A RISK FINANCING MODEL FOR LIVESTOCK EPIDEMICS IN THE EUROPEAN UNION

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EXECUTIVE SUMMARY

Introduction

Livestock epidemics, such as epidemics of classical swine fever (CSF) and foot and mouth disease (FMD), can result in substantial losses for governments, farmers and all the other participants of the livestock production chain involved. Governments (national and European) generally bear the largest part of the direct losses, such as the value of destroyed animals and organisational costs. Consequential losses, such as losses resulting from empty buildings and movement standstills, are almost always completely borne by the farmers themselves (and other participants of the production chain) if not insured privately. Due to various developments (enlargement of the European Union with acceding countries, budgetary constraints, possible interest of farmers to cover consequential losses by means of insurance), the current risk financing system for livestock epidemics is being reconsidered.

Goal of study

The goal of this study was to evaluate and further develop alternative risk financing instruments considering direct losses and consequential epidemic livestock losses (list-A diseases). Proposed schemes should as much as possible fulfil the following requirements: (1) no disturbance of markets; (2) compatible with WTO agreements; (3) run by the private market, without official EU participation; and (4) applicable to the whole of the European Union.

The project resulted in (1) a blueprint of a risk analysis and risk financing model, including a short list of the main considerations to be made; (2) insight into the feasibility of developing ‘a European system’; (3) recommendations for setting up further studies and pilot projects.

Current risk financing schemes in EU countries

A number of member states finance the non-EU compensated part of the direct losses entirely from the national budget. Other member states have set up some form of statutory system to co-finance the direct losses. These Public-Private financing schemes have a compulsory fund structure in which all farmers pay a levy. In case of co-financing to complement the public part, the amount that is financed by the sector is either proportional or non-proportional.

Only a limited number of countries apply free public disaster assistance. Some EU member states partly compensate consequential losses on basis of actual incurred losses (also a form of ad hoc relief program exists). In some countries the government compensates above the value of the animals which are compulsorily slaughtered to cover part of the consequential losses. Public-Private partnerships in the sense that national governments subsidise a consequential loss policy are scarce. In some other EU member states the absence of public assistance has led to the creation of private insurance schemes for some types of livestock production. The current applied consequential loss coverage can be based on the actual losses incurred or an estimation of the loss based on the period with business interruption (i.e., fixed sum per day times the duration) or a fixed amount (for example 10% of the animal value). In general, farms that are confronted with losses as a result of decreased market value of their products but are not infected with an epidemic disease or are not in a movement standstill zone are not eligible for compensation.

On basis of the conducted survey it can be concluded that producers do not commonly take up private policies that are specifically designed to cover consequential losses. (Only the German “Ertragsschadenversicherung” has a relative high level of participation.) Important aspects explaining the low level of participation can be found both at the demand side (producers might evaluate it as a less important business risk, cognitive failure to assess probability and extent of low-probability-high-consequence risks, schemes are new and farmers may need time to adopt, and producers may cope with this

business risk in alternative ways) and the supply side (research and development costs, difficulties in setting premium rates by insurers).

Blueprint risks analysis and risk financing

Since outbreaks occur irregularly in time and place it is difficult to derive general properties and predictive values. Also the probability distribution describing the possible spread of FMD and CSF is difficult to ascertain (i.e., severity). The latter is highly depending on the control strategy applied. However, a complete claim distribution is very seldom used as a basis for such premium calculation due to the fact that such information is seldom available. Another complicating factor is that the environment is dynamic by a prospective non-vaccination policy, changing herd intensity and structure, and liberalisation of markets (e.g., trade of live animals and products). In order to compare different risk transfer solutions an analytical model for risks associated with livestock diseases in the Netherlands was constructed. The model focuses on the epidemic diseases FMD and CSF and includes direct and consequential farm losses. Because of the lack of a complete claim distribution expert opinions of those working in this area (a combination of experience and understanding of current / future probabilities) were used to complement the more standard rating methodologies. The financial arrangements included are a proportional national coverage (fraction of the loss), non-proportional national coverage (‰ animal value), a limited insurance coverage in days, a deductible in days, a levy system, and an traditional insurance contract. The effects for all different levels – sector, national budget and EU budget – were estimated.

Feasibility of developing ‘a European system’

Given the specific risk under research, a mandatory levy system to finance direct losses will facilitate alertness and rapid alarm in case of an outbreak of an epidemic. Compensation of direct losses can either be based on a pre-set animal value or actual market value at the moment of culling. In contrast, a consequential loss insurance scheme might be voluntary (producers may cope with this business risk in alternative ways). Compensation for consequential losses can ideally be based on actual losses incurred. However, basing the indemnity on a fixed sum per day times the duration of business interruption is probably a more feasible solution. The largest involvement of farmers is likely to be achieved by organising a levy system that is organised (partly) by the farmers

themselves and mutual insurance scheme. Compensation of losses for farms as a result of decreased market value of their products but are not infected with an epidemic disease or are not in a movement standstill zone is not an option to be insured.

In contrast with the requirement of no disturbance of markets and no official EU participation, all EU member states finance (partly) direct losses and some finance partly consequential losses from the national budget. Harmonisation of EU financing schemes would at least level the playing field between farmers within the EU. The harmonisation criteria can be expressed as the maximum allowed level of proportional or non-proportional coverage by state. With respect to consequential losses also the maximum allowed compensation by each state is important too.

If reinsurance problems are hampering the development and sustainability of insurance products or are resulting in relatively high premiums, a Public-Private partnership for the reinsurance of the risk could be considered (possible in combination with a "Pool Re Europe" design or other alternative risk transfer solutions).

Recommendations for setting up further studies and/or pilot projects

- In order to construct and evaluate (regional) levy and insurance schemes the risk (i.e., probability of occurrence and magnitude of losses) and the control strategies applied in each main livestock sector need to be documented. As an approximation, the magnitude of the loss might be based on the average animal value in a country or region and the associated gross margins. Then the maximum level of national / regional support for direct losses and the effect on the national and EU budget can be determined. Also rates for consequential losses need to be determined.

- On the supply side, there is a need to investigate the potential for the insurance industry and farmers organisations to develop either limited or mutual insurance companies to cover consequential losses for those countries without these schemes.

- On the demand side, a market study in these countries could reveal under what conditions insurance schemes are feasible. An insurance to cover consequential losses is

feasible if there is sufficient participation (i.e. if sufficient farmers are willing to pay the premiums). In discussing the feasibility of an insurance for consequential losses, a number of aspects discussed for direct losses are also very relevant (e.g., effect of premium differentiation, deductible, importance of risk communication). However, the major issue is likely to be the participation of farmers in an insurance scheme: unlike a risk financing scheme for direct losses an insurance scheme for consequential losses is likely to be voluntary.

CONTENTS

1. Introduction

Epidemics in livestock, such as foot and mouth disease (FMD) and classical swine fever (CSF) may inevitably affect many farms at the same time. FMD is the most contagious disease of cloven-hoofed animals (cattle, pigs, sheep, goats and all wild ruminants and suidae) and has a great potential for causing severe economic losses. Many countries are officially free of FMD (without vaccination), other countries vaccinate against the disease (preventive vaccination), and in some countries FMD is still endemic. In the EU preventive vaccination is prohibited since 1991. After 1991, FMD epidemics occurred in Greece and Italy (1993, 1994, 1996) and the UK, Ireland, France and the Netherlands (2001-2002). CSF is also a highly infectious virus posing a threat to livestock production. Natural hosts of CSF are domestic pigs and wild boar. At the beginning of the 21st century, CSF is still endemic in many parts of the globe. Successful eradication has been achieved in many countries including North America, Australasia, and parts of Northern Europe. Preventive vaccination was stopped in all EU Member States in the early 1990's (Westergaard, 1991). The absence of vaccination resulted in a totally susceptible swine population (Edwards et al., 2000). In the wild boar population CSF is still endemic in Germany and Italy (Fritzmeier et al., 2000). In the 1990's large CSF outbreaks (more than 40 farms infected) occurred in the Netherlands (1997), Germany (1993, 1994, 1995, 1997, 1999, 2000), Belgium (1994) and Italy (1995, 1996, 1997) (Laevens, 1998 and Handistatus II of the OIE, 2001).

Member states are obliged to apply the control measures laid down in EU directives if an outbreak arises of so-called ‘List-A diseases’ (Office International des Epizooties, 1998). The basis for these measures originates from EU Council Directive 85/511/EEC and 80/217/EEC respectively. Measures include 1) stamping-out of infected herds; 2) pre-emptive slaughter of contact herds; and 3) the immediate establishment of surveillance zones around such herds. In these zones, animal movements are restricted and to a large extent prohibited. After obtaining EU approval, countries may take additional control measures such as slaughter of animals for reasons of animal welfare in areas with a movement standstill. Also, a more comprehensive pre-emptively slaughter scheme can be applied. Furthermore, all susceptible animals within a large area around the infected herds might be vaccinated (emergency vaccination, ‘ring vaccination’).

Obviously, these livestock epidemics can have large economic consequences for farmers but also other various parties of the production chain in terms of direct and consequential losses. Direct losses comprise the value of the animals culled under depopulation and welfare control measures and the costs of organisational aspects such as the monitoring of farms in restriction zones. Consequential losses that arise at farm level can comprise one or more of the following categories:

Business interruption: business interruption occurs because farm buildings become (partly) empty due to stamping-out and welfare slaughter or breeding prohibition, and stay empty until restriction zones are lifted.

Losses related to established restriction zones: farms in restriction zones face (long) periods in which animals (e.g., finishing pigs and veal calves) and manure can not be transported from the farm. These periods are characterised by animal welfare problems, extra feeding costs, and emergency measures for housing of pigs and storage of manure. Such losses will widely vary across farms and are therefore complicated to measure. Milk from dairy farms in restriction zones might be collected taking into consideration strict hygienic measures.

Additional repopulation costs: these losses include extra costs of animal health problems.

Losses from emergency vaccination: given a situation, in which vaccinated animals are destroyed, losses might arise of the above categories (business interruption, repopulation costs). However, for reasons of social acceptability, the rendering of vaccinated animals is under debate. With future epidemics, meat and milk from vaccinated animals may be destined to the local market, which likely leads to extra costs and/or lower prices. Something similar may be applied to animals under welfare slaughter programs.

Price effects: livestock epidemics can have a rather severe impact on prices, especially meat prices. The impact depends on aspects such as the size of the epidemic (duration, size of restricted area), reactions of other countries (closure of borders, increased production) and whether vaccination is applied (which generally leads to long periods of export limitations).

The direct losses are partly compensated by governments (national and European). Consequential losses are almost always completely borne by the farmers themselves if not insured privately. In some countries the consequential loss exposure is transferred by means of private insurance schemes.

Due to various developments (enlargement of the European Union with acceding countries, budgetary constraints, possible interest of farmers to cover consequential losses by means of insurance), the current risk financing system for livestock epidemics is being reconsidered. The goal of this study is to evaluate and further develop alternative risk financing instruments considering direct losses and consequential livestock losses (list-A diseases). Proposed schemes should as much as possible fulfil the following requirements: (1) no disturbance of markets; (2) compatible with WTO agreements; (3) run by the private market, without official EU participation; and (4) applicable to the whole of the European Union.

In particular the project addresses the following questions:

(1) What is the optimal organisational form for such instruments?
(2) Which risks can and should be covered by the instrument, and which risks should be excluded?
(3) What is the resulting premium and can it be borne by the participants (i.e. economically feasible premium)?
(4) What is the role of the public sector?
(5) What are the data needs to run the instrument successfully, and can these data be made available in the near future?
(6) What are necessary next steps to implement the instrument successfully (i.e. future outlook, role of commercial insurance companies, pilot test)?

The project consists of several parts:

(1) Quick scan of existing risk financing systems in the European Union.
(2) Risk analysis (epidemiological and economic).
(3) Outline of main considerations with respect to alternative risk financing instruments (e.g. veterinary fund owned by government, mutual fund owned by farmers, and private insurance), problems of asymmetric information and systemic risk, design of contracts, and participation.
(4) The points (2) and (3) are illustrated for the Netherlands, for which a large amount of data is already available.
(5) Feasibility of a European system.

The project results in (1) a blueprint of a risk analysis and risk financing model, including a short list of the main considerations to be made; (2) insight into the feasibility of developing ‘a European system’; (3) recommendations for setting up further studies and pilot projects.

2. Risk financing in EU countries

An obvious distinction has to be made between direct and consequential losses when evaluating risk financing schemes implemented in EU member states.

2.1 Compensation of direct losses

The veterinary budget of the European Union refunds 50 percent of the costs of compulsory and pre-emptive slaughter, 70 per cent of the costs of welfare slaughter, and 50 per cent of the organisational costs (Council Directive 90/424/EEC; Ministry of Agriculture, Nature Management, and Fisheries, 1998). The financing of the non-EU compensated part of the direct losses differs between the EU member states. In Table 1 an overview of the current financing schemes is depicted, focussing on whether or not the primary sector contributes via a levy system.

A number of member states finance the direct losses entirely from the national budget. Other member states have set up some form of statutory system to co-finance the non-EU compensated part of the direct losses. These Public-Private financing schemes have a compulsory fund structure in which all farmers pay a levy. In case of co-financing to complement the public part, the amount that is financed by the sector can be proportional or non-proportional.

Risk financing by means of a levy system is based on pooling over time within the sector. Payments to the fund can be organised through up-front payments (deposit) or through payments after an outbreak, or both. However, most member states have opted for an approach whereby producers have to pay the levy mainly after the epidemic. These latter systems have no annually fixed levies. The compensation payments are made from the available funds and the government will pay for the costs in advance if the fund runs out of money. The input of the government will however be repaid over the following years. Therefore, after an outbreak of an epidemic disease, the levy usually increases according to the needs of the fund. Note that the levy can and in most cases will also vary between species.

The private bank guarantee system is a modification of a levy system (transfer is absent). Within this system the government can withdraw capital from a private bank to (co-) finance actual losses. Any capital provided by the bank is paid back by the primary sector through additional payments over a certain time horizon.

Table 1: Direct livestock losses and the contribution of the sector[1]

	Contribution
Austria	+
Belgium	+
Denmark	-
Finland	-
France	-
Germany	+
Greece	+
Ireland	-
Italy	-
Luxembourg	-
Netherlands	+
Portugal	-
Spain	-
Sweden	-
United Kingdom	+/-

[1] -: no levy, +: (partly) levy or compulsory insurance scheme.

Austria: The Bundeslander (similar as in Germany) establish levies for the fund.

Belgium: The government has set up a fund that it is used to finance various animal health and quality improvement measures. All funds are paid to the Administrative Unit for animal quality and health (part of the Ministry). The levy can vary depending on the level set by the government. The levy is differentiated on basis of species and farm size. With respect to pig production in addition the premium is differentiated between open or closed pig production.

Denmark: The government pays only for the value of the animals which are compulsorily slaughtered. If a whole herd is slaughtered, a further 20% is paid to cover the loss of income from the herd. However the government does not pay for the commercial

impact of movement restrictions or other controls. No statutory or voluntary levies are operated to establish an emergency fund.

Finland: The government compensates farmers and no statutory or voluntary levies are operated to establish an emergency fund.

Germany: The German program is set up by national legislation but each Bundesland is responsible for running the program. The Bundeslander draw up the detailed rules of the application. The scheme is compulsory. The program is run by an administrative council that decides the level of the levy etc. The administrative council is made up of farmer and ministry representatives. The levy varies between species but more importantly is varied according to the needs of the fund. The compensation payments are made from the available funds and the Ministry of Agriculture will pay for the costs if the fund runs out of money. The input of the Ministry will however be repaid over the following years and this is usually why the levy increases after a disease outbreak. The levy is only used to co-finance the Community Veterinary measures following a disease outbreak. It therefore only pays for the slaughter of animals that have to be killed under EU Veterinary measures. The Lander and the levy fund each pay half of the remaining 50%. No compensation is paid to farmers in the surveillance zones.

Greece: The government operates a compulsory agricultural insurance scheme via the Greek Agricultural Insurance Organisation "ELGA". ELGA has the objective of organising and implementing programmes of proactive protection and insuring the production and assets of agricultural enterprises. More specifically, insurance with ELGA includes compulsory insurance against damage which is caused to for example animal assets of farmers. Persons who own stock-breeding or poultry or domestically produced products and by-products of animal origin shall be subject to insurance. ELGA is funded by an 'income from special insurance contributions' (of which the fee is 0.5% of the value of the sold livestock production) and this constitutes the major financial source.

Italy: No government compensation is available other than for slaughtered animals. No statutory or voluntary levies exist.

Luxembourg: The Luxembourg government pays compensation when animals are compulsorily slaughtered. There have been negotiations to introduce scheme that

would have been paid for by farmers, government and farmers' associations in equal shares. However, the scheme was never implemented.

The Netherlands: Following the epidemic of CSF in 1997, the Dutch government has decided that the producers must pay a larger proportion of the costs of any future epidemic and a system has now been put in place whereby pig producers will have cover for up to 227 million Euro per five years (the same holds for the cattle sector). The producers and the Ministry of Agriculture have agreed on a system where a bank guarantee is supplied and producers will have to pay the levy mainly after the epidemic. The amount of the levy will depend on the actual cost of the epidemic.

Spain: No government compensation is available other than for slaughtered animals. No statutory or voluntary levies exist.

Sweden: If a 'production unit' is closed during an epidemic of a notifiable disease the government can compensate the farmer for the destruction of the animals, animal value, decontamination and for production losses. Compensation for notifiable diseases like Paratuberculosis is 100% for both animal value and decontamination costs. Compensation for Salmonella varies from 0% to 70% depending on the size of the livestock unit and whether the farmer is taking part in a control program. Veterinary costs and other costs caused by the epidemic is not compensated.

United Kingdom: For FMD in cattle, sheep and pigs the government compensates destructed animals at 100% of the market value. There is no levy of farmers. The same applies for CSF and Swine vesicular disease (SVD) in pigs. The UK government also pays some compensation for animals slaughtered due to Bovine Tuberculosis, Brucellosis and BSE in cattle. As far as poultry diseases are concerned, such as Avian influenza and Newcastle disease, the government only pays compensation for birds slaughtered which are non-diseased (at 100% of their market value). For Aujeszky's disease in pigs the government will also pay 100% of the animal's market value. The only difference with Aujeszky's is that when the disease was in the country a levy was paid on all pigs at slaughter to cover the compensation costs. This levy is no longer collected but the legislation is in place to collect it again should the disease come in to the country again.

2.2 Compensation of consequential losses

In some countries the absence of public assistance has led to the creation of private insurance schemes for some types of livestock production. Other schemes include free public disaster assistance and hybrids in the form of Public-Private partnerships.

A number of public responses in the form of Public-Private partnerships to complement the private insurance market are possible. Within such partnership the government functions either as an insurer or as a reinsurer for the subsidised consequential loss policy. In the case of a Public-Private partnership with governmental reinsurance, the private insurer both retails and services the insurance policy, while retaining a part of the loss risk (Meuwissen et al., 2003). However, the policies are reinsured not solely through the reinsurance market but also / only by the government, either as a quota share or stop loss provision. Quota share provisions specify what percentage of premiums and loss exposure the private company will retain, with the remainder being passed on to the reinsurer. Stop loss provisions specify the maximum amount of loss that the company will have to cover before the reinsurer covers the additional losses (Skees and Barnet, 1999).

Governments can also provide financial assistance for consequential losses without requiring payments. Such government programmes can either be formalised by a public insurance scheme or by ad hoc disaster payments. In the case of public insurance, the risks covered are specified a priori, while disaster relief programmes usually operate only after a widespread disaster such as an epidemic (Skees and Barnet, 1999).

In Table 2 and Figure 1 the current EU financing schemes covering consequential livestock diseases are reviewed. The results are obtained from literature and a survey among members of CEA representatives (Comité Européan des Assurances) of the Agricultural Risks Insurance Committee. Few private insurance schemes exist on the European market to cover the risk of consequential losses from livestock epidemics.

Those that do exist are either extensions of general livestock insurance policies or are specific policies.

Many standard livestock insurance policies in Europe indemnify farmers for animal losses as a result of a number of perils, but some have been extended, sometimes as an option, to cover at least a part of consequential losses from epidemics. Most general livestock insurance schemes cover death and emergency slaughter due to illness, but also accident, theft, contamination of products, fire and storm are in most policies included. A more comprehensive policy that covers in addition more farm related diseases (e.g. mastitis and claw disorders) is rare.

The indemnity of additional consequential loss coverage is based on: 1) a percentage of the insured sum (for example 10% of the value of the livestock) or 2) duration of business interruption or 3) actual losses. In most cases the farmer chooses, within a certain range, the value of the livestock and the daily gross margin. Economic losses as a result of only movement standstills do not trigger indemnity payments given the first two coverage approaches. The indemnification of the third approach is based on the difference between the actual gross margin after the loss event and the insured gross margin. The insureds need to have accurate accounting records of a number of subsequent years. In general, farms that are confronted with losses as a result of decreased market value of their products but are not infected with an epidemic disease or are not in a movement standstill zone are not eligible for compensation.

All private insurance policies exclude direct losses that are met by the public sector. Additional constraints include a probationary period, a maximum coverage period, a multi-year policy term, a maximum insured amount, a maximum indemnification amount and a deductible.

Public-Private partnerships in the sense that governments subsidise a consequential loss policy are scarce. In some countries an additional public compensation above the value of the animals which are compulsorily slaughtered is paid to cover the consequential losses. This can be regarded as a form of Public-Private partnership since the compensation for direct losses generally stems from both public and private sources.

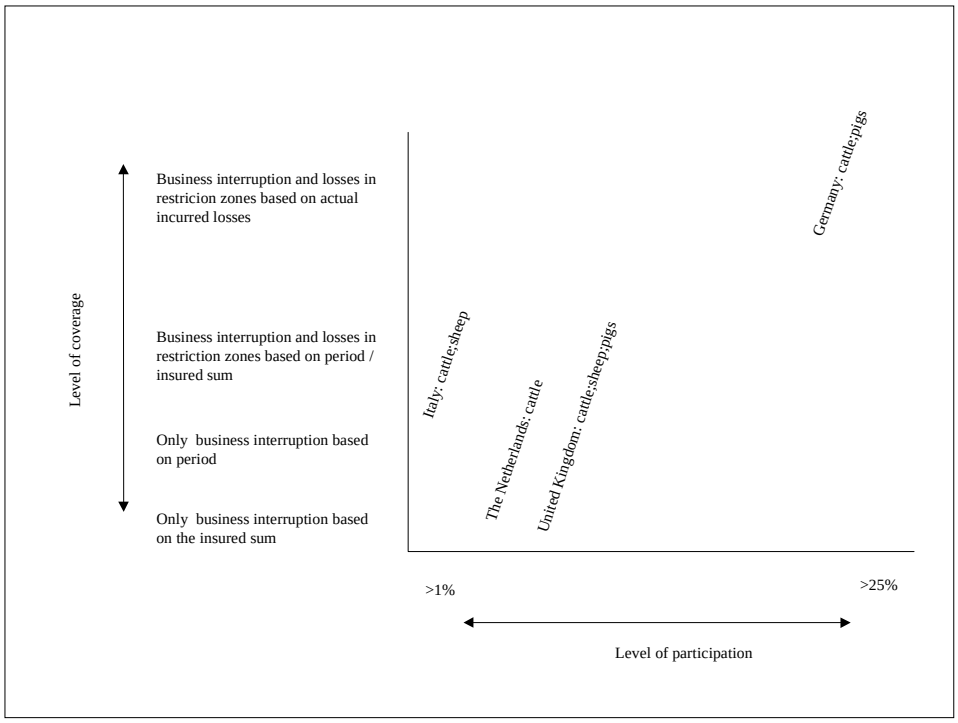


Figure 1: Level of participation and coverage for private voluntary insurance schemes.

Table 2: EU financing schemes covering (part of) consequential livestock losses[1]

	Financing system		
	Private	Public-Private	Public
Austria	-	-	-
Belgium	-	-	-
Denmark	-	-	+
Finland	-	-	+
France	-	-	+
Germany	+	-	-
Greece	-	+	-
Ireland	-	-	-
Italy	+/-	-	-
Luxembourg	-	-	-
Netherlands	+	-	-
Portugal	-	-	-
Spain	-	+	-
Sweden	+	-	+
United Kingdom	+	-	-

[1] -: not available, +: (partly) coverage and > 1% participation (ratio between insured livestock (in heads) and registered livestock (in heads)).

Denmark: If a whole herd is compulsorily slaughtered, the government pays a further 20% to cover the loss of income from the herd.

Finland: There are no commercial insurance companies offering insurance schemes for consequential losses caused by highly contagious animal diseases. Instead, the government is authorized to compensate consequential losses for farmers who suffer substantial income losses (hobby farmers and minor damages are not compensated). The current standard policy is to compensate business interruption losses when authorities have ordered culling of the herd. Since there is no money reserved for it, the policy is subject to available finance arrangements. In summary, the Finnish government can provide financial assistance for consequential losses via ad hoc disaster payments. Affected producers are uncertain whether or not and to what extent they will be indemnified by means of the disaster relief program. Consequential losses that could be compensated, were basically business interruption losses for those farmers who losed their herd because of infection or preventive culling. Defined as above, also substantial losses due to restriction zones can be compensated. In a recent BSE outbreak case, consequential loss was covered based on the duration of business interruption.

For diseases other than highly contagious animal diseases there are commercial insurance schemes. Generally, they have very low market share (less than 20% of farmers have commercial livestock insurance). For salmonella (only few cases of salmonella per year in Finland), a mutual insurance scheme exists where dairy, slaughterhouse etc. pays for the insurance and collects insurance payments from the farmers. It covers losses that are caused by a vet ordering, cleaning, disinfection, quarantine etc. measures. The scheme covers practically all farmers who produce livestock products.

France: There is no insurance in France to cover epidemic losses such as FMD, CFS and AI. When epidemics occur these losses are paid by public authorities according to the financial possibilities and importance of the epidemic.

Germany: In Germany the private “Ertragsschadenversicherung” indemnifies farmers against the full range of consequential losses as one of the coverage options, including those resulting from movement standstills. The indemnification is based on

the difference between the actual gross margin after the loss event and the insured gross margin, taking into account a deductible, and a covered period of 12 months. Losses as a result of movement standstills are indemnified with a percentage of 50%. The insureds need to have accurate accounting records of three years. The premium is a percentage of the insured sum, which is based on the value of the livestock and the gross margin per year. The farmer chooses, within a certain range, the value of the livestock. The standard gross margin differs between the performance levels. Participation level of dairy cows is over 50%, cattle 30%, sows 42% and hogs 23%. Insurance for sheep is not available. Insurance for poultry will not be prolonged (current participation <5%).

Italy: The additional coverage is only available for dairy cows and sheep. The level of participation is very limited (<5%). Covered perils are Brucellosis, Food and Mouth Disease, Tuberculosis and Leucose. Economic losses as a result of business interruption as well as losses in restriction zones trigger indemnity payments.

The Netherlands: The additional coverage (only available for cattle) is either a proportion of the insured sum of the culled animals (ranging from 10% up to 30%), or is based on the duration of business interruption (in some policies a limited period). In general, the indemnification is based on the number of cows that die or are culled. Covered perils are Brucellosis, BSE, Contagious Bovine Pleuropnemonia, Food and Mouth Disease, Rinderpest, Tuberculosis and Vesicular Stomatitis. Thus, economic losses as a result of only movement standstills do not trigger indemnity payments and coverage is only provided for cattle and not for pigs, poultry and sheep. Participation level is less than 10%. A mutual insurance scheme covers the consequential losses as a result of MG and Salomonella in breeder broilers.

Spain: Farmers in Spain can insure against disease outbreaks, though only for cattle (limited to animals for breeding and reproduction) and sheep and goats (AGROSEGURO). The insurance covers the difference between the actual level of aid farmers receive when an animal is slaughtered and its real value (which is another approach to direct loss compensation). These policies are government subsidised (up to a maximum of 41% in the case of cattle and 32% in the case of sheep and goats).

Sweden: The compensation that a farmer receives from the government is calculated as the difference between the actual profit and the expected profit if the farm was still engaged in production. Compensation is 50% in case of Salmonella and

Paratuberculosis. For diseases such as FMD, CSF and BSE, the compensation for consequential losses is 100%.

United Kingdom: There are insurance schemes for FMD, CSF and SVD which would pay towards consequential losses, but they are not arranged as typical business interruption covers, but merely pay a selected percentage (usually 25%) of the direct loss compensation. This means they only pay out when animals are slaughtered and do not cover losses in restricted zones or price effects. For Aujeszky's disease there is also insurance to contribute towards consequential losses which works in the same way as for FMD, CSF, and SVD. Insurance is also available to complement this compensation for animals slaughtered due to Bovine Tuberculosis, Brucellosis and BSE in cattle. The compensation and insurance schemes are more complicated for these diseases. The NFU Mutual Insurance Society does not provide any schemes covering consequential losses for poultry diseases. Approximately 10% of farmers insure against FMD, 10-15% of dairy farmers insure against Tuberculosis, approximately 10% of dairy farmers insure against Brucellosis. For the other insurable diseases less than 5% of farmers will insure against them.

3. Design risk financing model

3.1. Blueprint risk financing model

The list in Figure 2 provides a basis for constructing and evaluating a blueprint of a risk financing model. This list is a summary of the idealised conditions for a risk to be insurable (Ray, 1967; Rejda, 1998), but is also analogues to risk financing by means of a levy system. Both systems namely apply the principle of pooling which enables any loss costs to be spread over a larger group. However, Arrow (1992) regards insurance as a risk-transfer tool. The levy system is a risk-sharing strategy (also over time). But insurance can also be regarded as a risk-sharing tool with the insurer and re-insurer as intermediary. According to Vaughan and Vaughan (1996) both definitions are useful. The first reflects the indivual's perspective, the second the society. The insurance premium or levy amount are hence both referred to as rates. Each item in the list is addressed in turn below in a general context and subsequently focused on epidemic livestock risks.

1 There must be a large number of exposure units
2 The loss must be accidental and unintentional
3 The loss must be determinable and measurable
4 The loss should not be catastrophic
5 The probability of loss must be calculable
6 The rates must be economically feasible

Figure 2: Blue print pooling principle.

1. Large number of exposure units. Ideally, there should be a large group of roughly similar, but not necessarily identical, exposure units that are subject to the same peril or group of perils. The loss costs can then be spread over all participants in the underwriting class (Rejda, 1998).

2. Accidental and unintentional loss. In the ideal situation the loss should be fortuitous and outside the participant's control in order to prevent moral hazard (Rejda, 1998). With moral hazard, exposure units change their behaviour in a manner not predicted by the owner of system after signing the contract, for example by becoming more careless (Arrow, 1996).

3. Determinable and measurable loss. Determinable loss means that the amount of loss can be limited, and it can be clearly expressed if a certain expense is within the defined loss or not. Measurable means that the loss is financial and that its amount can be determined, either calculated or agreed upon or estimated.

4. Not catastrophic. In order to make the pooling technique workable, a large proportion of the exposure units should not incur losses at the same time. With systemic (or: correlated) risks, multiple participants can suffer losses at the same time (Skees et al., 1997). Examples of completely systemic risks include price risk and currency risk. Risks that are partly systemic include droughts, floods and epidemics. Problems arise with respect to pooling within a year and adequate reinsurance capacity is not usually available when the scale of the systemic risk is large (Jaffee and Russell, 1997; Miranda and Glauber, 1997). Thus, losses as a result of decreased market value of products are difficult to insure. Hedging by means of the futures market is a more appropriate risk financing tool.

5. *Calculation of probability of loss.* To set an appropriate rate, it is a prerequisite to calculate with some accuracy the cumulative distribution function of both the frequency and the severity of losses.

6. Feasible rates. The farmer must be willing to pay the rate. Individuals typically have problems in assessing the probability of, or the potential magnitude of, catastrophic loss events (Kunreuther, 1976). Because of such cognitive failure the demand for insurance is likely to be reduced (Skees and Barnett, 1999).

The idealised conditions for a risk to be financed by means of a pooling system do not all hold for the direct and consequential losses of livestock epidemics. Problems arise in relation to a number of the conditions. Yet this does not mean that a pooling system is impossible since the problems can be partially overcome with a sound design of the system.

Farmers can influence direct and consequential losses (criterion 2). Because meat prices might drop, sometimes dramatically during an epidemic, yet compensation is only paid for culled animals, there is an incentive for farmers to infect their herds deliberately and fraudulently. Only in this way they can get their animals culled and receive compensation (Heinz, 2000). Governments should therefore seek to reduce such dishonest conduct by farmers by establishing an appropriate legal framework covering epidemic fraud, with appropriate penalties, and by mobilising police to investigate any suspected cases (Heinz, 2000). Governments can also influence direct and consequential losses via the control strategies they use. For example, relatively large movement standstills are an effective strategy to eradicate the epidemic. The direct losses decrease while the consequential losses caused by the movement standstill increase. Therefore transparent control measures, systematically applied, are necessary.

The calculation of the direct and consequential losses are fairly cumbersome (criterion 3). Compensation of direct losses can either be based on a pre-set animal value or actual market value at the moment of culling. The indemnity for consequential losses should be based on the actual incurred loss or a proxy of the loss (for example based on duration and gross margin).

By means of reinsurance pooling problems can be overcome arising from a catastrophe. Difficulties in estimating the distribution of total indemnity payments might hamper the participation of reinsurers (criterion 4). Being such a niche segment, livestock insurance, especially for the epidemic exposure, is likely to be more difficult to place on the reinsurance market (Heinz, 2000). Even if reinsurance is available, it may attract a relatively high reinsurance premium. However, the reinsurance market is getting more acquainted with epidemic risks and are therefore more willing to underwrite these risks.

Calculating the cumulative distribution function of the risk (criterion 5) is difficult. Historical data on disease outbreaks and associated consequential losses are scarce and in any case may not be fully relevant if, say, the control measures to be used, have changed. Risk models estimating the impact of outbreak scenarios are scarce too.

Another problem relating to the design of insurance schemes for epidemics is that they are low probability events. Research shows that people typically have problems in assessing the probability of, or the potential magnitude of, low probability, catastrophic loss events (Kunreuther, 1976). Because of such cognitive failure the demand for insurance is likely to be reduced (criterion 6) (Skees and Barnett, 1999).

As described a sound design of the financing scheme a prerequisite. Within a voluntary system, like an insurance scheme, buyers can apply for the offered coverage. However, within a mandatory system all farmers need to pay the rates. A requirement for the levy payments is that can be easy implemented and is not subject to fraud. The rates can be charged on for example an annually basis at farm level or at the moments of slaughtering of the animals. In some (acceding) countries appropriate statistics are lacking, this also holds for an established sound payment system.

In addition to the previous discussed traditional financing solutions alternative risk transfer products (ART) can complement traditional solutions. Risk transfer through alternative carriers and through alternative products are the are two segments to the ART market. The market for alternative consists of self-insurance, captives, risk retention groups and pools. The alternative products consists of wide range of solutions, such as securitisation / insurance-linked securities and finite risk (re)insurance (Swiss Re, 2003). The advantages to use a pool construction and securitisation with respect to epidemic livestock losses will be elaborated on.

Pool constructions are an option in case capacity of the re-insurance industry is limited (SwissRe, 2003, PartnerRe, 2003). Insurance pools can provide protection against terrorism and atomic risks but can also include natural perils. Basically, the „insurance pools“ work as follows: 1) the ceding insurance companies establish a common Pool, 2) the Pool (as a partnership of the insurers) determines the premiums to be paid per risk and assumes the execution of the settlement of claim, 3) the insurers transmit the premiums to the Pool, 4) the Pool indemnifies the loss via the insurer to the policyholder, 5) the Pool manages the reinsurance risks, 6) and after the year-end, profit and loss are distributed to the involved insurers. The national or regional pools transfer the part of the premium volume, exceeding the necessary amount of retention and the amount already covered by the reinsurance protection, to the Pool (Wilkens, 2003). The advantage of an EU pool

arrangement is that if more countries / regions are participating the pooling principle works better and sufficient capacity for very large risks may be mobilised.

Insurance-linked securities are a way of increasing insurance capacity; the object here is to tap into bigger insurance capacities via the capital market. Insurance-linked securities have been either catastrophe bonds or life bonds, but it is also possible to securitise epidemic livestock risks. For example, the indemnity based catastrophe bond is triggered if an epidemic occurs, and the insurer may not have to pay interest (coupons) on the bonds, or the insurer may be able to delay the repayment. If, however, epidemic livestock losses are absent, the bond produces a high coupon yield. Note that catastrophic bonds often pay a high novelty premium in excess of the reinsurance capacity price.

3.1.1. Risk analysis

Premium or up front levy setting is very complicated and should be based on a profound knowledge of all factors included. The goal of rate making is to determine rates which will, when applied to the exposures underlying the risk being written, provide sufficient funds to pay expected losses and maintain an adequate margin for adverse deviation. In addition expected expenses and a return on (any) funds provided by investors could be taken into account. The rate is the product of the frequency of an outbreak (number of observed losses divided by the number of exposure units) and the severity (total losses divided by the number of observed losses). There are various actuarial methods for premium calculation, more or less sophisticated, being able to make as optimal use of the data and information available. The loss ratio approach indicates the rate changes, whereby the rate change is calculated as: experience loss ratio divided by the target loss ratio times the current premium rate. This method requires existing rates (for example agricultural hail insurance schemes with more than 100 years data). Thus this method cannot be used for a new line of a financing scheme. The pure premium approach indicates rates on basis of the total loss and the number of exposure units (Driscoll, 1997). Also the aspects such as classification of the risk and rate differentiation are all parts of premium calculation. Without proper rate differentiation, antiselection is likely to occur. Antiselection occurs when the exposure units most at risk buy more protection than others, and the extent to which this happens is not known a priori (Rejda, 1998).

Since outbreaks occur irregularly in time and place it is difficult to derive general properties and predictive values. Also the probability distribution describing the possible spread of FMD and CSF is difficult to ascertain (i.e., severity). The latter is highly depending on the control strategy applied. Another complicating factor is that the environment is dynamic by a prospective non-vaccination policy, changing herd intensity and structure, and liberalisation of markets (e.g., trade of live animals and products).

Because of the lack of experience the use of the expertise (a combination of experience and understanding of current / future probabilities) of those working in this area can complement the more standard rating methodologies. Elicitation of subjective knowledge can therefore provide the quantitative information for modelling purposes. The epidemiological extent can be estimated by means of a spatial dynamic and stochastic simulation model. Such models simulate the spread of a virus between farms through local spread and contacts (from transport, animals, and persons), and given a specific control strategy. By means of simulation the impact of strategies that have not been applied yet can be explored. Results provide insight into the number of farms infected and the number of farms under surveillance for each day of an epidemic (Jalvingh et al., 1999, Nielen et al., 1999). Subsequently, the economic analysis is based on these epidemiological results by placing them in the specific economic context (e.g., income per animal, output prices, import / export position of country).

Important aspect is to classify rates on expected claim cost if risks between farms are heterogeneous. The European area can be divided into various regions that differ with respect to the risk of livestock epidemics. A risk classification can be based on various criteria (Huirne and Windhorst, 2003).

1. Country borders. Livestock epidemic disease risks considerably differ across countries. The estimated number of FMD and CSF epidemics (primary outbreaks) presented in literature differ considerable between (groups of) countries (Horst et al., 1999; Ryan and Gallagher, 2000; Meuwissen et al., 2003).
2. Herd density. A higher herd density is likely to indicate more animal contacts and transports and thus a higher risk. Herd density can be expressed per km2 ‘total land’ (includes cities, roads etc.) and per km2 ‘agricultural land’.

3. Animal density. As with herd density, a higher animal density is likely related to a higher of being confronted with a livestock outbreak. Animal and herd density are, however, not completely interchangeable parameters since a region with less but larger farms may represent a lower risk than a region with more but smaller farms.
4. Import/export. The higher the amount of animals imported and/or exported, the higher the risk related to the imported animals and returning trucks. This argument also holds for different regions within a member state.
5. Natural borders. Natural borders, such as rivers and mountains, may be a barrier for disease spread since they are likely to lead to more controlled contacts between regions.

Note that the different risk classification methods partly complement each other in quantifying the risk of introduction and spread of an epidemic animal disease. Therefore more a multi-criteria approach to classify such areas because will be more accurate (Huirne and Windhorst, 2003).

3.1.2. Risk financing

Risk financing of epidemic livestock diseases can be based on either a levy system or insurance system. Both systems apply the principle of pooling which enables any loss costs to be spread over a larger group. In a levy system transfer is absent because losses are paid over time by the primary sector. However, the similar principle can also be accomplished by a multiple year loss sensitive plan with (re-) insurers (i.e., finite risk transfer or financial insurance) (Harrington and Niehaus, 1999). The farming sector pays a premium each year to the insurer who places the premiums in a fund (after taking out a fee). The fund accumulates interest at an agreed upon rate of return, and losses are paid from the fund. If the fund is insufficient to pay for all the losses in a given year, then the insurer will pay losses up to a stated limit. However, the sector's future premium payments are used to reimburse the insurer. Any surplus remaining in the fund at the end of the policy period is returned to the sector. These features imply that the sector pays most losses, but that the payments less volatile.

In case of a more classical insurance scheme, the risk retention and risk transfer have to be determined on the level of the insurer and the reinsurers. Risk retention and risk transfer on the level of the insured and the government do play a role for both the levy as

well as the insurance scheme. On all those four levels the division between risk retention and risk transfer can be made on a proportional basis, a non-proportional basis or a combination of both. For example on the level of the insurer a proportional retention means quota share or surplus reinsurance and a non-proportional retention means excess of loss or stop loss reinsurance.

The best way to determine the optimal arrangement is to construct a stochastic financial model. Such models simulate the effects for the assets and liabilities simultaneously for a number of years. The effects for all different levels – insured, insurer, reinsurer and government – could be made transparent in this way. The input for this model are the (re)insurance contracts and the loss distribution function. It is very important to determine minimum requirements for the retention levels to minimise the asymmetric information effects. Asymmetric information is referring to a situation in which one party (for example insured) has more or better information than the other party (for example insurer) about the risk. A higher retention leads to reduced moral hazard effects. The aspects related to the incentive structure are elaborated on in chapter 4.

3.2. Application risk financing model

An application of a risk analysis (epidemiological and economic) and an application of the main considerations with respect to alternative risk financing instruments are illustrated for the Netherlands, for which a large amount of data is already available.

3.2.1. Application risk analysis

The Farm Management Group of the Wageningen University in the Netherlands developed an epidemiological FMD and CSF model in the beginning of the nineties (Meuwissen et al., 1997; Horst et al., 1999; Jalvingh et al., 1999; Nielen et al., 1999, Meuwissen et al., 2000). Since the Netherlands is in principle free of FMD and CSF, the occurrence of an epidemic is caused by the introduction of virus from other countries. Parameters in the model that determine the number of epidemics in the Netherlands refer to the frequency of epidemics in other European countries, the duration of so-called “high

risk periods", the risks related to the import and export of livestock, and the import of animal products.

Parameters were based on assumptions made by eliciting subjective expert knowledge (Horst et al., 1999). The experiment was conducted with 43 experts, all involved in or related to disease control in one way or another in different European countries. Three-point estimation (eliciting minimum, most likely, and maximum values) was used to derive information concerning the probability of an outbreak. The epidemiological extent of epidemics once introduced in the Netherlands is derived from a detailed, spatial, dynamic simulation model. After the outbreak of CSF in 1997/1998 the previous described models were adjusted because of altered control strategies and regulations. In total three Dutch experts were consulted to update the models (Meuwissen et al., 2000). After the FMD-outbreak of 2001/2002 expert consultations were repeated on basis of again three experts from the Netherlands. After processing all questionnaires, results were sent back to the experts in order to reach consensus.

In contrast to the previous two elicitation rounds (Horst et al., 1999; Meuwissen et al., 2000) not only the most likely, minimum and maximum values about the probability of an outbreak but also the number of infected farms, duration and radius of restriction zones were elicited by region. As a result, solely on basis of these elicited numbers distributions of epidemiological outbreak characteristics could be estimated. The latter procedure is also employed in the current research. If available, the results described in literature are used to validate the input assumptions of the model.

A Monte-Carlo simulation model is constructed in order to obtain insight into the annual loss-distribution. Monte Carlo simulation is considered an appropriate and very flexible method of investigating aspects that are stochastic of nature, such as livestock epidemics. Including the possibility of these types of events in a simulation model is an important technique in risk analysis. Risks are thereby incorporated by using probability distributions, which can be manipulated by input modification with respect to the different scenarios. At each iteration randomly drawn numbers from specified distributions are used representing a possible combination of values that could occur. Combining the results of each iteration will lead to a distribution of output values, reflecting a realistic aspect of probability. In the Monte-Carlo simulation model, the

uncertainty about the introduction of an epidemic in a specific year is reflected by a Poisson distribution. The region in which an epidemic occurs is simulated by a discrete probability distribution. Epidemic and ultimately economic consequences are reflected by triangular distributions, with parameters referring to the most likely, minimum and maximum scenarios. Results are based on 5000 iterations.

3.2.1.1. Model assumptions

Description of regions

Herd and animal densities can vary regionally. However, for further analyses, i.e. as a basis for risk (and premium) calculations, the different regions need to be aggregated to a limited, and thus computable, number of regions. The country under consideration, the Netherlands (NL), is subdivided into two regions as follows: NLI (South-East: Limburg, Noord-Brabant, Gelderland, Overijssel) and NLII (North-West: all other provinces). The aggregated statistics of livestock production (cattle and pigs) by region are presented in Table 3. Farm densities are higher in NLI compared to NLII.

Table 3: Number of farms, animals per farm and herd density[1] by regions (census 2000-2001).

	NLI			NLII		
	Number of farms	Animals per farm	Farms per Km^2	Number of farms	Animals per farm	Farms per Km^2
Cattle	28,459	89	1.79	19,424	86	0.77
Dairy	18,783	51	1.19	12,820	49	0.51
Pigs	14,036	868	0.89	2,390	582	0.10
Farrowing sows	5,614	218	0.35	956	146	0.04
Finishing pigs	7,018	799	0.44	1,195	535	0.05

[1] Per km^2 land.

Sources: The Netherlands: Huirne and Windhorst (2001); Agricultural Economics research Institute and Statistics Netherlands (2001); Commodity Board.

Frequency of epidemics

Per 5-year period the expected number of epidemics is 1 for FMD and 1 for CSF (Table 4). The number of outbreaks varies across the two regions as a result of the number and

type of farms in combination with subjective expectations about the risk exposure of each region. On basis of previous assumptions the expected annual probability of an outbreak per region and disease can be determined. For example, the expected annual probability of an primary FMD outbreak in NLI equals 3/20 (1/5*75/100).

Table 4: Number of primary FMD and CSF outbreaks for the five-year period 2002-2007 (most likely, minimum and maximum value) and probability of occurrence per region[1].

	Country	Regions	
FMD	1 (0; 2)	NLI: 0.75	NLII: 0.25
CSF	1 (0; 2)	NLI: 0.80	NLII: 0.20

[1] Previous results in literature for the group "Great Britain, Ireland and Scandinavia": Horst et al. (1999): 0.5 FMD epidemics per 5 year (25 en 75 percentiles: 0.5 and 1 respectively) and 0.5 CSF epidemics per 5 year (25 en 75 percentiles: 0.5 and 1 respectively), "Great Britain, Ireland, Scandinavia and Iceland": Ryan and Gallagher (2000): 1 epidemic per 5 year (5 en 95 percentiles: 0 and 2 respectively).

Size of epidemics

When interviewing experts on the expected size of epidemics they were first asked to define the package of control measures for each of the regions under consideration. For FMD the control measures mentioned *in addition* to the minimum EU requirements (i.e. stamping-out of infected herds and contact herds and the implementation of restriction zones of 3 and 10 km) included: (1) a complete movement standstill of 3 days for The Netherlands as a whole (including transport of feed, milk and manure); (2) ring vaccination in 2 km around infected herds in NL and 1 km NLII; and (3) pre-emptive slaughter of all susceptible herds within a radius of 1 km of infected herds. For CSF, additional control measures included: (1) a complete movement standstill for live pigs of 3 days; and (2) pre-emptive slaughter of all susceptible herds within a radius of 1 km of infected herds (both for NLI and NLII).

Given these (additional) control measures, Table 5 shows the most likely, minimum and maximum scenarios with respect to the size of epidemics. Included are the number of farms infected, the duration of an epidemic (expressed in days), and the radius of restriction zones (in km). For the number of farms infected, the table also shows the expected ratio between the number of pig farms and the number of cattle farms infected.

The radius of restriction zones refers to the radius of the total area that is expected to be confronted with restrictive measures.

The size of an outbreak varies across the two regions as a result of the number and type of farms in combination with subjective expectations about the risk exposure of each region. With respect to the number of infected farms, it is generally expected that there are more cattle farms affected than pig farms. In the most likely scenario, FMD-epidemics are expected to be largest in NLI (45 infected farms, 45 days). With respect to the corresponding maximum scenario, the numbers are 100 infected farms and 100 days respectively.

Table 5. Expected size of FMD and CSF outbreaks for the five-year period 2002-2007 (Most Likely, MINimum and MAXimum scenario).

	NLI[1]			NLII[2]		
	ML	MIN	MAX	ML	MIN	MAX
FMD						
Number of pig and cattle farms infected	45	20	100	15	2	50
Ratio pig farms:cattle farms	1:3			1:10		
Duration of epidemic (days)	45	25	100	40	25	60
Radius of restriction zones (km)	20	10	40	15	10	30
CSF						
Number of pig farms infected	30	4	200	10	1	40
Duration of epidemic (days)	60	30	100	45	30	80
Radius of restriction zones (km)	15	10	30	12	10	25

[1] Considering similar control strategies, simulations with InterFMD (updated model of Jalvingh et al. 1999) for an FMD epidemic starting in Boekel (located in densely populated livestock area), result in 28 and 111 infected cattle, pig, goat and sheep herds (50% and 95% respectively) with a duration of respectively 49 and 88 days.

[2] Considering similar control strategies, simulations with InterFMD for an FMD epidemic starting in Veendam (located in a sparsely populated livestock area), result in 3 and 13 infected cattle, pig, goat and sheep herds (50% and 95% respectively) with a duration of 33 and 48 days.

Financial consequences

In order to calculate the losses for each scenario the financial consequences need to be assessed. The financial consequences are subdivided into direct costs and consequential

losses. In Table 6 an overview is provided of the financial parameters by farm type. Direct costs are reflected by the monetary values for animals destroyed.

With respect to the column 'business interruption after depopulation' special attention needs to be paid to the dairy farms. Losses for dairy farms are lower in case they are allowed to lease their milk quotum to other farmers during the period of business interruption, or, if they can 'catch up' after the epidemic. Temporarily leasing out of the milk quotum is, however, only feasible if the area affected with the FMD-epidemic is relatively limited. The opportunities of catching up after the epidemic is depending on the remaining time within the quotum year. For business interruption on depopulated dairy farms Table 6 shows each time two parameters: the first indicating losses if leasing (or 'catching up') is possible, the second if this is not possible.

Table 6. Financial parameters by farm type.

	Direct costs Depopulation (€/animal)	Business interruption (€/day)			Dairy farms in restriction zones (€/day)
		Depopulation	Welfare Slaughter	Breeding prohibition	
Dairy	688	0.70-6.66/cow[1]	n.a.[2]	n.a.[2]	0-6.66/cow
Farrowing sows	450	1.02/sow	0[3]	0.72/sow[5]	n.a.[2]
Finishing pigs	83	0.18/place	0.18/place	n.a.[2]	n.a.[2]

[1]For depopulated dairy farms, the first amount reflects losses in case 'leasing or catching up' is possible, the second in case this is not possible. For dairy farms in restriction zones, the first amount reflects losses in case milk is collected and paid as normal (€0.35/kg), the second in case milk has to be discarded (and there is also no 'leasing or catching up' opportunity).

[2]n.a.: not applicable.

[3]If governments compensate animals at their real value.

[5]Assuming a governmental compensation of € 32.30 per sow per month.

Sources: Agricultural Information and Knowledge Centre and Research Station for Animal Husbandry (2001), Hogeveen et al. (2002).

Also for dairy farms in restriction zones there are two parameters included in the table: if milk is collected and paid as normal, losses are zero. However, if this is not the case (i.e. milk has to be discarded), losses are assumed to be equal to the situation in which the

farm is depopulated (with or without leasing or 'catching up' opportunities)[1]. Experts' opinions about dairy farms in restriction zones are: milk is collected but not fully compensated.

With respect to the business interruption losses from welfare slaughter, losses only occur on finishing pig farms, since the farrowing farms can continue their production of piglets (unless a breeding prohibition is enforced).

Additional scenario assumptions

The following assumptions have been made:

1. For each infected farm, three farms are slaughtered pre-emptively. We need to make this assumption since we only know the 'pre-emptive slaughter policy' considered by the experts (1 km for the Netherlands), but not the exact number of pre-emptively slaughtered farms. The ratio coincides with the ratio from both the 1997/98 CSF-epidemic in the Netherlands (LNV, 1998) and the 2001 FMD-epidemic in the UK (DEFRA, 2002). However, the ratio from the 2001 FMD-epidemic in the Netherlands was approximately 1:40 (which was an exceptional stringent policy and included vaccinated animals). Note that—since our radius of restriction zones is fixed in each iteration—the total number of affected farms is not influenced by the ratio infected/pre-emptively slaughtered farms.
2. All affected farms (i.e. all farms that are infected, pre-emptively slaughtered, and/or located in a restriction zone) face restrictions for the whole duration of the epidemic (i.e. there are no temporarily removals of restrictions for part of the farms).
3. A welfare slaughter program for animals that are ready to be delivered (25-kg pigs on farrowing farms and 110-kg hogs on finishing farms) is enforced right from the beginning of an epidemic. Welfare slaughter of very young piglets is considered not to be applied at all. This is supported by experts' opinions about the application of welfare slaughter.
4. With respect to the enforcement of a breeding prohibition on pig farms, we assume a breeding prohibition for both FMD and CSF, starting from the beginning of an epidemic.

[1] Losses may even be higher on dairy farms in restriction zones than on depopulated farms, since farms in restriction zones still face their variable costs of feed, veterinary services etc.

5. For depopulated dairy farms, it is assumed that there are no possibilities for leasing and/or ‘catching up’ after the epidemic. Similarly, for dairy farms in restriction zones, we assume that milk is not collected or paid and that there are also no possibilities for ‘leasing or catching up’.
6. Herds that have been vaccinated are not destroyed. Although this subject is still being debated, we assume that it is not socially accepted to destroy vaccinated herds. If vaccinated herds would be destroyed, this could affect losses from business interruption.

Direct and consequential losses are obtained by merging the aggregated herd characteristics, epidemiological parameters and financial parameters. For both loss categories, i.e. losses from direct losses and consequential losses, the estimated losses resulting from FMD and CSF epidemics in the most likely scenario for the two regions. Also losses of minimum and maximum scenarios are provided. For example, the most likely annual direct loss in the dairy sector if an outbreak of FMD occurs in region I is based on the fraction of dairy holdings and cattle holdings in region, the average dairy herd size, the most likely total number of infected cattle holdings, ratio infected : pre-emptively slaughtered and direct loss per dairy cow. Risks are differentiated according to region and farm type, for the simplicity three main sectors are elaborated on, namely dairy sector, farrowing sow sector and finishing pig sector (Table 7).

Table 7: Annual losses FMD and CSF in most likely, minimum and maximum scenario.

	Direct losses			Consequential losses		
	Ml	Min	Max	Ml	Min	Max
FMD						
NLI						
Dairy	3,144,476	1,387,269	6,936,344	22,952,586	3,201,703	203,376,030
Farrowing sows	6,801,075	2,043,604	24,262,619	2,394,862	350,299	20,649,303
Finishing pigs	9,433,090	2,641,538	35,273,713	1,936,664	283,278	16,698,567
NLII						
Dairy	1,241,249	177,321	3,989,728	4,718,704	1,309,644	28,205,991
Farrowing sows	310,157	90,594	1,348,549	89,185	22,001	551,016
Finishing pigs	410,949	142,335	1,737,005	72,122	17,792	445,593
CSF						
NLI						
Farrowing sows	7,561,293	1,893,417	42,810,106	2,304,683	411,631	18,226,179
Finishing pigs	8,464,357	2,519,424	44,490,724	1,863,739	332,876	14,739,048
NLII						
Farrowing sows	1,181,482	194,627	4,776,946	163,984	33,220	1,205,754
Finishing pigs	1,092,769	229,435	4,451,229	132,610	26,864	975,063

Subsequently, in the Monte Carlo simulation model the most likely, minimum and maximum losses are accounted for by triangular probability distributions (per animal species, sector, region and disease).

3.2.1.2. Default results loss distribution

In Table 8 the loss distributions are presented by means of a number of fractile values and the average. Losses refer to the country level. Losses per epidemic and per region are aggregated into annual losses at the country level by considering (1) the number of epidemics in a certain year (if any); (2) the region of occurrence; and (3) the losses per epidemic. Further assumptions equal those described previous.

For example, considering the distribution of annual losses the there is a 90-percent probability that direct losses in the dairy sector are less than 2.93‰ of the animal value. However, there is a five-percent probability that the losses exceed more than 4.07‰ of the animal value. The average direct loss for FMD is 0.60‰ of the animal value. There is a 75% probability that an outbreak is absent.

The direct losses are particularly high within the farrowing sow sector and finishing pig sector in comparison to the dairy sector. This is mainly the result of having two perils, i.e., FMD and CSF. The opposite holds with respect to consequential losses as a result of losses of dairy farms in restriction zones.

Table 8: Direct and consequential losses FMD and CSF values (fractile values and average value)[1]

	50%	75%	90%	95%	100%[2]	Average
Direct losses						
Dairy	0.00	0.00	2.93	4.07	9.29	0.60
Farrowing sows	0.00	0.00	34.61	52.36	96.05	7.16
Finishing pigs	0.00	0.00	48.61	74.69	161.86	10.51
Consequential losses						
Dairy	0.00	0.00	44.37	81.04	229.83	10.52
Farrowing sows	0.00	0.00	18.05	26.36	67.12	3.66
Finishing pigs	0.00	0.00	17.38	27.40	62.77	3.72

[1] 1,000 @Risk-iterations, ‰ of animal value (in case of CSF only pigs).

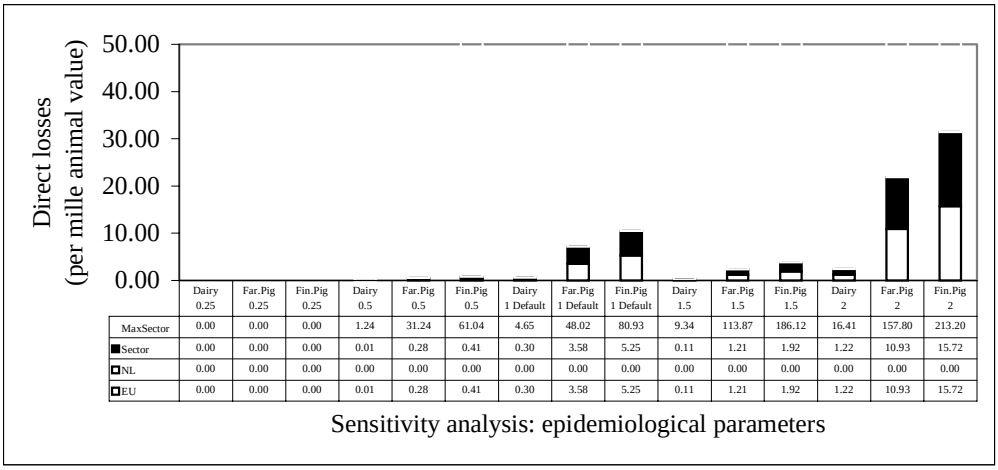
[2] 'Estimated maximum loss scenario' (EML) and not 'maximum possible loss scenario' (MPL).

3.2.1.3. Sensitivity analyses

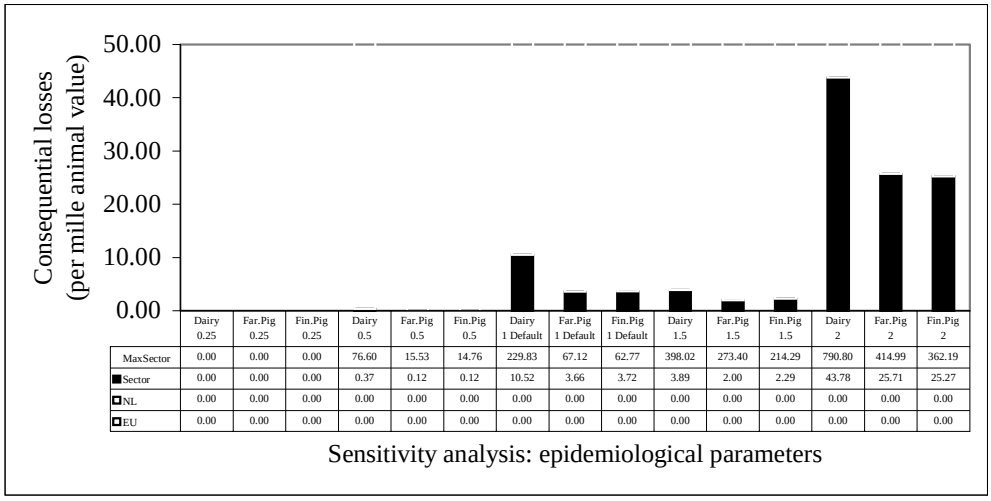
Sensitivity analyses, or, what-if analyses provide useful insight into deviations of the 'best guess estimates' of important variables in a model (Vose, 2000). In this section, sensitivity analyses are carried out with respect to (1) the epidemiological parameters concerning the expert opinions; (2) the financial parameters; and (3) the assumptions with respect to control and welfare measures.

Epidemiological parameters

Sensitivity analyses with respect to size of epidemics refer to variations in the frequency of an outbreak, number of infected farms and the duration of epidemics. Figures 3A and 3B show the results whereby the differences in comparison to the default situation are denoted by a factor; the frequency, number of infected farms and the duration are all multiplied with a certain factor (i.e., 0.25, 0.5, 1.5 and 2).



	Dairy 0.25	Far.Pig 0.25	Fin.Pig 0.25	Dairy 0.5	Far.Pig 0.5	Fin.Pig 0.5	Dairy 1 Default	Far.Pig 1 Default	Fin.Pig 1 Default	Dairy 1.5	Far.Pig 1.5	Fin.Pig 1.5	Dairy 2	Far.Pig 2	Fin.Pig 2
MaxSector	0.00	0.00	0.00	1.24	31.24	61.04	4.65	48.02	80.93	9.34	113.87	186.12	16.41	157.80	213.20
Sector	0.00	0.00	0.00	0.01	0.28	0.41	0.30	3.58	5.25	0.11	1.21	1.92	1.22	10.93	15.72
NL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.00	0.00	0.00	0.01	0.28	0.41	0.30	3.58	5.25	0.11	1.21	1.92	1.22	10.93	15.72



	Dairy 0.25	Far.Pig 0.25	Fin.Pig 0.25	Dairy 0.5	Far.Pig 0.5	Fin.Pig 0.5	Dairy 1 Default	Far.Pig 1 Default	Fin.Pig 1 Default	Dairy 1.5	Far.Pig 1.5	Fin.Pig 1.5	Dairy 2	Far.Pig 2	Fin.Pig 2
MaxSector	0.00	0.00	0.00	76.60	15.53	14.76	229.83	67.12	62.77	398.02	273.40	214.29	790.80	414.99	362.19
Sector	0.00	0.00	0.00	0.37	0.12	0.12	10.52	3.66	3.72	3.89	2.00	2.29	43.78	25.71	25.27
NL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 3A and 3B: Sensitivity analysis epidemiological parameters.

Given the default situation, the average direct losses in the dairy sector, farrowing pigs sector and finishing pig sector are 0.60‰ (0.30+0+0.30), 7.16‰ (3.58+0+3.58), and 10.50‰ (5.25+0+5.25), respectively. Differences with Table 8 are due to random draws of the simulation model and rounding. Note that the direct loss for the farming sector is assumed to be 50% of the previous derived loss in case EU subsidy is subtracted, while national co-financing is considered to be absent. All consequential losses are accounted to the farming sector since EU and national co-financing is considered to be absent. The maximum possible losses refer to the maximum retention of the sector.

A decrease in the assumption about the frequency, number of infected farms and the duration at the same time has a large impact on the loss amounts. For example, given a

deviation from the default by a factor ½ the losses for the most likely, minimum and maximum scenario deviate by a factor 1/8 (½ x ½ x ½).

Economic parameters

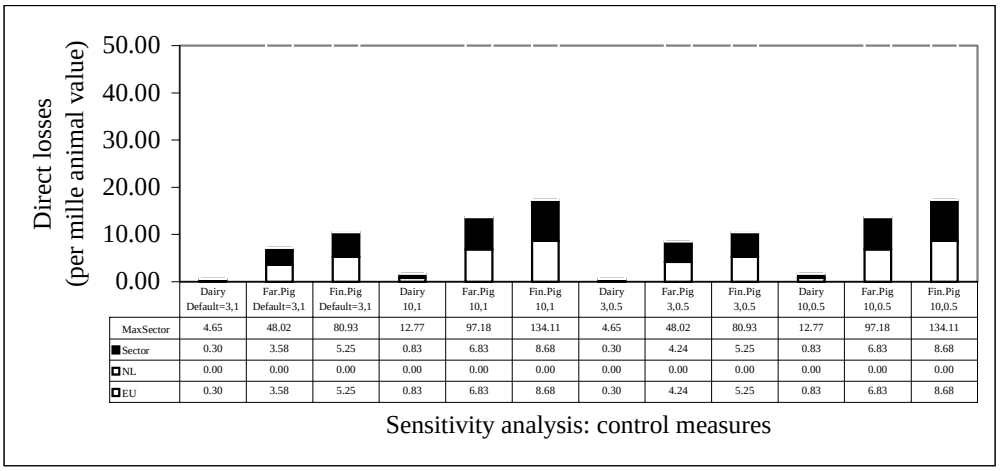
Besides the important aspect of direct costs which are reflected by the monetary values for animals destroyed alternative assumptions with respect to the incurred consequential losses are important too. The possibility for dairy farmers to lease their milk (or 'catch up' after the epidemic). In previous calculations we assumed that this was not possible. By leasing milk, business interruption losses per cow decrease significantly (€0.70 per cow). The possibility of leasing milk reduces average total consequential losses in the dairy sector considerably. The possibility to lease milk refers both to depopulated dairy farms as well as to dairy farms in restriction zones. In addition, a decrease in business interruption losses at depopulated farms can be reasoned. Farmers from depopulated farms (infected or pre-emptively slaughtered) are in principle able to reduce their net income loss, e.g. by off-farm work or by renovating their buildings for which otherwise people would have to be hired.

Control and welfare measures

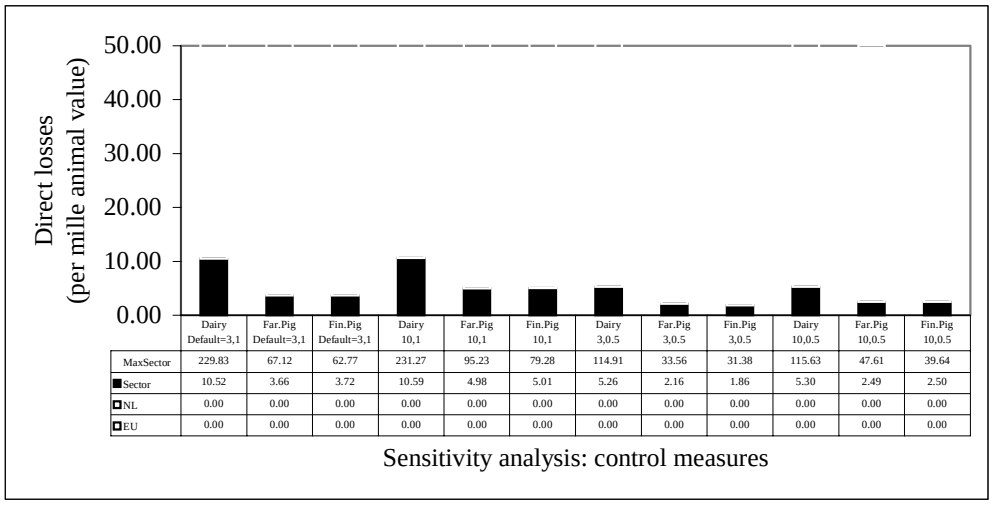
Sensitivity analyses with respect to the control and welfare measures refer to:

1. An increase in the ratio of infected and pre-emptively slaughtered herds (1:10 instead of 1:3).
2. Affected farms are confronted with restrictions during only half of the epidemic (some areas are not yet restricted in the beginning of an epidemic, other areas will be declared free before the end of the epidemic). In these analyses we assume that there is no effect on the size of epidemics, i.e. input parameters stay the same (Figure 4A and 4B).

Increasing the ratio of infected and pre-emptively slaughtered herds leads to an increase in the losses. Reducing the duration in which farms are faced with control measures has a major impact on losses.



	Dairy Default=3,1	Far.Pig Default=3,1	Fin.Pig Default=3,1	Dairy 10,1	Far.Pig 10,1	Fin.Pig 10,1	Dairy 3,0.5	Far.Pig 3,0.5	Fin.Pig 3,0.5	Dairy 10,0.5	Far.Pig 10,0.5	Fin.Pig 10,0.5
MaxSector	4.65	48.02	80.93	12.77	97.18	134.11	4.65	48.02	80.93	12.77	97.18	134.11
Sector	0.30	3.58	5.25	0.83	6.83	8.68	0.30	4.24	5.25	0.83	6.83	8.68
NL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.30	3.58	5.25	0.83	6.83	8.68	0.30	4.24	5.25	0.83	6.83	8.68



	Dairy Default=3,1	Far.Pig Default=3,1	Fin.Pig Default=3,1	Dairy 10,1	Far.Pig 10,1	Fin.Pig 10,1	Dairy 3,0.5	Far.Pig 3,0.5	Fin.Pig 3,0.5	Dairy 10,0.5	Far.Pig 10,0.5	Fin.Pig 10,0.5
MaxSector	229.83	67.12	62.77	231.27	95.23	79.28	114.91	33.56	31.38	115.63	47.61	39.64
Sector	10.52	3.66	3.72	10.59	4.98	5.01	5.26	2.16	1.86	5.30	2.49	2.50
NL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 4A and 4B: Sensitivity analysis control measures.

The overall conclusion with respect to the sensitivity analysis is that the subjective expert assumptions, the economic parameters and the control and welfare measures applied are the decisive elements in the risk analysis.

3.2.2. Application risk financing

Alternative risk financing arrangements are analysed using the estimated loss distribution function. Thus the effects for all different levels – sector, national budget and EU budget – are estimated. The financial arrangements included are a proportional national coverage (fraction of the loss), non-proportional national coverage (‰ animal value), a limited insurance coverage in days, a deductible in days, a levy system, and an insurance contract. Table 9 summarises key characteristics of different risk financing arrangements for comparison.

If risks are shared between the sector and the national government by means of a proportional contract (i.e., pro-rata contract), whereby the latter indemnifies a proportion of the claim costs, average and maximum retention for the sector decreases in case the national proportional coverage increases. Similar schemes can also be applied in the (re)-insurance contract.

With non-proportional contracts, the national government indemnifies only claims in excess of a particular threshold. The relative amount indemnified from the national budget compared with the total loss is lower in the dairy sector than in the farrowing pig sector and finishing pig sector. This is because the retention is formulated on a ‰ animal value and the losses for the latter two sectors are higher.

Decreasing the maximum coverage period to 100 days has no noteworthy impact on the claims for the national budget as a result of the expert expectations about the duration of the outbreak. A more restricted coverage period has an impact. Applying a deductible has a direct impact. The duration of the epidemics is expected to be short and thus increasing the deductible with a number of days, does have an important impact on premium rates. Levy payments are less volatile than the situation without smoothening over time. Increasing the roll-over period decreases the volatility.

Under investigation are also insurance schemes to cover direct (non-EU compensated part) and consequential losses. Reinsurance capacity is provided through a proportional layer. With insurance the minimum premium comprises the re-insurance premium and occurs if losses are absent. The maximum insurance premium is lower because of the non-proportional reinsurance layer. The average loss without insurance (default) is lower than the average insurance premium because of the costs associated with the transfer. However, the maximum amount financed by the sector is constrained.

Table 9: Features of risk financing arrangements for direct and consequential losses in the farrowing pig sector.

	Sector		National	EU
	Mean	Max	Mean	Mean
Default direct losses	3.58	48.02	0.00	3.58
National proportional coverage 50% (Annex I)	1.79	24.01	1.79	3.58
National non-proportional coverage 10‰ (Annex II)	1.69	10.00	1.89	3.58
Levy 3 years (Annex V)	3.59	24.89	0.00	3.59
Insurance (Annex VI)	4.37	8.79	0.00	3.58
Default consequential losses	3.66	67.12	0.00	0.00
National proportional coverage 50% (Annex I)	1.83	33.56	1.83	0.00
National non-proportional coverage 10‰ (Annex II)	1.61	10.00	2.05	0.00
Coverage period 50 days (Annex III)	1.77	33.48	1.89	0.00
Deductible period 28 days (Annex IV)	1.10	18.84	2.55	0.00
Levy 3 years (Annex V)	3.66	27.52	0.00	0.00
Insurance (Annex VI)	4.46	21.29	0.00	0.00

In summary, a proportional national (and/or EU) coverage (fraction of the loss) and a non-proportional national (and/or EU) coverage (‰ animal value) or a combination of both reduce in the maximum retention of the sector. With respect to the levy system and an insurance policy both rates are still volatile and originate from the number and severity of epidemics occurring. Chances of facing these extreme cases (both minimum and maximum rates) are higher in case of the levy system than in case of the insurance system. Levy payments in the levy system are more volatile since the risk is not transferred to another party but are to a lesser extend smoothened over time. However, the average levy is lower than the insurance premium because of the costs associated with the transfer.

4. Prospective risk financing systems

4.1. Incentives

In discussing the feasibility and efficiency of risk financing instruments, two aspects play a central role: risk financing costs, and incentives for risk prevention. Average risk financing costs are lower for a pooling instrument in comparison to a transfer instrument. However, the maximum possible size of levies and premiums are lower for the latter. The question of which of the instruments for direct and consequential losses should prevail depend on the (political) significance assigned to each characteristic (average costs or possible size of levies and premiums). There are several aspects of risk financing instruments that relate to incentives for risk prevention. A national minimum standard for 'good farming practices' (see for example Howe and Whittaker, 1996) induces principles of 'due diligence' on all farms. 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, 1996). Actuarially sound rating and limited coverage are the two major methods of reducing moral hazard. Both approaches provide incentives for insureds to take precautions after policies are issued by placing some risk on the insured. A certain amount of differentiation of levy or premium rates and/or indemnity payments is likely to encourage risk prevention.

4.2. Role of the public sector

A partnership for risk communication is important to prevent delaying debates about prevention and control strategies: some (additional) control measures may seem very expensive at the time they are taken but they may lead to substantial lower overall losses. A partnership for risk financing could be relevant to reduce moral hazard of governments: many catastrophes (here: epidemics) can be either prevented or magnified by government policies (or lack thereof). Having governments financially responsible for

some losses might be an incentive for them to put into place appropriate hazard management measures (Cutler and Zeckhauser, 1997).

Within an obligatory risk financing system in which payments are made by the private sector, incentives for alertness and rapid alarm can be given to all farmers. One of such incentives could be to discount compensations of farmers who report outbreaks too late (i.e. if there are already a number of dead animals on the farm at the time of stamping-out). This also holds in a system financed entirely from the national and EU budget.

Subsidies by the government may be justified in the case of market failure. Governments providing insurance would face the same problems as the private sector with respect to asymmetric information. On the other hand, they have a number of potential advantages with respect to systemic risks – notably 'very deep pockets', combined with a capacity to manage the outbreak, so influencing the potential losses. Hence, Public-Private partnerships may be considered. The implemented systems in Greece and Spain have such characteristics (state owned and state regulated). Governments could subsidise premium rates, administrative costs, and/or reinsurance. Considerations in selecting the basis for any Public-Private partnership is that agreements should not be too complex. Complexity is minimised by making the role of the government explicit and by using transparent parameters to measure the costs/risk.

If the government decides to become involved in a Public-Private partnership, it could agree to provide some reinsurance coverage to insurance companies at low or zero costs, or it could provide reinsurance at fully commercial rates. There are several arguments in favour of governments providing reinsurance at zero costs:

- If governments already provide disaster relief, the assistance through reinsurance seems more efficient. Disaster relief is very ad hoc and often involves problems of 'who receives the money'. There are also considerable administrative costs incurred to set up special agencies to organise and provide the disaster relief. By providing reinsurance, governments can use the experience and capacity of insurance companies in dealing with

moral hazard and antiselection problems and in handling large numbers of claims (Hazell, 1992; Barnett, 1999).

- Insurance schemes, like other risk-sharing devices, have potential advantages for society as a whole (Arrow, 1992). They enable farmers to move closer to the social optimum where expected marginal costs and returns are equated. Therefore, a case might be made that some modest subsidy, embodied in reinsurance, is socially beneficial.
- Having the government financially involved may address a moral hazard problem in government behaviour: many catastrophes can be either prevented or magnified by government policies (or lack thereof). Having governments financially responsible for some losses might be an incentive for them to put into place appropriate hazard management measures (Cutler and Zeckhauser, 1997).
- Having the government financially involved may reduce political pressure to provide ad hoc disaster relief.

There are also some arguments in favour of governments providing reinsurance at (fully) commercial rates.

- governments can potentially provide reinsurance more economically than can private market reinsurers (assuming the private sector could provide the needed capacity). Governments have substantial advantages because of their deep credit capacity and their unique position as the largest social entity in a country. These advantages enable them to diversify claims intertemporally and to spread risks broadly (Lewis and Murdock, 1996; Priest, 1996; Cutler and Zeckhauser, 1997).
- If governments charge for providing reinsurance at rates that will cover costs, some of these functions will be taken over by the private sector as capital markets deepen (Lewis and Murdock, 1996; Cutler and Zeckhauser, 1997). The development of capital markets is facilitated if governments participate in the market as a ‘market party’, not as an institution that provides free disaster relief to farmers (Barnett, 1999; Skees and Barnett, 1999).
- If farmers have to pay for their risk protection, the insurance scheme is really a risk management tool, not some form of income enhancement by the government (Skees,

1999). Mixing the two aims in one policy instrument makes management difficult and may compromise the attainment of both objectives.

4.3. Organisational form

Another important aspect is the owner of the system. The organisation that collects and manages the levies, as well as insurance companies collecting and managing premiums, can be set up in alternative ways. There are two broad approaches to insurance provision namely a mutual or a limited insurance company (Harrington and Niehaus, 1999), both of which have been employed in agriculture. All insurance companies are allowed to create various different frameworks and contracts according to which payments can be collected also afterwards or partly after claims payments.

Since mutuals are owned by the insured farmers, there is likely to be a broader support for differentiation of premiums and deductibles since colleague farmers impose these measures. A further implication of farmers owning the mutual is that they are very critical to what type of farmers are accepted as members of the insurance pool. Existing mutuals therefore apply strict underwriting criteria, for example by requiring certain certificates such as ICC (Integral Chain Control) and GAP (Good Agricultural Practices). Note that in theory also limited insurance companies can apply these enhancements. Probably farmers would be more willing to participate in a pool created by farmers themselves, although it may well be the case that they could be more prone to invest in a solid and solvent large and known insurance company.

The argument that the larger the involvement of farmers the more likely that there is commitment for risk prevention also holds for the levy system. The largest involvement of farmers is likely to be achieved by organising a levy system that is owned, or at least (partly) managed, by the farmers themselves.

4.4. Covered risks

Covered risks for direct losses comprise the value of the animals culled under depopulation and welfare control measures. Compensation of direct losses can either be based on a pre-set animal value or actual market value at the moment of culling.

Consequential loss compensation schemes should include farms that are confronted with business interruption and farms located in restriction zones. Farms that are confronted with losses as a result of decreased market value of their products but are not infected with an epidemic disease or are not in a movement standstill zone are not eligible for compensation. Hedging by means of the futures market is a more appropriate risk financing tool. Compensation of consequential losses can ideally be based on actual losses incurred. However, basing the indemnity on a fixed sum times the duration of business interruption is probably a more feasible solution.

4.5. Data needs and rate estimation

In order to rate the risk both the probability of occurrence and magnitude of losses need to be assessed on a national / regional level. This exercise is difficult and only an approximation. Also the control strategies applied in each main livestock sector need to be documented. The magnitude of the loss should be based on the average animal value in a country or region and the associated gross margins.

If the applied consequential loss coverage is based on the actual losses incurred the insureds need to have accurate accounting records of a number of subsequent years. If the coverage is based on a fixed sum per day times the duration of business interruption, less data needs are required. The latter is an easier and more feasible option.

4.7. Implementation

Levy systems to co-finance direct losses are implemented successfully in a number of EU countries. Also in a number of EU countries insurance policies covering consequential losses are implemented successfully. Compensation for consequential losses can ideally be based on actual losses incurred determined on basis of accurate historical accounting records (e.g., Germany). However, basing the indemnity on a fixed sum per day times the duration of business interruption is probably a more feasible solution (for example those countries joining the EU in the near future and those with inaccurate farm records).

5. Conclusions

5.1. Main conclusions current financing schemes

The main conclusions that can be drawn from this study with respect to the current applied risk financing schemes are:

- Direct losses. Only the values of the animals that are compulsorily slaughtered of the non-EU compensated part are compensated by means of a public or statutory private (i.e., sector) financing schemes. The amount that is payable by the farmer depends mainly on whether or not there were major outbreaks in previous years. To share the risks between the national government and the sector proportional as well as non-proportional schemes exist.
- Consequential losses. Livestock producers in Europe can currently obtain only limited coverage (private, Public-Private or public) for consequential losses as a result of an epidemic. A widely adopted EU insurance scheme covering all epidemic diseases for all types of livestock is absent. In some countries the government compensates above the value of the animals which are compulsorily slaughtered to cover part of the consequential losses. Some EU member states partly compensate consequential losses on basis of actual incurred losses (also a form of ad hoc relief program exists). In some other EU member states the absence of public assistance has led to the creation of private insurance schemes for some types of livestock production. The current applied consequential loss coverage can be based on the actual losses incurred or an estimation of the loss based on the period with business interruption (i.e., fixed sum per day times the duration) or a fixed amount (for example 10% of the animal value). In general, farms that are confronted with losses as a result of decreased market value of their products but are not infected with an epidemic disease or are not in a movement standstill zone are not eligible for compensation.
- Market uptake. On basis of the conducted survey it can be concluded that producers do not commonly take up private policies that are specifically designed to cover consequential losses. Only the German “Ertragsschadenversicherung” has a relative high level of participation.

- Market failure. Important aspects hereby can be found both at the demand side (producers might evaluate it as a less important business risk, cognitive failure to assess probability and extent of low-probability-high-consequence risks, schemes are new and farmers may need time to adopt) and the supply side (research and development costs, and difficulties in setting premium rates).

5.2. Main conclusions prospective financing schemes

Given the specific risk under research, a mandatory system to finance direct losses will facilitate alertness and rapid alarm in case of an outbreak of an epidemic. In contrast, a consequential loss compensation scheme might be voluntary (producers can cope with this business risk in alternative ways). Compensation of direct losses can either be based on a pre-set animal value or actual market value at the moment of culling. Compensation for consequential losses can ideally be based on actual losses incurred. However, basing the indemnity on a fixed sum per day times the duration of business interruption is probably a more feasible solution (for example those countries joining the EU in the near future and those with inaccurate farm records). Farms that are confronted with losses as a result of decreased market value of their products but are not infected with an epidemic disease or are not in a movement standstill zone should not eligible for compensation. The largest involvement of farmers is likely to be achieved by organising a levy system that is organised (partly) by the farmers themselves and a mutual insurance scheme.

The (prospective) schemes should as much as possible fulfil the following requirements: (1) no disturbance of markets; (2) compatible with WTO agreements; (3) run by the private market, without official EU participation; and (4) applicable to the whole of the EU.

Regardless of the requirement of no disturbance of markets and no official EU participation, all EU member states finance (partly) direct losses and some finance partly consequential losses from the national budget. Harmonisation of EU financing schemes would at least level the playing field between farmers within the EU. The harmonisation criteria can be expressed as the maximum allowed level of proportional or non-proportional coverage by state.

WTO agreements (increasingly) restrict the amount of subsidies that is allowed (Ritson and Harvey; Swinbank). To be classified under the green box (i.e., 'the allowed forms of support') support measures have to fulfil certain conditions. The conditions relate to the absence of price support, no or at most minimal trade-distorting effects and no effects on production. Public payments for relief programs (made available either directly or by way of financial participation via levy schemes) have basically to fulfil the same conditions. There are, however, a number of differences. Payments can only be triggered by a production loss resulting from a disaster, which is specifically recognised by the government. Payments can be based on losses of livestock but also on depressed income, and can compensate up to 100 per cent of the total costs of replacing losses. Ad hoc disaster relief programs applied need to be evaluated on a case by case basis whether they are in line with the WTO agreements. Public financial participation in insurance is classified as green box compatible if:

- insurance relates to income shortfall based on a reference period. The payments may not relate to the type or volume of production or the prices applying to such production or to the factors of production employed;
- income loss is more than 30 per cent and the amount of payments compensate for less than 70 per cent of the farmers income loss (European Commission, 2001).

The current (partly) public levy programs seem legitimate in the green box of the WTO-framework. Governments could facilitate the development and adoption of an insurance scheme for consequential losses. If reinsurance problems are hampering the development of insurance products or are resulting in relatively high premiums, a Public-Private partnership for the reinsurance of the risk could be considered (possible in combination with a "Pool Re Europe" design or other alternative risk transfer solution). To prevent inefficiencies, such Public-Private partnerships need to be properly designed to meet strict criteria.

The last condition is that the schemes should be applicable to the whole of the EU. A levy scheme and a insurance scheme can be implemented in all EU member states.

5.3. Issues for further research

The issues for further research are:

- In order to construct and evaluate (regional) levy and insurance schemes the risk (i.e., probability of occurrence and magnitude of losses) and the control strategies applied in each main livestock sector need to be documented. As an approximation of the magnitude of the loss might be based on the average animal value in a country or region and the associated gross margins. Then the maximum level of national / regional support for direct losses and the effect on the national and EU budget can be determined. Also rates for consequential losses need to be determined.
- On the supply side, there is a need to investigate the potential for the insurance industry and farmers organisations to develop either limited or mutual insurance companies to cover consequential losses for those countries without these schemes.
- On the demand side, a market study in these countries could reveal under what conditions insurance schemes are feasible. An insurance to cover consequential losses is feasible if there is sufficient participation (i.e. if sufficient farmers are willing to pay the premiums). In discussing the feasibility of an insurance for consequential losses, a number of aspects discussed for direct losses are also very relevant (e.g., effect of premium differentiation, deductible, importance of risk communication). However, the major issue is likely to be the participation of farmers in an insurance scheme: unlike a risk financing scheme for direct losses an insurance scheme for consequential losses is likely to be voluntary. The risk of livestock epidemics is a 'low-probability-high-consequence' risk. Research shows that people typically have problems in assessing the probability and/or the potential magnitude of such risks (Kunreuther, 1976). Because of such cognitive failure the demand for insurance is likely to be reduced (Skees and Barnett, 1999). Effective risk communication may be crucial in this respect.

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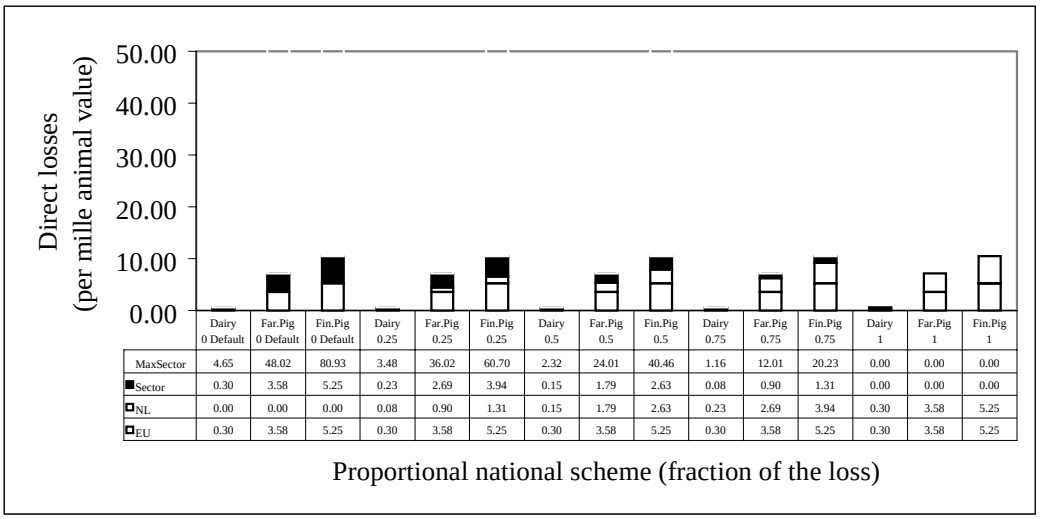

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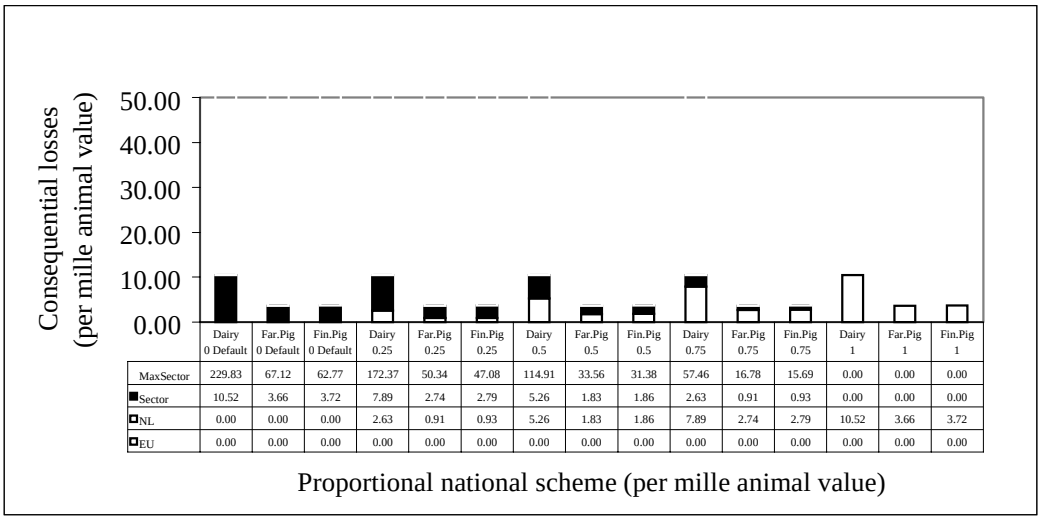
MaxSector	4.65	48.02	80.93	3.48	36.02	60.70	2.32	24.01	40.46	1.16	12.01	20.23	0.00	0.00	0.00
Sector	0.30	3.58	5.25	0.23	2.69	3.94	0.15	1.79	2.63	0.08	0.90	1.31	0.00	0.00	0.00
NL	0.00	0.00	0.00	0.08	0.90	1.31	0.15	1.79	2.63	0.23	2.69	3.94	0.30	3.58	5.25
EU	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.58	5.25



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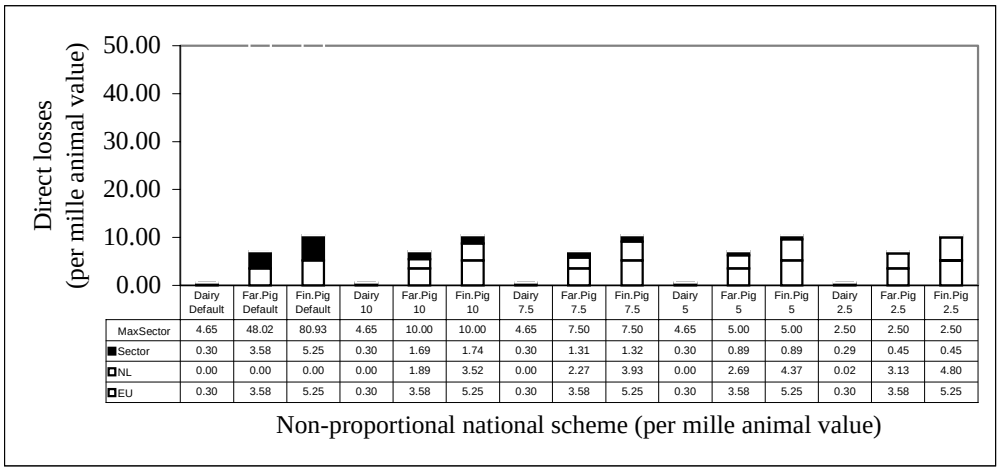
MaxSector	229.83	67.12	62.77	172.37	50.34	47.08	114.91	33.56	31.38	57.46	16.78	15.69	0.00	0.00	0.00
Sector	10.52	3.66	3.72	7.89	2.74	2.79	5.26	1.83	1.86	2.63	0.91	0.93	0.00	0.00	0.00
NL	0.00	0.00	0.00	2.63	0.91	0.93	5.26	1.83	1.86	7.89	2.74	2.79	10.52	3.66	3.72
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex I: Alternative proportional coverage by the national government.
The proportional coverage by the national government is altered from 0 to 100% in steps of 25%.



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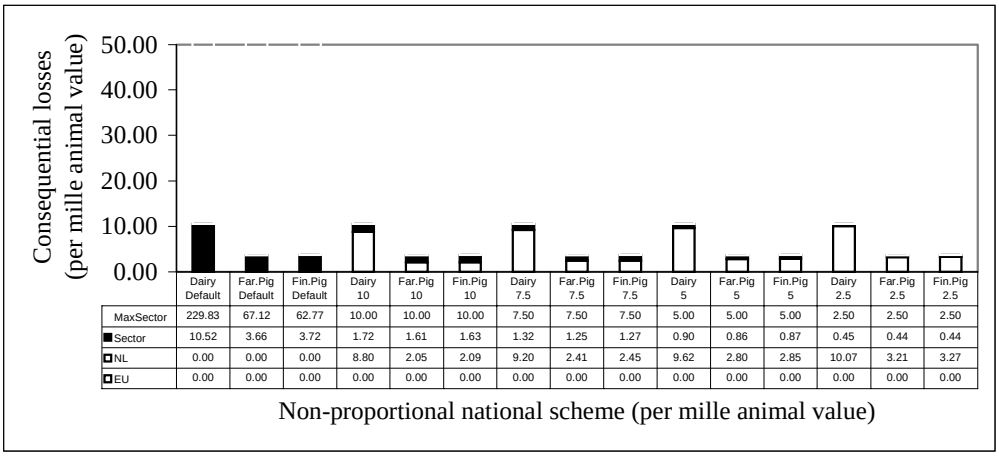
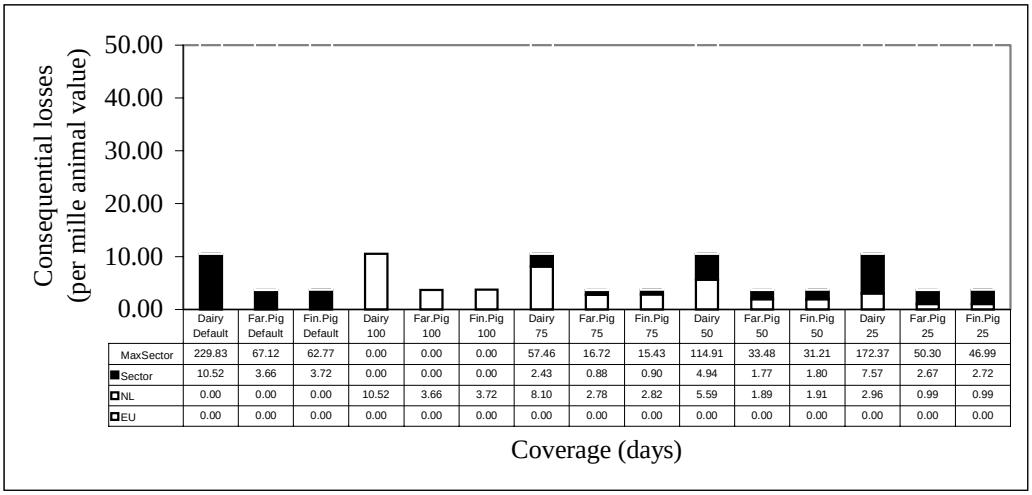
MaxSector	4.65	48.02	80.93	4.65	10.00	10.00	4.65	7.50	7.50	4.65	5.00	5.00	2.50	2.50	2.50
Sector	0.30	3.58	5.25	0.30	1.69	1.74	0.30	1.31	1.32	0.30	0.89	0.89	0.29	0.45	0.45
NL	0.00	0.00	0.00	0.00	1.89	3.52	0.00	2.27	3.93	0.00	2.69	4.37	0.02	3.13	4.80
EU	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.58	5.25



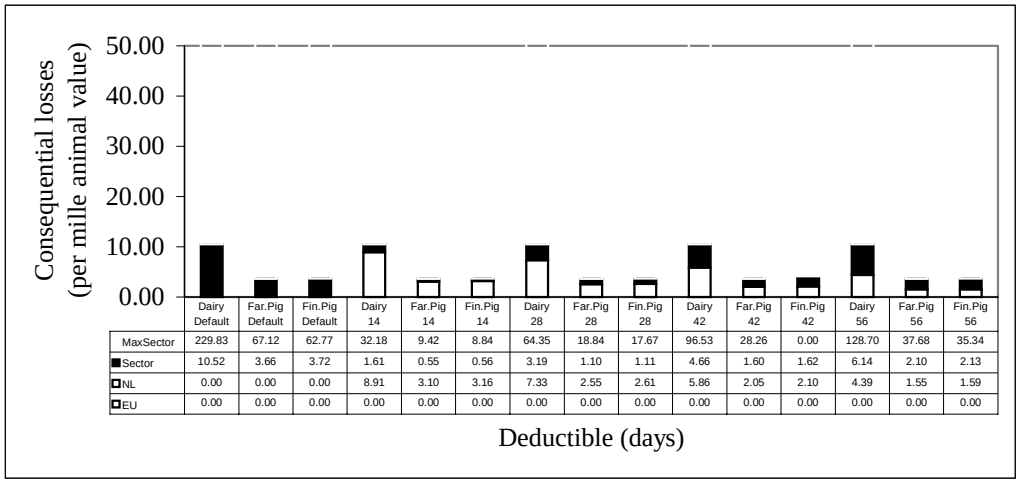
	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy 10	Far.Pig 10	Fin.Pig 10	Dairy 7.5	Far.Pig 7.5	Fin.Pig 7.5	Dairy 5	Far.Pig 5	Fin.Pig 5	Dairy 2.5	Far.Pig 2.5	Fin.Pig 2.5
MaxSector	229.83	67.12	62.77	10.00	10.00	10.00	7.50	7.50	7.50	5.00	5.00	5.00	2.50	2.50	2.50
Sector	10.52	3.66	3.72	1.72	1.61	1.63	1.32	1.25	1.27	0.90	0.86	0.87	0.45	0.44	0.44
NL	0.00	0.00	0.00	8.80	2.05	2.09	9.20	2.41	2.45	9.62	2.80	2.85	10.07	3.21	3.27
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex II: Alternative non-proportional coverage by the national government.
The non-proportional coverage by the national government is altered from 0 to 10‰ of the total animal value, in steps of 2.5‰.



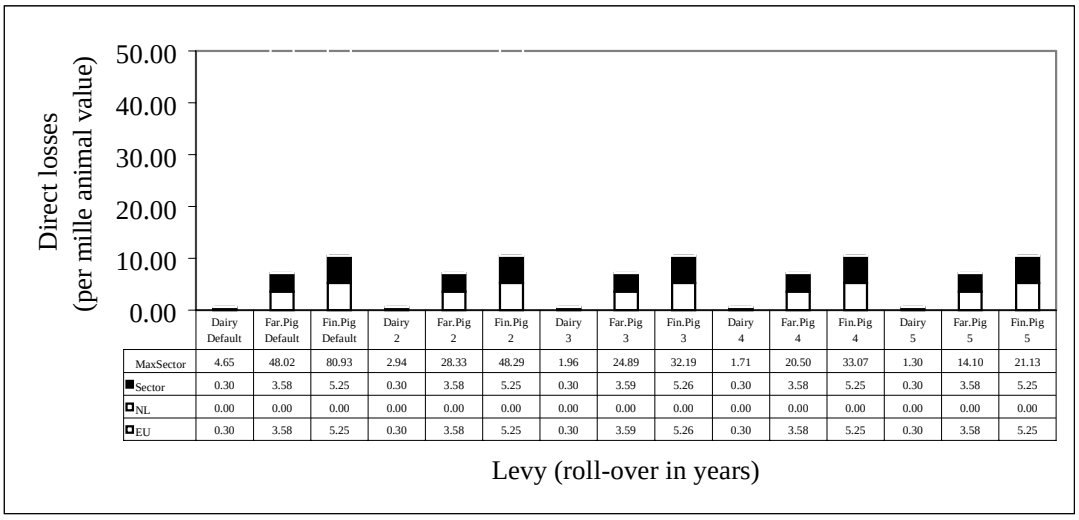
	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy 100	Far.Pig 100	Fin.Pig 100	Dairy 75	Far.Pig 75	Fin.Pig 75	Dairy 50	Far.Pig 50	Fin.Pig 50	Dairy 25	Far.Pig 25	Fin.Pig 25
MaxSector	229.83	67.12	62.77	0.00	0.00	0.00	57.46	16.72	15.43	114.91	33.48	31.21	172.37	50.30	46.99
Sector	10.52	3.66	3.72	0.00	0.00	0.00	2.43	0.88	0.90	4.94	1.77	1.80	7.57	2.67	2.72
NL	0.00	0.00	0.00	10.52	3.66	3.72	8.10	2.78	2.82	5.59	1.89	1.91	2.96	0.99	0.99
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex III: Alternative coverage periods by the national government.
The maximum coverage period is varied from 0 (default situation) to 100, 75, 50 and 25 days.

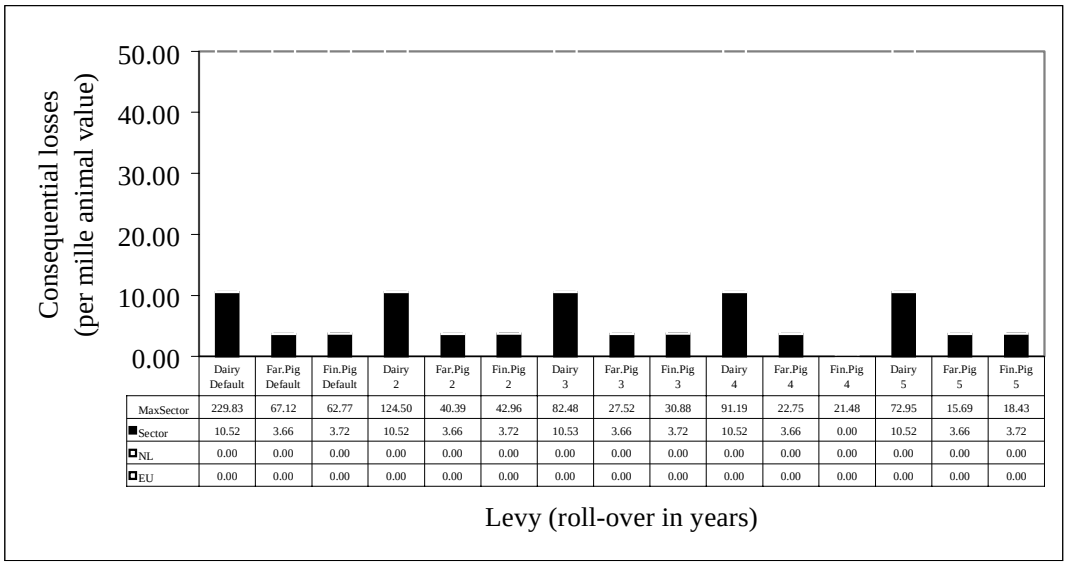


	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy 14	Far.Pig 14	Fin.Pig 14	Dairy 28	Far.Pig 28	Fin.Pig 28	Dairy 42	Far.Pig 42	Fin.Pig 42	Dairy 56	Far.Pig 56	Fin.Pig 56
MaxSector	229.83	67.12	62.77	32.18	9.42	8.84	64.35	18.84	17.67	96.53	28.26	0.00	128.70	37.68	35.34
Sector	10.52	3.66	3.72	1.61	0.55	0.56	3.19	1.10	1.11	4.66	1.60	1.62	6.14	2.10	2.13
NL	0.00	0.00	0.00	8.91	3.10	3.16	7.33	2.55	2.61	5.86	2.05	2.10	4.39	1.55	1.59
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex IV: Alternative deductible periods by the national government.
Duration of the deductible is varied from none (default) to 14, 28, 42 and 56 days.

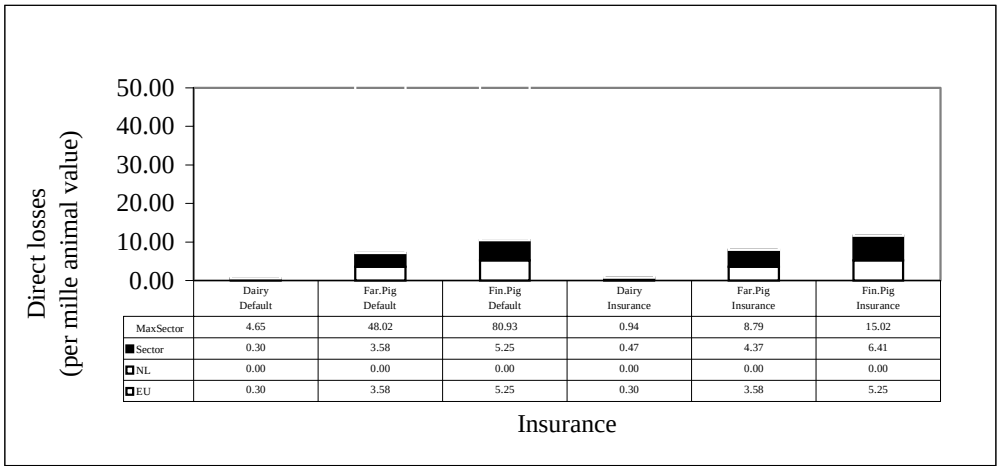


	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy 2	Far.Pig 2	Fin.Pig 2	Dairy 3	Far.Pig 3	Fin.Pig 3	Dairy 4	Far.Pig 4	Fin.Pig 4	Dairy 5	Far.Pig 5	Fin.Pig 5
MaxSector	4.65	48.02	80.93	2.94	28.33	48.29	1.96	24.89	32.19	1.71	20.50	33.07	1.30	14.10	21.13
Sector	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.59	5.26	0.30	3.58	5.25	0.30	3.58	5.25
NL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.30	3.58	5.25	0.30	3.58	5.25	0.30	3.59	5.26	0.30	3.58	5.25	0.30	3.58	5.25

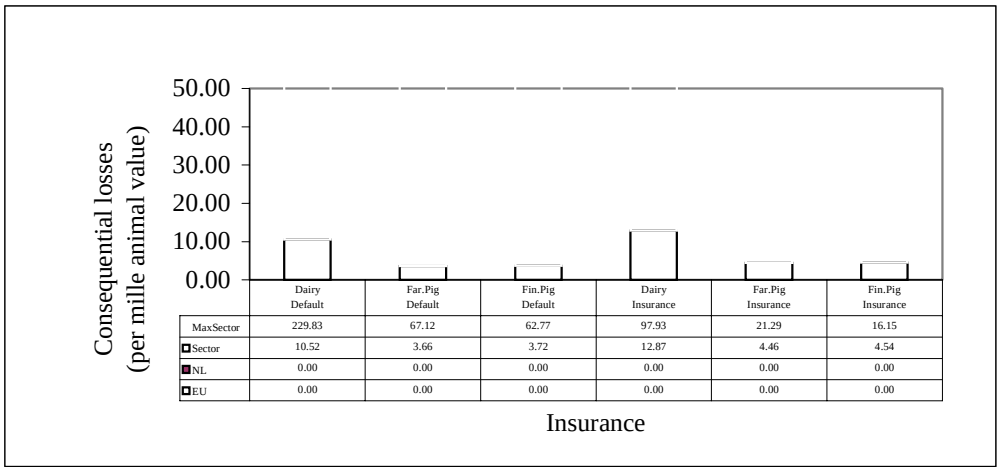


	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy 2	Far.Pig 2	Fin.Pig 2	Dairy 3	Far.Pig 3	Fin.Pig 3	Dairy 4	Far.Pig 4	Fin.Pig 4	Dairy 5	Far.Pig 5	Fin.Pig 5
MaxSector	229.83	67.12	62.77	124.50	40.39	42.96	82.48	27.52	30.88	91.19	22.75	21.48	72.95	15.69	18.43
Sector	10.52	3.66	3.72	10.52	3.66	3.72	10.53	3.66	3.72	10.52	3.66	0.00	10.52	3.66	3.72
NL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex V: Alternative levy schemes with respect to pay-back period.
The levy fund is set up with a pay-back period of a number of years, i.e., 2, 3, 4 or 5 years.



	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy Insurance	Far.Pig Insurance	Fin.Pig Insurance
MaxSector	4.65	48.02	80.93	0.94	8.79	15.02
Sector	0.30	3.58	5.25	0.47	4.37	6.41
NL	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.30	3.58	5.25	0.30	3.58	5.25



	Dairy Default	Far.Pig Default	Fin.Pig Default	Dairy Insurance	Far.Pig Insurance	Fin.Pig Insurance
MaxSector	229.83	67.12	62.77	97.93	21.29	16.15
Sector	10.52	3.66	3.72	12.87	4.46	4.54
NL	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.00	0.00	0.00	0.00	0.00	0.00

Annex VI: Insurance schemes.
A stop loss reinsurance layer of 20 in excess of 1.5 times the long time average loss.
This implies that every time losses exceed the long time average loss by 50%
the insurance company is compensated by the reinsurance contract,
up to a maximum of 20 times the long time average loss (20+1.5).
Losses that are in excess of 20 times the long time average loss are borne by the sector.
The reinsurance premium is based on a risk loading of 30% of the expected annual reinsurance loss.