Applied Genetic Evaluation Of Livestock

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30.03.2020

Program

Breeding organisation comes to Qualitas and asks for a new trait to be included in the breeding program.
Process of inclusion of a new trait is started

Examples of new traits are
> calf survival for Braunvieh Schweiz and Swissherdbook (April 2020)
> twin and multiple births in cattle (no decision about introduction, MSc of Sarah Widmer

Week	Date	Topic
1	30.03	Introduction
2	06.04	Model Selection
3	13.04	**Easter Monday**
4	20.04	Variance Components
5	27.04	Genetic Groups and Longitudinal Data
6	04.05	Suisag and The Swiss Pig Breeding Program
7	11.05	Braunvieh Schweiz and Qualitas AG
8	18.05	Questions and Test Exams
9	25.05	**Final Exams**

Course Objectives

are more directed toward application

Important to understand:
> tools of breeding
> what can be done with tools and cannot be achieved.

==> Difference between breeding and production / management
> Some problems can be addressed via the tools breeding (longer term)
> Other problems cannot be solved by breeding (shorter term)

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.

$\rightarrow$ What is the meaning of a predicted breeding value of -900 kg for milk yield

$\rightarrow$ 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

History

Around ~ 1850:
> railway networks ==> transports of grains, nutrients became possible and cheaper
==> imported food increased

Wars between Germany and France
First world war: Problems in supplying most of people with food

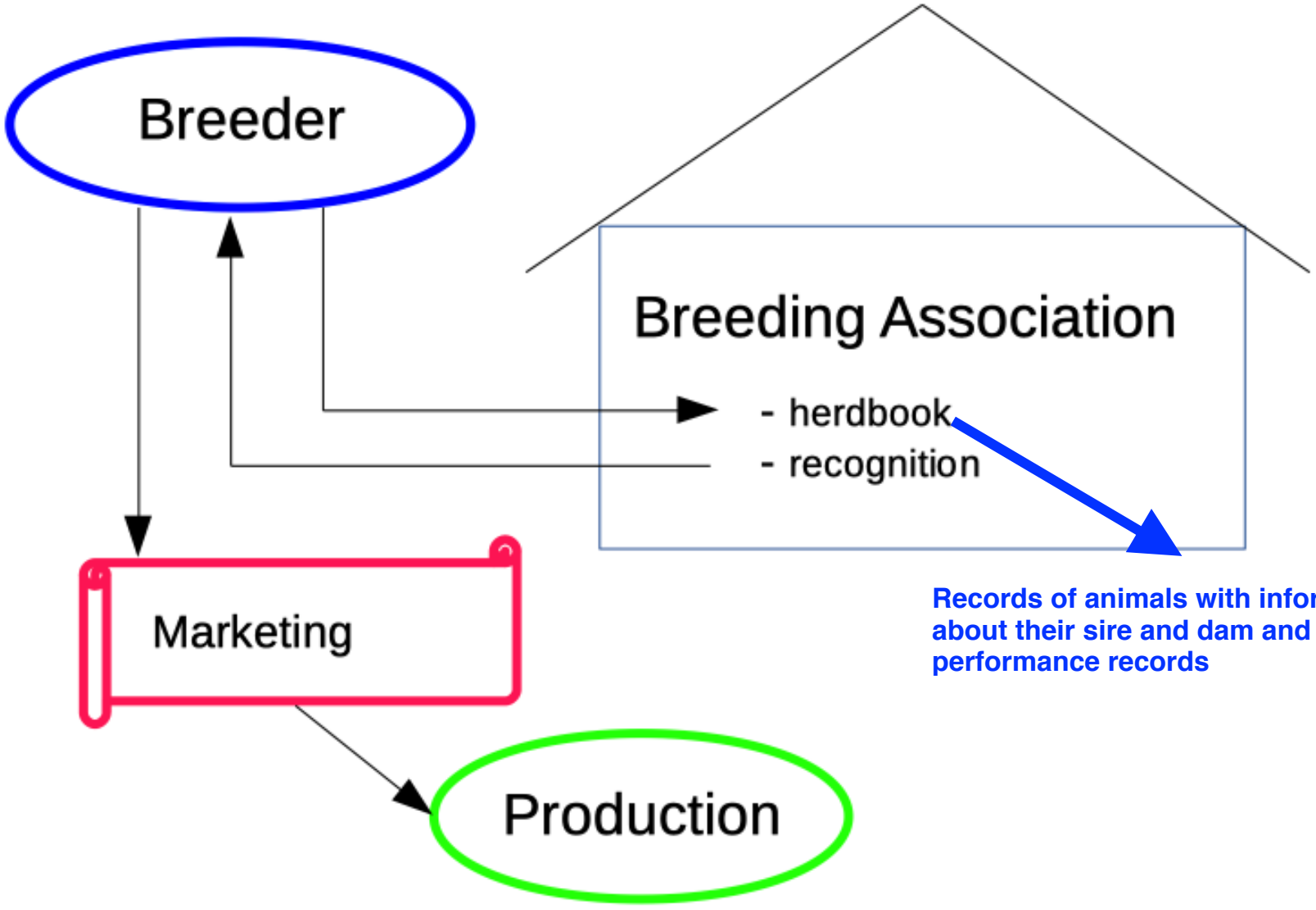
In CH: Federal regulations that determined the formation of Breeding organisations with the goal of increasing the livestock animal performance

- Formations of breeding organisation (BO)
- Tasks of BO: herdbooks and certification
- Crisis at beginning of 20^{th} century lead to federal regulations
- Developments of technologies
  - Reproduction
  - Molecular biology
  - Computer science

Used to increase performance of breeding animals

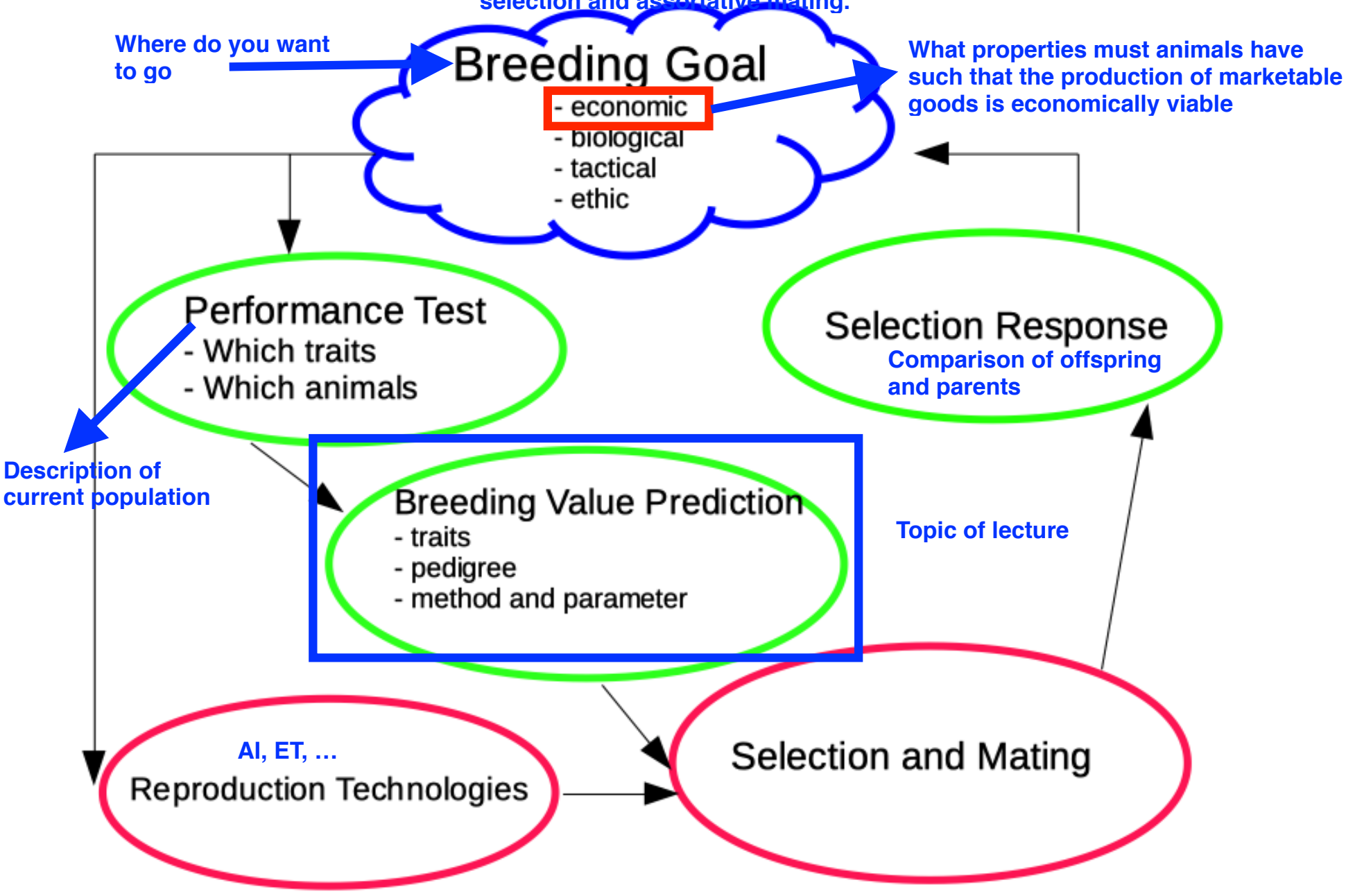
In other countries (US, CA, ...) economic aspects are more important to increase the performance

Breeding Organisations



Breeding Programs

Breeding organisation decides on a breeding program. Breeders want that the animals have certain properties. The way that animals are improved is via selection and assertative mating.



Parts of Breeding Program

* Most predicitions of breeding values are based on some form of the BLUP-AM
* For every trait, there are some special features of the model or some special parameters
  > example: Milk production in cattle: test-day model using random regression (longitudinal data)
  > Fertility traits: still use sire models
  > Longevity: Survival model

- 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

political description often contains phenotypic properties of animals that are considered to be ideal for a certain breed

Some animals in the population they are “better” than the description of your ideal animal ==> difficult what do with the “better” animals,

Dependencies between different traits are not accounted for.

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

Based on a collection of traits that we want to improve, we give the directions and the importance of each traits ==> corresponds to mathematical description of the breeding goal ==> aggregate Genotype (Gesamtzuchtwert)

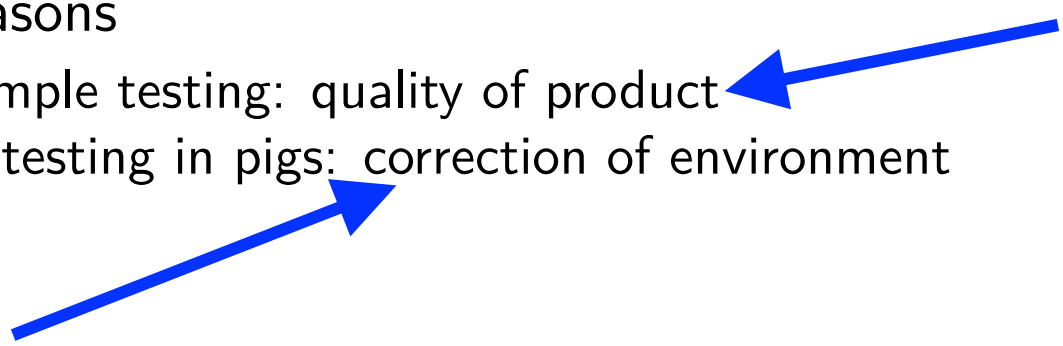
Performance Testing

Description of current status of the current population ==> where we are with the current population

Depending on species, there are larger differences
> e.g. dairy cattle: tendency to have as many animals under test as possible (milk performance)

> in pigs only few animals are in the herd book and only those are included in performance tests,
in pigs: 2 types: station testing and own-performance testing.

- 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

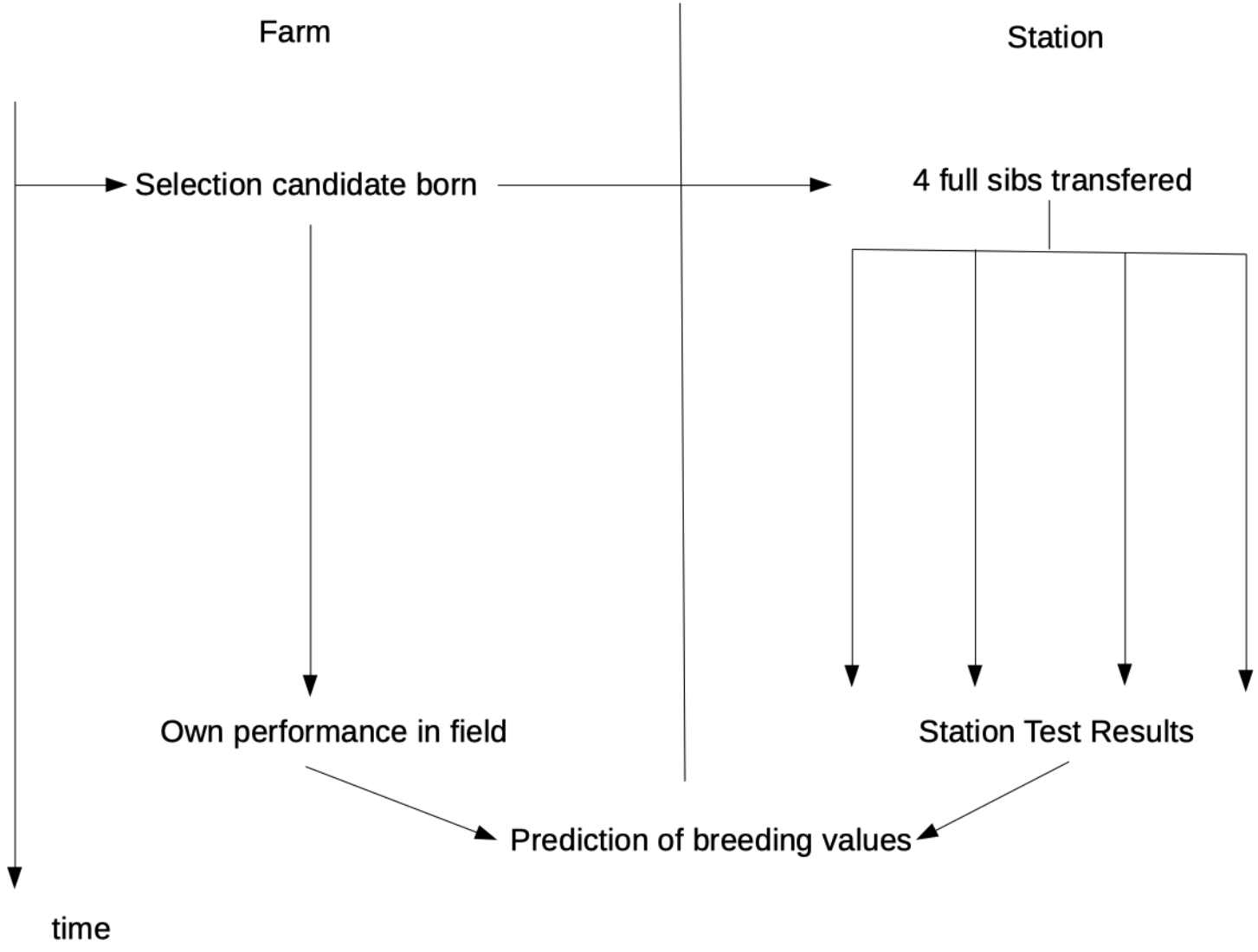


Classification of Performance Tests

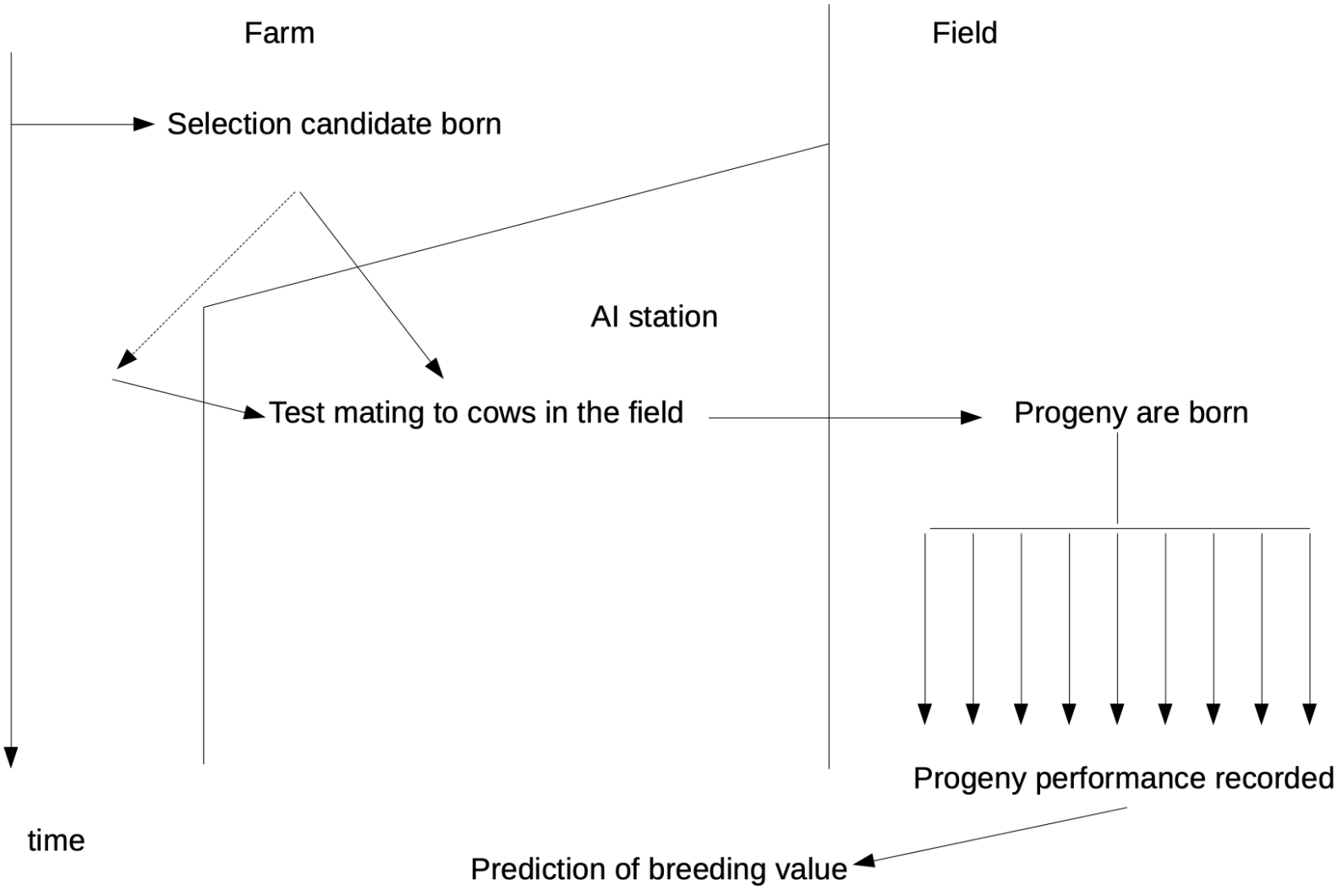
- Place
  - Station
  - Field
- Relationship between selection candidate and tested animal
  - own performance record
  - full-sib
  - progeny
- Traits
  - should have genetic variation
  - economic importance
  - measurable better than subjectively observed

Important to have new traits to be included in genetic evaluation, e.g. Methane, Ketosis derived traits from results of MIR-Spectra of milk. Traits derived from sensor data

Examples: Pigs



Examples: Cattle



Prediction Of Breeding Values

- Done in most breeding programs
- Federal regulation
- Performance tests much more expensive
- Different intervals
  - cattle: three times per year
  - pigs: nightly or weekly

Progress In Technologies

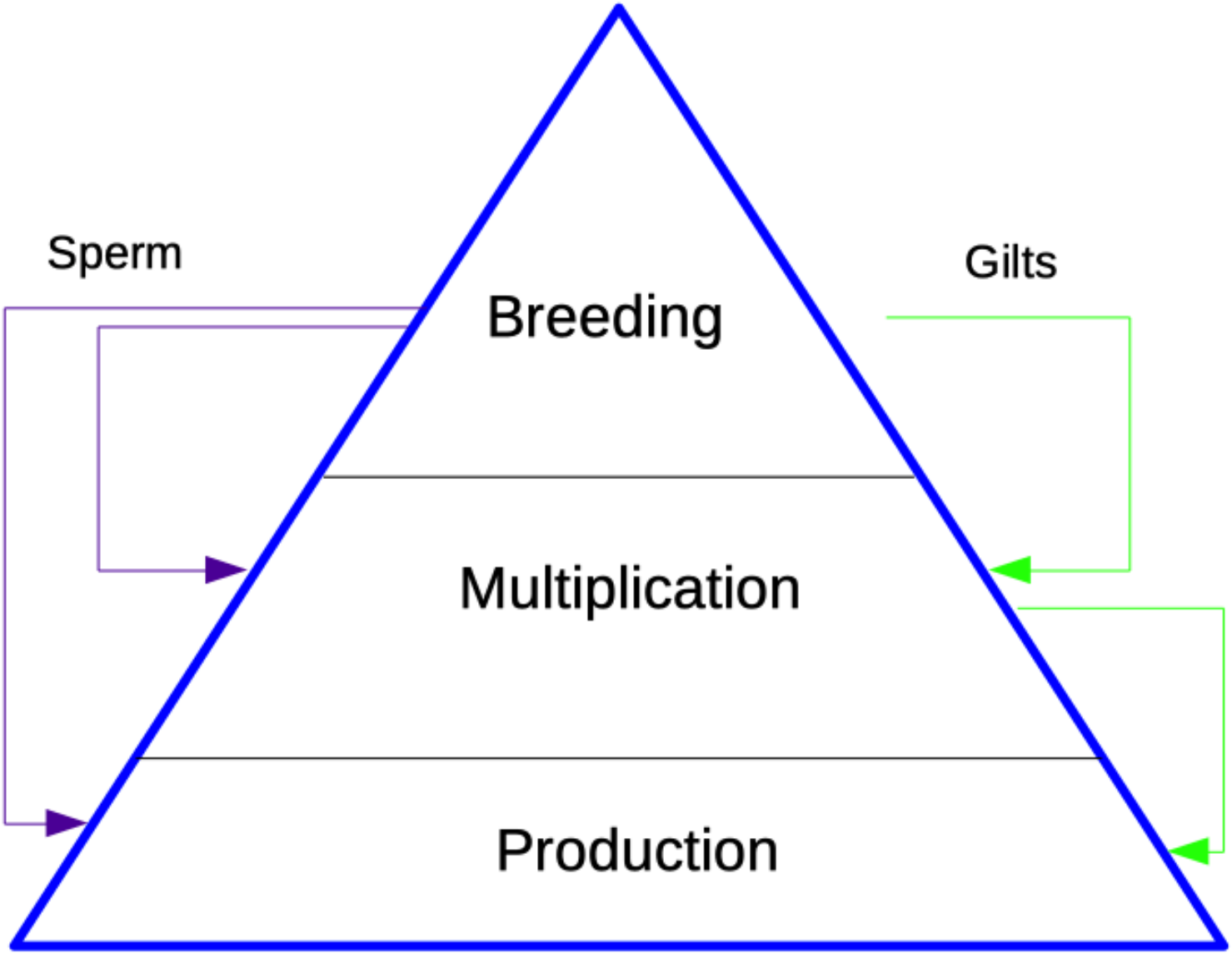
- Reproduction - AI
  - disease prevention
  - number of progeny per sire increased
  - better comparisons between herds
  - Future: more development on female side
- Molecular Biology
  - cheap and efficient large-scale genotyping
  - sequencing with more accuracy
- Computer Science
  - efficient evaluation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