Parameter Genetik:

Heritabilitas (h2)

Ripitabilitas (r) : L1 , L2 , L3, L4

Nilai Pemuliaan
Producing ability (MPPA)

The Model for Repeated Traits

- **Repeated trait:** a trait for which the animal have more than one performance record during its lifetime (measured more than once on the same animal).

- **Examples:** - milk production
  - wool production
  - litter size (number born)

Istilah : Producing Ability (PA) ?.

- **Producing ability** is the performance potential of an animal for a repeated trait (**the ability of the animal to repeat its performance in future records**).
- Producing ability is a function of all permanent factors (which permanently affect the performance potential of the animal) which include:
- All genetic factors.:,
- All permanent environmental factors.

$$PA = G + E_P \rightarrow PA = A + D + I + E_P$$

- The genetic model for repeated traits is:

$$P = \mu + A + D + I + E_P + E_T$$

Importance of producing ability

- It is important to commercial producers as a measure of productive capacity.
- Typically dairy farmers feed their cows according to their **producing ability**.
- Therefore, prediction of PA is quite useful in practice. The predicted value of PA is called **Most probable Producing Ability (MPPA).**

P = μ + MPPA is a prediction of the animal's next record.

The basic model

- **P = μ + G + E**
- P = phenotypic value of an animal for a given trait.
- μ = population mean or average phenotypic value for the trait of all animals in the population.
- G = the genotypic value of the animal for the trait.
- E = the effect of the environmental factors on the phenotype of the animal.
- G and E are expressed as deviations from the mean of the population. Therefore, the mean of G in the population and the mean of E is equal to zero.

The genotypic value is the sum of two values:
breeding value (BV or **A**) and Gene Combination Value (GCV).

G = A + GCV

= A + D + I

Components of Phenotypic variation

- The phenotype of an animal for **a repeated quantitative trait** can be modeled as:
- $P = \mu + A + D + I + E_P + E_T$
- **A** = Additive genetic effect (breeding value)
- **D** = Dominance effects
- **I** = Epistasis effects
- $\mathbf{E_p}$ = Permanent environmental effects
- $\mathbf{E_T}$ = Temporary environmental effects
    - Based on this model, the phenotypic variance can be decomposed (ignoring covariances) into:

$$\mathbf{V_P = V_A + V_D + V_I + V_{EP} + V_{ET}}$$

$\mathbf{V_P}$ = phenotypic variance

$\mathbf{V_A}$ = additive genetic variance

$\mathbf{V_D}$ = variance due to dominance effects

$\mathbf{V_I}$ = variance due to effects of epistasis

$\mathbf{V_{EP}}$ = variance due to permanent environmental effects

$\mathbf{V_{ET}}$ = variance due to temporary environmental effects

For repeated traits, the environmental effects are divided into two types:

1. **Permanent environmental effects (E_P):** the factors which permanently affect the performance of the animal (they influence all records of the same animal in the same way).

Examples:

- Nutrition at early stages of development affects the ability of beef and dairy cows to produce milk permanently.
- A permanent problem in the udder will affect milk production during all productive life of the cow or ewe.

2. **Temporary environmental effects (E_T):** The environmental effects which do not affect performance permanently.

Examples:

- forage quality
- weather conditions
- and some management practices.

These factors vary from season to season or year to year and so they do not influence different records in the same way.

Repeatability

- **Repeatability (*r*)** is the proportion of the phenotypic variance that is due to permanent effects (genetic effects and permanent environmental effects):

$$r = \frac{V_A + V_D + V_I + V_{EP}}{V_P}$$

What does the repeatability measure?

1. The strength of the relationship between repeated records. Therefore, repeatability can be estimated as the correlation between repeated records on the same animals.
2. The strength of the relationship between single performance records and producing ability (permanent effects)..

Importance of repeatability

1. It is useful in prediction of producing ability and therefore the animal's next record from the current and previous records:

   - If ***r*** is high, we can predict the animal's next record more accurately

   - If ***r*** is low then the prediction of the next record has low accuracy.

2. Repeatability is important in prediction of breeding values from multiple records on the same animals:

$$\hat{BV}_i = \frac{nh^2}{1+(n-1)r}(\overline{P}_i - \overline{P})$$

$\overline{P}_i$ is the average of the *n* records of the animal *i*

$\overline{P}$ is the mean for all animals.

3. Repeatability is important in making culling decisions:

When *r* is high we can cull animals of poor performance on the basis of the first record

When *r* is low one should wait for more records before making a culling decision on the animal.

Examples of Repeatability Estimates

- **Beef cattle:**
  - **Calving date (trait of the dam): 0.35**
  - **Birth weight (trait of the dam): 0.20**
  - **Weaning weight (trait of the dam): 0.40**
  - **Body measurements: 0.80**
- **Dairy cattle:**
  - **Services per conception: 0.15**
  - **Calving interval: 0.15**
  - **Milk yield: 0.50**
  - **% Fat: 0.60**
  - **Teat placement: 0.55**
- **Poultry:**
  - **Egg weight: 0.90**
  - **Egg shape: 0.95**
  - **Shell thickness: 0.65**
- **Sheep:**
  - **Number born: 0.15**
  - **Birth weight (trait of the dam): 0.35**
  - **60-day weaning weight (trait of the dam): 0.25**
  - **Fleece grade: 0.60**

Contoh Penggunana Ripitabilitas:

To predict the producing ability (**most probable producing ability, MPPA**) from *n* previous records:

$$MPPA = P\hat{A} = \frac{nr}{1+(n-1)r}(\overline{P}_i - \overline{P})$$

$\overline{P}_i$ is the average of the *n* records of the animal *i*

$\overline{P}$ is the mean for all animals.

- **Contoh :** suppose a cow has three milk records: 4000kg in the first record (L1), 5000 kg in the second (L2), and 6000 kg in the third (L3). The mean of all cows is 4600 kg and the repeatability of milk yield is 0.60, then the predicted producing ability of this cow is (MPPA):

$$P\hat{A}_i = \frac{(3)(0.60)}{1+(3-1)(0.60)}(5000-4600) = 327kg$$

$$\hat{P}_i = \overline{P} + P\hat{A} = 4600 + 327 = 4927kg$$

RIPITABILITAS dan NILAI PEMULIAAN

Repeatability is important in prediction of breeding values from multiple records on the same animals:

$$B\hat{V}_i = \frac{nh^2}{1+(n-1)r}(\overline{P}_i - \overline{P})$$

For the previous example if heritability of milk yield in this population is 0.25 then

$$B\hat{V}_i = \frac{(3)(0.25)}{1+(3-1)(0.60)}(5000-4600) = 204.6kg$$

- **Contoh Sederhana:** suppose that a locus affects litter size in swine with two alleles T and t and T is completely dominant over t. The independent effects are +0.1 pigs for T and – 0.1 pigs for t.

Genotype	BV	G	GCV
TT	0.2	0.2	0
Tt	0	0.2	0.2
tt	- 0.2	- 0.2	0

GCV is the part of the genotypic value that is due to gene combination effects (dominance and epistasis).
Because individual genes and not gene combinations survive segregation and independent assortment during meiosis, GCV can not be transmitted from parent to offspring and therefore it is not important in selection.

Contoh Aplikasi:

two records of 305-d milk production (in lbs) for two cows:

The genetic model for repeated traits is:

$$P = \mu + A + D + I + E_P + E_T$$

	μ	BV	GCV	E_p	E_t	P
Cow 1						
Record 1	**18 000**	**+1500**	**- 1000**	**+2500**	**+3000**	**24000**
Record 2	**18 000**	**+1500**	**- 1000**	**+2500**	**-1000**	**20000**
Cow 2						
Record 1	**18 000**	**+1000**	**+500**	**- 4500**	**+5000**	**20000**
Record 2	**18 000**	**+1000**	**+500**	**- 4500**	**-2000**	**13000**

PA for cow 1 = **1500 – 1000 + 2500** = 3000 lb

PA for cow 2 = **1000 + 500 – 4500** = -3000 lb

Kesimpulan :

If we were to cull (discard) one of these cows we will cull cow 2.