GMO Plant Technologies

Yi Li
Plant Science
University of Connecticut

GMO Technologies:

Transferring specific genes to crop plants

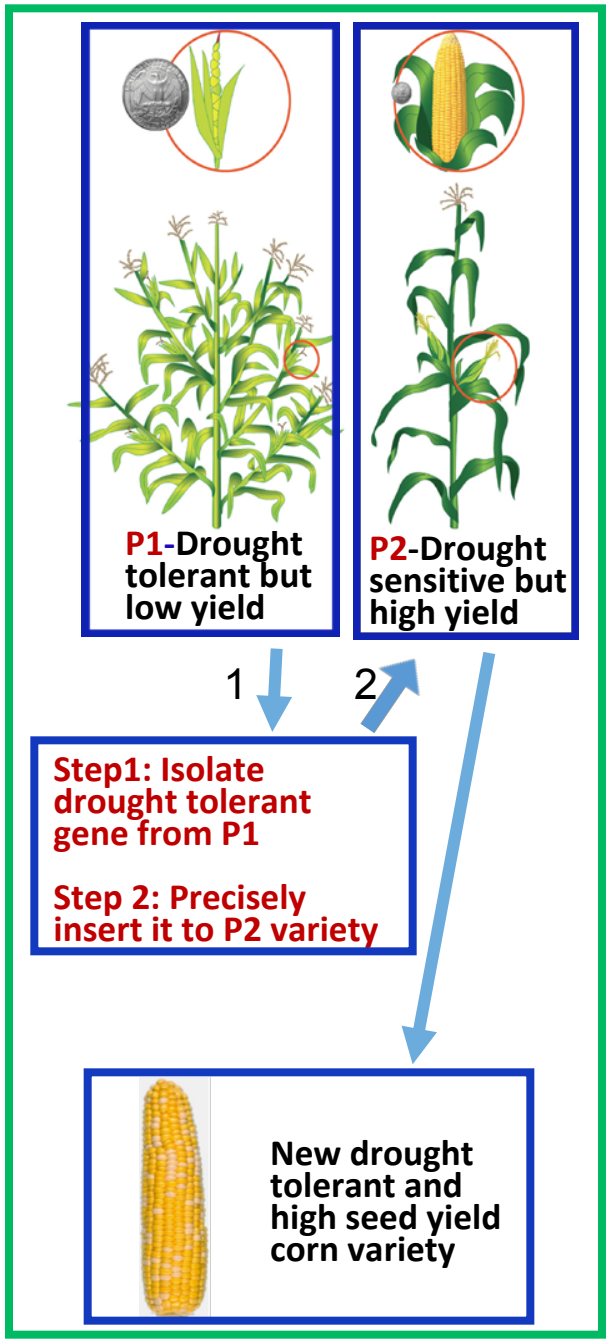
--Precise and efficient;

--Most powerful;

--Expensive for deregulation

--Publically less acceptable;

--Possible gene flow.



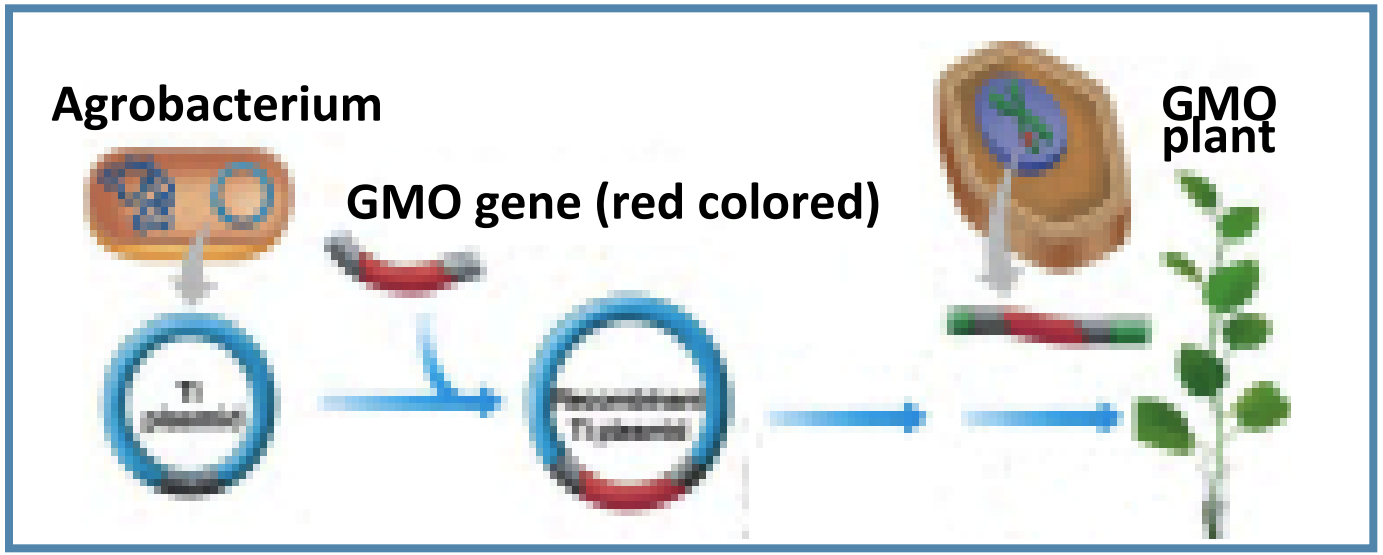
GMO plants are not monsters

PNAS

The genome of cultivated sweet potato contains *Agrobacterium* T-DNAs with expressed genes: An example of a naturally transgenic food crop

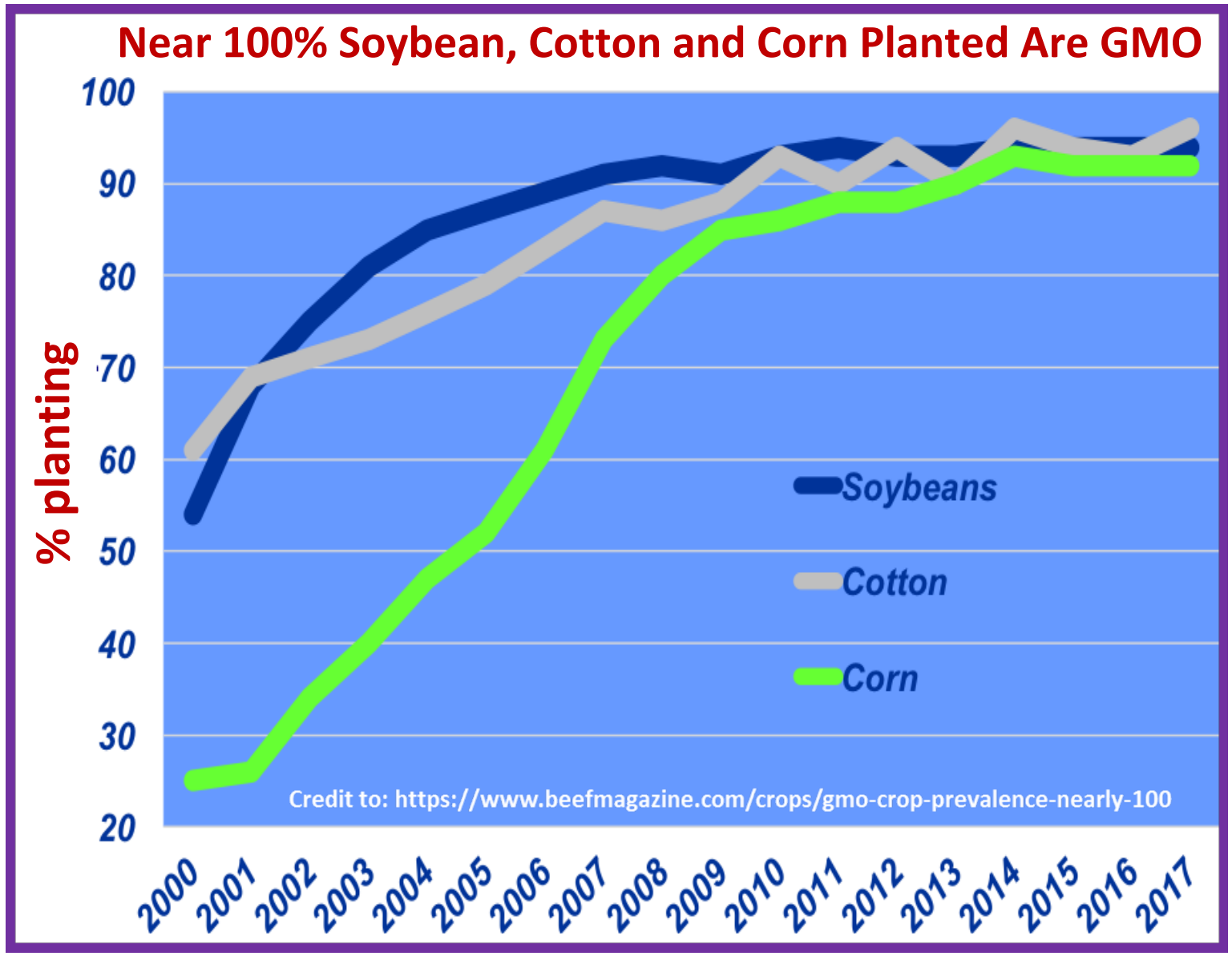
Tina Kyndt[a,1], Dora Quispe[a,b,1], Hong Zhai[c], Robert Jarret[d], Marc Ghislain[e], Qingchang Liu[c], Godelieve Gheysen[a], and Jan F. Kreps[e,2]

[a]Department of Molecular Biotechnology, Ghent University, 9000 Ghent, Belgium; [b]International Potato Center, Lima 12, Peru; [c]Beijing Key Laboratory of Crop Genetic Improvement/Laboratory of Crop Heterosis and Utilization, Ministry of Education, China Agricultural University, Beijing, China; and [d]Plant Genetic Resources Unit, US Department of Agriculture, Agricultural Research Service, Griffin, GA 30223



Natural GMO plants

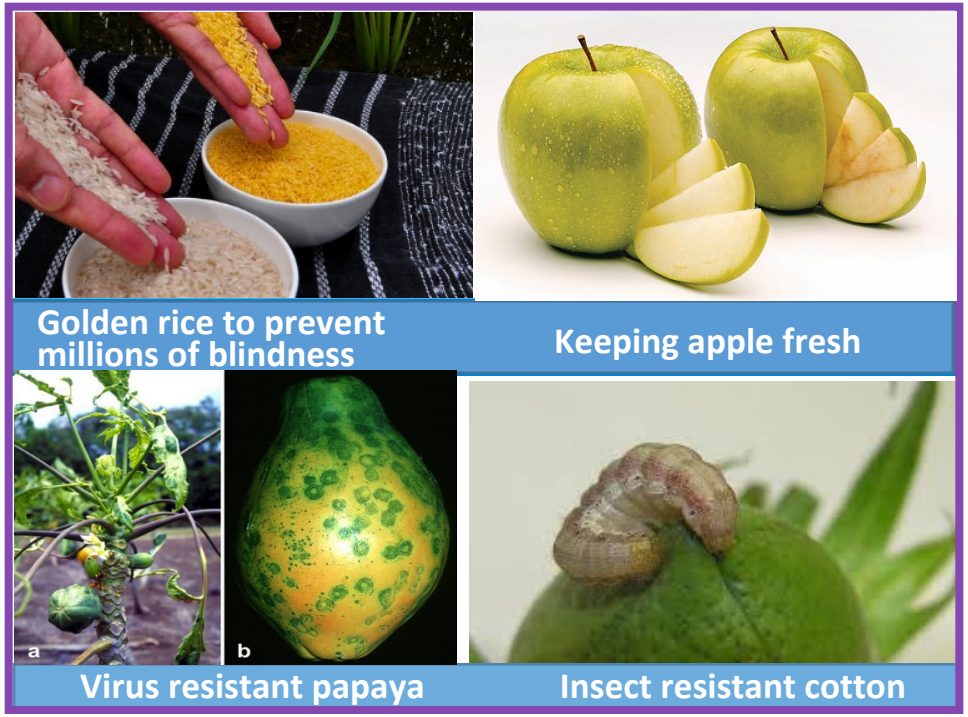
Some Impact of GMO Crop Plants



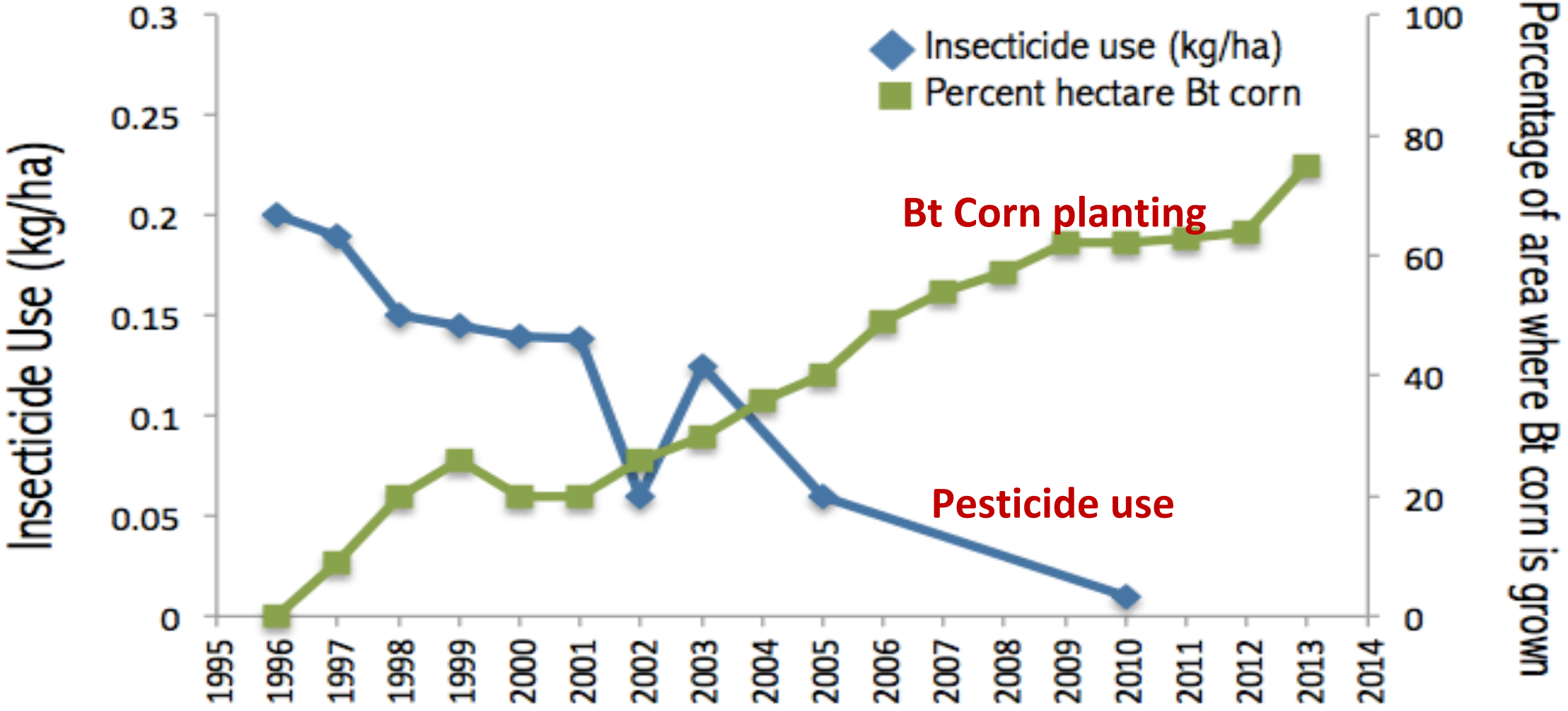
--We have consumed GMO food since 1997.

--Near 100% soybean, cotton and cotton planted in the US are GMO.

--Up to 80 percent of packaged foods contain GMO ingredients.



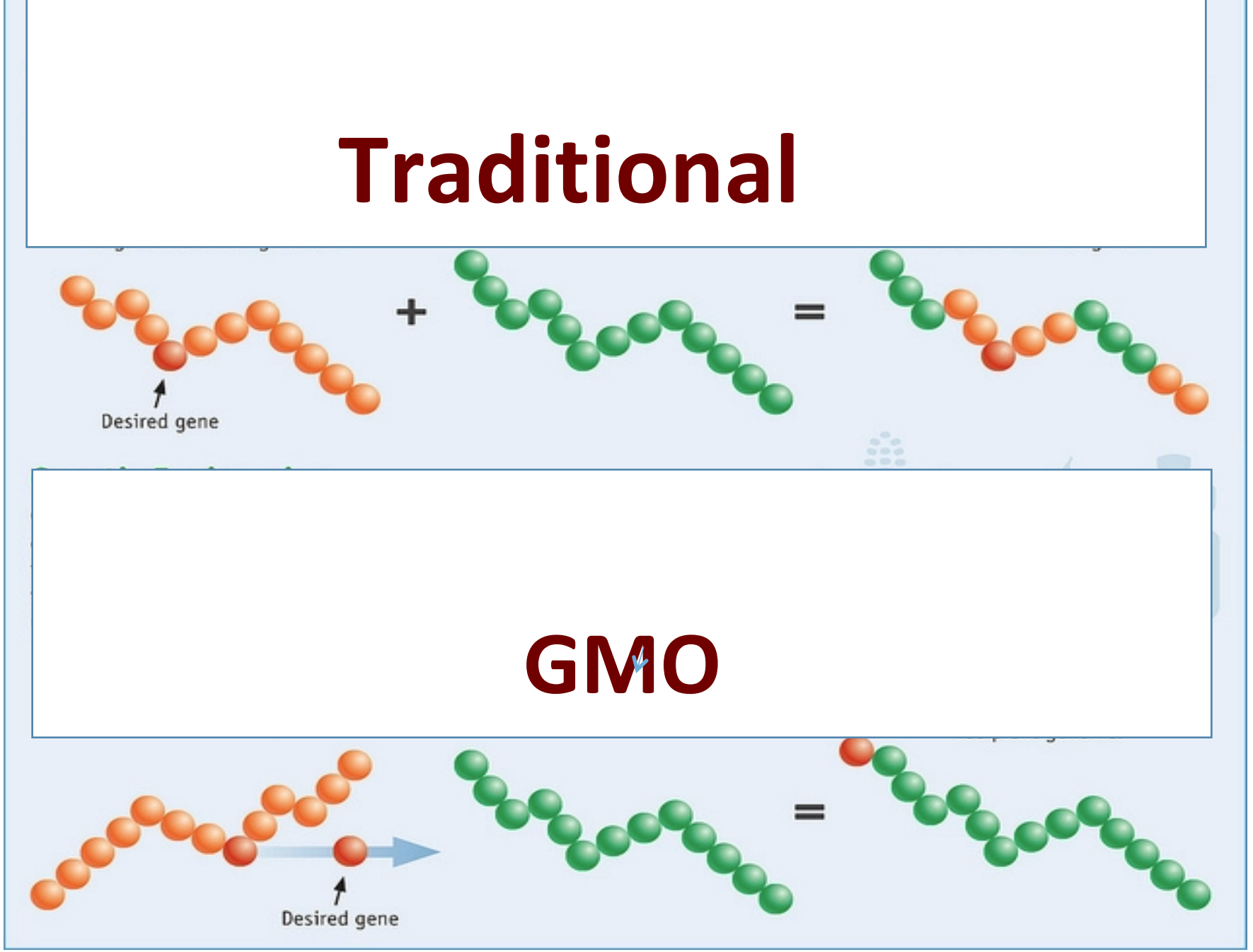
Bt corn uptake and insecticide use in U.S. corn fields



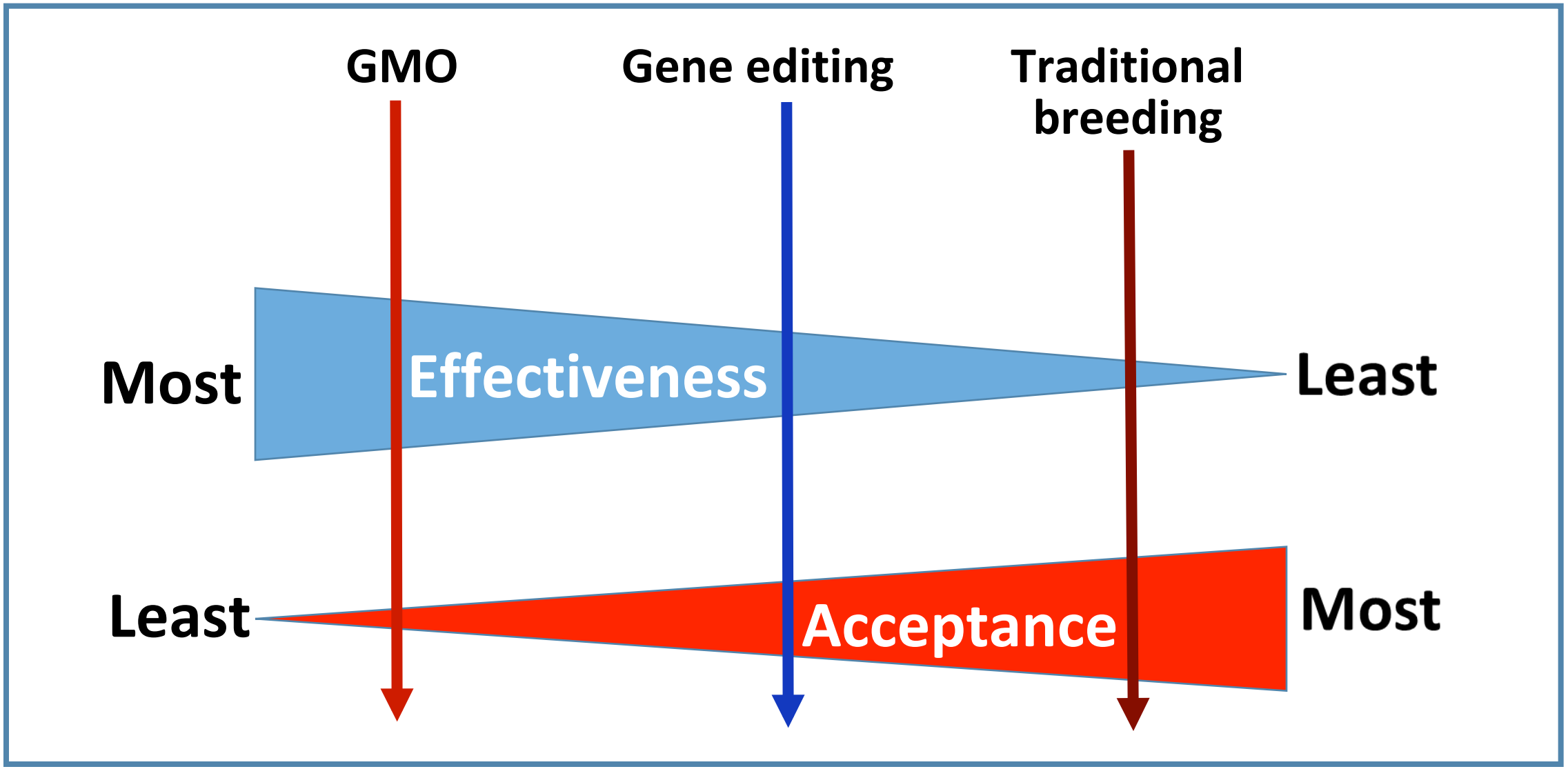
Adapted from Malakof D. and Stokstad E. Pesticide Planet. Science Magazine. 16 August 2013.

Fundamentally the same:

Traditional and GMO breeding methods both are involved in gene transfer.

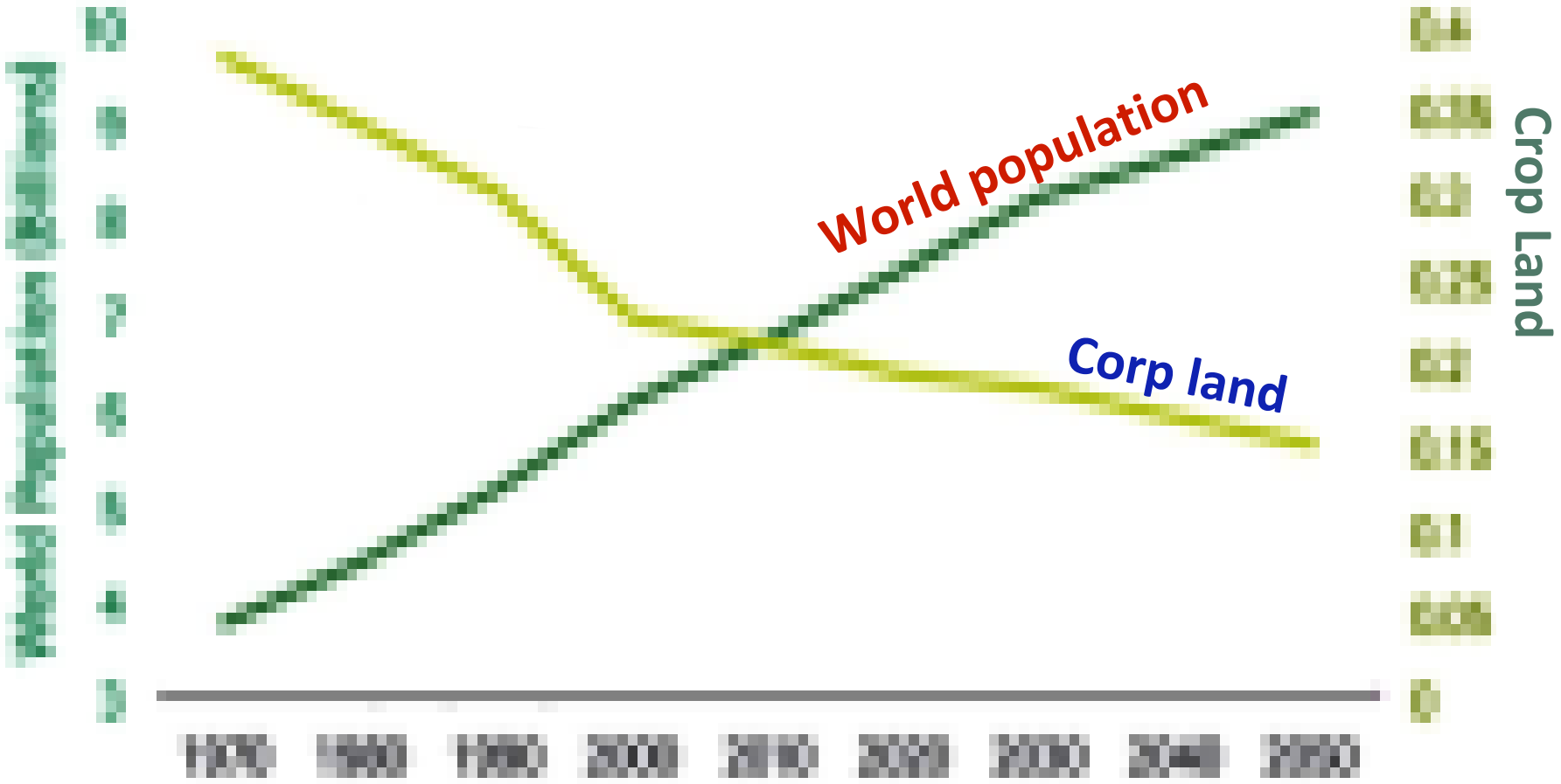


Effectiveness and public acceptance of three major plant breeding technologies

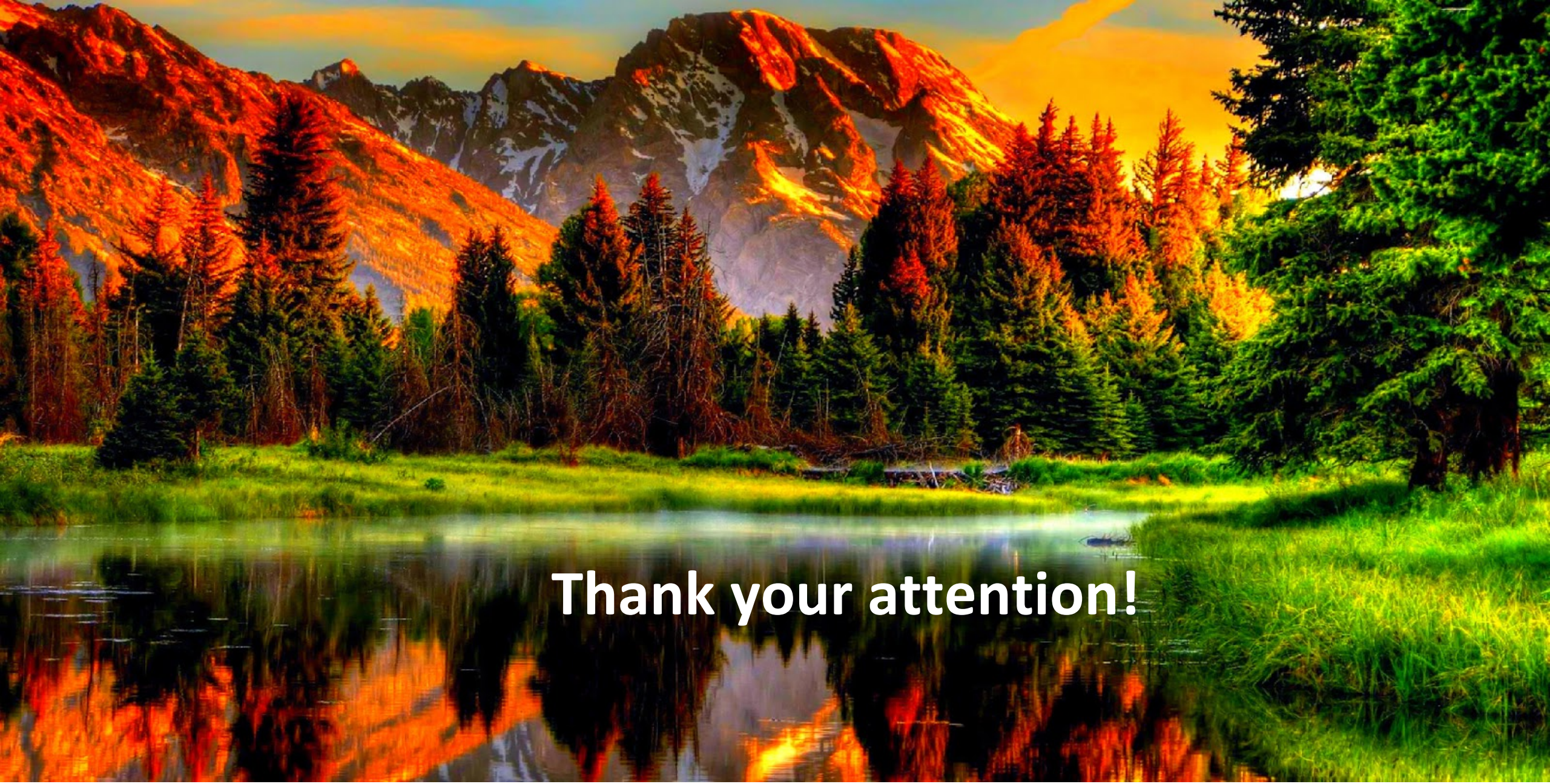


We need to use all possible tools to improve crop yield to feed the World

Increases in World Population versus Reduction in Crop Land



Source: FAO, United Nations, WHO

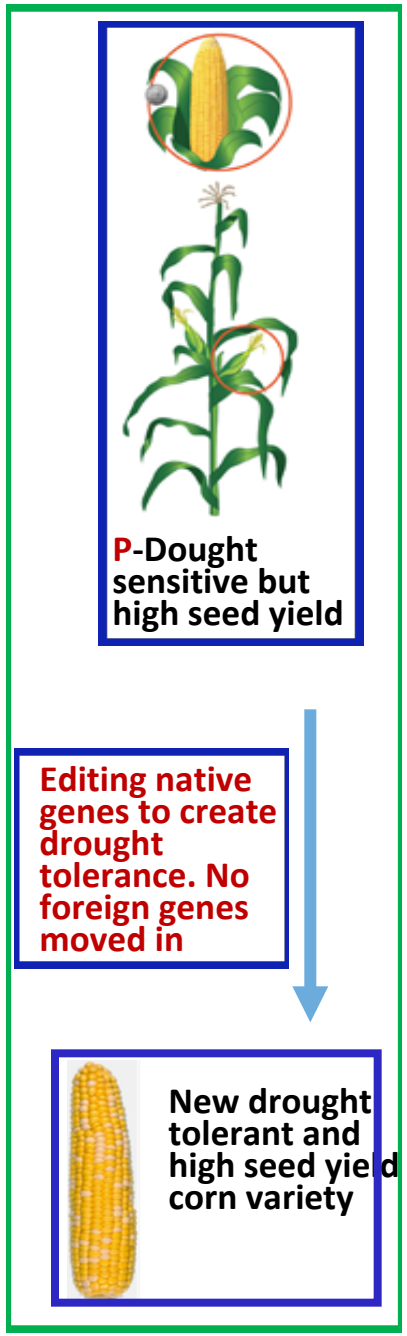


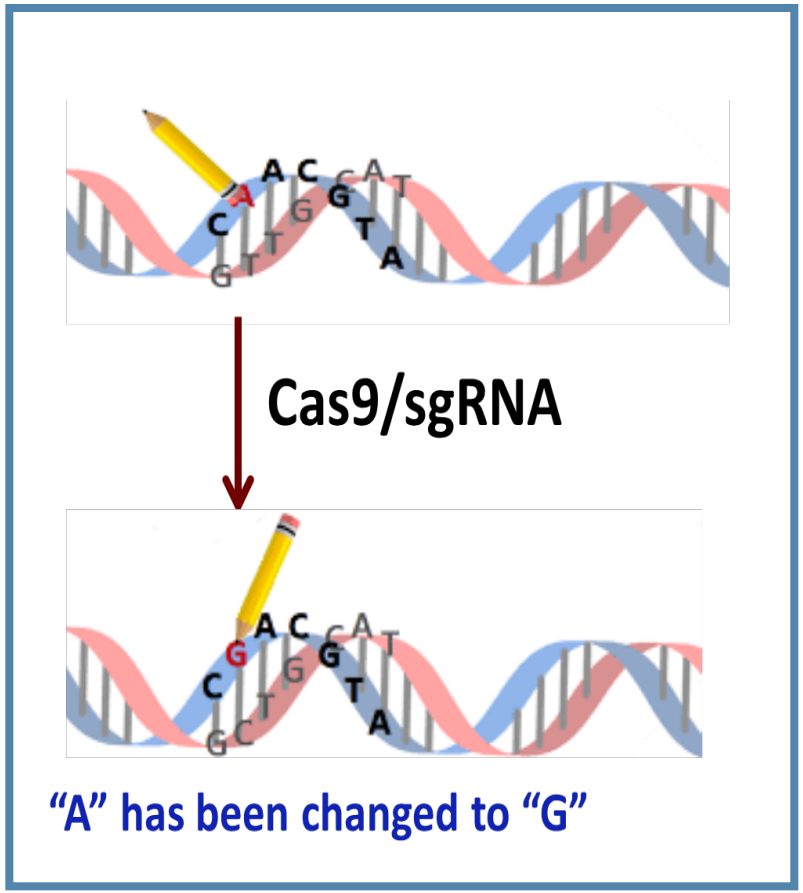
Improving crop yield also reduces impact on precious natural resources

Gene editing technologies

Modify native genes in plants

--Precise and efficient;
--No foreign genes in plants;
--Limited to native plant genes;
--Less powerful than GMO;
--Similar to conventionally bred, not regulated in US.

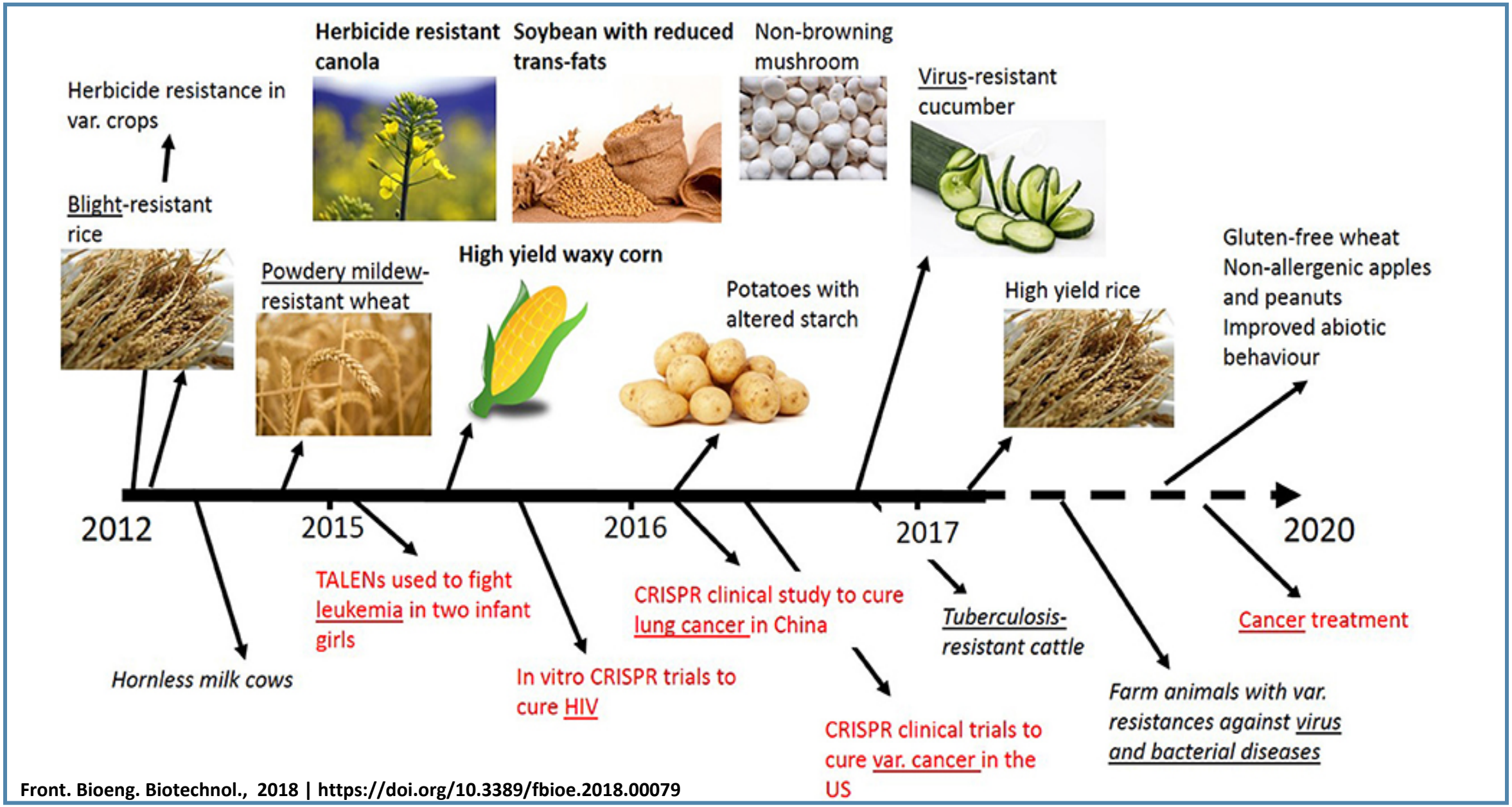




The modification may create drought tolerance

USDA greenlights gene-edited crops

Timeline of selected traits modified by genome editing in plants, animals and for medical applications (red)



Front. Bioeng. Biotechnol., 2018 | https://doi.org/10.3389/fbioe.2018.00079

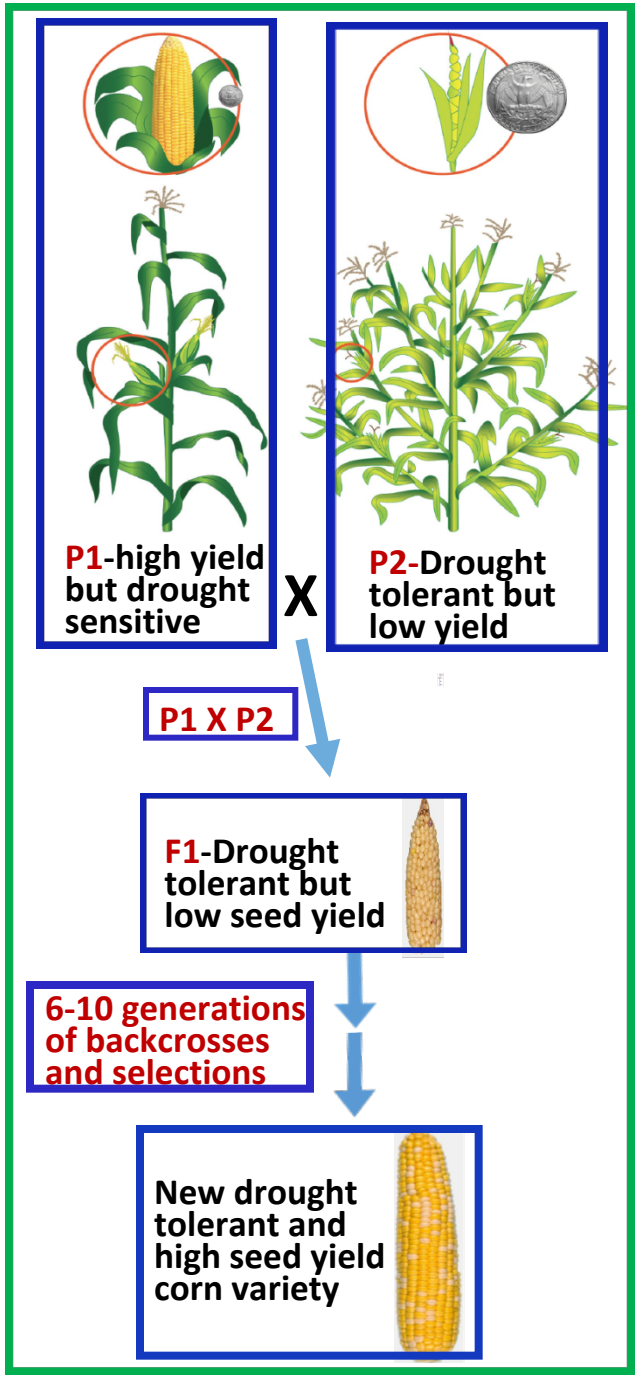
Traditional Breeding technologies:

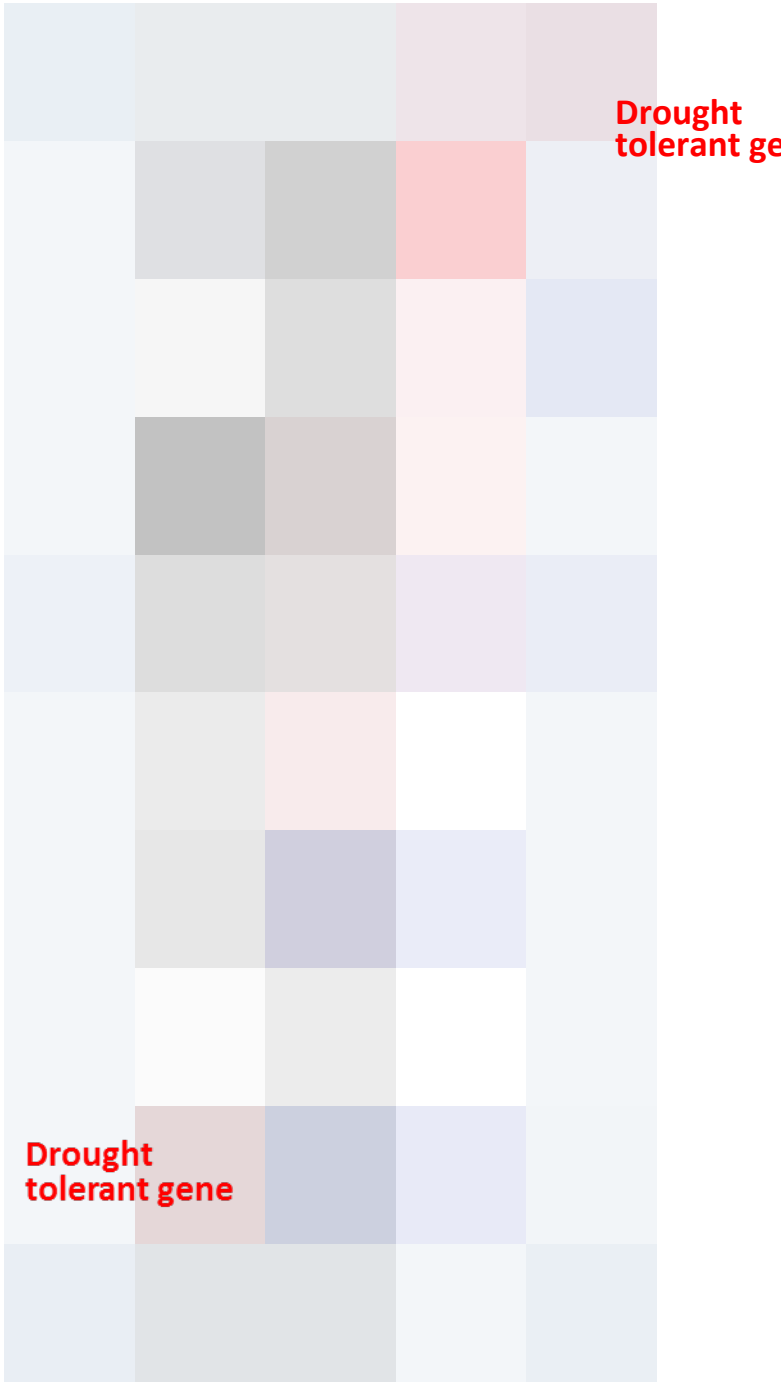
Transferring tens of thousands of genes from one plant to another.

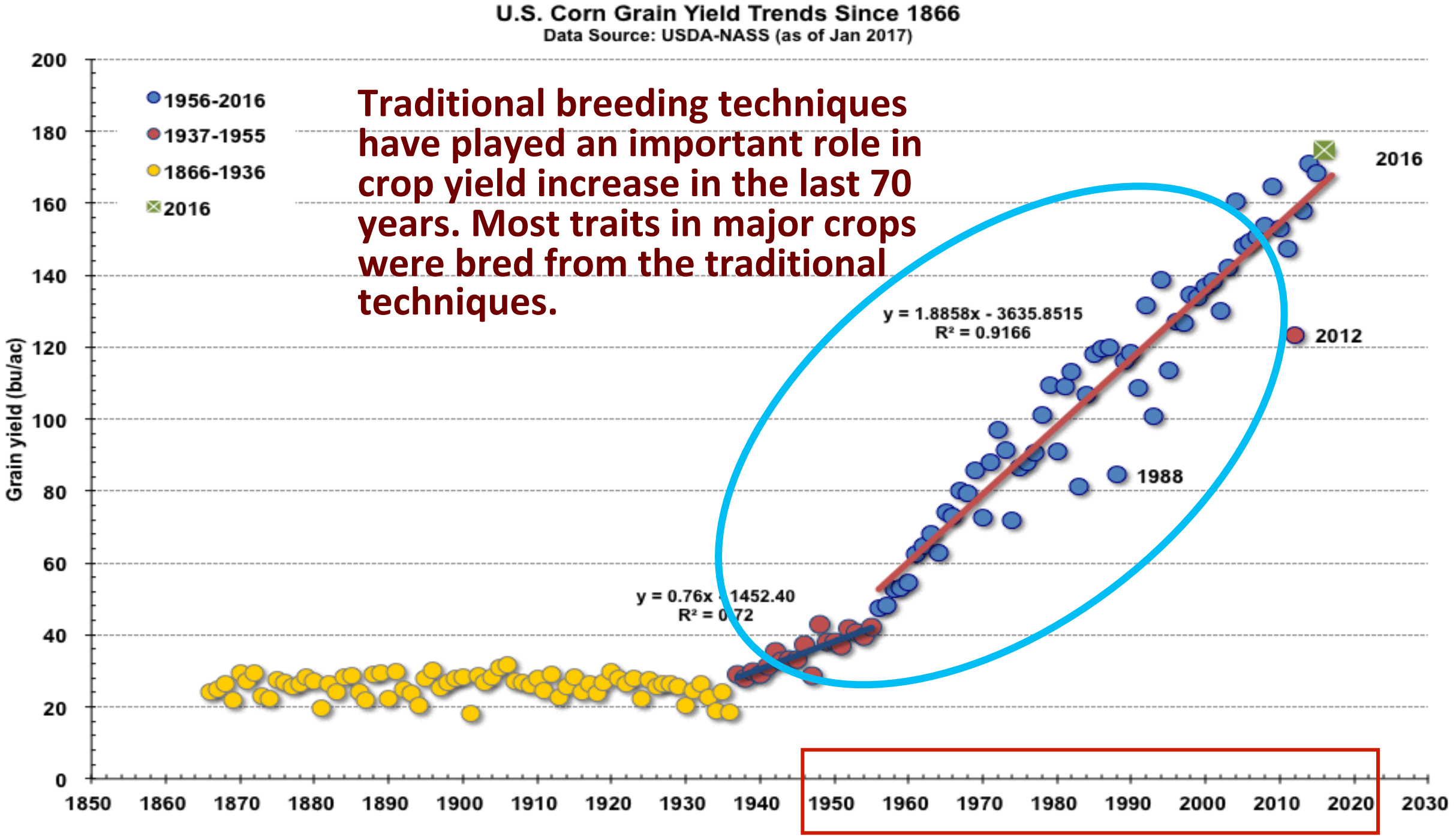
--Most currently used crops were bred using this approach;

--Publically acceptable;

--Not precise and inefficient.






U.S. Corn Grain Yield Trends Since 1866
Data Source: USDA-NASS (as of Jan 2017)
Traditional breeding techniques have played an important role in crop yield increase in the last 70 years. Most traits in major crops were bred from the traditional techniques.
1956-2016
1937-1955
1866-1936
2016
y = 1.8858x - 3635.8515
R² = 0.9166
y = 0.76x - 1452.40
R² = 0.72
2016
2012
1988
Grain yield (bu/ac)
0
20
40
60
80
100
120
140
160
180
200
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030

Using traditional breeding techniques, we have developed low mowing frequency lawn grasses and non-invasive burning bush

Sterile, non-invasive burning bush (Euonymus alatus)

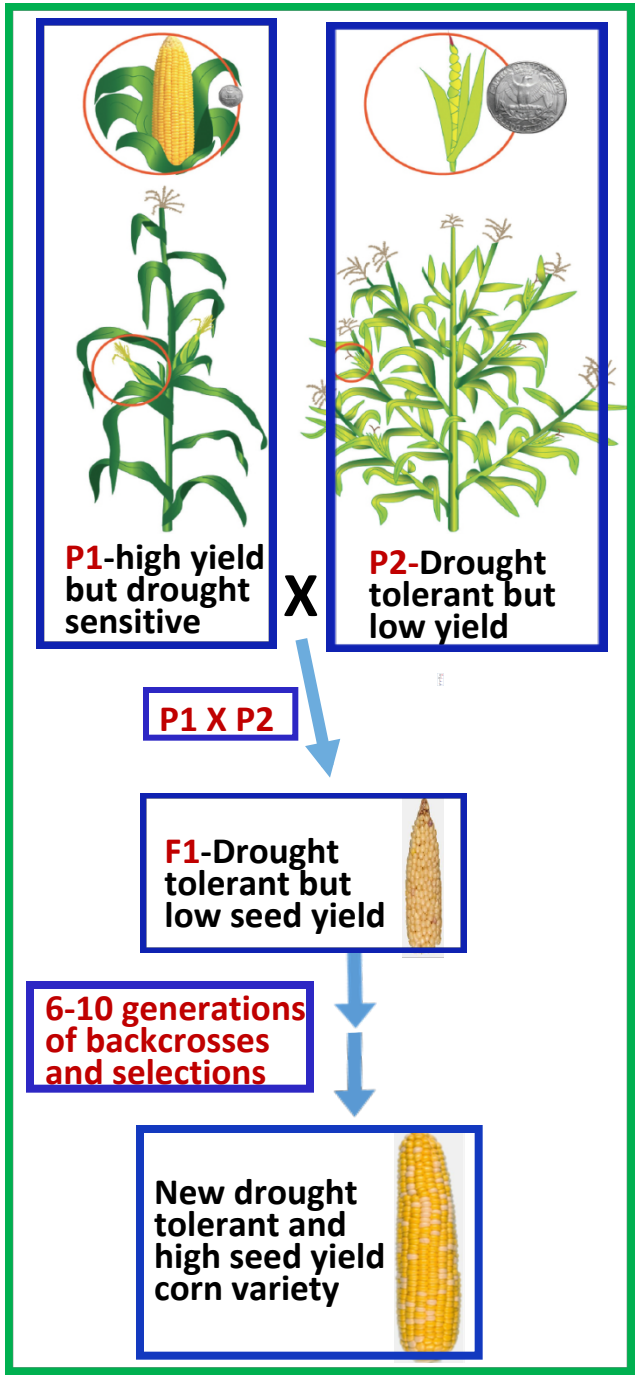
Traditional Breeding technologies:

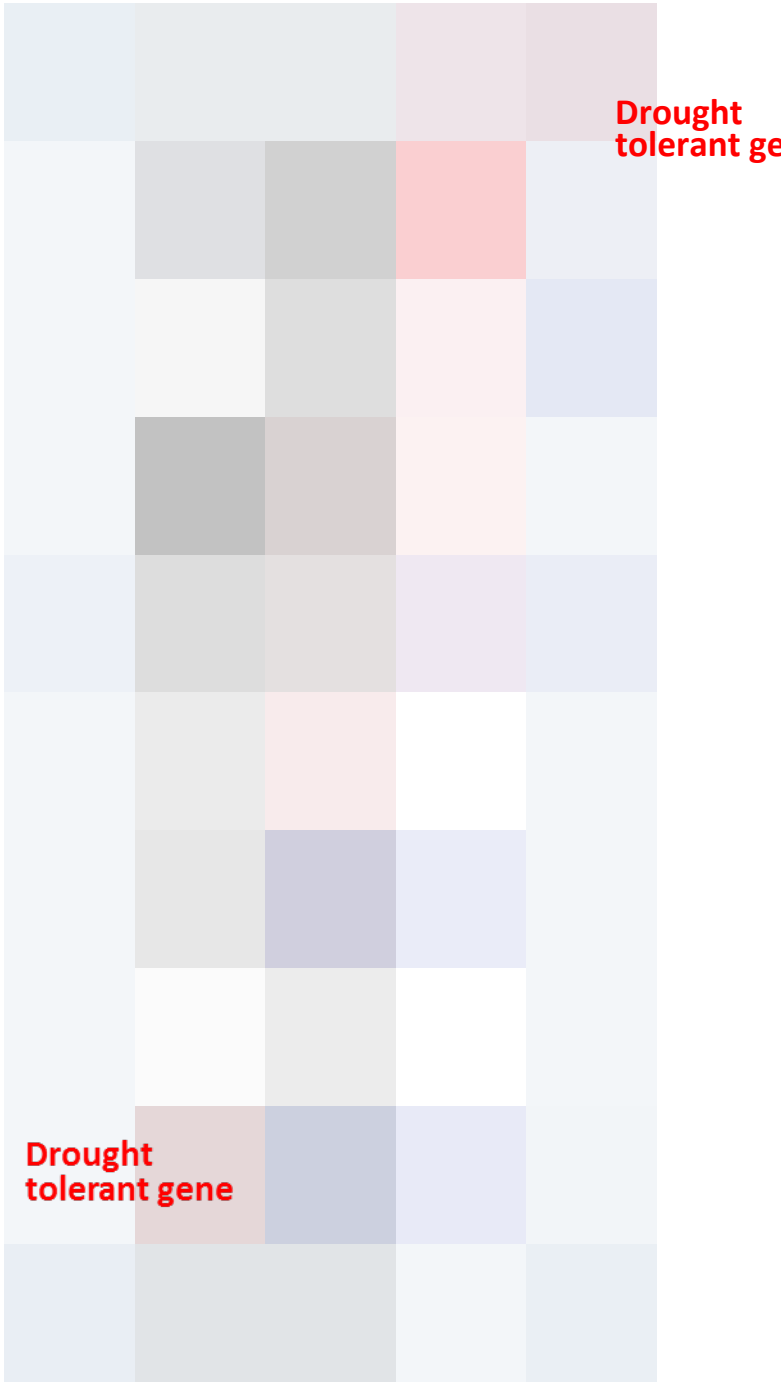
Transferring tens of thousands of genes from one plant to another.

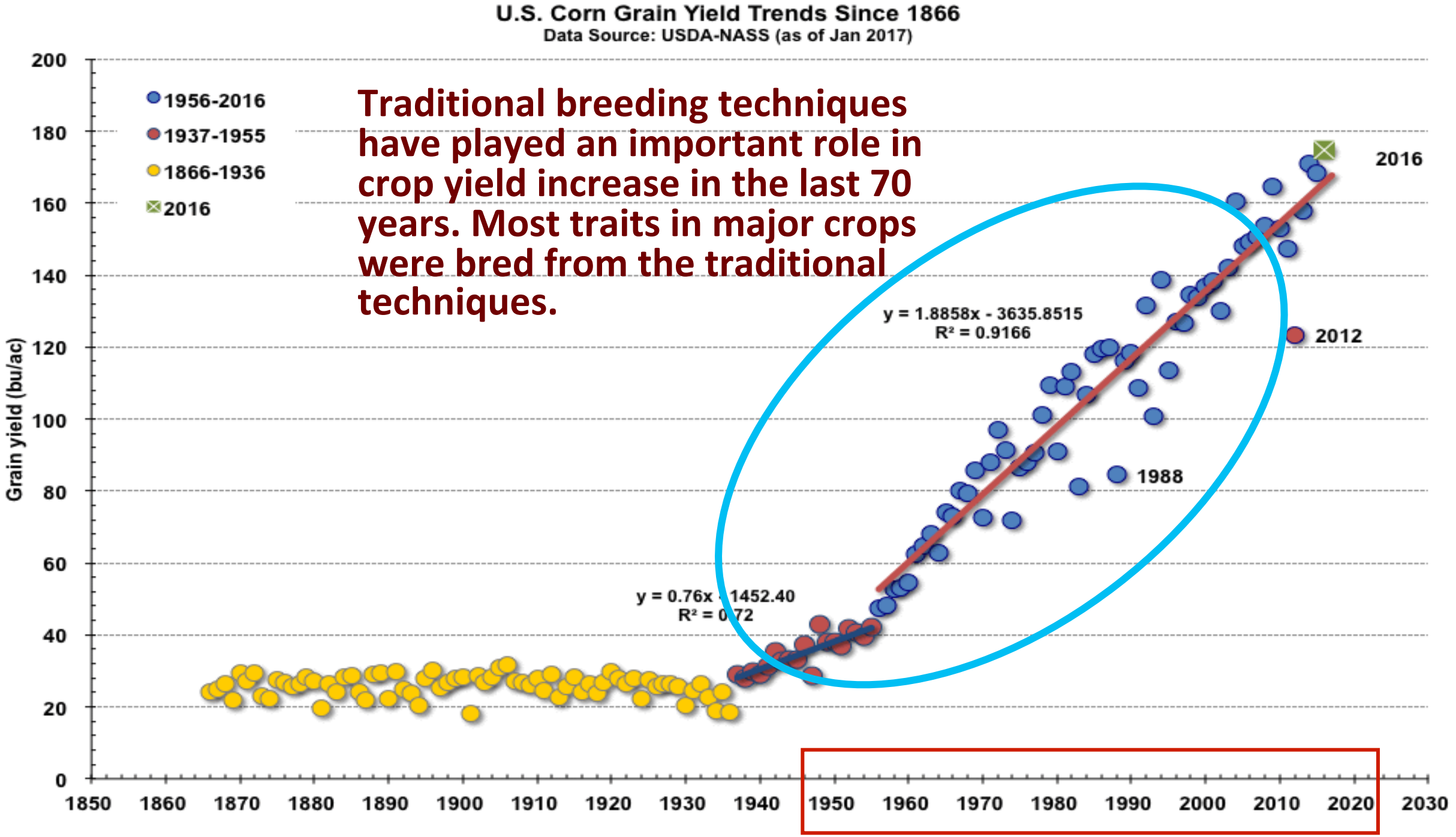
--Most currently used crops were bred using this approach;

--Publically acceptable;

--Not precise and inefficient.






U.S. Corn Grain Yield Trends Since 1866
Data Source: USDA-NASS (as of Jan 2017)
Traditional breeding techniques have played an important role in crop yield increase in the last 70 years. Most traits in major crops were bred from the traditional techniques.
1956-2016
1937-1955
1866-1936
2016
y = 1.8858x - 3635.8515
R² = 0.9166
y = 0.76x - 1452.40
R² = 0.72
2016
2012
1988
Grain yield (bu/ac)
0
20
40
60
80
100
120
140
160
180
200
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030

Using traditional breeding techniques, we have developed low mowing frequency lawn grasses and non-invasive burning bush

Sterile, non-invasive burning bush (Euonymus alatus)