Effectiveness of tactical and strategic measures to prevent classical swine fever introduction into the Netherlands

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Abstract

Introduction of classical swine fever virus (CSFV) is a continuing threat to the pig production sector in the Netherlands and can have major economic consequences. Reducing the probability of CSFV introduction (P_{CSFV}) by preventive measures is therefore of utmost importance. Preventive actions can either aim at reducing the number of risk factors (strategic measures) or at reducing the P_{CSFV} per risk factor (tactical measures). The objective of this study was to compare the effectiveness of both types of measures in reducing the annual P_{CSFV}. For this purpose, the reduction of the annual P_{CSFV} achieved by a selected set of measures was calculated using a scenario tree model for CSFV introduction. Results showed that the strategic measure resulting in integrated chains of pig farms located on 'industrial parks' was most effective. Separation of national and international transport of pigs was the most effective tactical measure. Only the hypothetical scenario in which both pig imports and exports were reduced by 90% was more effective than these measures.

Introduction

Recent history has demonstrated that classical swine fever (CSF) epidemics can incur high economic losses, especially for exporting countries that have densely populated pig areas and apply a strategy of non-vaccination, such as the Netherlands. Introduction of CSF virus (CSFV) remains a continuing threat to the pig production sector in the Netherlands. Sporadic outbreaks continue to occur in the domestic pig population of the European Union (EU). Besides, CSF is endemic in some of the European wild boar populations, representing a permanent CSFV reservoir. Reducing the annual probability of CSFV introduction (P_{CSFV}) by preventive measures is therefore of utmost importance. In principle, the annual P_{CSFV} is determined by (i) the occurrence of CSF worldwide, (ii) the presence and number of risk factors, and (iii) the P_{CSFV} per risk factor. Changing the CSF situation in the countries of origin is difficult, although the Netherlands has some influence through, for example, the standing veterinary committee (SVC) of the EU. Preventive actions can thus either be directed at the number of risk factors (strategic measures) or at the P_{CSFV} per risk factor (tactical measures). The objective of this study was to compare the effectiveness of tactical and strategic measures in reducing the annual P_{CSFV}.

Material and methods

Scenario tree model

To obtain more quantitative insight into the main risk factors for CSFV introduction into the Netherlands a computer model was developed. This model calculates the annual P_{CSFV} based on the contribution of (a) risk factors for CSFV introduction (defined as carriers and mechanisms that can transmit the virus from an infected to a susceptible animal) and (b) the possible countries from where CSFV introduction might originate (countries of origin). All 15 EU member states were included as such[1]. Risk factors included in the model are import of pigs (subdivided into three subgroups: piglets, breeding pigs, and fattening pigs), import of pork products (subdivided into four subgroups: fresh/chilled, frozen, non-heat-treated, and heat-treated), returning livestock trucks, and

[1] The research described was carried out before the enlargement of the EU by 10 new member states on May 1, 2004.

contacts with wild boar (subdivided into direct and indirect contacts). Calculations in the model are based on the principles of the scenario pathway approach (Vose, 1997). More details on the model can be found in De Vos et al. (2004).

The scenario tree model is a stochastic model taking into account the inherent variability of CSF epidemics in the countries of origin. Probability distributions were used for the input parameters describing these epidemics. Model calculations were iterated using Latin Hypercube Sampling (LHS), resulting in a probability distribution for each output parameter. The model was constructed in Microsoft Excel 97 with the add-in programme @Risk 4.5.2 (Palisade Corporation, 2002).

Default calculations based on 2003 trade figures indicated that the mean annual P_{CSFV} into the Netherlands is 0.040, indicating that the Netherlands can expect CSFV introduction on average once every 25 years. However, the annual P_{CSFV} can be as low as $6.2x10^{-4}$ and as high as $3.5x10^{-1}$. Returning livestock trucks contribute most to the annual P_{CSFV} with about 50%. The most likely sources of CSFV introduction into the Netherlands are Germany, Belgium, and Spain (De Vos et al., 2005).

Selection of preventive measures

The results of the default calculations were used to make a first selection of preventive measures. Then experts on CSF and/or the Dutch pig production sector were asked for their opinion on how realistic and effective the selected measures would be. This ultimately resulted in six tactical measures and two strategic measures. Most of the tactical measures were directed at mitigating the risk of returning livestock trucks, as this risk factor contributes most to the annual P_{CSFV} into the Netherlands. An overview of all preventive measures is given in Table 1. Furthermore, scenario tree model calculations were performed to explore the effectiveness of hypothetical strategic measures that reduced the imports or exports of live pigs by either 50% or 90%, or both imports and exports by either 50% or 90%.

Table 1 Overview of preventive measures

Abbreviation	Description	Type
LT_C&D	Cleansing and disinfection of all returning livestock trucks	Tactical
LT_N&I	Separation of national and international transport of pigs	Tactical
LT_CONT	Livestock trucks with detachable containers	Tactical
PF_S&D	Separate supply and delivery routes on primary farms	Tactical
SL_LOG	Logistic supply of fattening pigs at slaughterhouses	Tactical
IMP_TEST	Testing piglets and breeding pigs by a quick and reliable PCR	Tactical
STR_PARKS	Integrated chains of pig farms located on 'industrial parks'	Strategic
STR_DENSITY	Reduced pig density by diminishing the number of fattening pigs kept	Strategic

Results

In Fig. 1 the cumulative density function (cdf) for the overall annual P_{CSFV} into the Netherlands is shown for the default scenario and when each of the preventive measures is applied. In most iterations, the P_{CSFV} is highest for the default scenario, i.e. when no additional preventive measures are applied. However, in worst-case scenarios (cumulative probability • 0.9), STR_DENSITY results in a higher annual P_{CSFV}. This strategic measure might thus result in an increased risk of CSFV introduction, which can be attributed to the increased number of piglets exported when implementing this measure. STR_PARKS, on the contrary, is most effective in reducing the annual P_{CSFV}. LT_N&I is the most effective of all tactical measures. LT_C&D and LT_CONT are equally effective up till about the 0.85 percentile, but differ in their effectivity with regard to worst-case situations; then LT_C&D is more effective. SL_LOG and IMP_TEST are equally effective and attain only a small reduction in P_{CSFV} compared with the default scenario.

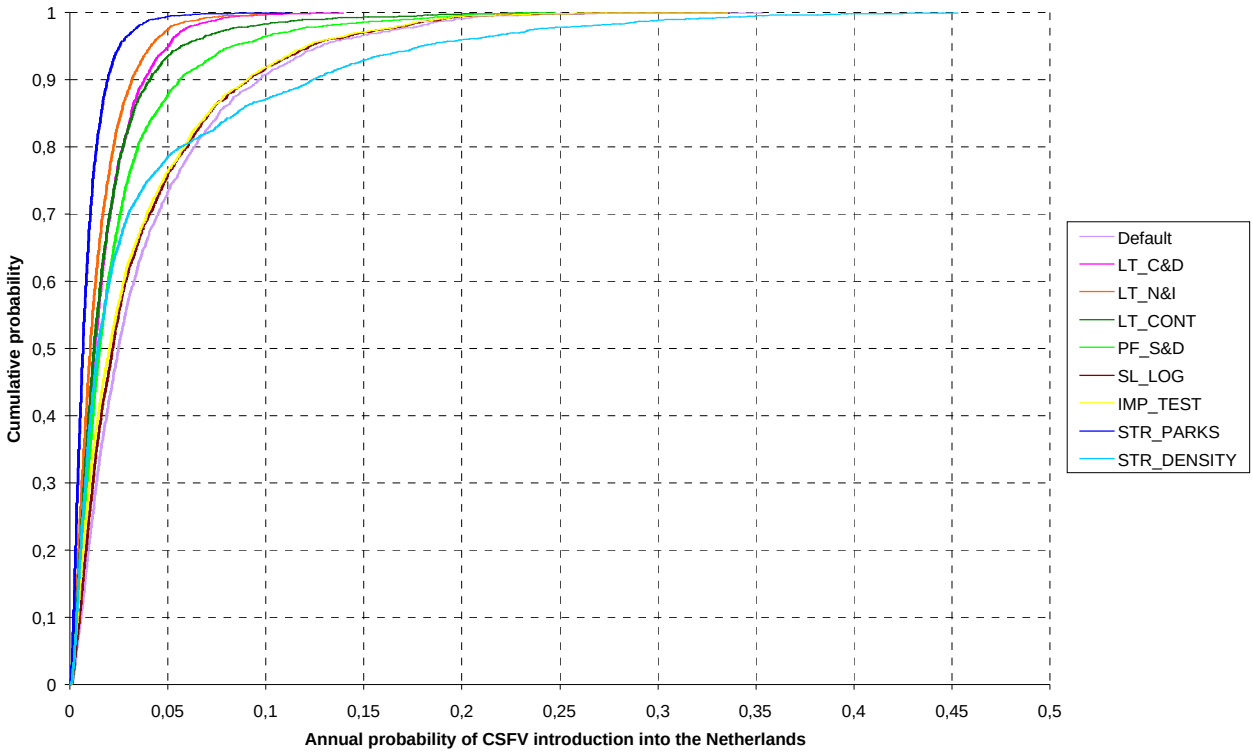

Figure 1 Cumulative density function of the annual probability of CSFV introduction into the Netherlands for the default scenario and when applying six tactical and two strategic measures aimed at preventing the introduction of CSFV into the country.

In Fig. 2 the cdf for the annual P_{CSFV} into the Netherlands is shown for the default scenario and when each of the hypothetical strategic measures resulting in reduced imports and/or exports of pigs is applied. For comparison purposes also the cdfs of the most effective tactical and strategic measures (LT_N&I and STR_PARKS, respectively) are shown. It is evident that for worst-case scenarios (cumulative probability • 0.9) reducing the imports of live pigs only (IMP_50 and IMP_90) is less effective than reducing the exports of live pigs only (EXP_50 and EXP_90). With respect to median values (cumulative probability = 0.5), however, EXP_50 is only slightly more effective than IMP_50. Reducing both imports and exports of live pigs by 90% (TOT_90) is by far the most effective measure and is the only hypothetical measure that is more effective than STR_PARKS.

Discussion

Tactical preventive measures reduce the P_{CSFV} per risk factor and most of them can be implemented on short or medium term. Strategic preventive measures, on the other hand, reduce the number of risk factors present and require structural changes in the Dutch pig production sector. Such changes cannot be enforced by legislation, but should be realised by the sector itself. Implementation of these measures requires a long time span and involves irreversible processes. This modelling study indicates, however, that reorganising the Dutch pig production into integrated chains of pig farms located on 'industrial parks' can be worthwhile with respect to the risk of CSFV introduction. Furthermore, this measure will have a large impact on the spread of CSFV after introduction and hence the size and cost of future epidemics. And, what is more, this strategic measure will not only change the probability and consequences of CSFV introduction, but also the risk of other contagious diseases, such as foot-and-mouth disease, swine vesicular disease, and Aujeszky's disease.

From a decision-maker's point of view, tactical preventive measures might, however, be preferred as these can be enforced by legislation and leave more flexibility to react to future changes in the risk of CSFV introduction. Separation of national and international transport of pigs was the most effective of all tactical preventive measures. When deciding on preventive measures, the cost of their implementation is, however, equally important for decision-makers. The cost of tactical measures was calculated by De Vos et al. (2005). Results indicated that IMP_TEST had the highest cost-effectiveness ratio for median values of the annual P_{CSFV}, whereas LT_N&I was by far the most cost-effective measure for 0.95 percentile values of the annual P_{CSFV}. Estimating the cost incurred by structural changes in the pig production sector, as required for strategic preventive measures, is rather complicated. It is likely that, on short term, costs of strategic preventive measures will be relatively high due to necessary new investments. On the long term, however, these measures can even result in reduced costs due to, for example, fewer pig transports. Preliminary calculations for STR_PARKS indicate, however, that the annual cost of this measure after the transition stage is still three to seven times higher than the annual cost of LT_N&I.

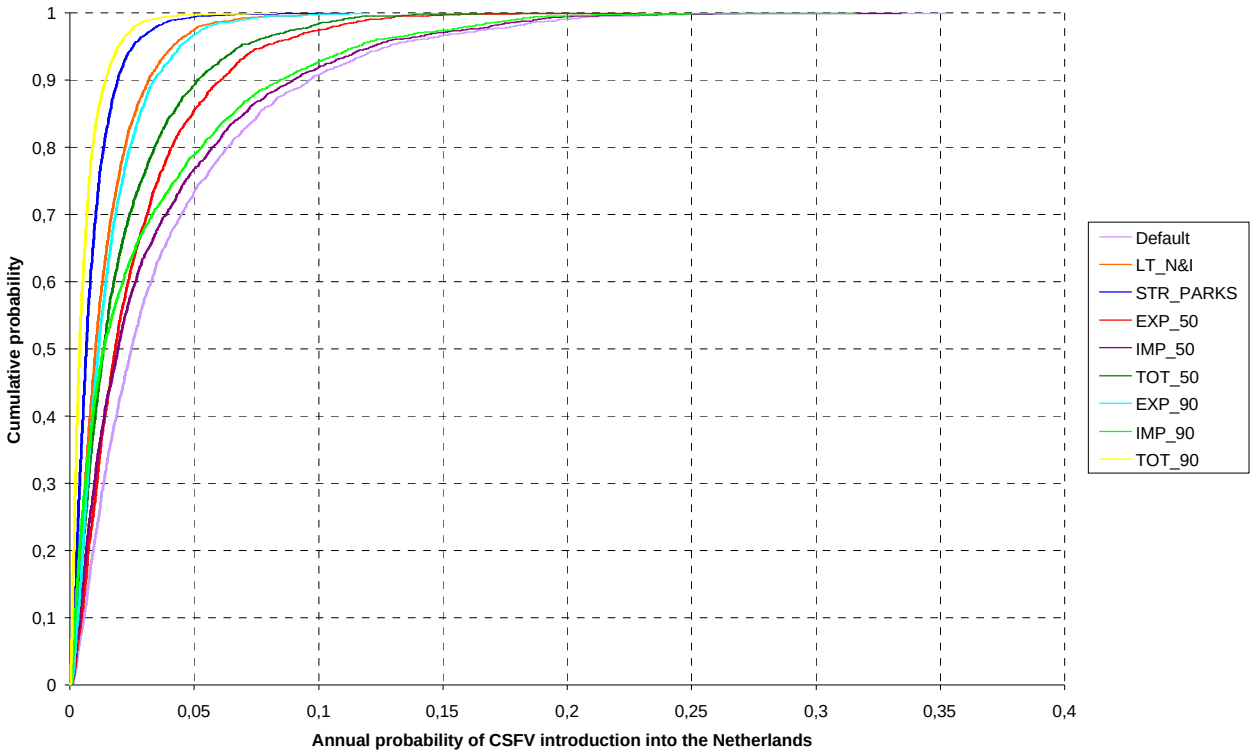

Figure 2 Cumulative density function of the annual probability of CSFV introduction into the Netherlands when imports or exports of pigs, or both imports and exports are reduced by either 50% or 90%. For comparison also the default scenario and the most effective tactical and strategic measures are shown.

Conclusions

Large differences were observed in the effectiveness of preventive measures. The strategic measure resulting in integrated chains of pig farms located on 'industrial parks' appeared to be most effective in reducing the annual P_{CSFV} into the Netherlands, whereas the strategic measure resulting in a lower pig density by diminishing the number of fattening pigs kept was least attractive of all measures simulated. A separation of national and international transport of pigs was the most effective tactical measure. Only the hypothetical scenario in which both pig imports and exports were reduced by 90% was more effective than the 'best' strategic and tactical measure.

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