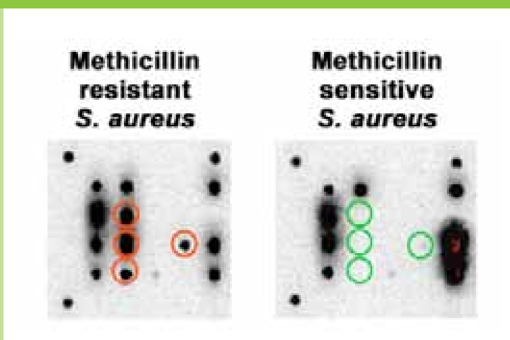
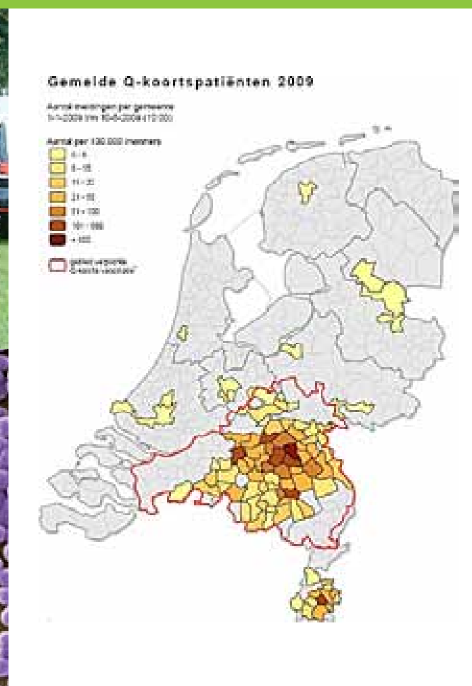
Agriculture-related infectious diseases

Practical risks and policy gaps

Platform Agriculture, Innovation & Society





Platform
Agriculture, Innovation & Society

Agriculture-related infectious diseases

Practical risks and policy gaps

Policy Advisory

Platform Agriculture, Innovation & Society

March 2014

Credits

This policy advisory is based on the following report (in Dutch):

Rougoor, Carin, Geart Benedictus, Jan Cees Vogelaar, Anne Loeber & Wouter van der Weijden (2014) *Landbouw-gerelateerde infectieziekten. Verkenning van risico's in praktijk en lacunes in beleid. Deel B: Analyse.*
http://www.platformlis.nl/rapporten/Landbouwgerelateerde_infectieziekten-Advies-Analyse-web.pdf

For references and appendix mentioned within this policy advisory see the report above.

Translation: Charles Frink

Cover photos (from top left clockwise):

- MRSA and MSSA (resistant and non-resistant *Staphylococcus aureus*)
- Transport of horses
- Distribution of reported patients with Q fever in 2009 (source: RIVM)
- Culling of goats on a farm with Q fever
- Use of anthelmintics in sheep
- Warning sign to denote the area with a transport ban
- Photo in the middle: MRSA bacteria

Policy Advisory: agriculture-related infectious diseases

Problem definition

The Netherlands is densely populated with both people and livestock. With some regularity, we are startled by a serious outbreak of an infectious animal disease. Since the swine fever outbreak in 1997, this has frequently been accompanied with severe damage to the sectors concerned, animal suffering, commotion and high costs for society. The damage to animals and the economy is especially severe because the Dutch livestock sector focuses primarily on export. During an outbreak, importing countries quickly close their borders. As a result, many animals must be culled. Moreover, some of these outbreaks involved zoonoses: diseases that can be transmitted from animals to people, such as BSE and Q fever.

In response to these outbreaks, the government and business community have substantially improved many aspects of their prevention, monitoring and control policies. Furthermore, these initiatives are increasingly based on the One Health concept, which is being embraced world-wide. In that concept, human health is linked with the health of domestic livestock and wild fauna. The complexity of the problem surrounding agriculture-related infectious diseases, and developments such as climate change and globalization, require constant alertness to new outbreaks and weak aspects of policy.

Based on these considerations, the Platform decided to prepare an advisory memorandum on this theme. To this end, the following research questions were formulated:

- What risks can be distinguished with respect to agriculture-related infectious diseases?
- After the recent improvements, are there still significant gaps or shortcomings in the policy (in the broad field of prevention, monitoring and control), with which the Netherlands can improve its protection against
  - known diseases that Dutch agriculture may or may not have experienced previously?
  - unknown, entirely new diseases or risks (the unknown unknowns)?

Delineation

In this memorandum, the Platform has focused on three categories of infectious diseases:

- human diseases that are related to agriculture (livestock, crops), the sector on which the Platform LIS focuses;
- diseases of livestock and crops that entail major societal risks;
- diseases of horses that entail such risks.

We included horses because this concerns a large sector and because an outbreak can cause more commotion than in sectors such as poultry.

Method

To answer these questions, the Platform undertook the following activities:

- Eleven experts and stakeholders were interviewed and asked about problems or concerns as seen from their perspective (see Appendix 1).
- Relevant points that emerged from these interviews were specified in greater detail based on studies conducted on the internet and in the relevant literature.
- The current governance structure of the national government with respect to agriculture-related infectious diseases was mapped.
- Two experts were asked to critically assess two contingency plans.

This advisory memorandum first addresses the theory of risk, identifies the risks of infectious diseases in practice and then provides recommendations on how these risks can be reduced. Finally, the memorandum focuses on the current governance structure and possibilities for making improvements within this structure.

Theory of risk, risk management, risk control and risk policy

The thinking about risk policy has developed rapidly in recent years. Traditionally, ‘risk’ is described as the probability that an event will happen, multiplied by the expected effect of the event: risk = probability x effect. This definition has become obsolete. For example, in 2011 the Scientific Council for Government Policy (WRR) stated:

> A quantitative assessment framework in which all policies for physical security can be modelled and tested is an obsolete illusion.

One problem with the application of classical risk theory in practice is that the probability of a disease outbreak is often unknown. This is especially the case when new methods are new technologies are introduced, or existing methods are modified. Frequently, the effects are often difficult or impossible to quantify, also because they can interact. And the question of how the various effects (for example on human health, animal welfare and economic results) must be weighed in relation to each other is often subjective and politically controversial. Moreover, disease outbreaks can cause ethical dilemmas and/or societal unrest. The perception of risks is at least as important as the scientific assessment of these risks.

Other approaches to risk offer a broader base for policy, such as the theory of Stirling & Scoones (2009), where it is precisely the uncertainties about probability and effect that establish the basis for the choice of methodology. The Scientific Council for Government Policy (2011) and the Health Council of the Netherlands (2008) have also described the practical application of this theory. Figure S1 schematically indicates how various situations can be placed in the various quadrants as defined by Stirling & Scoones. Each quadrant requires a different methodological approach. For example, on the upper left quadrant, classical risk theory can be applied (probability and effect are sufficiently known), while in the lower right quadrant methods such as early warning can be used to detect unknown unknowns.

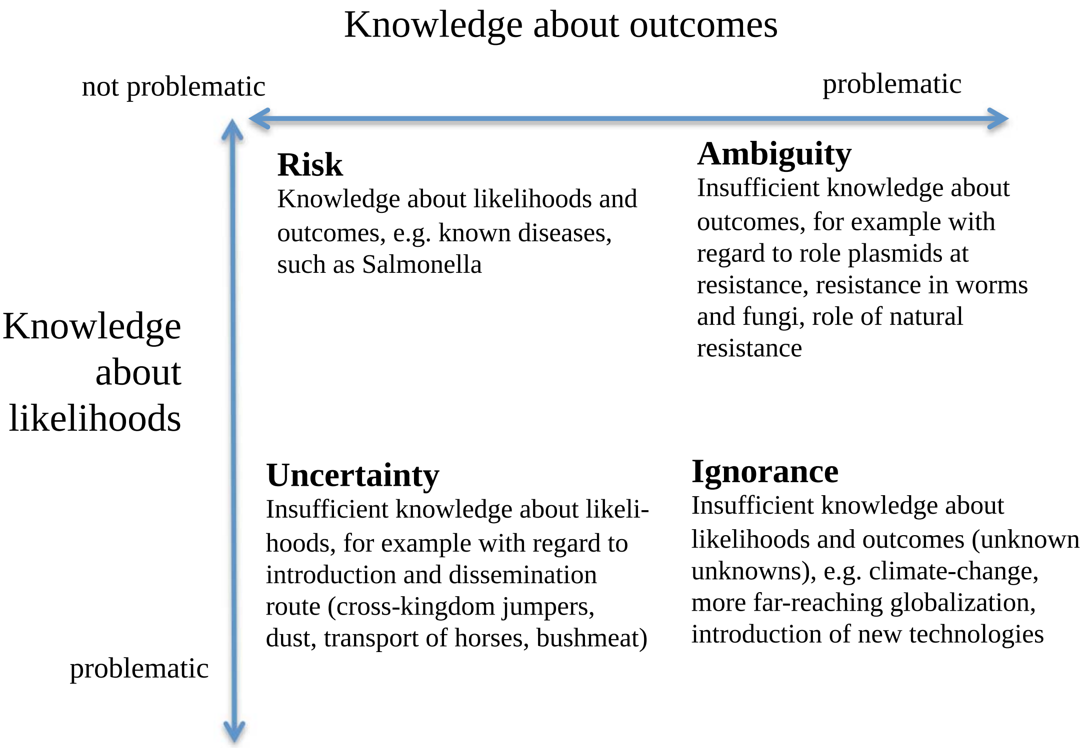


Figure S1 Example of placing situations in the quadrants of Stirling & Scoones (2009).

To acquire a picture of possible unknown unknowns, it is crucial to monitor new developments systematically. This includes new technologies, changes in consumption patterns, climate change and ongoing globalization. For example, based on the convergence model of King (2004), possible factors can be placed into major domains, with possible overlaps. Systematically 'patrolling' various domains reduces the probability that certain developments will be disregarded. Domains include ecological and environmental factors, socio-economic factors and biological factors. Subsequently, these risk factors can be prioritized based on expert judgement. The Animal Health Service (GD) conducted a pilot study on behalf of the Netherlands Food and Consumer Product Safety Authority (NVWA) on this topic, in which experts from many areas were asked to name and prioritize important developments. This format was also used for the present advisory memorandum.

Recommendation 1. Give uncertainties a bigger role in policy

More specifically:

a) Clearly identify the uncertainties within each policy domain and assess which methodological approach is the most effective to deal with these uncertainties.

b) *Early warning: ensure that monitoring and analysis of new developments that may lead to a risk of a disease outbreak becomes a structural component of policy. A pilot study conducted by the GD in this area provides a good start for this approach.*

Risks of infectious diseases in practice

Probability and consequences of an outbreak

The background report accompanying this advisory memorandum provides an overview of:

- pathogenic agents
- vectors that can transmit disease
- risk factors and dissemination risks
- associated uncertainties
- possible measures.

The background report shows that the risks of many diseases are well understood. High-risk diseases include avian influenza, Campylobacter and Toxoplasmosis. These diseases therefore have the attention of policy. However, several diseases for which the risk is fairly high are still given relatively limited attention, such as Crimean-Congo haemorrhagic fever.

We have distinguished the consequences of an outbreak as follows: effects on human health, effects on animals, social impact, economic effects, effects on movement of people and environmental effects.

Pathogens

The policy focuses on a wide range of pathogens: prions, viruses, bacteria (including resistant bacteria), fungi, insects, worms and possible vectors. In the Netherlands, the risks of zoonoses have been clearly defined. For example, Campylobacter and avian influenza have been classified as ‘high risk’ and agriculture-related diseases.

The use of antibiotics in livestock farming has almost certainly contributed to the problem of bacterial resistance. Besides normal chromosomes, certain bacteria may also contain plasmids. These can also transmit characteristics for antibiotic resistance.

During the past decade, MRSA problem has become increasingly severe (MARAN, 2012). ESBL-producing bacteria prevent antibiotics from being effective. These bacteria and the link with livestock farming are the focus of current policy. In recent years, government agencies, the livestock sector and veterinarians have committed themselves to reducing the use of antibiotics. These efforts are beginning to have an effect: during the first six months of 2012, antibiotic sales for veterinary use had fallen by more than 50% relative to 2009. Even more important, in 2012 the monitoring of the antibiotic resistance of bacteria in animals began to show a declining trend for the first time. This was attributed to the reductions in antibiotic use (MARAN, 2013).

However, there is still little attention to the fact that bacteria can also become resistant to disinfectants. This is even more problematic because the reduction in antibiotic use can lead to additional use of these products. As a result, the arsenal of antibacterial agents could shrink even further.

Little attention is being paid to the fact that other pathogens besides bacteria can also become resistant to biocides, specifically fungi and worms (Helminths[1]). Some species of parasitic worms have become resistant to anthelmintics (agents that destroy or cause the expulsion of such worms). For example, the resistance of *Fasciola hepatica* (the common liver fluke) to triclabendazole is continuing to expand in the Netherlands. Furthermore, there is still little attention for the so-called cross-kingdom jumpers; pathogens that can jump from one ‘kingdom’ of organisms to another, especially from plants to animals or to people.

Recommendation 2. Give more attention to development of resistance in pathogens other than bacteria and the risks of cross-kingdom jumpers.

More specifically:

a) *Conduct further research into the risk of resistance to disinfectants.*
b) *Permit the use of anthelmintics only when a severe infestation has been ascertained by faecal testing.*
c) *Also develop policy to prevent development of resistance in other types of pathogens such as protozoa. It is likely that the use of such pathogen control agents can become more effective and be reduced by observing the rules applying to the use of antibiotics: these agents can only be prescribed and used by a veterinarian, and usage must be registered.*
d) *In research and policy, pay attention to the risks of cross-kingdom jumpers (primarily fungi, bacteria) for human and animal health, in order to tackle this potential problem at an early stage.*

Livestock farming

Strengthen the immune system of livestock

Strengthening the immune system, in particular the ‘natural resistance’ of livestock, is potentially an important supplementary strategy for controlling farm-linked animal diseases (infectious or otherwise). Improved livestock resistance can probably increase the effectiveness of vaccinations, and in this way contribute to the control of highly contagious diseases. In recent years, more and more research has been done on this topic, but this has received relatively little attention in current livestock practice.

Livestock farmers can improve the natural resistance of their animals by giving more attention to good nutrition, care and housing, as well as reducing chronic stress. These measures can reduce the need for antibiotics. Greater genetic diversity in livestock can

---

1 The most customary classification of parasites is between ectoparasites and endoparasites, whereby the endoparasites are subdivided into Helminths (worm-like organisms) en Protozoa (single-celled organisms) (Kortbeek & Mank, 1999).

also contribute to overall animal health; such diversity can prevent all animals from having identical disease susceptibility.
Parameters that can be used in practice to determine the strength of the immune system are needed, but have just started to be developed. Such parameters can help livestock farmers and veterinarians to understand the immune status of the animals and provide tools for improvement. These parameters are being studied as part of the project *Weerbaar Vee* (resilient livestock). A few examples of such parameters have been described by Ploegaert (2010). She described titres of natural antibodies in milk that play a role in the prevention of a high somatic cell count, clinical mastitis and other diseases conditions. The advantage of this method is that no blood samples are required. Subsequent research can provide more insight into the relationship between livestock management (nutrition, housing, etc.) and these immune parameters. This can establish the basis for improved breeding criteria and nutritional strategies and for guiding livestock farmers.

The role of the veterinarian

At present, veterinarians depend primarily on livestock farmers as clients as well as on the sale of veterinary pharmaceuticals. If veterinarians were not reliant on the sales of pharmaceuticals, then a further reduction in antibiotic use would be more likely. Beemer et al. (2011) have evaluated the prescription status of the ‘URA’ veterinary pharmaceuticals (URA stands for ‘prescription only’). Since 2008, only veterinarians have been authorized to prescribe these products. According to Beemer et al. (2011), the introduction of this prescription obligation has led to increased awareness of animal welfare and animal health. However, they were unable to ascertain that these products are being used more selectively and restrictively. This situation could possibly be improved by assigning prescription competency exclusively to veterinarians, but allocating the sales of the products to other parties.

Policy is also being developed for measures to influence the role of the veterinarian. According to the announced regulation (UDD), all antibiotics will be administered only by veterinarians. Several exceptions are described whereby livestock farmers are permitted to administer antibiotics, but only under very specific conditions and under the supervision of a veterinarian.

The SGD, an independent foundation for the assurance of veterinary services, is working on improving the role of the veterinarian. For example, as part of the quality assurance system for the primary sector, it has been established that veterinarians, in consultation with cattle farmers, prepare a farm health plan, and that one-to-one relationships between veterinarians and livestock farmers are developed. Greater focus on prevention can also be transposed into a revenue model, where veterinarians are rewarded for healthy animals and/or for providing knowledge and expertise. The expectation is that this can further improve the health situation in the livestock farming sector. Research is ongoing.

Recommendation 3. Utilize new possibilities to improve the health situation for animals.

More specifically:

a) Strengthen the natural disease resistance of animals by focusing more on good nutrition, care and housing.

b) Promote the genetic diversity of livestock on individual farms and within the sector as a whole.

c) Plan follow-up research into the relationship between management (nutrition, housing, etc.) and immune parameters for natural resistance, and the use of these parameters in practice.

d) Experiment with a revenue model for veterinarians based on keeping the herd healthy, whereby the veterinarian does not earn money by selling veterinary pharmaceuticals. During this process it is important for the veterinarian to visit the farm frequently to monitor the animal health situation, develop a good relationship with the farmer and improve the veterinary knowledge of the farmer (who is the daily manager of animal health).

Pathways for disease introduction and spread

International transport of animals and/or animal products is subject to all kinds of regulations to prevent the spread of diseases. However, some forms of animal transport fall partly outside these regulations: transport by tourists, transport of horses and illegal imports of exotic animals and other animals. Illegal animal import is a major problem. Every year, millions of protected animals and billions of protected animal products (including ivory and hides) are imported illegally into Europe;[2] it is estimated that several hundred thousand exotic animals are imported annually into the Netherlands. In addition, wild fauna can carry diseases from Eastern Europe into the EU, after which they can be transported throughout the EU on legal animal transports.

The animal health risks of free trade within the EU are currently receiving much attention, but additional attention to the transport risks for horses and veal calves appears to be required. In the EU, the Netherlands is a centre for veal calve farming and slaughtering. Every day, calves are transported to the Netherlands from many parts of Europe (and back again). In 2012, more than 860,000 calves were imported into the Netherlands. This extensive transport is a result of the common market and the price differences between countries.

Horses are transported on a large scale as well. Because this partly concerns hobby transport, little reliable data is available. In principle, every horse must have an equine passport, as required by the I&R system (identification and registration), but the hobby-based nature of the sector makes monitoring difficult. Consequently, the veal calf sector and the equine sector both pose a major infection risk, which in the case of veal calves also applies to dairy farming.

A study of the relevant literature showed that various pathogens in various sectors can easily spread through the air (airborne transmission). In livestock farming and policy, it

2 Van Uhm (2009).

appears that these risks are still underestimated. The corresponding legislation also has a gap in this area. As part of the permit process (required for expansion of existing livestock forms or the establishment of new ones), only environmental issues are addressed. Infection risks cannot be included. This is a limitation for the Community Health Services (GGDs) who have to make recommendations on such permits. The Association of Community Health Services (GGD Nederland) and the Government Service for Land and Water Management (DLG) have developed an assessment framework concerning human health in relation to intensive livestock farming. However, this framework is difficult to apply due to the lack of standards and expertise about the risk-limiting measures that can be taken.

Recommendation 4. Limit the risks of spreading agriculture-related infectious diseases by focusing more on transport risks and regulating the permit process for livestock farms.

More specifically:

a) Regulate the veal calf sector to reduce transport risks. One policy option is to set a maximum on the number of transport addresses for new transport rounds. A second option is to encourage the veal calf sector to decentralize the slaughterhouses in the Netherlands and establish them throughout Europe, in collaboration with farms that supply the veal calves.

b) Improve the identification and registration system for the equine sector. This can perhaps be done through more attention to monitoring and enforcement.

c) Include infection risks in the reports required with permit applications for expansion of existing farms or establishing new farms. This requires further quantification of the actual risks.

Governance structure

Policy focuses emphatically on the question of how to deal with risks and uncertainties. In a letter to Parliament (29 May 2006), the previous coalition government explained that no substantive template exists which indicates how governance must deal with new and uncertain issues. Furthermore, no uniform system of standards is available that applies to all risks in every field of policy. Custom work will always be necessary with new or uncertain political-governance issues.

Over the years, many animal and human health organizations have been established, at three levels: national, European and global. Table 1 provides a concise summary of these organizations. The organizations have various aims and a broad set of instruments to achieve these aims, ranging from standards for trade, product quality, early warning and monitoring systems, prevention and intervention programmes, to policy advisory instruments.

Table 1 Organizations with tasks in human and veterinary health (H=human, V=veterinary).

	Organization	H*	V*	Aim relative to infectious diseases
World-wide	World Organisation for Animal Health (OIE)		■	Transparency of animal health, support for control and prevention of animal diseases
	World Health Organization (WHO)	■	(■)	Research agenda, establishing norms and standards, policy options, technical support, monitoring health trends
	World Trade Organization (WTO)	■	■	Ensuring trade flows
	Food and Agriculture Organization (FAO)	■		Assuring food quality and quantity
European	European Centre for Disease Prevention and Control (ECDC)	■	■	Defending Europe against infectious diseases
	European Food Safety Authority (EFSA)	■	■	Advising on food safety risks
National	Association of Community Health Services (GGD)	■		Health promotion and protection
	National Institute for Public Health and the Environment (RIVM)	■		Support, prevention, intervention, national coordination
	Animal Health Service (GD)		■	Preventing animals from becoming infected
	Netherlands Food and Consumer Product Safety Authority (NVWA)	■	■	Monitoring and enforcement
	Central Veterinary Institute (CVI)		■	Veterinary research
	Centre for Vector Monitoring (CMV)	■	■	Minimizing impact of vectors on public health
	Product boards		■	Supporting specific sectors

In 2006, the American Veterinary Medical Association (AVMA) stated:

> We need our colleagues in human medicine, public health, and the environmental health sciences.

That was the beginning of the *One Health* concept, a world-wide strategy to promote interdisciplinary cooperation and communication regarding all aspects of health for humans, animals and the environment:

> The One Health concept is a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment. The synergism achieved will advance health care for the 21st century and beyond by accelerating biomedical research discoveries, enhancing public health efficacy, expeditiously expanding the scientific

> knowledge base, and improving medical education and clinical care. When properly implemented it will help protect and save untold millions of lives in our present and future generation (Kaplan et al. 2009).

The governance structure regarding infectious diseases is increasingly being structured according to this One Health concept. Nevertheless, the interviewees expressed points of concern. On the basis of these concerns, we have ascertained that:

- The One Health concept is a good foundation for governance structure, but is still insufficiently implemented at the 'workplace' and has not been widely implemented in other parts of society (such as the transport sector, national defence). In some areas, the human and veterinary health sectors can improve their mutual coordination. For example, veterinarians, general practitioners and specialists can exchange more information on diseases (including zoonoses) that they observe in their surroundings. The fact that the same disease organisms sometimes have a different name and plant science than in medical science[3] hampers the communication between these disciplines. In addition, the human and veterinary health sectors can learn from each other's strengths.
- Decision-making within the zoonosis consultation is done – partly implicitly, partly explicitly – based on an assessment framework. By communicating clearly about this framework, the support in society for decisions can be improved. Transparency towards external parties on this topic can clarify why certain decisions are made. The Integrated Assessment Framework for policy and regulation (IAK)[4] provides a good guideline for this purpose.
- Many procedures are defined in protocols and contingency plans. This is necessary, but various experts that we interviewed stated that this leads to the risk that people – out of fear of not complying with the protocol – do not take sufficient action when necessary.

Recommendation 5. Continue implementing the One Health concept, including primary veterinary care and human health care, to the local level.

More specifically:

a) *Identify which disease organisms are subject to differing nomenclature in the various sectors. This is an important task for taxonomists, on the one hand to map out existing differences, and on the other hand to prevent such differences in nomenclature in the future.*
b) *Encourage general practitioners and veterinarians to communicate with each other regularly at the local level: what developments do they observe and what are the relationships between them? This knowledge can be used locally, but can also serve as input for the national zoonosis consultation.*
c) *Determine whether veterinarians can work with standard practices, similar to those used in human healthcare. Ensure national feedback.*
d) *Explicitly define the assessment framework, on the basis of which policy decisions (currently implicit in most cases) are made. This framework must clarify how aspects such as economic interests and public health interests are weighed against*

---

3 Koert (2007).

4 For more information, see: http://afweging.kc-wetgeving.nl

each other. A substantive assessment framework can clarify why specific decisions on prevention, monitoring and control are made.

e) Identify the potential animal health risks entailed by the current national overseas defence missions.

f) Some tasks regarding animal disease policy have been transferred to the Product Boards, but these boards will soon be abolished. The reformed CAP offers possibilities for having these tasks implemented by producer organizations or inter-branch organizations (IBOs). Ensure legal frameworks that can make the requirements of producer organizations, where necessary, generally binding

g) Prevent stakeholders from becoming paralyzed because the regulations have become excessively protocolized. Contingency plans are essential, but are somewhat static. You cannot deal with everything using such a plan, because every situation is different, and by definition these plans are not tailored to new problems. Therefore, it is essential that stakeholders are allocated sufficient responsibility and flexibility to act within the protocols.

Monitoring

Animal health monitoring in the Netherlands has the following aims

1) promptly detecting outbreaks of known diseases or pathogens that are not endemic;
2) detecting diseases that are still unknown;
3) monitoring trends and developments concerning the prevention of diseases.

Following the outbreak of Q fever in 2007, the veterinary and human health sectors began working closely together based on the One Health concept. The current monitoring and control system in the Netherlands offers a good basis for this cooperation. GGD Netherlands, National Regulations Service (*Dienst Regelingen*) and the Centre for Infectious Disease Control (CIb) have signed a mutual data provision agreement. As part of this agreement, various livestock data are shared with the CIb and the District Health Services (GGDs).
In practice, the professional/expert will be the hub of the monitoring system. Rapid job changes of policy officers in the departments erode the collective memory of the system.

Recommendation 6. Determine the possibilities to improve monitoring through smart use of using existing knowledge and information.

More specifically:

a) Identify the possibilities and impossibilities to improve the monitoring by using information that is already available from various sources. Work is already taking place in this area by means of information exchange between GGD Nederland, Dienst Regelingen *and the CIb, but can possibly be expanded to include information from farm management systems, veterinary practices (compare with the standard practices in human healthcare), BLGG AgroXpertus, CRV and milk testing. Determine whether linking this supplementary data provides additional information and whether it is feasible.*

b) Protect the human capital that is present with policymakers and at research institutes. Minimize unnecessarily rapid job changes among experts.

Policy contingency plans

The government has various contingency plans for dealing with contagious animal diseases. In 2013, the European Commission conducted an audit regarding the implementation of contingency plans in relation to animal diseases. This audit showed that the Netherlands largely complies with the EU requirements on contingency plans. However, several specific points for improvement were mentioned. For example, the information about the possibility of vaccinating free range and hobby chickens against avian influenza in the operational contingency plan of the Netherlands Food and Consumer Product Safety Authority deviates from the information in the policy contingency plan. This has been corrected in the new version of the policy contingency plan.

Reinhold (2012) described several basic requirements which a contingency plan must satisfy. Essentially, for each stakeholder it must be immediately clear who should do what and when. Many stakeholders, with various levels of expertise and experience, should be able to work with the contingency plan. A visual representation, for example using flowcharts, is preferable to large amounts of text.

Reinhold (2012) and Knols (2012) critically examined the contingency plan for African swine fever (ASF) and the draft contingency plan for African horse sickness (AHS). Their analysis showed, among other things, that the objective and the target group are not always clearly described, and that sometimes multiple objectives are intermingled. The core of the contingency plan must be the measures, where it is clear who has to do what.

A contingency plan goes into effect once an outbreak (or a suspected outbreak) is identified. In addition, as soon as the outbreak is over, systematic attention to preventive measures is essential (outside the contingency plan). Several points for improvement in this area emerged from the comments of Reinhold and Knols.

Recommendation 7. Improve the policy contingency plans and the communication about preventive measures

More specifically:

a) *Clearly describe the objective and target group in the policy contingency plans.*
b) *Make the contingency plans more operational by focusing on the information needed by stakeholders to properly implement the required measures. The other information, such as the text about crisis organization, can be shortened or moved to an appendix.*
c) *In the draft contingency plan for African Horse Sickness (AHS), briefly explain the scenarios.*
d) *Communicate clearly and in practical terms about preventive measures against African Swine Fever (ASF) and the corresponding enforcement.*
e) *Focus more on the risk of pathogens being introduced by meat products/waste and vectors originating from ships in the Port of Rotterdam. This is seen as a specific risk due to the large number of ships from Russia, Angola and Nigeria.*

Systems

Agriculture has various physical connections with other systems, such as energy chains, zoos, hospitals, the transport sector and the military. Each of these systems has specific risks concerning the spread of infectious diseases. The same applies to wild flora and fauna.
Therefore, coordination and communication between various parties and sectors is crucial. This coordination and communication is frequently lacking. Communication is often limited to one's own sector. For example, the military has only recently become aware that peace missions also can also entail animal health risks.

Research and knowledge infrastructure

From the interviews with experts and stakeholders, various points for attention have emerged regarding the knowledge infrastructure. Regarding this infrastructure, we have drawn the following conclusions:

- Management/strategy: From the interviews, the consensus emerged that the direction of research is too much dominated by the needs of businesses. Moreover, the 'top sector policy'[5] entails a number of risks. Independent research, including research focusing on long term issues, remains necessary.
- Vectors: Experts stated that the knowledge in the Netherlands concerning vectors that can transmit pathogenic agents appears to be inadequate. Furthermore, the knowledge about midges (biology, wintering, behaviour, reproduction, etc.) is insufficient to understand the corresponding outbreak risks.
- Resistance: Experts also signalled insufficient knowledge on the role of plasmids in resistance development.
- Ecosystem level: One expert referred to research at the ecosystem level as an important and relatively new field. For example, how does the balance shift within an ecosystem if a specific pathogen is effectively controlled? In practice, another pathogenic bacterium sometimes appears to have more room to proliferate.

Recommendation 8. Ensure a basic level of expertise for innovative research.

More specifically:

a) *Ensure that an up-to-date list of experts is available in all relevant fields. Attempt to retain experts with positive incentives.*
b) *Commission research into pathogens in the ecosystem context. How does the total ecosystem change if a specific pathogen is effectively controlled? Do other pathogens then get more room to proliferate?*

Table 2 addresses the recommendations to the various parties. The primary objective of the Platform is to advise the Ministry of Economic Affairs (EZ), but also, where

[5] The top sector approach is geared towards providing a solid exchange between businesses, knowledge institutes and the government (the 'golden triangle'). The government does not make its own proposals for the sectors, but invites businesses and scientists to draw up action plans.

appropriate, the Ministry of Health, Welfare and Sport (VWS) and the livestock or veterinary sectors.

Table 2 Summary of recommendations and the corresponding parties.

Recommendation	Ministry of Economic Affairs	Ministry of Health	Livestock sector	Veterinary sector
1a. Define uncertainties	■	■		
1b. Early warning		■	■	■
2a. Resistance bacteria to disinfectants	■	■	■	■
2b. Anthelmintics only after faecal testing	■		■	■
2c. Resistance policy protozoa, etc.	■			
2d. Research into *cross-kingdom jumpers*	■	■		
3a. Better nutrition, care, housing of livestock			■	■
3b. Genetic diversity livestock			■	
3c. Natural resistance parameters	■			■
3d. Alternative business model veterinarians	■		■	■
4a. Regulate veal calf sector	■		■	
4b. Enforcement of equine I&R	■			
4c. Infection risks in relation to permit system	■	■		
5a. Coordination of veterinary / human health care	■	■		
5b. Contact at local level	■	■		
5c. Veterinary standard practices	■			
5d. Assessment framework policy decisions	■	■		
5e. Identify risks of military missions	Defence			
5f. Assume tasks of product boards	■		■	
5g. Prevent excessive protocolization	■	■		
6a. Improve monitoring	■		■	■
6b. Prevent job switching by experts	■	■	■	■
7a. Goal + target group policy contingency plans	■	■		
7b. Operationalize contingency plans	■	■		
7c. Contingency plan AHS: explain scenario	■	■		
7d. Contingency plan ASF: prevention	■	■		
7e. Contingency plan ASF: introduction via seaport	■	■		
8a. List of experts	■			■
8b. Research planning	■			