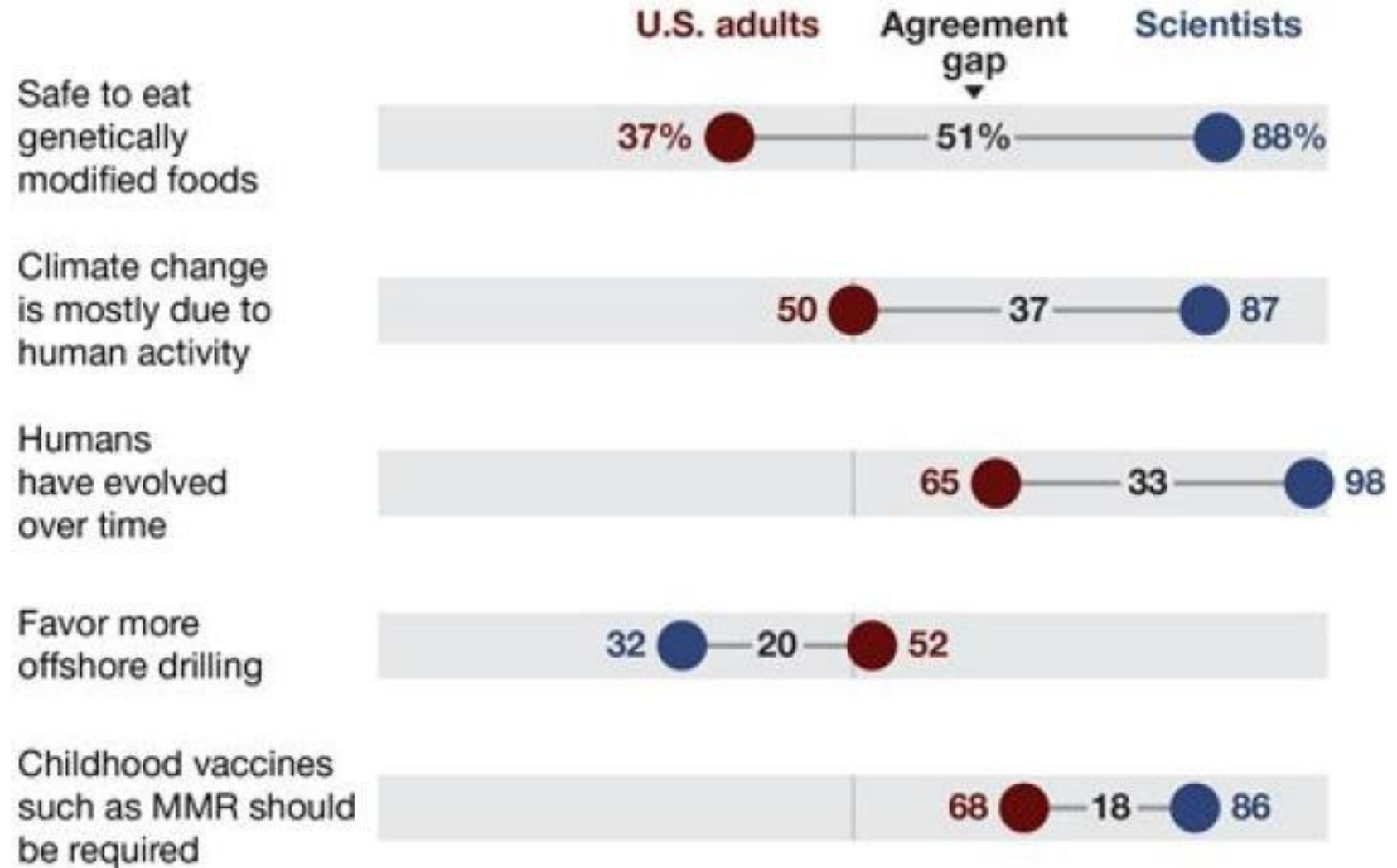


Approx. 70% of female Sprague–Dawley rats get mammary tumors by 2 years of age. Control image downloaded from

<http://www.ratfanclub.org/mamtumpics.html>

Opinion differences between the public and scientists

Percentage agreeing with statement





Genetically engineering salmon for fast growth – founder fish produced in 1989

AquAdvantage salmon: Transgenic and conventional sibling at the same age



Du SJ, Gong ZY, Fletcher GL, Shears MA, King MJ, et al. **1991.** Growth Enhancement in Transgenic Atlantic Salmon by the Use of an All Fish Chimeric Growth-Hormone Gene Construct. *Bio-Technology* 10: 176-81

The same anti-GMO groups that targeted genetically engineered crops such as Center for Food Safety, GM Watch, Consumer Reports go after Impossible Burger due to GE leghemoglobin and soy

GMOSCIENCE

Science Videos About Us Kids Test for Glyphosate

Rat Feeding Study Suggests the Impossible Burger May Not Be Safe to Eat

Published: June 25th, 2019 Last Updated: November 1st, 2019



Rats fed the genetically modified yeast-derived protein soy leghemoglobin - the burger's key ingredient - developed unexplained changes in weight gain and signs of toxicity. Report by Claire Robinson and Michael Antoniou, PhD

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CR Consumer Reports

CENTER FOR FOOD SAFETY

Meat Gets a Makeover

Are the new plant-based patties and eventual lab-grown meats safe, healthy, or tasty? And will they save the environment?

By Rachel Rabkin Peachman
August 29, 2019

717 SHARES

f t p e




PHOTO: SAM KAPLAN

A writer walks into a burger joint with a mission: to sample the burger options - whether made from plants or animals.

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OUR BEEF WITH THE GMO IMPOSSIBLE BURGER

By Jaydee Hanson, Policy Director

JUNE 20, 2019

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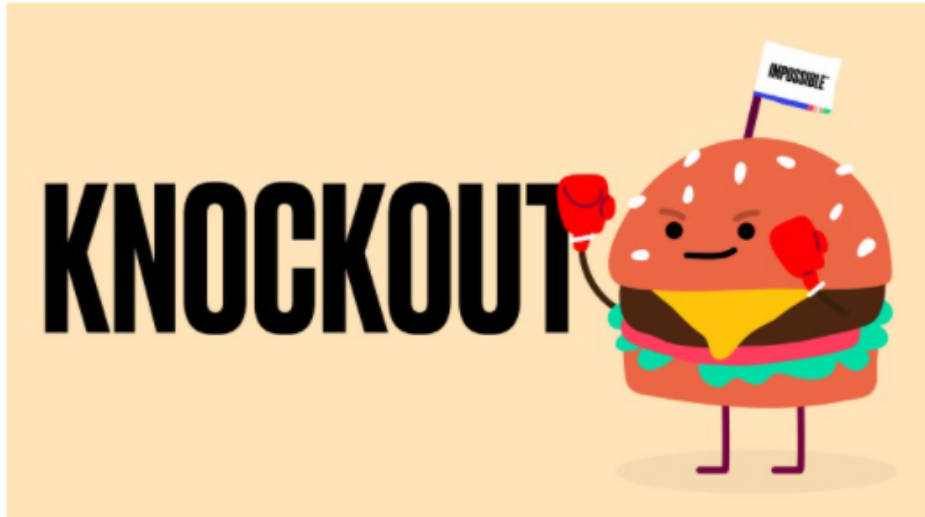
Our Beef with the GMO Impossible Burger

In the foodie world, 2019 might as well be named *The Year of the Impossible Burger*. This plant-based burger that "bleeds" can now be found on the menus of Burger King, Fatburger, Cheesecake Factory, Red Robin, White Castle, and many other national restaurant chains. Consumers praise the burger's meat-like texture and the product is advertised as an environmentally friendly alternative to traditional beef burgers.



SETTING THE RECORD STRAIGHT: MORE LIES FROM ANTI-GMO ACTIVIST GROUP CENTER FOR FOOD SAFETY

By Rachel Konrad, Chief Communications Officer, Impossible Foods
Wednesday, October 23rd, 2019



The Center for Food Safety (CFS) has been spreading lies about Impossible Foods for months, and the anti-GMO fundamentalist outfit ratcheted up these deceptions this week on social media. The group alleges that Impossible Foods is "illegally" selling the Impossible™ Burger in grocery stores, in violation of US Food and Drug Administration regulations; this claim is patently false. <https://impossiblefoods.com/blog/>

Errors, "experts" and hidden agendas: Keeping Consumer Reports accountable

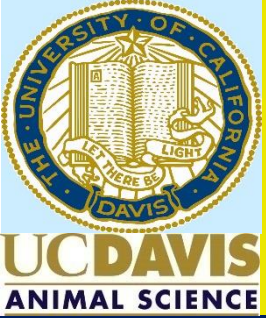
Impossible Foods Aug 29, 2019 · 4 min read



By Rachel Konrad, Chief Communications Officer, Impossible Foods

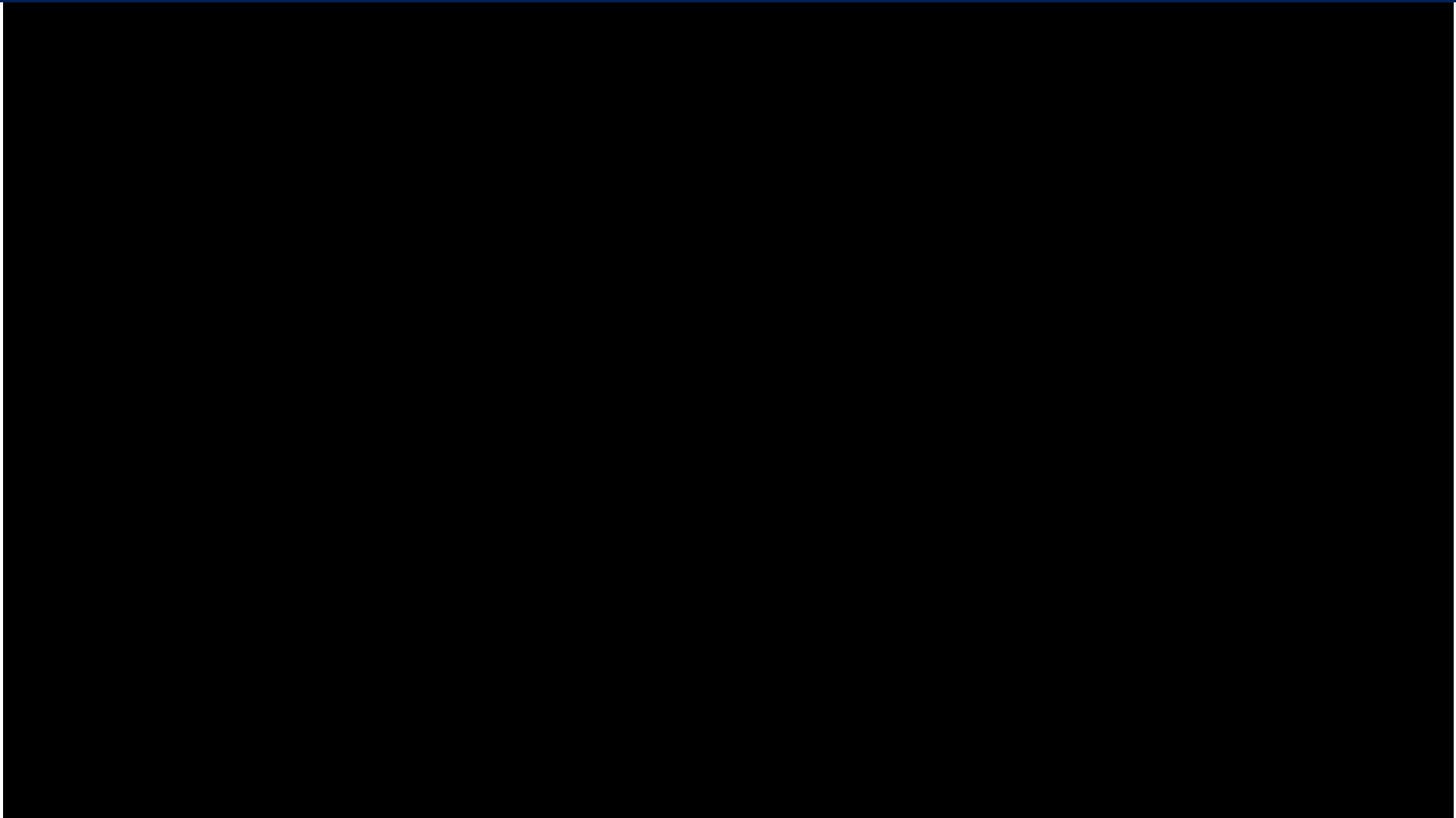


Impossible Foods deeply respects a free and independent media. We encourage journalists and all consumers to do their research on the food they eat.

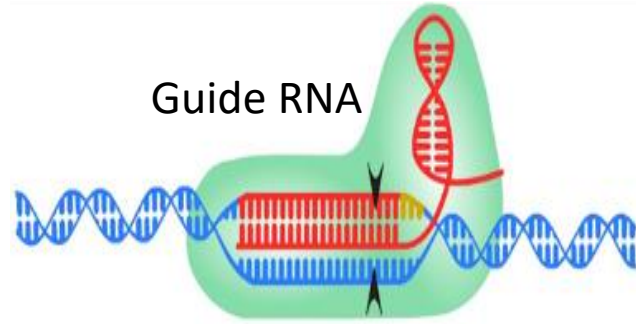


Thirty Years in the Making

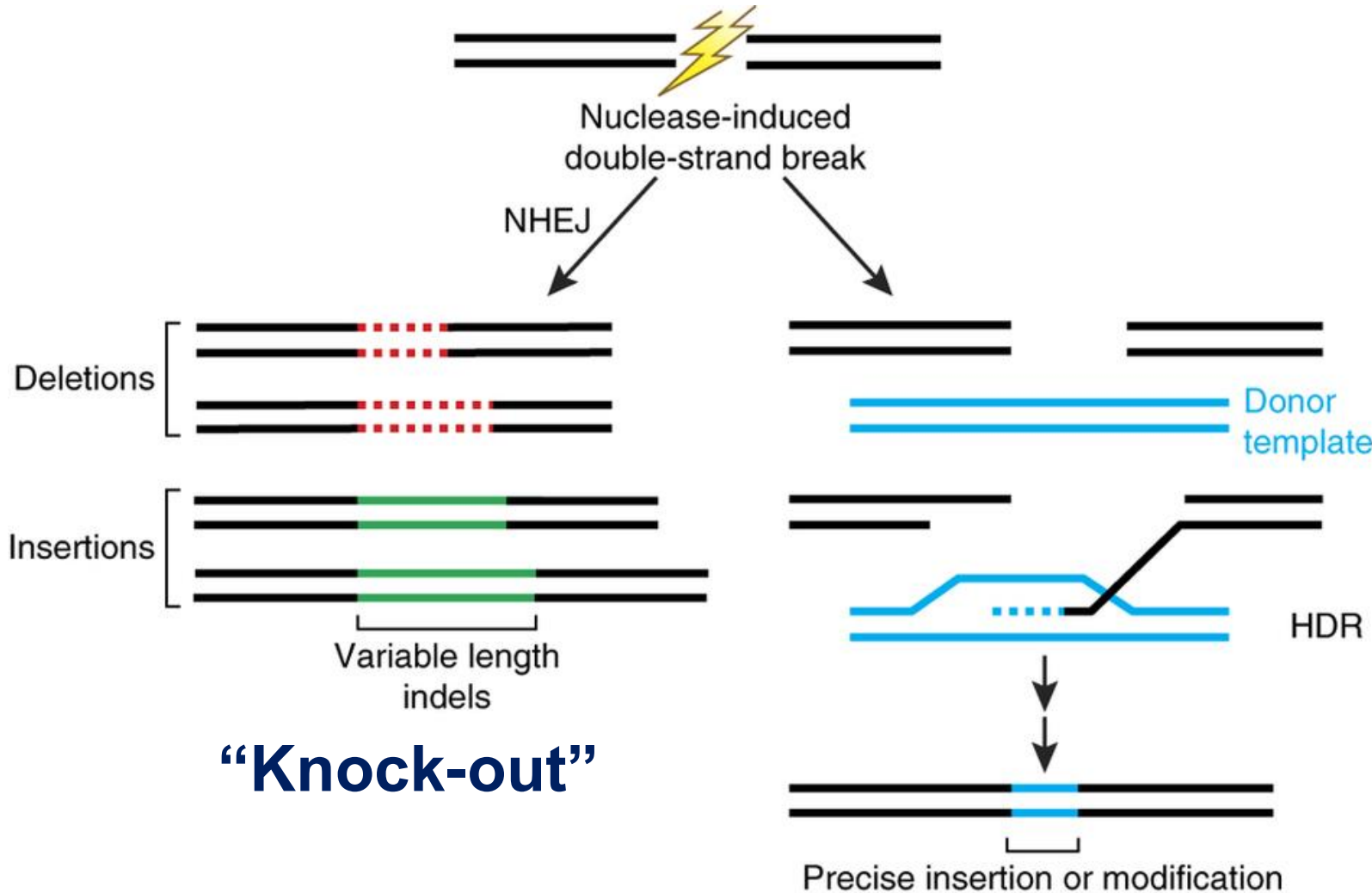
YouTube: <https://youtu.be/vrAkajpHGPI>



Gene editing offered new hope for animal breeders, especially if knocking-out a gene via targeted mutagenesis



CRISPR/Cas9



“Knock-out”

Genome Editing – on CFS radar



gene edit

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Sep 8th, 2020

New Test Detects Canola Engineered With Gene-Editing Technology

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Jun 7th, 2006

Lawsuit Challenges Unscientific FDA Policy on Gene-Altered Foods

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Media > Press Releases

Nov 21st, 2016

Organic standards will exclude next generation of GMOs

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Jun 13th, 2006

Contamination From Gene-Altered Crop Trials Pose Unappreciated Threats To Wildlife

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Nov 7th, 2014

Poorly Tested Gene Silencing Technology to Enter Food Supply with Simplot Potato

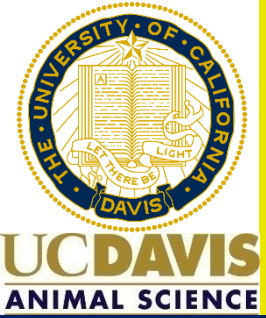
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Jan 19th, 2006

California Gets Failing Grade in Protecting the Public from Gene Altered Food Risks

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Genome Editing – NON GMO project

Understanding Biotechnology: N x +

https://www.nongmoproject.org/blog/understanding-biotechnology-new-gmos/

NON GMO Project

About GMO Facts Find Non-GMO Product Verification Get Involved Non-GMO Retailers Contact Donate

Understanding Biotechnology: New GMOs

December 6, 2019 - [Blog, homepage feature](#)

Please review [Understanding Biotechnology: What is a GMO?](#) for GMO basics.

THE EMERGENCE OF NEW GMOS

For the past 25 years, genetically modified organisms have been largely limited to transgenic crops and animals: organisms that have been genetically modified by combining the DNA from two or more different species. This is beginning to change. GMOs are now being created with newer genetic engineering techniques, some of which do not involve transgenic technologies. The Non-GMO Project is committed to preventing these new GMOs from entering the non-GMO supply chain. At present, several factors are making this difficult:

Testing for GMOs depends on the commercial availability of such tests. There currently are no tests commercially available for new GMOs or their derivatives. This means that tracking them relies heavily on affidavits and other documentation rather than tests.

Additionally, GMO regulations have not caught up with new GMOs. GMOs are regulated under the Coordinated Framework for Regulation of Biotechnology in the United States. This law has not been effectively updated since 1986 and does not reflect the current state of biotechnology. The more recent National Bioengineered Food Disclosure Standard, a labeling law, does not address these new techniques.

There is also some degree of confusion about whether products of new genetic engineering techniques are GMOs. Some of these new GMOs have been marketed as non-GMO. To be clear, all products of new genetic engineering techniques are GMOs.

NEW TECHNIQUES

Many techniques are being used to genetically modify living organisms. Some of the more prevalent or noteworthy techniques include:

Recent Posts

- Food waste fighting powerhouse LOOP Mission is now Non-GMO Project Verified
- What are Micro Ingredients and Why a They Important?
- What is Bioengineered Food?
- URBL is now Non-GMO Project Verifier
- What You Need To Know About Bioengineered (BE) Food Labeling

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The Non-GMO Project is committed to preventing these new GMOs from entering the non-GMO supply chain.



Gene Edited Polled Calves

Naturally-occurring bovine allele at polled locus

Production of hornless dairy cattle from genome-edited cell lines

To the Editor:

Physical dehorning of dairy cattle is practiced to protect animals and their handlers. Genetic analyses have identified variants that are associated with hornlessness (referred to as 'polled') in cattle, a trait that is common in beef but rare in dairy breeds. We have introgressed a candidate *POLLED* allele into dairy cattle by genome editing and reproductive cloning, providing both evidence for genetic causation and a means to introduce *POLLED* into livestock with the potential to improve the welfare of millions of cattle annually.

In the United States, an estimated 80%¹ of all dairy calves (4.8 million per year) and 25% (8.75 million animals) of beef cattle are dehorned every year. A lower proportion of beef cattle than dairy cattle need to be dehorned because the dominant *POLLED* locus is nearly fixed in beef cattle such as Angus, whereas dairy breeds such as Holstein have a much lower frequency of *POLLED* because of the small number of sires (6%) producing commercially available *POLLED* semen². Physical dehorning of cattle, which is done to protect animals and producers from accidental injury is not only

NATURE BIOTECHNOLOGY VOLUME 34 NUMBER 5 MAY 2016

 recombinetics
acceligen



Gene Edited Polled Calves

Naturally-occurring bovine allele at polled gene



10 base pairs (p)



212 base pairs (P)

POLLED GENE





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Browser address bar: <https://allianceforscience.comell.edu/blog/2016/03/video-precision-breeding-offers-new-alternative-to-dehorning-cattle/>

Browser tabs: Apps, Getting Started, From Google Chro..., Altmetric it!, DDX

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A close-up photograph of a black and white cow standing in a green field. The cow has a white face with black markings around its eyes and ears. The background shows trees and a fence.

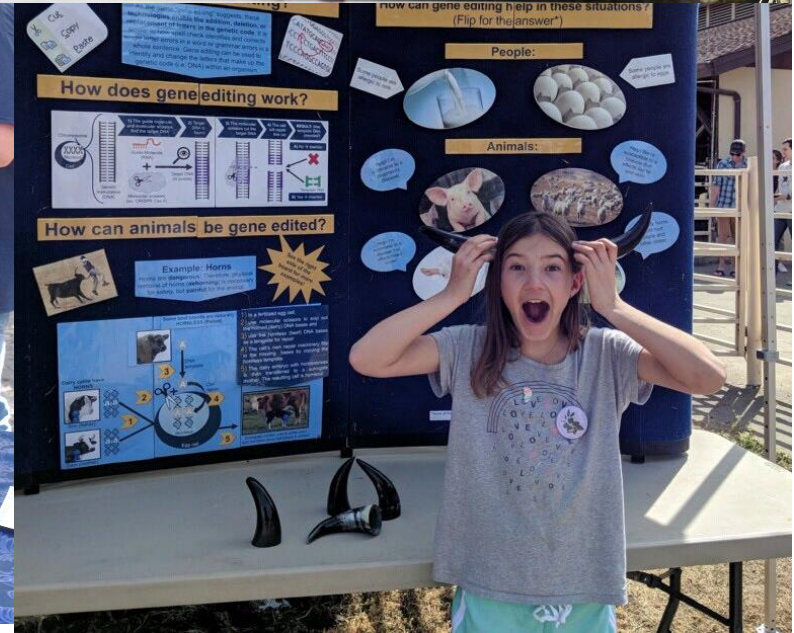
3/31/2016

Video: Precision Breeding Offers New Alternative to Dehorning Cattle



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Picnic Day



Surveyed public audience on gene editing

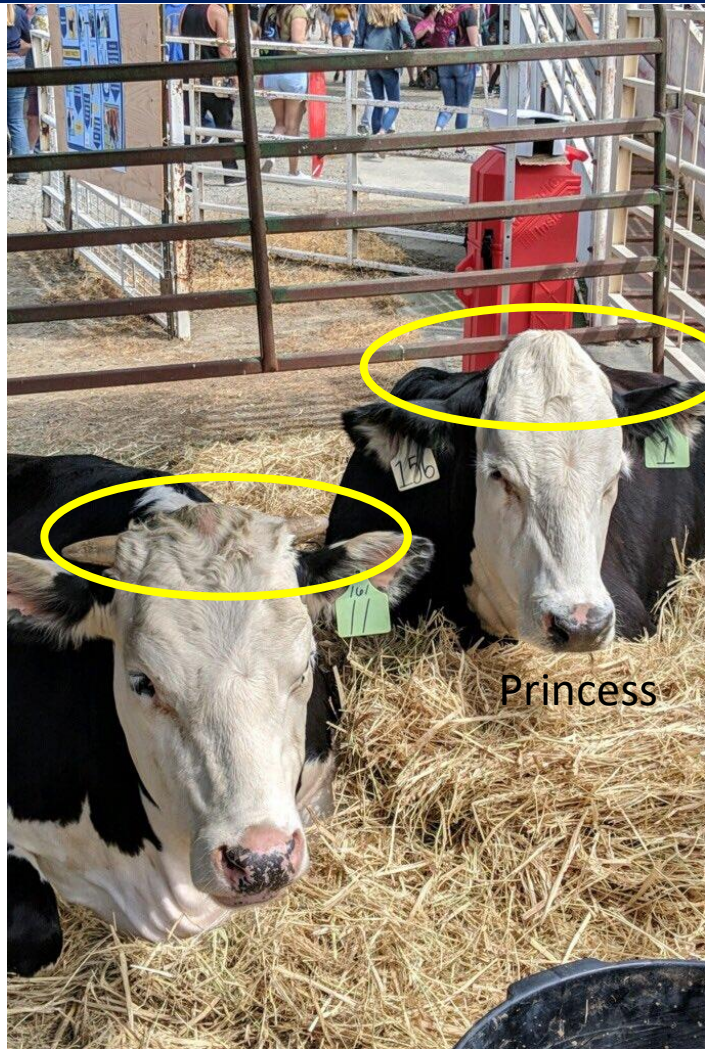
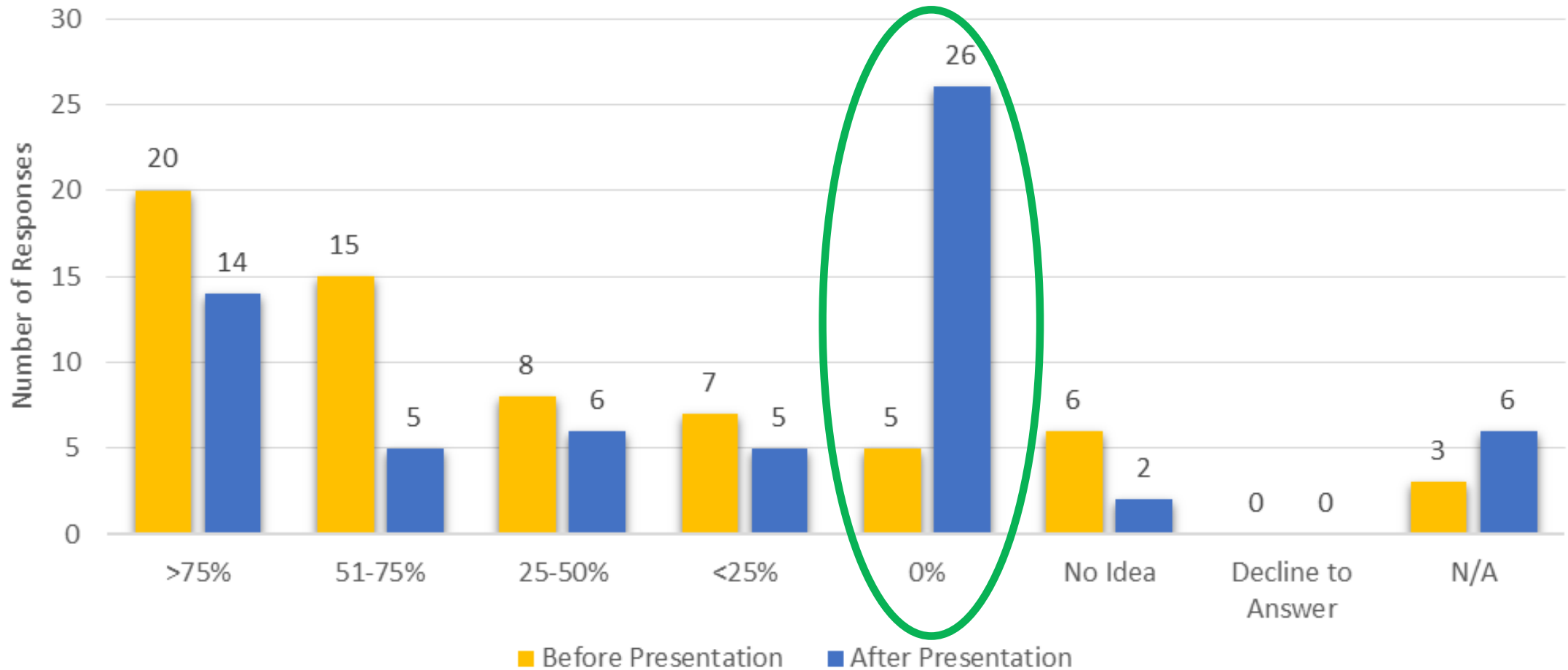
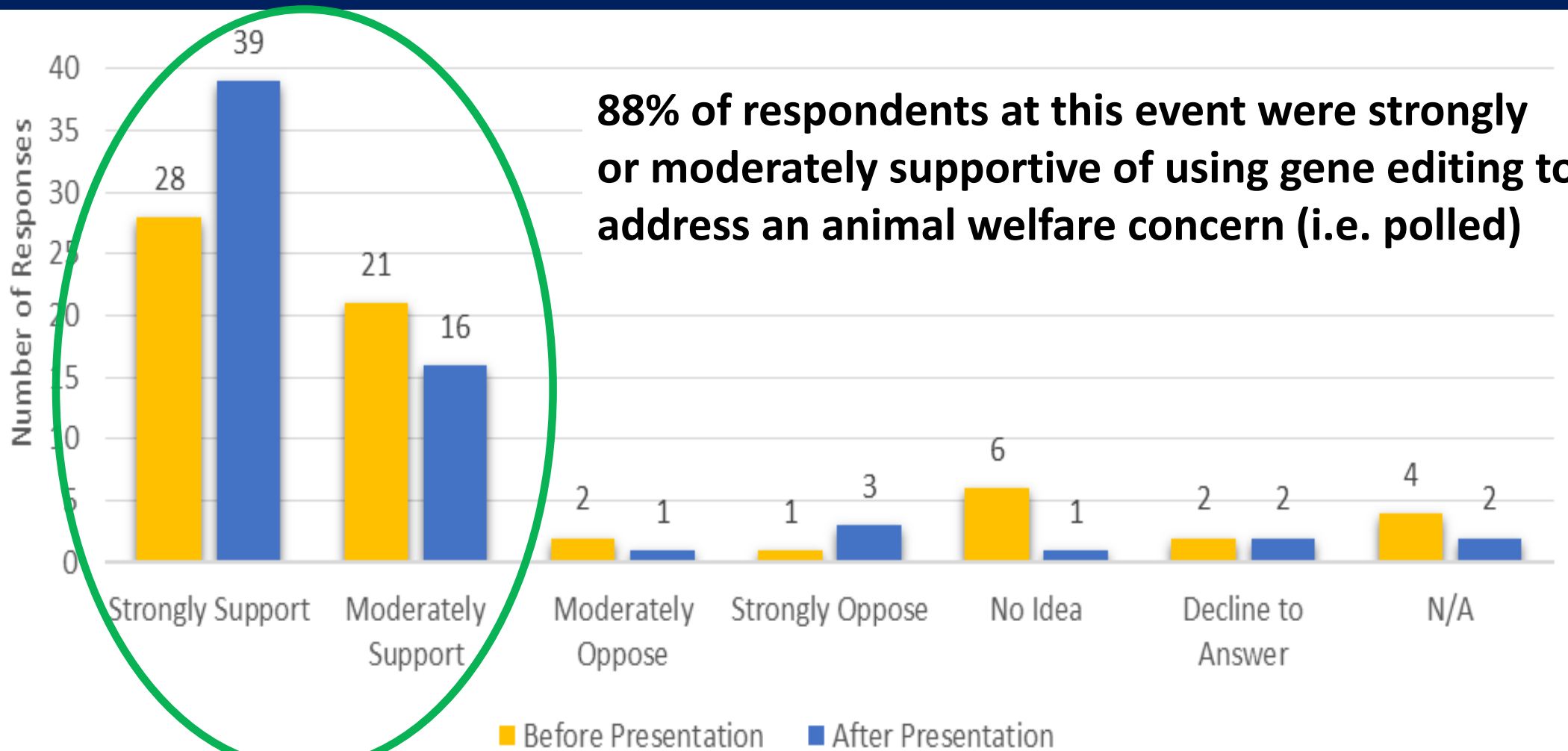


Photo credit Maci Mueller/UC Davis

What percentage of animal products like milk, meat, and eggs currently come from animals that have been produced using genetic engineering?



How do you feel about the use of gene editing to address an animal welfare concern?

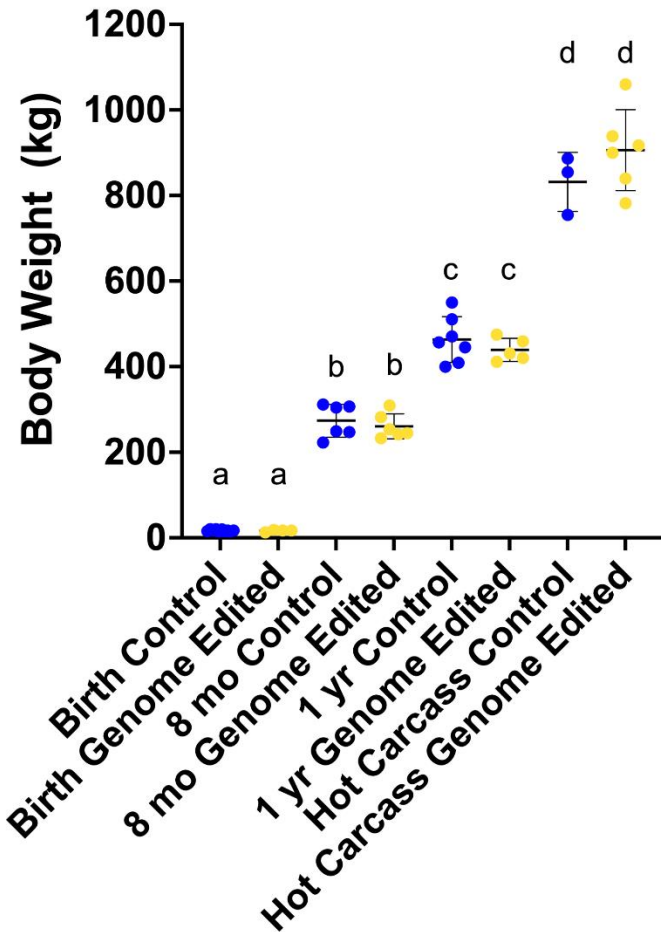


We analyzed these six polled calves and horned controls for several years



Young, A.E. *et al.* 2020. Genomic and phenotypic analyses of six offspring of a genome-edited hornless bull. *Nature Biotechnology* **38**, 225–232

The growth & health, and the milk and meat composition of the 6 heterozygous hornless offspring of the genome edited bull were equivalent to contemporary controls



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

Biotechnology Risk Assessment Grant
#2017-33522-27097

Trott, J. et al. 2022. Animal health and food safety analyses of six offspring of a genome-edited hornless bull. *GEN Biotechnology*. 1:2, 192-206

If the proposed regulatory pathway makes it so that only large companies are able to afford high regulatory and IP costs of bringing a genome edited animal product then.....

- I predict that there will be a targeted activist campaign against agricultural genome editing IRRESPECTIVE of the societal value of the traits
- Small companies and even academic research laboratories will be unable to make use of a technology that originally resulted from public research funds
- Activist groups funded by the natural and organic food industry are mobilizing to run a campaign of misinformation conflating gene editing and genetic engineering and to sell a value-added (\$\$\$) “absence-labelled” alternative
- Public sector scientists will be reticent to stick their neck out doing science communication and public outreach around a technology they cannot use. Especially when doing so will likely result in hostile freedom-of-information act requests, and reputational defamation by front groups financed by the natural and organic food industry such as U.S. Right To Know (as happened with genetic engineering).

Conclusions

- If products people want (market demand) are allowed to reach the market, they will buy them e.g. GloFish, Impossible Burger, AquAdvantage
- The narrative that the public will not accept the products produced by animal biotechnology has not really ever been put to the test – **as until recently such food products have not been available**
- The three strikes of death for a new breeding method are:
 - a lengthy and expensive regulatory step uniquely associated with commercializing products developed using that breeding method
 - competing business interests that can monetarize fear around the method to extract value (rent seeking) and selling their value-added (more expensive) product that avoids that breeding method
 - There is some way to track/differentiate products produced with or without that breeding method to enable value-added marketing

Acknowledgements

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- Dr. Josephine Trott
- Dr. Joey Owen
- Dr. James Murray
- Dr. Bret McNabb
- Dr. Elizabeth Maga
- Dr. C. Titus Brown
- Dr. Tamer A. Mansour
- Dr. Xiang (Crystal) Yang
- Amy Young
- Barbara Nitta
- Ross lab members

revive & restore
genetic rescue for endangered and extinct species



United States
Department of
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National Institute
of Food and
Agriculture

- Dr. John Cole, URUS Group LP
- Dr. Pablo Ross, ST genetics
- Dr. Tad Sonstegard, Acceligen
- Dr. Bo Harstine, Select Sires Inc.

