Genetic Resources: Vital Software for Food, Health and Security

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Outline

- Planet earth
  - The origins of agriculture: crossing the first threshold

- Increasing agricultural productivity
  - Dramatic and rapid changes in hardware
  - Crossing the second threshold-implications

- Genetic software
  - Biological resources
  - Need for change in productivity and crop husbandry
  - Requirements to allow adaptation and improved productivity
  - Vulnerabilities of a closed system

- Concluding comments
  - Needs for stewardship and appropriate use of biological resources
U.S. Corn Yields (1866-2006)

**Open-Polinated Varieties**

- 1866-1933: $b=0.0469$
- 1866-1906: $b=0.0854$

**Double-Cross Hybrids**

- 1934-1955: $b=0.9617$
- 1934-1955: $b=2.3604$

**Single-Cross Hybrids**

- 1956-1974: $b=1.9079$
- 1975-2006: $b=1.9079$

Year

Yield (bu/ac)
**The second threshold in agriculture**

- **The first threshold**
  - Domestication of crop plants
  - Co-dependence of crop species and humankind
- **The second threshold**
  - Scientific plant breeding
  - Farmers specialize in production
  - Breeders specialize in varietal improvement
- **Implications**
  - Conservation-stewardship
    - Germplasm lost forever unless conscious efforts to undertake
  - Dependence on successful sourcing of genetic diversity; global scope
Left 1990s  Right 1930s
ECB2, Natural Infestation

1940s Inbred

1970s Inbred
Changes in Other Traits

- 51 hybrids, 4 OPCs
- 1991-2001 (BLUPs)
- Increased yield
- Reduced ASI
- Reduced tassel size
- Improved staygreen
- Leaves more upright
- More ears/100 plants (fewer barren)
Grain Yield in 4 Seasons contributed by genetic software
Yields plotted as “optimum density per hybrid”

- 1992: favorable
- 1994: favorable
- 1991: hot & dry
- 1993: wet & cool
  - “year of the floods”
- Linear gains in every season, good or bad
Genetic software changes

Germplasm Backgrounds by Pedigree Decade Means for Hybrid in Decade Study Decade
1940s

1960s

1980s

2000s

Other

ABBY
BOONECOWH
BR2Y
BS5
FUNKYDENT
ILLHY
IODENT
KRUG
LANCCOMP
LANCLOBRK
LANCSURCROP
LLE
M3204
M41Y
MARYLDYDENT
MIDLAND
MINN13
OSTERYDNT
TROYERREID
WFRYD

ARGMAIZARM
BROOKINGS86
BS5
COKER616
DOCKDORF101
FCOP
FUNKYDENT
ILLONG
ILLTWOEAR
IODENT
LANCCOMP
LANCLOBRK
LLE
MIDLAND
MINN13
OSTERYDNT

ALBRTFLINT
ARGMAIZARM
BS5
DOCKDORF101
FCOP
FSOP
FUNKYDENT
ILLONG
ILLTWOEAR
IODENT
KRUG
LANCCOMP
LANCLOBRK
LLE
MIDLAND
MINN13
NWDENT
OSTERYDNT
Genetic software: Change in SSR Alleles

- From ERA hybrids
- 968 SSR alleles from 98 SSR loci distributed over 10 chromosomes
- Six groups based on mean allele frequency per decade
Genetic software: Sequential Change in SSR Alleles

- The 3 recent decades (since 1980) differ from the earlier decades
- Subgroups of early decades
  - OPCs & 1930s
  - 1940s & 1950s
  - 1960s & 1970s
Pedigree breeding and genetic diversity

• “The general practice of using good hybrids as source material for the development of new lines insures that there will be a gradual reduction in the total genetic base.”

U.S. National Academy of Sciences  1972
Evolution of North American Dent Corn from Public to Proprietary Germplasm.

- “Much of today's germplasm originates from seven progenitor lines: B73, LH82, LH123, PH207, PH595, PHG39, and Mo17.”
  - Mark Mikel and John Dudley (Univ. of Illinois)
Concluding comments

- Genetic software is a key biological resource
  - Requiring
    - Stewardship
      - Conscious efforts to conserve
      - Monitoring
    - Transparency
      - allowing farmers to manage through informed choice
  - Global perspective
    - Breeding
    - Conservation
    - Benefit sharing