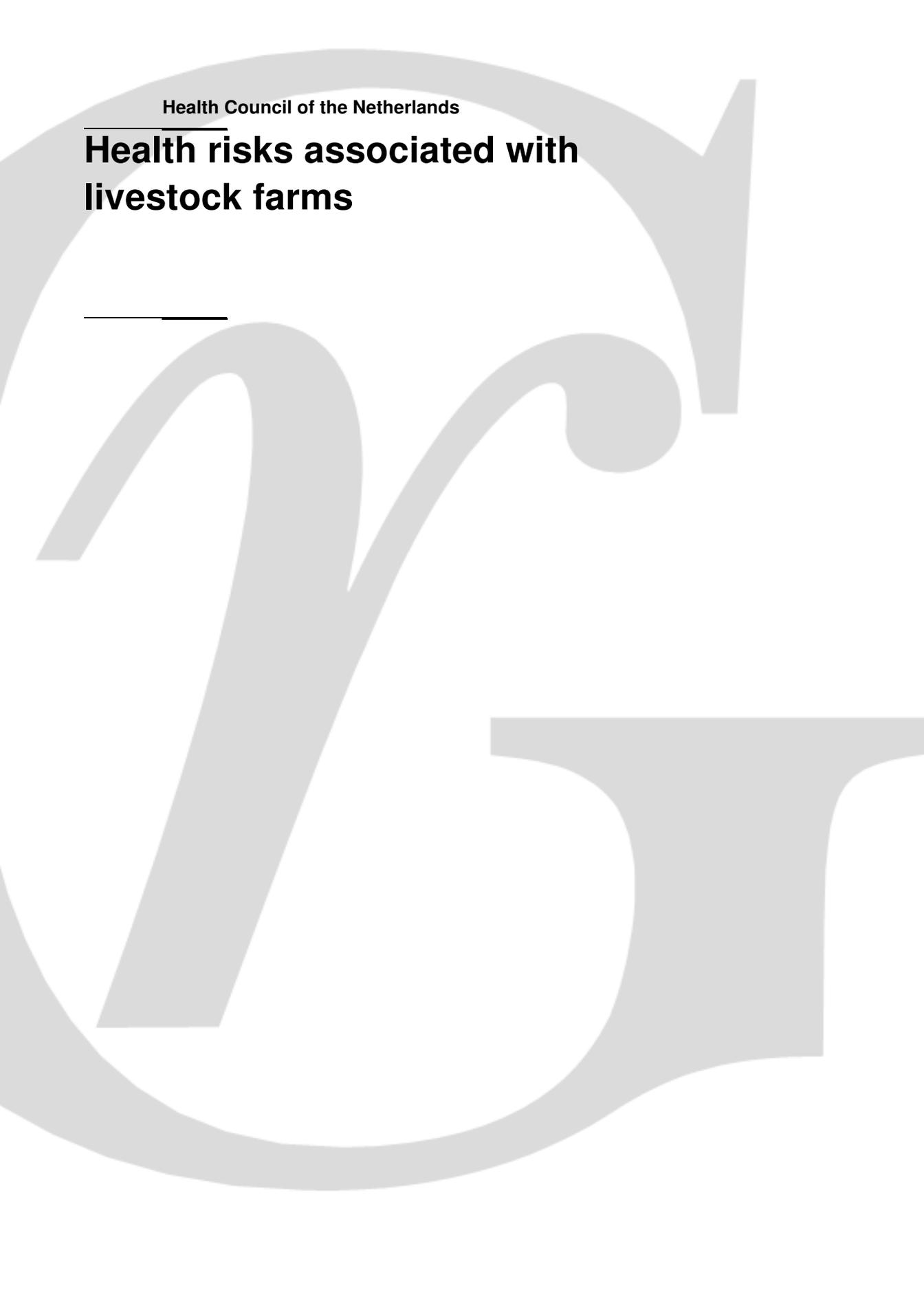


Health Council of the Netherlands

Health risks associated with livestock farms





To the Minister of Health, Welfare and Sport

Subject : presentation of advisory report
Health risks associated with livestock farms
Your reference : PG-CI-3077216
Our reference : I-1008/11/ES/db/812-D
Enclosure(s) : 1
Date : November 30, 2012

Dear Minister,

On 27 September 2011, you asked the Health Council of the Netherlands to develop an assessment framework for the risks posed by intensive farming to the health of local residents. This request was also on behalf of the former State Secretary for Economic Affairs, Agriculture and Innovation, and the State Secretary of Infrastructure and Environment. In this connection, you also asked the Council about the usefulness and necessity of imposing minimum separation distances between livestock farms and residential areas. A committee specially appointed for the purpose has drawn up the requested advisory report, which I hereby submit to you, after having consulted the Standing Committee on Health and the Environment, and the Standing Committee on Infection and Immunity.

In its deliberations, the Committee concluded that the current scientific data set is too limited to support a quantitative assessment framework, setting out the maximum permissible risk levels for local residents. Nor is anything known about the radius of the zone within which local residents are exposed to increased health risks. I share the Committee's view that this does not necessarily leave us empty-handed. Instead, a more policy-oriented assessment framework can provide useful points of reference for everyday practice. The establishment of policy-based and local separation distance standards is also entirely in keeping with this approach.

Gezondheidsraad

Health Council of the Netherlands



Subject : presentation of advisory report
Health risks associated with livestock farms

Our reference : I-1008/11/ES/db/812-D

Page : 2

Date : November 30, 2012

From the Health Council's perspective, I fully appreciate the importance of the Committee's decision to draw a sharp distinction between scientific analyses and policy considerations. From this same perspective, however, further research is also needed to reduce the large gaps in our knowledge of this area. This is of particular importance here in the Netherlands, where people and animals live cheek by jowl, and where public health and economic interests may sometimes be at odds. Accordingly, I wholeheartedly support the Committee's argument that the scientific basis needs to be strengthened.

Yours sincerely,
(signed)
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Health risks associated with livestock farms

to:

the Minister of Health, Welfare and Sport

State Secretary for Economic Affairs, Agriculture and Innovation

the State Secretary for Infrastructure and the Environment

No. 2012/27E, The Hague, November 30, 2012

The Health Council of the Netherlands, established in 1902, is an independent scientific advisory body. Its remit is “to advise the government and Parliament on the current level of knowledge with respect to public health issues and health (services) research...” (Section 22, Health Act).

The Health Council receives most requests for advice from the Ministers of Health, Welfare & Sport, Infrastructure & the Environment, Social Affairs & Employment, Economic Affairs, and Education, Culture & Science. The Council can publish advisory reports on its own initiative. It usually does this in order to ask attention for developments or trends that are thought to be relevant to government policy.

Most Health Council reports are prepared by multidisciplinary committees of Dutch or, sometimes, foreign experts, appointed in a personal capacity. The reports are available to the public.



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Executive summary

In recent years intensive livestock farming has provoked considerable social disquiet in the Netherlands. This involves various elements, such as animal welfare, sustainability, the quality of residential life, landscape quality, and public health risks (especially since the outbreak of Q fever). With a view to the latter point, the Minister of Health, Welfare and Sport – also on behalf of the State Secretary for Economic Affairs, Agriculture and Innovation, and the State Secretary for Infrastructure and the Environment – has approached the Health Council with a request for advice. These members of the government are interested in ways of assessing the health risks associated with living in the vicinity of livestock farms. They also want details of the usefulness and necessity of imposing minimum distances between livestock farms and residential areas. In response to the request for advice, the President of the Health Council has appointed a multidisciplinary expert committee. This advisory report presents the result of that Committee's deliberations.

To what agents might those living in the vicinity of livestock farms be exposed?

There is clear evidence that local residents can be exposed to micro-organisms and to substances derived from them, especially endotoxins (cell wall components from certain types of bacteria). These microbial components are mainly found in the coarser fraction of particulate matter, which is a collective

term for airborne particles of various sizes, origins, and chemical compositions. As a result, the cocktail of fine particulates in the vicinity of livestock farms has a significantly different composition to the fine particulates found in urban surroundings.

How is the concentration of these various components in outdoor air related to the distance between residential areas and livestock farms, and to the type of farm in question?

In general, it is true to say that the further away the farm, the lower the concentrations of certain particulates, endotoxins, and micro-organisms. These concentrations will also depend on the farm's emission levels. A range of other factors may also be involved, such as buildings and green areas in the vicinity, and meteorological conditions. Measurements taken in the course of a recently conducted study in the Netherlands revealed elevated endotoxin levels up to a distance of approximately 250 metres from certain farms. Levels five to ten times greater than background concentrations were found only a very short distance downwind of certain pig farms. The levels in question were slightly lower near a mink farm, and clearly higher near a poultry farm.

During the same study, measurements were also taken of certain micro-organisms in samples of particulate matter. These samples regularly tested positive for Q-fever bacteria, especially at measurement sites associated with numerous cases of Q-fever just a few years ago. In addition, the livestock-specific MRSA bacteria was detected more frequently and in higher concentrations within a radius of 1,000 meters of livestock farms.

The Committee points out that while this data may indeed indicate that local residents are being exposed (or potentially exposed), there are a number of issues about which we are still entirely in the dark. Further research is needed, particularly into the differences between small farms and large farms, in terms of emissions. There is a similar lack of clarity concerning the effect of general farm management on such emissions.

What health effects might be expected to occur in local residents, and to what extent do these bear any relationship to exposure data?

The Committee has determined that what little scientific information is available on this topic is both heterogeneous in nature and of limited predictive power. In addition to the above-mentioned Dutch study, two other relatively high-quality studies (one German and the other American) have been published on this topic.

However, differences in the design of these studies make it difficult to interpret the body of data as a whole. The Committee feels that there is some evidence to suggest that local residents might be affected. This involves effects on the respiratory system, in particular reduced lung function, and possible allergy. In the Netherlands, there was clearly a greater incidence of Q-fever in the vicinity of goat pens. There was also an increased incidence of pneumonia among those living near goat farms and poultry farms. A slightly lower incidence of asthma was found in the immediate vicinity of livestock farms. However, the data set is still too limited to support conclusions concerning quantitative causal relationships between the occurrence of health problems and exposure to specific fine particulate components. To date, Q-fever outbreaks are the only health risk for which there was robust scientific evidence. The Netherlands experienced such outbreaks just a few years ago.

To what extent does scientific information about specific components of the cocktail of fine particulates provide any guidance in determining the health risks in question?

There is only a limited amount of direct information on the health risks associated with living in the vicinity of livestock farms. Indirect information or extrapolation from other situations might shed more light on the matter. The Committee has explored these options with regard to the various components of the cocktail of fine particulates. While the health risks associated with exposure to particulate matter are reasonably well understood, the effects in question relate to urban situations. The Committee takes the view that the particulate matter found in urban environments and that found in the vicinity of livestock farms are too different for the former to provide a basis for risk assessment. Nor, indeed, does our knowledge of micro-organisms provide any useful points of reference. This is because we still know very little about the exposure-response relationships of these agents.

This is not true of endotoxins, however. On this topic, there is a considerable body of research into the exposure of workers in various sectors of industry, including those who work in animal pens. For instance, the concentrations found in livestock farming have, without exception, been found to have chronic effects on lung function, which are associated with respiratory complaints. In 2010, the Health Council derived a new health-based recommended exposure limit for workers: 90 EU/m³ (endotoxin units per cubic meter of air). Exposure to concentrations below that recommended exposure limit poses no risks to workers' health. However, there is a lack of data with regard to effects in the

general population. This could include groups of people who are more susceptible than workers. One way to allow for this would be to incorporate an uncertainty factor. In the light of current knowledge, it is impossible to say how large this factor would need to be. This is partly because it is unclear how the averaging of exposure over time should be discounted. Nevertheless, if the use of such an uncertainty factor is deemed to be desirable, the Committee feels that the standard factor 3 would be the obvious choice. This would give a health-based recommended exposure limit for the general population of 30 EU/m³.

When set against the very limited amount of exposure data available, it can be seen that within a few dozen metres of some livestock farms, and of one poultry farm in particular, endotoxin concentrations can be as high as 30 EU/m³. At greater distances, this concentration soon drops below 10 EU/m³. Based on the available knowledge, the Committee feels that it is too soon to reach a verdict concerning the possible adverse health effects that might be associated with such significantly lower exposure levels.

What other factors might be included in the deliberations on health risks?

The Committee concludes that the social disquiet provoked by intensive livestock farming is partly fuelled by perceptions of risk and by odour nuisance. Lack of control over a situation can exacerbate people's stress. While odour nuisance mainly impacts people's quality of life, some associate it with health problems.

What would constitute a suitable framework for assessing the health risks associated with intensive livestock farming?

Given the current level of knowledge, the Committee takes the view that it is not possible to develop a single quantitative assessment framework setting out policy-based maximum permissible risk levels for local residents. However, the Committee does feel that the current *Assessment Framework for Health and the Environment* can be of great use in this regard. This systematically addresses the scale of the problem, the severity of existing and potential health effects, people's perception of the problem, and the need for intervention (and the available options), as well as the costs and benefits of the measures in question. This also provides the clearest possible indication of where scientific analyses end and where policy-based deliberations begin.

There must also be a rigorous decision-making process, to achieve the requisite structuring and transparency. Each of the stakeholders must have the opportunity to add their own input. The Committee takes the view that this approach must be implemented at local level, as circumstances can vary from one location to another. As a result, the final evaluation of each of the aspects in the assessment framework will also have to take place at local level. Local authorities bear full responsibility for this process, with the municipal medical and health service acting in an advisory capacity.

Is it necessary and useful to impose minimum distances between residential areas and livestock farms?

Nothing is known about the size of the zone within which, under normal circumstances, people in the local vicinity (local residents, visitors) are exposed to increased health risks. Our knowledge of outbreaks of zoonoses is more complete. In the case of Q-fever, the distance involved can be up to five kilometres. In everyday practice, the minimum distances used are based on odour standards that are in accordance with the provisions of the Odour Nuisance and Livestock Farming Act. However, the simple reality is that there is still disquiet among many local residents. In order to meet their concerns, it may indeed be both useful and necessary to impose emission-related minimum distances that are not based on odour nuisance alone. If the assessment framework is used, as advocated by the Committee, these distances could then be determined using local, tailor-made approaches.

No less important, however, are measures for drastically cutting the emission of particles from animal pens. Various technologies, such as air scrubbers, can be of use in this regard. However, the Committee feels that there must also be an unremitting focus on new forms of farm management and occupational hygiene, and on greater sustainability within the livestock sector as a whole.

The future form of the livestock sector, in terms of size and location, is a political issue that could become the central theme of a national debate. Leaving aside the result of any such debate, there is a clear need for further research of the type that has recently been carried out in the Netherlands. This is the only way to improve our understanding of the health risks associated with living in the vicinity of livestock farms.

Introduction

Over the past few decades, the livestock industry in the Netherlands has grown steadily in both scale and intensity. The increase in scale involved has substantially ratcheted up pressure on the environment. Many laws and regulations have been passed over the years, in an attempt to turn back that tide. These have resulted in the implementation of numerous measures aimed at limiting the emission of harmful substances from animal pens. Other social issues have also been placed in the spotlight, such as animal welfare, sustainability and landscape quality.

In recent years there has been growing concern about the public health risks of intensive livestock farming. This initially involved food safety and odour nuisance. However, another issue has now emerged: are those who live near livestock farms at risk of health impairment or disease? The outbreak of Q fever, which is still fresh in people's memories, caused a great deal of public disquiet.

1.1 First step in an undeveloped field

The former Ministries of Health, Welfare and Sport and of Agriculture, Nature and Food Quality decided to launch a broad-based study of possible links between forms of intensive livestock farming and the health of local residents. The results of this study (conducted by the Institute for Risk Assessment Sciences, the Netherlands Institute for Health Services Research, and the National Institute of Public Health and the Environment, and entitled "Intensive

Animal Husbandry and Health” (IVG study) were published last year.¹ The authors emphasise that this is just a preliminary inventory study. Measurement data generated a picture of potential exposure to certain substances and micro-organisms. Information was also collected on the health of local residents. The researchers point out, however, that it is seldom possible to draw detailed conclusions about direct relationships between the proximity of livestock farms and effects on health. Instead, they feel that their findings offer points of reference for more targeted follow-up studies.

1.2 Request for advice and Committee

The social concerns, scientific findings and uncertainties outlined here prompted the Minister of Health, Welfare and Sport, who was also acting on behalf of the former State Secretary of Economic Affairs, Agriculture and Innovation and the State Secretary of Infrastructure and Environment, to submit a request for advice to the Health Council. These government officials are interested in ways of assessing the health risks associated with living in the vicinity of livestock farms. In this context, they make reference to an assessment framework. The request for advice also contains some more specific questions on issues such as the expected efficacy of risk mitigation measures, and the imposition of minimum separation distances between livestock farms and residential areas. The full text of the request for advice is set out in Annex A. In response to this request, a multidisciplinary expert committee has been appointed. Details of its membership are given in Annex B. In addition, the President of the Health Council notified these government officials by letter that the Committee had decided to waive the option of a two-phase response. For reasons of transparency and scientific quality, the Committee preferred to deliver a single advisory report in which all questions could be analysed and answered as a coherent whole.

1.3 The Committee’s procedures and the structure of the advisory report

The Committee was able to make use of various summary reports by the National Institute of Public Health and the Environment. These documents address the scientific literature on the public health aspects of livestock farms.²⁻⁴ The authors of the “Intensive Animal Husbandry and Health” report also focus on this literature.¹ These publications provided the Committee with a useful starting point. It also sought out any other articles or reports that might be able to shed more light on the matter. In addition, one systematic review article

was particularly valuable in this regard.⁵The Committee also incorporated previous Health Council advisory reports on assessment systems into its deliberations.⁹⁻⁶

The structure of the advisory report is as follows. Chapter 2 begins with a brief outline of the “Intensive Animal Husbandry and Health” study’s findings. The Committee then examines the various components of exposure (and potential exposure), before looking into what is known about the corresponding exposure-effect relationships and any high-risk groups. In Chapter 3, the Committee reviews social concerns about the proximity of livestock farms from a broader perspective. Here, specific issues such as odour nuisance and risk perception are briefly addressed. Chapter 4 is devoted to those elements that play a part (or might potentially do so) in the assessment and management of the risks involved. The answers to the questions posed by the government officials are set out in Chapter 5, the concluding chapter.

Risks: the scientific analysis

What agents are released from animal pens, and what routes are involved? Also, how are these emissions related to the species and number of animals involved, and to farm management practices? What is the associated relationship between the concentration of agents being released and the distance to the animal pens? At what point is there a risk to the health of local residents? Politicians and members of the public have many questions about these issues. A number of these questions were addressed in the “Intensive Animal Husbandry and Health” study. Accordingly, this study provides a good basis for an analysis of the available scientific information on the health risks of living near livestock farms (and intensive livestock farms). The Committee goes on to examine the three main categories of agents involved, at greater depth.

2.1 The IVG study: main results

The lines of research pursued in the “Intensive Animal Husbandry and Health” study into the health risks involved were derived from the following three questions¹:

- To what extent are local residents exposed to particulate matter containing endotoxins and micro-organisms?
- What health problems are encountered by local residents, as diagnosed by their GP?

- What is the relationship between the data obtained in response to questions 1 and 2?

For the purposes of the study, the health problems experienced by local residents living near intensive livestock farms in the eastern region of the province of North Brabant and north-west Limburg were compared to those encountered by the residents of rural areas elsewhere in the Netherlands, who had little or no exposure to intensive farming. In answering question 3, various epidemiological methods were used, including a case-control study.

2.1.1 *Exposure*

Fine particulates is a collective term for airborne particles (aerosols) of various sizes, origins, and chemical compositions. The smaller the particles, the deeper they can penetrate into the lungs. Current policy for fine particulates in the open air focuses on PM₁₀ (broadly speaking this consists of particles - Particulate Matter - that are smaller than 10 µm) and PM_{2,5} (particles smaller than 2.5 µm). The agricultural industry in general, and livestock farms in particular, are known to contribute to PM₁₀ concentrations in the open air.

Endotoxins are cell-wall components from Gram-negative bacteria. Their chemical composition varies from one bacterial species to another. In all probability, these organic components mainly occur in the coarser fraction of particulate matter. Elevated endotoxin levels have been measured up to a distance of approximately 250 metres from certain farms. Levels five to ten times greater than background concentrations were found only a very short distance downwind of certain pig farms (0.1 to 1 EU/m³), while absolute levels remained below 10 EU/m³. The levels in question were slightly lower near a mink farm. In contrast, the concentrations around a poultry farm were clearly higher. The highest downwind levels at a distance of 30 metres from the pens were around 50 EU/m³. Incidentally, measurements of endotoxin concentrations in homes found that the proximity of livestock farms had no effect.

The authors of the “Intensive Animal Husbandry and Health” report also carried out exploratory investigations into certain micro-organisms in the particulate matter samples. Their samples regularly tested positive for Q-fever bacteria, especially at measurement sites associated with numerous cases of Q fever. These workers indicated that the findings in question involved low background levels. In addition, the livestock-specific MRSA bacterium was detected more frequently and at higher concentrations within a radius of 1,000

metres of livestock farms. The more farms in the area, the higher the measured concentration.

2.1.2 *Health problems*

The researchers used existing registries from GPs' practices to compare the incidence of diseases (especially respiratory problems) in the study area and the control area. They found that the respiratory problems experienced by those living in the study area differed slightly, in several respects, from those in other rural areas, where there were fewer livestock farms and no large factory farms. Local residents suffering from asthma and COPD had a higher frequency of upper respiratory tract infections. Pneumonia and atopic eczema were also diagnosed more frequently. On the other hand, fewer cardiovascular problems, ear problems and respiratory complaints were reported in areas of intensive livestock farming. There were also indications that asthma and COPD are less common in these areas. The Committee feels that, on the whole, these findings raise many questions that cannot yet be satisfactorily answered. At the very least, it is important to find out what health problems have been detected by other studies.

2.1.3 *Links between health information and exposure*

Some of the analyses in the "Intensive Animal Husbandry and Health" study incorporated data on the distances to livestock farms. The study examined the associations between various disorders and the presence of different animal species. While differences were indeed found between these associations, the Committee feels that no firm conclusions can be drawn from this. Here the Committee gives further clarification of various findings. As stated in the previous section, asthma and COPD patients living in the areas around intensive livestock farms experience a higher frequency of respiratory infections. There was clearly a greater incidence of Q fever in the vicinity of goat pens. There was also an increased incidence of pneumonia among those living near goat farms and poultry farms.¹¹ Upper respiratory tract infections were not related to the concentrations of particulate matter (modelled on the basis of emission data) around the house, to the presence of intensive livestock farms in the vicinity, or to the distances to such livestock farms. A slightly lower incidence of asthma, COPD, hay fever, and acute upper respiratory tract infections was found in the immediate vicinity of livestock farms and at the higher concentrations of particulate matter measured there. There is also some evidence for this in the

scientific literature. For instance, it has been reported that people who grow up on farms are less likely to develop asthma.¹⁰ This association with asthma was confirmed by a case-control study in which it was possible to control for various confounding variables.

2.2 Other studies among local residents

The Committee found that very few studies have been carried out into the health of local residents living near livestock farms. Furthermore, not all of the studies in question are of good quality. The main findings are discussed in various reviews.¹⁻⁵ There is considerable heterogeneity in terms of size and method, which complicates the interpretation of results. The published studies range from ecological analyses of recorded morbidity to self-reports of health problems, often not linked to any objective clinical data. Several studies did indeed detect endotoxins and certain micro-organisms in the ambient air. However, with a few exceptions (which the Committee explores in greater detail later in this section), these did not include estimates of local residents' actual exposure to such agents.

2.2.1 German and American studies

Two studies clearly stand out in terms of their size, design, and procedural quality. A large German study involving nearly 7,000 participants found that individuals living within 500 meters of at least twelve livestock farms had a significantly lower lung function (7 percent) than a control group.¹²⁻¹⁴ They were also twice as likely to suffer from respiratory complaints. Self-reported respiratory symptoms increased in step with self-reported odour nuisance, but this relationship was not reflected by the clinical outcomes. In terms of other health problems, such as asthma or bronchial hyperreactivity, no link was found to the number of livestock farms in the area. Yet a reanalysis of the data (using improved modelling of exposure, based on information about ammonia emission) showed that sensitisation to certain allergens increased with exposure. The researchers had also made 24-hour measurements of endotoxin concentrations in local residents' back gardens. The geometric mean levels were 2.0 and 2.9 EU/m³, in winter and summer respectively. The highest levels measured were 20 and 23 EU/m³.

One American study carried out in the vicinity of pig farms demonstrated that acute complaints affecting the eyes, nose, and upper respiratory tract were associated with concentrations of PM₁₀, PM_{2.5}, endotoxins, and hydrogen sulphide in the open air.¹⁵ These complaints increased on days with elevated

levels of air pollution, when there was also an acute, reversible reduction in lung function. A rising level of endotoxins was reflected by an increase in throat and respiratory system complaints. Symptom prevalence increased by approximately 10 percent per 10 EU/m³ as measured in PM₁₀. A relation to the distance separating residential areas and livestock farms was not investigated further.

2.2.2 *Infection risks*

The National Institute of Public Health and the Environment recently completed a literature review with a special focus on infection risks arising from livestock farming activities.⁴ This addressed both normal situations and outbreaks. It found that there was only a limited amount of information available concerning the risk to local residents. Of six selected zoonoses (infectious diseases that can be transmitted from animals to humans), only in the case of Q fever were there clear indications that, during outbreaks, local residents were at increased risk. The level of risk involved was related to the distance between the individual's house and nearby dairy goat farms. These separation distances ranged up to about 5 km. Given the lack of research data on the other zoonoses, it was not possible to make substantiated statements about the health risks associated with specific distances to livestock farms.⁴

In the case of specific types of avian influenza (H7N7 2003NL, H5N1), however, research has been carried out into the risk of transmission between one poultry farm and another. Such transmission will, to some extent, be the result of visitors inadvertently carrying infectious material from one infected farm to another.¹⁷ However, a significant proportion of transmission (24 percent) will result from transport through the air, even over long distances (up to 25 kilometres).¹⁸ If individuals visiting infected farms adhere to strict hygiene protocols, then the risk is greatly reduced.¹⁸ However, there is no evidence to show that local residents living near infected farms can become infected, even in the case of H5N1 outbreaks in other countries. In outbreaks of highly pathogenic avian influenza, however, health effects (especially eye problems and respiratory symptoms) have been identified in those directly involved.¹⁹

The authors of the National Institute of Public Health and the Environment report also pointed that it is not really known whether there is a relationship between the size of a livestock farm and local residents' risk of infection.⁴ There is also a lack of data on the potential impact of specific animal husbandry systems and animal-species-specific farms. Here too, the situation pertaining to Q fever is the exception. A positive relationship was found between the presence of farms holding more than 1,500 goats and cases of Q fever among local

residents.^{4,11} Larger farms with a very open pen layout are probably a stronger emission source of Q fever bacteria, but there is a lack of quantitative information to substantiate this.

2.2.3 *Initial stocktaking*

This is the extent of current information on the health risks to which those living in the vicinity of livestock farms are exposed. There is clear evidence that such individuals can be exposed to micro-organisms and to substances derived from them, especially endotoxins. There is also some evidence to suggest that this involves effects on the respiratory system, in particular reduced lung function, and possible allergy. In the Netherlands, there was clearly a greater incidence of Q fever in the vicinity of goat pens. There was also an increased incidence of pneumonia among those living near goat farms and poultry farms. A slightly lower incidence of asthma was found in the immediate vicinity of livestock farms. With the exception of the Q-fever epidemic, however, the data set is still too limited to support conclusions about quantitative causal relationships between the occurrence of health problems and exposure to specific agents. This is one reason why we are not sure about what constitutes a safe separation distance from livestock farms for local residents, nor about the extent to which the type and size of farm involved could be a factor.

2.3 **Spotlight on particulate matter**

In Section 2.1.1, the Committee notes that particulate matter is a collective name for a wide variety of particles. One thing that these particles have in common is that they can pass through the larynx during inhalation. While various aspects of this material are fairly well understood (its sources, and the health effects of exposure), there are still many grey areas. This is the situation in which the Committee has explored various issues relating to the fine particulates emitted by livestock farms.

2.3.1 *Types and sizes of particulate matter*

At this point, in the interests of clarity, it is necessary to consider the various types of particulate matter in somewhat greater detail than hitherto. As mentioned in Section 2.1.1, the designation PM₁₀ covers all particles with an aerodynamic diameter of less than 10 µm. This designation is subdivided into three different fractions, based on particle size.

Ultrafine particulates

Firstly, there are ultrafine particulates, consisting of particles smaller than 100 nm. These are mainly released by combustion processes. The highest open-air concentrations generally occur beside busy roads. Recent measurements showed that particle numbers near a livestock farm were seven to eight times lower than near busy roads. They were also lower than urban background levels.²⁰

PM_{2.5}: particles smaller than 2.5 µm

PM_{2.5} refers to particles smaller than 2.5 µm, which can penetrate deep into the lungs. They are created by the agglomeration of very small particles, and by chemical reactions and condensation in the atmosphere. One factor in this context is the emission of ammonia. The livestock industry is responsible for over 90 percent of ammonia emissions in the Netherlands and, by extension, for more than 10 percent of the background concentration of these fine particulates. Locally, this could lead to sticking points in areas with numerous livestock farms and a high background concentration of fine particulates transported from densely populated areas in Germany and Belgium. This is the situation pertaining in the province of Brabant, for example.

Particles ranging from 2.5 µm to 10 µm in size

The coarser fraction of particulate matter, between 2.5 µm and 10 µm in size, is mainly produced by mechanical processes. This arises when street dust, soil dust, and dust from building materials is carried aloft by the wind. This fraction can also include organic material. The coarse particulates released from animal pens consist mainly of faecal particles, particles of skin and feathers, and food ingredients, along with any associated living and dead organic material. The particle concentrations found on livestock farms are influenced by the species and number of animals there, the type of housing, and the season of the year. Section 2.3.2 gives brief details of particulate emissions from animal pens.

Particles larger than 10 µm

Some particulates are larger than 10 µm. If they are inhaled, most of these particles become trapped in the nose and upper respiratory tract. Like the coarser fraction of fine particulates, these particles are often produced by mechanical processes. Due to their relatively large mass, these particles often have a short

residence time in the air. This will mainly restrict their effects to a few tens of meters from animal pens.

The composition of this cocktail of particulates can vary greatly

According to the results of a recent American study, the relationships between various types of particulates can largely depend on the circumstances.²¹ This study measured the size and composition of particulates in various poultry farms. As expected, total particulate concentrations were higher in free-range housing than in battery cages. Animals moving around freely stir up particulates, which then become airborne. However, endotoxin concentrations in these particulates revealed a different pattern. While concentrations of these substances in the fraction larger than 10 µm were indeed higher in free-range housing, the opposite was true of endotoxin concentrations in PM_{2.5}. The Committee feels that this underscores the importance of well-specified exposure assessments.

2.3.2 *Particulate emissions from animal pens*

For the purposes of granting permits, models are generally used to calculate particulate emissions from animal pens. These calculations are based on the number of animals involved, on the concentrations measured in animal pens, and on the estimated or measured ventilation rates. A measurement programme has mapped out the situation pertaining in the Netherlands from 2007 to 2010 for the main animal species and types of pens.^{22,23} As in previous studies, this showed that the bulk of the particulate mass emitted (approximately 60 percent) consists of particles larger than 10 µm. Another finding was that the average annual emissions of PM₁₀ and PM_{2.5} for a given type of animal pen and category of animal can vary widely from one farm to another. In addition, there is probably a wide range of seasonal variation around this annual average.

For the purposes of policy, the results of this and previous research have been converted into table form showing the annual average particulate emissions per animal species and type of pen. This table is used for testing particulate matter standards when issuing permits for livestock farms. This involves calculating the particulate matter concentrations in the open air around a farm. The Committee notes, however, that this calculation can involve a considerable degree of uncertainty. Moreover, individual cases can be expected to deviate from the modelled particulate matter concentrations.²⁴ This is due to the use of averaged figures and a simplified dispersion model.

2.3.3 *Exposure-effect relationships: partly well understood, partly poorly understood*

Most of the research carried out into the harmful effects of acute and chronic exposure to particulate matter has focused on the PM₁₀ and PM_{2.5} fractions in urban areas. Clear exposure-effect relationships have been established for decreased lung function, exacerbation of respiratory complaints, and early mortality mainly due to respiratory tract disorders and cardiovascular disease. In this connection, there is no evidence of a threshold value beneath which no effects occur.

The coarser fraction within PM₁₀ (particles between 2.5 µm and 10 µm in size) was initially believed to be much less harmful to health than PM_{2.5}. Some time ago, however, a review article concluded that exposure to coarse particulates, too, can cause respiratory complaints.²⁵ Since then, the results of several recently published studies have demonstrated the existence of a relationship between exposure to coarse particulates and early mortality.^{26,27} This also involved urban populations.

Little systematic research has been carried out into the health effects of exposure to particulates in rural areas. Virtually nothing is known about a possible difference in harmfulness between rural and urban particulates, or about the fractions involved. That also applies to the specific rural situations addressed by this advisory report, namely the harmfulness of rural particulate matter around livestock farms. In addition, given the current level of knowledge, it is unclear how results obtained for urban environments can be translated into these rural situations. The Committee nevertheless considers it likely, at least as far as the inhalable particulate fractions are concerned, that exposure-effect relationships in these situations do bear a certain resemblance to those for urban particulates. Given the higher concentrations of endotoxins and micro-organisms in rural particulates, however, it does seem likely that there will also be some differences.

One final comment on particulates larger than 10 µm. In practice, measurements of this fraction are now seldom made, and there is little or no research into its health effects. Yet this particulate fraction in particular is potentially highly relevant, as it has been linked with livestock farms and exposure to infectious agents. It could be involved in the development or aggravation of rhinitis symptoms (inflammation of the nasal mucosa). Many of the pollens that cause hay fever are contained in this particulate fraction. Little is known about the exposure-effect relationships associated with these coarser particles.

2.4 A closer look at endotoxins

Endotoxin is often regarded as an indicator of microbial exposure in general, partly because endotoxins are relatively easy to measure. There is a considerable body of research into the exposure of workers in various sectors of industry to endotoxins, including those who work in animal pens.²⁸ For instance, the concentrations encountered in livestock farming have, without exception, been found to have acute and chronic effects on lung function, which are associated with respiratory complaints. Also, experimental studies have shown that inflammatory reactions in the respiratory system can occur several hours after exposure to dust from animal pens.

The Committee makes reference to a 2010 Health Council advisory report for comprehensive scientific details on endotoxins and for the assessment of that information.²⁸ A new health-based recommended exposure limit for workers has been derived partly on the basis of experimental research into potentially susceptible individuals: 90 EU/m³.²⁸ The critical effect is an acute decline in lung function. According to the advisory report in question, exposure to concentrations below that recommended exposure limit poses no risks to workers' health.

As mentioned in Sections 2.1 and 2.2, concentrations measured in the open air around livestock farms are typically below 10 EU/m³, with the exception of measurements made in the vicinity of poultry farms (see Section 2.2.1). The "Intensive Animal Husbandry and Health" researchers emphasise that the measurement series in question was limited in scope. They also point out that the measurements may be highly dependent on specific meteorological conditions and local circumstances, and that no conclusions can be drawn about long-term averages.

While these measured values are indeed below the recommended exposure limit indicated above, local residents (or certain groups among them) might be more susceptible than the workers involved.^{29,30} One way to allow for this, in certain situations, would be to incorporate an intraspecies uncertainty factor.^{7,9} In the light of current knowledge, it is impossible to say how large this factor would need to be. This is partly because it is unclear how the averaging of exposure over time should be discounted. If the use of such an uncertainty factor is nevertheless deemed to be desirable, the Committee feels that, in the light of the current level of knowledge, the standard factor 3 would be the obvious choice.⁷ This would give a health-based recommended exposure limit for the general

population of 30 EU/m³. Section 4.1.2 gives brief details of the potential practical implications.

2.5 Micro-organisms: more questions than answers

The above-mentioned review addresses the occupational risks to which those working in the livestock industry are exposed, in terms of a representative selection of zoonoses.⁴ This can involve either being a carrier or suffering an infection, depending on the type of micro-organism in question. Transmission routes can vary greatly. These range from direct contact with animals to dispersal through the air, during transport and from manure.

Can the data on health effects in livestock farmers and workers in the livestock sector be extrapolated to risks to local residents? On the basis of documented occupational risks, the Committee cannot make any statements concerning the risks to those in the vicinity of livestock farms. However, it does have the impression that, under normal conditions (i.e. when there are no current outbreaks), the relevant microbial risks to local residents are limited. However, little is known about exposure-effect relationships or exposure-response relationships for micro-organisms, and there are no standard measurement methods.

2.6 Outbreaks of zoonoses

As the Committee pointed out in the previous section, under normal circumstances, it seems that those living in the vicinity of livestock farms in the Netherlands are only exposed to limited microbial risks. However, outbreaks of new zoonoses still occur from time to time. Such outbreaks can pose a threat to public health, as was shown in the case of Q fever. In a previous advisory report, the Health Council indicated that it is difficult to determine the risk of a zoonotic outbreak with any accuracy.³¹

For quite some time now, it has been recognised that there is room for improvement with regard to current systems for the early detection of new zoonotic diseases in humans and farm animals. In this connection, the Health Council pushed for changes to be introduced, such as the further development of syndrome surveillance (which focuses on categories of disease symptoms).³¹ Recently, a consortium of Dutch research institutes developed a blueprint for an improved horizon scanning/early warning system.³² In particular, this involved the establishment of a structurally integrated monitoring group, and the creation

of a protocol defining how the various agencies should cooperate to combat zoonotic outbreaks.

2.7 Final stocktaking

In the Committee's view, there is some evidence to indicate that - under normal circumstances (i.e. when there are no current outbreaks) - living near livestock farms can entail various health risks. However, the Committee adds that what little scientific information is available on this topic is both heterogeneous in nature and of limited power. Even the broad-based "Intensive Animal Husbandry and Health" study is more a point of departure for further research activities than a source of conclusive answers to the issues addressed in this advisory report. The Committee takes the view that, in scientific terms, a study's results can only provide a good basis for policy once their main points (or various relevant aspects thereof) have been confirmed by other studies.

However, there are additional considerations that may be relevant to policy. All of the available information on particulate matter points to a relationship between exposure and health problems. This finding is mainly based on studies carried out in urban areas. The Committee feels, however, that the detailed spectrum of health problems and complaints in the countryside is likely to present a rather different pattern. This is because the cocktail of particulates contains far fewer ultrafine particulates, less PM₁₀, and higher levels of coarse particulates involving various microbial components and endotoxins.

Incidentally, there are clear indications that exposure to endotoxins only produces an effect above a given threshold concentration. Given the current level of knowledge, it is not possible to give a reliable indication of the exact concentration involved. Current information relates to workers who have suffered relatively high levels of exposure. Significant differences in susceptibility might be found if the general population were to be compared to workers. The results of those studies described in Section 2.2.1 seem to indicate the existence of possible effects at relatively low exposure levels. However, the Committee feels that it is still far from clear how this data should be evaluated in relation to all of the other scientific information on endotoxins.

Even less is known about exposure-effect relationships or exposure-response relationships for micro-organisms. In the case of micro-organisms within a given animal species, limited exposure can lead to infection, with or without accompanying symptoms. Transmission to humans often requires a higher dose.

In addition, exposure to the various agents will depend on the type of animals involved, and on general farm management practices. In general, it is true to say that the further away the farm, the lower the concentrations of certain parti-

culates, endotoxins, and micro-organisms. These concentrations will also depend on the farm's emission levels. A range of other factors may also complicate matters, such as buildings and green areas in the vicinity, in addition to meteorological conditions. There is no data on the exact separation distances and concentrations associated with increased health risks to local residents (or to certain susceptible groups among them). The limited information available seems to suggest that poultry farms, pig farms, goat farms and mink farms are more likely to entail health risks than cattle farms. Further research is needed into the differences between small farms and large factory farms, in terms of emissions. Provided that they have good technical facilities, large farms are not automatically stronger sources of microbial agents.

To date, Q-fever outbreaks are the only health risk for which there is robust scientific evidence. Such outbreaks, which are known to occur from time to time, can involve health effects several kilometres away from the affected farm. There is also evidence of a higher risk around large farms.

Broader consideration of the risks

In the introductory chapter, the Committee notes that concerns about the risks of intensive livestock farming range far wider than clinically defined forms of health impairment alone. Debates throughout the country show that issues such as odour nuisance and risk perceptions, in particular, weigh heavily on people's minds. These perceptions are strongly coloured by other social values, such as animal welfare, sustainability, quality of residential life, landscape quality and economic considerations. Before long, this gives rise to a public discussion about experiences, feelings and interests, rather than a scientific debate about health risks. This involves entering an area that falls partly outside the remit of the Health Council, as a scientific advisory body. Nevertheless, a number of issues do merit scientific consideration, especially where odour nuisance and risk perceptions are concerned. Indeed, this is the topic of this particular chapter.

3.1 Odour nuisance, quality of life and health

In a general advisory report on air pollution issued as long ago as 1977, the Health Council stated that health impairment should be interpreted in broad terms, and that it involves more than just disease and reduced physical function.³¹ In taking this position, the Council was following the same broad definition of health as that propagated by the WHO, i.e. that health is not merely the absence of disease or other defects, it is “a state of complete physical, mental and social well-being”. This definition, too, is not without problems (see the

2010 background report by the Health Council³⁴), but it does do justice to the interdependence of health and well-being. The Committee takes the view that odour nuisance plays a particularly important part in the present issue.

3.1.1 *General insights*

Various studies (the main points of which are described in a report by the National Institute of Public Health and the Environment²) have shown that the emission of certain substances by industry and farms can have a direct effect, in the form of odour nuisance. This is true, even when individuals are exposed to concentration levels below which toxic effects can be excluded.

Various factors are involved in the occurrence of odour nuisance. These include the frequency and duration of exposure to the odour in question, as well as the intensity and character of the odour itself. The extent to which people are affected by odour nuisance depends partly on demographic factors such as age, gender, socioeconomic position, and partly on their own perceived state of health. Odour nuisance leads to adaptive behaviour (e.g. closing windows and doors, or staying inside) and may indirectly lead to health problems such as headaches, irritation of mucous membranes, nausea, and insomnia. All this is at the expense of the quality of residential life in the area. It also involves a great deal of social disquiet. Also, people who express concern tend to be more affected by nuisances and symptoms, as are patients with asthma, allergies or certain forms of hypersensitivity.²

3.1.2 *Odour nuisance around intensive livestock farms*

Some of the studies into odour nuisance have targeted the livestock sector. These tend to confirm the general picture outlined above.^{2,35} For example, one German study showed that an increase in the number of odour nuisance reports corresponded to a decline in people's quality of life.¹² It should also be pointed out that people with economic ties to the sector reported less odour nuisance. In the Netherlands, too, various studies have been carried out in this area.³⁶⁻³⁹ These included determinations of dose-response relationships for local residents in the vicinity of pig farms. In this context, a number of variables were taken into account. For a given level of odour immission (odour reception), local residents in areas with a high density of pig farms reported less odour nuisance than those living in areas with fewer pig farms. In addition, farmers reported the lowest levels of odour nuisance. For a given level of odour emission, single sources were associated with higher levels of odour nuisance than multiple sources. The

workers in question were unable to account for this effect. Those studies that included details of the distances to livestock farms found that some individuals reported odour nuisance at distances of up to several kilometres from the farm in question.

3.2 Risk perception: different perspectives

Even if people have not experienced any health problems (yet), they may still be concerned about the quality of their local environment. It is known that a lack of control over a situation can cause disquiet and exacerbate stress.^{2,40} When assessing risks, experts often tend to emphasise quantitative data and analyses, while lay people's judgment is much more strongly influenced by qualitative aspects, such as their ignorance or lack of control over the emissions in question, and the uncertainties of the health risks involved. In some cases, this situation can be reversed. For instance, those who are familiar with a given situation or who have economic ties to a given activity tend to characterise risks as being less serious. Another factor here is people's confidence in the authorities.

This certainly applies in the case of health risks to local residents living in the vicinity of livestock farms. As the Committee has already pointed out, social disquiet about the intensive livestock industry is determined by many different factors. These include sustainability, animal welfare, perceived nuisance, perceived quality of residential life, landscape quality and concern about outbreaks as a threat to public health, all in relation to the economic interests of the livestock sector. Accordingly, before reaching policy decisions, it is very important that there be timely consultation and an effective communication of concerns and policy objectives in this area. Such social debates can help all parties to reach a reasoned judgment. They can also help to improve the relationship of trust between the government, the people and the farmers.^{8,40} That, in turn, may contribute to the well-being of local residents, and foster support for control measures. In short, people and their concerns (which are occasionally quite grave) should be taken seriously. In the next chapter, the Committee describes how this process can take place in a structured and standardised way.

Risks: administrative assessment and management

In various advisory reports, the Health Council has given details of the elements involved in dealing with risk issues.⁶⁻⁹ These reports took an overall view of risk analysis on the one hand, and risk assessment and risk management on the other. The previous two chapters dealt with the description and analysis of risks, including the associated uncertainties, risk perceptions, and social values. In the present chapter, the Committee focuses on issues associated with the assessment and management of these risks. Could any existing frameworks be used to assess the severity, acceptability, or negligibility of the risks in question? If so, which ones, and subject to what conditions?

4.1 A single quantitative assessment framework: still just out of reach

The request for advice concludes that there is no broad assessment framework for the health risks associated with living in the vicinity of livestock farms. The Committee has pointed out that there is little evidence to confirm the existence of these risks. Nor do we have any direct exposure-effect relationships or exposure-response relationships. As a result, it is currently unable to derive a clear quantitative assessment framework setting out the maximum permissible risk levels for local residents. Nevertheless, this advisory report has already made brief mention of several other frameworks, relating to components of the cocktail of particulates around livestock farms. The Committee will address them briefly here.

4.1.1 *Standards for particulate matter*

European standards for particulate matter are already in place, although these do not relate to the composition of the particulates in question. The livestock sector is required to observe these standards. The standard for PM₁₀ involves an annual average of 40 µg/m³. The daily standard is 50 µg/m³, which may not be exceeded on more than 35 days per year. The standard for PM_{2.5} involves an annual average of 25 µg/m³. In terms of everyday policy, the main focus is on the daily standard for PM₁₀, because this standard is exceeded more frequently than the annual average standards for PM₁₀ and PM_{2.5}.

In Section 2.3.3, however, the Committee points out that rural particulates are, in many ways, clearly different to urban particulates. The Committee therefore feels that, given the current level of knowledge, the present particulate matter policy framework offers no effective points of reference for the assessment and management of the health risks in question.

4.1.2 *Health-based recommended exposure limit for endotoxins*

As the Committee pointed out in Section 2.4, with regard to endotoxins, while a health-based recommended exposure limit for workers (30 EU/m³) is already in place, there is still no recommended exposure limit for the general population. The Committee suggested the option of using a standard uncertainty factor of 3 when extrapolating from workers to the general population. That would yield a health-based recommended exposure limit of 30 EU/m³. Further research into the effects of endotoxin exposure in the general population (or in potential high-risk groups within that population) might, in theory, lead to a better substantiated recommended exposure limit.

When set against the very limited amount of exposure data available (cited in Chapter 2), it can be seen that within a few dozen metres of some livestock farms, and of one poultry farm in particular, endotoxin concentrations can be as high as 30 EU/m³. As far as we are currently aware, this concentration is significantly lower at greater distances. According to current data, it merges into the background level at a distance of about 250 metres. The concentrations may be higher in areas with a high density of livestock farms, but this possibility can neither be proven nor refuted as no data is yet available.

The studies discussed in Section 2.2, which were performed outside the Netherlands, appear not to exclude the possibility of effects at relatively low exposure levels. However, the information available to date is too limited and too

heterogeneous to support further conclusions. In other words, based on the available knowledge about endotoxins, the Committee feels that it is too soon to reach a verdict concerning the possible adverse health effects that might be associated with such significantly lower exposure levels.

4.1.3 *Micro-organisms: only recommended separation distances for farms and frameworks for outbreaks*

In general, virtually nothing is known about exposure-response relationships with regard to micro-organisms. Recommended separation distances have been formulated but, as the Committee pointed out, these are the distances that must be maintained between livestock farms to prevent the spread of animal diseases and zoonoses.⁴Based on the swine fever epidemic, separation distances of one to two kilometres have been recommended.⁴¹ There are also contingency plans for outbreaks of animal diseases. To some extent, these also focus on measures to protect public health. These policy frameworks are not intended for normal, everyday situations. Given the lack of exposure-response relationships, neither emission standards nor separation distance standards can be substantiated in health terms.

4.1.4 *Standard setting in accordance with the provisions of the Odour Nuisance and Livestock Farming Act*

The Odour Nuisance and Livestock Farming Act sets a lower limit on the permitted distance between the outside of an animal enclosure and the outside of a nearby residential property occupied by individuals not associated with the farm in question. For instance, pig farms and poultry farms are subject to minimum separation distances of 50 metres and 25 metres, respectively, inside and outside built-up areas. The corresponding separation distances for dairy farms are 100 metres and 50 metres respectively. Incidentally, using the odour nuisance calculated on the basis of the Odour Nuisance and Livestock Farming Act, a larger separation distance is used in the vast majority of cases.

However, neither the previous odour standards nor the current recommended standards set out in the Odour Nuisance and Livestock Farming Act are based on an exposure-response relationship. The Committee believes it is high time that legislation and enforcement in this area were placed on a firmer scientific footing. That would require further research.

The standards governing odour nuisance by livestock farms are considerably more flexible than those in industrial sectors. In the case of livestock farming, the

standard for sites which have numerous intensive livestock farms but which are located outside built-up areas is 14 ou_E/m³(European odour units, a measure of odour concentration), while for other industries a standard of around 2 ou_E/m³ is usual. The Odour Nuisance and Livestock Farming Act also allows local authorities to exceed the standard, within a given range. This is intended to provide scope for balancing economic interests against an acceptable level of environmental quality, at local level.

4.2 A procedural approach: the Health and Environment Assessment Framework

While, given the current level of knowledge, a single quantitative assessment framework may not be possible, it is nevertheless essential to have a clear strategy for dealing prudently with the available information, uncertainties, and social values. The Committee feels that it is vital to hold strategic discussions between the government, local populations, farmers and other stakeholders at an early stage (i.e. before matters are affected by specific permit applications).

First and foremost, a questionnaire should be used to systematically identify any relevant insights, perceptions, concerns and values (as cited or discussed by the Committee in the two previous chapters). The Committee feels that the *Assessment Framework for Health and the Environment*^{42,43} might prove very useful in this regard. That structured assessment framework incorporates five types of information (see Table 2 in Annex C): (1) the scale of the problem; (2) the severity of existing and potential health effects; (3) people's perception of the problem; (4) the need for intervention (and the available options); and (5) the costs and benefits of measures to curtail the risk involved. In past years, this assessment framework for decision-making on various environmental health issues has certainly proved its worth.⁴³ In the present case, there is a major shortage of quantitative information, and information categories (1) and (2) are still subject to numerous uncertainties. Yet the Committee feels that this in no way detracts from the usefulness of this framework. On the contrary, this actually provides the clearest possible indication of where scientific deliberations end and where policy-based deliberations begin.

As the Health Council noted, in a previous advisory report, a high quality assessment framework that has been fully filled-in must be complemented by a rigorous decision-making process if the requisite structuring and transparency is to be achieved.⁴³To foster sufficient support, each of the stakeholders must have the opportunity to add their own input. The Committee believes that this approach should mainly be implemented at local level, primarily because local

conditions can vary significantly (e.g. due to the number and type of livestock farms and to differences in population density). There may also be reasons for giving due consideration to various social interests (such as the establishment of new farms and new residential zoning plans). As a result, the final evaluation of each of the aspects in the assessment framework in question will also mainly have to take place at local level.

These local discussions are the responsibility of the local authorities. The Committee takes the view that the municipal medical and health service has a clear role in this matter, as it is this body's task to advise local authorities on their health policy. In this way, procedural standardisation and local customisation can go hand in hand. However, the Committee does reiterate the need for specific agreements to be reached in this regard. For instance, such customisation should focus on matters such as establishing locally applicable, emissions-related, minimum separation distances between livestock farms and residential areas.

4.3 Phased risk management

There are basically two approaches to risk management: cutting the emission of agents and, possibly as a supplementary measure, reducing human exposure.

Section 4.1 shows that, given the current level of knowledge, it is not possible to formulate scientifically substantiated separation distance requirements for livestock farms and residential areas (for the purpose of either preventing health risks or restricting them to an acceptable level). While our knowledge is patchy, this certainly does not preclude the enforcement of minimum separation distances or maximum permissible emissions on policy grounds. At the administrative level, the imposition of separation distance requirements is certainly an option. However, the Committee is fully aware that such separation distance requirements might well vary from one local authority to another, depending on specific local conditions. Various risk control options, each with their own positive and negative, certain and uncertain effects will have to be judged on their merits and assessed in a transparent manner, all at local level. The Committee outlines just such a procedural approach in Section 4.2.

Using a source-oriented approach, the Committee draws a distinction between short-term and longer-term measures. Risk mitigation measures and techniques such as air scrubbers (which are even now coming online, while still undergoing rapid development) can, to some extent, cut the emission of substances that cause odour nuisance or health impairment. However, the Committee feels that there must also be an unremitting focus on new forms of farm management and occupational hygiene. It is also vital to make further cut-

backs in antibiotic use. Last year, the Health Council focused extensively on this issue.⁴⁴ However, many more adjustments will be needed to make the livestock industry as zoonosis-free as possible. Finally, the future form of the livestock sector in the Netherlands, in terms of size and location, is a political issue that could become the central theme of a national debate.

4.4 Importance of further research

In areas characterised by little or no scientific knowledge, further focused research can either eliminate these deficiencies entirely or, at the very least, remedy them to some extent. Within the scope of this advisory report, the Committee can only outline the main points of such a research programme. Here too, the “Intensive Animal Husbandry and Health” study described in Section 2.1 forms a useful starting point. As the Committee has emphasised, there is a great need for high quality research of this type. In other words, for various local situations, we would like to know:

- 1 the exposure of local residents to endotoxins and micro-organisms in particular, as a function of their distance from livestock farms, and of the types of farms and categories of animals involved;
- 2 the extent to which health problems occur in these local residents and whether any susceptible groups can be identified in this connection;
- 3 what can be said, given more comprehensive and better information on (1) and (2), about exposure-effect relationships or exposure-response relationships.

There are also various problems associated with odour nuisance that need to be clarified. Studies of control measures against zoonoses also merit a place on the research agenda. Collectively, these separate elements should theoretically bring opportunities for quantitatively-based risk analysis and risk management within reach.

Response to the request for advice

This advisory report sheds light on the risks of living near livestock farms, from the scientific, social, and control viewpoints. It has become clear that there is relatively little scientific data on the health risks to local residents. This means that policy decisions in this area will have to lean, to a relatively large extent, on considerations of a different nature. In this final chapter, the Committee once again briefly summarises its main findings and conclusions. Here too (with reference to the preceding chapters), it also answers the four clusters of specific questions contained in the request for advice (see Annex A for details of the full text).

5.1 Tried and tested approach: a multidimensional assessment framework

What would constitute a suitable framework for assessing the health risks to local residents in areas with intensive livestock farming, one that could potentially provide a basis for setting standards and implementing measures? That is the key question submitted to the Health Council. The request for advice shows that the government officials in question are primarily concerned about the health risks under normal circumstances (i.e. when there are no current zoonotic outbreaks). While there is some evidence of such risks, the Committee feels that the current data set is too narrow and too heterogeneous to support any firm conclusions. Accordingly, when it comes to more detailed issues, we are

still working largely in the dark. In this situation, what separation distances between residential areas and livestock farms can be considered safe? Do the risks vary according to the type or size of the farm in question, or to the animal species involved? Are there any groups of local residents with heightened susceptibility? These are questions for which it is not yet possible to supply detailed answers, especially in quantitative terms.

In view of this state of affairs, a single general quantitative assessment framework (which sets out the maximum permissible risk to local residents) is still out of reach. Even with well substantiated quantitative benchmarks, when risk assessment and risk management are at issue additional considerations are involved. This is all the more so in the present situation. The many uncertainties involved, as well as social disquiet and differing perceptions of risk make an orderly and transparent discussion of all the facets (or dimensions) of this environmental health issue indispensable. The Committee feels that the current *Assessment Framework for Health and the Environment* provides useful points of reference in this connection. It is certainly the case that the size and severity of health effects are still subject to many uncertainties. Nevertheless, the Committee believes that the best way to help create support for policy decisions is to discuss the elements of that framework, in a structured way, with all of the stakeholders concerned. At the same time, this will also serve the well-being of local residents. The Committee takes the view that these discussions should be conducted at local level, under the responsibility of the local authorities, and with the support of the municipal medical and health service. Here, the focus should always be on agreements about locally applicable and emissions-related minimum separation distances between livestock farms and residential areas.

5.2 Does current policy on particulate matter provide sufficient guidance?

No. That policy is mainly based on studies carried out in urban areas. The cocktail of particulates around livestock farms is clearly different, in terms of its composition. It contains fewer ultrafine particulates, less PM₁₀, and higher levels of coarse particulates, including various microbial components and endotoxins. As a result, the spectrum of health problems and complaints can be expected to present a different pattern. Nevertheless, the Committee considers it likely that, as in the case of urban particulates, a reduction in particulate matter concentrations around livestock farms can help to reduce health risks. Further research is needed to determine which components of the cocktail of particulates

are most important in health terms. The current understanding is that microbial agents and endotoxins are particularly relevant in this respect.

5.3 How effective might risk mitigation measures be?

In this advisory report, the Committee has explained that it is unable to make clear statements about the health risks of living near livestock farms, due to shortcomings in the level of knowledge. This means that it is equally difficult to determine the effectiveness of targeted risk reduction measures. However, a number of research programmes have been launched with a view to improving management practices and occupational hygiene in the livestock industry. An integral aspect of this work involves the reduction of emissions, with particular emphasis on the emission of particulates and odour. For instance, the use of air scrubbers enabled many pig farms to limit their odour emissions and expand the scale of their operations. The fact is, however, that the operating efficiency of air scrubbers at many farms leaves much to be desired. As a result, there is an increased risk that local residents will suffer severe odour nuisance.

5.4 Is it necessary and useful to impose minimum separation distances between residential areas and livestock farms?

Our current knowledge is insufficient for us to answer the question about the radius of the zone within which, under normal conditions, local residents are exposed to increased health risks. Our knowledge of outbreaks is more complete. In the case of Q fever, the distance involved can be up to five kilometres. However, the simple reality is that there is still disquiet among many local residents. In order to meet their concerns, it may indeed be both necessary and useful to impose emission-related minimum separation distances that are not based on odour nuisance alone. These distances could then be determined using local, tailor-made approaches, in the context of a social dialogue (the elements and contours of which have been outlined by the Committee in Chapter 4). To summarise briefly, minimum separation distances can be substantiated in terms of policy but not in terms of health.

5.5 Do livestock farms pose any other significant health risks?

The Committee contended that this involves more than health risks, in the narrowest sense of the word. Furthermore, in scientific terms, this area is still poorly understood, except in situations where a zoonotic outbreak is taking

place. What is also important here is the very interdependence of health, well-being, and quality of residential life, as well as the reality of differing risk perceptions. This is why the Committee has emphasised that policy must also focus on reducing odour nuisance (see also Section 5.3). It feels that there is considerable scope for improvement through greater compliance with existing regulations in this area. In the Committee's view, it is particularly important that the issue addressed in this advisory report should not only be viewed from a scientific perspective. It should also be seen through the lens of social disquiet and attempts to ameliorate this. The presence or absence of health risks, however these may be defined, is just one of many underlying factors. The others range from animal welfare to sustainability, and from the quality of residential life to landscape quality. As the Committee has constantly emphasised, the only way to do justice to this complex issue is to stage an orderly and transparent local consultation exercise involving all of the stakeholders.

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- A Request for advice
 - B The Committee
 - C Assessment Framework for Health and the Environment

Annexes

Request for advice

Letter dated 27 September 2011 (reference PG-CI-3077216) from the Minister of Health, Welfare and Sport to the President of the Health Council of the Netherlands.

I hereby request, on behalf of myself, the State Secretary for Economic Affairs, Agriculture and Innovation, and the State Secretary of Infrastructure and Environment, that you develop an assessment framework for the health risks to the population posed by various micro-organisms and endotoxins emitted by the livestock industry. In this context, please advise me regarding the standards and measures that might potentially be implemented.

In June 2011, Utrecht University's Institute for Risk Assessment Sciences (IRAS), the Netherlands Institute for Health Services Research (NIVEL), and the National Institute of Public Health and the Environment (RIVM) published a report on the possible impact of intensive livestock farming on the health of local residents. One of the recommendations made in this report was that an assessment framework should be developed. In a letter to the Lower House of the Dutch Parliament (annex), I indicated that it was my intention to approach your Council for advice on this matter.

I would ask that you take the following issues into account when preparing an assessment framework:

- Distinguish between the different types of livestock farms and animal species involved. As the above-mentioned study also shows, every type of livestock farm has its own specific problems, which excludes the option of a generic approach.

- When developing an assessment framework, take into account the presence of susceptible groups within the population, and the period for which the general population is exposed.
- Allow for the effects of occupational exposure to endotoxins when developing the assessment framework.
- When developing an assessment framework, take account of comparable assessment frameworks for risks to the health of local residents, such as traffic, power lines and industrial processes.

In addition to the preparation of an assessment framework, I would be grateful for your views on the following issues:

- 1 Is current policy (including standard setting) on particulate matter from livestock farms also sufficient to effectively manage the risks posed by micro-organisms and endotoxins to the health of local residents? If not, in what way does it need to be supplemented?
- 2 How do individual variants of potential risk mitigation measures (such as management measures and the further restriction of emissions) vary in terms of their expected effectiveness? In this connection, please take account of all relevant exposure routes and possible targets for measures.
- 3 In this context, can you indicate the usefulness and necessity of imposing minimum separation distances (and if so, what should these be) between livestock farms and residential areas in the Netherlands. Please indicate whether it would be possible to reduce a given minimum separation distance, or omit it entirely, if certain emission abatement measures or other risk-management measures were to be taken.
- 4 Based on the available scientific information, can you indicate whether there are any relevant factors other than particulate matter, micro-organisms and endotoxins that might cause livestock farms to pose substantial risks to public health? In a partial advisory report to be issued separately, at a later date in 2012, would you address the questions of how these risks should be assessed and how they can be restricted (based on the available scientific information)?

I have given an undertaking to the Lower House of the Dutch Parliament that I would ask the Health Council to report to me on this matter before the end of the year. I would ask you to give high priority to this request for advice, with the exception of the partial advisory report referred to in Question 4, which can be issued at a later date. Can you give me an indication of when you expect to be able to report on the assessment framework and the first three questions?

Yours sincerely,
 The Minister of Health, Welfare and Sport,
 (signed) Mrs E.I. Schippers

B

The Committee

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- Prof. L.J. Gunning-Schepers, *chairman*
President of the Health Council (until 1 April 2012), President of the Executive Board of the University of Amsterdam/Amsterdam University of Applied Sciences
 - Prof. B. Brunekreef
Professor of Environmental Epidemiology, Institute for Risk Assessment Sciences, Utrecht University
 - Prof. J.T. van Dissel
Professor of Internal Medicine, in particular infectious diseases, Leiden University Medical Center
 - Prof. D.J.J. Heederik
Professor of Health Risk Analysis, Institute for Risk Assessment Studies, Utrecht University
 - Prof. J.A.P. Heesterbeek
Professor of Theoretical Epidemiology, University of Utrecht (until 1 April 2012)
 - Dr. R. Houba
Occupational hygienist, Netherlands Expertise Centre for Occupational Respiratory Disorders, Utrecht
 - H.W.A. Jans
Specialist in Environmental Medicine, Nijmegen
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- Prof. M.C.M. de Jong
Professor of Quantitative Veterinary Epidemiology, Wageningen University and Research Centre
- Prof. J.C. de Jongste
Professor of Paediatric Respiratory Medicine, Erasmus Medical Centre, Rotterdam
- Prof. M.P.G. Koopmans
Chief Virology Section, Diagnostic Laboratory for Infectious Diseases and Perinatal Screening, National Institute for Public Health and the Environment, Bilthoven
- Dr. N.W.M. Ogink
Researcher, Livestock and Environment, Wageningen University and Research Centre
- Prof. J.A. Stegeman
Professor of Farm Animal Health, Utrecht University
- J.W. van den Brink, *observer*
Ministry of Health, Welfare and Sport, The Hague
- K. Locher, *observer*
Ministry of Infrastructure and the Environment, The Hague
- J.W.F. Zijlker *observer*
Ministry of Economic Affairs, The Hague
- E.J. Schoten, *scientific secretary*
Health Council of the Netherlands, The Hague

The Health Council and interests

Members of Health Council Committees are appointed in a personal capacity because of their special expertise in the matters to be addressed. Nonetheless, it is precisely because of this expertise that they may also have interests. This in itself does not necessarily present an obstacle for membership of a Health Council Committee. Transparency regarding possible conflicts of interest is nonetheless important, both for the chairperson and members of a Committee and for the President of the Health Council. On being invited to join a Committee, members are asked to submit a form detailing the functions they hold and any other material and immaterial interests which could be relevant for the Committee's work. It is the responsibility of the President of the Health Council to assess whether the interests indicated constitute grounds for non-appointment. An advisorship will then sometimes make it possible to exploit the expertise of the specialist involved. During the inaugural meeting the

declarations issued are discussed, so that all members of the Committee are aware of each other's possible interests.

C

Assessment Framework for Health and the Environment

Table 1 is a diagrammatic illustration of the Assessment Framework for Health and the Environment. ⁴²

Table 1 From Assessment Framework for Health and the Environment.

I Scope of health impairment	II Severity of health effects	III Assigning a value to the effects or risks	IV Intervention: opportunities or necessity	V Costs and benefits
I1. How many individuals are exposed?	II1. Which diseases or symptoms are involved, what is known about the effects of this type of exposure?	III1. Does the risk threaten people's sense of security?	IV1. Do standards or requirements (European or otherwise) necessitate intervention?	V1. What are the costs of retaining current policies, unchanged?
I2. How many individuals become ill or develop symptoms?	II2. What health effects do the victims themselves, or local residents, attribute to the exposure in question?	III2. Is the risk voluntary and/or manageable?	IV2. Is intervention possible? at source or at the recipient at European, national, regional, local level economic, technical, spatial, subsidies, legal, information provision	V2. Are there any details of the likely budget for measures?
I3. Is this figure likely to change in the future?	II3. Who (high-risk groups?) is suffering these health effects?	III3. Are there any other reasons why some consider the risk involved to be unacceptable?	IV3. Which bodies are responsible for intervention measures? Which ones are advocated?	V3. What would risk reduction or risk avoidance measures cost?
I4. Does the risk exceed the accepted Maximum Permissible Risk Level?	II4. How often do health effects occur (regularly, occasionally, constantly)?		IV4. How effective are these in theory, with regard to exposure reduction or disease prevention?	V4. How does that compare to other forms of health gains?
I5. How firm is the relationship between exposure and health effects?	II5. Is treatment possible?		IV5. How effective are they in practice, how soon can results be expected, how great is the pressure to falsify results, is enforcement possible?	V5. Do the measures have the desired effects in other policy domains?
I6. Of the total number of cases of disease, how many can be attributed to exposure?			IV6. Is there any current or anticipated social or political pressure?	V6. Do the measures have adverse effects in other policy domains?