Chapter 3

Implementation Of A Breeding Program

3.1 Introduction

In chapter 2 in general and specifically in Figure 2.1 the different types of breeding programs and the components of a breeding program are shown and described. This chapter aims at giving an outline of how to implement a specific breeding program for a given population. We assume a beef breeding organisation that approaches us and we have to consult them on how to implement a breeding program. The breeding organisation wants to improve their breeding animals with respect to the economic profitability of the animal production. Together with the breeding organisation, we agree on a scientifically formulated breeding goal.

3.2 Development Of The Breeding Goal

According to [Phocas et al., 1998], three points are to be considered when developing a breeding goal.

1. description of production system
2. modelling the profit for a typical herd
3. derivation of economic values

For reasons of simplicity we are assuming that all herds have the same production system. It is important to note here that in a hierarchical breeding program such as shown in Figure 2.3, the herd described in subsection 3.2.1 comes from the production sector situated at the bottom of the triangle. The reason for

using a herd from the production tier as the basis of the description of the production is that the breeding and possibly the multiplier sections of the breeding program have to adapt their breeding animals to the needs and requirements of the production herds. Looking at the different participants of the breeding program as a client-supplier relationship, the producers are clients of the breeding and the multiplier farms for young production animals. These animals must meet the requirements of the production farms. As a consequence of that the breeding and multiplier farms have to raise young animals that fit the needs of the production farms. This is done by designing the breeding program implemented in the breeding farms according to the needs of the production farms. The implementation of the breeding program must yield tools for the breeding farms to be able to select the best animals as parents. One possibility of such an implementation is shown here for an idealized and simplified situation.

3.2.1 Description Of Production System

A production system is defined by its required inputs and by the products that are sold. Furthermore housing, feeding regimes and other management components that affect the production costs are important properties of a production system. Figure 3.1 illustrates a production system by showing the most important components affecting the profitability of a typical herd.

In our example, the assumed herd has N cows. Cows are inseminated using artificial insemination. Once a year the cows are expected to produce a calf. The calves are raised, fattened and sold as slaughter animals. From the N cows each years a proportion of 0.18 is culled and is replaced with young heifers which are bought from breeding or multiplier farms. Figure 3.2 corresponds to a simplified version of Figure 1 of [Phocas et al., 1998].

3.3 Determine Traits Of Economic Interest

Inputs shown in Figure 3.1 generate costs (C) and Outputs generate revenues (R). The difference between revenues and costs corresponds to profit (P) which is the key objective of the whole system that we want to improve. The traits of the animals in the production system which have an influence on the profit of the system are grouped together in the set of the **economically important** traits. The economically important traits are included in the aggregate genotype which is then used as selection criterion for the breeding animals.

For our example production herd, we are focusing on the carcass performance traits

- carcass conformation (CC)
- carcass fatness (CF) and
- carcass weight (CW).

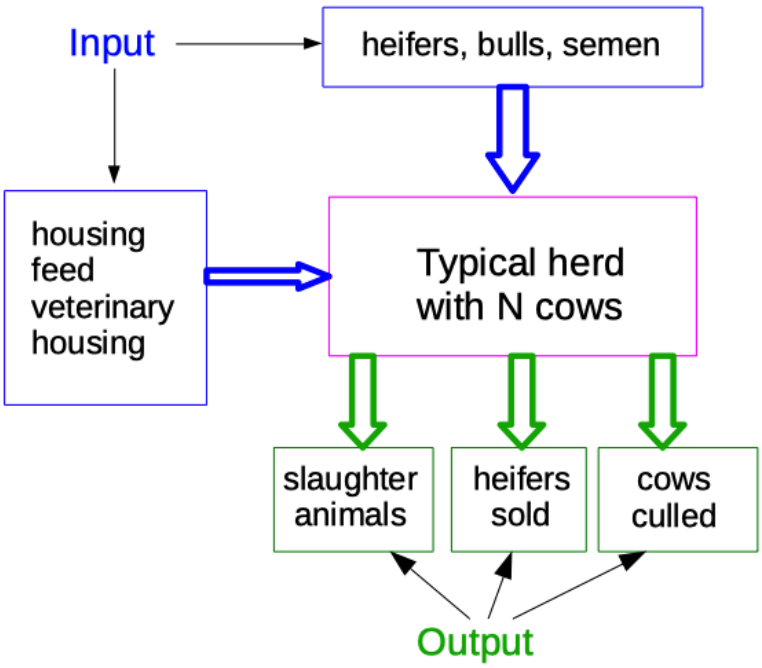

Figure 3.1: Production system illustrated by a typical herd

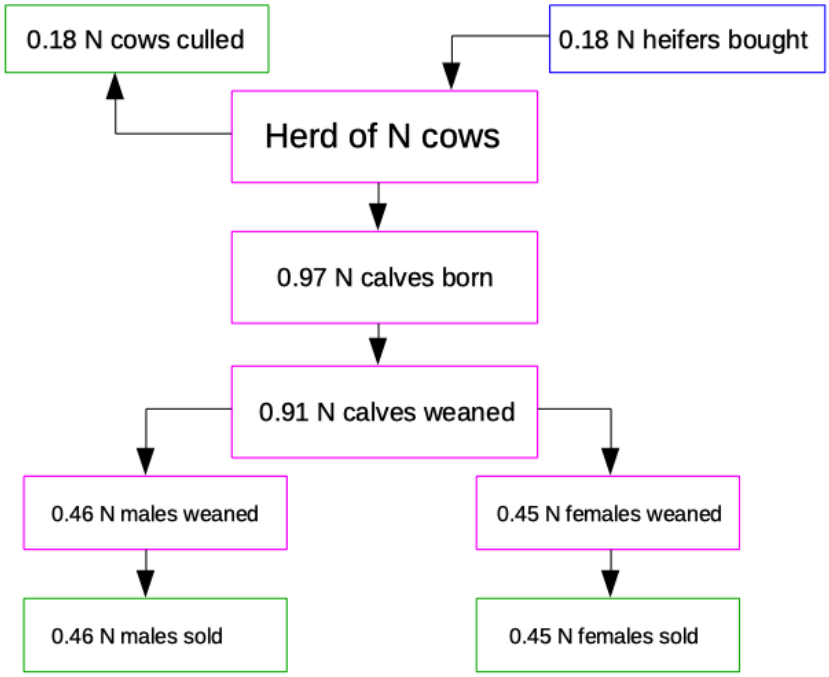

Figure 3.2: Assumed demography of typical production herd

At this stage of our analysis, we are ignoring all traits related to reproduction or survival of calves which are also important for the economic profitability of the production herd. For the moment, we focus on the three traits listed above. This means, we construct the aggregate genotype based on the three traits *CC*, *CF*, and *CW*. The weights of the different traits in the aggregate genotype is the result from the derivation of economic values listed as point 3 of subsection 3.2.

3.4 Genetic Evaluation

Once we have determined the traits of economic interest as described in subsection 3.3, we can start to have a look at the genetic part of our analysis of the breeding program. This is done in a genetic evaluation which consists of two parts

1. Variance components estimation
2. Prediction of breeding values.

In a practical analysis both parts are using linear mixed effect models with the traits of interest as response variables (y) and other characteristics as predictor variables (x). The difference between the two evaluation parts are the results that are of interest. In the first part we are primarily looking for the estimates of the variance components in the model. The second part produces predictions of the breeding values for all breeding animals.

Depending on the number of predictor variables that are available in the dataset that we have available from our breeding organisation, we first have to separate the important predictor variables from the variables that do not have an important effect on the response variable. This separation is done with a preparatory model selection step. In short, we are using all predictor variables available in a fixed linear effects model with the trait of interest as the response variable. Then we are in turn, eliminating the response variable with the smallest impact until a previously chosen model selection criterion is optimized. The remaining set of predictor variables in the optimal model is then used in the linear mixed effects model to estimate variance components and to predict breeding values.

In the chapters that follow, we are having a closer look at how to do the model selection and how to perform the two parts of the genetic evaluation.