

OHP Picture 1

Livestock Breeding

Terminology:

<u>Animal breeding</u> more general includes pet (dogs, ...)	<u>Livestock Breeding</u> animals on farm (cow, pig, sheep, goats, ...)
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Important: Separation between (Concept)

<u>Production</u> herd level (farm) <ul style="list-style-type: none">• Livestock to produce goods (milk, meat, ...) that can be marketed• Main goal: Optimum production with respect to economic efficiency measured by profit (P) $P = \text{Revenue} - \text{Costs}$ <ul style="list-style-type: none">• Ex: Dairy Cows the older a cow, the more efficient	<u>Breeding</u> → breed (Swiss SP) <ul style="list-style-type: none">• From <u>population</u> of animals parents are selected, such that offspring are "closer" to a pre-defined breeding goal.• Breeding goal (different traits)<ul style="list-style-type: none">1. political2. scientific(1) Breeders as customers(2) Define aggregate genotype based on economic impact of traits
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Animal breeding
more general
includes pet (dogs, ...)

Livestock Breeding
animals on farm
(cow, pig, sheep, goats, ...)

Important: Separation between (concept)

Production

herd level (farm)

- Livestock to produce goods (milk, meat, ...) that can be marketed
- Main goal: Optimum production with respect to economic efficiency measured by profit (P)

$P = \text{Revenue} - \text{Costs}$

- Ex: Dairy Cows
the older a cow, the more efficient

Breeding → breed (Swiss, French!)

- From population of animals parents are selected, such that offspring are "closer" to a pre-defined breeding goal.
- Breeding goal (different traits)
 - 1. political
 - 2. scientific

(1) Breeders as customers
(2) Define aggregate genotype based on economic importance of traits

• Young animals as parents are favorable compared to older animals
→ Genomic Selection!

OHP Picture 3

Phenotypes

- Observed / measured
- Values of traits or properties of animals
- Eg : . 9000 kg milk/year
- Weight at weaning : 315 kg

Population: Dataset of phenotypes

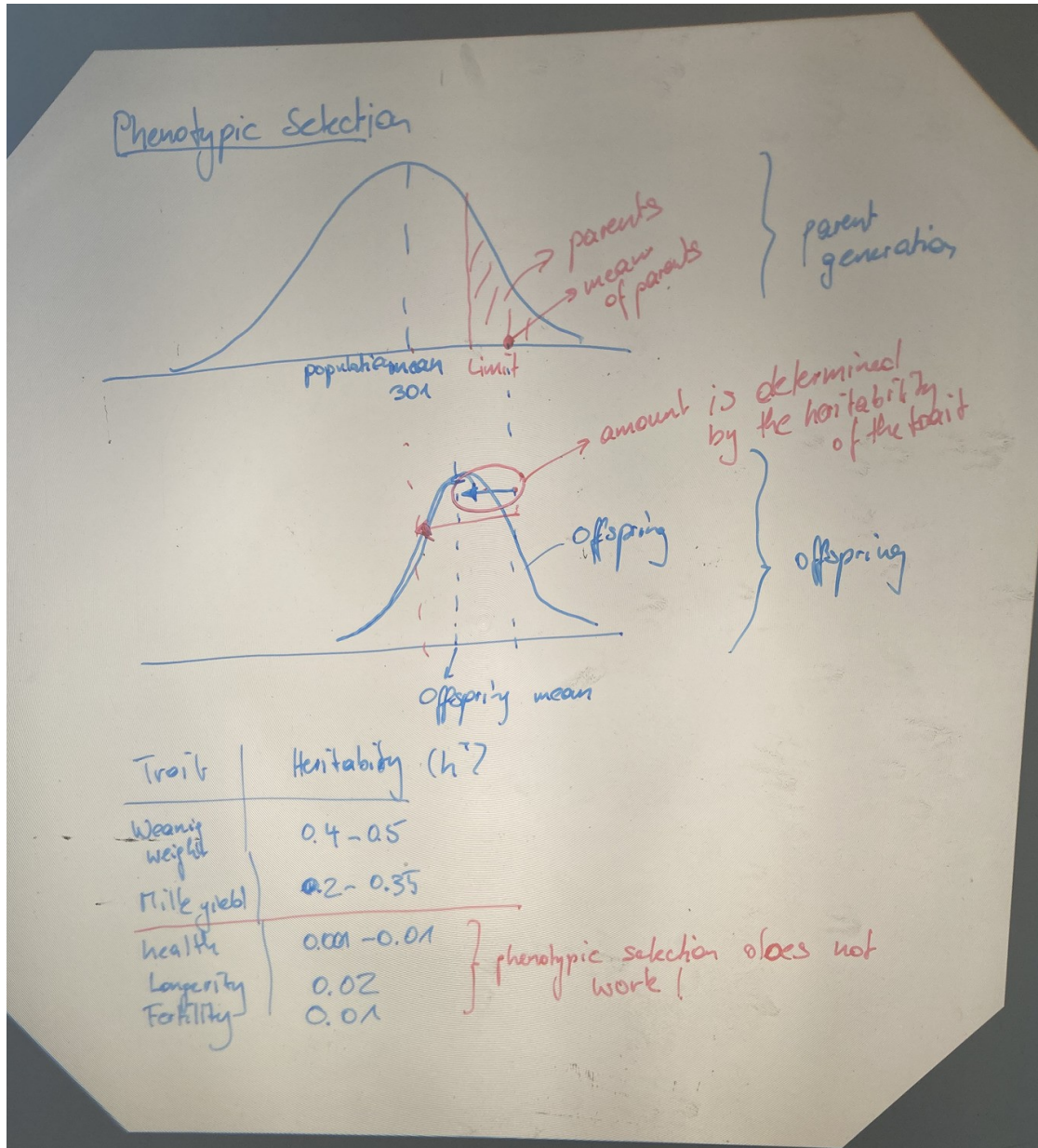
Animal	Weaning weight (in kg)
1	285
2	307
...	
N	299

phenotypic selection

Parents

mean 301
Limit
weaning weight in kg

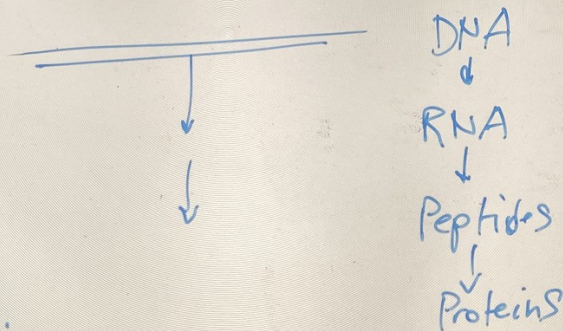
OHP Picture 4



Genetic Background

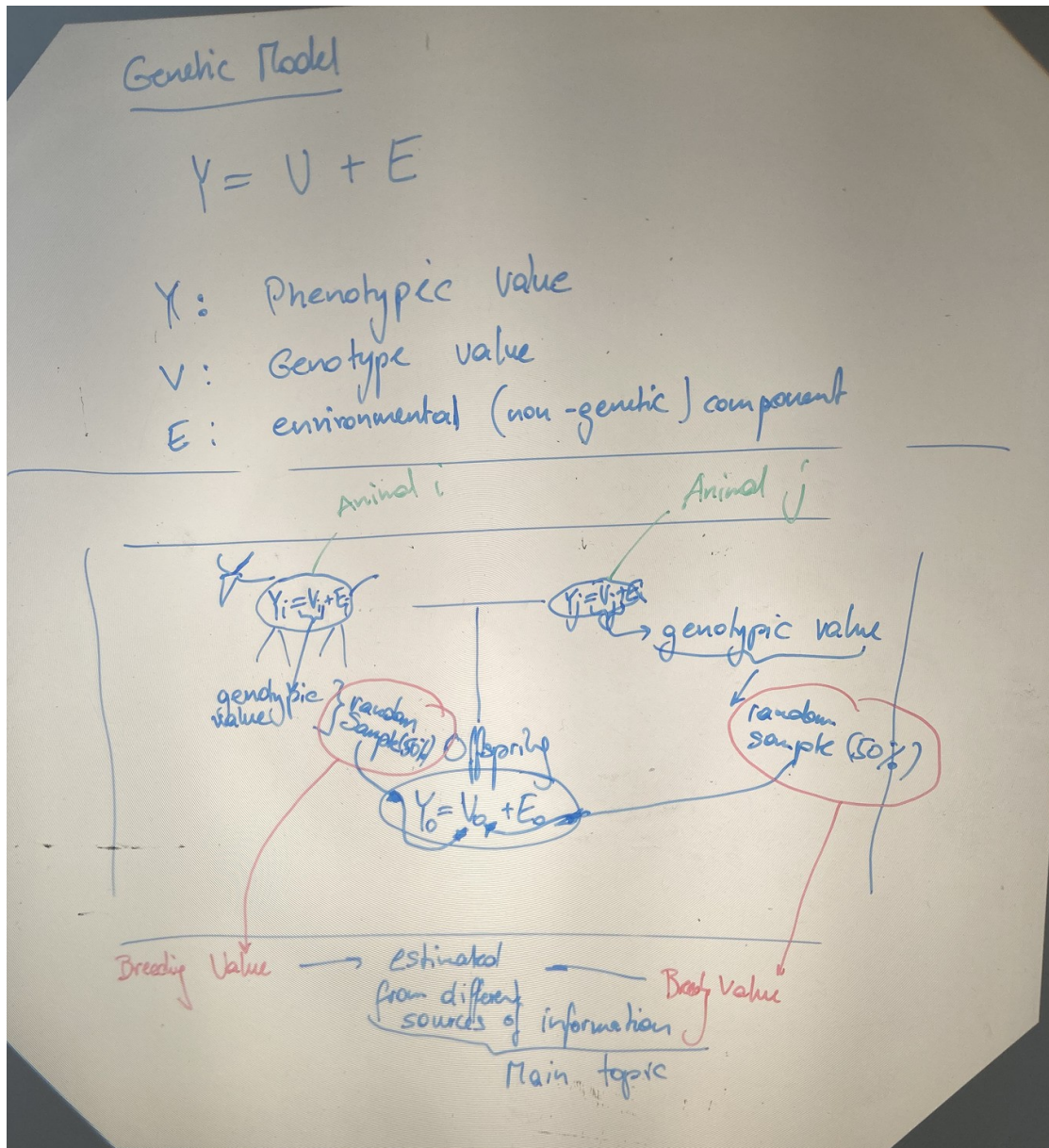
- Parents do not pass phenotypes to offspring but a random sample of their alleles/genes
- Every phenotypic observation has a genetic background, that means the set of all genes in an individual (genotype) has an effect on the expressed phenotype.

Why? \Rightarrow Central Dogma of Molecular Biology



- Result:
Every phenotypic observation (Y) \rightarrow weight, milk yield, health, methane
can be decomposed into a genetic component (V) and an environmental component (E)

OHP Picture 6



OHP Picture 7

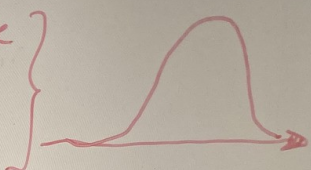
Tool of selection

- Predict Breeding values based on phenotypic information and pedigree (Stammbaum)
- Require:
 - existed already in 1950-60 } > Quantitative genetics \Rightarrow relationship between Y, V , breeding values
 - Statistics: estimate unknown quantities (breeding values) from data
 - only with cheap computing power 1990-2000 } > Computing > Software to run data analysis

Quantitative Genetics

Concept

- Quantitative Trait : phenotypic data available
 - measured on continuous scale
 - methane emission in g
 - weaning weight in kg



Opposite: qualitative traits

- discrete scale → few classes
 - healthy / diseased
 - Skin color
 - Litter size
 - Multiple birth

- Assumption :
 - quantitative trait with values V
 - is influenced by just one locus (G)
 - that means, one position in the genome determines the genetic component (V) in our genetic model

OHP Picture 9

Population : Locus G is bi-allelic,
(Size N=10) in the whole population alleles G₁
and G₂ can be observed.

$\frac{G_1}{G_1}$	$\frac{G_1}{G_1}$	$\frac{G_1}{G_1}$
$\frac{G_2}{G_2}$	$\frac{G_2}{G_1}$	$\frac{G_2}{G_1}$
$\frac{G_2}{G_2}$	$\frac{G_2}{G_1}$	$\frac{G_2}{G_2}$
$\frac{G_2}{G_2}$	$\frac{G_1}{G_1}$	$\frac{G_2}{G_1}$

Interest in genotypes $\Rightarrow G_1G_2 = G_2G_1$
(not haplotypes)

Genotype frequencies :

$$f(G_1G_1) = \frac{4}{10} = 0.4$$
$$f(G_1G_2) = \frac{3}{10} = 0.3$$
$$f(G_2G_2) = \frac{3}{10} = 0.3$$

Allele frequencies :

$$f(G_1) = \frac{11}{20} = 0.55 = p$$
$$f(G_2) = \frac{9}{20} = 0.45 = q = 1-p$$

Hardy-Weinberg

- Idealized population
- infinite size
- no selection / random mating ..
- Given allele frequencies $f(G_1) = p$; $f(G_2) = q$
- Resulting genotype frequencies:
 - $f(G_1G_1) = p^2$
 - $f(G_1G_2) = 2pq$
 - $f(G_2G_2) = q^2$

• From parents to offspring
 G_1G_1 - genotype as parent with frequency $f(G_1G_1) = p^2$

	G_1	G_2
G_1	$f(G_1G_1) = p^2 \cdot p$ $= p^3$	$f(G_1G_2) = p^2 \cdot q$ $f(G_2G_1) = p^2 \cdot q$

G_1G_2 as parent with $f(G_1G_2) = 2pq$

	G_1	G_2
G_1	$f(G_1G_1) = pq \cdot p$	$f(G_1G_2) = pq \cdot q$
G_2	$f(G_2G_1) = pq \cdot p$	$f(G_2G_2) = pq \cdot q$

$G_2G_2 \dots$

offspring
the
genotype
frequencies
remain
constant

OHP Picture 11

• Given parent in HWE
 ⇒ Genotype frequencies are given by
 $f(G_1G_1) = p^2$; $f(G_1G_2) = 2pq$; $f(G_2G_2) = q^2$

Offspring receive alleles from parents at random based on allele frequencies:

$$f(G_1) = f(G_1G_1) + \frac{1}{2} f(G_1G_2)$$

$$= p^2 + \frac{1}{2} \cdot 2pq = p(p+q) = p$$

$$f(G_2) = f(G_2G_2) + \frac{1}{2} f(G_1G_2)$$

$$= q^2 + \frac{1}{2} \cdot 2pq = q(q+p) = q$$

Alleles	G_1 with $f(G_1)=p$	G_2 with $f(G_2)=q$
G_1	$f(G_1G_1) = p \cdot p = p^2$	$f(G_1G_2) = p \cdot q$
G_2	$f(G_2G_1) = q \cdot p$	$f(G_2G_2) = q^2$

Genotype-frequencies Offspring

OHP Picture 12

