Breeding Self-Pollinated Crops

Common Wheat
Principles of plant breeding – The four stages of the plant breeding process

- Creation of genetic variability
- Selection to fix desired genes
- Evaluation of the selected lines
- Cultivar release
### Aberdeen Breeding Program

| Year 1: | Initial crosses made → P1 x Q1 400-800 |
| Year 2: | Additional crossing → P1/Q1 x P1 or P2 |
| Year 3: | F₁ progeny rows |
| Years 4-5: | F₂-F₃ plots, one bulk/plot |
| Year 6: | F₄ plots, 200 heads/plot |
| Year 7: | F₅ head rows, 5-15% selection index |
| Year 8: | Non-replicated, two environments |
| Year 9: | Replicated, two environments |
| Year 10: | Elite yield trials, multiple environments |
| Year 11: | Elite and Western Regional yield trials |
| Year 12: | Repeat Y11, start PNW variety trials |
Aberdeen Breeding Program
Stage IV – Cultivar Release

Year 13: Repeat Y12, Breeder seed production,
Year 14: Repeat Y13, release and PVP, Foundation seed production
Year 15: Repeat Y14, Registered seed production
Year 16: Repeat Y15, Certified seed production
Stage I: Planning & Hybridization – creating genetic variation

- Define breeding objectives
- Determine mating methods
- Traditional crossing
- Chromosome engineering
- Mutagenesis
- Tissue culture
- Transgenic
Stage I: Planning & Hybridization – creating genetic variation

Year 1: Initial crosses made → PI x Q1 400-800
Year 2: Additional crossing → PI/Q1 x P1 or P2
> 50% of Idaho wheat
> 50% of spring wheat
> 85% irrigated wheat
> Five classes of wheat
Fusarium Head Blight or Scab
Wheat Black Chaff
Barley Yellow Dwarf Virus
Wheat Hessian Fly

Fly/eggs

Larvae
Dwarf Bunt
Dryland Foot Rot
Abiotic Stresses
Pre-harvest Sprouting - PHS

Alpha-amylase

Falling number test

Starch
Bread Baking Quality

IDO651
IDO653
Above

AB
HZ

HZ
AB
Stage II: Early Generation Advancement

Year 3: $F_1$ progeny rows
Years 4-5: $F_2$-$F_3$ plots, one bulk/plot
Years 6: $F_4$ plots, 200 heads/plot
Year 7: $F_5$ head rows, 5-15% selection index
Proportion of Homozygous and Heterozygous Genotypes in a Population

AA x aa

\[
\frac{1}{4}^n
\]

F1

F2

F3

F4

F5

F6

25% AA

50% Aa

6.25% AABB, AAbb

6.25% aaBB, aabb

25% aa

25% Aa

12.5% AA

12.5% aa

50% Aa

6.25% AA

12.5% Aa

6.25% aa

6.25% AAbb, AAbb

6.25% aaBB, aabb

12.5% AA

6.25% AA

12.5% Aa

37.5% AA

3.125% AA

6.25% Aa

3.125% aa

43.75% AA

3.125% AA

6.25% Aa

3.125% aa

46.875% AA

1.562% AA

3.125% Aa

1.562% aa

46.875% aa
Bulk- Population of Selection
Doubled – Haploid Procedure

1. Variety A × Variety B
2. F₁
3. Bulk plot culture anthers
4. F₂
5. Haploids
6. Double chromosomes with colchicine
7. Doubled haploids
8. F₃
9. Seed increase
10. F₄
11. Plant rows
12. F₅
13. Preliminary yield trial
14. F₆ to F₈
15. Yield trials
**Di-haploid (doubled) System**

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Initial crosses made</td>
<td>AABB x aabb</td>
</tr>
<tr>
<td>2nd</td>
<td>F1</td>
<td>AaBb</td>
</tr>
<tr>
<td></td>
<td>Gametes</td>
<td>AB Ab aB ab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Haploid production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Colchicine treatment</td>
</tr>
<tr>
<td></td>
<td>Doubled Haploid (25%)</td>
<td>AABB AAbb aaBB aabb</td>
</tr>
<tr>
<td>3rd</td>
<td>DH seed increase</td>
<td>DH headrows</td>
</tr>
<tr>
<td>4th</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Single Seed Descent of Selection

Diagram:
- Variety A × Variety B
- F₁ → Bulk plot
- F₂ → Single plants
- F₃ → Single plants
- F₄ → Single plants
- F₅ → Single plants
- F₆ → Plant or head rows
- F₇ → Preliminary yield trial
- F₈ to F₁₀ → Yield trials
Pedigree of Selection
Pedigree vs. Single Seed Descent
Modified Bulk - Population of Selection

Diagram:
- Variety A × Variety B
- F1 → Bulk plot
- F2 → Bulk plot
- F3 → Bulk plot
- F4 → Bulk plot
- F5 → Space planted
- F6 → Plant or head rows
- F7 → Preliminary yield trial
- F8 to F10 → Yield trials

Image: People working in a field.
Stage III: Line Evaluation

Year 8: Non-replicated, two environments (groups 31, 32, 33; groups 301, 302, 303)

Year 9: Replicated, two environments (groups 21, 22, 23; groups 201, 202, 203)

Year 10: Elite yield trials, multiple environments (groups 11, 12, 13; groups 101, 102, 103)
**Stage III – Line Evaluation**

Year 11 - 12: Western regional trials, PNW (5-10 lines)
Year 13: State variety trials, PNW (2-5 lines)
Stage IV – Cultivar Release
Year 13 - 16

- Justification and decision to release cultivar
- Development and maintenance of breeder seed
- Cultivar Registration and Plant Variety Protection