

# Applied Genetic Evaluation Of Livestock

Peter von Rohr

12.04.2021

# Program

Week	Date	Topic
→ 1	12.04	Introduction to Genetic Evaluation of Livestock
2	19.04	Model Selection
3	26.04	Variance Components
4	03.05	Genetic Groups and Longitudinal Data
5	10.05	Genomic Selection
↓ 6	17.05	<u>Questions, Test Exam</u> → Exam from last year
7	24.05	<b>Pfingstmontag</b>
8	31.05	Exams → 08:15-09:00 Applied Statistical Methods 09:15-10:00 Genetic Evaluation

Topic: How to introduce a new trait into the breeding program of a livestock species

# Course Objectives

## The students

- ▶ understand the theoretical background and the practical application of the prediction of breeding values in Swiss cattle breeding, in pigs, sheeps and goats.
- ▶ know how to interpret predicted breeding values.

→ What is the meaning of a predicted breeding value of -900 kg for milk yield

→ What is the difference between production and breeding



## Further Reading

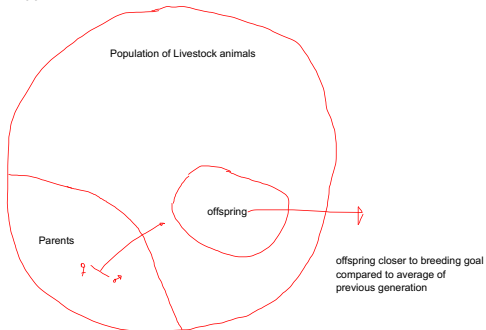
- ▶ Willam und Simianer: Tierzucht - Grundwissen Bachelor (Ulmer, UTB 3526 2011). This book gives an introduction into evolution, livestock production and breeding programs.
- ▶ Falconer and Mackay: Introduction to Quantitative Genetics (Longman). The de-facto standard in the area of quantitative genetics uses many examples from experimental research to illustrate the concepts of quantitative genetics.
- ▶ Mrode: Linear Models for the Prediction of Animal Breeding Values (CABI Publishing, 2005). The main focus is on prediction of breeding values using different models.

# Terminology

- ▶ Livestock breeding versus animal husbandry: no difference made
- ▶ Breeding (in German: *Zucht*) used in different contexts with different meanings
- ▶ Science:  
*“Selection and Mating of parents are used such that offspring generations are closer to a defined goal.”*
- ▶ Distinction between
  - ▶ livestock breeding and production
  - ▶ cattle breeding and milk or beef production
  - ▶ pig breeding and pork production and
  - ▶ chicken breeding and egg producers

Breeding Goal:

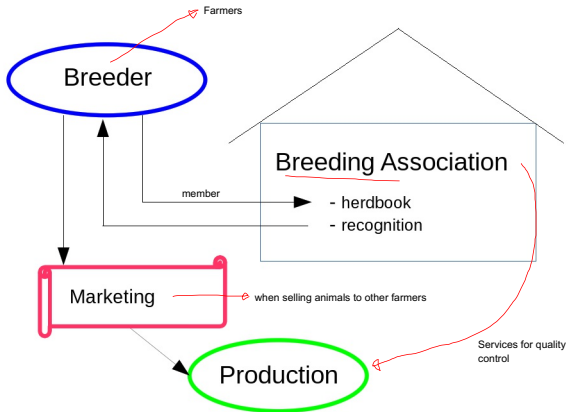
\* based on breeding goal a selection criterion can be derived



# History

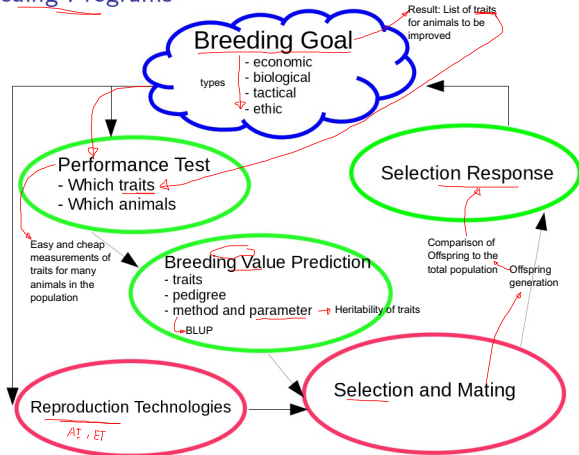
- ▶ Formations of breeding organisation (BO)
- ▶ Tasks of BO: herdbooks and certification
- ▶ Crisis at beginning of 20<sup>th</sup> century lead to federal regulations
- ▶ Developments of technologies
  - ▶ Reproduction
  - ▶ Molecular biology
  - ▶ Computer science

# Breeding Organisations





# Breeding Programs



## Parts of Breeding Program

- ▶ Applied prediction of breeding values is a part of the breeding program
- ▶ Design and planning of a breeding program requires to answer the questions
  - ▶ What goal do we want to achieve
  - ▶ What measures do we want to use to achieve the goal

# Types of Breeding Programs

Two types of breeding programs

1. Focus on **selection response**
  - ▶ countries with limited resources
  - ▶ big farms or big companies
2. Focus on clients and services
  - ▶ cattle and pig breeding of developed countries
  - ▶ economic interest of companies and farms

# Breeding Goals

## Types of breeding goals

- ▶ economic
- ▶ biological
- ▶ tactical
- ▶ ethical

## Breeding goals might be formulated in different ways

- ▶ **political**: description of idealized image of future animal.  
Often conflicting and not verifiable

- ▶ **scientific**: mathematical description of direction of desired change. Measurable via selection response

▶ Aggregate Genotype (Gesamtzuchtwert)

# Performance Testing

Can we use the traits from the breeding goal (aggregate genotype H) as traits in performance test?

If no, we have to find auxiliary traits (Hilfsmerkmale) which are closely related or highly correlated to the original trait in H.


Example: Somatic Cell Count as an auxiliary trait for Mastitis Resistance

- ▶ Basic question: What trait is measured when for which animals
- ▶ Breeding should be based on data
- ▶ Quality of derived parameters (heritability, predicted breeding values) depend on accuracy of collected data
- ▶ Data collection used for performance testing often started for different reasons
  - ▶ milk sample testing: quality of product
  - ▶ station testing in pigs: correction of environment

2 Types of performance testing:

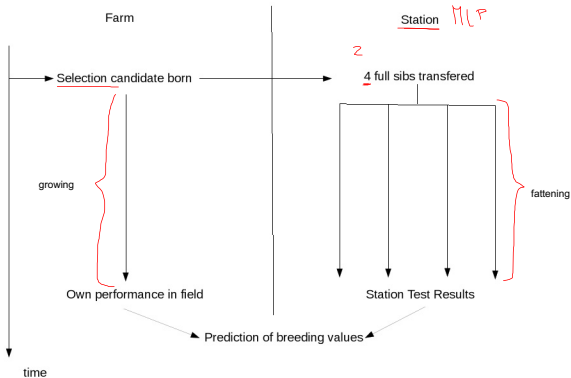
1. Field tests = milk sample in dairy cattle
2. Station testing = pigs

# Classification of Performance Tests

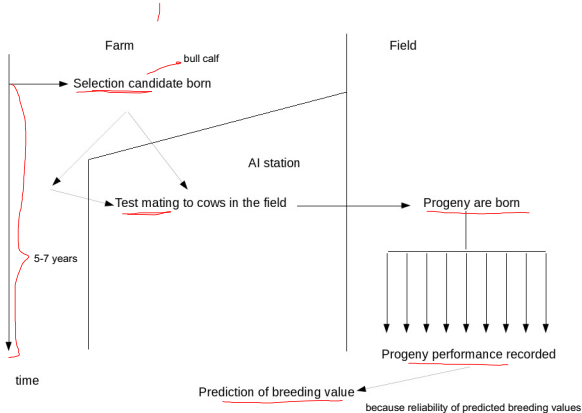
- ▶ Place
  - ▶ Station  CH: pigs only
  - ▶ Field
- ▶ Relationship between selection candidate and tested animal
  - ▶ own performance record
  - ▶ full-sib
  - ▶ progeny
- ▶ Traits
  - ▶ should have genetic variation
  - ▶ economic importance
  - ▶ measurable better than subjectively observed

# Examples: Pigs

Both types (field and station) of performance tests



# Examples: Cattle → Traditional progeny base field test





# Prediction Of Breeding Values

- ▶ Done in most breeding programs
- ▶ Federal regulation → Tierzuchtverordnung
- ▶ Performance tests much more expensive
- ▶ Different intervals → data is collected for other reasons, e.g., quality control, ...
  - ▶ cattle: three times per year
  - ▶ pigs: nightly or weekly

# Progress In Technologies

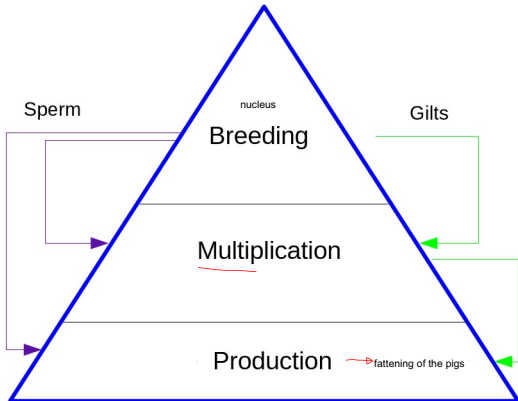
- ▶ Reproduction - AI
  - ▶ disease prevention
  - ▶ number of progeny per sire increased
  - ▶ better comparisons between herds
  - ▶ Future: more development on female side
- ▶ Molecular Biology
  - ▶ cheap and efficient large-scale genotyping
  - ▶ sequencing with more accuracy
- ▶ Computer Science
  - ▶ efficient evaluation of large amounts of data
  - ▶ big data technologies - continuous monitoring

## Differences Of BP Between Species

Breeding programs (BP) for different species have different structure

- ▶ **hierarchical**: pigs and chicken
- ▶ **flat**: cattle and horse

# Hierarchical Structure



# Monolithic Structure

