Economics - Part 2:

PRRS Economic Simulator

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Introduction

The PRRS Economic Simulator is designed to estimate a farm's loss due to diseases caused by Porcine Reproductive and Respiratory Syndrome virus (PRRSV) in sows, piglets and fattening pigs. Moreover, the simulator is able to approximate the expected benefit (i.e. reduction in losses) for the most common intervention strategies that can be applied for combating PRRS on herd level. The users - farmers, veterinarians and consultants - can enter various farm specific data like production performance data, disease data and prices in order to receive individual estimates of losses and expected benefits for the farm of interest. Today, the simulator can be used for different farm types:

1. Breeding farms with sale of piglets at weaning;
2. Breeding farms with sale of nursery pigs;
3. Nursery farms,
4. Fattening farms; and
5. Farrow-to-finish farms.

Furthermore, it can be customized to various farm specific settings, e.g. the type of batch farrowing (one-week- or three-week-rhythm) and the length of the suckling period (three, four or five weeks). If the user is unsure about certain input parameters, the simulator offers average / standard values for these inputs (e.g. average price per weight unit sow feed), also considering the country in which the farm is situated.

Background

The backbone of the PRRS Economic Simulator is a pig production model. This simulates the various processes throughout the different stages of pig production. It consists of three parts: (A) breeding, (B) nursery and (C) fattening. For each part, the production 'outputs' are calculated[1]. Subsequently, these outputs are utilized to calculate the costs and revenue of the particular farm part. By combining the costs and revenue for the breeding, nursery and fattening part, respectively, the different production systems, i.e. farm types, can be modelled. Figure 1 shows a flow diagram that reflects the production processes in the breeding part; Figure 2 shows the processes in the nursery part (those in the fattening part are similar and therefore not shown separately).

The biological impact of PRRS on the production processes (see Figure 1 & Figure 2) is incorporated in this general pig production model. In the breeding part, PRRS is assumed to lead to higher return-to-oestrus and abortion rates, fewer numbers of litters per sow per year, additional inseminations, fewer piglets born alive per litter, an increase in pre-weaning mortality and a reduced average weight at weaning, etc. Likewise, in the nursery and fattening part, PRRS causes an increased overall mortality, a decrease in the number of pigs produced, an increased feed conversion ratio (FCR) and decreased average daily gain (ADG), etc. All this causes a change in farm costs and revenue, including higher veterinary and labour costs or lower revenue for animals sold.

In order to assess the yearly loss due to PRRS on a PRRS-affected farm, costs and revenue of this farm are compared to the costs and revenue that would incur, if this farm was not affected by PRRS (PRRSV negative). The production outputs and related costs and revenue resulting from farm data entered by the user are compared to production outputs, costs and revenue that would result, if a farm was PRRSV negative or 'healthy'. The difference in costs and revenue then gives the farm's loss due to PRRS[2]. An example of these 'reference' or baseline values for an average negative farm in Germany are show in Table 1.

In the second part of the PRRS Economic Simulator, the benefit that a farm could expect is calculated for different intervention measures. These are:

- depopulation/repopulation (D/R)[3]
- close & roll-over (C&R)[4]
- test & removal (T&R)[5]
- mass vaccination of sows (MS)[6]
- vaccination of sows according to the status of reproduction (6/60)[7]
- mass vaccination of sows and vaccination of piglets (MS+piglets)[8]
- vaccination of sows (6/60) and vaccination of piglets (6/60+piglets)
- improvements in internal biosecurity (BSM)[9]
- combinations of vaccinations with BSM

Not all interventions work for every farm scenario. The applicability of each strategy depends on the farm type, herd stability, the seroprevalence in sows or the current vaccination protocol; e.g., elimination strategies are evaluated only for farms accommodating sows.

Figure 1. Production processes in breeding

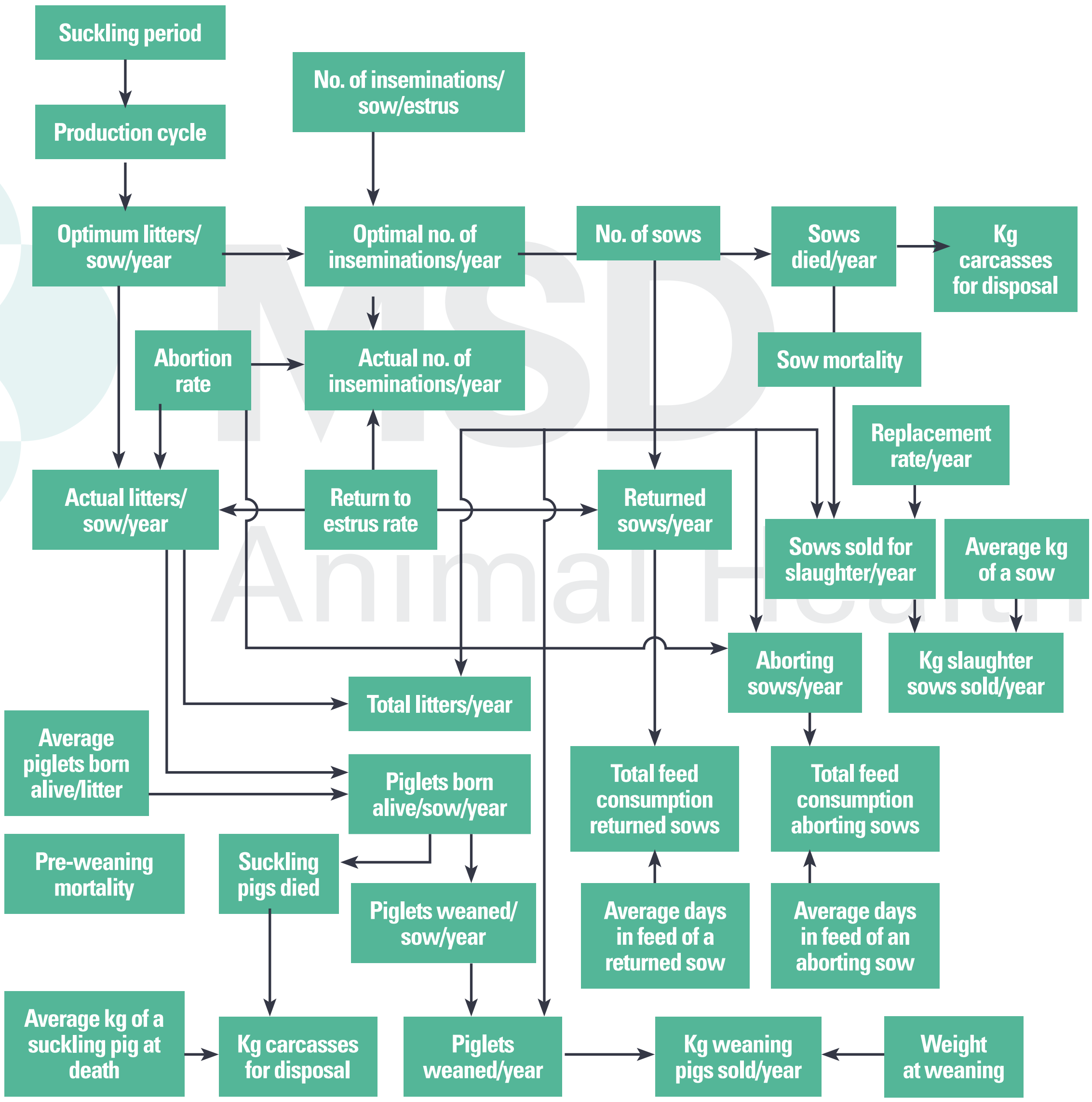
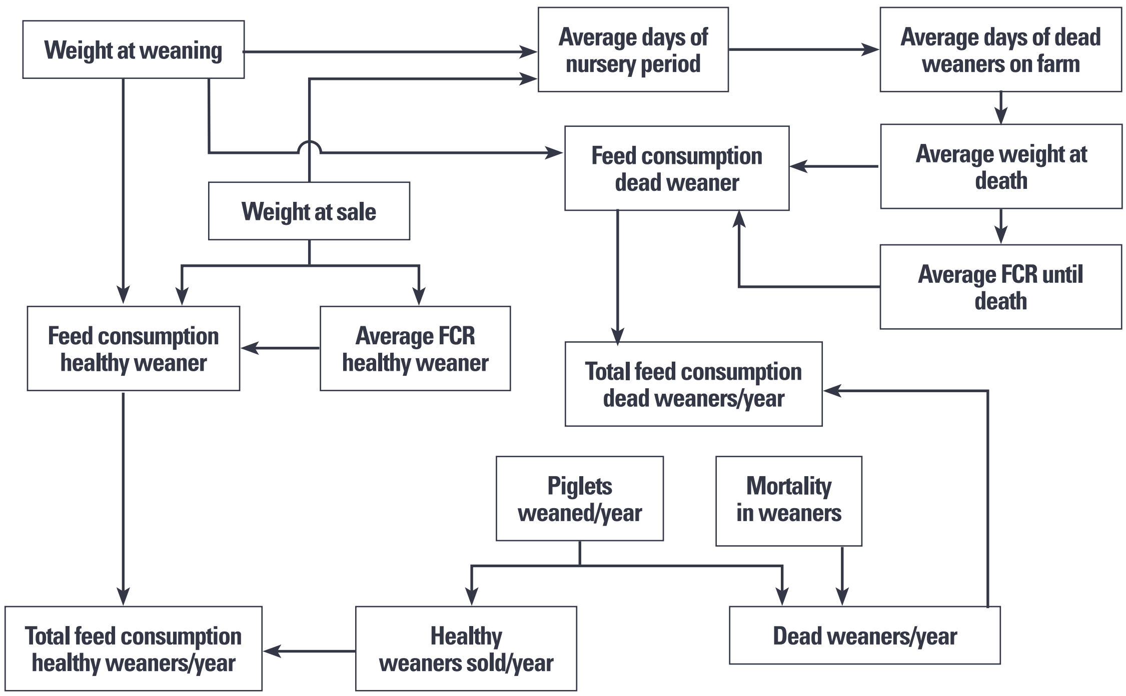


Figure 2. Production processes in nursery



Technically, for each intervention, the improvement on performance and production parameters is estimated[10] and the resulting costs and revenue compared to the costs and revenue of the status quo (i.e. if the farm did not change anything). Since some of the measures need some time to become effective, the result, the so-called 'expected value', is calculated over a period of **5 years**.

The data used in this simulator were obtained from different sources: Production and performance data of an average PRRSV negative farm[11] were retrieved from country-specific benchmarking reports. Data on the impact of PRRS on production and performance parameters as well as the improvement in these parameters achievable by the different intervention strategies was retrieved from literature and an expert poll[12].

As mentioned before, the simulator is a stochastic model: the model uses value distributions rather than fixed values for many of the input parameters (e.g. the degree of improvement of a given production parameter after a given intervention). The reason for this is to account for uncertainty and variability in inputs. The simulator calculates the final results by repeating the calculations many different times and taking their average or, more correctly, *median*. It also indicates the range in which 90% of the single calculations' result lie (called the *90% confidence interval*).

Example and interpretation of specific results / interventions

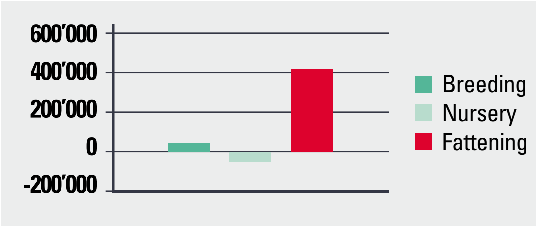
As an example, we look at a farrow to finish-farm based somewhere in Northern Germany:

- 1000 working sows
- no PRRS vaccination
- 1-weekly production rhythm
- 3 weeks of suckling
- 35% replacement rate per year
- 30 kg weight of pigs at end of nursery
- 120 kg live weight of pigs at finishing

The farm's production and performance data are indicated in Table 2. In all farm parts from breeding to fattening, moderate deviations from what should be expected in an average PRRSV negative farm are seen. Therefore, this farm can be viewed as moderately affected by PRRS.

For this farm, the economic simulator yields an estimated median annual loss of around € 440'000. As can be seen in Figure 3, the big parts of losses occur in the fattening, whereas there are even some costs saved in the nursery.

Figure 3. Median annual losses for the given farm example, indicated for each farm part

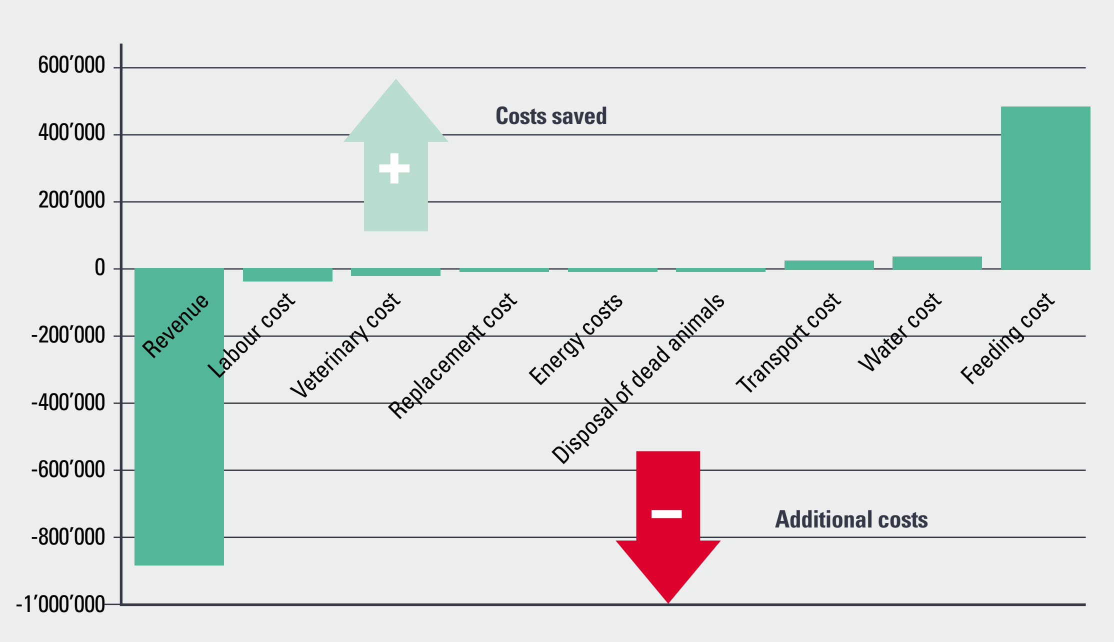


The reason for this finding can be concluded from another graph (Figure 4): The revenue for a fattening farm incurs when finishers are marketed. A lower number of finishers produced means lower revenue. On the other hand, since already the number of piglets weaned is reduced due to PRRS, this means fewer weaners (and fatteners) need feed, and therefore feed costs go down.

Table 1. Production and performance data of a farm example and baseline values if the farm was PRRS virus negative

	Parameter	Our example farm	'Reference' or baseline values (negative farm)
Breeding	Return-to-estrus rate %	↗ 13.5	10.0
	Abortion rate %	↗ 3.9	2.0
	Piglets born alive / sow / litter	↘ 11.4	12.7
	Pre-weaning mortality %	↗ 13.5	11.0
	Weight at weaning kg	↘ 5.5	6
Nursery	Days in nursery	↗ 50	45
	PRRS morbidity in weaners %	↗ 20.0	-
	Mortality in weaners %	↗ 10.0	3.0
Fattening	Days in fattening	↗ 127	119
	PRRS morbidity in fatteners %	↗ 20.0	-
	Mortality in fatteners %	↗ 3.0	1.5

Figure 4. Difference in individual costs occuring for the farm example as compared to the costs if the farm was negative.



For the presented farm, 'close & roll-over' has been simulated being the economically most efficient intervention strategy leading to the highest expected value over a 5 years period (Figure 5). However, the 90% confidence interval for this measure is also huge, reflecting the economic uncertainty of this method. In contrast, vaccination is expected to be similar efficient in terms of economic outcome and shows a notably smaller confidence interval, thereby being the more preferred method of choice.

Another point to consider is presented in Figure 6. As most of the measures require some upfront investment, the cash flow of every intervention strategy is simulated and displayed. Farmers having no possibility of significant investments at the beginning of the intervention can examine the cash flow during the 5 years and decide on a method that does not require financial assets.

Figure 5. Expected values of 12 different intervention strategies for the presented farm scenario. The blue bars indicate the median expected values over 5 years; the black error bars indicate the 90% confidence interval.

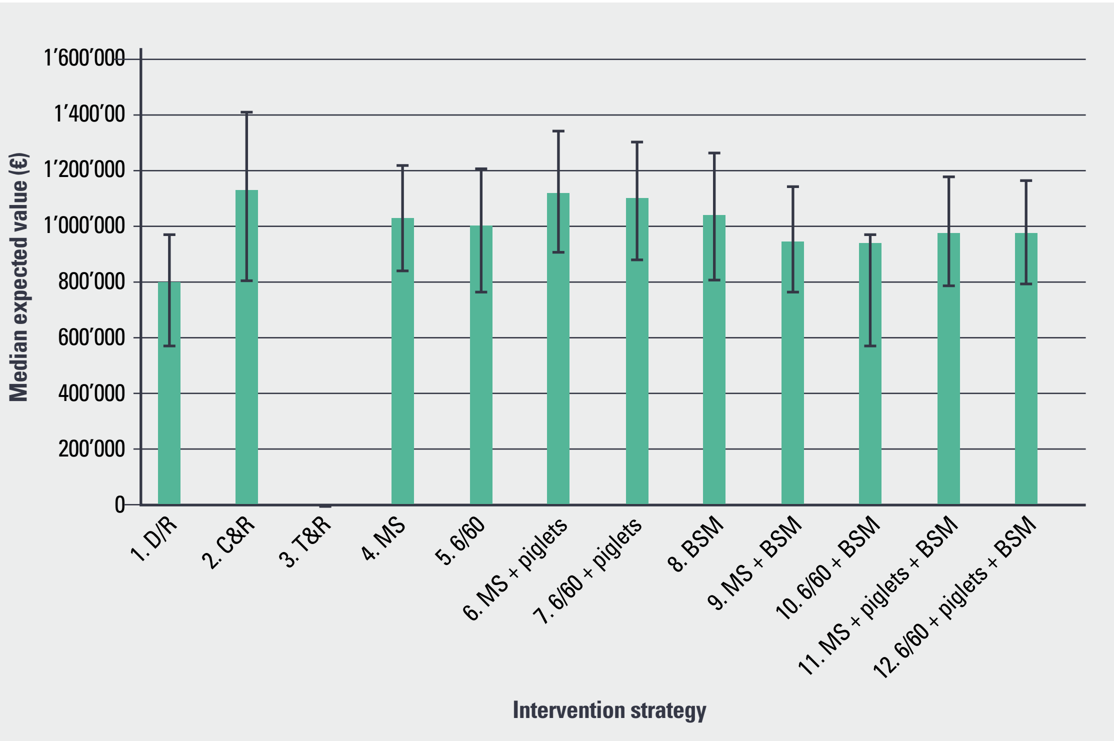
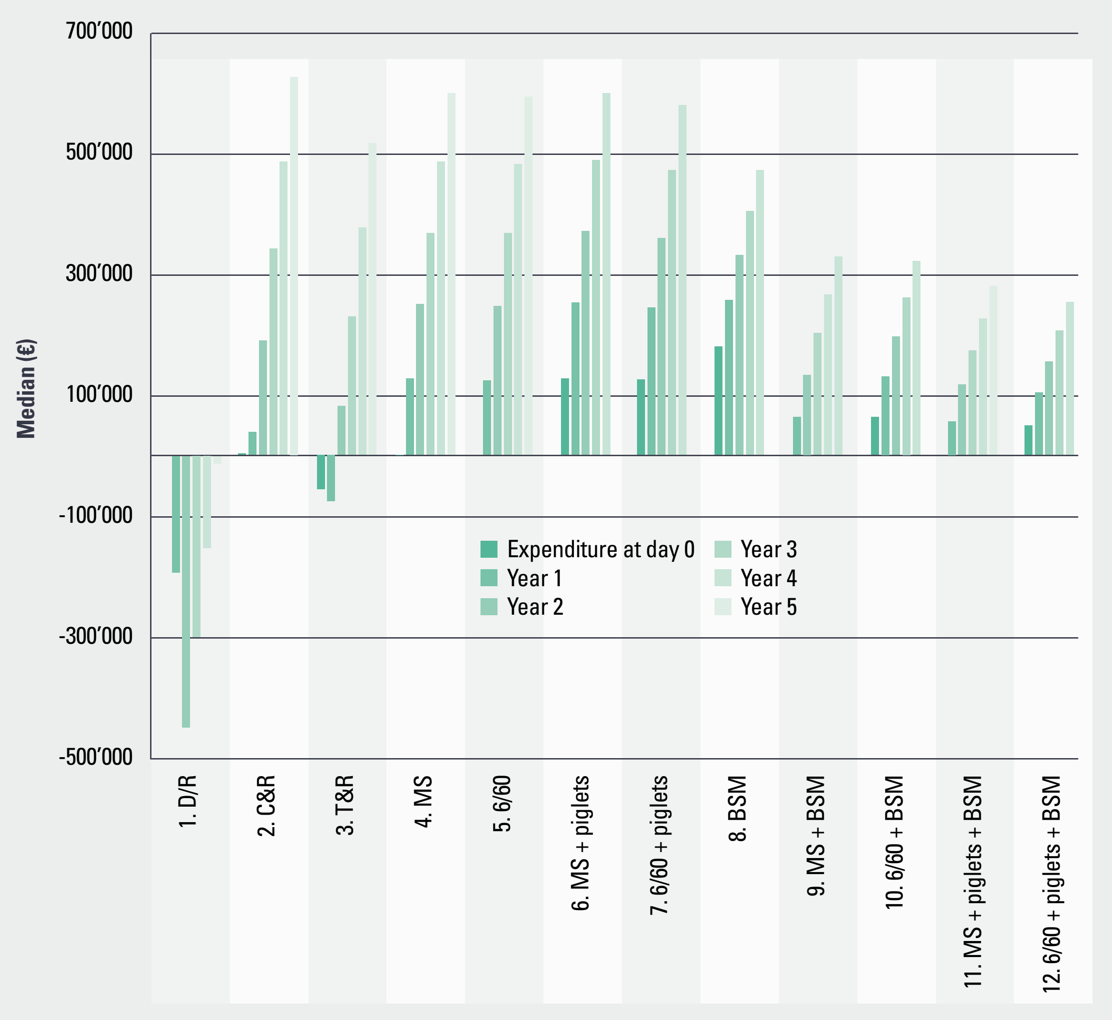


Figure 6. Cash-flow of 12 different intervention strategies for the presented farm scenario



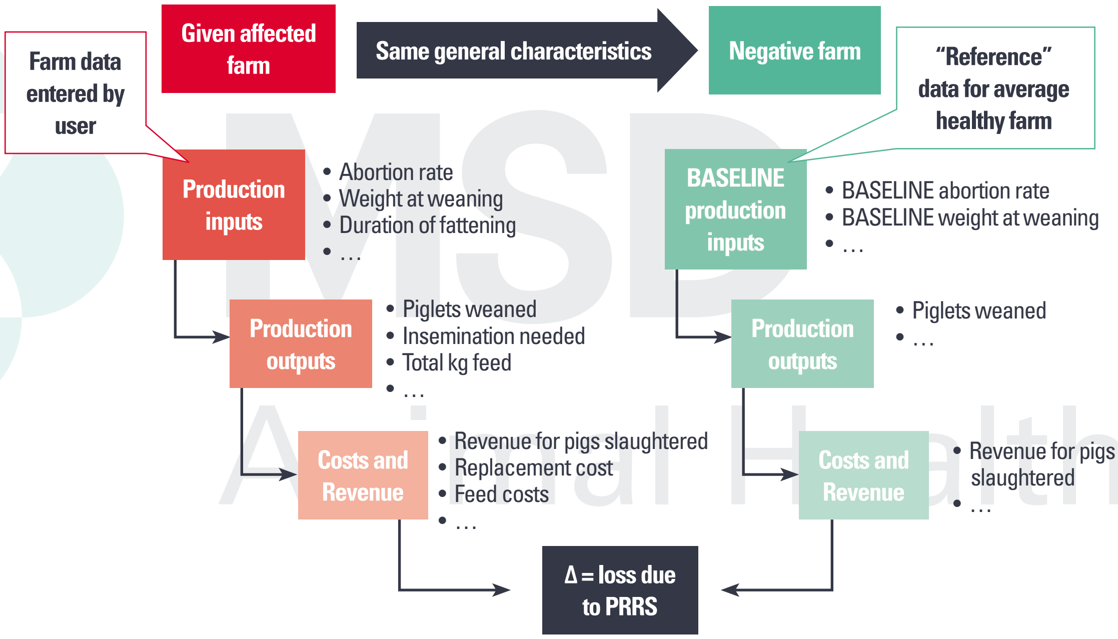
Do´s and don'ts

The PRRS Economic Simulator has been designed to estimate the financial losses due to PRRS and to evaluate the economic efficiency of different intervention strategies. The simulator does not substitute the veterinarian's advice regarding the biologically most logical intervention measure in a given farm setting. This means that thorough herd examination, assessment of risk factors, etc. is needed and results should be included in the decision making process.

The simulator also requires a best practise diagnosis of PRRS before used in a given farm. If other infections than PRRSV are causing the problems, the estimates will not be valid and the effect of interventions might be overestimated. Thus, the use of the diagnostic protocol for an appropriate PRRS diagnosis is highly recommended.

Finally, the simulator relies on the long-term efficiency of the interventions and does not consider the risk of (re-) introduction of PRRSV in a farm once the measures have been implemented. This means that eradication programs will only reach the expected values, when no re-infection occurs. If a farm is located in a densely pig-populated area, where most of the farms are endemically infected with PRRSV, then options of eradication might be inconvenient.

References

1. e.g. the total number of piglets, nursery pigs and fattening pigs produced and associated live weight sold, the number of piglets which died, the number of sows replaced, died, returned and aborting in a year and the total quantity of feed, water and artificial insemination doses used.
2. 

3. This comprises the slaughter or culling of all pigs present at the farm, followed by a restocking with PRRSV-negative animals
4. No introduction of new and thus naïve animals that for a period of 6 months
5. All adult animals in the herd are tested and all PRRSV seropositive animals are culled
6. All sows are vaccinated every 3 months
7. Vaccination of each sow 6 days after every farrowing and at day 60 of every gestation
8. Piglets are vaccinated once at day 12-21 after birth
9. BSM comprises a set of different measures that can be implemented, depending on the current situation on the farm. These could be:
   - strict all-in-all-out regime in farrowing, nursery and fattening units and proper cleaning and disinfection
   - appropriate gilt acclimatization
   - no cross-fostering of suckling pigs >24h after birth
   - change of injection needles at least between litters
   - facilities to separate sick animals from others
   - segregated early weaning
   - buy vaccinated weaners / fatteners
   - gilts/boars/semen from certified PRRS-negative sources
   - treat co-infections

   The herd attending veterinarian should be consulted to discuss the measures appropriate for the farm.
10. E.g. the percentage by which the current abortion rate, piglet mortality etc. are assumed to improve after implementing a certain vaccination protocol or improvement of biosecurity. For the elimination strategies, since the herd is assumed to become PRRSV negative, all production and performance parameters are set to their negative baseline values by default.
11. These baseline values for production and performance parameters were set at levels that should be achieved at minimum by any average PRRSV negative i.e. "healthy" farm.