A.B. Maunder, Dekalb sorghum breeder:

“A proper strategy for meeting short-term goals in an applied breeding program is to emphasize elite germplasm with sufficient genetic variability for yield and quantitative traits...supported by a backcross program utilizing the best known sources of insect and disease resistance”
The breeder’s (favorite) equation:

\[ R_t = \frac{ir \sigma_A}{y} \]

- **Selection Intensity**
  - Increase (to a limit)
  - Need bigger populations

- **Selection Accuracy**
  - Increase
  - More precise measurements
  - Reduce Errors
  - Correct for environment

- **Genetic Variance (Diversity)**
  - Increase
  - Mixed bag (not all good)
  - A must have

- **Years per Cycle**
  - Decrease!
  - Constant ‘rate’ of return

J. Poland
Sources of Genetic Variation

- Mutation (allelic differences)
- Recombination (different combinations of genes, “re-shuffling”; or crossovers within genes)
- Transgenics, gene edits
- Epigenetics (heritable variation that do not involve changes in the underlying DNA sequence, but structural or chemical modification)

Germ plasm of many types, from different species to different varieties, is a source of all these types of variation
Population Development Considerations

- Target environment(s)
- Traits
- Mean performance
- Variance (~genetic diversity)
- Difficulty of crossing, Doubled Haploid, Single seed descent, Speed breeding, Backcrossing, Derived Generation, Off-season nurseries, etc.
Population Selection and Inbreeding considerations

• Automation
• Hybrid wheat
• Gene-editing
• DNA-based prediction
• Rapid breeding cycles
• Minimizing bad relationships
• Systems-based improvement
• Precise identification of traits
• F2 populations planted in WA, F3 in Arizona. Pumphrey, DeMacon, Ryneanson plus grad students and post-docs select

DeMacon and Pumphrey plus grad students and post-docs select and harvest F4 headrows

Jitkov, Nyongesa test F7 at two locations in single plots, F8 at 3 replicated locations, F9 at 4 locations

DeMacon, Pumphrey select F5:6 at Pullman

Chen: ~1500 lines for stripe rust

DeMacon, Nyongesa conduct all early generation grain quality screening, then greenhouse SSD F5

Jitkov, Pumphrey complete all proposals, PVP

DeMacon and Ryneanson fast-track some populations by rapid greenhouse SSD

DeMacon, Nyongesa test F7 at two locations in single plots, F8 at 3 replicated locations, F9 at 4 locations

We grow seed increases for OVA, quality lab, and other programs

We coordinate Al tolerance, Hessian fly R, Falling numbers sampling, for all varieties

We operate 6 spring wheat VT locations

Quality lab test >700 lines

>100 lines screened for Hessian fly resistance

Chen: ~1500 lines for stripe rust

We grow two Western Regional Nursery locations

DeMacon rates

Crossing

Early generation

Yield testing

Variety testing

• DeMacon, Nyongesa

• Ryneanson does special crossing and Marker-assisted selection in F2 or BCF1

Jitkov/Pumphrey

Jitkov/Pumphrey

Complete all proposals, PVP
Genetic Variation

Male Reproductive Structures

Anther 1

Anther 2

Anther 3
Female Reproductive Structure

Pistil
Hybrid Wheat Seeds

• 50% of the genes are from the female

• 50% of the genes are from the male
Early generation plots of F2 and F3 segregating lines

80 head rows per F4 family for selection