

Pig Science - Breeding

Peter von Rohr

2022-04-27

Program

Program

Datum	Day	Room	Time	Dozent	Topic
23.02.2022	Wednesday	LFW B2	8-10	SN	Introd. Genetics
25.02.2022	Friday	AgroVet Strickhof	9-12	SN	Pig housing, constitution
02.03.2022	Wednesday	LFW B2	8-10	GB	Feeding and meat quality
09.03.2022	Wednesday	LFW B2	8-10	GB	Feeding and meat quality
16.03.2022	Wednesday	LFW B2	8-10	SN	Genetics
23.03.2022	Wednesday	LFW B2	8-10	SN/GB	Student presentations 1
30.03.2022	Wednesday	LFW B2	8-10	SN/GB	Student presentations 2
06.04.2022	Wednesday	LFW B2	8-10	SN	Genetics
13.04.2022	Wednesday	LFW B2	8-10	GB	Feeding and meat quality
20.04.2022 Easter break					
27.04.2022	Wednesday	LFW B2	8-10	PvR	Breeding
04.05.2022	Wednesday	LFW B2	8-10	PvR	Breeding
11.05.2022	Wednesday	LFW B2	8-10	PvR	Breeding
18.05.2022	Wednesday	LFW B2	8-10	CK	Sustainable pigs
25.05.2022 no lecture					
01.06.2022	Wednesday	LFW B2	8-10	SN	Exam

Lecturers:

SN	Stefan Neuenschwander
GB	Giuseppe Bee
PvR	Peter von Rohr
CK	Claudia Kasper

Program - Breeding

Week	Date	Topic
1	27.04	Extension of Breeding Programs
2	04.05	Genomic Selection in Pig Breeding
3	11.05	Breeding Program via Aggregate Genotype

Course Objectives

The students

- ▶ understand the theoretical background and the practical application of the prediction of breeding values in a livestock breeding
- ▶ know how to interpret predicted breeding values.

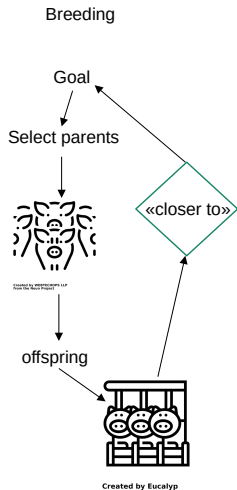
→ What is the meaning of a predicted aggregate genotype —9 index points

→ 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



Production



Husbandry



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... and into many other products according to
https://www.ted.com/talks/christien_meindertsma_how_pig_parts_make_the_world_turn

Scientific Definition

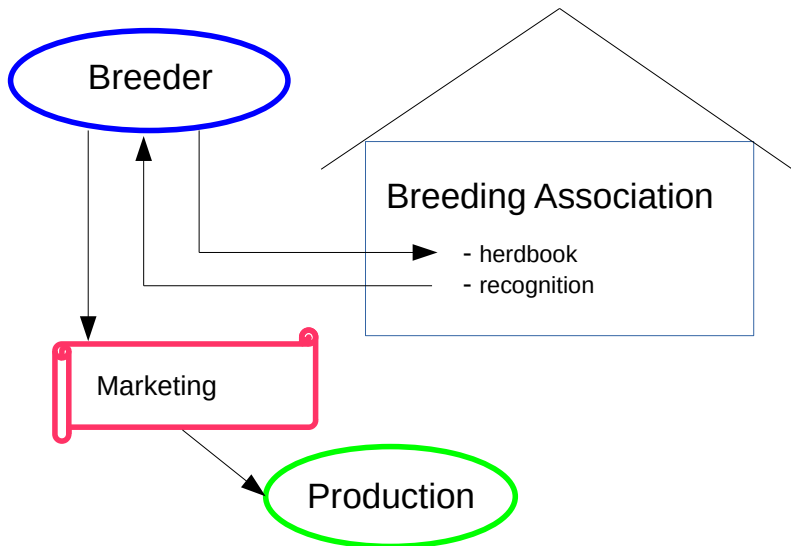
“Selection and Mating of parents are used such that offspring generations are closer to a defined goal.”

- ▶ Distinction between
 - ▶ livestock breeding and production
 - ▶ cattle breeding and milk or beef production
 - ▶ pig breeding and pork production and
 - ▶ chicken breeding and egg producers

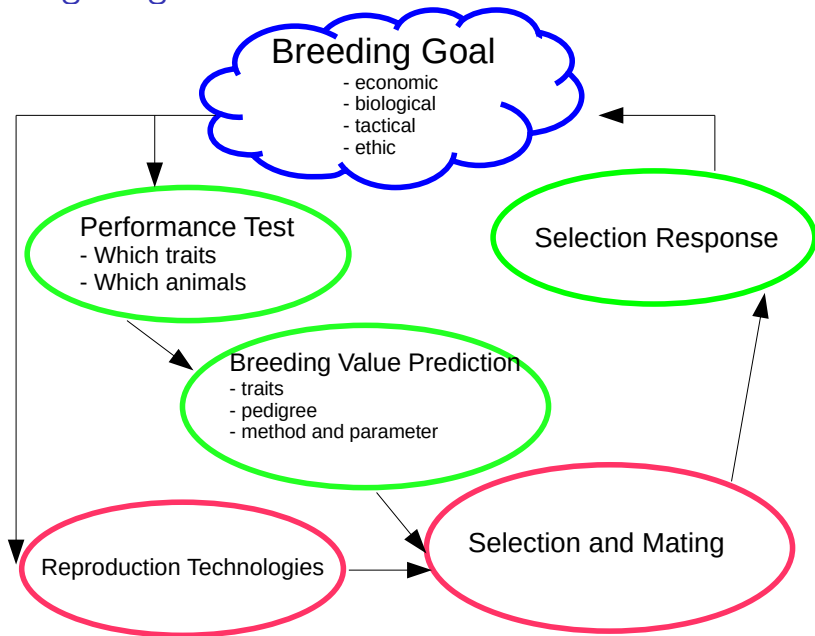
History

- ▶ Formations of breeding organisation (BO)
- ▶ Tasks of BO: herdbooks and certification
- ▶ Crisis at beginning of 20th century lead to federal regulations
- ▶ Focus on increasing production after 1945
- ▶ 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

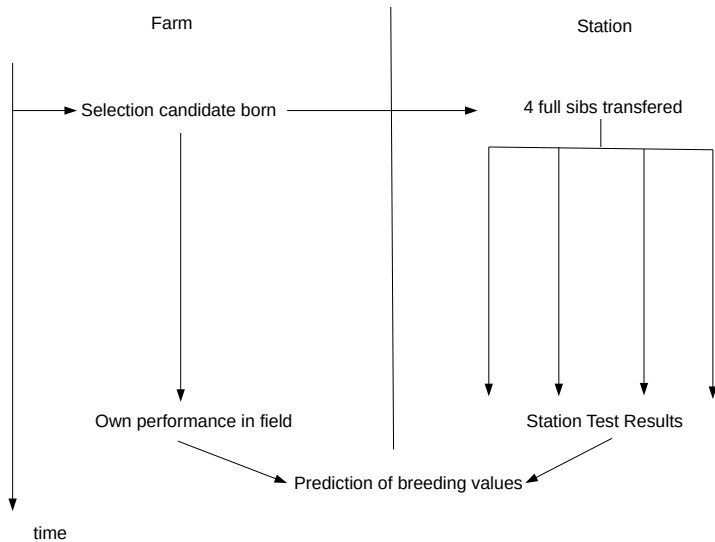
Performance Testing

- ▶ 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

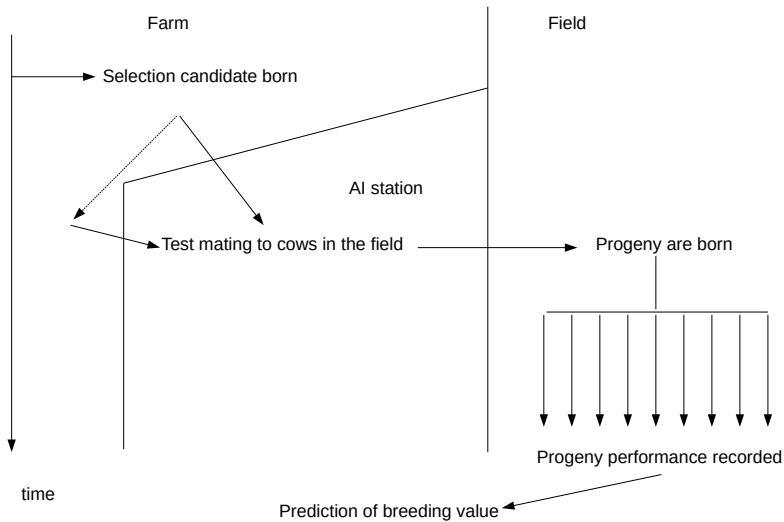
Classification of Performance Tests

- ▶ 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

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

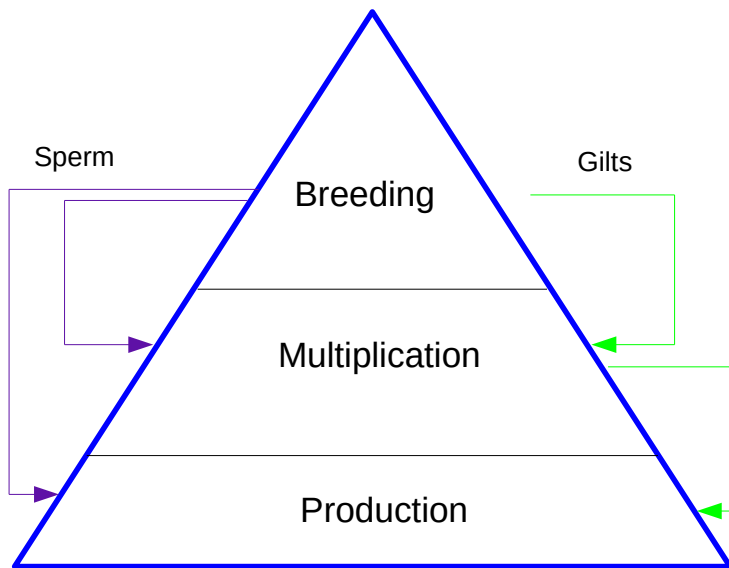
- ▶ Reproduction - AI
 - ▶ disease prevention
 - ▶ number of progeny per sire increased
 - ▶ better comparisons between herds
 - ▶ Future: more development on female side
- ▶ Molecular Biology
 - ▶ cheap and efficient large-scale genotyping
 - ▶ sequencing with more accuracy
- ▶ Computer Science
 - ▶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

Differences Of BP Between Species

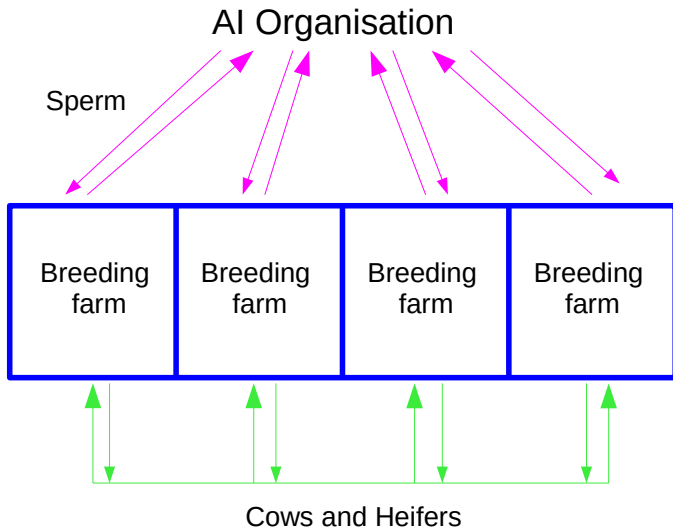
Breeding programs (BP) for different species have different structure

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

Hierarchical Structure



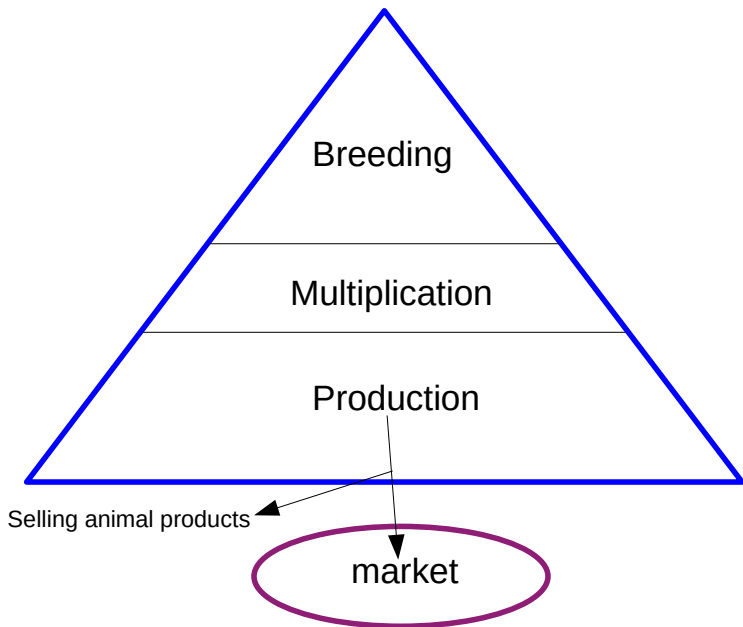
Monolithic Structure



Example of Implementation

- ▶ Assume: pig breeding organisation
- ▶ Improvement of animal at production level with respect to economic profitability
- ▶ Implementation of scientific breeding program
- ▶ Start to design and to develop economic breeding goal
- ▶ Combine economically important traits into an aggregate genotype (H)
- ▶ Use hierarchical structure

Hierarchical Breeding Program

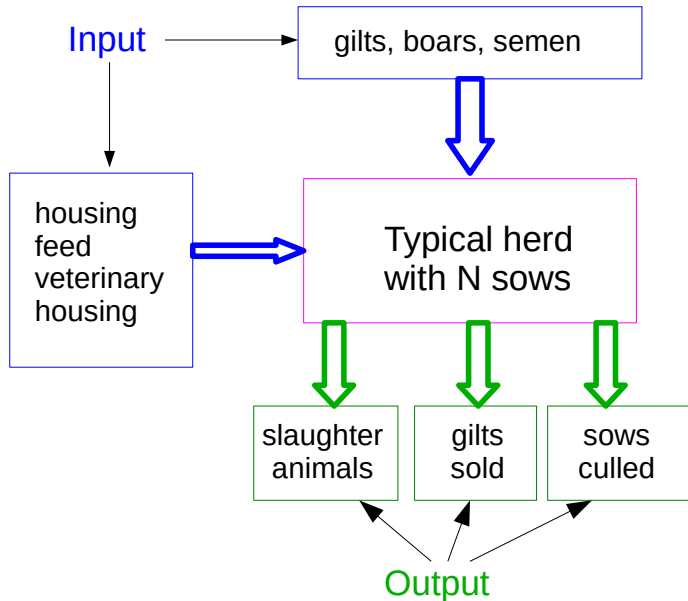


Three Steps To Design Economic Breeding Goal

The following steps are needed to implement a breeding program

1. description of production system
2. modelling profit of a typical herd
3. derive economic values

Production System



What is a Production System

- ▶ Simulation of production herd
- ▶ Collect input parameters (costs, biological parameters, labor, ...) from literature
- ▶ Use collected input parameters for simulation
- ▶ Run simulation
- ▶ Record output quantities (revenue, animals sold)

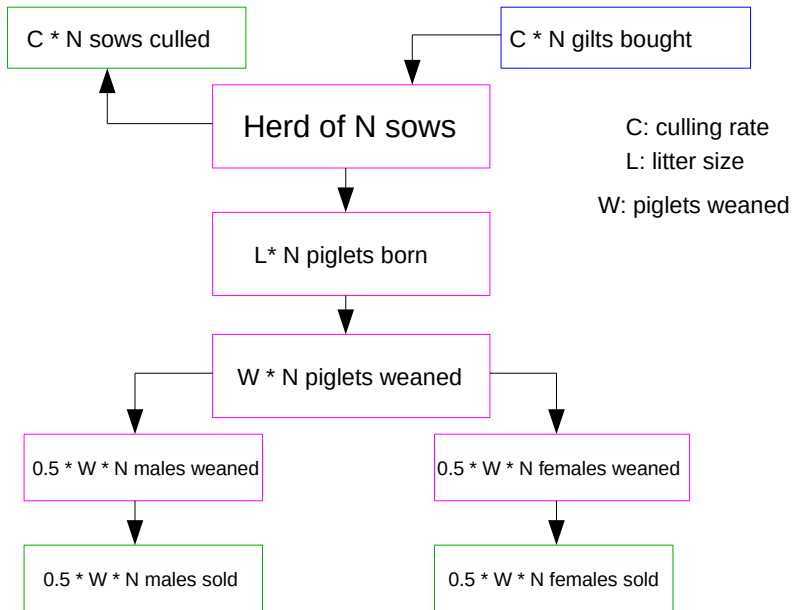
Why Production System

- ▶ Profit is computed based on revenue and costs
- ▶ Characteristics and traits of animals with impact on profitability are found
- ▶ Impact of traits on profitability detected by changing input parameters
- ▶ Progeny must meet needs of production farms
- ▶ Breeders must select parents such that optimal progeny produced for production farms

Structure of Production System

- ▶ Assume a hierarchical structure of the breeding program
- ▶ Alternatively: mixed farms in monolithic structure
- ▶ Breeding (and possibly multiplier) farms are selling their progeny to production farms

Example Of Typical Production Farm



Traits Of Interest

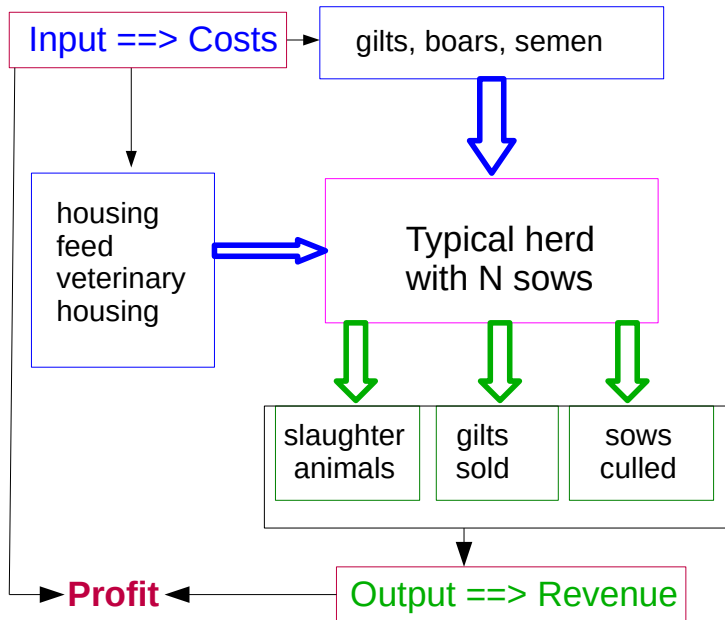
- ▶ Profit (P) of production farm determined by revenues (R) and costs (C)

$$P = R - C$$

- ▶ Traits of economic interest influence P
- ▶ Restrict ourselves to output
 - ▶ age corrected carcass weight (CW)
 - ▶ carcass confirmation (CC)
 - ▶ carcass fat (CF)
- ▶ Above traits will be included in aggregate genotype (H)

$$H = a^T \cdot u$$

Economic Evaluation



Economic Values

- ▶ ... also known as economic weights
- ▶ Change of profit (P) due to small change of trait mean (μ_x)
- ▶ For trait x with mean μ_x , the economic value a_x is defined as

$$a_x = \frac{\partial P}{\partial \mu_x}$$

Genetic Evaluation

- ▶ Statistical modelling
- ▶ Stochastic relationship between genetic background and phenotypic expression
- ▶ Contrast: deterministic modelling in physics, e.g. law of gravity

Statistical Modelling

- ▶ In most cases, two steps plus preparation
- ▶ Given: dataset on breeding animals containing traits of interest as response variables and predictor variables
- ▶ Preparation: do model selection to eliminate unimportant predictor variables
- ▶ Steps:
 1. variance components estimation
 2. prediction of breeding values