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.

$\rightarrow$ What is the meaning of a predicted aggregate genotype -9 index points

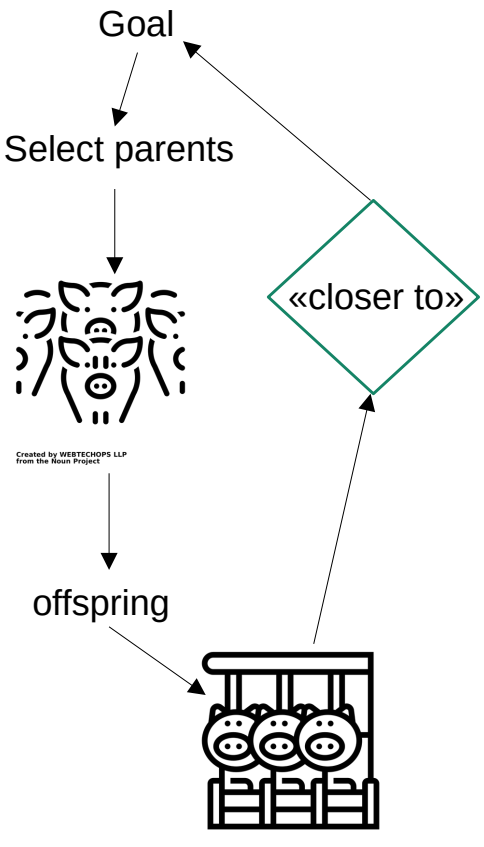
$\rightarrow$ What is the difference between production and breeding

Further Reading

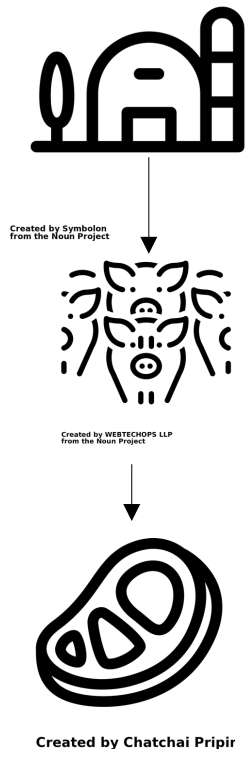
- Willam und Simianer: Tierzucht - Grundwissen Bachelor (Ulmer, UTB 3526 2011). This book gives an introduction into evolution, livestock production and breeding programs.
- Falconer and Mackay: Introduction to Quantitative Genetics (Longman). The de-facto standard in the area of quantitative genetics 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

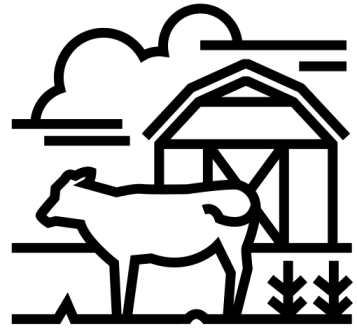
Breeding



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

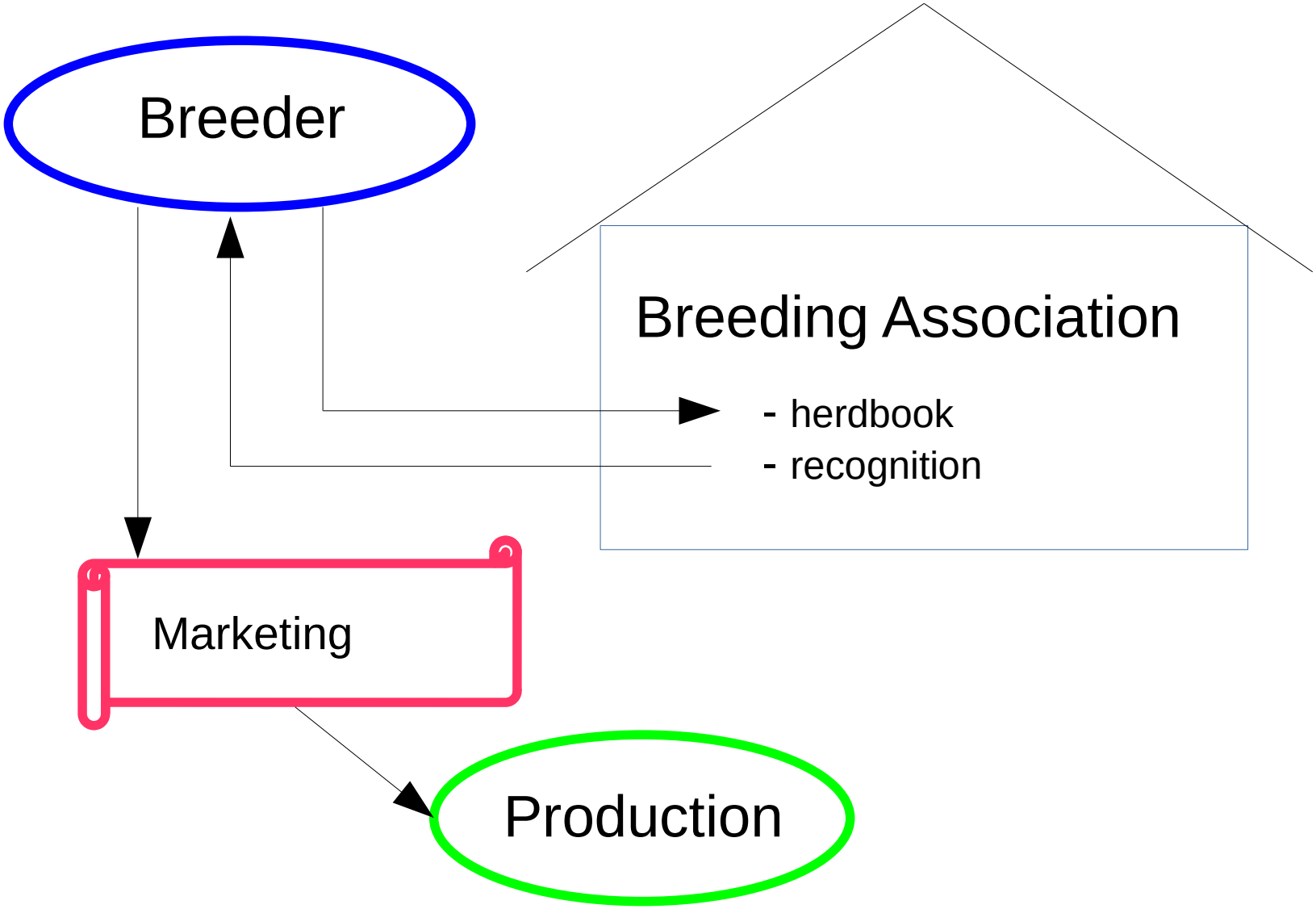
"Selection and Mating of parents are used such that offspring generations are closer to a defined goal."

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

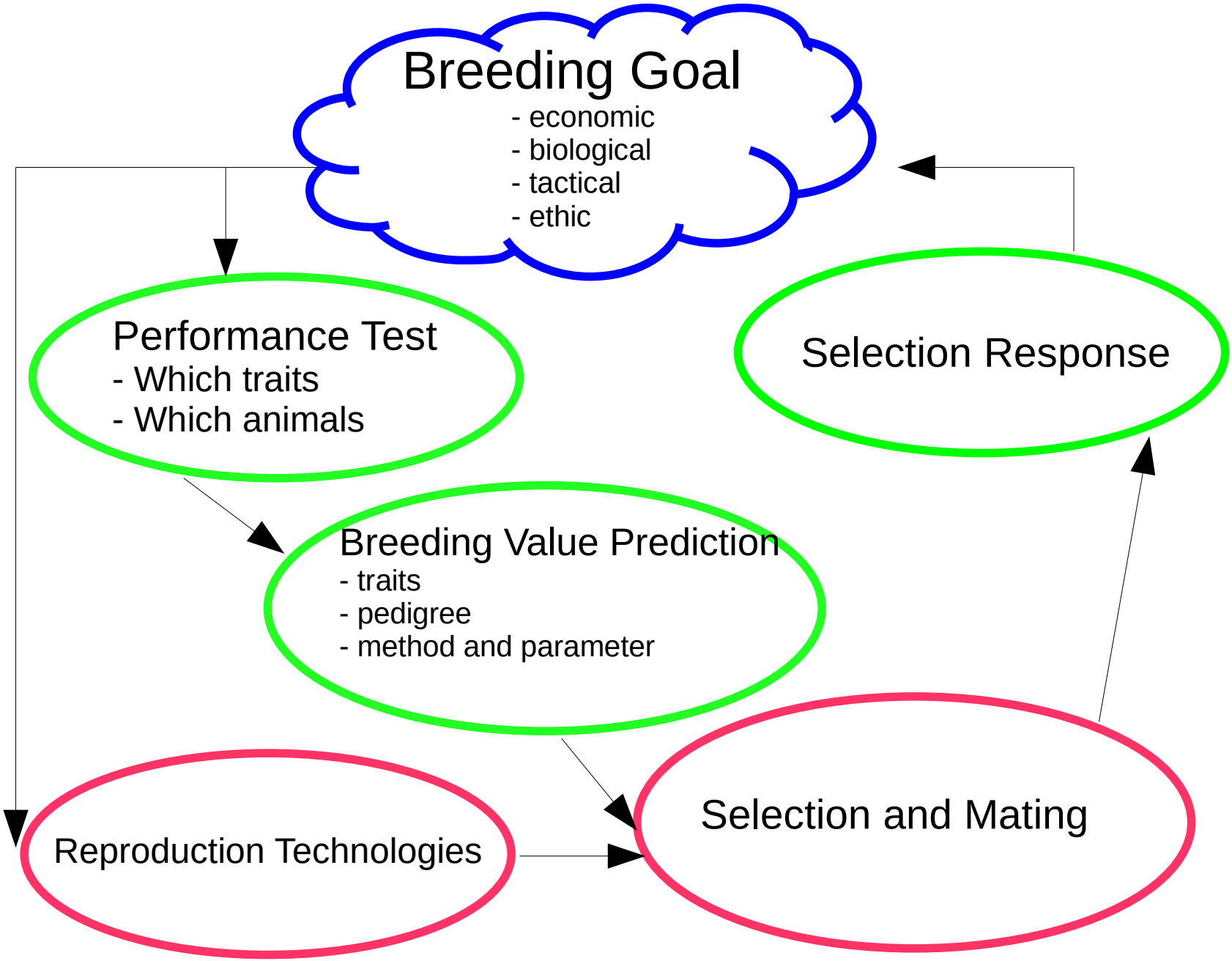
History

- Formations of breeding organisation (BO)
- Tasks of BO: herdbooks and certification
- Crisis at beginning of 20^{th} 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

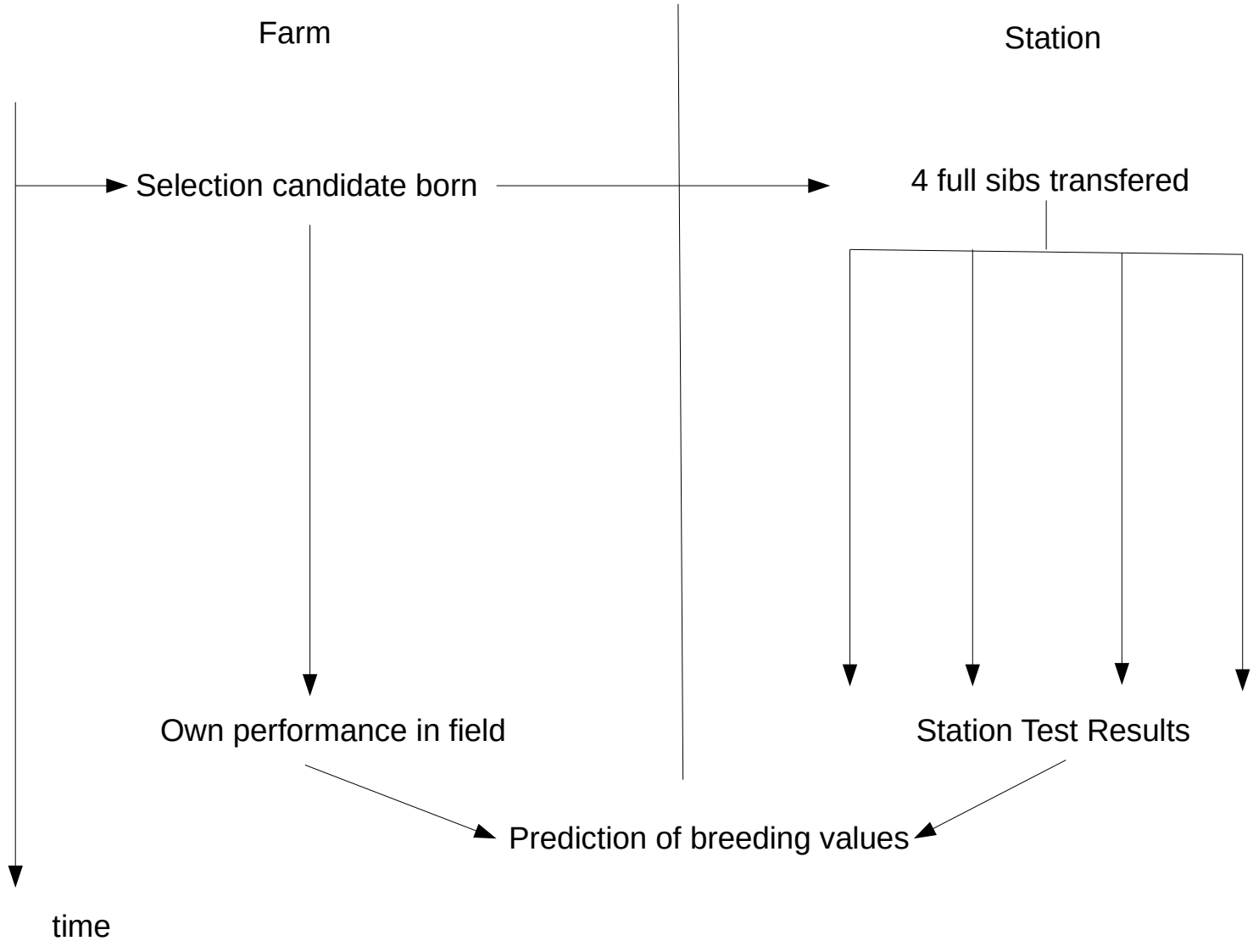
Performance Testing

- 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

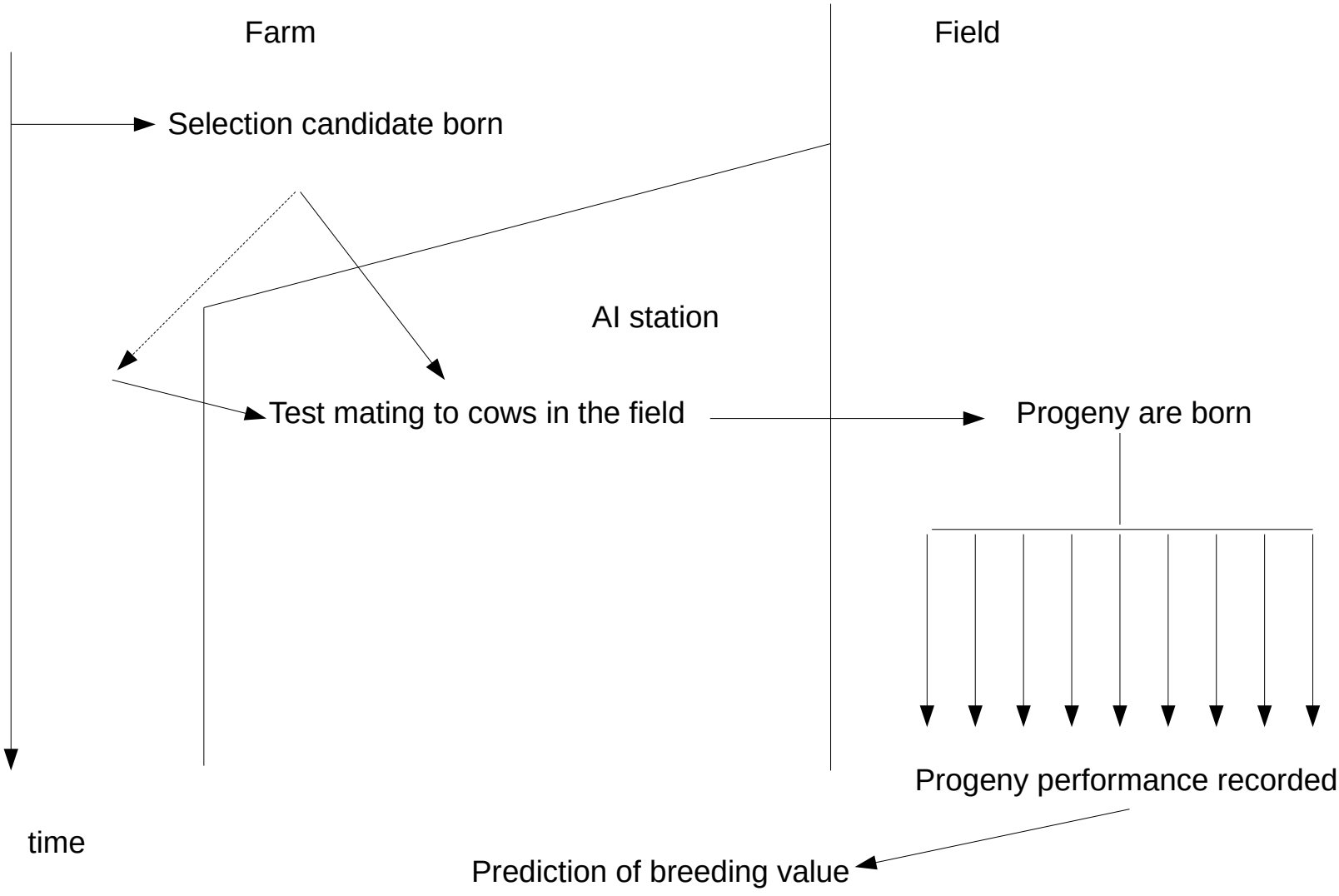
Classification of Performance Tests

- 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

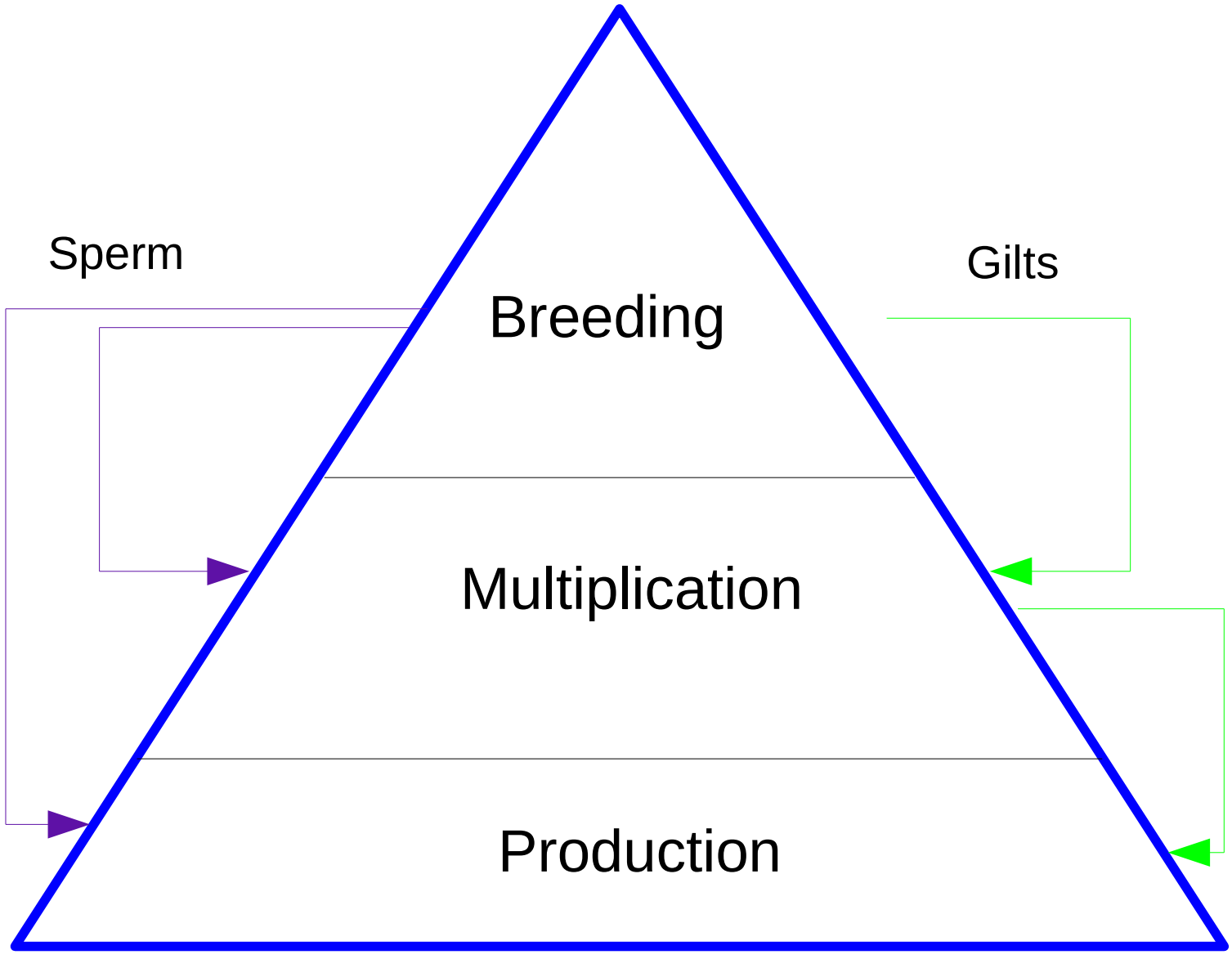
- Reproduction - AI
  - disease prevention
  - number of progeny per sire increased
  - better comparisons between herds
  - Future: more development on female side
- Molecular Biology
  - cheap and efficient large-scale genotyping
  - sequencing with more accuracy
- Computer Science
  - efficient evaluation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

Differences Of BP Between Species

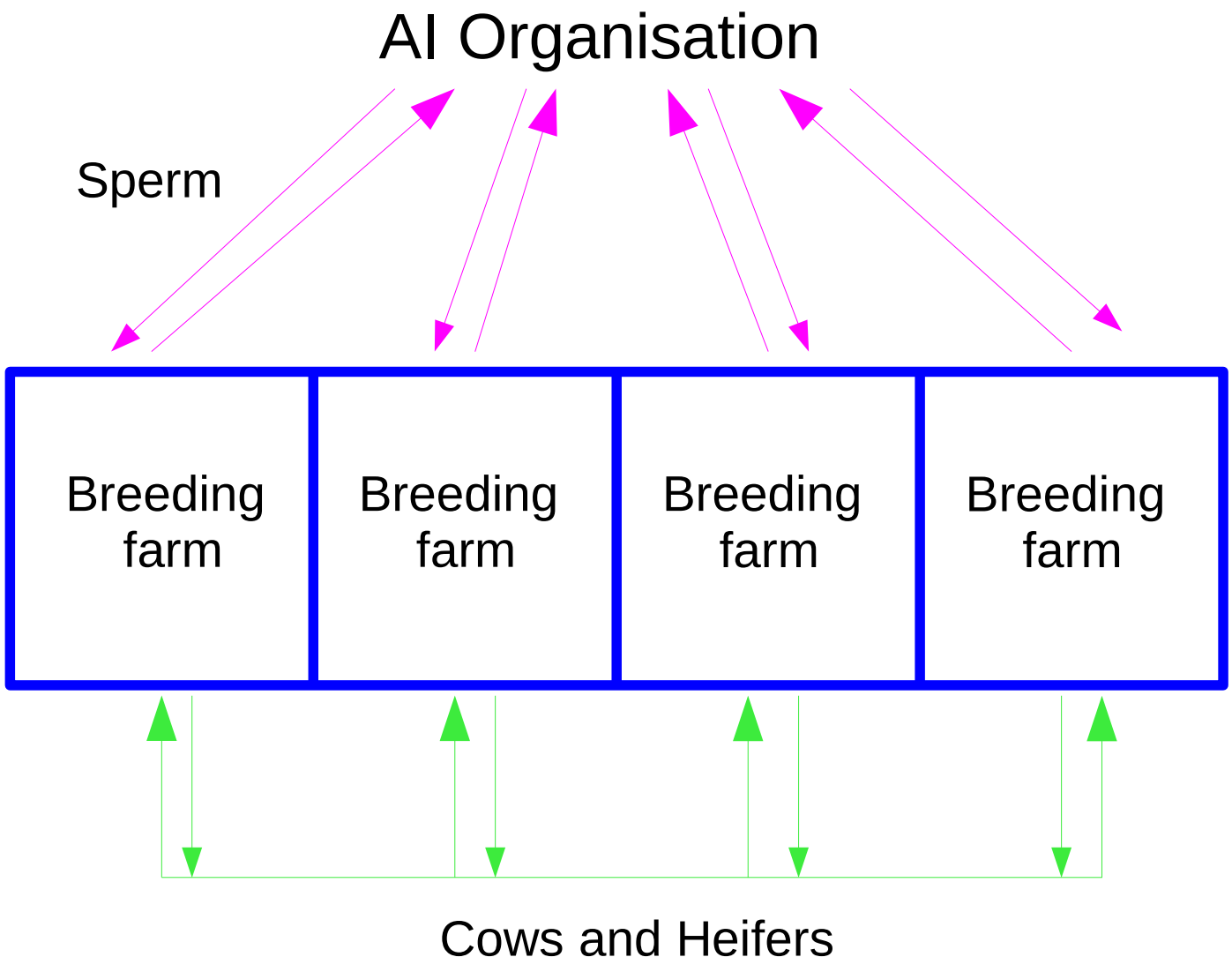
Breeding programs (BP) for different species have different structure

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

Hierarchical Structure



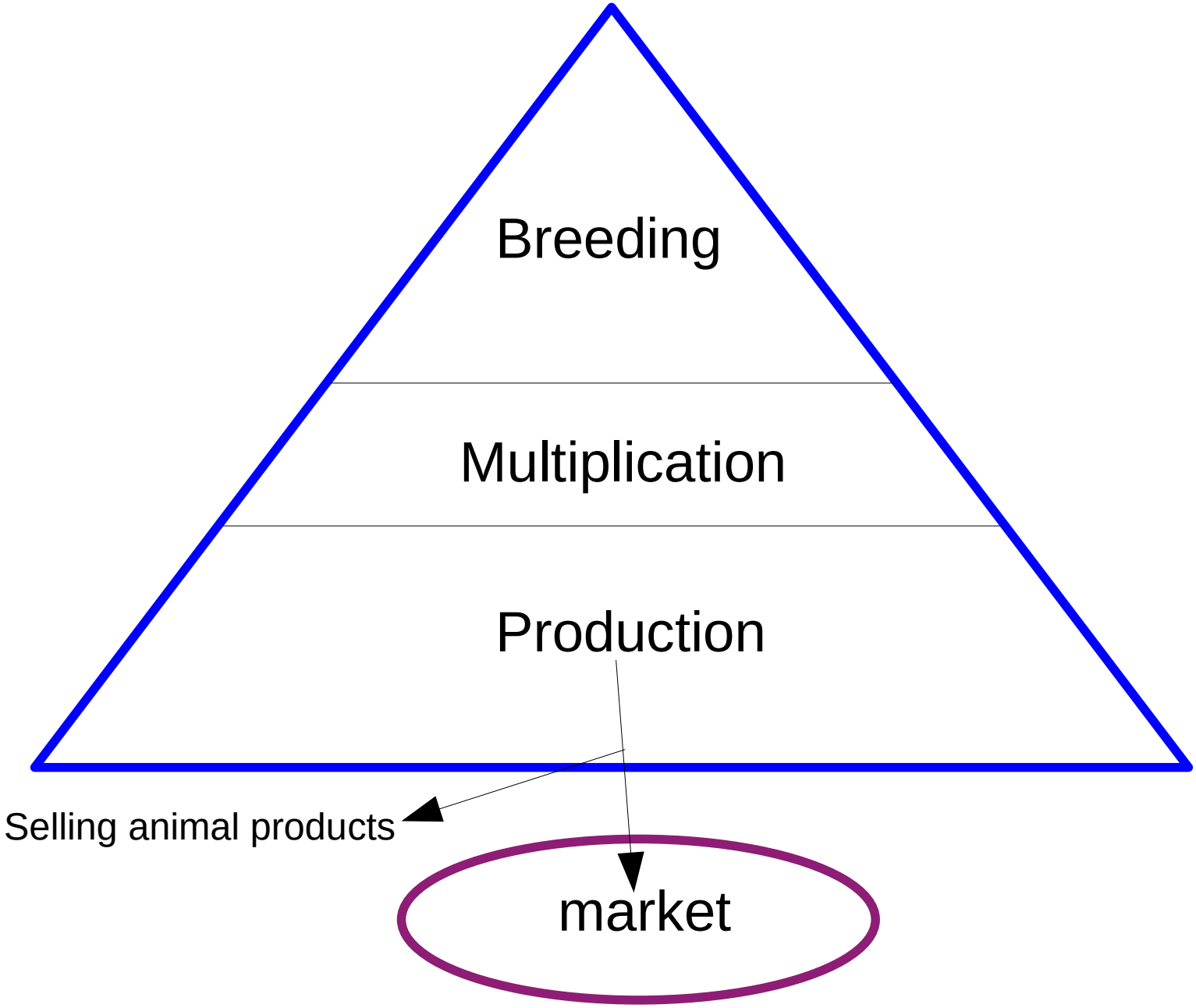
Monolithic Structure



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

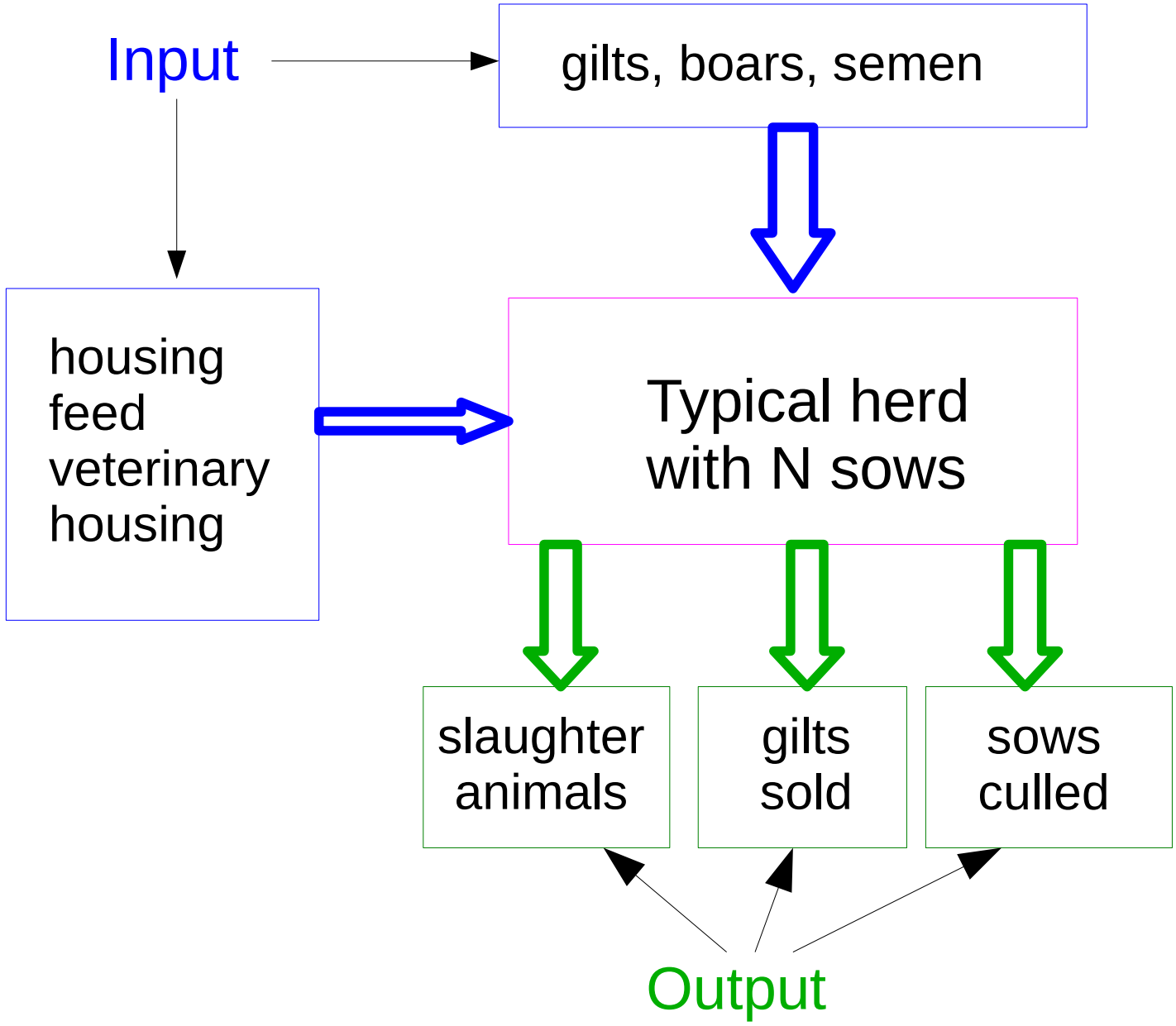


Three Steps To Design Economic Breeding Goal

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)

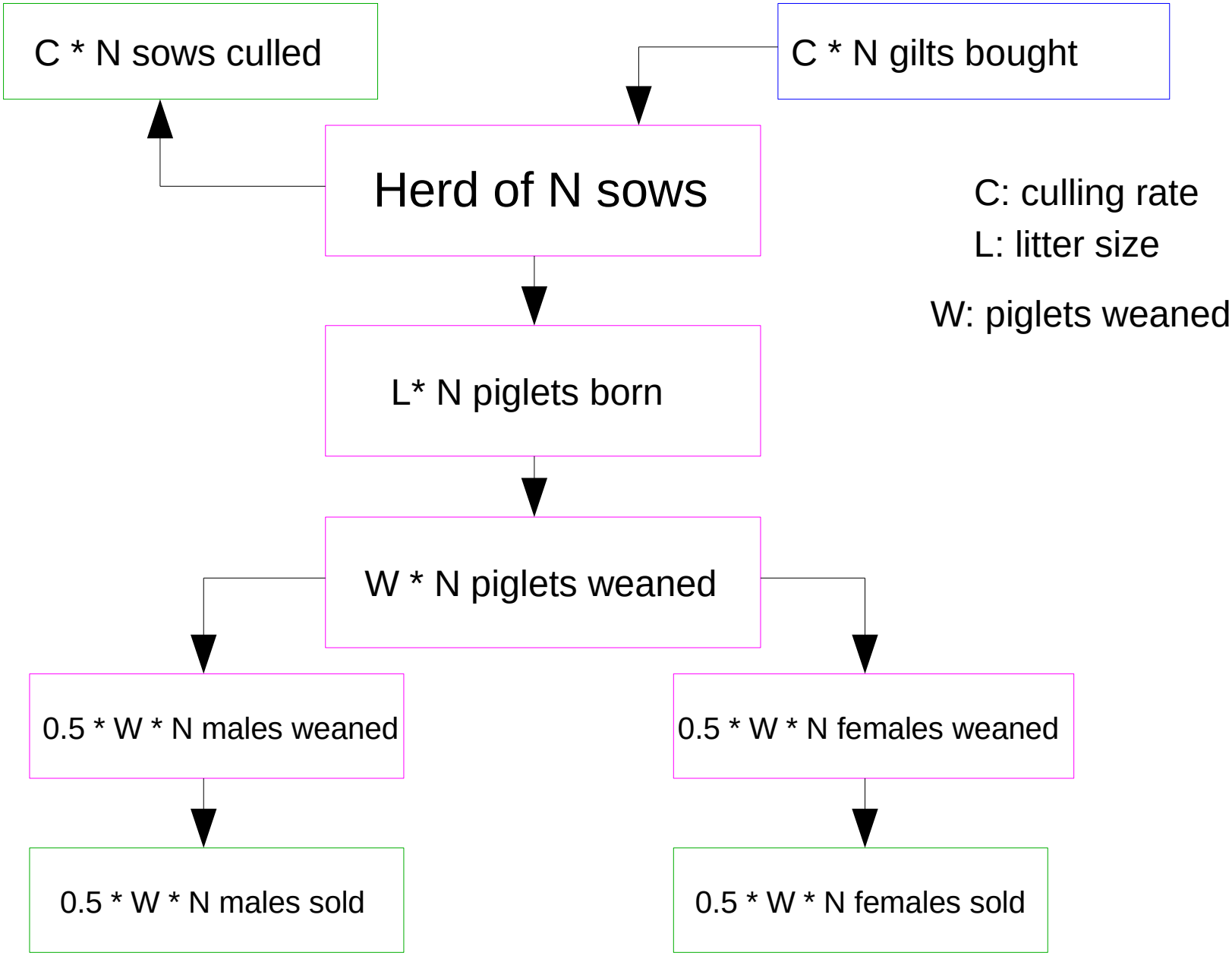
Why Production System

- 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

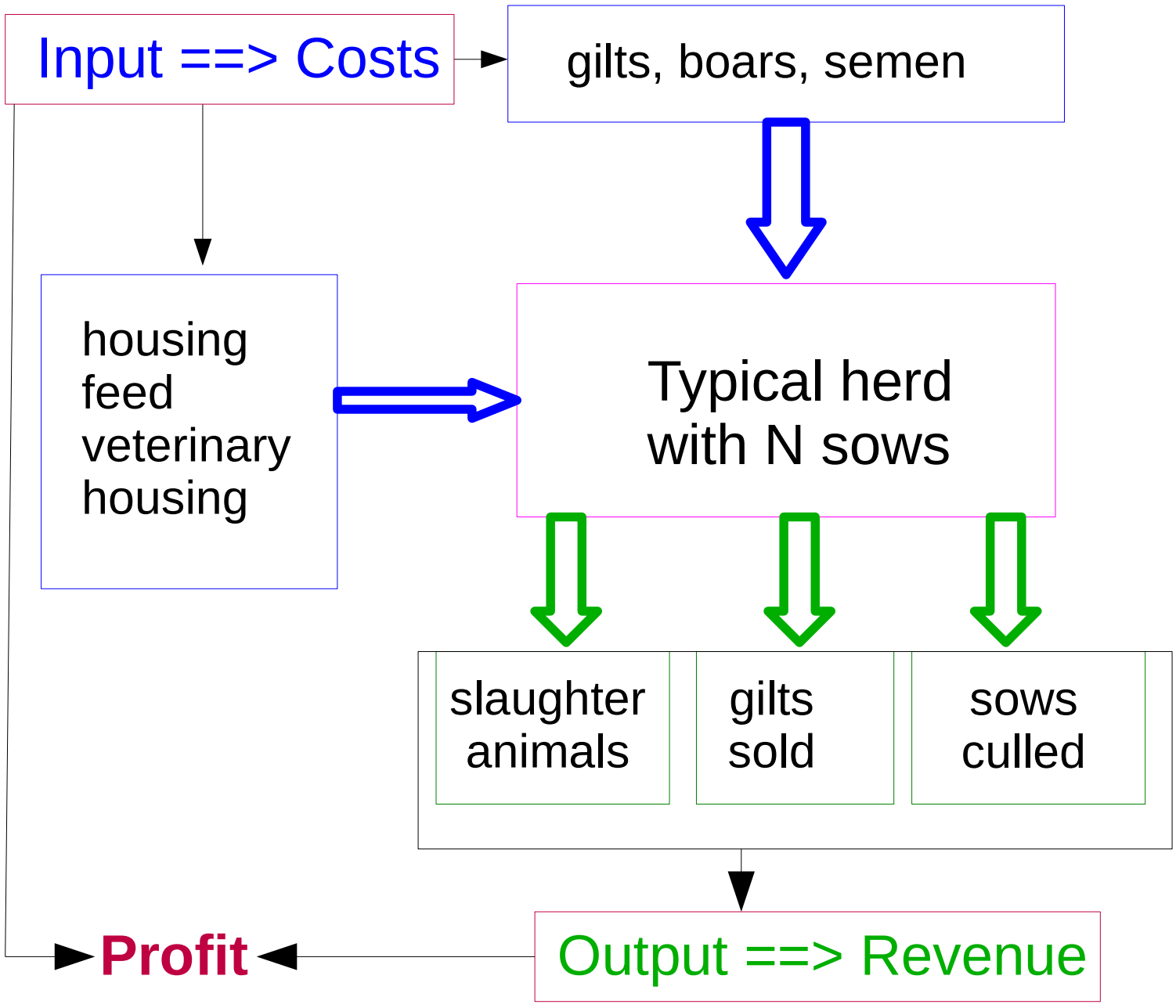
- Profit (P) of production farm determined by revenues (R) and costs (C)

$$P = R - C$$

- 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