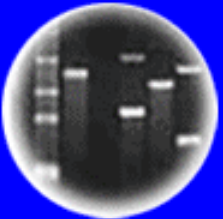


DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

HC70A Spring 2015 Genetic Engineering in Medicine, Agriculture, and Law

**Professors Bob Goldberg, Channapatna
Prakash & John Harada**

Lecture- April 16, 2015

If your Dining Table could talk?

***– History of Food
and future of farming***

UCLA

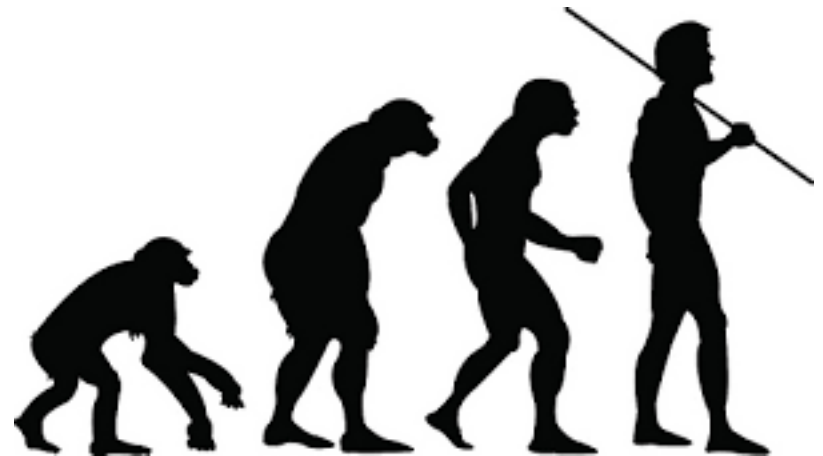
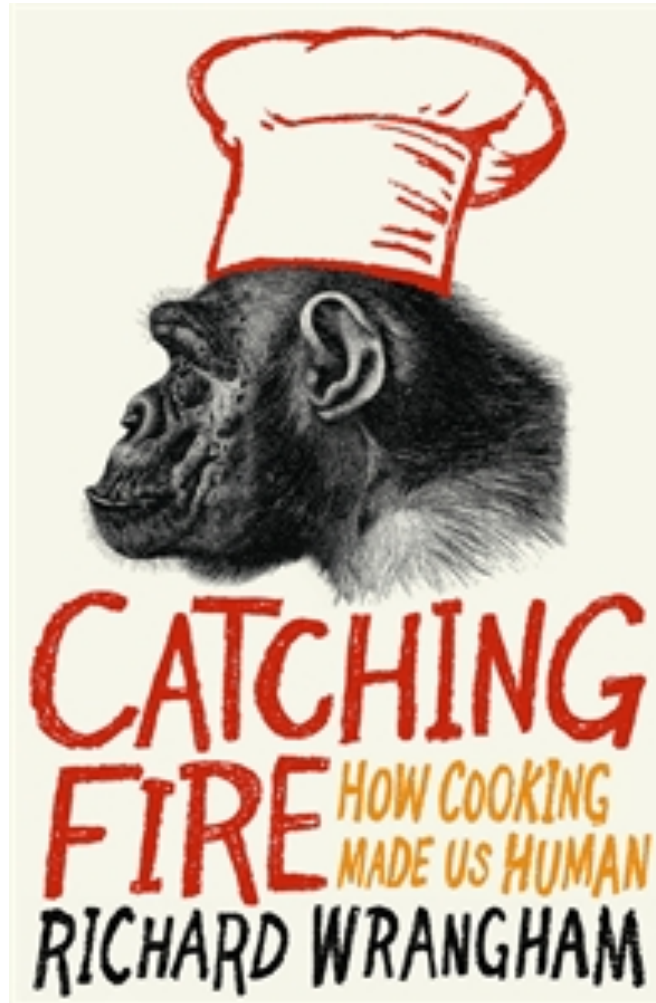


UC DAVIS
UNIVERSITY OF CALIFORNIA



PROTESTING AGAINST NEW TECHNOLOGY - THE EARLY DAYS

INKCINCT





From Foraging to farming: Transition from Hunter Gatherers'



Genetic Manipulation Feeding Humanity Since 10,000 BC



Farming Invented at many locales in parallel

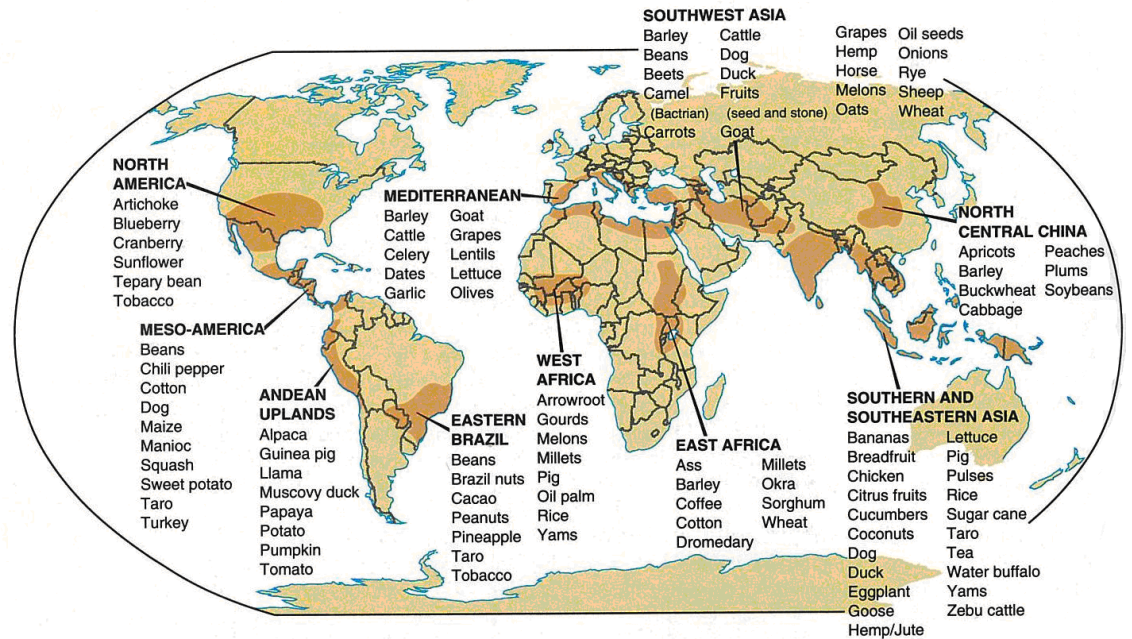
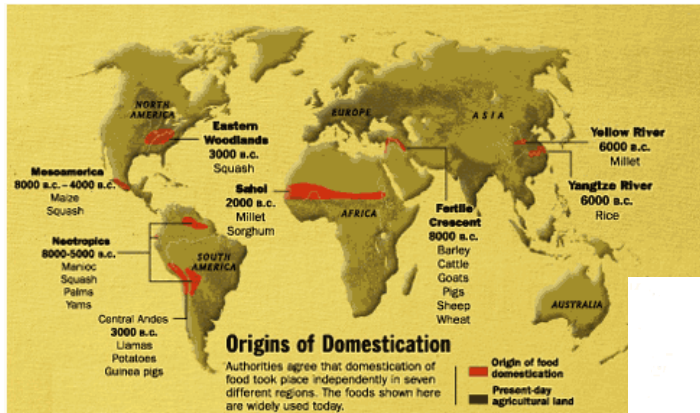
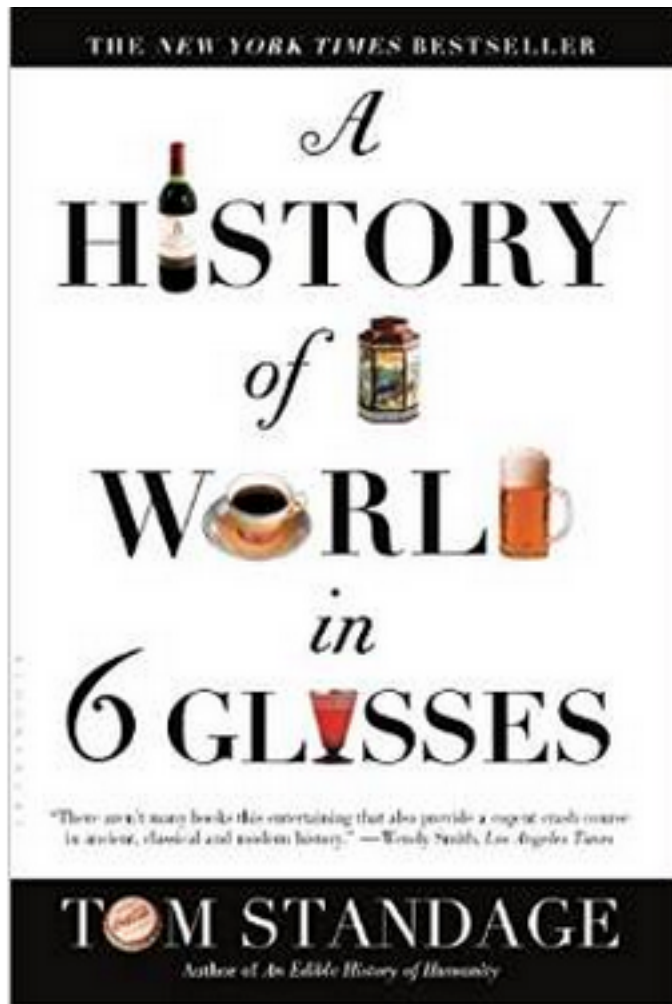


Figure 7-1. This map shows the origins of the world's food crops and domesticated animals. These plants and animals have been so widely redistributed, however, that today's leading producers of many of these are not the same as the areas in which they were first domesticated.

Cooks made us human, bartenders civilized us!



*Bread didn't motivate our ancestors
to start grain farming.
It was beer. Pints over pastry!*



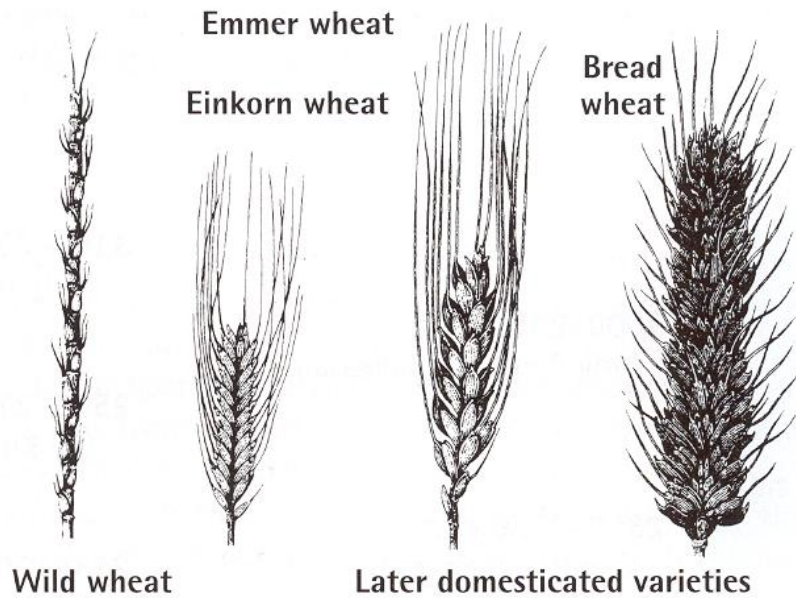
<http://nautil.us/issue/8/home/beer-domesticated-man>

Human civilization evolved in parallel with crop domestication and breeding



Image credits: [P. Cos](#), [Cacaphony](#), [USDA](#), [CIMMYT](#)

Evolution of our food



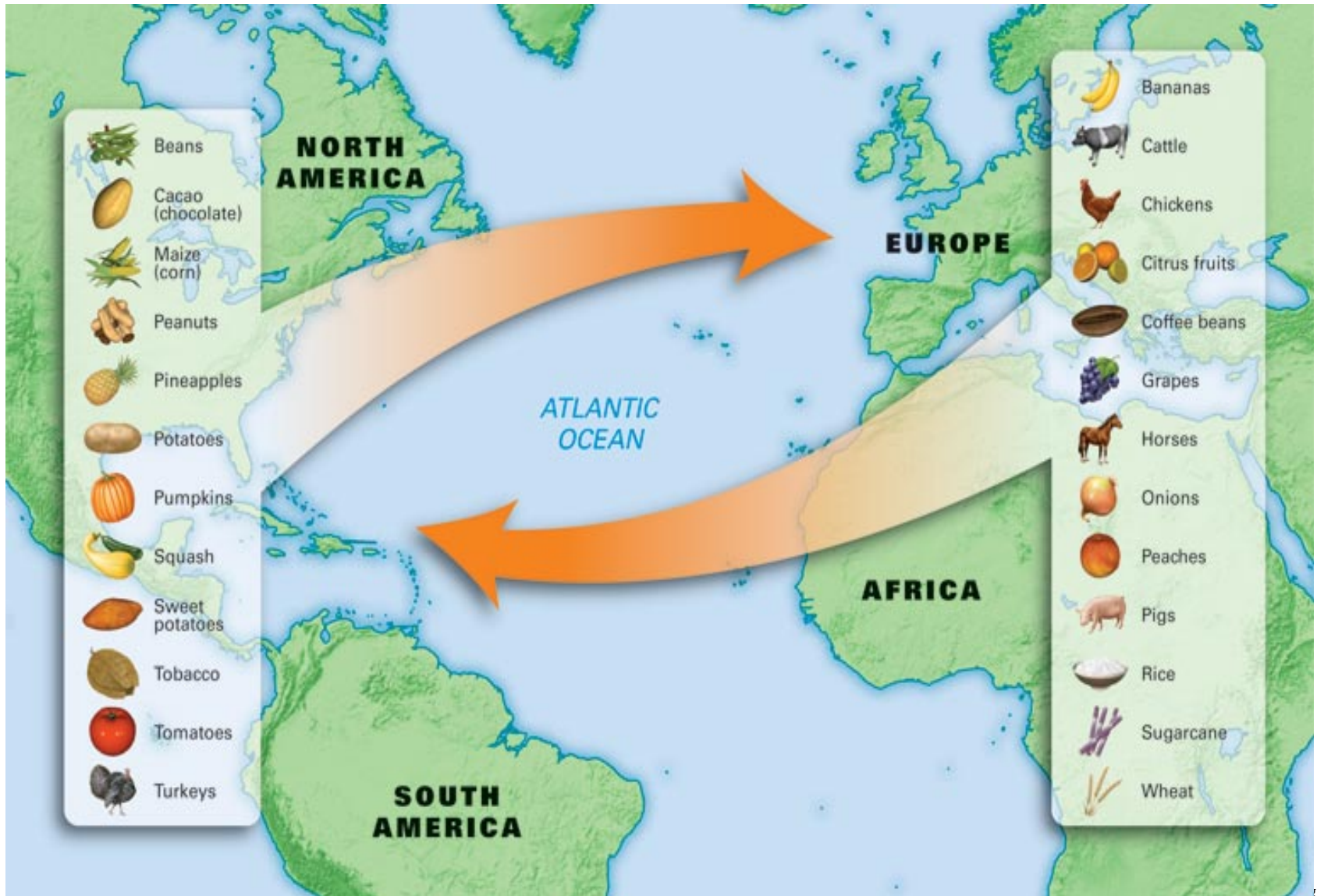
A natural “unmodified” food!



Carrot

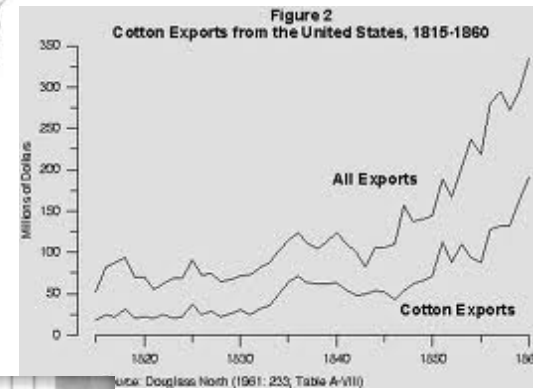


Globalization of Food

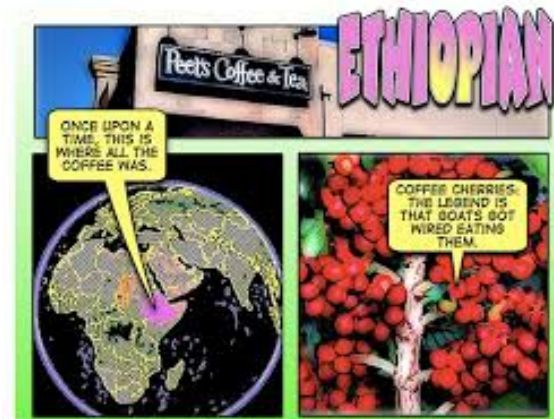
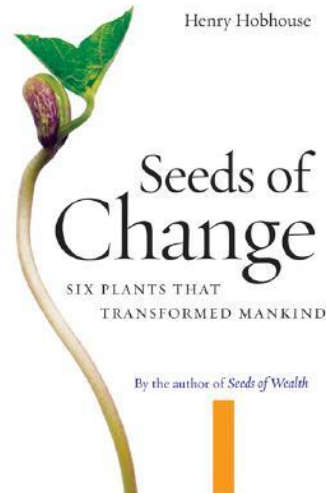




Cotton



Coffee





Potato



The Gardeners' Chronicle.

SATURDAY, SEPTEMBER 13, 1845.

MEETINGS FOR THE TWO FOLLOWING WEEKS.
Wednesday, Sept. 17—South London Floricultural. 1 P.M.

COUNTRY SHOWS.

Wednesday, Sept. 17—Hertford Florical and Horticultural.
Friday, Sept. 19—Derby and Eastern Horticultural and Flor.
Thursday, Sept. 20—Notre Horticultural and Flor.

We stop the Press, with very great regret, to announce that the POTATO MURRAIN has unequivocally declared itself in Ireland. The crops about Dublin are suddenly perishing. The conversion of Potatoes into flour, by the processes described by





Tomato



Attack of the Killer What?



"THE DOSE MAKES THE POISON"

APPLE SEEDS



CONTAIN AMYGDALIN
~0.6g/kg of seeds

PEARS



CONTAIN FORMALDEHYDE
~0.06g/kg

POTATOES



CONTAIN SOLANIN
~0.2g/kg
(higher in green potatoes)

COURGETTES



CONTAIN CUCURBITACIN E
Variable
(higher in bitter courgettes)

ALL OF THE FOOD ITEMS ABOVE CONTAIN NATURAL CHEMICALS THAT ARE TOXIC TO HUMANS. HOWEVER, THEY ARE USUALLY PRESENT IN VERY SMALL AMOUNTS, FAR BELOW THE HARMFUL DOSE.

JUST BECAUSE A CHEMICAL IS PRESENT, DOES NOT MEAN THAT IT IS HARMFUL IN THE *AMOUNT* PRESENT.



Pasteurization, raw milk



Irradiation of Food



**DON'T NUKE
OUR FOOD**
STOP FOOD IRRADIATION

Peace Resource Project P.O. Box 1122 Arcata, CA 95521 USA



Cold Pasteurized

Plants as Modified by Man.

Geo. W. Carver.

Man is simply nature's agent or employee to assist her in her work, hence the more careful and scientific the man is the more valuable he is as an aid to nature in carrying out her plans methodically, instead of at random as is the case when left to herself to perform the work.

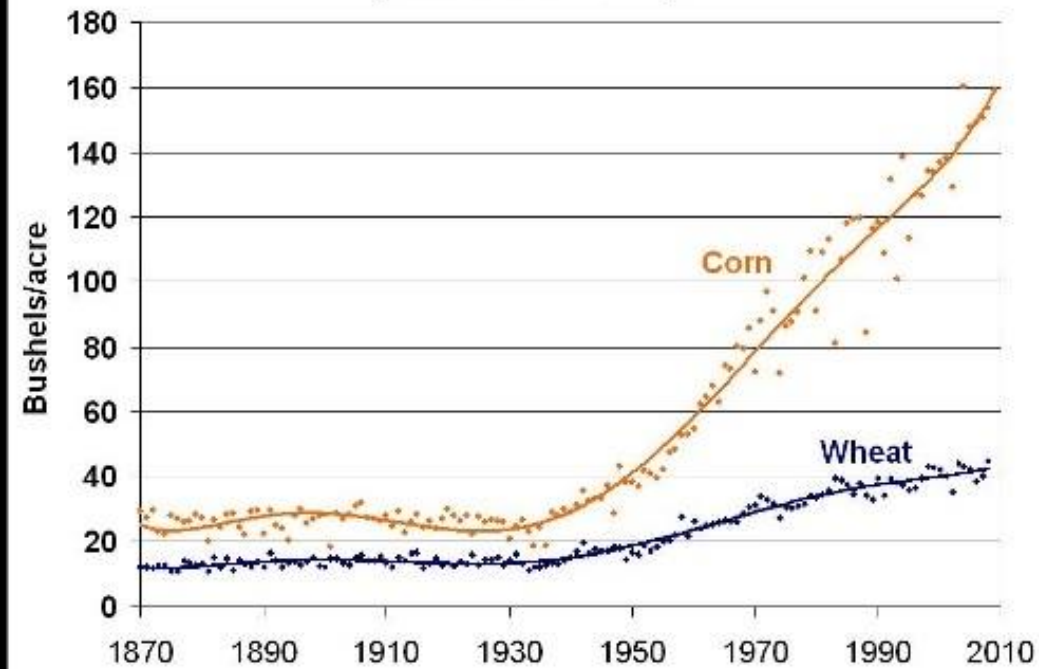
and only to know the true of all characteristics.

With these few mile-stones to guide us in our course, dare we not predict that the day is not far distant when man workshop need no longer be chaos, but will be able to use the tools nature has placed before him from a purely scientific basis, free from all conjecture.

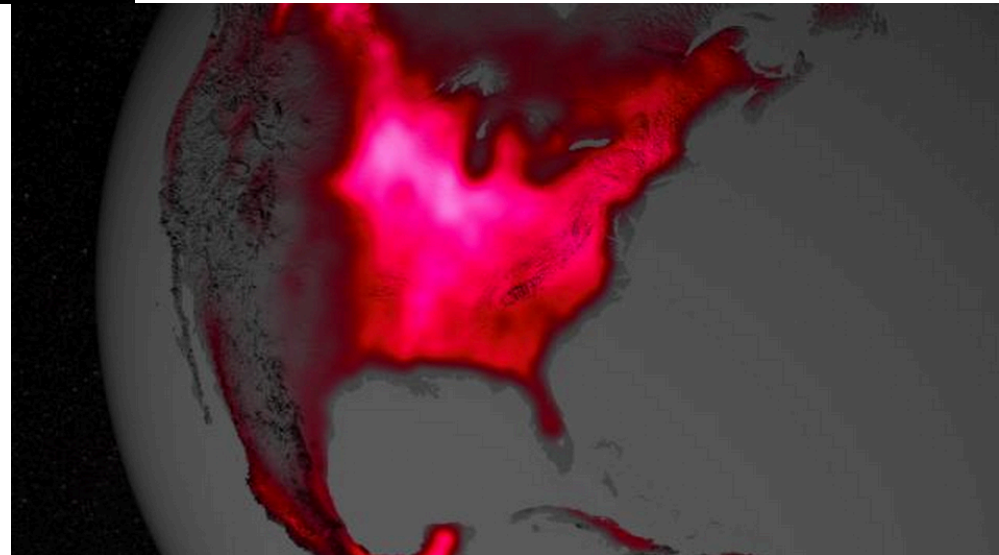
George Washington Carver's Masters Thesis - 1894



Historical Crop Yield Progress in the United States
(Source USDA NASS)



NASA Satellite Image showing
US corn belt as the most producing
Photosynthesis on earth!



Land Needed to Grow One Bushel of Corn

2030 145.2 square feet*

2009 264 square feet

1997 340 square feet

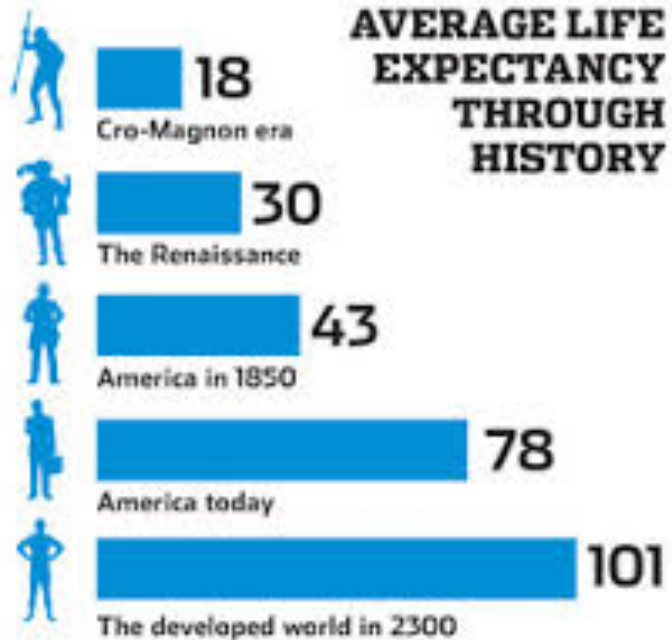
1970s 484 square feet

1950s 968 square feet

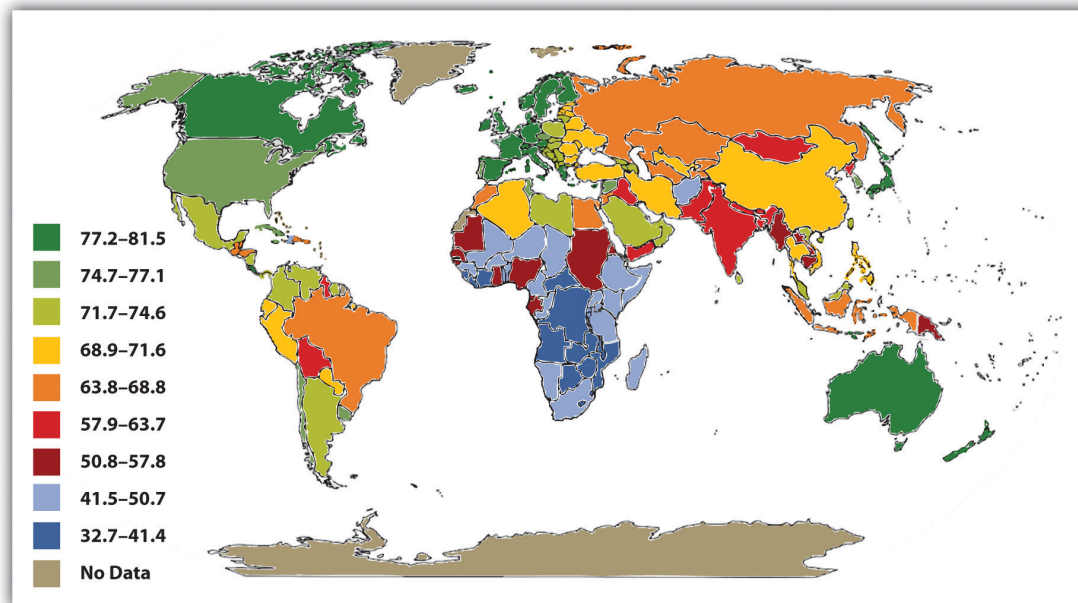
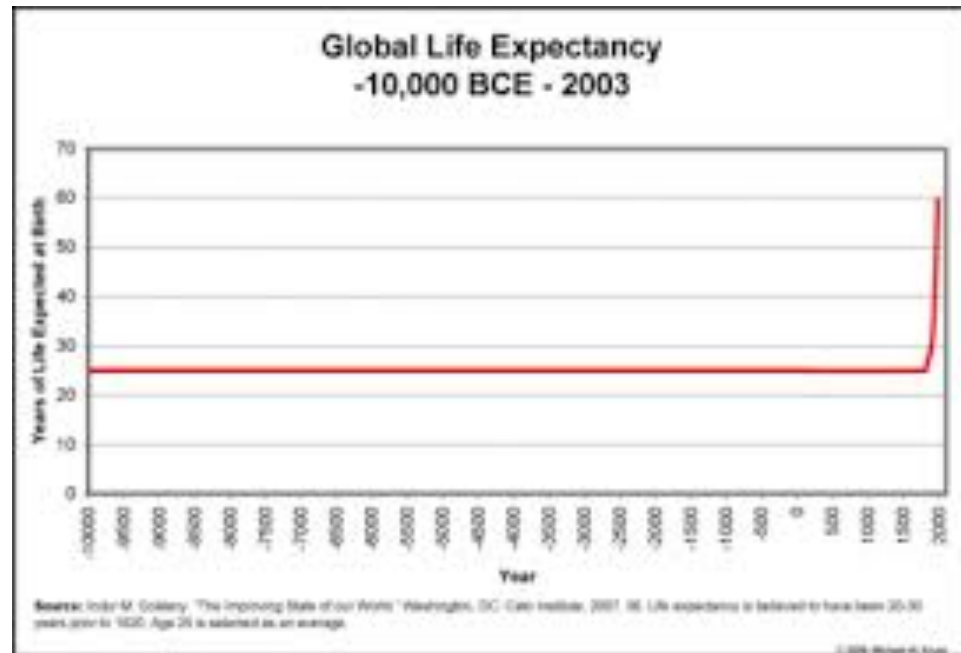
1866–1920
1742 – 1452 square feet



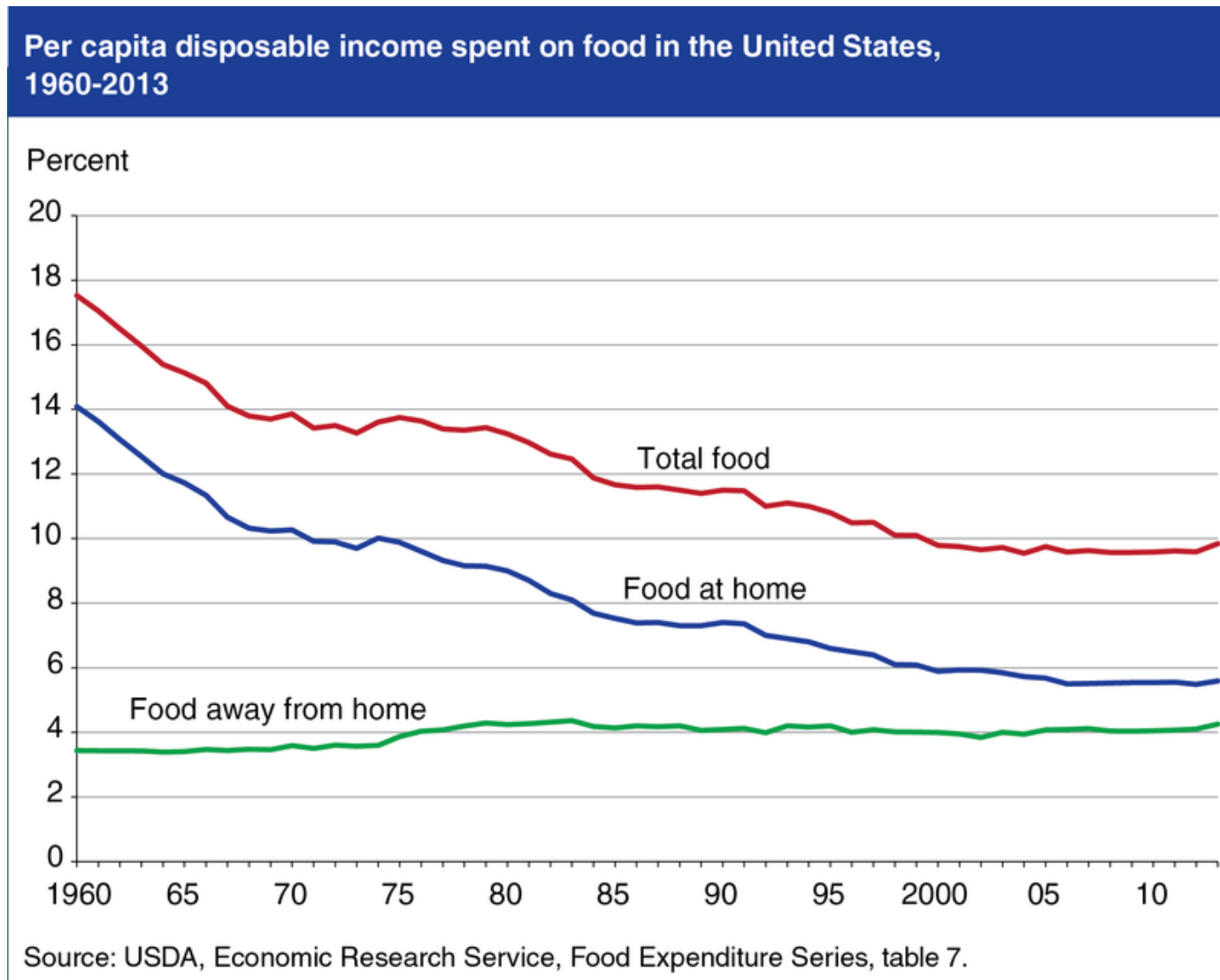
*projected



Sources: "100 Plus," United Nations




Americans spend less than 10% of their income on food



How Crops Are Genetically Modified

Traditional Breeding



Crossing plants and selecting offspring

Almost All Crops

Mutagenesis



Exposing crops to chemicals or radiation




RNA Interference




Switching off selected genes with RNA



Transgenics



Inserting selected genes using recombinant DNA methods



Number of Genes Affected

10K - >300K

? No way to assess

1 - 2

1 - 4

Desired gene(s) inserted with other genetic material. No safety testing requirements.

Random changes in genome, usually unpredictable. No safety testing requirements.

Targeted gene(s) switched off or 'silenced'. Safety testing required.

Desired gene(s) inserted only at known locations. Safety testing required.

Mutagenesis: Look what Chernobyl tech did to our food?



BEFORE & AFTER

GMO or Non-GMO?

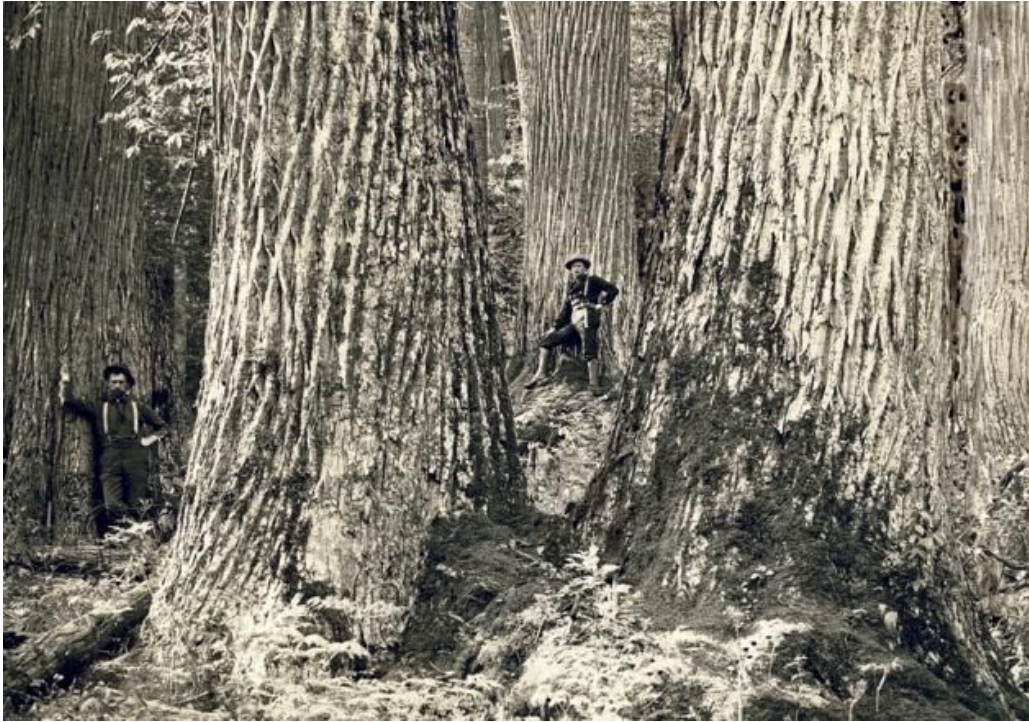




This is why we plant Bt cotton.
100% yield loss from bollworm in non Bt strips.

via @acatchot #GMO <http://bit.ly/WhyBtCotton>

Bringing back the Great American Chestnut



Climate Smart crops: Drought Tolerant Corn



Photo: Monsanto Co.

Freeze Tolerant Biotech *Eucalyptus*

Results from first winter in
South Carolina

Results from second winter
in Alabama



Field results indicate freezing tolerance to ~16°F (- 8° to - 9°C)

Source: www.arborgen.us

Flood-tolerant Rice



International Rice Research Institute, Philippines

Golden Rice

- Milled rice has no beta-carotene
- Vitamin A deficiency - 200 million children and women
- About 500,000 children go blind (60 every hour!)
- 2 million children die each year
- Golden Rice may provide one of the many solutions



The Golden Rice project wins the Patents for Humanity Award 2015



PATENTS for HUMANITY
It's not just an invention.

The White House Office of Science and Technology Policy and the U.S. Patent and Trademark Office (USPTO) have announced the winners of the 2015 recipients of the Patents for Humanity Award, among them the Golden Rice Project.

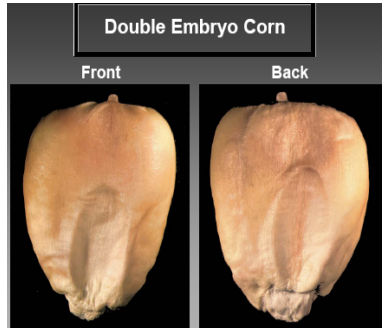
Patents for Humanity is a USPTO program that recognizes patent owners and licensees working to improve global health and living standards for underserved populations. The program advances the President's global development agenda by recognizing private sector leaders who bring life-saving technologies to those in need, while showing how patents are an integral part of tackling the world's challenges.



The award has been bestowed upon the Golden Rice Project, in particular to Prof Ingo Potrykus, Prof Peter Beyer, and Dr Adrian Dubock, with the ceremony happening on 20 April 2015.



Improved Nutritional Content



Many common food crops not perfect for nutritional requirements of humans or animals.

Higher Protein Content and Improved Protein Quality: Maize, wheat, Sweet potato and cassava



- High Lysine maize:
- N assimilation modified pathway GDH 12% increase protein
- SRP Nonallergenic Amaranthus Albumin for potato
- Artificial Proteins:
 - ASP-1-sweet potato 67% increase protein (EAA 80%)



Improved Nutritional Content

Carbohydrates

- Starch High Amylose - resistant starch
- * High starch potato

Fibre – Humans increase

- Polymers, Inulins, Fructo-oligosaccharides (FOS)
- Potato synthesize the full spectrum of inulins from globe artichoke roots
- Lignans: enterodiol/lactone estrogen-dependent cancer

Forage Crops Fibre – Animals Decrease

- Brown midrib (COMT)–Decreased lignin increase digestibility better feed conversion, livestock prefer (Sorghum)

Source: Dr. Martina McGloughlin, UC Davis

Improved Nutritional Content

Oils and Fatty acids

- Altering chain length and saturation level
- Novel genes to produce unusual fatty acids in oilseed
- High Oleic Acid (Low-Linolenic) : more stable than PUFA heat/ oxidation resistant, little or no postrefining (hydrogenation)
- MCT: medical foods, ergogenic aids. Acyl-ACPT canola, increase in capric (C10) and caprylic (C8) (Dehesh)
- Omega -3 DHA-EPA “Fish Oil” CV/thrombosis/ Cancer/ Arthritis/ Cognitive/Mental/ premies
- W- 6 GLA- 4X Safflower: Neurodegenerative/ inflammation
- Sitostanol: phytosterol phospholipid Block cholesterol

Source: Dr. Martina McGloughlin, UC Davis



Zmapp – Ebola serum produced in GMO tobacco in Kentucky

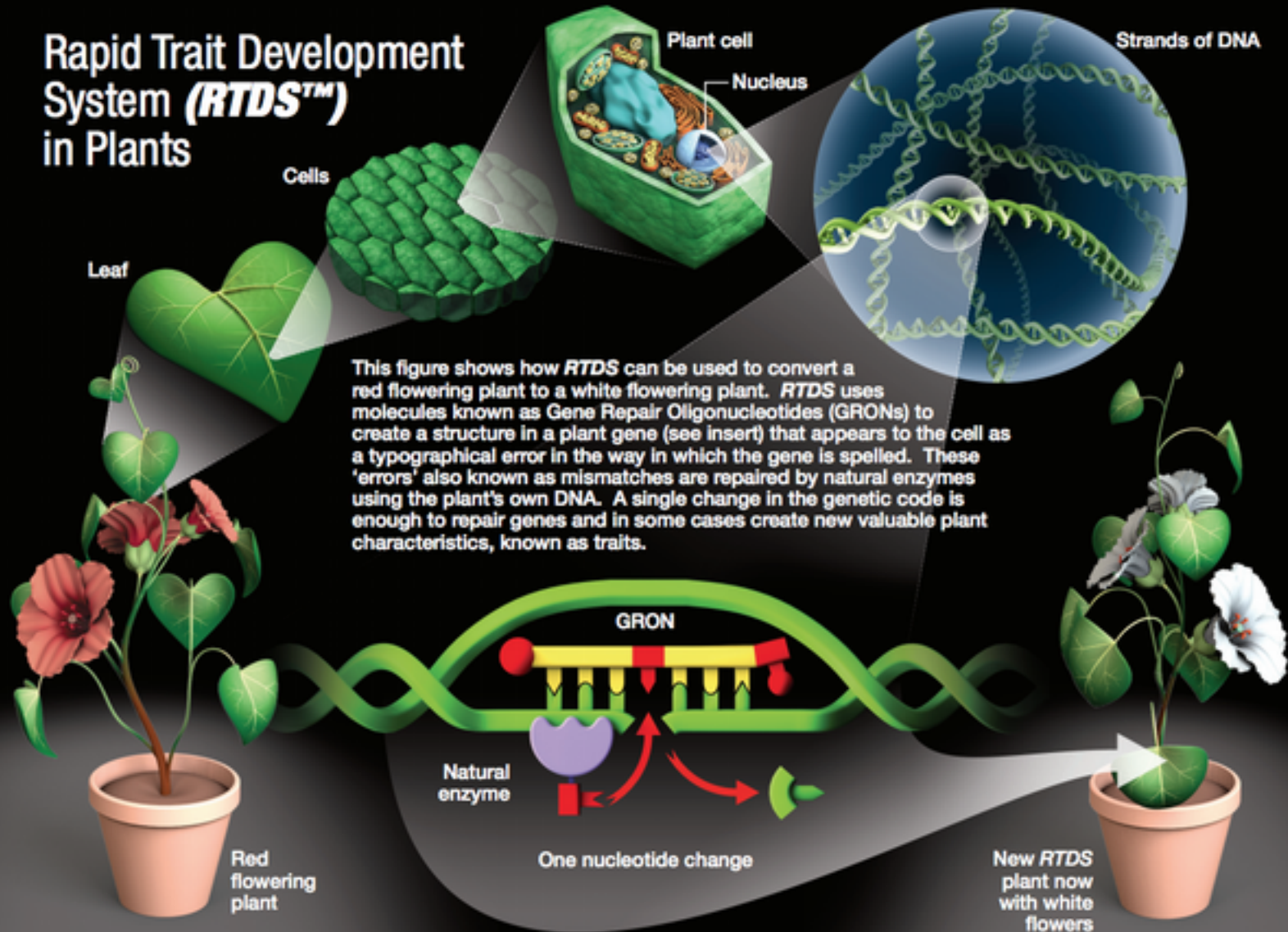


Tobacco plants grown in greenhouses at Kentucky BioProcessing in Owensboro were "infected" with a protein, which the plants then reproduced, that is turned into a serum to fight the Ebola virus

Blue Rose!



Rapid Trait Development System (*RTDS*[™]) in Plants



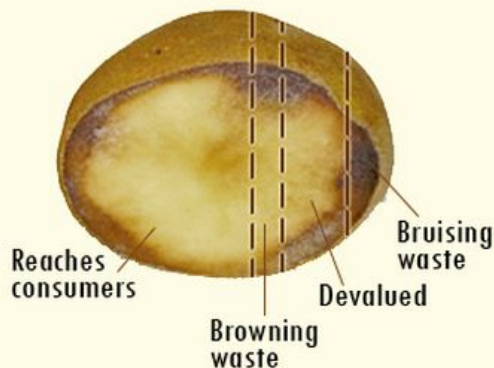
What Are The Differences Between A Conventional Potato And A Simplot Innate™ Potato?

The U.S. produces over 40 billion pounds of potatoes a year.

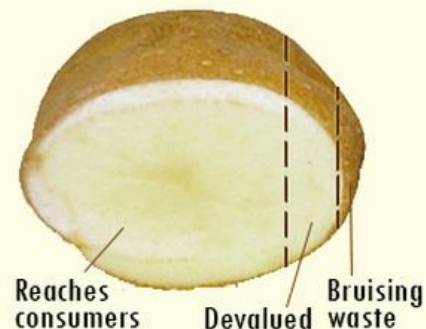


Simplot Innate potatoes are genetically modified using only potato genes to resist wasteful potato bruising and browning without affecting taste or nutrition.

Conventional



Simplot Innate



If all Fresh Russet potatoes were Simplot Innate potatoes, the U.S. would have saved **400 million lbs** of potato waste each year.

That means also saving:



\$90 million in producer costs



60 million lbs of CO₂ emissions



6.7 billion gallons of water



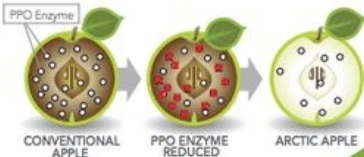
170,000 acres from pesticide sprayings



MAKING THE PERFECT FRUIT EVEN BETTER

HOW APPLES BROWN

When an apple is cut, bitten or bruised, an enzyme called Polyphenol Oxidase (PPO) triggers the browning reaction



WHY MAKE A NONBROWNING APPLE?

After learning about Arctic apples, consumers say they're 3 times more likely to buy them than not buy them



ARCTIC® APPLES ARE JUST AS SAFE & HEALTHY AS ALL APPLES

No new proteins

The same nutrition

The only difference is when you bite, cut or bruise the apple!

24 WKS

Creating an Arctic apple tree takes about 24 weeks

50% WASTED

About 50% of apples grown are wasted

71% MORE

Kids eat 71% more apples when they're pre-sliced

HOW DO WE STOP BROWNING?

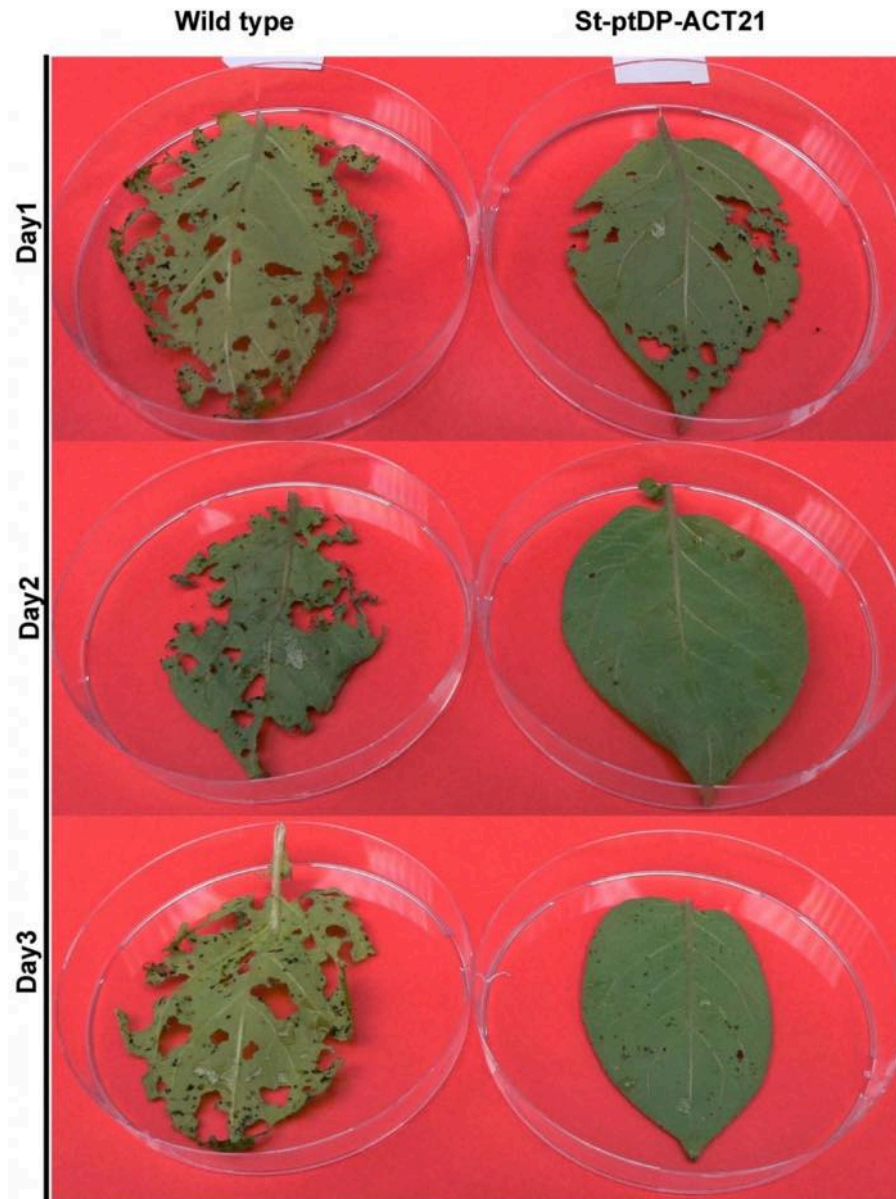
One way to think of it

We replace one piece of a "railway track" (the PPO genes) on a coast-to-coast railway (genetic code) with a slightly different piece of track

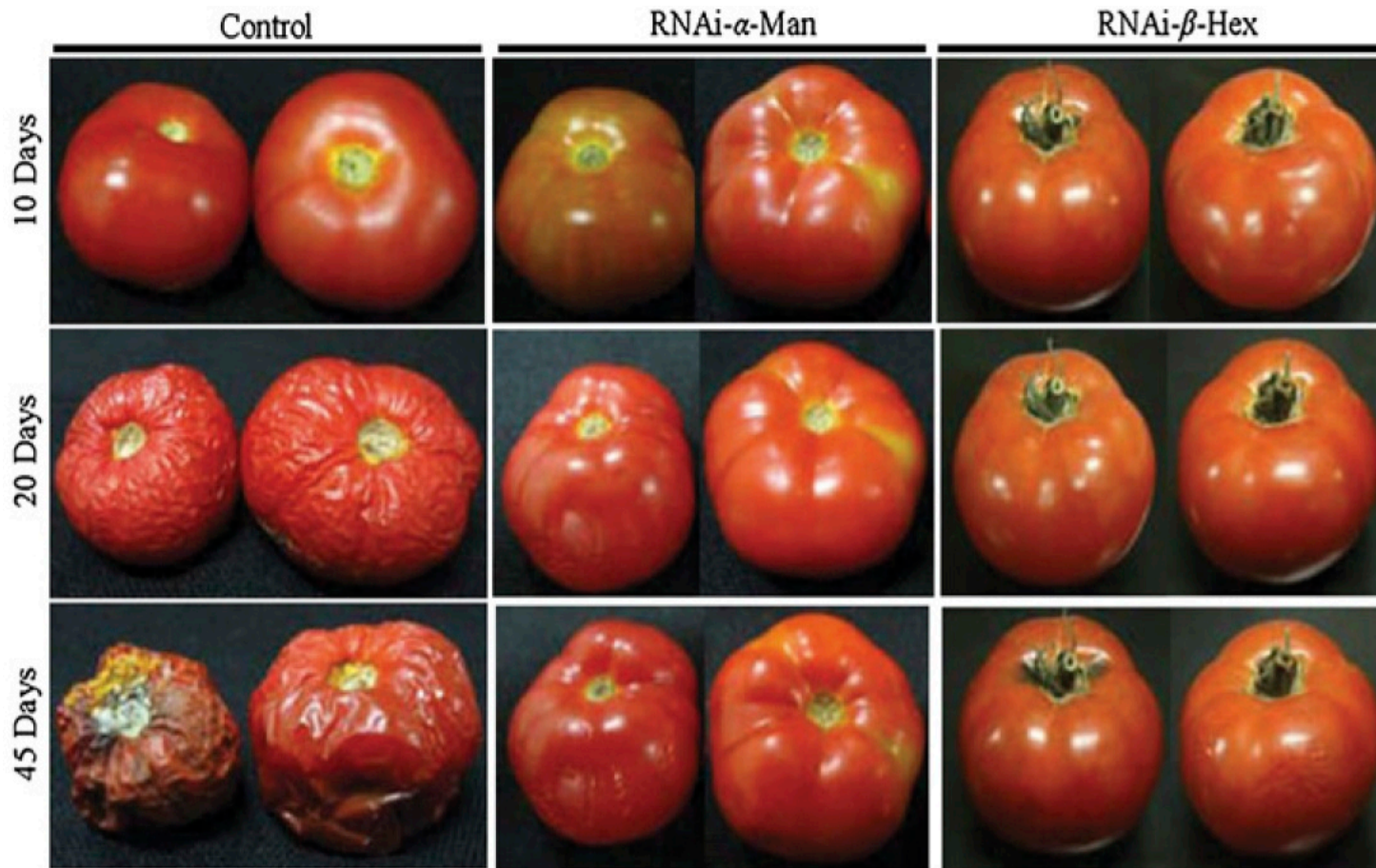
Another way to think of it



Potato Colorado Beetle – RNA Interference



Engineered tomatoes have ~30 day extension of shelf life




SOURCE: Meli, V.S., Ghosh, S., Prabha, T.N., Chakraborty, N., Chakraborty, S., and Datta, A. 2010. Enhancement of fruit shelf life by suppressing N-glycan processing enzymes. *Proceedings of the National Academy of Sciences USA*, doi/10.1073/pnas.0909329107.



I hope that there is nothing genetically modified in this



A photograph of two men laughing heartily in an outdoor setting. The man on the left is wearing a green and white baseball cap and a light blue button-down shirt. The man on the right has long brown hair and a beard, wearing a yellow shirt. In the background, a green John Deere tractor is parked in front of a building with a corrugated metal roof. The scene is brightly lit, suggesting it's daytime.

...and then the guy in flip flops says "you know the worlds food supply is controlled by Monsanto"

Monsanto controlling your food?

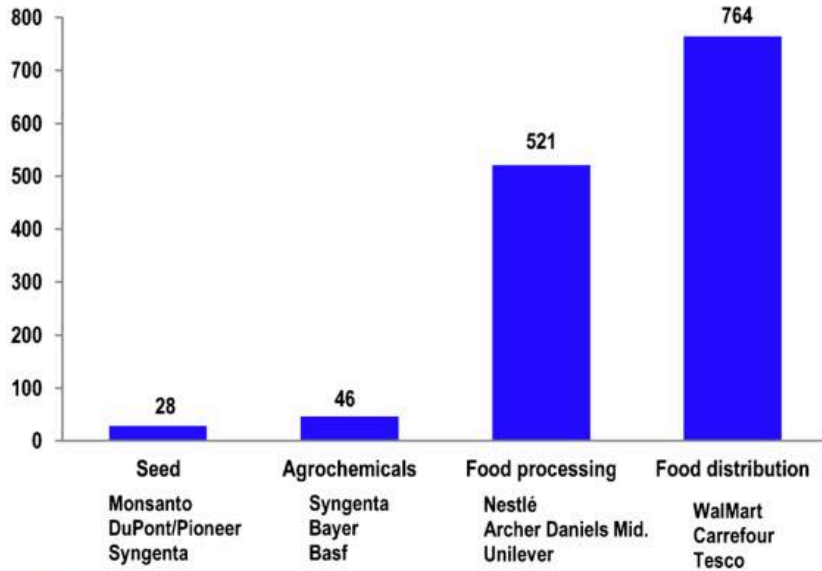
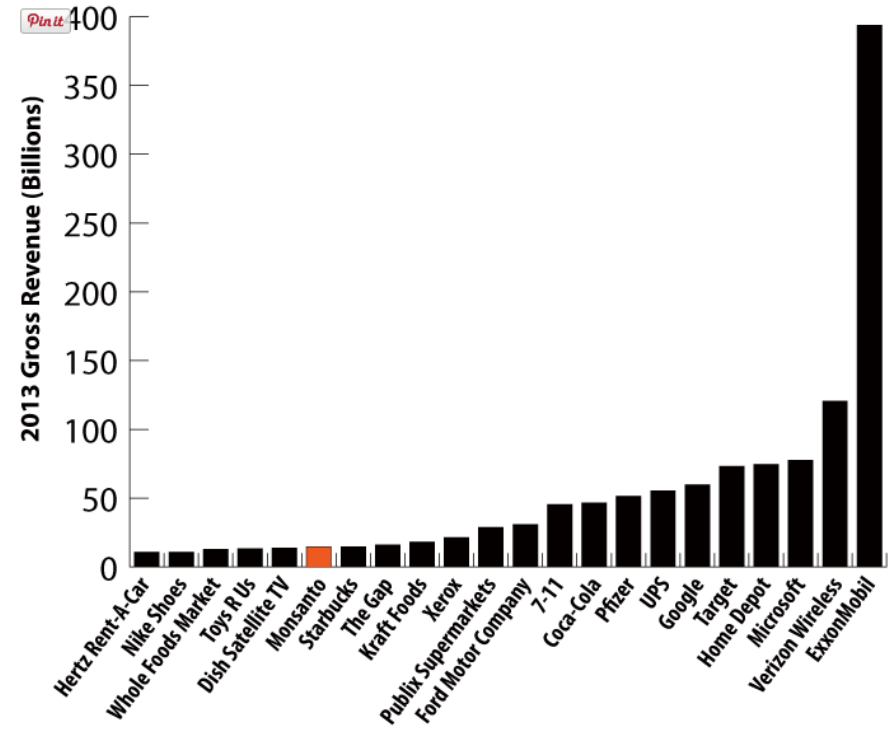
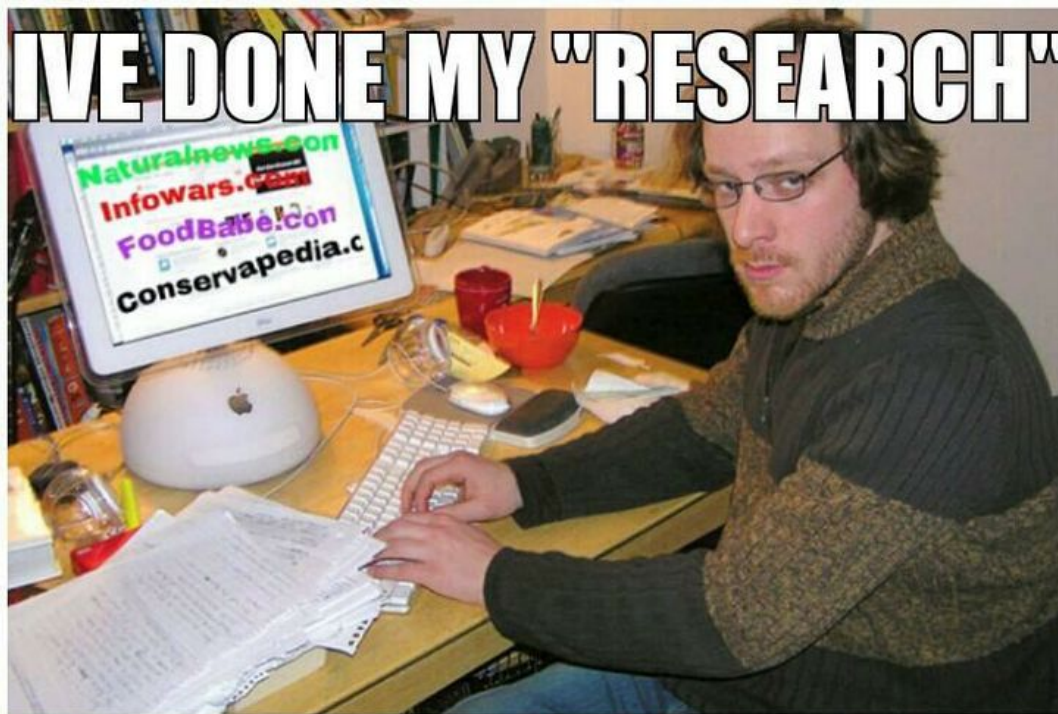


Fig. 1 Global sales of the top ten companies in four sectors: seed, agrochemicals, food processing, and food retailing (in 2012, billion USD). The names of the 3 major groups are indicated for each sector (from Forbes 2013; Supermarket News 2013)



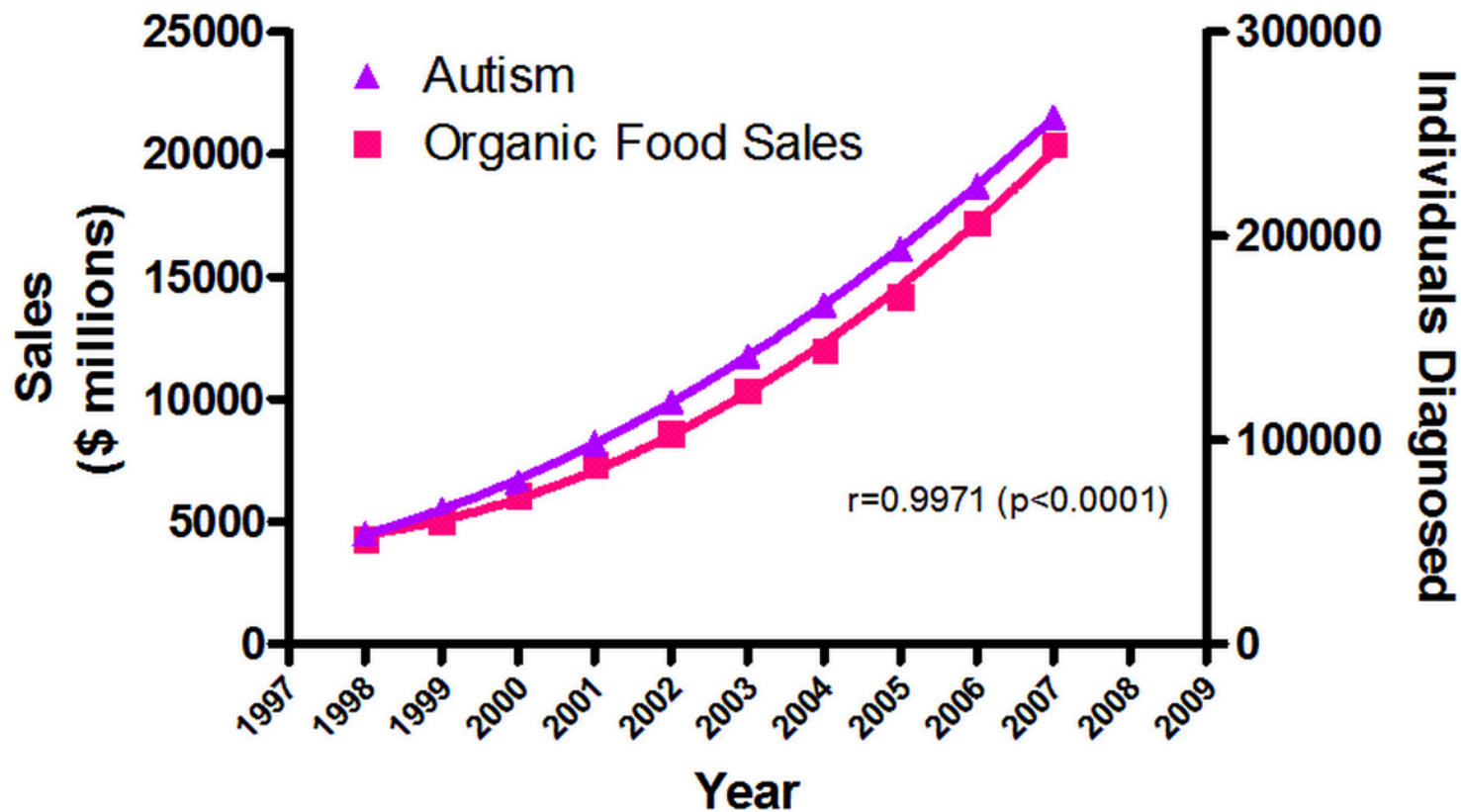
IVE DONE MY "RESEARCH"



THAT'S CUTE

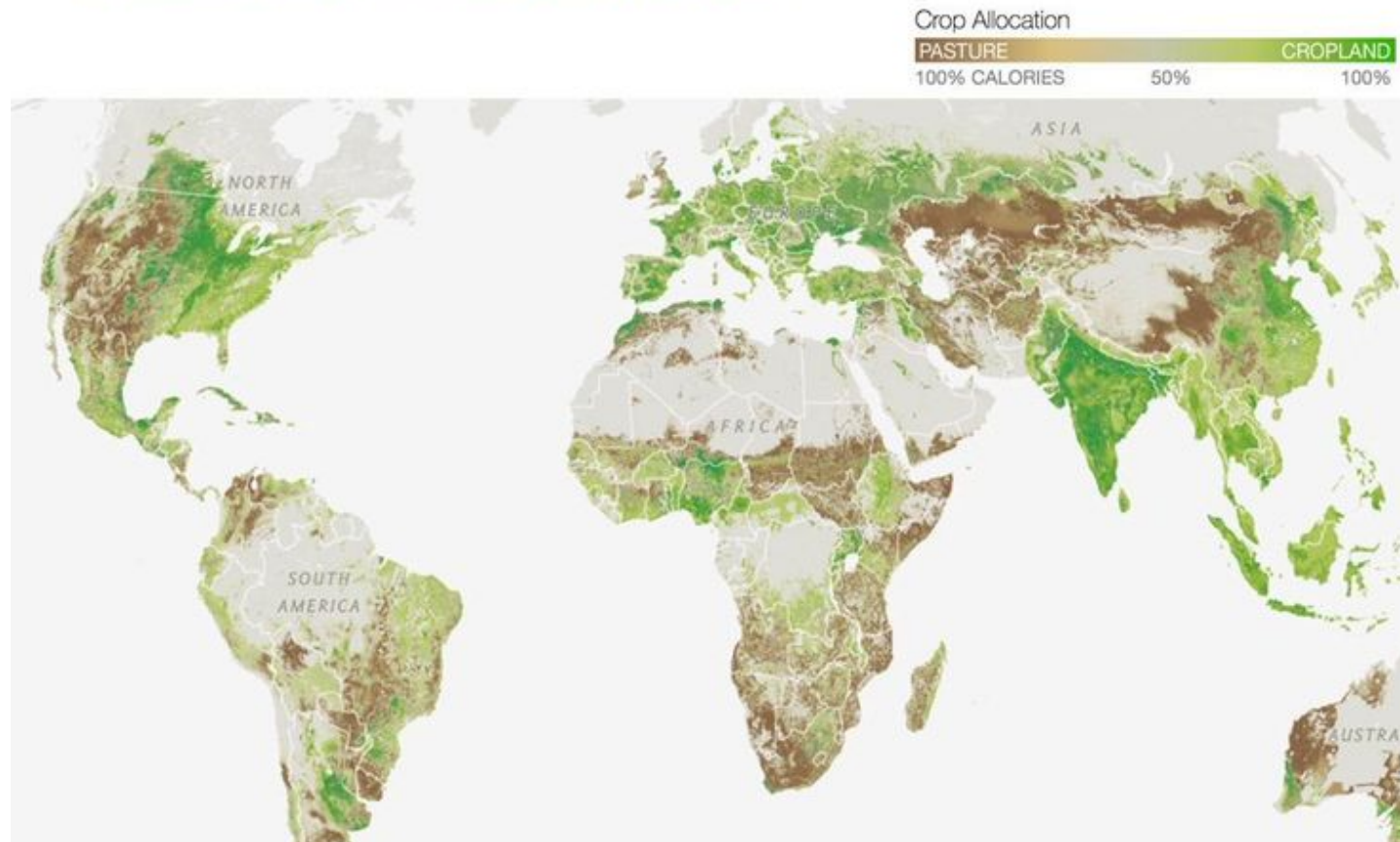
Correlation is NOT causation

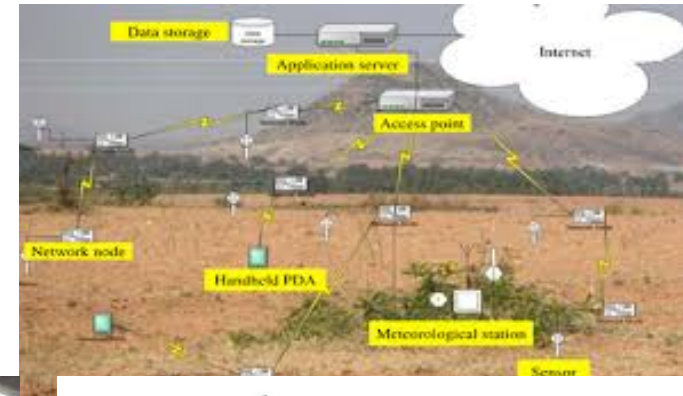
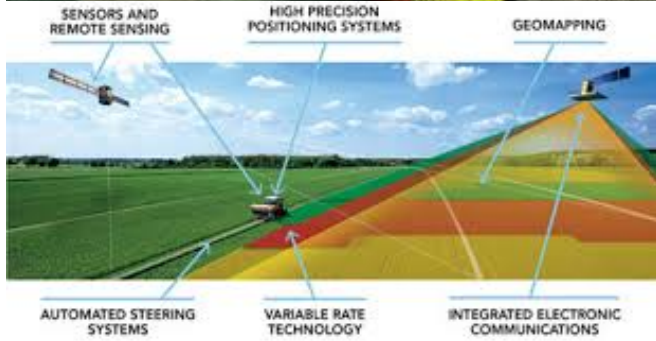
The real cause of increasing autism prevalence?



Sources: Organic Trade Association, 2011 Organic Industry Survey; U.S. Department of Education, Office of Special Education Programs, Data Analysis System (DANS), OMB# 1820-0043: "Children with Disabilities Receiving Special Education Under Part B of the Individuals with Disabilities Education Act"

We can no longer afford to increase food production through agricultural expansion.





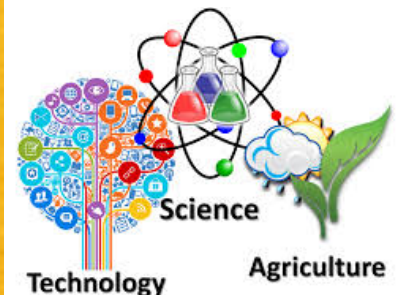


**The saddest aspect of
life right now is that
science gathers
knowledge faster than
society gathers wisdom.**

Isaac Asimov

American Scientist

QUOTEHD.COM



Thank you!



Slides Sources

Dr. Peggy Lemaux - ucbiotech.org
Dr. Wayne Parrott - University of Georgia
Dr. Mary Williams – [ASPB plantcell.org](http://ASPB.plantcell.org)
ISAAA.org
GMOAnswers.com
Acsh.org
Sivb.org

prakash@mytu.tuskegee.edu

twitter.com/AgBioWorld

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