An Analytical Framework for Discussing Farm Business Interruption Insurance for Classical Swine Fever

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Epidemics of Classical Swine Fever (CSF) can have very large, devastating financial consequences. Recent CSF-epidemics in Europe include epidemics in Belgium (1990 and 1993/94), Germany (1993/94), Spain and the Netherlands (1997/98), and (again) Germany (1999) (Office International des Epizooties, and OIE-internet site). The financial consequences of the CSF-epidemic in the Netherlands were the highest so far totaling US $2.3 billion (Meuwissen et al.). Part of these losses were borne by governments. However, business interruption losses (US $247 million) had to be completely borne by farmers. As a result, many affected farms were close to bankruptcy. Some farmers would even have gone bankrupt if banks and other financiers had not been willing to work with them.

We study the feasibility of business interruption insurance for Classical Swine Fever to protect farmers against such financial disasters in the future. Meuwissen, Huirne and Hardaker found that farmers perceive the risk of epidemics as a very important source of risk and that farmers are interested in buying insurance protection against losses caused by epidemics.

In discussing insurance for Classical Swine Fever, an important issue is the little information available about the size of risk. This study provides such insight by a detailed Monte-Carlo simulation model. The model is partly based on insights provided by existing (epidemiological and financial) models (Horst et al., 1999a, Jalvingh et al., Meuwissen et al., and Nielen et al.).

Published literature on insuring losses from livestock epidemics is scarce. Available work by Davies, and Howe and Whittaker is only qualitative and refers to direct costs instead of business interruption losses.

This paper begins with a short background on livestock epidemics (control measures, loss factors, compensation by government). Then the structure and results of the Monte-Carlo simulation model are described, followed by a range of issues that need to be considered when introducing a business interruption insurance for epidemics. The last sections include the discussion and conclusions respectively.

Background

Livestock epidemics in the European Union of so-called 'List-A diseases' (Office International des Epizooties), such as Classical Swine Fever, are controlled by stamping-out infected herds, pre-emptive slaughter of contact herds, and by immediately establishing surveillance zones around such herds. In these zones, animal movements are restricted and to a large extent prohibited. Depending on the severity of the epidemic, national governments can take additional control measures, such as the pre-emptive slaughter of all herds within a certain radius (for example 1 km) of infected herds. If the established surveillance zones lead to severe animal welfare problems on the farms that are located in these zones, so-called welfare slaughter is generally applied to reduce such problems (Vanthemsche, and Pluimers et al.).

Losses related to the control measures can be divided into direct costs and consequential losses (Meuwissen et al.). Direct costs refer to the value of destroyed animals (all animals in stamping-out, pre-emptive slaughter, and welfare slaughter programs are destroyed and rendered), and the costs of organizational aspects such as the monitoring of farms in surveillance zones.

For farmers, consequential losses include, among others, losses from business interruption, and, after a time, costs of repopulating the farm. Business interruption occurs because farm buildings become empty due to stamping-out, pre-emptive slaughter, or welfare slaughter, and stay empty until surveillance zones are lifted. With stamping-out and pre-emptive slaughter, buildings are completely emptied (i.e. depopulated). With welfare slaughter, buildings may only become partly empty (depending on the type (age/weight) of pigs slaughtered and on the type of farm). Losses related to repopulating the farm include losses due to extra weeks with empty buildings (for example because new sows are not readily available) and extra costs of animal health problems[1].

The other source of consequential losses for farmers includes losses related to established surveillance zones: farms in surveillance zones face (long) periods in which pigs (such as fattening pigs and culled sows) and manure can not be transported from the farm. These periods are characterized by animal welfare problems, extra feeding costs, and emergency measures for housing of pigs and storage of manure.

For related industries, consequential losses originate from such aspects as a decline in the number of animals slaughtered, the number of trade transactions, and quantity of feed sold.

Direct costs are largely borne by governments (national and EU). Consequential losses need to be borne by farmers and related industries (Horst et al., 1999b). For business interruption on farms, losses include US $1.18 per day for a farrowing sow and US $0.20 per day for a finishing place. For a typical one-person Dutch farm this is about US $300 per day or 0.3 per cent of a farmer’s typical annual income (Meuwissen et al.).

The size of risk

Ideally, insight into the size of risk is obtained from historical information. For epidemics, however, historical data, if at all available, has limited value due to a low frequency of epidemics, continuously changing legislation with respect to prevention and control strategies applied, and a large variability in possible outcomes. Monte-Carlo simulation is an appropriate alternative for obtaining insight into losses, and what-if analyses can be used to study the impact of changes in the input parameters (Law and Kelton).

Monte-Carlo simulation of Classical Swine Fever

A Monte-Carlo simulation model is developed (in @Risk; Palisade) that gives insight into expected losses from CSF-epidemics. To demonstrate the features of the model, we applied it to the southern part of the Netherlands, which is an area of very dense swine population (Nagel) and the center of the 1997/98 CSF-epidemic. The area contains more than 75 per cent of the total number of pigs (i.e. 14 million) in the Netherlands. Figure 1 shows the structure of the simulation model.

Figure 1

The model consists of three major parts (so-called 'sub-models'). The first part provides the simulation model with information on the number of CSF-epidemics per year. The second and third part simulate the epidemiological and financial extent of each of these epidemics. Then, losses from year t are summed and multiple iterations[2] provide insight into the distribution of annual losses (Law and Kelton). The three sub-models are explained below.

Frequency of epidemics. Since the Netherlands are in principle free of CSF, the occurrence of an epidemic is caused by the introduction of CSF-virus from other countries. Parameters in the sub-model that determine the number of CSF-epidemics in the Netherlands refer to the frequency of CSF-epidemics in other European countries, the duration of so-called 'high risk periods'[3], and the risks related to the import and export of livestock, and the import of animal products. For a more detailed description of this sub-model, reference is made to Horst et al. (1999a).

Epidemiological extent of epidemics. The sub-model on the epidemiological extent of epidemics refers to a very detailed, spatial, dynamic and stochastic simulation model. Given the occurrence of a CSF-epidemic, the model simulates the spread of CSF-virus between farms through local spread and contacts (from transport, animals, and persons), and given a specific control strategy. Parameters in the model are, among others, based on the 1997/98 CSF-epidemic in the Netherlands. Output from this sub-model is very extensive and includes among others the number of farms infected and the number of farms under surveillance for each day of an epidemic. Details of the model are provided by Jalvingh et al. and Nielen et al.

Financial impact of epidemics. Epidemiological information is translated into financial data by the third sub-model. This financial model calculates—also on a very detailed level—direct costs and consequential losses for all participants of the livestock production chain. Details of this sub-model are explained by Meuwissen et al.

Results of Monte-Carlo simulation

Results of sub-models: most likely scenarios. In relation to the frequency of CSF-epidemics in the southern part of the Netherlands (first sub-model), the most likely scenario concerns a frequency of on average 1 epidemic per 5 years (Horst et al., 1999a). Figure 2 shows the probability density function of the number of epidemics per year for this scenario.

Figure 2

As Figure 2 illustrates, the probability of zero epidemics per year is highest, i.e. 0.82. The probability of 1, or more than 1, epidemic per year is 0.17 and 0.01 respectively. The mean number of epidemics per year resulting from this distribution is 0.20 with a standard deviation of 0.44.

With regard to the epidemiological extent of epidemics, the most likely scenario concerns a scenario in which epidemics are controlled by the minimum EU control strategy. Given this strategy (and combining output from the sub-models on the epidemiological and financial extent of epidemics), Figure 3 shows the expected total losses (million US $) from a CSF-epidemic in the southern part of the Netherlands (the left-hand part of the figure subdivides expected total losses into different categories, the right-hand part subdivides expected consequential losses for farmers into different causes of loss).

Figure 3

As Figure 3 shows, expected total losses mainly consist of direct costs; these include US $872 million. The expected values of the consequential losses of related industries and farmers are US $268 million and US $170 million respectively. Of the consequential losses for farmers, US $76 million is due to repopulation and surveillance zones, and US $51 million and US $43 million due to business interruption (from depopulation and welfare slaughter respectively). Figure 4 shows the range around the expected values for both types of business interruption losses.

Figure 4

As Figure 4 illustrates, the range of business interruption losses from depopulation is wider than that of business interruption losses from welfare slaughter, i.e. for depopulation, losses range from US $17 million to US $158 million, while these numbers are US $28 million and US $115 million respectively for welfare slaughter.

Results of sub-models: alternative scenarios. In relation to the frequency of epidemics we defined two alternative scenarios, i.e. one with an increase in the number of epidemics (to on average 2 per 5 years) and one with a decrease in the number of epidemics (to on average 1 per 10 years). In the pessimistic scenario of on average 2 epidemics per 5 years, the mean number of epidemics per year is 0.40, with a spread from 0 to 4. In the optimistic scenario of 1 epidemic per 10 years, these numbers are 0.10, 0, and 2 respectively.

With regard to the epidemiological extent of epidemics, also two alternative strategies were defined (Nielen et al.): one in which the minimum EU control strategy is extended with a pre-emptive slaughter program of all herds within a 2-km radius of infected herds, and one in which surveillance zones have a radius of 20 km instead of 10 km. With the more severe pre-emptive slaughter program (and focusing on business interruption losses), losses decrease significantly, i.e. expected business interruption losses decrease from $51 million for depopulation and US $43 million for welfare slaughter (see Figure 3) to US $28 million and US $10 million respectively. In the scenario with larger surveillance zones, expected business interruption losses from depopulation decrease, i.e. to US $47 million, but those of welfare slaughter increase (to US $77 million).

Results of the overall simulation model: most likely scenario. The first part of Table 1 shows the results of the overall model for the most likely scenario of on average 1 epidemic per 5 years and with the minimum EU control strategy.

Table 1

Table 1 shows that in the most likely scenario, expected annual total losses from CSF in the southern part of the Netherlands are US $246 million, with a range from zero to US $4.5 billion. The expected annual losses of business interruption total US $18 million, with a range from zero to US $396 million (US $181 million + US $215 million).

Results of the overall simulation model: alternative scenarios. In the pessimistic scenario (with on average 2 epidemics per 5 years and the control strategy with larger surveillance zones), expected annual total losses are three times higher than in the most likely scenario, i.e. US $761 million (Table 1). Expected annual losses from business interruption are US $48 million (US $18 million + US $30 million), with a 0.95 fractile of US $207 million and a maximum of US $482 million.

In the optimistic scenario (with on average 1 epidemic per 10 years and the more severe pre-emptive slaughter program), expected annual total losses are US $75 million. Expected annual business interruption losses are now US $3 million and US $1 million for depopulation and welfare slaughter respectively.

Careful considerations when introducing a farm business interruption insurance for livestock epidemics

Premium rates. For the three scenarios presented in Table 1, premium rates for farm business interruption insurance (covering business interruption from depopulation as well as from welfare slaughter) have been calculated. Rates are based on expected claim cost (with zero deductible) for two situations, i.e. a situation in which expected losses are based on the whole loss distribution (as shown in Table 1), and a situation that considers the same loss distribution but without the catastrophic part of it, which is defined as the ‘last 5 per cent’ (or, the upper tail) of the loss distribution. Table 2 shows the expected premium rates for both situations.

Table 2

In the most likely scenario and taking into account the whole loss distribution, premium rates per sow and per finishing place are US $8.44 and US $1.77 per year respectively. If farmers' premiums do not need to cover the catastrophic part of the distribution, rates reduce significantly: to US $5.23 and US $1.09 respectively. Premium rates in the pessimistic and optimistic scenarios are significantly higher and lower respectively compared to these numbers.

The rates in the most likely scenario (and including the catastrophic part of the loss distribution), are about 2 per cent of the mean gross margin of sows and fattening pigs (Agricultural Information and Knowledge Center and Research Station for Animal Husbandry), and would be about 8 per cent of the mean insured value. If premiums in this same scenario were to be based on the data without the catastrophic part, these numbers are about 1 and 5 per cent respectively. Compared to other insurance schemes, such rates are relatively high.

The systemic character of the risk. Since epidemics generally involve many farms at the same time, losses can be catastrophic (as indicated by the maximum losses in Table 1). However, whether the maximum loss in the pessimistic scenario (US $199 million + US $283 million = US $482 million; Table 1) is 'catastrophic' for an individual insurer, depends on several factors, such as the number and geographic spread of insured farmers, the extent to which the insurer's portfolio is diversified, and the way reinsurance is arranged (Vaughan and Vaughan, and Miranda and Glauber). Considering the extent to which insurers already can deal with other systemic risks, such as hurricanes and earthquakes (Harrington and Niehaus), the systemic nature of the CSF-risk seems to be manageable for most insurers.

Influence of farmers on the size of risk. A farmer can influence the expected probability of his/her herd becoming infected. Factors that influence this probability include the sanitary barriers and hygiene on the farm, number of animal contacts, and the place stock is purchased (from sources with known health status versus markets and dealers premises) (Davies). Such influence of farmers on the size of risk is likely to cause problems of adverse selection and moral hazard (Rejda).

Adverse selection is to be minimized by differentiating premiums according to (measurable) risk factors. Measuring the risk of farms is facilitated through evolving systems in the field of ‘animal safety indices’ (Bokma-Bakker and Vesseur) and national identification and recording systems (Saatkamp et al.).

Moral hazard is to be minimized by contract specifications on ‘due diligence’ (again requiring measurable aspects of farming practices), and by the use of deductibles (for example by not covering the first week with business interruption). In relation to infected herds, the number of animals already dead at the time of stamping-out may be used as an (additional) measurable aspect of farming practices; many dead animals may indicate little alertness of the farmer.

Influence of governments on the size of risk. Governments decide on (and are held responsible for) the control measures taken during an epidemic. In this way, they largely influence the size of losses (of which they cover the direct costs themselves). In case of business interruption insurance, agreements between governments and insurers about the control strategies to be applied under various circumstances are necessary in order to prevent debates on this issue during an epidemic. For example, some measures may seem very expensive at the time they are taken but they may lead to significant lower eventual losses.

Hazard prone areas. In some areas the expected frequency of epidemics is higher than in other areas (Horst et al., 1999a). Stated factors determining this risk include the animal and herd densities, the incidence of wildlife that may be carriers, and the proximity of airports and seaports as source of infection. Also, the expected size of epidemics varies across areas, (also) largely depending on animal and herd densities. Differentiation of premiums according to the location of a farm is likely to increase the interest of farmers from outside hazard prone areas in the insurance (giving the insurer potential for risk spreading).

Solidarity instead of liability. The fact that, after the notification of an outbreak, governments decide on such measures as surveillance zones and pre-emptive slaughter makes it unreasonable to hold the farmer with the outbreak liable for the losses suffered by other farmers as a consequence of the measures taken. This is especially true since it is generally not possible to prove that the outbreak is due to the farmer's (or for example a trader's, or veterinarian's) negligence (Howe and Whittaker). In these circumstances there is a need for some degree of solidarity among farmers. Solidarity is stimulated through setting minimum standards for 'good farming practices' at the national level; such standards give each farmer incentives to reduce the risk—also those farmers who choose not to insure, for example because they can bear business interruption losses themselves, or, because they are 'free riders' (Stevens, and Howe and Whittaker).

Defining "business interruption". The business interruption insurance in this paper covers business interruption losses from (partly) empty buildings. The losses related to repopulating the farm at the end of the period with business interruption are not considered insurable for reasons of moral hazard (although some fixed indemnity might be included in a business interruption insurance to cover such losses). Also for reasons of moral hazard, losses caused by surveillance zones are not considered insurable.

In relation to business interruption losses from empty buildings, the issue whether farm buildings are empty can be determined objectively, leaving few opportunities for fraud. This is especially true in case of depopulation; in case of buildings emptied from welfare slaughter, information from official sources about the exact moment of welfare slaughter and the number of animals actually slaughtered is likely to be necessary to exclude fraud.

Discussion

There are several arguments in favor of increasing the feasibility of a farm business interruption insurance for Classical Swine Fever. First, the insurance may reduce the size of the risk through such aspects as premium differentiation and clauses of ‘due diligence’ (see also Kunreuther). Second, more generally, insurance schemes have potential benefits for the society as a whole (see for example Arrow).

A possible way to increase the feasibility of business interruption insurance is to (further) reduce the size of risk (so that premium rates can become lower). Giving farmers incentives for preventing losses (and minimizing the extent of losses during an epidemic) is crucial in this respect. Mutual insurance companies have more opportunities to give such higher incentives to farmers than insurance companies organized otherwise (Vaughan and Vaughan). Mutuals are owned by the insured farmers. There is therefore likely to be broader support for premium differentiation since colleague farmers—instead of anonymous insurance companies—impose these measures. Mutuals also make proper loss assessment easier (which reduces problems of moral hazard and fraud) because of social control, and familiarity of colleague farmers with production circumstances. Mutuals are furthermore allowed to charge insureds relatively low advance premiums but additionally assess them ‘surcharges’ (generally to some limit) once losses become larger than the advance premiums paid. Such surcharges are a direct incentive for loss prevention (Vaughan and Vaughan).

Another possible way to increase the feasibility of the insurance is to decrease farmers’ premium rates by spreading the risks more broadly. In our case this would, for example, imply that rates for farmers in the northern part of the Netherlands would not be completely differentiated according to the lower levels of risk in this part of the country. Such solidarity would be justified if farmers in less hazard prone areas face increased profits from the occurrence of epidemics (as was the case during the 1997/98 CSF-epidemic in the Netherlands).

Some financial involvement of governments could also increase the feasibility of business interruption insurance. Governments could, for example, provide some starting buffer for insurers (to handle the risk of major epidemics occurring after the start of the insurance), or they could subsidize farmers’ premiums to some extent. If governments subsidize the catastrophic part of the risk (i.e. the upper tail of the loss distribution), premiums would reduce significantly (as shown in Table 2). Note that the premiums in Table 2 were based on expected claim costs alone. Had we included other costs such as reserve loads, the relative decrease in premiums would be even larger since insurers generally include large reserve and catastrophe loads for the catastrophic part of risks (Hogarth and Kunreuther, and Doherty).

Conclusions

The goal of this paper was to study the feasibility of a farm business interruption insurance for Classical Swine Fever. Given that quantitative insight into the size of risk can be obtained from such detailed simulation model as described in this paper, and carefully considering issues such as the systemic character of the risk, farmers' and governments' influence on the size of risk, and the importance of some degree of solidarity among farmers, we conclude that a business interruption insurance for Classical Swine Fever is in principle feasible.

The feasibility of the insurance would be improved through spreading the risk among larger groups of farmers, through some financial involvement of the government, and by the provision of the insurance through 'mutual companies'.

Considering similar analytical frameworks as presented in this paper, we argue that business interruption insurance is in principle also feasible for other livestock epidemics, such as Foot and Mouth Disease and Swine Vesicular Disease.

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Footnotes

[1] These losses thus do not refer to the costs of buying a new herd; government compensation for the slaughtered herd is generally sufficient to buy back a herd of equal quality.

[2] The number of iterations carried out is at least 500, or until the percentage change of the mean and standard deviation of the losses is 1.5 per cent or lower.

[3] The ‘high risk period’ is the period in which virus is already present in a country but not yet detected or under control (Horst et al., 1999a).

Table 1. Annual losses from CSF in the southern part of the Netherlands (expected values and fractile values) for three scenarios (million US $)

	Expected value	Min	50%	95%	Max
Most likely scenario (i=3100)[a]					
Total losses	246	0	0	1404	4462
Consequential losses farmers					
- Business interruption from depopulation	10	0	0	61	181
- Business interruption from welfare slaughter	8	0	0	47	215
- Repopulation and surveillance zones	14	0	0	89	292
Pessimistic scenario (i=1800)					
Total losses	761	0	0	3336	8572
Consequential losses farmers					
- Business interruption from depopulation	18	0	0	77	199
- Business interruption from welfare slaughter	30	0	0	130	283
- Repopulation and surveillance zones	38	0	0	168	434
Optimistic scenario (i=3800)					
Total losses	75	0	0	641	2653
Consequential losses farmers					
- Business interruption from depopulation	3	0	0	25	118
- Business interruption from welfare slaughter	1	0	0	8	61
- Repopulation and surveillance zones	6	0	0	49	159

[a] Number of iterations carried out.

Table 2. Expected premium rates for farm business interruption insurance with and without catastrophic part of loss distribution[a] (in US $)

	With catastrophic risk	Without catastrophic risk
Most likely scenario		
Premium per sow (US $ / year)	8.44	5.23
Premium per finishing place (US $ / year)	1.77	1.09
Pessimistic scenario		
Premium per sow (US $ / year)	23.11	11.41
Premium per finishing place (US $ / year)	4.84	2.39
Optimistic scenario		
Premium per sow (US $ / year)	1.91	0.71
Premium per finishing place (US $ / year)	0.40	0.15

[a] Catastrophic part of the distribution is defined as the upper tail (last 5 per cent).

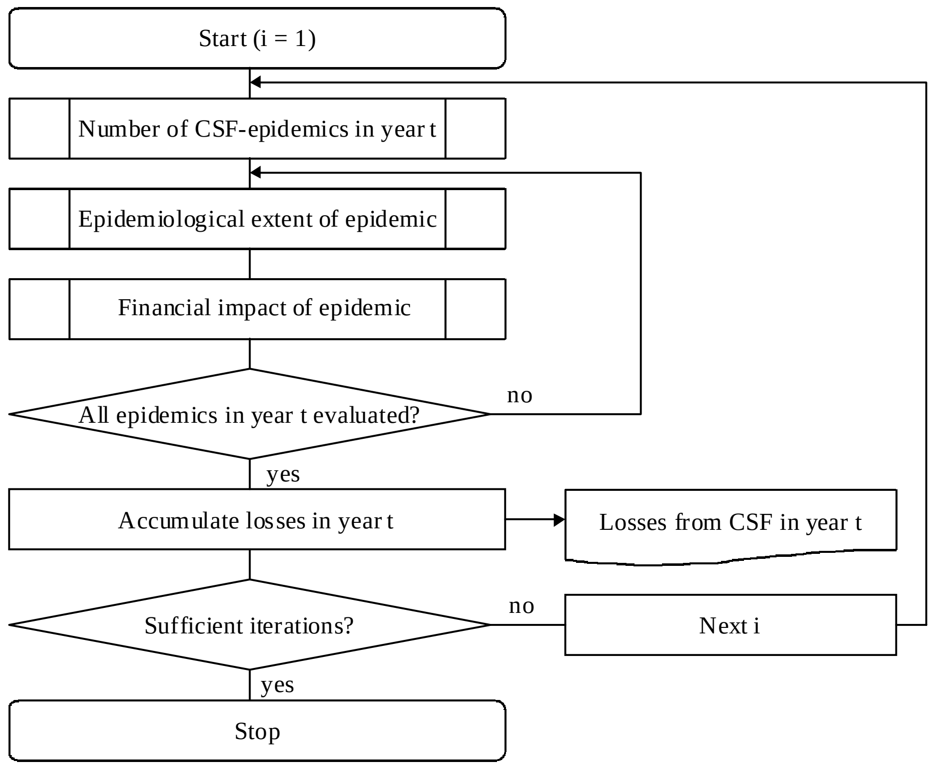

Figure 1. Flow diagram of Monte-Carlo simulation model for Classical Swine Fever

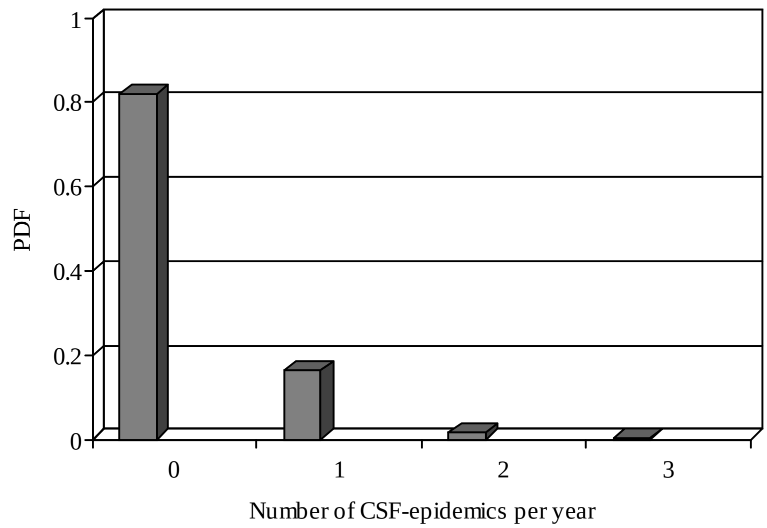

Figure 2. Probability density function (PDF) of the number of CSF-epidemics in the southern part of the Netherlands per year in most likely scenario

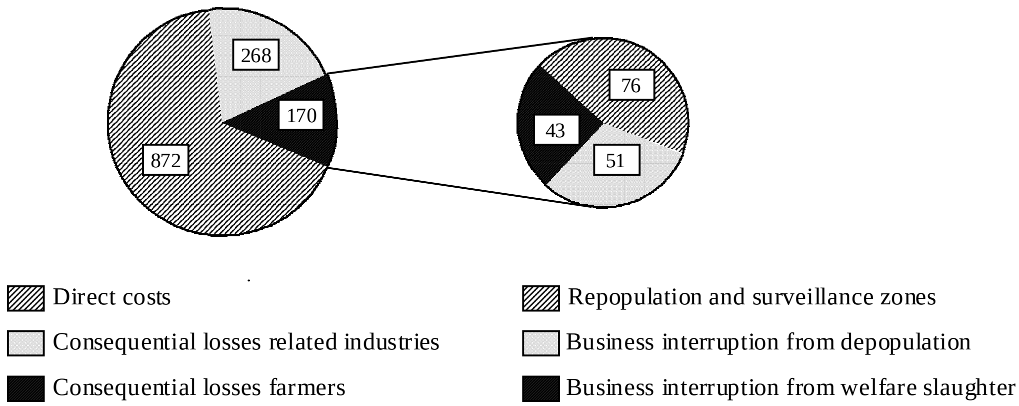

Figure 3. Expected total losses from a CSF-epidemic in the southern part of the Netherlands in most likely scenario (million US $)

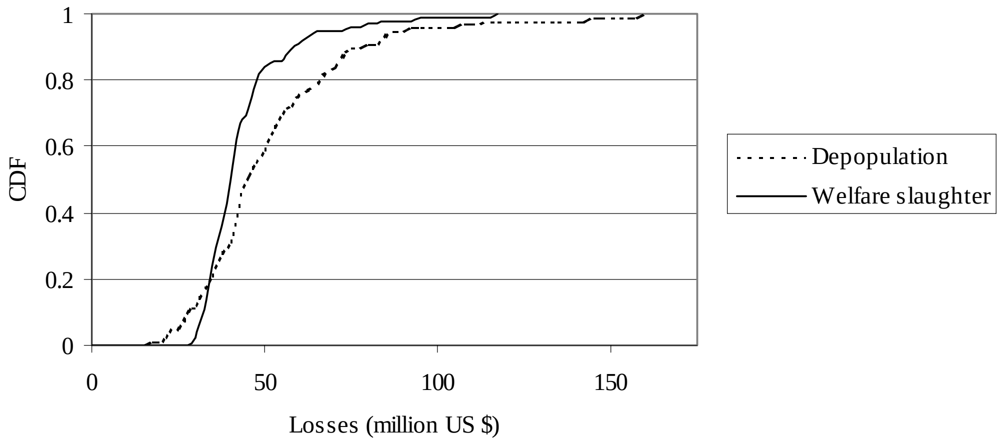

Figure 4. Cumulative distribution functions (CDFs) of business interruption losses from a CSF-epidemic in the southern part of the Netherlands in most likely scenario (million US $)