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Genetic Resources: Vital Software for Food, Health and Security

USDA Agricultural Outlook Forum

March 1st and 2nd 2007

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DuPont Agriculture and Nutrition

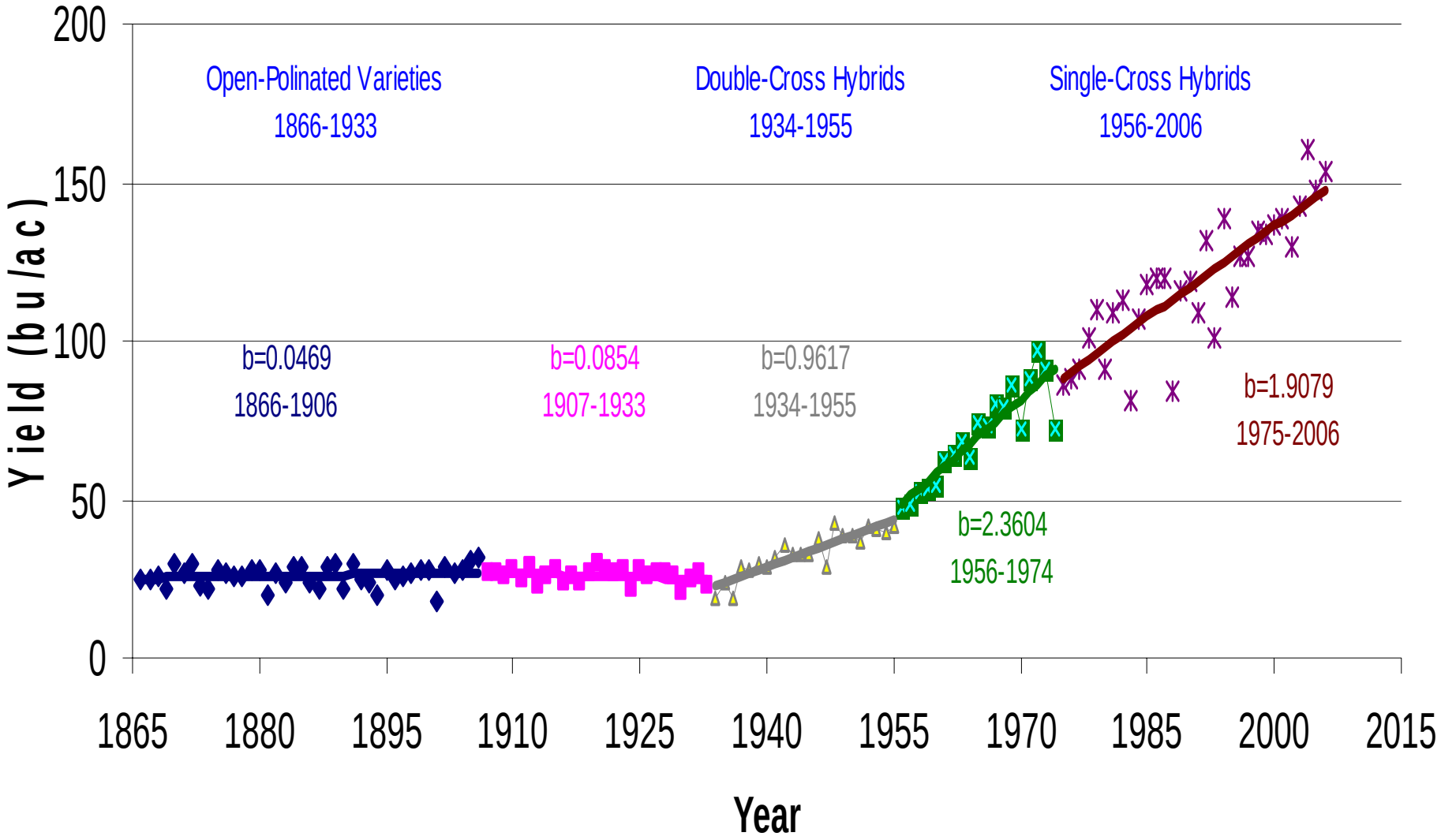
PIONEER
A DuPont Company

DUPONT

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)



Fowler 15226 Tiny Tim

Barry Finch photo


MARSHALL'S


CLAAS
LEXION 570

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

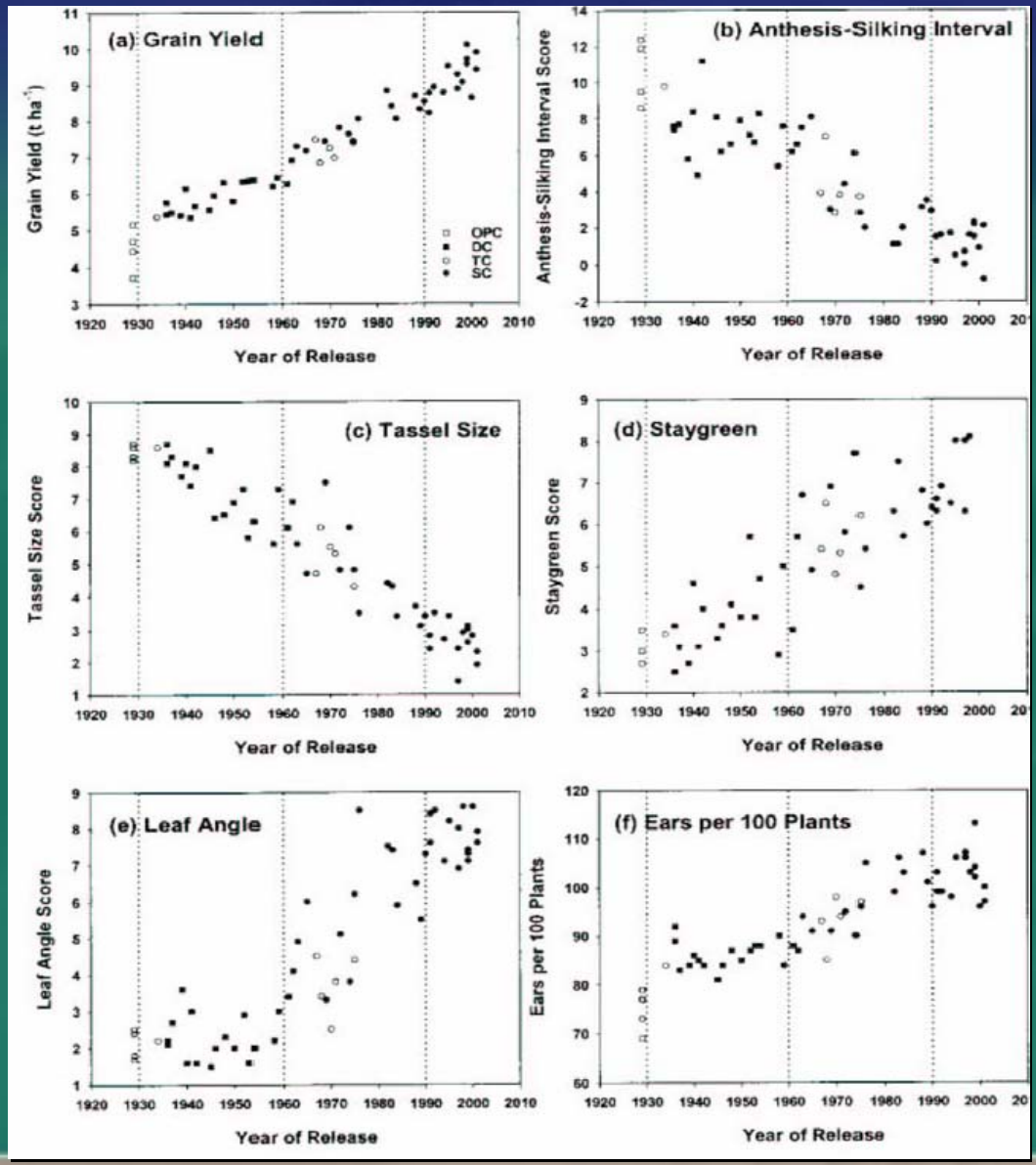
1940s Inbred

1970s Inbred

Changes in Other Traits

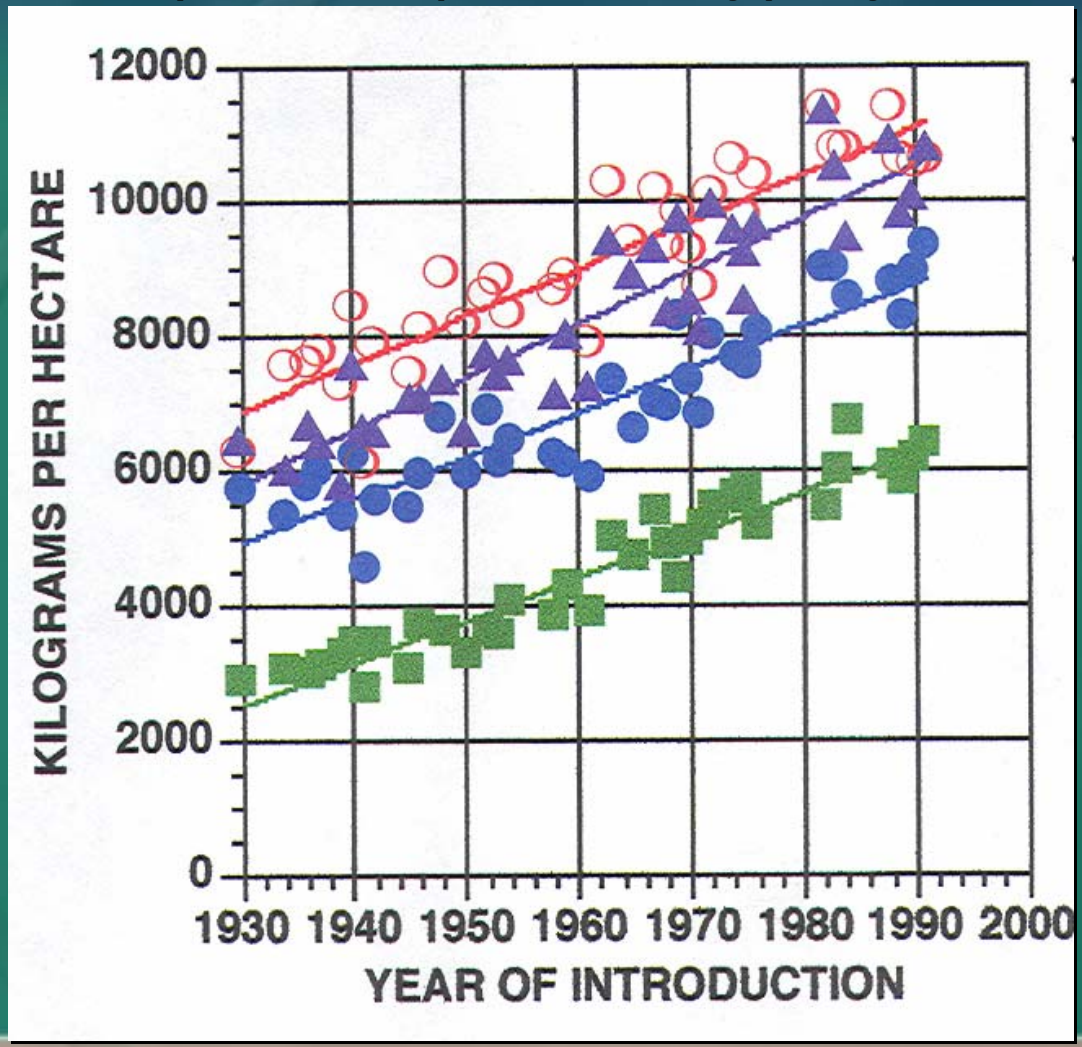
- 51 hybrids, 4 OPCs
- 1991-2001(BLUPs)

- *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"

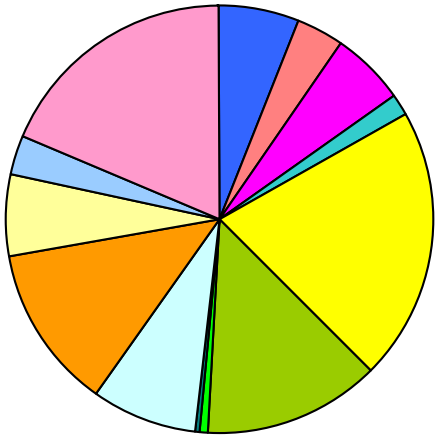


- 1992: favorable
- 1994: favorable
- 1991: hot & dry
- 1993: wet & cool
  - "year of the floods"
- ***Linear gains in every season, good or bad***

1990s Hardware and Software1930s

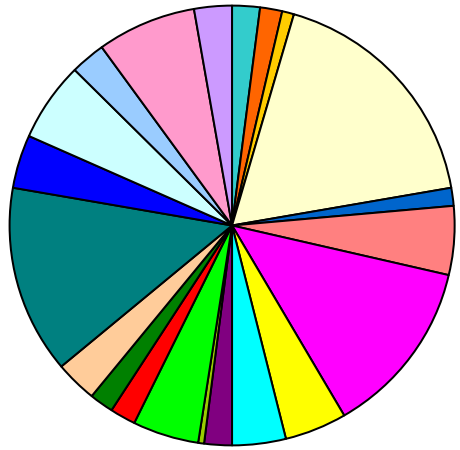
Genetic software changes

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



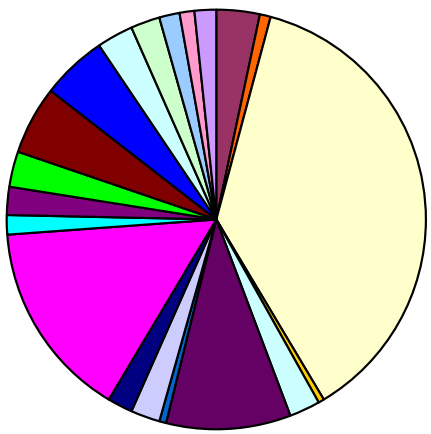
- FUNKS176A
- ILLHY
- IODENT
- K140
- KRUG
- LANCSURCROP
- LLE
- MIDLAND
- OSTERYDNT
- REID
- STOP
- TROYERREID
- WFRYD

Germplasm Backgrounds by Pedigree Decade Means for Hybrids in Decade Study Decade 1960s



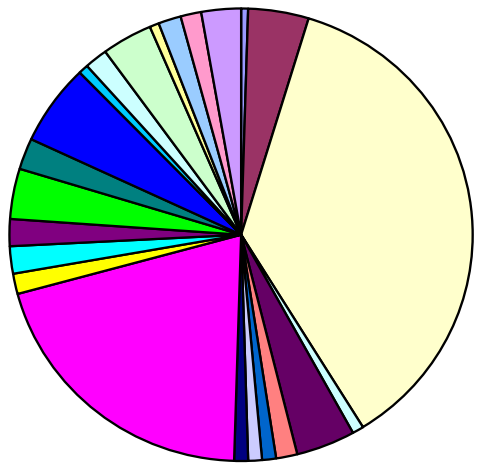
- AB8Y
- BOONECOWH
- BR2Y
- BSSS
- FUNKYDENT
- ILLHY
- IODENT
- KRUG
- LANCCOMP
- LANCLOBRK
- LANCSURCROP
- LLE
- M3204
- M41Y
- MARYLDYDENT
- MIDLAND
- MINN13
- OSTERYDNT
- TROYERREID
- WFRYD
- Other

Germplasm Backgrounds by Pedigree Deca Means for Hybrids in Decade Study Decade 1980s



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

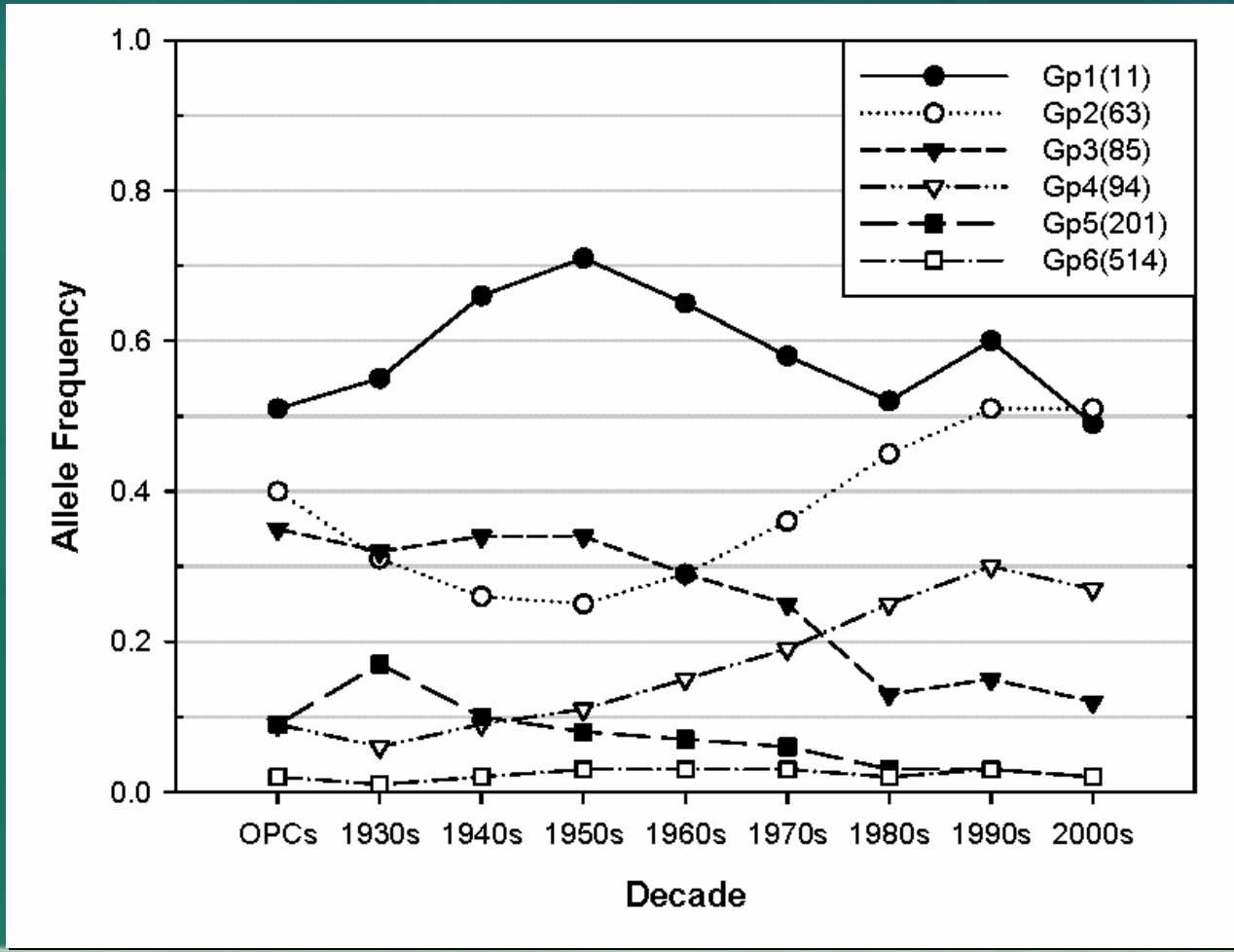
Germplasm Backgrounds by Pedigree Decade Means for Hybrids in Decade Study Decade 2000s



- ALBRTFLINT
- ARGMAIZARM
- BSSS
- DOCKDORF101
- FCOP
- FSOP
- FUNKYDENT
- ILLONG
- ILLTWOEAR
- IODENT
- KRUG
- LANCCOMP
- LANCLOBRK
- LLE
- MIDLAND
- MINN13
- NWDENT
- OSTERYDNT

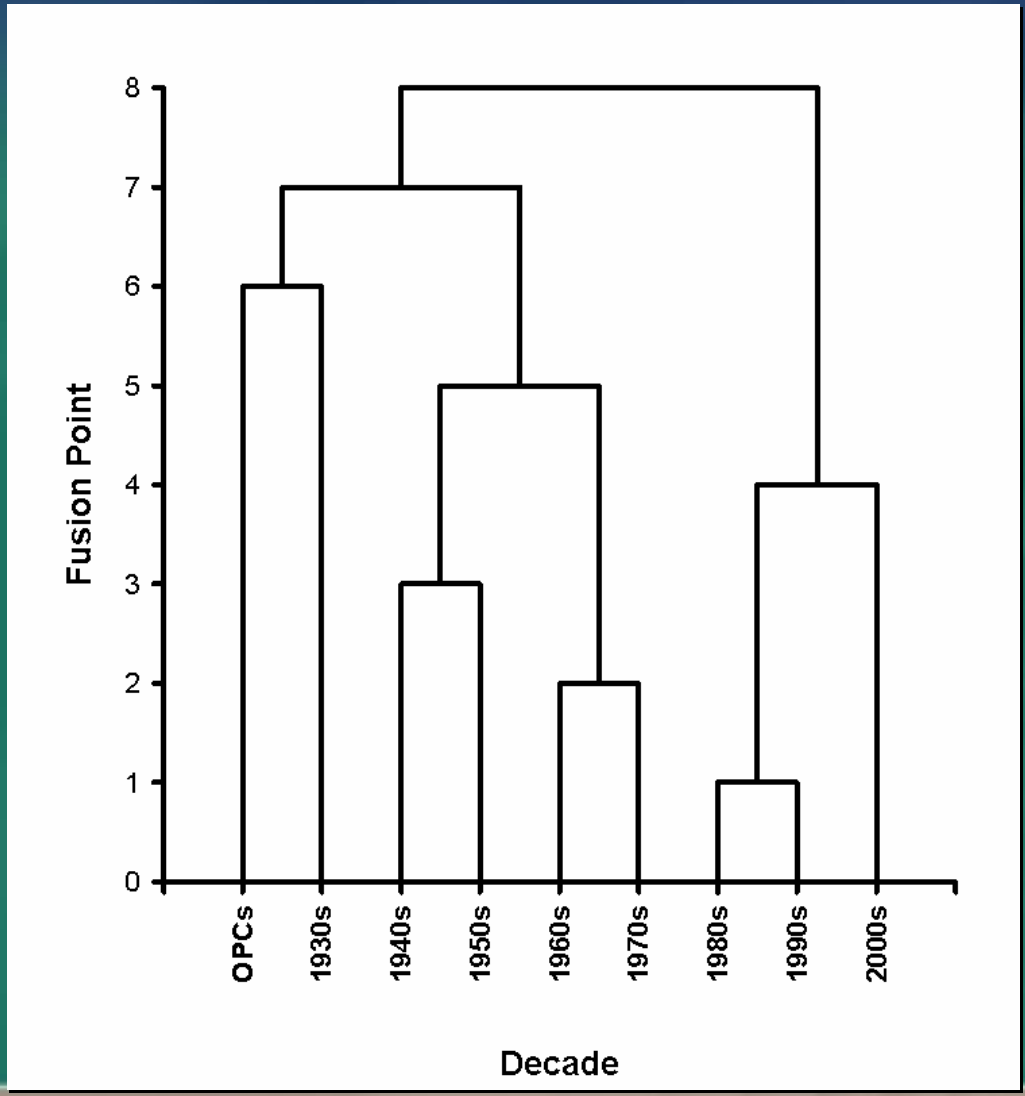
Genetic software: Change in SSR Alleles

- 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*

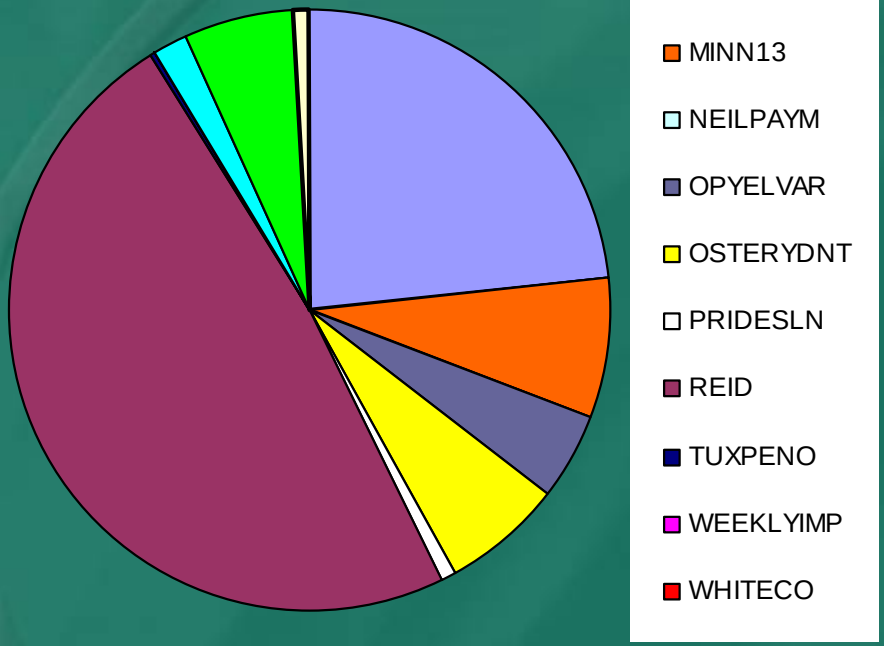


Pedigree breeding and genetic diversity

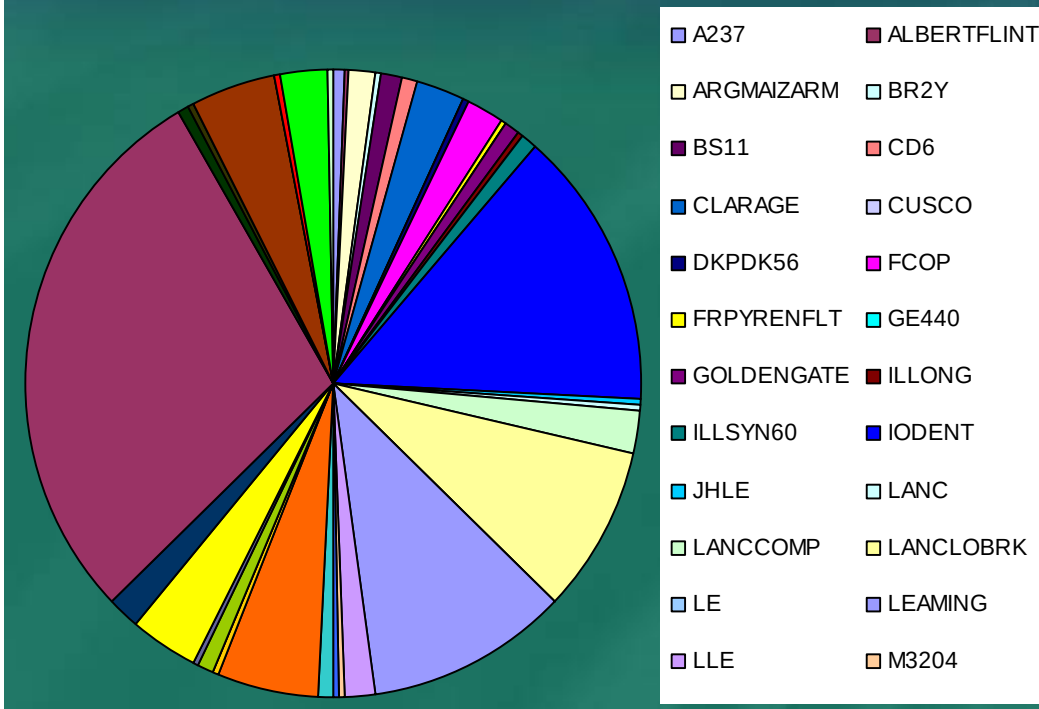
- "The general practice of using good hybrids as source material for the development of new lines insures that there will be a gradual reduction in the total genetic base."

U.S. National Academy of Sciences 1972

Public Lines 1985



Public and Private Lines 2006



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