

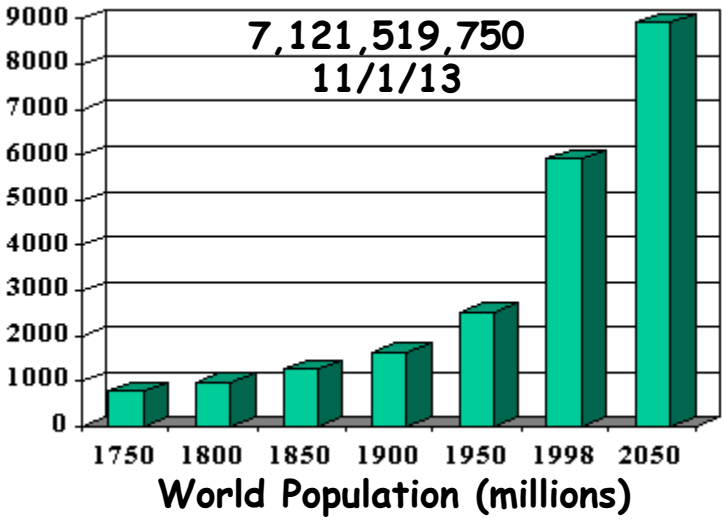

UCLA PARENTS' WEEKEND

SEEDS OF HOPE

BOB GOLDBERG

PROFESSOR OF MOLECULAR, CELL AND DEVELOPMENTAL BIOLOGY


We Face Major Challenges in Agriculture



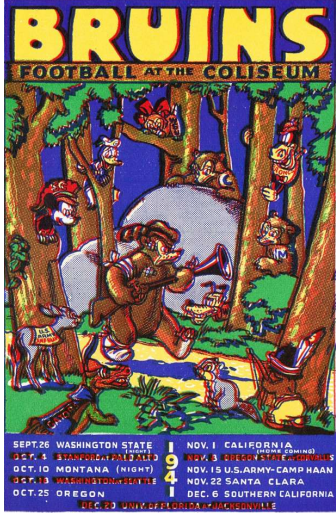
OVER THE NEXT 50 YEARS WE WILL NEED TO PRODUCE MORE FOOD THAN IN THE WHOLE OF HUMAN HISTORY

AND DO IT WITH FEWER INPUTS ON LESS ARABLE LAND!!!!

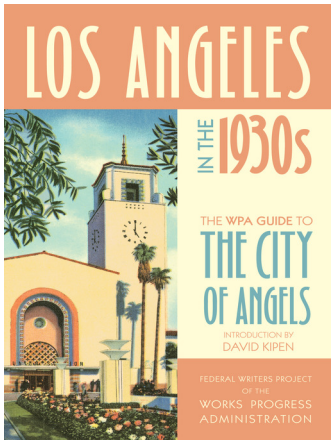
CROP YIELDS NEED TO BE INCREASED SIGNIFICANTLY!!

3,000 Acres/Day of Productive Farmland is Lost to Development Each Day in the United States

"Major Land Uses Overview." USDA, Economic Research Service, Web, April 3, 2013.



An Example From UCLA & Los Angeles History….



Aerial Photograph of UCLA in 1929

Original UCLA College of Agriculture-1930

UNIVERSITY OF CALIFORNIA

BULLETIN

General Catalogue

1939-40

DEPARTMENTS AT LOS ANGELES

For sale by the

STUDENTS COÖPERATIVE BOOK STORE, LOS ANGELES

PRICE, TWENTY-FIVE CENTS

COLLEGE OF AGRICULTURE

THE COLLEGE OF AGRICULTURE of the University of California offers at Los Angeles the Plant Science curriculum and the major in Subtropical Horticulture leading to the Bachelor of Science degree. Students electing other majors in this curriculum may spend the freshman and sophomore years at Los Angeles and then transfer to the campus where their major work is offered. Graduate work in agriculture is also offered which leads to the degrees of Master of Science and Doctor of Philosophy.

Students electing other curricula in the College of Agriculture—Animal Science, Agricultural Economics, Entomology and Parasitology, Forestry, Soil Science, Home Economics, and Agricultural Education—and those electing the curriculum in Agricultural Engineering, may spend the first two years at Los Angeles and then transfer to Berkeley or Davis without serious loss of time. Students who plan to major in Landscape Design are advised to transfer to Berkeley at the beginning of the sophomore year. Students who register at Los Angeles with the intention of later transferring to Berkeley or Davis to pursue other curricula or to obtain majors in the Plant Science curriculum other than Subtropical Horticulture are requested to consult the PROSPECTUS OF THE COLLEGE OF AGRICULTURE and the appropriate adviser in Agriculture at Los Angeles.

108. Fruit Physiology and Storage Problems. (2) I. Mr. Biale

Lectures and discussions, two hours.

Prerequisite: consent of the instructor.

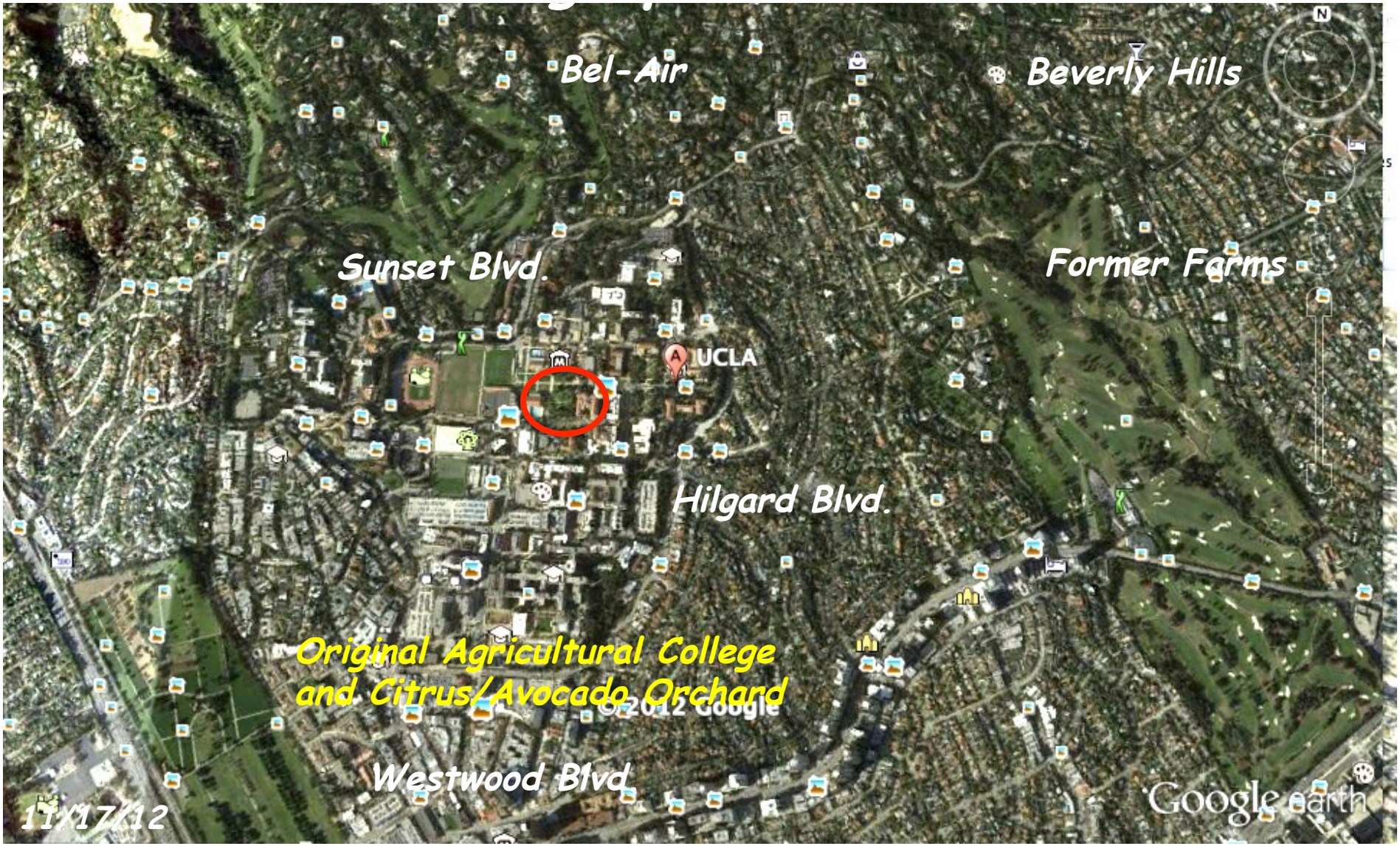
Ripening processes of fruit on the tree; maturity standards and tests; ripening and respiration as affected by ethylene gas treatment; chemical and physiological changes at low temperatures; cold storage and refrigerated gas storage; role of volatile substances; differences in species and varietal responses.

Origins of Avocado Research

Avocado Rootstock Progeny Nursery on the UCLA Campus in 1936

CA Schroeder, Cal. Avocado Year Book, 1992

Aerial Photograph of UCLA in 2013



Los Angeles Population = 3,893,000

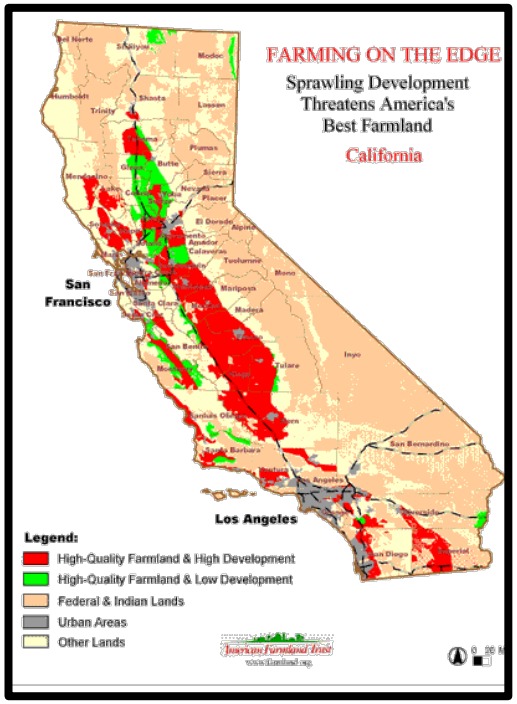
What Happened to the UCLA College of Agriculture?

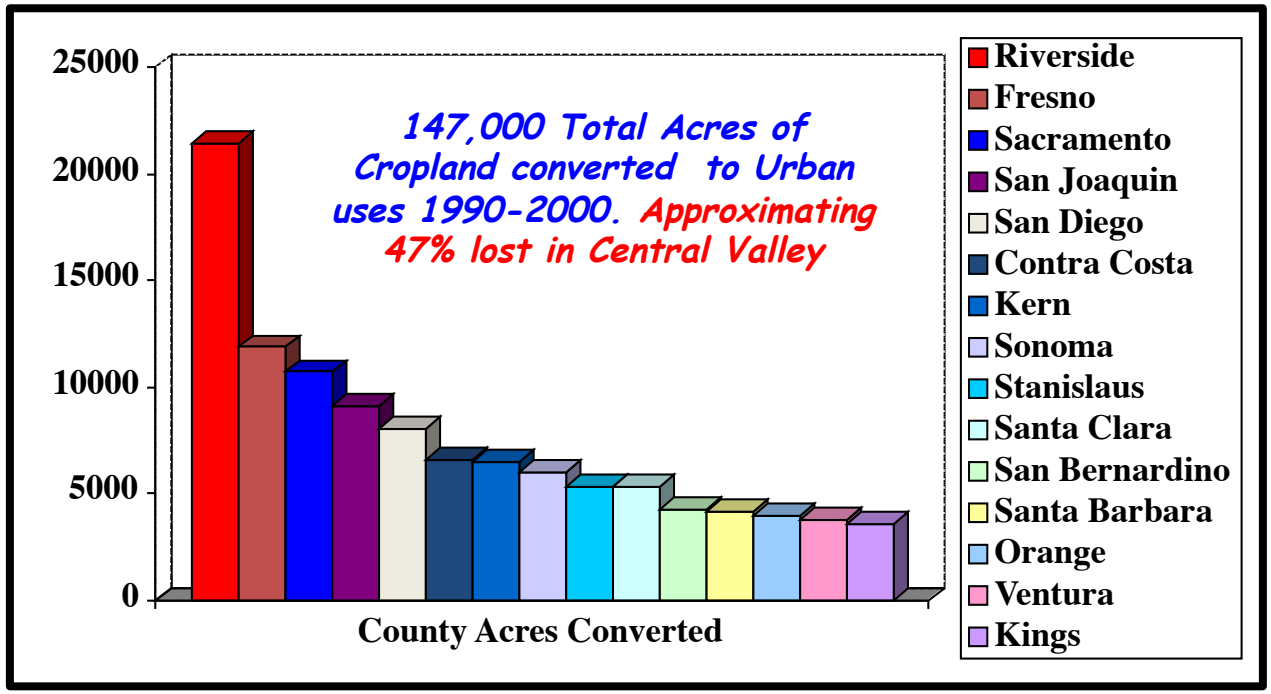
UNIVERSITY OF CALIFORNIA
UC RIVERSIDE | College of Natural & Agricultural Sciences

Agricultural Experiment Station
1907 2007
University of California, Riverside

Far left, the parasitic wasp *Gonatocerus triguttatus* was evaluated at the Citrus Experiment Station (CES) for biological control of the glassy-winged sharpshooter. *Left and above,* in 1918, CES moved from Mt. Rubidoux near downtown to the site that would become UC Riverside.

California Conversion of Cropland to Urban Uses is Occurring Statewide – Crop Yields Need to Be Increased!!





12,000,000 Total Acres of Cropland

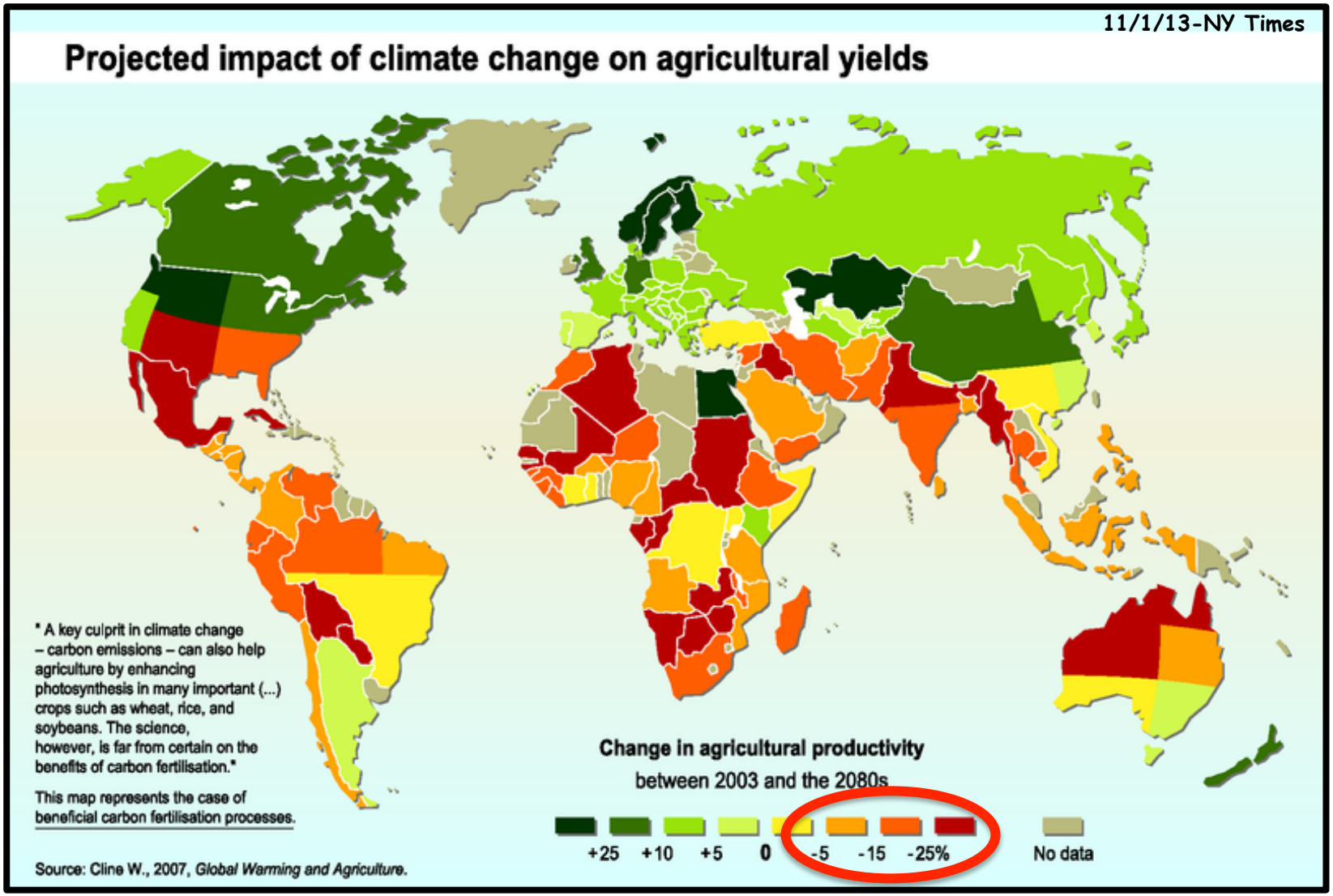
15,000,000 Total Acres of Grazing Land

Los Angeles Times May 25, 2003

Climate Change Will Also Have a Major Impact on Crop Yields in the Future!

Climate Change Seen Posing Risk to Food Supplies

11/1/13-NY Times



How Have Crop Yields Increased Over the Past 100 Years?

Big Changes in the US Over The Past 100 Years

"We've Come a Long Way Baby"

	1900	2013
Life Expectancy	48 (women)	81 (women)
Average Family Income (2013 Dollars)	$8,000	$50,000
Gasoline Use Per Capita	34 gallons	1,100 gallons
Flush Toilets Per Housing Unit	10%	99%
High School Grads	13%	90%
Farm Workers	55%	1.5%

CROP YIELD INCREASES HAVE "ROCKETED UPWARDS" OVER THE LAST 100 YEARS AND CONTRIBUTED TO A LONGER AND "BETTER" LIFE

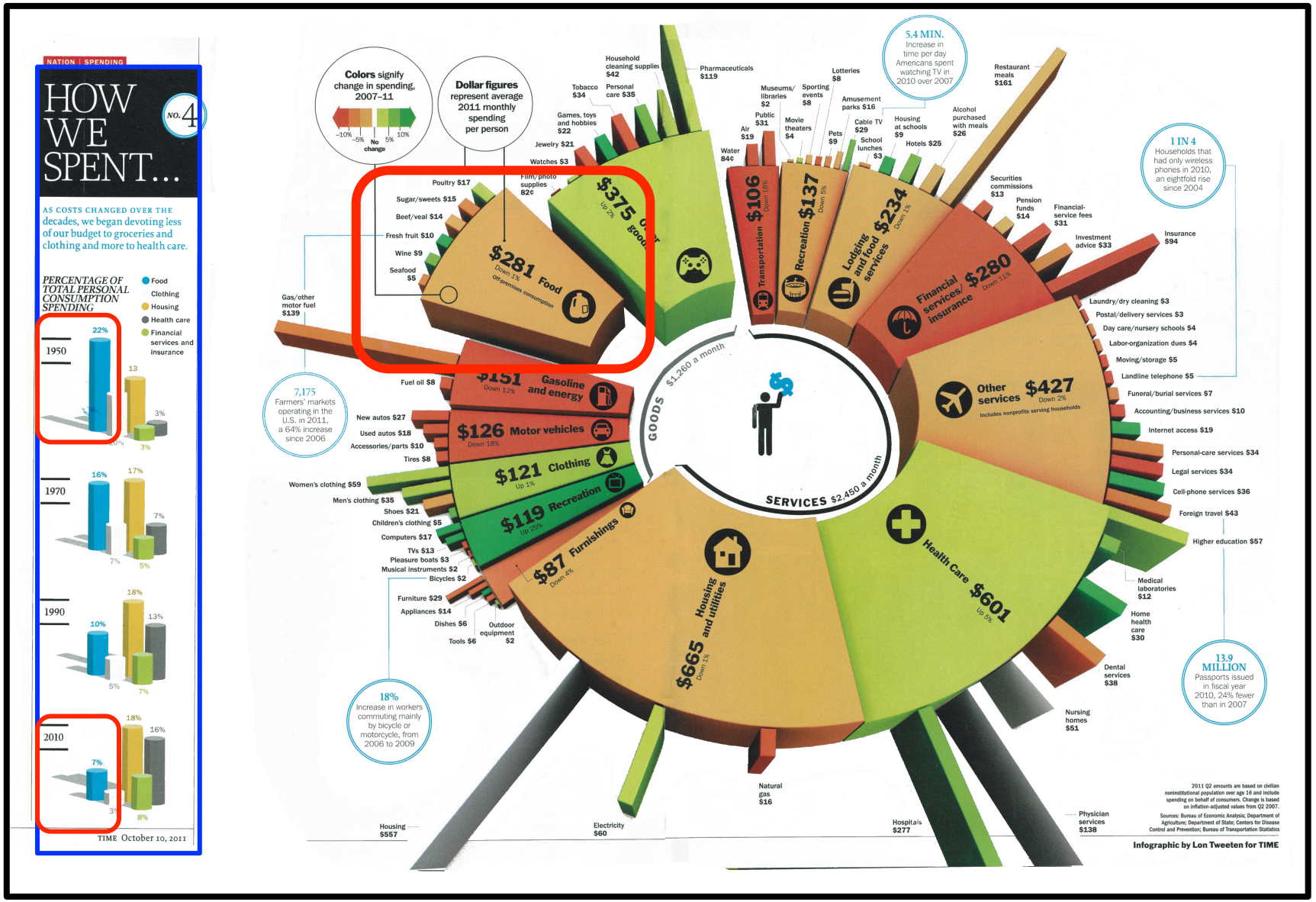
% Farm Workers	% Income on Food		Bushels/Acre	Life Span
55%	50% →	• 1900	30	← 48 Years
		• 1920	30	
		• 1940	40	
		• 1960	60	
	22% →	• 1980	100	
1.5%	7% →	• 2013	155	← 80 Years

1930: 30 bushels/acre
1930: 1 farmer fed 10 people

2013: 155 bushels/acre
2013: 1 farmer feeds 200 people

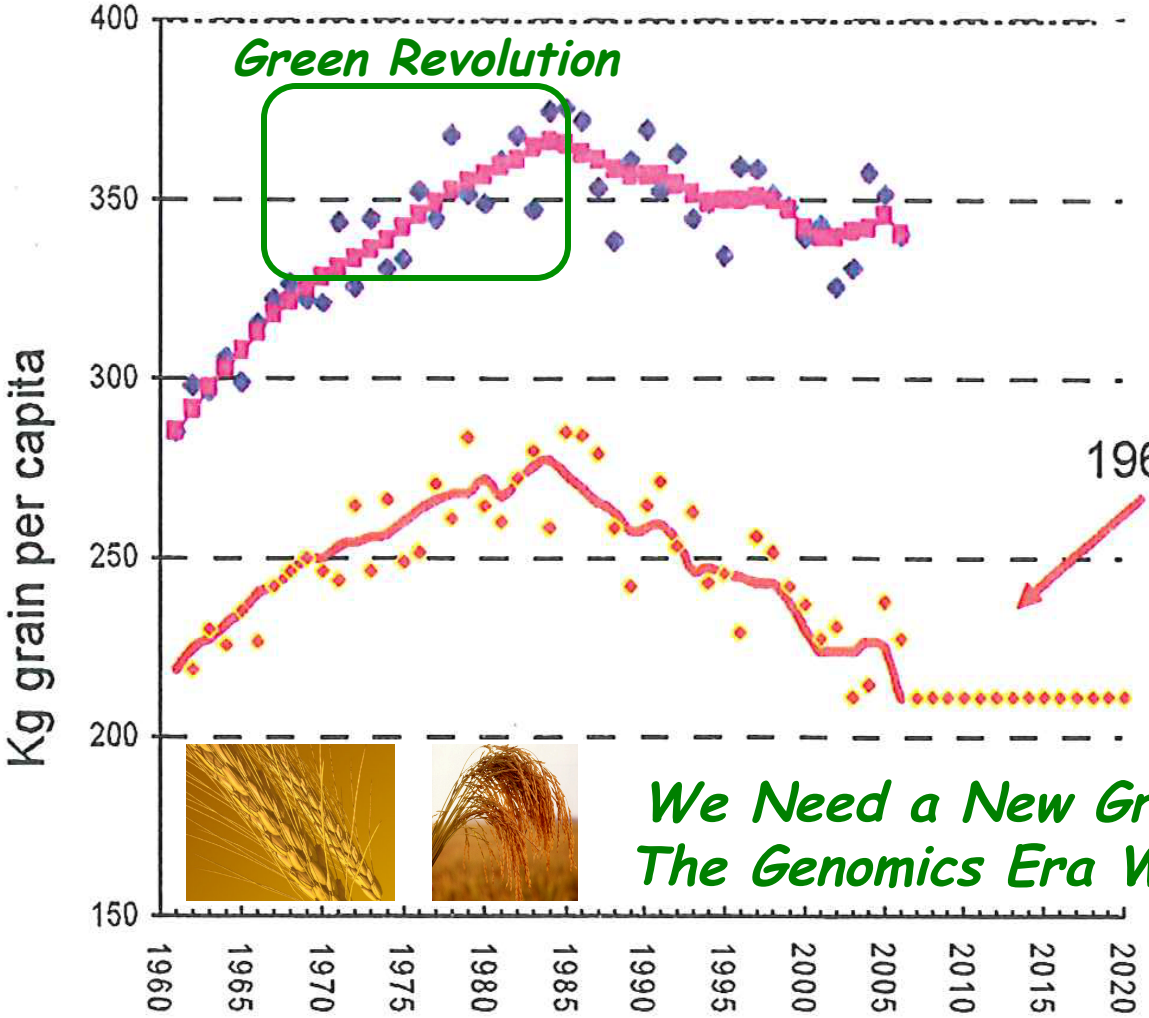
Conclusion: Crop yields increased >500% over the past 100 years and lead to a similar reduction in food costs!!!!!

Only 7% of Our Monthly Budget is Spent on Food!



Time Magazine-2011

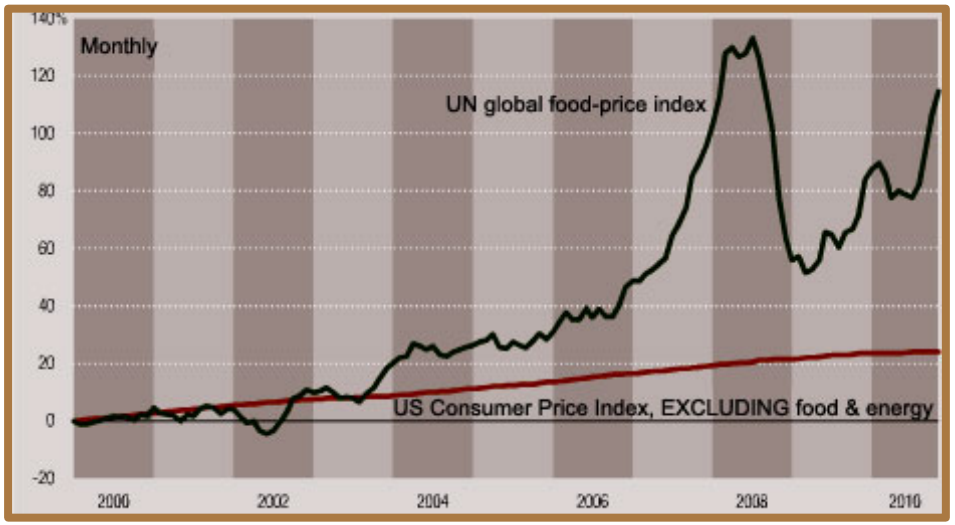
World Crop Production is Leveling Off on a Per Capita Basis-a Warning Sign!

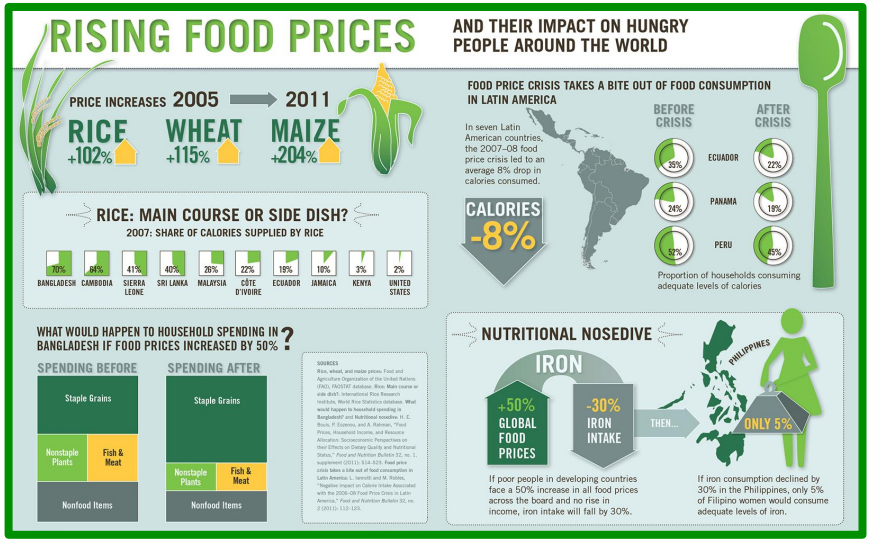


We Need a New Green Revolution……
The Genomics Era Will Be the Driver!

Per Capita Cereal Production

World Crop Production is Leveling Off on a Per Capita Basis-Higher Prices Ahead?



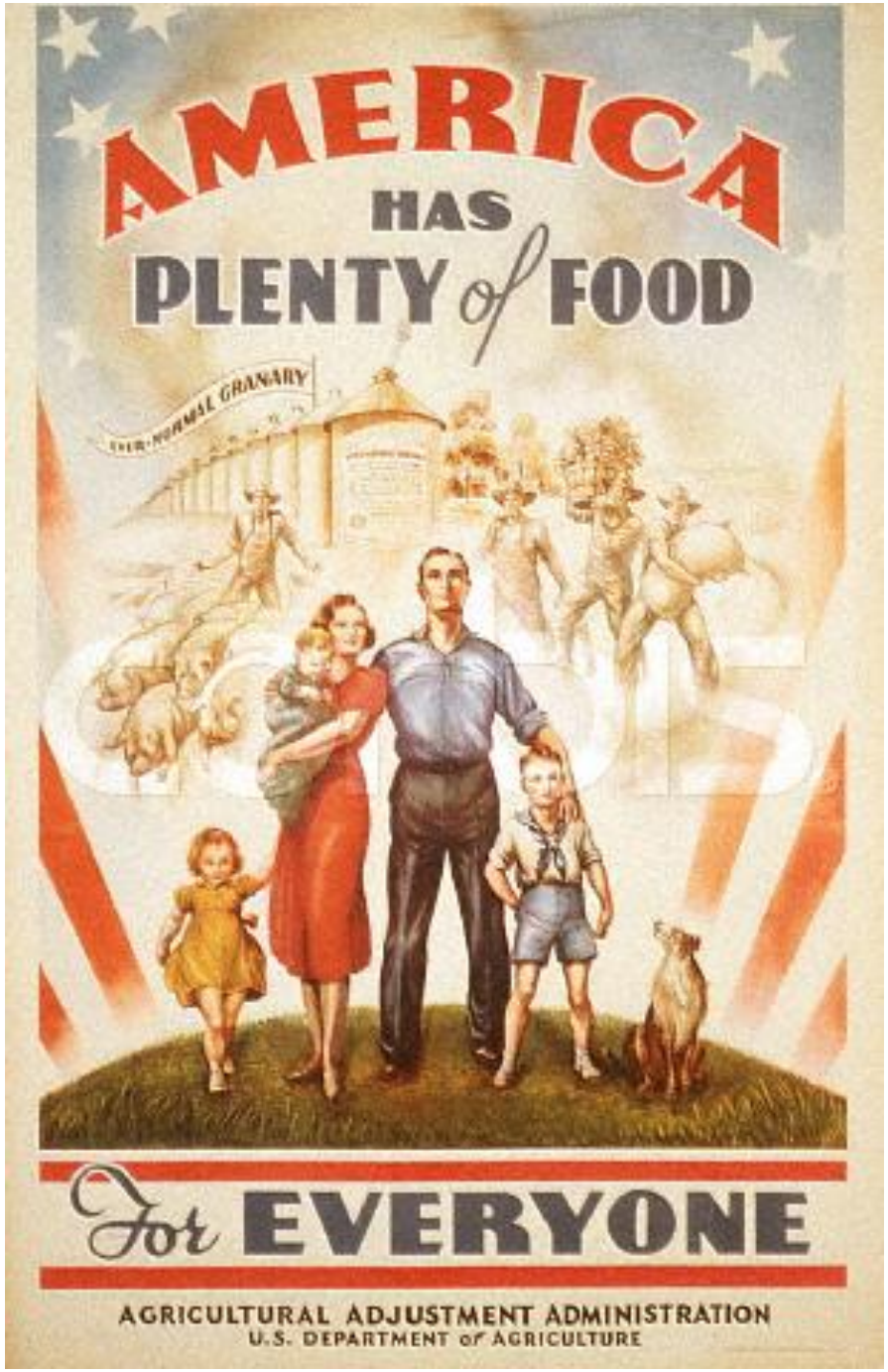


Food riots fear after rice price hits a high

Rising food prices: A global crisis

Action needed now to avert poverty and hunger

Yields Need to Increase to Produce More Food & Grow More on Less Land



How Was This Accomplished Over the Past 100 Years?

What Role Did Science & Technology Play in Increasing Crop Yields?

What About in the Future When There are 350 Million People in the USA and 9 Billion in the World?

How Were Crop Yields Increased?

WHAT TECHNOLOGIES CAUSED AN INCREASE IN CROP YIELDS OVER THE PAST 100 YEARS?

- PLANT BREEDING (New Hybrids-Green Revolution)
- IRRIGATION
- FERTILIZERS
- PESTICIDES & HERBICIDES
- MECHANIZATION (e.g., Tractor)
- GLOBAL POSITIONING AND SATELLITE IMAGING
- GENOMICS & GENETIC ENGINEERING (New Traits)

These technologies have resulted in a >300% increase in US crop productivity!

Need to sustain this yield increase by applying the best technology and agricultural practices!

The Past 100 Years Has Produced a Revolution in Genetic Research and Knowledge Leading to Remarkable Advances in Medicine and Agriculture

1900: Rediscovery of Mendel's Work

DeVries, Correns and Tschermak independently rediscover Mendel's work.

Three botanists - Hugo DeVries, Carl Correns and Erich von Tschermak - independently rediscovered Mendel's work in the same year, a generation after Mendel published his papers. They helped expand awareness of the Mendelian laws of inheritance in the scientific world.

The three Europeans, unknown to each other, were working on different plant hybrids when they each worked out the laws of inheritance. When they reviewed the literature before publishing their own results, they were startled to find Mendel's old papers spelling out those laws in detail. Each man announced Mendel's discoveries and his own work as confirmation of them.

1909: The Word Gene Coined

Danish botanist Wilhelm Johannsen coined the word gene to describe the Mendelian units of heredity.

He also made the distinction between the outward appearance of an individual (phenotype) and its genetic traits (genotype).

Four years earlier, William Bateson, an early geneticist and a proponent of Mendel's ideas, had used the word *genetics* in a letter; he felt the need for a new term to describe the study of heredity and inherited variations. But the term didn't start spreading until Wilhelm Johannsen suggested that the Mendelian factors of inheritance be called *genes*.

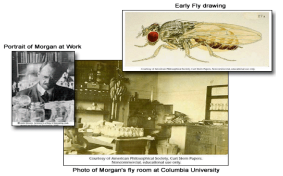
The proposed word traced from the Greek word *genos*, meaning "birth". The word spawned others, like *genome*.

1911: Fruit Flies Illuminate the Chromosome Theory

Using fruit flies as a model organism, Thomas Hunt Morgan and his group at Columbia University showed that genes, strung on chromosomes, are the units of heredity.

Morgan and his students made many important contributions to genetics. His students, who included such important geneticists as Alfred Sturtevant, Hermann Muller and Calvin Bridges, studied the fruit fly *Drosophila melanogaster*. They showed that chromosomes carry genes, discovered genetic linkage - the fact that genes are arrayed on linear chromosomes - and described chromosome recombination.

In 1933, Morgan received the Nobel Prize in Physiology or Medicine for helping establish the chromosome theory of inheritance.



1973: Genetic Engineering is Invented

Biochemists working in California have developed a practical method of transplanting genes, the chemical units of heredity, from cells as complex as those of animals into the extremely simple, fast-multiplying cells known as bacteria. [END OF FIRST PARAGRAPH]

SAVE

1983: First Genetically Engineered Plant

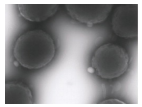
1990: First Genetically Engineered Human

2004: Refined Analysis of Complete Human Genome Sequence

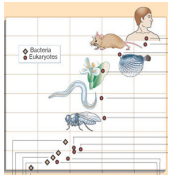
The International Human Gene Sequencing Consortium led in the United States by the National Human Genome Research Institute and the Department of Energy published a description of the finished human gene sequence. The analysis reduced the estimated number of genes (which as recently as the mid-1990's had been ~100,000) from 35,000 to only 20,000-25,000. The fact that the human genome has far fewer genes than was originally thought suggests that humans "get more" out of their genetic information than do other animals. For example, the average human gene is able to produce three different gene products.

The finished sequence contains 2.85 billion nucleotides interrupted by only 341 gaps. It covers 99 percent of the genome with an accuracy of 1 error per 100,000 bases. Researchers confirmed the existence of 19,599 protein-coding genes and identified 2,188 other DNA segments that are thought to be protein-coding genes. Although the genome sequence is described as "finished," it isn't perfect. The small gaps that remain cannot be sequenced by the industrial-scale methods used by the Human Genome Project. Filling in these gaps will have to await a series of small targeted efforts by researchers using other techniques and possibly new technologies. The finished genome sequence can be freely accessed through public databases and may be used by researchers without restrictions.

20110: Era of Synthetic Biology Begins – Genome Synthesized From Chemicals

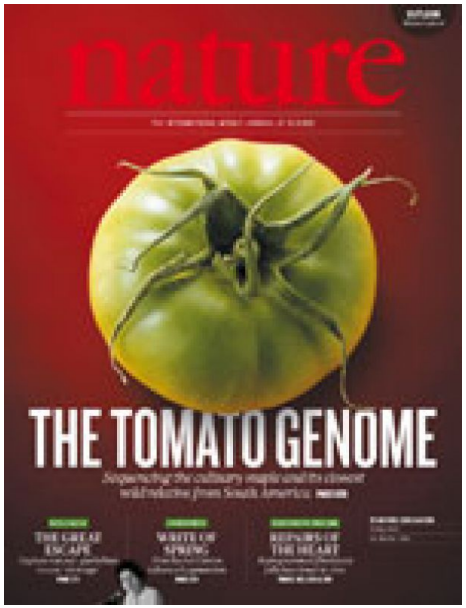


2013 : Genome Sequencing Explosion



2100??

2013 - All Major Crop Genomes Have Been Sequenced!!

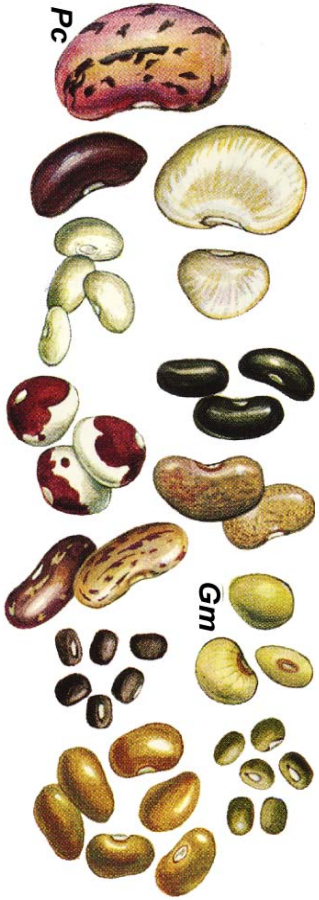


How Will Crop Yields Be Increased in the Future?

…By Using a Variety of Approaches to Identify Genes and Processes That Will Help Increase Crop Yields and Food Production Significantly in the 21st Century….

Yield (Developmental Traits)

- Seed Number
- Seed Size
- Growth Rate
- Organ Size (More Seeds)
- Plant Architecture
- Flowering Time
- Senescence
- Maturity
- Stature

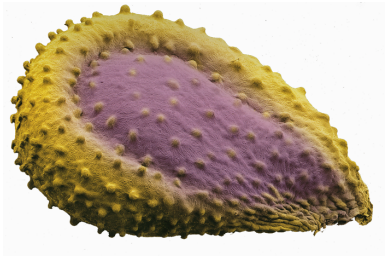


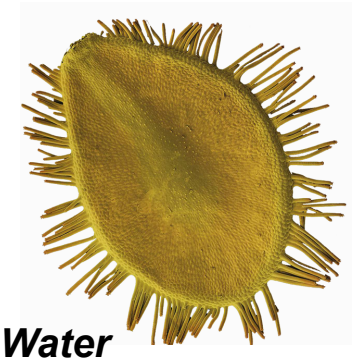
Yield (Stress Traits)

- Nutrient Uptake
- Drought Resistance
- Heat Resistance
- Cold Tolerance
- Salt Tolerance
- Shade Tolerance
- Disease Resistance

…….And by Using Genomics, Breeding, and Genetic Engineering to Introduce These "Yield" Genes Into Crops (One thing we can be sure of-we can't predict what new technology will be the driver 10-25 years out!)

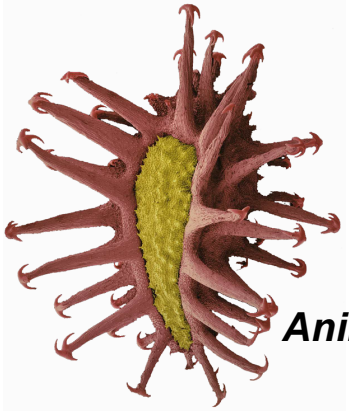
So……Why Seeds??



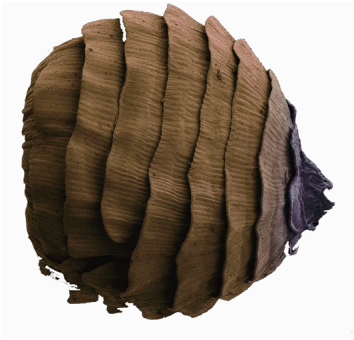


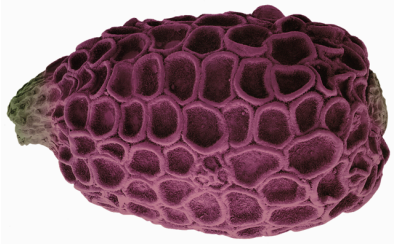
Water

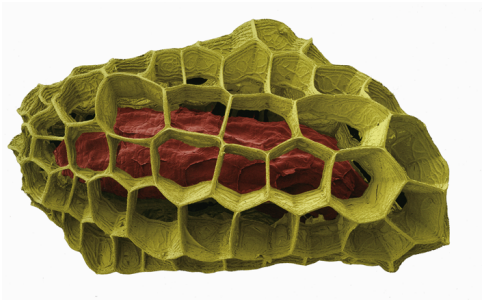
Wind



Animals







Seeds Protect and Disperse Plant Embryos
and Come in Many Shapes and Sizes!

Most Importantly….. Our Food is Derived From Fifteen Crops & Over Half Produce Seeds For Human and Animal Consumption

Seed Crops

- Wheat
- Rice
- Corn
- Barley
- Sorghum
- Soybean
- Common Bean
- Coconut
- Canola

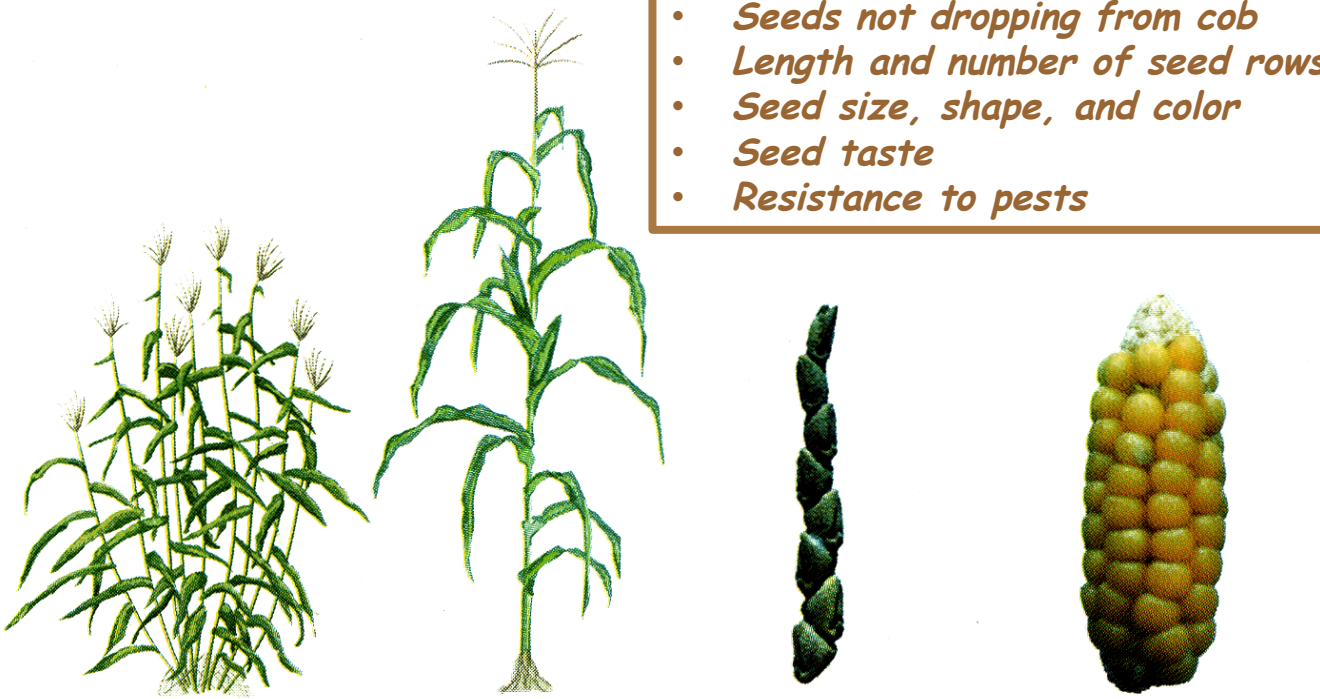
Non-Seed Crops

- Potato
- Sweet Potato
- Cassava
- Sugar Beet
- Sugar Cane
- Banana

In Some World Populations 75% of Calories Are Derived From Seeds!

All Crops Have Been Engineered -Turning Wild Teosinte Into Domesticated Corn 10,000 Years Ago – Seed & Pant Engineering!!

- Types & amounts of seed starch production
- Seeds not dropping from cob
- Length and number of seed rows
- Seed size, shape, and color
- Seed taste
- Resistance to pests

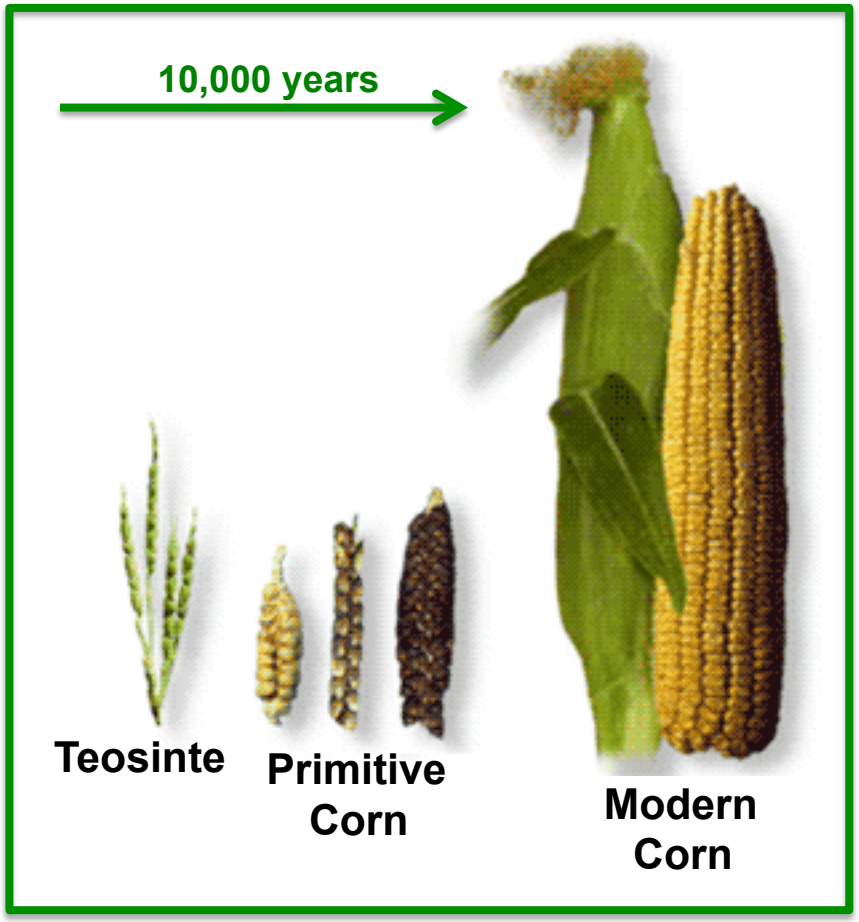


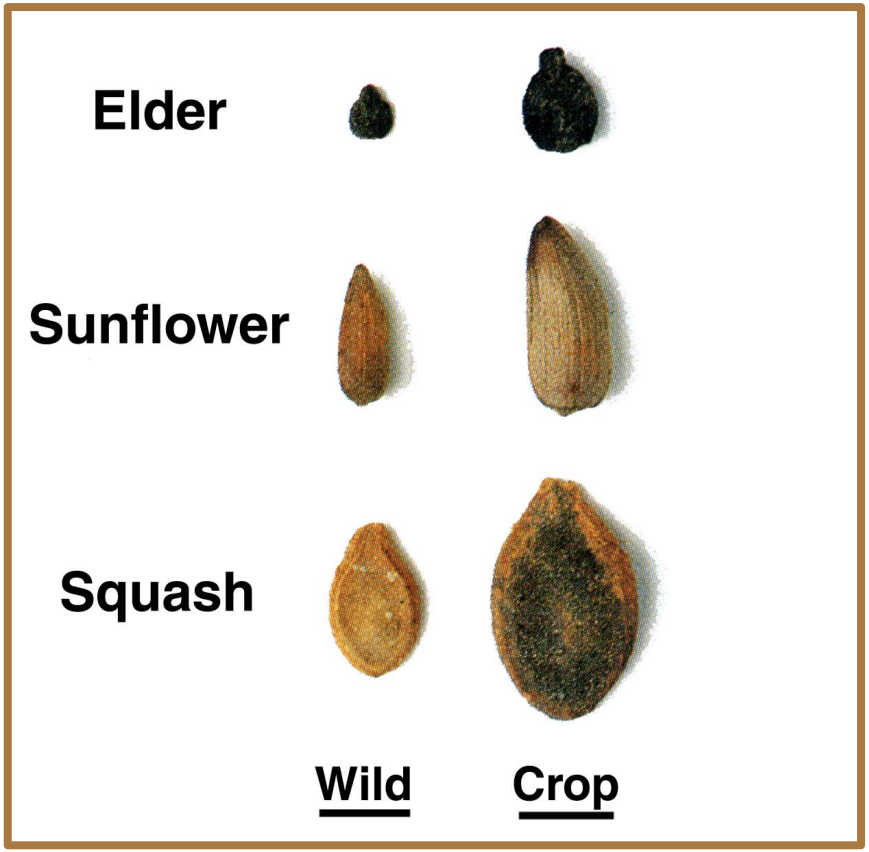
Teosinte | Domesticated corn | Teosinte | Early domesticated corn

Note: Architecture and Fruit (cob) Size

Only Five Genes Cause These Plants to Differ & We Now Know What They Are

"Manipulating" Plants to Increase Seed Yield Is Not New…….. Seed Size!





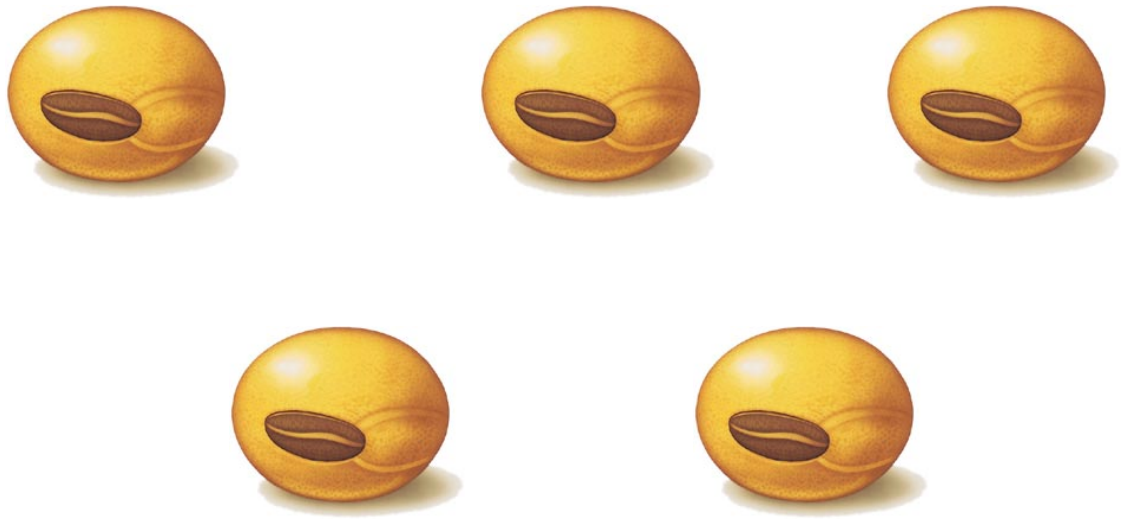
All Vegetables in Grocery Store are "GMOs!!"

Diversity of Oil Seed Plants

Why Soybean?-A Reminder

- Second Major US Crop
- Total Crop Value $32Billion
  (50% Value Exported)
- Important Biofuel Source
  (Biodiesel~20% of US Soybean Oil Production)
- Excellent Model Plant
  (Transformation, Knockdowns, Genetics)
- Genome Sequenced
- Major Food Source

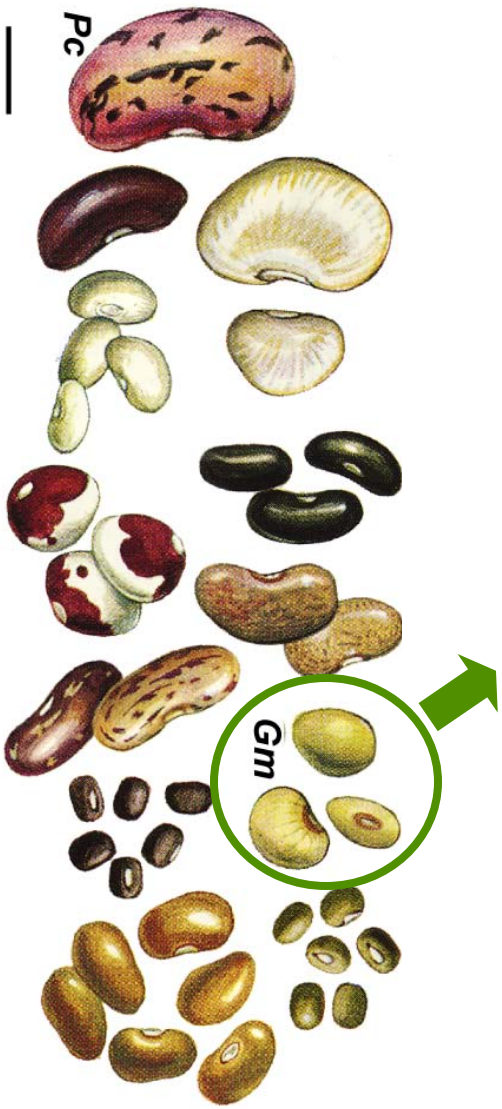
How Is a Seed Formed?



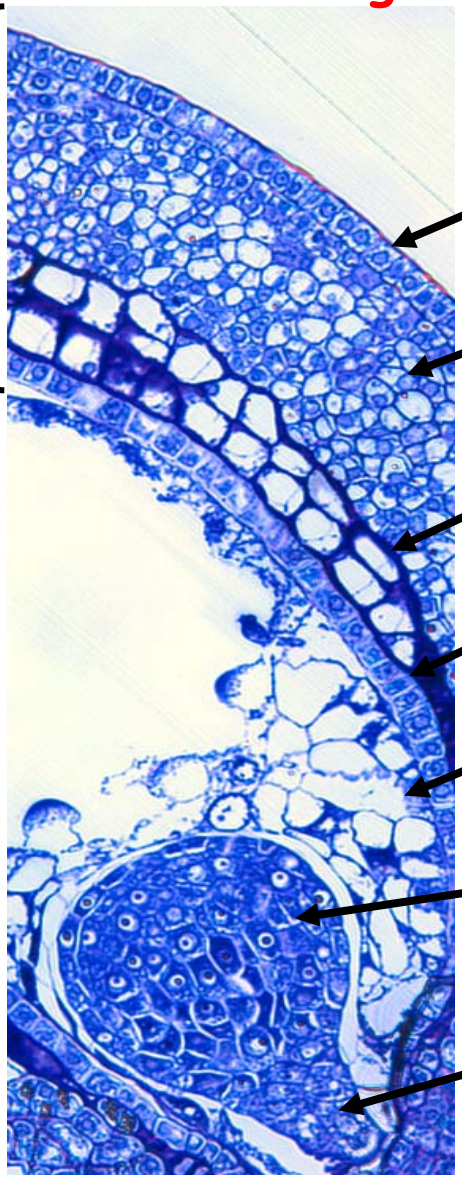
In the Beginning....

http://estdb.biology.ucla.edu/seed/presentation

Goal - What Are the Genes Required to Make a Seed?



Globular-Stage



Seed coat (Protection)

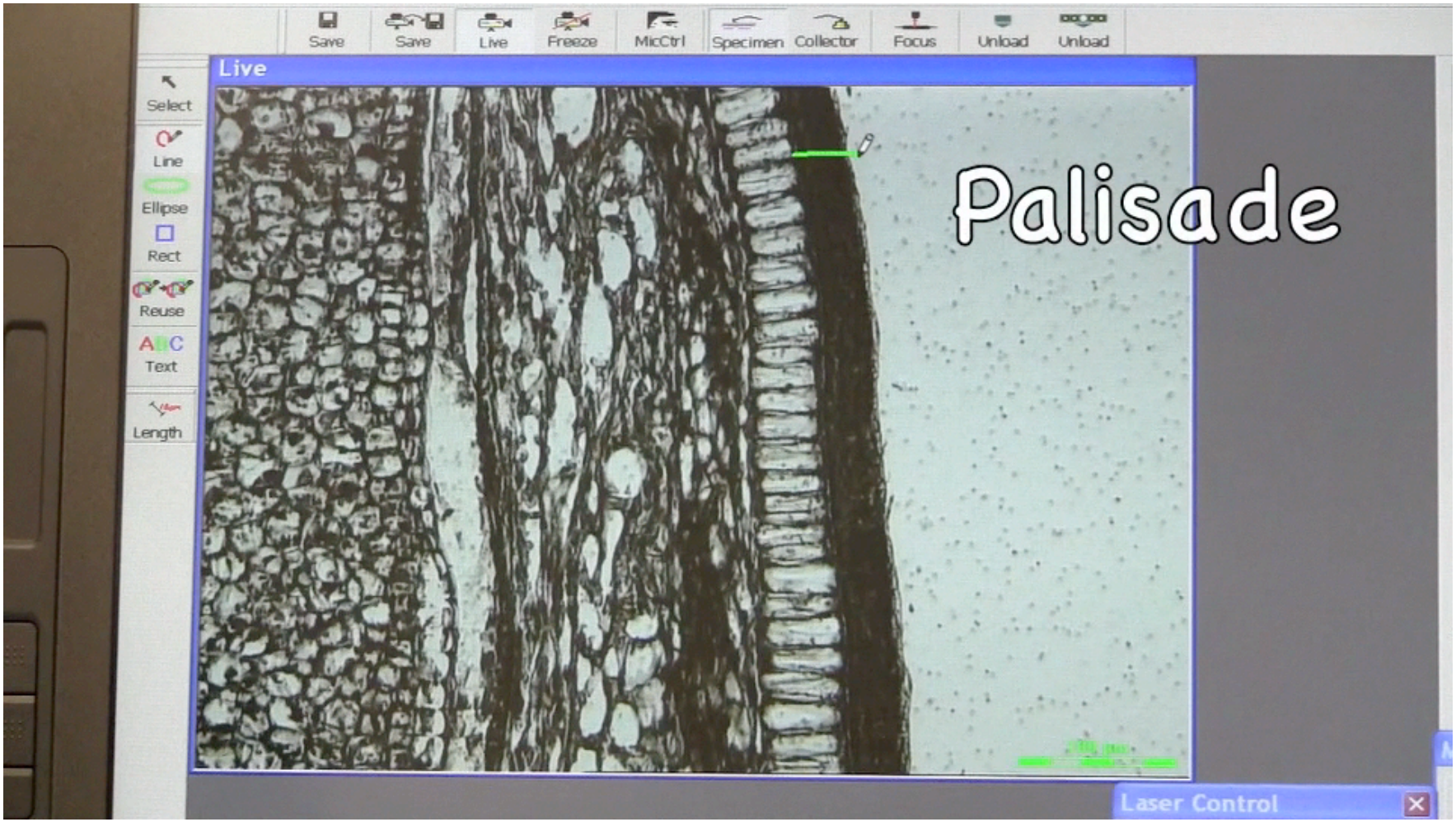
Endosperm (Nourishment)

Embryo (Next Generation)

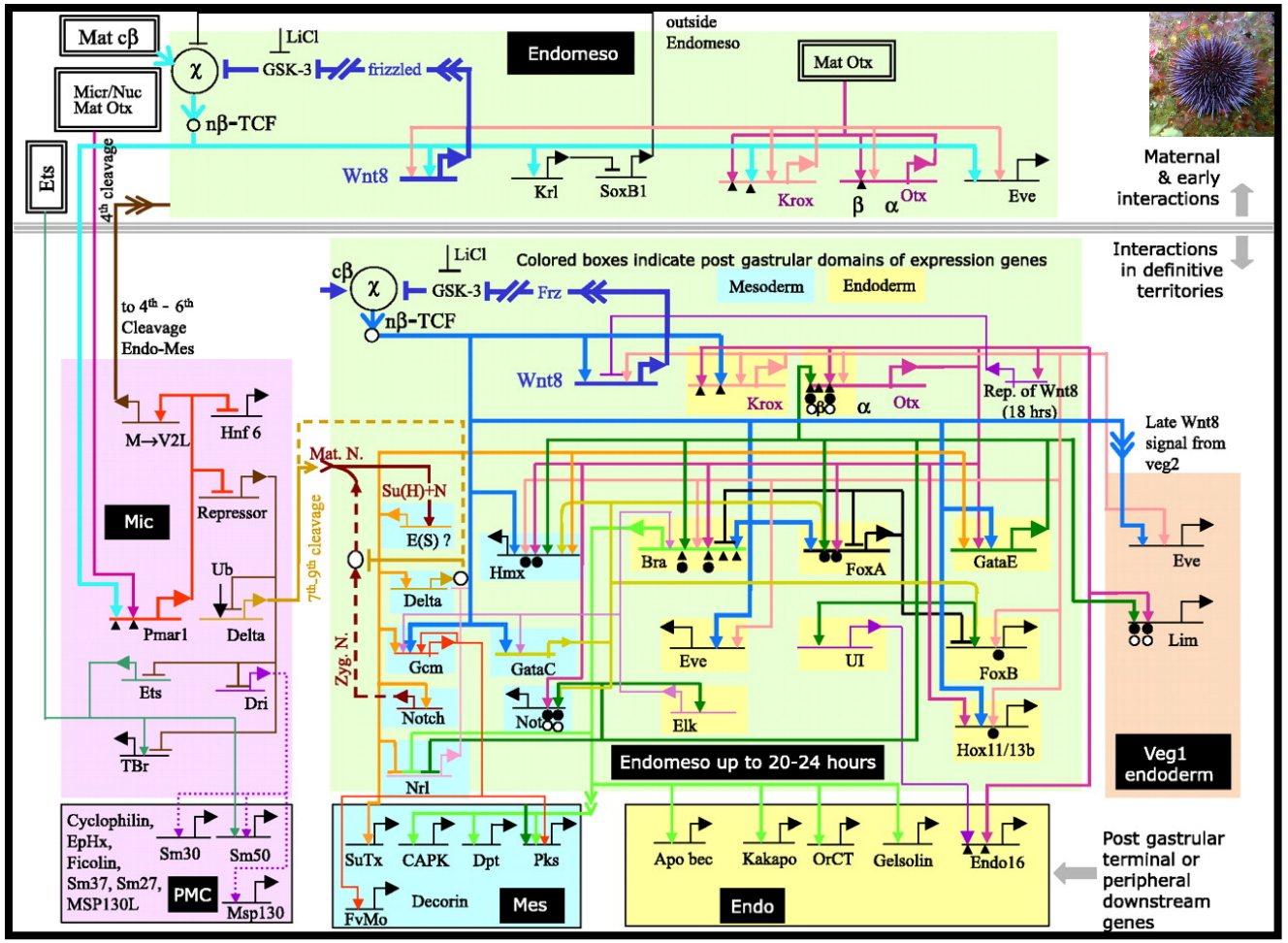
- Epidermis
- Outer Integument
- Inner Integument
- Endothelium
- Endosperm
- Embryo proper
- Suspensor

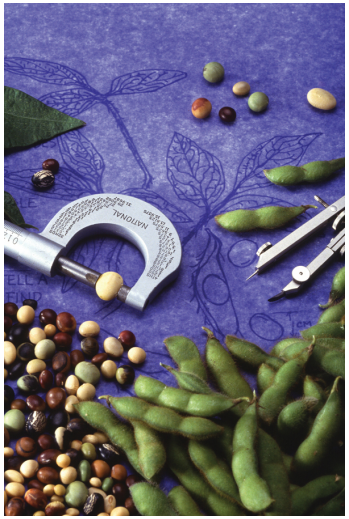
And How Are They Wired in a Plant Genome?

Using Lasers & Genome Sequencing to Identify Genes in Every Cell, Tissue, & Region Required to Make a Seed



Ultimate Goal……To Uncover Regulatory Genes and Circuits Driving Seed Differentiation and Development Using Genomics to Increase Seed YIELD!





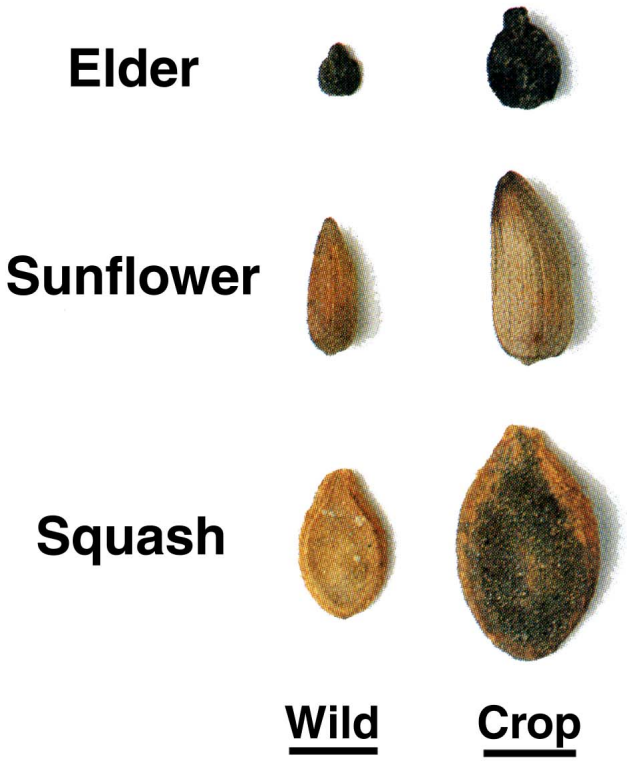
Learn How To Make a Seed To Engineer….

- Big Seeds
- More Seeds
- More Yield
- Increased Food and Fuel

Eric Davidson et al. Science, 2007

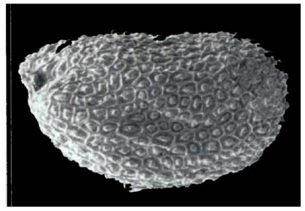
Using Modern Genetic Tools to Engineer For Seed Size

Engineering Bigger Seeds 10,000 Years Ago



Our American Ancestors, 10,000 BC

Engineering Bigger Seeds Today



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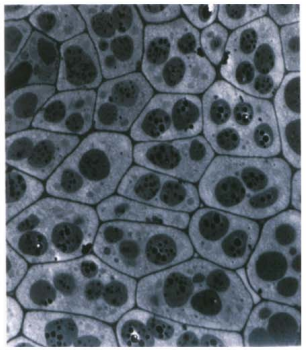
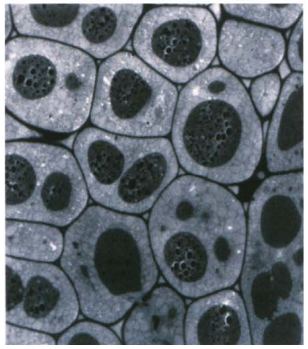


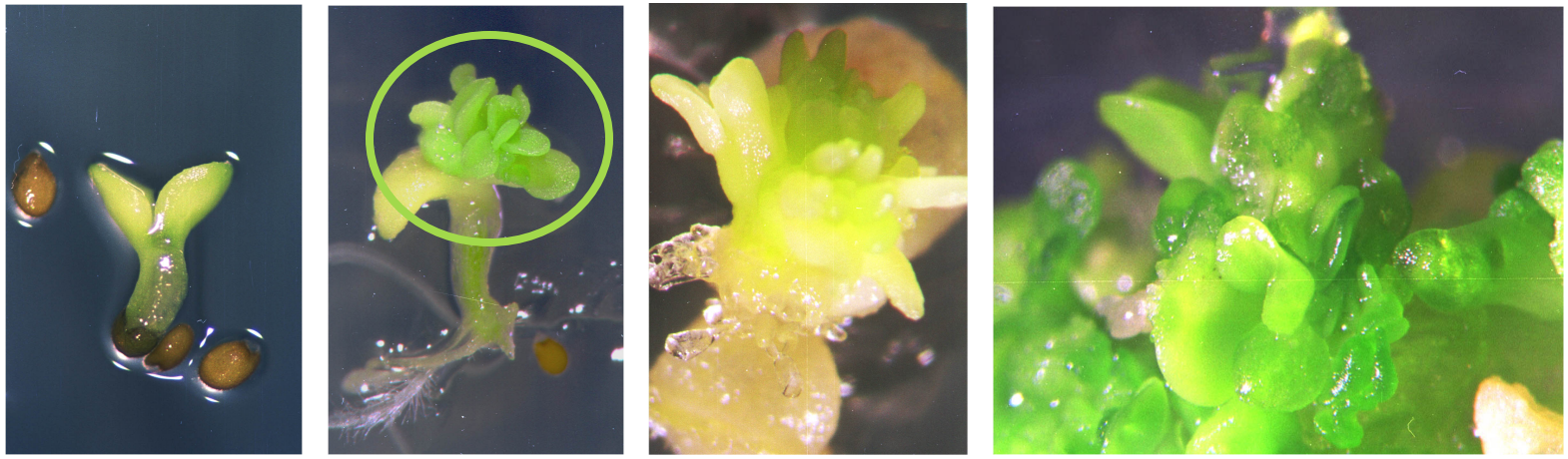
ap2-10

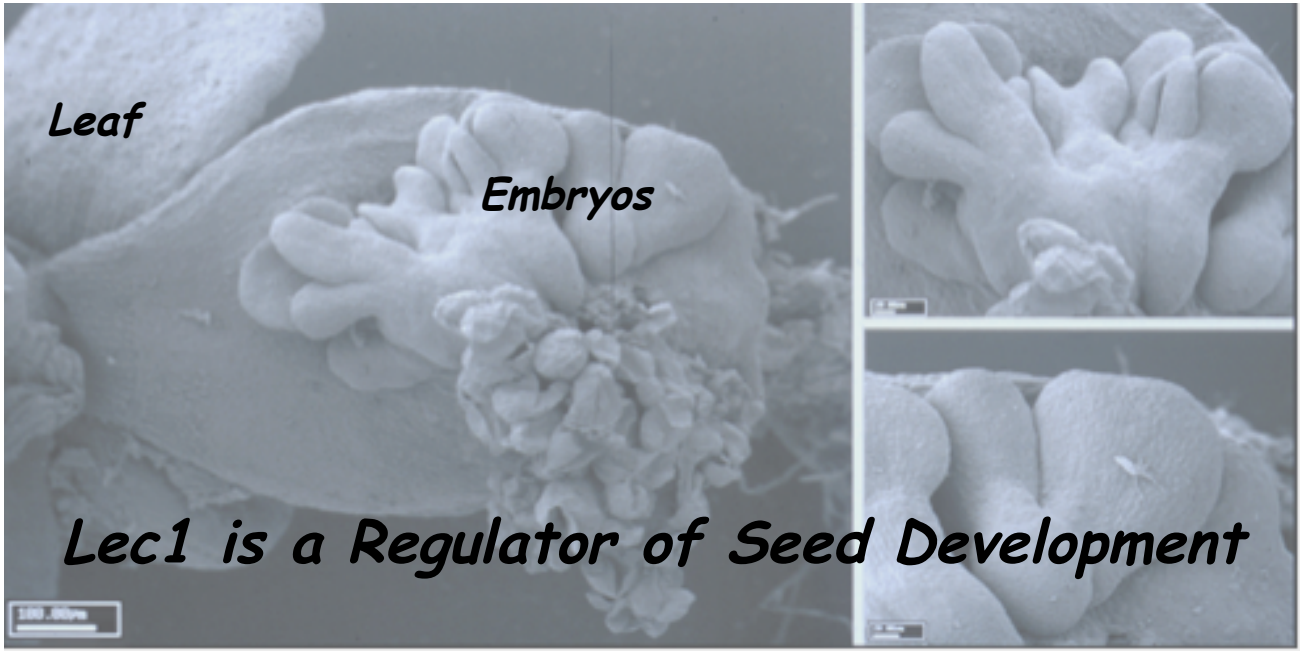


But Need to Identify the Critical Genes

Jofuku et al., PNAS, 2005

Seed Regulators to "Engineer" Seeds on Leaves!





Imagine the Possibilities

Lotan et al., Cell, 1998; Lee et al., PNAS, 2003; Kwong et al., Plant Cell, 2003

Plants Have Been Engineered For Large Numbers of Traits in Laboratories Around the World –And More Exciting Traits to Come!

Tens of Thousands of Genetic Engineering Experiments!!

Genetically Engineered Traits

Improving Pest and Weed Management

- Herbicide tolerance
- Virus resistance
- Insect resistance
- Bacterial resistance
- Fungal resistance

**Chemical Free* Crops*

Improving Agronomic Properties

- Altering cold sensitivity
- Improving water stress tolerance
- Improving salt tolerance
- Improving nutrient uptake
- Drought Resistance*

Crops in Desert & Drought

Improving PostHarvest Qualities

- Delay of fruit ripening
- Delay of flower senescence/timing
- High-solids tomatoes
- High-starch potatoes
- Sweeter vegetables

Longer Lasting Crops

Improving Plant Breeding

- Male sterility; production of hybrid seeds

Improving Nutritional Quality

- High-methionine and high-lysine seeds
- Decaffeinated Coffee*
- Vitamin-enriched grains
- Allergen-free seeds/grains*

**Healthier* Crops*

Molecular Farming

- Oils
- Starch
- Plastic
- Enzymes, Pharmaceuticals
- Ethanol/Transportation Fuel*

*Crops as Factories & *Vaccines**

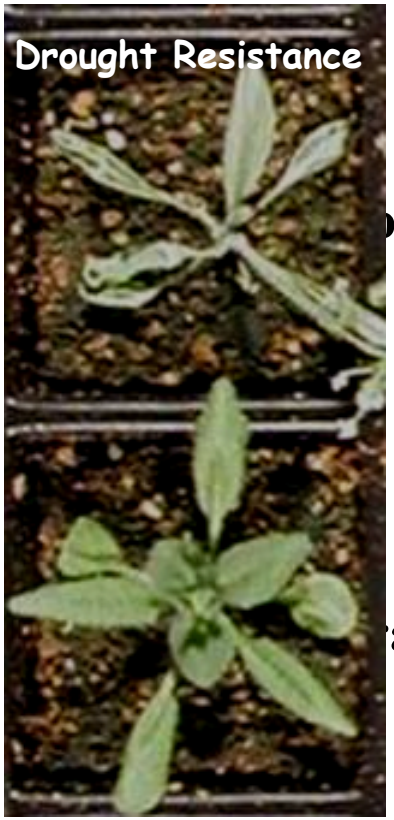
Detoxifying Contaminated Soils

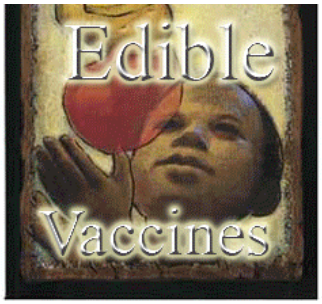
Crops to Clean Environment

But Only a Few Have Helped Generate New Crops!

The "Simple Ones With Economic Drivers"

Genetic Engineering Examples






INSECT
RESISTANCE
with Bt
CONTROL
Bt

Genetic Engineering - Most Rapidly Adopted Technology in Agricultural History

Global Status of Commercialized Biotech/GM Crops in 2012

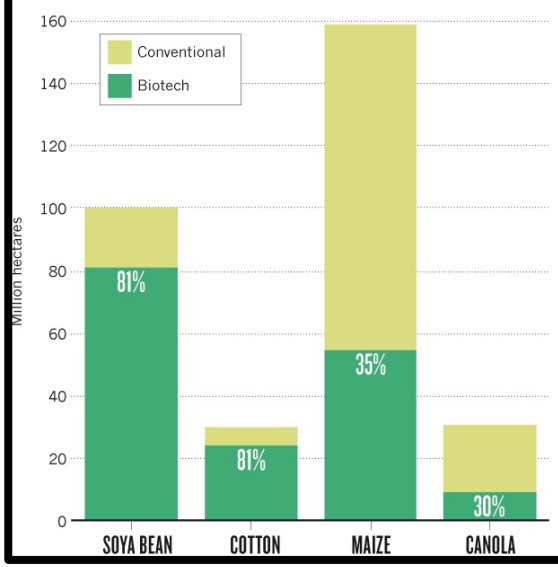
17 million farmers in 28 countries planted **170** million hectares of biotech crops

12% of Land in Cultivation

For the first time, developing countries grew more biotech crops than industrial countries.

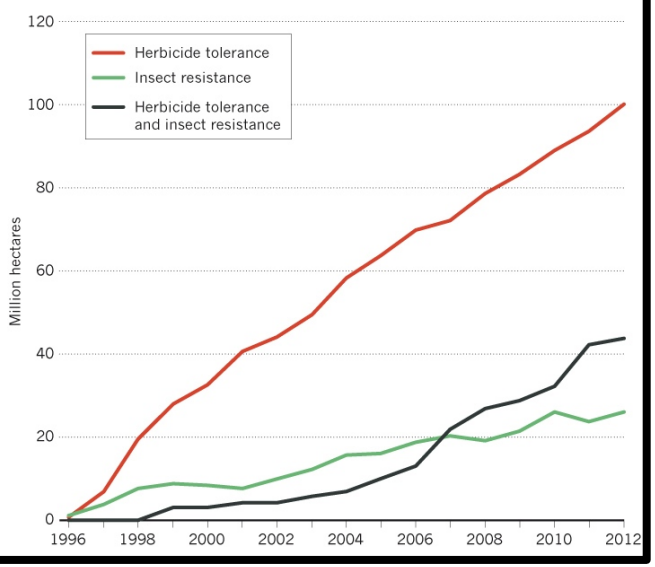
Popular crops

GM soya bean, maize (corn), cotton and canola crops accounted for nearly all GM crops grown in 2012.



Popular traits

Of some 30 traits that are currently engineered into plants for commercial use, the most popular are those that confer herbicide tolerance, insect resistance or both 'stacked' traits.







Some Benefits of Biotech Crops –Dispelling the Myths (1996-2013)

- Increased Crop Value by $78B
- ~75% of Crop Added Value Went to Small Farmers
- Reduced Pesticide Use 10% or 200M Pounds!
- Reduced CO_2 Emissions by 40B Pounds or the Equivalent of Taking 9M Cars Off the Road
- Saved Billions of Tons of Topsoil by Using No-Till Farming (1B per year)
- Improved the Health of Farmers in Developing Countries (Reduced Pesticides)
- Contributed to Reduced Food Costs in the US and Elsewhere

However…There's a Battle Raging to Get Bioengineered Crops Banned in Many Parts of the World

YES 37 Right to Know GMO
LABEL GENETICALLY ENGINEERED FOODS

YES ON 522
LABEL GENETICALLY ENGINEERED FOODS

NO GMOs

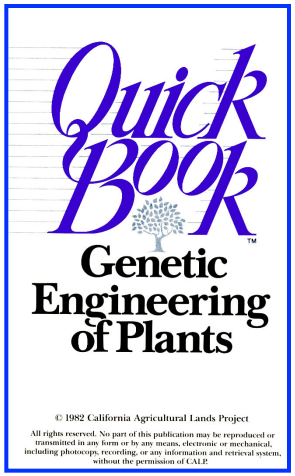
Los Angeles Proposes Banning GMOs

NO ON 37
STOP THE DECEPTIVE FOOD LABELING SCHEME

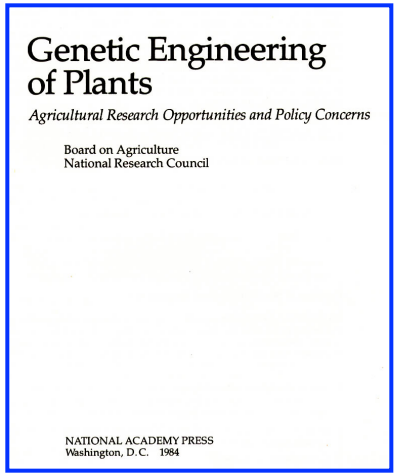
The GMO "Controversy" is Complex and Not Science Based

- Organic Growers/Markets - Gain Market Share (Follow the $!!)
- Pollen Flow & Transgene "Contamination" - Native Species "Contamination" With GMO Transgenes
- Ideology /Anti-Technology /Anti-Science/ Not "Natural"
- Labeling - Right to Know and Choose What is Eaten (CA-Proposition 37)
- No "Obvious" Consumer Benefit
- Unsafe – "Perceived" Negative Health Effects
- Mistrust of International/US Corporations (Monsanto!)/ Anti-Market
- Anti-Globalization - Anti-Patent/Intellectual Property
- Ecological & Environmental Issues - Lack of Confidence in Government - No Strong USDA, FDA, or EPA Tradition in Europe (Protect Food Supply - Mad Cow - Dioxin)!
- Industrial-Oriented Conventional Farming That Uses GMOs
- Lack of Public Science Awareness

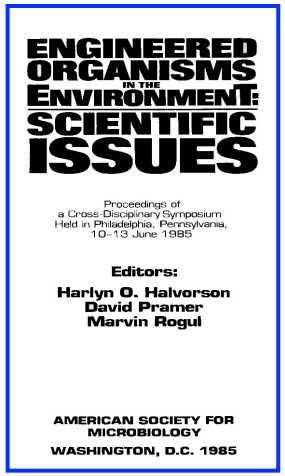
Safety Issues of Genetically Engineered Plants Have Been Investigated and Discussed For 30 Years -Thousands of Studies - Unanimous Conclusion - GMOs are Safe For Human Consumption!!



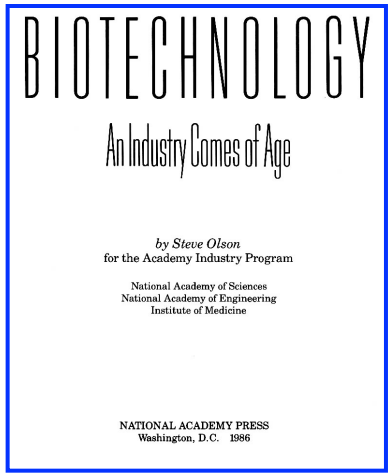
1982



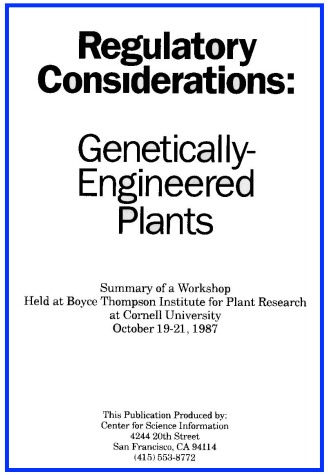
1984



1985



1986



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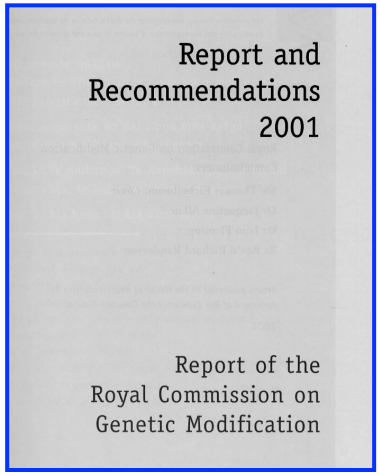
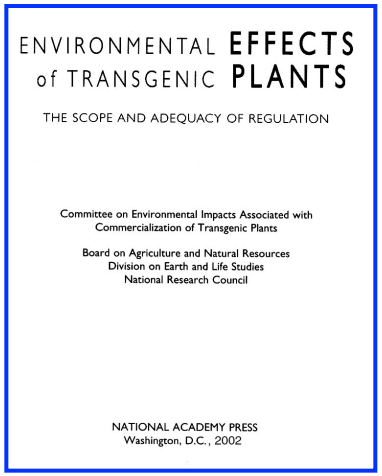
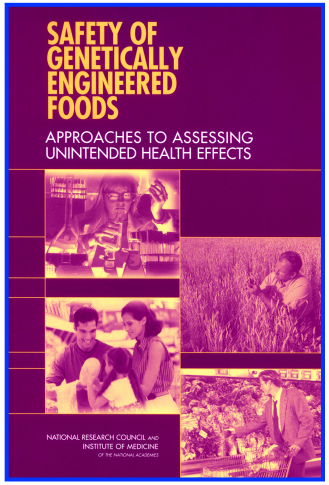


2001



2002



2004

2011

Critical Reviews in Biotechnology

http://informahealthcare.com/bty
ISSN: 0738-8551 (print), 1549-7801 (electronic)

Crit Rev Biotechnol, Early Online: 1–12
 DOI: 10.3109/07388551.2013.823595

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healthcare

REVIEW ARTICLE

An overview of the last 10 years of genetically engineered crop safety research

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[1]*Department of Applied Biology, Faculty of Agriculture, University of Perugia, Perugia, Italy and* [2]*Ministry of Agriculture, Food and Forestry Policies (MiPAAF), Rome, Italy*

Abstract

The technology to produce genetically engineered (GE) plants is celebrating its 30th anniversary and one of the major achievements has been the development of GE crops. The safety of GE crops is crucial for their adoption and has been the object of intense research work often ignored in the public debate. We have reviewed the scientific literature on GE crop safety during the last 10 years, built a classified and manageable list of scientific papers, and analyzed the distribution and composition of the published literature. We selected original research papers, reviews, relevant opinions and reports addressing all the major issues that emerged in the debate on GE crops, trying to catch the scientific consensus that has matured since GE plants became widely cultivated worldwide. The scientific research conducted so far has not detected any significant hazards directly connected with the use of GE crops; however, the debate is still intense. An improvement in the efficacy of scientific communication could have a significant impact on the future of agricultural GE. Our collection of scientific records is available to researchers, communicators and teachers at all levels to help create an informed, balanced public perception on the important issue of GE use in agriculture.

Keywords

Biodiversity, environment, feed, food, gene flow, –omics, substantial equivalence, traceability

History

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Here's the Irony…..The Engineered Protein in GMO Soybeans is a Protein that Occurs Naturally in All Plants and that You Eat Everyday in Organic and Non-GMO Vegetables!!!

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Bacteria  ------------------------------------------------------------------------------
Corn      ------------------------------------------------------------------------------A  1
Soybean   -MAQVSRVHNLAQSTQIFGHSSNSNKLKSVNSVSLRPRLWGASKSRIPMHKNGSFMGNFNVGKGNSGVFKVSASVAAAEKPS  81
Cotton    MATQVGKIYNGTQKTCVLPNVSKTQNPKHVPFVSFKSNLNGKTSSWGLVVKNNGKFGSIKARS-----LKVSASTATAEKPS  77

Bacteria  MIELTITPPDHPLSGKVEPPGSKSITNRALLLAGLAKGKSRLTGALKSDDTLYMAEALREMGVKVT-EPDATTFVVEGTG--  79
Corn      GAEEIVLQPIKEISGTVKLPGSKSLSNRILLLAALSEGTTVVDNLLNSEDVHYMLGALRTLGLSVEADKAAKRAVVVGCGGK  83
Soybean   TSPEIVLEPIKDFSGTITLPGSKSLSNRILLLAALSEGTTVVDNLLYSEDIHYMLGALRTLGLRVEDDKTTKQAIVEGCGGL  163
Cotton    RASEIVLQPINEISGTVKLPGSKSLSNRILLLAALSEGTTVVENLLNSDDVHHMLVALGKLGLYVKHDSEKKQAIVEGCGGQ  159

Bacteria  ----VLQQPEKPLFLGNAGTATRFLTAAAALVDG--AVIIDGDEHMRKRPIMPLVEALRSLGVEAEAPTG--CPPVTVCGKG  153
Corn      FPVEDAK-EEVQLFLGNAGTAMRPLTAAVTAAGGNATYVLDGVPRMRERPIGDLVVGLKQLGADVDCFLGTDCPPVRVNGIG  164
Soybean   FPTSKESKDEINLFLGNAGTAMRPLTAAVVAAGGNASYVLDGVPRMRERPIGDLVAGLKQLGADVDCFLGTNCPPVRVNGKG  245
Cotton    FPVGKGEGQEIELFLGNAGTAMRPLTAAITAAGGNSSYVLDGVPRMRERPIGDLVTGLKQLGADVDCILGTNCPPVRIEGKG  241

Bacteria  TGFPKGSVTIDANLSSQYVSALLMAAACGDKPVDIVLKGEEIGAKGYIDLTTSAMEAFGAKIERVSNAIWRVHPTG---YTA  232
Corn      -GLPGGKVKLSGSISSQYLSALLMAAPLALGDVEIEIIDKLISIP-YVEMTLRLMERFGVKAEHSDSWDRFYIKGGQKYKSP  244
Soybean   -GLPGGKVKLSGSVSSQYLTALLMAAPLALGDVEIEIVDKLISVP-YVEMTLKLMERFGVSVEHSGNWDRFLVHGGQKYKSP  325
Cotton    -GLPGGKVKLSGSISSQYLTALLMAAPLALGDVEIEIIDKLISIP-YVEMTMKLMERFGVTVEHTDSWDRFFIRGGQKYMSP  321

Bacteria  TDFHIEPDASAATYLWGAELLTGGAIDIGTPADKFTQPDAKAYDVMAKF-------------PHLPAEIDG-----------  289
Corn      KNAYVEGDASSASYFLAGAAITGGTVTVEGCGTTSLQGDVKFAEVLEMMGAKVTWTETSVTVTGPPREPFGRKHLKAIDVNM  326
Soybean   GNAFVEGDASSASYLLAGAAITGGTITVNGCGTSSLQGDVKFAEVLEKMGAKVTWSENSVTVSGPPRDFSGRKVLRGIDVNM  407
Cotton    GNAYVEGDASSASYFLAGAAVTGGTVTVEGCGTSSLQGDVKFAEVLEMMGAKVTWTENSVTVTGPPRNSSGRKHLRAIDVNM  403

Bacteria  SQMQDAIPTIAVLAAFNETPVRFVGIANLRVKECDRIRAVSLGLNEIRNGLAHEEGDDLIVHADPALAGQTVKASIDTFADH  371
Corn      NKMPDVAMTLAVVALFADGPTAIRDVASWRVKETERMVAIRTELTKL--GASVEEGPDYCIITPPEKLNVT---AIDTYDDH  403
Soybean   NKMPDVAMTLAVVALFANGPTAIRDVASWRVKETERMIAICTELRKL--GATVEEGPDYCVITPPEKLNVT---AIDTYDDH  484
Cotton    NKMPDVAMTLAVVALYADGPTAIRDVASWRVKETERMIAICTELRKL--GATVEEGPDYCVITPPEKLNVT---AIDTYDDH  480

Bacteria  RIAMSFALAALKIGGIAIQNPACVGKTYPGYWKALASLGVDYTEKESAAEPQH  425
Corn      RMAMAFSLAACAEVPVTIRDPGCTRKTFPDYFDVLSTFVKN------------  444
Soybean   RMAMAFSLAACGDVPVTIKDPGCTRKTFPDYFEVLERLTKH------------  525
Cotton    RMAMAFSLAACAEVPVTIKDPGCTRKTFPDYFEVLDRVTKH------------  521
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The New York Times
nytimes.com

August 18, 2002

Zambia Bars Altered Corn From U.S.

Telegraph.co.uk

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Starving Zambia rejects America's GM maize

What Has Been Some of the Real Life Affects of the GMO Controversy?

AFRICAN COUNTRIES REJECT GM FOOD AID

Zimbabwe and Zambia have rejected genetically modified food donations intended to avert drought-induced food shortages. Wisdom Mdzungairi reports for Harare that participants to an international conference on genetic engineering and sustainable agriculture in Lusaka, Zambia commended the countries' decision to mill some of the donated food instead.

Dr. Luke Mumba, chairman of the Biosafety Council of Zambia and research of the University of Zambia, commented that while there was respect for the two countries' decision, there was need to adopt safe biotechnological advances, and that the use of GM technology could contribute to the complex problems of alleviating poverty and malnutrition. Meanwhile, Zambian Minister of Science and Technology Judith Kapijimpanga said the problem of food insecurity in Africa was a result of complex issues that required an integrated approach for sustainability.

See the article in http://allafrica.com/stories/200510110710.html.


Professor Frank Furedi
University of Cantebury

The Real Seeds of Hope

The End….or The Beginning?

Thank You UCLA Parents!!!!