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Economic evaluation of the eradication program for bovine viral diarrhea in the Swiss dairy sector

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ABSTRACT

Since 2008, the Swiss veterinary service has been running a mandatory eradication program for Bovine Viral Diarrhea (BVD) that is focused on detecting and eliminating persistently infected (PI) animals. Detection was initially based on antigen testing from ear tag samples of the entire cattle population, followed by antigen testing of all newborn calves until 2012. Since then, bulk milk serology (dairy herds) and blood sample serology (beef herds) have been used for the surveillance of disease-free herds. From 2008 to 2012, the proportion of newborn PI calves decreased from 1.4% to less than 0.02%. However, this success was associated with substantial expenditures.

The aim of this study was to conduct an economic evaluation of the BVD eradication program in the Swiss dairy sector. The situation before the start of the program (herd-level prevalence: 20%) served as a baseline scenario. Production models for three dairy farm types were used to estimate gross margins as well as net production losses and expenditures caused by BVD. The total economic benefit was estimated as the difference in disease costs between the baseline scenario and the implemented eradication program and was compared to the total eradication costs in a benefit-cost analysis. Data on the impact of BVD virus (BVDV) infection on animal health, fertility and production parameters were obtained empirically in a retrospective epidemiological case-control study in Swiss dairy herds and complemented by literature. Economic and additional production parameters were based on benchmarking data and published agricultural statistics. The eradication costs comprised the cumulative expenses for sampling and diagnostics. The economic model consisted of a stochastic simulation in @Risk for Excel with 20,000 iterations and was conducted for a time period of 14 years (2008–2021).

The estimated annual financial losses in BVDV infected herds were CHF 85–89 per dairy cow and CHF 1337–2535 for an average farm, depending on the production type. The median net present value (NPV) was estimated at CHF 44.9 million (90% central range: CHF 13.4 million–69.4 million) and the break-even point to have been reached in 2015. Overall, the outcomes demonstrate that the Swiss BVD eradication program results in a net benefit for the dairy sector. These findings are relevant for planning similar BVD control programs in other countries.

1. Introduction

Bovine viral diarrhea virus (BVDV), a *Pestivirus*, is endemic in cattle populations worldwide, including various European countries, and causes substantial economic losses. These losses result from decreased outputs due to reduced milk production, lower reproductive performance, reduced weight gain, increased mortality, premature culling as well as increased expenditures for veterinary services (Houe, 2003). Different studies show herd-level economic losses between €21–135 per cow (Fourichon et al., 2005; Heuer et al., 2007; Houe, 2003; Lindberg et al., 2006; Valle et al., 2005). Infections with BVDV may either lead to transiently infected or persistently infected (PI) animals, depending on the time of infection (Lanyon et al., 2014). Persistently infected animals are generated from intrauterine infections in an early stage of gestation, are immunotolerant against BVDV, and shed large quantities of virus

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throughout their lives. Therefore PI animals represent the main source for spreading the virus to naïve animals.

Several European countries implemented either mandatory or voluntary BVD surveillance and control programs (Pinior et al., 2017). The Swiss BVD eradication program has been running since 2008 and is mandatory for the entire cattle population (Presi and Heim, 2010). It is focused on detecting and eliminating PI animals and is divided into three different phases: (i) the initial phase in 2008 when the entire cattle population was ear-notched and antigen tested, (ii) the calf phase with antigen testing of all newborn calves from October 2008 to December 2012, and (iii) the surveillance phase with serological testing of disease-free herds via bulk milk (dairy herds) and blood sample (beef herds) analyses since 2012. The results from the census in the initial phase showed that 0.8% of animals and 20.0% of farms were virus positive (Presi et al., 2011). From 2008 to 2012, the proportion of newborn PI calves decreased from 1.4% to less than 0.02% (FSVO, 2016a). However, complete eradication of BVDV in Switzerland has not yet been achieved. In 2015, a total of 111 farms (0.2%) newly infected through PI animals have been reported (FSVO, 2016b). This resulted in an adaptation of the eradication program and the implementation of intensive investigations in newly infected farms, including tracing of all contacts with other herds.

Häsler et al. (2012) conducted an economic analysis of the Swiss BVD eradication program and reported baseline disease costs for the entire cattle sector of CHF 16 million in 2008 and that the break-even point would be reached five years after the start of the program. However, their estimations of the benefits relied largely on data from scientific literature and epidemiological models. Furthermore, the authors predicted that complete eradication would have been achieved in 2012. Hence, as new cases of PI animals continue to occur and eradication costs have surpassed initial predictions, the question was raised whether the program is still economically beneficial.

The aim of this study was to perform a benefit-cost analysis (BCA) of the BVD eradication program for the Swiss dairy cattle sector for the time period of 2008–2021. Specifically, the aims were (i) to estimate the benefits and costs of the eradication program in the dairy sector from 2008 to 2021, (ii) to determine the break-even point of the program, and (iii) to assess the net economic value of the BVD eradication program. The analysis took into account the most recent data and adjustments of the eradication program and was supported with empirical data from a recent epidemiological case-control study in Swiss dairy cattle herds.

2. Materials and methods

2.1. General overview and baseline scenario

The benefit of eliminating BVD from the Swiss dairy sector was compared with the total eradication expenditures in a BCA. The analysis included four main components: (i) production models combined with (ii) gross margin (GM) analyses for the benefit estimation; (iii) surveillance and control costs, and (iv) epidemiological case investigations (ECI) expenditures for the overall cost estimation.

The BCA was a combination of *ex post* and *ex ante* analysis. It was conducted for a time period of 14 years: from the start of the eradication campaign in 2008 until the expected end of the campaign in 2021, when complete elimination of BVDV infections was assumed to be reached. This assumption was based on discussions with senior officials responsible for the implementation of the program. The models were developed in MS Excel (Microsoft Corp., Redmond, WA) and the BCA was conducted as a stochastic simulation with the add-on @Risk 7 (Palisade Corp., Ithaca, NY), which allowed for variation of uncertain input variables, and was performed with 20,000 iterations. The built-in @Risk sensitivity analysis tool was used to assess the impact of uncertain input values on the outputs.

Table 1
Farm characteristics of the 3 production types and input data used to estimate Bovine Viral Diarrhea (BVD) disease costs.

Production type	Extensive	Medium	Intensive
Milk yield (kg/305d)	6000	7000	8000
Milk specification	organic	raw milk cheese	standard
Milk price (CHF/kg)	0.78	0.69	0.58
Herd size (n)	15	20	30
Forages			
Grass (%)	52	55	53
Hay (%)	18	45	17
Grass silage (%)	15	–	15
Corn silage (%)	15	–	15
Concentrates (kg/d)	0.8	2.9	2.5

All monetary values were expressed in Swiss Francs, CHF (CHF 1 = US$0.99 at the time of analysis). The start of the program in 2008 was set as reference point and all future benefits and costs were converted into present values and discounted at a rate of 2%. The discount rate was estimated using the mean yield on Swiss Confederation long term (20 years) bond issues from 2008 to 2015 (SNB, 2016a) subtracted by the mean change in consumer prices (SNB, 2016b) for the same time period. Economic key figures, namely net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR), were then calculated as described by Rushton et al. (1999).

The situation at the start of the BVD eradication program was chosen as a baseline scenario and compared with the intervention. For the baseline scenario, the estimated BVDV herd-level prevalence of 20% and a calculated within-herd prevalence of 7% (mean number of virus positive animals per herd: 1.6) derived from the census in the initial phase were used (Presi et al., 2011). As the reported animal-level virus prevalence (0.81%) was similar to the situation in 2000 (0.64%; Rüfenacht et al., 2000), a situation of endemic disease equilibrium was assumed. For the prevalence during the eradication program, the number of case farms with PI animals was obtained from the information system for cases of notifiable diseases (FSVO, 2016c). The future number of cases was predicted using expert opinion. The experts were two specialists (E. Di Labio, H. Schwermer; Federal Food Safety and Veterinary Office, FSVO) with long standing experience and senior roles in the Swiss BVD eradication program. Poisson distributions were fitted to the mean number of cases per year predicted by the experts to account for uncertainty of these values. Demographic characteristics of the Swiss dairy sector were obtained from the annual reports on dairy production published by the Federal Office for Agriculture (FOAG) for the years 2008–2015. At the start of the eradication program in 2008, there were 28,014 registered dairy farms in Switzerland, with an average herd size of 20 dairy cows, accounting for an average annual milk production of 114,000 kg/farm (FOAG, 2009). Further input variables on production and disease impact are described in detail below.

2.2. Production models and gross margin analyses

The production models were developed for three main production types based on Swiss benchmarking data (AGRIDEA, 2012; FOAG, 2009): (i) 50% extensive, (ii) 30% medium, and (iii) 20% intensive farms, respectively. Key differentiating variables between the production types were the milk yield and the general farming type: organic dairy production, dairy production for raw milk cheese making with silage-free feeding and standard dairy produc-