SUSTAINABLE AND HEALTHY

WORKING TOGETHER TOWARDS A SUSTAINABLE FOOD SYSTEM

MARCH 2018

Council
for the Environment
and Infrastructure

About the Council for the Environment and Infrastructure

The Council for the Environment and Infrastructure (*Raad voor de leefomgeving en infrastructuur*, Rli) advises the Dutch government and Parliament on strategic issues concerning the sustainable development of the living and working environment. The Council is independent, and offers solicited and unsolicited advice on long-term issues of strategic importance to the Netherlands. Through its integrated approach and strategic advice, the Council strives to provide greater depth and breadth to the political and social debate, and to improve the quality of decision-making processes.

The Council for the Environment and Infrastructure (Rli)

Bezuidenhoutseweg 30

P.O. Box 20906

2500 EX The Hague

the Netherlands

info@rli.nl

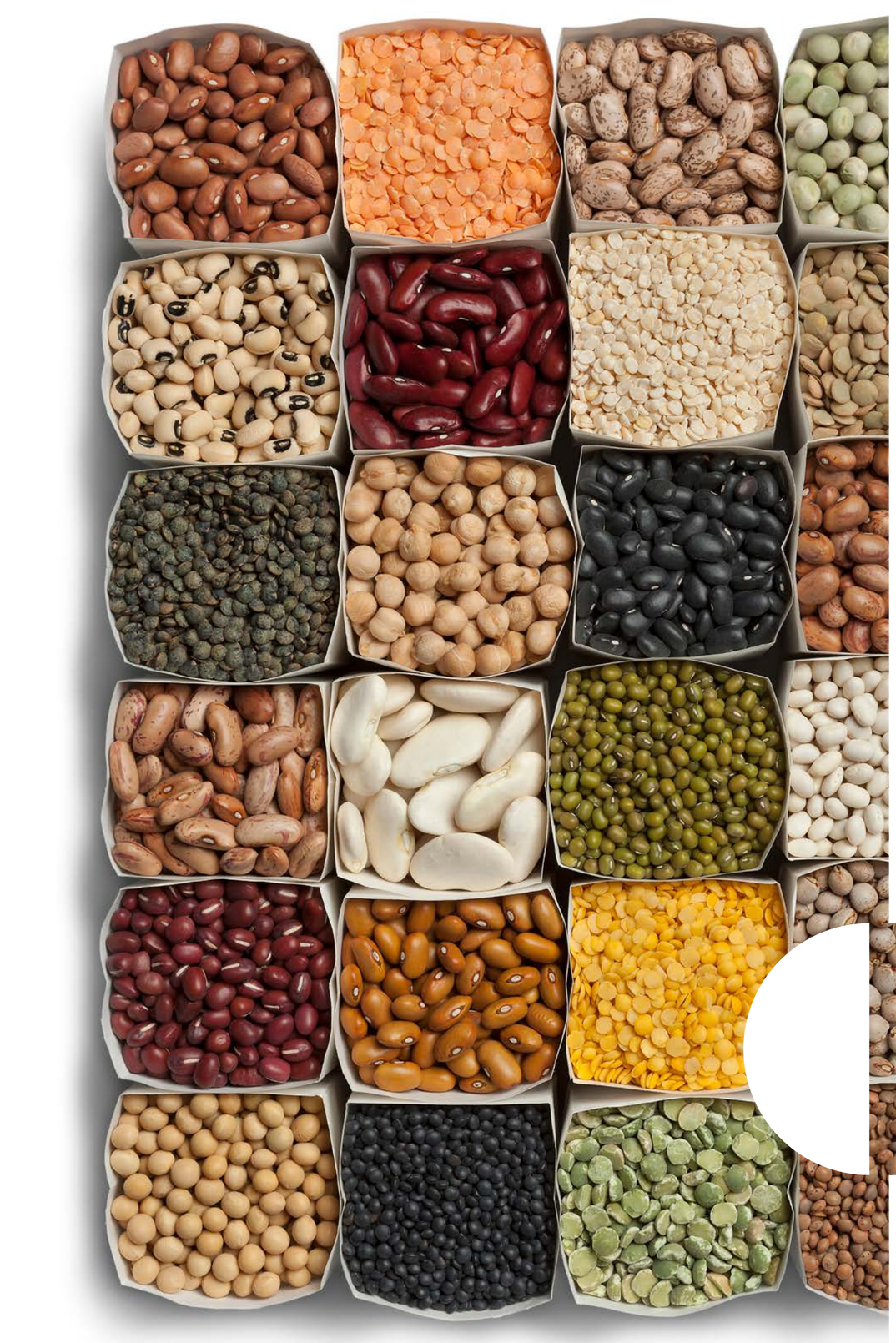
www.rli.nl

CONTENT

DESCRIPTION OF THE PROBLEM

POLICY

PERSPECTIVES



SUMMARY

The targets for reducing greenhouse gas emissions in the Paris climate agreement make the transition to a sustainable and healthy food system all the more urgent. The production and consumption of animal products such as meat, eggs and dairy products make a substantial contribution to the greenhouse gas emissions from this system. In 2050 the Dutch menu will contain fewer animal products and the emissions from livestock farming will be smaller. The Council for the Environment and Infrastructure (Rli) advises that food policy should be revised in anticipation of these developments in order to reduce the negative consequences of the necessary transition and take advantage of the opportunities, which also exist. A food policy for a sustainable and healthy food system will make it easier to resolve the climate change and other environmental problems in the livestock farming sector, while at the same time the environment will become healthier.

The food supply system in the Netherlands seems at first sight to be in good shape. More food is available than ever before, it is safer and relatively cheap. Dutch food is efficiently produced and exported all around the world. At the same time, though, scientists and the public have concerns about the impacts on the environment, biodiversity, health and animal welfare of the production and consumption of food. A more recent concern is how the production of our food affects climate change.

Climate change makes the transition more urgent

The Paris climate agreement presents the Netherlands with a huge challenge: in 2050 Dutch greenhouse gas emissions must be 95% lower than in 1990. At the moment livestock farming accounts for 10% of all greenhouse gas emissions in the Netherlands. Even if all the currently known technical measures were taken to reduce these emissions, in 2050 agricultural CO_2 emissions would take up the total amount of the Netherlands' permitted greenhouse gas emissions at that time (10 Mt CO_2-equivalents). Technological advances may well be able to reduce emissions further, but by how much remains far from certain. All things considered, the Council considers it more than likely that the livestock population will eventually have to be reduced in order to meet the climate targets and ensure a balanced distribution of the emissions reduction burden across the economy. It is imperative to revise food policy now, in anticipation of the necessary changes, and to present the livestock farming sector with a clear indication of where it stands and its prospects for the future. The economic losses to be borne by individual farmers will then be smaller and the costs to society will be lower.

Livestock farmers need clarity on emissions ceilings soon

Livestock farmers will have to make major reductions in their greenhouse gas emissions. If livestock farmers are to make the necessary long-term investments, the industry will soon need to know the emissions ceilings that will be imposed over the next few decades. These can be formalised in a Climate Act and the permitted emissions for each type of animal made transferable in the form of tradable 'emission rights', thus precluding the

need for more severe cuts in future and livestock sheds standing half empty. Giving farmers and parties in the value chain clarity about future emissions reductions will encourage them to bring forward innovations, develop new business models and/or shift their activities towards more plant-based food products.

Regional problems require measures agreed with provincial governments
Smaller livestock populations will in time reduce the impacts of livestock farming on the environment, landscape and biodiversity. Nevertheless, in several regions some environmental and health problems will remain, and for this reason specific policies will be needed to limit the impacts of livestock farming in these regions. The Council advises the national government to open negotiations with the relevant provincial governments on the financial and legal instruments needed to pursue such policies, preferably to be backed by a farm closure scheme.

Less animal protein on the menu
These emissions reductions are not just the responsibility of the livestock farming sector, but will also require a change in eating habits. A sustainable and healthy diet contains proportionally less animal protein and more plant protein. This implies a considerable change in dietary behaviour, because the consumption of animal protein has actually increased sharply over the past few decades. The Council advises adopting a food policy that aims to reduce animal protein consumption to no more than 40% of total protein consumption by 2030. The government can deploy various policy instruments to entice consumers to make healthy and sustainable dietary choices, for example by showing what a healthy and sustainable diet can consist of with the assistance of the 'Wheel of Five' (the rules and components of a healthy diet published by the Netherlands Nutrition Centre) and by mobilising TV chefs and others as ambassadors. Cooperation with the retail trade and 'out-of-home' food sector (restaurants, meal delivery services and business catering) will be essential to ensure consumption of more plant protein, vegetables and fruit. The government could also raise VAT or introduce an excise duty on animal products.

Opportunities for innovative plant-based protein products
Changes in consumer demand will create opportunities for the production of new, sustainable protein products prepared from plants such as pulses, beans and seaweed. A well-tuned food policy can create a domestic market for innovative products such as these. In turn, this will create new export opportunities for the Dutch food industry, and growing the raw produce needed to make these products will open up new prospects for farming.

Unique coalition of producers and consumers
In the 1950s and 1960s Dutch agricultural policy was dominated by the drive to achieve food security, which led to the leading international position currently enjoyed by the Dutch agricultural sector. Now, partly because of climate change, we again stand at the threshold of a crucial transition. The inescapable need to adapt our food system provides an excellent opportunity to unite farmers, the food processing industry, the retail sector and consumers in a unique coalition for sustainable and healthy food.

PART 1 | ADVICE

1

INTRODUCTION

The food supply system in the Netherlands seems at first sight to be in good shape. More food is available than ever before, and it is safer and relatively cheap. Dutch food is efficiently produced and exported all around the world. At the same time, though, scientists and the public have concerns about the impacts of the way this food is produced and consumed on the environment and biodiversity, both in the Netherlands and abroad, as well as on our own health and on animal welfare. A more recent concern is how the production of food affects climate change. These concerns are not new and efforts have been ongoing for many years to limit the environmental impacts of food production. However, these measures have so far had little effect.

Subject of this advice

In this advisory report the Council for the Environment and Infrastructure (Rli) provides pointers towards a sustainable and healthy production and consumption of food,[1] with an emphasis on the production and consumption of animal products.

The Council took the whole food supply chain into consideration, because, as the Scientific Council for Government Policy has argued (WRR, 2014), a policy for sustainable and healthy food can only be effective if it addresses all the parties involved. Also, in its advice on speeding up the transition to sustainable livestock farming [*Versnelling duurzame veehouderij*], the Social and Economic Council of the Netherlands argued for a joint approach and joint responsibility (Sociaal-Economische Raad, 2016). Not only farmers, but also consumers, the food industry (food manufacturing and processing) and the retail sector will have to play an active part in bringing about this transition.

The need to act now has become much more urgent in the wake of the recent Paris climate agreement. A large proportion (20% to 30%) of global greenhouse gas emissions are caused by the production and consumption of food. The food system therefore makes a major contribution to climate change (United Nations Environment Programme, 2016). Livestock farming is one of the main sources of greenhouses gases within the food system. According to the Food and Agriculture Organization of the United Nations, global livestock farming is responsible for around half of all emissions from the food sector (Gerber et al., 2013).

During the course of the twentieth century Dutch livestock farming expanded considerably in scale and now produces for domestic and international markets. The diet of the Dutch population has changed in step with this growth of the livestock farming industry and increasing amounts of animal products, and thus animal protein, are consumed. Making the national diet healthier and more sustainable will require a shift towards less animal and more plant protein in the daily diet (Gezondheidsraad, 2015; RIVM, 2017a). There are signs that we have reached this turning point. The long period of growth in the consumption of animal products appears to have come to an end and interesting prospects for new plant-based products are opening up for the food industry.

1 International organisations define a sustainable food system as follows: A sustainable food system is a food system that delivers food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised. See: http://www.un.org/sustainabledevelopment/development-agenda

Request for advice

What additional policy, or change of policy, is needed to speed up the transition to a sustainable and healthy food system (production and consumption)?

In this advisory report the Council focuses on animal products, because these products make a significant contribution to climate change and to public health and environmental problems. Moreover, the debate about possible solutions, such as reducing the size of the livestock population and cutting back on the consumption of animal products, is highly polarised. Animal welfare and food wastage fall outside the scope of this advice. For information on the health effects of the consumption of animal products we refer the reader to the publication Dutch Dietary Guidelines 2015 [*Richtlijnen Goede Voeding 2015*] by the Health Council of the Netherlands (Gezondheidsraad, 2015).

Starting assumptions

The Council is of the opinion that the Dutch livestock farming sector alone cannot be held responsible for the issues surrounding the food system. The dietary choices consumers make give them a responsibility, too. The production of meat places an undue burden on the use of natural resources, such as land and freshwater reserves, both in the Netherlands and elsewhere in the world. By choosing a healthier and more sustainable menu based on less animal-based and more plant-based food, consumers can help to make a more sustainable world.

The transition to a food system that is based less on animal products provides opportunities for the food processing industry and the retail sector, which can focus on the development of plant-based alternatives to meat, dairy products and eggs. At the same time, the transition also provides opportunities for the livestock farming industry. As environmental, health and above all climate policy make growing demands on farming practices, alternative business models oriented to the sustainable segment of the market will increasingly come to the fore. There will be opportunities for a 'nature-inclusive' approach with benefits for agro-biodiversity and landscape management, as well as circular principles for material flows aimed at reuse and waste prevention.

Structure of the report

Part 1 of this advisory report is structured as follows:

- Chapter 2 contains an inventory of the impacts of livestock farming on climate change, the environment and public health.
- In Chapter 3 the Council draws conclusions from this inventory and looks to the future. What are the goals to work towards? What conditions must be met to bring these goals within reach?
- Chapter 4 concludes Part 1 of the advisory report and contains policy recommendations.

Part 2 of this advisory report provides background information on specific topics discussed in Part 1. References are made to this supporting information at various places in Part 1.

2

IMPACTS OF LIVESTOCK FARMING

2.1 Impacts of livestock farming on climate change

Livestock farming involves the emission of methane and nitrous oxide, which are released during the digestion of organic matter and from manure. Both methane and nitrous oxide are powerful greenhouse gases. The annual emissions of these gases from livestock farming in 2015 were equivalent to 18 Mt CO_2 (18 Mt CO_2-equivalents), which makes livestock farming responsible for about 10% of total Dutch greenhouse gas emissions.[2]

The current target for 2020 for the Dutch agricultural sector is to reduce annual emissions of methane and nitrous oxide to 16 Mt CO_2-equivalents (Tweede Kamer, 2011). The coalition agreement for the third Rutte Government (Tweede Kamer, 2017a) contains a proposal for an additional indicative reduction of 1 Mt CO_2-equivalents of methane from livestock farming and manure application by 2030. A further reduction of 1.5 Mt CO_2-equivalents by 2030 is to be achieved from changes in land use, some of which are related to livestock farming.

The livestock farming sector is not expected to achieve its reduction targets for 2020 (Schoots et al., 2017). This is alarming, because the reduction targets for greenhouse gas emissions for 2030 and 2050 will be higher still.

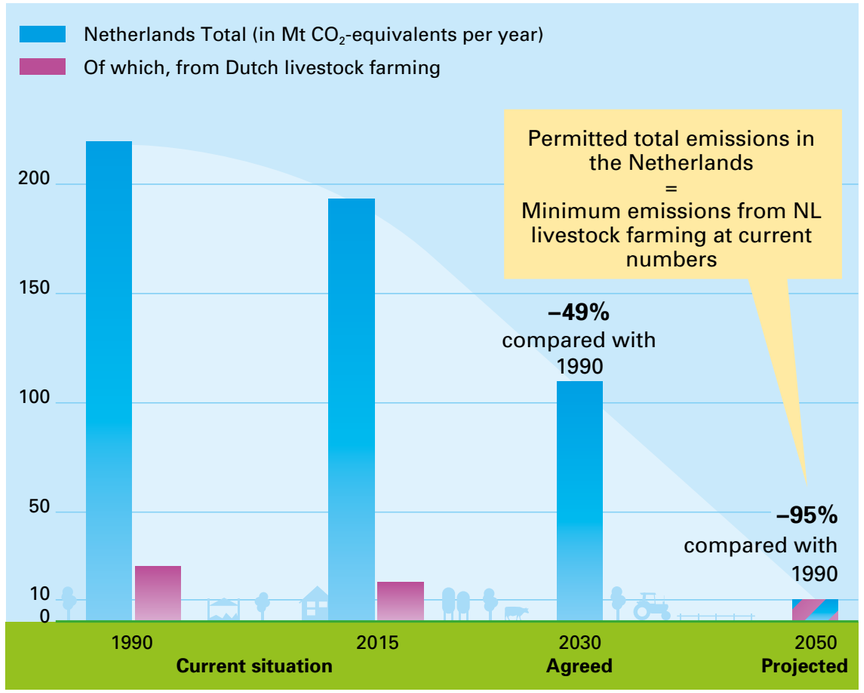
International and national climate agreements and targets

Greenhouse gas emissions are known to be the main cause of global warming. The sooner and quicker the emissions of greenhouse gases are reduced, the better it will be for preventing climate change. The need to reduce these emissions has been agreed in a series of international climate conferences and conventions. At the Paris climate conference (UNFCCC, 2015) a legally binding agreement was reached that sets a goal of limiting global warming to well below 2 °C, with 1.5 °C as the target to aim for. The European Union (EU) had previously agreed that by 2050 emissions of greenhouse gases must be between 80% and 95% lower than in 1990. As an interim target for 2030 the EU Member States have agreed a reduction of 40% from 1990 levels (European Council, 2014). The third Rutte Government has set a reduction target for 2030 of 49% (Tweede Kamer, 2017a).

In the light of the Paris agreement to limit global warming to well below 2 °C, the Netherlands Environmental Assessment Agency (PBL) considers a national CO_2 emissions reduction of 95% from the 1990 level by 2050 to be an appropriate target (Koelemeijer et al., 2017). In its Energy Agenda [*Energieagenda*], the government has already stated that a 95% reduction will probably be needed to meet the targets agreed in Paris (Tweede Kamer, 2016a). This means that in 2050 the maximum permitted annual emissions for the whole Dutch economy will be 10 Mt CO_2-equivalents.

2 For 2015 figures, see: http://www.emissieregistratie.nl/erpubliek/erpub/international/broeikasgassen.aspx

Figure 1: Greenhouse gas reduction targets for the Netherlands to 2050, the reduction achieved in 2015 and expected emissions in 2050 at current livestock numbers and available technologies.



Source: Emissieregistratie (2017), Schoots et al. (2017)

What does this emissions reduction target for 2050 mean for the livestock farming industry? What reductions will the livestock sector have to make, and under what conditions will they be feasible? PBL has calculated that the maximum achievable emissions reduction by 2050, assuming the current size of the livestock population and the fullest and most effective use of all the currently known technological and other measures, is 10 Mt (Ross & Daniëls, 2017; see also Part 2, section 4.1). In this scenario, the livestock sector would be responsible for the full amount of the Netherlands' permitted annual greenhouse gas emissions. That is not a realistic proposition, because emissions from all Dutch households and all other businesses and industries throughout the country would then have to have been reduced to zero. The costs of this would be unreasonably high. Further reductions from livestock farming will be needed and, at the current state of technology, this implies that livestock numbers will have to be reduced. Scientific and technological advances may be able to offset some of this reduction, but how much remains uncertain. The Council considers it more than likely that a reduction in livestock numbers will still be needed.

2.2 Environmental impacts of livestock farming

Dutch livestock farming not only has impacts that influence global climate change, but it also has environmental impacts on a regional scale.

The Dutch livestock population is so big that only some of the animals can be fed with feed grown in the Netherlands. A substantial proportion of the required animal feed has to be imported. A large proportion of the meat, dairy products and egg produced in the Netherlands is exported, primarily to markets within Europe – but the manure produced by the animals remains behind in the Netherlands (see also Part 2, section 4.2).

In 2016 the livestock population in the Netherlands produced 78 billion kg of manure (PBL, 2017a). Most of this manure is spread on the land. Measures to reduce the volume of manure produced have not been very effective and in several regions of the country considerably larger quantities of nutrients are added to the soil than can be taken up by the crops. This nutrient surplus accumulates in the soil or leaches into the groundwater and surface water bodies (PBL, 2017a). As a consequence, chemical and ecological quality standards for surface waters are exceeded in many Dutch regions (50% of water bodies). The 2027 targets for the protection and restoration of ecosystem health set down in the EU Water Framework Directive (WFD) will not be met (PBL, 2017b).

Manure also releases ammonia, which disperses through the air and causes odour nuisance. Some of this ammonia is deposited in the surrounding area (nitrogen deposition). Over the years this has led, among other things, to an accumulation of nitrogen in protected areas, with a consequent decline in biodiversity. Despite the Nitrogen Reduction Programme (PAS), in which national government, the provincial governments, nature conservation organisations and farmers take measures to combat excessive nitrogen deposition on natural and semi-natural habitats, about three quarters of the total area of habitat in the Netherlands is subjected to excessive nitrogen deposition (PBL, 2017a).

The remainder of the ammonia is converted in the atmosphere into particulate matter. Particulate matter is also emitted directly from livestock farms in many forms, including tiny particles of skin, feather and hair, feed, straw and manure, and microorganisms. This is detrimental to air quality and contributes to health problems in the surrounding area (see section 2.3).

2.3 Public health impacts of livestock farming

Besides having environmental and climate impacts, the production of meat, milk and eggs entails risks to human health (Eijsackers et al., 2010). Poultry and pig farms in particular emit particulates and ammonia and there are strong indications that these emissions affect the lung function of people living in the area (Hagenaars et al., 2017). These problems are found mainly in areas of high livestock densities where many people also live. The Health Council of the Netherlands advises further reductions of particulate matter emissions. So far no clear causal link between emissions and health effects has been established, but too few studies of the required quality have been done to reach any firm conclusions yet (Gezondheidsraad, 2018).

In addition, people who live near livestock farms run the risk of infection with diseases that can be transmitted from animals to humans (zoonoses), such as Q fever and avian influenza. An outbreak of one of these diseases can have major public health consequences, as was shown during the Q fever outbreak from 2007 to 2010. This outbreak caused 4,000 people to become ill and claimed 26 lives (RIVM, 2017b; Tempelman et al., 2011), although this is almost certainly an underestimate because it only includes people who had acute Q fever. Information from hospital databases indicate that the real death toll was as high as 74 (RIVM, 2017b).

Widespread and persistent use of antibiotics in the livestock farming sector also poses health risks to people. Growing numbers of bacteria are becoming resistant to antibiotics and infections with these bacteria (such as MRSA and ESBL-producing E. coli) are very hard to treat. About 10% to 15% of human MRSA infections are caught from livestock. More than 60% of livestock farmers in the Netherlands and about 10% of their family members are infected (Van Cleef, 2016).

National policy led to a 64% decline in the use of antibiotics in livestock between 2009 and 2012 (PBL, 2017a). Since then this decline has levelled off and at the end of 2017 the policy objective of a 70% reduction by 2015 had not been achieved.

3

CONCLUSIONS, GOALS AND PREREQUISITES

3.1 Conclusions

Of the impacts of livestock farming described above, the climate change impact presents the greatest challenge. Reducing the climate impact of livestock farming would help to solve some of the environmental and public health issues in the areas of the Netherlands with high livestock densities, because these regional problems are related to livestock numbers.

The longer term climate targets for the Netherlands (2030 and 2050) are so challenging that livestock farming will also have to contribute towards meeting them. Emissions from this sector currently stand at 18 Mt CO_2-equivalents and will have to be reduced to well below 10 Mt. Part of this reduction may be achieved through the introduction of more efficient technologies as they become available in future, but the Council considers it likely that to meet the target it will also be necessary to reduce livestock numbers. It is important that the government announces as soon as possible what the 2030 and 2050 emission targets for livestock farming will be. Clarity on this is needed not only for livestock farmers, but also their suppliers, the processing industry and the retail sector so that they can prepare for the future.

Carbon leakage

Per unit of product, Dutch livestock farms are among the most efficient, environmentally friendly and low carbon in the world. Reducing the number of animals in the Netherlands could lead to an increase in production elsewhere in the world and if this relocated production is less efficient, the net global environmental effect could be negative (carbon leakage), at least in the short term. The Council acknowledges this risk, but is of the opinion that this is no reason to postpone the proposed rapid transition in Dutch livestock farming, especially given the need to reduce emissions under the Paris climate agreement (along with the other EU Member States). Relocating production will also make it more difficult for the receiving countries to meet their climate targets. But as much of the relocated production will be from the least efficient farms in the Netherlands to the most efficient farms in the recipient countries, the leakage effect should not be over-estimated.

The Council sees real opportunities for a circular livestock industry within the limits imposed by the climate targets. Key elements in a circular livestock industry are using residual waste as raw materials (including waste from arable farming and the food industry) and using grasslands for pasturing livestock where these cannot easily be put to new uses. In taking this line the Council builds on the advice by the Social and Economic Council on sustainable livestock farming (SER, 2016), paying particular attention to the implications of the climate targets.

Creating a sustainable and healthy food system is a shared interest and a joint responsibility. Producers may be expected to take responsibility for introducing healthier and more sustainable production processes, while consumers have a responsibility to adopt healthier and more sustainable diets. Parties in the middle of the value chain – the food industry and the

wholesale and retail sectors – also have an important part to play. They not only form the link between the consumer and producer, but also have considerable influence on both.

This approach has the added advantage of uniting the food processing industry, the retail sector and consumers behind a common goal (see also WRR, 2014). When a secure food supply was the common goal in the post-war years, a major strength of the Dutch food system was the joint effort made by all parties to that end. In recent decades this cooperative spirit has been put under pressure by environmental and animal welfare standards and the competitive position of livestock farming has been weakened. Climate change makes it imperative to find a common goal and work together again.

3.2 Goals and prerequisites for 2030

Because it is important that all parties quickly get to work on the task at hand, the Council has formulated a number of policy goals and prerequisites for 2030. These goals can serve as an intermediate staging post in the transition to the situation in 2050. After 2030 the climate targets will be even more critical and more drastic measures will be needed.

1. Livestock farming makes a full contribution to meeting Dutch climate targets.
In 2030 the Dutch livestock farming sector will be responsible for a much bigger share of total Dutch emission reductions than currently proposed. This will prevent a situation arising in future in which livestock farming takes up the whole of the Dutch emissions allocation, which would raise the costs of climate policy in other sectors to unacceptably high levels.

2. There are no more manure surpluses and ammonia emissions are much reduced.
In 2030 manure production will not exceed the volume that can be safely applied to the land or processed. Manure surpluses will therefore be a thing of the past, thus avoiding further environmental damage caused by the discharge of large amounts of nutrients and the deposition of nitrogen on natural and semi-natural habitats. EU environmental standards such as those in the Water Framework Directive and the Nitrates Directive will be met.

3. The risks posed by livestock farms to public health have been minimised.
In 2030 an effective policy will be pursued to prevent local health problems associated with livestock farms in areas with high livestock densities. Technical measures will have been introduced and livestock farms are situated such that they cause the least possible harm to public health.

4. The Dutch diet is sustainable and the supply of food reflects the shift towards the consumption of proportionally more plant proteins.
In 2030 the Dutch diet will have been altered to such an extent that it no longer makes an undue demand on natural resources. Food will be produced in a sustainable manner, both in the Netherlands and abroad. Parties in the food value chain, such as food companies and retailers, will

play an important part in realising this goal as they determine to a large extent what food is available to consumers.

The Council considers that a sustainable and healthy food system will meet the following conditions:

a. Livestock farming operates according to a healthy revenue model.
In 2030 Dutch livestock farming will operate according to a financially healthy revenue model. Livestock farmers' incomes will not be dependent on subsidies, apart from payments for providing public services such as landscape, agri-environmental and water management.

b. A sustainable meal, including a limited amount of animal products, is affordable.
The Council considers it reasonable and realistic that the prices of meat and dairy products will rise. However, the consumption of animal products in amounts appropriate to a sustainable and healthy diet should remain affordable to all income groups.

4

RECOMMENDATIONS

The Council feels that the targets for reducing greenhouse gas emissions in the Paris climate agreement make it urgent that we speed up the transition to a healthier and more sustainable food system. This transition is a task for producers, consumers and value chain parties alike. The following recommendations to the national government are therefore relevant to all parties.

4.1 Provide clarity on future emissions ceilings for livestock farming

The climate targets for the Netherlands mean that in the longer long-term the ceilings on permitted emissions from livestock farming will be drastically reduced. All livestock farmers will benefit from clear information on current and future permissible production capacities. It is therefore crucial that national government provides this clarity as soon as possible.

Recommendation 1

In view of the national climate targets, provide clarity on emissions ceilings for livestock farming in 2030 and 2050 as soon as possible, and translate this into a system of emission rights.

The allocation of carbon reduction targets for 2030 between sectors will be set down in the Climate and Energy Agreement, as announced in the coalition agreement for the third Rutte Government (Tweede Kamer, 2017a). The livestock farming sector will have to be included in this package. The reduction targets for all sectors – including livestock farming – will become tighter after 2030.

RIi recommends that the government sets national emissions ceilings for livestock farming as part of the policy for meeting the national climate targets for 2030 and 2050, and that it does this as soon as possible. To provide sufficient clarity to individual farmers, the Council advises that the current system of phosphate rights and animal production rights be expanded to include CO_2 rights. The system can then evolve into an integrated system of tradable rights. Further optimisation of the system will be possible by extending it to include the whole agricultural sector, including feed production.
Clear emission targets will give farmers certainty about how much they will be able to produce in future and enable them to avoid making investments that become stranded assets. Moreover, clarity on future emission targets may encourage innovations and stimulate their application.

Steps: explicit goals, legal basis, emission rights system

- Translate the national greenhouse gas emissions reduction target for 2030 into specific reduction targets for the livestock farming sector (in Mt CO_2-equivalents per year).
- Formulate an indicative reduction target for livestock farming in 2050.
- Lay down a 2030 reduction target for livestock farming in the Climate Act, thus putting it beyond doubt.

- Transform the current system of phosphate rights and animal production rights into a system of national tradable CO_2 emission rights, to include the following elements:
  - allocation of emission rights to farms based on current livestock numbers (reference year 2016), differentiating between the different types of farm animals on the basis of a climate impact score per animal type;
  - a compulsory emissions accounting and reporting system based on index numbers, in which all greenhouse gas emissions are recorded, with room to adjust the index numbers when it is demonstrated that new technologies or smart solutions reduce emissions;
  - annual reductions in emission rights allocated to livestock farms until the targets for 2030 and 2050 are reached.

Consequences for livestock farming

An expected consequence of setting national emissions ceilings for livestock farming is that livestock numbers will decline. To offset the impact on livestock farmers, it will be crucial to provide clarity on the relevant policy measures to be taken so that farmers can align their plans (invest, change or stop) to these policy measures. The policies for milk and phosphate quota have shown how changes in policy can radically alter the profitability of investments. In particular, young farmers must be able to decide in good time whether or not to take over a farm and what business strategy they should adopt.

- *Invest*. Livestock farmers who want to continue and produce within the available emissions ceilings will have to invest in emission reduction technologies and 'smart' land use solutions (carbon sequestration, reduced lowering of groundwater levels), which can be developed with research institutes and the supply industries. The emission rights will galvanise the industry into making the necessary investments in research and development. Government also has a part to play. The EU agricultural and innovation policies contain instruments that can be used to facilitate technological development, some of which can also be exported.
- *Transform*. Livestock farmers can also adopt new business strategies based on low stocking rates, more nature-inclusive agriculture and a more circular business model. The high visibility in the landscape of dairy farming in particular makes it suitable for the development of business models that include landscape management. Farms with low stocking densities have potential if they can create added value, for example by selling produce locally or providing services to the public (such as nature conservation, water storage, social or recreational services, etc.). The government can contribute by providing grants only to farmers who develop activities that serve a public interest (such as meadow bird management, water storage, landscape maintenance, etc.) EU agricultural subsidies can be used to maximum effect to make the livestock farming sector more innovative and sustainable. In this respect, the Council points to previous advisory reports on EU agricultural policy (see Rli, 2011; 2013).

- *Stop*. Livestock farmers who have to cut back production because of the emission reduction measures (and the companies which depend on that production) may face considerable financial consequences. When farm businesses shut down, the investments made lose their value (stranded assets), which makes it difficult to pay off loans. Farm closures are also often emotional affairs, which is one of the reasons why these decisions are often postponed and why closing down a farm is a lengthy process. The problem of stranded assets can be reduced if the government adopts a long-term policy, as argued here by the Council. Tradable emission rights will make it easier to wind up farming operations. The government could develop a policy for farm closure in cooperation with financial institutions, the processing industry and the livestock farming sector. Such a policy should address concrete issues such as compensation and assisting farmers who have to relocate or close their farms as a result of the reduced emissions allocation at the national or regional level.

Consequences for areas with high livestock densities

Measures that reduce greenhouse gas emissions at the national scale will also help towards solving other environmental problems. However, a national emission rights system will not entirely resolve existing regional disparities, particularly in areas with high livestock densities. The location, size and concentration of livestock farms will continue to cause local and regional environmental problems and public health risks, particularly farms with pigs, poultry and goats. To meet regional environmental and public health restrictions it may be necessary to relocate farms, cut back the scale of their activities or even close them altogether. The instruments currently available are not fully up to this task.[3]

Recommendation 2

National government should enter into negotiations with the provinces which have areas with high livestock densities to see what additional policy is required to tackle the remaining environmental, biodiversity and public health problems.

4.2 Towards sustainable consumption

More sustainable production should be accompanied by more sustainable consumption. For the nation's diet to be sustainable and healthy there must be a shift in eating habits away from animal protein and towards more plant protein. The current ratio between the two is 70/30 (RIVM, 2017a). According to calculations by the Green Protein Alliance (GPA) this ratio must move to 50/50 by 2025 (GPA, 2017). The biggest change in the current diet that will be needed is an increase in vegetables, pulses and vegetarian products on the daily menu and a substantial reduction in meat and meat products, along with a somewhat less drastic reduction in the consumption of dairy products (see Part 2, Chapter 4).

3 The proposed 'High Livestock Density Areas (Interim) Act' (Ministry of Economic Affairs, 2017) aimed to give the provinces more legal powers. This bill has now been withdrawn.

Recommendation 3

Set a target of reducing animal protein consumption to 40% of total protein in the diet by 2030.

RIi considers a 40/60 ratio between animal and plant protein in the diet by 2030 to be both possible and desirable in view of the climate targets. Such a diet leaves room for modest amounts of sustainably produced meat, dairy products and eggs. After 2030 the ratio can shift further in the same direction (see Part 2, section 6.1).

The government will have to play its part in this. A diet of sustainable and healthy food is in the public interest and the market is not doing enough to effectively promote this interest (De Schutter, 2017). The government will have to ensure that its policy objectives and the means it employs to achieve them are both transparent and objective. It will also be advisable to cooperate with retailers and the hospitality industry. Not only do these parties have a major influence on consumer behaviour, but with the introduction of online sales and home delivery they are also innovating rapidly.

Various instruments can be used to entice consumers to make healthy and sustainable dietary choices, from giving them more information to providing financial incentives. For more information on the effective use of instruments to support consumer policy, see Part 2, Chapter 6.

Inform, enthuse and convince

- Adapt the Wheel of Five principles for a healthy diet to bring it in line with the aim of reducing animal protein consumption to 40% of total protein in the diet by 2030, and make it easy for people to use these guidelines in recipes and menus.
- Appoint ambassadors, such as TV chefs, to associate eating more fruit and vegetables and fewer animal products with attractive, tasty and easy to prepare meals. Investigate (with behavioural scientists and experts) what actions are effective in practice.
- Set ambitious goals for sustainable procurement, establish minimum standards and make transition agreements with responsible parties. Establish proactive government monitoring of these goals and agreements. Ensure that the catering services in public spaces (such as stations, schools, healthcare institutions and government buildings) offer sustainable and healthy options.

Financial incentives

The consumption of animal products is partly influenced by price. Current prices are not realistic, though. Animal products have always been low-VAT rated. The argument behind this was that these products belong to the shopping basket of basic necessities, but given the availability of good alternatives that have a much lower impact on the environment and the climate, this argument would no longer appear to be valid. Moreover, the current prices of animal products do not reflect the social costs of their production and cover little or none of the external costs. One option for making these prices more realistically reflect the true costs may be to

introduce a price incentive. Depending on practical considerations, this could be done by altering the VAT rate or introducing an excise duty.

4.3 Enlist value chain parties to make production and consumption more sustainable

Value chain parties are the link between producers and consumers. Because of the major influence they have in both directions, these parties have an important part to play in the transition to a healthier and more sustainable food system. Besides, they themselves have an interest in finding new solutions. RIi feels the government can bring the parties together and play a facilitating role through the deployment of policy instruments.

Recommendation 4

Work with value chain parties to support sustainable and healthy production and consumption and to develop the market for plant-based protein products.

Given the power of parties in the value chain (food industry, wholesale, retail) and their influence on both producers and consumers, these parties have a clear role to play in the transition to a healthier and more sustainable food system. They can stimulate sustainable production and ensure producers receive a good price. At the same time, they can ensure that consumers are offered a range of tasty and affordable alternatives to animal proteins.

Supporting the transition to more sustainable production by livestock farmers

The government can make agreements with value chain parties on requirements to be met by animal production that are consistent with Dutch climate, environmental and public health targets. A key element in this is that primary producers receive realistic prices for their sustainable products. To this end use can be made of the sustainability agendas that international value chain parties already work with, including contractual agreements with livestock farmers on the conditions under which animal products are produced. Value chain parties can use these agreements to gain a premium position in national and international markets and create added value that can be used to reward livestock farmers for their expertise.

Supporting the transition to more sustainable consumption

The government can draw up a roadmap with the retail sector for the period from 2018 to 2030 on how to expand the range of innovative plant-based protein products and on marketing sustainable and healthy food. This can take advantage of the structural changes taking place in the retail sector (online sales, prepared foods, home delivery of meals). The roadmap can be attached to existing agreements and alliances. But the government must also be prepared to adopt more binding measures if results are disappointing.

Development of new protein products

There is a growing market for fresh, healthy products and for a larger and more varied range of alternatives to meat, dairy products and eggs. It is not just new players that are active in this market, but parties that used to operate solely in the animal product supply chain are also responding to this trend. Among these are meat processors who are introducing wholly or partly plant-based products into their product range (see Part 2, section 2.2). The private and public sectors are also working to develop alternative ingredients based on algae, insects and other ingredients. Cultured or in-vitro meat is also under development. These developments are already so far advanced that the pioneering start-ups on the market have already been joined by the big dairy conglomerates and meat processors. A large and innovative home market for new plant-based products will offer new export opportunities to fill the gap when European demand for meat and dairy products declines. In addition to its existing role in providing subsidies for research and innovation, the government can help with the development of export markets (via trade missions or Dutch government representatives in other countries).

4.4 In conclusion

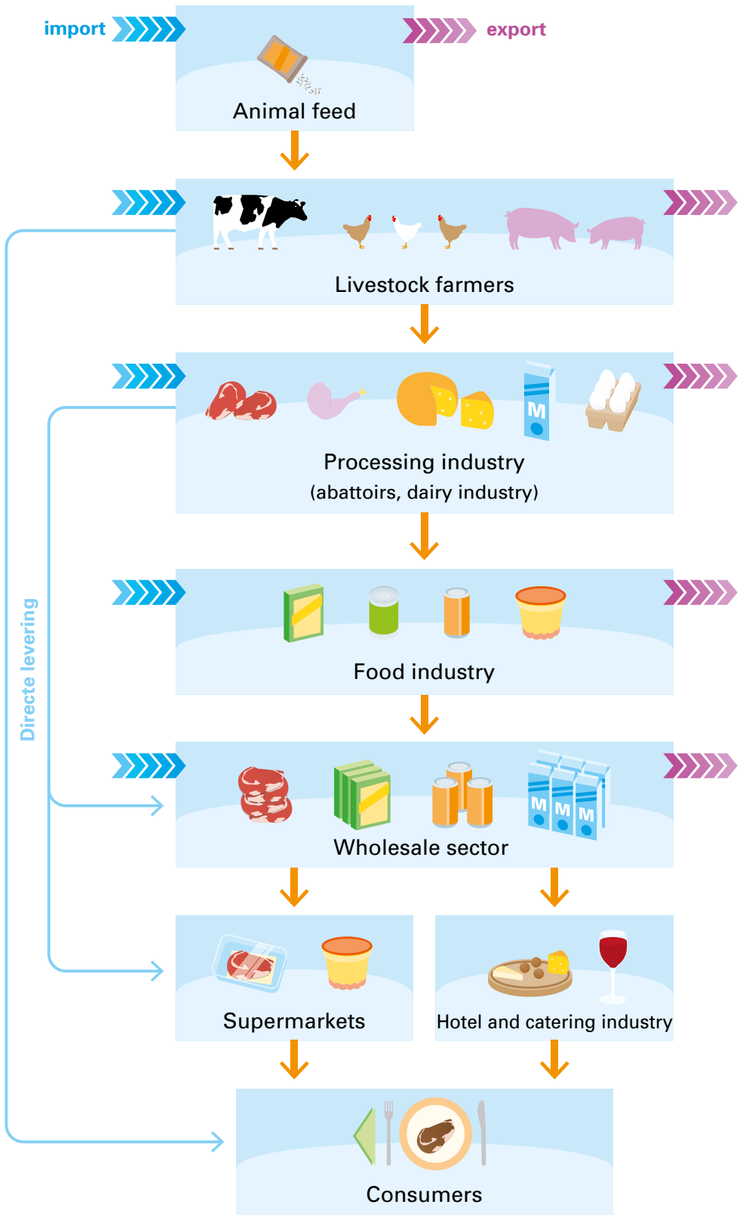
In making these recommendations, Rli calls upon all parties to play their part in the necessary transition. Cooperation between consumers, producers and value chain parties is essential for making this transition in the food system – a transition that can be compared with the way national and European agricultural policies brought about food security in the post-war years and led to the leading international position enjoyed the Dutch agricultural sector. Now, partly in response to the challenge presented by climate change, the Netherlands again stands on the threshold of a crucial transition. The inescapable changes that will have to be made to the food system provide an excellent opportunity to again unite farmers, the food processing industry, the retail sector and consumers, but this time with the aim of creating a sustainable and healthy food system. To achieve this it is essential that these recommendations are acted upon in a comprehensive and coordinated manner.

PART 2 | ANALYSIS

INTRODUCTION AND READING GUIDE

Part 2 of this advisory report provides more detailed information and goes deeper into various aspects of the food system (see Figure 2). The first three chapters describe the current situation in livestock farming, the food value chain and food consumption patterns. Chapter 4 goes deeper into the impacts of food production and consumption on the environment. Chapter 5 describes relevant developments in policy. Chapters 6 and 7 describe the prospects for sustainable and healthy consumption and for animal production.

Figure 2: The food system



1

LIVESTOCK FARMING

1.1 Livestock numbers

In 2015 the total livestock population in the Netherlands amounted to more than 100 million poultry, 4 million cattle, almost 13 million pigs, 1 million sheep and about half a million goats (Wageningen Economic Research [WecR], 2017). These animals are kept for their meat, milk or eggs. In this report these three product groups are referred to collectively as 'animal products'. Cattle, pig, poultry and goat farms in particular have a substantial impact on public health, climate change and the environment. This part of the advisory report, therefore, focuses on cattle farming, pig farming, goat farming and poultry farming.

The Dutch *cattle farming sector* consists of about 27,000 farms (Centraal Bureau voor de Statistiek [CBS], 2017a).[4] Dairy cattle are strongly associated with the image the Dutch have of their country, its history, culture and landscape. There are about 1.7 million dairy cows and 900,000 veal calves in the Netherlands. Dairy cows that are no longer productive are sent for slaughter as 'lean cows'.

In 2016 the Dutch *pig farming sector* consisted of about 4,500 pig farms. The pig farming industry consists of three types of farms:

- Pig fattening farms: farms where piglets are grown on and fattened for slaughter. Fattening pigs make up about half of all the pigs in the Netherlands (WecR, 2017).
- Pig breeding farms: farms where piglets are born and then sold on to pig fattening farms for rearing and finishing.
- Closed cycle pig farms: farms which produce piglets, wean them, and rear and finish them for slaughter.

In 2016 the *poultry farming sector* in the Netherlands consisted of just under 2,000 farms, with a combined total of about 105 million poultry. The number of poultry has remained more or less stable for many years, with the exception of a sharp fall in numbers in 2003, when the Dutch poultry flock declined in size by about 20% as a result of the avian flu outbreak and subsequent buy-out schemes (WecR, 2017).

The number of goats in the Netherlands is much smaller than the numbers of cows, pigs and poultry. Numbers have been steadily increasing for some years because of the relatively high profitability of the sector. Moreover, the lightweight regulatory regime, in comparison with cows and pigs, does little to constrain this growth in numbers. There are about 2,600 goat farms.

1.2 Spatial distribution of livestock

Farm livestock are not evenly distributed across the country, but are concentrated in certain areas for each type of animal.

Dairy cattle are widely distributed across the countryside, but the economic importance of dairy farming varies considerably between regions. Dairy farming clusters which are economically dominant are found in the

4 See: http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=80780ned&D1=0,501-516,518-519,524,528,535,540-557,580,598&D2=0,13&D3=0,5,10,14-16&HDR=G1,G2&STB=T&VW=Tv

provinces of Utrecht, Zuid-Holland, Friesland and parts of the southern and eastern Netherlands. Dairy farming is a minor farming activity in the mainly arable farming regions in the provinces of Limburg, Zeeland, West-Brabant, Noord-Holland and Flevoland and in the Veenkoloniën (an area of former peat workings in the north-east of the country). The area of grassland and feed crops in use for dairy farming was 810,000 hectares in 2014,[5] or 44% of the total area of agricultural and horticultural land. Dairy farming therefore plays a major part in shaping the landscape in many regions (WecR, 2017).

Most pig farms are located on the sandy soils in the south and east of the country. All the provinces with major concentrations of pig farming have seen farm numbers decline, but in recent years the numbers lost have been relatively high in the provinces of Gelderland and Overijssel (Ploegmakers & Stevens, 2015).

The regions with very high concentrations of poultry, particularly laying farms, are the Gelderse Vallei, the area around Venray (in the north of Limburg) and the area around Weert (central Limburg and south-east Brabant). Broiler farms are more widely distributed over the south, east and north of the country. A third of all broilers are held in the northern provinces. There are hardly any poultry farms in the west of the Netherlands.[6]

The provinces of Noord-Brabant and Gelderland have by far the greatest number of dairy goats. However, compared with the other livestock farms, the numbers are small. Goats are included in this advisory report despite their relatively small numbers because of the health problems associated with these animals, especially Q fever (see section 4.3.2).

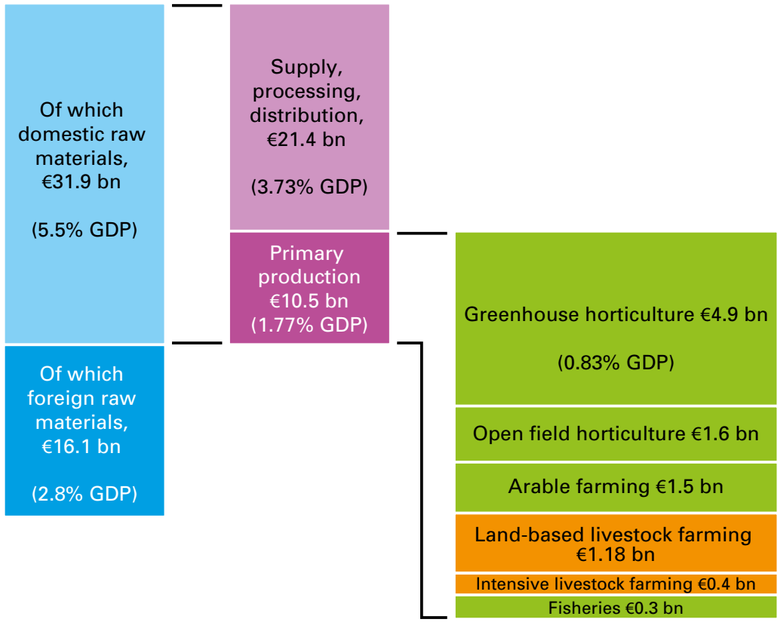
1.3 Economic significance of livestock farming

The total added value of primary agricultural and horticultural production in the Netherlands amounts to 1.77% of national income (€10.5 billion). Livestock farming makes up just a fraction of this (see Figure 3). In 2013 the intensive livestock farming sector generated 0.07% of national income (€400 million) and land-based livestock farming generated 0.3% (almost €2 billion). Arable farming and field vegetables together account for about the same income as land-based livestock farming. The total plant-based sector, including ornamental horticulture, accounts for the vast majority of primary agricultural and horticultural production, at 1.35% of gross domestic product (GDP) or €8 billion.

5 ZuivelNL (2016) report 1.2 million hectares of grassland and fodder maize.
6 See: http://agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2285&indicatorID=2031&sectorID=2249

Figure 3: Added value of the Dutch agro-complex

Total size of the agro sector in 2015: € 48 billion



Source: WecR, 2017

In addition to primary production by farmers and growers, added value is generated by the trade in and processing of foreign raw materials destined for the European market (such as cacao and other tropical products) and by agricultural supply and processing industries. These industries, together with primary production, are referred to collectively as the 'agro-complex'. The total agro-complex makes up 8.3% of GDP.

In recent decades the companies in this secondary industry have grown into multinationals and also do business with farmers in neighbouring countries (and even on other continents). Their location in the Netherlands (with the added value of their head offices and research laboratories) is not due entirely to the history and size of Dutch agricultural production, but also to the tax environment, the research and innovation system, international connections and the attractiveness of the living and working environment for employees.

1.4 Structure of the sector

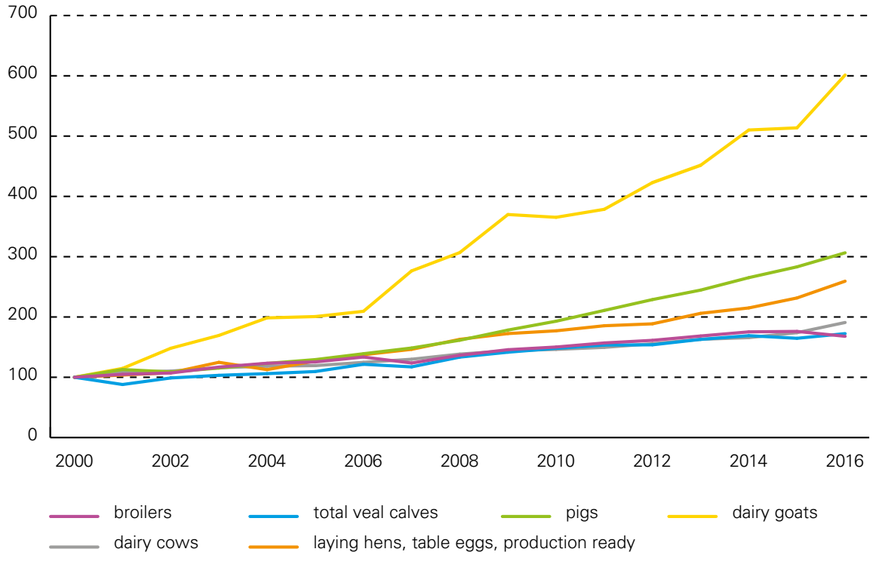
1.4.1 Economies of scale

The pursuit of lower costs is continually driving up the scale of livestock production. Large units of production benefit from economies of scale, enabling them to produce at lower unit costs. In all livestock sectors the trend is towards fewer farms with larger numbers of animals.

Between 2000 and 2016 most livestock farms at least doubled in size (number of animals). Expansion has been greatest in the poultry, pig and goat farming sectors. Between 2000 and 2016 the proportion of dairy farms with more than 150 cows rose from 1.1% to 13.8% (ZuivelNL)[7] and now 30% of all dairy cows are on farms with more than 150 cows (see Figure 4).

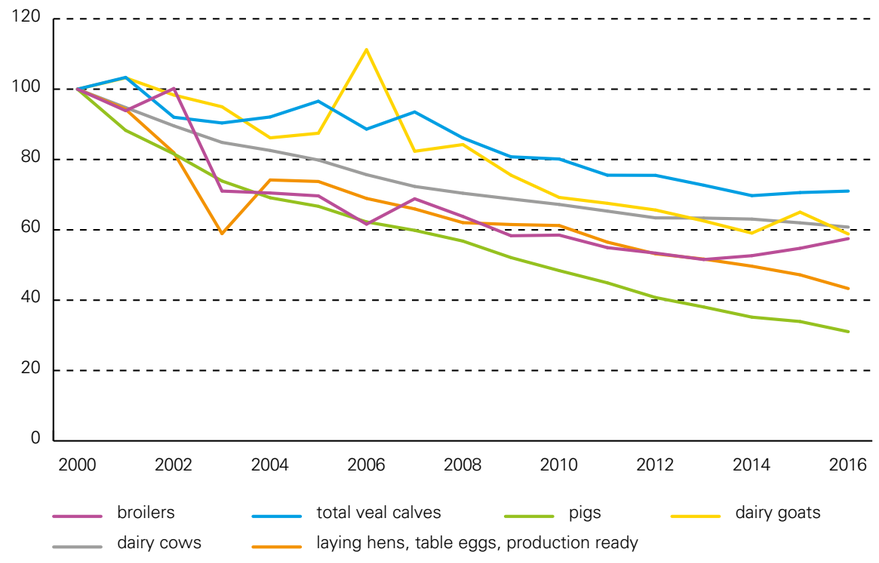
7 Dutch dairy in figures, 2016. See: http://www.zuivelnl.org/zuivel-in-cijfers/

Figure 4: Number of animals per livestock farm 2000-2016



Source: WecR, 2017

Figure 5: Number of livestock farms in the period 2000-2016



Source: WecR, 2017

In section 1.1 of this chapter we saw that total livestock numbers in the Netherlands have remained reasonably constant over the years. The increase in the number of animals per farm has therefore been accompanied by a steep decline in the number of farms (see Figure 5).

The number of farms has been steadily declining in all sectors. Between 2000 and 2016 the number of pig farms declined by almost 70%. The rate of decline has been slower among cattle and goat farms. Dairy farms are by far the most numerous. In 2016 there were still almost 18,000 dairy farms (WecR, 2017), as opposed to just under 4,000 pig farms and fewer than 1,000 laying farms.

The number of pig farms appears to be falling by half every ten years. It is expected that this trend will continue, which means that in 2020 there will be about 3,300 pig farms left and in 2024 about 2,500.
The continued trend towards larger production units also has an effect on family farms. The Dutch agricultural sector has traditionally contained many family farms, but as farms get bigger the next generation of young farmers need ever larger amounts of starting capital to take over the family farm (Poppe & Puister, 2017).

1.4.2 Farm incomes

Incomes from livestock farms are subject to strong fluctuations. Besides the peaks and troughs in average incomes, an interesting trend is the proportion of farms with a low income: the number of farms with an annual income below €23,000 varies greatly from year to year within a range of between 0% and 80% of farms. Low incomes are a particularly frequent phenomenon in the intensive livestock farming sector. Over the past four years goat farmers obtained average family incomes of €196,000, making goat farming currently one of the most profitable of all livestock farming sectors (WecR, 2017).

1.4.3 Influence of EU subsidies

The European Union (EU) pursues a common agricultural policy (CAP) to support the agricultural sector. This consists mainly of income support in the form of direct payments (‘pillar 1’) based on historical land ownership and land use, which means that payments under this pillar go mainly to land-based farms, such as dairy farms. In 2015 the total budget for direct income support was about €750 million (Vogelzang et al., 2017), around half of which went to dairy farmers and €95 million to the remaining land-based livestock farms. The average dairy farmer receives about €22,000 in income support from pillar 1 of the CAP.

Direct payments are complemented by pillar 2 support schemes linked to the EU rural development programmes. These second pillar funds are for things like knowledge transfer and innovation, conservation and landscape management, quality schemes and investment support. The total annual budget is just under €90 million. All measures under the second pillar are conditional upon national co-financing (from the national government or other government authority or agency).

2

VALUE CHAIN PARTIES

Animal products are usually processed and pass through various stages in the food supply chain before they are consumed. The products consumed are not just meat balls, glasses of milk or fried eggs, for example, but include things like pizzas with cheese and salami toppings, bowls of Dutch custard (*vla*) and cakes.

Each stage of processing adds value. The economic significance of the food supply chain is therefore much greater than that of farming alone. The various value chain parties, such as abattoirs, the food manufacturing and processing industries, wholesalers and retailers, also have major interests. Some operate internationally.

It is important to note that the food system not only puts food on the table in households; consumption via hotels, restaurants and cafes, works canteens and office catering services is growing. Of the €57 billion consumers spent on food and drink in 2015, 50% was spent in supermarkets, 30% in bars, cafes, restaurants and other catering establishments, and the remaining 20% was spent in specialty stores (WecR, 2017).

The various value chain parties between the farmer and the plate are described in more detail in this chapter, although much less information is available about these parties than about the agricultural sector. The agricultural sector has been investigated in detail and large quantities of data and statistics are available, but the secondary industries associated with agricultural production are not nearly as well documented (CBS, 2017b). The commodity boards used to keep track of what happened to agricultural produce, but since they were abolished most of this information has been lost.

2.1 Animal feed

The first link in the food value chain for meat, milk and eggs is the use of animal feed. Traditional feed includes grains such as wheat, maize and barley, most of which are grown inside the EU. However, protein is an important component of animal feed and the protein content of these crops is low.

For this reason, much animal feed is produced elsewhere in the world. Imported protein-rich animal feed consists for the most part of soy products (about 70% of the total), palm kernel meal and maize gluten (Cormont & Van Krimpen, 2016). About half of all animal feed used globally is imported. Soybean meal comes almost exclusively from Brazil, Argentina and the US.[8]

There are a number of animal feed producers in the Netherlands, three of which are much larger than the rest: ForFarmers in Lochem, Agrifirm in Apeldoorn and De Heus in Ede. They supply feed for pigs, cattle, poultry and goats in the Netherlands and elsewhere, and in 2012 they had a combined turnover of €7.3 billion (Bron, 2016). The size of the Dutch market for animal feed has not grown for some time because of improved

8 See: http://www.boerderij.nl/Home/Achtergrond/2017/4/Veevoersector-sterk-importafhankelijk-119430E/

feed conversion rates and because livestock numbers have been stable for many years.

2.2 Abattoirs and the meat processing industry

In 2017 there were 280 abattoirs in the Netherlands (excluding for poultry), employing 9,600 people (CBS, 2017a). In 2015 the combined turnover of the Dutch abattoirs was almost €4 billion. Dutch abattoirs not only take animals from Dutch farms, but also animals from a number of neighbouring countries.

Pigs

About 15 million pigs are slaughtered each year in the Netherlands, producing about 1.5 million tonnes of pig carcasses. Just under 400,000 tonnes of pork are imported. Two thirds of all this pork is exported and one third is consumed in the Netherlands (WecR, 2017). Some Dutch pigs are slaughtered just over the border in Germany and the meat sent back to the Netherlands (Wisman & Jukema, 2017). German abattoirs have excess capacity since many sow farms in Nedersaksen and Nordrhein-Westfalen have closed. The amount exported to German abattoirs depends heavily on the prices charged by Dutch and German abattoirs. Vion slaughters about half of all the pigs in the Netherlands.

Calves

About 1.5 million calves are slaughtered in the Netherlands each year, producing about 225,000 tonnes of carcasses. Veal is mainly produced by companies that carry out a number of different activities, such as feed production, slaughter, processing and transport. The VanDrie Group and the Pali Group are major processors with their own slaughterhouse (WecR, 2017).

Lean cows

Dairy cows are slaughtered at the end of their productive lives. Their meat is usually processed into sausages and mince. Each year about 500,000 cows are slaughtered, producing a total carcass weight of 147,000 tonnes (CBS, 2017b, 2016 figures).

Poultry

There are 19 poultry abattoirs in the Netherlands, which slaughtered more than 1 million tonnes living weight in 2012. About 80% of the slaughtered weight comes from the Netherlands and the remaining 20% is imported. Most of the meat is then exported. Fresh chicken (fillet) is exported to Germany and the United Kingdom; frozen products (legs and drumsticks) go mainly to Africa and Asia (WecR, 2017). Some of the abattoirs are looking to move into new markets in meat substitutes (see text box).

Meat substitutes in the meat processing industry

The Dutch market for meat substitutes in the supermarket segment is worth around €70 million. More and more meat processors are picking up on the growing demand for meat substitutes, including Tyson (the second meat

processing company in the US) and Tönnies (the biggest pig slaughterer in Germany). The market is also changing fast in the Netherlands: Meatless is a spin-off from meat processor Hubro, and poultry slaughterers and processed meat manufacturers such as Meyn Food and Zwanenburg (Kipsgroep) are also active in this market. The dairy industry has moved into the market with meat substitutes based on dairy products (Friesland Campina with Valess) and Unilever and Vegetarische Slager have jointly marketed soup and satay with vegetarian 'meatballs'.

2.3 Dairy industry

In 2015 there were 25 dairy companies in the Netherlands, together employing 12,000 people at a total of 54 sites. At these factories raw milk is processed into cheese, milk powder, drinking milk and milk products, condensed milk, butter oil and other products. Most of the milk produced in the Netherlands goes to dairy factories. Just 1.5% remains behind on the farm for local use and for sale locally.

FrieslandCampina is the biggest dairy processing company and with a turnover of €11.1 billion is the sixth biggest milk processor in the world. DOC Kaas is the second largest cheese cooperative in the Netherlands with an annual turnover of €450 million. In 2009 the Swedish-German dairy concern Arla entered the Dutch market and opened a factory in Nijkerk. The concern estimates its share of the Dutch market is now more than 20% (ZuivelNL).[9]

The Dutch dairy industry is known for its efficient large-scale processing and marketing operations. The industry serves various markets, from supermarket concerns across Europe to consumers in Asia and Africa. The Netherlands has a high concentration of milk processing activities and cost levels are competitive in north-west Europe, where the Dutch dairy industry holds the middle ground. However, the differences with other countries and continents are becoming smaller as a consequence of rising costs to meet environmental measures required in the Netherlands (WecR, 2017).

2.4 The food industry

Besides smaller-scale regional producers, the Netherlands is home to several multinational food companies with global product lines. About half of the total turnover in the food industry is from dairy and meat products and from oils and fats. Meat and dairy products are responsible for 13% and 12% of employment in the food industry (Federatie Nederlandse Levensmiddelenindustrie [FNLI], 2017).

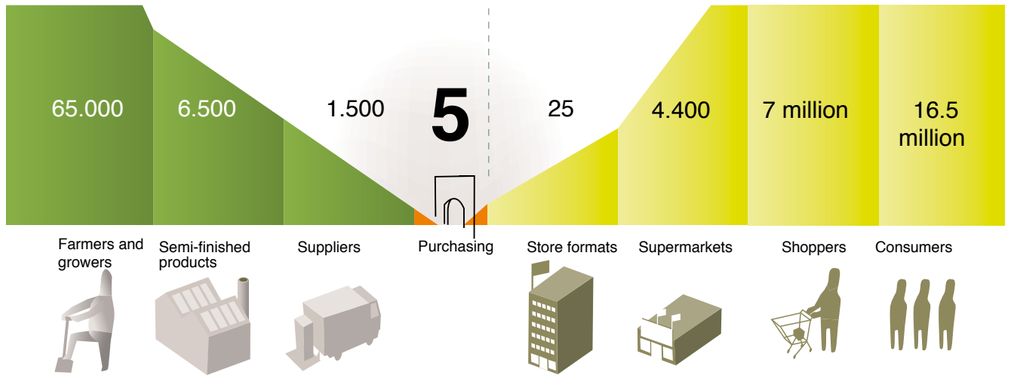
About a hundred companies are active in the Dutch meat industry, which employs about 3,000 people. Turnover in 2012 was over €1 billion (Productschap Pluimvee en Eieren & Productschap Vee en Vlees, 2013). About 80% of this turnover is exported, the biggest export markets being the United Kingdom and Germany. Of the exported meat products 93% remain within the EU.

9 Dutch dairy in figures, 2016. See: http://www.zuivelnl.org/zuivel-in-cijfers/

2.5 Supermarkets and purchasing groups

Supermarkets account for most consumer purchases of meat, dairy products and eggs. They sell 80% of the meat and 90% of the milk, cheese and eggs bought by consumers (Detailhandel.info, 2017). About 15% of meat is sold by butchers and poulterers.

Figure 6: Main parties in the food value chain



Source: Backus et al. 2011

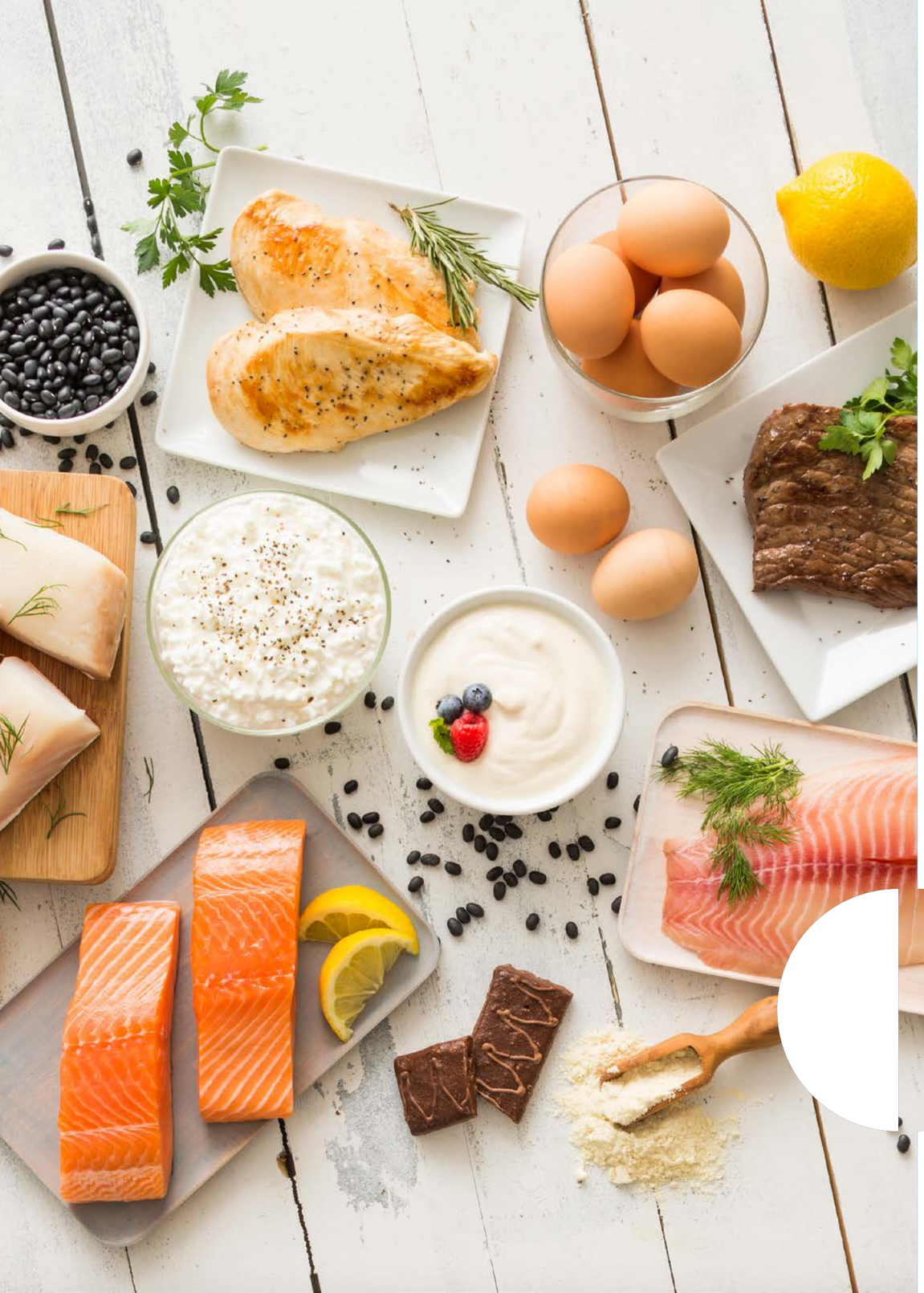
Purchasing groups

Supermarket purchasing groups have considerable influence in the food value chain. The three biggest purchasing groups have a combined market share of 84% (RIVM, 2016a); the top five account for virtually the whole market, which gives them power over the prices the food suppliers and producers can charge; they determine the range of products available to consumers and the prices they have to pay. The major supermarket chains purchase their stock independently. Each of these supermarket chains – Ahold (Albert Heijn), Jumbo, Lidl and Aldi – is itself one of the major purchasing groups. The smaller chains (such as Dirk, Deen, Bas and Sligro) belong to the Superunie purchasing group.

Supermarkets

The group with the biggest turnover is Ahold, which also has most retail outlets in the Netherlands. Including all store formats, the total number of its retail outlets is just under 1,000, which is almost double the number of Jumbo stores (less than 600). Aldi and Lidl are more or less comparable in size.

The supermarkets use advertising, offers, shop displays, labels and packaging and other marketing strategies to entice consumers to buy more and make more impulse purchases. The products they promote in these ways are often neither sustainable nor healthy, but are energy-rich, nutrient-poor processed foods and relatively cheap meat products. These parties also have a major influence on the information made available to consumers. The flow of information to the consumer is abundant and often contradictory, which makes it difficult for consumers to decide which products are healthy, fair, animal friendly and/or sustainable.



3

THE CONSUMPTION OF MEAT, DAIRY PRODUCTS AND EGGS

Since the 1950s the consumption of meat, dairy products and eggs in the Netherlands has risen rapidly. The post-war policy of increasing food production and self-sufficiency was highly successful. The emerging mechanisation of farming and the land reparcelling and consolidation schemes made it possible for farms to expand and scale up their production. As the economy grew, consumers had more to spend: a hot meal had to include a piece of meat or fish, and bread could not be served without butter, cheese and milk.

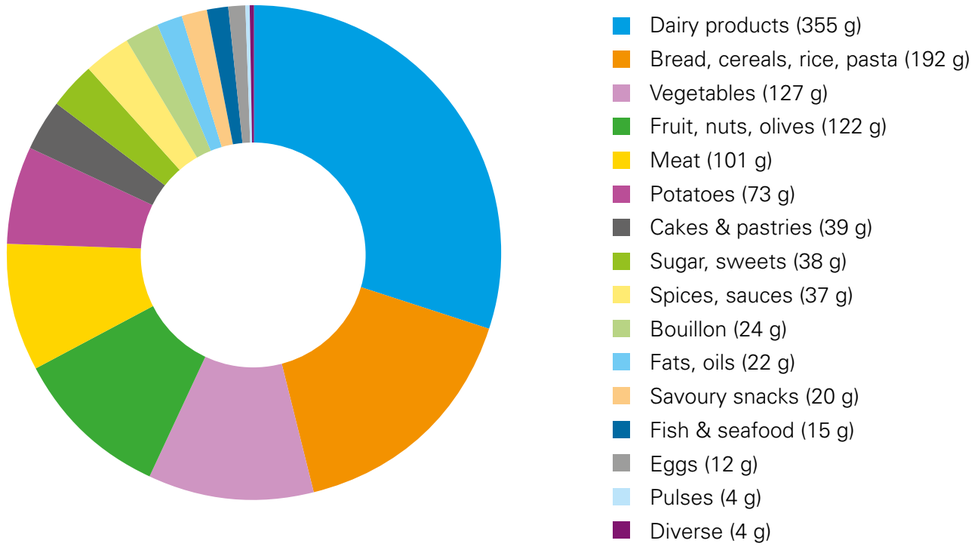
This chapter begins with a brief review of the food consumption surveys, which show the trends in the proportions of meat, dairy products and eggs in the Dutch diet. An impression will then be given of the trends in consumer spending on various foods. This in turn is followed by a discussion of the trends in the consumption of specific meats, dairy products and eggs. Chapter 6 examines the consumption of plant-based alternatives to meat.

3.1 Food consumption surveys

The National Institute for Public Health and the Environment (RIVM) regularly carries out food consumption surveys.[10] The results for the period 2012–2016 are expected in 2018. Figure 7 shows the composition of the average diet in the period 2012–2014.

Compared with the previous survey (2007–2010) the Dutch consumed fewer potatoes, fats and oils, alcoholic drinks, dairy products, cakes and pastries, and meat. The amounts of fruit and vegetables eaten remained the same, but are still not at the levels recommended in the Wheel of Five (the rules and components of a healthy diet published by the Netherlands Nutrition Centre). Bread and meat remain popular and are eaten six to seven days in the week. In contrast, fish and pulses are eaten on average on just one day of the week or less (Van Rossum et al., 2016). The average daily diet per person includes about 350 g dairy produce (including cheese), 100 g meat[11] (or meat products), 125 g vegetables and 125 g fruit and nuts.

Figure 7: Average daily consumption by people aged 1 to 79 years



Source: RIVM, 2017a

10 See: http://www.rivm.nl/Onderwerpen/V/Voedselconsumptiepeiling

11 Excluding losses in the supply chain and abattoir waste.

Consumption of animal products increased from the 1950s to the 1990s. At the moment, 16% of food in the Netherlands – 28% of what we eat and 10% of what we drink – is of animal origin. Our daily protein intake consists of 70% animal protein and 30% plant protein (RIVM, 2017a).

3.2 Share of food in consumer spending and prices of foods

Spending on food, beverages and tobacco in 2016 amounted to 14.8% of total consumer expenditure on goods and services (WecR, 2017) and this proportion has been fairly stable for some years. Of the €45 billion spent on food, beverages and tobacco, almost €29 million was spent on dairy products, meat, fish, potatoes, vegetables, fruit and bread. The rest was spent on sweet items such as ice cream and confectionery and on beverages and tobacco.

In general, food prices have remained largely stable in recent years. The prices of potato products, eggs and poultry meat have risen the most, at 6%–7% between 2013 and 2016. The prices of beef and bread have hardly changed at all, at between 0% and -1%. The biggest fall in prices was for pork, at -4%. Fresh fruit and vegetables became 2% more expensive between 2013 and 2016. After declining each year, the consumption of fruit and vegetables increased in 2016 by 2% and 1% respectively.

In recent years consumers have increased their preference for organically grown and reared foods across all product groups as part of their basic shopping basket, as revealed by the Sustainable Food Monitor for 2016 [*Monitor Duurzaam Voedsel*] (Logatcheva, 2017). Organic products tend to be a little more expensive than their non-organic equivalents.

3.3 Meat consumption

In the second half of the twentieth century the Dutch diet changed. As people become more prosperous they ate more, particularly more animal products, and the balance between animal and plant proteins on the daily menu changed. Since 1960 the Dutch have increased their protein consumption by 25% and the ratio of plant to animal protein in the diet has shifted from 50/50 to 30/70 (RIVM, 2017a). Most of the population consume more animal products than necessary for a healthy and sustainable diet.

Meat consumption has declined slightly since 2010. Between 2010 and 2015 consumption declined by about 3%, from 79 kg per person in 2010 to just over 76 kg in 2015, as a result of a slight drop in the consumption of pork and beef. Consumption of other types of meat has remained fairly stable. This decline in 2010–2015 followed a slight increase in consumption in the years 2005–2010, from over 76 kg to 79 kg per person. Meat consumption in 2016, therefore, was back at the 2005 level. In 2016 total consumption of meat and meat products per head of the population was almost exactly the same as the year before (Terluin et al., 2017). Pork is still the most popular meat and makes up half of all the meat consumed. Poultry meat accounts for about a third of all meat consumed in the Netherlands and beef a fifth. These consumption figures are based on carcass weight, which includes

the bone. As a rule of thumb, half this weight is taken to consist of meat; the remainder is abattoir waste.

3.4 Dairy consumption

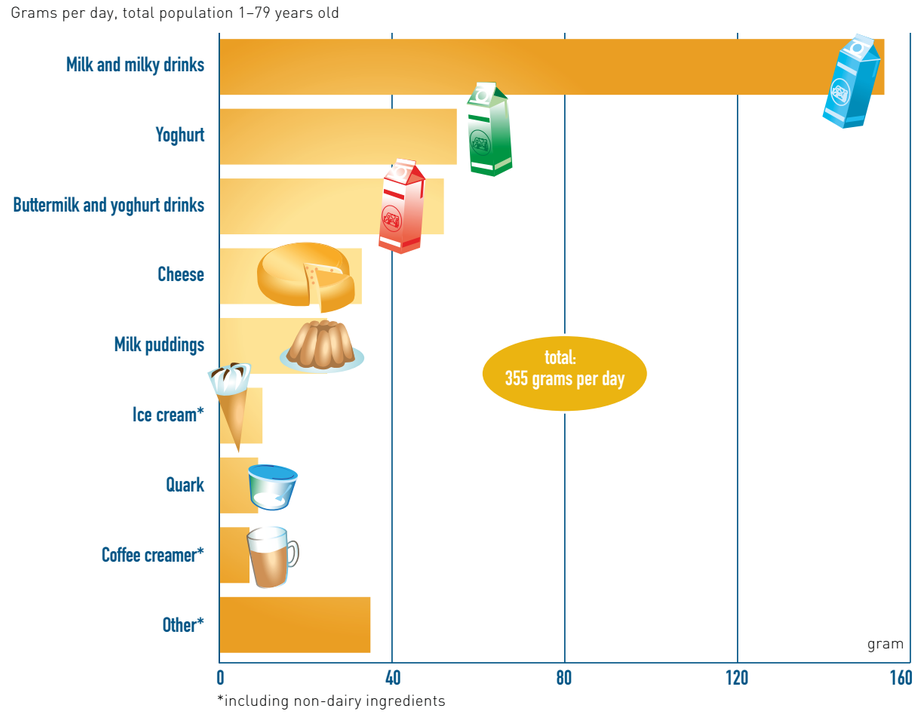
Dairy consumption in the Netherlands has a long tradition and is actively encouraged by the government. Milk, cheese, yoghurt and dairy desserts are fixed items in the daily diet of a large part of the population. Cheese consumption per head of the Dutch population was 23.2 kg in 2015 and for years has been above the European average of 18.5 kg in the EU-28. The total value of dairy products consumed in the Netherlands in 2015 was €49 billion (ZuivelNL, 2016; CBS, 2016).

3.5 Consumption of eggs

In 2015 the average number of eggs consumed per person in the Netherlands was just over 200. Of these, an estimated 65%–70% were eaten boiled and the remainder were used in the preparation of other dishes (puddings, cakes and pastries, ice cream, ready-to-eat meals).

The average per head consumption of eggs in the EU-27 (2012 figures) is 213 per year. The highest figure is for Spain, at 280 eggs per head of the population. The Portuguese eat just 142 eggs per person per year (Rabobank, 2017).

Figure 8: Dairy consumption in the Netherlands



Source: ZuivelNL, cijfers 2016. See: http://www.zuivelnl.org/zuivel-in-cijfers

In 2016 sales of organic eggs rose by 15%, sales of free-range eggs rose by 9% and sales of barn eggs fell by 1% (Van Loon, 2016). Dutch retail egg sales are therefore shifting towards the high-end segment of free-range and organic eggs. In 2015 these eggs already accounted for 35% of turnover and it is expected that this will increase further (Rabobank, 2017).

New regulations and changing consumer preferences have shaken up the market for European eggs and the Dutch egg supply chain has responded. At the moment the market for eggs sold in the Netherlands consists mainly of barn and perchery eggs (Rabobank, 2017; Hilkens & Rijkers, 2016).

4

IMPACTS OF THE PRODUCTION AND CONSUMPTION OF ANIMAL FOODS

The first three sections of this chapter are about the impacts of livestock farming on climate change (via greenhouse gas emissions), the environment (via manure surpluses) and public health (via emissions of particulates and ammonia, the transmission of diseases from animals to humans, and the use of antibiotics in animals). In the fourth section we turn our attention to the consumer. Livestock farming exists only because of the consumer, and so what consumers choose to eat has an influence on the environmental and health impacts arising earlier in the supply chain. Moreover, some health impacts are directly associated with consumers' eating habits.

4.1 Impacts of livestock farming on greenhouse gas emissions

What contribution does Dutch livestock farming make to Dutch greenhouse gas emissions? And how does this compare with the emissions targets the Netherlands has to meet by 2030 and 2050? This section explores the greenhouse gas emissions from livestock farming and gives an indication of the external costs associated with them.

4.1.1 Greenhouse gas emissions from livestock farming

The agricultural sector as a whole is responsible for 26 Mt CO_2-equivalents of the total Dutch greenhouse gas emissions of 195 Mt. Some of these are CO_2 emissions from energy consumed largely by greenhouse horticulture. Separate targets have been set for these emissions, but they are not discussed here. A total of 19 Mt CO_2-equivalents is emitted in the form of other greenhouse gases: methane (CH_4) and nitrous oxide (N_2O). Of this, about 18 Mt can be attributed to livestock farming (ruminant digestion,[12] manure production and a small fraction from domestic animal feed production) (2015 figures, Emissieregistratie 2017).

Greenhouse gas emissions from land use

Agricultural production leads to greenhouse gas emissions from energy use (mechanical processes, greenhouse horticulture), livestock farming (ruminant digestion) and the application of manure and fertilisers. In addition, the use of land has an influence on carbon sequestration in the soil and biomass. Deep drainage of fen meadow areas to support grassland for grazing leads to oxidisation of the organic matter in the soil, which results in net emissions of CO_2. Deforestation also leads to net greenhouse gas emissions. Agricultural practices such as ploughing or not ploughing arable land and the use of green manures also have an influence on carbon sequestration. These 'LULUCF emissions' (land use, land use change and forestry) are not yet included in the climate targets or the emissions registration system. Under a proposal by the European Commission, these emissions and/or fixation of greenhouse gases will be included in the energy and climate policy for 2030 (European Commission, 2016), but it is uncertain whether or not this will lead to additional reduction targets. Net Dutch LULUCF emissions have been estimated at 6.3 Mt CO_2-equivalents per year (Schoots et al., 2017).

12 The formal name for this is 'rumen fermentation'. In the first stomach compartment, the rumen, the food undergoes a preliminary digestive process involving fermentation by microorganisms.

4.1.2 Standardisation

Greenhouse gas emission targets follow from a succession of international climate treaties, of which the 2015 Paris climate agreement has been the most proactive to date. This agreement sets a concrete and legally binding goal of keeping global warming well below 2˚C, with 1.5˚C as the target to aim for (UNFCCC, 2015).

This goal is currently being translated into greenhouse gas reduction targets for various countries and economic sectors. In a response to the Paris agreement, PBL states that the 2˚C goal means that in 2050 greenhouse gas emissions in the Netherlands must be 85% to 95% lower than in 1990 (Van Vuren et al., 2016). Limiting the temperature rise to 1.5˚C would even require an emissions reduction of more than 100% – which means net carbon fixation. In its analysis of the coalition agreement of the third Rutte Government, PBL considers that an appropriate climate target for 2050 in line with the Paris goal of limiting global warming to well below 2˚C is a greenhouse gas emissions reduction of 95%.

Current EU policy states that emissions of greenhouse gases within the EU in 2050 will have to be 80% to 95% lower than in 1990. The interim targets for total greenhouse gas emissions in 2030 are being prepared and translated into targets for the individual Member States. Under the current proposals by the European Commission, Dutch greenhouse gas emissions by the transport, agriculture, built environment and waste sectors in that year will have to be 36% lower than in 2005 (European Commission, 2016). For the time being there is an interim target for 2020 in which Dutch emissions must be 16% lower than in 1990. This has been translated in Dutch policy into a target for the agricultural sector of reducing annual emissions of methane and nitrous oxide (‘other greenhouse gases’) to 16 Mt in 2020 (Tweede Kamer, 2011).

In the coalition agreement (Tweede Kamer, 2017a) the government states its aim of reducing total greenhouse gas emission in the Netherlands to 49% of the 1990 level by 2030 and translates this into an indicative extra reduction target in addition to current policy for the various sectors. Relevant targets for livestock farming are an extra reduction of 1 Mt CO_2 by cutting methane emissions and an extra 1.5 Mt from changes in land use.

4.1.3 Estimated future emissions

The National Energy Outlook [*Nationale Energieverkenning*] (Schoots et al., 2017) presents estimates of emissions under current and proposed policy for livestock farming and other sectors. The Outlook observes that the targets for other greenhouse gas emissions from agriculture (CH_4, N_2O) in particular are not expected to be met.[13] It is anticipated that under current and proposed policy, the other greenhouse gas emissions from agriculture will stabilise at 18.8 Mt CO_2-equivalents in 2020 and 18.7 Mt CO_2-equivalents in 2030.

13 However, it should be noted that these targets are based on old guidelines issued by the UN IPPC in 1996. To take account of new understanding of the warming effects of nitrous oxide and methane, since 2015 emissions (and thus also any related target values) must be based on the 2006 IPPC guidelines. Application of the newer 2006 guidelines leads to higher emissions of non-CO_2 greenhouse gases of about 2 Mt CO_2-equivalents. However, the Ministry of Infrastructure and the Environment did not correct the 2011 target values to bring them into line with the IPPC guidelines.

PBL and ECN (Energy Research Centre of the Netherlands) state that with additional technical measures and policy for animal feed, the use of fertilisers and the anaerobic digestion of manure, among other things, emissions in the livestock sector can be reduced to about 10 Mt CO_2-equivalents in 2050 (Ros & Daniël, 2017). Under a 90% reduction target for 2050, the livestock farming sector would take up half of the remaining permitted emissions. If the target is for a 95% reduction, emissions from livestock farming would then use up all the remaining permitted emissions.

4.1.4 The hidden costs of greenhouse gas emissions from livestock farming

The emission of greenhouse gases from livestock farming in the Netherlands causes external effects, the costs of which are not borne by the sector itself but are passed on to society. The size of the costs that are passed on can be estimated from the CO_2 Emissions Trading System (ETS). Although agriculture does not fall within the ETS, the current price per tonne of CO_2 in the ETS can serve as an indicator. This price determines (at least in theory) the costs that would have to be incurred in other sectors to cut back the same amount of emissions. The Netherlands Bureau for Economic Policy Analysis (Aalbers et al., 2016) has made estimates of ETS prices until 2050, based on existing scenarios for welfare and the environment, for use in cost-benefit analyses. Because in practice the ETS does not cover the costs of prevention or greening production systems, the ETS price is a conservative estimate of the external costs.

The table on the next page gives an indication of the hidden costs of agricultural greenhouse gas emissions, based on the above-mentioned emission targets and prognoses.

Table 1: The hidden costs of agricultural greenhouse gas emissions

		Actual	2020		2030		2050	
ETS-CO_2-price*	euros/tonne	5	5	15-40	40-160			
			Target	Prognosis	Target***	Prognosis	Projection	Maximum emission reduction measures****
Agriculture / other greenhouse gases (CH_4, N_2O)**	CO_2-eq in Mt/year	19.2	16	18.8	12-15.8	18,7	18,6	10
Cost	million €/year	96	80	94	237-480	280.5-748	744-2976	400-1600

* Aalbers et al., 2016

** Schoots et al., 2017

*** Suggested by PBL as a plausible translation of the national reduction target of 36% from 2005 levels (Ross & Daniëls, 2017)

**** Based on maximum achievable emission reduction without major changes to the production structure (Ross & Daniëls, 2017)

A more realistic indication of the ETS price is given by what are called the prevention costs. The ETS price is arrived at in a CO_2 market determined by a fixed emissions ceiling. However, to remain within the 1.5˚C to 2˚C target in the Paris agreement (prevention), further reduction to below a lower ceiling will be necessary. The CO_2 price based on prevention costs is many times higher than that based on the current ETS ceiling, at €100–€500 in 2030, rising to €200–€1,000 in 2050 (Aalbers et al., 2016). See table 2.

Table 2: Forecasted prevention costs

		2030	2050	
Prevention costs of 2˚C policy	euros/tonne	100-500	200-1000	
		Prognosis	Projection	Maximum emission reduction measures
Agriculture / other greenhouse gases (CH_4, N_2O)	CO_2-eq in Mt/year	18.7	18.6	10
Cost	million €/year	1870–9350	3720–18,600	2200–11,000

Source: Aalbers et al., 2016

The hidden costs of the primary production sector caused by greenhouse gas emissions from livestock farming can be offset against the added value (GNP) of €2.4 billion (€2 billion and €0.4 billion from the land-based and intensive livestock sectors).[14] If the added value of livestock farming remains more or less the same over the coming years, then these hidden costs amount to 4% now, 11%–30% in 2030 and 30%–120% in 2050 of the added value of livestock farming, based on ETS prices under the current system. If the prevention prices are used, then the hidden costs of greenhouse gas emissions from livestock farming will greatly exceed its added value.

14 Figures for 2013 from WecR, 2017. See Chapter 2.

4.2 Impacts of livestock farming on the environment

Livestock farming in the Netherlands impacts the environment in various ways, including land use, odour nuisance and use of natural resources. This section is limited to a description of the impact of manure on the quality of surface water and groundwater and the environmental impacts of ammonia emissions. The high numbers of livestock farmed in the Netherlands lead to nutrient surpluses in the environment, caused in the first place by the application of manure as a fertiliser on arable land and grassland. Leaching of surplus nutrients to the groundwater and surface water bodies leads to exceedances of water quality standards, failure to achieve ecological objectives and problems for drinking water quality. Nutrients are also dispersed through the air in the form of ammonia. Deposition of ammonia in and around protected natural and semi-natural

habitats leads to an impoverishment of biodiversity and failure to meet the biodiversity conservation objectives for these sites.

4.2.1 Quality of groundwater and surface water

The water quality in large areas of the Netherlands does not yet meet the targets for 2027 under the EU Water Framework Directive (WFD). A major reason for this is the application on land of animal manure from livestock farming. The current fertiliser policy has been effective in improving water quality, but the improvement is now stalling (PBL, 2017b) and there will be hardly any further reduction in the eutrophication of surface waters in the period to 2027. Under current policy, in 2027 the targets for nitrogen and phosphorus will be met in about half of all surface water bodies. As a result, in most surface waters the 2027 ecological targets will not be achieved. If there is no change in policy, in 2027 the nitrate concentrations in the groundwater in the southern sandy soils area are expected exceed the 50 mg/l standard by 20%, which will affect drinking water quality.

Water quality standards

The Dutch river basin management plans for implementing the WFD contain specific standards for surface water quality. The goal of the WFD is to improve water quality with the aim of restoring and maintaining its chemical and ecological health. The high concentrations of nitrogen and phosphorus in Dutch surface water bodies are an impediment to achieving the WFD ecological targets. About 55% of the nitrogen and phosphorus comes from the fertilisation of agricultural land, mostly with manure from livestock farms (PBL et al., 2017). Other sources of nutrients are the deposition of ammonia (via the air), the drainage of peaty soils and surface seepage from deep, nutrient-rich groundwater.

The Nitrates Directive regulates the use of agricultural fertilisers with the aim of preventing and reducing water pollution by manure and fertilisers. It contains a use standard for the application of nitrogen in manure. The maximum application rate for all crops is 170 kg nitrogen per hectare from animal manure, unless a Member State has received a derogation. The Netherlands has a derogation for grazing livestock farms (230 kg nitrogen per hectare in/on sandy soils in the south of the country; 250 kg nitrogen per hectare elsewhere). This derogation is subject to certain conditions, including an obligation to monitor the effects of manure application and report on this annually and to restrict total manure production to within a manure production ceiling (equal to the 2002 level).

The Dutch government has transposed the Nitrates Directive into the Act on Manures and Fertilisers. The Act on Manures and Fertilisers includes provisions on the total amounts of nitrogen and phosphate that may be applied to arable land and grassland via chemical fertilisers and manures and the methods that must be used to apply them.

Exceedances of nitrogen and phosphorus standards in surface water

Problems with water quality resulting from manure application are largely regional in nature and depend on the composition of the soil and subsoil (clay and peat soils, sandy soils) and land use.

- *Phosphorus/phosphate in surface water.* The WFD has been transposed into Dutch law with different standards for phosphate concentrations per surface water type and region: flowing waters and streams are found mainly in the higher lying areas of the country where the soils are usually sandy; ditches, lakes, canals and waterways are found mainly in the lower lying areas of the country with either clay or peaty soils. The average phosphorus concentrations in the water bodies affected by agricultural activities in the sandy soil regions are twice as high as the WFD standard of 0.11 mg P per litre. The average phosphorus concentrations in the clay and peaty soil regions are more than three times as high as the WFD standard of 0.22 mg P per litre. Under continuation of the current policy, the proportion of regional water bodies that meet the standards for nitrogen and phosphorus will rise from about 45% in 2013 to 50% in 2027, due primarily to emission reduction measures at sewage treatment plants (PBL, 2017b). Persistent replenishment of phosphorus from soils laden with excess concentrations and from phosphate-rich groundwater seepage (only in the lower lying regions of the country) are the main reasons why phosphorus concentrations in surface waters are hardly being reduced. The gradual tightening of use standards for phosphate in the Act on Manures and Fertilisers between 2006 and 2014 has now put a halt to and reversed this accumulation of phosphate in soils. But it will be only after 2027 that this decrease in the phosphorus stocks in soils will actually lead to an improvement in the quality of regional surface waters (PBL, 2017b).
- *Nitrogen/nitrate in surface water.* The nitrogen standards also depend on the type of water. After an initial decrease in the period 2012–2015, average nitrogen concentrations in the sandy soils regions are still about 40% above the standard of 2.3 mg N per litre. Concentrations in the clay and peaty soils regions are about 20% above the WFD standard of 2.4 mg N per litre (PBL, 2017b). Although concentrations are declining, it is expected that under continuation of current policy in 2027 the WFD targets will not have been achieved in 50% of surface waters.

Groundwater

Besides the standards for surface water, the EU has also set quality standards for groundwater. The Groundwater Directive sets a maximum concentration for nitrate in groundwater of 50 mg per litre. This quality standard is met in most areas and is exceeded only in the southern sandy soils region, where average nitrate concentrations in the shallow groundwater layer are around 80 mg per litre. It is expected that without a change in policy, the decrease in nitrate concentrations in the southern sandy soils region will not be enough to achieve the nitrate target by 2027 and that concentrations will still be 10 mg per litre too high (PBL, 2017b).

The degradation of nitrate in the groundwater can lead to an increase in the concentrations of heavy metals and sulfate and an increase in the hardness of the water. As a consequence, quality standards for drinking water may also be exceeded. In the period from 2000 to 2015 this occurred in water from 89 drinking water abstractions in the sandy soils region. According

to PBL, these cases are probably a consequence of higher applications of chemical fertilisers and manures in the past (PBL, 2017b).

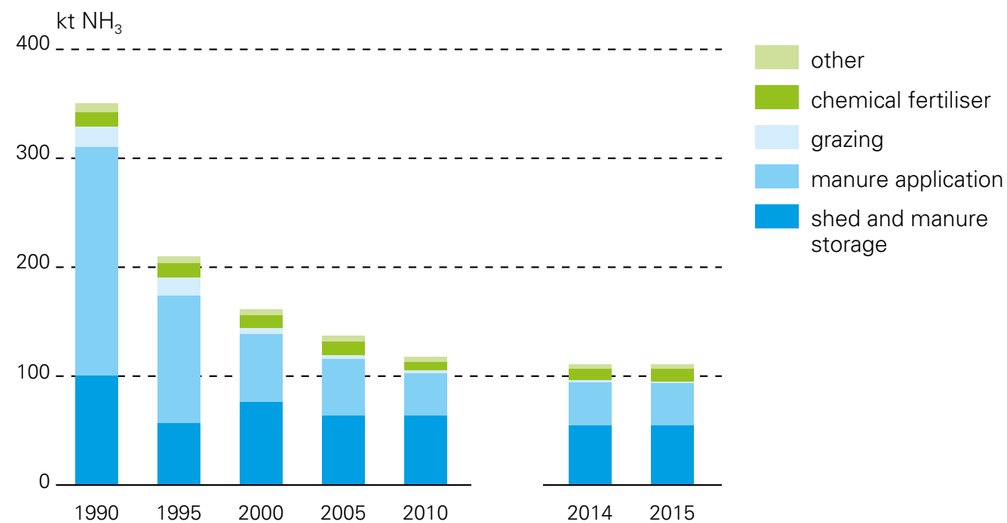
4.2.2 Atmospheric deposition of nitrogen

Agriculture and horticulture are responsible for a large proportion of the nitrogen distributed through the atmosphere in the form of ammonia emitted largely from livestock sheds and manure. The total ammonia emissions in the Netherlands (including emissions from other sources) are subject to the EU National Emissions Ceilings Directive (NECD) (Europese Unie, 2016). The ammonia emissions ceiling for the Netherlands was set at 128,000 tonnes from 2010. The agricultural and horticultural sectors account for 110,000 tonnes. Ammonia emissions have fallen sharply since the 1990s, particularly as a result of the introduction of manure injection, the covering of manure storage and technical measures taken in livestock sheds, and have been stable since 2014 (see Figure 9).

Although the above figures indicate that ammonia emissions for the Netherlands as a whole meet the NECD ceiling, there is still some debate about the method for determining ammonia emissions, throwing doubt on whether or not the 2010 emissions ceiling has been met. There is also a commitment to reduce emissions by 13% from the 2005 level by 2020 (PBL et al., 2017).[15] Moreover, it is not just the total ammonia emissions that count, but the intensity of emissions as well, and at 60 kg ammonia per hectare of agricultural land, emissions in the Netherlands are the highest in EU.

15 See: http://www.clo.nl/indicatoren/nl0101-ammoniakemissie-door-de-land--en-tuinbouw

Figure 9: Ammonia emission by agri- en horticulture

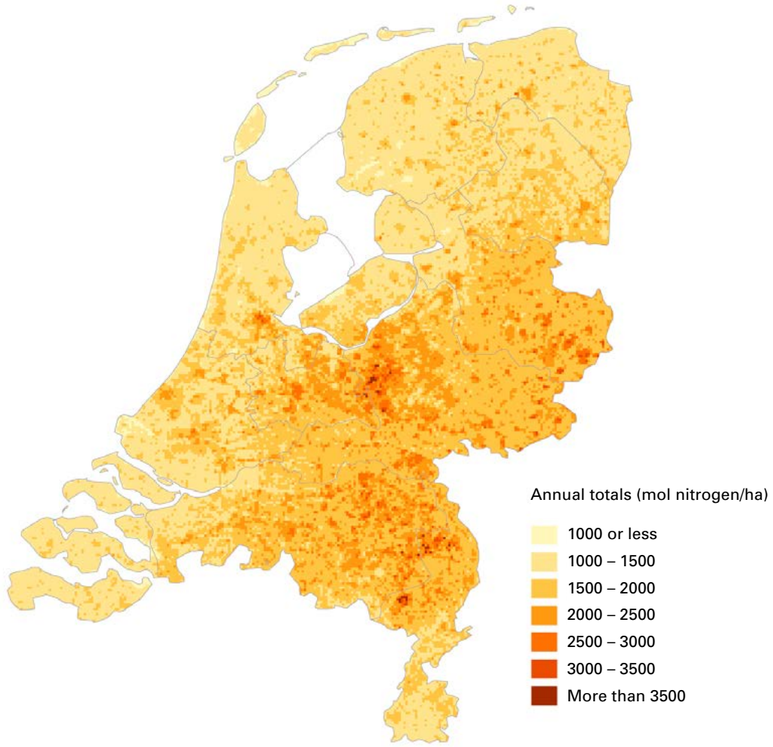


Source: PBL et al., 2017

Ammonia from agriculture accounts for 40% of nitrogen deposition on soils, the remainder is in the form of nitrogen oxides from traffic emissions and from other sources (predominantly nitrogen oxides). Outside the cities, the proportion originating from agricultural activities is 60%. This deposition leads to eutrophication (see Figure 10) (PBL et al., 2017).[16]

16 See: http://www.clo.nl/indicatoren/nl0189-vermestende-depositie

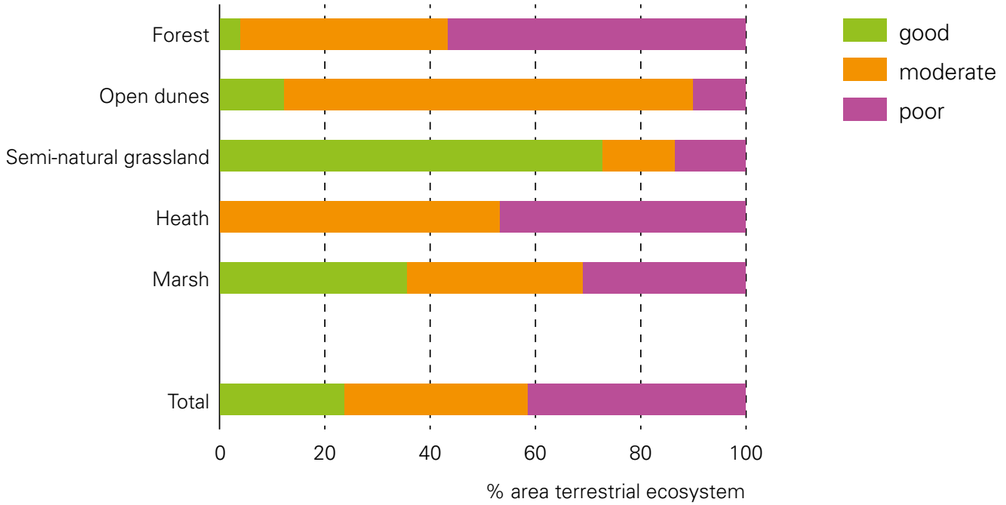
Figure 10: Eutrophying deposition 2015



Source: PBL et al., 2017

Nitrogen deposition has consequences for environmental conditions in natural and semi-natural habitats, particularly on the nutrient-poor sandy soils in areas with concentrations of intensive livestock farms. The environmental quality in more than three quarters of the total area of terrestrial ecosystems is moderate to poor, especially in forest, open dune and heath ecosystems (see Figure 11) (PBL, 2017a). This is undermining efforts to achieve the conservation objectives for Natura 2000 sites under the EU Habitats Directive (Raad voor de Europese Gemeenschappen, 1992).

Figure 11: Effect of nitrogen deposition on the suitability of environmental conditions for terrestrial ecosystems



Source: PBL 2017a

The aim of the Nitrogen Reduction Programme (PAS) (Staatscourant, 2017) is to reduce the adverse impacts of nitrogen deposition on biodiversity. But all the alternatives scenarios examined under the programme indicate that in 60%–70% of the Dutch terrestrial Natura 2000 sites nitrogen concentrations will remain too high (PBL, 2017a).

4.2.3 Costs of the environmental impacts of livestock farming

The livestock farming sector is incurring costs for the measures it is taking to limit its environmental impacts, particularly for the removal and processing of manure. In this section we estimate the size of these costs, both for individual farms and for the Netherlands as a whole. In addition, the environmental impacts themselves lead to external costs. The pollution of surface waters and groundwater with phosphate and nitrate leads to costs to society, including the costs of combating eutrophication, the extra costs of producing drinking water and the loss of safe swimming water. The loss of habitats and biodiversity (on land or in surface waters) also brings costs to society. An estimate of these external costs requires a deeper analysis, which has not been made for this advisory report.

The costs incurred by dairy, veal and pig farms for the disposal of manure required under current policy amount to €361 million per year (PBL, 2017b; 2015 figures). About half the manure is used on the farms where it is produced and this is mostly manure from grazing livestock. A quarter of the manure, mostly pig manure, is sent to arable farms in the Netherlands for a manure acceptance fee. The remaining quarter, including most of the poultry manure, is processed and/or exported.

Manure disposal costs per farm are rising, partly because farm sizes are increasing and partly because of the tightening of the manure application standards. As a consequence, the manure surpluses in 2015 were larger than in previous years. The manure disposal costs for pig farms increased to an average of more than €42,000 per farm and for dairy farms to about €5,000 per farm (WecR, 2017). These costs amount to 6% and 1.4% respectively of the turnover of an average farm. While livestock farms have to bear these manure disposal costs, arable farms that take this manure benefit by receiving a fee for accepting the manure and by the savings accruing from reducing their use of artificial fertilisers.

Vrolijk et al. (2010) have estimated the total numbers of cattle and pigs at which the manure market would be brought back into balance by 2020. In this situation, the amount of manure produced can all be disposed of within the Netherlands and the users of manure will again pay for it. Assuming an economically optimal allocation of this reduction in livestock numbers, there would be 12% fewer dairy cattle, 30% fewer breeding pigs and 35% fewer fattening pigs compared with the situation in 2006.

4.3 Public health in relation to livestock farming

Livestock farming on the scale and at the concentrations found in the Netherlands is causing increasing concern about public health and liveability in the areas around livestock farms. This seciton is about the main health impacts of livestock farming and what causes them. We examine the health effects of particulates, zoonoses and the use of antibiotics. What are the risks to local residents and how are these risks mitigated?

4.3.1 Particulate matter

Particulate matter is a collective term for tiny airborne particles of varying sizes and composition (Nijdam & Van Dam, 2011). These particles can cause respiratory problems and other illnesses. Along with traffic and industry, livestock farming is an important source of particulate matter.

Primary particulate matter is emitted directly to the atmosphere from various sources. It consists of soot particles (traffic, industry), wind-blown sand and sea salt, and endotoxins from livestock farms: skin particles, fungi, bacteria and bacterial components. Secondary particulate matter is formed in the atmosphere by ammonia reacting with polluting gases to form aerosols.

On average about half of all particulate matter consists of secondary particulates. In areas with high concentrations of livestock, more than 20% of primary particulate matter is from poultry and pig farms. Of the secondary particulate matter in the Netherlands, 90% of the ammonia originates from livestock farms (particularly dairy farms, followed by pig, poultry and goat farms) (Ruiter & Rougoor, 2017).

Secondary particulate matter is a national and international problem. If farmers in northern France spread manure on their land the resulting secondary particulate matter can cause respiratory problems in London. Primary particulate matter, on the other hand, is mainly a regional and local problem.

Health impacts

According to RIVM, each year a few thousand people in the Netherlands die a few days to some months early as a result of short-term exposure to high concentrations of particulate matter. These are mostly older people and people with heart, vascular or pulmonary diseases. Long-term exposure to lower concentrations of particulate matter, even concentrations below the EU limit values, also have adverse health effects. Lifelong exposure can lead to permanent health effects such as reduced lung function, aggravation of respiratory conditions and premature death of patients with respiratory diseases or heart and pulmonary diseases.

Particulate matter is probably always harmful. No threshold has been found below which particulate matter has no health effects. In other words, no concentration has been found below which epidemiological studies indicate that there are no health effects, which implies that ambient concentrations of particulate matter below the current limit values can cause health effects (RIVM, 2017d).

Risks

Research by RIVM strongly indicates that living near and working on livestock farms has an adverse effect on health. Health effects have been found among people living within one kilometre of livestock farms (RIVM, 2016b). A study by Alterra Wageningen UR has identified that 87% of livestock farms in the Netherlands are located less than 250 metres from one or more homes and about 355,000 homes are located within 250 metres of a livestock farm (Van Os & Jeurissen, 2016).

The Animal Sciences Groep (Ogink et al., 2016) has studied the concentration of endotoxins in the air around intensive livestock farms. One of the conclusions of their study is that the current methods for assessing particulate matter concentrations and odours from poultry farms (broilers and laying hens) provide insufficient protection against exceedances of the endotoxin limit value. Moreover, the method for assessing exposure takes no account of cumulative sources.

The subsequent advice by the Health Council of the Netherlands on the health risks around livestock farms states that recent research results confirm that people living near a livestock farm are more likely to have reduced lung function and a higher risk of pneumonia. However, it is not clear whether or not there is a causal link between emissions and health effects, because too few studies of the required calibre have been done. The Health Council of the Netherlands does advise a further reduction of particulate matter emissions (Gezondheidsraad, 2018).

Monitoring standards

Dutch air quality policy aims to meet the EU limit values and to this end the national government, the provinces and municipalities are working together in the National Cooperative Air Quality Programme (NSL) to improve air quality. The progress being made in the NSL has been monitored annually since 2010, including the levels of exposure among the population to particulate matter and nitrogen dioxide. Lowering the concentrations of these pollutants will lead to improvements in public health, even if the concentrations are already below the EU limit values (PBL et al., 2017).[17]

Although the calculated concentrations of particulate matter and nitrogen dioxide are below the EU standards across most of the Netherlands, the concentrations are too high in areas with intensive livestock farming or industry. Average concentrations of particulate matter fell in 2015, but this decline looks like stagnating over the next few years. The Netherlands should have met the standards for particulate matter across the whole country by mid 2011 (RIVM, 2016b).

Costs

In 2005 the Astmafonds (now Longfonds – the Lung Fund) carried out a study of the social costs of the health effects of air pollution (Lebret et al., 2005). The main message of the report is that the effects of air pollution cost society at least €4 billion per year, most of which is due to premature death as a result of long-term exposure to particulate matter. How much of this is down to particulate matter from livestock farms is not known.

17 See: http://www.clo.nl/indicatoren/nl0243-fijn-stof-pm10-in-lucht

4.3.2 Zoonoses

Zoonoses are infectious diseases that can be transmitted from animals to people. The animal itself does not have to be ill to transmit the pathogen to people; the transmission can be by contact with the animal or its manure, via other animal species, or via materials, food, the air or the environment (Ruiter & Rougoor, 2017). Known zoonoses in the Netherlands are BSE ('mad cow disease'), bird flu, salmonella, campylobacter and Q fever.

Health impacts

In 1992–1993 there was an outbreak of BSE in the UK, which subsequently spread to other countries. People infected with BSE could acquire variant Creutzfeld-Jakob disease, a fatal brain disorder. Three people in the Netherlands died from this infection.

Outbreaks of bird flu (avian influenza) occur regularly. The effects on people depend heavily on the type of virus. Since 2003 transmission of this type of virus from animals to humans has been rare. During the 2003 outbreak 86 infections were recorded, mainly among poultry farmers. One of them died.

Q fever can be contracted by inhaling air that contains the bacteria. Sources of the disease in the Netherlands have been infected dairy goats and dairy sheep. The bacteria escape to the air during the lambing of infected goats and sheep (RIVM, 2017b). In 2007 and 2008 there were major Q fever outbreaks in the Dutch provinces of Noord-Brabant and Limburg, particularly in areas with high concentrations of dairy goat farms. Of the people infected with Q fever, 20% had flu-like symptoms lasting two or three days. In a further 20% the infection led to a bout of acute Q fever (2 weeks). Of this group, a quarter suffered from chronic fatigue syndrome, which can persist for some time. On average, 2% of people with Q fever develop chronic Q fever, which can lead to inflammation of the heart valves (Tempelman et al., 2011).

Since 2007 there have been 26 officially recorded deaths as a result of Q fever and more than 4,000 reported cases of the disease, with a peak in the period 2007–2009. However, this is almost certainly an underestimate because it only includes people with acute Q fever. The total number of deaths recorded in hospital databases is 74. Vaccination of dairy goats and dairy sheep has proved effective in combating the disease (RIVM, 2017b).

Risks

The risk of people becoming infected with BSE is now virtually nil as a result of the extensive package of measures in force (see below under Policy). The risk of contracting bird flu and swine flu is limited primarily to people who work with poultry and pigs. Nevertheless, there is considerable concern about the possibility of a pandemic, which could be caused, for example, by new strains of the H7N9 virus in China. Experts consider it inevitable that there will be new outbreaks of Q fever and similar zoonoses (Rougoor et al., 2014).

Climate change, changes in consumption patterns and increasing international travel and transport (of both people and animals) all

compound the risk of new (unknown) pathogens being introduced from abroad. What makes this risk so unpredictable is that pathogens can mutate and so there is always the chance that a relatively harmless pathogen will develop into a much riskier strain. The possibility of person-to-person contamination also increases the risks.

Policy

Over the years the Netherlands has introduced an increasingly comprehensive range of measures to control BSE. These measures are designed on the one hand to ensure food safety and on the other hand to eradicate the disease (Wageningen University & Research [WUR], 2017a). Any occurrence of certain infectious diseases of livestock must be reported. Preventive vaccination of livestock can help to prevent major outbreaks. After the Q fever outbreak in 2007–2011 a more thorough national prevention programme was established in the hope that this would enable early identification and control of zoonoses. At the moment, vaccination is compulsory for farms with dairy goats and dairy sheep and premises with animals that are open to the public (such as petting farms). All other holders of goats and sheep may voluntarily have their animals vaccinated. However, vaccination of commercially owned animals against bird flu is not permitted, because vaccinated and infected animals cannot be told apart and so it would be impossible to determine whether an animal for export is infected or not.

Costs

According to the World Bank (2010) the direct economic costs of the outbreaks of BSE, SARS, H5N1 and H1N1 amounted to more than 20 billion dollars each, but the costs of a relatively serious global epidemic of a highly pathogenic strain of bird flu could well rise to as much as 3,000 billion dollars.

Q fever infections in people are the most costly. People can become seriously ill and the medical tests, treatment and care of patients can be expensive. The social costs of the Q fever outbreak in the Netherlands have been estimated by LEI-Wageningen UR and SEO Economic Research at between €250 million and €600 million (Tempelman et al., 2011), 85% of which are estimated to be human costs, such as work lost due to sickness. In addition, Q fever infections have been linked to the deaths of 25 people between 2007 and 2012.[18]

4.3.3 Use of antibiotics

Antibiotics are needed to control bacterial infections in humans and animals. Persistent use of antibiotics, however, leads to resistance in bacteria. In recent decades there has been an increase in bacterial resistance, but almost no new antibiotics are being developed to control these infections (Tempelman et al., 2011). Because the same antibiotics are used on people and animals, excessive use of antibiotics in livestock farming also involves risks to humans.

18 See: https://www.agriholland.nl/dossiers/qkoorts/home.html

Monitoring reduction targets

In 2009 the government adopted a policy of reducing the use of antibiotics in livestock farming by 70% from the 2009 levels, to be achieved by 2015. Since then sales of antibiotics for use in livestock have fallen by 64% (figures from FIDIN, the Dutch veterinary pharmacy association). The rate of decline was rapid until 2012, but has since levelled off and the policy objective of a 70% reduction by 2015 has not been achieved (WUR, 2017b).

Fall in antibiotic use per sector

The annual monitoring by the Netherlands Veterinary Medicines Institute (SDa) indicates that the reduction in numbers of treatments with antibiotics from 2009 levels has been greatest in broilers, at more than 70%. The reduction in antibiotic use in pig farming was more than 55% (SDa, 2017). The reduction was least in the veal farming sector, at just under 40%. The most frequent use of antibiotic treatments in 2016 was by veal farmers and turkey farmers, at an average of 20 and 26 treatments per year. Dairy cows received the lowest number of antibiotic treatments, at an average of between 3 and 4 per year.
Antibiotic use per kg live weight in the Netherlands is lower than the European average and far below the level of antibiotic use in Belgium, Germany, France, Italy and Spain (Rougoor et al., 2016).

In 2016, in an attempt to achieve the 70% reduction target, the government set sector-specific targets for 2020 (Tweede Kamer, 2016d), putting the responsibility for reducing antibiotic use on the livestock farming sector. The government remains responsible for overseeing the safe and responsible use of antibiotics. Regulatory measures include registration of use and prescribing behaviour, fixed contracts between farmers and vets, restrictions on group medication and a ban on the administering of antibiotics by farmers themselves if they have no farm health and treatment plan.

Also in 2016, the livestock farming sector made plans for a safe reduction in the use of antibiotics, including measures like better feed, better hygiene, well ventilated sheds and avoiding putting animals under stress. Studies are currently underway to identify which measures can best be introduced to responsibly reduce the copious use of antibiotics and determine what sector-specific reduction targets are justified. The Netherlands Veterinary Medicines Institute (SDa) is working with the government and the livestock farming sector to establish new benchmarks to serve as a basis for setting reduction targets for 2020 for each sector (SDa, 2017).

Costs

Little is known about the extra healthcare costs of antibiotic resistance in the Netherlands. Dutch hospitals have set up an additional screening procedure for livestock-related antibiotic resistance. The annual costs of antibiotic resistance in the EU are estimated to be at least €1.5 billion (European Centre for Disease Prevention and Control, 2009). This figure includes the extra healthcare costs and loss of productivity, but not social costs such as loss of income and working days lost due to sickness.

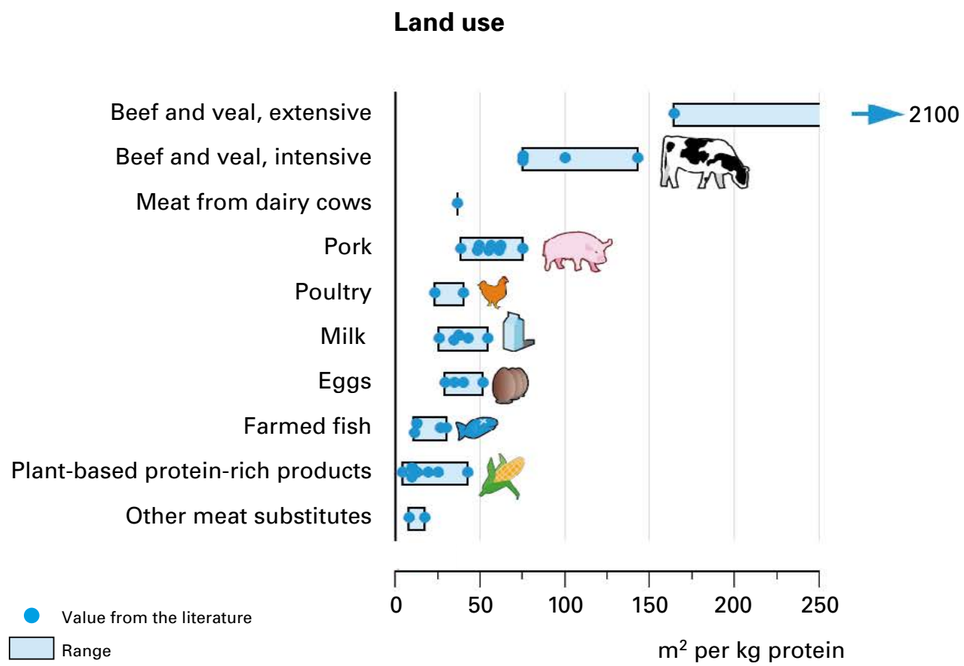
4.4 Impacts of diet on climate change, the environment and health

The Dutch diet changed during the second half of the twentieth century. As people become more prosperous, they ate more, especially more animal products. Since 1960 the Dutch eat about 25% more protein and the proportion of plant to animal protein in the diet has shifted from 50/50 to 30/70 (RIVM, 2017a). The consumption of animal products in particular has increased the environmental impacts of the food supply and the pressure it puts on natural resources, both in the Netherlands and abroad. The growing consumption of animal products also contributes to the increasing incidence of overweight and obesity and various 'prosperity diseases' among the Dutch population.

4.4.1 Impacts on the environment and sustainability

The supply chain that puts the food on the consumer's plate makes use of natural resources in the Netherlands and elsewhere in the world. The global demand for food is growing and from 2012 to 2050 it is expected to increase by 50% (Food and Agricultural Organization of the United Nations [FAO], 2017). Moreover, as global prosperity grows, the demand for animal products is expected to increase. And it is animal products that make a relative large demand on natural resources, such as land (see Figure 12). A scenario study by Odegard & Van der Voet (2014) indicates that the current global trend in consumption of animal products cannot be reconciled with the limited availability of natural resources (fertile land, fresh water, phosphate). Even with maximum efficiency gains in global production, a diet such as that enjoyed in the industrialised world is simply not possible for the whole of the world's population. Under a just and fair (equal) distribution of natural resources, Western food consumption will have to become more sustainable.

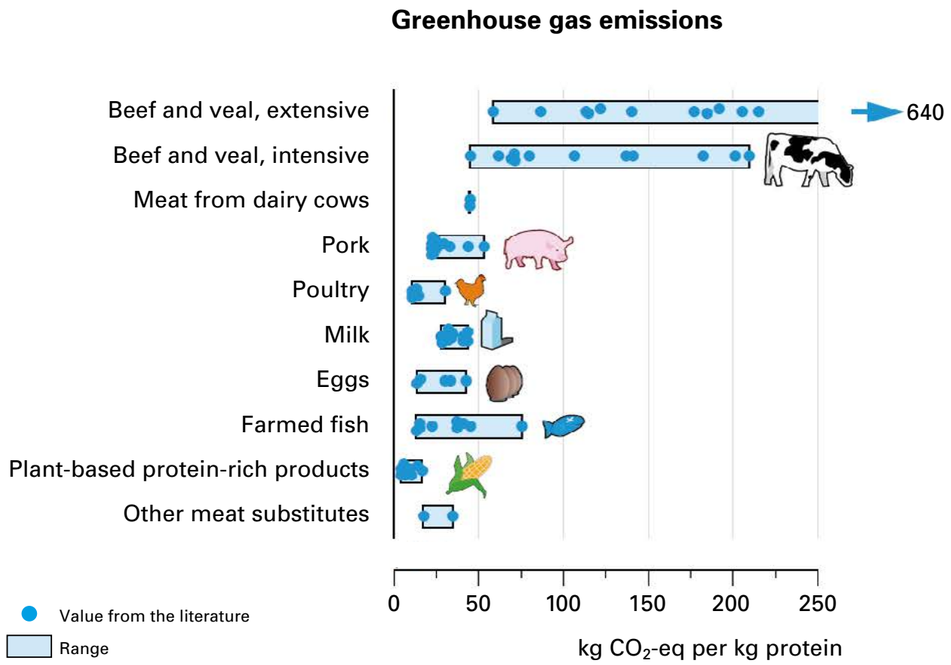
Figure 12: Land use by protein source



Source: Westhoek et al., 2013

In addition, greenhouse gas emissions from the food supply chain are considerable: the global food system is responsible for 21% to 25% of total greenhouse gas emissions (FAO, 2016; RIVM, 2017; Bailey et al., 2014). Here too, animal products make a disproportionate contribution to emissions, particularly from the cultivation of food crops and from methane emissions from livestock farming (see Figure 13). The Dutch diet contains relatively large quantities of animal products and is responsible for the emission of 35 Mt CO_2-equivalents per year (RIVM, 2017a).

Figure 13: Greenhouse gas emissions by protein source



Source: Westhoek et al., 2013

4.4.2 Health impacts of diet

Diets rich in meat and meat products have an adverse effect on the health of the consumer and many known prosperity diseases can be attributed to diet. The Health Council of the Netherlands (Gezondheidsraad, 2015) has systematically evaluated the scientific evidence on the relation between nutrition and the ten most common chronic diseases and considers it plausible that the consumption of red meat and processed meat is linked to a higher risk of suffering a stroke, diabetes, intestinal cancer and lung cancer. Diets that contain a lot of fruit, vegetables and pulses reduce the risk of coronary heart disease.

The health of the consumer does not depend on the composition of the diet alone, but also on the amount eaten. The Netherlands Nutrition Centre advises that 0.8 g of protein per kg of body weight per day is sufficient, or 60 g per day for a person who weighs 75 kg. The current average intake is considerably higher, at 108 g per person per day. This overconsumption of protein, and of food in general, means that more than half (50.3%) of the Dutch population who are 20 years or older are moderately or severely overweight (RIVM, 2017a; 2015 figures).

4.4.3 The real cost of food

The price consumers pay for food does not reflect the social costs associated with its production and consumption. The greenhouse gas emissions and other impacts on the environment, in the Netherlands and elsewhere, from across the whole food value chain are the ‘external costs’ of the food system. These costs are expressed, for example, in a

stronger greenhouse effect, the exhaustion of agricultural land, reduced water quality, reduced recreational possibilities near farms, odour nuisance and health effects. The costs of these impacts that are not borne by the food production chain are passed on to society, both in the Netherlands and elsewhere. As the environmental impacts of the production and consumption of animal products are greater than those of plant products, the costs of animal-based foods that are passed on to society are also higher.

A study by the FAO (2014) estimates that the ecological costs (climate, soil, water, biodiversity) of global food production are 2,100 billion dollars and the social costs (health, quality of life) are 2,700 billion dollars, compared with a production value of 3,000 billion dollars. This means that the environmental costs of the food value chain that are passed on to society amount to 160% of the price of food in the shops.

Blonk et al. (2011) have estimated the external costs of pork and dairy products in the Netherlands. These costs are €1.84 and €0.17 per kg of product respectively, or about the same as the production costs incurred by the livestock farmer. These figures do not include the costs resulting from impacts on the landscape, noise and odour nuisance, and the drying of habitats, and the health impacts of antibiotic resistance and zoonoses.

Wageningen University & Research and True Price are developing a method to obtain a systematic picture of the negative effects of the consumption of specific foods in the Netherlands (WUR, 2017c). The method generates an objective picture of the impact of a product on six 'capitals': financial, produced, intellectual, natural, social and human capital. As yet there is no single indicator (for example, in euros) for the various impacts, and neither is there a validated weighting system.

Because the social costs are not expressed in the price of food paid by the consumer, current retail prices provide no incentive to choose healthier or more sustainable products. For farmers and parties in the food value chain who want to produce more sustainable products there is little room to factor the extra costs involved into the price, unless healthier and more sustainable products are positioned as luxury goods and the retail sector passes the higher returns back to the primary producers.

5

BRIEF OVERVIEW OF RELEVANT POLICIES

5.1 Pre-2013 policies

At the beginning of this century livestock farming found itself in a difficult position. A series of crises and scandals and the persistent pressure it exerts on the environment had undermined the industry's automatic 'licence to produce'. In 2001, at the request of the government, the Wijffels Commission presented its advice on the transformation of intensive livestock farming into an ecologically, socially and economically sustainable industry. A public debate on the future of intensive livestock farming was launched in 2003. The outcome of this debate (Tweede Kamer, 2004) was that there is a future for an intensive livestock farming industry in the Netherlands that produces quality products for the north-west European fresh and convenience food markets, backed by sophisticated logistics and high quality service.

Two documents were published before the end of the first decade: The Future of Intensive Livestock Farming [*Toekomst van de intensieve veehouderij*] and the Policy Document on Sustainable Food [*nota Duurzaam Voedsel*]. Both documents take a global perspective that acknowledges the growing concern about the scarcity of natural resources. They also consider the social aspects of livestock farming and food production and consumption. The Future of Intensive Livestock Farming report (Tweede Kamer, 2008) states that in 15 years' time livestock farming in the Netherlands will have to be fully sustainable, which means that as well as being profitable it will have to respect the environment, animal welfare and animal health. The Policy Document on Sustainable Food (Tweede Kamer, 2009a) discusses aspects such as land use, use of resources, emissions, and water and energy use, as well as cutting out waste and improving animal and human welfare. Consumers should have a choice of good products that challenge them to adopt a more sustainable purchasing behaviour. Materials loops must be largely closed, but links between consumers, producers and the environment kept open. The food value chain must become more demand-led on health and sustainability issues.

The Vision for the Future of Livestock Farming [*Toekomstvisie Veehouderij*] formed the basis for the policy agenda for sustainable livestock farming [*Uitvoeringsagenda Duurzame Veehouderij*] (Tweede Kamer, 2009b) drawn up by the Ministry of Agriculture, Nature and Food Quality, the Dutch Federation of Agriculture and Horticulture (LTO), the Dutch Dairy Association (NZO), the Dutch Meat Association (COV), the Dutch Feed Industry Association (Nevedi), Rabobank Nederland, environmental organisation Natuur & Milieu and the Dutch Society for the Protection of Animals (Dierenbescherming), and later also the Association of Provinces of the Netherlands (IPO). Following the publication of both these documents and an implementation agenda, the national government has focused its efforts increasingly on bringing about the necessary changes by involving the whole value chain and formalising agreements in the form of covenants and alliances. The implementation agenda contains a roadmap towards a sustainable livestock sector in 2023, after which the implementation agenda will be periodically updated. In 2013 a set of

15 ‘ambitions’,[19] or long-term goals, were agreed for the implementation agenda for sustainable livestock farming.

Over the years, legislation has been adopted to tackle specific environmental, water, biodiversity, public health and animal welfare problems, such as the Act on Manures and Fertilisers, the Nitrogen Reduction Programme (PAS), various animal welfare policies and visions, and regulations on improving air quality (particulate matter) and reducing the use of antibiotics. These are largely based on EU directives such as the Water Framework Directive, the Nitrates Directive, Natura 2000 and the EU ambient air quality standards. Targets have also been set for the reduction of greenhouse gas emissions. (See Chapter 4 for a more detailed description.)

5.2 Food policy

In 2014 the Scientific Council for Government Policy (WRR) concluded that for decades the Dutch government has pursued an implicit food policy which for a long period mirrored its agricultural and food safety policies. Over time other goals have been added, often in the form of flanking policies, such as public health, animal welfare, environmental and landscape management policies. The WRR made a case for transforming agricultural policy into a food policy (WRR, 2014): ‘A food policy takes account of the range of different values attributed to food, the links between production and consumption, and the changing power relations.’ In October 2015, in response to the WRR advice, the government published its Agenda for Safe, Healthy and Sustainable Food [Voedselagenda voor veilig, gezond en duurzaam voedsel] on the development of a comprehensive policy for the whole food system (Tweede Kamer, 2015). This agenda outlines the first steps towards a policy for a healthy, ecological sustainable and robust food system.

In 2016 the food agenda was modified and refined in consultation with industry, consumers and civil society organisations (Tweede Kamer, 2016b). A public debate confirmed that many parties are highly committed, that many initiatives are being pursued and that food policy is closely bound up with many issues such as public health, climate, energy, animal welfare and the circular economy. This was again confirmed at the Food Summit held in January 2017 (Tweede Kamer, 2017b).

During the Food Summit long-term goals were agreed in line with earlier agreements formalised in covenants and alliances and with policy measures for different target groups. The ‘healthy option’ must be made easier and more attractive, based on the guidelines by the Health Council of the Netherlands and their translation in the Wheel of Five rules for a healthy diet prepared by the Netherlands Nutrition Centre. Consumers must be in a position to eat healthy and tasty meals, with healthy food available to them in supermarkets, hotels, restaurants and cafes, healthcare institutions, roadside services, at work, at school and in sports club canteens.

19 http://www.uitvoeringsagendaduurzameveehouderij.nl/integraal-duurzame-veehouderij/15-ambities/

Table 3: Goals agreed at the Food Summit

Final Declaration of the Food Summit: Sufficient, healthy and sustainable food for everyone!	
Producers	• The lowest greenhouse gas emissions per product worldwide. In the longer term, the production of all our food will be climate neutral. • Minimise the damage to nature (plants and animals) and in ten years' time lead the way internationally in showing how agriculture and nature can be in harmony, even in intensively farmed areas. • Reduce the use of antibiotics to the lowest possible level.
Consumers	• Consumers must be in a position to eat healthy and tasty meals, with healthy food available to them in supermarkets, hotels, restaurants and cafes, healthcare institutions, roadside services, at work, at school and in sports club canteens. • Lifelong learning about food from a young age for everyone. • Clear information on the composition and provenance of food on the label and via public information services and online apps.
Value chain	• New, innovative products will come onto the market, for example with more vegetables and plant proteins. • A circular economy for food in which wastes from the food chain are recycled and reused. • A strong domestic market that stimulates consumers to choose healthy and sustainable products that meet these ambitions.

Tweede Kamer, 2017b

Government-wide programme on the circular economy: A Circular Economy in the Netherlands by 2050

Under the government-wide programme on the circular economy launched in 2016 (Tweede Kamer, 2016e), five transition agendas were published in January 2018. The Biomass & Food transition agenda (Transitieteam Biomassa & Voedsel, 2018) sets out six courses of action, including the transition to more plant proteins. The goal is a radical shift towards a much more sustainable production and consumption of proteins:

- In 2050 the proportion of animal to plant proteins in our diet will be the opposite of what it is today – a shift from 60% animal and 40% plant protein to 40% animal and 60% plant protein. Total protein consumption per person in 2050 will be 10%–15% lower than today.
- The footprint of proteins produced in the Netherlands (including land use, greenhouse gas emissions and nitrogen losses) will be 50% lower by 2050, resulting in a total potential reduction in greenhouse gas emissions of 12.5 Mt CO_2-equivalents (production: 4.5 Mt; consumption: 8 Mt). This must not lead to negative side-effects, such as an expansion of intensive livestock farming, given that the aim is to keep the materials cycles as small as possible (i.e. land-based livestock farming).

5.3 The future of livestock farming

Continued efforts will be needed to make livestock farming in the Netherlands more sustainable. In 2016 the Dutch government appointed two commissions to advise on issues surrounding the revitalisation of pig farming and on speeding up the transition to sustainable livestock farming.

The Action Plan to Revitalise Pig Farming [*Actieplan Vitalisering Varkenshouderij*] (Tweede Kamer, 2016c) was prepared by the Regiegroep Vitale Varkenshouderij (Vital Pig Farming Coordination Group) chaired by Mr Rosenthal. The coordination group consisted of the Pig Farming Producers' Organisation (Producenten Organisatie Varkenshouderij), Rabobank and the Ministry of Economic Affairs. The Action Plan contains measures to strengthen the market orientation of pig farming, respond to customers' wishes and therefore gain a stronger position in the domestic and foreign markets; enhance cooperation throughout the value chain; improve the public image of the sector and the value chain as a whole; and revitalise the pig farming sector and improve the financial returns to pig farmers. In addition, the plan aims to make the sector healthy again through farm closures, compulsory purchase and mergers. The financial resources (€200 million) needed for this consolidation will have to come from government (Ministry of Economic Affairs, the provinces and municipalities) and from Rabobank, which has made funds available in the hope of limiting the damage resulting from a series of bankruptcies. In the coalition agreement the new government has set aside €200 million for the restructuring of pig farming in the province of Noord-Brabant.

The advice by the Social and Economic Council of the Netherlands (SER) on speeding up the transition to sustainable livestock farming [*Versnelling duurzame veehouderij 2016*] was prepared by a commission headed by Ed Nijpels (SER, 2016). The SER concludes that speeding up the transition will have irrevocable consequences for all stages in the value chain, from producer to consumer. A large group of livestock farms are now in a dire economic situation and the public health risks and environmental impacts associated with livestock farming are no longer considered acceptable. A speeding up of the transition to sustainable livestock farming is unavoidable and urgently needed and will require central coordination under independent leadership (similar to the arrangements for the Energy Agreement for Sustainable Growth and the Delta Commission).

In its response to the Action Plan to Revitalise Pig Farming (Tweede Kamer, 2016c) and the SER advice (Tweede Kamer, 2016f), the government endorses the recommendations and asks parties in the value chain to cooperate with the sector on working up the proposed actions and putting them into effect. Where possible these will be supported by the government.

5.4 Animal production rights and phosphate rights

To manage the national production of manure, the government's manure policy includes a system of animal production rights. Since January 2006 these rights have applied only to pigs and poultry (Rijksdienst voor Ondernemend Nederland [RVO], 2017a). Within a single calendar year a farm may on average hold no more pigs or poultry than the number for which it owns animal production rights. These rights may be split between farms, transferred or relocated. Rules have been instituted to control this. The rules distinguish between areas where there are large number of animals (concentration areas) and areas where there are fewer animals

(non-concentration areas). It is not allowed to transfer rights between concentration and non-concentration areas.

A recent development in manure policy is the introduction of *phosphate rights* (RVO, 2017b). In 2015, after the abolition of the milk quota, Dutch livestock farms produced much more phosphate than permitted under EU agreements. For this reason, on 1 January 2018 phosphate rights were introduced for dairy farms and a phosphate ceiling was introduced. The number of registered phosphate rights reflects the volume of animal manure that may be produced by dairy cows on a farm in a single calendar year.

Phosphate rights are comparable with phosphate quota, but the advantage of phosphate rights is that they have a direct impact on phosphate production and allow farmers to increase their phosphate efficiency (phosphate restricting measures on dairy farms) instead of reducing the number of animals. This policy therefore encourages technical innovation.

5.5 Approach to tackling problems in areas with high livestock densities

In areas with high livestock densities, livestock farms not only cause environmental problems resulting from the large quantities of manure produced, but also present risks to public health (see section 4.3). To tackle these problems, at the beginning of 2017 a proposal for an interim act (Ministry of Economic Affairs, 2017) was sent for consultation to the Association of Provinces of the Netherlands (IPO), the Association of Netherlands Municipalities (VNG) and the farming community. At the same time an internet consultation exercise was launched. The bill proposed giving the provinces the power to limit the number of livestock in areas with high livestock densities with a view to protecting environmental quality (and particularly public health). On 1 November the prime minister informed the House of Representatives that this bill will be withdrawn. The minister of infrastructure and environment (now infrastructure and water management) is preparing guidance on livestock and public health to help government authorities deal with the public health impacts of livestock farming. This guidance will provide information on provincial policy and practice for issuing environmental permits for livestock farms, on the establishment of new livestock farms and the expansion of existing permit-exempt livestock farms, and on relevant planning policy.

6

CHANGING CONSUMPTION PATTERNS

Investments made at the beginning of the food value chain to reduce the environmental impacts of the food system (in other words: investments in products and/or production process that have less impact on the environment) will affect consumers: the food on their plates will be more sustainable. Conversely, by making certain choices consumers can stimulate the market for more sustainable products. Consumer demand for sustainable and healthy food will encourage farmers and the food value chain to develop new products and supply chains (Van 't Veer et al., 2017). Making the food system more sustainable will therefore require a change in consumers' eating habits. The types of changes needed are described in section 6.1. In section 6.2 we look at how consumer choice can be influenced. Following on from this, section 6.3 discusses the changes in eating patterns that can already be observed in the Netherlands and the part played by value chain parties in bringing about these changes. Finally, in section 6.4 we consider what a strategy for radical change could look like.

6.1 Visions on the desired changes in diet

Rli's aim is to make healthy, 'honest' and environmentally friendly the 'new normal' in consumers' food preferences, so that in 2030 we choose healthier food that makes no excessive demands on natural resources and pay the prices for this food that reflect its environmental impact, both in the Netherlands and elsewhere. But what does this mean in concrete terms for what people will be eating every day? Below we summarise the thinking of a few research institutes and other stakeholders.

National Institute for Public health and the Environment (RIVM)

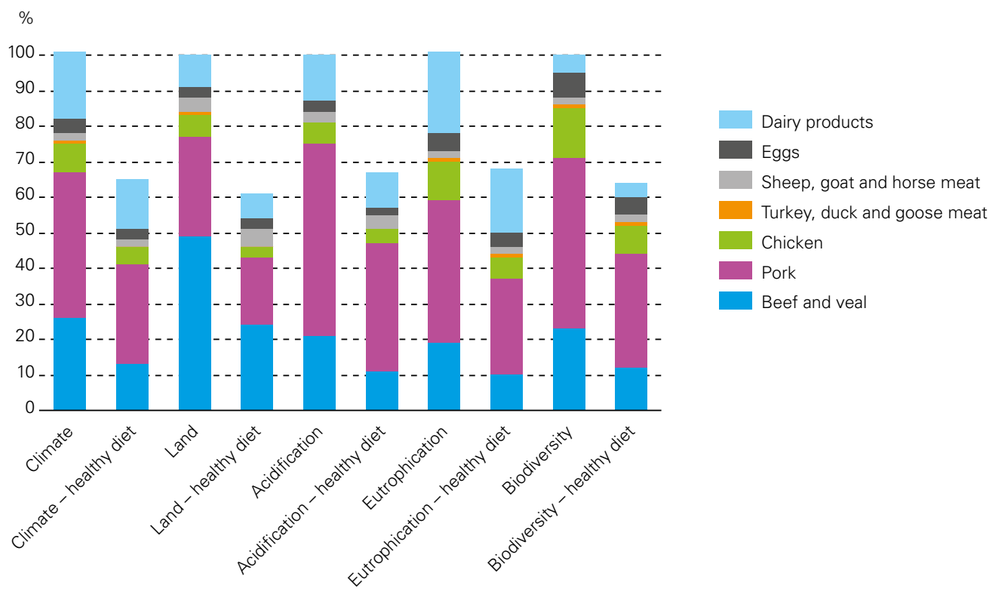
RIVM (2017a) confirms that a shift towards eating more plant-based products and fewer animal-based products can deliver benefits for public health as well as ecological sustainability. Such a shift will in general reduce the environmental impacts of food production. At the same time, it delivers health benefits. Eating less meat and cheese and more plant-based foods such as fruit, vegetables, grains and pulses reduces people's intake of saturated fats and salt and increases their fibre intake. Because lower socioeconomic groups eat little fruit and vegetables, the health benefits for them may well be greater.

Netherlands Nutrition Centre (Voedingscentrum)

CE Delft (Odegard & Bergsma, 2012) have compared various healthier and greener diets and found that a healthy diet according to the recommendations by the Netherlands Nutrition Centre (under certain assumptions about the amount of various types of meat consumed) already leads to a reduction in various environmental impacts of around 35% (see Figure 14). According to the Netherlands Nutrition Centre, 43% of the protein intake in a healthy diet should be plant protein[20] should be plant protein

20 CE Delft uses the proportion of plant protein in total protein consumption as an indicator of the degree to which the transition to a sustainable and healthy diet is being achieved. See also: Odegard & Bergsma, 2017.

Figure 14: Relative reduction in environmental impact of a switch to the diet recommended by the Netherlands Nutrition Centre



Source: Odegard & Bergsma, 2012

The 'Menu for Tomorrow' based on Health Council of the Netherlands (Gezondheidsraad) guidelines and climate/environmental criteria

The Menu for Tomorrow (Menu van Morgen) report (Kramer & Blonk, 2015) presents a series of healthy diets that are based on the guidelines prepared by the Health Council of the Netherlands, but also take account of the need to considerably reduce greenhouse gas emissions (commensurate with a 2˚C limit on global warming),[21] to ensure a just distribution of environmental space and to respect animal welfare. It proved possible to put together a varied diet that meets these conditions without having to pay a higher price (see Table 4).

The biggest changes to the current diet implied by the menu for 2030 are an increase in vegetables, pulses and vegetarian products and a reduction in meat and poultry. The Menu for Tomorrow also looks ahead to 2050, when the continuation of the changes set in motion mean that there will be almost no meat on the menu and considerably less cheese and eggs. According to Kramer & Blonk (2015), the ratio of plant to animal protein on the 2030 menu will be 48/52 and in 2050 even 75/25 (calculations by CE Delft).

21 It is assumed that emissions reduction in agriculture keep pace with the overall reduction targets for 2030 and 2050.

Table 4: 'Menu for Tomorrow' compared with the current diet in the Netherlands

Group	Present 2010 (g/day)	Menu for Tomorrow 2030 (g/day)
Potatoes	98	99
Alcoholic and non-alcoholic drinks	1957	1791
Bread	154	169
Eggs	12	12
Fruit	110	104
Cakes and pastries	48	25
Cereal products and binding agents	53	56
Vegetables	127	191
Savoury spreads	4	5
Cheese	36	21
Milk and milk products	373	223
Nuts, seeds and snacks	32	34
Pulses	3	22
Prepared meals	3	5
Soups	61	16
Soya products and vegetarian products	5	10
Sugar, sweets, sweet spreads and sweet sauces	35	16
Fats, oils and savoury sauces	59	41
Fish	16	20
Meat, meat products and fowl	108	30
Greenhouse gases (kg CO_2-eq/day)	3.83	2.12
Price (€/day)	5.02	5.00

Source: Kramer & Blonk, 2015

Green Protein Alliance

The Green Protein Alliance (GPA) is a partnership of various market participants and knowledge partners,[22] supported by the government, that aims to stimulate consumer demand for plant proteins and thus contribute to a healthier and more sustainable food system. The GPA's goal is to achieve a 50/50 ratio of plant to animal protein in the Dutch diet as early as 2025 (GPA, 2017).

Rli's ambition

The most ambitious of the various proposals for dietary change discussed here is the Menu for Tomorrow. However, the Paris climate agreement sets even tighter climate change targets (warming well below 2˚C and preferably closer to 1.5˚C) than those used in the calculations. In turn, this means that a more rapid change in diet than in the Menu for Tomorrow scenarios is desirable. Rli therefore chooses an ambitious goal for 2030 that is based on the Menu for Tomorrow for 2030, but which incorporates the more ambitious climate change target by raising the proportion of plant protein in the Dutch diet to 60%, reducing the share of animal protein in 2030 to 40%. The supply chain will have to adapt to this, from raw materials and primary producers to the food processing industry and the retail sector.

22 Producers of plant-based protein products, a few supermarket chains, the environmental organisation Natuur & Milieu, the Netherlands Nutrition Centre and Milieu Centraal.

6.2 Influencing consumer choices

A change in diet means a change in behaviour. That raises the question of whether or not such a change in behaviour can be managed and what exactly should be done to bring it about.

To determine whether and how the desired shift in consumption pattern can be brought about, it will be necessary to analyse consumer behaviour. In a previous advisory report (Rli, 2014) Rli presented an analytical framework for this purpose which distinguishes between four groups of behavioural determinants:

- *Competencies:* Are people informed about the impacts of different dietary choices and do they have the knowledge (for example about healthy and sustainable food), information (for example about product characteristics) and skills (such as cooking skills) necessary to make other food choices?
- *Motives:* To what extent do the values underlying a more sustainable food system match those of the consumer? Do changes in diet lead to positive emotions (we can help to create a more sustainable world) or negative emotions (we have to abandon our way of life)? Are there personal advantages, such as health benefits?
- *Circumstances:* What costs and benefits, in a broad sense, are associated with changes in behaviour? Is there a sufficiently attractive offer available in the neighbourhood? What are the financial consequences of a change in behaviour? Is a different diet compatible with cultural values (regional or cultural cuisine, religious prescriptions)?
- *Decision processes:* What unconscious and conscious decision processes determine the way in which we actually behave? Are our choices associative or do we go through a systematic decision process at the moment we make our choices?

These factors can be used to describe behaviour and determine the possibilities for changing that behaviour. The box below explores the issue of the legitimacy of a government policy for influencing behaviour.

Legitimacy of government policy for influencing consumer behaviour

Governments have always sought to influence people's behaviour, even things as personal as consumption. The means used to do this include imposing excise duties and age limits for tobacco and alcohol, campaigns encouraging the consumption of specific products such as milk, information campaigns on healthy eating, etc. How far government may or should go to promote environmentally friendly behaviour touches upon normative and political notions about the role of government. In 2014 Rli formulated some pointers for determining whether policy strategies for more environmentally friendly behaviour are acceptable or not. Use can also be made of all that is known about behavioural determinants, because:

- people often do not make conscious and balanced decisions and so their behaviour is not always in line with either their own interests or democratically legitimate collective interests;

- a number of pressing and complex environmental issues cannot be resolved and environmental goals cannot be achieved without people changing their behaviour;
- using knowledge of behaviour in the design of environmental policy makes more effective policy and helps to generate broader support.

A condition is that there is a recognised public interest and that it is a government task to promote that interest. In doing so, the government should be transparent about the means to be used and the goals to be achieved, and it must be able to demonstrate the effectiveness of the measures employed.

When interpreting answers from consumers asked about the choices they make, it is important to consider possible discrepancies between stated preferences and revealed preferences. Consumers' behaviour does not necessarily reflect their values and intentions (Reinders et al., 2013); they may lack certain competencies or there may be competing motives and circumstances that steer their behaviour in another direction. Many people are all for health, sustainability and animal welfare, but as consumers they can easily be swayed by habit, convenience and price. They may also not be well informed or they may hold misconceptions about sustainability and health. Rising food prices (either real or perceived) can also be decisive for certain socioeconomic groups. Moreover, consumers make use of a limited range of information when making purchasing decisions; they base their choices on all sorts of associations, emotions and rules of thumb (Ingebeek & Immink, 2011).

6.3 Trends in consumption and the role of value chain parties

Diets are strongly rooted in culture and tradition. Meat and dairy products have traditionally been important items in the Dutch menu. Over a period of some decades, though, there have been clear changes in the eating habits of the Dutch population. The traditional Dutch meal of meat, potatoes and vegetables is now just one of many types of dishes eaten rather than the standard.

Trends in consumption

Consumption per head of the population of most animal products has remained relatively stable (see Chapter 3), but eating less meat is nevertheless a growing phenomenon. In 2012 the 'light meat reducers' – people who eat no meat at least one day in the week – were far and away in the majority, at 77.1% of the population (69.5% in 2009), and the number of daily meat eaters had fallen significantly, from 26.7% in 2009 to 18.4% (Dagevos et al., 2012). At the same time, the consumption of alternatives to animal proteins is increasing (see text box). Consumption of plant protein sources, such as pulses, is increasing by about 10% per year (GPA, 2017). At the moment the Dutch get most of their protein from animal products – meat and meat products (29%), dairy products (23%) and fish (4%) – and the rest comes from sources such as grains and grain products (22%),

potatoes (3%) and nuts (3%). The Dutch diet contains sufficient protein, and often more than is needed: women 60–75 grams per day and men 61–98 grams per day (Van Dooren & Postma-Smeets, 2015).

One in eight Dutch people eat ready-made meat substitutes every week

More than four out of ten people sometimes eat ready-made meat substitutes (44%); one in eight do this at least once a week (12%). Young adults (<40 years) in particular occasionally eat ready-made meat substitutes (54%); the over 60s eat the least (37%). The percentage of highly educated people who eat ready-made meat substitutes more than once a week (19%) is higher than among middle and low educated people (7%). Most of the Dutch population are open to the idea of eating ready-made meat substitutes more often; six out of ten (60%) would probably eat ready-made meat substitutes more often if they were tastier. Around four in ten would do so if the products could not be distinguished from real meat (42%), if there was a broader range of these products on offer (39%) and/or if they were cheaper (38%). (Kien, 2015)

Wageningen Economic Research has been publishing the Sustainable Food Monitor [*Monitor Duurzaam Voedsel*], which surveys and records consumer expenditure on 'sustainable' food, since 2011 (Ministerie van Economische Zaken, Landbouw en Innovatie, 2011; Bos et al., 2017). This expenditure has risen from €1,034 billion in 2009 to €3,745 billion in 2016. During this period the market share of sustainable food grew from 2.7% to 10%. Growth in supermarket sales of sustainable food has been particularly big and the market share in supermarkets is now 12%. However, these figures need to be viewed with caution because of the way the term 'sustainable' is interpreted. The Monitor measures trends in expenditure on food that bears one or more of a selected group of labels, such as *Beter Leven, Milieukeur* and 'organic', which are awarded to relatively sustainable products within certain product groups. It does not monitor the shift in consumption from animal products to plant-based alternatives. Moreover, such quality labels are often based primarily on a single aspect of sustainability (such as 'organic' or 'animal friendly'), which does not automatically mean that they are better for the climate, the environment or public health.

Role of value chain parties

Value chain parties, particularly the food industry and the retail sector, have a key part to play in making the food system more sustainable. On the one hand, their purchasing power allows them to determine the price farmers can ask for their products and thus the financial leeway available for making primary production more sustainable (activities about which they are also able to make demands). On the other hand, they also determine what is on offer to consumers and they are able to use information and behavioural tools (such as shop layouts and price incentives) to steer consumer choice in the direction of more sustainable products.

Since the Policy Document on Sustainable Food was published (Tweede Kamer, 2009a), the parties in the food value chain have been discussing ways to make production and consumption more sustainable (see Chapter 5). In the transition towards lower production and consumption

of animal protein, these parties can play an important role by increasing the number and amount of plant-based alternatives to animal products, promoting them and making them more attractive. The Food Balance 2011 [*Voedselbalans 2011*] states that about 35% of food suppliers consider themselves to be pioneers and an example to others in the area of sustainability (Backus et al., 2011). If these pioneers make progress towards sustainability, other companies will tend to follow.

Value chain parties have developed various product concepts that should guarantee more sustainable production. Examples include the following:

- The *Beter Leven* label (in cooperation with the Dutch Society for the Protection of Animals (*Dierenbescherming*)) is for animal-based products, mainly fresh meat products. These products carry a 1, 2 or 3 star label based on animal welfare criteria. In 2016 Beter Leven products accounted for a combined turnover of €1,118 million (Logatcheva, 2017).
- *Kipster* is a chicken farm concept that combines animal welfare (loose housing systems meet 3 star Beter Leven requirements), the prevention of food waste (through recycling of wastes from bakeries and arable farms and by also rearing young cocks as broilers) and the aim of climate-neutral production. Since October 2017 these products are sold exclusively via Lidl supermarkets.
- *Varken van Morgen* (Pigs of Tomorrow) is the result of sustainability agreements between the Central Food Trade Office (*Centraal Bureau Levensmiddelenhandel*) and the production sector. Besides animal welfare standards, this label includes environmental standards, such as responsible soy for feed, green electricity, restrictions on ammonia emissions and phosphate efficiency.
- A comparable concept launched in 2013 was *Kip van Morgen* (Chickens of Tomorrow), which included standards for animal welfare (slower growing breeds, more space per animal, a natural day/night rhythm and distraction material), public health (less use of antibiotics) and environmental aspects (responsible soy in feed, ammonia and particulate matter emissions, and closed nutrient cycles). However, this initiative failed due to competition regulations. Comparable concepts have been introduced onto the market under the brand names *Nieuwe AH-kip* (Albert Heijn) and *Nieuwe standaardkip* (Jumbo). See *Boerderij* (2017).

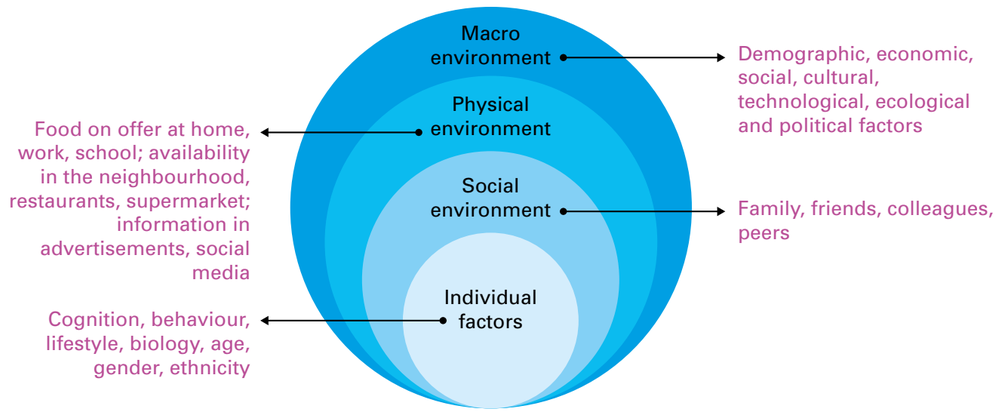
In these sustainability concepts the value chain partners respond primarily to the importance that consumers place on animal welfare. As climate change, environment and public health come to dominate the agenda, sustainability concepts will increasingly develop in that direction.

The National ThinkTank Foundation (*Stichting Nationale Denktank*) (2012) sees various ways in which supermarkets can help customers make more sustainable choices: Groene Gastheer, which informs and inspires consumers when making choices in the shop; introducing savings schemes for greener choices; offering alternative recipes with less (or no) meat; using sustainability as the theme for special offers and shelf layouts.

6.4 Policy interventions

RIVM (2017a) states that the consumption of food is determined to a large extent by habitual behaviour. Rational factors, such as knowledge and motivation, play a relatively small role in the large number of decisions about food that consumers make each day. Nonetheless, the development of competencies at a young age will help to make sustainable choices second nature. Likewise, interventions focused on the environment in which food choices are made can also lead to a change in habits. See Figure 15.

Figure 15: Determinants of food choice



Source: RIVM, 2017a

We do not yet have a complete picture of motives and circumstances. It is advisable when developing policy interventions to first systematically analyse the various behavioural factors. Below we discuss a number of factors on which policy interventions could be targeted.

Competencies

Consumers will be able to make a conscious choice for sustainable and healthy food only if they know which products contribute towards this goal and to what degree. Clear labelling, quality marks, information campaigns and schooling of adults as well as young people, and offering appropriate recipes can all help. However, the great diversity of quality labels, which reflects a great diversity of quality standards (from animal welfare to fair trade to ecological sustainability), presents us with a dilemma. Generic recommendations such as the Wheel of Five are also based on a compromise between different quality objectives. Another question is the multiplicity of opinions among the public about what a healthy and sustainable diet is. And these opinions are often based on outdated or unproven ideas.

Motives

Various sources indicate that when people make conscious choices for healthier and more sustainable food, they pay more attention to attributes of the food itself, such as ‘tasty’, ‘healthy’ and ‘high quality’, than to social aspects such as low environmental impact and animal welfare (Baltussen et al., 2006; RIVM, 2016a). Emphasising the health aspect would appear to be most effective in reaching large groups of people.

PBL (Vringer et al., 2013) concludes from an economic behaviour experiment that the participants weigh up their own individual contribution to sustainability against what it costs them ('response effectiveness'). It therefore makes sense to emphasise the individual's contribution. Furthermore, participants turned out to be 'conditionally cooperative': they are more willing to contribute towards social goals through the choices they make if enough other people are also prepared to do the same. This is an argument for collective measures.

Circumstances

Ensuring a sufficient and attractive offer of food that is of good quality, culturally varied and readily available in the neighbourhood is primarily a task for business. This can be stimulated by increasing the demand for sustainable and healthy food. The government can play a coordinating and perhaps more coercive role by entering into agreements with industry and, if necessary, adopting regulations.

Various sources also indicate that changes in price have a major influence on consumer choice. Raising and lowering prices directly influences consumers' choices at the time of purchase, which provides leverage for policy interventions:

- Government can use *taxes* to raise the prices of high-energy non-staple foods containing saturated fats, trans fats, sugar and salt.
- It can use *subsidies* to make basic foods such as vegetables, fruit and whole grain products affordable.

The effects of such pricing policies are greater on people of a lower socioeconomic status, because they spend a bigger share of their income on food and respond more quickly to price adjustments.

Baltussen et al. (2006) conducted an experiment on the impact of a 5%–25% reduction in the price of organic products on consumer choice in 11 supermarket formats. The observed changes in consumers' purchasing behaviour are attributed to the price reduction. Both the quantity of organic products sold and the turnover in euros rose.

Arguments for and against a pricing policy

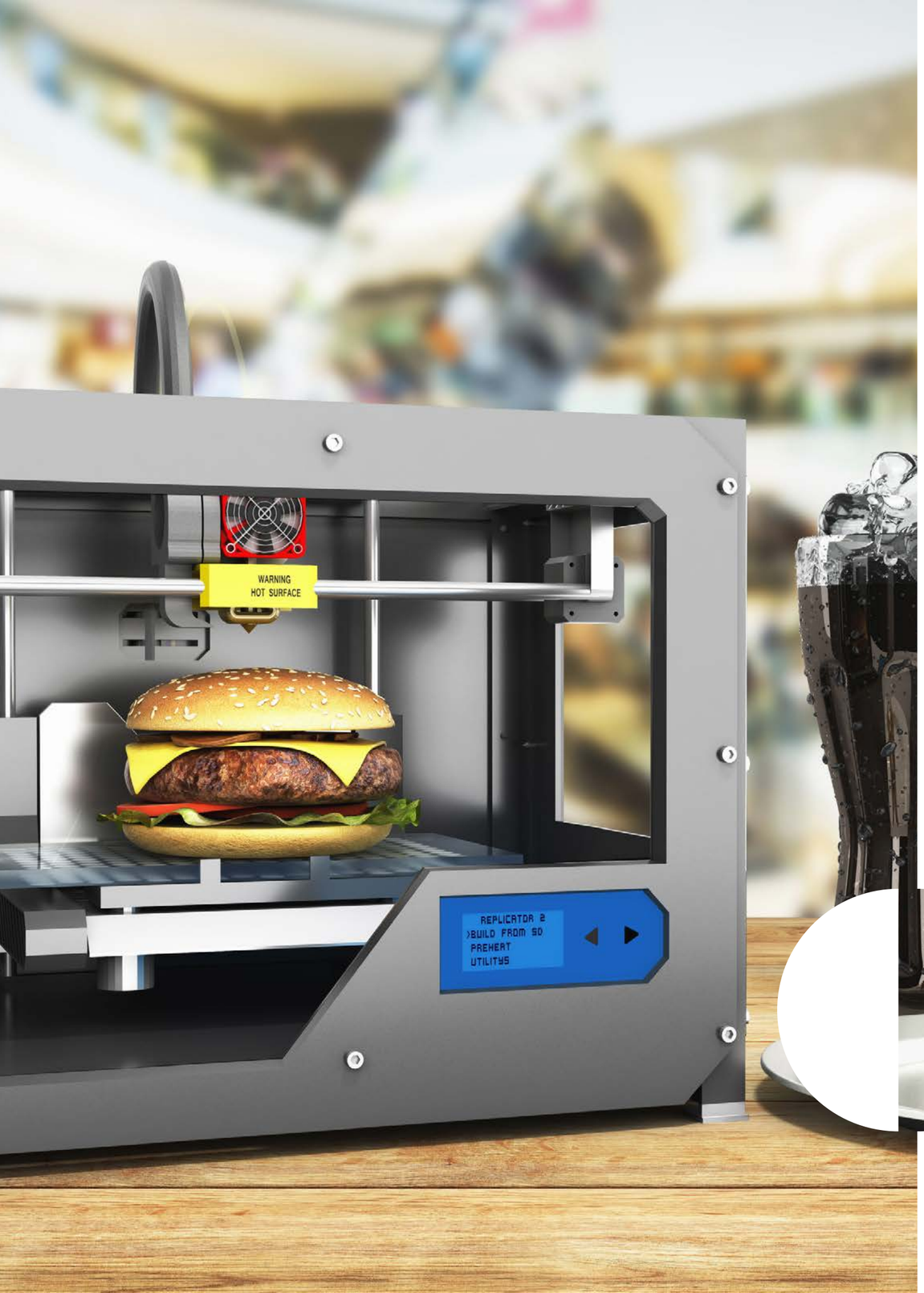
A strong economic argument in favour of pricing policy is that pricing measures are more effective at incorporating the external costs of environmental impacts in product prices, and that this also leads to real changes in consumer choice behaviour. Experience is currently being gained in various countries with financial instruments such as sugar and fat taxes.

- Denmark taxes products containing saturated fatty acids;
- Finland taxes sweets, ice cream and soft drinks;
- Hungary taxes soft drinks, energy drinks, pastries, salty snacks, flavoured alcoholic beverages and fruit jams;
- France taxes sweet drinks containing sugar and sweeteners.

In a literature review, Davegos (2017) concludes that the empirical evidence for the effectiveness of a meat tax is limited, but that there is

no reason to reject the instrument either. Besides effectiveness, feasibility, ease of implementation and support are factors that determine the success or otherwise of a pricing policy. Social and political resistance to price interventions are to be expected (Caro et al., 2017) and there will be questions about how to differentiate between animal, plant and composite products.

RIVM (2016a) states that for consumers price is the biggest barrier to buying food with an environmental or animal welfare label. Consumers are generally prepared to pay only slightly more for products with a green label. A study by Odegard & Bergsma (2012) shows that an increase in VAT on meat, dairy products and eggs from 6% to 21% would lead to a reduction in the environmental impact of food consumption in the Netherlands by 8% to 12%. A study by Caillavet et al. (2016) shows a similar effect using French supermarket data for a 20% environmental tax on animal-based food products, with a limited impact on household expenditure on food (4%).



7

STUDIES ON OPTIMUM LIVESTOCK NUMBERS

In recent years various studies have been carried out to determine the number of livestock that can be farmed in the Netherlands while remaining within the emission limits imposed by climate and environmental policies. The studies differ in their starting assumptions and scope. None of the studies give the numbers of livestock at which the system remains in balance for all aspects. It is therefore not possible to draw any conclusions about the optimum size of the livestock population from a sustainability point of view or for a specific year. However, the literature does provide a consistent picture indicating that to make the transition to sustainable livestock farming it is inevitable that the number of animals will have to be considerably reduced, by a few dozen per cent, between now and 2030.

Effectiveness of reducing livestock numbers

The National Energy Outlook [*Nationale Energieverkenning*] for 2015 makes use of model calculations of atmospheric emissions from livestock farming by Velthof et al. (2016). A sensitivity analysis of the results shows that a 20% reduction in the number of pigs and a 10% reduction in the number of dairy cattle will lead to 7.5% lower ammonia emissions and 11% lower methane emissions, mainly due to the reduction in dairy cattle numbers. The effects on other emissions are smaller: -5% nitrous oxide and -2% particulate matter.

Livestock numbers for a balanced manure market

Silvas et al. (2009) calculated the numbers of livestock in 2020 at which the manure market would be in balance. The outcome would mean a reduction compared with a continuation of present trends to 2020. Assuming a proportional reduction in all sectors, the required overall reduction in numbers would be 19.5%. The economic impact of this would be greatest in the dairy farming and veal farming sectors. If manure production is brought below a production ceiling for nitrogen and phosphate and if production rights can be transferred between sectors and regions, the reduction can be allocated in an economically optimum way. This would mean a 12% reduction in the numbers of dairy cows and calves, a 30% reduction in the number of breeding pigs and a 35% reduction in the number of fattening pigs. In this case, fattening pig farms would bear the greatest impact on incomes.

Study of dairy farming within environmental limits

The Louis Bolk Institute (De Wit & Van Veluw, 2017) has calculated that to meet the ammonia emission targets for 2030 the dairy farming sector will have to be reduced in size from about 1.6 million dairy cows to 1.3 million. Assuming land-based dairy farming, this means about 1.95 livestock units per hectare of feed crops. To meet the climate targets, the number of cows would have to be reduced to about 1.1 million. The researchers indicate that because of the many uncertainties, such as the expected emission per kg of milk and the climate change target, these figures should be viewed with caution. The calculated decrease in livestock numbers will reduce social costs by €300 to €800 million. The net added value (annual remunerations for labour and capital), and therefore the incomes for dairy farmers and dairy processing, will fall by about €250 million per year. The cost of buying out animals is estimated at a maximum of €65 million per year until 2030.

Natuur & Milieu vision on food

In its Food Vision [Voedselvisie] the environmental organisation Natuur & Milieu (2017) states that if agriculture is to make a proportionate contribution to greenhouse gas emission reductions in 2030, assuming a scenario in which warming is limited to 2˚C, the sector will have to reduce emissions by 47% from 1990 levels. In terms of livestock numbers, this means a reduction of about 40% of the current cattle and pig populations and about 20% of the poultry population. The study by Natuur & Milieu also indicates what the associated land use changes would be. In a review of Natuur & Milieu's Food Vision, Rougoor et al. (2017) state that a reduction in numbers on this scale would eradicate any manure surplus.

REFERENCES

Aalbers, A., Renes, G. & Romijn, G. (2016). *WLO-klimaatscenario's en de waardering van CO_2-uitstoot in MKBA's*. CPB/PBL achtergronddocument. Den Haag: CPB.

Backus, G., Meeuwsen, M., Dagevos, H. & Riet, J. van 't (2011). *Voedselbalans 2011: deel 1*. Den Haag: LEI Wageningen UR.

Bailey, R., Froggatt, A. & Wellesley, L. (2014). *Livestock: climate change's forgotten sector. Global Public Opinion on Meat and Dairy Consumption*. London: Chatham House.

Baltussen, W.H.M., Wertheim-Heck, S.C.O., Bunte, F.H.J., Tacken, G.M.L., Galen, M.A. van, Bakker, J.H. & Winter, M.A. de (2006). *Een Biologisch Prijsexperiment: grenzen in zicht?* Den Haag: LEI onderdeel van Wageningen UR.

Blonk, H., Pluimers, J., Broekema, R., Latesteijn, H. van, Spaans, L., Aiking, H., Kuik, O. & Drunen, M. van (2011). *Economische dimensie verduurzaming voedselproductie: hoofdrapport.* Gouda: Blonk Milieu Advies BV.

Boerderij (2017). *De kip van morgen is bijna overal.* Geraadpleegd op 6 november 2017 via http://www.boerderij.nl/pluimveehouderij/achtergrond/2017/3/de-kip-van-morgen-is-bijna-overal-104559e/

Bos, A.P., Puente-Rodríguez, D., Reijs, J.W., Peet, G.F.V van der & Groot Koerkamp, P.W.G. (2017). *Monitoring verduurzaming veehouderij 1.0: een eerste proeve van een monitorings-systematiek voor de 15 ambities van de Uitvoeringsagenda Duurzame Veehouderij, met initiële resultaten voor drie diersectoren en een aantal keteninitiatieven.* Wageningen: Wageningen Livestock Research.

Bron, J.C. (2016). *Grote drie domineren mengvoermarkt*. Via: http://www.boerderij.nl/Home/Achtergrond/2016/8/Grote-drie-domineren-mengvoermarkt-2846640W/

Caillavet, F., Fadhuile, A. & Nichèle, V. (2016). *Taxing animal-based foods for sustainability*. In: European Review of Agricultural Economics. 43(2), 537-560.

Caro, D., P. Frederiksen, M. Thomsen & A. Branth Pedersen (2017). *Toward a more consistent combined approach of reduction targets and climate policy regulations: The illustrative case of a meat tax in Denmark*. In: Environmental Science and Policy 76 (2017) 78–81.

Cleef, B.A.G.L. van (2016). *MRSA in pig farms: human epidemiology.* 's-Hertogenbosch: Uitgeverij BoxPress.

Centraal Bureau voor Statistiek (2016). *Consumptieve bestedingen van huishoudens (mld. euro) a), 2013-2016.* Geraadpleegd op 12 december 2016 via https://www.cbs.nl

Centraal Bureau voor Statistiek (2017a). *Landbouw; gewassen, dieren en grondgebruik naar regio.* Geraadpleegd op 8 december 2017 via http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=80780ned&D1=502-519,540-557&D2=0,13&D3=0,5,10,14-16&VW=T

Centraal Bureau voor Statistiek (2017b). *Richting een toekomstbestendige agribusiness.* Paper.

Commissie Wijffels (2001). *Toekomst voor de veehouderij: agenda voor een herontwerp van de sector.* Den Haag.

Cormont, A. & Krimpen, M. van (2016). *Het percentage regionaal eiwit in het Nederlands mengvoerrantsoen - update voor 2015.* Wageningen University & Research. Wageningen.

Dagevos, H. (2017). *Vleesbelasting- Wat weten we ervan?* Geraadpleegd op 9 november 2017 via http://www.agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=7332

Detailhandel.info (2017). Geraadpleegd op 1 december 2017 via http://detailhandel.info/

Dagevos, H., Voordouw, J., Hoeven, L. van, Weele, C. van der & Bakker, E. de (2012). *Vlees vooral(snog) vanzelfsprekend: consumenten over vlees eten en vleesminderen.* Den Haag: LEI onderdeel van Wageningen UR.

Dooren, C. van & Postma-Smeets, A. (2015). *Nieuwe eiwitbronnen als vleesvervangers: factsheet.* Den Haag: Voedingscentrum.

Doorn, A. van, Melman, D., Westerink, J., Polman, P., Vogelzang, H. & Korevaar, H. (2016). *Food for thought: natuurinclusieve landbouw.* Wageningen: Wageningen University & Research.

Emissieregistratie (2017). *Nationale Broeikasgasemissie volgens IPCC*. Geraadpleegd op 19 december 2017 via http://www.emissieregistratie.nl/erpubliek/erpub/international/broeikasgassen.aspx

European Centre for Disease prevention and Control (2009). *The bacterial challenge-time to react: A call to narrow the gap between multidrug-resistant bacteria in the EU and the development of new antibacterial agents*. Stockholm. European Commission (2016). *Proposal for a Regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for a resilient Energy Union and to meet commitments under the Paris Agreement and amending Regulation No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and other information relevant to climate change*. Brussels.

Europese Raad (2014). *Europese Raad 23 en 24 oktober 2014: conclusies*. Brussel.

European Council (2014). European Council (23 and 24 October 2014) – Conclusions. Brussels.

Europese Unie (2016). *Betreffende de vermindering van de nationale emissies van bepaalde luchtverontreinigende stoffen: richtlijn 2016/2284 van het Europees Parlement en de Raad van 14 december 2016.* Brussel.

Eijsackers, H.J.P., Scholten, M.C.T., Arendonk, J.A.M. van, Backus, G.B.C., Bianchi, A.T.J., Gremmen, H.G.J., Hermans, T., Ittersum, M.K. van, Jochemsen, H., Oude Lansink, A.G.J.M. & Stassen, E.N. (2010). *Over zorgvuldige veehouderij: veel instrumenten, één concert.* Essaybundel. WUR.

Federatie Nederlandse Levensmiddelenindustrie (2017). *Monitor levensmiddelenindustrie 2016*. Den Haag.

Food and Agriculture Organization of the United Nations (2014). *Food wastage footprint: full cost accounting. Final report*. Rome.

Food and Agriculture Organization of the United Nations (2016). *The state of food and agriculture: climate change, agriculture and food security*. Rome.

Food and Agriculture Organization of the United Nations (2017). *The future of food and agriculture: trends and challenges*. Rome.

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. (2013). *Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities*. Rome: Food and Agriculture Organization of the United Nations (FAO).

Gezondheidsraad (2015). *Richtlijnen gezonde voeding 2015*. Den Haag.

Gezondheidsraad (2018). *Gezondheidsrisico's rond veehouderijen: vervolg advies*. Den Haag.

Green Protein Alliance (2017). *Green protein growth plan samen naar 50:50 in 2025*.

Hagenaars, T. (WBVR), Hoeksma, P. (WLR), Roda Husman, A.M. de, Swart, A. & Wouters, I. (IRAS). (2017). *Veehouderij en Gezondheid Omwonenden (aanvullende studies): analyse van gezondheidseffecten, risicofactoren en uitstoot van bio-aerosolen.* Bilthoven: RIVM.

Hilkens, W. & Rijkers, F. (2016). *Geld voor je eieren.* Amsterdam: ABN AMRO.

Ingenbleek, P.T.M. & Immink, V.M. (2011). *Consumer decision making for animal-friendly products: synthesis and implications.* Animal Welfare, 20 (1), pp. 11 - 19. Geraadpleegd op 21 september 2017 via http://www.ingentaconnect.com/contentone/ufaw/aw/2011/00000020/00000001/art00003

Kien (2015). *Onderzoek vleesconsumptie: Natuur & Milieu*. Groningen.

Koelemeijer, R. (PBL), Daniëls, B. (ECN), Boot, P. (PBL), Koutstaal, P. (ECN), Kruitwagen, S. (PBL), Geilenkirchen, G. (PBL), Menkveld, M. (ECN), Ros, J. (PBL), Born, G.J. van den (PBL), Lensink, S. (ECN) & Hout, M. van (ECN) (2017). *Analyse regeerakkoord Rutte-III: effecten op klimaat en energie.* Den Haag: PBL.

Kramer, G. & Blonk, H. (2015). *Menu van morgen. Gezond en duurzaam eten in Nederland: nu en later.* Gouda: Blonk Consultants.

Lebret, E., Leidelmeijer, K., Poll, H.F.P.M. van (Eds.) (2005). *MCA en MKBA: structureren of sturen? Een verkenning van beslissingsondersteunende instrumenten voor Nuchter omgaan met Risico's.* Bilthoven: RIVM.

Logatcheva, K. (2017). *Monitor Duurzaam Voedsel 2016.* Den Haag: Wageningen Economic Research- WECr.

Loon, M. van (2016). *Eierconsumptie gestegen.* Geraadpleegd op 13 december via https://www.pluimveeweb.nl/artikelen/2016/08/eierconsumptie-gestegen/

Ministerie van Economische Zaken (2017). *Wetvoorstel 11 april 2017: Interimwet Veedichte gebieden.* Den Haag.

Ministerie van Economische Zaken, Landbouw en Innovatie, LEI onderdeel Wageningen UR (2011). *Monitor Duurzaam Voedsel 2010*. Den Haag/ Wageningen.

Nijdam, R. & Dam, A.S.G. van (2011). *Informatieblad Intensieve Veehouderij en Gezondheid, Update 2011*. GGD Nederland.

Odegard, I.Y.R. & Bergsma, G.C. (2012). *Milieueffecten van verbeteropties voor de Nederlandse eiwitconsumptie.* Delft: CE Delft.

Odegard, I.Y.R. & Bergsma, G.C. (2017). *Met een eiwittransitie-target naar een duurzaam voedselaanbod: verkenning van eiwittransitie-indicator en targets voor monitoring door supermarkten, NGO's en overheid*. Delft: CE Delft.

Odegard, I.Y.R. & Voet, E. van der (2014). *The future of food scenarios and effect on natural resources in agriculture in 2015.* Elsevier, Ecological Economics, 97 (2014) 51-59.

Ogink, N.W.M., Erbrink, J.J. (Eds.), Heederik, D.J.J., Winkel, A. & Wouters, I.M. (2016). *Emissies van endotoxinen uit de veehouderij: emissiemetingen en verspreidingsmodellering.* Wageningen: Livestock Research/Wageningen UR.

Os, J. van, Smidt, R.A. & Jeurissen, L.J.J. (2016). *Afstand tussen veehouderij en woningen:een onderzoek naar aantallen veehouderijen en woningen op minder dan 250 meter van elkaar.* Wageningen: Alterra/ Wageningen UR.

Planbureau voor de Leefomgeving (2017a). *Milieu- en ruimtelijke condities nog onvoldoende voor landnatuur*. Geraadpleegd op 22 december via http://themasites.pbl.nl/balansvandeleefomgeving/jaargang-2017/themas/natuur/trends-en-toestand-milieu-en-ruimtelijke-condities-landnatuur

Planbureau voor de Leefomgeving (2017b). *Evaluatie meststoffenwet 2016: syntheserapport*. Den Haag.

Planbureau voor de Leefomgeving, Centraal Bureau voor de Statistiek & Wageningen University & Research (2017). *Compendium voor Leefomgeving*, zie www.clo.nl

Ploegmakers, M. & Stevens, R. (2015). *Afname aantal varkensbedrijven zet door*. Geraadpleegd op 21 september 2017 via http://www.boerderij.nl/Varkenshouderij/Nieuws/2015/1/Afname-aantal-varkensbedrijven-zet-door-1694371W/

Poppe, K. & Puister, L. (2017). *De positie van het gezinsbedrijf in de Nederlandse landbouw*. Wageningen: Wageningen Economic Research.

Productschap Pluimvee en Eieren & Productschap vee en vlees (2013). *Vee, vlees en eieren in Nederland. Kengetallen 2012*. Zoetermeer.

Raad van de Europese Gemeenschappen (1992). *Richtlijn 92/43/EEG van de Raad van 21 mei 1992 inzake de instandhouding van de natuurlijke habitats en de wilde flora en fauna*. Geraadpleegd op 22 december via https://natura2000-prd-477218783059.s3-eu-west-1.amazonaws.com/s3fs-public/236/over_Natura_2000/habitatrichtlijn_92-43-eg_geconsolideerde_versie_van_01-01-2007.pdf

Raad voor de leefomgeving en infrastructuur (2013). *Duurzame keuzes bij de toepassing van het Europees landbouwbeleid in Nederland.* Den Haag.

Raad voor de leefomgeving en infrastructuur (2014). *Doen en laten, effectiever milieubeleid door mensenkennis.* Den Haag.

Rabobank (2017). *Cijfers & Trends: Legpluimvee-visie.* Geraadpleegd op 13 december via https://www.rabobankcijfersentrends.nl/

Raden voor de leefomgeving en infrastructuur (2011). *Europees landbouwbeleid. Het Europees landbouwbeleid als transitie-instrument voor land- en tuinbouw.* Den Haag.

Reinders, M., Poppe, K., Immink, V., Broek, E. van den, Horne, P. van & Hoste, R. (2013). *Waardevolle perspectieven voor vlees.* Den Haag: LEI Wageningen UR.

Rijksdienst voor Ondernemend Nederland (2017a). *Wegwijs in het mestbeleid: hoe hangen alle regelingen met elkaar samen?* Geraadpleegd op 22 december via https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest-en-grond/mest/achtergrond/wegwijs-het-mestbeleid-0

Rijksdienst voor Ondernemend Nederland (2017b). *Fosfaatrechten: algemene informatie.* Geraadpleegd op 20 december via https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest-en-grond/mest/fosfaatrechten-algemeen

Rijksinstituut voor Volksgezondheid en Milieu (2016a*). Drijvende krachten van de voedselconsumptie en het voedselaanbod.* Bilthoven.

Rijksinstituut voor Volksgezondheid en Milieu (2016b). *Monitoringsrapportage NSL 2016: stand van zaken nationaal samenwerkingsprogramma luchtkwaliteit.* Bilthoven.

Rijksinstituut voor Volksgezondheid en Milieu (2017a). *Wat ligt er op ons bord? Veilig, gezond en duurzaam eten in Nederland*. Bilthoven.

Rijksinstituut voor Volksgezondheid en Milieu (2017b). *Q-koorts*. Geraadpleegd op 21 december via http://www.rivm.nl/Onderwerpen/Q/Q_koorts

Rijksinstituut voor Volksgezondheid en Milieu (2017c). *Voedselconsumptiepeilingen.* Geraadpleegd op 12 december 2017 via http://www.rivm.nl/Onderwerpen/V/Voedselconsumptiepeiling

Rijksinstituut voor Volksgezondheid en Milieu (2017d). *Effecten fijnstof.* Geraadpleegd op 22 december via http://www.rivm.nl/Onderwerpen/F/Fijn_stof/Effecten

Ros, J. (PBL) & Bert Daniëls, B. (ECN) (2015). *Sectordoelen voor niet-ETS-broeikasgasemissies*. Den Haag: PBL.

Ros, J. (PBL) & Bert Daniëls, B. (ECN) (2017). *Verkenning van klimaatdoelen: van lange termijn beelden naar korte termijn actie.* Policy brief. Den Haag: PBL.

Rossum, C.T.M. van, Buurma-Rethans, E.J.M., Vennemann, F.B.C., Beukers, M., Brants, H.A.M., Boer, E.J. de & Ocké, M.C. (2016). *The diet of the Dutch. Results of the first two years of the Dutch National Food Consumption Survey 2012-2016.* RIVM Letter report 2016-0082. Bilthoven.

Rougoor, C. W., Allema, A.B., Leendertse, P.C. & van Vliet, J. (2016). *Diergeneesmiddelen en waterkwaliteit: een verkenning van stoffen, gebruik en effecten op waterkwaliteit.* Amersfoort: STOWA.

Rougoor, C., Benedictus, G., Vogelaar, J.C., Loeber, A.M.C. & Weijden, W. van der (2014). *Landbouw-gerelateerde infectieziekten: verkenning van risico's in praktijk en lacunes in beleid. Deel B: Analyse.* Amsterdam: Universiteit van Amsterdam.

Rougoor, C., Well, E. van & Schans, F. van der (2017). *Review Voedselvisie natuur en Milieu: een quick scan.* Utrecht: Natuur & Milieu.

Ruiter, M. & Rougoor, C. (2017). *Volksgezondheid en veehouderij: alles op een rij.* Tilburg: Brabantse Milieufederatie.

Schoots, K., Hekkenberg, M. & Hammingh, P. (2017). *Nationale Energieverkenning 2017.* Den Haag: PBL, Petten: ECN.

Schutter, O. de (2017). *The political economy of food systems reform.* In: European Review of Agricultural Economics, vol. 44. Number 4, September 2017.

SDa (2017). *Het gebruik van antibiotica bij landbouw huisdieren in 2016: trends, benchmarken bedrijven en dierenartsen*. Utrecht: Autoriteit Diergeneesmiddelen SDa.

Silvis, H.J., Bont, C.J.A.M. de, Helming, J.F.M, Leeuwen, M.G.A. van, Bunte, F. & Meijl, J.C.M. van (2009). *De agrarische sector in Nederland naar 2020: perspectieven en onzekerheden.* Wageningen: LEI Wageningen UR.

Sociaal-Economische Raad (2016). *Versnelling duurzame veehouderij.* Advies 16/06. Oktober 2016. Den Haag.

Staatscourant (2017). *Besluit van de Staatssecretaris van Economische Zaken en de Minister van Infrastructuur en Milieu van 10 maart 2017, nr. DGAN-NB / 17017029, houdende wijziging van het programma aanpak stikstof 2015–2021*. (AERIUS, versie 2016). Den Haag.

Stichting Nationale denktank (2012). *Samenvatting van de bevindingen van de Nationale DenkTank 2012*. Amsterdam.

Stichting Natuur en Milieu (2017). *Voedselvisie: naar een gezond en duurzaam voedselsysteem in 2030.* Utrecht.

Tempelman, C., Prins, J. & Koopmans, C. (2011). *Economische gevolgen van de uitbraak van Q-koorts: eindrapport.* Amsterdam: SEO Economisch Onderzoek.

Terluin, I., Verhoog, D., Dagevos, H., Horne, P. van & Hoste, R. (2017). *Vleesconsumptie per hoofd van de bevolking in Nederland, 2005-2016.* Wageningen: Wageningen Economic Research.

Transitieteam Biomassa & Voedsel (2018). *Transitie-agenda circulaire economie 2018. Biomassa en voedsel: Food for thought, appetite for action*. Den Haag.

Tweede Kamer (2004). *Debat toekomst intensieve veehouderij.* Brief van de Minister van Landbouw, Natuur en Voedselkwaliteit aan de voorzitter van de Tweede Kamer van 8 januari 2004. Vergaderjaar 2003-2004, 28 973, nr. 2.

Tweede Kamer (2008). *Toekomst van de intensieve veehouderij.* Brief van de minister van Landbouw, Natuur en Voedselkwaliteit aan de voorzitter van de Tweede Kamer van 16 januari 2008. Vergaderjaar 2007–2008, 28 973, nr. 18.

Tweede Kamer (2009a). *Nota Duurzaam voedsel: Naar een duurzame consumptie en productie van ons voedsel.* Brief van de minister van Landbouw, Natuur en Voedselkwaliteit aan de voorzitter van de Tweede Kamer van 29 juni 2009. Vergaderjaar 2008–2009, 31 532, nr. 18.

Tweede Kamer (2009b). *Uitvoeringsagenda Duurzame Veehouderij*. Brief van de minister van Landbouw, Natuur en Voedselkwaliteit aan de voorzitter van de Tweede Kamer van 19 mei 2009. Vergaderjaar 2008–2009, 28 973, nr. 34.

Tweede Kamer (2011). *Kabinetsaanpak Klimaatbeleid op weg naar 2020*. Brief van de staatssecretaris van Infrastructuur en Milieu aan de voorzitter van de Tweede Kamer van 8 juni 2011. Vergaderjaar 2010-2011, 32813, nr. 1.

Tweede Kamer (2015). *Voedingsbeleid. Voedselagenda voor veilig, gezond en duurzaam voedsel*. Brief van de staatssecretaris van Economische Zaken en de minister van Volksgezondheid, Welzijn en Sport aan de Tweede Kamer van 30 oktober 2015. Vergaderjaar 2015-2016, 31 532, nr. 156.

Tweede Kamer (2016a). *Energieagenda. Naar een CO_2-arme energievoorziening*. Brief van de Minister van Economische Zaken aan de voorzitter van de Tweede Kamer der Staten Generaal van 7 december 2016. Vergaderjaar 2016–2017, 31 510, nr. 64.

Tweede Kamer (2016b). Voedingsbeleid*. Voortgang Voedselagenda voor veilig, gezond en duurzaam voedsel*. Brief van de Staatssecretaris van Economische Zaken en de Minister van Volksgezondheid, Welzijn en Sport aan de voorzitter van de Tweede Kamer van 2 november 2016. Vergaderjaar 2016–2017, 31 532, nr. 174.

Tweede Kamer (2016c). *Actieplan vitalisering varkenshouderij*. Brief van de staatssecretaris van Economische Zaken aan de Tweede Kamer van 23 juni 2016. Vergaderjaar 2015–2016, 28 973, nr. 180.

Tweede Kamer (2016d). *Vervolgbeleid antibiotica in de veehouderij.* Brief van de minister van Volksgezondheid, Welzijn en Sport aan de voorzitter van de Tweede Kamer van 8 juli 2016. Vergaderjaar 2015–2016, 29 683, nr. 220.

Tweede Kamer (2016e). *Nederland circulair in 2050: Rijksbreed programma Circulaire Economie*. Brief van de Staatssecretaris van Infrastructuur en Milieu en de Minister van Economische Zaken aan de voorzitter van de Tweede Kamer van 14 september 2016. Vergaderjaar 2015–2016, 32 852, nr. 33.

Tweede Kamer (2016f). *Toekomst veehouderij*. Brief van de Staatssecretaris van Economische Zaken aan de voorzitter van de Tweede Kamer van 21 november 2016. Vergaderjaar 2016–2017, 28 973, nr. 184.

Tweede Kamer (2017a). *Vertrouwen in de toekomst. Regeerakkoord 2017-2021.* VVD, CDA, D66 en ChristenUnie. Vergaderjaar 2017-2018, 34700 nr. 34. Bijlage 820240.

Tweede Kamer (2017b). *Slotverklaring Voedseltop.* Brief van de staatssecretaris van Economische Zaken aan de Tweede Kamer van 23 februari 2017. Vergaderjaar 2016-2017, 31 532, nr. 180.

United Nations Environment Programme (2016). *Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel*. Westhoek, H, Ingram J., Van Berkum, S., Özay, L., and Hajer M.

United Nations Framework Convention on Climate Change (2015). *Paris Climate Change Conference, November 2015*. geraadpleegd op 3 november via http://unfccc.int/meetings/paris_nov_2015/meeting/8926.php

Veer, P. van 't, Fresco, L.O. & Poppe, K.J. (2017). *Towards a European Food and Nutrition Policy*. Wageningen: Wageningen UR.

Velthof, G.L.(WER-Alterra), Bruggen, C. van (CBS), Groenestein, C.M.(WLR), Huijsmans, J.F.M.(WPS), Luesink, H.H. (WER-LEI), Sluis, S.M. van der (PBL), Klok, J.W.H. van der (WER-Alterra), Kolk, J.W.H. van der(WER-Alterra), Oude Voshaar, S.V.(RIVM), Vonk, J.(RIVM) & Schijndel, M.W.(PBL) (2016). *Referentieraming van emissies naar lucht uit de landbouw tot 2030:achtergronddocument bij de Nationale Energieverkenning 2015, met emissies van ammoniak, methaan, lachgas, stikstofoxide en fijnstof uit de landbouw tot 2030.* Wageningen: Wageningen Environmental Research.

Vogelzang, Th., Berkhout, P. & Jager, J. (2017). *GLB-bestedingen in Nederland.* Wageningen University & Research. Wageningen.

Vringer, K., Vollebergh, H., Soest, D. van, Heijden, E. van der, Dietz, F. (2013). *Dilemma's rond duurzame consumptie. Een onderzoek naar het draagvlak voor verduurzaming van consumptie.* PBL, Den Haag.

Vrolijk, H., Blokland, P.W., Helming, J., Luesink, H.& Prins, H. (2010). *Economische gevolgen van een beperking van de veestapel: quick scan naar winnaars en verliezers.* Wageningen: LEI/ Wageningen UR.

Vuuren, D.P. van, Boot, P., Ros, J., Hof, A. & Elzen, M. den (2016). *Wat betekent het Parijsakkoord voor het Nederlandse langetermijn-klimaatbeleid?* Den Haag: PBL.

Wageningen Economic Research [WecR] (2017). *Agrimatie-informatie over de agrosector: onderzoeksresultaten.* Geraadpleegd op 8 december via http://agrimatie.nl

Wageningen University & Research (2017a). *BSE, de gekke koeienziekte.* Geraadpleegd op 26 juli 2017 via http://www.wur.nl/nl/show/BSE-1.htm

Wageningen University & Research (2017b). *MARAN-2017. Monitoring of Antimicrobial Resistance and Antibiotic Usage in Animals in the Netherlands in 2016.* Wageningen.

Wageningen University & Research (2017c). *Maatschappelijk effecten van voedsel: een verkenning van een nieuwe methodiek.* Wageningen.

Westhoek, H., Rood, T., Eerdt, M. van, Gelder, M. van, Grinsven, H. van, Reudink, M. & Zeijts, H. (2013). *De macht van het menu. Opgaven en kansen voor duurzaam en gezond voedsel*. Den Haag: PBL.

Wetenschappelijke Raad voor het Regeringsbeleid (2014). *Naar een Voedselbeleid.* Den Haag/Amsterdam: University Press.

Wisman, A. & Jukema, G. (2017). *Nederlandse handel in Varkens.* Wageningen: Wageningen University & Research.

Wit, J. de & Veluw, K. van (2017). *Verkenning naar een grondgebonden melkveehouderij: minder koeien om binnen milieugrenzen te komen*. Driebergen: Louis Bolk Instituut.

World Bank (2010). *People, pathogens, and our planet. Volume 1: towards a one health approach for controlling zoonotic diseases.* Washington.

ZuivelNL (2016). *Zuivel in cijfers 2016*. Den Haag.

APPENDICES

RESPONSIBILITY AND ACKNOWLEDGEMENTS

Advisory committee

Marjolein Demmers MBA, member of the Council for the Environment and Infrastructure, member of the advisory committee until 1 November 2017

Ingrid Odegard MSc, junior Council member

Krijn Poppe, Council member and chair of the committee

Project team

Mirjan Bouwman PhD, project staff member from 2 October 2017

Nicole van Buren PhD, project staff member until 2 October 2017

Anneke Koose-Verschoor, project assistant

Hannah Koutstaal, project leader

Bart Thorborg, project staff member

Consultees

Expert meeting, 25 April 2017

Geert Bergsma, CE Delft

Petra Berkhout, Wageningen University & Research

Ado Bloemendal, Pure Graze

Stijn Derks, executive board of NAJK (Dutch young farmers organisation)

Prof. Peter Groot Koerkamp, Wageningen University & Research

Hendrik Hoeksema, Dutch Agriculture and Horticulture Federation, Southern Region (ZLTO)
Martine Hoogsteen, National Institute for Public Health and the Environment (RIVM)
Jorrit Kiewik, Youth Food Movement
Jan Klink, Ministry of Economic Affairs
Jaap Korteweg, The Vegetarian Butcher
Sonja Kruitwagen PhD, PBL Netherlands Environmental Assessment Agency
Frits van der Schans, CLM Research and Advice
Albert Vermuë, Dutch Water Authorities (UvW)

Expert meeting, 5 July 2017
Sijas Akkerman, Natuur en Milieufederatie Noord
Pieter Jelle Beers PhD, DRIFT
Roline Broekema, Blonk Consultants
Jeroen Candel, Wageningen University & Research
Hans Dagevos, Wageningen University & Research
Vera Dalm, Milieu Centraal
Corné van Dooren, Netherlands Nutrition Centre
Hilde Engels, Stichting Natuur & Milieu
Prof. Atze Jan van der Goot, Wageningen University & Research
Willemieke Hornis PhD, Ministry of Infrastructure and the Environment
Joost de Jong, PUM
Heleen van Kernebeek, Wageningen University & Research
Willem Lageweg, Dutch Federation of Agriculture and Horticulture (LTO Nederland)
Prof. Gert Spaargaren, Wageningen University & Research
Inge Stoelhorst, Ministry of Health, Welfare and Sport
Gijs Theunissen, Ministry of Economic Affairs
Jeroen Willemsen, Green Protein Alliance

Individuals consulted
Petra Berkhout, Wageningen University & Research
Gert Jan van den Born, PBL Netherlands Environmental Assessment Agency
Werner Buck, Royal FrieslandCampina N.V.
Marc Calon, Dutch Federation of Agriculture and Horticulture (LTO Nederland)
Martha van Eerdt, PBL Netherlands Environmental Assessment Agency
Frank van Gaalen, PBL Netherlands Environmental Assessment Agency
Marian Geluk, Federation of Dutch Food Industries (Federatie Nederlandse Levensmiddelen Industrie)
Hans van Grinsven, PBL Netherlands Environmental Assessment Agency
Guus de Hollander PhD, PBL Netherlands Environmental Assessment Agency
Prof. Ruud Huirne, Rabobank
Gerbrand van ’t Klooster, Dutch Federation of Agriculture and Horticulture (LTO Nederland)
Marc Jansen, Dutch Food Retail Association (CBL)
Tim Lohmann, Federation of Dutch Food Industries (FNLI)
Oscar Meuffels, Dutch Dairy Association (NZO)
Marian van Schijndel, PBL Netherlands Environmental Assessment Agency

Anne Marie Spierings, Noord-Brabant Provincial Executive
Marijke Vonk, PBL Netherlands Environmental Assessment Agency
Henk Westhoek, PBL Netherlands Environmental Assessment Agency

Individuals consulted at ministries
Robert Baayen, Ministry of Agriculture, Nature and Food Quality
Frank Bouman, Ministry of Infrastcructure and Water Management
Rob van Brouwershaven, Ministry of Agriculture, Nature and Food Quality
Olaf Cornielje PhD, Ministry of Infrastructure and Water Management
Marjan van Creij Phd, Ministry of Agriculture, Nature and Food Quality
Joke Dorenbos-van den Hil, Ministry of Economic Affairs and Climate Policy
Niek Hazendonk, Ministry of Agriculture, Nature and Food Quality
Dr Henk Reinen, Ministry of Health, Welfare and Sport
Ellen Reuver, Ministry of Agriculture, Nature and Food Quality
Hans Rutten, Ministry of Agriculture, Nature and Food Quality
Marc Schakenraad, Council on Animal Affairs (RDA)
Marjolein Sonnema, Ministry of Agriculture, Nature and Food Quality
Inge Stoelhorst, Ministry of Health, Welfare and Sport
Peter van Velzen, Ministry of Agriculture, Nature and Food Quality
Miranda Vroom, Ministry of Health, Welfare and Sport
Koos van Wissen, Ministry of Agriculture, Nature and Food Quality

External reviewers
Prof. Erik Mathijs, KU Leuven
Martin Scholten PhD, Wageningen University & Research
Em. Prof. André van der Zande

OVERVIEW OF PUBLICATIONS

2018

Electricity provision in the face of ongoing digitalisation [*'Stroomvoorziening onder digitale spanning'*]. February 2018 (Rli 2018/01)

2017

A Broad View of Heritage: The Interactions between Heritage and Transitions in the Physical Environment [*'Brede blik op erfgoed, over de wisselwerking tussen erfgoed en transities in de leefomgeving'*]. December 2017 (Rli 2017/03).

Energietransitie en Leefomgeving: kennisnotitie. [only available in Dutch]. December 2017 (Rli 2017).

Land for Development: Land Policy Instruments for an Enterprising Society [*'Grond voor Gebiedsontwikkeling. Instrumenten voor grondbeleid in een energieke samenleving'*]. June 2017 (Rli 2017/02).

Assessing the Value of Technology: Guidance Document [*'Technologie op waarde schatten. Een handreiking'*]. January 2017 (Rli 2017/01).

2016

Faster and Closer: Opportunities for Improving Accessibility in Urban Regions [*'Dichterbij en sneller: kansen voor betere bereikbaarheid in stedelijke regio's'*]. December 2016 (Rli 2016/05).

International Scan 2016: Emerging Issues in an International Context. November 2016 (Rli/EEAC).

The Connecting Landscape [*'Verbindend landschap'*]. November 2016 (Rli 2016/04).

Challenges for Sustainable Development: Main Focus Areas Identified in Advisory Reports Published in the Past Four Years by the Council for the Environment and Infrastructure [*'Opgaven voor duurzame ontwikkeling: hoofdlijnen uit vier jaar advisering door de Raad voor de leefomgeving en infrastructuur'*]. July 2016 (Rli 2016/03).

Beyond Mainports [*'Mainports voorbij'*]. July 2016 (Rli 2016/02).

System Responsibility in the Physical Living Environment. [*'Notitie Systeemverantwoordelijkheid in de fysieke Leefomgeving'* – only available in Dutch]. May 2016 (Rli 2016/01).

2015

Reform of Environmental Law: Realise your Ambitions [*'Vernieuwing omgevingsrecht: maak de ambities waar'*]. December 2015 (Rli 2015/07).

A Prosperous Nation Without CO_2: Towards a Sustainable Energy Supply by 2050 [*'Rijk zonder CO_2: naar een duurzame energievoorziening in 2050'*]. September 2015 (Rli 2015/06).

Room for the Regions in European Policy [*'Ruimte voor de regio in Europees beleid'*]. September 2015 (Rli 2015/05).

Changing Trends in Housing: Flexibility and Regionalisation Within Housing Policy [*'Wonen in verandering, over flexibilisering en regionalisering in het woonbeleid'*]. June 2015 (Rli 2015/04).

Stelselherziening omgevingsrecht. May 2015 (Rli 2015/03).

Circular Economy: From Wish to Practice [*'Circulaire economie: van wens naar uitvoering'*]. June 2015 (Rli 2015/02).

Survey of Technological Innovations in the Living Environment [*'Verkenning technologische innovaties in de leefomgeving'*]. January 2015 (Rli 2015/01).

2014

Managing Surplus Government Real Estate: Balancing Public Interest and Financial Gain [*'Vrijkomend rijksvastgoed, over maatschappelijke doelen en geld'*]. December 2014 (Rli 2014/07).

Risks Assessed: Towards a Transparent and Adaptive Risk Policy [*'Risico's gewaardeerd, naar een transparant en adaptief risicobeleid'*]. June 2014 (Rli 2014/06).

Recovering the Costs of Environmental Damage: Advisory Letter on Financial Indemnity to be Provided by High-Risk Companies [*'Milieuschade verhalen, advies financiële zekerheidstelling milieuschade Brzo- en IPPC4-bedrijven'*]. June 2014 (Rli 2014/05).

International Scan 2014: Signals: Emerging Issues in an International Context [*'Internationale verkenning 2014. Signalen: de opkomende vraagstukken uit het internationale veld'*]. May 2014 (Rli 2014).

The Future of the City: The Power of New Connections [*'De toekomst van de stad, de kracht van nieuwe verbindingen'*]. April 2014 (Rli 2014/04).

Quality Without Growth: On the Future of the Built Environment [*'Kwaliteit zonder groei, over de toekomst van de leefomgeving'*]. April 2014 (Rli 2014/03).

Influencing Behaviour: More Effective Environmental Policy through Insight into Human Behaviour [*'Doen en laten, effectiever milieubeleid door mensenkennis'*]. March 2014 (Rli 2014/02).

Living Independently for Longer: A Shared Responsibility of the Housing, Health and Welfare Policy Domains [*'Langer zelfstandig, een gedeelde opgave van wonen, zorg en welzijn'*]. January 2014 (Rli 2014/01).

2013

Sustainable Choices in the Implementation of the Common Agricultural Policy in the Netherlands [*'Duurzame keuzes bij de toepassing van het Europese landbouwbeleid in Nederland'*]. October 2013 (Rli 2013/06).

Pulling Together: Governance in the Schiphol/Amsterdam Metropolitan Region [*'Sturen op samenhang, governance in de metropolitane regio Schiphol/Amsterdam'*]. September 2013 (Rli 2013/05).

Safety at Companies Subject to the Major Accidents Risks Decree: Responsibility and Effective Action [*'Veiligheid bij Brzo-bedrijven, verantwoordelijkheid en daadkracht'*], June 2013 (Rli 2013/04).

Dutch Logistics 2040: Designed to Last [*'Nederlandse logistiek 2040, designed to last'*]. June 2013 (Rli 2013/03).

Nature's Imperative: Towards a Robust Nature Policy [*'Onbeperkt houdbaar, naar een robuust natuurbeleid'*]. May 2013 (Rli 2013/02).

Room for Sustainable Agriculture [*'Ruimte voor duurzame landbouw'*]. March 2013 (Rli 2013/01).

2012

Keep Moving, Towards Sustainable Mobility. Edited by Bert van Wee. October 2012 (Rli/EEAC).

Original title

Duurzaam en gezond. Samen naar een houdbaar voedselsysteem

Text Editing

Saskia van As, Tekstkantoor van As

Photo Credits

Cover: EyeEm / Hollandse Hoogte

Page 6: Pauliene Wessel / 123RF

Page 30: Andy Warhol / Hollandse Hoogte

Page 36: Henk Siteur / Nationale Beeldbank

Page 41: Mike Kemp / Hollandse Hoogte

Page 46: Shinedawn / Shutterstock

Page 65: Jan Wijga via ReclameArsenaal

Page 71: Photographee.eu / Shutterstock

Page 82: nosua / 123RF

Infographics

Joris Fiselier, pages 14 en 29

Graphic Design

Jenneke Drupsteen Grafische vormgeving

Publication RIi 2018/02

March 2018

Translation

Derek Middleton

ISBN 978-90-77166-73-4

NUR 740