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Foot and Mouth Disease epidemics; financial damage for veal chains

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Preface

In commission of VanDrie Group, the project ‘Foot and Mouth disease epidemics; financial damage for veal supply chains’ is performed as final thesis of both my master studies ‘Management and Economics’ at Wageningen University and ‘Food and Resource Economics’ at the Rheinische Friedrich- Wilhelms-University Bonn .

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Summary

Foot and Mouth Disease (FMD) is a highly infectious disease which can cause high financial damage (Huirne et al, 2002 and Meuwissen et al, 2004). Due to changed legislation (EC, 2003a) practising protective vaccination is possible to fight FMD. The veal sector is highly integrated in the production chain. Integrated veal production companies own different partners of the supply chain; e.g. the animals, feed industry and slaughterhouses. Until now, no analysis has been done for the financial damage in a worst case scenario for the veal supply chain as a whole.

The objectives of this study are: 1) analyzing the financial damage for the veal supply chain in case of a worst case outbreak of FMD in the Netherlands, when protective vaccination is practiced and 2) exploring risk financing instruments to manage the risk of financial damage for veal integrated production companies.

The Netherlands is characterized by the production of white and rosé veal. Production of white veal is for 95% under contract of integrated veal production companies. Of the rosé veal production, only a small percentage is contracted. The total number of calves slaughtered annually in the period 2005-2007 was almost 1.4 million white and rosé veal calves, corresponding to a production of about 210,000 ton of veal and to 25% of the total EU production. Of the total Dutch production of veal, 95% is being exported to about 60 countries from which France, Italy and Germany are the most important.

In case of an outbreak of FMD both Dutch and EU legislation come into practice. Dutch legislation consists of an action plan ‘Beleidsdraaiboek Mond- en Klauwzeer, versie 2.0’ and EU legislation consists of the ‘Council Directive 2003/85/EC’. Council Directive 2003/85/EC obliges the fighting of FMD outbreaks, applies for all member states of the European Union and meets the OIE legislation. In case of using protective vaccination to fight the FMD virus, three phases come into place according to EU and OIE legislation. During phase 1, all carcasses of slaughtered calves have to be channelized, maturated for 24 hours, deboned and have to undergo a heat treatment. The veal gets a mark with a diagonal cross and can than be put on the market. During phase 2, all carcasses of slaughtered calves have to channelized, maturated for 24 hours, deboned and gets the EEC health mark. The veal can be put on the EU market under restriction of certification. During phase 3, carcasses of slaughtered non-vaccinated calves have to be channelized, get the EEC health mark and can be put on the EU market under the restriction of certification. Carcasses of slaughtered vaccinated calves or from offspring of vaccinated cattle have to be channelized, maturated for 24 hours and have to be deboned. Veal gets the EEC health mark and can be put on the EU market under the restriction of certification. Veal from calves slaughtered in the ‘not affected’ areas of the Netherlands can be traded within the EU depending on transport restrictions which are decided on by the Dutch Ministry of Agriculture in cooperation with experts (LNV, 2005).

Various studies have been done in the past which modelled the epidemical and economic impact of FMD epidemics in the Netherlands. A worst case scenario of an outbreak of FMD is the starting point

for the calculations of the model in this study in order to calculate the expected maximum financial damage. The worst case scenario is based on Meuwissen et al. (2004). The scenario is a simulated outbreak of FMD in an area in the centre of the Netherlands, the Veluwe, where protective vaccination is used in a circle with a two kilometre radius around infected farms.

Table 1: Numbers and percentages of calves slaughtered during different phases based on a worst case outbreak

	White		Rosé	
Stamping out	5,700	(1%)	1,200	(0,5%)
Calves in vaccination zone				
Phase 1	12,500	(2%)	2,700	(1%)
Phase 2	12,500	(2%)	2,700	(1%)
Phase 3 non-vaccinated	207,000	(34%)	45,000	(20%)
Phase 3 vaccinated	35,000	(6%)	7,600	(3%)
Calves in free areas in NL	342,000	(56%)	169,000	(74%)
Total	**615,000**	**(100%)**	**229,000**	**(100%)**

The number of calves in table 1 are adjusted for the actual number of calves present in the Netherlands. Figures about the duration of the different phases are derived from the schematic overview of the outbreak (Table 16, paragraph 5.2.3) and used in the calculation model.

Table 2: Distinguished groups of calves with percentages decrease in prices and collected price in € / kg

	White veal ≤ 8 months	White veal 9 ≤ 12 months	Rosé veal calves ≤ 12 months	Rose veal calves > 12 months
	€4.75/kg	€4.75/kg	€2.75/kg	€2.75/kg
Calves in affected area				
Phase 1	-/- 85% (€ 0.71)	-/- 85% (€ 0.71)	-/- 75% (€ 0.69)	-/- 75% (€ 0.69)
Phase 2	-/- 65% (€ 1.66)	-/- 74% (€ 1.24)	-/- 55% (€ 1.24)	-/- 55% (€ 1.24)
Phase 3 non-vaccinated	-/- 25% (€ 3.56)	-/- 50% (€ 2.38)	-/- 25% (€ 2.06)	-/- 10% (€ 2.48)
Phase 3 vaccinated	-/- 65% (€ 1.66)	-/- 74% (€ 1.24)	-/- 55% (€ 1.24)	-/- 55% (€ 1.24)
Calves free areas in NL	-/- 25% (€ 3.56)		-/- 15% (€ 2.34)	-/- 5% (€ 2.61)

Table 2 gives way the assumed collected prices based on Meuwissen et al. (2004), EC (2003a) and EC (2007b). These prices are used within the calculation model to calculate the financial damage.

Table 3: Financial damage default scenario and sensitivity analysis white veal sector

	Default	**Scenario 1**	**Scenario 2**	**Scenario 3**
Direct costs	5.8			
Indirect costs				
Primary sector				
> Costs empty barns	0.4			0.2
> Costs calves staying longer in barn	118.2			93.8
> Decreased revenues	158.4	121	118	
Slaughter and processing industry	8.2			6.4
Feeding industry	1.7			1.7
Calfskin processing industry	4.2			4.4
Trading industry	9.8			7.7
Total financial damage (x € million)	**307**	**269**	**265**	**278**

Table 3 shows the financial damage for the white veal supply chain which is € 307 million in total. If veal from white veal calves can be sold as white veal instead of rosé veal due to increased slaughter age,

this leads to a decrease of the financial damage of € 38 million (scenario 1). Assuming prices decrease 10% less results in higher collected prices and a decrease of the financial damage of € 41 million (scenario 2). A decrease in duration of the FMD period with 2 weeks, 70 instead of 84 days, results in a decrease of the financial damage of € 28 million (scenario 3).

Table 4: Financial damage default scenario and sensitivity analysis rosé veal sector

	Default	**Scenario 1**	**Scenario 2**
Direct costs	1.9		
Indirect costs			
Primary sector			
> Costs empty barns	0.1		0.1
> Costs calves staying longer in barn	19.6		14.5
> Decreased revenues	23.1	11.2	
Slaughter and processing industry	1.8		1.1
Feeding industry	-		
Calfskin processing industry	1.4		1.4
Trading industry	2.2		1.9
Total financial damage (x € million)	**50**	**41**	**44**

Table 4 shows the financial damage for the rosé veal sector which is € 50 million in total. Assuming prices decrease 10% less results in higher collected prices and a decrease in financial damage of € 9 million (scenario 1). A decrease in duration of the FMD period with 2 weeks, 70 instead of 84 days, results in decrease of financial damage of € 6 million (scenario 2).

Two possibilities are discussed which integrated production companies can use to protect themselves against the risk of the financial damage in case of an outbreak of FMD: funding and captives. Funding are company savings for costs occuring in the future. A captive is a reinsurance company with which a company can insure risks which cannot be insured via the normal procedure.

Most important conclusions drawn are:

1. The financial damage for the veal supply chain based on a worst case scenario (in 95% of all simulated cases) and protective vaccination is practised, is accounted at € 307 million for the white veal supply chain and € 50 million for the rosé veal supply chain.
2. From the financial damage for the white veal supply chain, 38% is caused by calves staying longer in barns due to transport restrictions and 52% by decreased revenues due to lower collected prices.
3. For the rosé veal supply chain, 40% of the financial damage is caused by calves staying longer in barns and 46% by decreased revenues.
4. The primary sector accounts for 90% (white) and for 85% (rosé) of the financial damage of both supply chains. The other partners; slaughter industry, feeding industry, calfskin processing industry and trading industry, account together for 8% (white) and 11% (rosé) of the total financial damage.
5. A captive is favourable above funding because a captive covers the total financial damage in case of a worst case outbreak of FMD from the first year onwards. Funding covers only the financial damage equal to the allocated money at the moment of the outbreak of FMD. Additional losses have to be covered alternatively which can lead to financial problems for the company.

Samenvatting

Mond- en Klauwzeer (MKZ) is een zeer besmettelijke ziekte welke grote financiële gevolgen kan hebben (Huirne et al, 2002 and Meuwissen et al, 2004). Door verandering in wetgeving (EC, 2003a) is het mogelijk geworden beschermende vaccinatie toe te passen bij het bestrijden van MKZ. De kalfsvleessector is in verregaande mate geïntegreerd in de productieketen. Kalfsvlees integraties bezitten verschillende schakels in de productieketen; zoals de kalveren, de kalvermelkpoeder productie en de slachthuizen. Tot op dit moment is nooit onderzoek gedaan naar de financiële schade ten gevolge van een worst case uitbraak van MKZ voor de kalfsvleesketen in zijn totaliteit.

De doelen van dit onderzoek zijn: 1) analyseren van de financiële schade voor de kalfsvleesketen naar aanleiding van een gesimuleerde worst case uitbraak van MKZ en waarbij beschermende vaccinatie wordt toegepast en 2) onderzoeken van risico financieringsinstrumenten waarmee kalfsvlees integraties het financiële risico van een worst case uitbraak van MKZ geheel of gedeeltelijk kunnen afdekken.

In Nederland vindt zowel de productie van blank als van rosékalfsvlees plaats. De productie van blank kalfsvlees vindt voor 95% plaats op basis van voergeldcontracten die door de integraties aangeboden worden. Van de rosévleeskalveren wordt maar een klein percentage op contract gemest. In de periode 2005-2007 werden gemiddeld 1,4 miljoen blank- en rosévleeskalveren per jaar geslacht. Dit staat gelijk aan 210.000 ton kalfsvlees en aan 25% van de totale productie van kalfsvlees in Europa. Van de gehele Nederlandse productie wordt 95% geëxporteerd naar meer dan 60 landen waaronder Frankrijk, Italië en Duitsland de belangrijkste afnemers zijn.

Op het moment van een uitbraak van MKZ treedt zowel Nederlandse als Europese wetgeving in werking. Nederlandse wetgeving is beschreven in het ‘Beleidsdraaiboek Mond- en Klauwzeer, versie 2.0’. Europese wetgeving is beschreven in de ‘Council Directive 2003/85/EC’. Council Directive 2003/85/EC verplicht het bestrijden van uitbraken van MKZ en geldt voor alle lidstaten van de gemeenschap. Europese wetgeving is gedeeltelijk gebaseerd op wetgeving van het OIE. In geval van toepassing van beschermende vaccinatie, moeten drie verschillende fasen doorlopen worden. Tijdens fase 1 moeten alle karkassen van geslachte kalveren gekanaliseerd worden, 24 uur matureren, geheel worden uitgebeend en daarna een hittebehandeling ondergaan. Het kalfsvlees krijgt een stempel met een diagonaalkruis en kan vervolgens verkocht worden. Tijdens fase 2 moeten alle karkassen van geslachte kalveren gekanaliseerd worden, 24 uur matureren, geheel worden uitgebeend en krijgen het EEC gezondheidsstempel. Het kalfsvlees kan binnen de EU verkocht worden onder de voorwaarde van certificering. Tijdens fase 3 moeten karkassen van geslachte niet-gevaccineerde kalveren worden gekanaliseerd, krijgen een EEC gezondheidsstempel en kunnen onder voorwaarde van certificatie binnen de EU verkocht worden. Karkassen van geslachte gevaccineerde kalveren, of van kalveren geboren uit gevaccineerde moederdieren, moeten gekanaliseerd worden, 24 uur matureren en geheel worden uitgebeend. Het kalfsvlees krijgt het EEC gezondheidsstempel en kan onder voorwaarde van certificatie binnen de EU verkocht worden. Kalfsvlees afkomstig van kalveren uit de ‘niet besmette’

gebieden in Nederland kan binnen de EU verkocht worden afhankelijk van transportverboden welke besloten worden door de Minister van LNV in samenwerking met experts (LNV, 2005).

Verschillende studies zijn in het verleden gedaan die de epidemiologische en economische impact van een MKZ epidemie in Nederland hebben gemodelleerd. Een worst case scenario van een MKZ uitbraak is het uitgangspunt van het model in deze studie waarmee de verwachte maximale financiële schade berekend wordt. Het worst case scenario is gebaseerd op Meuwissen et al. (2004). Het scenario is een gesimuleerde uitbraak van MKZ op de Veluwe, waarbij beschermende vaccinatie is toegepast in een straal van twee kilometer rondom de besmette bedrijven.

Tabel 1: Aantal en percentages van kalveren die geslacht worden tijdens de verschillende fasen en gebaseerd op een worst case uitbraak

	Blank		Rosé	
Geruimd	5.700	(1%)	1.200	(0,5%)
Kalveren in vaccinatie zone				
Fase 1	12.500	(2%)	2.700	(1%)
Fase 2	12.500	(2%)	2.700	(1%)
Fase 3 nietgevaccineerd	207.000	(34%)	45.000	(20%)
Fase 3 gevaccineerd	35.000	(6%)	7.600	(3%)
Kalveren in vrije gebieden in NL	342.000	(56%)	169.000	(74%)
Totaal	**615.000**	**(100%)**	**229.000**	**(100%)**

Het aantal kalveren in tabel 1 is aangepast aan het gemiddeld aantal kalveren dat in de aflopen drie jaar in Nederland gehouden werd. De gegevens over de lengte van de verschillende fasen zijn afgeleid van het schematisch overzicht van de uitbraak (tabel 16, paragraaf 5.2.3) en gebruikt in the rekenmodel.

Tabel 2: Veronderstelde groepen kalveren met de daling van de opbrengstprijs in % en in € / kg

	Blank kalfsvlees ≤ 8 maanden	Blank kalfsvlees 9 ≤ 12maanden	Rosé kalfsvlees ≤ 12 maanden	Rosé kalfsvlees > 12 maanden
	€4.75/kg	€4.75/kg	€2.75/kg	€2.75/kg
Kalveren in vaccinatie zone				
Fase 1	-/- 85% (€ 0.71)	-/- 85% (€ 0.71)	-/- 75% (€ 0.69)	-/- 75% (€ 0.69)
Fase 2	-/- 65% (€ 1.66)	-/- 74% (€ 1.24)	-/- 55% (€ 1.24)	-/- 55% (€ 1.24)
Fase 3 niet gevaccineerd	-/- 25% (€ 3.56)	-/- 50% (€ 2.38)	-/- 25% (€ 2.06)	-/- 10% (€ 2.48)
Fase 3 gevaccineerd	-/- 65% (€ 1.66)	-/- 74% (€ 1.24)	-/- 55% (€ 1.24)	-/- 55% (€ 1.24)
Kalveren vrije gebieden NL	-/- 25% (€ 3.56)		-/- 15% (€ 2.34)	-/- 5% (€ 2.61)

Tabel 2 geeft de verwachte te ontvangen prijzen weer, gebaseerd op Meuwissen et al. (2004), EC (2003a) en EC (2007b). Deze prijzen worden gebruikt in the rekenmodel om de financiële schade mee te berekenen.

Tabel 3: Financiële schade default scenario and sensitiviteits analyse blankvlees sector

	Default	Scenario 1	Scenario 2	Scenario 3
Directe kosten	5,8			
Indirecte kosten				
Primaire sector				
> Kosten lege stallen	0,4			0,2
> Kosten kalveren langer in stal	118,2			93,8
> Gederfde opbrengsten	158,4	121	118	
Slachterij en vleesverwerkende industrie	8,2			6,4
Kalvermelkpoederproductie	1,7			1,7
Kalfshuiden conservering	4,2			4,4
Handel en transport	9,8			7,7
Totale financiële schade (miljoen €)	**307**	**269**	**265**	**278**

Tabel 3 laat zien dat de financiële schade voor de blank kalfsvlees productieketen in totaal € 307 miljoen bedraagt. Als kalfsvlees van blanke kalveren ook als blank verkocht kan worden in plaats van als rosé vanwege de toegenomen slachtleeftijd, dan daalt de financiële schade met € 38 miljoen (scenario 1). Een 10% minder lage afwaardering, welke hoger opbrengsten tot gevolg heeft, heeft € 41 miljoen minder financiële schade tot gevolg (scenario 2). Als de uitbraak twee weken kort duurt, 70 in plaats van 84 dagen, dan heeft dit € 28 miljoen minder financiële schade tot gevolg (scenario 3).

Tabel 4: Financiële schade default scenario and sensitiviteits analyse rosévlees sector

	Default	Scenario 1	Scenario 2
Directe kosten	1,9		
Indirecte kosten			
Primaire sector			
> Kosten lege stallen	0,1		0,1
> Kosten kalveren langer in stal	19,6		14,5
> Gederfde opbrengsten	23,1	11,2	
Slachterij en vleesverwerkende industrie	1,8		1,1
Kalvermelkpoederproductie	-		
Kalfshuiden conservering	1,4		1,4
Handel en transport	2,2		1,9
Totale financiële schade (miljoen €)	**50**	**41**	**44**

Tabel 4 laat zien dat de financiële schade voor de rosévlees productieketen in totaal € 50 miljoen bedraagt. Een 10% minder lage afwaardering, welke hoger opbrengsten tot gevolg heeft, heeft een € 9 miljoen lagere financiële schade tot gevolg (scenario 1). Als de uitbraak twee weken kort duurt, 70 in plaats van 84 dagen, dan heeft dit € 6 miljoen minder financiële schade tot gevolg (scenario 2).

Twee risicofinancieringsinstrumenten zijn vergeleken waarmee integraties een deel, of de gehele schade van een uitbraak van MKZ mee af kunnen dekken: reserveren en een captive. Reserveren is het sparen binnen een bedrijf voor kosten met een grote omvang die in de toekomst gemaakt gaan worden. Een captive is een herverzekering waarmee een integratie zichzelf kan verzekeren tegen risico's die niet via de gebruikelijke verzekeringen zijn af te dekken.

De belangrijkste conclusies van dit onderzoek zijn:

1. De financiële schade voor de kalfsvlees productieketen, gebaseerd op een worst case uitbraak van MKZ (in 95% van de simulaties) en waarbij beschermende vaccinatie is toegepast, bedraagt voor de blank kalfsvleesproductieketen € 307 miljoen en voor de rosé kalfsvleesproductieketen € 50 miljoen.
2. Van de gehele financiële schade van de blank kalfsvleesproductieketen wordt 38% veroorzaakt door kalveren die langer op stal staan door transport verboden. 52% van de financiële schade wordt veroorzaakt door lagere opbrengsten door lagere prijzen.
3. Voor de rosé kalfsvleesproductieketen wordt de financiële schade voor 40% veroorzaakt door kalveren die langer op stal staan en voor 46% door lagere opbrengsten door lagere prijzen.
4. De schade voor de primaire sector bedraagt 95% (blank) en 85% (rosé) van de totale schade voor de beide productieketens. De andere schakels, slachterij, kalvermelkpoederproductie, kalverhuiden en handel en transport, nemen 8% (blank) en 11% (rosé) van de schade voor hun rekening.
5. Een captive is vanaf het eerste jaar een betere optie om financiële schade door een mogelijke MKZ uitbraak op te vangen ten opzichte van reserveren. Bij reserveren is de afgedekte schade de hoogte van de al gedane reserveringen op het moment dat MKZ uitbreekt. Een hogere schade zal alternatief opgevangen moeten worden wat kan leiden tot financiële problemen bij de integratie. Bij een captive is vanaf moment één de maximaal berekende schade gedekt, onafhankelijk van de looptijd.

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1 Introduction

The veal sector in the Netherlands is a highly integrated production chain. The four integrated veal production companies are owner of the calves and own the calfmilk replacement production and/or slaughterhouses. Two different kinds of veal are being produced; the largest amount (75%) is called veal, 'Kalbfleisch' or 'blankkalfsvlees'. The other 25% is called rosé veal, 'Jungrindfleisch', or 'rosékalfslvees'. Veal comes from calves with a maximum age of 8 months and have been fed with mostly calfmilk replacement. About 95% of the veal calves are owned by the integrated veal production companies. Rosé veal comes from calves with a maximum age of 12 months and have mainly been fed with roughage and compound feed. Only a small percentage of the rosé veal calves are owned by the integrated veal production companies.

On average, 1.4 million calves were slaughtered on average over the last three years, which correspond to 206,000 tons of veal and rosé veal. Of the total production, 95% is exported (PVE, 2007a). The veal sector is dominated by four large integrated veal production companies: VanDrie Group, Alpuro Groep, Denkavit and Pali Group. These companies enter into integration contracts with calf farmers, have their own factories for the production of calfmilk replacement and/or slaughter the calves in their own slaughterhouses. The EU and NL market leader in the production of veal is the VanDrie Group with a turnover of € 1.6 billion. VanDrie Group is situated in The Netherlands, France, Italy, Germany and Belgium and has a market share in The Netherlands of 60% and in Europe of 25% (Bont et al., 2007).

FMD is a highly infectious disease among even hoofed animals, e.g. cattle and pigs. An outbreak of FMD can cause large epidemiological and economical damages (Meuwissen et al., 2004). The last outbreak of FMD in the Netherlands was in 2001. The last outbreak of FMD in Europe was in the UK, in the summer of 2007.

In 2001 a stamping-out policy and emergency vaccination was practiced in the Netherlands in order to become an FMD free country again according to the standards of the OIE, The World Organization for Animal Health. The stamping-out policy, together with the emergency vaccination, resulted in the killing and destroying of the carcasses of 470,000 animals in total, subdivided in 161,000 cattle, 234,000 pigs and other animals (Abbas et al., 2002).

The public opinion was very negative about the killing of so many 'healthy' animals for the reason of regaining the status of an FMD free country. In recent years, changes of regulations of the OIE have taken place because of the development of a marker vaccine for FMD, which makes it possible to use protective vaccination. Protective vaccination means that the animals can stay alive after vaccination because the FMD virus can be distinguished from the vaccine due to the marker within the vaccine. The meat of vaccinated animals can, under restrictions, be sold on the market (OIE 2007 and EU 2003).

The ‘Animal Health Fund’ (AHF) (diergezondheidsfonds), covers the surveillance and direct costs in case of an outbreak of an infectious disease like e.g. FMD. The AHF only focuses on the owners of the animals, the primary production stage of the supply chain. Financing of the AHF for the cattle sector, is done by the sector itself. The cattle sector as a whole has the duty to pay at maximum € 85 million for the period 2005-2009, after deduction of possible EU payments, for the costs made in according to the stamping-out policy, compensation payments for the slaughtered animals due to stamping out and costs of vaccination. The Dutch government pays additional costs above € 85 million of direct costs and pays for the costs made by different governmental departments. Costs rising above € 85 million is assumed to occur at a chance of 0.4% (LNV, 2005 and Meuwissen et al., 2005b). In the case of the veal sector, integrated veal production companies are often the owner of the calves and therefore collect the compensation payments for the slaughtered calves due to stamping out. Costs that are not covered for by the AHF, indirect costs, are e.g. the costs of losing markets, empty barns and lower prices of products from vaccinated animals. In case of protective vaccination, direct costs will decrease and indirect costs will increase, compared to a stamping out policy without using protective vaccination (Meuwissen et al., 2004).

1.1 Relevance of research

Regulation has changed in the last years to make it possible to use protective vaccination in case of an outbreak of FMD. Although regulations make it possible to sell products of vaccinated animals, no guarantees exist that supermarkets and consumers accept these products. Second, it is not clear against which price difference according to animal products of non-vaccinated animals supermarkets and consumers are willing to accept products of vaccinated animals.

The veal sector is, compared to e.g. the pig sector, highly integrated in the production chain. The financial damage in the veal sector occurs at different stages of the supply chain but affects the integrated veal production company which owns the different partners of the supply chain; e.g. the animals, feed industry, and slaughterhouses. No analysis has been done for the financial damage in a worst case scenario for the veal supply chain as a whole.

1.2 Objectives

The two objectives within this research are:

1) Analyzing the financial damage for the veal supply chain in case of a worst case outbreak of FMD in the Netherlands, and when protective vaccination is practiced.
2) Exploring risk financing instruments to manage the risk of financial damage for veal integrated production companies.

1.3 Research questions

Four research questions are answered within this research. The questions asked are:

1. What are the characteristics of the veal sector in the Netherlands?
2. What happens in case of a worst case outbreak of FMD?
   2.1. Which regulations are in place?
   2.2. What is protective vaccination?
   2.3. Which problems occur according to trading of veal?
   2.4. Will meat products from vaccinated calves be accepted?
   2.5. How many calves are affected?
3. How large is the financial damage for the veal supply chain?
   3.1. Which partners of the veal supply chain are taken into account?
   3.2. Which different costs and losses can be distinguished within the different partners of the veal supply chain?
   3.3. How large is the financial damage, specified for the different partners of the veal supply chain?
4. Which risk financing instrument is best suitable for integrated production companies?
   4.1. Which risk financing instruments are possible?
   4.2. What are their characteristics?
   4.3. Can they be used by integrated production companies?

1.4 Methods of research

The risk analysis (objective 1) is divided into a literature research and expert interviews and in the development of a spreadsheet model. The literature research will give inside into the veal supply chain, the worst case scenario outbreak of FMD and in defining the financial damage. Expert interviews will be held to complete the outcomes of the literature research and to gather more input data for the spreadsheet model. A spreadsheet model will be developed in order to calculate the financial damage.

The risk management (objective 2) is performed by literature research and by expert interviews with Eureko Re, a reinsurance company of Interpolis-Achmea.

All prices are without VAT.

1.5 Structure of report

The report starts with a summary in both English and Dutch. The relevance, objectives, research questions and methods of research are described in chapter 1. Chapter 2 describes the characteristics of the veal sector with use of facts and figures. Also an schematic overview of the veal sector is drawn and the different chain partners are described. Chapter 3 focuses on legislation according to FMD. Especially the measures to be taken in case of protective vaccination are of importance for the assumptions used for calculating the financial damage. In chapter 4 are various researches described

which have modelled FMD. Based on former studies, a spreadsheet calculation is chosen to model and calculate the financial damage within this research. The simulation of a worst case outbreak of FMD is described in chapter 5, together with the input parameters of the model, their description and the assumptions made. Results together with a sensitivity analysis are described in chapter 6. Risk financing, chapter 7, compares funding against a captive for covering (part of) the financial damage faced by integrated veal production companies. Conclusion are drawn in chapter 8 followed by the discussion and recommendations. The report ends with the references and the appendixes.

2 Veal sector

2.1 Introduction

The veal sector has it's origin in gaining surplus value on calves that could not be used on dairy farms. First, dairy farms fattened their own calves on the farm with the use of cow milk. During the years, the veal sector has specialized itself into a very professional veal supply chain. Nowadays, specialized calves farms fatten the calves with calfmilk replacement on to an age of about 26 weeks. Calfmilk replacement is used in order to decrease the costs of feed from about 45 cents per litre cow milk to 10 to 15 cents per litre calfmilk replacement. This is done by using skinned milk powder, whey and whey derived products, plant based proteins and animal fat (Bondt et al., 2007, personal communication, VanDrie Group) .

First some facts and figures about the veal sector are discussed in order to get an understanding of what is discussed. In the following paragraph, the veal supply chain is defined. With the use of a figure, every relevant stage of the supply chain is described in detail to understand the underlying cooperation. Together with the facts and figures of paragraph 2.2, research question 1 is answered in the conclusion of the chapter.

2.2 Facts and figures

The veal sector in the Netherlands consists of two sub-sectors: veal and rosé veal. Regulation (EG) Nr. 700/2007 gives two definitions for meat from cattle that have been slaughtered on an age younger than 12 months. These two definitions are:

1) Veal for meat that comes from calves that have been slaughtered on a maximum age of eight months. In Dutch it is called 'blank kalfsvlees'. In this research the name white veal is used in order to prevent misunderstanding.
2) Rosé veal for meat that comes from calves which have been slaughtered on an age of between eight and twelve months. In Dutch it is called 'rosé kalfsvlees'.

The name for both categories of veal have been registered for every member of the European Union and is applied on meat of calves that are being slaughtered after the 1st of July 2008.

The veal sub-sector (blankvleeskalverhouderij) consist of 90 tot 95% under contract fattened calves where the farmer gets paid for caring and housing. The integrated veal production companies own the calves or guarantee to buy the fattened calves against a set price, are responsible for the delivery of the 2 to 5 weeks old calves and the calfmilk replacement. Besides that, the integrated veal production companies also take care of slaughtering and wholesale of the veal. White veal calves have been fed with mainly calfmilk replacement and a bit of roughage. The age of slaughtering is about 26 weeks. The veal is very light of colour and very tender. This makes it an exclusive and expensive product. The 5 to 10% of the contract free calves can be fattened because of the existence of the integrated veal producing companies which are needed to deliver the calfmilk replacement, slaughtering of the calves and selling of the veal.

The rosé veal sub-sector (rosévleeskalverhouderij) is started as an alternative for very exclusive and expensive white veal. Rosé veal calves are only the first couple weeks being fed with calf milk replacement. After those weeks, they are being fed with high protein compound feed and roughage. Only 10% of rosé veal calves are held under the same contract conditions as the veal calves (personal communication VanDrie Group, 2008). Rosé veal is, as the name already says, rosé and tender and the calves are being slaughtered around 10 to 12 months. Because the colour is less important, the feed not as costly and the quality of the veal not as dependent on the slaughtering age, the risk of keeping rosé veal calves is smaller compared to veal calves.

Table 1: Number of white and rosé veal calves in the Netherlands in the period 2005 – 2007 (x 1,000 calves)

	2005	**2006**	**2007**	**Average**
White veal calves	625	622	598	**615**
Rosé veal calves	204	222	262	**229**
Total number of calves	829	844	860	**844**

Source: PVE (2007a)

Table 1 shows that the majority of the veal calves held in the Netherlands are white veal calves, about 75%. The number of white veal calves is decreasing. The number of rosé veal calves has strongly increased during the years 2005-2007.

Table 2: Number of white and rosé veal calves slaughtered in the Netherlands in the period 2005 – 2007 (x 1,000 calves)

	2005	**2006**	**2007**	**Average (06-07)**
White veal calves	*	1,079	1,054	**1,067**
Rosé veal calves	*	287	345	**316**
Total number of calves slaughtered	1,376	1,366	1,399	**1,383**

*) Not known

Source: PVE (2007a) and personal communication PVE (2008)

As the number of white veal calves being held in the Netherlands decreases, so does the number of white veal calves slaughtered, as can be seen in table 2. Only the total number of calves in 2005 was specified. For the rosé veal calves, the number of calves being held and the number of calves slaughtered increases strongly.

Table 3 Net production white and rosé veal per country EU 25 in the period 2004-2007 (Weight including bone x 1,000 tons)

	2004	2005	2006	2007	Average (04-06)
France	236	244	241	*	**240**
The Netherlands	**202**	**212**	**205**	**212**	**(05-07)210**
Italy	141	142	140	*	**141**
Germany	46	45	45	*	**45**
Belgium/Luxemburg	49	54	56	*	**53**
Others	112	111	102	*	**108**
Total EU 25	**786**	**808**	**789**	*	**794**

*) Not known

Source: PVE (2007a) and CBS (2007)

Table 3 shows that the average number of 1.38 million calves slaughtered, corresponds with an average production of 210,000 tons of veal and rosé veal. The Dutch production accounts for about 25% of the total European production. Only France has an higher production. At the time this research was performed, no figures were specified yet for the other countries.

Table 4: Export of white and rosé veal from the Netherlands to country of destination in the period 2004-2006 (Weight x 1,000 tons)

	2004	2005	2006	Average
France	42	39	36	**39**
Italy	81	85	79	**82**
Germany	43	41	40	**41**
Belgium/Luxemburg	5	4	4	**4**
Others	28	29	29	**29**
Total	**198**	**199**	**188**	**195**

Source: PVE (2007a)

Table 4 shows that 75% of the veal and rosé veal is being exported to France, Italy and Germany. The countries with the largest own production of veal and rosé veal are also the largest importers of veal and rosé veal from the Netherlands. The Netherlands exports 95% of its production. France, Italy and Germany instead, are importing countries although they have a large national production.

White and rosé veal prices

Table 5: Market price white and rosé veal in the period 2005-2007 (€ per kg slaughtered weight, excl. VAT, including kidney fat and liver)

	2005	2006	2007	Average
White veal calves 'roodbont'	4.44	4.97	5.18	**4.86**
White veal calves 'zwartbont'	4.10	4.63	4.84	**4.52**
Rosé veal calves 'zwartbont'[1]	2.59	2.88	2.55	**2.67**

[1]) Producer price € / kg slaughtered weight, farm price, excl. VAT (LEI, 2007)

Source: PVE (2007a)

Table 5 shows the average prices of white and rosé veal. The prices of rosé veal are farm prices which means that transport, handling and commission are not included. White veal prices have strongly increased in the years 2004-2007, while rosé veal prices were stable.

Slaughter premiums

Because of a decrease in intervention prices of beef slaughter premiums have been established for both grown up cattle and calves in 2000. A difference is made between premiums for calves, which are slaughtered on a maximum age of eight months and a maximum slaughtered weight of 185 kilograms and the premium for cattle which applies from a slaughter age above eight months. For calves, the premium has a maximum of euro 50 per animal and a national total maximum of € 40.3 million. The actual premium in 2005 and 2006 was approximately € 40 per calf (Bont et al., 2007 and EC, art. 130, 2003)

Rosé veal calves are normally slaughtered at an age of eight months onwards. Therefore, the slaughter premium for grown up cattle is applied. This premium has a maximum of € 80 per head and a national total maximum of € 62.2 million. The actual premium for rosé veal calves in 2006 has been around € 70 per rosé veal calf (Bondt et al., 2007 en EC art. 130, 2003).

2.3 Veal supply chain

Vertical coordination consists of methods to synchronize different partners in the production chain on e.g. quantity, quality and timing of product flows. The intensity of vertical coordination can vary from almost no vertical integration at all (open market) to 100% vertical integration (full ownership). In between both extremes, different other forms of coordination are possible (Van Horne, 2007). Figure 1 gives a schematic overview and table 6 describes characteristics of different levels of cooperation.

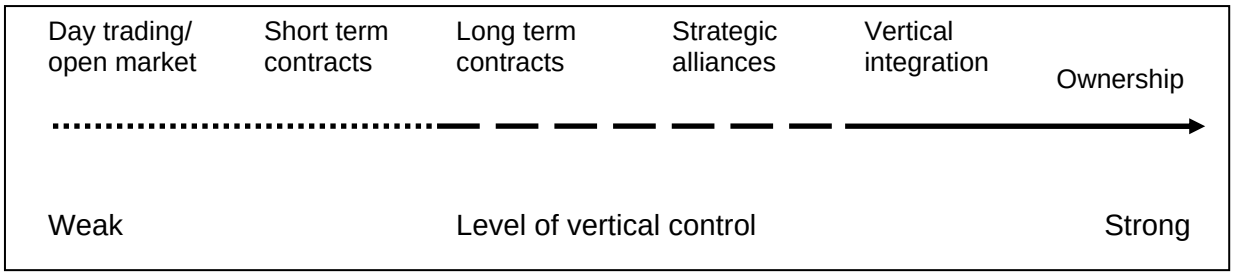

Figure 1: Different forms of vertical coordination (Van Horne, 2007)

Table 6: Characteristics and their relation to different levels cooperation

Characteristic	Open market		Full integration
Decisions	Independent		Centralized
Production	Not synchronized	⟷	Regulations
Ownership	Independent		100% owned
End product	Separated / divers		Uniform

Source: Van Horne, 2007

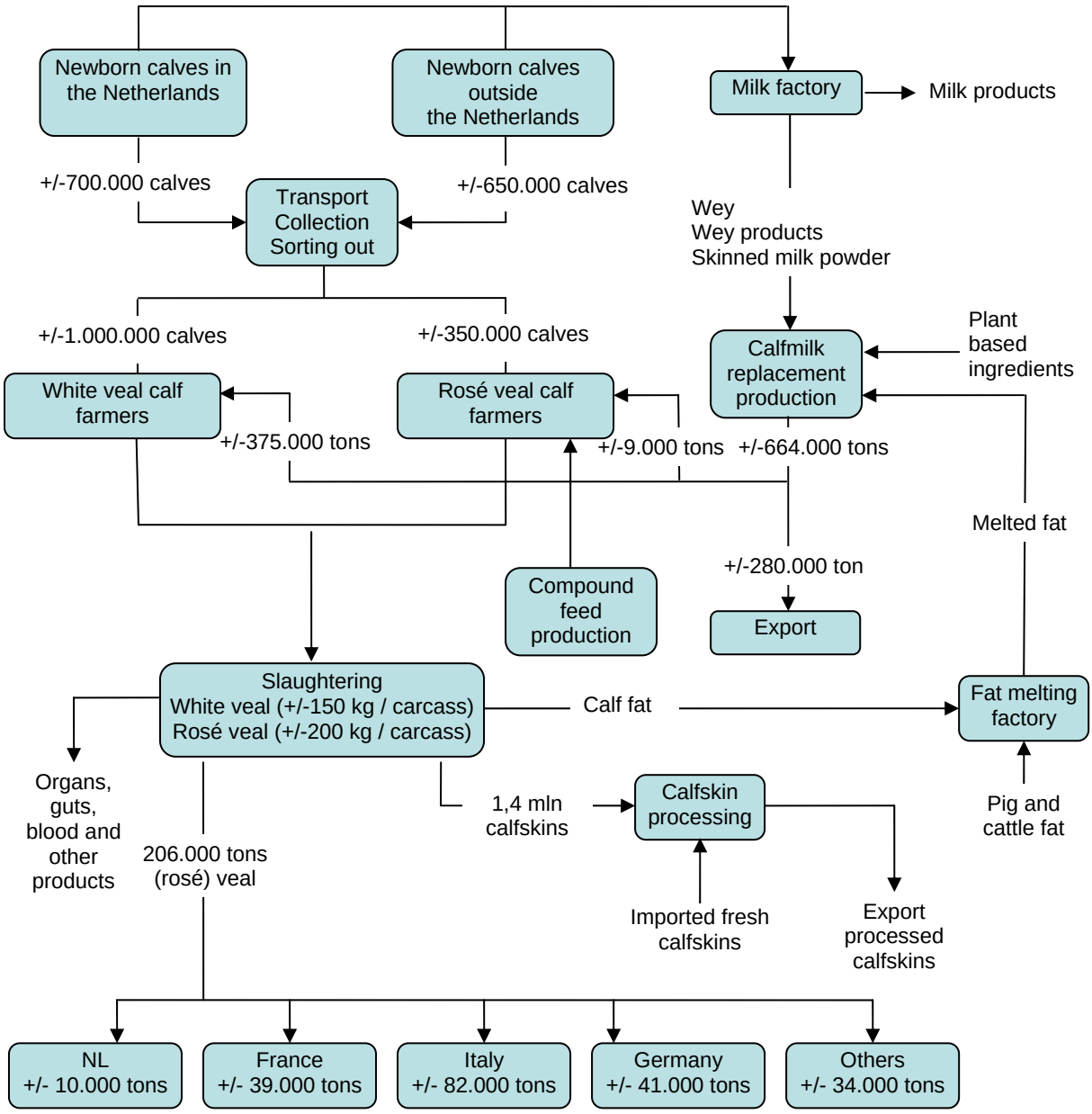

Figure 2: The veal supply chain

Figure 2 shows the different actors in the veal supply chain. The numbers used in the figure are based on the different tables in this research. Besides the actors shown in the figure, also different quality systems are present throughout the chain. Examples are SKV (veal calf quality guarantee foundation) and VanDrie Group private integral chain management system Safety Guard. The different partners in the supply chain that are distinguished in figure 2 are described in the following paragraphs.

Newborn calves

Table 7: Trade balance of calves in the Netherlands in the period 2004-2006 (x 1,000 calves)

	2004	2005	2006	Average
Production	810	786	711	**796**
Import	625	660	696	**660**
Export	74	70	73	**72**
Slaughtered	1,362	1,376	1,334	**1,357**

Source: PVE, 2007a

Table 7 shows that the production of calves in the Netherlands decreased over the years 2004-2006. The number of imported calves increased. In 2006 the number of imported calves and national production were nearly the same. The newborn calves come from different countries throughout the EU. Germany is the largest supplier of newborn calves.

Transport, collection and sorting out of the calves

Newborn calves in the Netherlands:

This stage of the supply chain consists of a lot of different actors. First, the calves are being collected by various cattle traders. Those traders bring the calves to collection centres where the calves are being sorted out on the different ability the calves have on putting on weight, based on gender and breeding. After the calves are being sorted out, they are transported to the different rosé and white veal calf farmers. At each farm, only one type of calve is fattened.

Newborn calves from abroad:

Although the newborn calves from abroad are not included in the calculation of the financial damage, they do play an important role in the veal supply chain as can be seen in table 8. Calves from abroad are collected and sorted out in the country of origin. From the collection centre, these calves go directly to a farm in the Netherlands. Because of possible animal diseases, inland calves and calves from abroad are separated as much as possible during transport and during the fattening period. Foreign and inland newborn calves are placed at separate farms as much as possible.

Veal calf farmers

Table 8: Development of specialized veal calf farmers in the Netherlands in the period 2000 - 2006 (Number of calves x 1,000)

	2000	2002	2004	2005	2006
Number of veal calves	**599**	**562**	**617**	**653**	**688**
White veal calves	526	480	511	549	558
Rosé veal calves	64	72	96	92	118
Number of specialized veal calf farms	**1,281**	**1,119**	**1,161**	**1,133**	**1,159**
White veal calf farms	1,078	876	834	837	817
Rosé veal calf farms	203	243	327	296	342
Number of veal calves per specialized farm	**467**	**502**	**531**	**576**	**594**
Number of white veal calves per specialized farm	488	548	612	656	683
Number of rosé veal calves per specialized farm	315	296	294	309	343

Source: Bont et al. (2007)

Table 8 shows that the total number of specialized farms mainly stays the same. In 2006 were about 3,000 calf farms which held on average 266 calves (PVE, 2007a). Of these 3,000 farms, about 1,150 are specialized calf farms. The average number of calves being held is increasing for both white and rosé veal calf farms. The number of white veal calf farms is decreasing where the number of rosé calf farms show an increase over the years. The veal calf farmers are getting more specialized, hold more calves per farm and an increasing percentage of the calves are being held by specialized calf farmers.

Cow milk processing companies

Cow milk processing companies process the cow milk of the dairy farms. When processing the cow milk, products like e.g. skinned milk powder and whey are produced which are used as ingredients for calf milk replacement (Bondt et al., 2007).

Fat melting companies

Fat melting companies collect category 3 fat of slaughterhouses. Category 3 means that the fat comes from animals which have been approved for human consumption. Fat melting companies then process the fat. The processed fat is then being used by e.g. calfmilk replacement factories. About 20% of the calfmilk replacement consists of animal fat (personal communication VanDrie Group, 2008).

Calfmilk replacement production

Three categories of calfmilk replacement are produced: calfmilk replacement for white veal calves, for rosé veal calves and for breeding calves. Calfmilk replacement for white veal calves is produced by the integrated veal production companies which have about 95% of the white veal calves contracted. A white veal calf needs about 350 kg of calfmilk replacer to fatten until about 26 weeks. Rosé veal and breeding calves need about 25 kg of calfmilk replacer during the first period of their life (KWIN, 2007).

The most important components of calfmilk replacement are skinned milk powder, whey powder and from whey derived components, completed with fat from animal and vegetable origin, soya and wheat proteins and other components. The use of different components depends on the price. Skinned milk powder, for example, can be 100% replaced by soya and wheat protein. Whey on the other hand cannot be replaced at all (Huirne et al., 2002 and personal communication VanDrie Group, 2008).

Table 9: Production and export calfmilk replacement in the period 1998-2006 (x 1,000 tons)

Year	Veal calves Production	Export	Inland use	Breeding calves Production
1998	641	247	394	91
1999	662	250	372	99
2000	679	265	414	93
2001	613	-	-	97
2002	572	219	353	94
2003	586	225	361	104
2004	611	231	379	117
2005	644	252	392	131
2006	673	283	390	147

Source: personal communication PDV (2008)

Table 9 shows the production and export of calfmilk replacement. The figures are extracted of the levies for export that the factories have to pay to the PDV and out of the levies paid for production, divided in veal and breeding, to SKV via the PDV. Next, the inland use of calfmilk replacement for veal calves can be calculated. For 2001, the only reliable figure is the total production of veal and breeding calfmilk replacement. No accurate figures were available to calculate the export. The breeding calfmilk replacement production shows, in contradiction to the veal calfmilk replacement, an increase in production in 2001, the year of the FMD outbreak. The cause of this effect could be that more calfmilk replacement was used at dairy farms because calves could not be transported due to the restrictions. In 2002, the production of calfmilk replacement again decreased although the FMD epidemic already ended in the autumn of 2001 and the number of cattle slaughtered was already increased in 2002 which leads to more calfmilk replacement needed. The only explanation that can be thought of is that the export of calfmilk replacement has faced difficulties even though the FMD epidemic was already finished.

Slaughterhouses

In 2006, there were seven slaughterhouses in the Netherlands that slaughtered white and/or rosé veal calves. Two slaughterhouses slaughter both cattle and veal calves, these are: Abattoir Amsterdam and Slachthuis Leeuwarden. Slaughterhouses where cattle is slaughtered, can also slaughter veal calves. Some slaughterhouses can only slaughter white veal calves because of the weight of the calves and the height of the slaughter line. Appendix IV shows the places in the Netherlands where the different slaughterhouses are situated.

Table 10: Veal calf slaughterhouses (more than 20,000 calves slaughtered per year)

Name	Place	Slaughter capacity per year
KSA	Aalten	20,000 – 150,000
Abattoir Amsterdam	Amsterdam	20,000 – 150,000
Ekro b.v.	Apeldoorn	> 150,000
ESA	Apeldoorn	> 150,000
Vitelco	Den Bosch	20,000 – 150,000
Slachthuis Leeuwarden	Leeuwarden	20,000 – 150,000
T. Boer en Zn	Nieuwerkerk a/d IJssel	> 150,000

Source: PVE (2007b)

Table 11: Cattle slaughterhouses (more than 10,000 head of cattle slaughtered per year)

Name	Place	Slaughter capacity per year
Abattoir Amsterdam	Amsterdam	25,000 – 75,000
Slachterij Wouters	De Hoef	10,000 – 25,000
Weyl Beef Products	Enschede	> 75,000
Exportslachterij J. Gosschalk en Zn	Epe	> 75,000
G.J. Hutten en Zn	Nieuw Heeten	10,000 – 25,000
Nijmeegse Grossiers Combinatie	Nijmegen	25,000 – 75,000
Slachthuis Leeuwarden	Leeuwarden	25,000 – 75,000
Vion Food Group	Tilburg	> 75,000

Source: PVE (2007b)

Calfskin processing

Calf leather is a very luxurious good. This makes the calf skin very worthy. In the Netherlands there are several companies that process, or to say conserve, the calf skin before they are being sold to leader producing companies, so called tan companies (leerlooierijen). All skins of calves slaughtered in the Netherlands, and some imported skins, are being processed in the Netherlands. Processing means weighting, classification and salting of the skins (personal communication VanDrie Group, 2008).

Approximately 95% of all skins is exported. The EU is still the most important market for calfskins, especially the southern European countries like France, Italy and Portugal. Asia, and especially China, have become more important during the years. Most calfskins are used for making exclusive shoes. The other skins are used to produce other leather products like hand bags or car seats. In 2007, fresh calfskins were worth around 50 euro. Almost no price difference exists between skins from white or rosé veal calves. Being fed with calfmilk replacement, makes the skin of a white veal calf lighter of weight and thinner then a skin of a rosé veal calf (personal communication VanDrie Group, 2008).

Integrated veal production companies

The veal supply chain is being dominated by several large integrated veal production companies: VanDrie Group, Alpuro Groep, Denkavit and the Pali Groep. These companies enter into integration contracts with calf farmers, have their own factories for the production of calfmilk replacement and/or slaughter the calves in their own slaughterhouses. The largest integrated veal production company in the Netherlands, and in the Europe, is VanDrie Group. VanDrie Group owns several slaughterhouses and calfmilk replacement factories throughout Europe and a calfskin processing company in the Netherlands. VanDrie Group has a market share of about 60% in the Netherlands and of 25% in Europe (Bont et al, 2007).

2.4 Conclusion

The answer to research question 1 ‘What are the characteristics of the veal sector in The Netherlands?’ is that the veal sector in the Netherlands is characterized by the production of white and rosé veal. Production of white veal is for 95% under contract from integrated veal production companies. Of the rosé veal production, only a small percentage of the calves is being held under contract of the integrated veal production companies.

On average, there were 615,000 white veal and 230,000 rosé veal calves held over the years 2005 - 2007 in the Netherlands. The total number of calves slaughtered in the same period was almost 1.4 million white and rosé veal calves which corresponds to a production of about 210,000 tons of veal. The total production of the 25 countries of the EU is about 800,000 ton. Of the total Dutch production of veal, 95% is being exported to about 60 countries from which France, Italy and Germany are the most important.

Slaughter premiums are divided in a premium for cattle slaughtered on a maximum age of eight months and of 185 kilogram and in a premium for cattle slaughtered on an age older than eight months. The first premium is important for white veal calves and has a maximum of 50 euro per animal and a maximum national budget of 40.3 million euro. The premium in 2005 and 2006 has been around 40 euro per animal. The second premium is important for rosé veal calves and has a maximum of 80 euro per animal and a maximum national budget of 62.2 million euro. The premium in 2005 and 2006 has been around 70 euro per animal (Bont et al., 2007).

White veal prices have increased by approximately 15% during the last three years up to over € 5 per kilo in 2007. The average white veal price in the period 2005-2007 is approximately € 4.75 per kilogram. Rosé veal prices stayed more or less the same over the period 2005-2007 at about € 2.75 per kilogram.

The veal supply chain consists of many actors with mutual relations that differ in intensity and dependency. Actors that can be distinguished are: new born calves, transport, cow milk processing, fat melting, veal calf farmers, calfmilk replacement production, compound feed production, slaughterhouses, calfskin processing and integrated veal production companies. The veal production in the Netherlands is dominated by four integrated veal production companies of which VanDrie Group is the most important with a market share in the Netherlands of around 60% and in Europe of about 25%. VanDrie Group owns several slaughterhouses, calfmilk replacement factories and a calfskin processing company. Integrated veal production companies are organized in a combination of vertical integration and ownership of the different partners within the supply chain. Especially the veal calf farming stage is a form of vertical integration where the farmers provide housing and care and the integrated veal production companies provide the calves, calfmilk replacement, medicines, etc. Slaughterhouses and calfmilk replacement factories are typical examples of where the integrated company is owner of different partners of the supply chain.

3 FMD legislation

3.1 Introduction

This chapter describes relevant legislation for the veal supply chain in case of FMD. For a better understanding of how FMD legislation is organized, a short description of the different levels of FMD legislation is given. Next, measures in case of an outbreak of FMD are described to answer research question 2.1, protective vaccination is explained to answer research question 2.2 and last measures in case of vaccination are described in order to answer research question 2.3. In the last paragraph, conclusions are drawn and the answers are given on the different research questions.

3.2 Organization of FMD legislation

Because of the need to fight infectious animal diseases at a global level, the Office International des Epizooties was founded by the signing of the International Agreement in 1924. In May 2003 the Office became the World Organization for Animal Health but kept its historical acronym OIE. The OIE decides on which status a country or territory gets in accordance to the situation of the specific animal disease in that country. Speaking of FMD, the highest status is 'free of FMD without vaccination'. The status, decided by the OIE, gives other countries legal basis to decide whether it accepts products of animal origin from that specific country (OIE, 2007). Because of possible trade restrictions, it is very important for the Netherlands to have and keep the status 'free of FMD without vaccination. Only with the highest status, no trade restrictions can be put forward by other countries. The OIE has set up regulation how to regain the status 'free of FMD without vaccination' again after vaccination is practiced to fight an outbreak of FMD.

The European Union obliges the fighting of FMD outbreaks according to Council Directive 2003/85/EC. The Council Directive 2003/85/EC is based on the regulations of the OIE. Besides that, the EU has also put in place extra legislation for fighting an outbreak of FMD. Within the Council Directive 2003/85/EC, all regulations can be found which EU member states have to implement in case of an outbreak of FMD. Also described are conditions according to the trade of products from animal origin between member states during an outbreak of FMD and when vaccination is practiced. At a national level, the EU legislation according to FMD has to be followed. Besides the EU legislation, national governments can decide on extra measures to be taken to fight an outbreak of FMD. An example of such an extra measure is the 72 hours standstill which can be put in place by the Dutch Minister of Agriculture in case of an outbreak of FMD or a very strong suspicion.

3.3 Measures in case of outbreak

In case of an outbreak of FMD in the Netherlands, plan of action 'Beleidsdraaiboek Mond- en Klauwzeer, versie 2.0' is put into practice immediately. First action to be taken is a 72 hours standstill. During the standstill, no transportation of animals, products from animal origin or feed is allowed. Also the cause and size of the outbreak is being investigated by tracing all farm contacts and animal movements of the farm where FMD is confirmed and from all farms which have been in contact in any

physical way with the farm where FMD is confirmed. Measures that are put into action during the standstill are (LNV, 2005):

- Farms where FMD is confirmed, farms that have been physically in contact with an infected farm and farms within a one kilometre radius are surveyed to see how many animals have the FMD virus and how many animals have antibodies against the virus. With this information the number of days the virus is present on the farm can be calculated.
- All animals on the farm where the outbreak is confirmed, on the farms which have been in contact and on the farms within a one kilometre radius around the farm where the outbreak is confirmed, shall be slaughtered on the spot and the carcasses have to be destroyed.
- Protection and surveillance zones are put in to place.
- White the use of a risk analysis performed by experts, the decision will be made to use vaccination.
- Regionalization is put in to place.
- Export is banned of animals and meat and meat is traced that has been produced till 21 days before the existence of the FMD virus in the Netherlands.

Within the first 72 hours, other or changes in the regulations and measures are decided on by the Ministry of Agriculture in cooperation with experts. Specific measures that are used in case of vaccination are described in the next paragraph.

3.4 Measures in case of vaccination

Two different kinds of emergency vaccination can be used according to fighting the spreading of the FMD virus. Suppressive vaccination means that after vaccination, all vaccinated animals are slaughtered and destroyed. Protective vaccination means that after vaccination, vaccinated animals can stay alive and products of those animals, e.g. milk and meat, can be sold within the EU (EC, 2003a). In case of a worst case outbreak of FMD, as is being assumed in this research, protective vaccination is used in the Netherlands in order fight the disease as fast as possible and to slaughter and destroy the carcasses of as less healthy animals as needed.

At the moment that is decided on the use of protective vaccination, vaccination with keeping the animals alive, phases 1 to 3 do apply (EC, 2003) until the moment of regaining the status ‘free of FMD without vaccination’ according to the OIE. During the period of the 3 phases, different areas are distinguished. According to Meuwissen et al. (2004) the best option to vaccinate is in a radius of two kilometre around the contaminated farm. This circle is called the vaccination circle. When more farms become contaminated and are positioned on a further distance of the ‘source’ farm, more vaccination circles can exist.

The vaccination zone is the area which includes all vaccination circles. By larger distances between the vaccination circles, more vaccination zones can exist. The vaccination zone includes vaccinated as well as non-vaccinated animals. The vaccination zone is surrounded by a surveillance area (surveillance zone as defined by OIE) of at least 10 kilometre width from the perimeters of the vaccination zone (EC,

2003a, art. 52). The different phases apply for the vaccination area as well as the surveillance area. During phase 1 and 2, restrictions between the areas can differ. In phase 3, restrictions are the same for all affected areas.

Phase 1

The duration of phase 1 lasts from the beginning of the vaccination until at least 30 days have passed after the last animal is vaccinated. Measures taken within PS-areas are more or less the same as measures taken within vaccination circles. Measures within PS-areas last at least until 30 days after the last outbreak. Phase 1, is presumed, will therefore also last until approximately 30 days have past since the last outbreak. During phase 1, only because of animal welfare, after permission and under restrictions, transport is possible from non vaccinated and FMD free animals to a slaughterhouse situated within or as close as possible to the vaccination area. At the slaughterhouse, the animals should be slaughtered as soon as possible. When protective vaccination is used, no animals will be bought by the government from the viewpoint of animal welfare. Instead, slaughter out of the viewpoint of animal welfare will be made possible (LNV, 2005).

The fresh meat from vaccinated animals, slaughtered in phase 1, can be placed on the market after meeting the following conditions, according to EC (2003a) article 54(3):

a) Bears the mark provided for in Directive 2002/99/EC.

Directive 2002/99/EC, Article 4(1, i): Products have been obtained, handled, transported and stored separately, or at different times.

Annex II: Mark for fresh meat must bear a diagonal cross and other information.

b) Is being stored and transported separately from meat not bearing the mark referred to and shall subsequently be transported in sealed containers to an establishment designated by the competent authorities for treatment in accordance with point 1 in Part A of Annex VII

Annex VI (1): Meat products that have undergone at least one of the treatments provided for in the first column in Table 1 of Annex III of Directive 2002/99/EC.

Directive 2002/99/EC, Annex III, Table 1:

1) *Heat treatment in a hermetically sealed container with an F0 value of 3,00 or more.*
2) *Heat treatment ensuring a core temperature of at least 65℃ is reached for the time necessary to achieve a pasteurization value equal to or more than 40.*

Phase 2

Phase 2 consists of two sub-phases A and B. Those phases are farm specific. Phase 2 A starts after the completion of phase 1 and consist of a clinical and serological survey of the holdings (farms) within the vaccination zone. Phase 2-B starts after the completion of phase 2 A and is farm specific. Phase 2 B consists of the classification of herds in the vaccination zone. When phase 2 B is finished on a specific farm, this farm can move on to phase 3.

The fresh meat produced from vaccinated animals, slaughtered in phase 2, can be placed on the market within and outside the vaccination zone after meeting the following conditions, according to EC (2003a) article 55(4):

a) Fresh meat can be placed on the EU market under the condition of being clearly identified, transported and stored separately during the production process, has to be deboned and for at least 24 hours maturated.
b) Fresh meat gets the EEC health mark and needs certification when placed on EU market.

Phase 3

Phase 3 starts after the completion of phase 2 B and its measures are applicable in the vaccination zone until the FMD free status is recovered.

The fresh meat produced from non-vaccinated animals can be placed on the market within and outside the vaccination zone after meeting the following conditions, according to EC (2003a) article 58:

a) Subsection 6: Fresh meat gets EEC mark and is throughout the production process clearly be identified, and transported and stored separately.
b) Subsection 12: Certification needed when fresh meat is intended for intra-Community trade.

The fresh meat produced from vaccinated animals or produced from non-vaccinated offspring of vaccinated dams, can be placed on the market within and outside the vaccination zone after meeting the following conditions, according to EC (2003a) article 58:

a) Subsection 7 and 8: Fresh meat can be placed on the EU market under the condition of being clearly identified, transported and stored separately during the production process, has to be de-boned and for at least 24 hours maturated. Fresh meat gets the EEC health mark.
b) Subsection 12: Certification needed when fresh meat is intended for intra-Community trade.

Phase 3 ends when the vaccination zone recovers the status ‘free of FMD without vaccination’ of the OIE. The status can be recovered at a minimum period of six months after the last outbreak of FMD and after finishing vaccination. After six months, all measures within the vaccination zone and the surveillance zone are lifted (OIE, 2007).

3.5 Conclusion

Research question 2.1 ‘Which regulations are in place?’ is answered in paragraph 3.3 and 3.4. In case of an outbreak of FMD both Dutch and EU legislation come into place. Dutch legislation consists of action plan ‘Beleidsdraaiboek Mond- en Klauwzeer, versie 2.0’ in which specific measures are described about how the FMD virus has to fought within the Netherlands according to the EU legislation. Also extra measures are applied in the Netherlands such as a 72 hour standstill when an outbreak is suspected or already confirmed. EU legislation consists of the ‘Council Directive 2003/85/EC’. The Council Directive 2003/85/EC obliges the fighting of FMD outbreaks and applies for all member states of the European Union and meets OIE legislation. In case of using emergency vaccination to fight the FMD virus, three phases come into place according to EU and OIE legislation.

Also different areas are put into practice: vaccination circles, the vaccination area and the surveillance zone. Phase 1 is applied during the period of vaccination of all animals within the vaccination circle. Phase 2 consists of a clinical and serological survey of the holdings (farms) within the vaccination zone. After a farm is examined, it goes to phase 3. Phase 3 is in place until the FMD free status is recovered according to the OIE.

Research question 2.2 ‘What is protective vaccination?’ is answered in paragraph 3.3. Two kinds of emergency vaccination exist; suppressive and protective vaccination. Protective vaccination means that the vaccinated animals can stay alive and that products from those vaccinated animals, e.g. milk and meat, can be sold within the EU.

Research question 2.3 ‘Which problems occur according to trading of veal?’ is divided into two sub questions: veal from non-vaccinated calves and veal from vaccinated calves or veal from offspring of vaccinated animals. In the affected areas, slaughtering of the calves and trading of veal depends on which of the three phases is in place. During phase 1, all carcasses of slaughtered calves have to be channelized, maturated for 24 hours, deboned and have to undergo a heat treatment. The veal gets a mark with a diagonal cross and can then be put on the market. During phase 2, all carcasses of slaughtered calves have to channelized, maturated for 24 hours, deboned and gets the EEC health mark. The veal can be put on the EU market under restriction of certification. During phase 3, carcasses of slaughtered non-vaccinated calves have to be channelized, get the EEC health mark and can be put on the EU market under the restriction of certification. Carcasses of slaughtered vaccinated calves or from offspring of vaccinated cattle have to be channelized, maturated for 24 hours and have to be deboned. Veal gets the EEC health mark and can be put on the EU market under the restriction of certification. Veal from calves slaughtered in the ‘not affected’ areas of the Netherlands can be traded within the EU depending on transport restrictions which are decided on by the Dutch Ministry of Agriculture in cooperation with experts.

4 FMD modelling

4.1 Introduction

Various studies have tried to model the epidemical and economic impact of FMD epidemics in the Netherlands. As the current study focus on the economic impact in particular, only studies with a strong focus on economic impact are taken into account. An overview of various relevant studies is described in paragraph 4.2. Conclusions are drawn in paragraph 4.3.

4.2 Methods of modelling

Various studies with a focus on economic impact are described in Table 12. The oldest study described was published in 1990, the latest one in 2007. The table starts with naming the authors. Second, the used epidemiological modelling method is mentioned because all studies use epidemical data before proceeding to the calculation of the economic impact. Following the epidemiological modelling method, the economic methods of modelling used are described. Chain partners are mentioned on which the various studies focuses an the table ends with describing different cost parameters which have been used to model the economic impact.

Table 12: Methods modelling financial impact FMD			
Authors	Berentsen et al. (1990)	Meuwissen et al. (1997)	Huirne et al. (2002)
Epidemiological modelling method	State transition approach (Miller, 1979) consisting of a Markov chain model (Carpenter, 1988)	Spatial and stochastic simulation model Interspread (Jalvingh et al., 1995)	2001 FMD outbreak evaluation
Economical modelling method	Product oriented export model based on outbreak calculated via dissemination rates (Dijkhuizen et al., 1986) and three regions	Economic calculations based on average, minimum and maximum outbreak of FMD	Economic calculations with micro perspective Economic calculations with macro perspective based on input / output analysis
Chain partner(s)	Producers Consumers Government	Primary sector Slaughterhouses Trading Breeding and reproduction Dairy industry Feeding industry Government	Farmers Feeding industry Trading Slaughterhouses Dairy industry Breeding industry Government (EU and NL) Tourism industry

Cost specified	Preventive costs
	- Annual routine vaccination
	
	Costs resulting from an outbreak
	<u>Direct costs</u>
	- Costs of ring vaccination
	- Stamping out costs
	  - value of slaughtered and destroyed animals (government)
	  - evaluation, transport, disinfection etc (government)
	  - loss of income during time affected farms are empty (producer)
	  - loss of income in trade and industry (producer)
	  - incidental costs on farms (producer)
	
	<u>Indirect costs</u>
	- Temporary closure of borders which can lead to price drop
	- All other financial consequences for producers, consumers and government of border closure by other countries
		Primary sector
		- Costs slaughtered animals
		- Extra feeding costs
		- Costs of empty barns
		Slaughterhouses
		- Decreasing of turnover due to stamping out
		- Closing down production facilities due to transport restrictions (75% of normal slaughter costs)
		- Losses which occur due to export bans or trade restrictions.
		Trading
		- Decreasing turnover due to stamping out
		Breeding and reproduction
		- Losses due to stamping out breeding farms
		- Losses due to transport restrictions
		Dairy industry
		- Channelization costs milk
		Feeding industry
		- Decrease in turnover due to stamping out
		- Increase of turnover due to transport restrictions animals
		- Costs extra hygienic measures (not quantified)
		Government
		- Stamping out costs
		- Control costs (diagnose, taxation, cleaning and disinfection, AID, clinical and serological research)
		- Cost of welfare slaughter
			Farmers
			- Decreased revenues due to decreased prices
			- Increased slaughter weight and decreased quality of veal calves
			- Empty barns
			Feeding industry
			- Decrease in turnover due to stamping out
			- Increase of turnover due to transport restrictions animals
			- Costs due to extra hygienic measures and logistical difficulties
			Trading
			- Decreasing turnover due to stamping out and transport restrictions (calves: approx. 12 million euro total)
			- Other logistics (meat) (approx. 6 million euro per week standstill)
			Slaughterhouses
			- Decreasing of turnover due to stamping out
			- Closing down production facilities due to transport restrictions
			Dairy industry
			- Logistical costs
			- Costs due to export problems
			Breeding industry
			- Decrease of turnover due to not being able to provide service
			Government EU
			- Bears 60% of costs for stamping out: vaccination, compensation payments killed animals, costs of control measures
			Government NL
			- All other costs: e.g. AID, RVV, vet's, laboratories, etc

Table 12 (continuation): Methods modelling financial impact FMD			
Authors	Huirne et al. (2002)	Meuwissen et al. (2004)	Hoste and Bergevoet (2007)
Epidemiological modelling method	Epidemiological spatial and stochastic simulation model: InterFMD (Jalvingh et al., 1998, Mourits et al., 2002)	Epidemiological spatial and stochastic simulation model: InterFMD (Jalvingh et al., 1998, Mourits et al., 2002)	Epidemiological simulation data (Meuwissen et al., 2004)
Economical modelling method	Economic calculations with macro perspective based on: - input / output analyses (Van Leeuwen and Verhoog, 1995) - 50% and 95% outbreak of FMD - 7 source farms divided over 3 density levels - eight different control strategies	Economic calculations based on - 50% and 95% outbreak of FMD - three different regions, area in the south of the Netherlands (high density pigs), are in the centre (high density pigs/cattle) and North (low density of animals) - six different control strategies	Spreadsheet model with ten scenarios based on five different volumes and two different sale channels (retail and meat products)
Chain partner(s)	Agricultural supply chain - Affected area - Area rest NL Tourism industry	Primary sector - Dairy - Cattle - Rosé veal calves - White veal calves - Sheep and goats - Pigs	Primary sector Processing industry
Cost specified	<u>Direct costs</u> - Compensation payments slaughtered animals - Control costs (diagnose, taxation, slaughtering, disinfection, administration, screening, destroying and vaccination: 150 euro / calf) - Losses due to empty barns (50% of employee costs and fixed costs: 0.31 euro / calf / day) - Losses due to transport restrictions of animals and products of animal origin (extra feed, loss of quality, etc: 0.24 euro / calf / day) <u>Indirect costs</u> - Depends on international trade barriers; duration, region and products that are involved.	<u>Direct costs</u> - Control costs - Compensation payments killed animals <u>Indirect costs</u> 'affected' area - Empty barns divided in a) infected farms, b) neighbour farms, c) vaccinated farms and d) welfare slaughter - Market damage divided in a) vaccinated farms, b) welfare slaughter, c) other farms in 'affected' area and d) farms which are not any more in the 'affected' area <u>Indirect costs</u> 'free' area - Decreased revenues Calves white (€5.65/kg) - Vaccinated: price -/- 75% - Welfare slaughter: price -/- 10% - Other in affected area: price -/- 65% - Other outside affected areas: -/- 25% Calves rosé (€2.62/kg) - Vaccinated: price -/- 55% - Welfare slaughter: price -/- 10% - Other in affected area: price -/- 10% - Other outside affected areas: -/- 5%	<u>Indirect costs</u> Channelization costs taken into account - Not making 100% use of slaughterhouse / processing place - Costs to get rid of slaughter by products instead of collecting revenues - Costs of changing process lines to other products - Extra product numbers for processing and distribution, extra time for administration, pricing and billing - Order picking due to increased amount of product numbers - Logistics due to inefficient transport to retail. Increased product numbers per customer and less weight per truck - Cutter, cook and slice costs. Different batches of meat from (non) vaccinated animals - Decreased prices due to non-optimal sales of cut and processed meat and by the use of high value meat as ingredient for meat products Channelization costs not taken into account due to assumed small size - Extra transport costs animals - Not making 100% of storage places - Costs of cleaning - Extra control costs like VWA

4.3 Conclusions

Five relevant studies were found that have modelled financial impact of FMD in the Netherlands. Results of the Epidemiologic spatial and stochastic simulation model were used to calculate the financial impact within all studies except in Berentsen et al. (1990). Economic calculations in the most recent studies were based on 50% and 95% outbreaks and on areas with a different density of animals.

The chain partners where the various researches focuses on when calculating the financial damage differ. Berentsen et al. (1990) only distinguishes producers, consumers and government where Meuwissen et al. (1997 and 2004), Huirne et al. (2002) and Hoste and Bergevoet (2007) focus on the different partners within the supply chain. The researches do differ in the number of chain partners distinguished, whether they take into account the government and by focussing on several animals or one in specific like Hoste and Bergevoet (2007).

Summarizing the chain partners which are relevant for this research are:

- Primary sector
- Slaughterhouses and processing industry
- Feeding industry
- Trading
- Government

The various researches distinguish, and often quantify, different costs for the chain partners. Those costs and their values are used in Table 17 “input parameters” in paragraph 5.4.

5 Materials and methods

5.1 Introduction

In this chapter the model and the model inputs are discussed. First, the simulated worst case scenario of the FMD outbreak is discussed in paragraph 5.2 where also the number of calves involved is calculated. In paragraph 5.3, the modelling tool and chain parameters are described which are used within the model. Paragraph 5.4 gives an overview of all input parameters of the model with their value and source. The background of the different parameters is described in the sub-paragraphs. In the last paragraph, paragraph 5.5, the model assumptions are described.

5.2 Scenario

5.2.1 Introduction

A worst case scenario of an outbreak of FMD is the starting point for the calculations in order to calculate the expected maximum financial damage. The worst case scenario within this research is based on calculations of Meuwissen et al. (2004). The scenario is a simulated outbreak of FMD in an area in the centre of the Netherlands, the Veluwe, where protective vaccination is used within a circle with a two kilometre radius around infected farms. Protective vaccination means that vaccinated animals can stay alive. This simulation where a vaccination circle with a two kilometre radius is used, is the most effective simulation when vaccination is practiced. The Veluwe is the area where most white veal calves are situated. Rosé veal calves are more spread over the Netherlands (LEI, 2007a). The simulated outbreak has a duration of 84 days, counted from day of detection of the first case of FMD until 30 days have passed since the last outbreak, based on 95% percentile value. This means that in 95% of the simulations the duration did not exceed 84 days.

To be able to place the simulated worst case scenario in the right perspective, a comparison is made with the outbreak of FMD in 2001. In paragraph 5.2.2, the outbreak in 2001 is shortly described together with a future perspective. In paragraph 5.2.3, the number of white and rosé veal calves are simulated.

5.2.2 FMD outbreak perspective

The last outbreak of FMD in the Netherlands was in 2001 and started in the UK on the 20th of February. From the 22nd, collection of animals was not allowed anymore in the Netherlands, except direct transportation to a slaughterhouse or farm. Three weeks later, at the 13th of March, an outbreak of FMD was confirmed in France. At that moment, also transportation of animals to slaughterhouses was banned in the Netherlands. A week later, at the 21st of March, the first outbreak of FMD in the Netherlands was confirmed (Abbas et al., 2002).

At the moment that the first case of FMD was confirmed in the Netherlands, a standstill was put into place for all animals and no export of products from animal origin was allowed anymore. At the 26th of April, 5 weeks and 1 day later, transport of animals to slaughterhouses was possible again (Abbas et all., 2002, page 231). On May 11, all areas, except the protection and surveillance areas, got the status

of Annex II area which made export of meat possible again (Abbas et al., 2002, page 238). At the 26th of June, 96 days after the outbreak, EU Commission Decision 2001/223 was withdrawn which meant that all restrictions concerning FMD were raised (Abbas et al., 2002).

The outbreak of FMD in 2001 has had a great impact on the production and trade of veal. An overview of the development of the production and trade of veal in the years 1998 - 2006 is shown in Table 13.

Table 13: Overview production and trade of veal in the years 1998 – 2006

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Slaughtered white and rosé (x 1,000)	1,373	1,399	1,386	1,029	1,214	1,272	1,362	1,376	1,334
Weight including bone (x 1,000 ton)									
Production from slaughtering	198	211	199	165	177	186	202	212	205
Import	2	2	5	4	3	7	7	3	3
Export	180	192	183	133	173	173	185	190	181
Change of stock	0	0	0	15	-14	-1	0	0	0

Source: PVE (2007a)

Different conclusions can be drawn from Table 13. The number of calves slaughtered in 2001 is about 350,000 calves lower than in 2000. This accounts for about 25% of the annual production. Not until three years later, in 2004, has the number of calves slaughtered risen above 1.3 million calves again. Together with the decrease of the number of calves slaughtered during 2001, also the production of veal decreased. The decrease in export was larger than the decrease in production in 2001. This is explained by the change in stock of 15,000 ton of veal. Until 2004 the production and export levels did not reach the same levels as before the FMD outbreak in 2001.

The last case of an FMD outbreak in Europe were two single outbreaks in August and September in 2007 in the UK (EC 2007a). In the future, for the period 2005-2009, an outbreak of FMD is expected to take place ones in eight years. This risk is the same as it was expected in the years 1999-2004 (Meuwissen et al., 2005).

5.2.3 FMD outbreak simulation

In order to get a realistic calculation of the financial damage for the veal supply chain, average numbers of calves present in the Netherlands in the last couple of years are used. Meuwissen et al. (2004) has calculated the number of calves involved in an outbreak with the use of an epidemic simulation model. The average number of white and rosé veal calves has increased over the years. Based on the assumption that the percentage increase of calves is equal in every area in the Netherlands, the number of calves for every distinguished group is calculated based on the average number of veal calves present in the years 2005-2007 (Table 1).

Table 14: Numbers of white and rosé veal calves involved in a worst case outbreak FMD in "Centre NL" and "Vacc-2km-life" (95%) with duration of 84 days

	White veal calves		Rosé veal calves	
	2004[1]	2005-2007[2]	2004[1]	2005-2007[2]
Stamping out	5,308	5,723	778	1,249
Vaccinated	32,364	34,895	4,745	7,620
Welfare slaughter[3]	23,170	24,982	3,396	5,454
Other calves in surveillance zone	191,974	206,986	28,136	45,183
Other calves in NL	317,584	342,419	105,544	169,492
Total NL	**570,400**	**615,000**	**142,600**	**229,000**

[1]) 2004; Meuwissen et al. (2004, page 20)
[2]) 2005-2007;based on average number of calves 2005-2007, see Table 1 (PVE, 2007a)
[3]) Welfare slaughter; in this research is veal of calves slaughter because of animal welfare always sold for human consumption

Meuwissen et al. (2004) did not take into account the different phases. A new deviation is therefore made which is shown in Table 15.

Table 15: Numbers and percentages of calves slaughtered during different phases based on a worst case outbreak

	Number of calves			
	White		Rosé	
Stamping out	5,700	(1%)	1,200	(0,5%)
Calves in vaccination zone				
Phase 1	12,500	(2%)	2,700	(1%)
Phase 2	12,500	(2%)	2,700	(1%)
Phase 3 non-vaccinated	207,000	(34%)	45,000	(20%)
Phase 3 vaccinated	35,000	(6%)	7,600	(3%)
Calves in free areas in NL	342,000	(56%)	169,000	(74%)
Total	**615,000**	**(100%)**	**229,000**	**(100%)**

The numbers in Table 15 are rounded numbers to make it easier to interpret. Phase 1 and 2 reflect the number of calves slaughtered because of animal welfare. A further explanation of the new deviation made, is given with the use of Table 16. The percentages behind the rounded number of calves helps to interpret the numbers. Table 16 shows that there are two very dominant groups of calves; non-vaccinated calves in the vaccination zone and calves in the free areas of the Netherlands. The number of calves which are directly involved, stamping out and vaccinated calves, do account for 6% (white) and 3.5% (rosé) of the total number of calves present in the Netherlands. The calves which are slaughtered because of animal welfare, during phase 1 and 2, account for 4% (white) and 3% (rosé) in comparison to the total number of calves. The difference between the percentages of both white and rosé veal calves caused by the fact that white veal calves are more concentrated in the area in the centre of the Netherlands instead of rosé veal calves which are more equally spread over the whole country (LEI, 2007a)

When vaccination is practiced, a vaccination zone is put into place and different phases are implemented within the vaccination zone. A scheme is drawn in Table 16 to show the time frame which is assumed according to the different phases.

Table 16: Different phase during FMD epidemics (weeks)

Week	1 – 5	8 – 9	12 – 13	15 – 16	39
Phase 1	Outbreaks Stamping out (W 5,700; R 1,200)	30 days			
	Vaccination				
		Welfare slaughter (W 12,500; R 2,700)			
Phase 2			A: clinical and serological survey		
			B: classification		
			Welfare slaughter (W 12,500; R 2,700)		
Phase 3				Individual per farm	
				Slaughter non-vaccinated (W 207,000 and R 45,000)	
				Slaughter vaccinated (W 35,000 and R 7,600)	
Free areas NL	Transport possible again to slaughterhouse; slaughter W 342,000 and R 169,000				

Based on EC (2003a) and own assumption

Phase 1

The FMD epidemic in 2001 lasted for 96 days; almost 14 weeks (Abbas et al., 2002). The scenario used in this research lasts for 84 days, 12 weeks, accounted from day of confirmation of the outbreak until 30 days have past after the last outbreak (Meuwissen et al., 2004). In case of vaccination, see paragraph 3.4, lasts phase 1 until 30 days after vaccination is finished. It is assumed that after every outbreak vaccination is practiced which results in phase 1 lasting until at minimum 30 days have past after the last outbreak. Start of vaccination will be some time after the first outbreak because experts and the ministry of agriculture has to decide on whether to vaccinated or not (LNV, 2005). In the simulation of Meuwissen et al. (2004) comes forward that 25,000 white and 7,600 rosé veal calves will be slaughtered because of animal welfare. In 2001, animals slaughtered because of animal welfare were slaughtered and carcasses were destroyed. The animals were compensated by the government. When vaccination is practiced, the animals will not be compensated by the government anymore but it will be made possible to transport them to a slaughterhouse. The meat can be placed on the market meeting conditions as described in paragraph 3.4 (LNV, 2005). In the simulation of Meuwissen et al. (2004) are animals that are slaughtered because of animal welfare, slaughtered during the FMD epidemic which lasts for 96 days including 30 days after the last outbreak. When doing this when vaccination is practiced and phases are applied, this means that those animals are slaughtered during phase 1. One condition of phase 1 is that the veal has to be heated (see paragraph 3.4). This will result in a major decrease in price. It is therefore assumed within this research that half of the calves are slaughtered because of animal welfare during phase 1 and half of the number of calves during phase 2.

It is assumed that calves slaughtered in phase 1 can be transported during the period that vaccination is ended, in week 9, until the end of phase 1, in week 12. Also is assumed that calves are being slaughtered in equal numbers over the weeks. This results in that calves in phase 1 are slaughtered in week 10 on average.

Phase 2

Phase 2 starts after the completion of phase 1 and lasts for some time due to the clinical and serological survey of all holdings with animals. Farms which hold vaccinated calves first go through phase 2A which means the clinical and serological survey of all animals. After phase 2A is finished, individual farms move on to phase 2B which means the classification of the farms based on the results of phase 2A. When no infected animals are found, individual farms can move on to phase 3 which makes it possible to transport calves to slaughterhouses again. It is assumed that during phase 2 transport restrictions apply for the whole vaccination zone, which also includes non-vaccinated animals. Besides the assumption that transport restrictions apply, do also the conditions under which veal can be traded from slaughtered animals in phase 2, affect the moment of slaughtering. Veal from non-vaccinated calves slaughtered in phase 3 does not have to be deboned and maturated. This results in a lower decrease in revenues because a higher price can be collected. It is therefore assumed that both vaccinated and non-vaccinated calves are all slaughtered during phase 3 except for 12,500 white and 2,700 rosé veal calves which are slaughtered because of animal welfare. Phase 2 is assumed to last for some weeks, say for four weeks in total. Calves slaughtered because of animal welfare during phase 2 A are assumed to be slaughtered in equal numbers over the weeks. This means that calves slaughtered because of animal welfare are slaughtered on average in week 14½.

Phase 3

Phase 3 starts for every farm with vaccinated calves individually after phase 2B is finished. In the former paragraph is already discussed why all vaccinated and non-vaccinated calves are assumed to be slaughtered in phase 3. Phase 3 ends when six months have past after the last outbreak of FMD and after finishing vaccination. The different phases are in place in the vaccination zone where also non-vaccinated calves are present. Therefore is assumed that at the moment that farms with vaccinated calves can proceed to phase 3, also farms with non-vaccinated calves can have the calves slaughtered under the conditions of phase 3.

5.3 Modelling tool

This research takes into account the three different phases which are implemented in the vaccination zone at the moment vaccination is practiced. The only research that takes into account the different phases, which do affect the financial damage, is the research of Hoste and Bergevoet (2007). Hoste and Bergevoet (2007) did take into account phase 1 and 2 according to the financial damage in the sale of pork. Pigs have different regulations to meet (EC, 2003a). This research focuses specific on the veal supply chain as a whole.

A spreadsheet model gives the opportunity to adjust prices or assumptions made according to the calculations because of its dynamic character. A micro perspective is used in order to get inside in to the financial damage of different chain partners. This gives the opportunity to compare the sector in the case of a low level of integration versus a high level of integration. Details on level of integration can be found in paragraph 2.3.

The chain partners that are taken into account within this research (research question 3.1) are chain partners which do primarily depend on the production of rosé and / or white veal. These chain partners are a) the primary sector which takes care of housing and fattening of the calves, b) the processing industry which slaughters the calves and processes the veal so that it can be sold on the market, c) the feeding industry which produce the calfmilk replacement with which the calves are fattened and d) calfskin processing industry.

The calfskin processing industry doesn't come forward out of the different studies described in Table 12 but is described as part of the veal supply chain in paragraph 2.3. The calfskin processing industry is fully specialized in conserving calfskins. They cannot change their production to skins of other animals and is therefore also taken into account.

5.4 Input parameters

The input parameters are divided into direct and indirect costs. Indirect costs are divided according to the different involved chain partners; primary industry, slaughter and processing industry, feeding industry, calfskin processing industry and trading and logistics. Table 18, on the next page, gives an overview of all distinguished costs, assumptions and sources. In the following sub-paragraphs, the background of the assumptions are described together with a description of how the calculations of the financial damage are performed.

Table 17: Input parameters direct and indirect financial damage different chain partners

Direct costs	Unit	White	Rosé	Assumption	Source
1. Value slaughtered calves stamping out	€ / calf	446	446		Meuwissen et al. (2005a)
2. Costs of execution stamping out	€ / calf	150	150	Slaughtering, destroying and disinfection Average farm size	Huirne et al. (2002) and Meuwissen et al. (2004)
3. Initial costs	Million € / outbreak	2.3	1.2	Screening, costs of crisis centre, catering, hired people, ministry of agriculture, etc	Meuwissen et al. (2005a)
4. Cost of vaccination	€ / calf	2.60	2.60		Meuwissen et al. (2004)
Indirect costs					
Primary sector					
5. Costs empty barns	€ / place / week	2.33	2.32	Fixed costs + 50% labour costs	KWIN (2007) De kalverhouder (2008)
6. Costs calves staying longer in barn	€ / calf / week	21.24	11.20	Fixed and variable costs	KWIN (2007)
7. Decreased revenues caused by lower prices				Based on price white (€ 4.75/kg) and rosé (€ 2.75/kg)	
Calves in affected area:					
- phase 1	-/- 85%, (€ 573/calf)	-/- 75%, (€ 392/calf)		White 2 % and rosé 1 % of calves	Derived from Meuwissen et al. (2004)
- phase 2	-/- 74%, (€ 489/calf)	-/- 55%, (€ 287/calf)		White 2 % and rosé 1 % of calves	
- phase 3 non-vaccinated	-/- 50%, (€ 337/calf)	-/- 25%, (€ 131/calf)		White 34 % and rosé 20 % of calves	
- phase 3 vaccinated	-/- 74%, (€ 489/calf)	-/- 55%, (€ 287/calf)		White 6 % and rosé 3 % of calves	
Calves in free areas NL	-/- 25%, (€ 169/calf)	-/- 15%, (€ 78/calf)		White 56 % and rosé 74 % of calves	
Slaughter and processing industry					
8. Financial damage caused by stamping out and by transport restrictions	€ / calf	35.00	35.00	Number of calves slaughtered less based on # weeks less production possible on farms * 75% of normal slaughter costs	Meuwissen et al. (1997) Huirne et al. (2002) www.vas-zas.nl/zas/tarieven_abattoir.nl (2008)
Feeding industry					
9. Financial damage	€ / ton	20.00	-	Based on outbreak 2001 Financial damage on produced maintenance feed	Personal communication VanDrie Group (2008)
Calfskin processing industry					
10. Financial damage caused by transport restrictions	€ / skin	5.00	5.00	10% per skin caused by quality, age and inefficient production. Total number of skins processed in year of FMD	Personal communication VanDrie Group (2008)
Trading and logistics					
11. Financial damage of transport to slaughterhouses caused by stamping out	€ / calf	7.50	7.50	75% of transport fee and trade commission Number of calves (white / rosé) slaughtered stamping out	Personal communication VanDrie Group (2008)
12. Financial damage of transport to slaughterhouses caused by transport restrictions and empty barns	€ / calf	7.50	7.50	75% of transport fee and trade commission Number of calves (white / rosé) slaughtered less (excluding calves stamping out) based on # weeks less production possible on farms	
13. Financial damage of transport newborns caused by transport restrictions and empty barns	€ / calf	30.00	30.00	75% of fee for collection newborns from dairy farms, commission, re-grouping and transport to veal calf farm	LNV (2007)
14. Financial damage other logistics	€ 2300 / truck / week standstill			(# calves slaughtered less * living weight) / kg 25,000 kg = number of days less work for trucks	Huirne et al. (2002) Own calculations

5.4.1 Direct costs

Direct financial damage is divided into four different parameters:

1) The value of calves which are slaughtered due to stamping out is derived from KWIN (2007). It is assumed that the slaughtered calves are randomly divided by age. The value of the calves is therefore assumed to be half of the total revenues which would be collected at the right age of slaughter.

2) Costs of execution of stamping out are based on the costs of slaughtering, destroying and disinfection of the farms. Costs of € 150 per calf are based on average farm size (Huirne et al., 2002 and Meuwissen et al., 2004).

3) Initial costs are costs for screening, crisis centre, Ministry of Agriculture etc. Those costs cannot be divided between different farms and are therefore fixed costs. IRMA (2004) states that the initial costs are € 35 million which can be distributed over cattle, pigs and sheep/goats at a rate of 4:4:1. The cattle sector is accounted for € 15.55 million. In 2006 (LEI, 2007a) there were 3.8 million head of cattle of which 0.84 million head are veal calves, divided in 2/3 white and 1/3 rosé (Table 1). Estimated costs for white and rosé veal sector are then € 2.3 and € 1.2 million.

4) Costs of vaccination does not differ between white and rosé veal calves and is about € 2.60 per calf (Meuwissen et al. (2004).

5.4.2 Primary sector

The indirect costs of the primary sector are divided into three different parameters. The first parameter is:

Costs empty barns

Farms which are emptied due to stamping out face costs of empty barns until newborns can be transported again. Costs of empty barns are assumed to be fixed costs and 50% of the labor costs. Assumed is that 50% of the labor can be used somewhere else (Huirne et al., 2002). All cost are based on KWIN (2007) except for the wages which are assumed to be € 30,000 a year per worker. The calculation of costs of empty barns is done as followed:

Per calf place per year	**White**	**Rosé**
Interest calf place / year	€ 19.00	€ 16.80
Depreciation barn (investment excl VAT, 5% / year)	€ 40.75	€ 42.44
Depreciation “hokinrichting” (investment excl VAT, 10% / year)	€ 29.41	€ 21.43
Depreciation feeding system (investment excl VAT, 10% / year)	€ 10.50	€ 6.72
Wages (50% of 30.000 a year, 700 white or 450 rosé calves)	€ 21.42	€ 33.33
Total per year (52 weeks)	€ 121.08	€ 120.72
Total fixed costs per calf place per week	**€ 2.33**	**€ 2.32**

Average contract fee for white veal calf farmers is according to De kalverhouder (2008) about € 175 in 2006 and 2007. The contract fee is based on average results and in a market where no profit is made and thus no profit payments are paid by the integrated veal production companies. The contract fee

covers the labour costs and the costs for housing, energy, water and manure disposal (KWIN 2007). Variable costs on white veal farms are:

- energy hot water; € 12 / year (KWIN, 2007)
- other energy costs; € 9.88 / year (KWIN, 2007)
- manure disposal; 3 m³ * € 11.15 = € 33.45 / year (KWIN, 2007 and De Kalverhouder, 2008)
- costs for water; € 5,80 / year (KWIN, 2007)

Makes a total of € 61.13 / calf place / year. Contract fee of € 175 -/- € 61 = € 114 / 52 weeks = € 2.20 fixed costs per week. Assuming that the contract fees are reasonably low (De Kalverhouder, 2008), fixed costs of € 2.33 for white calves and € 2.32 are assumed to be reasonable.

5,700 white veal calves and 1,200 rosé veal calves are slaughtered due to stamping out. It is assumed that in phase 3 calves can be transported again. Stamping out lasts for eight weeks (Table 16). Assuming that the number of calves are equally divided over the weeks results in on average stamping out in week four. After stamping out, there is a period of 30 days, four weeks, before phase 2 can start which is assumed to last another four weeks. This results in empty barns caused by stamping out for 12 weeks. Welfare slaughter is assumed to take place on average in week 10 and on average in week 14,5. This results in empty barns caused by welfare slaughter for six weeks during phase 1 and 1,5 weeks on average of empty barns caused by welfare slaughter during phase 2.

The second parameter of the primary sector is:

Costs calves staying longer in barn

Transport restrictions lead to calves staying longer in the barn than usually. Because the calves cannot be transported to the slaughterhouse, additional costs are made for housing, feed, labour, etc. Calculations of those costs are based on KWIN (2007) and discussed as followes:

Per calf per week	**White**	**Rosé**
Fixed costs + 100% labour costs (€ 142.50 and € 154.05 per year)	€ 2.74	€ 2.96
Feeding - white: 2 kg / day at € 1.15 and roughage € 0.51 / week	€ 16.61	
- rosé: roughage and compound feed at € 0.19 per kg)		€ 7.00
Common additional costs ((€ 35 / calf *1.9) / 52 = and € 0.10 / day)	€ 1.28	€ 0.70
Animal health (€ 0.05 and € 0.05 / day)	€ 0.35	€ 0.35
Mortality (white € 7 per calf * 1.9 per year and rosé € 7 per calf * 1.4)	€ 0.26	€ 0.19
Total costs for housing, feed, labour, etc per calf per week	**€ 21.24**	**€ 11.20**

The third parameter of the primary sector is:

Decreased revenues caused by lower prices

Transport restrictions lead to a decrease of slaughter quality which results in lower prices. No increase in slaughter weight is assumed because of the use of maintenance feed. Transport restrictions can lead to an increase in slaughter age for white veal calves older than 8 months and for rosé veal calves older than 12 months. This leads to the problem that veal from white veal calves slaughtered older than 8 months are not allowed to be sold as white veal anymore and rosé from rosé veal calves cannot be sold

anymore as rosé but has to be sold as beef (see paragraph 2.2). How this problem is taken into account is discussed later on.

Besides transport restrictions also the conditions under which the calves have to be slaughtered within the different phases lead to a decrease in collected prices. Those conditions are (paragraph 3.4):

Phase 1	Channelizing, maturation, deboning, certification and heating of the veal.
Phase 2	Channelizing, maturation, deboning and certification.
Phase 3 non-vaccinated	Channelizing and certification.
Phase 3 vaccinated	Channelizing, maturation, deboning and certification.
Free areas NL	No specific conditions.

Channelization costs occur because the carcasses and veal from vaccinated calves, offspring from vaccinated cattle and from non-vaccinated calves out of the protection zone have to be channelized and certified in order to be distinguishable (paragraph 3.5). According to the VWA (Dutch Food and Health Organization) in Hoste and Bergevoet (2007), is clear identification together with leaving production lines five minutes empty, sufficient to meet the channelization regulations. This means that in the same slaughterhouse at the same day, different ‘ kinds’ of veal can be slaughtered. Hoste and Bergevoet (2007) distinguished costs which occur when channelization of pork is practiced. These costs are:

1) Certification costs. Those costs consists out of costs for control, administration, etc. Those costs are expected not to be that high that they are of relevance.
2) Costs to empty slaughter and process lines because workers cannot work for five minutes (Hoste and Bergevoet, 2007). Only when the slaughterhouse is completely used to slaughter vaccinated animals, these costs do not exist.
3) Costs for extra product numbers for processing and distribution. Extra time is necessary for administration, pricing, ordering and billing.
4) Extra costs for order picking due to increased number of product numbers.
5) Costs due to extra logistics because of inefficient transport to retailers because of increased product numbers per customer and less weight per truck.
6) Cutter, cook, and slice costs. Extra costs for processing due to different batches for meat for vaccinated and non-vaccinated animals.
7) Decreased prices due to non-optimal proportions in the sales of cut and processed meat to retail and by the use of high value meat as ingredient for meat products.

Decrease in revenues account for the largest part in the total costs per kilogram of pork. Besides decreased revenues, Hoste and Bergevoet (2007, page 24-26) found that logistical costs, cost of order picking and decreased revenues of slaughter by products (e.g. blood, guts, etc) did account for a large part of the total cost.

There was no opportunity within this research to quantify the distinguished channelization costs found by Hoste and Bergevoet (2007). Hoste and Bergevoet (2007) found that the decrease in revenues accounted for the largest part in the total cost. This research therefore focuses on the decrease in prices assuming that all channelization costs are included together with the costs for maturating, deboning and certification.

The only research which has calculated market damage in case of FMD epidemics is the research of Meuwissen et al. (2004). Meuwissen et al. (2004, p.19) distinguishes four groups of calves and different percentages decrease in price to calculate market damage with. Those groups and percentages decrease are:

	White veal calves	Rosé veal calves
	€5.65/kg	€2.62/kg
- Vaccinated	-/- 75%	-/- 55%
- Welfare slaughter	-/- 10%	-/- 10%
- Other in affected area	-/- 65%	-/- 10%
- Affected areas free again	-/- 25%	-/- 5%
- Free area	-/- 25%	-/- 5%

Meuwissen et al. (2004) did not take into account the different phases according to vaccination because the research was done before legislation (EC, 2003a) was put into place. Also the name under which veal could be sold was not depending on age which is going to be changed in July 2008 (EC, 2007b). The distinguished groups and percentages decrease of prices are therefore adjusted to make them useable for the calculations within this research.

Table 18: Distinguished groups of calves with percentages decrease in prices and collected price in €/kg

	White veal ≤ 8 months	'White' veal 9 ≤ 12 months	Rose veal 9 ≤ 12 months	'Rose' veal > 12 months
	€4.75/kg	€4.75/kg	€2.75/kg	€2.75/kg
Calves in affected area				
Phase 1	-/- 85% (€ 0.71)	-/- 85% (€ 0.71)	-/- 75% (€ 0.69)	-/- 75% (€ 0.69)
Phase 2	-/- 65% (€ 1.66)	-/- 74% (€ 1.24)	-/- 55% (€ 1.24)	-/- 55% (€ 1.24)
Phase 3 non-vaccinated	-/- 25% (€ 3.56)	-/- 50% (€ 2.38)	-/- 25% (€ 2.06)	-/- 25% (€ 2.06)
Phase 3 vaccinated	-/- 65% (€ 1.66)	-/- 74% (€ 1.24)	-/- 55% (€ 1.24)	-/- 55% (€ 1.24)
Calves free areas in NL	-/- 25% (€ 3.56)		-/- 15% (€ 2.34)	-/- 15% (€ 2.34)

Table 18 shows the decrease in prices of different groups of calves which are assumed within this research and are based on figures of Meuwissen et al. (2004). In the following subsections a description is given of how the assumptions are made. Important to notice is the slaughter age and the corresponding name under which the veal can be sold (EC, 2007b). White veal calves are transported to the veal calf farm at an age of between two and five weeks. The fattening period last for about 26 to 28 weeks. In this way the calves are approximately seven and a half months of age when they are slaughtered. In case of an outbreak, the age of slaughtering increases to over eight months resulting in having to sell white veal as rosé veal which leads to an extra decrease in price. Rosé veal calves have to be slaughtered at an age of maximum 12 months, otherwise it has to be sold as beef. Because beef

has a more or less comparable price (average 2005-2007 of € 2.76 / kg excl VAT; PVE, 2007d), it is assumed that rosé veal calves slaughtered at an age older than 12 months do not decrease in price anymore when comparing to being slaughtered at an age under 12 months.

Phase 1:

Veal from calves slaughtered during phase 1 has to be heated (paragraph 3.4). Heated veal is not a common product and can only be used to make meat products. It is the question which price can be collected for it. Because Meuwissen et al. (2004) assumes a decrease in price of 75% and 55% for veal from vaccinated calves. Both heated veal from white and rosé veal calves is assumed to be sold against comparable prices. Integrated veal production companies slaughter both white and rosé veal calves. For both kinds of veal, no sale channel exists. It is therefore assumed that when a sale channel is found, both the heated white and rosé veal will be sold via the same sale channel. It is therefore assumed that heated veal will decrease in price with 85% (white) and 75% (rosé). Assumed is that the costs are including channelization, maturation, deboning, heating and certification.

Phase 2:

Veal from calves slaughtered during phase 2 has to meet the same conditions as veal from vaccinated calves. It is therefore assumed that veal from calves slaughtered during phase 2 also decreases in price as much as veal from vaccinated calves. An other fact that is taken into account is that the calculation of Meuwissen et al. (2004) does only take into account the period from the first outbreak until 30 days have past after the last outbreak. White veal calves slaughtered in phase 2 will therefore have to be sold as rosé veal. A decrease of price of 74% (white) and 55% (rosé) give comparable prices. Assumed is that the costs are including channelization, maturation, deboning and certification.

Phase 3:

The calves slaughtered in phase 3 are divided into two groups; vaccinated and non-vaccinated. Main reason is the different conditions that both veal from non-vaccinated and vaccinated calves have to meet before it is allowed to be put on the market. The calculation of Meuwissen et al. (2004) does only take into account the period of first outbreak until 30 days have past after the last outbreak. Phase 2 and phase 3 are in place after this period. Because the conditions under which veal from vaccinated calves can be put on the market do not differ between phase 2 and 3, the same decrease in price is assumed (white 74%; € 1.24 and rosé 55%; € 1.24).

Veal from non-vaccinated calves only has to be channelized and certified. This makes the veal recognizable and is therefore assumed to be stigmatized which leads to decrease in prices. Meuwissen et al. (2004) assumes 5% decrease for the rosé veal calves in the ‘free areas’. In the research of Meuwissen et al. (2004) this means the calves are slaughtered during the period of outbreaks + 30 days. Legislation (OIE, 2007 and EC, 2003a) makes it possible to divide a country in more than one area which can be differ in status according to FMD. It is therefore assumed that prices decreases with 25% (€ 2.06) of rosé veal because it is recognizable as veal from calves from the affected areas.

Veal from white veal calves slaughtered during phase 3 has to be sold as rosé veal because of the age of slaughtering is older than eight months. The price of this veal is the price of rosé veal, which is € 2.06. Taking this price to calculate the decrease in percentage but assuming a small difference, results in 50% (€ 2.38) decrease for the veal of non-vaccinated white veal calves slaughtered at an age older than 8 months with. When veal from non-vaccinated calves in affected area can be sold as white veal, it is assumed that the decrease in price is comparable with calves in the free areas (25% decrease). In phase 3, transport is possible again and veal only has to be channelized and certified (EC, 2003a).

Calves free areas in the Netherlands:

As said in the former paragraph, legislation (OIE, 2007 and EC, 2003a) makes it possible to have different zones within a country with a different status according to the FMD situation. This makes the export of veal within Europe possible without having too much difficulties or specific conditions to meet. A second point is that it can be expected that the European countries will accept veal from the 'free zone' within the Netherlands. The Netherlands account for 25% of the total production of veal in Europe (see table 3) Not accepting veal from the Netherlands will therefore lead to a shortage of veal in Europe and this will lead to increased prices. It is therefore assumed that a decrease in price can be expected which leads to decrease in price with 25%; € 3.56 (white) and 15%; € 2.34 (rosé) based on Meuwissen et al. (2004).

In the argumentation above is nothing said about the slaughter age. When white veal calves are slaughtered five weeks later than normal, they have a great chance of reaching an age of above eight months. The youngest calves are two weeks of age at the start of the fattening period which lasts for 26 weeks. A transport ban of five weeks will result in an age of 33 weeks or 7.7 months. It is also possible that the calves were older at the start of the fattening period and / or that the fattening period lasts for more than 26 weeks. In this case increasing the slaughter age to more than eight months results in a large decrease in the collected price.

5.4.3 Slaughter and processing industry

The financial damage for the slaughter and processing industry consists of a decrease in turnover due to stamping out, closing down production facilities due to transport restrictions, losses due to export bans and trade restrictions and channelization costs (Table 12). Losses due to export bans and trade restrictions and channelization costs are assumed to be passed on to the owner of animals which then collects a lower price. The decrease in turnover consists of two different causes. The first is stamping out which results in less animals to be slaughtered and loss in production caused by barns staying empty which results in less animals to slaughter. The second cause is a transport ban which leads to the closing down of slaughterhouses and production facilities. The transport ban also leads to calves staying longer in the barns than necessary, which leads to a decrease in total number of animals that can be slaughtered.

Table 19 distinguishes different costs of slaughterhouses and the percentage for which each cost is fixed. On average, 75% of the costs of slaughterhouses are fixed costs.

Table 19: Costs of slaughterhouses and the percentage fixed

	% fixed		% fixed
Wages employees	100	Housing	100
Wages temporary employees	0	Energy	75
Environmental taxes/fees	0	Maintenance	50
Depreciation/interest	100	Water supply (waterwinning)	75
Inspection fees (keurlonen)	0	Water discharge	50
Common management	100	Cleaning	50
(Algemeen beheer)		Administration	100
Insurance	100	Other costs	100
Sales costs	85		
Transport	25	Total fixed (weighted)	75%

Source: Meuwissen et al. (1997)

When slaughterhouses get permission from the authorities to send employees home because of special circumstances (werktijdverkorting), 70% of the wages is refunded by the government and leads to a decrease of the percentage weighted total costs to 50% (Meuwissen et al., 1997). This so called 'werktijdsverkorting' has also been applied for in 2001 and was partly granted for by the government (Huirne et al., 2002). Slaughter fee is about € 47.50 (www.vas-zas.nl/zas/ tarieven_abattoir.nl, May 2008). 75% of € 47,50 is approximately € 35.

The calculation of the financial damage of the slaughter industry is based on the number of calves that are slaughtered less due to FMD epidemics. The lower number of calves slaughtered is calculated by the number of weeks that barns are empty, summarized with the number of weeks that calves stood longer in the barn than necessary. Summed up, this gives the total number of weeks on loss on production. This number of weeks divided by 26 weeks (white) and 35 weeks (rosé) (KWIN, 2007) results in the number of calves produced less due to FMD epidemics.

Table 20: Number of calves produced less due to FMD epidemics

Number of weeks less production (x 1,000)		White	Rosé
Empty barns due to stamping out	W 5,700 x 12 weeks R 1,200 x 12 weeks	68	14
All other calves in affected area	W 267,700 x 16 weeks R 58,800 x 16 weeks	4,283	941
Number of calves in free areas NL	W 342,000 x 5 weeks R 169,000 x 5 weeks	1,710	845
Total number of weeks less production		6,062	1,800
Total calves produced less (x 1,000)	White: 26 weeks / calf Rosé: 35 weeks / calf	**233**	**51**

5.4.4 Feeding industry

Table 9 shows the quantity of production of calfmilk replacement of veal and breeding calves and the export quantity. The total produced quantity of veal calfmilk replacement is about 700,000 ton of which about 40% is exported. The figures show that the export recovered faster than the inland use. The decrease in production in 2001 is not only because of the FMD outbreak. Also the BSE-crisis resulted in decreasing of production and the number of calves from the end of 2000 onward (Huirne et al., 2002).

Little research is done on the financial damage of the feed industry during the outbreak of FMD. Huirne et al. (2002) assumes the financial damage for the pig and cattle feed industry as a whole at € 15 million. The quantity produced in 2001 was about the same as in 2000, because decreased sales due to the killed animals and increased sales due to the transport restrictions of fattened animals. Costs consisted therefore mainly of logistic costs due to the disinfection of trucks, driving other routes than usual and the total standstill (Huirne et al., 2002).

The financial damage of the calfmilk replacement production mainly consists of three factors (personal communication VanDrie Group, 2008):

1) Change in recipes due to the use of maintenance feed. Cost occur by having the wrong inputs in stock and having to purchase different inputs at higher costs.
2) Costs due to not making full use of production facilities. Stamping out and the production of maintenance feed lead to lower production volumes. When feeding maintenance feed, only ½ of the quantity is fed (Meuwissen et al., 1997).
3) In stock of end-products. Due to changing production to maintenance feed, calfmilk replacement in stock cannot or hardly be used anymore.

Total financial damage, of which the change in recipes account for the largest part, are estimated at € 20 per ton produced calfmilk replacement and is based on figures of 2001 (personal communication VanDrie Group, 2008). Estimated financial damage is assumed to apply on calfmilk replacement produced for calves under transport restrictions. Calves are fed with 4 kg calfmilk replacement per day (KWIN, 2007) x 50% when feeding maintenance calfmilk replacement = 2 kg per day per calf. The calculation of the quantity produced maintenance calfmilk replacement is done as followed:

- 5,700 calves slaughtered stamping out at week 4 on average x 2 kg per day = 319 ton
- 12,500 calves welfare slaughter phase 1 at week 10 on average x 2 kg per day = 1,750 ton
- 12,500 calves welfare slaughter phase 2 at week 14.5 on average x 2 kg per day = 2,538 ton
- 207,000 non vaccinated and 35,000 vaccinated calves within affected area x 2 kg per day x 16 weeks = 54,208 ton
- 342,000 calves in free areas NL cannot be transported for 5 weeks x 2 kg per day = 23,940 ton

Total production of maintenance calfmilk replacement = 83,000 ton and corresponds to about 20 % of the yearly quantity calfmilk replacement produced for inland use (Table 9).

The production facilities for producing compound feed are not specialized like the production facilities of calfmilk replacement. Compound feed for rosé calves is produced by feed companies that often produce compound feed for other animals like cattle, pigs, etc as well due to similar inputs and the production process which is the same. Calfmilk replacement uses a total different production process and different inputs. Assumed is no financial damage for compound feed production for rosé calves due to the low level of specialized production.

5.4.5 Calfskin processing industry

The financial damage of the calfskin processing industry is mainly caused by the change in quality of the skins due to the changed slaughter age and by inefficient production and standstill. Skins of white veal calves are thinner and lighter of weight than skins from rosé veal calves. Both kinds of fresh skins account for a revenue of about € 50. In case of a standstill period after an outbreak of FMD is confirmed, no calves are slaughtered which results in a standstill for the calfskin processing as well (personal communication VanDrie Group, 2008). Based on figures of VanDrie Group a financial damage is assumed at 10% per fresh skin produced in the year of outbreak of FMD.

On average 1,383,000 calves are slaughtered in the years 2006 and 2007 of which 1,067,000 white veal and 316,000 rosé veal calves (table 2). The number of skins produced in the year of outbreak with a worst case scenario is calculated by extracting the number of calves less produced from the average production in 2006 and 2007. For white veal skins this results in 1,067,000 -/- 230,000 = 837,000 skins. For rosé veal skins this results in 316,000 -/- 43,000 = 273,000 skins

5.4.6 Trading industry

The trading industry collects the newborns from dairy farmers, take care of sorting out of the newborns, transport them to the veal calf farmers and transport the fattened calves to the slaughterhouse. Transport fee and trade commission of both white and rosé veal calves is about € 10 per calf (personal communication VanDrie Group, 2008). The fee for collecting newborns, grouping and transport to the veal calf farmer is about € 40 per white and rosé veal calf (LNV, 2007). The fee covers both fixed and variable costs. It is not clear which percentage is fixed and which percentage of the fees is variable. Variable costs are e.g. fuel costs and some labour costs. It is therefore assumed that 75% of the fees are fixed costs and therefore account for financial damage.

Financial damage is caused by stamping out and by transport restrictions. Stamping out lead to less calves that have to be transported to slaughterhouses. This number of calves is the number of calves which are slaughtered due to stamping out. The financial damage caused by stamping out is calculated by multiplying the number of calves stamped out by € 10 per white or rosé calf multiplied with 75%. The financial damage caused by transport restrictions depends on the number of calves are produced less due to FMD. The calculation of the number of calves that are produced less is described in paragraph 5.4.3.

Other logistics is meant to be the transport of meat, slaughter products, waste, etc. Huirne et al. (2002) assumes a financial damage of approximately € 2300 per truck per week. The financial damage for other logistics is calculated under the assumption trucks do on average one truckload a day of 25,000 kilo. The financial damage is calculated based on the number of calves slaughtered less due to decrease in production caused by empty barns and calves staying longer in barns. For white veal calves: 230.000 calves slaughtered less x 237 kilo living weight (KWIN, 2007) = 54,500,000 kg divided by 125,000 kilo transported per truck per week = 436 weeks of missed transport x € 2,300 = € 1 million

financial damage. Calculation for rosé veal calves is based on 345 kg living weight per calf (KWIN, 2007) and calves less produced is 43,000.

5.5 Model assumptions

Several assumptions are made in the model. These assumptions are:

1) Intergraded veal production companies only slaughter as many calves as they think they can sell the veal of. The veal supply chain is sale oriented, not production oriented. This leads to the problem that when a transport ban in whole the Netherlands lasts for five weeks, like in 2001 (Abbas et al., 2001), all calves present in the Netherlands at that moment will be slaughtered five weeks later then usual because slaughterhouses cannot slaughter higher numbers of calves then they are able to sell. Table 13, shows that normally no veal is held in stock but that in 2001 15,000 ton of veal was stocked. This shows that veal production companies have tried to slaughter the veal calves as soon as possible but that in this way the year following the veal put in stock has to be sold to.
2) It is assumed that during phase 3 transport becomes possible again. Newborns can be transported again which results in no empty barns anymore and thus no financial damage or loss of production during phase 3.
3) The difference between slaughter premiums of calves (≤ 8 months) and rosé / cattle (> 8 months is about € 30 (paragraph 2.2). It is assumed that slaughter premiums are included in the decreased prices with which the financial damage is calculated.

6 Results

Calculations of the financial damage are performed based on the simulated scenario described in paragraph 5.2. The number of calves together with the input parameters (paragraph 5.4) made it possible to calculate the financial damage in case of a worst case outbreak in a spreadsheet model in Excel (paragraph 5.3). Assumptions made in the calculation are described in paragraph 5.5.

6.1 Results

Table 21: Overview financial damage white veal sector (x € 1,000)

Direct costs	**Value**	**Financial impact**
Value slaughtered calves stamping out	(5,700 calves * € 446)	2,542
Execution cost stamping out	(5,700 calves * € 150)	855
Initial costs	per outbreak (fixed)	2,300
Costs of vaccination	(35,000 calves * € 2.60)	91
Total		**5,788**
Indirect costs		
Primary sector		
Costs empty barns		
> slaughtered due to stamping out	(5,700 calves * € 2.33 * 12 wks)	159
> welfare slaughter during phase 1	(12,500 calves * € 2.33 * 6 wks)	175
> welfare slaughter during phase 2	(12,500 calves * € 2.33 * 1.5 wks)	44
Subtotal		**378**
Costs calves staying longer in barn		
Affected area:		
> phase 1; welfare slaughter	(12,500 calves * €20,07 * 10 wks)	2,509
> phase 2; welfare slaughter	(12,500 calves * €20,07 * 14.5 wks)	3,638
> phase 3; non-vaccinated calves	(207,000 calves * €20,07 * 16 wks)	66,472
> phase 3; vaccinated calves	(35,000 calves * €20,07 * 16 wks)	11,239
> calves free areas in NL	(342,000 calves * €20,07 * 5 wks)	34,320
Subtotal		**118,177**
Decreased revenues		
> Phase 1	(12,500 calves * € 573) (-85%)	7,163
> Phase 2	(12,500 calves * € 498) (-74%)	6,225
> Phase 3 non-vaccinated	(207,000 calves * € 337) (-50%)	69,759
> Phase 3 vaccinated	(35,000 calves * € 498) (-74%)	17,430
> calves free areas in NL	(342,000 calves * € 169) (-25%)	57,798
Subtotal		**158,375**
Slaughter and processing industry		
Total financial damage	(233,000 calves * € 35)	8,155
Feeding industry		
Financial damage	(83,000 ton * € 20)	1,660
Calfskin processing industry		
Total financial damage	(837,000 skins * € 5)	4,185
Trading industry		
Financial damage		
> Stamping out	(5,700 calves * € 7.50)	43
> Transport restrictions	(233,000 calves * (€ 7.50 + € 30))	8,738
> Other logistics	(436 'truck' weeks * €2,300/week)	1,003
Subtotal		**9,783**
Total financial damage		**306,501**

Table 22: **Overview financial damage rosé veal sector** (x € 1,000)		
Direct costs	**Value**	**Financial impact**
Value slaughtered calves stamping out	(1,200 calves * € 446)	535
Execution cost stamping out	(1,200 calves * € 150)	180
Initial costs	fixed, per outbreak	1,200
Costs of vaccination	(7,600 calves * € 2.60)	20
Total		**1,935**
Indirect financial damage		
Primary sector		
Costs empty barns		
> slaughtered due to stamping out	(1,200 calves * € 2.32 * 12 wks)	33
> welfare slaughter during phase 1	(2,700 calves * € 2.32 * 6 wks)	38
> welfare slaughter during phase 2	(2,700 calves * € 2.32 * 1.5 wks)	9
Subtotal		**80**
Costs calves staying longer in barn		
Affected area:		
> phase 1; welfare slaughter	(2,700 calves * € 11,20 * 10 wks)	302
> phase 2; welfare slaughter	(2,700 calves * € 11,20 * 14.5 wks)	438
> phase 3; non-vaccinated calves	(45,000 calves * € 11,20 * 16 wks)	8,064
> phase 3; vaccinated calves	(7,600 calves * € 11,20 * 16 wks)	1,362
> calves free areas in NL	(169,000 calves * € 11,20 * 5 wks)	9,464
Subtotal		**19,631**
Decreased revenues		
> Phase 1	(2,700 calves * € 392) (-75%)	1,058
> Phase 2	(2,700 calves * € 287) (-55%)	775
> Phase 3 non-vaccinated	(45,000 calves * € 131) (-25%)	5,895
> Phase 3 vaccinated	(7,600 calves * € 287) (-55%)	2,181
> calves free areas in NL	(169,000 calves * € 78) (-15%,)	13,182
Subtotal		**23,092**
Slaughter and processing industry		
Total financial damage fixed costs	(51,000 calves * € 35)	1,785
Feeding industry		
Financial damage	No financial damage assumed	-
Calfskin processing industry		
Total financial damage	(273,000 skins * € 5.00)	1,365
Trading industry		
Financial damage		
> Stamping out	(1,200 calves * € 7.50)	9
> Transport restrictions	(51,000 calves * (€ 37.50))	1,913
> Other logistics	(118 'truck' weeks * €2,300 / week)	271
Subtotal		**2,193**
Total financial damage		**50,081**

Conclusions drawn from Table 21 and Table 22:

- The worst case financial damage for the white and rosé veal sector = € 357 million. The worst case scenario is based on 95 percentile value meaning that in 95% of the simulations the duration did not exceed 84 days.
- The white veal sector accounts for 85% of the total financial damage of the veal sector as a whole.
- Approximately 40% of the financial damage for both the white and rosé veal sector is caused by costs for calves staying longer in barns due to transport restrictions.

- Approximately 52% (white) and 47% (rosé) of the financial damage is caused by decreased revenues.
- Financial damage of 'non-vaccinated calves in affected area', for "costs staying longer in barn" and "decreased revenues, account for 45% of the total financial damage of the white veal calves and for 28% of the total financial damage of the rosé veal calves.
- Financial damage of 'calves in free areas in NL', for "costs staying longer in barn" and "decreased revenues", account for 30% of the total financial damage of the white veal calves and for 46% of the total financial damage of the rosé veal calves.
    - Differences in % of total financial damage between white and rosé for non-vaccinated calves in affected areas and calves in free areas can be explained by the fact that white veal calves are more situated in the area in the centre of the Netherlands whereas rosé veal calves are more equally spread across the Netherlands.
- Direct costs account for 2% (white) and 3.5% (rosé) of the total financial damage.
- Financial damage of other chain partners than the primary sector account for 8% (white) and 10% (rosé) of the total financial damage.

6.2 Sensitivity analysis

The calculation of the financial damage is based on a worst case scenario. Table 23 and Table 24 show the effect when prices decrease less than assumed, the outbreak last shorter and if calves do put on 20 kilogram weight although maintenance feed is fed. Those changes in assumptions result in a lower total financial damage.

Table 23: Default scenario and sensitivity analyses white veal sector (million €)[1]

Scenario	**default**	**1**	**2**	**3**	**4**	**5**
Costs calves staying longer in barn						
> Welfare slaughter phase 1	2.5				2.0	
> Welfare slaughter phase 2	3.5				3.1	
> Affected area; non-vaccinated calves	66.5				58.2	
> Affected area; vaccinated calves	11.2				9.8	
> Calves free areas in NL	34.3				20.6	
Subtotal	**118.2**				**93.7**	
Decreased revenues						
> Phase 1	7.2	7.2		6.3		7.0
> Phase 2	6.2	5.5		5.5		6.0
> Phase 3 non-vaccinated	69.8	35.0		55.9		59.8
> Phase 3 vaccinated	17.4	15.3		15.3		16.9
> calves free areas in NL	57.8	57.8	34.5	34.5		33.5
Subtotal	**158.4**	**120.7**	**135.1**	**117.6**		**123.2**
Direct financial damage	5.8					
Indirect financial damage other chain partners	24.2				**20.4**	
Total	**306.5**	**268.9**	**283.4**	**265.7**	**278.3**	**271.3**
Difference (€)	**0**	**-37.6**	**-23.3**	**-40.8**	**-28.2**	**-35.2**
Difference (%)	**0**	**-12%**	**-8%**	**-14%**	**-9%**	**-12%**

[1]) Sensitivity analyses include the scenarios described at Table 24.

Table 24: Default scenario and sensitivity analyses rosé veal sector (million €)[1]

Scenario	default	1	2	3	4	5
Costs calves staying longer in barn						
> Welfare slaughter phase 1	0.3				0.2	
> Welfare slaughter phase 2	0.4				0.4	
> Affected area; non-vaccinated calves	8.1				7.1	
> Affected area; vaccinated calves	1.4				1.2	
> Calves free areas in NL	9.5				5.7	
Subtotal	**19.6**				**14.5**	
Decreased revenues						
> Phase 1	1.1			0.9		1.0
> Phase 2	0.8			0.6		0.7
> Phase 3 non-vaccinated	5.9			3.5		4.1
> Phase 3 vaccinated	2.2			1.8		2.0
> calves free areas in NL	13.2		4.4	4.4		5.2
Subtotal	**23.1**		**14.3**	**11.2**		**13.0**
Direct financial damage	1.9					
Indirect financial damage other chain partners	5.3				4.4	
Total	**50.1**		**41.3**	**38.2**	**44.0**	**40.0**
Difference (€)	**0**		**-8.8**	**-11.8**	**-6.1**	**-10.1**
Difference (%)	**0**		**-17%**	**-24%**	**-11%**	**-20%**

[1]) Sensitivity analyses include the following scenarios:

1) White veal calves in affected area can be sold as white veal instead of rosé veal although increased slaughter age: phase 2 65% (instead of 74%), phase 3 non-vaccinated 25% (instead of 50%) and phase 3 vaccinated (65% instead of 74%) (paragraph 5.4.2).
2) Calves in free areas in the Netherlands 10% smaller decrease in price: white 15% (instead of 25%) and rosé 5% (instead of 15%).
3) Decrease in collected prices not as high as assumed: all prices 10% less decrease.
4) Duration of FMD epidemics not 84 days but 70 days duration (two weeks less) until 30 days have passed after last outbreak of FMD.
5) Increase in slaughter weight of 20 kg of calves due to longer staying in barn resulting in extra revenues (extra kg x decreased price).

Conclusion drawn from Table 23 and Table 24:

- New legislation, which is put in place in July 2008 (EC, 2007b) makes it impossible to sell veal of calves which are fed with calfmilk replacement and are slaughtered at an age of over 8 months as white veal. In case of an outbreak of FMD, veal of those calves has to be put on the market as rosé veal which accounts for € 38 million (12%) of the total financial damage for the white veal sector. € 35 million is caused by a smaller decrease in price of non-vaccinated calves within the affected area.
- Financial damage for the white veal sector is € 41 million (14%) lower when the decrease in prices is 10% lower than assumed. Of the € 41 million, € 18 million (6%) less financial damage occurs for calves within the affected areas and € 23 million (8%) occurs for calves in free areas of the Netherlands.

- Financial damage for the rose veal sector is € 12 million (24) lower when decrease in prices is 10% lower than assumed. Of the € 12 million, € 3 million (7%) lower financial damage occurs for calves within the affected areas and € 9 million (17%) occurs for calves in free areas of the Netherlands.
- If restrictions last 70 days instead of 84 days, approximately 10% lower financial damage occurs due to lower costs for calves staying longer in barns and due to lower financial damage of other chain partners caused by a lower decrease in production of calves. Combining a shorter duration of restrictions together with a 10% lower decrease in prices of all calves, leads to a decrease in financial damage of € 69 million (23%) for the white veal sector and of € 18 million (35%) for the rosé veal sector (scenario 3 and 4 combined).
- No increase in slaughter weight is assumed due to use of maintenance feed. When calves do put on weight because of not at all or partly using maintenance feed, the extra kilo's gain extra revenues. Assuming that calves put on 20 kilo on average slaughtered weight results in € 36 million (12%) lower financial damage for the white veal sector and in € 10 million (20%) lower financial damage for the rosé veal sector.

7 Risk financing

Livestock epidemics, such as foot and mouth disease (FMD) can result in substantial losses for governments, farmers and all other participants of the livestock production chain. Also can livestock epidemics cause severe cash flow problems or even result in bankruptcy (Asseldonk et al., 2003). Vaccination is very likely to be used to fight an outbreak of FMD in the Netherlands in the future (EC, 2003a). Stamping out and protective vaccination result in a lower number of animals slaughtered compared to only using stamping out to fight FMD. Direct costs for fighting the disease are lower in case of vaccination but indirect costs, mainly market damage, increases (Meuwissen et al., 2004). As already mentioned paragraph 1.1, direct costs are covered for by the animal health fund. The cattle sector itself contributes for a maximum of € 85 million. Direct costs above € 85 million, and which are not covered for by the European Union, will be paid for by the Dutch government. This will happen in 0.4% of the cases (Meuwissen, 2005b).

Indirect costs, as calculated in chapter 6, cause high financial losses throughout the veal supply chain. This results in high financial losses for the owners of the calves in specific. Due to the high integration within the veal supply chain, integrated veal production companies face high financial losses which they have to be prepared for due to the risk of bankruptcy. An integrated veal production company with a 30% market share will face financial losses of € 100 million (30% x € 350 million).

The traditional way of handling risk is by either purchasing an insurance policy or by retaining the risk and allocation funds to meet expected losses, also known as “self insurance”. No insurance policy exists which covers the indirect financial damage of FMD epidemics. One risk financing instrument in particular is especially useful for (large) integrated production companies and can be used to insure companies against high financial losses in case of FMD epidemics; a captive (personal communication Euroke Re, 2008).

In paragraph 7.1 funding is described which is a common used method to allocate money for costs which are made in the future. Paragraph 7.2 describes the captive and its characteristics and costs.

7.1 Funding

Companies can allocate funds for costs that the company will face in the future, like maintenance on buildings. The sum of money that a company allocates in a fund can be extracted from the companies profit. In this way the company does not have to pay profit tax over the sum of money allocated in the fund (Belastingdienst, 2008). The idea behind is that otherwise those costs of e.g. the maintenance on a building, are extracted from the companies profit in the future which results in lower profit tax to be paid. The net sum of profit tax paid is zero. Differences are interest revenues and increased liquidity when profit tax does not have to be paid. The money stays in the company, interest revenues can be collected and equity is higher.

7.2 Captive

Captives are a special type of insurance company set up by a parent company, trade association or group of companies to insure the risks of its owner(s). Two different captives can be distinguished: group and single parent captives. Group captives can be owned by several companies and may insure the risks of organizations other than their major owners. Single parent captives are totally owned by large corporations and only insures the risks of its parent. Captives are often located in countries where they enjoy tax advantages and relative freedom of regulation (Insurance Information Institute, 2008).

Eureko Re (2008) describes the single owner reinsurance captive as the most frequent used structure. In common a captive functions as an insurance or reinsurance company that primarily insures the risks of the parent company. The captive is actively managed by the parent company often with the assistance of a captive management company, e.g. Euroke Re. Eureko Re is an example of a company that can provide the insurance policy, reinsurance of the insurance policy via a captive and can manage the captive. The assets of a captive are owned by the parent company. The captive is a licensed insurance or reinsurance entity and thus able to (re) insure the risks of a company's affiliated businesses. The single owner reinsurance captive in particular, underwrites only the parent company's risks and are recommended for large companies with high insurance expenses or for smaller companies with high costs in one particular class of risk.

A captive is a useful tool when insurance premiums of the company, world wide, exceed 1 million euro. First step for companies willing to make use of a captive is putting specific risks into an insurance policy which is offered by an insurance company. All risks can be put into a single captive except the legal obligated insurances like e.g. the legal responsibility insurance (WA verzekering). In the next step, the insurance company 100% reinsures the insurance policy via the captive reinsurance company. The captive is owned by the parent company and in this way the company insures its own risks. The insurance premium calculation is based on a risk analysis.

A captive has three major advantages for the parent company:

1. Insurance premiums can be subtracted from the company’s profit which results in tax benefits.
2. The build up capital within the captive is free of tax.
3. Profits made on the capital within the captive, e.g. on the stock market, can flow back to the Netherlands free of tax or can stay in Ireland where it is taxed after Irish legislation.

Other important characteristics of a captive are that the costs of a captive are more or less fixed costs of € 100,000. Assuming € 100,000 for € 10 million risk capital, fixed costs for € 100 million risk capital could be € 200,000. The amount of fixed costs depends on the number and complexity of the risks insured. A single owned captive is being managed by the insurance company (so called ‘fronter’, e.g. Euroke) which also provides the insurance policy. The fixed costs represent management and administration fees for the fronter for running the captive company in Ireland and of costs of two

(obligatory) meetings of the board in Ireland. In the board of the captive company are both Euroke Re and the parent company represented.

About € 2.3 million has to be invested as stock capital in the captive company. This is needed as a warranty and has to stay in Ireland. The owner of the captive is not allowed to bare the financial risk of the captive in case of bankruptcy. Otherwise the company who owns the captive, is not allowed anymore to extract the insurance premium from the companies profit. The risk of bankruptcy of the captive is captured by catastrophe bonds (reinsurance of captive; also called retro session). In case this retro session is not sufficient, the fronter is responsible in case of bankruptcy of the captive (personal communication Euroke Re, 2008).

The size of the retro session depends on the total sum of insurance premiums paid during the years in comparison to the highest financial damage possible. The financial risk which is captured via the retro session will be lower when the total sum of premiums paid are more in balance with the total financial damage that can be expected in case of a worst case scenario. This makes it unnecessary to pay higher premiums in the first years to cover financial damage if it occurs in e.g. the second year.

7.3 Comparison

For comparing funding vs. a captive, the following assumptions are made:

- Chance on an outbreak of FMD is ones in every eight years (Meuwissen et al., 2005b).
- Maximum financial damage for an integrated veal production company of € 100 million[1]
- Profit tax in the Netherlands 25%
- Profit tax in Ireland 12.5%
- Insurance premium tax (assurantiebelasting) 7.5%
- Assumed profit on allocated money per year 4%
- Fixed costs captive annual € 200,000

[1]) The veal sector is dominated by four integrated veal production companies (Bont et al., 2007). An integrated veal production company with a 30% market share will face financial losses of € 100 million (30% x € 350 million).

Table 25:**Total capital after eight years funding vs. captive** (x million €)

	Fund (no tax benefits)	Fund (tax benefits)	Captive
Gross annual premium	12.5	12.5	12.5
Annual profit tax[1]	-/- 3.1		
Annual insurance premium tax[2]			-/- 0.9
Net annual premium	9.4	12.5	11.6
Total premium allocated	**75.0**	**100.0**	**92.5**
Profit on allocated money[3]	10.9	14.5	15.8
Fixed costs			-/- 1.6
Total capital after eight years	**85.9**	**114.5**	**106.7**

[1]) 25% x € 12.5 million = € 3.1 million tax profit to pay per year when allocating the money
[2]) 7.5% * € 12.5 million = € 0.9 million insurance premium tax to pay per year when allocating the money
[3]) 4% per year x (allocated money + already made profits)

Table 25 shows the difference in build up capital after eight years using either funding or a captive. Funding with no tax benefits leads to the lowest total capital after eight years. When an outbreak of FMD occurs and financial losses are suffered, integrated veal production companies can deduct former paid tax profit paid. Also future profits decrease which leads to lower profit tax to pay (Belastingdienst, 2008).

Funding with enjoying tax benefits leads to the highest build up capital after eight years when no outbreaks of FMD occurred. Funding covers only the financial damage equal to the allocated capital at the moment of the outbreak of FMD. A worst case outbreak of FMD occurring in e.g. the first year after funding has started, can lead to financial problems for the company when additional financial losses cannot be covered for; financial damage is € 100 million, net allocated capital is €12.5 million, financial damage to be covered otherwise is € 87.5 million. Current legislation does not allow funding for financial damage caused by FMD together with enjoying tax benefits. In this way, net allocated capital is € 9.4 million and financial damage to be covered otherwise is € 90.6 million.

When using a captive, the total financial damage of a worst case outbreak of FMD is covered for from the first moment, not depending on the sum of capital allocated via paid premiums. A worst case outbreak of FMD occurring in the first year, or two outbreaks in a row, are 100% covered for by the captive and the parent company will not run into financial problems; financial damage is € 100 million, net capital premiums paid is € 11.6 million, money paid out by captive is € 100 million which leaves no financial damage to be covered otherwise.

The calculation is based on the maximum expected financial damage. The chance on an outbreak of FMD is ones in eight years. The chance on a worst case outbreak is therefore less than ones in eight year. When funding is used, the total capital to cover the maximum financial risk has to be allocated in as less years as possible to prevent the company from running into financial problems when maximum financial damage occurs. In case of a captive, annual premiums can decrease because chance on maximum financial risk is lower, but covered financial damage in case of a worst case outbreak, not depending on time of occurrence, stays the same.

8 Conclusions and recommendations

8.1 Conclusions

Conclusions drawn from the first objective “Analyzing the financial damage for the veal supply chain as a whole, in the case of a worst case outbreak of FMD in the Netherlands, and when protective vaccination is practiced.” are:

1. The financial damage for the veal supply chain based on a worst case scenario (in 95% of all cases) and protective vaccination is practised, is accounted at € 307 million for the white veal supply chain and of € 50 million of the rosé veal supply chain.
2. Of the financial damage for the white veal supply chain, 38% is caused by calves staying longer in barns due to transport restrictions and 52% by decreased revenues due to lower collected prices.
3. For the rosé veal supply chain, 40% of the financial damage is caused by calves staying longer in barns and 46% by decreased revenues.
4. Direct costs, which are covered for by the animal health fund, account for 2% (white) and 4% (rosé) of the total financial damage of both supply chains.
5. The primary sector accounts for 90% (white) and for 85% (rosé) of the financial damage of both supply chains. The other partners; slaughter industry, feeding industry, calfskin processing industry and trading industry, account together for 8% (white) and 11% (rosé) of the total financial damage.

Conclusions drawn from the second objective “Exploring of risk financing instruments to manage the risk of financial damage for veal integrated production companies.” are:

1. A captive is a reinsurance company with which a company can insure risks which cannot be insured via the normal procedure.
2. Funding together with enjoying tax benefits leads to higher build up capital after a specific period compared to a captive but is not allowed in current legislation.
3. A captive is favourable above funding with or without enjoying tax benefits because a captive covers the total financial damage in case of a worst case outbreak of FMD from the first year onwards. Funding covers only the financial damage equal to the allocated capital at the moment of the outbreak of FMD. Additional losses have to be covered alternatively which can lead the company running into financial problems.

8.2 Discussion and recommendations

1. Huirne et al. (2002) calculated the financial damage of the 2001 outbreak of FMD for the veal sector at € 137 million. Duration of the FMD epidemic in 2001 was 96 days and emergency vaccination was practised. 87,000 head of cattle where slaughtered due to stamping out and 71,000 head of cattle were vaccinated, slaughtered and destroyed.
2. Meuwissen et al. (2004) calculated the financial damage of the white veal sector in case of a worst case scenario (95% of all cases) at € 171 million and for the rosé veal sector at € 2 million. Meuwissen et al. did not take into account the costs of calves staying longer in barns due to transport restrictions (calculated at € 118 million white and € 20 million for rosé) and did not take into account the different phases which are put into place when practising vaccination. Also is the calculation of Meuwissen et al. (2004) based on 570,400 white veal and 142,600 rosé veal calves.
3. Further research is recommended on calculating the financial damage based on an outbreak with 50 percentile value (maximum outbreak in 50% of the cases simulated). This outbreak is more likely to occur.
4. Assumed is a chance of outbreak of FMD of ones in eight years. If this chance is ones in 16 years, the premiums per year are 50% smaller and makes investing in risk mitigation (decrease chance of risk occurrence and decrease size of risk if it occurs) less interesting.
5. A veal calf farm receives calves from many different dairy farms in a period of several days to several weeks. Also are approximately 650,000 calves (about 50% of total production) being imported from other countries in Europe. Although various preventive measures are taken against spreading of diseases, continues improvement of safety and surveillance measures are recommended.
6. Non-vaccinated calves in affected areas account for the largest part of the financial damage. Sooner slaughtering or higher collected prices have a great impact on the total financial damage. Recommended is specific legislation for this ‘group’ of calves.
7. Six months after the last outbreak occurred or after the last animal is vaccinated, the status “free of FMD without vaccination” is regained again. Nothing is said in legislation about vaccinated animals present at that time (e.g. dairy cows) and about off-spring of vaccinated animals (e.g. calves). It is not clear whether countries outside Europe open their borders again for products from animal origin from the Netherlands.
8. Not clear is whether integrated veal production companies accept newborn calves which are vaccinated, are offspring from vaccinated dairy cows or are above five weeks of age. Integrated veal production companies can run into problems due to legislation under which veal can be sold as white veal (maximum slaughter age 34 weeks) and due to serving customers which do not accept veal from vaccinated calves or from calves which are offspring of vaccinated calves.
9. Due to high fixed costs of a captive (minimum of € 100,000), a captive is more useful for large companies which face several millions of financial risks. FMD and other infectious diseases affect all companies, big and small, in the supply chain. Being able to fund and enjoying tax benefits can help especially the smaller companies (e.g. farms) with covering the financial risk in case of infectious disease.

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Appendix I: EU veal prices

Veal prices in the EU (€ per kg slaughtered weight, slaughterhouse price (af slachterij), excl. VAT)

	2004	2005	2006	Average
The Netherlands	4.62	4.22	4.75	**4.53**
Italy	4.78	4.40	4.89	**4.69**
France	5.71	5.16	5.80	**5.56**
Belgium	5.25	5.08	5.82	**5.38**
EU	5.16	4.71	5.30	**5.06**

Source: PVE (2007A)

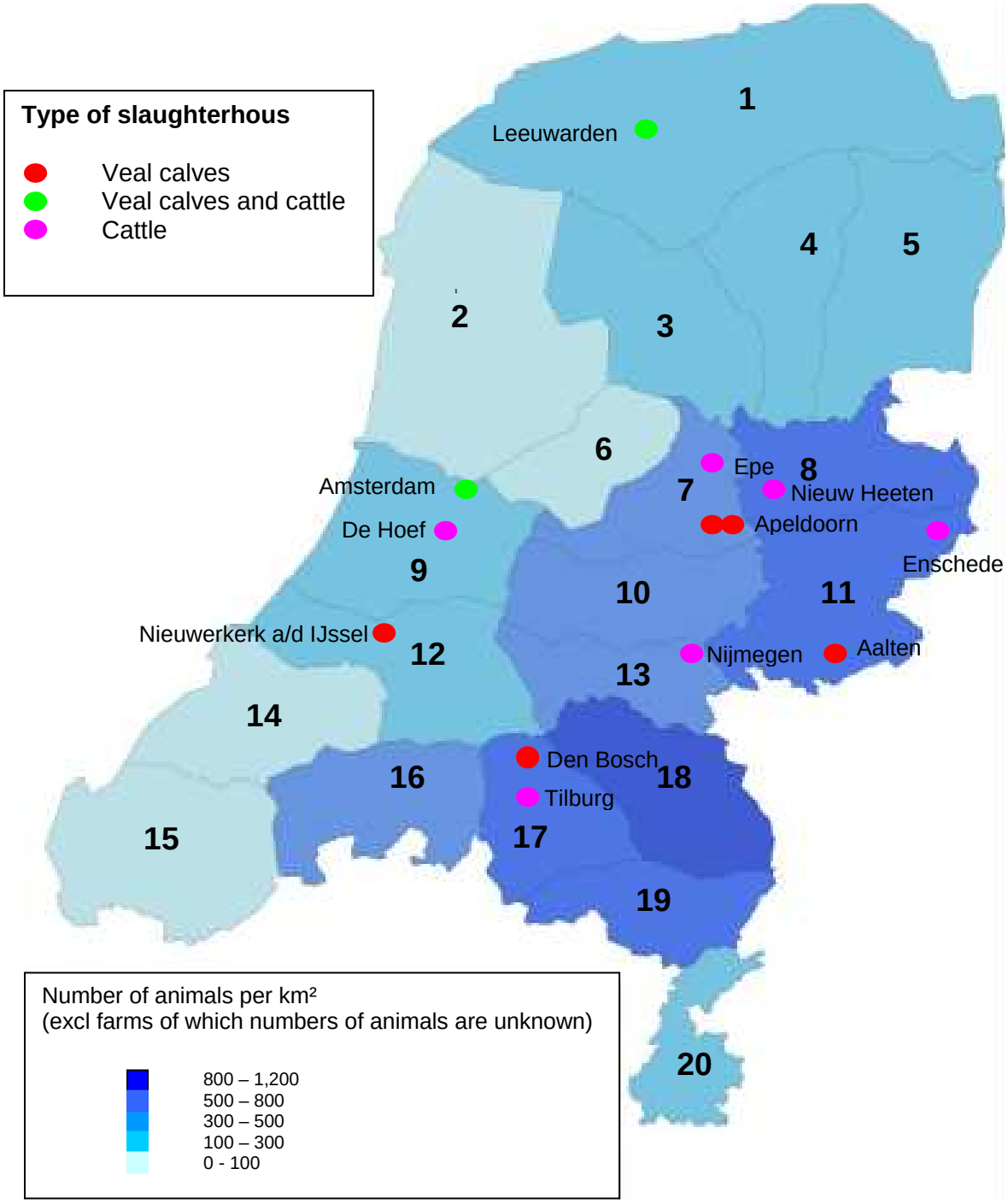
Appendix II: Decreased revenues per veal calf

Decreased revenues per calf based on slaughter weight of 142 kg (white) and 190 kg (rosé) (KWIN, 2007) and when slaughter weight increases 20 kg

	White veal			Rosé veal		
Percentage decrease	collected price	decreased revenues (142 kg)	decreased revenues (162 kg)	collected price	decreased revenues (190 kg)	decreased revenues (210 kg)
0%	4.75	0	-95	2.75	0	-55
5%	4.51	34	-57	2.61	26	-26
10%	4.28	67	-18	2.48	52	3
15%	4.04	101	20	2.34	78	32
20%	3.80	135	59	2.20	105	61
25%	3.56	169	97	2.06	131	89
30%	3.33	202	136	1.93	157	118
35%	3.09	236	174	1.79	183	147
40%	2.85	270	213	1.65	209	176
45%	2.61	304	251	1.51	235	205
50%	2.38	337	290	1.38	261	234
55%	2.14	371	328	1.24	287	263
60%	1.90	405	367	1.10	314	292
65%	1.66	438	405	0.96	340	320
70%	1.43	472	444	0.83	366	349
74%	1.24	498	473			
75%	1.19	506	482	0.69	392	378
80%	0.95	540	521	0.55	418	407
85%	0.71	573	559	0.41	444	436
90%	0.48	607	598	0.28	470	465
95%	0.24	641	636	0.14	496	494
100%	0	675	675	0	523	523

Appendix III: Overview slaughterhouses, regionalization, number of animals per km²

Number of animals per km² (24-02-2004), regionalization (28-11-2003) and slaughterhouses



Source: PVE (2007b) and LNV (2005)