



FMD introduction in densely populated areas: evaluation of the costs of different control strategies

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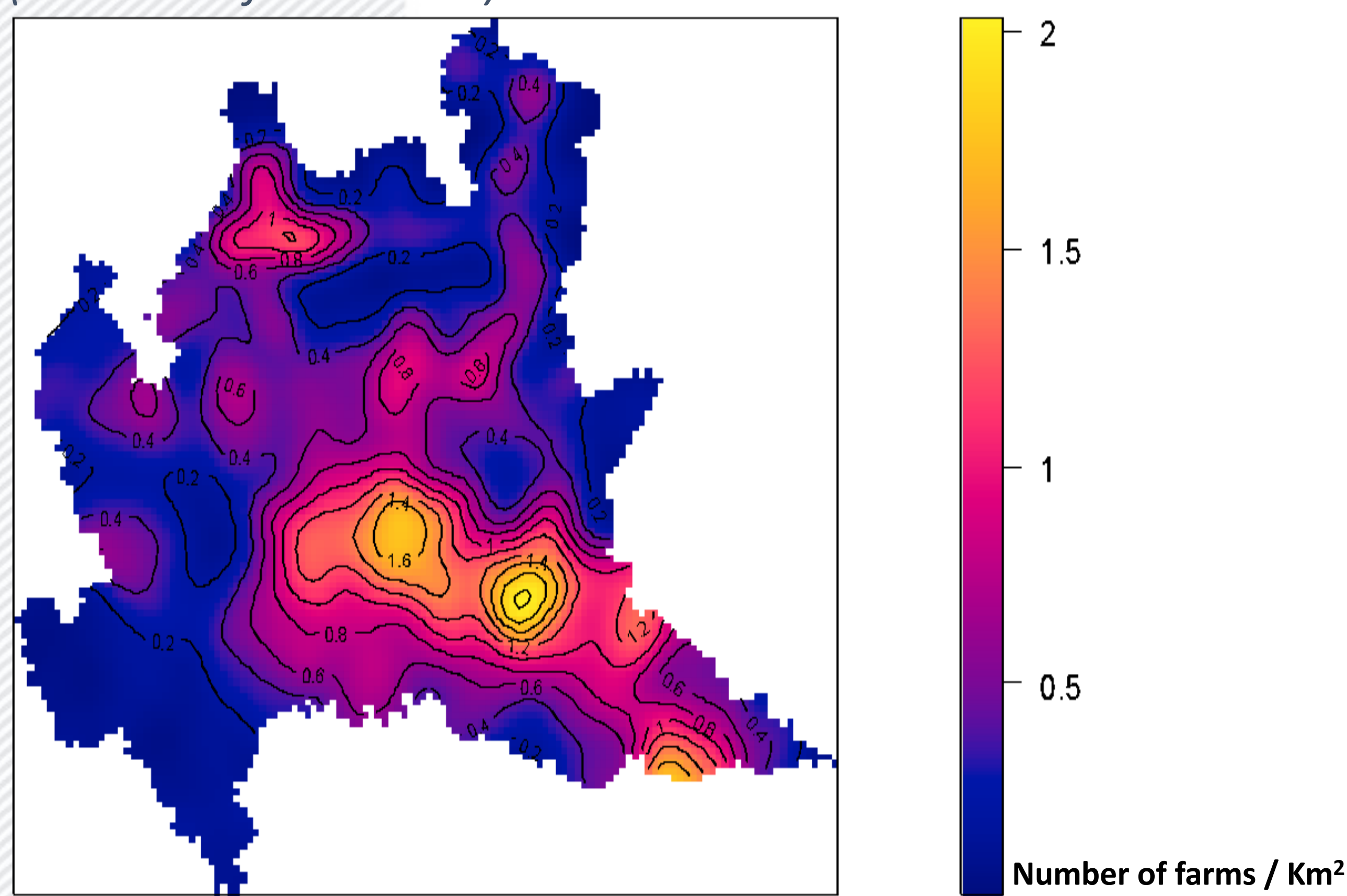
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Introduction

The structure and density of FMD susceptible population species are crucial for disease spread and, in turn, for the choice of the control strategy to apply.

The aim of this study was to compare the effectiveness and the cost of different FMD disease control options in containing FMD outbreak in a livestock densely populated area of Northern Italy and to estimate the relative economic resources necessary to achieve outbreak control.

Figure 1. Smoothed heat map of farm density in Lombardy Region (cloven hoofed animals)

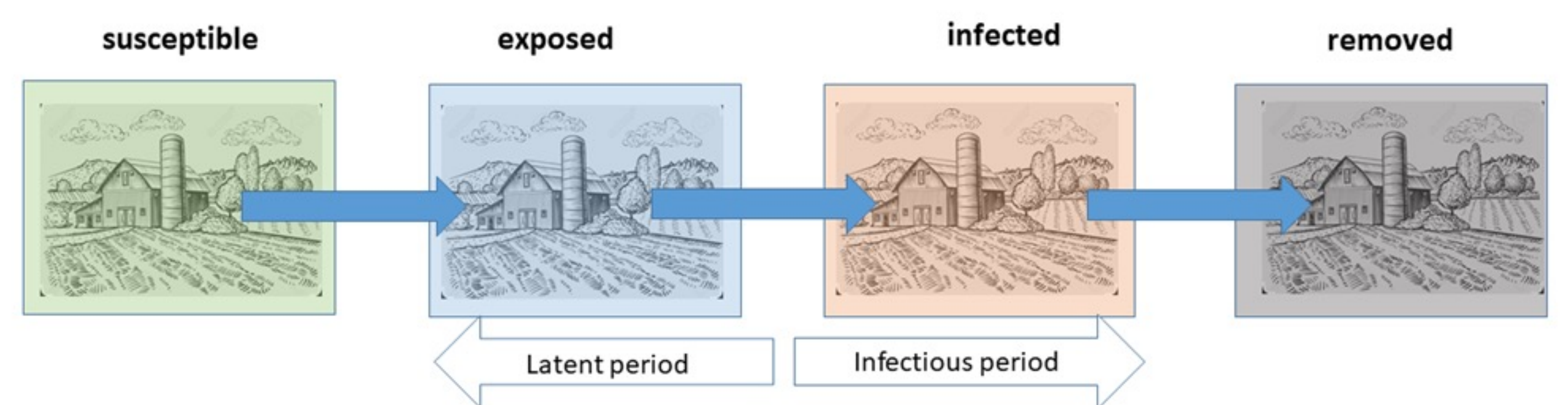


Method

Culling infected and at-risk animals (SO), pre-emptive culling (PC) and protective vaccination (VACC) within 5 km radius from the outbreak were the strategies compared using an agent-based, stochastic, computational model.

FMD transmission parameters were based upon a kernel function considering distance among herds and upon herd attributes, such as animal species and herd size. The uncertainty of between-herd transmission were modelled by Beta distributions. Vaccination efficacy was set at 40%.

Figure 2. SEIR model



The estimate of the cost of the different control options were calculated taking into consideration (Marschik et al., 2021):

1. Culled animal compensation
2. Cleaning and disinfection of the farm and animal disposal
3. Surveillance
4. Personnel
5. Vaccination

Results

The outcome of the model showed that SO is unable to control the FMD outbreak, the number of infected farms steadily increases till the end of the simulation period.

PC, which foresees the preventive culling of 50 farms, can slow down disease spread and is associated with the highest cost (€ 211,809,370), followed by SO (€ 187,647,673) and VACC (€ 50,705,079). VACC appears to be the most cost-effective option with an expense of 24% and 27% compared to SO and PC, respectively.

At the end of the simulation period 571, 689 and 99 farms are culled under the SO, PC and VACC scenario. Compensation due to culling has the highest impact on the cost of all scenarios considered accounting for 78.4% for SO, 79.6% for PC and 47.7% for VACC.

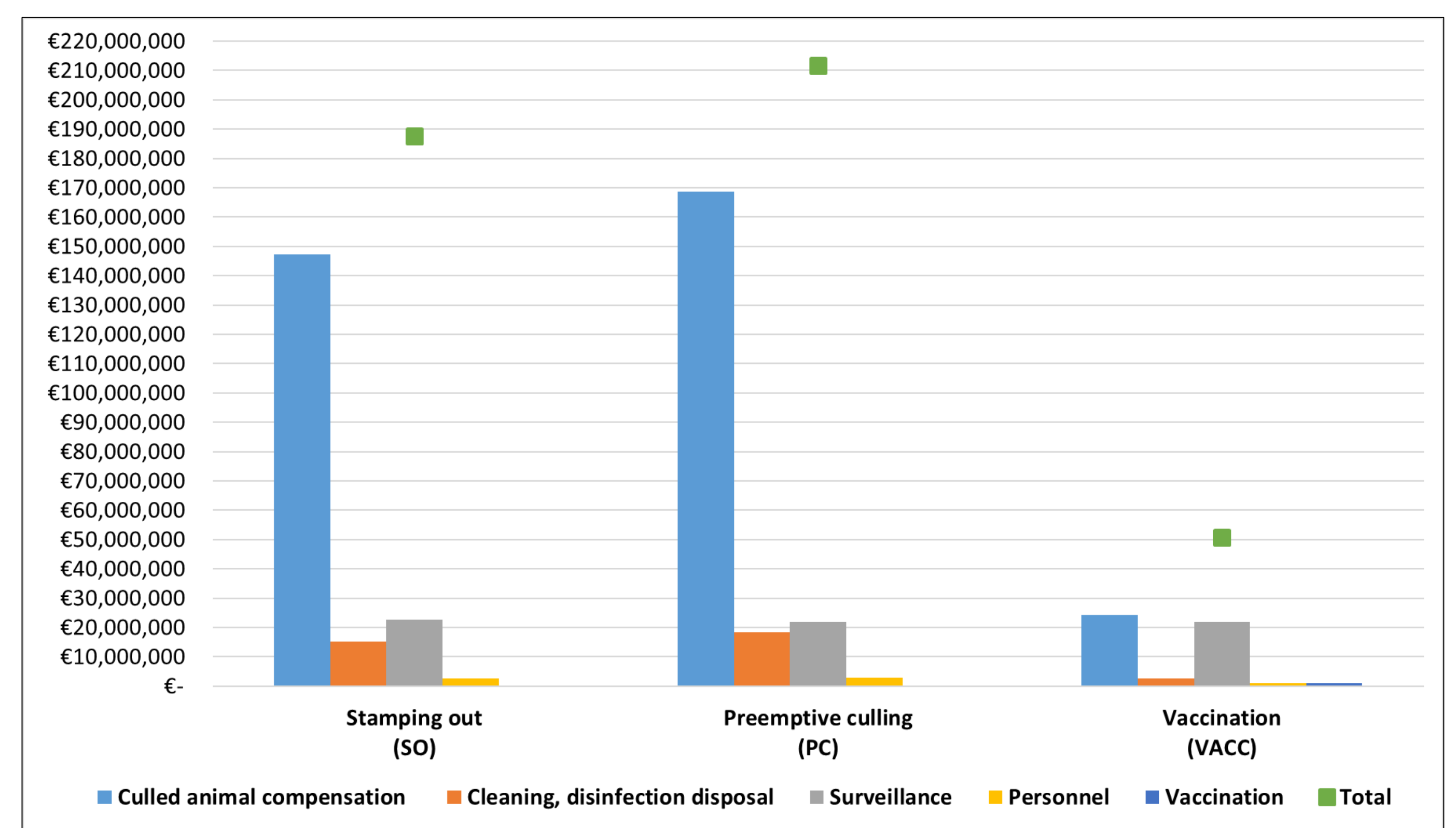
The surveillance is the second most expensive activity with comparable costs across all scenarios: SO (€ 22,602,080), PC (€ 21,851,080) and VACC (€ 21,841,280).

Cleaning and disinfection disposal have costs proportional to the number of culled farms with an expenditure of € 15,217,224 (SO), € 18,385,198 (PC) and € 2,640,004 (VACC).

Such activity does not appear to be an economical constraint accounting for 8.1% in the case of SO, 8.7% for PC and 5.2% for VACC of the total cost of each intervention strategy.

Figure 3. Table and histogram of results of SO, PC and VACC scenario

Costs	Stamping out (SO)	Preemptive culling (PC)	Vaccination (VACC)
Culled animal compensation	€ 147,189,546	€ 168,554,800	€ 24,206,170
Cleaning, disinfection disposal	€ 15,217,224	€ 18,385,198	€ 2,640,004
Surveillance	€ 22,602,080	€ 21,851,080	€ 21,841,280
Personnel	€ 2,638,824	€ 3,018,292	€ 1,127,203
Vaccination	€ -	€ -	€ 890,423
Total	€ 187,647,673	€ 211,809,370	€ 50,705,079



Conclusions

In livestock densely populated area, vaccination proves to be an effective control strategy as already demonstrated in previously developed simulation study of FMD epidemic (Roche et al., 2015). This is also due to the highest impact that culling compensation has on the cost. Vaccination strategy reduces the number of culled animals and, in turn, decreases the total cost. The benefit of vaccination compared to PC should be weighted with the longer restrictions to regain FMD free status and consequently access to market.



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