2. Commonly used mating designs in tree breeding

Mating design is used to generate genetic pedigrees, genetic information and materials that can be used in a breeding program

Objectives of mating designs:

1) Provide information for evaluating parents
2) Provide estimates of genetic parameters
3) Provide estimates of genetic gains
4) Provide a base population for selection

A **single mating design** may not be the best (efficient) for all objectives. A **complementary design** with several simple designs may be used to achieve several objectives

Commonly used mating designs:

1) Open-pollinated
2) Polycross
3) Single-pair mating
4) Nested mating
5) Factorial mating & tester design
6) Diallel mating (full, half, partial & disconnected)

Single-pair mating

Parents are mated only once by pairs
P parents generate ½ *P* full-sib families

- Provide good information for full-sib family performance
- Provide estimates of some genetic parameters
- Not for estimating genetic gains from V_A
- Maximum unrelated ness but not optimum for selection
- Low cost

1 x 2
3 x 4
5 x 6
7 x 8
... x ...

$COV_{FS} = 1/2\ V_A + 1/4 V_D + ...$

Nested mating (NC Design I)

Each of male parents is mated to a different subset of female parents

♀ \ ♂	1	2	3
A	X		
B	X		
C	X		
D		X	
E		X	
F		X	
G			X
H			X
I			X

$COV_{PHS} = 1/4\ V_A$

$V_{female/male} = COV_{FS} - COV_{HS}$

$= 1/2\ V_A + 1/4 V_D - 1/4\ V_A$

$= 1/4\ V_A + 1/4\ V_D$

- Provide information for parents and full-sib families
- Provide estimates of both additive and dominance effects
- Provide estimates of genetic gains from both V_A and V_D
- Not efficient for selection
- Low cost for controlled mating

Factorial mating (NC Design II)

Each member of a group of males is mated to each member of group of females

♀ \ ♂	1	2	3	4	5
A	X	X	X	X	X
B	X	X	X	X	X
C	X	X	X	X	X
D	X	X	X	X	X
E	X	X	X	X	X

$COV_{PHS} = 1/4\ V_A$

$COV_{MHS} = 1/4\ V_A$

$V_{female\ x\ male} = COV_{FS} - COV_{HSm} - COV_{HSf}$

$= 1/4\ V_D$

- Provide good information for parents and full-sib families
- Provide estimates of both additive and dominance effects
- Provide estimates of genetic gains from both V_A and V_D
- Limited selection intensity
- High cost

Tester mating design (Factorial)

Each parent in a population is mated to each member of the testers that chosen for a particular reason

♀ \ ♂	1	2	3	4	5
A	X	X	X	X	X
B	X	X	X	X	X
C	X	X	X	X	X
D	X	X	X	X	X
E	X	X	X	X	X
.	.	.	.	.	.
n	X	X	X	X	X

$COV_{PHS} = 1/4\ V_A$
$COV_{MHS} = 1/4\ V_A$
$V_{\text{female x male}} = COV_{FS} - COV_{HSm} - COV_{HSf}$
$= 1/4\ V_D$

- Provide good information for parents and full-sib families
- Provide estimates of both additive and dominance effects
- Provide estimates of genetic gains from both V_A and V_D
- Limited selection intensity
- High cost

Diallel mating design

Full diallel –each parent is mated with every other parent in the population, including selfs and reciprocal:

♀ \ ♂	1	2	3	4	5
1	X	X	X	X	X
2	X	X	X	X	X
3	X	X	X	X	X
4	X	X	X	X	X
5	X	X	X	X	X

Half diallel – each parent is mated with every other parent in the population, excluding selfs and reciprocal:

♀ \ ♂	1	2	3	4	5
1	X	X	X	X	X
2		X	X	X	X
3			X	X	X
4				X	X
5					X

Partial Diallel – selected subsets of full diallels:

♀ \ ♂	1	2	3	4	5	.	n
1		X	X	X			
2			X	X	X		
3				X	X	X	
4					X	X	X
5	X					X	X
.	X	X					X
n	X	X	X				

Disconnected half diallel – selected subsets of full diallels:

♀ \ ♂	1	2	3	4	5	.	.	n
1	X	X	X	X				
2		X	X	X				
3			X	X				
4				X				
5					X	X	X	X
.						X	X	X
.							X	X
n								X

Diallel analysis

$COV_{HS} = 1/4\ V_A$
$COV_{FS} = 1/2\ V_A + 1/4\ V_D$
$COV_{FS} = COV_{FS} - 2COV_{HS} = 1/4\ V_D$

- Provide good evaluation of parents and full-sib families
- Provide estimates of both additive and dominance effects
- Provide estimates of genetic gains from both V_A and V_D
- High cost

Complementary mating design

Complementary mating designs are used to combine different natures of single matings.
For example;
> use the Polycross for evaluating parents
> use a type of a controlled cross for generating a base population for selection