ISAGREED

Genetic gain

Modul no. 3: Animal Breeding

Ewa Salamończyk
Siedlce University of Natural Sciences and Humanities
Faculty of Agrobioengineering and Animal Husbandry

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

ISAGREED

Co-funded by the European Union

The objectives of animal breeding

- A challenge for animal production is to meet the growing demand for animal products while limiting the impact on the environment. This means that there is a need to increase the efficiency and resilience of animals, as well as the quality of animal products.
- Improving efficiency should focus on the overall performance, which can be enhanced not only by increasing production but also by improving traits such as health, reproduction, and longevity.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

The objectives of animal breeding

- The goal of animal breeding is to genetically improve animals in a specific direction.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Breeding program

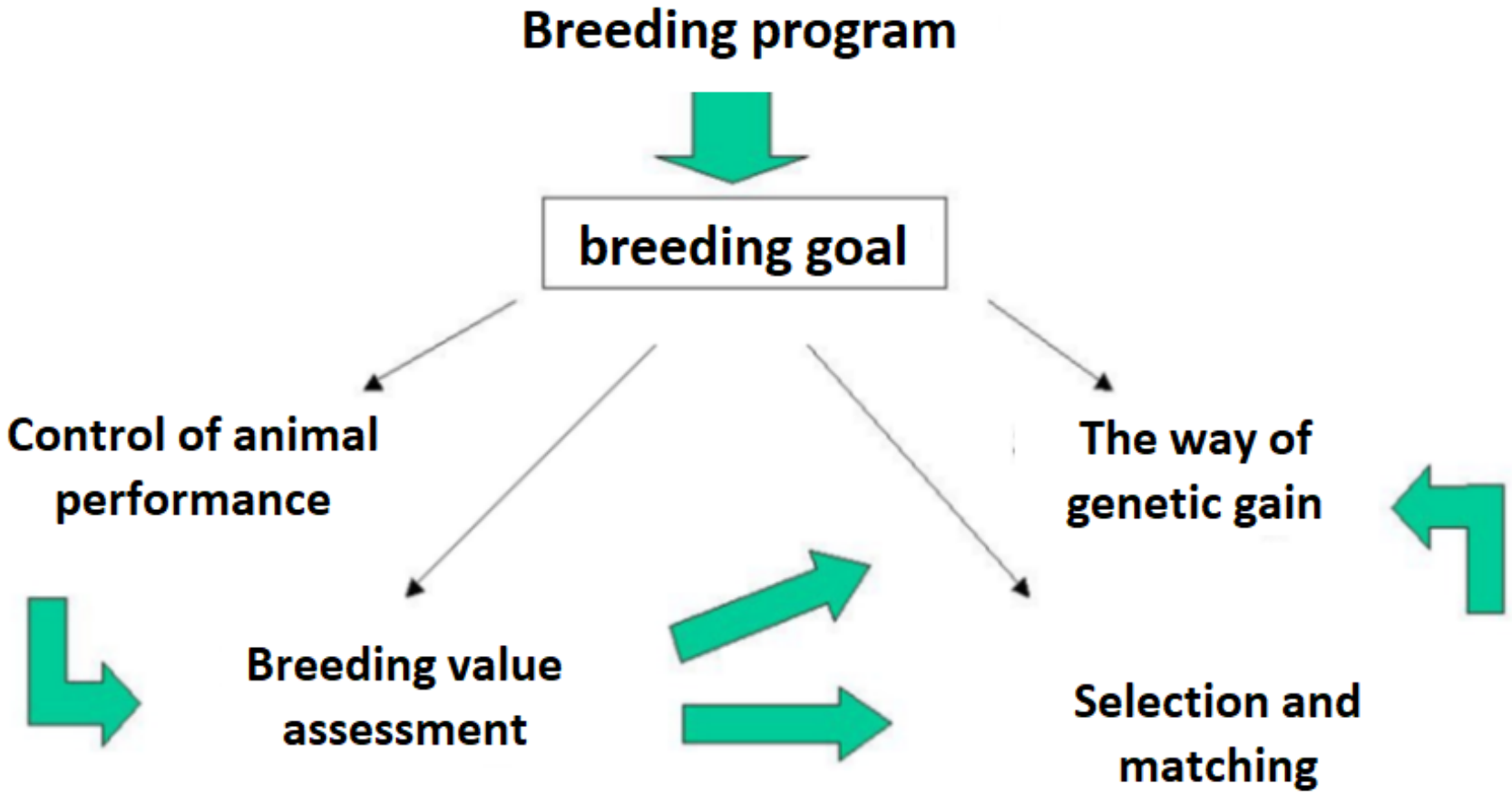
- This is a detailed diagram of the genetic improvement of the population.

- Parts of the breeding program are:
  - breeding goal,
  - data collection system,
  - methods and tools for evaluating the breeding value,
  - selection and matching system,
  - structure for transferring the progress achieved in the production population.

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

ISAGREED
Co-funded by the European Union

Breeding program - structure



Source: Strabel T., 2010. Programy hodowlane Materiały do zajęć. Uniwersytet Przyrodniczy w Poznaniu, Katedra Genetyki i Podstaw Hodowli Zwierząt.

ISAGREED
Co-funded by the European Union

Breeding program

- The breeding program aims at genetic improvement through the selection of individuals for the parents of the next generation.

- The breeding goal expresses the combinations of traits that the breeder wants to improve in the selection process. The amount of progress achieved in the breeding goal (and the traits included in it) depends on the accuracy of selection, its intensity and the spacing of generations.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Breeding program for dairy cattle - objectives

- improvement of production characteristics, with particular emphasis on the composition and quality of milk, which have a large impact on its price, i.e. content and yield of fat, protein and lactose in milk, dry matter content,
- improve functional characteristics that have a significant impact onreducing production costs, such as:
  a) characteristics of type and conformation;
  b) fertility;
  c) udder health (somatic cell count);
  d) longevity;
  e) characteristics of milking capacity;
  f) the course of farrowing.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Breeding program for pigs - objectives

- improvement of reproductive characteristics (number of piglets born, number of weaned piglets, number of nipples, age of first birth),
- improvement of fattening and slaughter performance (daily gain, meat content in the carcass, area of the "eye" of the loin, intramuscular fat content, water holding capacity, active acidity, color, meat texture characteristics).

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

The assessment of breeding value

- The objective of assessing the breeding value of animals is to create a ranking of breeding animals that reflects their genetic worth, in order to select those that meet established selection criteria from the evaluated group of animals.
- Selection, as a process that changes the frequency of genes and genotypes in a selected population, enables the achievement of goals set by a breeding program, which often focuses on improving the breeding value of a selected group of traits to maximize profit.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Selection

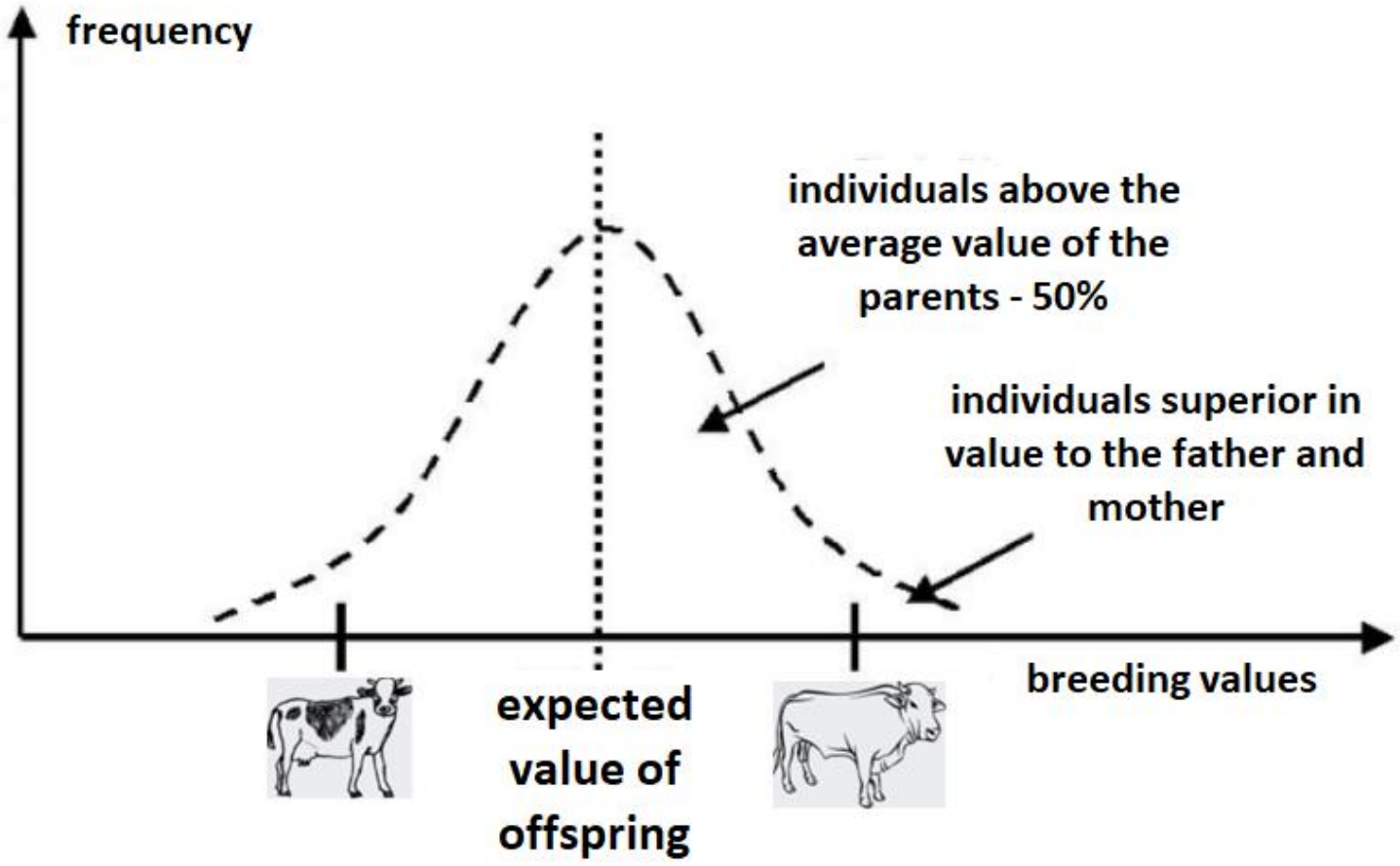
- In the evaluation of selection effects on quantitative (measurable) traits, it is helpful to compare the mean phenotypic and breeding values of the improved traits.

- Selection is effective if the offspring generation is genetically superior to the parental generation.

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain



$$\Delta G = h^2 S$$

Distribution of breeding value of offspring from mating parents with known values

Source: Strabel T., 2006. Genetyka cech ilościowych zwierząt w praktyce Materiały do zajęć. Akademia Rolnicza im. Augusta Cieszkowskiego w Poznaniu, https://merlin.up.poznan.pl/~strabel/dydaktyka/gci.pdf

ISAGREED
Co-funded by the European Union

Genetic gain

- it increases the genetic value of animals over time, underin relation to a specific feature or group of features.

or otherwise

- is the difference between the genetic value of a given trait of the progeny and the value of that trait of the parent herd, obtained as a result of selection that resulted in a favorable change in gene frequency in the progeny compared to the parents.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

- is the response of the population to selection

$$\Delta A = A_1 - A_0$$

ΔA – genetic gain
A_1 - offspring generation
A_0 - parental generation

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- the accuracy of the assessment of the genetic value of individuals subjected to selection,
- selection intensity,
- genetic variability of the selected trait,
- heritability of the selected trait.

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- **the accuracy of the assessment of the genetic value of individuals subjected to selection,** which is reflected in the correlation between the phenotypic and genetic value of individuals.
- determines the strength of the relationship between the true breeding value and its estimation for the trait for which the selection is carried out. The accuracy of the selection ranges from 0 to 1.

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- **selection intensity,** which measures the extent to which breeders are determined to select only the best animals.
- expressed in units of standard deviation of the trait, the advantage of selected animals over the average value of candidates for selection.

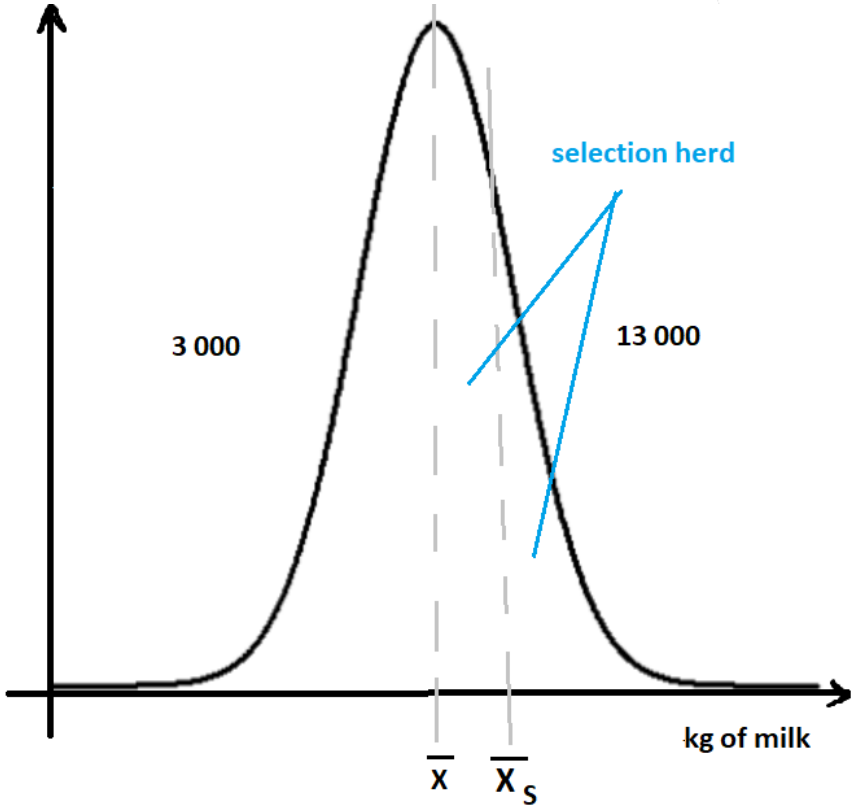
Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- **selection intensity,** e.g. 10% of the population or 20%, 30%, ...



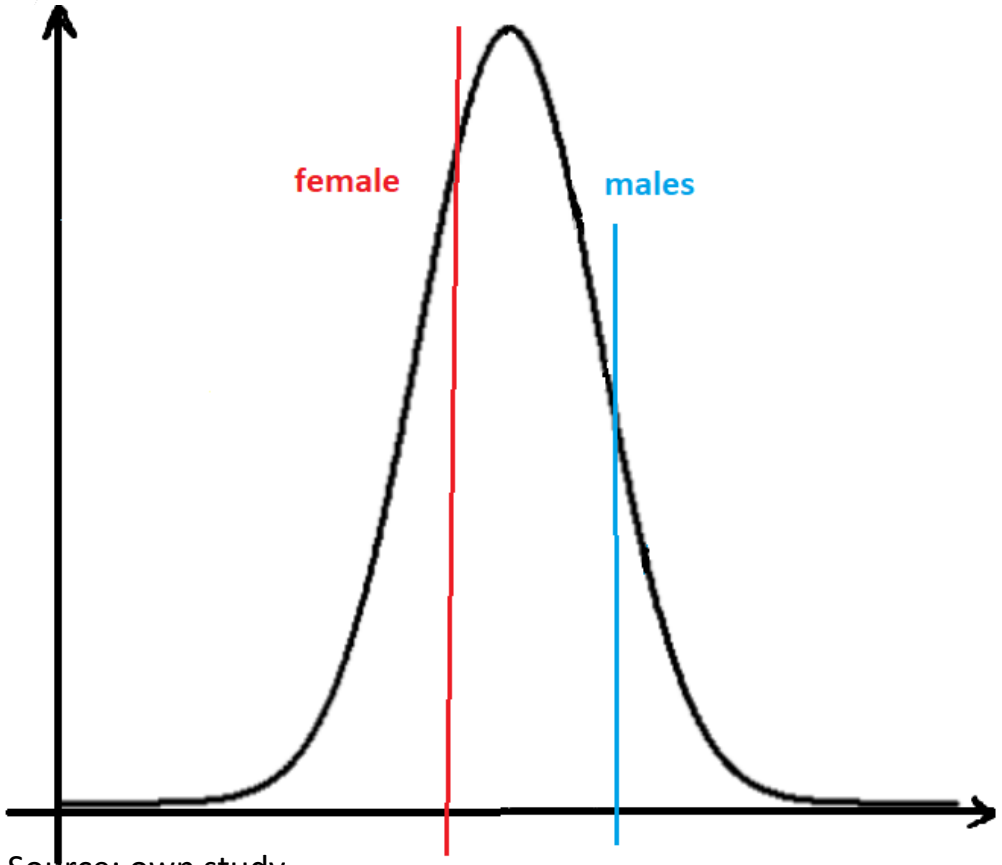
Source: own study

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- **the intensity of selection is greater in males**



Source: own study

Species	% female	% males
Cattle	50-60	0,5-1
Pigs	5-10	0,2
Horses	30-40	0,5-2

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- **genetic variability of the selected trait,** additive genetic standard deviation, or variability of breeding values in the population for the improved trait.

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain

The value of genetic gain depends on:

- **heritability of the selected trait**

Trait	Heritability coefficient (h^2)
Cow milk yield	0,20
Content of fat and protein in cow's milk	0,40
Body conformation traits	0,10 – 0,63
milk character	0,37
feet and legs	0,10
Longevity of cows	0,07
Cow fertility	0,10

Source: Guliński P., 2017. Bydło domowe. Hodowla i użytkowanie. Wyd. Naukowe PWN

Co-funded by the European Union

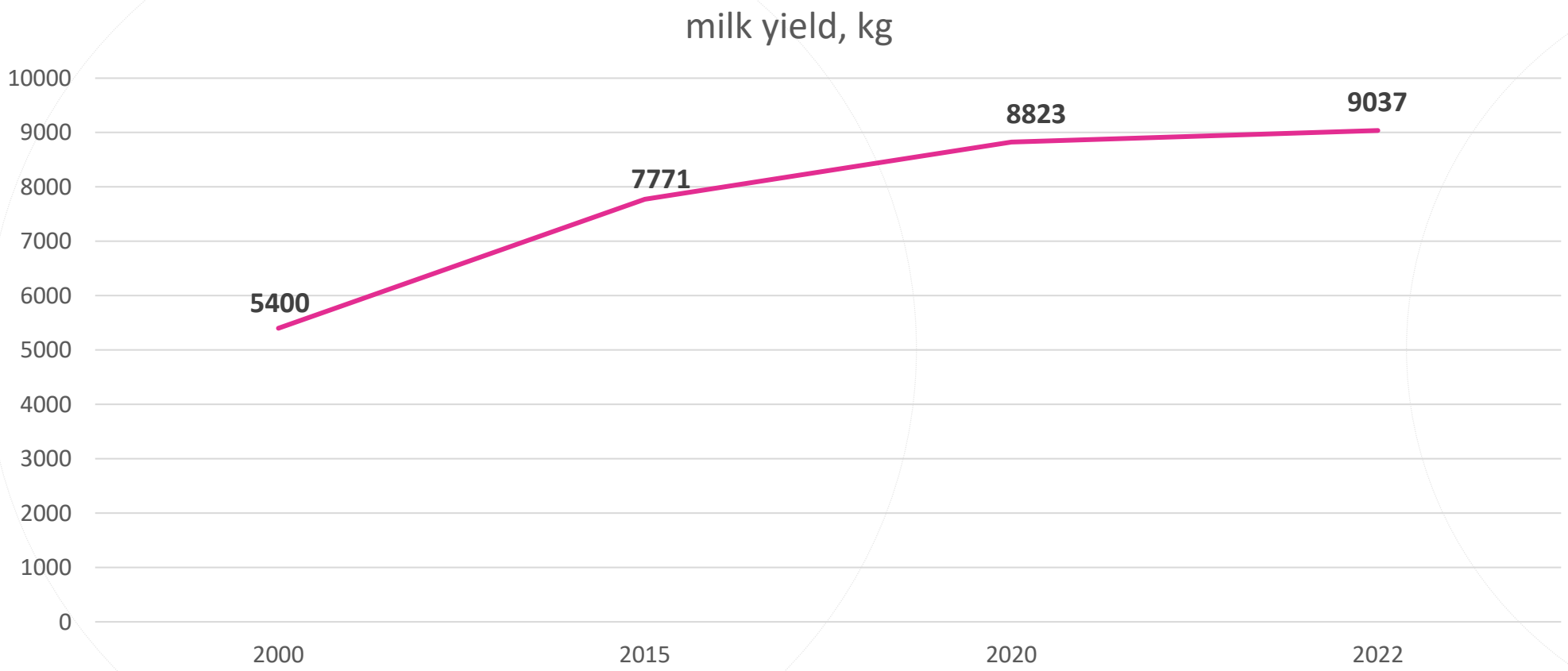
Genetic gain

- genotype
- environmental conditions

phenotype

Co-funded by the European Union

Genetic gain in dairy cattle



Source: own study based on the results of the assessment of the utility value of dairy cattle in Poland, PFHBiPM

Co-funded by the European Union

Genetic gain in pigs

Table 1. Expected changes in the percentage of meat in the carcass in paternal and maternal breeds and in the production of fattening pigs as a result of breeding work

Years	1	2	3	4	5	6
Father breeds	57,4		58,6		59,8	
Mother breeds	56,2		56,2		57,4	
Maternal breed gilts and F1 crosses		56,2		56,8		57,4
Pork production			58,3		57,4	

Source: Szwaczkowski T., Korwin-Kossakowska A., Pierzchała M., Eckert R., Żak G., 2019. In. Hodowla i chów świń. Pod red. Rekiel A.,, Szwaczkowski T., Eckert R. Wyd. UP w Poznaniu

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

Genetic gain - summary

- is the improvement of a selected trait or multiple traits in a population over generations,
- this process consists in identifying individuals with outstanding genetic characteristics and using them as parents for the next generation. Through the selection and reproduction of these individuals, their valuable genetic material is passed on to the offspring, which leads to an increase in the frequency of desired traits in the population,
- depends on several factors, including the heritability of the traits of interest, the intensity of selection, the genetic variation in the population, and the generation interval (the time it takes to complete one reproductive cycle).

ISAGREED

Erasmus+ project 2021-1-SK01-KA220-HED-000032068

Co-funded by the European Union

ISAGREED

Partners:

Slovak University of Agriculture Nitra

Mendel University in Brno

Siedlce University of Natural Sciences and Humanities

Czech University of Life Sciences Prague

Thank you for your attention!

This presentation has been supported by the Erasmus+ KA2 Cooperation Partnerships grant no. ***2021-1-SK01-KA220-HED-000032068 "Innovation of the structure and content of study programs in the field of animal genetic and food resources management with the use of digitalisation - Inovácia obsahu a štruktúry študijných programov v oblasti manažmentu živočíšnych genetických a potravinových zdrojov s využitím digitalizácie"****. The European Commission support for the production of this presentation does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.*

Ewa Salamończyk

ewa.salamonczyk@uph.edu.pl

ISAGREED

Co-funded by the European Union