



Will Animal Genetics Innovations Be Embraced Or Eschewed? The #Scicomm Challenge Facing Agricultural Biotechnology

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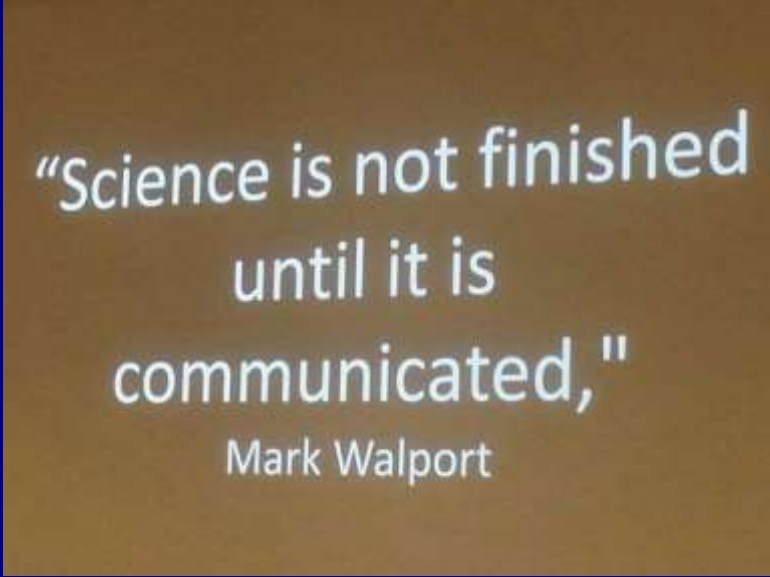
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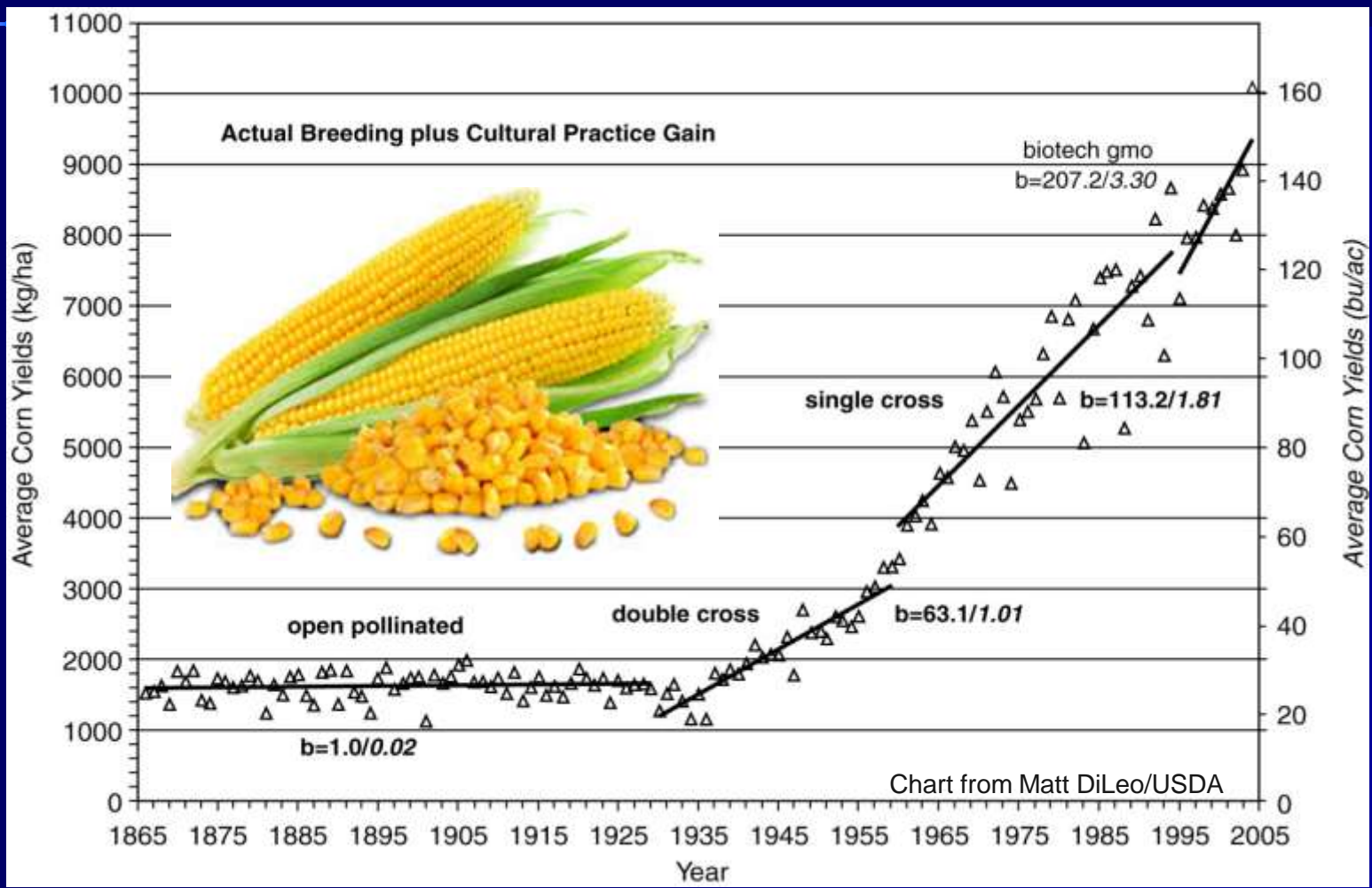
Twitter: [@BioBeef](https://twitter.com/BioBeef) BLOG: <http://biobeef.faculty.ucdavis.edu>

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





Plant and animal breeders have perhaps the most compelling sustainability story of all time

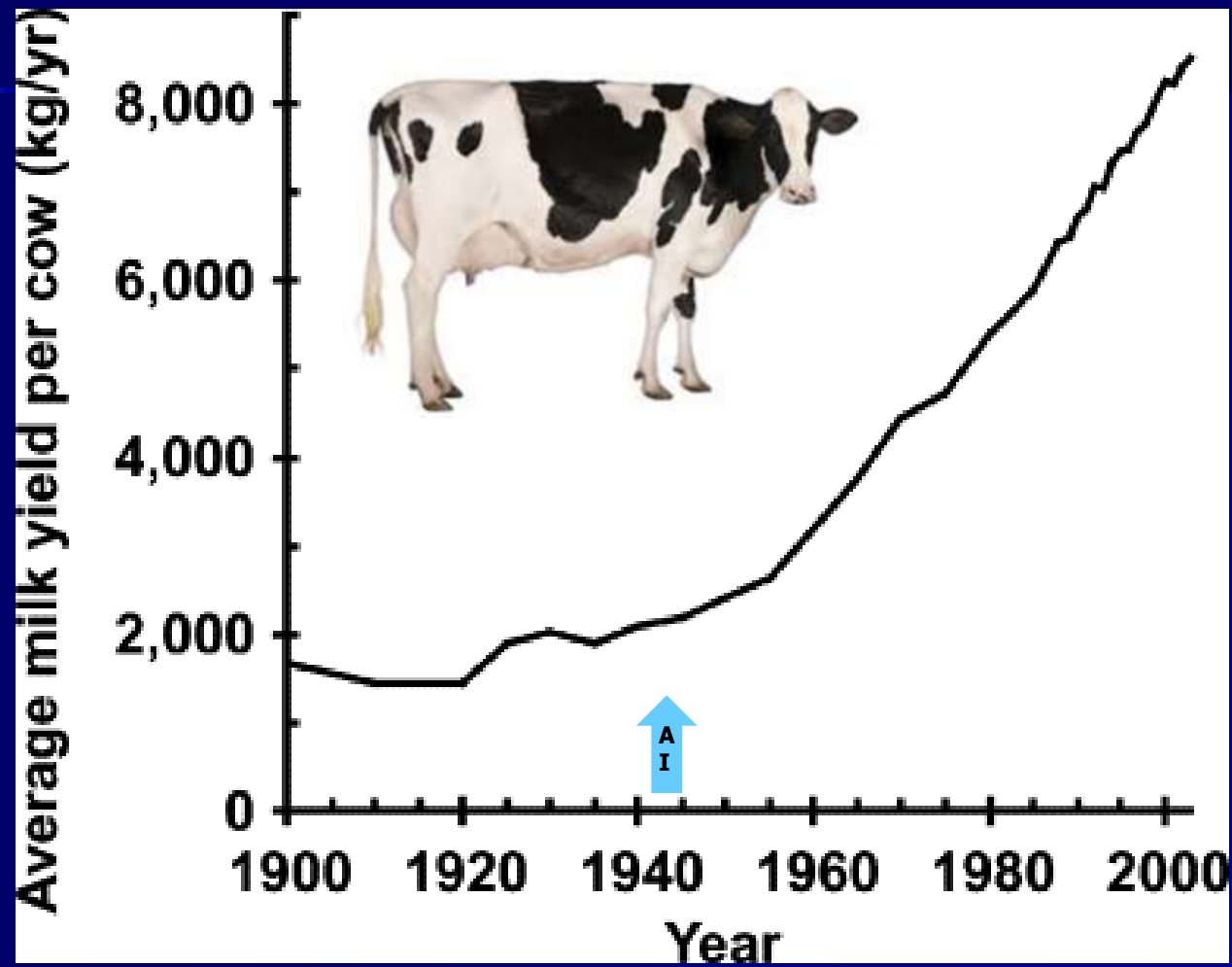


<https://grist.files.wordpress.com/2015/12/corn-hybrid-yields.jpeg>



1944: 25.6 million animals; total annual milk production of 53.1 billion kg.
1997: 9.2 million animals; total annual milk production of 84.2 billion kg.

About half of this 369% increase in production efficiency is attributable to genetic improvement enabled by AI



VandeHaar, M.J. and St-Pierre, N. (2006). **Major Advances in Nutrition: Relevance to the Sustainability of the Dairy Industry.** *Journal of Dairy Science* 89, 1280-1291.



Artificial insemination was initially a controversial technology



"In the initial stages of attempting to develop AI there were several obstacles. The general public was against research that had anything to do with sex. Associated with this was the fear that AI would lead to abnormalities. Finally, it was difficult to secure funds to support research because influential cattle breeders opposed AI, believing that this would destroy their bull market."

Foote, R.H. 2002. The history of artificial insemination: Selected notes and notables. J. Anim. Sci., 80 (E. Suppl.) (2002), pp. E22–E32

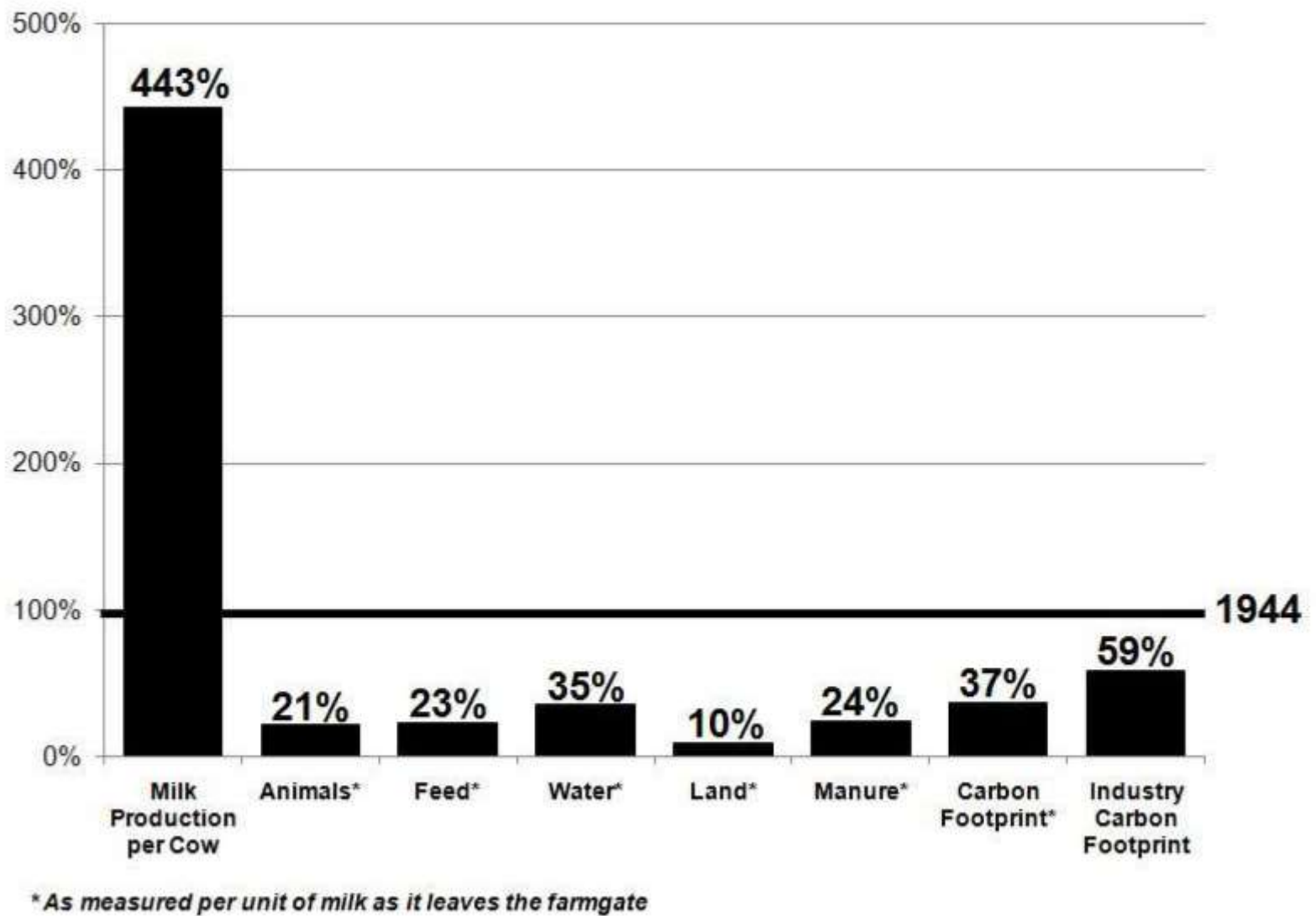


Figure 3. The 2007 U.S. milk production, resource use and emissions expressed as a percentage of the 1944 dairy production system. Adapted from Capper et al. (2009).

Capper, JL and DE Bauman, 2013. The Role of Productivity in Improving the Environmental Sustainability of Ruminant Production Systems. Annual Review of Animal Biosciences. 1 pp. 9.1–9.21

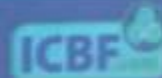
And the Irish Beef Genomics scheme get this

The Irish Beef Genomics Scheme

- Focused on breeding more profitable, sustainable and carbon efficient cows.

ICBF role and philosophy

- The body in charge of the recording and processing of all data in Irish cattle breeding.
- Established in 1998
- **Mission statement:** We exist to benefit our farmers, our agri-food industry and our wider communities.
- We do this by developing and applying science and technology to ensure our farmers and our industry make the most profitable and sustainable decisions



© Irish Cattle Breeding Federation Ltd 2013



The 8-week old body weight of broiler (meat) chickens has increased from 0.81 kg to 3.14 kg over the period 1957 to 2001, and approximately 80% of this four-fold increase has been the result of genetic selection.

1957 vs. 2001 chickens

1957



2001



43

57

71

85 d.

Havenstein, G., et al. (2003). **Growth, livability, and feed conversion of 1957 versus 2001 broilers when fed representative 1957 and 2001 broiler diets.** *Poultry Science* 82, 1500-1508.





POPULATION

Food for Thought

There will soon be seven billion humans on Earth, but how does that number compare to other species on the planet? We are certainly outnumbered by ants. Harvard biologist and ant expert Edward O. Wilson

has estimated that there are a thousand trillion to ten thousand trillion ants at any one time.* That would be about a million ants for every one of us. And doesn't it seem like that when they invade our kitchens?

Estimating animal populations, especially wild ones, is hard, but here's a look at one category of animals we can count: the ones we eat. —Nigel Holmes

**7
SEVEN
BILLION**



*And they're edible. Ants are a good source of protein and are considered a delicacy in many parts of the world.

animals killed for food 2009

1.7 million camels



24 million water buffalo



293 million cows



398 million goats



518 million sheep



633 million turkeys



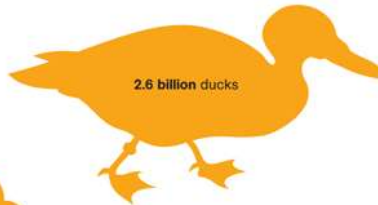
1.1 billion rabbits



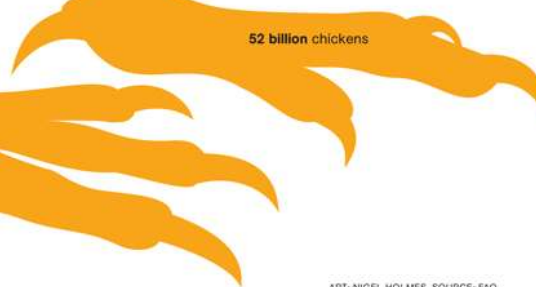
1.3 billion pigs



2.6 billion ducks



52 billion chickens










What if we had not genetically improved our food animals?

1.3 billion pigs

2.6 billion ducks

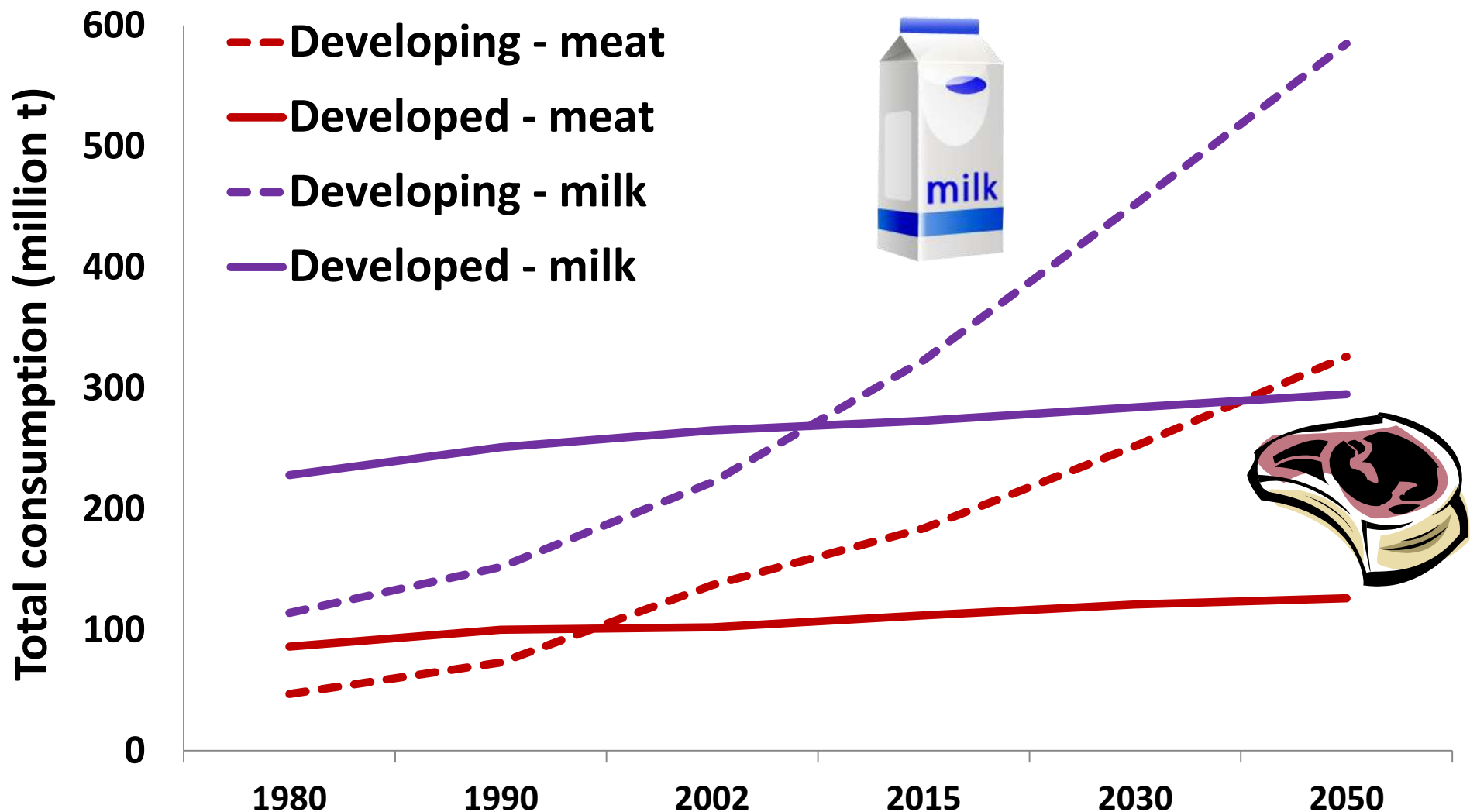
52 billion chickens

- 59 million tons eggs
- 90 million tons meat

| | 2014 total production | 2014 | Amount needed at 1950s rate | Additional needed |
|---|---|--|--|--|
| Soybeans  | 3,927,090,000 BU (235,562,540,000 lb) (106,849,370,802 kg) | 82,591,000 Acres (33,423,392 ha) | 180,971,889 Acres (73,236,725 ha) | ~ 98 million Acres  (~40 million ha) |
| Corn  | 14,215,532,000 BU (796,069,979,000 lb) (361,091,268,460 kg) | 83,136,000 Acres (33,643,946 ha) | 372,134,346 Acres (150,597,427 ha) | ~ 289 million Acres  (~120 million ha) |
| Dairy cattle  | 206,046,000,000 lbs milk (93,460,893,469 kg) | 9,257,166 head | 38,774,181 head | ~ 30 million head  |
| Broilers  | 51,373,100,000 lbs meat (23,302,446,000 kg) | 8,544,100,000 head | 16,679,545,455 head | ~ 8 billion head + an additional 81.5 billion lbs feed due to less efficient FCR |

Past and projected trends in consumption of meat and milk in developing and developed countries

(Thornton, P.K. 2010 Livestock production: recent trends, future prospects. Philosophical Transactions of the Royal Society B: Biological Sciences 365:2853-2867).

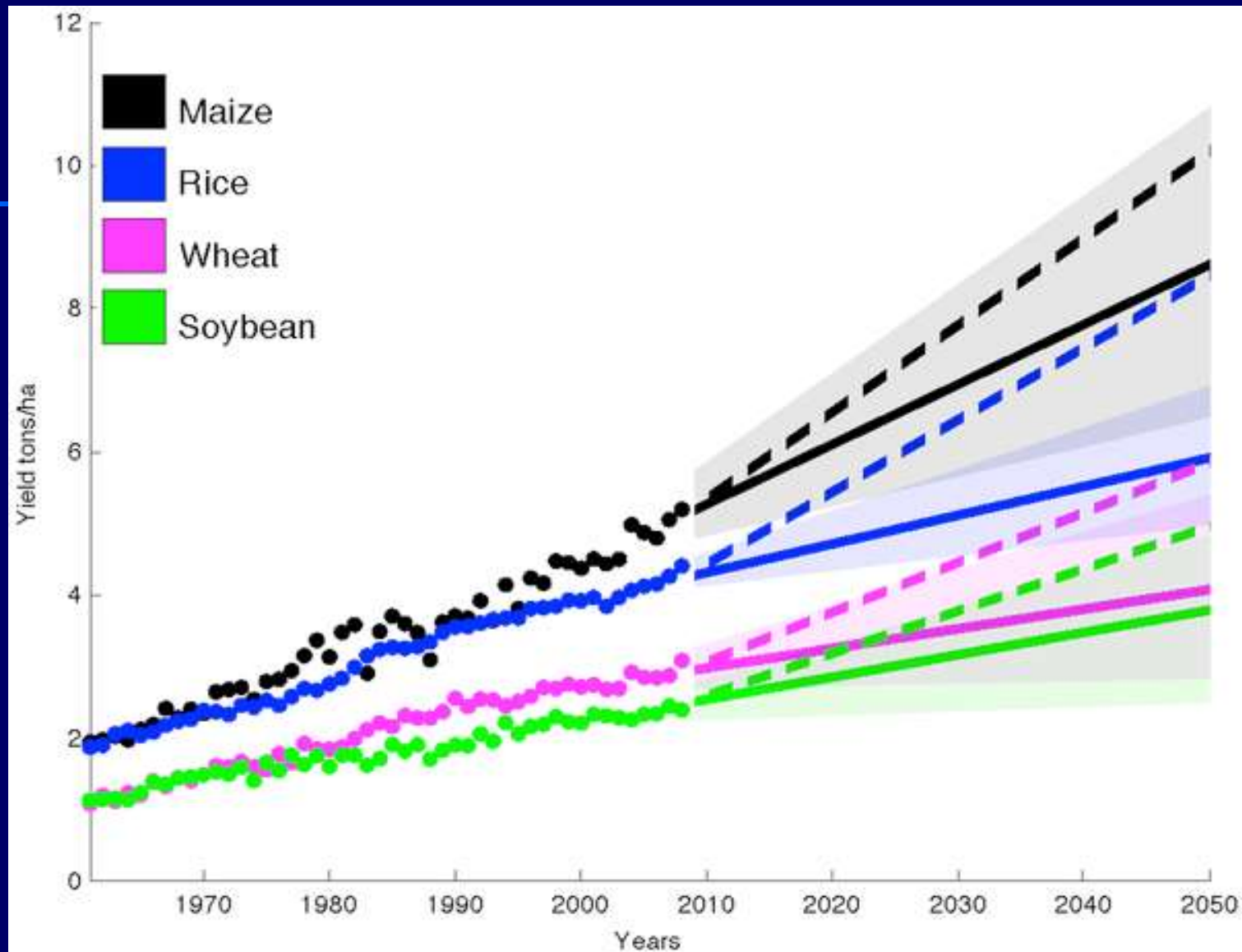


Were those the days my friend?

<https://youtu.be/6B-CH-NCdiY>



Yield Trends Are Insufficient to Double Global Crop Production by 2050



Ray DK, Mueller ND, West PC, Foley JA (2013) Yield Trends Are Insufficient to Double Global Crop Production by 2050. PLoS ONE 8(6): e66428. doi:10.1371/journal.pone.0066428 <http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0066428>

Van Eenennaam 7/20/2017

Animal Genomics and Biotechnology Education

Rate of gain

↑ Accuracy

↑ Intensity

↑ Genetic Variation

↓ Generation interval



Tools/Methods Available

Selective Breeding

Genomic Selection

Embryo Transfer

Artificial Insemination

Sterile Insect Technique

Cloning

Genetic Engineering

Genome Editing

Research

Millions of genetically engineered Mice/Laboratory Rodents/Zebrafish



Biomedical Products

Pigs – Xenotransplantation; Blastocyst complementation of organs



Pharma products

Rabbit – Ruconest
Goat – ATryn, spider silk;
Chickens – Kanuma
Cows – polyclonal antibodies



Pets

GloFish
Micropigs



Pest Control

TseTse fly – sleeping sickness
Mosquitoes – zika/malaria resistance
Moths – agricultural pest control



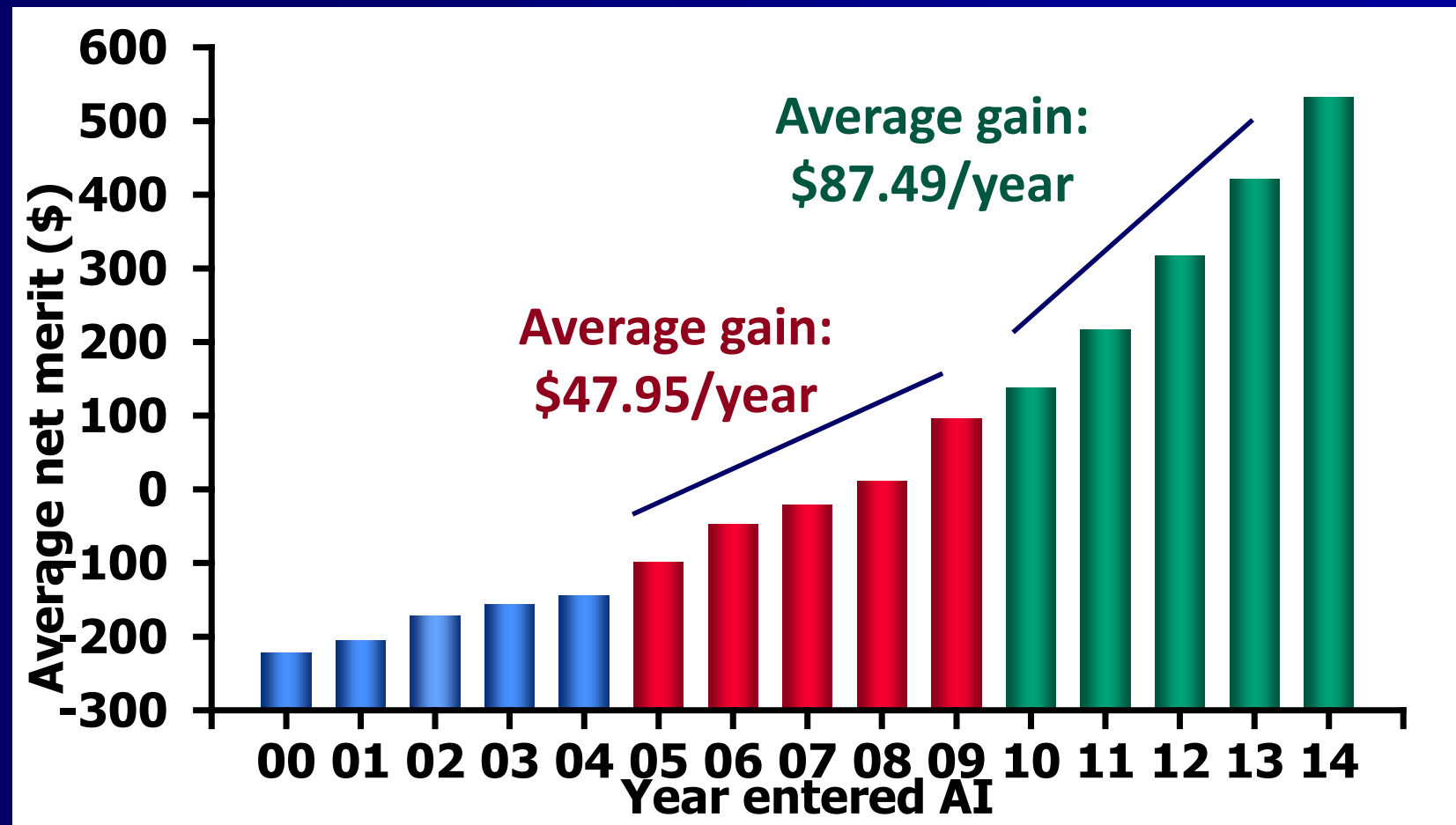
Agriculture/ Food products

AquAdvantage Salmon – fast growth
Disease resistance
Improved product quality
Decrease environmental footprint
Single gender offspring





Rate of genetic gain in marketed Holstein bulls has doubled since 2009 genomic selection introduction



Data from George Wiggins, USDA ARS (7/2015)

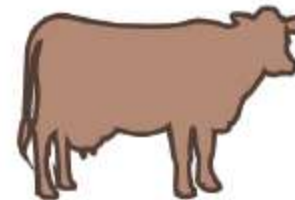


Advanced reproductive technologies

3 weeks



IVF embryos



Embryo transfer



Collect fetuses

Genomic selection

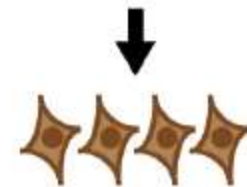
1-2 months



Genotyping and genetic merit evaluation



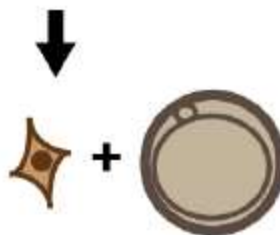
Frozen cell line aliquots



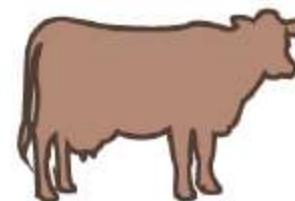
Establish fibroblast cell lines

Somatic cell nuclear transfer (SCNT)

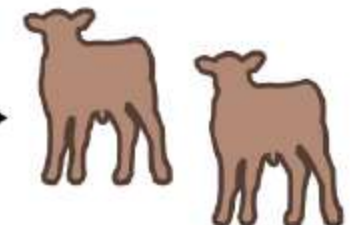
9 months



Fibroblasts with desired genetics are used as SCNT donor cells



Embryo transfer



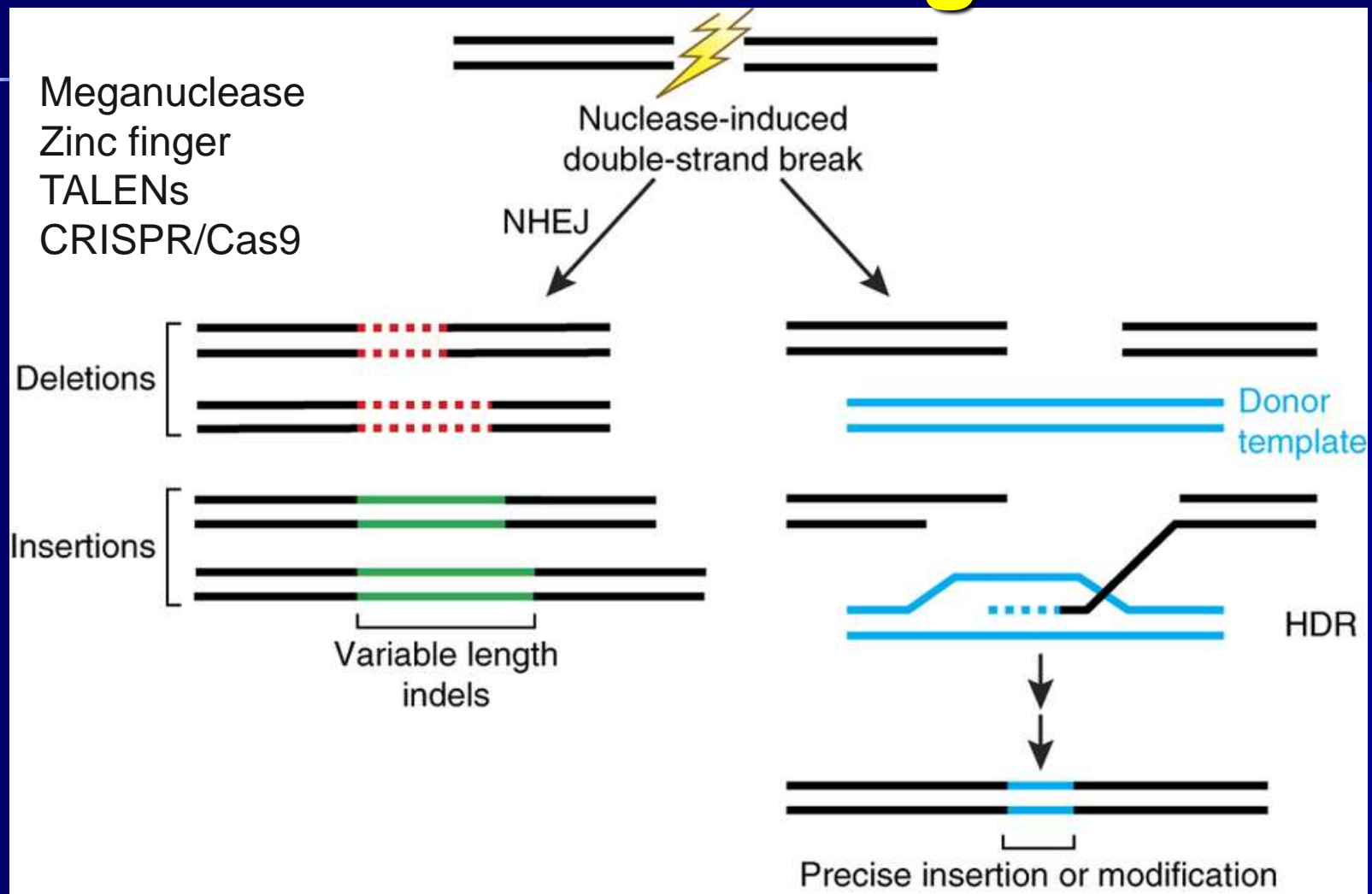
High genetic merit calves

Kasinathan, P. *et al.* 2015. **Acceleration of genetic gain in cattle by reduction of generation interval.** Sci. Rep. 5, 8674; DOI:10.1038/srep08674



Gene or Genome Editing

What are we talking about?





How might gene editing be used in animal breeding?



| Species | Target | Targeted Trait/Goal |
|---------|---|---------------------------------|
| Cattle | Intraspecies POLLED allele substitution | No horns |
| | Myostatin gene knockout | Increased muscle yield |
| | Beta-lactoglobulin gene knockout | Elimination of milk allergen |
| | Insertion of lysostaphin transgene | Disease resistance |
| | Insertion of lysozyme transgene | Disease resistance |
| | Insertion of SP110 transgene | Resistance to tuberculosis |
| Chicken | Ovalbumin gene knockout | Elimination of ovalbumin in egg |
| | Insertion of Immunoglobulin heavy chain locus | Germline gene editing |
| Goat | Myostatin gene knockout | Increased muscle growth |
| | Prion protein gene knockout | Elimination of prion protein |
| | Beta-lactoglobulin gene knockout | Elimination of milk allergen |
| Pig | CD163 gene knockout | PRRS Virus Resistance |
| | Interspecies RELA allele substitution | African Swine Fever Resistance |
| | Myostatin gene knockout | Increased muscle yield |
| Sheep | Myostatin gene knockout | Increased muscle yield |

Van Eenennaam, A. L. 2017. **Genetic Modification of Food Animals.** Current Opinion in Biotechnology. 44:27-34.



The Telegraph

Home Video News World Sport **Finance** Comment Culture Travel Life Women Fa
Companies Comment Personal Finance ISAs Economy Markets Property Enterprise F



When we work as one,
the insight to achieve t
athenahealth

HOME » FINANCE » NEWS BY SECTOR » **PHARMACEUTICALS AND CHEMICALS**

Genus breeds first pigs resistant to major infection

The genetically-enhanced porkers are a "potential game-changer" for the industry

27 0 14 41 Email



Genus helps farmers breed high quality livestock by supplying them with semen from genetically superior animals Photo: EPA



- African Swine Fever
- Porcine Reproductive and Respiratory Syndrome (PRRSV) virus

Lillico et al. 2016. **Mammalian interspecies substitution of immune modulatory alleles by genome editing.** Sci Rep 6:21645.

Whitworth et al. 2016. **Gene-edited pigs are protected from porcine reproductive and respiratory syndrome virus (PRRSV).** Nature Biotechnology 34:20-22.



Genetic improvement (permanent, cumulative) as a solution to animal disease rather than antibiotics/chemicals



Gene editing of myostatin to obtain double muscle Nelore cattle – intraspecies allele substitution



Proudfoot C, et al. 2015. Genome edited sheep and cattle. Transgenic Res. 2015 Feb;24(1):147-53.



Gene Edited Polled Calves

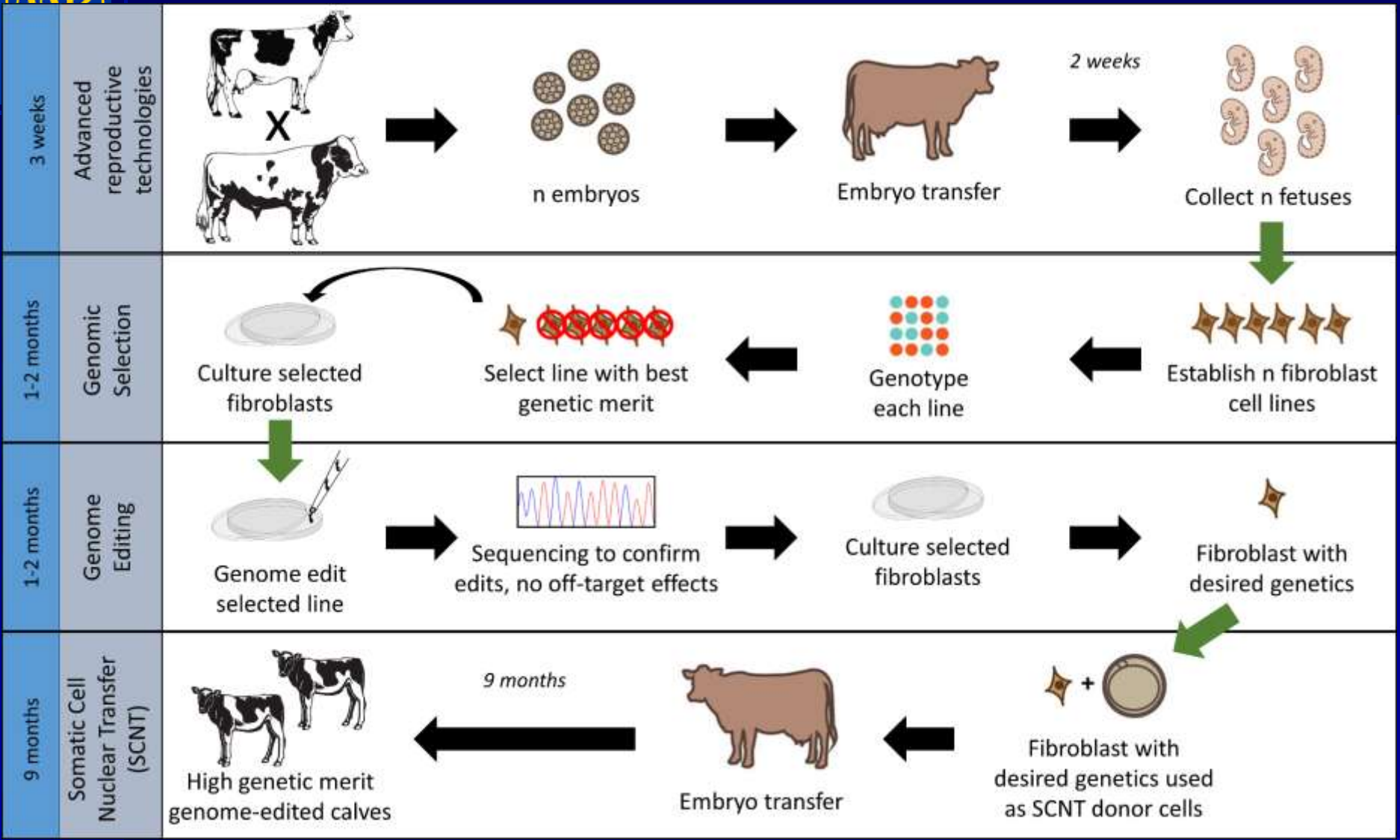
Intraspecies allele substitution at polled locus



Carlson DF, Lancto CA, Zang B, Kim E-S, Walton M, et al. 2016. **Production of hornless dairy cattle from genome-edited cell lines.** Nat Biotech 34: 479-81

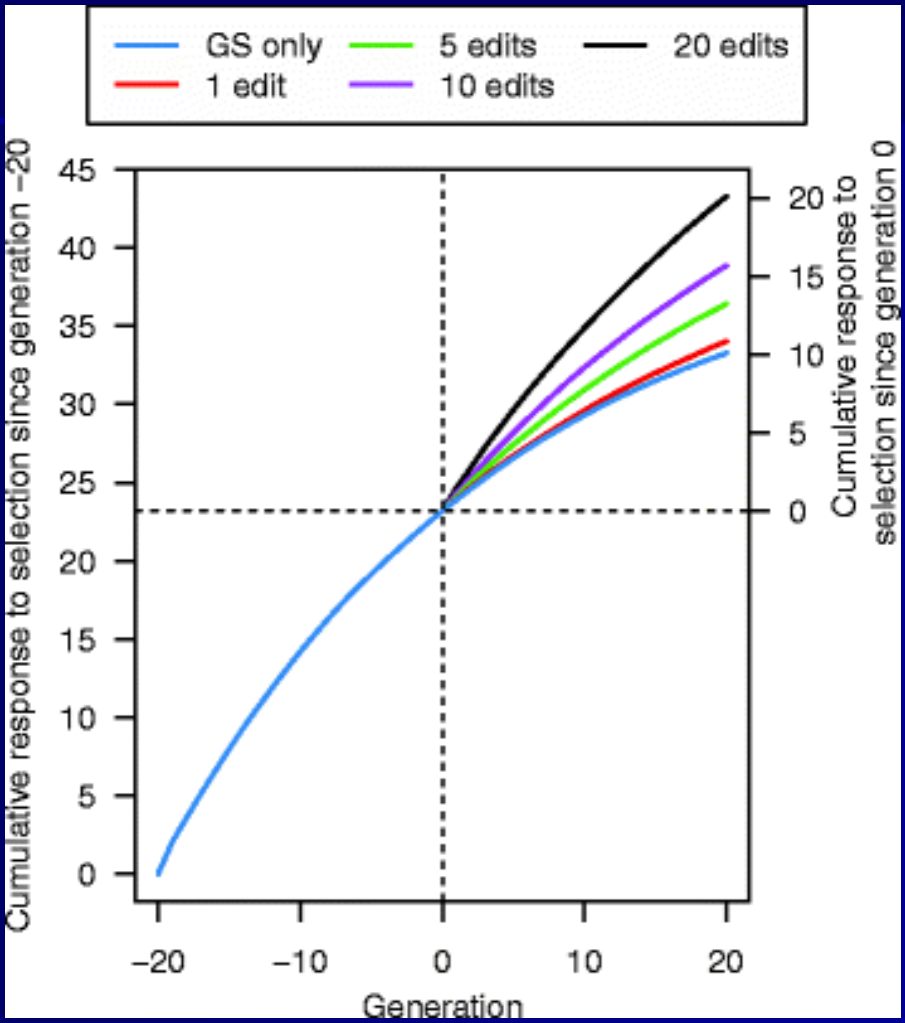


How might gene editing be integrated with genomic selection programs?





Accelerated rate of gain when promoting 1-20 genome edits in genomic selection



Jenko, J. et al. 2015. **Potential of promotion of alleles by genome editing to improve quantitative traits in livestock breeding programs.** Genetics Selection Evolution 47: 1-14.

Editing is the Cherry on Top of Breeding Sundae

It will be able to introduce useful alleles without linkage drag, and potentially bring in useful novel genetic variation from other species



Genome Editing

Somatic cell nuclear transfer cloning

Genomic Selection

Embryo Transfer

Artificial insemination

Progeny testing

Performance recording

Development of breeding goals

Association of like minded breeders



**Will breeders
be able to use
gene
editing
or will it go
the way of
GMOs
THAT'S THE BIG
QUESTION !!**





Orange Juice
May Soon
Contain
Pig Genes

GMOs

5 DANGERS + THE AUTISM/ALLERGY CONNECTION



400% increase

in allergies since GMOs were introduced.



Coalition Powered by Green America

GMO INSIDE!

#SimilacNoGMO

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.

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!

**GMO FOOD IS
DANGEROUS!**



United Nations Photo

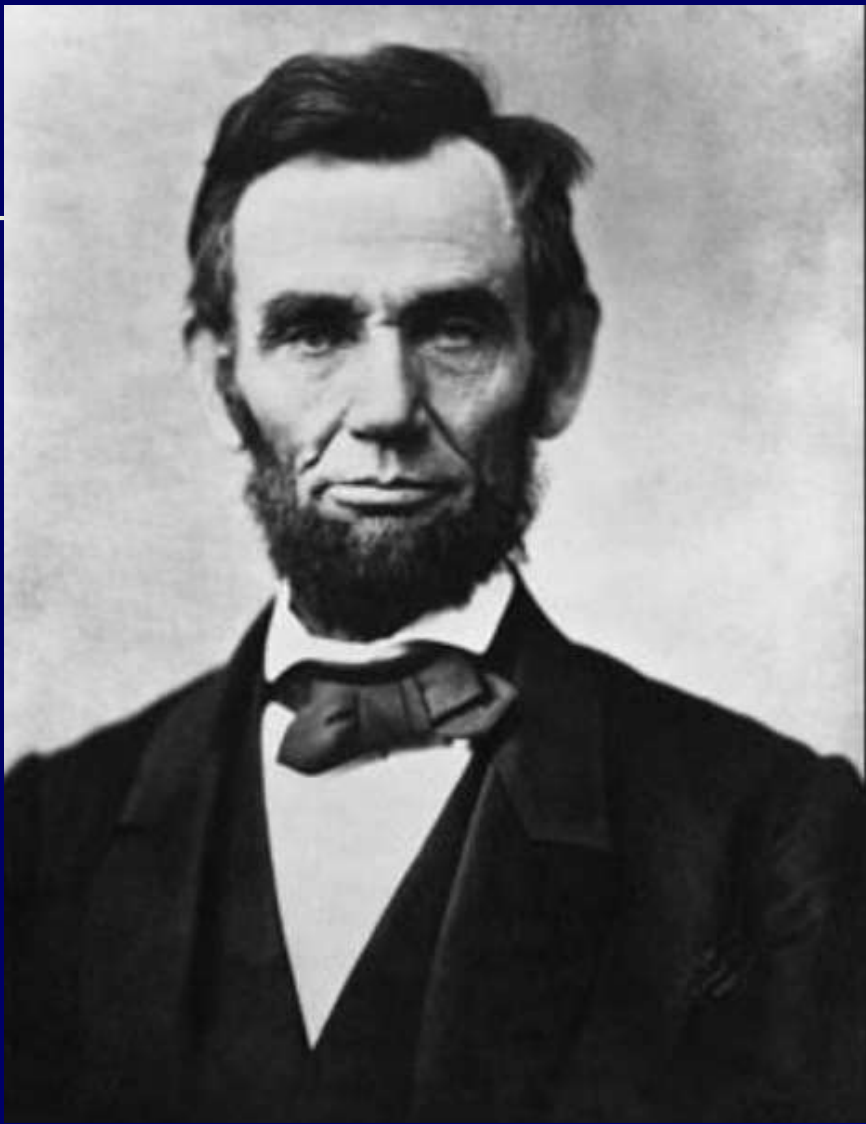


Will **Roundup** rob
him of someday having
babies of his own?

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!





“Don’t believe everything you read on the Internet just because there’s a picture with a quote next to it.”

—Abraham Lincoln

<http://weknowmemes.com/2012/07/dont-believe-everything-you-read-on-the-internet>



Opinion differences between the public and scientists

Percentage agreeing with statement

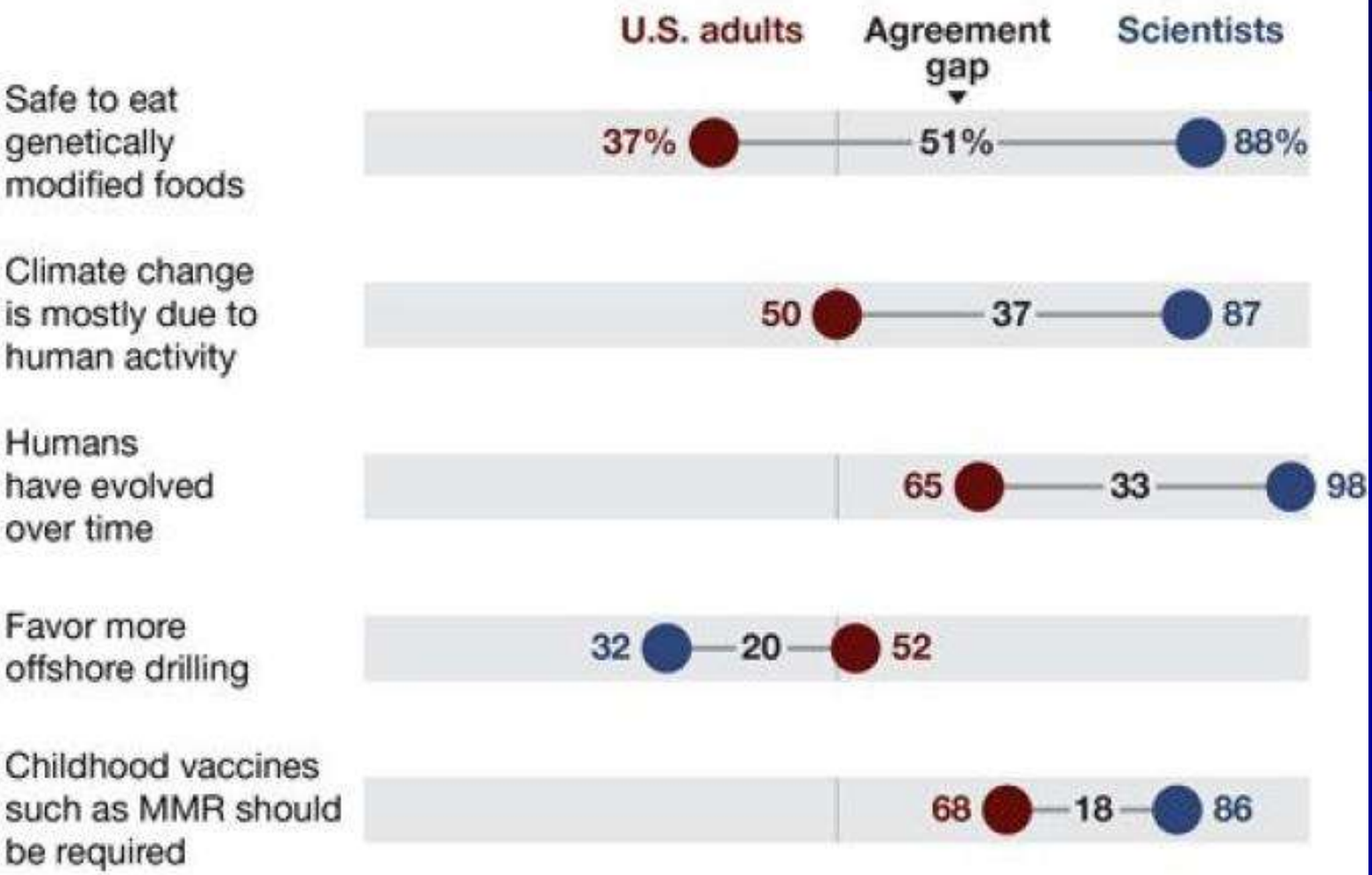


Image from <http://news.nationalgeographic.com/news/2014/06/150129-public-opinion-aaas-health-education-science/>
http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/pi_2015-01-29_science-and-society-00-01/



Why should I care about GMOs? I do not use them in my breeding program





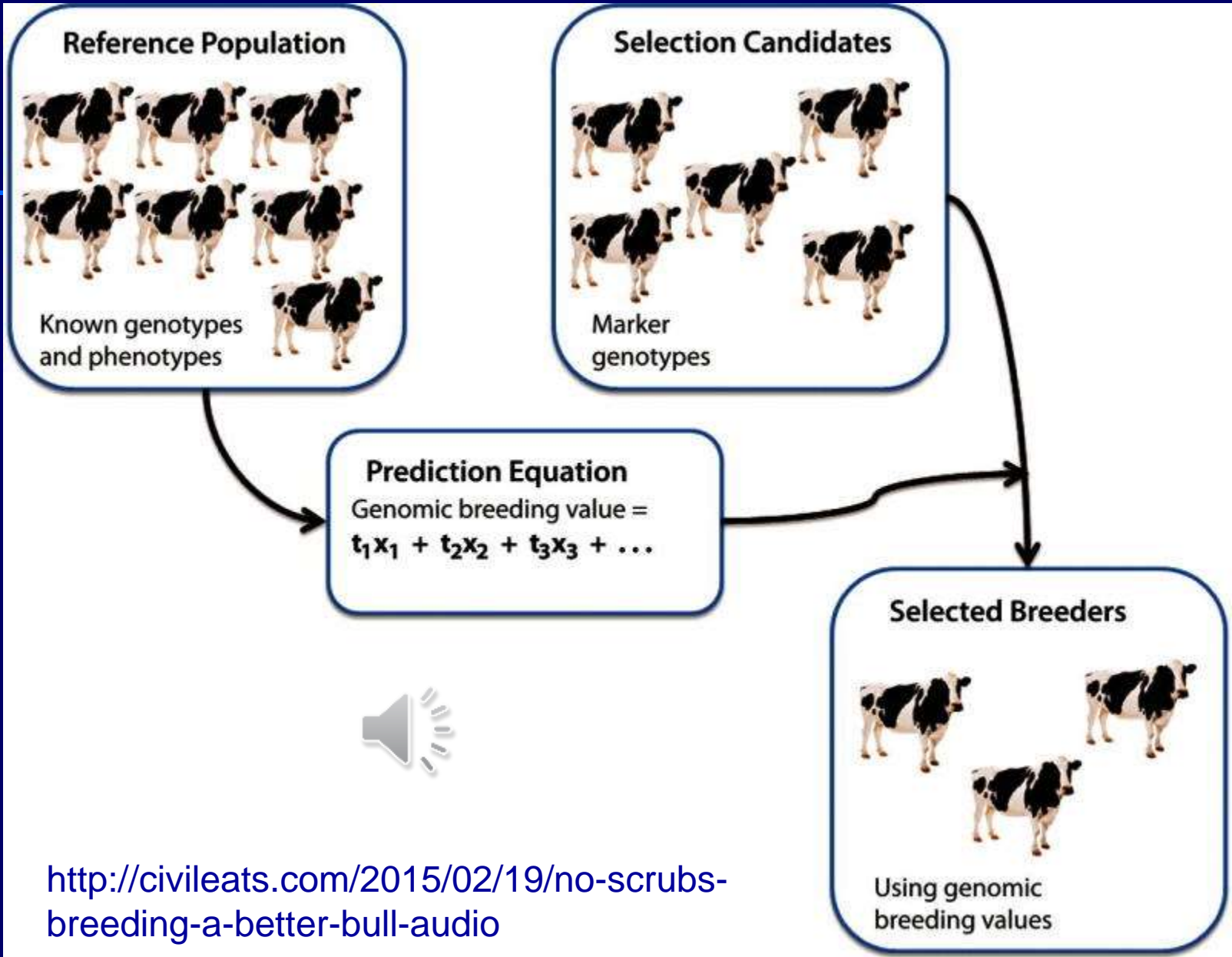
Mr. Chow from The Hangover



<https://www.pinterest.com/pin/475552041874709302/>



The Genomic Bull



<http://civileats.com/2015/02/19/no-scrubs-breeding-a-better-bull-audio>

https://www.animalsciencepublications.org/images/publications/af/2/1/AF0027_f2.jpeg



Concerns around breeding not new

Who said this? and when?

"We have recently advanced our knowledge of genetics to the point where we can manipulate life in a way never intended by nature. We must proceed with the utmost caution in the application of this new found knowledge."

LUTHER BURBANK

Creator of over 800 new plant varieties through plant breeding
1906





Whole Foods Market (and Denmark) going to stock slow-growing chickens that grow less than 50 grams/day – ostensibly for animal welfare reasons

Why Slow-Growing Chickens Are the Next Big Thing

The change coming to chicken.

By CHRIS NUTTALL-SMITH Art by MOLLY MATALON





Entering the Whole Foods “alternative fact” zone

Whole Foods, have committed “to replace fast-growing chicken breeds with slower-growing breeds.”

Nothing else about how the chickens are being raised is changing, they are just around for 14 more days before slaughter....

Why? According to Theo Weening, the global meat buyer for Whole Foods Market, the slow-growing bird ***“is a much better, healthier chicken, and at the same time it's a much [more] flavorful chicken as well”***.

- Why is growing less than 50 g/d of weight gained per chicken for 58 days better for welfare than growing at 61 g/d for 44 days?
- Evidence-based literature suggests that the livability (survival expectancy) of broilers is improving 0.22% per year – evidence for health claim?
- Why would slow growth equate to a more flavorful chicken if none of the other production parameters changed?







This is the fate that we will suffer if we don't get science communication right



First they came for the Socialists, and I did not speak out —
Because I was not a Socialist.

Then they came for the Trade Unionists, and I did not speak out —
Because I was not a Trade Unionist.

Then they came for the Jews, and I did not speak out —
Because I was not a Jew.

Then they came for me —
and there was no one left to speak for me.

Pastor Martin Niemöller (1892–1984)
following the Nazis' rise to power and the
subsequent purging of their chosen targets, group after group



Keynote address of ISAG sometime in the future “Ode to forgone technology”



First they came for the use of **recombinant Bovine Somatotropin**, and I did not speak out — Because I did not use rBST.

Then they came for **Growth Hormone Implants**, and I did not speak out — Because I did not use growth hormone implants.

Then they came for the **Genetic Engineers**, and I did not speak out — Because I did not use Genetic Engineering.

Then they came for **Genome Editors**, and I did not speak out — Because I did not use Genome Editing.

Then they came for the **Genomic Selectors**, and I did not speak out — Because I did not use Genomic Selection.

Then they came for **my chosen breeding method/production practice** — And there was no one left to speak for me.

If we don't get #scicomm right then add this proviso



The Irish Beef Genomics Scheme.

- Focused on breeding more profitable, sustainable and carbon efficient cows.

- Mission statement: We exist to benefit our farmers, our agri-food industry and our wider communities.
- We do this by developing and applying science and technology to ensure our farmers and our industry make the most profitable and sustainable decisions

ICBF

*“using only non-controversial Greenpeace-approved methods (and forgoing many other safe innovations to avoid uncomfortable media exposure and political angst)”



Opinion: Scientists' Intuitive Failures

Much of what researchers believe about the public and effective communication is wrong.

“given the norms of our profession...it is ironic that many of these debates about how to best communicate science with lay populations are driven by intuitive assumptions on the part of scientists rather than the growing body of social science research on the topic that has developed over the past 2 decades”

Matthew C Nisbet and Dietram A Scheufele

<http://www.the-scientist.com/?articles.view/articleNo/32384/title/Opinion--Scientists--Intuitive-Failures/>





The problem is the public, not scientists or policymakers

“Scientists have long believed that when the public disagreed with them on matters of policy, public ignorance was to blame..... But research shows that science literacy has only a limited connection to public attitudes. Instead, **trust, emotion, social identity, and how an issue is framed** matter more, putting much of the burden of effective communication on scientists and their institutions.”

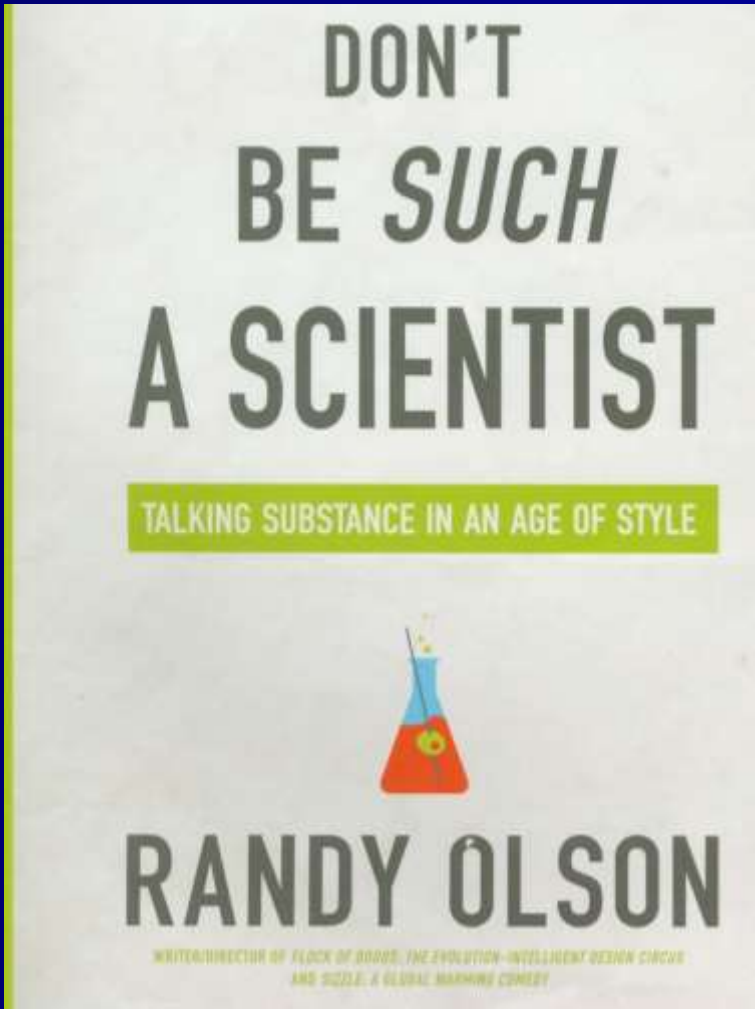
Matthew C Nisbet and Dietram A Scheufele

<http://www.the-scientist.com/?articles.view/articleNo/32384/title/Opinion--Scientists--Intuitive-Failures/>





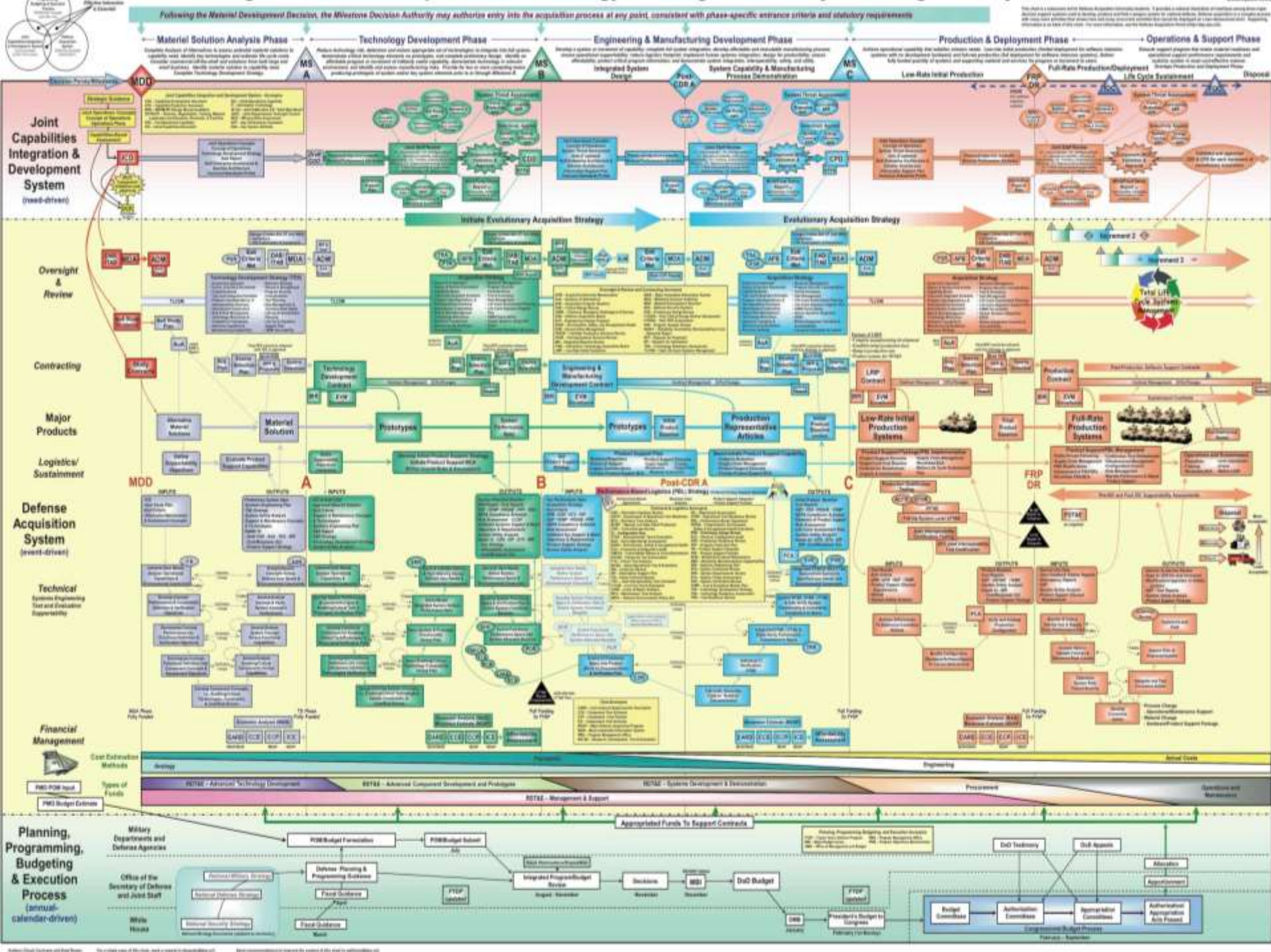
Part of the problem is that communication styles need to differ depending upon the audience



How Academic audiences respond to various aspects of communication

| Communication aspect | Academic |
|--------------------------|---------------------|
| Main information channel | Audio and visual |
| Structure | Information is fine |
| Mode of response | Cerebral |
| Need humor? | Not necessarily |
| Like sincerity? | Suspicious of it |
| Sex appeal? | Potential disaster |
| Know your stuff? | Yes |
| Effective elements | Information |
| Effective organs | Head |
| Preferred voice | Robotic |

Olson, R. 2009. **Don't be such a scientist. Talking substance in an age of style.** Island Press.



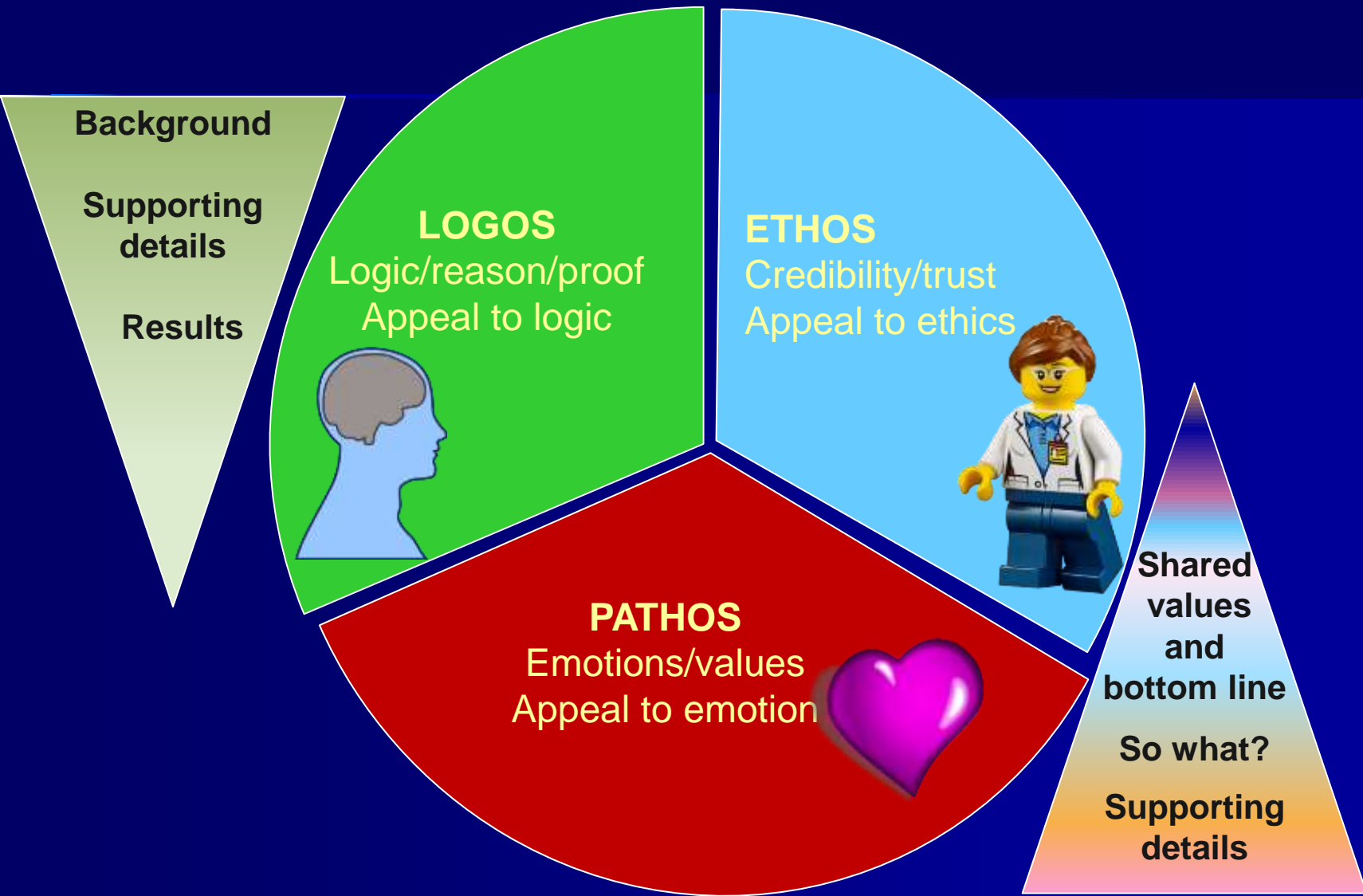
How Academic versus “General Public” audiences respond to various aspects of communication

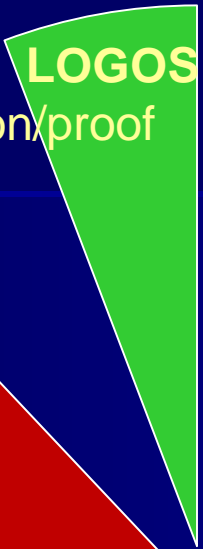
| Communication aspect | Academic | General Public |
|--------------------------|---------------------|------------------------------|
| Main information channel | Audio and visual | Visual |
| Structure | Information is fine | Need a story |
| Mode of response | Cerebral | Visceral |
| Need humor? | Not necessarily | Pretty much |
| Like sincerity? | Suspicious of it | Always |
| Sex appeal? | Potential disaster | The ultimate |
| Know your stuff? | Yes | No (don't trust you!) |
| Effective elements | Information | Humor, sincerity, sex |
| Effective organs | Head | Heart, gut, gonads |
| Preferred voice | Robotic | Human |

Olson, R. 2009. **Don't be such a scientist. Talking substance in an age of style.** Island Press.

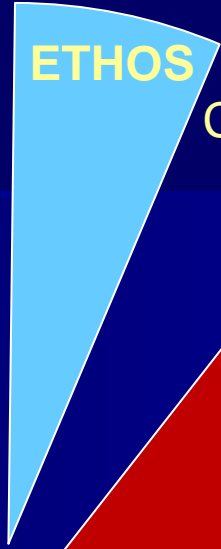


Aristotle's Rhetorical Triangle - the available means of persuasion

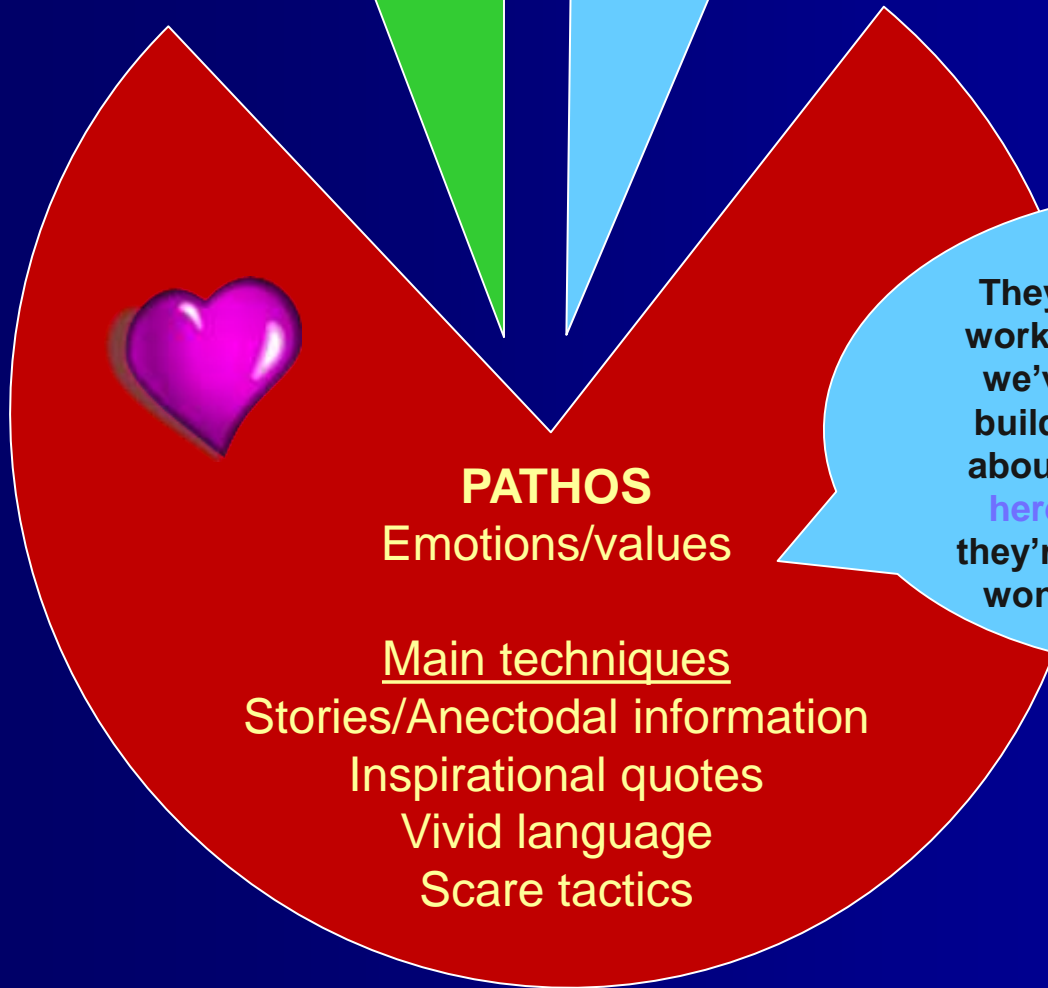




LOGOS
Logic/reason/proof



ETHOS
Credibility/trust



PATHOS
Emotions/values

- Main techniques
Stories/Anecdotal information
Inspirational quotes
Vivid language
Scare tactics

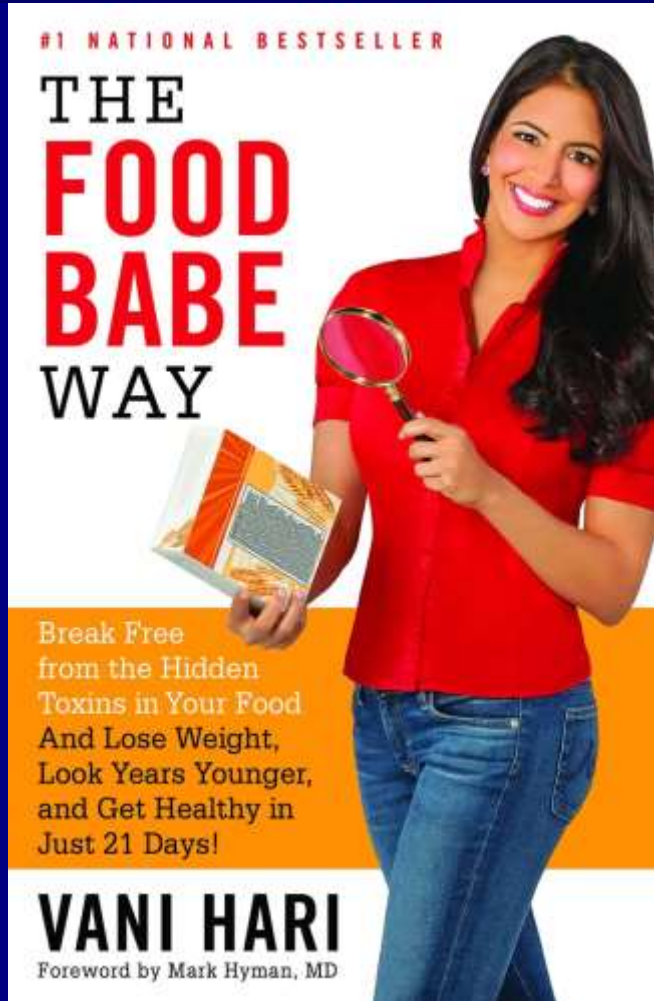
They (**insert enemy here**) worked against everything we've worked so hard to build, and they don't care about (**insert shared value here**). Make no mistake, they're the enemy, and they won't stop until we're all destroyed.





Narratives that are based on emotion or fear are difficult to address using logic or reason

Jenny McCarthy – Vaccinations Vani Hari – Chemicals in food





Name the technological innovation

"It is unknown what long term health consequences may unfold. The studies are not adequate. Furthermore, this will likely not be available or cost effective for small farmers, it will decrease product acceptance and consumption."

*Quote from the introduction of the
Pasteurized Milk Ordinance*

1924





Gene Edited Polled Calves

Naturally-occurring bovine allele at polled locus



Tan et al. 2013. Efficient nonmeiotic allele introgression in livestock using custom endonucleases. PNAS 110: 16526-31.

https://www.youtube.com/watch?v=-Qks_LMmodw



Buri and Spotigy, 8-month-old Holstein calves genetically engineered to be hornless, have arrived at the UC Davis campus.

First genetically edited cows arrive at UC Davis

Two calves have been modified so that they don't grow horns

Technique designed to pack more cows into pens

Technique expected to lower costs for farmers

BY EDWARD ORTIZ
eortiz@sacbee.com

The two calves that grace a muddy pen on the UC Davis campus will never grow horns typical of their breed. Instead, they'll always

sport soft hair on the parts of their heads where hard mounds normally emerge.

Named Spotigy and Buri, the calves were designed in a petri dish at a Minnesota-based genetics lab, with the goal of making them easier to pack into pens and trucks without the nuisance of their

horns taking up valuable space. Their offspring may also lack horns, and generations of hornless cows could follow, potentially saving the dairy and cattle industry millions of dollars, said Alison Van Eenennaam, a geneticist at UC Davis' College of Agriculture and Envi-

ronmental Sciences who worked with the Minnesota lab Recombinetics.

This first-of-a-kind result of a process called genetic editing is a test run that's expected to deeply impact the cattle and dairy industry and the entire food supply, Van Eenennaam said. It's also part of a flurry of research looking at how to make cattle easier to maintain, transport and turned into food. The research has raised concerns among some farmers and animal-rights activists who warn of the health and ethical risks of consuming genetically modified food, but

only male offspring. "Males grow faster than females, and in beef production they are more desirable," Ross said.

Another project uses stem cells to produce a clone animal, Ross said. Genetic editing could help design cows that are less prone to pneumonia, which would reduce the need for antibiotics.

Van Eenennaam is on using word processing as an analogy to describe the differences between genetic editing and engineering. She likens genetic editing to changing the spelling of a word in a document and genetic engineering to changing a word from a completely different document.

"You're not bringing something foreign into a pen, you're introducing a change to a tomato into a tomato, which is what is associated with genetic engineering," said.

With the two calves, a preliminary DNA response to growth was measured and replaced with a trait that does not grow horns, including dairy cows and feed given to them.

"Named Spotigy and Buri, the calves were designed in a petri dish at a Minnesota-based genetics lab, with the goal of making them easier to pack into pens and trucks without the nuisance of their horns taking up valuable space"



January 18th, 2017 FDA draft guidance considers all gene edited animals whose genomes have been “altered intentionally” to be drugs



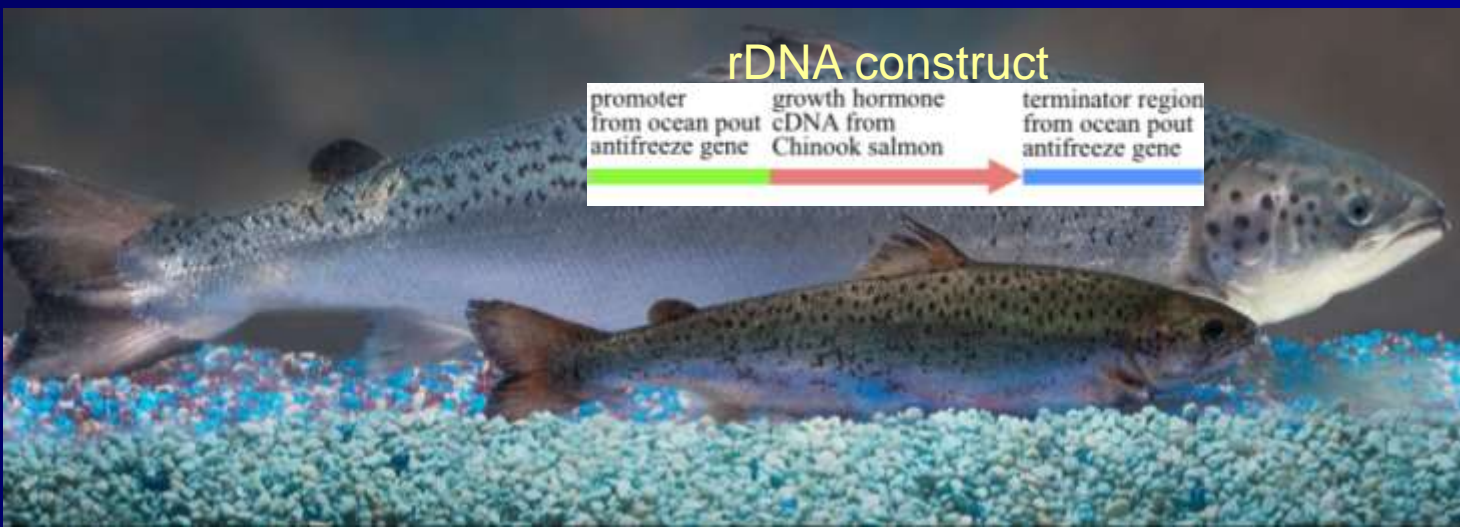
Image by Aleksandra Domanović and Spencer Lowell

<http://www.fda.gov/downloads/AnimalVeterinary/GuidanceComplianceEnforcement/GuidanceforIndustry/UCM113903.pdf>



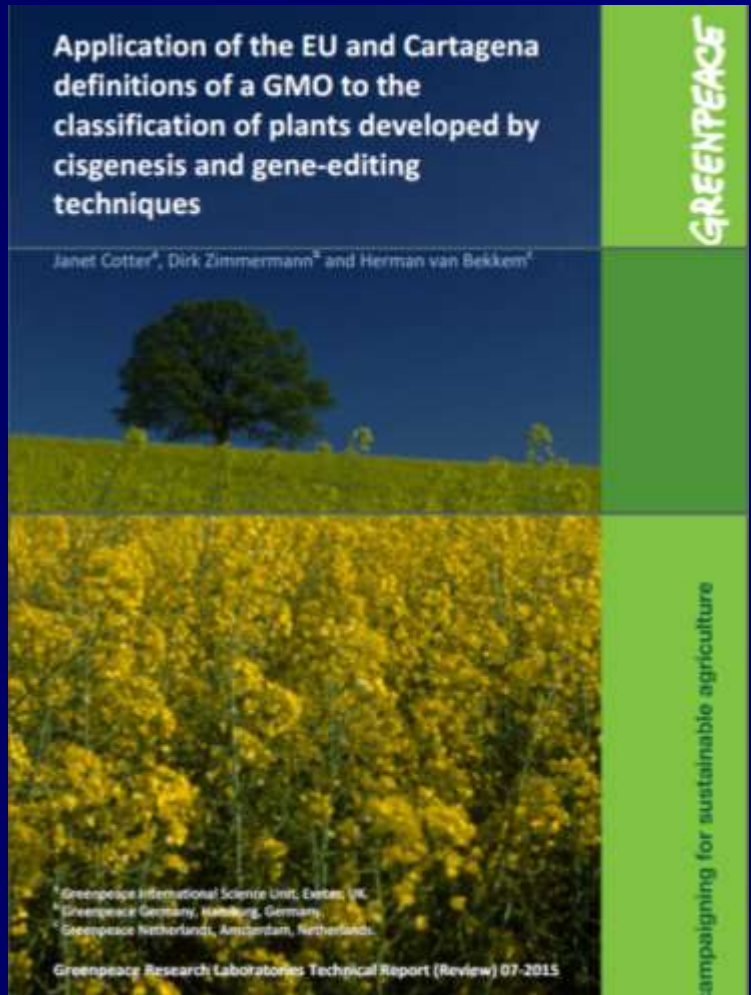
Draft FDA regulations consider all animals whose genomes have been altered intentionally as drugs

In the past, FDA has used the term “genetically engineered” to refer to animals containing recombinant DNA constructs intended to alter the structure or function of the body of the animal. The new guidance uses the phrase **“animals whose genomes have been altered intentionally”**. In general, each specific genomic alteration is considered to be a separate new animal drug subject to new animal drug approval requirements.





"A fundamental concept in defining a GMO within both the Cartagena Protocol and the EU is that the genetic material has been directly modified using modern biotechnological techniques, with an emphasis on the use of *in vitro* techniques." Greenpeace 2015



"...the genetic modification is enacted by heritable material (or material causing a heritable change) that has, for at least part of the procedure, been handled outside the organism by people. In both the EU and Cartagena Protocol, the definitions of a GMO refer to (but not exclusively) the use of such *in vitro* techniques."



Does it really make sense to regulate polled dairy calves differently to polled beef calves?



Carroll D, Van Eenennaam AL, Taylor JF, Seger J, Voytas DF. 2016. **Regulate genome-edited products, not genome editing itself.** *Nat Biotech* 34: 477-9 rdcu.be/hUVn



BIOBEEF BLOG

Thoughts of public sector animal geneticists, and others, on my own

<http://biobeef.faculty.ucdavis.edu/>

False and Misleading

JULY 7, 2017 · 458 WORDS · 1 COMMENT OFF



The standard for voluntary food labeling in the US is that it must be "truthful and not misleading". I wish that was true for all speech. In this era of alternative facts and disdain for expertise, there are many politicized topics where objective facts and inconvenient truths are ignored if they don't match up with preexisting beliefs.

Although many on the left like to point fingers at the right as science deniers when it comes to climate change, there are also some topics such as vaccines and GMOs that are sacred cows, facts be damned for some left of center folks.

I am a faculty member at UC Davis, and I happen to work in animal agriculture. Our sector, in particular, has been the target of many misinformation campaigns. Think of the "pink slime" lawsuit that was just settled between a producer of lean finely textured beef and ABC News. Meanwhile, people routinely reach for milk labelled free of antibiotics, despite the fact that all milk is free of antibiotics. This flows from the oft-repeated myth that dairy cows are "pumped full" of antibiotics. They are not, despite what this misleading labeling might have you believe, and every single tanker of milk in the state is tested prior to sale to ensure it contains no antibiotic residues.

Perhaps nowhere is food fear-mongering more prevalent than in the toxic debate around genetic engineering and "GMOs". The 51% gap in perception between the public's feelings on the safety of GMOs and the understanding of the scientific community (37% of the public think GE products are safe versus 86% of scientists) is greater than the gap for any other topic, including anthropogenic climate change.

For 20 years, thousands of studies, eleven National Academies reports, and indeed every major scientific society in the world have attempted to interject objective evidence of GMO safety into the debate without making much progress. The fear-mongering, however, has been relentless – and often – disingenuous, as evidenced by the "non-GMO" labeled rock salt that has popped up in the grocery story (spoiler alert – salt doesn't contain DNA so salt cannot be genetically engineered – all salt is "non-GMO" salt). But, it is much easier to sell fear than science.

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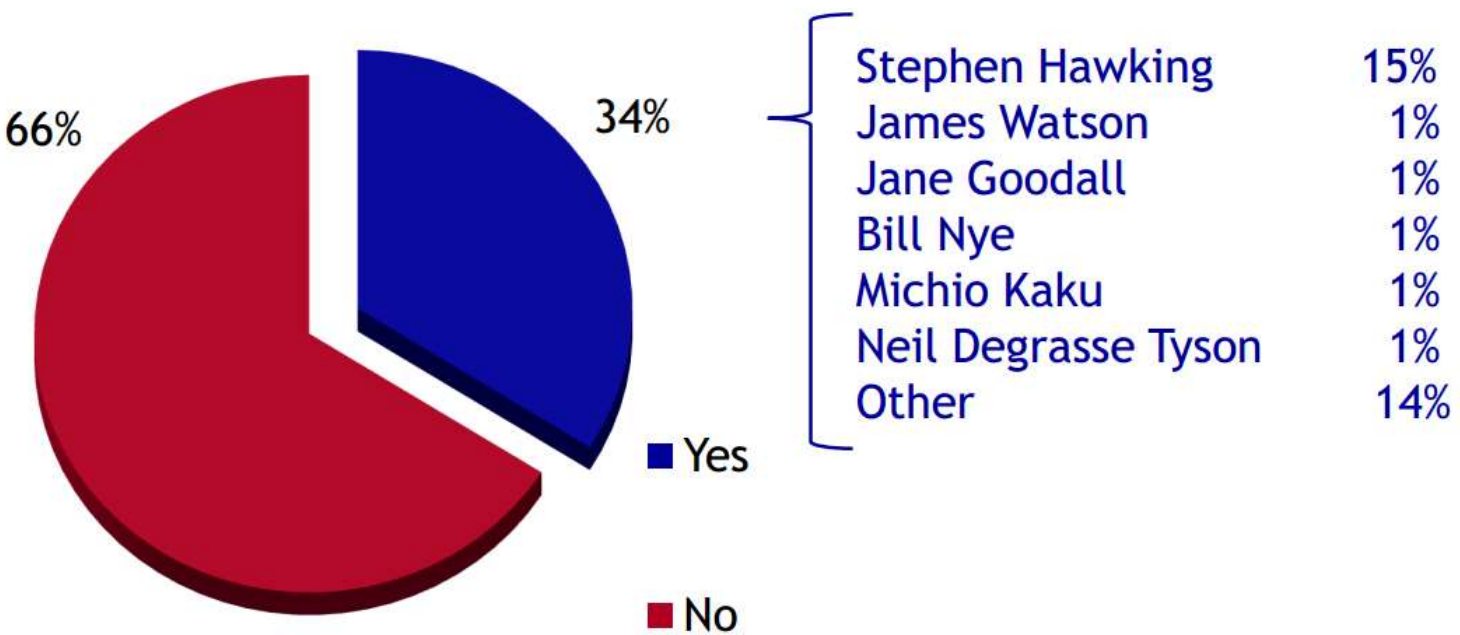
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Most Americans Can't Name a Living Scientist

Can you name a living scientist? (first volunteered responses)



Source: *Your Congress - Your Health* Survey, March 2011
Charlton Research Company for Research!America



<http://www.researchamerica.org/sites/default/files/uploads/MostAmericansCantNameaLivingScientist.pdf>



FEAST ON FACTS



FROM ACADEMY AWARD® NOMINEE **SCOTT HAMILTON KENNEDY**
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BLACK HALEY FILMS in association with BODIMOVEX, INC. "FOOD EVOLUTION" a film by SCOTT HAMILTON KENNEDY
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Neil deGrasse Tyson

“Insanity: doing the same thing over and over again and expecting different results”

Albert Einstein

Follow **@foodevomovie** on Twitter

Screening this Friday July 21st at Festival of Curiosity in Dublin 6-8 pm

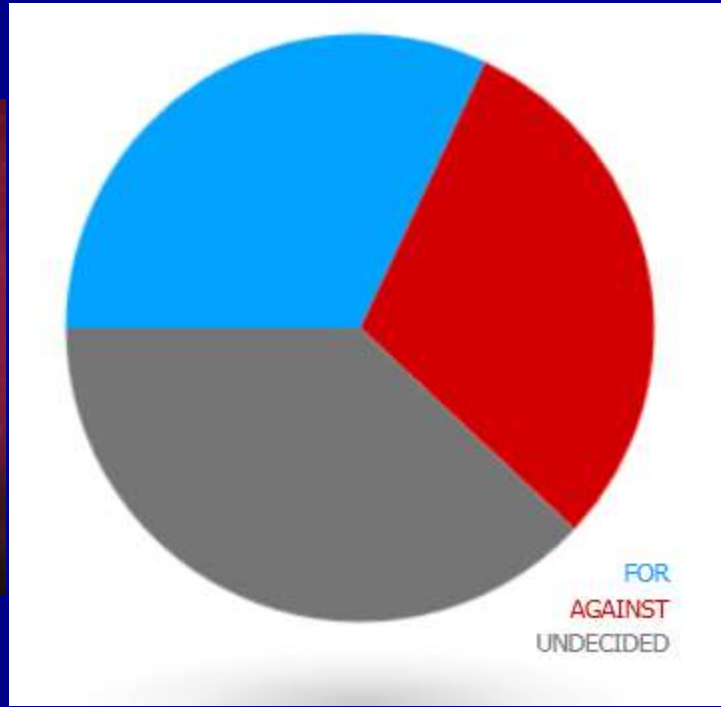
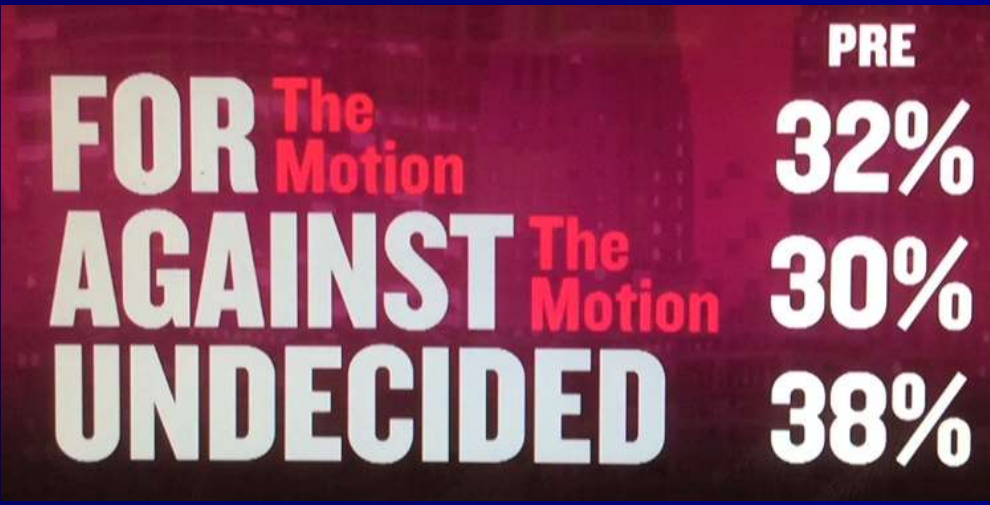
<http://festivalofcuriosity.ie/food-evolution-directors-qa/>

Intelligence Squared debate on GM food New York City, December 2014





Genetically modify food?





Van Eenennaam 7/20/2017

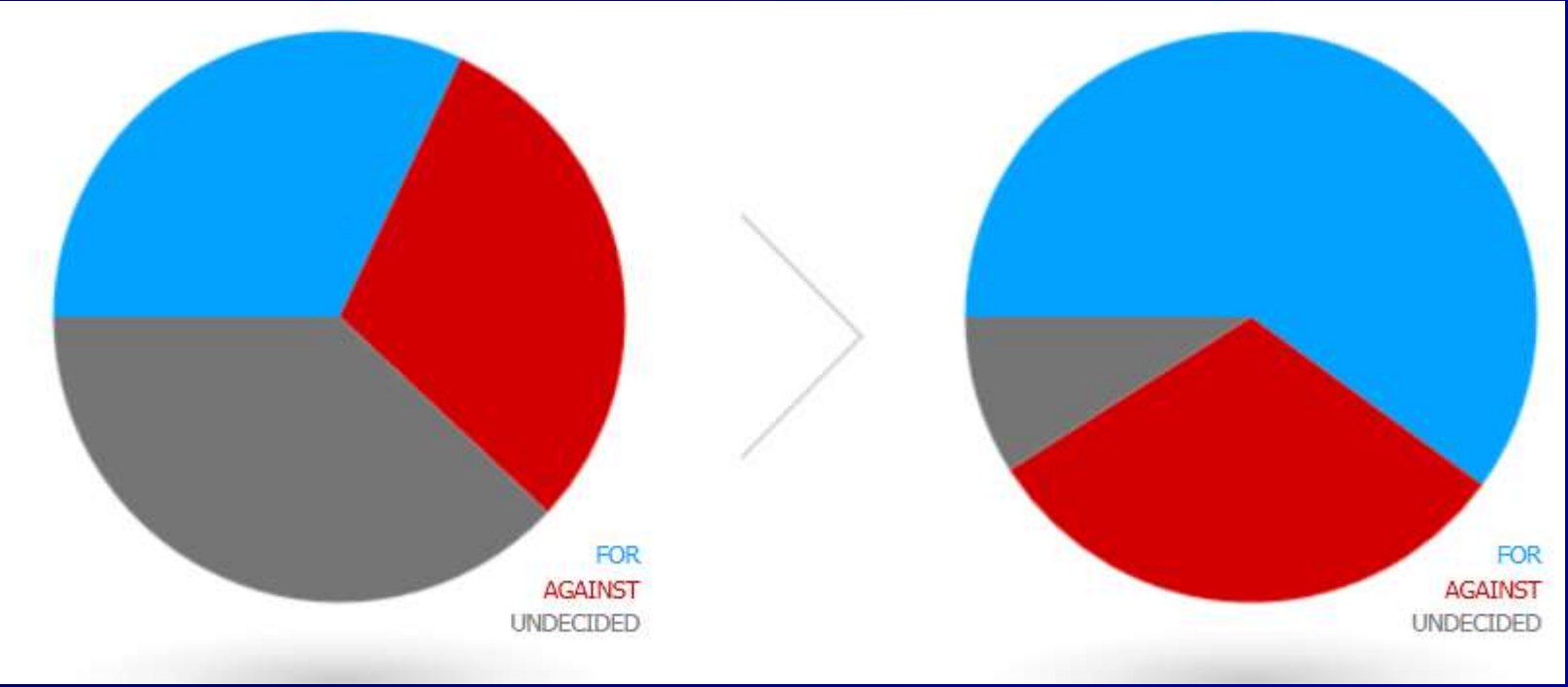
New York City, December 4, 2014

Animal Genomics and Biotechnology Education



| | PRE | FINAL |
|----------------------------------|------------|------------|
| FOR <i>The Motion</i> | 32% | 60% |
| AGAINST <i>The Motion</i> | 30% | 31% |
| UNDECIDED | 38% | 9% |

intelligence²
DEBATES





Perhaps doing nothing is even more scary than participating in the debate!



"It's a foreboding I have – maybe ill-placed – of an America in my children's generation or my grandchildren's generation.... when clutching our horoscopes, our critical faculties in steep decline, unable to distinguish between what's true and what feels good, we slide almost without noticing, into superstition and darkness"

Carl Sagan

(9 Nov 1934 - 20 Dec 1996)

Picture you will probably never see as part of speaker profile – although sometimes apropos – riding the "Drop of Death" at the State fair

Need humor? Pretty much





We need to defend the science we do and the scientific method and call out fearmongering – or else risk losing access to innovation in agriculture.

**ONLY
YOU
CAN PREVENT
MISINFORMATION**



Seriously.

**It is up to the you to
defend animal breeding,
innovation, and the need
for evidence-based policy**



<https://youtu.be/C0MBI0BANHg>
“Can’t stop the feeding”

A. Van Eenennaam
Laboratory

Prior Authorization and
Training Required Before Using
Any Equipment In This Lab





Thanks for your attention – now go forth and #sci communicate

Alison Van Eenennaam, Ph.D.

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