# ANIMAL BREEDING

## Hybrid vigor

***Hybrid vigor**: is the increase in certain characteristics like growth rate, size, fertility, yield etc. of a particular hybrid organism over its parents.* It may be calculated using the following formula

**% Heterosis = [(progeny average – parents average) ÷ parent average] x 100**

**P:** $$\frac{ABCDE}{ABCDE} \times \frac{abcde}{abcde}$$

**F1 :** $$\frac{ABCDE}{abcde}$$

For example, if the average weaning weight of the straight bred calves was 475 pounds for Breed A and 535 pounds for Breed B, the average of the straight bred parents would be 505 pounds. If Breed A and Breed B were crossed and the resulting calves had an average weaning weight of 525 pounds, heterosis would be calculated as:

$$\text{hybrid vigor (\%)} = \frac{F_1 - P_1}{P_1} \times 100$$

**[(525 – 505) ÷ 505] X 100 = 4%**

**LOSS OF HYBRID VIGOR** : Hybrid vigor is maximized in the F1 or first cross of unrelated (though not necessarily purebred) populations, and we refer to the amount of vigor gained in this initial cross as **F1 hybrid vigor.** Can we maintain this amount of hybrid vigor? What happens to hybrid vigor if F1s are mated to F1s of the same kind to produce F2s? What happens if hybrids are mated back to parent lines or breeds?

# SELECTION

The process of choosing animals to produce the next generation. The goal of selection is to increase the number of animals with optimal levels of performance, while culling individuals with poorer performance. Genetic improvement is a slow process and can take several generations to see an improvement in a trait. Selection occurs only when the individuals of a population are diverse in their characteristic

**Basis for Selection**

Effective selection requires that traits be:

1- High Heritability.

2-Relatively easy to measure.

3-Associated with economic value.

4-Genetic estimates are accurate.

5-Genetic variation is available.

## Selection Methods in large Animals

**1- Selection for a single trait :**It is the quickest way to make progress in that individual trait. this simple method is generally not practical. Correlation between traits can also cause problems in this type of selection. For example, if we simply selected for individual weaning weight alone, we will reduce fertility and twinning rate in the herd.

**2- Selection indexes;**

Selection indexes have been utilized for many years. The use of an index requires the calculation of economic values for each trait and then putting the individual's performance into an equation. The result of that equation is an index value for the animal and that index is then ranked to identify the best animals for the combination of traits included in the index. The index is expressed as an equation:

Index = b1BW32 + b 2EMl-b3FCl

**3- Independent culling levels:**

are a more common and practical method of selecting breeding stock. This method requires the producer to determine the levels of traits they wish to keep for example 1500 g or more for body weight and 250 egg per year.

## Selection Methods in Poultry

**A number of methods of selection are practiced:**

**(1) mass selection, (2) family selection, (3) pedigree selection, and (4) selection by progeny testing.**

**In poultry breeding**, **mass selection** and **progeny testing** are the most important. Mass selection simply means that a group within the population is selected having the necessary selection differential, and this is used for breeding; similar selection is then applied to subsequent generations. Mass selection is useful in the initial selection procedures, but to gain the optimum improvement a more refined method is necessary.

### Phenotypic Variation in Population

Phenotypic Variation in animal Population is due to two factors:

**1-Genotipic differences**: which belongs to:-

a-The differences of parents genotypes.

b- The chance, which occurs during zygote formation according to random distribution of gametes.

c- Mutation and chromosomal abnormalities.

**2- Environmental Differences:** which summarized in

a**-** Non – genetic maternal effects**.**

b- Atmospheric circumstances (Heat, Humidity).

c- Different animal husbandry and care.

## Components of Phenotypic Variation in Population

The **Phenotypic Variation** divided into two components;

1- **Genetic variance**( $\boldsymbol{\sigma^2}_G$). sub-divided into :

a- Additive variance. $\boldsymbol{\sigma^2}_A$

b- Dominance variance. $\boldsymbol{\sigma^2}_D$

c- Epistastic variance. $\boldsymbol{\sigma^2}_I$

These type of variance the genetic variance and expressed by the following equation :-

$$\boldsymbol{\sigma^2_G = \sigma^2_A + \sigma^2_D + \sigma^2_I}$$

2- **Environmental Variance ( σ2**$_E$). sub-divided into :

a- Permanent environmental variation( $\sigma^2_{EP}$).
b- Temporary environmental variation( $\sigma^2_{ET}$).

### According to the above mentioned information,

Total Phenotypic Variance = Genetic variance ( $\sigma^2_G$) + Environmental Variance ( $\sigma^2_E$)+ Genetic environmental interaction. $\boldsymbol{\sigma^2_{EG}}$

$$\boldsymbol{\sigma^2_P = \sigma^2 G + \sigma^2_E + \sigma^2_{EG}}$$

## Heritability

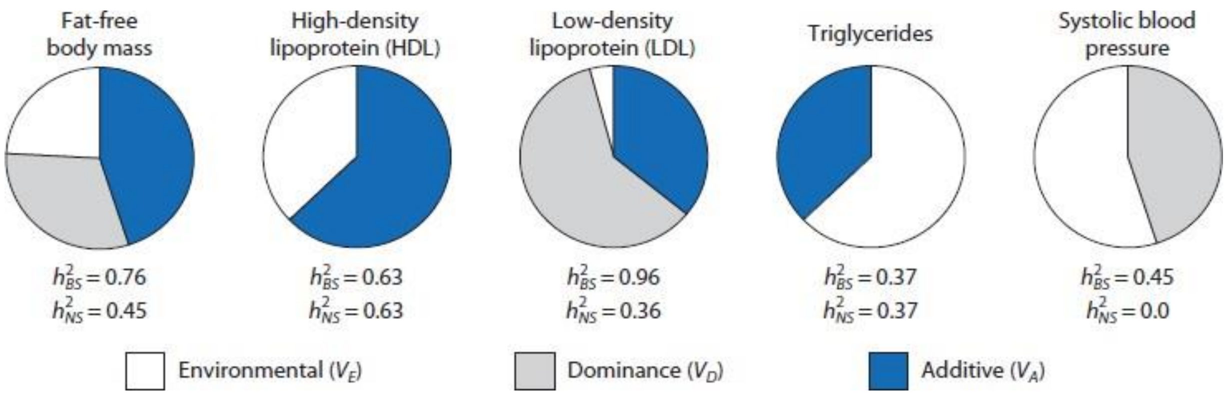
The **heritability** is used to express the proportion of the total phenotypic variance (*VP*) that is caused by either all types of genotypic variance (*VG*) or by only the additive genetic variance (*VA*). The proportion of the total phenotypic variance caused by genotypic variance defines the **broad-sense heritability**:

$$h^2_{BS} = \frac{V_G}{V_P}$$

Since genotypic variance is composed of the separate components *VA* + *VD* + *VI*, the proportion of the total phenotypic variance caused by only the additive genetic variance defines the **narrow-sense heritability:**

$$h^2_{NS} = \frac{V_A}{V_P}$$

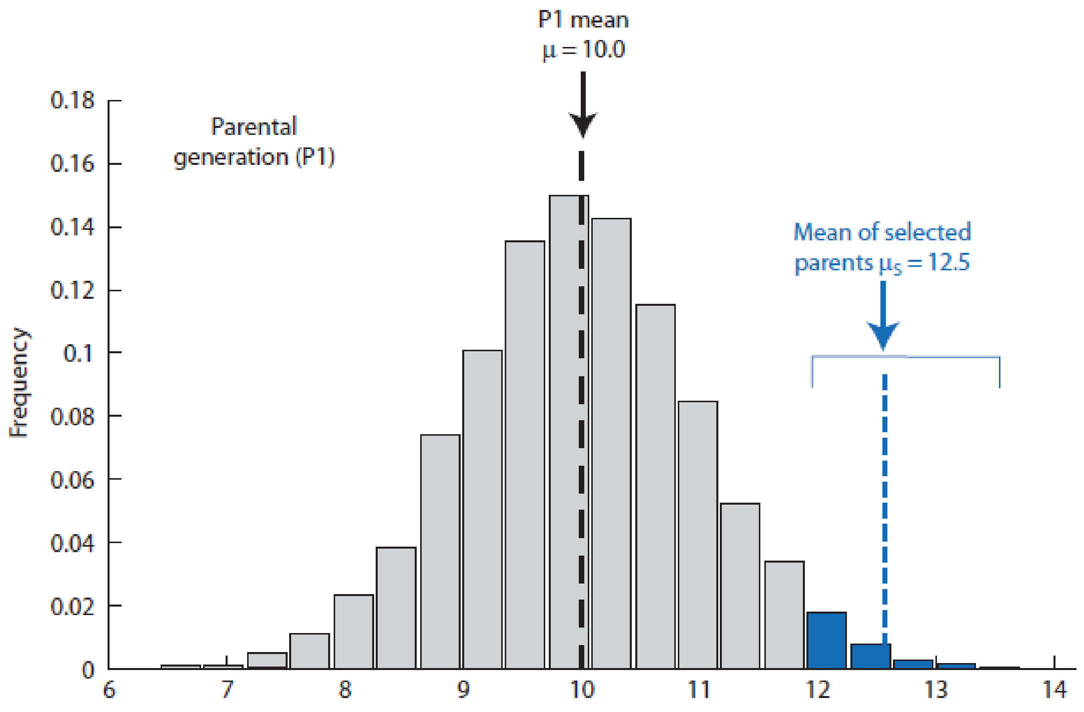
Idealized heritabilities are ranged between **0.0 and 1.0**




The heritability provides the basis for predicting the outcome of selection on quantitative traits according to:

$$R = h^2 s \qquad \textbf{(Breeder Equation)}$$

Where **R** is the response to selection, $\mathbf{h^2}$ is the narrowsense heritability, and **s** is the selection differential. The selection differential is computed as the difference in the phenotypic mean of the selected parents ($\mu_s$) and the phenotypic mean of the entire P1 population ($\mu$): $\mathbf{s = \mu_s - \mu}$



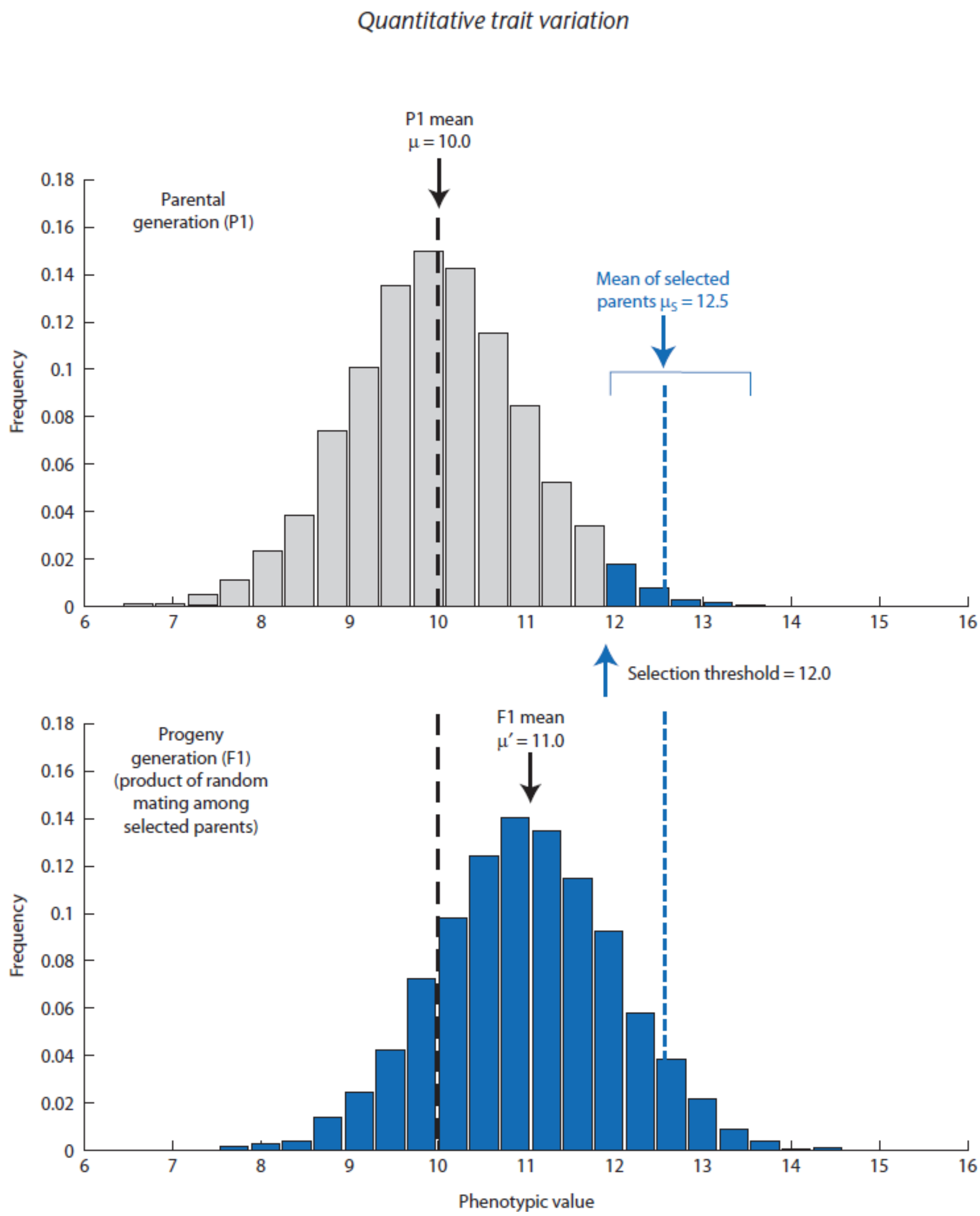
$s = 12.5 - 10.0 = 2.5$

which expresses that the selected parents have a 2.5-unit greater average phenotypic value than the full population that they were sampled from. Larger selection differential values indicate stronger selection .

It is commonly called the **breeder's equation** because it predicts the change in phenotype mean in a population that will occur due to one generation of artificial selection as often employed by animal and plant breeders.

it is then possible to estimate the heritability by rearranging the breeder's equation**:** $h^2 = R/s$

When estimated in this way, $h^2$ is called the **realized heritability** since it is estimated from the observed response to selection.




A hypothetical example of directional selection and response to selection. In the parental generation those individuals with a phenotypic value of 12.0 or greater are allowed to mate. The selection differential is $s = 12.5 - 10.0 = 2.5$.

Random mating among this subset of the parental population produces a distribution of progeny phenotypic values with a mean value of 11.0. The response to selection is $R = 11.0 - 10.0 = 1.0$. The realized heritability is therefore $h2 = 1.0/2.5 = 0.40$.