



Agricultural Research Service

Biotechnology in Agriculture

Jeff Walenta

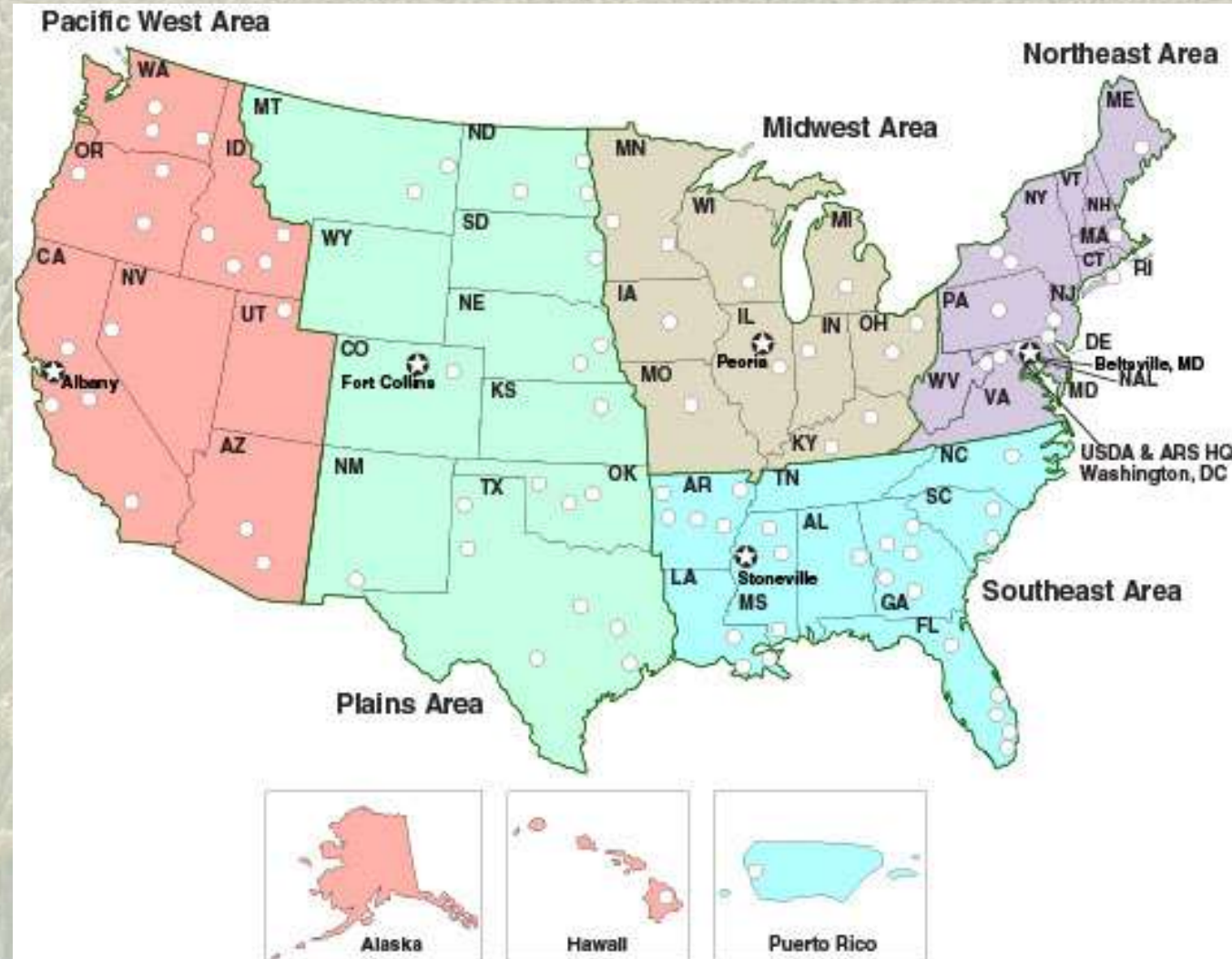
Technology Transfer Coordinator

USDA, ARS, Plains Area

2019



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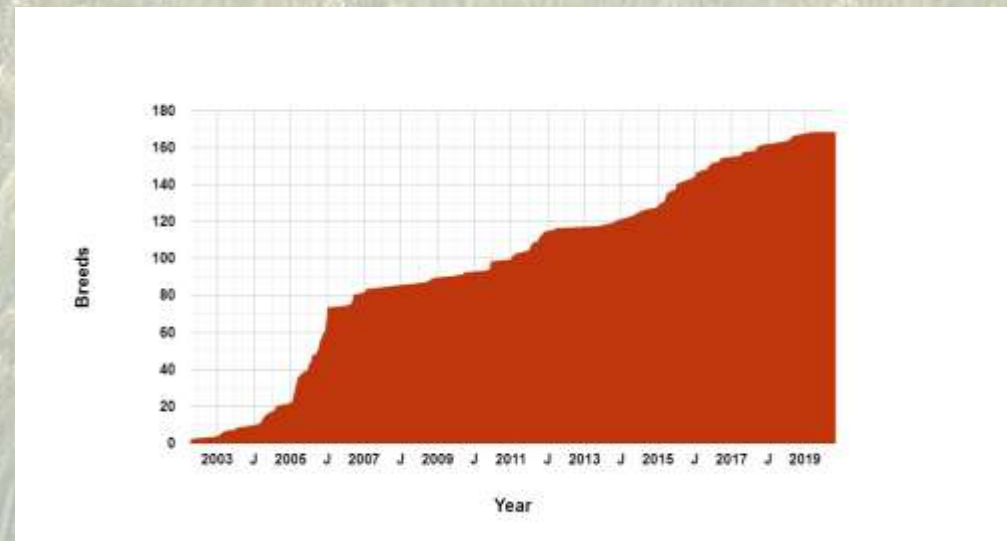
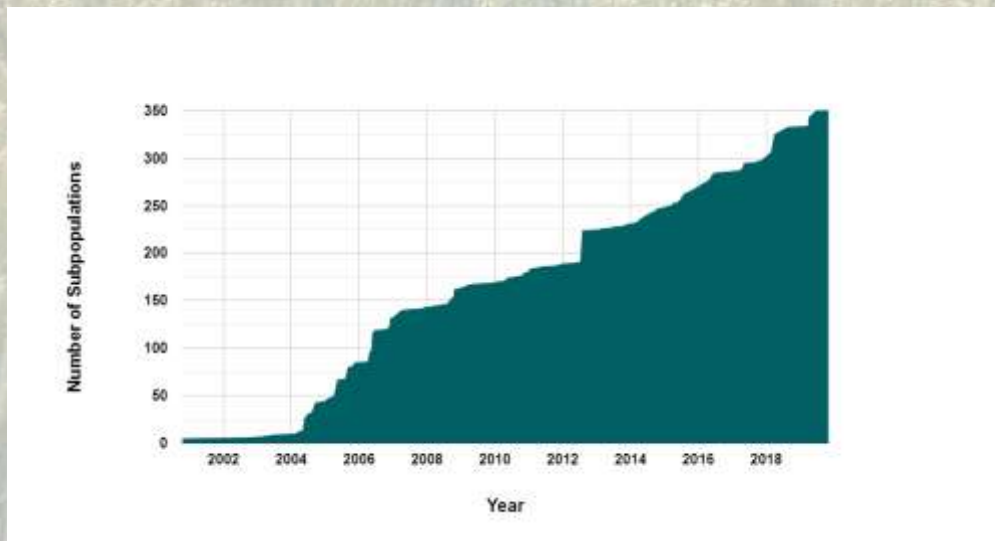
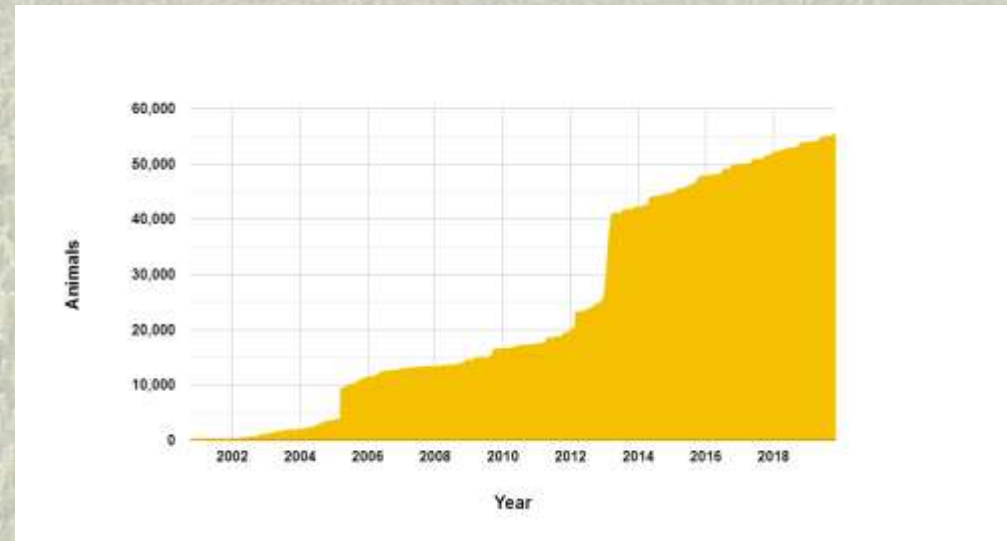
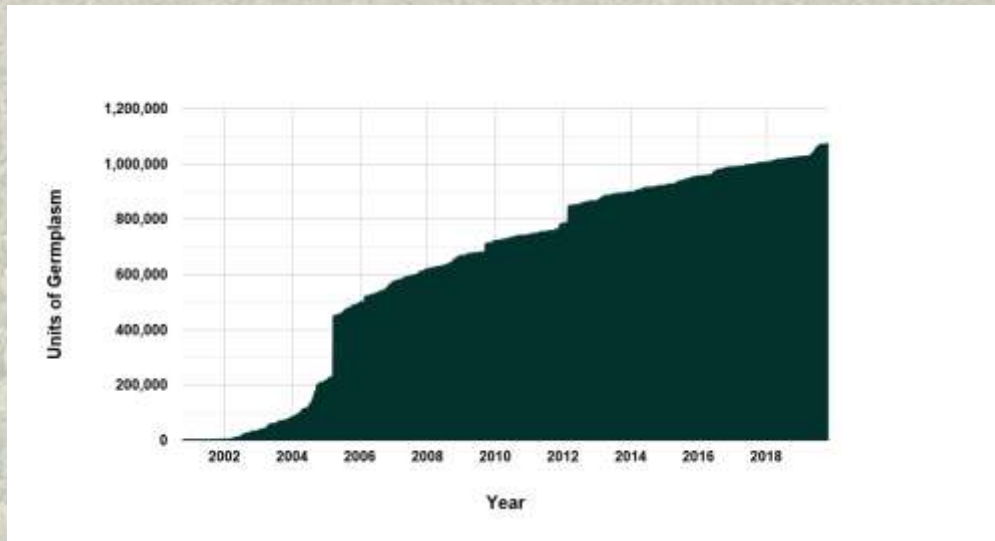
Biotechnology

- **Definition of *biotechnology*** ^{*1}
- **1:** the manipulation (as through genetic engineering) of living organisms or their components to produce useful usually commercial products (such as pest resistant crops, new bacterial strains, or novel pharmaceuticals) *also* : any of various applications of biological science used in such manipulation

USDA National Plant Germplasm System

Site	Collection name	Location	No. of accessions
BRW	National Germplasm Repository–Brownwood	Brownwood, TX	4,066
COR	National. Germplasm Repository–Corvallis	Corvallis, OR	12,241
COT	Cotton Collection	College Station, TX	9,521
DAV	National Germplasm Repository–Davis	Davis, CA	8,719
DLEG	Desert Legume Program	Vail, AZ	2,611
GEN	National Germplasm Repository–Geneva	Geneva, NY	7,468
GSOR	Rice Genetic Stock Center	Stuttgart, AR	36,678
GSPI	Pea Genetic Stock Collection	Pullman, WA	712
GSZE	Maize Genetic Stock Center	Urbana, IL	8,127
HILO	National Germplasm Repository–Hilo	Hilo, HI	783
MAY	National Germplasm Repository–Mayaguez	Mayaguez, PR	1,153
MIA	National Germplasm Repository–Miami	Miami, FL	3,273
NA	National Arboretum	Washington, DC	4,517
NC7	North Central Regional PI Station	Ames, IA	54,067
NE9	Northeast Regional PI Station	Geneva, NY	12,624
NR6	Potato Germplasm Introduction Station	Sturgeon Bay, WI	5,931
NSGC	National Small Grains Collection	Aberdeen, ID	143,287
NSSL	National Laboratory for Genetic Resources Preservation	Fort Collins, CO	12,660
NTSL	Forest Service National Seed Laboratory	Dry Branch, GA	7,600
OPGC	Ornamental Plant Germplasm Center	Columbus, OH	5,050
PARL	National Arid Land Plant Genetic Resources Unit	Parlier, CA	1,494
PGQO	Plant Germplasm Quarantine Program	Beltsville, MD	951
PVPO	Plant Variety Protection Voucher Collection	Fort Collins, CO	7,502
RIV	National Germplasm Repository–Riverside	Riverside, CA	1,789
S9	Plant Genetic Resources Conservation Unit	Griffin, GA	99,151
SOY	Soybean Collection	Urbana, IL	22,143
TGRC	C.M. Rick Tomato Genetics Resource Center	Davis, CA	3,716
TOB	US Nicotiana Germplasm Collection	Oxford, NC	2,229
W6	Western Regional PI Station	Pullman, WA	96,262
	Total		576,325

USDA National Animal Germplasm System



Gene and Genomic Sequencing

- Plants
- Animals
- Insects
- Pathogens
- Nutrition
- Big Effort at USDA-ARS



Hereford Gene Assembly – Originally \$53M now \$120K in 19 months

2018 FLC Mid-Continent Partnership Award for ARS – USDA, et al.

Genetic Modification

- The production of heritable improvements in plants or animals for specific uses, via either genetic engineering or other more traditional methods.

Traditional Breeding

- Transfer of Genes – Selective Breeding.
- Correlating Genotype (Genes) to Phenotype (Traits).
- Mapping – Markers
- Mutations – Single Nucleotide Polymorphisms
- Selecting for Beneficial Genes/Traits
- Many Programs in Multiple Organisms at USDA-ARS

Recombinant DNA Technology

Procedures used to join together DNA segments in a cell-free system (e.g. in a test tube outside living cells or organisms). Under appropriate conditions, a recombinant DNA molecule can be introduced into a cell and copy itself (replicate), either as an independent entity (autonomously) or as an integral part of a cellular chromosome.

Genetically Engineered (GE) Organisms

- Transfer of Genes – Recombinant DNA Technology
 - Polymerase Chain Reaction (PCR)
- Physical Gene Insertion – i.e. Gene Gun
- Vector w/ Gene Insertion – i.e. Agrobacterium
- Targeted Gene Insertion
 - Transcription Activator-like Effector Nuclease (TALENs)
 - Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)
 - Cas9
 - ?

Regulation -Plants

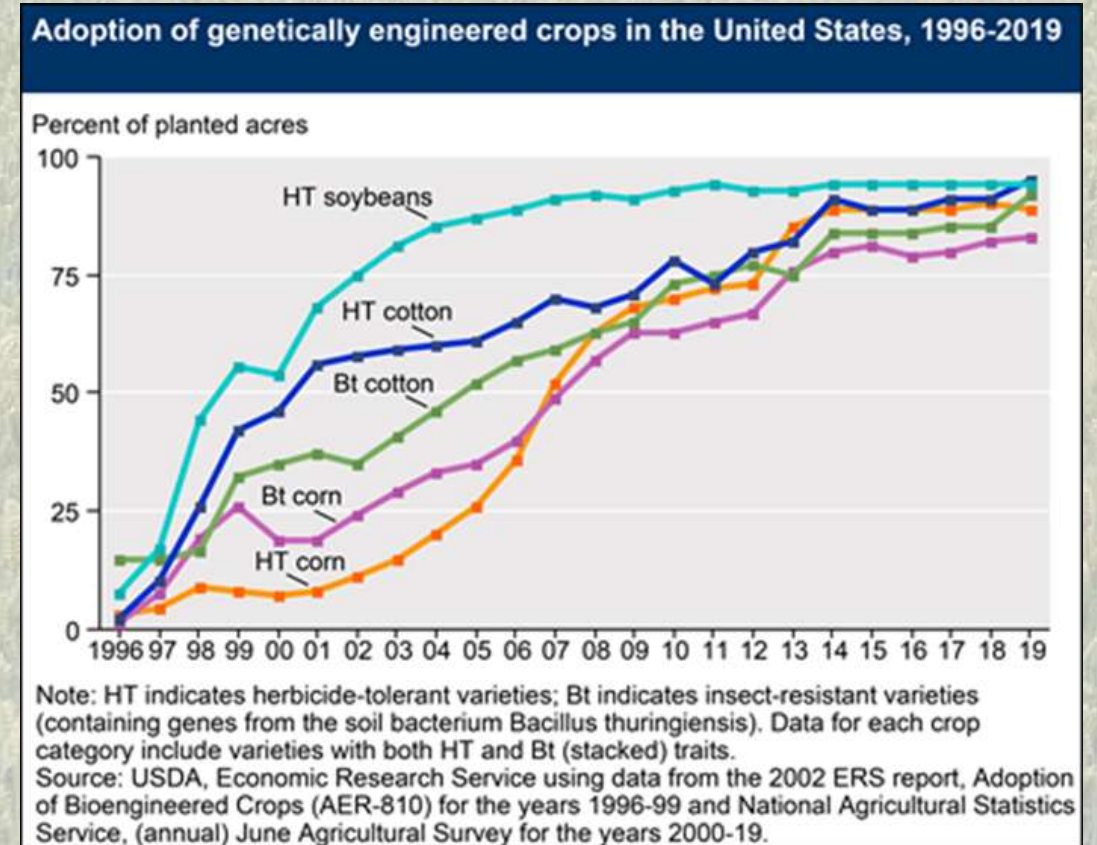
- USDA Animal and Plant Health Inspection Service (APHIS)
 - USDA-APHIS regulates organisms and products that are known or suspected to be plant pests or to pose a plant pest risk, including those that have been altered or produced through genetic engineering.
 - <https://www.aphis.usda.gov/aphis/ourfocus/biotechnology>
- U.S. Environmental Protection Agency
 - The EPA through a registration process regulates the sale, distribution and use of pesticides in order to protect health, and the environment, regardless of how the pesticide was made or its mode of action.
 - <https://www.epa.gov/pesticides/biopesticides>
- U.S. Food and Drug Administration
 - The FDA is responsible for ensuring the safety and proper labeling of all plant-derived food and feed, including those developed through genetic engineering.
 - <https://www.fda.gov/food/food-ingredients-packaging/food-new-plant-varieties>

USDA Guidance

Under its biotechnology regulations, USDA does not regulate or have any plans to regulate plants that could otherwise have been developed through traditional breeding techniques as long as they are not plant pests or developed using plant pests. This includes a set of new techniques that are increasingly being used by plant breeders to produce new plant varieties that are indistinguishable from those developed through traditional breeding methods. The newest of these methods, such as genome editing, expand traditional plant breeding tools because they can introduce new plant traits more quickly and precisely, potentially saving years or even decades in bringing needed new varieties to farmers.

GE Plant Approvals and Adoption

- GE Cotton Adoption
 - 98% of all cotton planted in U.S.
- GE Corn Adoption
 - 92 % of all corn planted in U.S.
- GE Soybean Adoption
 - 94% of all soybean planted in U.S.
- Stakeholder and Crop Specific at USDA-ARS



Regulation - Animals

- Food and Drug Administration (FDA)
 - A genetically engineered (GE) animal is one that contains an intentional genomic alteration (IGA) made by inserting additional or altered genetic material.
 - FDA regulates the IGA in GE animals under the “new animal drug”¹ provisions of the Federal Food, Drug, and Cosmetic Act (FD&C Act), FDA’s implementing regulations for new animal drugs, and National Environmental Policy Act (1970).

¹The new animal drug approval requirements are described in the Code of Federal Regulations under 21 CFR 514.

- USDA - Agricultural Marketing Service (AMS)
 - Regulates labeling statements concerning bioengineered content for human food under National Bioengineered Food Disclosure Standard and the labeling of most meat not covered by the National Bioengineered Food Disclosure Standard.
 - <https://www.ams.usda.gov/rules-regulations/be>

GE Animal Approvals

- 2003 – Fluorescent Zebrafish.
- 2009 – Goat that produces biologic drug ATryn™.
- 2015 – AquAdvantage™ Salmon engineered to grow faster.
- 2015 – Chicken that produces eggs containing human biologic Kanuma™.
- ?

Computational Biology

- Comparative genomics
- Correlation of Genotypes to Phenotypes
- Single Nucleotide Polymorphisms (SNP)
- Quantitative Gene Loci (QTL)
- Vaccine – Antigen/Epitope determination
- Immunotherapy
- ?

Big Data

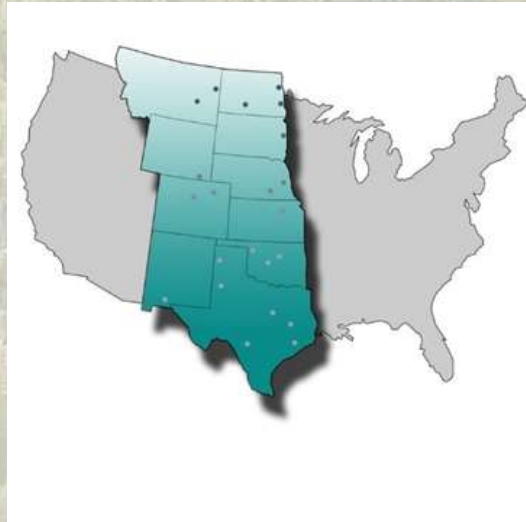
- A modern trend in which the combination of technology and advanced analytics creates a new way of processing information that is more useful and timely^{*1}
- Major Focus to Promote Big Data at USDA-ARS

^{*1} Big Data in Agriculture – Congressional Research Service

Contact



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