Economic evaluation of an introduction of emerging vector-borne horse diseases within the Netherlands

Thesis Business Economics
BEC 80424

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Date: **April 28, 2009**

Preface

This essay is in the context of my minor thesis in Agricultural Business Economics. The subject of my essay is: 'Economic evaluation of emerging vector-borne horse diseases within the Netherlands'. I really liked the subject of my essay because I am interested in the economic impact of animal diseases.
My parents have a pig farm, as you probably know the pig sector has some experiences with epidemic diseases like classical swine fever and mouth and foot disease. Due to the farm of my parents I know what the consequences of epidemic diseases can be for farmers, even if they are not infected.
Since my hobby is horseback riding the subject is even more interesting for me. If vector-borne horse diseases will be introduced in the Netherlands it will have consequences for myself. The difficulty was that there is not much data available about the horse sector, but this also made the subject more of a challenge.

I would like to thank everybody who helped me with my report, especially my supervisor Monique Mourits. I also want to thank Marianne Sloet (Utrecht University), Eelco Ronteltap (Ministry of Agriculture, Nature Management and Fisheries) and Mirjam Nielen (Utrecht University) for helping me, giving me feedback and providing information.

Tineke Eppink,
April 16, 2009

Summary

The rather unexpected introduction of Blue Tongue in 2006 in the Netherlands, has risen the awareness of other emerging vector-borne diseases. The vector-borne disease that seems most emerging in horses is African Horse Sickness (AHS). AHS is transmitted by the same insects as the Blue Tongue virus. The mortality of AHS is very high, 70-95% (Mellor 2004). In this report the economic consequences of the first 12 months after an introduction of AHS for the primary horse sector in the Netherlands are calculated.
To control an introduction of African Horse Sickness the EU has established a directive. The ministry of Agriculture, Nature Management and Fisheries (LNV) in the Netherlands has his own legislation which deviates on some points from the EU directive. The most important derogatory point in the legislation is that euthanasia is no control measure in the Netherlands. Euthanasia is only applied if the animal is in too much pain, the horse owner makes this decision. Whereas according to the EU directive all horses with clinical symptoms are euthanized. After an introduction of AHS in the Netherlands the country will be divided in several areas. 20 km area around the infection in which all equines should be vaccinated and housed, 20-100 and 100-150 km area around the infection in which equines may not leave the farm for at least 60 days and the free area remained. Although vaccination is a control measure, there is no vaccine allowed in the EU at this moment because the vaccine available is a life vaccine there are risks of mutation. In case of an introduction of AHS the vaccine will be allowed. As AHS is introduced in the Netherlands all horses should stay in the original zone for at least 12 months, there will also be an export ban. Because the ministry of LNV takes some measures to control the disease they will carry also a part of the costs. These are vaccination costs, costs to control the 72 hours transport prohibition, costs for area guarding and costs for monitoring and surveillance.

The horse sector is a very heterogeneous sector. Many different types of stakeholders are involved, a part are professional but also a large part are non-professional. The primary sector has been defined by the following 3 segments and 9 types of horse holders:
Breeding: Stallion holder, mare holder and rearing stable
Recreation and sport: Training and sport stable, riding school, hobby horse holder, boarding stable
Trade: sport horses trader, fast trader

For the economic evaluation of the impact of an introduction of AHS in the Netherlands, the technique of partial budgeting is used. The costs calculated per average horse keeper are divided in direct costs, direct consequential costs and indirect consequential costs. Costs per average horse keeper are, subsequently, aggregated to national level. With this aggregation a homogeneous distribution of the horse keepers over the Netherlands is assumed.

If a company is infected the economic consequences are largest for the sport horse traders and subsequently for the stallion holder and riding schools. The consequences are lowest for the hobby horse owners and boarding stables. With the aggregation to national level the total economic consequences of the primary sector will be around 115 million euro of which 75% as a result of consequential costs. This figure reflects the consequences of a minor outbreak, with only one 20 km zone in the middle of the Netherlands.
This report shows that the costs are not homogeneous distributed over the different types of horse keepers. In case of an introduction almost all horse keepers will have economic consequences, also in the free area. Due to the high expected economic impact and the chance that the disease will get endemic if it is introduced it is important to invest in preventive measures as well as in the development of an efficient DIVA vaccine.

Samenvatting

Met de introductie van Blauw Tong in 2006 in Nederland is het bewustzijn omtrent de mogelijke gevolgen van een introductie van een vectorgebonden ziekten toegenomen. De vectorziekte die in paarden het meest bedreigend lijkt, is Afrikaanse Paarden Pest (APP). APP wordt door dezelfde insecten overgebracht als blauwtong. De mortaliteit bij APP ligt erg hoog, 70-95% (Mellor 2004). In dit verslag worden de economische gevolgen van de eerste 12 maanden na een introductie van APP voor de primaire paarden sector in Nederland berekend.

Voor de bestrijding van Afrikaanse Paarden Pest heeft de EU een richtlijn opgesteld. Het Ministerie van LNV in Nederland heeft een eigen regelgeving die op enkele punten afwijkt van de EU richtlijn. Het belangrijkste afwijkende punt in de regelgeving is dat in Nederland geen paarden verplichte ge-euthanaseert worden. Euthanasie wordt alleen toegepast als het dier anders te veel pijn heeft, de eigenaar neemt hierbij de beslissing. Terwijl volgens de EU richtlijn alle paarden met klinische symptomen ge-euthanaseert moeten worden. Na een introductie van APP in Nederland zal het land in verschillende zones verdeeld worden. De 20 km zone om de infectie waarin alle paardachtigen gevaccineerd en opgestald moeten worden, de 20-100 en 100-150 km zone om de infectie waarin paardachtigen de houderij voor 60 dagen niet mogen verlaten en het overgebleven vrije gebied. Op dit moment is het vaccin tegen APP nog niet toegestaan in de EU omdat het beschikbare vaccin een levend vaccin is, en er hierdoor een risico bestaat op mutatie. Als APP uitbreekt zal het vaccin toegestaan zijn. Op het moment van introductie van APP mogen er geen paarden meer geëxporteerd worden, en moeten paarden voor tenminste 12 maanden in de oorspronkelijke zone blijven.
Doordat het ministerie van LNV enkele maatregelen neemt mbt controle van de ziekte zullen zij ook een deel van de kosten dragen. Dit zijn kosten voor vaccinatie, controle 72 uur vervoersverbod, zone bewaking en monitoring en surveillance.

De paardensector is een erg heterogene sector. Er zijn verschillende stakeholders betrokken bij de paardenhouderij, een deel hiervan is professioneel maar ook een groot deel is niet professioneel. De primaire sector is opgebouwd uit de volgende 3 segmenten en 9 typen paardenhouders:

- Fokkerij: Hengstenhouder, Merriehouder en Opfok stal
- Recreatie en Sport: Training en Sport stal, Manege, Hobby paardenhouder, Pensionstal
- Handel: Sportpaarden handelaar, Snelle handelaar

Voor de economische evaluatie van de gevolgen van een APP introductie in Nederland is gebruik gemaakt van de partial budgetting techniek. De berekende kosten per gemiddelde paardenhouder zijn onderverdeeld in directe kosten, directe gevolgschade en indirecte gevolgschade. De berekende kosten voor de gemiddelde paardenhouders zijn vervolgens geaggregeerd naar nationaal niveau. Hierbij is aangenomen dat de paardenhouders homogeen verdeeld zijn over Nederland.

Als een bedrijf geïnfecteerd is zijn de economische gevolgen het grootst voor de sportpaardenhandel en vervolgens voor de hengstenhouders en maneges. De gevolgen zijn het laagst voor de hobby houders en de pensionstallen. Bij de aggregatie naar nationaal niveau komt de totale economische impact voor de primaire sector op ongeveer 115 miljoen euro, waarvan 75% gevolgschade is. Hierbij wordt uitgegaan van een kleine uitbraak met één 20 km zone in het midden van Nederland.

Dit verslag geeft een goed beeld van een eerste verkenning van het probleem. Het geeft aan dat de kosten niet homogeen verdeeld zijn over de verschillende typen paardenhouders. Bij een introductie zullen vrijwel alle paardenhouders economische gevolgen hebben, want ook in het kleine vrije gebied dat overblijft zal er schade optreden. De hoge economische gevolgen en de kans dat de ziekte endemisch wordt als het eenmaal geïntroduceerd onderstrepen het belang van het investeren in preventieve maatregelen als tevens de ontwikkeling van een marker vaccin.

Content

1. Introduction

Recently an increase in concerns about emerging vector-borne diseases in horses, like African Horse Sickness , has been observed. To what extent are these vector-borne diseases a serious threat for the horse sector in the Netherlands?

In August 2006, an outbreak of Bluetongue within ruminants in the Netherlands occurred. Bluetongue is called a vector-borne disease because a vector is needed to transmit the virus (LNV 2008: website – Afrikaanse paardenpest). The vectors that transmit the Bluetongue-virus are mainly the Culicoides imicola (Enserink 2006: website). These Culicoides normally live in places with a high annual temperature. Over the last 100 years significant statistical differences in the climate of the Netherlands have occurred. Mean temperatures did rise, number of summer days did increase and the total amount of rainfall did increase (Visser et al. 2007). Warm and high moist environments are good habitats for insects like the Cullicoides. Because of the changing climate the Culicoides seem to move northward into countries with an increasing annual temperatures. Usually the Bluetongue virus is only present in Southern Europe, but with their march northward the Culicoides also carried Bluetongue northward. The rather unexpected introduction of Blue Tongue, or in other words, of disease transmitting vectors has risen the awareness of other vector-borne diseases.

In horses, there are several vector-borne diseases known. Examples are African Horse Sickness, West Nile Fever, Equine Infectious Anemia and Vesicular Stomatitis. These diseases has not occurred yet within the Netherlands, but because of the global warming, the need for the horse sector to prepare itself against a possible introduction has been recognised. Take for instance African Horse Sickness (AHS). This is a disease caused by a virus, which is - just like the Bluetongue virus - a RNA virus belonging to the genus Orbivirus and transmitted by the same vector as the Bluetongue Virus. Because of these similarities, the risk of an introduction of AHS in the Netherlands has increased.. Originally the AHS virus only occurs South of the Sahara, but there have been outbreaks in Spain (1987), Morocco, Turkey and Portugal (1989-1991) (Portas et al. 1999).

The horse sector within the Netherlands is not familiar with epidemic diseases, this is why an introduction of a vector-borne disease is probably even more dangerous. The sector is at this moment unprepared and relatively unorganised. But there are many horses present in the Netherlands, the estimated number ranges from 400,000 to 590,000 (Rijksen 2005; Schuring 2005). The exact number and location of the horses is not known because a good closed I&R system is lacking.
The horse sector is a relatively young sector that has gone through a large and rapid growth during the last years. This is probably why, when comparing this sector to other agricultural sectors, the sector is still relatively unorganised. The horse sector is trying to improve its level of organisation, but one of the main difficulties is the heterogeneous character of the sector. Horses are very diverse; there are many different horse breeds and they are used in many different activities. This is why there is also a large diversity in stakeholders. At a professional horse company there

are often combinations of activities performed, for instance a boarding stable that also trains horses, or a stallion holder that also rears young horses.

In this study an economic evaluation of the consequences of an introduction of an emerging vector-borne horse disease within the Netherlands is made. AHS is chosen as evaluation case as it is expected to be the most emerging horse vector borne disease (personal announcement Marianne Sloet, 2008). Moreover, AHS is listed as a regulated disease by the OIE. Specific control measures (as defined by the EU and national animal health authorities) have to be applied after an introduction of the disease. These measures - directed to the control of the disease - can seriously affect the economic activities on horse holdings. An economic evaluation is, therefore, useful to obtain insight in the economic consequences for the different stakeholders. Insights from such an evaluation are important so that decisions can be made in the best possible way if the disease is introduced. The economic evaluation will also make people aware of the seriousness of the economic impact the disease can have.

Part of the Dutch horse-sector is professional but even a larger part is non-professional. Due to the large non-professional part the emotional damage when a vector-borne disease is introduced can be very large, as many horse owners have a very close bond with their horse. In this report we focus on the economic impact, or - more specific - on the economic impact for the primary part of the sector. With primary part all horse keepers, professional and non-professional, are considered.

Due to variation in disease characteristics it will be difficult to extrapolate findings on AHS to other horse vector borne diseases. For instance, West Nile Fever is also considered as a serious threat. This vector-borne disease is, however, not regulated because infected horses are considered as "dead" ends with respect to virus replication. An introduction of WNF will therefore affect the economic activities differently than AHS. To evaluate the differences between the two diseases the economic consequences of both diseases are compared in a qualitative way.

This reports starts with a chapter to describe the findings of the literature review on African Horse Sickness and the Dutch horse sector. This chapter is followed by the chapters on Material and Methods, Results, Discussion and Conclusion. Within these chapters focus is on the economic evaluation of an introduction of AHS. In a separate appendix, a description of the qualitative comparison of African Horse Sickness with West Nile Fever is given.

2. Literature review on the disease and on the sector

2.1 African Horse Sickness

African Horse Sickness is a disease caused by a virus, Orbivirus Reoviridae (CVI 2008: website – Afrikaanse Paardenpest). It is a vector borne disease. Vector borne diseases are diseases that are transmitted by insects. An animal can only get infected with the virus if it is bitten by an infected insect. There are nine different strains of the AHS virus known. The disease is a highly infectious disease with a very high mortality in horses (70-95%). The virus affects all equines, but donkeys and mules are less sensitive to the disease. The incidence of disease in these species when infected with the virus is respectively 10 and 50 %.

There are 4 different forms of the disease. These forms are depended on where in the animal the antigen is primarily situated.:

- *Acute pulmonary form*. This form has an incubation period of 3-5 days and can develop so rapidly that infected horses die without first showing any signs of illness. Symptoms are depression and fever (Mellor 2004) followed by heavy breathing and coughing. Death usually occurs a few hours after showing the first clinical symptoms (Mellor 2004). 95% of the horses with this type of disease die (Defra 2008: website – African horse sickness).

- *Cardiac or Sub-acute form*. This form has an incubation period of 7-14 days. Symptoms are swellings over head and eyelids, under the jaw, cheeks and lips. The time course of this form is several weeks, other characteristics are fever and often Colic. The mortality rate is expected to exceed 50% (Mellor et al. 2004). Most of the horses that die due to this type of disease die within a week (Defra 2008: website – African horse sickness).

- *Mixed form*. This is a combination of the Acute pulmonary and the Cardiac form. This form has an incubation period of 5-7 days. Symptoms are mild respiratory signs followed by swelling symptoms of the cardiac form. The mortality rate is around 70%. Death usually occurs within 3-6 days after the onset of the fever. The mixed form is the most common form of AHS (Mellor 2004).

- *Horse sickness fever*. This is the mildest form. Symptoms are a fever with low temperatures in the morning and high temperatures in the afternoon (Defra 2008: website – African horse sickness). This form usually occurs in zebras and donkeys and in horses with some degree of immunity (Mellor et al. 2004). No mortality occurs with this form of disease (Mellor et al. 2004).

2.1.1 Transmission

AHS cannot be transmitted by direct contact between an infected and a non-infected equine; the only transmission path is via a vector. This means that the disease can only be transmitted if a vector first bites an infected animal, and subsequently bites a non-infected animal. The main vectors for disease spread in Europe are expected to be the Culicoides (Mellor et al. 2004). Especially the Culicoides Imicola and the Culicoides Obsoletus are mentioned (CVI 2008: website – Afrikaanse paardenpest).

Because the disease is transmitted by insects high moist and warm weather favour the spread of the disease. If the temperature rises the infection rates seem to increase, virogenesis is faster and transmission seems to occur sooner (Mellor et al. 2004). Replication of the African Horse Sickness Virus does not seem to occur at a temperature below 15 degrees. However, if Culicoids from environments with this lower temperature are placed in environments with a higher temperature, 'latent' virus, that is still present, can start to replicate again (Mellor et al. 2004).

2.1.2 Previous outbreaks

African Horse Sickness is endemic at the South of the Sahara in Africa. Since 1993 AHS has been reported to the OIE from Botswana, Burkina Faso, Cape Verde, Eritrea, Ethiopia, Gambia, Lesotho, Malawi, Mozambique, Namibia, Nigeria, Republic of South Africa, Senegal, Swaziland and Zimbabwe (Sabirovic et al. 2008). Sometimes outbreaks in Asia (1959-1961) and even in Europe (Spain, 1965, 1987, 1988, 1989 and 1990) have occurred (Mellor et al. 2004). The virus has not survived in these areas but it did cause large outbreaks with high mortality rates (Sabirovic et al. 2008).

2.1.3 Legislation

African Horse Sickness is a disease that is obliged to control. There is an EU directive with respect to the control of this disease (Council directive 92/35/EEC). In the Netherlands there is a legislation for the control of African Horse Sickness as described in 'Concept beleidsdraaiboek Afrikaanse Paardenpest' from the ministry of agriculture, nature and food quality (LNV 2008: website – concept beleidsdraaiboek Afrikaanse paardenpest). At 22 December 2008 an advice of the group of experts with respect to control and prevention of equine diseases was published. These comments made by the group of experts are assumed to be taken into account in the new legislation.

In this study the economic evaluation is based upon the legislation as described in 'Concept beleidsdraaiboek Afrikaanse Paardenpest', supplemented with the comments made by the group of experts. In short:

If a possible introduction of AHS is suspected this should be reported immediately. After the notification of a possible introduction a complete standstill order of at least 72 hours for all equines is installed. The possible source of introduction is then traced back. If the suspected case is diagnosed to be a real case of AHS, the whole country will be divided in control zones (see tables 1, 2 and 3); a zone of 20 km around the detected infection followed by a 20-150 km zone and a free area outside the 150 km zone. All the horses in a zone of at least 20 km around the infection source will be vaccinated. These vaccinated horses should be marked and may not be slaughtered for consumption. Euthanasia of infected horses is not a control measure in the Dutch legislation. The horse owner decides whether to euthanize the infected horse or not. Within the 20 km zone all horses should be kept inside, if this is not possible they should wear special insect blankets. In the advice of the group of experts there was no duration mentioned for this control measure, because this is depended of the seriousness of the outbreak. Since the duration of most of the strict control measures is 60 days, this is also taken as a minimum for the housing period.

The 20-150 km zone around an infection source is called the protection-, and surveillance area. Horses within the protection-, and surveillance area may not be transported, and should be protected against the vector for at least sixty days after the last vaccination. There are no exceptions! Sixty days or more after the last vaccination the measures are liberalized. Transportation within the protection- and surveillance zones is then allowed. These more liberalized legislation measures apply for at least 12 months. No export from the protection- and surveillance zone is allowed, outside these zones export is only possible under the conditions of the European Legislation.

Table 1: Dutch measures within 20 km zone
X=Forbidden, O=obliged, ?=depends on the duration of the housing period
All horses within the 20 km zone should be vaccinated.

	Until 60 days after last vaccination	As from 60 days after last vaccination
Housing	O	?
Leaf 20 km zone	X	X
Transporting horse	X	?
Measures against vector	O	O
Bring horses into the 20 km zone	X	X
Exporting	X	X

Table 2: Dutch measures within the 20-150 km zone

	Until 60 days after last vaccination	As from 60 days after last vaccination
Outdoor ridings	X	A
Leaf farm	X	A
Leaf 20-150 km zone	X	X
Transporting horse	X	A
Measures against vector	O	O
Exporting	X	X
Bring horses into the 20-150 km zone	X	A

X=Forbidden, O=obliged, A=Allowed

Table 3: Dutch measures within the Free area

	During 72 hours of stand-still order	After complete stand-still order
Leaf farm	X	A
Outdoor ridings	X	A
Leaf free area	X	X
Transporting horse	X	A
Exporting	X	A[1]
Import horses	X	A[2]

X=Forbidden, O=Obliged, A=Allowed

1) Only possible under the conditions of the European Legislation
2) Only possible if 20-150 km will not be entered

At some points the Dutch 'Concept beleidsdraaiboek Afrikaanse Paardenpest' supplemented with the advice of the group of experts differs from the EU directive. The main difference is with respect to the measure on euthanasia of infected horses. In the EU directive all horses that are infected and/or show clinical symptoms should be euthanized, while the Dutch group of experts suggests that it is better not to regulate euthanasia of diseased horses. The expert group state this opinion with the experiences obtained from the Blue Tongue case, where culling of infected animals did not prove to be an effective control measure of vector-borne diseases (LNV 2008: website – advies groep van deskundigen). Moreover in the case of horses the emotions of people can run up high if their horse has to be euthanized when it seems rather healthy, or better said, when they think the horse can still recover. The group of experts suggests that people will earlier warn the authorities when their horse is sick, and that the risk of illegal displacement of infected horses outside the 20 km zone (to hide them from the authorities) is less if they don't have to be euthanized by law. This is important as it will prevent contacts of infected horses with uninfected vectors.

- Control costs LNV

Since the Ministry of Agriculture, Nature Management and Fisheries (LNV) imposes control measures it also has to compensate some of the costs. The most important costs that are assigned to the Ministry of LNV are: i) a part of the diagnostic costs, ii) the costs of controlling the 72 hour stand-still order, iii) vaccination costs, iv) Zone guarding costs and v) Monitoring & Surveillance costs. Finally these costs should be recovered again from the horse sector, for instance, by imposing a kind of tax on horse feed.

i) Diagnostic costs:

The diagnostic costs are the costs to diagnose African Horse Sickness. Usually if a horse owner has a sick horse he calls his own veterinarian. The costs related to the visit of the own veterinarian are costs for the horse owner. If the veterinarian thinks the horse is infected with the African Horse Sickness Virus the Food and Consumer Product safety authority (VWA) is contacted. A veterinarian from this organisation is send to the horse holding to evaluate the situation and to take some blood samples. These samples are serological tested in a reference lab to confirm whether the horse is really infected or not. The costs of the VWA veterinarian and the tests are costs assigned to the Ministry of LNV.

ii) 72 hour stand-still order:

During the first 72 hour after the discovery of an introduction of AHS a complete stand still order all over the country will take place. Transportation from and to the infected horse keeper are traced back. Costs made are the costs to check if there are no equines transported.

iii) Vaccination costs:

In the Dutch legislation for AHS all horses within the 20 km zone around an infected horse keeper should be vaccinated. These costs consist of the visiting fee of a veterinarian, registration costs, material costs and vaccine costs. In case of an

emergency vaccination, the costs of the vaccine are usually compensated by the EU (personal announcement Eelco Ronteltap).

iv) Zone guarding costs:
In the Dutch legislation the country will be divided in zones in case of an introduction of AHS. There will be a 20 km zone around the infected horse keeper, a 20-150 km protection and surveillance zone. The borders between these zones should be guarded. Horses should stay within the same zone for at least 12 months. This means that the borders around the 20 km zone and around the 150 km zone should be guarded for at least 12 months. There are no concrete approach plans available, this is why the costs of zone guarding are difficult to calculate.

v) Monitoring & Surveillance costs:

For the purpose of monitoring and surveillance various measures have been defined;

- *Vector monitoring*

Vector monitoring is done by placing traps at different locations within the Netherlands. This is done to observe which vectors are important for the transmission of the virus, and to determine if the vector free period has started or ended.

- *Active clinical surveillance of horses* (screening)

At the start of an introduction of AHS it is important to get a good view of how the disease is spreading. Because the disease shows clear clinical symptoms the active clinical surveillance will be an effective method to find infected equines.

- *Passive clinical surveillance* (duty to report)

The passive clinical surveillance is the same as the duty to report. The horse keeper has to report an infected animal immediately. This is a cheap but effective surveillance measure.

- *Surveillance of donkeys/mules including serological tests*

Monkeys and mules show little or no clinical symptoms, this is why for monkeys and mules a blood test is necessary to find a possible infection. This should be done within the 20 km and 20-150 km zone.

- *Sentinel monitoring*

Sentinel monitoring is used to declare the country free of AHS. Unvaccinated, negative equines are placed at different location in the Netherlands. These equines are tested at certain time points.

During the crisis phase the monitoring and surveillance measures within the 20 km zone consist of vector monitoring, active clinical surveillance of horses (screening), passive clinical surveillance (duty to report), surveillance with serological tests of donkeys/ mules and sentinel monitoring.

Within the 20-150 km zone the measures are the same, only there is probably no active clinical surveillance of horses (screening). In the free area the only measures taken are the vector monitoring and passive clinical surveillance (duty to report).

2.1.4 Vaccine

Based on the Dutch legislation all equines in a zone of at least 20 km around an AHS infected and detected animal should be vaccinated. A live vaccine will be used to protect against the disease. There are still some concerns about this vaccine. The only vaccines against African Horse Sickness are produced in South Africa, and none of these vaccines are licensed for use in the EU at this moment. These live vaccines are offered as two standard polyvalent preparations. Polyvalent means that the vaccine protects against more than one strain of the virus. There is no polyvalent vaccine available that protects against all the different strains of the virus, this can cause a delay of several weeks to months for emergency vaccination. A monovalent vaccine gives better protection but requires even more knowledge on the emerging strains (OIE 2008: website – African Horse Sickness). The vaccines can sometimes cause mortality in healthy vaccinated horses (Portas et al. 1999) and can cause abortion in pregnant mares. Another point of concern is that it is not known whether the live vaccine can mutate (Mellor 2004).

2.2 Horse sector in the Netherlands

The Dutch horse sector is a very heterogeneous sector. Dutch horses are very diverse in their breeds and many different (economic) activities are performed with them. This has led to a large diversity in stakeholders. In this section the size of the total horse sector within the Netherlands and the structure of the primary part of the horse sector within the Netherlands are described.

2.2.1 Size of the horse sector

Within the last years the total revenue of the horse sector in the Netherlands did grow enormous. In 1991 the total revenue was €0.57 Billion, in 1997 this was €0.9 Billion and it did grow further to €1.2 Billion in 2004 (Koolen 2005). Since 2004 the total revenue of the horse sector probably grew even further, but there are no numbers available for these last years. To make a comparison of these numbers with other sectors in the Netherlands, the revenue in 1997 of the broiler sector was €1.14 Billion and of the flower bulb sector was €0.45 Billion (Koolen 2005). The employment in the total horse sector is estimated at 12.000 persons (Koolen 2005). These numbers are for the whole horse sector, so also the supplying companies, like feed companies, are included. This evaluation focuses only at the economic consequences for the primary part of the horse sector. The primary part of the horse sector involves all horse keepers, professional as well as non-professional.

The estimated total number of horses (ponies included) in the Netherlands ranges from 400,000 to 590,000 horses (Rijksen et al. 2005; Schuring 2005). Because a good closed I&R system is lacking the exact number and location of the horses are not known. The current identification system in the Netherlands is that all equines should have a passport and a matching chip. It is estimated that only 50-60% of all equines are chipped (LNV 2008: website - Advies groep van deskundigen). The system only contains information on equines that are chipped. Information on the current location of the horses is lacking. Horses that die or are exported are often not deleted from the system. An additional problem is that there is no central registration system (Rijksen et al. 2005), as different authorities provide the passports. The main passport providers are the different studbooks and the KNHS (Royal Dutch Equestrian Sport Union) (Paardenpaspoort 2009: website – uitgevende instanties).

There are 66,568 active competition riders in the Netherlands (KNHS 2009: website – Jaarverslag 2007). In total the KNHS (Royal Dutch Equestrian Sport Union) has 195,526 members. The number of recreational riders at riding schools and boarding stables is estimated at 340,000 persons (Schuring 2005). In 2007 there have been 7,358 equestrian events (KNHS 2009: website – Jaarverslag 2007). Many people did visit these events or did watch them on television. The number of people passively involved in the horse sector, so excluding the people that actually ride a horse, is estimated at 425,000 persons (Schuring 2005). These figures show that many people are involved in the horse sector.

2.2.2 Structure of the primary part of the horse sector

The primary part of the horse sector involves all horse keepers. This part of the sector can be roughly divided in 4 different branches: Breeding, Recreation & Sports, Trade and Slaughtering. In the Netherlands there are no companies known that keep horses just for fattening, this is why in this evaluation the slaughtering branch is left out.

When looking at the activities that take place in the primary sector, we could divide the horse keepers within these branches by a number of categories, as described below. To simplify the overview only the most common categories are mentioned, for example dairy horse farms are left out.

A company is assigned to a category if the activity that is described as main activity generates the largest total revenue for that company. Next to this main activity companies often have different side activities (i.e. another type of horse keeping, agriculture, catering, jobs outside the holding).

Breeding

In the Netherlands, there are many different horse breeds. Most of these breeds have their own studbook. In total there are 25 acknowledged studbooks in the Netherlands. In the breeding part of the primary sector there are 3 main activities. These main activities involve the breeding stallion, the breeding mare and young horses that should be reared, defining the categories of stallion holder, mare holder and rearing stables.

- *Stallion holder*: The main activity of a stallion holder is selling semen of his breeding stallions. The breeding stallions are the stallions that are used to produce the next generation of horses. These stallions are often selected by the studbook. This means that not all the stallions can become a breeding stallion.

- *Mare holder*: The main activity of a mare holder is producing foals with their breeding mares. The breeding mares are the mares that are used to produce the next generation of horses. These mares are not selected by the studbook, the mare owner can decide whether he wants a foal of his/her mare or not. The number of used breeding mares each year is estimated at 42,000, note that this number also includes breeding mares of hobby horse owners and other type of holdings (Rijksen et al. 2005).

- *Rearing stable*: The main activity of a rearing stable is taking care of young horses. These young horses can be owned by the rearing stable, but can also be horses of others. A rearing horse is a horse from around 4 months until 36 months of age, this is roughly the period from the time the foal is weaned until the young horse is trained. During the rearing period the young horses usually stand in groups. The total number of rearing horses is estimated at 120,000, note that not all these horses are positioned at a rearing stable (Rijksen et al. 2005).

Recreation & Sports

If the horses are around 2-3 years old they get prepared for their further life. This further life depends on the qualities of the horse, but even more on the wishes of the

owners. If at this stage a horse owner wants to use his/her horse in breeding, the horse is often prepared for the mare-, or stallion inspection. The horses can also be used for recreation or sports, if this is the case the breaking usually starts at an age of 3 years. Based on its final use, the following horse keepers can be categorised;

- *Training-, Sport stable:* The main activities of training and sport stables are breaking and training of horses, competing with them in sports and preparing horses for mare-, and stallion inspections. These horses can be own horses but also horses of others. The total number of horses competing in sports is estimated at 150,000 (Rijksen et al. 2005). Note that not all these horses are positioned at a training and sport horse stable.

- *Riding school:* The main activity of a riding school is teaching people to ride a horse. People who don't have an own horse can have riding lessons, or hire a horse for outdoor ridings. The riding school horses are owned by the riding school.

- *Boarding stable:* The main activity of a boarding stable is taking care of horses of others. This are usually horses of hobby horse owners who cannot keep their horse at home. The people pay a monthly payment to the boarding stable to clean the box of the horse, feed the horse and put the horse outside regularly. Additional costs like veterinarian and blacksmith costs are usually not included.

- *Hobby horse owner:* The hobby horse owners represent a difficult category. As they do not have to generate any revenue, and therefore have no main activity, they can not be assigned to one of the other categories. The activities of this group of horse keepers can be very diverse, they can for example have breeding mares, rearing horses, sport horses or recreational horses. So they can perform the same activities as the professional companies do, but usually the hobby horse owner performs these activities at a much smaller scale.

Trade

Also the trade of horses can be done professional or unprofessional. In professional horse traders we make a distinction between Sport horse traders and Quick traders.

- *Sport horse trading stable*: These traders sell horses in the upper segment of the horse sector. They sell for instance good performing sport horses, these horses are often more expensive. Around 7650 sport horses are sold each year (Rijksen et al. 2005).

- *Quick trading stable*: These traders sell more, but cheaper horses. These are more the normal horses for the recreation or basic sports riders.

3. Material and Methods

In this essay the economic impact of an introduction of African Horse Sickness is evaluated. The evaluation is made for the primary part of the horse sector (section 2.2.2) for the first 12 months after the introduction of the disease. For as far as possible actual data were used. However, for some parts information was seriously lacking. In these cases expert estimations were used.

3.1 Structure of the economic evaluation

The consequences of an introduction of AHS are economically evaluated for an average horse keeper per defined category of horse keepers (section 2.2.2 & 3.2.1). A distinction is made for the disease status (infected, non-infected) and the location of the company with respect to the regulated zones. Based on these distinctions, evaluations will be made for i) an infected farm within the 20 km zone, ii) a non-infected farm within the 20 Km zone, iii) a non-infected farm within the 20-150 km zone and iv) a non-infected farm in the free area.

Currently epidemiological insight with respect to the spread of the disease is lacking. For this reason, only the consequences of a minor outbreak – resulting in the installation of a single 20km zone – are evaluated, providing insight in the minimal costs to expect. If an outbreak is more severe the 20 km zone can be enlarged.

After the economic evaluation at company level the results per average horse keeper are combined to determine the consequences at national level. A true aggregation to national level will not be possible, because exact numbers of horses or horse keepers are lacking. A composition of the sector is therefore derived from the available information and expert opinions.

An introduction of West Nile Fever will affect the economic activities differently. To evaluate the differences between the two diseases the economic consequences of both diseases are compared in a qualitative way. This comparison will be discussed separately in appendix 1.

3.2 Assumptions made:

With respect to the introduction and spread of AHS the following general assumptions are made:

- The introduction takes place in July, in the centre of the Netherlands and is a rather isolated introduction (e.g. due to the import of an infected horse).
- For the calculation of the consequences for an infected horse keeper it is defined that only one horse is infected per horse keeper.
- It is assumed that the company size stays unchanged over the year. This means that there will be the same number of horses present all year long. This number will only be affected when - within the 20 km zone - horses die because of the disease. The boxes stay empty for the rest of the year.

- The last general assumption is that no horses are sold within the 20 km zone during the first 12 months after the first introduction. In theory it is possible to sell horses after 60 days within the 20 km zone, but within the evaluation it is assumed that – due to the control measures that take place - no horse keeper within the 20 km zone wants to buy a horse in the first 12 months after the first introduction of the disease. (see 2.1.3 on regulation)

3.2.1 Assumptions for the evaluation at company level

In section 2.2.2. the horse keepers are roughly divided in different categories according to the activity that generates the highest revenue. For each of these 9 categories an 'average' horse keeper is defined to make an economic evaluation at company level. The definition of the average companies is based on the report "Structuur van de paardenhouderij" written by C.S. Schuring (2005).

Breeding:

Stallion holder:
The size of an average stallion holder is set equal to 3 pony stallions or 3 horse stallions and 38 rearing horses. The horse stallions serve on average 82 mares/year, the average price of a service is € 776,-. The average value of a stallion is € 120,500.-. The pony stallions serve on average 23 mares, the average price of a service is € 136,-. The average value of a pony stallion is € 5,125.-.

The average value of a rearing horse at the start of the rearing period is € 2,150.- and at the end of the rearing period the value of the horse has risen to € 4,950.-. It is assumed that the rearing horses are housed outdoors for 45% of the year (KWIN-V 2008-2009). The indoor housing costs of a horse are €787,-/year (KWIN-V 2008-2009). With the indoor housing costs the costs of concentrates, hay, litter and manure disposal are meant if a horse is kept inside for one year. In an average situation only 55% of these costs occur, because the horse is outside for 45% of the year.

Mare holder:
The average number of horses per mare holder is 8 breeding mares and 19 rearing horses. Only 6 of these 8 breeding mares produce actually a foal. At the moment of introduction the number of foals present is set equal to 6 and 6 mares are already pregnant again. The average market value of a breeding mare is € 9,500.-. The market value of a foal is on average € 3,775.-. Of the 19 rearing horses the market value at the beginning of the rearing period is on average € 3,620.- and at the end of the rearing period this is on average € 5,900.-. All horses at this kind of company are outside for 45% of the year (KWIN-V 2008-2009). The indoor housing costs for rearing horses are €787.-/year, for mares € 1,209.-/year (KWIN-V 2008-2009).

Rearing farm:
The average number of horses at a rearing farm is 44, of which 21 horses are owned by the rearing farm, and 23 horses by others. At the start of the rearing period the market value of a rearing horse is around € 3,204.- and at the end of the rearing period this has risen to € 8,045.-. Horses at a rearing farm are outside for 45% of

the year (KWIN-V 2008-2009). The indoor housing costs of a horse are €787,-/year (KWIN-V 2008-2009). The payment the rearing farm receives for rearing horses owned by others is €73,-/month in the outdoor season and €110,-/month in the indoor season.

Training & Sports:

Training-, sport stable:
The average number of horses is 7 own horses and 23 horses owned by others. These horses are divided in categories of training stage. Of the own horses there is 1 horse broken, 3 horses trained and 3 horses compete in sports. It is assumed that 3 horses are sold each year, a horse is on average owned by the company for 2 years (own assumption). Of the horses owned by others there are 9 horses prepared for inspections, 4 horses are broken, 6 horses are trained and 4 horses compete in sports. Horse owners pay different fees for these horses per month, respectively €486,-, €479,-, €495,- and €511,-. The price difference between an untrained horse and a broken horse is very small, therefore the average value of both groups of horses is set equal to €5,875.-. The market value of a trained horse equals €9,609.-.

Riding school:
A riding school has on average 12 horses and 12 ponies for riding lessons, and also 22 horses and 7 ponies in boarding. These 12 riding horses occupy in 535 group lessons, 80 private lessons and 126 outdoor ridings each year. The payment for these activities are respectively €11,-, €24,- and €13,- per hour. The 12 ponies occupy in 542 group lessons, 93 private lessons and 112 outdoor ridings each year. The payment for these activities are respectively €9,-, €24,- and €11,- per hour. Riding school horses are kept outside for 45% of the year (KWIN-V, 2008-2009). The costs of keeping the horse inside all year are €902,- for horses and €541,- for ponies (KWIN-V 2008-2009).

The 22 boarding horses and 7 boarding ponies are kept outside for 33% of the year (KWIN-V 2008-2009). The indoor housing costs for keeping horses are respectively €951,- and €558,- (KWIN-V 2008-2009).

Hobby horse owner:
An average hobby horse owner has 1.75 horses. The market value of a hobby horse is on average €3,000.-. The market value can vary in a range from €100,- for a Shetland pony to €20,000.- for a good sports horse. The percentage kept at boarding stables is set equal to 40%, and the ability of housing equals 60%. Horses are kept outside for 60% or the year (own assumption). The indoor housing costs for keeping horses are €800,-/year (own assumption).

Boarding stable:
A boarding stable has on average 11 horses and 5 ponies. The monthly payment they receive for boarding is on average €231,- for a horse and €200,- for a pony. The horses and ponies are kept outside for 45% (KWIN-V 2008-2009) of the year. The feed and litter costs when a horse is kept inside are €951,- for horses and €558,- for ponies per year (KWIN-V 2008-2009).

Trade:

Sport horse trading:
At a Sport horse trading stable there are on average 65 horses and 3 ponies present. Each year 56 horses and 3 ponies are sold on average. The purchase and selling prices of horses are respectively €10,150.- and €13,500.-. For ponies these are respectively €4,900.- and €5,300.-. Total costs per horse present are €1,297.- for horses and €778,20 for ponies. In the total costs all costs are included, also veterinarian costs, training costs and blacksmith costs.

Quick trading:
At a Quick trading stable there are on average 21 horses and 39 ponies present.
Each year 68 horses and 56 ponies are sold on average. The purchase and selling price of horses are respectively €1,946,- and €2,290,-. For ponies this is respectively €719,- and €891,-. Total costs per horse present are €243,- for horses and €92,- for ponies.

3.2.2 Assumptions for the evaluation at national level:

To aggregate the economic impact to national level the number of horse keepers within the Netherlands should be known. Also important is the distribution of the horses and different horse keepers over the country. Companies in the primary part of the horse sector do not have to be registered, this is why the number of companies is not known exactly.

Using the "Gouden Gids" and insights obtained from the reports of (Rijksen et al. 2005; Schuring 2005). Total number of the different types of horse keepers are estimated.
Number of breeding horse keepers:

- Stallion holders: 700
- Mare holders: 500
- Rearing farms: 500

Number of Training & Sports horse keepers:

- Training and sport stable: 100
- Riding schools: 1,000
- Hobby horse owner: 181,886
- Boarding stable: 5,800

Number of horse traders:

- Sport horse traders: 50
- Quick traders: 250

Note that a part of the horses of hobby horse owners are stabled at rearing farms, training & sport stables, and at boarding stables. The total number of horses is set equal to around 450.000 horses.

For simplicity it is first assumed that the distribution of the horse keepers and the type of horse keepers is homogeneous over the country.

The total surface of the Netherlands is 41,526 km^2 (Holland 2009: website – algemeen). With a length from East to West of around 200 km, and from North to South of around 300 km.

Figure 1: plan of the Netherlands

The surface of the 20km zone and the 20-150 km zone can be calculated by using the formula: surface circle=pi*radius^2. For the 20-150 km zone the surface of a circle with a radius of 150 km – the surface of a circle with a radius of 20 km.

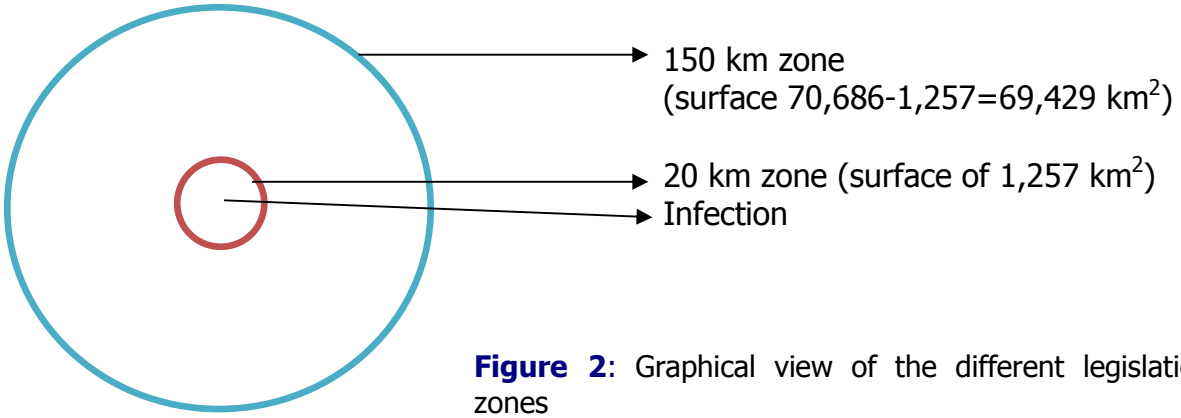

Figure 2: Graphical view of the different legislation zones

As can be seen above the surface of the surveillance and protection zone exceeds the total surface of the Netherlands. This means that if AHS is introduced at a central point of the Netherlands the whole country will be within the 20 km zone or the 20-150 km zone, no free area will be left.

3.3 Description economic evaluation

This evaluation analyses the consequences for the primary part of the sector for the first 12 months after the introduction of AHS by using the partial budgeting approach. Partial budgeting is a tool to estimate how a particular change will effect a business. It is a good way to show the impact of a disease like African Horse Sickness since it only considers the changes in income and expenses. The aspects of income that are unchanged are not important for this kind of problem.

The costs involved are divided in *Direct costs*, *Consequential costs,* which are subdivided in *Direct Consequential costs* and *Indirect Consequential costs*. Usually there are also *Aftermath costs*, these are costs made during the recovery period. These costs are left out because this report only considers the costs made during the

first 12 months after the discovery of AHS in the Netherlands. Since regulations exceeds this period of time there are no aftermath costs known yet.

Some of the costs made are paid for by the Ministry of Agriculture, Nature Management and Fisheries (Ministry of LNV). These costs are no direct costs for the horse keepers and are therefore not calculated in this essay.

3.3.1 Costs horse keeper

3.3.1.1 Direct costs

Direct costs are related to the costs for control of the outbreak, e.g. mortality costs, veterinarian costs and surveillance costs.

- *Mortality costs:*
  Costs related to the mortality of horses due to the disease. With AHS the mortality is assumed to be 70% in case of the mixed form. The mortality costs are the sum of the market values of the horses that die due to the disease.

- *Diagnostic costs:*
  Costs made for diagnosing the disease. If a horse is sick the horse keeper first asks his/her own veterinarian to examine the animal. It is assumed that the veterinarian needs 30 minutes for the examination. Visiting expenses of the veterinarian are set equal to €20,85 by an hourly wage of €116,17. If the own veterinarian assumes an infection of a disease that is obliged to notify VWA, which will send a VWA veterinarian to visit the horse owner and check if the diagnosis is right. The VWA veterinarian has to take some blood samples so that a reference lab can confirm whether it is really the expected disease. The costs of the VWA veterinarian and the reference lab are paid by the Ministry of LNV

- *Treatment costs:*
  Costs made for treatment of the sick animal. There is no specific treatment for the disease. Most treatment costs are costs for painkillers and anti-inflammatory drugs. The treatment costs per infected horse are derived from the treatment costs for cattle in case of Bluetongue (Velthuis et al. 2008) and are set at €40.

- *Costs of measures against vector:*
  Cost of measures taken against the vector. In case of AHS measures against the vector should be taken, and horses within the 20 km zone should be kept inside. If horses cannot be housed they should wear special horse blankets against flies. These are the same blankets as used for horses suffering from sweet itch. The costs of these blankets are around €100,- (Divoza 2009: website - eczeemdekens). All professional horse keepers are assumed to have housing options for all horses present.
  As a measure against the vector horses and stables are treated with insecticides. The costs of these insecticides are assumed to be €4,- per box of 12,25m2 and €1,09 per animal, the treatment should be repeated around 14 times a year. The insecticide costs are derived from the insecticide costs for cattle in case of Bluetongue (Velthuis et al. 2008).

- *Costs of vaccinating:*
  Costs of vaccinating animals against the disease. In case of AHS all horses within the 20 km zone around the infected horse owner should be vaccinated. These emergency vaccination costs are costs for the Ministry of LNV.
  The costs of this vaccination include the visiting fee of the veterinarian (€20,85), a quarter of the hourly wage of the veterinarian (€29,04), material costs (€0,02), vaccine costs (€0,40) and costs of registration (€0,05). At national level these costs are calculated to show the consequence of this regulation measure.

- *Euthanasia costs:*
  Cost for Euthanizing horses. This includes the call fee and hourly wage of the veterinarian. It is assumed that all horses that die of the disease are euthanized. Euthanizing costs are estimated at €100,- per horse (personal announcement Marianne Sloet).

- *Monitoring and Surveillance costs:*
  In case of AHS monitoring and surveillance measures are taken. These are costs for the Ministry of LNV.

3.3.1.2 Consequential costs

Consequential costs reflect the economic consequences of the measures for controlling the disease. The direct consequential costs are the costs that are directly related to the control measures. The indirect consequential costs are price drops or price increases due to control measures.

Direct consequential cost:

- Vaccination related costs
  - *Mortality due to vaccine*: Because the vaccine against AHS is not 100% safe, some horses may die due to the vaccine. The mortality rate after vaccination is assumed to be 0,05% (Portas et al. 1999).
  - *Abortion due to vaccine*: Some pregnant mares show abortion in case they are vaccinated against AHS. The abortion rate is assumed to be 0,1% (own assumption).

- Housing related costs: In case of an AHS outbreak horses within the 20km zone should be kept inside. It is assumed that the housing restriction takes 60 days.
  - *Costs due to no training*: During these 60 days the horses cannot be trained, this means that during these days there is no rise in value of the horses. As a consequence it is assumed that the horses have to be kept 60 days longer before they are sold.
  - *Lower monthly payment because no training possible*: At a training and sport stable people pay a monthly fee to train their horses. During the housing period no training is possible. It is assumed that the horse owners pay during this period only the boarding fee of €230,- and not the extra training fee.

- *No riding lessons*: These are losses for riding schools. During the 60 days of housing riding schools cannot give any riding lessons.
- *Extra feed and litter costs*: If horses can not go outside they eat more concentrates and hay. Also their stables have to be cleaned more often, this leads to higher manure disposal and litter costs. These costs are different per type of horse. It is assumed that breeding stallions, training- & sport horses and horses in the trading circuit are on average not enough outside to cause a significant cost if they are kept inside.

- Transport restrictions related costs:
  - *Loss due to not exporting/transporting semen and horses*: Because of the transport restrictions and export ban there will be no sales for at least 60 days. Within the 20 km zone it is assumed that there will be no sales of horses all year, despite the possibility to transport horses within the zone after 60 days.
  - *No outdoor riding* (riding schools): For the riding schools within the 20 km zone for the first 60 days the losses of no outdoor riding are already calculated as housing related costs. For the riding schools within the 20-150 km zone outdoor ridings is also prohibited for 60 days due to the transport restriction.

Indirect consequential cost: economic impact of export bans

- Due to the export ban there will probably be a price drop in horses and semen. The Netherlands is a net exporting country for horses (Rijksen 2005). Due to the export ban the sales will decrease, therefore there will be more horses present in the Netherlands, decreasing the price of horses. In the free area horses can be exported under special conditions. However, it is assumed that also in the free area no horses are exported, because other countries probably do not want to buy a horse from an infected country. To calculate these losses due to price drop and lower sales a reduction factor is used. The reduction factor is a factor that takes into account the price drop and lower sales due to the introduction of African Horse Sickness. This reduction factor is assumed to be 50%.

3.4 Sensitivity analysis:

A number of sensitivity analyses is performed to show the impact of the assumptions made. Some assumptions were made at horse keeper level, others at general level.

First the sensitivity analyses at horse keeper level are discussed:

- Stallion holder within 20 km zone: Stallion holders within the 20 km zone can not transport semen for at least 60 days. After these 60 days it is assumed that they can transport semen again but that there are 50 euro test costs per service and there is a price drop/lower sales of 50%. It is not known if this transportation is allowed, or whether people want to buy semen from a stallion holder within the 20 km zone. It is calculated what would be the difference in economic impact if the stallion holder does not sell any semen at all for 12 months.

- Training and Sport stable: For the training and sport stable almost no data was available about the own horses of the company. It is unknown how many own horses are sold each year, and for what period they are trained before they are sold. It is now assumed that 3 own trained horses are sold each year and that these horses are prepared in 2 years from untrained/just broken horses to trained horses before they are sold. This number was used because it is assumed that the own horse are used to attract more customers by competing in a relatively high level, but they also do not want to make losses out of them. By selling 3 horses each year there is a good compromise between these both aspects. What are the economic consequences of an introduction of AHS if there are 2 instead of 3 own horses sold each year?

- Hobby horse owner:
  The average number of horses per horse owner is 1.75. Since a horse keeper can not have 1.75 horses the number of horses per horse owner is varied from 1 to 2, also the market value of the horse is varied since this price has a large impact at the total costs and can be very different. The average value of a horse is set at €3,000.-. In case of a Shetland pony this will be more like €100.- and in case of a good sport horse this can even be €20,000.-.

Sensitivity analyses at general level:

- *Mortality* disease:

It is assumed that the mortality of African Horse Sickness is 70% this corresponds to the mortality rate in case of the mixed form. It is also possible that not the mixed form, but the acute or sub-acute form is introduced, this will lead to a mortality rate of respectively 90% and 50%. What will be the difference in economic impact?

- Duration of housing (at least 60 days)

The group of experts recommends housing but they do not mention what will be the duration of this restriction. The duration depends on the severity of the introduction. It is now assumed that the housing restriction will take 60 days. This is assumed because many of the other strict measures also have a duration of at least 60 days. What will be the economic impact of a longer duration of the housing restriction? (120 days or 180 days)

- Reduction factor

For the calculation of the lower sales and price drop due to the introduction of AHS and the measures related to the introduction a reduction factor is used. The reduction factor is now set at 50%. What will be the impact if the reduction factor is not 50% but more like 25% or 75%?

4. Results

For every average horse keeper, as described in section 3.2.1, the economic consequences of an introduction of African Horse Sickness are calculated for the first 12 months. Costs are calculated for an infected horse keeper, a horse keeper within the 20 km zone, a horse keeper within the 20-150 km zone and a horse keeper in the free area. In these different zones there are different measures taken, so the non-infected horse keepers have to deal with different legislation measures.

4.1 Results per average horse keeper

4.1.1. Economic impact and sensitivity analyses at horse keeper level

Stallion holder:
In table 4 the economic impact for an average stallion holder in case of an introduction of AHS is shown. Within the 20 km zone the transport restriction has the highest economic impact, for the stallion holders within the 20-150 km zone and the free area the price drop and lower sales seem to have the highest economic impact.

Table 4: Direct and consequential costs for the stallion holder in the different legislation zones in for the first year of an introduction of African Horse Sickness (€)

	Infected:	20km Zone:	20-150km Zone:	Free area:
Direct costs:				
Mortality	7,234			
Diagnostic	79			
Treatment	40			
Measures against vector	2,922	2,922	2,922	
Euthanasia	70			
Consequential costs:				
Breeding stallion activity:				
Mortality due to vaccin	144	144		
Transport restriction: No export/transport semen	111,664	111,664	25,114	
Export ban: Price drop and lower sales semen			55,107	76,389
Rearing activity:				
Mortality due to vaccin	66	67		
Transport restriction: not selling 3 year olds	11,620	11,822	1,943	
Housing: Extra feed and litter costs	2,178	2,213		
Export ban: Price drop and lower sales 3 year old horses			4,939	5,911
Total	**136,017**	**128,883**	**90,026**	**82,300**

In table 4 it is assumed that the stallion holders within the 20 km zone do not sell any semen during the first 60 days after the introduction of AHS, after these 60 days

semen is sold again but the price and sales have dropped 50% and there are €50,- testcosts per service. Another possibility is that the stallion holders within the 20 km zone do not sell any semen all year, this is the worst case scenario. This will lead to the total costs as shown in table 4a. In this table only the costs that change due to not selling semen are mentioned.

Table 4a: Transport restriction costs and Total costs stallion holder if within the 20 km zone no semen is sold for 12 months (€)

	Infected:	20km Zone:	20-150km Zone:	Free area:
Transport restriction: No export/transport semen	152,778	152,778	32,923	
Total	**177,131**	**169,947**	**90,026**	**82,300**

Mare holder:

The economic consequences for an average mare holder in case of an introduction of AHS are shown in table 5. Again the transport restriction and the price drop and lower sales seem to have the highest economic impact. The most costs/losses are assigned to the rearing activity.

Table 5: Direct and consequential costs for the mare holder in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Mortality	4,011			
Diagnostic	79			
Treatment	40			
Measures against vector	2,352	2,352	2,352	
Euthanasia	70			
Consequential costs:				
Breeding mares activity:				
Mortality due to vaccin	48	49		
Abortion due to vaccin	13	14		
Housing: Extra feed and litter costs	827	827		
Rearing activity:				
Mortality due to vaccin	44	45		
Transport restriction: Not selling 3 year old horses	12,191	12,456	2,047	
Export ban: Price drop and lower sales 3 year old horse			5,204	6,228
Housing: Extra feed and litter costs	1,083	1,106		
Total	**20,759**	**16,849**	**9,603**	**6,228**

Rearing farm:

The economic impact of an introduction of AHS for an average rearing farm is shown in table 6. Within the 20 km zone again the transport restriction seems to have the

highest economic impact. Within the 20-150 km zone the direct costs, due to measures against vector, are higher than the consequential costs.

Table 6: Direct and consequential costs for the rearing farm in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone:	Free area :
Direct costs:				
Mortality	1,879			
Diagnostic	38			
Treatment	19			
Measures against vector	3,135	3,135	3,135	
Euthanasia	33			
Consequential costs:				
Mortality due to vaccin	58	59		
Transport restriction: Not selling 3 year old horses	11,116	11,296	909	
Export ban: Price drop and lower sales 3 year old horses			674	807
Housing: Extra feed and litter	2,522	2,562		
Empty box due to mortality horse	113			
Total	**18,913**	**17,053**	**4,719**	**807**

Training & Sport stable:

The economic consequences for an average training and sport stable in case of an introduction of AHS are shown in table 7. Within the 20 km zone both own horses and horses owned by others lead to costs/losses. Especially the housing and transport restriction have an impact. Within the 20-150 km zone and the free area the price drop and lower sales of the own horses have an economic impact for the average company. During the housing period it is assumed that the horse owners who have their horses in training at the training & sport stable only pay the boarding fee and not the additional training fee. If there is no housing period (anymore) it is assumed that the horses of others stay at the training and sport stable, the company size stays unchanged.

Table 7: Direct and consequential costs for the training and sport stable in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone:	Free area
Direct costs:				
Mortality	1,482			
Diagnostic	79			
Treatment	40			
Measures against vector	2,138	2,138	2,138	
Euthanasia	70			
Consequential costs:				
Own horses:				

Mortality due to vaccin	27			
Housing: Cost due to no training	2,015	2,015		
Transport restriction: Not selling horses	5,470	5,601		
Export ban: Price drop and lower sales			2,801	2,801
Horses of others:				
Empty box due to mortality horse	2,689			
Housing: Lower monthly payment because training not possible	6,014	6,014		
Total	**20,024**	**15,768**	**4,938**	**2,801**

In table 7 the average sport and training stable sell each year 3 own horses, these horses are present at the company for 2 years. In table 4a the economic impact is shown if they sell 2 instead of 3 horses each year.

Table 7a: Total costs for the training and sport stable in case of an introduction of AHS if there are 2 own horses sold each year in stead of 3 own horses (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Transport restriction: not selling horses	3,603	3,734		
Transport restriction: Price drop horses			1,867	1,867
Total	**18,157**	**13,901**	**4,005**	**1,867**

Riding school:

The introduction of AHS has an economic impact at the average riding school, these figures are shown in table 8. Especially within the 20 km zone the economic impact is large, the main losses are due to housing regulation. Within the 20-150 km zone the transport restriction has the highest economic impact.

Table 8: Direct and consequential costs for the riding school in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Mortality	532			
Diagnostic	36			
Treatment	18			
Measures against vector	3,777	3,777	3,777	
Euthanasia	32			
Consequential costs:				
Riding school activity:				
Mortality due to vaccin	20	20		
Housing: No lessons	34,619	35,083		
Housing: Extra feed and litter	1,264	1,281		
Transport restriction: no outdoor ridings			5,661	
Boarding activity:				
Housing: Extra feed and litter	1,347	1,347		

Empty box due to mortality horse	782			
Total	**42,426**	**41,508**	**9,438**	**0**

Hobby horse owner:

For the average horse owner the economic impact of an introduction of AHS are mentioned in table 9. In table 9.1a, 9.1b and 9.2 the market value of the horse and the number of horses is varied. For the average hobby horse owner the direct costs have the highest impact.

Table 9: Direct and consequential costs for the hobby horse owner in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone:	Free area:
Direct costs:				
Mortality	2100			
Diagnostic	79			
Treatment	40			
Measures against vector	103	103	75	
Euthanasia	70			
Consequential costs:				
Mortality due to vaccin	1	3		
Housing: extra feed and litter	30	50		
Total	2422	155	75	0

Table 9.1a: Total costs hobby horse owner in the 20 km zone in case of an introduction of AHS if the market value of the horse is €100,- (€)

	Infected:	20 km zone:
Direct costs:		
Mortality	70	
Consequential costs:		
Mortality due to vaccin	0	0
Total	**391**	**152**

Table 9.1b: Total costs hobby horse owner in the 20 km zone in case of an introduction of AHS if the market value of the horse is €20,000,- (€)

	Infected:	20 km zone:
Direct costs:		
Mortality	14,000	
Consequential costs:		
Mortality due to vaccin	8	18
Total	**14,329**	**170**

Tabel 9.2a: Total costs hobby horse owner in case of an introduction of AHS if 1 horse is present instead of 1.75 (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Measures against vector	59	59	43	

Consequential costs:				
Mortality due to vaccin	0	2		
Housing: extra feed and litter	9	28		
Total	**2356**	**89**	**43**	**0**

Tabel 9.2b: Total costs hobby horse owner in case of an introduction of AHS if 2 horses are present instead of 1.75 (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Measures against vector	117	117	86	
Consequential costs:				
Mortality due to vaccin	2	3		
Housing: extra feed and litter	37	57		
Total	**2,445**	**177**	**86**	**0**

Boarding stable:

The economic impact of an introduction of AHS for an average boarding stable are mentioned in table 10. The economic impact is relatively low, the only costs are the measures against the vector, the costs due to housing and if a horse dies due to the disease this box cannot be filled again within the 20 km zone.

Table 10: Direct and consequential costs for the boarding stable in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Measures against vector	1,140	1,140	1,140	
Consequential costs:				
Housing: extra feed and litter	937	980		
Empty box due to mortality horse	1,135			
Total	**4,347**	**2,120**	**1,140**	**0**

Sport horse trading:

In table 11 the economic consequences of an introduction of AHS for an average sport horse trader are mentioned. For the sport horses traders within the 20 km zone the transport restriction has the highest impact. For the sport horse traders within the 20-150 km zone and in the free area the price drop and lower sales have the highest economic impact. For the sport horse traders also the housing measure has a relatively large impact.

Table 11: Direct and consequential costs for the Sport horse trading stable in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Mortality	3,554			
Diagnostic	79			

Treatment	40			
Measures against vector	4,846	4,846	4,846	
Euthanasia	70			
Consequential costs:				
Mortality due to vaccin	165	167		
Housing: Cost due to no training	14,242	14,242		
Transport restriction: No sales	186,856	188,800	31,036	
Export ban: Price drop and lower sales			94,301	94,400
Total	**209,858**	**208,060**	**130,183**	**94,400**

Quick trading:

The economic impact of an introduction of AHS for an average quick horse trader is shown in table 12. For this group of horse keepers again the transport restriction has the highest impact within the 20 km zone, outside this zone the price drop and lower sales is the main cost increaser.

Table 12: Direct and consequential costs for the Quick trading stable in the different legislation zones for the first year of an introduction of African Horse Sickness (€)

	Infected:	20 km zone:	20-150 km zone :	Free area :
Direct costs:				
Mortality	885			
Diagnostic	79			
Treatment	40			
Measures against vector	4,276	4,276	4,276	
Euthanasia	70			
Consequential costs:				
Mortality due to vaccin	37	38		
Transport restriction: No sales	32,827	33,024	5,429	
Export ban: Price drop and lower sales			13,798	16,512
Total	**38,215**	**37,338**	**23,502**	**16,512**

4.1.2 General Sensitivity analyses:

The total economic impact for the different average horse keepers if AHS is introduced in the Netherlands are summarized in table 13. The economic consequences seem to be highest for the sport horse traders and stallion holders.

Table 13: Total economic consequences of an introduction of African Horse Sickness per average horse keeper in the different legislation zones (€) (use given assumptions)

	infected	20km zone	20-150 km zone	Free area :
Hobby horse owner:	2,422	155	75	0
Boarding stable:	4,347	2,120	1,140	0
Rearing stable:	18,913	17,053	4,719	807
Training & Sport stable:	20,024	13,901	4,005	1,867
Mare holder:	20,759	16,849	9,603	6,228
Quick trading:	38,215	37,338	23,502	16,512
Riding School:	42,426	41,508	9,438	0
Stallion holder:	136,017	128,883	90,026	82,300
Sport horse trading:	209,858	208,060	130,183	94,400

Mortality rate:

The mortality of the form of AHS that is introduced is not exactly known since it is a fictitious introduction. The mortality was assumed to be 70%. In table 13.1 the economic impact if the mortality rates are varied is shown. Change of the mortality rate does not have a large economic impact, the impact is highest for the stallion holders.

Tables 13.1: Total economic impact for the first 12 months of an introduction of AHS for the infected average horse keepers if the mortality is 50%, 70% (Base) or 90% (in €)

	50% Mortality	70% Mortality	90% Mortality
Hobby horse owner:	1,808	2,422	3,037
Boarding stable:	3,711	4,347	4,984
Rearing stable:	18,398	18,913	19,429
Training & Sport stable:	18,850	20,024	21,199
Mare holder:	19,676	20,759	21,842
Quick trading:	37,998	38,215	38,431
Riding School:	42,179	42,426	42,674
Stallion holder:	133,998	136,017	138,036
Sport horse trading:	209,378	209,858	210,338

Duration housing regulation:

As mentioned in the Material & Method the duration of the housing measure was set at 60 days. In table 13.2 the economic impact is shown if the duration is not 60 days, but 120 or 180 days. Change in the duration of housing has the highest economic impact for the riding schools.

Tables 13.2

Total economic impact for the first 12 months of an introduction of AHS for the horse keepers within the 20 km zone if the duration of the housing measure is 60 days (base), 120 days or 180 days (€)

	Duration housing meausure 60 days		*Duration housing measure 120 days*		*Duration housing measure 180 days*	
	infected	20km zone	Infected:	20 km zone:	Infected:	20 km zone:
Hobby horse owner	2,422	155	2,452	205	2,482	254
Boarding stable	4,347	2,120	5,285	3,101	6,222	4,081
Rearing stable	18,913	17,053	21,435	19,615	23,956	22,177
Training & Sport stable	20,024	13,901	22,039	17,782	24,054	19,797
Mare holder	20,759	16,849	22,669	18,783	24,580	20,717
Quick trading	38,215	37,338	38,215	37,338	38,215	37,338
Riding School	42,426	41,508	79,657	79,218	116,887	116,929
Stallion holder	136,017	128,833	138,194	131,046	140,372	133,259
Sport horse trading	209,858	208,060	224,100	222,303	238,342	236,545

Reduction factor:

To calculate the impact of the introduction of AHS on the sales and the price of horses and semen a reduction factor was used. This reduction factor was set at 50%. In table 13.3 the economic consequences are shown if this reduction factor is not 50% but 25% or 75%. Change in the reduction factor has the highest impact for the sport horse traders and stallion holders.

Tables 13.3:

a. Total economic impact for the average horse keepers in the different legislation zones for the first year of an introduction of AHS if the reduction factor is 25% (€)
b. Total economic impact for the average horse keepers in the different legislation zones for the first year of an introduction of AHS if the reduction factor is 75% (€)

	Infected:	20 km zone:	20-150 km zone:	Free area:
Hobby horse owner	2,422	155	75	0
Boarding stable	4,347	2,120	1,140	0
Rearing stable	18,913	17,053	4,382	403
Training & Sport stable	20,024	15,768	3,538	1,400
Mare holder	20,759	16,849	7,001	3,114
Quick trading	38,215	37,338	16,603	8,256
Riding School	42,426	41,508	9,438	0
Stallion holder	97,903	90,719	60,579	41,150
Sport horse trading	209,858	208,060	83,032	47,200

a.

	Infected:	20 km zone:	20-150 km zone:	Free area:
Hobby horse owner	2,422	155	75	0
Boarding stable	4,347	2,120	1,140	0
Rearing stable	18,913	17,053	5,056	1,210
Training & Sport stable	20,024	15,768	6,339	4,201
Mare holder	20,759	16,849	12,205	9,342
Quick trading	38,215	37,338	30,401	24,768
Riding School	42,426	41,508	9,438	0
Stallion holder	174,130	166,946	119,472	123,451
Sport horse trading	209,858	208,060	177,333	141,600

b.

Table 13.4: Difference in total impact for the average horse keepers in the different legislation zones for the first year of an introduction of AHS if the reduction factor is changed by 25% (€)

	Infected:	20 km zone:	20-150 km zone:	Free area:
Riding School	0	0	0	0
Hobby horse owner	0	0	0	0
Boarding stable	0	0	0	0
Rearing stable	0	0	337	403
Training & Sport stable	0	0	1,400	1,400
Mare holder	0	0	2,602	3,114
Quick trading	0	0	6,899	8,256
Stallion holder	38,114	38,114	29,447	44,150
Sport horse trading	0	0	47,151	47,200

4.2 Results at National level

- Total costs primary sector

The 20 km zone has a surface of 1,257 km^2, this is 3% of the total surface of the Netherlands. This means that if AHS is introduced at the centre of the Netherlands 3% of all horse keeper are located within the 20 km zone. The remaining 97% of the horse keepers are located within the 20-150 km zone. This leads to the following costs.

Table 14: Total economic consequences at national level for the first year in case of an introduction of AHS within the Netherlands (€)

	20 km zone:	20-150 km zone:
Stallion holder	2,706,543	61,127,654
Mare holder	16,849	4,657,505
Rearing stable	255,789	2,288,562
Training & Sport stable	47,303	479,015
Riding School	1,245,228	9,155,005
Hobby horse owner	845,769	13,232,186
Boarding stable	357,816	6,220,998
Sport horse trading	312,091	6,313,859
Quick trading	280,032	5,699,211
Total consequence per zone:	6,067,420	109,173,995
Total economic consequence primary sector:		**115,241,415**

- Vaccination costs

In case of an introduction of AHS all horses in the 20 km zone around the infected horse keeper should be vaccinated. The costs of this emergency vaccination are paid for by the ministry of LNV.

The costs will include the visiting fee of the veterinarian, hourly wage, vaccine, registration and material costs. The visiting fee is €20.85 should be multiplied by the number of horse keepers within the 20 km zone. This number is equal to 5,076 horse keepers. (taken into account that a part of the hobby horses is stabled at a boarding stable, training & sport stable etc.) *(€105,544.-)*

The costs of the vaccine application are €29.51, which should be multiplied by the 13,476 horses present within the 20 km zone. (This includes hobby horse, no horses are counted double) *(€397,677.-)*

Aggregation of both cost elements leads to total vaccination costs of €503,221.-.

5. Discussion

5.1 General discussion about AHS legislation:

At this moment it is not exactly known how many equines are present in the Netherlands, and also the location of the equines is unknown. In the legislation there are some measures like vaccination within the 20 km zone and serological testing of donkeys and mules for which it is necessary to locate all equines. The development of a good I&R system is necessary to follow up the measures described in the legislation.

The different zones mentioned in the legislation are 20 km, 20-150 km, during the first 60 days horses within these zones should stay at the same farm. And during at least 12 months the horses should stay in the same zone, also horses from the free area may not be transported into the zones. This means that for at least 12 months the borders between these large zones should be guarded. At this moment there are no concrete approach plans present. This can be a difficulty in case of controlling an introduction of African Horse Sickness.

5.2 Discussion about research assumptions:

In this evaluation it is assumed that there is only one horse infected per infected horse keeper. It is not taken into account that the chance for horses at the same company to get infected is higher than for horses that are not near the infected horse. The assumption of only one horse infected per infected horse keeper leads to the minimal economic impact in case of an AHS introduction. In table 10.1 can be seen that the mortality rate of the disease does not have a large influence at the economic consequences for the horse keeper.

The assumption that the company size stays unchanged also leads to the minimal economic impact. For example the mortality with another cause of dead than AHS is not taken into account. If horses die during the first 12 months of an outbreak of AHS empty boxes can occur. These empty boxes will also have economic consequences, which are at this moment not taken into account.
It is now assumed that the horses owned by others at boarding, training and sport and rearing stables stay present at the farm all year, there are no empty boxes due to the introduction of the disease. During the outbreak period it can not be predicted how people react, do they still stable there horse at a training and sport stable?

For the average horse keepers there are also some assumptions made that are discussable. For the mare holder it is assumed that all breeding mares are already inseminated again at the point of introduction of AHS. Since it is assumed that the company size stays unaffected, the next breeding season it is assumed that all breeding mares, including mares within the 20 km zone, are inseminated again. It is not known if the mare holder will inseminate his/her horse again if there is an introduction of a dangerous disease, and if semen of the stallions they want to use is still available.

For the training and sport stable there were no numbers known about sales of own horses. This number was estimated by calculating the profit they make with these

horses. It is assumed that the company has own horses to create a good reputation, but they also don't want to make losses due to these horses. The sensitivity analysis was used to show the impact of this assumption.
The consequences for own horses during the housing period are taken into account by calculating 60 days of the total costs per horse per year. It is assumed that horses are kept 60 days longer because it takes 60 days longer to reach the same training level. If the horses that are housed are horses that are trained intensively these economic consequences are probably an underestimation. It will take a few days before the horse is back at the same training level as before the housing period. Due to the box rest the reduction in muscle mass has started and the stamina of the horse is lower, this is why the horse can not be trained intensively right away after these 60 days. These extra costs are not calculated.

In this essay it is assumed that the boarding stables do not pay diagnostic and treatment costs, but they do pay the costs for extra feed and litter during the housing period, and the costs of measures against the vector. It is not sure that this will be the case in the real situation. This division of costs depend on the agreements between the boarding stable and the horse owner.

The distribution of the horse keepers over the country is not known. Expected is that there are more horses in the east and south of the Netherlands.

5.3 Discussion about results

In table 13 the total economic consequences for the first 12 months after an introduction of AHS for the average horse keepers are shown in an overview. If a horse keeper has an infected horse than this has the highest economic impact for the sport horse trader (€209,858) followed by the stallion holder (€173,006), the riding school (€42,426) and the quick trader (€38,215). In the 20-150 km zone and the free area the economic consequences are higher for the quick traders than for the riding schools. This has to do with price drop and lower sales due to the transport and export ban, the riding schools are not depended on the sale of horses. In the free area the economic impact is highest for the stallion holder (€100,140) and followed by the sport horse trader (€97,400). In the free area only hobby horse owner, boarding stables and riding schools have no losses.

The economic impact for the sport horse trader and stallion holder are very high, this could be expected since the trader and stallion holder are depended on the market value of horses/semen and the ability to sell horses/semen. The transport and export restriction influence both these aspects. Horse traders sell less horses and for a lower price. Stallion holders sell less semen, for a lower price and also have to pay testing costs per service.

Also for the mare holder the highest economic impact is due to the transport restriction. Striking is that the highest economic impact is not in their main activity, the breeding mares, but on their rearing activity. This is because it is assumed that the foals of the mares go to their own rearing farm, the transport restriction has no influence on this internal movement of foals. For the rearing farm is the measure with the largest economic impact also the transport restriction.

For almost all horse keepers the consequential costs are the highest, but this is not the case for the hobby horse owners. Here the direct costs are higher than the consequential costs. This could be expected since the hobby horse owners do not generate income through their horse. The direct costs are highly depended on the value of the horse that is owned. The costs per hobby horse owner are relatively low in comparison with other horse keepers, on the contrary the costs per horse are relatively high. At national level there are many horse keepers present and is the economic impact much larger.
Also for the boarding stable the economic impact of the introduction of African Horse Sickness is relatively low. This is because most of the disease related costs are assigned to the horse owner, and since it is assumed that the company size stays unchanged the boarding stable will be more or less unaffected.

The impact of the housing period is highest for the riding schools. During the housing period there can be no horseback riding lessons. The impact of the housing period is also high for horse keepers that have horses that are trained intensively, like sport horses, or horses that are usually outside for a large part of the year, like rearing horses.
For the training and sport stables within the 20 km zone the housing measure is the restriction that leads to the highest costs. Around €2000,- for the own horses and around €6000,- for the horses owned by others. During the housing period the horses can not be trained, this training is the activity that generates the highest revenue for the training and sport stables.

At national level the impact is very large. The highest economic impact is experienced by the stallion holders, riding schools and hobby horse owners.

In this report a minor outbreak is assumed. There is only one 20 km zone, and the virus stays within this zone. The vaccination area - 20 km zone - does not have to be enlarged. If the outbreak would be more severe this would mean that more horse keepers have to deal with the strict regulation of the 20 km zone, and more horses should be vaccinated. Another consequence of an enlarged 20 km zone is that, after 60 days, there are more possibilities of trading horses, since there are more horse keepers in the same zone. If AHS is present in a large part or in whole Europe there is a possibility that the legislation will be less strict. An example is that trading might be possible, because of that the consequential costs would go down.

This analysis is only for the first 12 months after the introduction of AHS. What can be predicted about the consequences for the other years? A country is declared free of AHS if there has not been a case of AHS within 2 years. This means that there is an export ban for at least 2 years. So the lower sales and price drop will be present for at least another year. The current legislation with a minimal duration of 12 months is based on the vaccine that is present in Africa at this moment. If a marker (DIVA) vaccine is developed this duration can probably be shortened. With a marker vaccine infected horses can be differentiated from vaccinated horse. At this moment the consequential costs account for roughly 75% of the total costs at national level. Most of these costs are due to the lower sales and the not exporting of horses, if a

DIVA vaccine is developed these costs could be reduced if the duration of restrictions will be shortened.

Since all horse keepers have to deal with the consequences if AHS is introduced within the Netherlands an insurance against AHS at national level is not possible.

Many professional horse keepers have side activities, this can influence the risk for the horse keepers. For instance a large part of the riding schools also have a canteen, if there are no riding lessons there will also be lower or no income from this canteen. Another example is if a horse keeper has next to his horse keeping also an activity that is not related to horses, for instance agriculture, than this gives some kind of a buffer to the horse keeper.

5.4 Discussion about sensitivity analyses:

In the sensitivity analysis also the duration of the housing measure is evaluated. The extra costs of 60 days longer housing are calculated. Since there is no information available about the effect of the housing measure at the spread of the disease we can not point out the effectiveness of the 60 days longer housing. This means that only the losses and not the benefits are calculated. The impact of a longer duration of the housing measures only seems to have large influence for the riding schools and sport horse traders. More research is needed to calculate the benefits of a longer housing period. Whether a housing period of 60 days or even longer is an option from the animal welfare point of view is another discussion point.

The sensitivity analysis for the mortality rate and the reduction factor show that these number have relatively little influence. Only for the stallion holder and sport horse trader the change of the reduction factor has a higher impact.

6. Conclusion

In short it can be concluded that the impact of an introduction of AHS for the primary part of the horse sector is very large. Almost all companies in all different zones, including the free area, have losses due to the introduction. In this evaluation only a minor outbreak – with no further spread - was evaluated, but still the costs are really high. The economic consequences are not homogenous distributed over the various types of horse keepers.

Experts expect that if AHS is introduced it can develop to be endemic, just like Blue Tongue. Considering this and the high expected economic impact of an introduction it can be concluded that the investment in preventive measures is very important. A good investment would be the development of a marker/ DIVA vaccine. Due to this vaccine the consequential costs, which now account for 75% of the total costs, would be decreased.

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8. Appendices

Appendix 1: Qualitative comparison of the economic consequences of an introduction of AHS with an introduction of WNF:

In this chapter the economic consequences of an introduction of African Horse Sickness are qualitatively compared to the impact of an introduction of West Nile Fever, another vector-borne disease. The points at which the economic impact for WNF could differ are mentioned and explained. The reason for a comparison between these two diseases is that the diseases differ in some important characteristics. These characteristics could lead to large differences in economic impact. A quantitative comparison is not possible since precise immunological data is lacking and the reactions of people in case of an introduction are unpredictable.

1.1 West Nile Fever facts

West Nile Fever is a disease caused by the West Nile Virus, belonging to the Flavivirus Flaviviridae (CVI 2008: website - West Nile Virus). This virus can cause disease in birds and vertebrates, mainly horses and humans. West Nile Fever is a zoönotic disease that can cause encephalitis and meningitis, which can be fatal. Infection in horses usually does not show any clinical illness. During the last outbreak in Portugal approximately 10% of the infected horses showed neurological disorders (Castillo-Olivares et al. 2004). The most common symptoms are ataxia and paralysis of the limbs. The mortality rates among clinically affected horses are estimated to be around 38% (USA in 2000), 57% (France in 2000) and 42% (Italy in 1998) (Castillo-Olivares et al. 2004).

1.1.1 Transmission

West Nile Virus is just like African Horse Sickness a vector-borne disease. Mainly mosquitoes are the vectors for this disease. Birds are the reservoir host of the virus, but they usually stay unaffected. There are exceptions, especially corvids (crow family) can be infected. Mass die of these birds can be an indication of the presence of West Nile Fever. Horses seem to be more susceptible for the virus than other animals (Defra 2008: website – West Nile Virus).

The virus can be transmitted by a mosquito which bites an infected bird and after that bites an animal or human, and thereby transmits the virus (figure 3). The main vector are *Culex* species. Animals and humans are in the case of West Nile Fever referred to as incidental hosts or 'dead-end' hosts (Castillo-Olivares et al. 2004). This is because they rarely develop enough titres to infect mosquitoes. Mosquitoes feeding on infected horses are therefore unlikely to ingest enough of the virus to transmit the virus to another animal. It is estimated that the incubation period in equines is 3 – 15 days (OIE 2008: website – Terrestrial Manual 2008).

The temperature dependence of virus replication in vectors and mosquito reproduction causes large variation per season. Most cases of encephalitis are seen in the late summer and autumn because during this period the number of insects is highest (Castillo-Olivares et al. 2004).

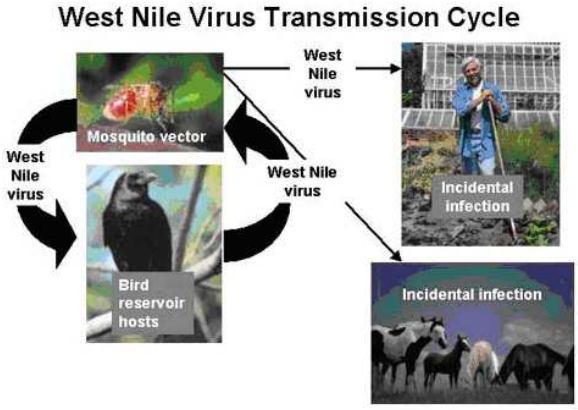

Figure 3: West Nile Virus Transmission Cycle (CDC 2008: website – west nile cycle)

1.1.2 Previous outbreaks

West Nile Virus originally only occurred in Africa. The virus was isolated first in Uganda in 1937 from the blood of a sick woman. Nowadays the virus also occurs more northward. The virus is endemic around the Mediterranean Sea, in India and in Central- and South Africa (CVI 2008: website – West Nile Virus). In August 1999 the virus was introduced in the area around New York city. Although the cold winter in New York the virus did not disappear. After this first introduction the disease did spread in only 10 years in whole North America, including Mexico and Canada (OIE 2008: website – West Nile Fever). The last years there have also been outbreaks reported from Romania and Morocco in 1996, Tunisia in 1997, Italy in 1998, Russia and Israel in 1999 and France in 2000. These outbreaks seem to be more severe than previous outbreaks. The outbreak in Morocco in 1996 did lead to 42 dead horses. In Israel 33 people and 15 horses died (Castillo-Olivares et al., 2004).

1.1.3 Legislation

The CVI serologically screens horses for export. West Nile Fever is a notifiable disease, because the disease is a danger for public health. The ministry of agriculture, nature and food quality does not regulate the control when WNF is introduced because in this case the horse is only an end host, and there is a good vaccine available for horses.
Strategies of prevention against WNF are vaccination and protection against the vector. If this disease is introduced in the Netherlands all horse owners can voluntarily vaccinate their horses against the disease.

1.1.4 Vaccine

There is a good working vaccine available to prevent West Nile disease in horses. Because of the introduction in 1999 of WNF in North America the pressure was high to develop a good vaccine against this disease (Mac Lachlan et al. 2007).

1.2 Differences with African Horse Sickness:

Although African Horse Sickness and West Nile Fever are both vector borne diseases they differ at three important points which can cause big differences in the economic impact the diseases have.

1. In case of WNF horses are 'dead-end' hosts. This means that mosquitoes feeding on infected horses are unlikely to ingest enough virus to transmit the virus to another animal. While in case of AHS insects feeding on infected horses can ingest enough virus to infect another horse.
2. For African Horse Sickness there is not yet a good and safe vaccine available, while there is such a vaccine for WNF. All horse keepers are free to vaccinate their horses if WNF is introduced within the Netherlands.
3. West Nile Fever is seen as a human health issue, this is why the Ministry of Agriculture, Nature Management and Fisheries has no legislation available for the horse sector if WNF is introduced. There will be no export ban. As could be read before in case of AHS there is a script available. The case that West Nile Fever is a zoonotic disease makes the situation more complex.

1.2.1 Costs:

Since there is no legislation in case of WNF all the costs are assigned to the horse keepers. The economic consequences are:

Direct costs

Mortality costs

The mortality rate of clinically affected horses is around 30% (Castillo-Olivares et al. 2004). This is much lower than the mortality rate for AHS. This means that the mortality costs will be lower.

Treatment costs

There has been an economic evaluation for West Nile Virus for the equine industry in Colorado and Nebraska (USDA 2009: website – economic evaluation WNV). The numbers used in that evaluation are based on the introduction of West Nile virus in 2002. The treatment costs were estimated at 200 dollar for mild cases, 400 dollar for moderate cases and 250 dollar for severe cases. The treatment cost for severe cases is lower because many equines with a severe case of WNV were euthanized before high treatment costs were made. At the end of 2002 one US dollar was almost equal to one euro (DNB 2009: website - wisselkoersen).

Measures against vector

Different than for AHS measures against the vector are not obliged to be taken in case of WNV. Although it is assumed that horse owners will try to protect their horses. A good way to protect a horse is to take measures against the vector, like insecticides.

Cost of vaccinating

Because the horse owners are free to vaccinate the costs made are costs for the horse owner self. The costs of this vaccination is assumed to be the same as for African horse sickness. These costs are based on the costs for vaccination in case of Blue Tongue in cattle (Velthuis et al. 2008). For the economic evaluation of an

introduction of West Nile Fever in Colorado and Nebraska also vaccination costs were calculated. Horses are vaccinated 2 times, the costs per dose are 25 dollar. So the vaccination costs per horse are around 50 dollar (USDA 2009: website – economic evaluation WNV). Since 1 US dollar was worth almost the same as 1 euro in 2002 the costs calculated based on Blue Tongue are in agreement with the costs made in Colorado and Nebraska.
In Table 11 the vaccination costs per average horse keeper are mentioned if all horses are vaccinated. The costs for infected horse keepers are a bit lower since it is assumed that an infected horse will not be vaccinated. Since the horse keepers are free to decide whether or not to vaccinate his/her horse these costs can be an overestimation.

Table 15: Vaccination costs per average horse keeper

	Infected	non-infected
Hobby horse owner	0	50
Boarding stable	464	493
Training & Sport stable	877	906
Mare holder	965	995
Stallion holder	1290	1319
Rearing stable	1290	1319
Riding School	1556	1585
Quick trading	1762	1792
Sport horse trading	1998	2028

Euthanasia costs

Cost for euthanasia of horses. This includes the call fee and hourly wage of the veterinarian. Horses with a severe case of WNF can be euthanized if they are in to much pain. Probably less horses will be euthanized than for AHS since the chance of survival is much higher for West Nile Fever.

Consequential costs

Lower sales and price drop of horses and/or semen due to the introduction of WNF

Since equines are dead-end hosts in case of WNF it is not assumed that the impact at the export market will be large. Also in the USA no export drop is known due to the introduction of WNF (USDA 2009: website - United States Animal Health Report chapter 7). In the economic evaluation of WNF on the equine industry of Colorado and Nebraska (USDA 2009: website – economic evaluation WNF) and in the article that calculated the economic impact of WNF on the equine industry in North Dakota (Ndiva Mongoh et al. 2007) no lower sales and price drops were found.

1.3 Discussion and Conclusion

A problem with WNF is that not all horses show clinical symptoms, therefore it can take a while until the introduction of the disease is discovered. If the infected animal is imported and no infected vectors are present in the Netherlands than this can cause no harm. But if infected vectors are present it is important to discover the disease as fast as possible, to decrease the chance of further spread.

It can be that because WNF is a human health issue people will react in a different way than in case of AHS. It can be that people do not want to be in the contact with horses anymore, this could cause more costs to riding schools. But in fact it can cause no harm being around horses since horses are dead-end hosts, only there are usually more insects in the neighbourhood of horses.

Main losses in case of an introduction of West Nile Fever are expected to be the direct costs; losses due to death or euthanasia of equines, treatment costs and vaccination costs. For AHS the consequential costs, as a consequence of the control measures are expected to be the main losses.

Since in the US there did not seem to be any consequences for the horse export it is assumed that AHS will have a higher economic impact. The Netherlands is of course a much smaller country than the US, therefore it can be that an introduction in the Netherlands can have an impact for horse export.

A second point is that this economic evaluation does not say anything about the severity of the spread of the disease. Only the first 12 months of the introduction are compared, it can be that one of the diseases gets endemic and the other is under control very fast. This will largely influence the economic impact. But the legislation in case of AHS will at least take 12 months.