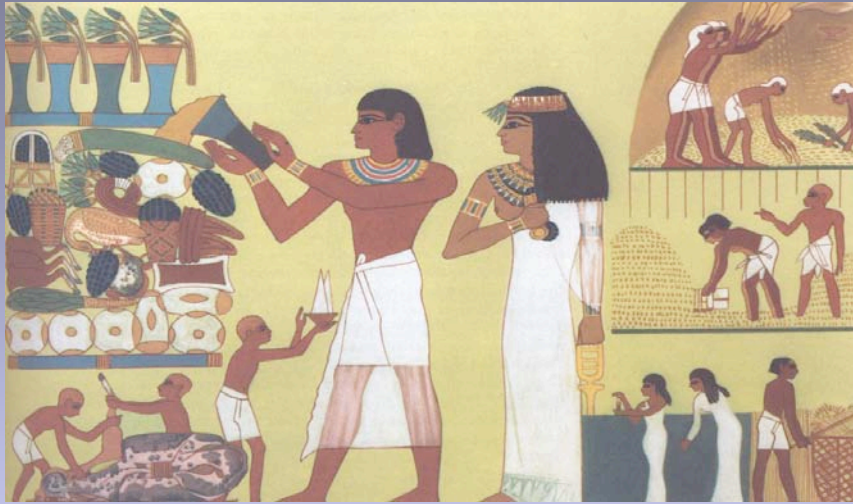


A photograph of a field of purple flowers, likely a species of lupine or similar legume. The central stem is in sharp focus, showing a cluster of small purple flowers and several developing seed pods. The background is a soft-focus field of similar flowers and green foliage.

# *GENETICS AND AGRICULTURE*

**Peggy G. Lemaux**  
*Cooperative Extension Specialist*  
*UC Berkeley*

# Agriculture was the Driving Force in Development of Civilization



Egyptian tomb mural ~ 4200 BP

Changed Man From a Forager  
Into a Sedentary Life Style.

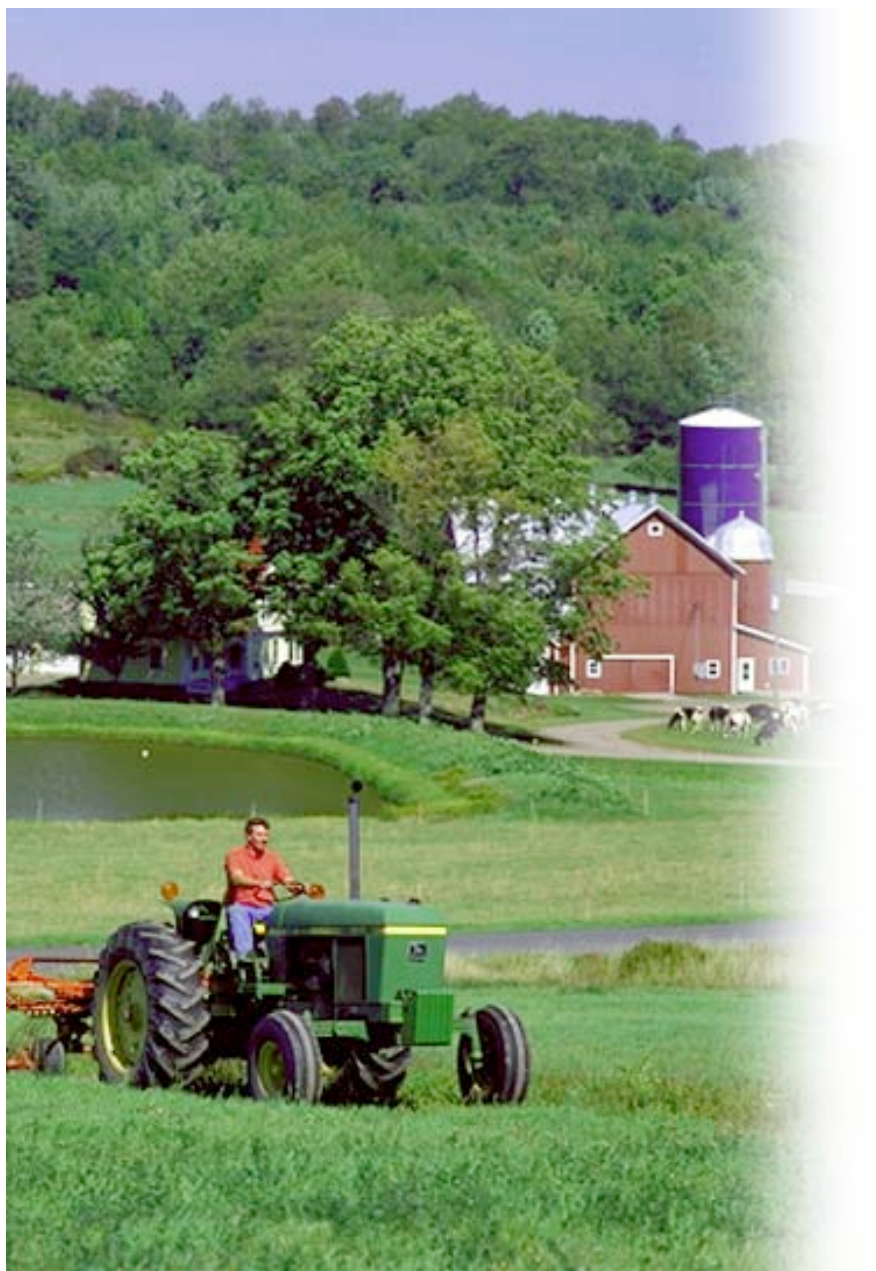




**Teosinte: an ancient  
relative of...**



**Modern corn**

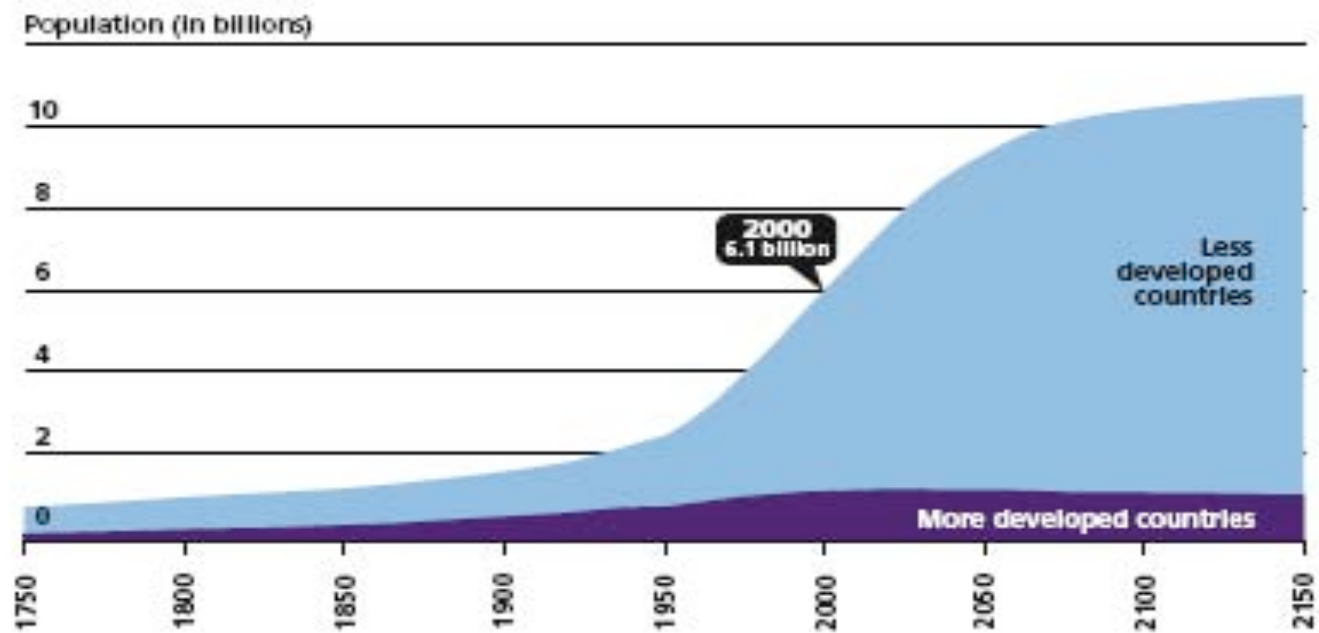


**From  
small  
farms  
to...**



**...large farms with higher yields!**

## World population growth, 1750-2150



Source: United Nations, *World Population Prospects, The 1998 Revision* (New York: UN, 1998); and estimates by the Population Reference Bureau.

Copyright © 2001 Population Reference Bureau

**How is a new wheat  
variety created by  
classical breeding?**



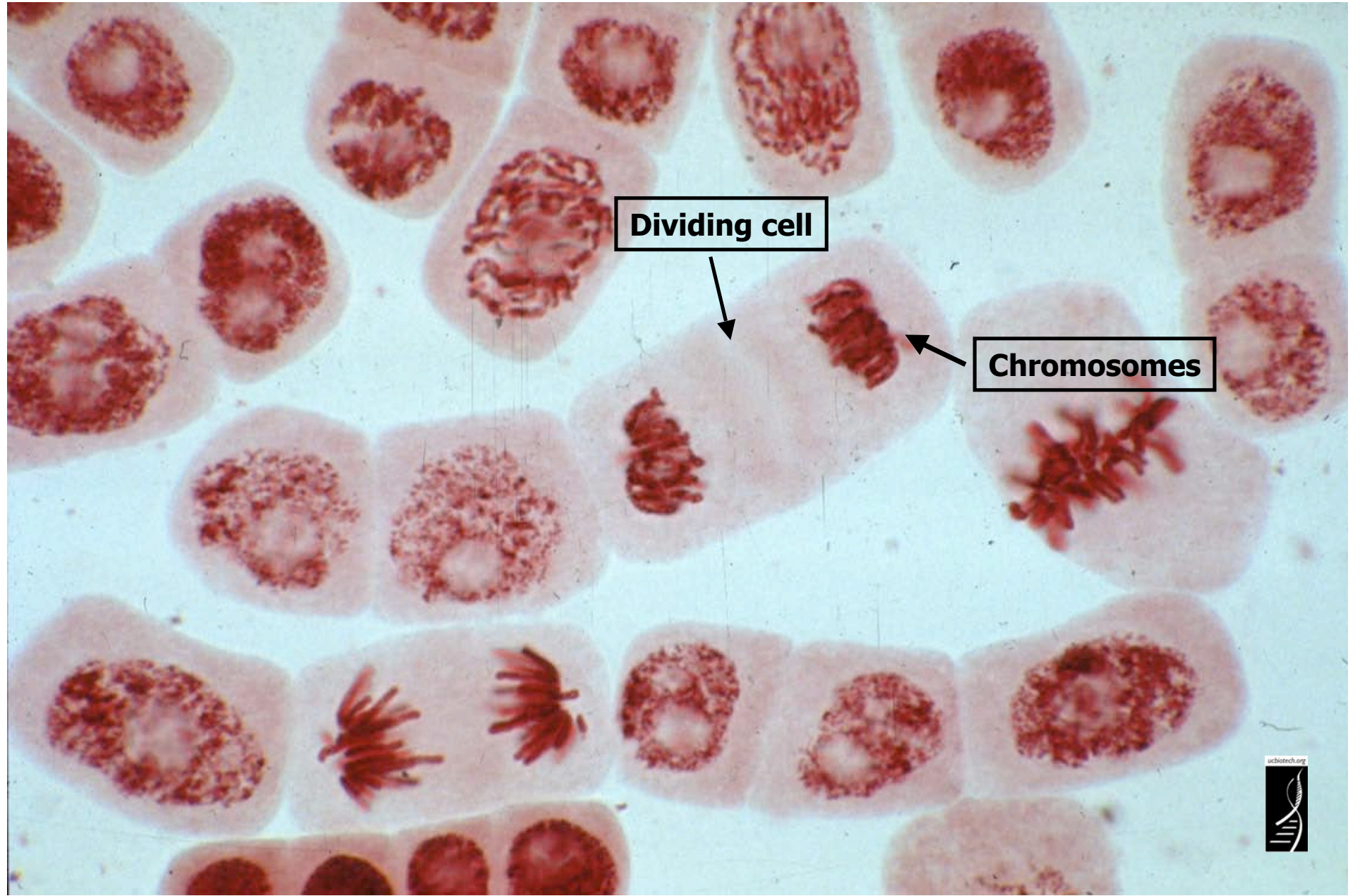
*Triticum aestivum*

**Modern bread variety**

*Triticum monococcum*

**Ancient variety**





**Dividing cell**

**Chromosomes**



# Information in the wheat genome

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...



1700 books  
1000 pages each



1700 books  
(or 1.7 million pages)



# Hybridization or cross breeding of wheat



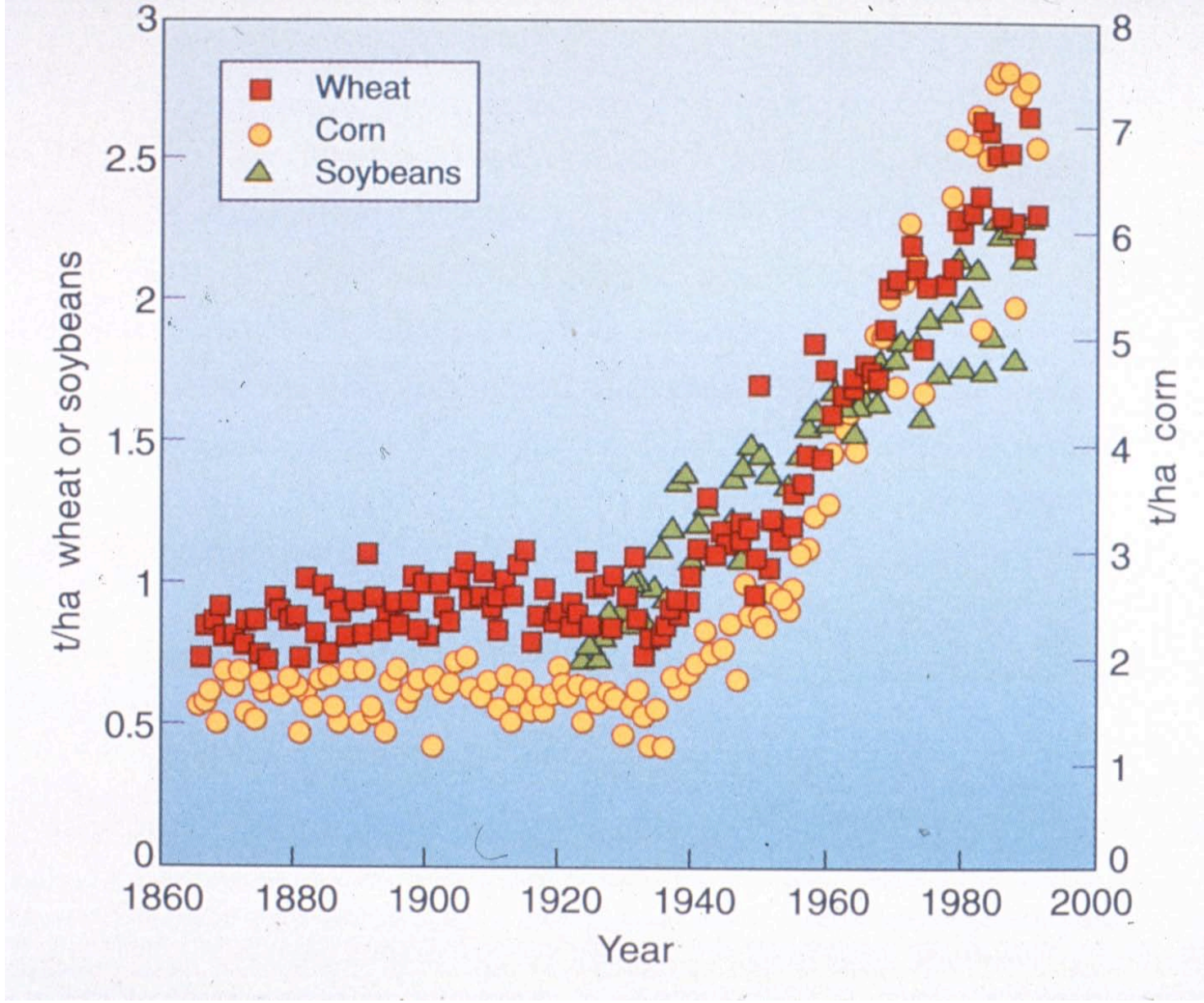
**X**



Random  
retention of  
information  
from each  
parent

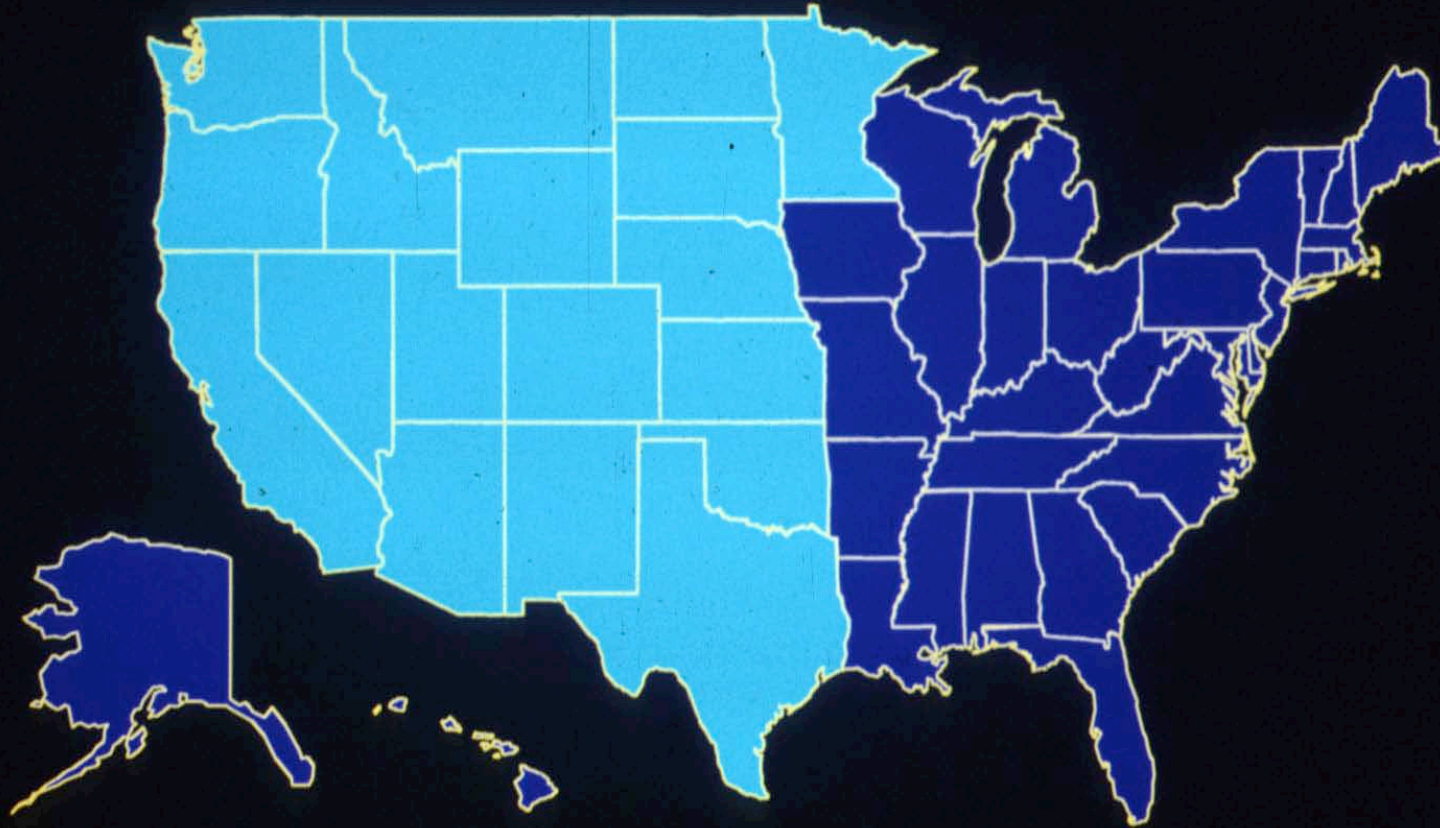
1700 books  
(or 1.7 million pages)    1700 books  
(or 1.7 million pages)    1700 books  
(or 1.7 million pages)







# U.S. Cultivated Land

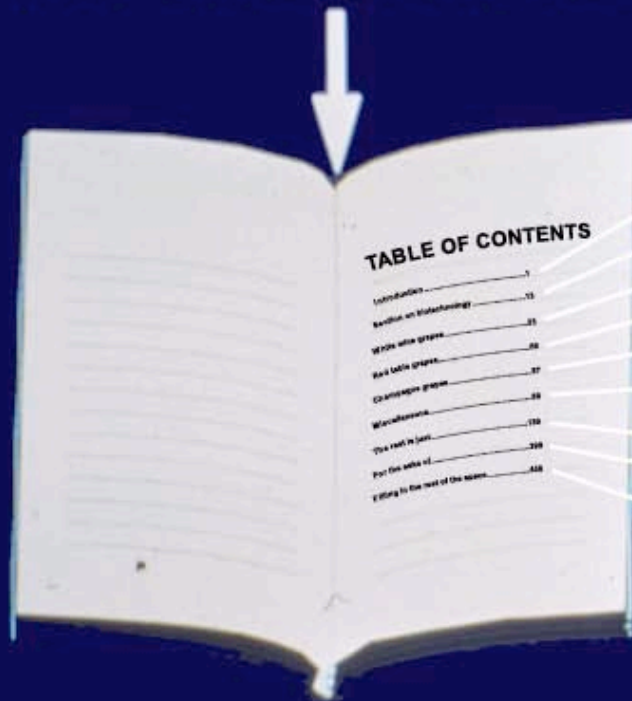


Acreage Needed at 1929 Production Levels



# Table of contents for genes in wheat

...CTGACCTAATGCCGTA...



**Genomics**



**Used for  
Marker-  
Assisted  
Breeding**

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



# MAS For Quality Traits In Wheat

## Selection of Hard and Soft Wheat

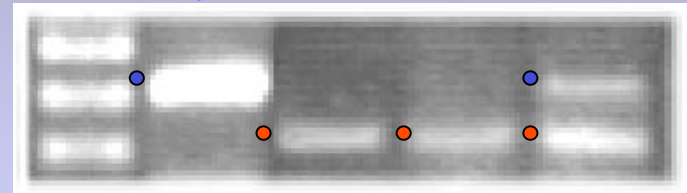
5' A AAC AAC ATT GAA AAC **ATG AAG ACC TTA TTC CTC CTA** GCT  
 CTC CTT GCT CTT GTA GCG AGC ACA ACC TTC GCG CAA TAC TCA  
 GAA GTT GGC GGC TGG TAC AAT GAA GTT GGC GGA GGA GGT GGT  
 TCT CAA CAA TGT CCG CAG GAG CGG CCG AAG CTA AGC TCT TGC  
 AAG GAT TAC GTG ATG GAG CGA TGT TTC ACA ATG AAG GAT TTT

Gly  
 CCA GTC ACC TGG CCC ACA AAA TGG TGG AAG **GGC GGC** TGT GAG  
 AGC  
 Ser

CAT GAG GTT CGG GAG AAG TGC TGC AAG CAG CTG AGC CAG ATA  
 GCA CCA CAA TGT CGC TGT GAT TCT ATC CGG CGA GTG ATC CAA  
 GGC AGG CTC GGT GGC TTC TTG GGC ATT TGG CGA GGT GAG GTA  
 TTC AAA CAA CTT CAG AGG GCC CAG AGC CTC CCC TCA AAG TGC  
 AAC ATG GGC GCC GAC TGC **AAG TTC CCT AGT GGC TAT TAC TGG TGA**

TGA TAT AGC CTC TAT TCG TGC CAA TAA AAT GTC ACA TAT CAT  
 AGC AAG TGG CAA ATA AGA GTG CTG AGT GAT GAT CTA TGA ATA  
 AAA TCA CCC TTG TAT ATT GAT CTG TGT TCG AGA AAA AAA AAA  
 AAA AAA AAA 3'

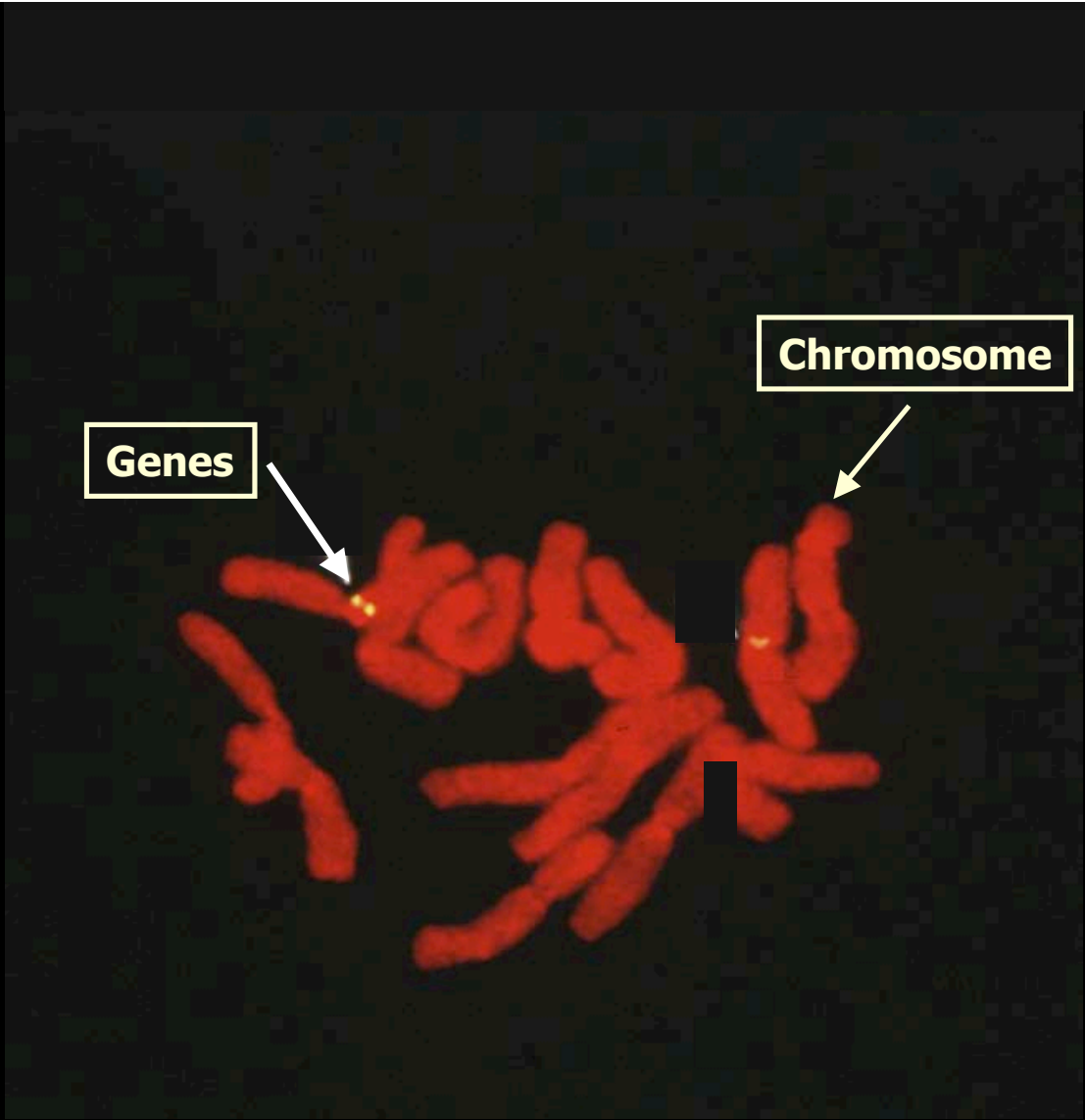
Soft      Hard      Homozygous soft      Heterozygote



• PCR amplification of puroindoline **b** + • Digestion with **Bsr-BI**

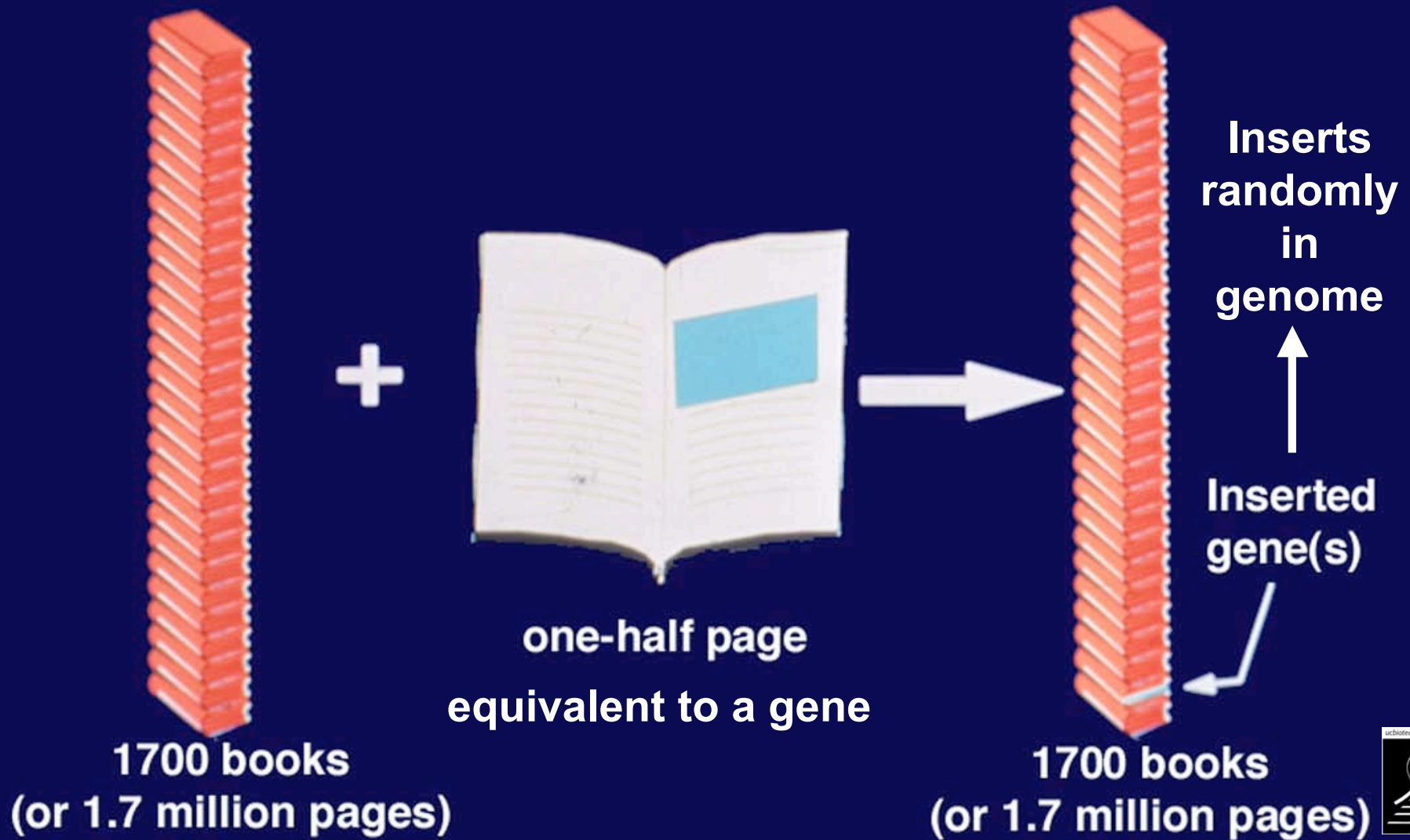
**Hard** allele: cut      **Soft** allele: uncut

**GAG CGG: *Bsr-BI* restriction site.**





# Genetic Engineering Methods



## TERMS USED

**GMO**

Genetically Modified Organism

**GEO**

Genetically Engineered Organism

**LMO**

Living Modified Organism

**rDNA**

Recombinant DNA

**Biotechnology**

## ***Classical Breeding***

compared to

## ***Genetic Engineering***

Uses plant machinery in plant

Gene exchange is random  
involving entire genome

When/where genes expressed  
not controlled by breeder

Only between closely related or  
within species

Uses plant machinery in laboratory

Gene exchange is specific,  
single or a few genes

When/where gene expressed  
can be controlled precisely

Source of gene from any  
organism

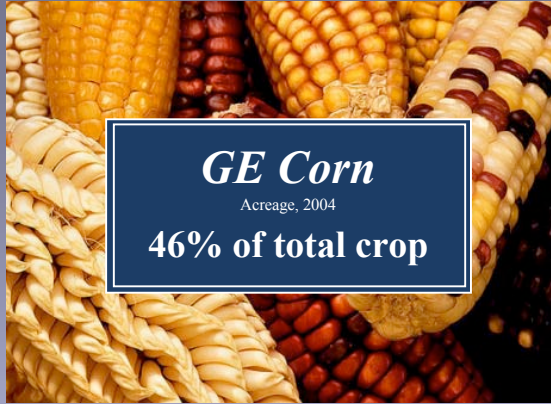




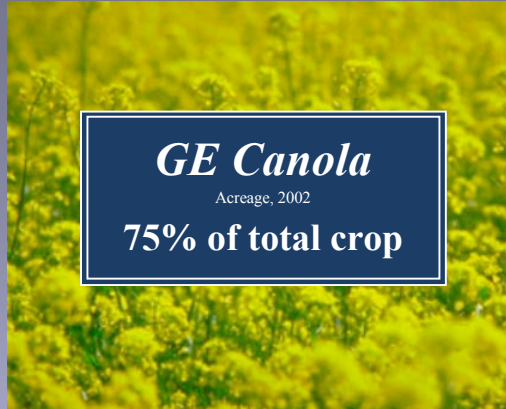
## **Crops Granted Nonregulated Status**

Adequate data collected to demonstrate new crop is not a plant pest, poses not threat to agriculture or the environment and should no longer be regulated by USDA.

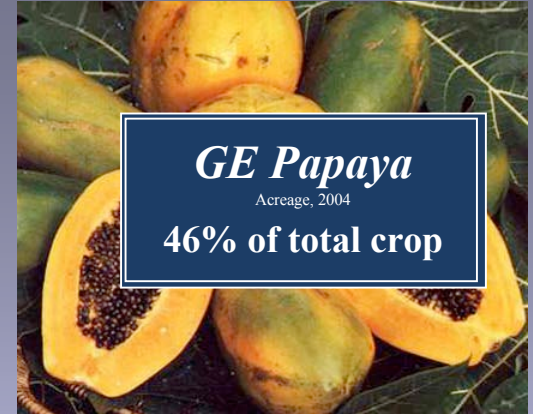
**Alfalfa, Canola, Corn, Cotton, Papaya, Potato, Soybean, Squash, Tomato**



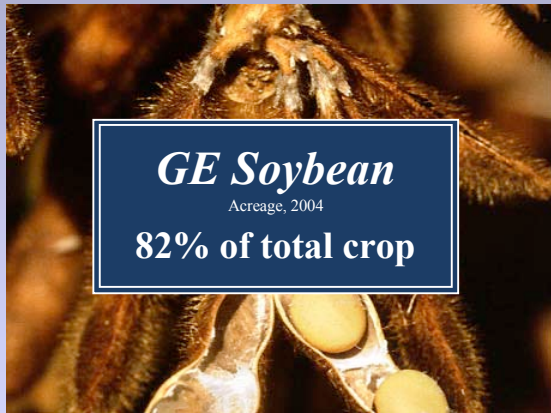
***GE Corn***  
Acreage, 2004  
**46% of total crop**



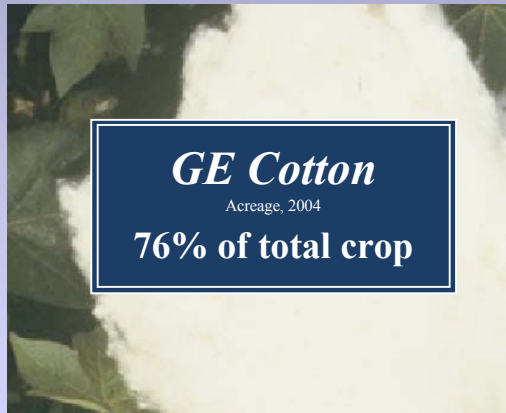
***GE Canola***  
Acreage, 2002  
**75% of total crop**



***GE Papaya***  
Acreage, 2004  
**46% of total crop**



***GE Soybean***  
Acreage, 2004  
**82% of total crop**



***GE Cotton***  
Acreage, 2004  
**76% of total crop**



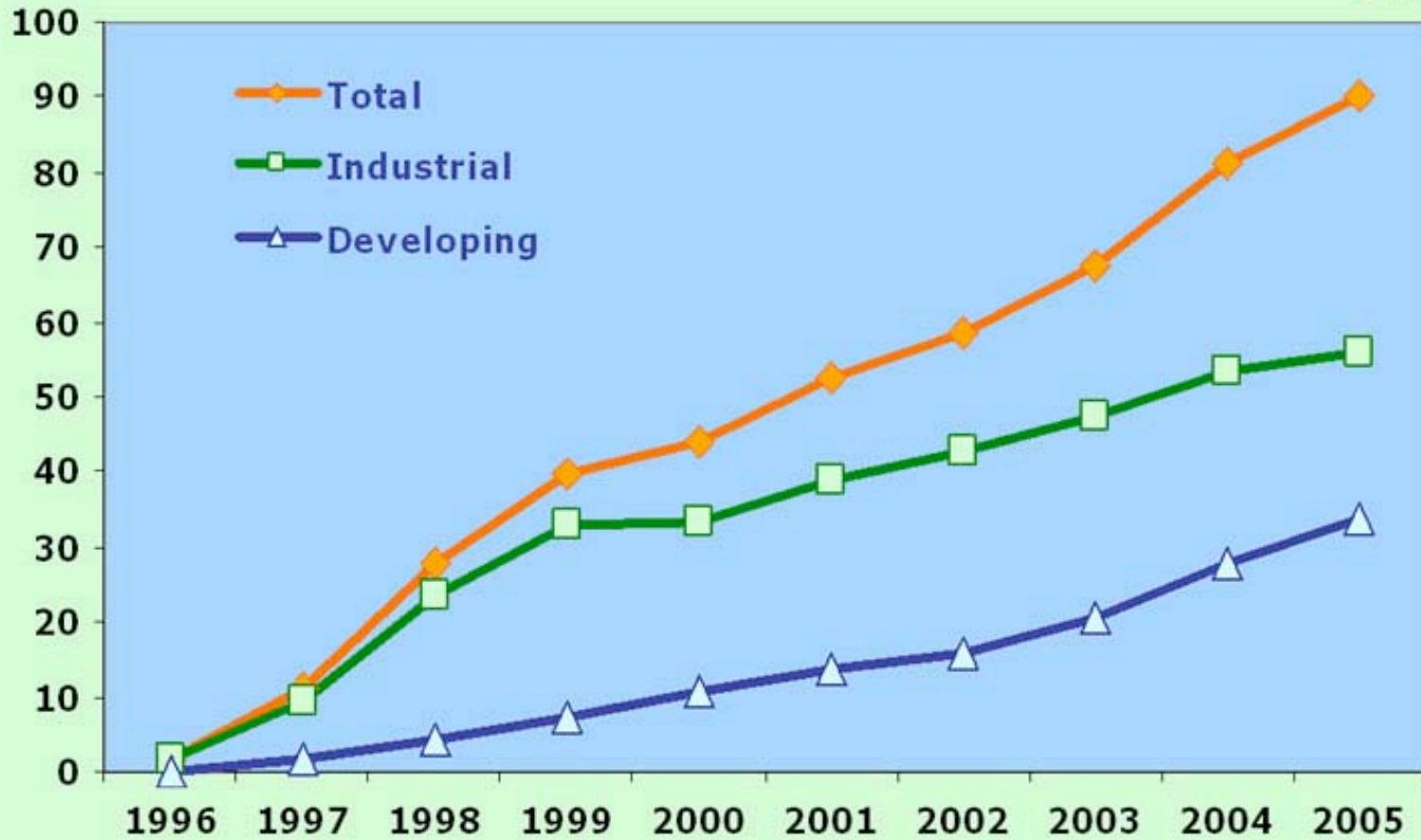
***GE Squash***  
Acreage, 2004  
**19% of total crop**

SOURCE: NCFAP; USDA, USA Today



# GLOBAL AREA OF BIOTECH CROPS

Million Hectares (1996 to 2005)



*Increase of 11%, 9.0 million hectares or 22 million acres, between 2004 and 2005.*

Source: Clive James, 2005





Estimated 75% of Processed Foods  
Have GE Ingredients



## Field Tests of Regulated Articles

Apple, Avocado, Banana, Blueberry, Carrot, Cranberry, Eggplant, Grape, Grapefruit, Lettuce, Lime, Melon, Onion, Pea, Pepper, Persimmon, Pineapple, Plum, Potato, Serviceberry, Squash, Strawberry, Sweet Potato, Tomato, Watermelon





- **Strawberries resistant to molds**
- **Tomatoes protected against root nematode attack**
- **Grapes resistant to Pierce's disease, powdery mildew**
- **Peppers resistant to bacterial diseases**
- **Plant foods with omega-3 and omega-6 oils**
- **Potatoes no longer susceptible to blight**
- **Sugar pine resistant to white pine blister rust**
- **Foods with increased folate levels**
- **Frost-tolerant pears**
- **Pollen with reduced allergy symptoms**
- **Blue, longer lived roses**



# FOOD FIGHTS IN CALIFORNIA

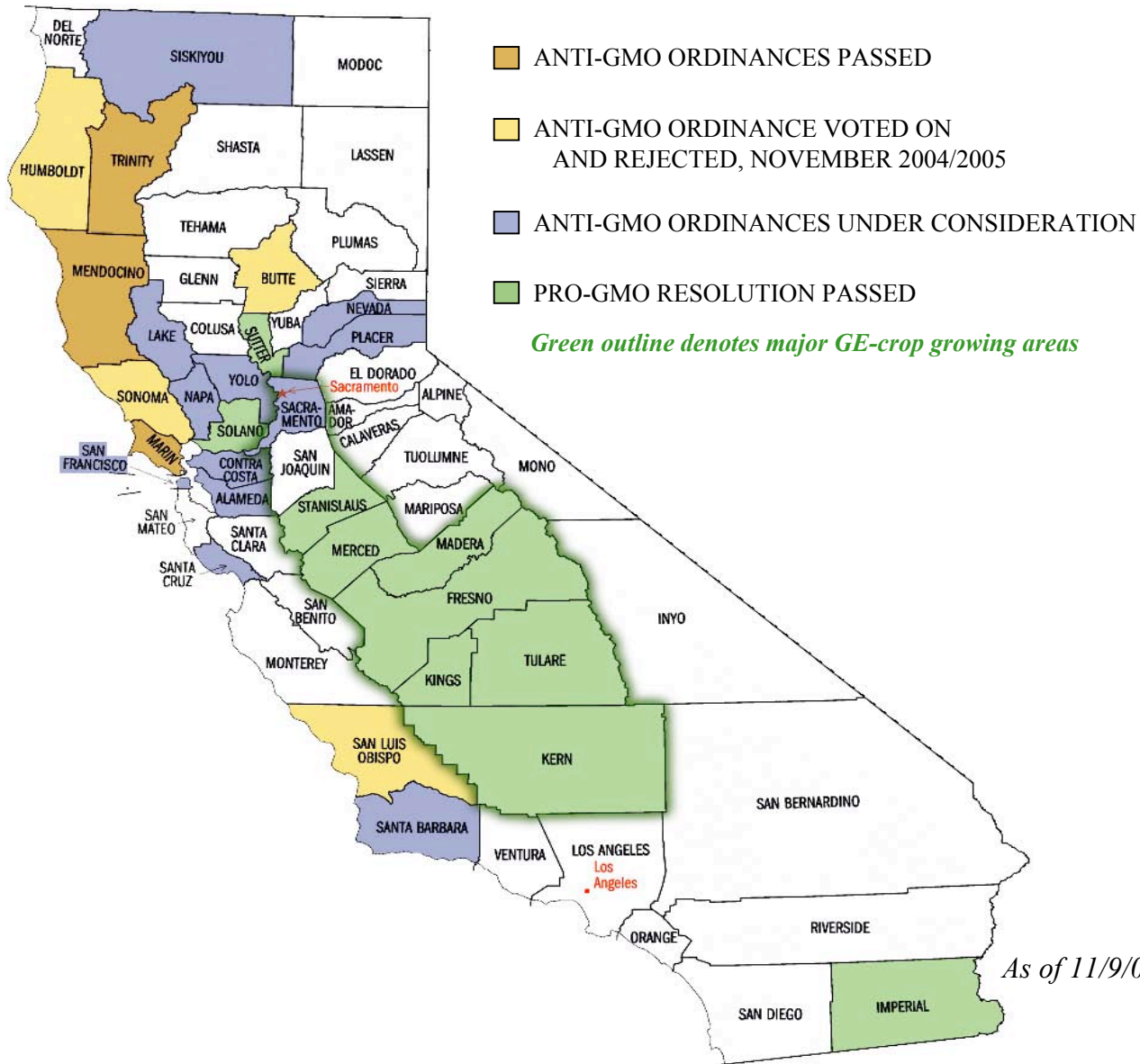
## County GMO Ordinances

**GrowGmoFree.ORG**  
Paid for by The Committee for Humboldt Green Genes (#1264406) (707)826-1031 (707)442-3481 (707)923-1116 PO Box 4841, Arcata, CA 95518

**NO on Q**  
It's Bad for Farmers.

**No On "D"**  
Families & Farmers For  
A Healthy Environment

**YES Q**  
HEALTHY FARMS AND FAMILIES



**March 2004 MENDOCINO  
MEASURE H -2,579 signatures obtained**

- **“unlawful for any person, firm, or corporation to propagate, cultivate, raise, or grow genetically modified organisms in Mendocino County”**

**“unlawful for any person, firm, or corporation to propagate, cultivate, raise, or grow genetically modified organisms in Mendocino County”  
(excludes microorganisms)**

- **The ban does not pertain to properties within city limits, or lands managed by State, Tribal and Federal agencies.**
- **At election time, no GE organisms were known to be in production in Mendocino County.**

November 2004, Fresno

Passed: Board of Supervisors 5 For; 0 Against

- Whereas, biotechnology has the potential to greatly improve the health, nutrition and

**County of Fresno affirms the right for farmers and ranchers to choose to utilize the widest range of technologies available to produce a safe, healthy, abundant and affordable food supply, and that the safe, federally regulated use of biotechnology is a promising component of progressive agricultural production.**

and ranchers to choose to utilize the widest range of technologies available to produce a safe, healthy, abundant and affordable food supply, and that the safe, federally regulated use of biotechnology is a promising component of progressive agricultural production.



# Some food safety concerns with genetically engineered foods

- Changes in nutritional content
- Creation of allergen
- Activation of toxin gene
- Horizontal gene flow from food to intestinal flora
- Increase in antibiotic resistance
- Labeling

# Some environmental concerns with genetically engineered crops

- Transgene movement via pollen flow
- Transfer of transgenes to non-GMO / organic crops
- Generation of "superweeds" (transfer of herbicide-tolerance to wild/weedy species)
- Spread of pharmaceutical genes to edible crops
- Loss of genetic diversity
- Property rights (gene patents)