



Jour d'Onion

Or what makes an onion, an onion?















How are the genes and chromosomes manipulated to create a new plant variety by classical breeding?





Triticum monococcumTriticum aestivumAncient varietyModern bread variety



Information in the wheat genome

Chemical units represented by alphabetic letters



1700 books 1000 pages each

1700 books (or 1.7 million pages)



Hybridization or cross breeding of wheat

X

Random retention of information from each parent

1700 books (or 1.7 million pages) 1700 books (or 1.7 million pages) 1700 books (or 1.7 million pages)















Table of contents for genes in wheat



Used for Marker-Assisted Selection

1700 books (or 1.7 million pages)





Marker-assisted selection used to protect rice against bacterial blight and blast disease

Protection limited to diversity in crop and compatible relatives



But there are other ways to create new varieties using the modern tools of genetics



Genetic Engineering Methods



Classical Breeding

compared to

Genetic Engineering

Uses plant machinery in plant

Gene exchange is random involving whole genome

When/where gene expressed not controlled by breeder

Source of gene primarily within genera – not between kingdoms like plants & bacteria Uses plant machinery in laboratory

Gene exchange is specific involving single or few genes

When/where gene expressed controlled precisely

Source of gene from any organism



How do you engineer a crop, citrus, for example?

nytimes

ittp.

SOURCE: "A Race of Save the Orange by Altering Its DNA", New York Times, July 27, om/2013/07/2019 ce/a-race-to-save-the-orange-by-altering-its-dna.html?pagewanted=



What Is Engineered into the Plant? Construct with Gene of Interest Created Using Recombinant DNA?

- PromoterGene of interestOff switchPromoterMarkerOff switch(on switch)(transgene)(on switch)(on switch)(find the second second
- Promoter: controls when and where gene is made
- Off switch: stops expression of gene
- Gene of interest: gene you want to introduce into plant
- Marker: used to identify which cells have gene of interest



Number of different commercially available large acreage GE crops is limited





Number of different traits available in GE crops is also limited





Herbicide-tolerant engineered with genes to tolerate herbicide application



Bt Crops - engineered for insect resistance using gene from naturally occurring bacterium



These types of large-acreage GE crops lead to estimates that 60-80% of processed foods in U.S. have GE ingredients



SOURCE: https://factsaboutgmos.org/disclosure-statement

There are only a few whole, genetically engineered foods in the U.S market



GE Sweet Corn Acreage unknown







Despite the same limited U.S. crop and trait types, worldwide acreage is increasing in 20 developing, 8 developed countries



acres (>3X size of California) – over 90% were small acreage farmers





Field Trials Conducted in California with Grape Root Stocks Engineered for Resistance to Fanleaf Virus





Does a path forward for citrus and greening disease involve genetic engineering of the citrus or the psyllid insect?



The New York Times

July 27, 2013

A Race to Save the Orange by Altering Its DNA

By AMY HARMON

CLEWISTON, Fla. — The call Ricke Kress and every other citrus grower in Florida dreaded came while he was driving.

"It's here" was all his grove manager needed to say to force him over to the side of the road.

The disease that sours oranges and leaves them half green, already ravaging citrus crops across the world, had reached the state's storied groves. Mr. Kress, the president of Southern Gardens Citrus, in charge of two and a half million orange trees and a factory that squeezes juice for Tropicana and Florida's Natural, sat in silence for several long moments.

"O.K.," he said finally on that fall day in 2005, "let's make a plan."

In the years that followed, he and the 8,000 other Florida growers who supply most of the nation's orange juice poured everything they had into fighting the disease they call citrus greening.

To slow the spread of the bacterium that causes the scourge, they chopped down hundreds of thousands of infected trees and sprayed an expanding array of pesticides on the winged insect that carries it. But the contagion could not be contained.

Australian researchers identify grape genes that provide resistance to powdery mildew

Arcadia Biosciences develops canola that uses 50% less nitrogen fertilizer



SOURCE: http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet_april_10.htm#story0

Yields in rice and maize increase under water-limiting conditions

SOURCE: Castiglioni, P. et al. 2008. Bacterial RNA Chaperones Confer Abiotic Stress Tolerance in Plants and Improved Grain Yield in Maize under Water-Limited Conditions. Plant Physiology 147: 446-455. <u>(</u>

About 80% of tomatoes under certain conditions suffer blossom end rot. Tomatoes engineered for high solids resist the disease

SOURCE: Transgenic processing tomato also resists blossom end rot , The Grower, 5/24/12 http://www.thegrower.com/e-newsletters/fresh-from-the-field/Transgenic-processing-tomato-also-resists-blossom-end-rot-152327065.html



Engineering tomato to increase health-promoting compounds

C John Innes Centre

High anthocyanin purple GE tomatoes protect against cardiovascular disease and certain cancers. Diets with 10% purple tomatoes increased lifespan of cancer-prone mice

Golden Rice engineered to contain bioavailable pro-Vitamin A



Normal portion of Golden Rice 2 provides half of a child's Vitamin A needs





Innate[™] (L) and traditional (R) potato 10 hours after cutting

Low acrylamide, low sugar, bruising-resistant potato engineered only with potato DNA – under consideration for deregulation by APHIS



Canadian Okanagen Specialty Fruits will voluntarily label their nonbrowning GE apples



SOURCE: "This GMO Apple Won't Brown. Will That Sour The Fruit's Image?", Wisconsin Public Radio News, January 8, 2014.

Photo courtesy of Okanagan Specialty Fruits Inc.

Engineered Peas Protect Chickens against Parasitic Coccidiosis

SOURCE: "Engineered pea seeds protect against parasites", BioMed Central, 9/10/09, http://www.eurekalert.org/pub_releases/2009-09/bc-eps090909.php Zimmermann, J., Saalbach, I., Jahn, D., Giersberg, M., Haehnel, S., Wedel, J., Macek, J., Zoufal, K., Glunder, G., Falkenburg, D. and Kiprijanov, S.M. 2009. Antibody expressing pea seeds as fodder for prevention of gastrointestinal parasitic infections in chickens. BMC Biotechnology, in press.



ucbiotech.or

Japanese scientists create blue rose with blue pigments from pansies



SOURCE: http://www.japantimes.co.jp/cgi-bin/getarticle.pl5?nn20040701a2.htm

Slow-Mow grass addresses watering, maintenance and weed problems

SOURCE: "Engineering a mow-less lawn", New York Times, 4/22/06 http://www.nytimes.com/2006/04/22/business/22offline.html?_r=1&oref=slogin



What is the U.S. regulatory process that governs these engineered plants?





U.S. Regulatory Agencies



- Field testing

 Permits
 Notifications
- Determination of non-regulated status

Plant pest?

- Food safety
- Feed safety

- Pesticidal plants

 tolerance
 exemption
 registrations
- Herbicide registration

Danger to people? Risk to environment?

APHIS Determines Nonregulated Status – 111 granted

(8-2-2014)

Once nonregulated, organism no longer requires APHIS review for movement or release in U.S.

- ✓ Alfalfa HT removed, reinstated
- ✓ Corn HT, IR, AP
- ✓ Cotton HT, IR
- ✓ Soybean HT, PQ
- Potato IR, VR
- Tomato PQSquash VR
- ✓ Canola HT

✓ Large-scale production♦ Not on market

Papaya - VR

- Plum VR
- Rice HT

Rapeseed - HT, AP, PQ

- ✓ Sugar beet HT removed, reinstated
- Flax HT
- Chicory AP
- Tobacco PQ
- Rose PQ

(http://www.aphis.usda.gov/brs/not_reg.html)

Why Are GE Crops and Foods (GMOs) So Controversial?





It started in Europe: Factors that fueled and continue to fuel the controversy in Europe

- Food safety scares
- Involuntary nature of the change
- Cultural differences
- Economic incentives



Then: Lord Melchett participating in GM protest – 1999



Controversy Continues today in Europe (Germany) February 2014



GMO HATE. People protests against the authorization of genetically modified (GM) maize with signs and banners reading 'Stop GMO Maize 1507 ', 'Only a NO can protect us' and 'No to GMO Maize 1507' in front of the Federal Chancellor's Office in Berlin, Germany, 05 February 2014. Joerg Carstensen/EPA

Genetically modified potatoes are studied, criticized in Ireland

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In a secured government greenhouse in Carlow, Ireland, plant scientist Ewen Mullins examines transplants of genetically modified potatoes engineered to resist late blight disease. (Adrian Higgins/The Washington Post)



Even with a product that addresses an E.U. issue that led to thousands of deaths in the very country that helped develop a "cure" for late blight responsible for the **Irish potato famine**



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But anti-GE sentiment is not universal. German farmers protest field destruction, demanding punishment for people committing these acts



What Are Some Other Issues?





What are some food safety issues?

- Lack of peer-reviewed food safety tests
- Creation of allergens or activation of toxins
- Pharma crops contaminating food supply
- Labeling
- Gene flow from food to intestinal bacteria increasing antibiotic resistance



What are some environmental and other issues?

- Transfer of engineered genes to non-GMO/ organic crops?
- Development of herbicide-tolerant weeds or pesticide-resistant insects
- Spread of pharmaceutical genes into commercial crops?
- Loss of genetic diversity?
- Property rights (gene patents)?

