Implementation Of A Breeding Programs

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Recall

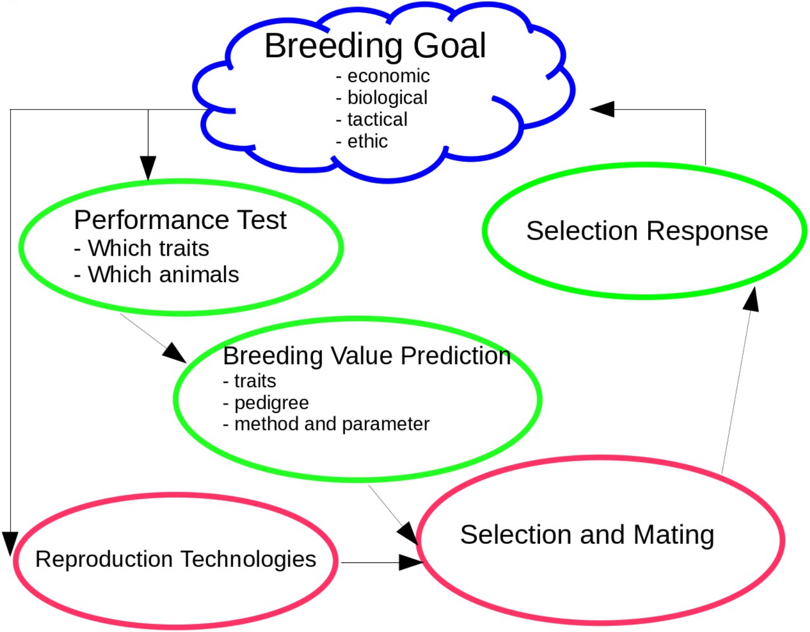
* scientific: establish a procedure that allows us to select animals as parents of future generations such that the selection response is the primary focus.
* selection response (per generation): difference between average offspring population and average parental generation
* main focus is on: selection response per year := selection response per generation / generation interval
* generation interval: average age of a parent when offspring is born (eg, cattle: 4-5 years)

Types of breeding programs:

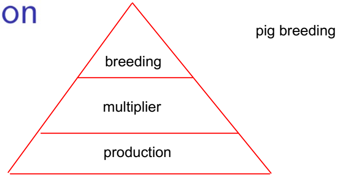
- focus on selection response (scientific)
- focus on customers and services (political)

members of a breeding organisation and breeding organisation is organised like a company

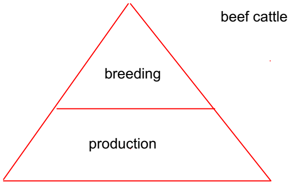
Components of a Breeding Program



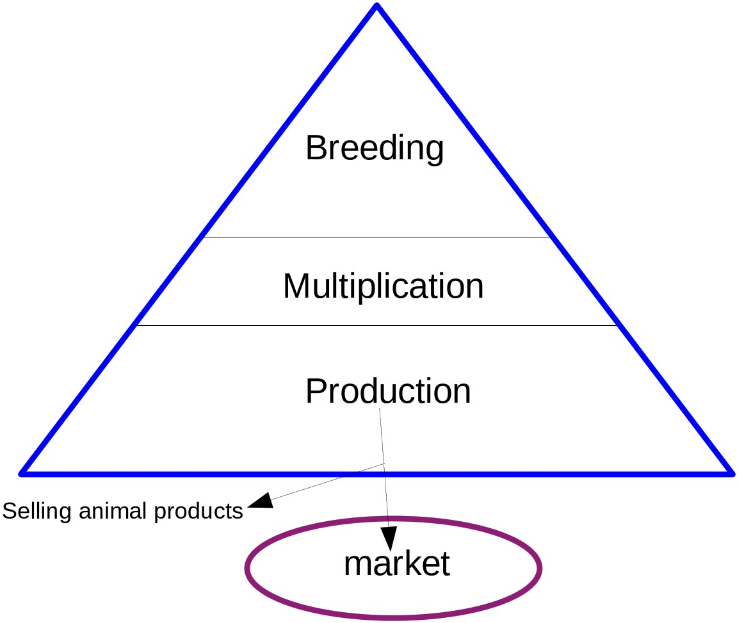
Example of Implementation



- Assume: beef 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



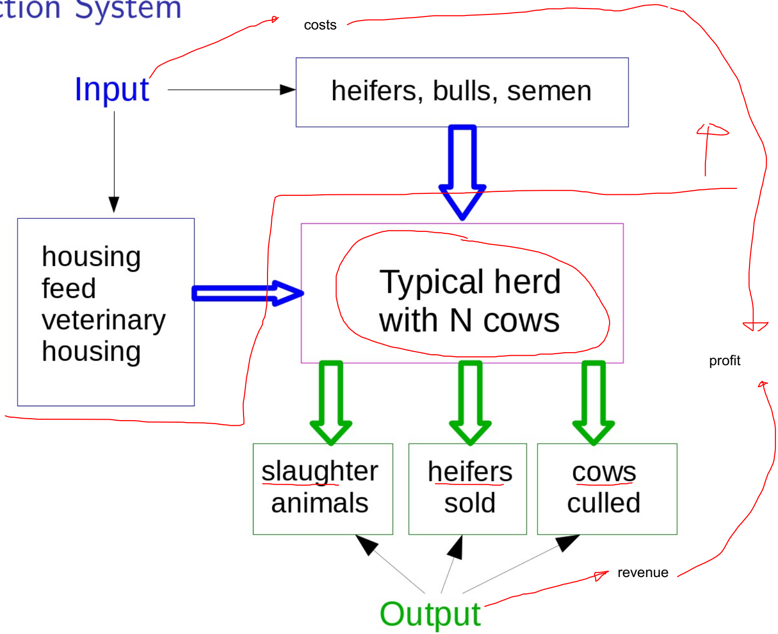
Three Steps To Design Economic Breeding Goal

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

will be used as weights in the aggregate Genotype (H)

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 → over different time spans, e.g. 10 year versus 25 years
- Record output quantities (revenue, animals sold)

profit

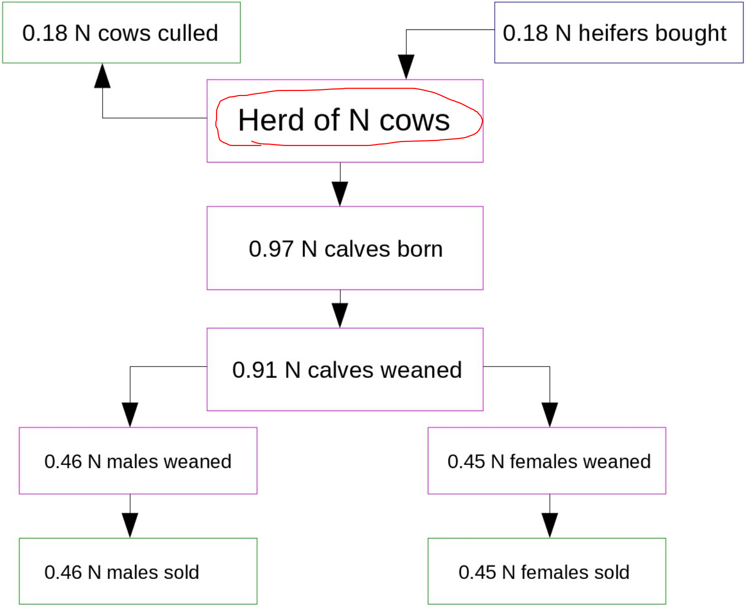
Why Production System

- 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) → measure for growth, comparable to average daily gain
  - carcass confirmation (CC) → CH-TAX classification
  - carcass fat (CF) → 1-5 classification, with 3 being optimal
- Above traits will be included in aggregate genotype (H) → Gesamtzuchtwert

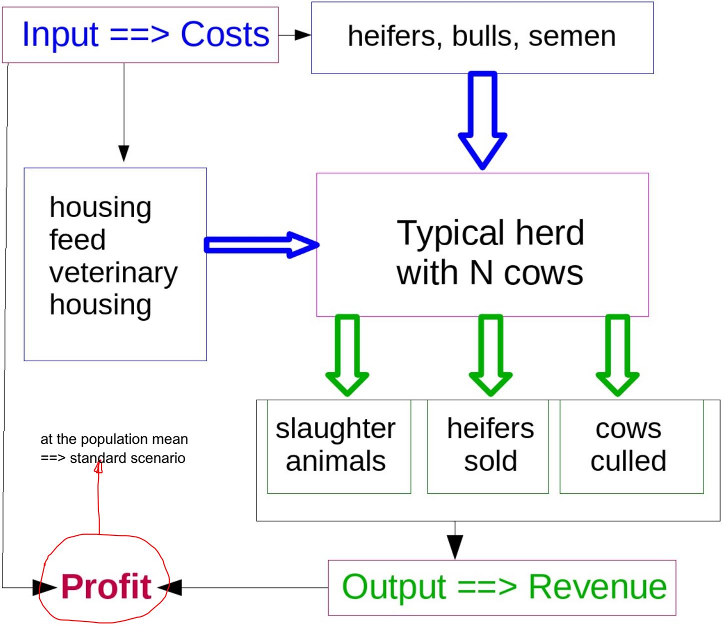
$$H = a^T \cdot u$$

vector of economic values (a)

vector of breeding values (u)

Economic Evaluation

Parameters such as three traits in H and other quantities such as fertility, health traits, etc are chose to be at the population mean



Economic values are computed in two steps:

Step1: Compute profit in the standard scenario ==> Result is profit: P0
(Assume carcass fatness to have a population mean of 2.8)

Step2: We select one trait from H, e.g. carcass fatness. For CF, the population mean is increased by a small amount, e.g. 0.01 class units ==> the new populatio mean for CF is 2.81. With this new average in CF, the profit is computed again and the result is the profit: P1

Economic value for CF: (P1-P0) / 0.01

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

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

Change in profit

Change in the population mean of the trait

Why do we need economic values (EV)?

* Assume H with three traits: CW, CC, CF
* H contains the breeding value for each of the three traits.

For two selection candidates:

	Candidate 1	Candiate 2
CW	+50	+30
CC	+0.2	+3
CF	-0.1	+1

The main question for a breeder is, should I choose Candidate1 or Candidate 2 as parent?

Candidate1: Estimated H ==> EV(CW) * 50 + EV(CC) * 0.2 + EV(CF) * (-0.1) ==> H1
Candidate2: Estimated H ==> EV(CW) * 30 + EV(CC) * 3 + EV(CV) * 1 ==> H2

if (H1 > H2) ==> choose Candidate 1 as parent
if (H2 > H1) ==> choose Candidate 2

Genetic Evaluation

Aggregate Genotype H consists of
* economic values (a)
* breeding values (u)

Because the true breeding values u cannot be observed, they must be predicted.
Predictions of breeding values u are done with statistical models, mixed linear effect models

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

Statistical Modelling

At the beginning of every genetic evaluation, we need data that include the traits in our aggregate genotype (or it might also be traits that are closely related) and we need data from all factors that influence the traits of interest. For example: dataset consists of CW, CC, CF and of all factors that influence these traits. Influence factors might be: herd, year, slaughterhouse, classifier, sex, ...

- 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