Crossbreeding (1)

Lecture 19

Introduction to Breeding and Genetics

GENE 251/351

School of Environment and Rural Science (Genetics)

Crossbreeding: Overview

reasons for crossbreeding

understanding crossbreeding effects

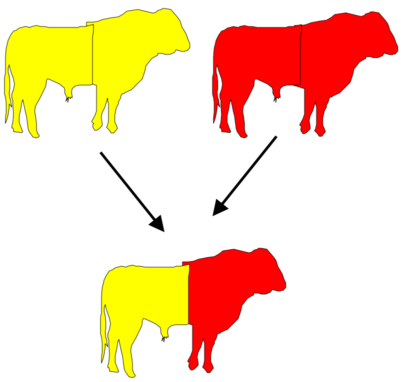
predicting crossbreeding effects

crossbreeding versus selection

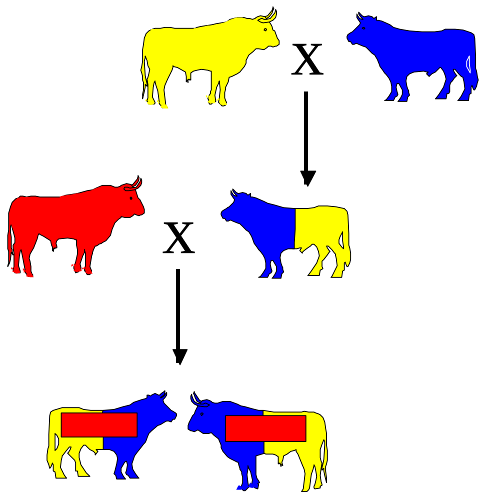
- So far we have focused on selection
  - Improvement of a breed or population
  - Utilizing with breed variation
- Note that there is a lot of variation between breeds
- It might be quicker to improve via using other breeds

Crossbreeding Examples

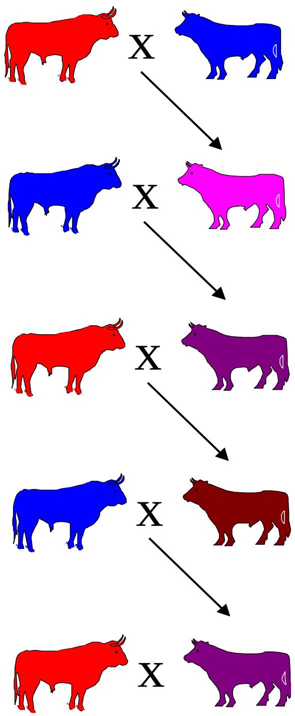
2-Breed Cross



3-Breed Cross



Rotational Cross



Reasons for crossbreeding

1. Sire-Dam complementation
2. The averaging of breed effects
3. Grading up to a new breed
4. Step towards creation of synthetic/composite
5. To introduce a single gene
6. To exploit heterosis

Sire-Dam complementation

Combine the goodies of paternal and maternal breeds (or lines)

- Paternal: large, fast growth, good carcass
- Maternal: small mature size, good fertility

……….to increase the efficiency of the whole production system

Most common reason for crossbreeding

use of terminal sire breeds (Poll Dorset, White Suffolk)

paternal lines in pigs and poultry

Breed averaging

- has good characteristics from different (extreme) breeds
  - Dairy breed x Beef breed to make a dual purpose
  - Being intermediate for each trait might be more profitable overall

……….to increase the efficiency of each animal
in the production system

Upgrading

- Gradually cross with a better breed

  A * B

  A x AB

  A x A(AB)

  A x A(A(AB)

  - “Holstein Friesianization” of many dairy breeds

Start of synthetic / composite

- Initial cross toward a synthetic

A * B

C x AB

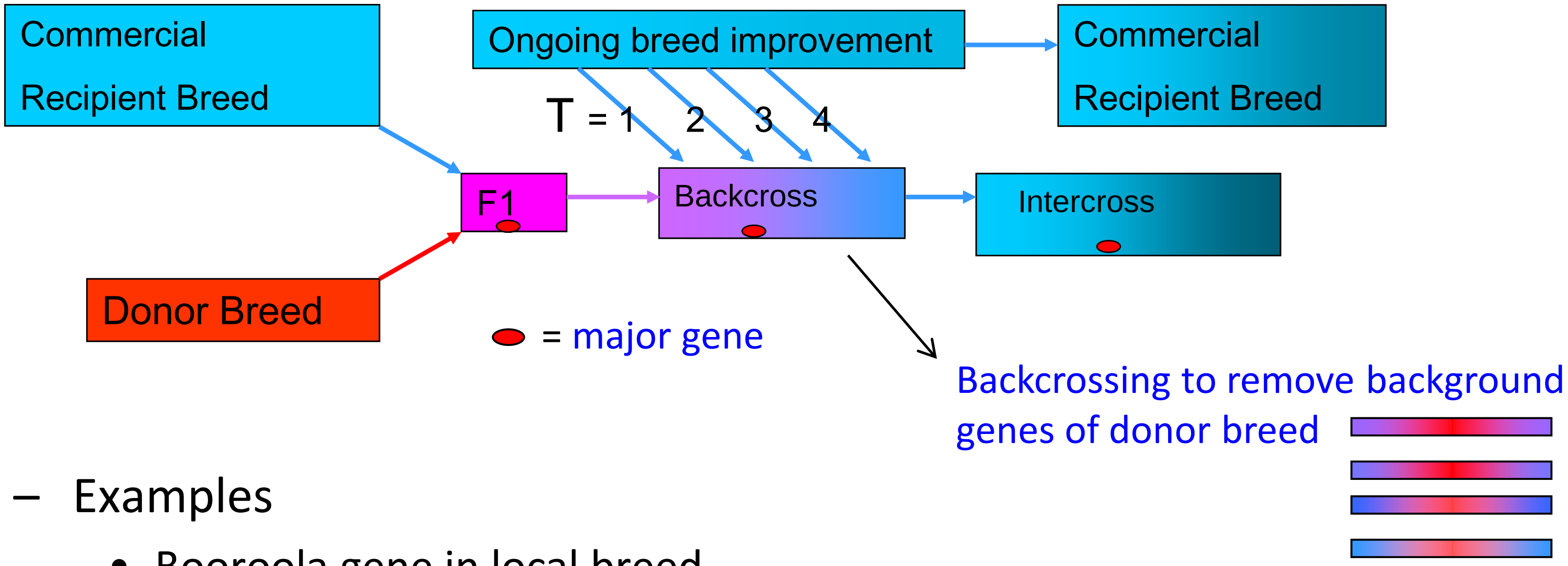
C x C(AB)

A x C(C(AB)

To introduce a single gene

Introgression

– Such is much easier when there is a marker for the single gene

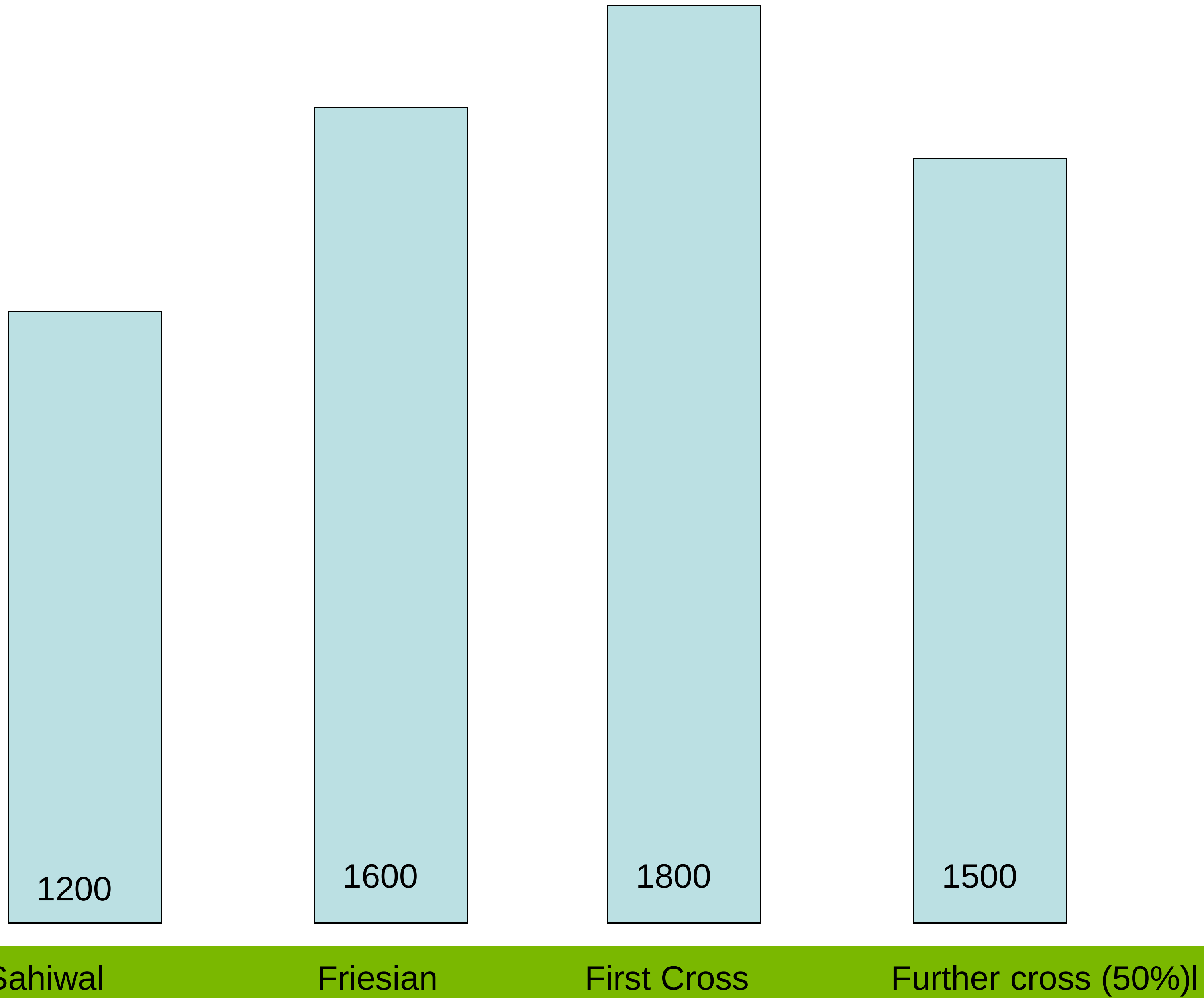


– Examples
  - Booroola gene in local breed
  - Brahman breed over European breeds to introduce tick resistance
  - Litter size major gene from the Meishan breed in pigs

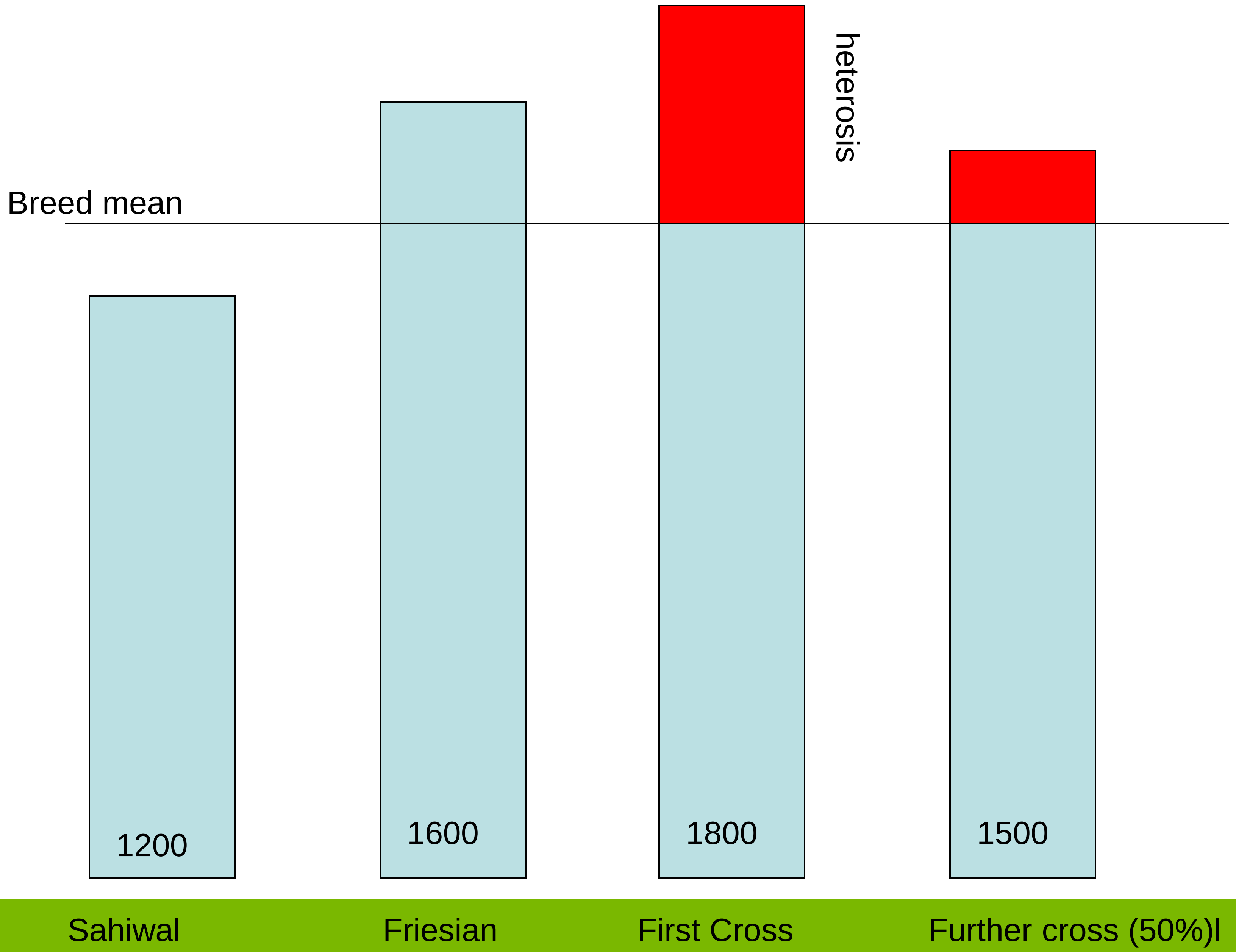
To exploit heterosis

- Hybrid vigour for crossbred animals
- Usually more for traits related to ‘fitness’
  - Reproduction, adaptability, disease resistance etc.
  - Or…for traits that show more dominance
- Expect more heterosis if breeds are more apart

Annual Milk production per cow in Pakistan



Annual Milk production per cow in Pakistan

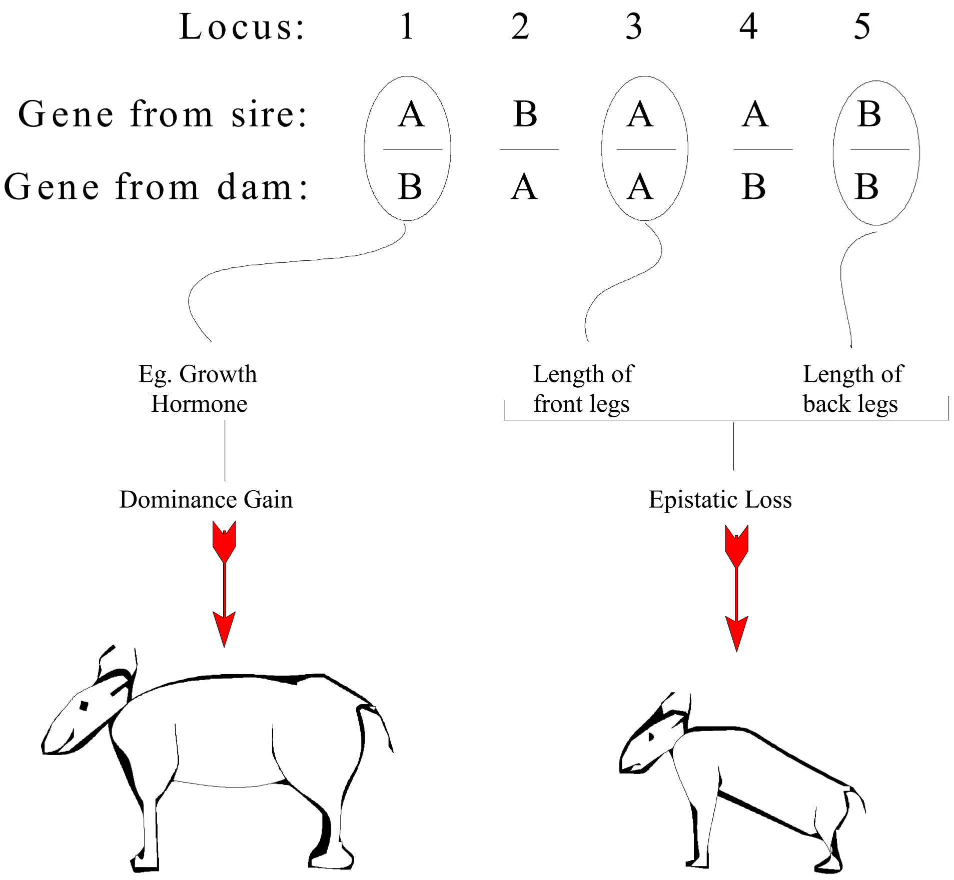


A need to know the genetic basis of heterosis ...

GENOTYPE	MERIT	=	Average of parental breeds	+	Heterosis
Breed A	10	=	10	+	0
Breed B	12	=	12	+	0
Breed C	16	=	16	+	0
A x B	16	=	11	+	5
A x (B x C)	17	=	12	+	5
A x (A x B)	?	=	10.5	+	?

We are able to predict this

Dominance and epistasis cause heterosis



DOMINANCE - wider genetic base leads to better performance.

Eg. Two isozymes that operate efficiently at two different body temperatures might confer higher fitness to heterozygotes in a variable environment.

EPISTASIS - breakdown of favourable interactions leads to loss of performance.

Potential to create animal that are "out of harmony" with themselves.

Dominance model of heterosis

Purebreed "A"	Genes from sire:	A A A A A A A A
	Genes from dam :	A A A A A A A A

Heterosis expression = 0%

F_1 cross "A x B"	Genes from sire:	A A A A A A A A
	Genes from dam :	B B B B B B B B

Heterosis expression = 100%

Dominance model of heterosis

F_2 cross	Genes from sire:	A A B B A A B B
"(AxB) x (AxB)”	Genes from dam :	A B A B A B A B

Heterosis expression = 50%

Backcross	Genes from sire:	A A A A A A A A
"A x (AxB)"	Genes from dam :	A B A B A B A B

Heterosis expression = 50%

3 breed cross	Genes from sire:	C C C C C C C C
"C x (AxB)"	Genes from dam :	A B A B A B A B

Heterosis expression = 100%

	How much heterosis?
Purebreds	0
F1	100%
F2	50%
Backcross	50%

A need to know the genetic basis of heterosis ...

GENOTYPE	MERIT	=	Average of parental breeds	+	Heterosis
Breed A	10	=	10	+	0
Breed B	12	=	12	+	0
Breed C	16	=	16	+	0
A x B	16	=	11	+	5
A x (B x C)	17	=	12	+	5
A x (A x B)	13	=	10.5	+	+2.5

We are able to predict this

Summary