



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

What *is* on our *plate*?

Safe, healthy and sustainable
diets in the Netherlands





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Foreword

Food is important, complicated and challenging.

At the RIVM we have been working to ensure the safety and health of our diet for a very long time. In our renowned report *Our food, our health (Ons eten gemeten)* we provided a summary of our insights into this complex material over ten years ago. The sustainability of our diet is also an important objective. After all, the production, processing, transport, consumption and packaging of our food are also important factors in the sustainability of our planet and our country.

This is our first attempt to disentangle and analyse the integrated complexity of safe, healthy and sustainable diets. In view of the mission of the RIVM: *Standing up for a healthy population in a healthy living environment* we consider it our duty and obligation to take on this challenge. In doing so we sought maximum cooperation with our knowledge partners and stakeholders in the area of food.

We discovered that the trio of safety, health and sustainability is not enough when it comes to the actual behavioural motives related to food. Consumer motives like convenience, enjoyment and cost, as well as prosperity motives like employment and export and ethical issues like animal welfare are also involved. These are all legitimate issues that carry weight individually and in society. In this report we have concentrated on safe, healthy and sustainable diets without disregarding these other motives.

What is on our plate? thus provides our best attempt to create order in the confusion surrounding food. That is not an easy task in a post-truth era in which many prophets preach remarkable truths and untruths about food. Although we are under no illusion that this report can enable us to draw final conclusions about our diet and about future food policy, we are proud of this synthesis. It is also a contribution from which hope and confidence can be drawn. There are good opportunities for further enhancing the combination of safe, healthy and sustainable food. This won't happen automatically, because tough mechanisms are involved and the easier measures have already been used. On the other hand, the Netherlands has proven to be very innovative.

We hope this report challenges you to take steps with regard to food on the basis of this knowledge synthesis. Our health and living environment are worth it.

André van der Zande
Director-General of RIVM

Synopsis

What is on our plate?

Safe, healthy and sustainable diets in the Netherlands

Huge challenges and ambitions

Most Dutch people are healthy and life expectancy is growing. Simultaneously, half of the Dutch population is overweight and this rate is even higher in lower socioeconomic groups. In addition, 9 out of 10 people eat too little fruit and vegetables, and nearly 30 percent of our food is of animal origin. The diet of an average Dutch person does not only lead to health losses, but also constitutes a major burden on the environment. It results in greenhouse gas emissions comparable to transport emissions. The annual food waste is 47 kilograms per person. Food in the Netherlands is mostly safe: approximately 1 in 24 people a year have a food infection, which usually is not serious. Most chemicals in food pose a negligible risk to public health. The Netherlands aims to take the lead in the international ambition for a healthy, sustainable and safe dietary pattern. To achieve this aim an integral policy is required, in which safety, health and sustainability are taken into account.

Opportunities

In this report, RIVM presents facts and figures about the safety, health and ecological sustainability of diets in the Netherlands and analyses the dilemmas and opportunities for an integrated food policy. Avoiding overconsumption, a diet with more plant-based and less animal-based products, and less sugar-containing and alcoholic drinks: these constitute three opportunities for a healthier and more sustainable dietary pattern. Taking advantage of these opportunities will lower the number of chronically ill, reduce health inequalities and contain the impact of food production on the environment. And, it tends to have a positive effect on the safety of our diet, as a lower meat consumption is associated with a lower rate of food infections.

Dilemmas

There are however dilemmas to be faced. Not all measures related to a healthy diet are sustainable and safe, and vice versa. For example, it is eco-friendly if every part of an animal is used for consumption. This also implies the consumption of processed meat, such as sausage, which in itself is less healthy. Moreover, there is a tension between abstract, long-term goals (healthier, more sustainable and safe) and concrete choices in everyday life. Many citizens and businesses consider health and sustainability to be important, but when shopping for food, consumers' choices are primarily determined by price and convenience. Companies, in turn, want to serve these consumers and make a profit.

Making choices

The tension between sustainable, healthy and safe diets on the one hand, and convenience, affordability and economy on the other, necessitates choices. To find a way out requires the government to take on an active role, and to cooperate with the agricultural sector, businesses, citizens and social organizations. Not only do consumers

need to be well informed, but a healthier and more sustainable food supply is also needed. The same applies to an environment that promotes healthy and sustainable behaviour. Influential parties, such as purchasing organizations for supermarkets and retail, are potentially important partners. The fact that many citizens and businesses attach importance to sustainable, healthy and safe food legitimizes the government taking on this active role.

Seizing opportunities

There are opportunities for an integrated approach. Dutch society is characterized by entrepreneurship and innovation capacity. Presently, there are citizens' initiatives that focus on responsible diets. Companies welcome these initiatives and contribute through smart solutions that allow them to make a profit. If the government encourages and facilitates these developments, the social ambitions, entrepreneurial spirit and innovative capacity of all parties will be taken advantage of.

Keywords: food, diet, health, safety, sustainability, integral policy

Publiekssamenvatting

Wat ligt er op ons bord?

Veilig, gezond en duurzaam eten in Nederland

Uitdagingen en ambities zijn groot

De meeste Nederlanders zijn gezond en de levensverwachting stijgt. Tegelijkertijd heeft de helft van de Nederlanders overgewicht; in lagere sociaaleconomische groepen is dit nog meer. Ook eten 9 van de 10 mensen te weinig groente en fruit en is bijna 30 procent van ons eten van dierlijke oorsprong. Het voedingspatroon van een gemiddelde Nederlander leidt niet alleen tot gezondheidsverlies, maar vormt ook een grote belasting voor het milieu. Het zorgt voor een uitstoot aan broeikasgassen die vergelijkbaar is met die van vervoer. Jaarlijks verspillen Nederlanders per persoon 47 kilogram voedsel. Voedsel in Nederland is overwegend veilig: ongeveer 1 op de 24 mensen maakt jaarlijks een voedselinfectie door, die meestal niet ernstig verloopt. Voor de meeste chemische stoffen in voedsel is het risico voor de volksgezondheid verwaarloosbaar. Nederland wil voorop lopen in de internationale ambitie voor een gezond, duurzaam en veilig voedingspatroon. Om dat te realiseren is integraal beleid nodig gericht op veiligheid, gezondheid en duurzaamheid tegelijkertijd.

Kansen

In dit onderzoek heeft het RIVM de feiten en cijfers over de veiligheid, gezondheid en ecologische duurzaamheid van voedsel in Nederland verzameld en geanalyseerd welke kansen en dilemma's er zijn voor een integraal voedselbeleid. Niet teveel eten, een voedingspatroon met meer plantaardige en minder dierlijke producten en minder suikerhoudende en alcoholische dranken: dat zijn drie kansen voor een gezonder en duurzamer voedingspatroon. Deze veranderingen verminderen het aantal chronisch zieken, verkleinen de gezondheidsverschillen en beperken de milieubelasting van voedsel. In de meeste gevallen wordt het voedsel daarmee ook veiliger; zo gaat de consumptie van minder vlees samen met minder voedselinfecties.

Dilemma's

Er zijn ook dilemma's. Niet alle maatregelen voor gezonde voeding zijn duurzaam en veilig, en vice versa. Zo is het duurzaam om bij vleesconsumptie het hele dier van kop tot staart te eten. Dit betekent ook bewerkte vleesproducten, zoals worst, die weer minder gezond zijn. Daarnaast bestaat er een spanningsveld tussen abstracte doelstellingen op lange termijn ('gezonder, duurzamer en veilig') en concrete keuzen in het dagelijks leven. Veel burgers en bedrijven vinden gezondheid en duurzaamheid belangrijk, maar in de winkel letten consumenten toch vooral op prijs en gemak. Bedrijven willen op hun beurt deze consument dienen en winst maken.

Keuzen maken

De spanning tussen duurzaam, gezond en veilig voedsel, en het gemak, de betaalbaarheid en de economie vraagt om keuzen. Om hier een uitweg in te vinden is een actieve rol van de overheid gewenst, die

samen optrekt met de agrarische sector, bedrijven, burgers en maatschappelijke organisaties. Daarbij is niet alleen een goede informatievoorziening voor de consument nodig, maar ook een gezonder en duurzamer aanbod. Hetzelfde geldt voor een omgeving die gezond en duurzaam gedrag stimuleert. Partijen die hier veel invloed op hebben, zoals inkooporganisaties voor supermarkten en de detailhandel, kunnen een belangrijke partner zijn. Dat veel burgers en bedrijven duurzaam, gezond en veilig voedsel belangrijk vinden, creëert legitimiteit voor deze actieve rol.

Kansen benutten

Kansen voor een integrale aanpak zijn er. De Nederlandse maatschappij kenmerkt zich door ondernemingsgeest en innovatievermogen. Er zijn al burgerinitiatieven gaande die werk maken van verantwoord voedsel. Bedrijven en de agrarische sector willen hieraan bijdragen door slimme oplossingen waarmee winst te maken is. Als de overheid deze ontwikkelingen stimuleert en faciliteert, worden de maatschappelijke ambities, de ondernemingsgeest en het innovatievermogen van alle partijen benut.

Kernwoorden: voedsel, voedingspatroon, gezondheid, veiligheid, duurzaamheid, integraal beleid

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1 Introduction

In a nutshell

The challenges with regard to sustainability and public health are huge. Food production and consumption play an important role in this respect. There is public debate on healthy eating and on food production with attention for the environment, animal welfare and food safety, and there is a need for more transparency about the origins of our food, and what is safe, healthy and sustainable. At the same time, the Dutch agricultural sector and food industry are among the international leaders and play an important role in the Dutch economy. Meanwhile, consumers want convenient, affordable and delicious food.

An integrated food policy is required in order to respond to social challenges concerning safe, healthy and sustainable diets in a complex arena involving the interests of the consumer and the economy. In addition to the challenges, the ambitions are huge. The Netherlands wants to take the lead in the food transition that is needed in order to achieve the Dutch, European and global ambitions with regard to health and sustainability.

'What is on our plate? Safe, healthy and sustainable diets in the Netherlands' provides the facts and figures on the current dietary pattern and the safety, health and sustainability of this pattern. Through a systematic analysis of various policy options, the report provides tools to raise the safety, health and sustainability of our diet to an even higher level based on an integrated approach. Both opportunities and dilemmas are addressed.

1.1 Background

Are beans healthy? The myth of E-numbers. How healthy are meat substitutes? Nearly half of tinned vegetables contain added sugar. Intensive agriculture is a more urgent problem than global warming. Dutch onion taking over the world. One-fifth of the world's population obese by 2025. Nuts are healthy, but not very sustainable. What counts? The chicken or the money?

These are just a few recent newspaper headlines (see Appendix C), to illustrate a number of issues. First, there are still plenty of challenges with regard to food safety, public health and sustainability. Second, the extent to which a safe, healthy and sustainable diet go together is unclear. Third, there are other important values of food, such as the economy, enjoyment and animal welfare. Finally, there is a lot of confusion about food, as a result of which consumer confidence in food is not always high. This calls for an integrated perspective on food and food policy.

'What is on our plate? Safe, healthy and sustainable diets in the Netherlands' is a report that provides building blocks for an integrated food policy. The starting point is the current Dutch food consumption pattern, so literally what is on our plate. And also figuratively: which

challenges are on our plate? The report concludes with an outline of the opportunities and choices for food policy.

This report is a follow-up to the report '*Our food, our health. Healthy diet and safe food in the Netherlands*', published by the RIVM in 2004 (van Kreijl, et al. 2004). At the time, this was an answer to the demand for integrated information about healthy and safe food, necessary for the formulation of policy priorities in the area of health protection and health promotion. In this new report, the RIVM not only integrates information about health and safety, but also about the ecological sustainability of food, necessary for further integration of food policy.

1.2 Values and interests related to food

The call for an integrated approach to food is also made in the 2014 report by the Scientific Council for Government Policy (WRR) on the consequences for the Netherlands of the global developments and societal challenges with regard to food (WRR 2014). One of the conclusions is that food policy should take into account the divergent values and interests surrounding food: economic values, ecological sustainability and health, which according to the WRR includes both food safety and public health. Values for the consumer, such as convenience, price and the role of food 'as a source of enjoyment, a bearer of culture, an expression of identity' should also be taken into account according to the WRR. In the European Commission's vision for the future, safe food and a healthy diet in 2050 are also viewed from various angles: global food, regional food, partnership food and pharma food (Mylona, et al. 2016). The sustainable development agenda, adopted by the United Nations in September 2015, also refers to the various values of food. Finally, these values are presented in the broad FAO definition of sustainable food patterns: 'diets protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources' (FAO 2010).

In the RIVM's Foodture project (see box), a large number of parties were asked which values they attribute to food (Van Raaij, et al.). They named a total of 11 values, which we have grouped into five clusters: safety, health, sustainability, economy and consumer values. These clusters form the basis of this report.

Foodture: values related to diet and food

Food is a way of expressing yourself. It is far more than feeding yourself and others. Those who prepare food can show that they are creative, have money, are hospitable, or want the best for the world. In the context of identifying the food of the future, sessions were organised with scientists, policymakers, civil society organisations, producers and manufacturers, supermarkets and consumers. These sessions produced 11 'lenses' through which to view the future of food. These lenses can be regarded as values that people consider important when it comes to food. Each value is associated with specific challenges, some of which are presented below. These values are partly dependent on the interests of specific stakeholders, but also reflect the standards and values of individual people.

1. Economy: contribution by food sector to economic growth, import and export of food
2. Sustainability: environmental effects, waste, animal welfare
3. Fast & convenient food: it's all about simplicity
4. The consumer decides: diversity and freedom of choice
5. Eating together: food as a social occasion
6. Food safety: improving safety and confidence
7. Healthy diet: eating according to the 'Wheel of Five' (*Schijf van vijf*)
8. Affordable food: good food for any budget
9. Fair trade: promoting global justice
10. Local & self-sufficient: promoting locally produced food and shorter food chains
11. Taste: delicious food

1.3 Objective and target group

This report provides building blocks for an integrated food policy in the Netherlands. The Netherlands is ambitious in this area, and wants to take the lead in the food transition that is needed in order to achieve the Dutch, European and global ambitions with regard to health and sustainability (Rijksoverheid 2015b). A systematic analysis of intended and unintended effects of policy aimed at safety, health and sustainability linked to our diet and underlying food production identifies possible connections while simultaneously showing where dilemmas are. Where policy focused on a particular societal challenge (e.g. sustainability) also has positive effects on other challenges (e.g. health), useful connections can be made. This creates opportunities for policy. If policy focused on a particular societal challenge has a negative effect on other challenges, this results in policy dilemmas. This asks for choices to be made or extra efforts to compensate these negative effects. With this summary of opportunities and choices, the report provides tools to raise the safety, health and sustainability of our diet to an even higher level. This is viewed from an integrated perspective on food, taking into account divergent values of food, such as convenience, affordability and the Dutch export position.

This publication is intended primarily for policymakers who focus on the safety, health and sustainability of food; policymakers with the government, and also in science, in the business community, in consumer organisations, etc. Readers who require more background information can find in-depth information on the scientific basis and the methodology in a series of background reports (see box).

Justification

The information in this publication is based on a series of six background reports (partly in English). The complete reference for each publication can be found in Appendix B.

- Food consumption in the Netherlands and its determinants
- Driving forces behind food consumption and the food supply
- How safe is our food?
- Health aspects of the Dutch diet
- The environmental sustainability of our diet
- What is on our plate? Methodological background report.

The scientific sources are stated in these reports. For reasons of readability, the number of references to the literature have been limited in this publication. More references can be found in the background reports.

The study was conducted within the RIVM's Strategic Programme, which focuses on themes that influence public health and the living environment of the future. In this way, the RIVM is preparing for the issues of tomorrow.

To guarantee the scientific quality and increase the usefulness of the report, the project team was assisted by people from the fields of science, policy and practice (see Appendix A).

1.4

Reader's guide

Chapter 2 describes the current state of affairs with regard to the Dutch diet. What is on our plate today? In other words: what do the Dutch eat and what are the societal challenges when it comes to the safety, health and sustainability of this diet? What will be on our plate tomorrow is the theme of Chapter 3, which shows how safely, healthily and sustainably our dietary pattern will develop on the basis of external factors, if policy remains unchanged. Chapter 4 provides a summary of interventions, measures and policy in the Netherlands to improve food safety, health and sustainability of the dietary pattern. Chapter 5 provides opportunities to link policy on food safety, health and sustainability, and where the dilemmas are.

2 What is on our plate today?

In a nutshell

We eat approximately 1 kg and drink 2 litres every day.

An average person in the Netherlands eats 1 kilogram and drinks 2 litres per day. We divide this between breakfast, lunch and dinner, with an average of 4 extra eating moments throughout the day. On average we consume about 350 grams of dairy (including cheese), 100 grams of meat (and meat products), 125 grams of vegetables and 125 grams of fruit (and nuts) per person per day. The consumption of animal products increased from the 1950s to the 1990s. Today, 16% of our food, 28% of what we eat and 10% of what we drink is of animal origin. 60% of our protein consumption is of animal origin while 40% comes from plant-based foods.

What we eat is safe

The Netherlands has a high level of food safety. About one in 24 persons per year have a food-borne infection, usually without serious consequences. Food-borne infections are responsible for slightly less than 10% of the loss of health (premature death and loss of quality of life) as a result of infectious diseases in total, but less than 0.5% of the loss of health from all diseases combined (such as cardiovascular disease, cancer, psychological disorders, infectious diseases, etc.). In principle, consumers ingest so little of the studied substances that are permitted by the government for use in the food production process, that there is no risk to public health. For some substances, which occur in our food in the form of contamination (from the environment, through processing or preparation), the amount ingested by a proportion of consumers is higher than the recommended safe levels. This concerns three mycotoxins and acrylamide. This does not necessarily mean that a loss of health occurs. Due to a lack of data it is difficult to calculate this precisely, but at current exposure levels the risk to public health appears to be low.

Health gains possible through healthier diet

While most Dutch people are healthy and life expectancy is increasing, the prevalence of chronic diseases is high and almost half the population is overweight. Substantial health gains can be made through a healthier diet and a healthier body weight. This applies even more so to the lower socio-economic groups. A healthier diet lowers the chance of premature death, cardiovascular disease and diabetes by approximately 15 to 20 percent. A healthy diet is characterised by not eating too much or too little, and eating primarily plant-based and few animal products. More specifically: a healthy menu is rich in fruit, vegetables, legumes, nuts, fish and wholegrain products, contains sufficient low-fat dairy products, and is low in red and processed meats, alcoholic and sugar-containing drinks, salt and saturated fats.

The diet in the Netherlands has a significant impact on the environment

The production and consumption of food put pressure on the environment, for example through the emission of greenhouse gases, use of land, water use, use of non-renewable resources and loss of biodiversity. Food accounts for more than 25% of greenhouse gas emissions and 60% of the loss of biodiversity worldwide. Food consumption in the Netherlands is associated with the emission of 4 to 5 kg of greenhouse gases per person per day, comparable to the daily emissions from motorised vehicles. Meat, dairy products (including cheese) and beverages are most harmful to the environment. The consumption of animal products causes 55% of the food-related greenhouse gas emissions, while animal products constitute 16% of our diet by weight. Beverages, in particular soft drinks, juices and alcoholic beverages, contribute an average of 10%. The annual food waste is 47 kilograms per person in the consumer phase. The objectives of the climate agenda are only achievable if we also limit the emission of greenhouse gases due to food consumption.

Introduction

This chapter provides information about what we eat in the Netherlands and the degree to which our food is safe and our dietary pattern healthy and ecologically sustainable. We will describe ecological sustainability according to the most important effects on the environment.

2.1 What do we eat?

Dutch people eat and drink about 3 kilograms per day

The average Dutch person consumes an average of approximately 21 different food products per day, which amounts to 2 litres of beverages and 1 kilogram of food. The beverages comprise water, coffee, soft drinks, tea, alcohol, dairy drinks and juices. Bread and cereals, dairy products (cheese, yoghurt, desserts and ice cream), fruit, vegetables and potatoes make up the biggest proportion of food by weight (see Figure 2.1) (Van Rossum, et al. 2016).

Sixteen percent of the total consumption is of animal origin

More than a quarter (28%) of the food and 10% of the beverages are of animal origin, representing 16% of the total food consumption. Over 60% of the total protein consumption is of animal origin (Beukers, et al. 2016). The average meat consumption is about 100 grams per day. Most of this consists of processed meat (such as sliced meats, smoked and fresh sausage, 48 grams), chicken (15 grams), beef (14 grams) and pork (13 grams). The average fish consumption is 15 grams per day. Two-thirds of Dutch people eat meat for dinner on a daily basis (Van Rossum, et al. 2016). Two to four percent are vegetarian or vegan (Beukers, et al. 2012; Dagevos, et al. 2012).

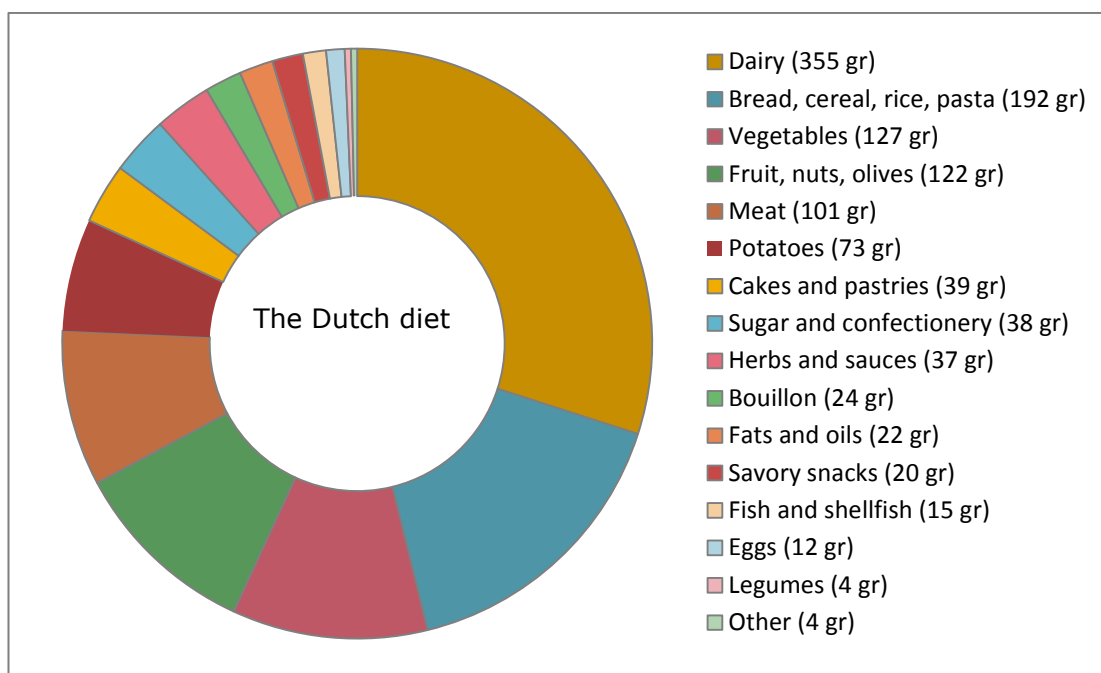


Figure 2.1 The average consumption of foods in grams per day by 1-79 year olds (excluding alcoholic and non-alcoholic beverages, 152 and 1725 grams per day, respectively), VCP 2012-2014 (Van Rossum, et al. 2016).

Three meals per day and many snacks

More than 80% of Dutch people consume something more than seven times a day. So besides breakfast, lunch and dinner, there are four other times at which food is consumed. About 14% of the total energy intake is provided by breakfast, 21% by lunch and 36% by dinner. The remaining 30% of calories are provided by all snacks combined (Van Rossum, et al. 2011).

The average Dutch eater does not exist

Food consumption varies from one person to another. There are systematic differences between population groups:

- Men eat more than women and young adults eat more than children and older adults, simply because they have higher energy requirements. This translates to all product groups with a few exceptions: women eat more fruit than men and children eat more sweet and savoury snacks than adults (Van Rossum, et al. 2016).
- Highly educated people eat more fruit, vegetables and fish and drink more water, coffee, tea and juice than less educated people. They are also more likely to use nutritional supplements. Less educated people eat more meat, spreads and cooking fats and drink more soft drinks than higher educated people (Geurts, et al. 2015).
- The largest population groups with a migration background consume less dairy products and alcohol than those with a Dutch background. Dutch people of Surinamese origin eat more seafood and noodles and rice dishes. Turks in the Netherlands have a relatively high consumption of legumes, (Turkish) bread, meat, fruit and vegetables, and inhabitants with a Moroccan

background have a higher consumption of seafood, (Moroccan) bread and meat (De Boer, et al. 2015).

Values are related to food choice

Consumption is also determined by people's lifestyle-related standards and values. Research by Motivaction (Keuchenius, et al. 2015) shows that people with traditional values (moralistic, dutiful and status quo oriented) eat more potatoes, fruit and dairy products. The consumption pattern of convenience-oriented people (who aspire to material wealth, entertainment and convenience) and the upwardly mobile (who want to make a career for themselves, achieve social status and be free from tradition) are characterised by a relatively high consumption of snacks, soft drinks and fast food. The diet of socially critical idealists (with attention for intangible values and self-fulfilment) is characterised by less meat and more fruit and vegetables (Keuchenius, et al. 2015).

The Dutch eat more snacks and desserts than other Europeans

Compared with other Europeans, the Dutch consume many beverages, potatoes, dairy products, desserts and snacks, and less eggs, fish, fruit and legumes. Compared with Southern and Eastern European countries, people in the Netherlands eat less fruit and vegetables. Southern Europeans use more vegetable oils and less animal fats than the Dutch (EFSA 2011).

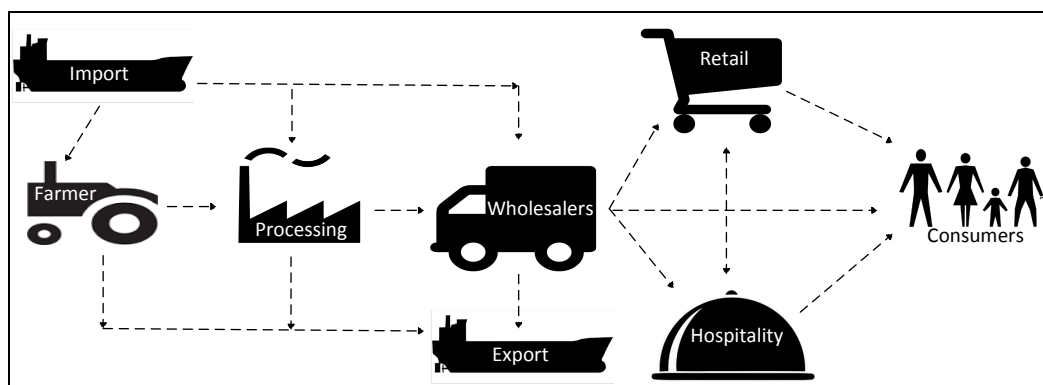


Figure 2.2 Diagram of the food chain from producer to consumer.

Foods are becoming increasingly complex, reflecting a complex food network

Food production has developed into a complex network of flows of raw materials and intermediate goods, which in turn are processed and combined to create foods. The Netherlands Scientific Council for Government Policy refers to this complex network as the 'food net' (WRR 2014). The food supply consists largely of composite foods, including ultra-processed foods. Ultra-processed foods are made from processed ingredients, such as hydrogenated oils and fats, starch and flour, variants of sugar and cheap parts or remnants of animal foods, aromas, colouring or flavouring agents, and few to no basic foods. Ingredients used in industrially prepared foods often originate from all over the world. And food processing also often takes place in other countries (where workers receive lower wages) than the country of primary production. Figure 2.2 shows a simplified representation of the

food net as a food chain, with import and export taking place in all parts of the chain. The majority of the total food imports come from the EU, with the exception of fruit imports of which only 30% come from EU countries (Van der Knijff, et al. 2011).

2.2 Food safety in the Netherlands

What is food safety?

Consumers want to trust that the food they buy is safe. It should not be contaminated with harmful bacteria, viruses or parasites. And any exposure to potentially harmful chemicals must be below the health standard levels, generally the so-called health based guidance values (see underneath).

How is food safety measured?

Food is safe if the number of pathogenic microorganisms, any toxins produced by these microorganisms (microbiological food safety) and the levels of potentially harmful chemicals in foods (chemical food safety) are sufficiently low that consuming the food does not pose a risk to human health. It is also important that no pieces of metal, glass or plastic make their way into food. This is referred to as physical hazards of food, and is beyond the scope of this report.

Microbiological food safety

We define microorganisms as bacteria, fungi, viruses and parasites. These organisms can be pathogenic themselves and may cause infections. Some microorganisms produce substances that may cause food poisoning (toxins). Microbiological food safety is represented by the number of infections including cases of food poisoning that occur per year.

Chemical food safety

Chemical substances (including their residues) can get into foods because their use is permitted during the production, transport or storage of foods (such as plant protection products and preservatives). They can also occur 'naturally' in the raw materials for the production of a food or in the foods themselves (e.g. heavy metals and mycotoxins) or be produced during preparation (e.g. acrylamide). Chemical food safety can be expressed in a risk quotient (RQ). This RQ represents the relationship between the exposure to a particular substance (P99 for plant protection products and P95 for other substances) and the health-based guidance value (HBGV) of that substance. An example of such a guidance value is the tolerable daily intake (TDI). If the RQ is between 0 and 1, the health risk is negligible. If the RQ is higher than 1, a health risk cannot be ruled out.

Food can become contaminated at various places in the chain

Foods, for example vegetables, potatoes, meat and cereals go through a long production process before making their way to our plate. This chain 'from farm to fork' is particularly complex for processed products (see also underneath). Food can be exposed to microbiological pathogens or become contaminated with chemicals at various places in a food chain.

Contamination in the food production chain

Primary production

Fruit and vegetables can be contaminated with pathogenic microorganisms in the primary production phase by means of the irrigation system, the manure, the soil or through contact with wild animals. In the case of livestock, pathogens may be present in feed, water or other environmental factors, such as animals of the same or other species, the stable, the soil or humans. The majority of microbiological incidents are linked to the consumption of beef, followed by poultry, fish¹, dairy products and pork.

There is also a risk of chemical contamination during the production process. Mycotoxins are the most common chemical contaminants in plant-based foods. Mycotoxins are toxins produced by fungi, which occur relatively frequently in cereals and nuts, herbs and spices, and also in products made using these ingredients, such as peanut butter, bread, beer and animal feed. For example, mycotoxins can get into milk through contaminated feed. Plant-based foods can also contain residues of plant protection products or become contaminated with substances that are not readily degradable, such as heavy metals. Animal-based foods can become contaminated with residues from veterinary drugs used in the feed. The living environment of animals can also result in contamination. For example, high concentrations of cadmium have been found in mussels and high methylmercury concentrations have been found in predatory fish such as swordfish and tuna.

Processing

Inadequate hygiene and cross contamination are major causes of microbiological contamination during processing (cutting and packaging) of foods. This often concerns contamination with bacteria that occur in the intestinal contents of animals. Contamination of food with noroviruses and rotaviruses also occurs in the processing phase. In these cases, humans are the source of contamination through saliva and sneezing.

Additives are often added to our food during processing. These include synthetic or natural substances, such as aromas, colouring and flavouring agents, sweeteners, acidity regulators and antioxidants. Other chemicals can get into our food when food is improperly smoked, baked or fried. This can occur in the factory, and also during preparation at home (see below). Furthermore, residues from disinfectants, preservatives used in detergents, pesticides and fungicides can get into our food unintentionally.

Transport and retail

After production and processing, foods are transported to retailers to be sold. If conditions such as temperature and humidity are not adequately controlled, any microorganisms in the food, such as *C. perfringens*, *B. cereus* and *C. botulinum*, will have the opportunity to grow. Examples are improperly cooled sauces, soups and ragout. Fungi that produce

¹ Based on the total number of incidences, but not taking into account the Salmonella incident in 2012.

mycotoxins also thrive under these conditions. Contamination of foods with other chemicals is limited during transport and retail. However, it is possible for substances from packaging materials to get into foods.

Storage and preparation

Consumers who handle their food unhygienically after purchasing increase their risk of a foodborne infection. For example, food is not always sufficiently cooled during storage and some animal products are eaten raw or after minimal heating, thus not killing the bacteria, fungi, parasites or viruses that may be present in the food. Examples are steak tartare, carpaccio, smoked fish, prawns and raw milk cheese. Chopping boards, knives and other cooking utensils as well as poor personal hygiene can also form a source of contamination. Chemical risks in this phase are attributable to things like heating foods for too long and at excessively high temperatures (e.g. acrylamide formation during deep-frying and PAHs² during barbecuing).

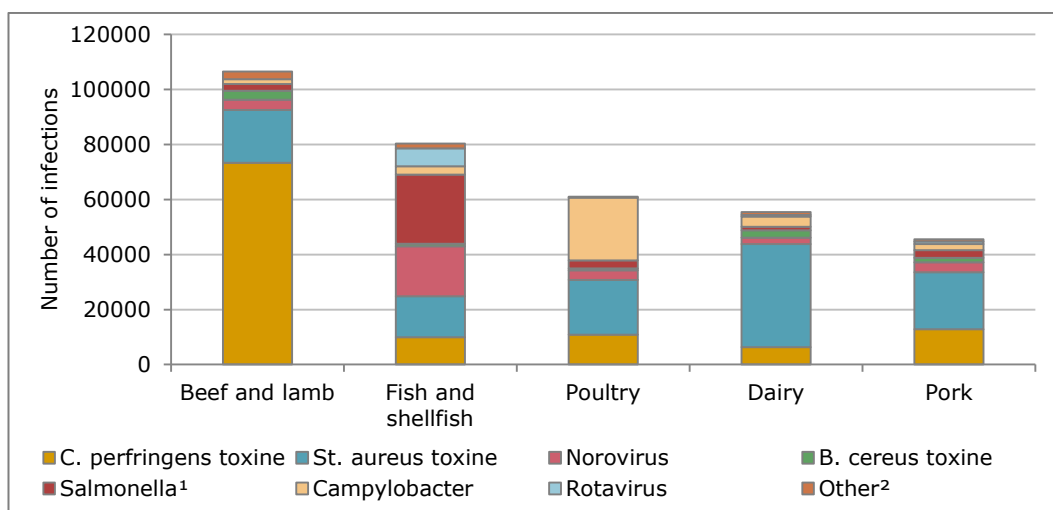
700,000 foodborne infections per year

It is estimated that approximately 700,000 people in the Netherlands fall ill as a result of a foodborne infection per year; this amounts to approximately 1 in 24 people. The total number of foodborne infections remained virtually unchanged between 2009 and 2013, although there were fluctuations due to specific outbreaks. Of the total loss of health due to infectious diseases (premature death and loss of quality of life), close to 10% is caused by foodborne infections. Compared to the annual loss of health in the Netherlands by all diseases combined (infectious diseases, cardiovascular disease, cancer, etc.), this is less than 0.5%.

Although foodborne infections are relatively common, they usually only result in gastroenteritis. However, sometimes the consequences are more serious. This applies mainly to risk groups, such as young children, pregnant women, the elderly and people with impaired immune systems. A well-known example is *Toxoplasma* infection from eating insufficiently cooked meat during pregnancy. This can result in miscarriage. In 2012, 75 people died from a foodborne infection, usually caused by an infection with *Campylobacter* or *Salmonella*.

Microbiological infections are often attributable to bacteria such as *Campylobacter* (especially in chicken) and *Salmonella* (e.g. in raw eggs, raw salmon or raw milk cheese) and also food poisoning caused by *Clostridium perfringens*, *Bacillus cereus* and *Staphylococcus aureus* (see Figure 2.3). Beef is the main animal source of contamination, with raw meat, such as *filet américain* (Dutch version of steak tartare) and *ossenworst* (raw beef sausage) forming the greatest risk. The risk groups mentioned above are advised not to eat raw or dried meat, raw eggs and dairy products made from raw milk (such as raw milk cheeses).

² PAHs are Polycyclic Aromatic Hydrocarbons, such as benzo[a]pyrene.



¹ Salmonella infections: an outbreak of Salmonella in salmon in only one company resulted in estimated 24,000 of the 25,000 Salmonella infections caused by seafood in 2012.

² Other pathogens include STEC O157, *Listeria monocytogenes*, hepatitis A and hepatitis E, *Cryptosporidium parvum*, *Giardia lamblia* and *Toxoplasma gondii*.

Figure 2.3 Incidence (absolute number of cases in 2012) of symptomatic infections per pathogen and food group³ (Bouwknegt, et al. 2014).

Exposure too high for small proportion of substances

In Europe, the European Food Safety Authority (EFSA) identifies knowledge about potential health effects of a large number of substances, and establishes health based guidance values (HBGVs) on the basis of this. None of the investigated substances which the government permits for the food production process exceed the HBGV. For some substances that occur in our food in the form of contamination, the exposure by a proportion of consumers is higher than the HBGVs (see Figure 2.4). These include environmental food contaminants and contaminants due to food processing or preparation. This concerns three mycotoxins and acrylamide, and for 2-6 year olds (not shown in Figure 2.4) also the heavy metals cadmium and lead. For these substances a risk cannot be ruled out. This does not concern the average exposure, but adults and children with a high exposure (P95). The exposure has been calculated for a total of 36 substances in the Dutch diet. For lead this calculation is limited to young children (2-6 year olds).

The three agricultural contaminants that exceed the HBGV are the mycotoxins aflatoxin, alternariol and alternariol monomethyl ether. Mycotoxins are natural toxins produced by fungi. The exposure to too much of a mycotoxin can lead to various health effects varying in severity, including liver damage and the development of tumours. Acrylamide (a process contaminant) is a substance that can occur when starchy products, such as potatoes and cereals, are heated above 120°C. The exposure to acrylamide through food may increase the risk of developing cancer.

Health effect probably low, but difficult to quantify.

For most substances the health risk is negligible. For a few substances a health risk cannot be ruled out. However, for these substances it is difficult to determine the exact health effects in humans. Often it does not concern immediate loss of health, but long-term effects due to substances accumulating in the body and/or effects only becoming noticeable over time. The loss of health caused by exposure to chemical substances is difficult to calculate due to the lack of epidemiological data. An additional complicating factor is that determining the risk of exposure to combinations of chemical substances is not yet possible, since a method is under development.

The Netherlands has a high level of food safety

Compared to most countries in Europe and the rest of the world, food safety in the Netherlands is high. The challenge in the Netherlands lies mainly in maintaining this high food safety level. In the next chapter we describe various developments that may put food safety under pressure.

Suspicion concerning synthetic additives

When it comes to food safety, the perception of consumers does not correspond to scientific knowledge. Consumers are suspicious about many additives (characterised by E-numbers), for example those added to foods to improve taste, texture or shelf life (Haen 2014). In addition, many consumers perceive naturally occurring substances as less dangerous than synthetic chemical substances. Many consumers also think that risks caused by chemical substances are greater than risks caused by microbiological contamination (Kher, et al. 2013). This perception is contrary to scientific insights. E-numbers are additives that have been assessed by EFSA, and subsequently approved for use by EU policymakers. Furthermore, microbiological contamination is associated with more acute risks than chemical contamination. In addition, 'naturally' occurring chemicals are more likely to lead to health problems than synthetic chemicals. Examples of this are the mycotoxins produced by fungi and toxins produced by plants and shellfish.

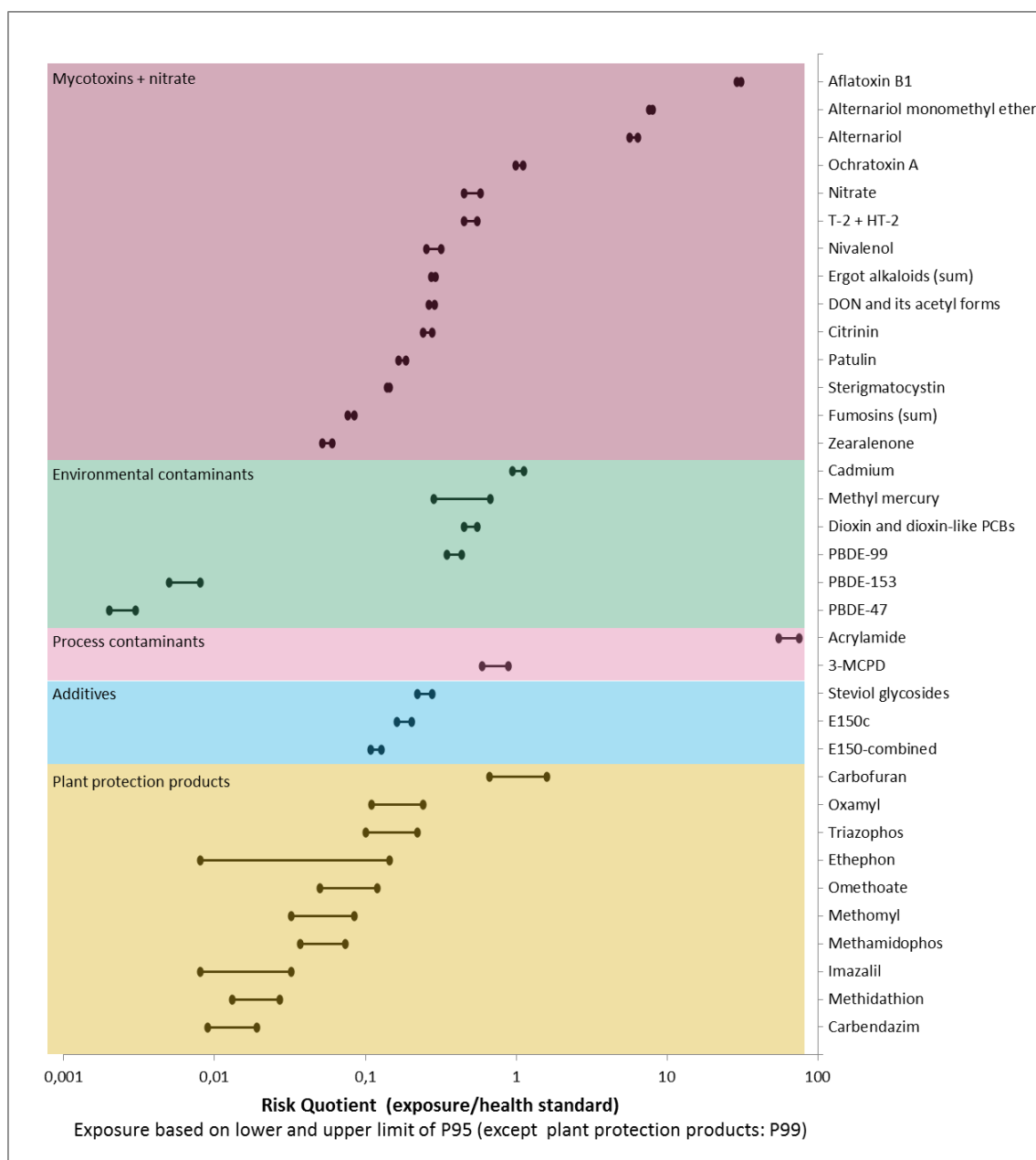


Figure 2.4 Calculated risk quotients for children and adults (aged 7-69 years) for various mycotoxins and nitrate (dark pink), environmental contaminants (green), process contaminants (light pink), additives (light blue) and plant protection products (yellow).

2.3

How healthy is our diet?

What is a healthy diet?

Healthy diets are rich in fruit, vegetables, legumes, nuts, fish and wholegrain products, contain sufficient low-fat dairy products, and are low in red and processed meat, salt, alcoholic and sugar-containing beverages. In addition, healthy diets are characterised by a relatively high proportion of polyunsaturated fatty acids and a relatively low proportion of saturated fatty acids. Examples of healthy diets are a vegetarian diet, the Mediterranean diet and a diet according to the 'Dutch Dietary Guidelines' (*Richtlijnen goede voeding* (Gezondheidsraad

2015)) or the 'Wheel of Five'(Brink, et al. 2016). See box for an explanation. Eating healthily is also about consuming a varied diet, getting enough essential nutrients and about the amount we eat. An energy intake associated with a healthy body weight, not too much and not too little, is an important characteristic of a healthy diet.

What is a healthy diet?

In 2015, the Health Council of the Netherlands systematically assessed the scientific knowledge about the relationship between diet and ten major chronic diseases (Gezondheidsraad 2015). This concerned coronary heart disease, stroke, heart failure, diabetes mellitus type 2, chronic obstructive pulmonary disorder (COPD), breast cancer, colorectal cancer, lung cancer, dementia and cognitive decline, and depression. New Dutch Dietary Guidelines were formulated on the basis of this.

These guidelines can be summarised as follows:

- On a daily basis, eat at least 200 grams of vegetables, 200 grams of fruit, 90 grams of brown bread, wholegrain bread or other wholegrain products, 15 grams of unsalted nuts, and a few portions of dairy, and drink three cups of tea. Eat legumes and fish (preferably oily fish) once a week.
- Replace refined cereal products with wholegrain products; replace butter, hard margarine and cooking fats with soft margarine, liquid cooking fats and vegetable oils; replace unfiltered coffee with filtered coffee.
- Limit the consumption of red meat, particularly processed meat, sugar-containing beverages, alcohol (none or no more than one glass per day), the intake of table salt to a maximum of 6 grams per day.
- The use of nutritional supplements is not necessary, except for people in a specific group for which supplementation is recommended.

The Health Council of the Netherlands also looked at healthy diets, such as the traditional Mediterranean diet, the new Nordic diet and the American Dietary Approaches to Stop Hypertension (DASH) diet. These diets contain less animal-based and more plant-based basic foods and reduce the risk of coronary heart disease and stroke. They are rich in fruit, vegetables, wholegrain products, nuts, legumes, oils rich in cis-unsaturated fatty acids, semi-skimmed and low-fat dairy products, poultry and fish; and contain little red meat and processed meat, full-fat dairy products, hard fats, table salt and beverages (and other products) with added sugar; and use alcohol in moderation. The amounts can vary. Vegetarian diets without meat or without animal products reduce the risk of coronary heart disease.

The Netherlands Nutrition Centre (*Voedingscentrum*) has translated the Dutch Dietary Guidelines into recommendations for recommended daily allowance of food groups for different target groups (Wheel of Five), see paragraph 4.2.

The Dutch do not eat according to the Dutch Dietary Guidelines

Hardly anyone in the Netherlands follows the Dutch Dietary Guidelines completely. About 15% of adults consume the recommended 200 grams of vegetables and 200 grams of fruit per day. However, approximately half of the adult population eats enough brown bread and wholegrain products (guideline is 90 grams) and almost 60% eat fish at least once a week (see Figure 2.5) (Geurts, et al. 2015; Boer, et al. 2017). See

paragraph 2.1 for information on the consumption of different types of meat. The consumption of saturated fatty acids, alcohol and salt is too high, while the consumption of fibre is too low (Van Rossum, et al. 2011; Van Rossum, et al. 2012). The intake of vitamins and minerals is more favourable, for most of these micronutrients the intake is sufficient. Only the intake of folic acid and vitamin D is too low. The latter applies mainly to older adults and to some other population groups, such as pregnant women (folic acid) and inhabitants with a migration background (vitamin D) (Gezondheidsraad 2009).

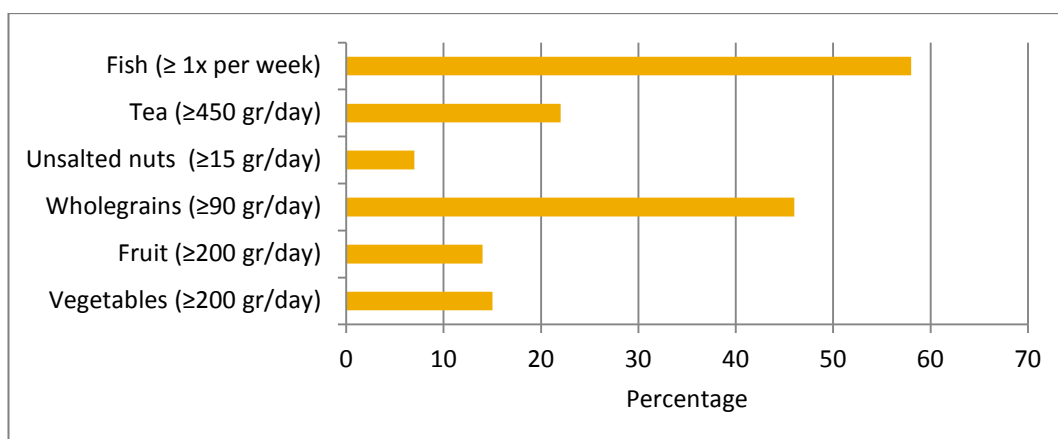


Figure 2.5 Percentage of adults that adhere to the quantitative guidelines of the Dutch Dietary Guidelines 2015 (interim results of the VCP 2012-2014 (Boer, et al. 2017)).

Half of the Dutch population is overweight

In 2015, half (50.3%) of the Dutch population aged 20 years and older was moderately or severely overweight. Moderate overweight (body mass index between 25 and 30 kg/m²) is more common among men than among women. The opposite is true for obesity, severe overweight (body mass index of 30 kg/m² or higher): more women than men are obese. A total of 13.7% of adults in the Netherlands are obese. These figures are based on self-reported height and weight (CBS 2016). In 2015, 12% of children of primary school age (4 to 12 years) were overweight. One-third of these, 4%, were obese. The prevalence of overweight is the same for boys and girls (Gezondheidsmonitor Jeugd GGD'en en RIVM 2015).

Differences between socioeconomic groups and groups with a migration background in the Netherlands

Differences in the diet of people with different socioeconomic statuses point in the same direction: an unhealthier diet for lower socioeconomic groups than for higher socioeconomic groups. The less educated group eat less fruit, vegetables and fish and more meat and fats than the highly educated group (van Bussel, artikel in voorbereiding). The differences in consumption between groups with a migration background are more ambiguous. Sometimes the diet is healthier, and sometimes unhealthier. Inhabitants with a Turkish background, for example, drink less alcohol and eat more vegetables and legumes than average. On the other hand, they also eat less fish and more meat than average (De Boer, et al. 2015).

Over 60% of poorly educated adults are overweight compared to 40% of more highly educated people, see Figure 2.6. Overweight also occurs more frequently among inhabitants with a migration background. The differences are particularly significant among children; 22% of 4 to 12 year-olds with a non-Western background are overweight, compared to 9% of children in the same age group with a native Dutch background. The corresponding figures for obesity are 9 and 2 percent, respectively (Gezondheidsmonitor Jeugd GGD'en en RIVM 2015).

What does this mean for disease and health in the Netherlands?

A healthy diet lowers blood pressure and the risk of a number of chronic diseases. Eating in accordance with the Dutch Dietary Guidelines or the Mediterranean diet reduces the risk of premature death by approximately 20% and the risk of stroke, coronary heart disease, diabetes and colorectal cancer by 15-20% (Gezondheidsraad 2015). In an ideal situation in which overweight and obesity did not occur in the Dutch population, the disease free life expectancy would increase by over two years (van Kreijl, et al. 2004).

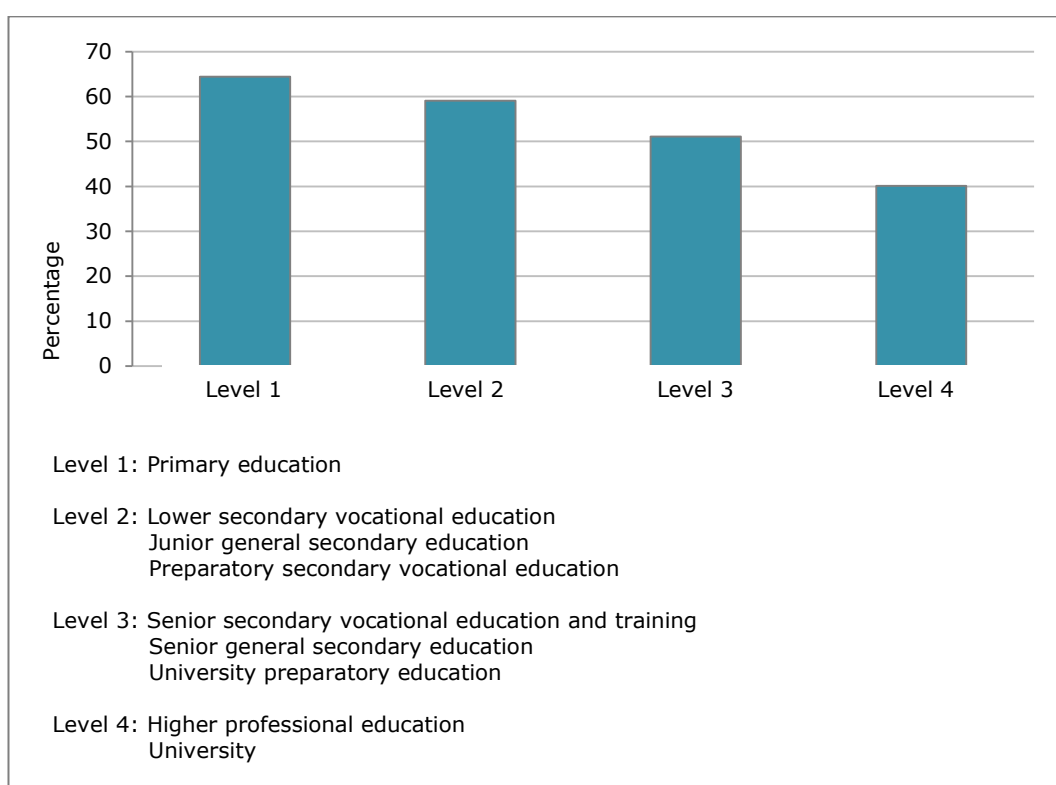


Figure 2.6 Overweight by level of education among adults aged 25 and older in 2012 (Gezondheidsmonitor Volwassenen GGD'en en RIVM 2012).

Significant health gains to be made by improving the diet

After smoking, overweight and nutrition are the most important lifestyle factors that determine the total loss of health and the socioeconomic health inequalities in the Netherlands. The diet therefore is and will continue to be an important intervention opportunity for improving public health, in particular that of lower socioeconomic groups. The current diet provides various opportunities in this respect, such as

eating more fruit, vegetables and wholegrain products and less meat and salt. Prevention of overweight also contributes to public health and to reducing health inequalities, for example through a lower energy intake by reducing the consumption of sugar-containing and alcoholic beverages and other energy-containing products that are not included in the Wheel of Five. Sufficient physical activity also plays a role in the prevention of overweight.

2.4 How ecologically sustainable is our diet?

What is an ecologically sustainable diet?

An ecologically sustainable diet maintains the food and nutritional requirements of current and future generations and protects the ecological system with which the food is produced (FAO 2010). This section of our report focuses on the environmental effects of a diet (see box) and disregards other aspects that are categorised under sustainability, such as fair trade, animal welfare and health. These aspects are addressed elsewhere in this report.

How can you measure the environmental impact of food?

The most common ways of expressing the environmental effects of human actions include the emission of greenhouse gases, use of land, use of water, eutrophication, acidification, soil degradation, the use of non-renewable resources and the loss of biodiversity. The importance of these environmental effects varies throughout the world. For example, water consumption plays a smaller role in the Netherlands than it does in dry areas like the Sahel and California. Eutrophication and acidification are important factors in the Netherlands with its intensive livestock farming. Whereas the Netherlands has a surplus of fertilisers, in other places, such as Africa, the soil is being depleted.

To illustrate the environmental effects of food consumption in the Netherlands, we will focus primarily on greenhouse gases and land use in this report. This concerns the effects throughout the entire lifecycle of the food. Of the greenhouse gases, carbon dioxide (CO₂) and methane (CH₄) are the best known, in addition to nitrous oxide (N₂O) and fluorinated gases (HFCs, PFCs and SF₆). The emission of non-CO₂ greenhouse gases is relatively low, but the warming effect is relatively high. The total global warming potential (GWP) of the emission of all greenhouse gases is expressed in CO₂ equivalents (CO₂-eq). Land use indicates how many square metres of land area is needed per year for the production of 1 kg of product, or of the total food consumption. The conversion of natural land to agricultural land is translated into greenhouse gas emissions and included in the environmental indicator.

Food puts great pressure on the environment

The food we eat on a daily basis not only affects our own health but also the environment. This is caused, among other things, by intensive use of agricultural land and by the emission of greenhouse gases during the production of food. Food production and consumption are responsible for over 25% of the total emission of greenhouse gases worldwide and for 60% of the loss of variation of crops and animals (biodiversity) (UNEP 2016). The food we consume in the Netherlands is also associated with substantial emission of greenhouse gases. The daily diet of the average

adult in the Netherlands is associated with the emission of 5 kg greenhouse gases per day per man and 4 kg per woman. This is comparable to the total emission from transport per person per day. Furthermore, approximately 4.5 m² of land per person (5 m² for men and 4 m² for women) is needed to grow enough food for one day. An area of approximately two-thirds of the total area of the Netherlands would be needed in order to feed everyone in the Netherlands. The figures mentioned are conservative estimates. Estimates vary depending on the analysis method used.

Environmental impact of food production is determined mainly by meat, dairy products and beverages

The agricultural production of food requires land, water, energy, manure, fertiliser, veterinary drugs (including antibiotics) and plant protection products. This results in greenhouse gases, fertilisers and plant protection products being released into the environment, and often in soil degradation. Two-thirds of agricultural land in Europe is used for the production (also through feed) of animal-based foods (Westhoek, et al. 2011). For example, the production of a kilogram of beef requires 10 m² for one year, while a kilo of apples requires 0.6 m². Animal-based foods have a greater impact on the environment than plant-based foods. The production of meat not only scores high for land use, but also for the runoff of fertilisers and the emission of greenhouse gases (see Figure 2.7). This also includes the environmental effects of the production of animal feed. The production of beef is associated with almost three times the emission of greenhouse gases compared with the production of chicken and pork. The type of feed the animals are given and how efficiently they convert it into meat are the most important determining factors for these differences. The production of fruit requires less land area and is associated with less greenhouse gas emissions, but does require a relatively large amount of water, particularly if irrigation is needed.

Production is the most damaging phase in the production chain

For almost all product groups, the agricultural production phase causes the greatest environmental impact. This applies mainly to the indicators land use, acidification and eutrophication. The other phases of the production chain, such as industrial processing, storage, transport and distribution, are also important for the indicators greenhouse gas emissions and water use (Figure 2.7). The phases of industrial processing, storage, packaging and transport contribute more for foods with a lower environmental impact, such as fruit and heavily processed foods. The main determining factors for the degree of environmental impact in these phases are the use of fossil fuels and raw materials.

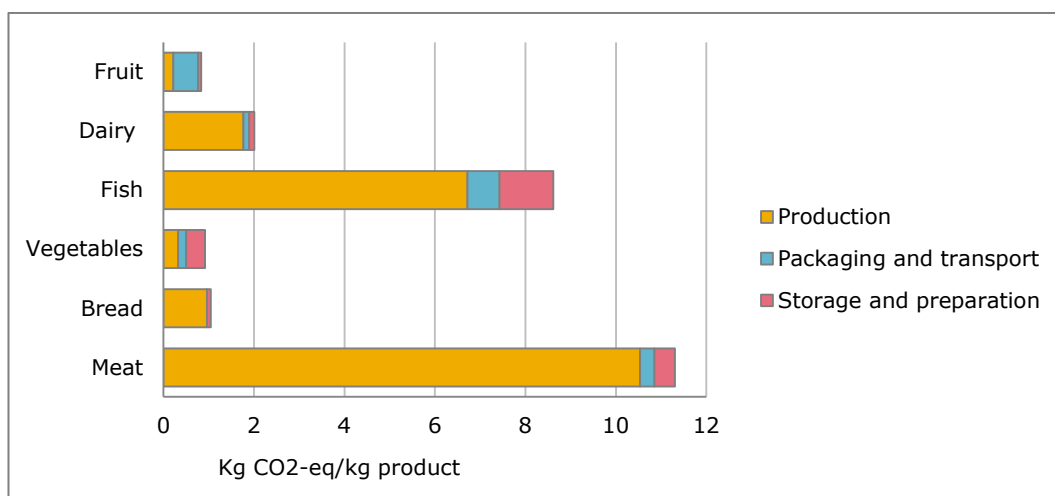


Figure 2.7 Median emission of greenhouse gases of food groups per kg of food throughout the entire lifecycle (De Valk 2016).

Majority of emissions due to consumption of animal products and beverages

While products of animal origin represent 16% of the total diet, approximately 55% of the food-related greenhouse gas emissions from the daily food consumption can be attributed to the consumption of products of animal origin (particularly dairy products, meat and cheese). Beverages, mainly soft drinks, juices and alcoholic beverages, contribute an average of 10%. Dinner and snacks between meals are associated with the greatest environmental impact; particularly due to the amount of (red) meat and the type of beverages consumed (see Figure 2.8).

Total greenhouse emissions are the same for socioeconomic groups

The total consumption of meat is lower in the higher socioeconomic group compared to the group with a lower socioeconomic status. Nevertheless, average greenhouse emissions are not lower. This is because people in the higher socioeconomic group eat more beef. This group also consumes more vegetables (+25%), fish (+31%) and fruit juice (+33%) than the lower socioeconomic group. This is associated with associated increase in environmental impact. On the other hand, men from the higher socioeconomic group drink 60% less soft drinks than men in the lower socioeconomic group (van Bussel). In total, greenhouse gas emissions are the same for the different socioeconomic groups.

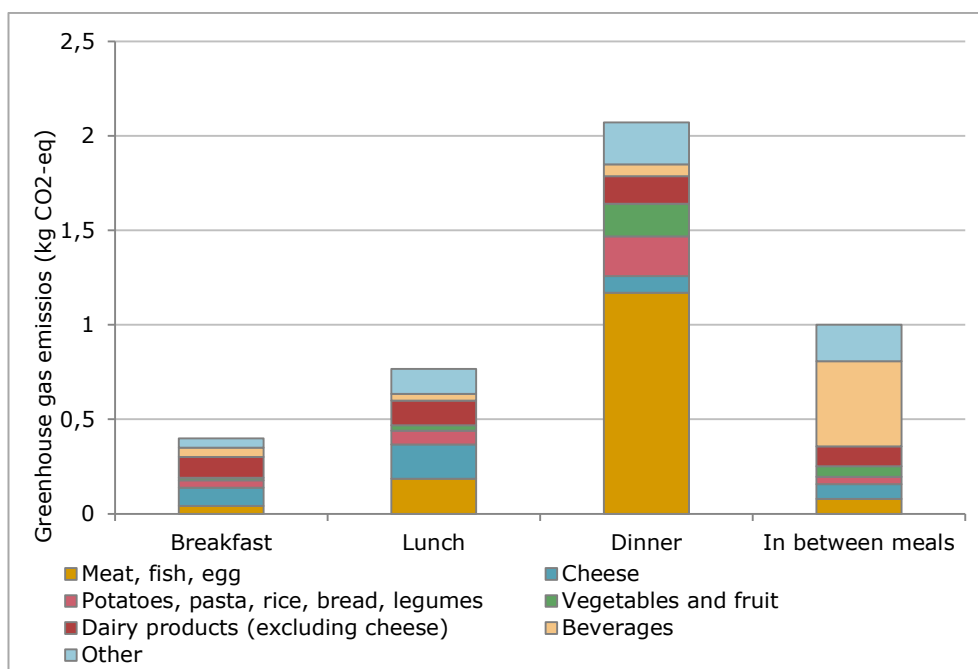


Figure 2.8 Average greenhouse gas emissions (kg CO₂-eq) per food group during various meal and snack times (Van de Kamp, et al.).

Environmental impact depends on amount and type of food

There is a strong relationship between energy intake and the emission of greenhouse gases. In other words: the more people eat and drink, the higher the environmental impact of their food consumption. However, it is interesting to note that there are considerable differences in the emission of greenhouse gases between people with the same energy intake. At an energy intake of 2000 Kcal, for example, greenhouse gas emissions range between 2 and 7 kg CO₂-eq. The choice of which foods and beverages are consumed has a significant effect on the environmental impact of the diet.

Consumers also influence environmental impact through choices of food transport, storage and preparation

Apart from the choice of food, consumers influence the environmental effects of their food consumption in various ways. The choice for the method of transport of the food purchased (by bicycle or by car), the type of energy used for food storage and preparation (clean energy or fossil fuels), and the method of storage (consume immediately or refrigerate/freeze) and preparation (stir-frying or stewing) of food is associated with different impacts on the environment.

More than 2 million tonnes of food is wasted per year

In the Netherlands, between 1.9 and 2.6 million tonnes of food is wasted throughout the food chain, amounting to 114 to 157 kg per person per year (Soethoudt 2016). This is largely attributable to Dutch households in which 47 kg of edible food per person is discarded per year; this amounts to 14% of the consumption (excluding beverages, including dairy drinks). The main foods wasted by consumers themselves are dairy products, fruit, vegetables and bread (Figure 2.9).

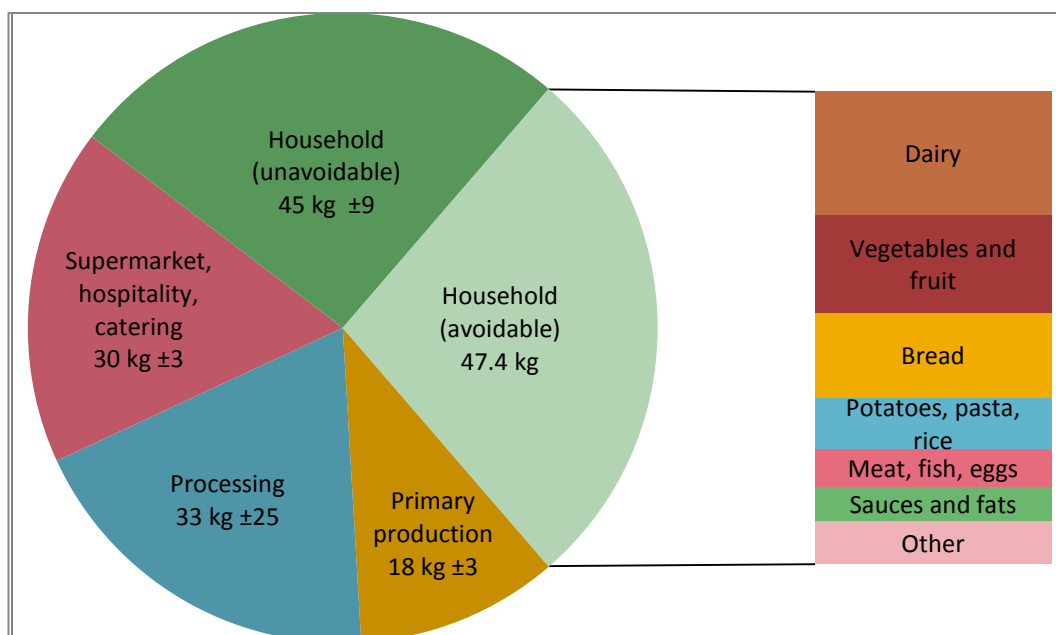


Figure 2.9 Pie chart: food loss and waste in the food chain in EU-28 in 2012 (in kg per person with 95% confidence interval). Adapted from (Stenmarck 2016). Bar chart: Avoidable food waste in Dutch households. Adapted from: (van Westerhoven 2013).

More environmentally friendly diet needed in order to achieve climate goals

There is a broad international consensus that the current global system of food production and consumption is untenable. The environmental effects are too great (UNEP 2016). The Netherlands has committed itself internationally to the climate and sustainable development goals (UN 2015a) and has expressed its ambition in the climate agenda to limit the emission of greenhouse gases to 71-75 Mt CO₂-eq per year by 2030 (Rijksoverheid 2013). This is only feasible if the emission of greenhouse gases from food consumption is also reduced. So the Netherlands faces a major challenge of limiting the environmental effects of our diet to the extent that 'an ecologically sustainable food system' (Rijksoverheid 2015b) is achieved. There are opportunities for this throughout the chain: from primary production, where a contribution can be made by reducing the use of fertiliser, irrigation water and plant protection products; to influencing the food supply and consumers who can contribute through their choice for certain foods, eating meat less frequently and seasonal fruit and vegetables more frequently, and by minimising wastage. The links in between can also contribute (see Chapter 4).

3 What will be on our plate tomorrow?

In a nutshell

External factors will influence food consumption in the future

The future supply of and demand for food will be influenced by demographic, economic, sociocultural, technological, ecological and political factors. In 2040 the Dutch population will include more elderly people, more people with a migration background, more people in big cities, and more small households. Partly connected to this, individualisation and focus on convenience will increase. In addition, the trend of 24/7 availability of food and food temptation will continue. The food chain is globalising and becoming more complex, as a result of which we eat more ingredients from all over the world. The concentration of power in the food chain is shifting towards non-agricultural parties. Parts of the food chain are dominated by a few multinationals, particularly the seed and breeding companies and purchasing organisations of supermarkets. Technological progress makes a substantial contribution to the increasing yield from agriculture and industry. New innovations continue to be made, for example related to the reuse of materials, development of alternatives to meat and improvements in the composition of foods from a health perspective. Due to the effects of climate change and scarcity of natural resources, food production will not be able to keep up with the increasing global demand for food. As a result, food prices will fluctuate and may possibly rise in the future.

Trends: increase in meat consumption reversed, fruit and vegetables stable, portion size increasing

Since the 1950s, the consumption of meat and cheese has increased while that of potatoes and vegetables has decreased. In the period from 1987 to 2010, the Dutch ate even less potatoes and vegetables and also less fruit. The consumption of meat, cheese and other dairy products and bread remained stable. Since 2012, the consumption of potatoes has decreased even further, and the consumption of dairy products and meat has also decreased. The consumption of vegetables and cereal products has remained about the same. Children have started eating more fruit. In addition, there is a trend towards more processed and pre-packaged food and towards bigger portions. At the same time, the availability of organic, animal-friendly, sustainable, locally produced or fair trade products is also increasing, although these market shares are still small.

Significant challenges will remain if policy does not change; technology as solution?

Recent trends in food consumption show a number of positive developments: a decrease in meat consumption and a stabilisation of or increase in the consumption of fruit and vegetables. Nevertheless, we expect most demographic, sociocultural, ecological and economic developments to lead to an increase in the consumption of unhealthy products. This will lead to an increase in the number of chronically ill people and possibly also in the differences between socioeconomic groups. Safety and sustainability are also under pressure from these

factors. Positive effects are expected from technological developments. Consumers are critical with regard to some technological innovations in agriculture and industry. Consumer organisations demand transparency, for example through labelling. Acceptance by consumers and their desire for transparency must be taken into account when developing and applying technological solutions.

Extra efforts needed for healthier and more sustainable diet

If the policy to limit the emission of greenhouse gases through Dutch food consumption and underlying production remains unchanged, the Netherlands will not meet the objectives of the climate agenda. Without extra efforts to make the diet healthier, it will also not be possible to reduce the number of chronic diseases and reduce health inequalities.

Introduction

In this chapter we will answer the question of how the safety, health and ecological sustainability of our food consumption will change if the policy remains the same. We will first describe trends in the macro-environment, which influence the demand for food (3.1). This will be followed by trends in food consumption (3.2). Based on these trends, the RIVM has made estimates concerning the safety, health and ecological sustainability of our food consumption if policy remains unchanged (paragraph 3.3-3.5).

3.1 The macro-environment of food supply and consumption

In the macro-environment, the supply of and demand for food is influenced by demographic, economic, sociocultural, technological, ecological and political factors. Relevant developments in these external factors are summarised below.

Climate change and population growth may lead to higher food prices

Climate change, higher temperatures, changing precipitation patterns and extreme weather conditions have an effect on food production. Ecology also influences the global food system, which is needed for food consumption in the Netherlands. Climate change is one of the main reasons for migration worldwide. Other consequences of climate change are not currently noticeable in the Netherlands. But this may change in the future. The world's population is expected to grow from over 7 billion in 2015 to almost 10 billion by 2050 (UN 2015b). Prosperity is also increasing, particularly in developing countries. This will cause a substantial increase in the demand for animal products. Due to the effects of climate change and scarcity of natural resources, food production will not be able to keep up with the increasing global demand for food. As a result, food prices will fluctuate and may possibly rise in the future. For many Dutch households this does not necessarily have to be problematic, as they currently spend only 12% of their household income on food. However, the situation may be different for low-income households.

More elderly people, single-person households and migrants in the Netherlands

The size of the Dutch population is growing. The Netherlands currently has a population of 17 million, which is expected to increase to more than 18 million by 2040. This increase is attributable to the ageing population and an increase in the number of migrants. The ageing population will reach its peak around 2040, when the Netherlands is expected to have 4.8 million inhabitants aged 65 and over, compared to 3.1 million in 2016. The Dutch population in 2040 is also expected to include 5 million people with a migration background, compared to 3.8 million now (CBS 2014). Along with the ageing population, the number of single-person households will increase from 2.9 million in 2016 to 3.6 million in 2040 (Van Duin, et al. 2016). Population growth will occur mainly in urban areas.

The food chain will become increasingly global and complex

The food chain is globalising and thus becoming more and more complex. International trade in food has increased sharply, but volume varies considerably from one food product to another. Soy, cereals, palm oil, fish, cocoa, coffee and tea are the main products that are traded globally. The international trade in packaged foods is also increasing. The effect of globalisation is reflected in the food supply and in food consumption. We eat more and more products from other countries, and we eat more and more composite products with ingredients from all over the world (see Chapter 2). Globalisation has standardised the global diet towards high-calorie and processed foods.

Increasing power for supermarkets and their purchasing organisations

The concentration of power in the food chain has changed over time from agricultural to non-agricultural parties. There is also an increase in the concentration of power in which parts of the food chain are dominated by a small group of multinationals, such as internationally operating seed and breeding companies and purchasing organisations that serve the supermarkets. Consumers are buying an increasing proportion of their food from supermarkets, at the expense of greengrocers, butchers and markets. Whereas 40% of the food was purchased in supermarkets in 1990, this figure has since risen to 66% (Westhoek, et al. 2013; WRR 2014). Supermarket buyers therefore have more and more influence on what consumers buy, although the precise effect of this on consumption is not yet clear. But foods in the supermarket consist largely of packaged and processed products. A more recent trend is online ordering of food for home delivery.

Sales figures reflect growth in social values

In the Netherlands, and in other Western countries, attention for nutrition and food is increasing. There are more television programmes about food and cooking now than ever before. In addition, specific values are ascribed to food and nutrition, such as those aimed at health, convenience, sustainability, animal welfare, taste or enjoyment. The changing interests of consumers with regard to certain values are reflected in sales figures. For example, convenience food has expanded enormously. Furthermore, the total share of products that are organic, animal friendly, sustainable or fair trade increased from 7% in 2013 to 8.2% in 2015 (CBL 2015). There is also a trend to eat more locally

produced food with a transparent, short production chain. And initiatives such as urban farming are making the distance between us and our food smaller. However, these are relatively minor trends in the total food system. Sales figures are determined partly by changes in the supply rather than by conscious choices by consumers (PBL 2012).

Technological progress can contribute to social challenges

In recent decades, technological progress has made a significant contribution to an increase in yield from the agricultural sector and the food industry. There is even more to be gained in the future, for example through precision agriculture. Other important innovations concern the reuse of materials or the use of waste flows. The food supply is also changing as a result of technological innovations. Technology contributes to the development of alternatives to meat, such as cultured meat, seaweed and insects. Technology also makes it possible to improve the composition of foods that traditionally contain high levels of fat, salt or sugar or low amounts of fibre in order to make them healthier. This is called food reformulation. Furthermore, additives, such as aromas, colouring and flavouring agents, acidity regulators and antioxidants, make it possible to optimise the shelf life, colour, flavour or texture of foods. Increasingly advanced additives have been developed in recent decades, thanks in parts to developments in molecular biology and nanotechnology. This also applies to smart packaging, which reduces spoilage or displays a warning when a product becomes microbiologically unsafe. This innovation can lead to less waste and fewer foodborne infections. Relevant technological innovations are also taking place outside the food industry. This includes technological developments of mobile and electronic devices and robots. These will provide more and more support for personal monitoring and management in the area of food and health (personalised food).

Consumers demand transparency about technology

Consumers are critical with regard to some technological innovations in agriculture and industry. This is often due to fear, uncertainty or suspicion with regard to food processing, such as genetically modified crops and food irradiation. Consumer organisations demand transparency, for example through labelling. Acceptance by consumers and their desire for transparency must be taken into account when developing and applying technological solutions. Technology can also aid in this transparency. Technological developments make it possible to provide consumers with more information about processing, origin, sustainability and health, for example through apps. Ensuring good quality of data is an important challenge in this respect.

European regulations focus mainly on food safety and food production

European regulations on food focus mainly on food safety and food production. All aspects of the food production chain are viewed as a whole, from the production of animal feed, including primary production, to the sale or supply of food to the consumer, as each part of the chain can influence food safety. Legislation on chemicals is largely compartmentalised, with separate legislation for e.g. (residues of) plant protection products, (residues of) veterinary drugs, additives, flavouring agents and contaminants. See also Chapter 4. The EU's Common Agricultural Policy strongly influences the food system. Economic values

of free trade and entrepreneurship play a dominant role in the existing policy for the agricultural and food sectors. These developments support the deregulation and globalisation of the food market. Since 2013, the Common Agricultural Policy will also take into account environmental aspects, such as efficient use of resources, soil and water quality, and threats to ecosystems and biodiversity (Westhoek, et al. 2013). Policy focused on health and sustainability of our diet is usually national, and is based less on legislation and regulations.

3.2 Trends in food consumption

Stop rise in meat consumption and decline in fruit and vegetable consumption

The Dutch diet has changed a lot since the 1950s. From then, the consumption of meat and cheese increased while the consumption of potatoes and vegetables decreased (van der Bie, et al. 2012). In the period from 1987 to 2010 the consumption of cereals (particularly rice and pasta) and non-alcoholic beverages increased. At the same time, the Dutch consumed less potatoes and vegetables and also less fruit and eggs. There were no significant changes in the consumption of meat, cheese and other dairy products, bread and cake/biscuits in this period (Geurts, et al. 2014). The consumption of potatoes decreased further from 2012. And the consumption of fats and oils, alcoholic beverages, dairy products, biscuits and cake, and meat has also decreased since then (see Figure 3.1). The consumption of vegetables and cereal products has remained about the same, while the consumption of non-alcoholic beverages, herbs and sauces has increased. Children have started eating more fruit (Van Rossum, et al. 2016).

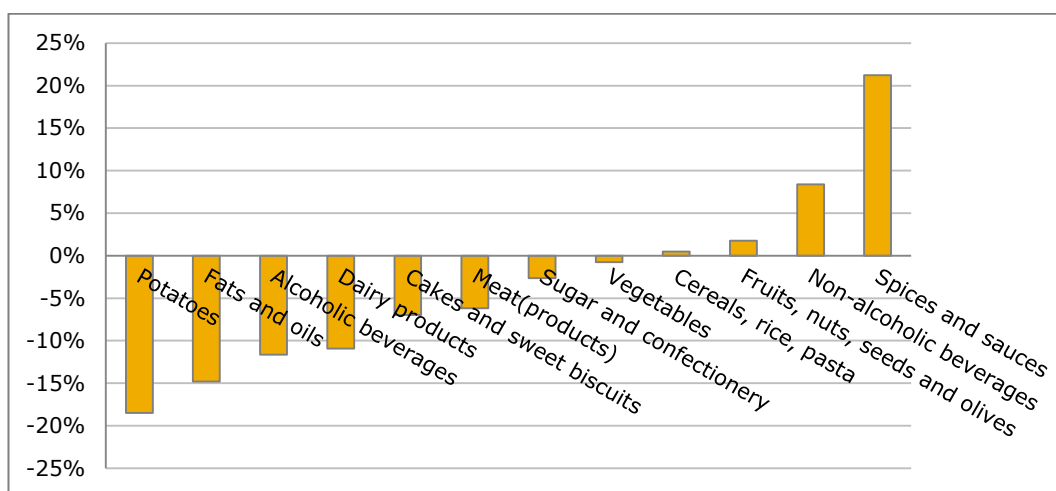


Figure 3.1 Recent changes in food consumption. VCP 2012-2014 compared to VCP 2007-2010 for 9-69 year olds (Van Rossum, et al. 2016).

Portion sizes are increasing

As well as the changes in the consumption of product groups as described above, we are also seeing changes within these product groups. We are eating fewer basic products and more processed and packaged foods. Many convenience foods fall into this category. The consumption of foods with labels for animal friendliness, fair trade and organic foods has increased slightly (see paragraph 3.1). Furthermore,

portion sizes have increased, particularly those of energy-rich foods (Steenhuis, et al. 2010). This applies to the size of a hamburger, for example, and the contents of soft drink bottles. Once a larger portion size is added to the product range, consumers' perception of an average portion size changes, as a result of which people opt for larger portions on average. The portions served in restaurants are also relatively large.

3.3 Future developments in food safety

Safety under pressure due to globalisation, ageing population and climate

The increasing globalisation of the food supply is leading to a growing supply of imported food. With a stable budget for import controls, the chance of introducing less safe food is increasing. The growth of the world's population is also putting more pressure on global food production. This can also lead to less safe food (from a microbiological and chemical perspective). The increase in the number of elderly people brings about additional risks, because they are exposed to accumulating chemicals for a longer period of time and because their generally more fragile health leads to reduced immunity to pathogens. Ecological developments such as climate change (failed harvests), global scarcity of agricultural land or depletion of (chemical) raw materials is leading to scarcity of raw materials. As a result, food prices will fluctuate and may possibly rise in the future. This can pave the way to fraud and potentially to a decrease in food safety. The illegal addition of melamine to infant formula is an example of this.

Another threat to food safety is antibiotic resistance. The excessive use of antibiotics in the livestock industry increases the chance of bacteria adapting and becoming immune. People can come into contact with these resistant bacteria through the consumption of animal-based foods.

Changes in consumption pattern have both positive and negative effects

Further growth in the consumption of cereals, nuts and seeds can lead to a further decline in chemical food safety due to the possible presence of mycotoxins. If the recent decrease in the consumption of meat and dairy products continues, this will lead to a decrease in exposure to pathogens and a number of persistent chemicals in animal fats, and therefore to an increase in food safety. A decrease in the consumption of raw or improperly heated meat will also lead to an increase in food safety due to the decrease in exposure to pathogens.

Improvements in food safety through technological developments

If an expected concentration of power in the food network leads to a few major players and not to monopolisation, the interests of producing and supplying safe food will become greater, which can have a positive influence on food safety. Technological developments can lead to an improvement in food safety, for example through techniques that increase food production yields, that develop (flavourful) alternatives to meat and apply smart food packaging.

Consumer confidence difficult to predict

Technological developments are often met with scepticism by consumers. For example, consumers perceive the idea of insects as an alternative protein source as strange or distasteful and are quick to have doubts

regarding safety. The same applies to technologically high-quality products that are perceived as 'unnatural' or 'manipulated'. Based on current consumer perception, an increase in additives in our food will lead to a decrease in consumer confidence in food safety. Conversely, consumers associate sustainable and healthy food with being safe. The development of green technology is thus expected to have a positive influence on confidence. Sociocultural developments, such as more attention for animal welfare, small scale and fair trade, will cause an increase in confidence. If policy remains unchanged, we expect consumer perception on food safety with regard to certain subjects (such as hygiene, additives and technological developments) to continue to differ from that of scientists.

3.4 Future developments in the health of our diet

Less healthy diet due to demographic, sociocultural and economic developments

In 2040, the Dutch population will include more elderly people and more Dutch citizens with a migration background. These are population groups in which overweight is more common. There will also be more people living in major cities and households will be smaller than they are today (see paragraph 3.1). Partly connected to this, individualisation and focus on convenience will increase. In addition, we expect a further increase in liberalisation, globalisation and concentration of power in the food chain and the trend of 24/7 availability of food and food temptation will continue. These demographic, sociocultural and economic developments will lead to an increase in the consumption of processed foods with an unhealthy composition. On the other hand, recent food consumption data indicate a number of favourable developments: an end to the decline in fruit and vegetable consumption and a decrease in meat consumption. Children are eating more fruit than they did 5 years ago (see paragraph 3.2).

Technology partly compensates unfavourable trend

Technological developments, such as improving the composition of processed foods (reformulation) and food tailored to the specific needs of individuals (personalised food), can counteract unfavourable trends. Without changes to the policy, the technological possibilities in 2040 probably will not be able to fully compensate the consequences of the unfavourable demographic and economic developments. If the policy remains unchanged, we therefore expect an increase in the disease burden and in the percentage of overweight people as a result of an unhealthy diet.

Socioeconomic differences are growing

In addition, a number of developments are contributing to an increase in socioeconomic differences. These are price increases due to a global increase in the demand for food. We estimate that people who do not have a lot of money will therefore purchase cheaper food with a lower nutritional value. Socioeconomic health inequalities will then grow larger. We mainly expect to see increased attention for health and sustainability in the higher socioeconomic groups. This will also cause an increase in health inequalities. Although other developments, such as reformulation of foods (less salt, sugar and calories), are likely to reduce the socioeconomic differences, if policy remains unchanged we expect to see larger differences in the healthiness of the diet between socioeconomic groups.

3.5 Future developments in the sustainability of our diet

Pressure on ecological sustainability through population growth

The increase in the global and Dutch population is increasing the pressure on food production. This can lead to more intensive use of land, water and renewable and non-renewable raw materials and the associated environmental impact in the form of emissions, soil degradation, acidification, eutrophication and pressure on biodiversity. The current climate policy in the Netherlands is not consistent with the ambitious targets of the Paris Agreement. In order to achieve the targets with regard to emission reduction and reduced global warming, the Netherlands would have to reduce its total greenhouse gas emissions by approximately 40-50% by 2030 (van Vuuren 2016).

Besides an increase in the Dutch population, we also expect a further reduction in the average household size. This also has a negative effect on ecological sustainability, because food storage and preparation may become less efficient and more food may be wasted.

Increasing prosperity and further globalisation increase pressure on sustainability

If the current policy is continued, increasing prosperity will be at the expense of ecological sustainability. Increasing prosperity is associated with higher meat consumption. The consumption of animal products is then expected to remain high, in spite of recent decreases in meat consumption. In addition, more exotic products, such as fruit, vegetables, tropical fats and cocoa are being consumed. These products have a greater impact on the environment through production, transport, packaging and storage. If the current policy is continued, this will continue to be based mainly on fossil fuels. Under the current policy, further globalisation of the food supply is associated with more pressure on the environment, although that depends largely on how and according to which principles this is organised. Globalisation usually does not concern where production can take place with the lowest environmental impact, but where production can take place at the lowest costs. Current concentrations of power in the food network are also increasing the pressure to minimise production costs. This can change if producers and supermarkets differentiate themselves more in terms of sustainability. After all, the purchase of sustainable food continues to increase.

Innovation and change in behaviour needed

If the current policy is continued, it will not be possible to combat the potential loss of biodiversity, climate change and the increasing demand for water. A new, effective policy (and accompanying innovations and change in behaviour) aimed at reducing the environmental impact of food and at reducing food waste is crucial in this respect. This concerns a wide variety of innovations, such as a technologically different type of agriculture, and innovation in the logistics of food distribution, such as bringing farmers and consumers closer together.

3.6 In conclusion

Without additional efforts to limit the emission of greenhouse gases through Dutch food consumption and underlying production, the Netherlands will not meet the objectives of the climate agenda. Without

extra efforts to make the diet healthier, it will also not be possible to reduce the number of chronic diseases and reduce health inequalities. Chapter 4 includes a summary of the current policy measures and interventions to safeguard and promote the safety, health and sustainability of our diet.

4 How can our diet become safer, healthier and more sustainable?

In a nutshell

Consumption determined mainly by habitual behaviour and the food supply

Most food choices are based on routine. Intentions based on knowledge and motivation play a relatively minor role. With regard to the motivation to eat a safe, healthy and sustainable diet, consumers make choices based on their own perception, which does not always correspond to scientific knowledge. For example, many people perceive meat as healthy and underestimate the negative environmental effects. This discrepancy is also related to the flow of information about food, which is confusing and often conflicting. This makes the choice for a healthy and sustainable diet more difficult. Factors involved besides habits, knowledge and motivation include social norms and the social and physical environment. The food supply in the immediate environment, such as in shops, canteens, care institutions and online, is a significant factor in food choice. Because eating behaviour is habitual behaviour, changing food consumption requires changes in food production, the supply, the environment, the availability and the price, as well as improving knowledge and skills of consumers themselves.

There is room to intensify policy

The Netherlands has a high level of food safety, which is guaranteed through legislation and regulations. There is still some room for improvement in consumer awareness and skills with regard to hygiene and in extra measures in the food production chain. Policies to promote healthy eating are focused on providing information and positively influencing the living environment. Examples of the latter are the commitment to healthy school canteens, the use of campaigns to change behaviour (e.g. 'Young People at a Healthy Weight' (*Jongeren op Gezond Gewicht*), JOGG), advertising restrictions, alcohol duty and agreements for product improvement. However, the scale of these measures leaves room for intensification. Policy to promote sustainability focuses on producers and food chains (stimulating sustainable production and processing) and consumers (information). Ranking policy measures and interventions by intrusiveness not only illustrates how strongly policy intervenes, but also which possibilities there are to intervene more or less strongly. There is also room for intensification of the measures taken to make the food consumption pattern healthier and more sustainable.

Introduction

There are plenty of challenges with regard to the safety, health and sustainability of our diet, as described in Chapter 2. These issues will continue to exist if policy remains unchanged (see Chapter 3). This chapter, Chapter 4, provides a summary of the current policy measures and interventions in the Netherlands to safeguard and promote the safety, health and sustainability of our diet. This concerns matters such as health protection through legislation and regulations and health

promotion through transparent information and communication about food and diets.

Food consumption is the basis of this report. Knowledge about factors that influence food consumption is needed in order to influence food consumption. This chapter briefly summarises these factors (paragraph 4.1), and then outlines the current policy (paragraph 4.2). Finally, by positioning the existing policy on the 'intervention ladder', we will show where there is room for intensification of the policy (paragraph 4.3).

4.1 Factors that influence food consumption

Habits, rather than rational choices, important in food choices

Food choices are determined by a multitude of individual and environmental factors, see Figure 4.1. See the background report 'Food consumption in the Netherlands and its determinants' for more information (Geurts, et al. 2017). Habitual behaviour turns out to be one of the major determinants, while rational factors, such as intentions based on knowledge and motivation, play a relatively minor role. Habitual behaviour is difficult to change and stands in the way of intentions to make other food choices.

Consumers overestimate health effects and underestimate environmental effects of meat

Consumers differ in the importance they attach to various values associated with food and nutrition. Health is important to some, while others focus on convenience or on animal welfare or sustainability. Besides importance, perception also plays a role. When asked how they define safe food, consumers often mention other concerns than those mentioned by scientists (see Chapter 2). For healthy food, the perception corresponds reasonably well to scientific knowledge: fruit and vegetables are healthy; sweet and savoury snacks are unhealthy. However, this does not apply to the same extent for meat. Meat has a healthy image among some consumers, whereas the Health Council of the Netherlands recommends minimising the consumption of, mainly, red and processed meat (Gezondheidsraad 2015). Furthermore, consumers often underestimate the environmental effects of consuming meat. And consumers differ in their interpretations of the term 'sustainable food'. Some think of animal welfare, while others think of organically produced foods or fair trade. Often no distinction is made between sustainable, healthy and safe. A food is more likely to be viewed as good or not good.

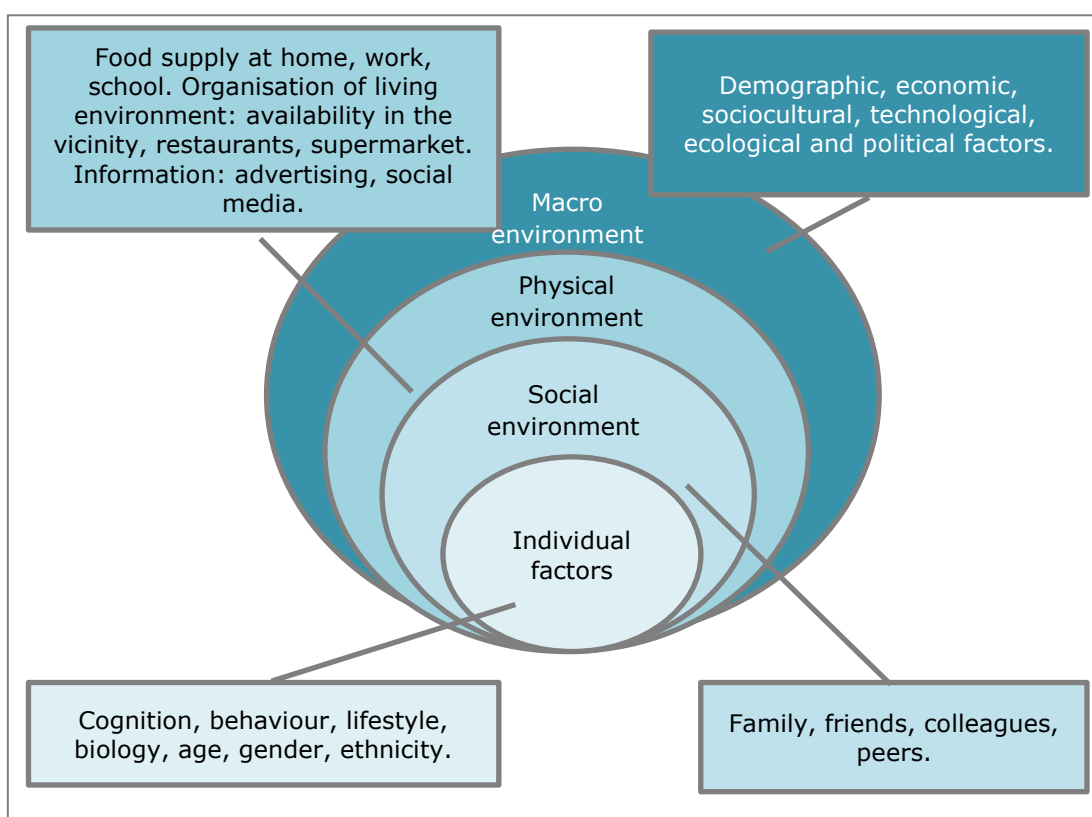


Figure 4.1 Determinants of food choice; figure is based on (Story, et al. 2008).

Family, friends and role models influence food choice

Food has an important social function. We often eat with other people, and eating together is an important part of our cultural experience. When we eat together, we generally also eat and drink more. The social environment consists of interactions with family, friends, peers and others in society. Effects on food choice occur through mechanisms such as role models, social norms and social support. Social norms determine what is 'good' behaviour in a specific social group. These groups can be an individual's own family or circle of friends, or important role models in social media or of an individual's own nationality. Social norms are usually implicit; they are also indirectly defined through things like the portion sizes served.

Parents play an important role in the dietary behaviour of their children

Parents determine much of their children's diet, not only *what* their children eat, but also factors such as how often and where they eat. Parenting styles also play an important role in what children eat. Parents and children eating together on a daily basis is an important factor in learning to follow a healthy diet. This is extra important because routines and habits ultimately form one of the most important factors in food choice.

Wide availability of food leads to higher consumption

The food supply in the immediate environment has a significant influence on food choice. For children, the presence of fruit, vegetables and soft drinks in a visible and acceptable place in the home influences the intake of these products. Food choice at school is also associated

with the food supply. The availability of snacks and soft drinks in the school canteen or vending machine leads to higher consumption of these products, and to lower consumption of fruit, vegetables and milk. The food supply and the environment are strong factors in food choice. These are often greater than other aspects valued by consumers, and thus complicate self-regulation. On the other hand, this also provides an opportunity to influence food consumption through the food supply. We live in a world in which we are surrounded by food. The retail sector, fast food restaurants and food companies have knowledge about effective marketing strategies to entice consumers to purchase and consume specific products as well as a greater number of products.

The flow of information about food is confusing and often conflicting
Consumers receive and seek a lot of information through various channels and also through food packaging. The flow of information is confusing and often conflicting. As a result of this, consumers often do not know which products are healthy, honest, animal-friendly and/or sustainable. There is a strong flow of information from the producers and retailers. They use advertising, special offers, in-store displays, labels and packaging. Food gurus take advantage of the consumer demand for quick and clear recommendations for a healthy or sustainable lifestyle. According to some people, information from the Netherlands Nutrition Centre and scientific community is nothing more than an opinion. On the other hand, surveys show that most people trust institutions such as the Netherlands Nutrition Centre (Voedingscentrum 2015) and science (De Jonge 2015).

Food choices take place in a changing macro environment
The macro-environment, including demographic, economic, sociocultural, technological, ecological and political factors, influences the supply of and demand for food (see Chapter 3). Globalisation of the food chain, as a result of which it is becoming increasingly complex, is a recent development. This also applies to the increased concentration of power in the food chain, with parts of the food chain dominated by a small group of multinationals. The technological possibilities and innovations in the agricultural sector and food industry also determine the supply and thus food consumption.

Summary

Factors that influence food consumption are the 'knobs' which policy can turn to change food consumption towards more safety, health and sustainability. Some of these are on the consumer side, where information, education and transparency can help consumers to make consumption fit better with what they consider important, or to make other choices. But because many food choices are determined by habits, good information provision for consumers is not sufficient on its own. A healthier, safe and more sustainable food supply is also needed. This concerns the production, processing and transport; important steps in the food chain to ensure safety and promote sustainability. It also concerns the supply in shops, and in canteens, schools and healthcare institutions. An environment that stimulates safe, healthy and sustainable behaviour is also essential. Purchasing organisations for supermarkets and retailers have a significant influence on the food supply and the environment (Chapter 3). The government has various

options for exerting influence, such as legislation and regulation, voluntary agreements and setting a good example itself through public tendering procedures. The next paragraph outlines the measures, interventions and policies that currently exist in the Netherlands. A more detailed description with references can be found in the background reports (Boer, et al. 2017; Hollander, et al. 2017; Mengelers, et al. 2017).

4.2 The current policy in the Netherlands in brief

4.2.1 *Ensuring and promoting food safety*

Measures to maintain and improve microbiological and chemical food safety are embedded at various levels. At the global, European and national level. At each level there are organisations with a regulatory and a monitoring role. Thanks to the full range of measures, food safety in the Netherlands is at a high level.

Legislation and regulations

Food producers must take various preventive measures to guarantee the microbiological food safety of their products. After all, it is impossible to inspect all products afterwards. The overarching European General Food Regulation includes a number of measures, referred to together as the 'hygiene package'. Roughly speaking these measures focus on controlling the production process and set criteria for products (Food Safety Criteria) or processes (Process Hygiene Criteria). Much of the European legislation concerning microbial food safety focuses on *Salmonella*. The Dutch Commodities Act adds to this European legislation with product standards for multiple pathogens in order to provide even better protection of public health.

To guarantee the chemical food safety of products, European legislation is in effect for six different chemical groups: additives, biocides, contaminants, food contact materials, plant protection products and veterinary drugs. Substances in five of the six chemical groups (with the exception of contaminants) may only be used if it is proven that the amount ingested does not pose a health risk.

Organisations responsible for risk management create legislation and regulations to guarantee food safety at various levels. At the global level this is done in the Codex Alimentarius, a partnership between the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO). In Europe the European Commission plays a regulatory role and in the Netherlands this role is fulfilled by the Ministry of Health, Welfare and Sport and the Ministry of Economic Affairs. The Netherlands Food and Consumer Product Safety Authority (NVWA) monitors enforcement of the policy.

Risk assessment

Besides risk management, the assessment of food safety is also involved. At national and European level, various organisations are responsible for monitoring, assessment and advising on the food safety of products available on the market. In the Netherlands, this is done by the National Institute for Public Health and the Environment (RIVM), the NVWA, the Board for the Authorization of Plant Protection Products and

Biocides (Ctgb) and the Medicines Evaluation Board - Veterinary Medicinal Products Unit (MEB-VMPU). The European Food Safety Authority (EFSA) assesses food safety at the European level.

Communication

The Netherlands Nutrition Centre informs consumers in the Netherlands about food safety and the correct way to prepare food and handle it hygienically. If certain products form a direct threat to human health, it is the NVWA's responsibility to inform the public.

4.2.2 *Promoting a healthy diet*

A healthier diet is a challenge for consumers as well as for the government, producers, the industry and the retail sector. They use a variety of instruments to promote a healthy diet.

Product improvement

In the past, the food industry has successfully reduced the amount of trans-fatty acids in margarines and frying fats, and in products containing these ingredients (e.g. biscuits, cakes, crackers, chips, meat-based snacks) and lowering the salt content in bread. Thanks in part to these results, the 'National Agreement To Improve Product Composition' (*Akkoord verbetering productsamenstelling*) was concluded in 2014 on the initiative of the Ministry of Health, Welfare and Sport (*Akkoord Verbetering Productsamenstelling 2014*). In this Agreement, the Ministry makes agreements with the food industry, the retail sector, hotels, restaurants and caterers with regard to reducing the amount of salt, saturated fat and sugar in processed foods. The reduction should be such that consumers who eat in accordance with the Dutch Dietary Guidelines can meet the target of a maximum intake of 6 grams of salt per day by 2020. It should also become easier for consumers to obtain no more than 10% of their total energy intake from saturated fats and to reduce their energy intake (through fat and sugar). The Agreement also lays down agreements on increasing the availability of healthy products and smaller portions in hotels and restaurants, catering and the retail sector. Modelling studies show that product reformulation has the potential to positively influence health at the population level. Although the salt content in some food groups has decreased, such as in bread, in other foods it has remained the same or increased. The daily salt intake has not changed in recent years. Despite the fact that various agreements have been made for different product groups, it is not certain whether the pace of the current efforts will enable the targets of the Agreement to be achieved by 2020.

Tax and subsidies

The government stimulates a healthy diet through taxes and subsidies. Alcoholic beverages are subject to excise duty and a higher VAT rate than other foods (21% versus 6%), partly with the aim of discouraging alcohol consumption. The European government also stimulates a healthy diet for primary school children by offering subsidised milk and the 'School Fruit' programme with free fruit at school for a limited time. The Dutch government is more cautious with regard to such price measures for food than a number of other countries in Europe. In Hungary, for example, there is extra tax on foods such as soft drinks with added sugar, energy drinks, sweets, savoury snacks, high-sugar

alcoholic drinks and ice cream. In France, there is an extra tax on sweetened soft drinks. The consumption or sale of the taxed products has decreased in these countries (WHO 2015).

Information on food packaging

At the European level, the 'Food Information' regulation contributes to the availability of information about nutritional content and ingredients on the label. In the Netherlands, this regulation is included in the Commodities Act. Front-of-pack food choice logos can inform consumers about healthy products and encourage food producers to produce healthier products. The 'Check Mark' (*Vinkje*) was a private initiative of the food industry under which producers who met a number of criteria concerning nutrient composition were allowed to bear the Check Mark. The Check Mark indicated that the product had a healthier nutrient composition than other products in the same product group. However, not all producers participated in the Check Mark initiative. The Minister of Health, Welfare and Sport supported the Check Mark as part of the food policy until October 2016. For future decision-making, a committee identified the scientific evidence concerning food choice logos. The committee concluded that it has not been scientifically proven that such logos actually contribute to producers offering a healthier product range and consumers making healthier product choices (Hoogendoorn, et al. 2016). However, food choice logos fit the objective of the food policy to inform consumers about a healthy diet.

Advertising code for foods

An advertising code for foods has been drawn up on the initiative of the food industry. Under the revised advertising code, which came into effect on 1 January 2015, it has been agreed that no advertising for foods will be aimed at children less than 13 years of age, unless the advertising comes about in cooperation with a recognised authority or the product satisfies specific nutritional criteria. The Dutch Food Industry Federation (FNLI) monitors compliance with the code by the industrial parties on media such as television and their own websites on an annual basis. The rise of social media and the internet forms a challenge for the regulation and monitoring of food advertising aimed at children. There has not been any research into the effect of this self-regulation on the diet of children. In the countries of the European Union, self-regulation is applied more frequently than legal regulation of advertising for children.

Enrichment

The addition of micronutrients, such as vitamins and minerals, to certain foods (referred to as 'enrichment'), can make an important contribution to the intake of those nutrients. In the Netherlands, the government stimulates the addition of iodised salt to bread and vitamin A and D to margarine in voluntary agreements with the industry. There are also manufacturers that enrich certain foods based on commercial considerations. However, these enrichments do not have any significant impact on public health. This often concerns products eaten by relatively few people, or nutrients for which the intake is not too low even without enrichment.

Communication to consumers

The Netherlands Nutrition Centre is responsible for information for the general public about a healthy diet. This is often based on the recommendations of the Health Council of the Netherlands. Examples of this are the Dutch Dietary Guidelines and recommendations for the use of certain nutritional supplements by vulnerable groups such as pregnant women and elderly people. The Wheel of Five is one of the methods used to provide information. In addition, the Netherlands Nutrition Centre also uses the online 'Food Meter' (*Eetmeter*) program and other tools to advise consumers based on their individual needs. The Netherlands Nutrition Centre also provides tools to improve the eating environment, such as school canteens.

Programmes with combinations of interventions appear to be effective

The Dutch government supports a number of programmes, such as 'The Healthy School' (*De gezonde School*) and 'Young People at a Healthy Weight' (*Jongeren Op Gezond Gewicht*, JOGG), with the aim of creating a healthier 'food environment' for young people. The first results from the JOGG municipalities show a decrease in the percentage of overweight children (*Jongeren Op Gezond Gewicht* 2016). The Dutch National Food Consumption Survey (*Voedselconsumptiepeiling*) (Van Rossum, et al. 2016) also shows that the consumption of fruit by young people increased between 2010 and 2014, but it is unclear whether this effect could be attributed to these programmes.

4.2.3 *Reduction of environmental impact of our diet*

The reduction of the environmental impact of our diet is a challenge for the government, producers, the industry, retailers and consumers.

The government focuses on producers and consumers

The Dutch government recognises the challenge to limit the environmental effects of food production and consumption (Rijksoverheid 2015a; Rijksoverheid 2016). The government focuses on the industry by supporting various initiatives by the industry (as described below). The focus of both Dutch and European policy is shifting from increasing production yield to stimulating an ecologically sustainable food system. For example, the sustainable use of natural resources is stimulated under the Common Agricultural Policy. The government also focuses on consumers. For example, the information of the Netherlands Nutrition Centre and public information organisation *Milieu Centraal* ('Environment Central') includes attention for the environmental effects of food and for food wastage (Rijksoverheid 2016).

Cooperation in the chain

Primary producers, industry and retailers work together at various levels to embed sustainability throughout the food chain, for example in the 'Sustainable Food Alliance' (*Alliantie Verduurzaming Voedsel*). The industry and civil society organisations also cooperate in various sectors of primary agricultural production, for instance in 'Future Vision on Sustainable Livestock Farming' (*Toekomst visie Duurzame Veehouderij*), with aims such as reducing the emission of greenhouse gases, closing the manure cycle and stimulating the generation of renewable energy. Another initiative is the Green Protein Alliance (GPA). The GPA is an

alliance established by representatives of producers and retailers of 'green' sustainable proteins. The GPA is supported financially and otherwise by the Ministry of Economic Affairs, the Netherlands Nutrition Centre and the Netherlands Enterprise Agency. The aim of the GPA is to decrease the ratio of animal to plant-based proteins in human consumption from 60:40 to 50:50 by 2025. The government also provides incentives to reduce the use of antibiotics, improve animal welfare and increase sustainability in livestock farming (Rijksoverheid 2016).

Labels

The industry uses independent labels to show its efforts to reduce the environmental effects of its food production. The 'MSC' label for sustainable fishing is one of the best known labels.

Consumers

Some consumers support civil society organisations (NGOs) that strive for more ecological sustainability. However, consumers can also significantly reduce the environmental impact of their food consumption by eating fewer animal products such as meat and cheese, drinking fewer soft drinks and alcoholic beverages, and consuming less fruit from regions with water shortages, or replacing these with foods that have a smaller impact on the environment. Recent data on food consumption from the RIVM (Van Rossum, et al. 2016) and on food purchases from Wageningen Economic Research (Terluin, et al. 2016) indicate that the Dutch are eating slightly less meat. The market share of products with a sustainability label has been rising slightly for a few years (by 1% last year) (Logatcheva 2016). Another way for consumers to reduce the environmental effects of their diet is to prevent food wastage. Food wastage in the Netherlands has not decreased in recent years (Bos-Brouwers, et al. 2015).

Effect of these measures and initiatives unknown

Whether the national and European policy changes and private initiatives will lead to a reduction of the environmental effects of the Dutch diet is still unclear. There are not enough scientific studies available on this subject. However, some trends indicate that the effects, if any, are small. For example, the environmental effects of Dutch agriculture and horticulture have hardly decreased in the last ten years (PBL 2012), whereas this phase of primary production (i.e. agriculture and horticulture) is the most important factor for the total environmental effect of those foods. In addition, the use of fossil fuels for packaging, transport, storage and preparation of products plays a determining role in the environmental impact. The use of renewable energy has been limited up to now, also in comparison with other EU countries.

4.3 Room for intensification of policy?

How much room is there to further increase the safety, health and sustainability of our diet? In order to gain an impression of this, we have placed the existing policy measures and interventions on the intervention ladder. This provides an impression of non-committal character or intrusiveness of the policy, and thus also provides an impression of the scope that exists to intensify the policy.

Intervention ladder

Policy measures and interventions can be ranked by their degree of intrusiveness. The more intrusive, the greater the restrictions on people's freedom of choice. The UK-based Nuffield Council on Bioethics developed an 'intervention ladder' for this purpose, in which the least intrusive and most non-committal measures are placed at the bottom, and the most intrusive and most invasive measures are placed at the top (Nuffield Council on Bioethics 2007). The ladder goes from doing nothing and monitoring to eliminating certain choices. This intervention ladder is used in various reports in the area of prevention. A recent example is the Interdepartmental Policy Study on 'Healthy Lifestyle' (*Gezonde Leefstijl*), which concludes: "The position of the current policy on the intervention ladder is highest for tobacco and alcohol, whereas this position is much lower for overweight." The intervention ladder not only illustrates how strongly policy intervenes, but also which possibilities there are to intervene strongly or less strongly. The assumption in this respect is that the most intrusive measures are often but not always the most effective measures (Werkgroep IBO preventie 2007).

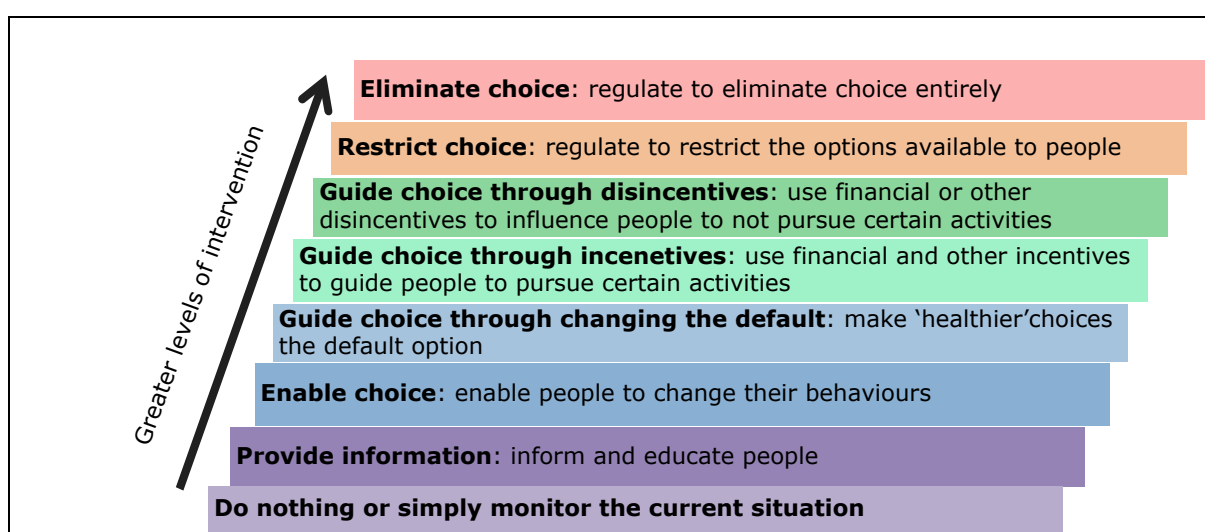


Figure 4.2 Visual representation of the intervention ladder, developed by the Nuffield Council on Bioethics (Nuffield Council on Bioethics 2007).

Safety

Placement of the various measures related to food safety on the intervention ladder shows that the majority of the measures are found at the top of the ladder. After all, this concerns regulation through legislation and the enforcement thereof. In addition, information on food safety is provided by the Netherlands Nutrition Centre, and by the Netherlands Food and Consumer Product Safety Authority in the case of incidents. There are also various organisations involved in risk assessment. These last two activities can be found at the bottom of the intervention ladder: monitoring and information provision.

Health

Many of the current measures focused on a healthy diet can be found at the bottom of the intervention ladder. These include the provision of information (e.g. nutrition labelling and the Wheel of Five). There are

also various programmes that involve the stimulation of a healthy diet (e.g. 'The Healthy School' and 'Young People at a Healthy Weight'). Along with the activities in the context of the Agreement to Improve Product Composition, these activities can be placed on the third rung of the intervention ladder. There are also some financial incentives in the form of subsidies (e.g. school milk). Measures at the top of the intervention ladder, such as financial disincentives and regulation through legislation are not part of the current food policy in the Netherlands. The exception to this is legislation concerning micronutrient enrichment and supplementation and the excise duty on alcohol.

Sustainability

With regard to sustainable food, we see that information provision through labels and by the Netherlands Nutrition Centre and *Milieu Centraal* occupy the bottom rungs of the intervention ladder. In addition, there are various initiatives by the industry to make food production more sustainable. These can be found on the third or fourth rung of the ladder. European and Dutch legislation to contribute to more sustainable food production and a more sustainable food chain can be found at the top of the intervention ladder.

In conclusion

Food safety is tightly regulated. The government has a responsibility in the protection of human health, and this includes food safety policy. The Netherlands has a high level of food safety. There is still some scope for additional measures in the food production chain and in awareness and improvement of hygiene by consumers. Many policy measures to promote healthy eating are associated with information provision, although there are also initiatives that go beyond information alone, such as healthy school canteens and product improvements. However, these still exist on a relatively small scale. Thus there appears to be scope to intensify this policy. This also applies to policy measures to promote sustainability. Whether or not this scope is used is a political decision.

5 Towards an integrated food policy

In a nutshell

Building blocks for an integrated approach to safe, healthy and sustainable diet

An integrated food policy focuses on safety, health and sustainability, as well as on the economy and consumer values such as affordability, convenience and freedom of choice. Where policy focused on a particular social task (e.g. sustainability) also has positive effects on other tasks (e.g. health), useful connections in policy can be made. If policy focused on a particular task has a negative effect on other tasks, this leads to policy dilemmas. In that case it must be decided whether additional efforts will be made to compensate these negative effects. A systematic analysis of these effects provides building blocks for integrated policy.

Opportunities for healthier and more sustainable diet simultaneously

There are multiple connecting elements in the strategies, with changes to the diet having positive effect on public health as well as on ecological sustainability: not eating too much, a diet with more plant-based and fewer animal-based products and with less sugar-containing and alcoholic beverages. Without overconsumption, the disease burden will decrease by 5% and the emission of greenhouse gases as a result of food consumption by approximately 10%. The health effect among the lower socioeconomic groups may be even greater. Nevertheless, it is not the case that every change towards a healthier diet will automatically lead to a lower environmental impact, and vice versa. For example, it is considered eco-friendly if every part of an animal is used for consumption. This also implies the consumption of processed meat, such as sausage, which in itself is less healthy. In order to be effective in terms of both health and sustainability, the policy must focus on both objectives simultaneously. This means that every measure focusing on health also takes into account sustainability aspects, and vice versa.

Healthiness and sustainability do not go at the expense of safety

Focusing on health and sustainability has a positive effect on food safety in some respects. For example, the consumption of less meat will lead to fewer foodborne infections. On the other hand, increased consumption of nuts and cereals can lead to increased exposure to mycotoxins and lead, and longer term storage of food is associated with an increased risk of foodborne infections. Although the expected negative effects on food safety are small, it is important to keep a careful eye on food safety when working towards healthier and more sustainable diets. In other words: this too calls for an integrated approach.

Further intensification of food safety policy comes at a price

The current high level of food safety must be maintained, with old and new risks excluded as much as possible. This calls for ongoing vigilance from policymakers, actors in the food chain and consumers. Substantial intensification of the food safety policy does not appear necessary at this time. The law of diminishing returns applies here: the level is high and additional investments yield less and less while the price grows higher and

higher. This not only applies from an economic perspective, but also in terms of ecological sustainability, animal welfare and freedom of choice.

Is focusing on healthy, sustainable and safe diet at the expense of consumer values?

Tension exists between contributions to health, sustainability and safety and consumer wishes, such as affordability, freedom of choice, convenience and taste. For example, a higher price for animal products impacts affordability, while a far-reaching agreement on product improvement affects citizens' freedom of choice. But the question is how strong this tension is and whether the effects thereof are temporary. The difference between citizens and consumers is also important. We know that many citizens want to take health, sustainability and animal welfare into account. But as soon as those value-driven citizens make purchases as consumers, habit, convenience and affordability become the decisive factors. The goal is abstract and far away, whereas the choice is close by and tangible. One of the recommendations is to stimulate further transparency about the sustainability and health (and safety, if applicable) of products, adapted to modern technology. This is beneficial to citizens, as well as to consumers, because the range of available foods will change. Producers that have to provide transparency will want to present themselves in the best possible light.

Opportunities and dilemmas for the Dutch economy

Focusing on safe, healthy and sustainable diets offers opportunities for agriculture and the food industry. The high level of knowledge, production, processing and innovation increases the Netherlands' export options. Examples include innovations in agriculture to enable sustainable production, techniques to enhance safety, and personalised nutrition. Focusing on health and sustainability also raises challenges for the economy. Consuming less and a shift from animal-based to plant-based foods may reduce the added value of the agricultural complex. Agriculture and industry are highly adaptable, and the main challenges exist in the short term. However, opportunities and challenges are not evenly distributed between the various actors.

Cooperative and active government

Integrated policy aimed at a healthy, safe and sustainable diet appears possible, so why doesn't it exist yet? There is an area of tension between abstract, long-term goals (healthier, more sustainable and safe) and concrete choices in everyday life for consumers and businesses. This discrepancy gives the government scope and legitimacy to adopt a more active role in making the food supply healthier and more sustainable based on the collective values. The government can take an active, initiating role to implement these measures, in consultation with the agricultural sector, businesses, citizens and civil society organisations. And these parties also introduce initiatives themselves. Besides taking the lead itself, the government can stimulate and facilitate new and existing initiatives, based on the concept of a cooperative government. Because the other parties share the same values, cooperation would be mutually beneficial. The government has begun work on this by means of the food agenda, in which four ministries work together.

Introduction

Current policy strategies, as described in Chapter 4, focus primarily on one of the societal challenges. Other societal challenges are included in these strategies as preconditions more and more frequently. However, there is not yet a truly integrated policy, simultaneously aimed at safety, health and sustainability. This chapter describes the opportunities and dilemmas associated with an integrated food policy.

The systematic confrontation of perspectives

Opportunities and challenges are clarified through systematic analysis of the effects of strategies from one perspective on the challenges of other perspectives. Suppose, for example, that we focus entirely on food safety. Would this have positive, negative or neutral consequences for the ecological sustainability or the health aspects of our diet?

Opportunities are created if a strategy from one perspective has positive effects on the challenges from another perspective. Useful connections can be made in this respect. A dilemma exists if a strategy from one perspective has a negative effect on the challenges from another perspective. This requires choices to be made or additional efforts to compensate negative effects. Strategies were determined on the basis of idealised future scenarios, with a focus on one of the challenges - safety, health or ecological sustainability. The other challenges are secondary in these scenarios. The effects on each other's challenges and on economic and consumer values were then analysed. These scenarios are tools to expose opportunities and dilemmas. They have therefore deliberately been formulated as extreme and hypothetical scenarios; none of the scenarios will become reality by themselves.

Reader's guide

In this chapter we start by outlining three idealised future scenarios in section 5.1. Section 5.2 shows how the scenarios were confronted with each other and with the other perspectives on diet. Section 5.3 subsequently presents a summary of the results. The opportunities and choices found are detailed in sections 5.4 to 5.7, including examples. Finally, section 5.8 provides recommendations for the various parties.

5.1 Three idealised future scenarios

The societal challenges in the area of a safe, healthy and ecologically sustainable diet form the basis for the three future scenarios: 'Safe diet in 2040', 'Healthy diet in 2040' and 'Ecologically sustainable diet in 2040'. Each scenario consists of four parts: the societal challenges, the target situation or desired future from the perspective of that challenge alone, the associated production and consumption pattern, and a strategy to achieve this.

Future scenario 1: Safe diet in 2040

Challenges and motives

- Maximum food safety for everyone
- Optimal protection from avoidable food-related risks
- Transparency concerning potential pathogens and contaminants in foods
- High level of hygiene during food preparation
- Consumers have confidence in the safety of the food

Target situation

In 2040, avoidable microbiological and chemical risks are absent from foods. Safety is guaranteed in every link of the food chain. The potential unavoidable microbiological and chemical risks are printed on packaging. Smart sensors in packaging measures the pathogens and chemical contaminants in foods. Children learn about food safety at school. Kitchens, both at home and in the hotel, restaurant and catering industry and retail establishments, are hygienic. Legislation and regulations for virtually all microbiological and chemical contaminants are harmonised at the European level and worldwide. Thanks to transparency, education about risks and hygienic preparation of food, consumer confidence in food safety is high. In this scenario our diet in the Netherlands is safer than ever!

Consumption and production

Consumers store and prepare food in a safe manner. Raw meat (in particular red meat), raw fish and some raw vegetables, such as vegetable sprouts, have disappeared from our diet. This also applies to species of fish that contain unacceptable concentrations of environmental contaminants (e.g. tuna and swordfish due to the presence of methylmercury). Producers have optimised the food production process in such a way that there is no threat to health. The entire production chain and the hotel, restaurant and catering industry are subject to optimal risk-based monitoring of food safety by producers and the NVWA. Thanks to advanced traceability of ingredients, transparency within the food chain has improved significantly. Food is packaged in smart packaging, which indicates when it contains unavoidable microbiological contaminants, and provides personalised customised advice on the amount and method of consumption. The packaging also lists the unavoidable chemical contaminants and indicates how frequently and in what amount the product can be consumed.

Characteristics of the strategy

The central government is in charge of food safety, supported by global agreements. The government uses regulations, subsidies, information, tax measures and financial penalties in this respect. Microbiological and chemical risks are assessed and controlled at the European level. The NVWA closely supervises the food industry. Producers are transparent about microbiological and chemical risks. Technological developments contribute to safe food. Schools teach children about safety risks.

Future scenario 2: Healthy diet in 2040

Challenges and motives

- A healthy diet for everyone
- A healthy body weight for everyone, and thus an energy intake that is in balance with energy use
- A food supply and a social and physical food environment that makes the healthy choice the obvious choice

Target situation

Everything is about healthy eating in 2040. Thanks to information and regulations, everyone - including less educated people - has a healthy diet. The environment invites healthy eating, not too much and not too little. Fruit and vegetables are prominently available and affordable everywhere. Restaurants, catering organisations and canteens create healthy dishes. Small portions are the standard. Packaging and apps provide clear information on the health aspects of a product. At school, children learn food skills and are taught to use all information wisely. In the health care sector, patients are taught to eat a healthy diet and not to eat too much. Apps monitor personal food consumption and health and provide personalised diet recommendations on the basis of this. Businesses and universities continue to develop new, pioneering food innovations, such as functional foods and foods that are customised to the needs of the individual body. In this scenario we are eating healthier than ever!

Consumption, food supply and production

The amount we eat fits with the amount of energy we use. We eat three nutritious meals per day. These contain everything our bodies need. As a result we hardly consume any sweet or savoury snacks in between meals. Mediterranean diets has become immensely popular; the menu mainly contains plant-based foods without a lot of processing: fruit, vegetables, legumes, cereals, nuts and oils rich in unsaturated fats, such as olive oil and sunflower oil. We rarely eat red meat, processed or unprocessed. Farmed or wild fish, chicken and plant-based products are on the menu instead. Drinking water or tea is the norm; sugared and alcoholic drinks are the exception. Production ties in with a high demand for plant-based and a low demand for animal based products. Processed foods contain low amounts of salt, sugar and saturated fat. Functional foods and nutritional supplements are in line with individual needs.

Characteristics of the strategy

The central government is in charge of health and is responsible for the coordination of the policy at local and international level. Municipal authorities stimulate and facilitate partnerships between public-private parties to stimulate healthy eating in the community. A trusted institution provides objective, unambiguous and accessible information and communication about healthy eating. Schools, child care facilities, healthcare institutions, businesses and offices offer healthy food. Businesses develop innovative healthy foods. The food industry and suppliers are transparent with regard to ingredients and nutritional value. Suppliers (supermarkets, retailers) give healthy foods a central place in their stores and ensure that they are clearly recognisable.

Future scenario 3: Ecologically sustainable diet in 2040

Challenges and motives

- Food production and consumption preserve natural resources and do not deplete them. This applies to abiotic factors such as soil, water, air and raw materials, as well as biotic factors, i.e. biodiversity.
- Food production and consumption are associated with as little environmental burden as possible, e.g. through climate change, loss of species (biodiversity) and water shortages.
- Food is valued, and therefore nothing is wasted throughout the food chain.

Target situation

In 2040, our production and consumption of food is entirely within the carrying capacity of the system and ecosystem. We produce and consume precisely enough; we do not waste anything. All of our food is produced in nutrient cycles that are as closed as possible, so that food production does not lead to depletion. Producers only use renewable energy for production, packaging, storage and preparation. A sustainable range of food in the supermarkets is self-evident. Consumers have access to information about environmental impact, which helps them to make sustainable choices. Consumers pay the 'real price' for their food, with environmental effects passed on transparently in these prices. At school, children are taught about the importance of ecological sustainability and how they can contribute to it themselves. In this scenario we take care of our planet!

Food consumption and production

We do not eat or drink too much. Our food consumption pattern consists mainly of plant-based products: vegetables, legumes, fruit, nuts and seeds. Meat, fish and dairy products only feature on the menu occasionally. We use all parts of the animal; we do not throw anything away. We eat seasonal fresh fruit and vegetables. Tinned or jarred fruit and vegetables are a good alternative. We mainly drink tap water. All foods are produced with respect for the environment.

Characteristics of the strategy

The central government is in charge of sustainability and is responsible for the coordination of the policy at local and international level. The government aims for production with the lowest possible environmental impact. It sets and enforces standards. Producers produce foods with a minimal impact on the environment, such as plant-based products and foods with 'new' protein sources such as algae. They produce with a view to preserving natural resources (less monoculture, fewer plant protection products, sustainable cultivation, insight into emissions and the natural boundaries of surrounding ecosystems, no exceeding of standards) and do not waste anything. Actors in the food chain are transparent about the origin and environmental effects of the food. Innovation focuses on new techniques for efficient production with a relatively low environmental impact. Ecologically sustainable food is offered as standards in schools, child care facilities, healthcare institutions, offices and businesses.

5.2 Confrontation of the scenarios

The intended and unintended effects of the three ideal-type scenarios have been identified systematically and visualised in a table of opportunities and choices. The three future scenarios are shown in the columns, while the societal challenges in the area of diets are shown in the rows.

Experts from within and outside the RIVM (see Appendix A) evaluated the effects of the three future scenarios on the existing challenges in five sessions. One row of cells was discussed in each session. Experts indicated whether they expect the indicators for each challenge to develop favourably, neutrally or negatively, and provided accompanying arguments. They did this a total of three times, once for each strategy. This was done according to the method of the group decision model (see methodology background report).

The cells of the table have been coloured on the basis of the answers. Green if, according to the experts, the scenario has a predominantly positive effect on the challenge, and red for a predominantly negative effect. A white cell is used to indicate either no effect (indicator is not sensitive to the strategy) or that there are opposing effects that virtually cancel each other out. Each future scenario is expected to have a positive effect on its own challenge. For example, the strategy of the future scenario 'Ecologically sustainable diet in 2040' should lead to an improvement in ecological sustainability.

In order to be able to score the challenges, they have been translated into indicators. The indicators for food safety, health and ecological sustainability are explained underneath. We will also briefly describe them again here. In addition, we will introduce - in more words - the indicators for consumer values and economic values. We refer readers who would like to obtain more information on the latter aspects to the methodology background report.

Challenges	Future scenarios		
	Safe diet in 2040	Healthy diet in 2040	Ecologically sustainable diet in 2040
Food safety			
Health			
Ecological sustainability			
Consumer values			
Economic values			

Safety indicators

- The number of foodborne infections.
- The percentage of chemical substances for which the health based guidance value is exceeded.
- The percentage of fines and warnings related to food safety.
- Consumer confidence in the safety of food.

Health indicators

- Disease burden (in disability-adjusted life years, DALYs) attributable to an unhealthy diet. Disease burden as a measure of total loss of health due to premature death and loss of quality of life.
- Prevalence of overweight.
- Socioeconomic differences in the consumption of healthy diets.

Ecological sustainability indicators

- The total global greenhouse gas emissions attributable to Dutch food consumption.
- Global water use attributable to Dutch food consumption.
- Changes in biodiversity attributable to Dutch food consumption.

Consumer value indicators

- Freedom of choice for consumers. This depends on the quantity and the diversity of the foods offered. For example, a store may offer ten different types of muesli, but if they all contain sugar the freedom of choice is nevertheless limited.
- The speed and ease with which someone can fulfil his need for food. This indicator says something about the ability to fit food into a busy schedule. Think of ordering food online, delivery services and ready meals in the supermarket.
- The sociocultural function of food. Food brings people together, hospitality is important and food is a way of expressing yourself.
- Appreciation of the taste of food.
- Fair trade. A fair price is paid for the product provided throughout the chain.
- Animal welfare (assessed by Sustainability experts). The market share of meat that scores three stars in accordance with the 'Better Life Label' (*Beter Leven Keurmerk*) compared to the total amount of meat sold.
- The price of the shopping cart (assessed by Economics experts). As an indicator of the amount of money spent on the dietary pattern followed in the Netherlands. In the current dietary pattern, the Dutch spend a relatively large amount of money on meat and alcoholic beverages and a relatively low amount on rice and pasta (see Figure 5.2). In the Netherlands, we spend approximately 12% of the household budget on food (CBS 2016).
- Loss of utility (assessed by Economics experts). The current consumption pattern reflects the consumer's preference, given the current prices and information.

Economic value indicators

- The added value of the Dutch agricultural complex. The agricultural complex is the entirety of direct and indirect activities connected to the Dutch agricultural sector. The added value of

the total agricultural complex was 48 billion euros in 2013 and concerned 8% of the national total. Table 5.1 provides the distribution between foreign and domestic agricultural raw materials and the distribution of primary, secondary and tertiary. The domestic raw materials come from arable farming (22%), glasshouse horticulture (22%), field horticulture (9%), land-based livestock farming (30%), intensive livestock farming (15%) and fishing (2%).

- Trade balance, i.e. the difference between import and export of goods. Increasing exports are good for the value of the euro and for limiting inflation. Increasing imports does the opposite and also increases the dependence on other countries. This can pose risks to the security of the food supply and the guarantee of the safety of imported agricultural products and the sustainability of the production method. In 2015, the agricultural complex contributed 57% to the Dutch trade balance, with 19% to exports and 14% to imports (see Figure 5.1). The main export products were potatoes, fruit and vegetables, processed foods (such as dairy, meat and vegetables), live animals, meat, dairy products and eggs. Imports primarily concerned potatoes, fruit and vegetables, processed foods, live animals, meat, cereal products, cocoa and cocoa products, and oils and fats.

Table 5.1 Key figures of the Dutch agricultural complex, 2013 (LEI 2015).

	Added value (factor costs, in billions of euros)	Share in national total
Total complex, domestic and foreign agricultural raw materials	48.0	8.3%
Total complex, foreign agricultural raw materials	16.1	2.8%
Total complex, domestic agricultural raw materials	31.9	5.5%
- Primary production	10.5	
- Processing	4.5	
- Supply	12.8	
- Distribution	4.1	

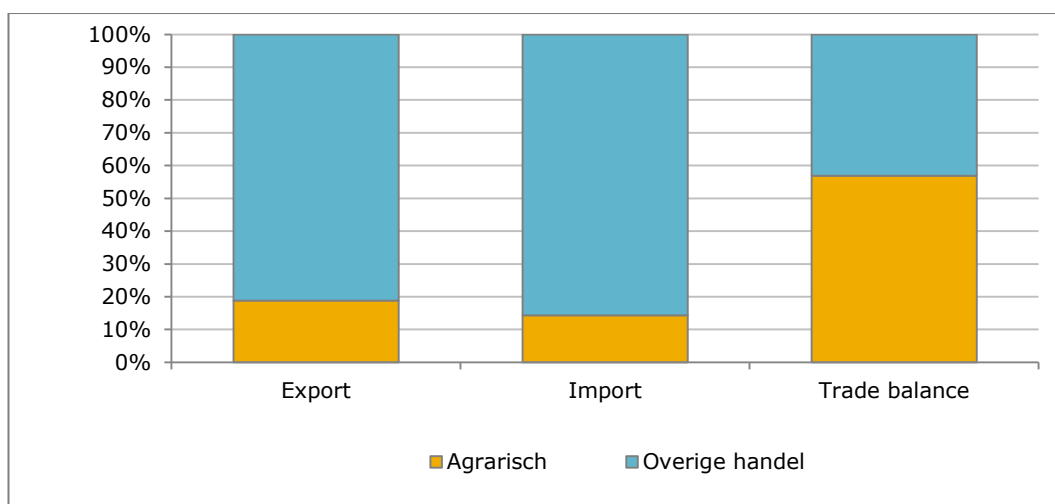


Figure 5.1 Share of agricultural trade in total Dutch Trade (Wageningen UR 2016).

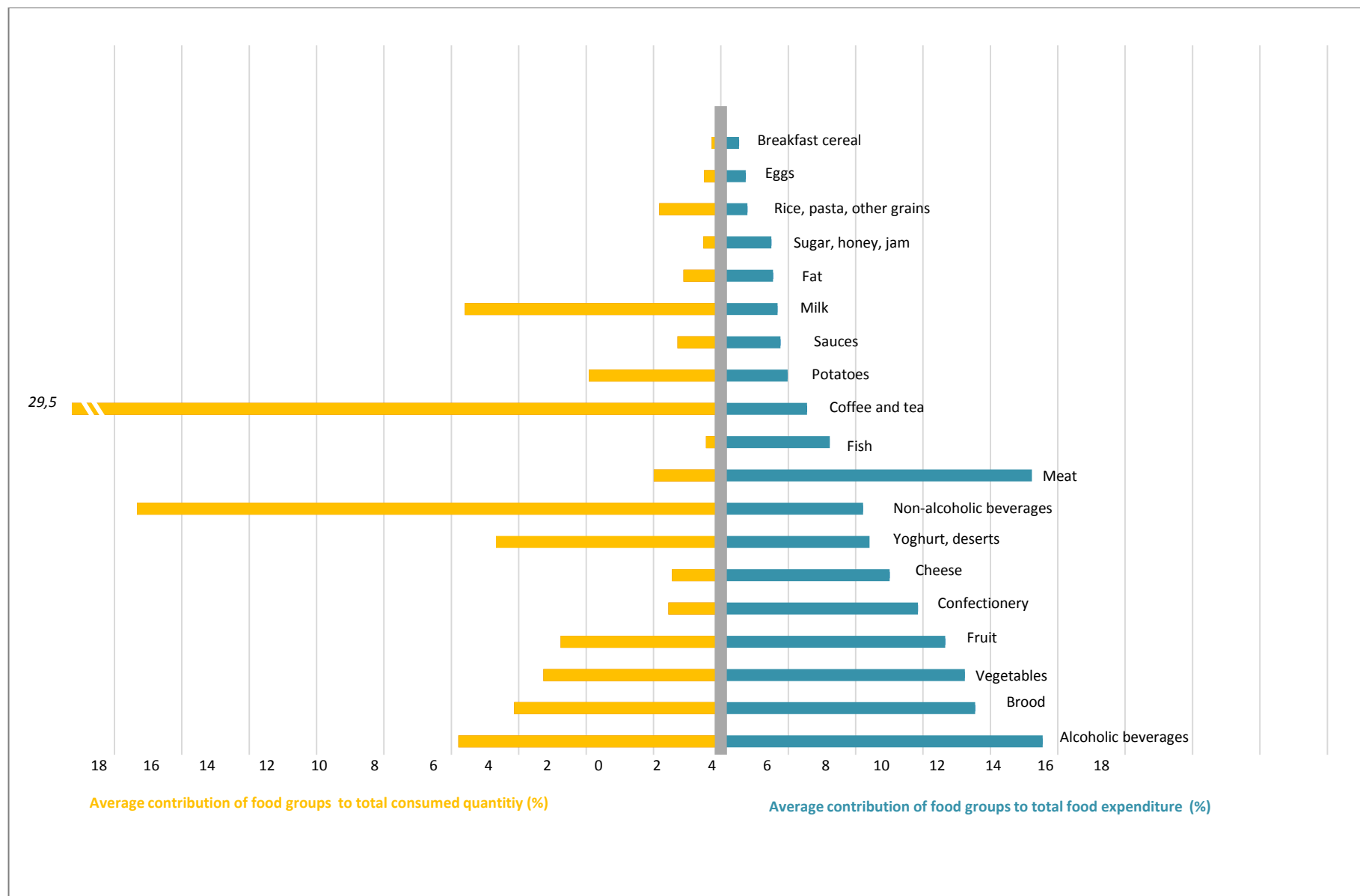


Figure 5.2 Contribution in terms of percentage to amount consumed (in grams) and expenditure on food (in euros) (CBS 2016; Van Rossum, et al. 2016).

5.3 Opportunities and choices

The 'opportunities and choices table' was scored on the basis of the results of the five expert sessions (see Table 5.2). Cut-off points were applied. The opportunities and choices described here are based on these scores and cut-off points, as well as on the arguments of the experts. Four opportunities and choices were formulated (see the ovals in the table).

1. Strategies aimed at public health and ecological sustainability offer win-win opportunities and are not at the expense of safety (see 5.4);
2. Further intensification of food safety comes at a price (see 5.5);
3. Tension between societal challenges and consumer values (see 5.6);
4. Policy focused on safe, healthy and sustainable diets provides opportunities and dilemmas for the economy (see 5.7).

Table 5.2 Opportunities and choices.

	Future scenarios and strategy for 2040		
	Safe Diet	Healthy Diet	Sustainable Diet
Safety			
Number of foodborne infections		1	
Percentage of health standard (HBGV) violations			
Percentage of NVWA fines			
Confidence in food			
Health			
DALYs due to unhealthy diet			
Prevalence of overweight			
SES (social and economic status) differences			
(Ecological) Sustainability	2		
Greenhouse gas emissions			
Water use			
Biodiversity			
Consumer values			
Price of shopping cart			
Freedom of choice for consumers			
Speed/convenience			
Sociocultural function of food			
Appreciation of taste of food			3
Loss of utility			
Animal welfare			
Fair trade			
Economic values			
Added value of agricultural complex			4
Export-Import balance of payments			

These four opportunities and choices are described in greater detail in sections 5.4 to 5.7, respectively, based on the arguments of the experts, supplemented with knowledge from the literature if possible.

5.4 A healthier and more sustainable diet is possible, without sacrificing safety

Focusing on healthy diet can promote ecological sustainability and vice versa. There are multiple connecting elements in the strategies, with changes to the diet having positive effects on public health as well as on the ecological sustainability of food consumption in the Netherlands. However, this will not happen by itself.

Changes to food consumption both healthy and sustainable

Eating less

A reduction in food consumption will lead to both less overweight and less food production, and thus to a lower environmental impact. The total disease burden in the Netherlands will decrease by 5% if there are no longer any overweight people. French estimates show that without 'overconsumption' the emission of greenhouse gases as a result of food consumption could decrease by approximately 10% (Vieux, et al. 2012). It is likely that this will be on the same order of magnitude for the Netherlands. Naturally, eating less is only advisable for people who are overweight or who experience undesired weight gain. This can potentially also reduce the health inequalities between socioeconomic groups. The prevalence of overweight is particularly high in the lower socioeconomic groups.

Eating differently

A shift in the dietary pattern towards more plant-based and fewer animal-based products can be beneficial to public health as well as ecological sustainability (Westhoek, et al. 2011; Temme, et al. 2013; Biesbroek, et al. 2014; Temme, et al. 2015; Nelson, et al. 2016). The environmental effects of the production of animal-based products are high in comparison with the production of plant-based products. At the same time, a shift towards the consumption of more plant-based foods also has positive health effects. A diet with less meat and cheese and more plant-based foods, such as vegetables, fruit, cereals and legumes, generally contains less saturated fat, less salt and more fibre (Seves, et al.). Because lower socioeconomic groups eat less fruit and vegetables on average, the health effect may be even greater for them.

Drinking differently

Reducing the consumption of soft drinks, fruit juices and alcoholic beverages could potentially also be beneficial to health and ecological sustainability. The current dietary guidelines recommend a maximum of one glass of alcohol per day, or none at all. The consumption of soft drinks and fruit juices is not recommended either because these products contain high amounts of sugar and hardly any other nutrients. The environmental effects of the production of these beverages are lower per kilogram of product than for the production of animal-based foods. Nevertheless, the consumption of these alcoholic beverages and soft drinks contributes approximately 10% to the emission of greenhouse gases from Dutch food consumption (Temme, et al. 2015),

particularly due to the relatively large amounts consumed. Modelling studies in the United Kingdom have shown that a reduction in the consumption of meat and soft drinks in particular would be necessary in order to achieve a reduction in the emission of greenhouse gases as a result of food consumption (Green, et al. 2015; Horgan, et al. 2016). This is confirmed by our own research (Biesbroek, et al.; Van de Kamp).

But connection between health and sustainability does not happen automatically

There are opportunities to improve the health and ecological sustainability of the Dutch diet together. Healthy diets are not always sustainable. Conversely, sustainable diets are not always healthy. As a rule, people who follow the Dietary Guidelines of the Health Council of the Netherlands or the WHO have a somewhat more environmentally friendly diet (Biesbroek, et al.). Nevertheless, it is not the case that every change towards a healthier diet will automatically lead to a lower environmental impact (Tyszler, et al. 2014). For example, eating in accordance with the Wheel of Five is healthier, but only more sustainable if specific choices are made to consume environmentally friendly products and/or less meat (Van de Kamp, et al.). If meat is replaced by plant-based products with a relatively high impact on the environment, there is no benefit in terms of ecological sustainability. It is also not always the case that a shift from more animal-based products to more plant-based products leads to the desired effects on health as well as ecological sustainability (Biesbroek, et al. 2014).

Conversely, a sustainable diet is not always healthy for everyone. The more animal-based foods are replaced, the more attention is needed for the choice and variation of the substitute foods, such that they provide sufficient vitamins and minerals (Seves, et al. ; Temme, et al. 2015). Using every part of an animal from head to tail for meat consumption is also considered sustainable. This also implies the consumption of processed meat, such as sausage, which in itself is less healthy (Temme, et al. 2016).

To further substantiate this, the effects of various changes to the dietary pattern have been calculated. (see box). If we completely replace the current average consumption of meat, fish and eggs with more ecologically sustainable nuts and legumes, we expect approximately 15% fewer new cases of colorectal cancer and 25% fewer cases of diabetes. These raw estimates assume amongst others additivity of the health effects of meat, sliced meats and legumes, which probably lead to overestimation of the total effect size. At the same time, we also see that the average intake of vitamin B12 will decrease by approximately 30%. The intake of iron would increase by almost 20%, but being from plant-based sources it will be less easily absorbed by the body. Replacing meat with nuts on a weight basis alone increases energy intake and thus increases the prevalence of overweight. This example illustrates the potentially positive and negative health effects of an ecologically sustainable diet. Such calculations help to find the optimal consumption pattern, which leads to a lower environmental impact and a healthier diet.

Apples and Oranges

As we have seen in this chapter, measures focusing on one societal challenge may have negative effects on another challenge. In such cases it may be necessary to choose between societal challenges. To illustrate the complexity of such challenges, a case study which focused on the different consumption patterns for meat and meat substitutes was conducted. The effects of different consumption patterns, such as the complete replacement of egg, fish and egg consumption with meat substitutes, legumes and nuts, have been estimated for a limited set of indicators for food safety, health of the diet and ecological sustainability. We provide the results of some of these calculations here. This case study is described in more detail in the methodological background report for this publication (see Appendix B).

Healthy and sustainable diet without sacrificing food safety

Focusing on health and ecological sustainability has both positive and negative effects on food safety. A reduction in meat consumption will result in a decrease in the number of foodborne infections, partly because less raw and improperly heated meat will be consumed. Furthermore, there will be a decrease in the intake of certain chemical contaminants that occur primarily in (fatty) animal-based foods (such as dioxins).

We have also calculated the effects of different variants here (see box). If, for example, we shift the current average consumption of meat, fish, eggs, nuts, legumes and meat substitutes towards more plant-based foods, so that we eat 40% less meat, approximately the same amount of fish, slightly more eggs and significantly more nuts and legumes (according to the Wheel of Five), over 20% less disease burden will be attributable to foodborne infections and the average exposure to dioxins will decrease slightly (6%). More significant effects will occur if we completely replace the current average consumption of meat, fish and eggs with ecologically sustainable products such as nuts and legumes. In that case the disease burden due to foodborne infections will decrease by two-thirds, and the average exposure to dioxins by 40%.

These positive effects may be counterbalanced by a possible increase in the number of foodborne infections due to the higher consumption of some types of raw vegetables and vegetable sprouts. The intake of mycotoxins, cadmium and lead may also increase as a result of a diet in which more nuts and cereals are consumed (Mengelers, et al. 2017). However, experts do not expect this to lead to a substantial increase in exposure. Another undesired effect of more attention for sustainability and less wastage is that microbiologically contaminated food may be consumed more frequently. Although this may result in an increase in the number of foodborne infections, these infections are generally mild. Experts expect the positive effects of healthy and sustainable diets on the number of foodborne infections to outweigh the negative effects. The effect of the reduced consumption of animal products is a decisive factor in this respect.

Recommendation

The consumption of animal products plays a crucial role in the way the Dutch diet can be made healthier and more ecologically sustainable. Policy aimed at reducing the consumption of animal-based products, particularly meat, and substituted with increased consumption of a varied range of fruit, vegetables, nuts, cereals and legumes makes an important contribution to both societal challenges. This also applies to a diet with fewer sugar-containing and alcoholic beverages. However, the challenges do need to be approached in conjunction with each other. Policy focused on a single challenge, with the other challenge of secondary importance, will not achieve synergy between these challenges, as shown by the example of the Wheel of Five. It is important to remain vigilant about the effects of chemical and other forms of food safety in order to maintain the high level thereof.

All actors (government, producers, trade, hotel, restaurant and catering industry, and consumers) have a role

Government authorities can use measures to play a guiding and facilitating role with respect to producers, processors, commercial chains and consumers. Actors can reduce the environmental effects of the processes throughout the production and distribution chain from farm to fork. They also play a role in the food choices made by consumers. They can do this by, for example, providing clear information about health and sustainability aspects of their products, or by offering smaller portions in restaurants, catering and the retail trade. Finally, consumers are themselves responsible for paying attention to health and environmental effects in their food choices. They can be most effective by consuming fewer animal products and fewer juices and soft drinks, and more plant-based products and tap water.

Consumer choices are linked to how much they value other aspects of food, such as price, convenience and taste. Focusing on healthier and more ecologically sustainable diets can put pressure on other aspects of food and nutrition. The transition to a more plant-based diet will also have an impact on the Dutch agricultural sector. These economic values and consumer values are addressed in sections 5.6 and 5.7.

5.5 Further intensification of food safety policy comes at a price

Food safety is high; the law of diminishing returns will apply

As described in previous chapters, food safety in the Netherlands is at a high level. There are still improvements to be made through education (change in behaviour of consumers and producers) and further optimisation of the production chain. There are opportunities to reduce the exposure to a few chemical contaminants by setting even higher product standards for specific chemicals. However, for further intensification of both microbiological and chemical food safety, the law of diminishing returns applies: the level is high and additional investments yield less and less while the price grows higher and higher.

Intensification of food safety policy is negative for the environment

Apart from the fact raising food safety to a substantially higher level requires a disproportionate amount of time and money, it is also associated with negative effects on ecological sustainability. Further

increasing food safety through changes to the food production chain, such as further processing of raw materials, semi-manufactured products and end products, usually leads to an increase in energy and water use. However, this is not the case for all measures. For example, educating consumers, producers, the industry and the hotel, restaurant and catering sector can reduce the number of foodborne infections without negatively affecting sustainability.

Innovation is needed in order to limit these negative effects

It may be possible to reduce the negative effect on sustainability through innovations that promote both safety and ecological sustainability. Smart packaging, for example, can reduce spoilage or warn consumers when a product becomes microbiologically unsafe. This innovation can lead to fewer foodborne infections because the current 'use by' date only applies under specific conditions (e.g. unopened package and a maximum storage temperature) that do not always correspond to the actual conditions. This innovation may also lead to less wastage because products are not always unsafe once the 'use by' date has lapsed.

Innovation sometimes at odds with consumer acceptance or confidence

We do not expect consumers to have a negative attitude towards smart packaging. However, this does not apply to all technological solutions. For example, irradiating food with gamma rays makes the food safer and increases its shelf life. It kills insects and bacteria. Thus irradiation increases food safety and may reduce wastage due to the longer shelf life of products. However, consumers are critical of this technology. In any case, consumer organisations demand clear labelling, so that consumers can make their own choices. When developing and applying technological solutions to benefit food safety, the acceptance of these solutions and the desire for transparency must be taken into account.

Food safety also conflicts with animal welfare, fair trade ...

As well as affecting ecological sustainability, focusing on food safety also has negative effects on animal welfare and fair trade. Keeping animals under stricter, more controlled conditions is expected to lead to a decline in animal welfare. Setting higher product standards globally may result often small-scale producers in developing countries being unable to comply with them. This could affect fair trade.

... and with price, freedom of choice and other consumer values

Experts also expect intensification of the food safety policy to negatively affect price, freedom of choice, the sociocultural function and the appreciation of the taste of food. These aspects are addressed in the next section.

Recommendations

As food safety is high and the law of diminishing returns applies, it is important to consider whether and at what price (literally and figuratively) this would be desirable. Stimulating technological innovations that benefit food safety, ecological sustainability and animal welfare as well as consumer values provides opportunities to lower this price. Taking into account consumer acceptance and their desire for transparency plays an important role in the chance of success.

Businesses can play an important role in this together with research and knowledge institutions. A stimulating or facilitating role by the government is desirable in this respect.

5.6 Tension between societal challenges and consumer values

Focusing on sustainable, healthy and safe diets limits freedom of choice

Focusing on sustainability, health and safety will change the range of available foods. For food safety reasons, the availability of certain products such as raw animal-based products will be limited. From the health perspective, the availability of foods with high sugar, fat and/or salt content will decrease or become more expensive. Company and school canteens will limit their range of less healthy products. From a sustainability perspective, the availability of animal-based and other products with a relatively high environmental impact will decrease or become more expensive. Limiting the availability of fruit and vegetables to regional seasonal products may affect the choices available to consumers. For example, it will be virtually impossible to buy strawberries in the winter. Consumers may perceive these changes as limiting their freedom of choice.

Expenditure on food will change

Focusing on safety, healthy and sustainable diets will also affect household expenditure on food. Higher food safety requirements, such as further reduction of product contamination, will involve higher production costs, which are at least partly passed on to consumers. A shift towards a healthier diet is associated with reduced consumption of meat, alcohol and snacks. On the other hand, expenditure on fruit and vegetables will increase. Experts expect total expenditure to decrease. However, there is also research that shows that a healthy diet is more expensive (Rehm, et al. 2011). Reduced consumption of meat and beverages will keep down the costs of the sustainable shopping cart in the same way. However, sustainable production is linked to higher production costs with the 'true price' passed on to consumers, and the value of the environmental damage factored into the price. Experts estimate that savings due to reduced meat and beverage consumption will be unable to compensate this cost increase and that food will therefore become more expensive.

Taste, convenience and sociocultural function also under pressure?

Besides freedom of choice and affordability, food also has a sociocultural function, and consumers value taste, speed and convenience. For example, many parties go hand in hand with culinary traditions. This often concerns products with a high sugar or fat content, such as meat, cheese and cake, which do not fit well into a healthy diet. Grilling meat on a barbecue also does not fit well into a safe, healthy or sustainable diet. Focusing on further increasing food safety will result in foods being processed more frequently and becoming more clinical in nature. This may negatively affect taste or taste perception, while it may increase convenience. A diet that is both healthier and more sustainable than the current diet will include fewer animal-based and more plant-based basic foods, and will also lead to a reduced consumption of sugar, fat and salt. This may have a negative effect on consumers' taste perception. Another possible consequence is that the availability of processed, pre-

packaged products decreases, which consumers perceive as a limitation of the speed and ease with which they can fulfil their need for food.

Some effects are relative and temporary

Too much freedom of choice can lead to stress of choice. The negative effect of safe, healthy and sustainable diets on freedom of choice is also put into perspective by the fact that this limitation may only be temporary. The perception of freedom of choice adapts to the changing conditions. It is also realistic to assume that producers will also adapt and provide a broader range of safe, healthy and sustainable products, as a result of which the perceived freedom of choice will be restored. We expect most of the effects mentioned here to be temporary, occurring during a transitional period. Dutch society has changed in recent decades, and our diet is also different than it was 50 years ago. Our perception of taste, costs, speed and convenience has been adjusted accordingly. This may not be the case for the effect on expenditure on food. Focusing on healthy diets probably will not increase expenditure, but focusing on safer and more sustainable diets will. The extent to which consumers are prepared to pay for this is an important factor in this respect. However, the higher costs associated with sustainable production will likely decrease in time due to innovation and an increase in knowledge.

Citizen versus consumer

Up to now, we have talked about consumers and consumer values. However, it is interesting to differentiate between citizens and consumers. Most citizens consider sustainability as well as health, animal welfare and fair trade to be important and relevant (Vringer 2013). This is illustrated by the growing attention for these challenges. Media pay attention to healthy and sustainable diets, and there are apps with which consumers can view information about the nutritional value and origin of specific foods. Many people also have intentions of taking this into consideration themselves, for example by choosing other products, or by paying more for specific products. The market share of products with labels for sustainability, fair trade and animal welfare has been increasing for years (Logatcheva 2016). Nevertheless, these values are still only responsible for a small proportion of the consumers' product choices in the here and now. When value-driven citizens make purchases as consumers, factors such as price and convenience become more important. This is because of the fact that consumers make choices at a tangible level, where the immediate benefits of a purchase outweigh the benefits in the long term. The goal is abstract and far away, whereas the choice is close by and tangible (van Dam 2016).

Recommendations

Opportunities exist to combine safety, health and ecological sustainability in an integrated food policy. So why don't we do that? This is partly related to the effects on affordability, freedom of choice, convenience and other values which consumers consider important when it comes to food. There is tension between societal challenges and consumer values. The extent to which this tension influences the success of an integrated policy depends on several factors, two of which we refer to here. First, we should question how strong the effects are and whether these effects are temporary. Second, we know that many

citizens consider health, sustainability, fair trade and animal welfare important, yet convenience and affordability become decisive factors once citizens make purchases as consumers. This gives the government scope to make further choices to make the food supply healthier and more sustainable, for example through compulsory food education, labelling with or without health and sustainability logos, availability of healthy and sustainable products in schools, healthcare institutions and other public spaces. This would be done in cooperation with citizens, in order to create support and legitimacy. Three-quarters of the Dutch population think the government should promote products with a sustainability or animal welfare label (Vringer 2013).

However, the label should then be less ambiguous than it is now, in order to stimulate further transparency with regard to the sustainability and health of products. This would have an effect on consumers, such as increasing awareness and making it easy to make healthy and sustainable choices, and would also make the food supply healthier and more sustainable. If the producer has to provide even more transparency about the products, the producer will change its product range in order to present itself in the best possible light.

Another recommendation follows from the finding that consumer values are less negatively affected when focusing on health compared to focusing on sustainability. Because changes to the diet are both healthy and sustainable, consumers can be confronted with both issues simultaneously. In communication, measures to ensure more ecological sustainability can benefit from the value consumers place on health, and sometimes vice versa. Smaller food portions in the retail sector and in the hotel, restaurant and catering sector can help reduce wastage and also have a positive effect on health.

5.7 Policy focused on safe, healthy and sustainable diets provides opportunities and dilemmas for the economy.

The agricultural sector is important to the Dutch economy. It should also be noted that the Dutch economy is part of a global network, with changes here having consequences elsewhere and vice versa. In order to clarify economic opportunities and dilemmas, we assume (purely hypothetically) that the shifts towards safe, healthy or sustainable diets will take place not only in the Netherlands, but worldwide.

Focusing on safety beneficial to economy through export of high-quality technology

In a world in which the focus is on food safety, the Netherlands can export its knowledge, experience and products to other countries. This benefits the trade balance. This would require the Netherlands to maintain its leading position in this area, which is only possible if new quality requirements are adopted in time. A higher level of food safety often also necessitates the addition of extra procedures during the production process, for which advanced technology may need to be acquired. This can lead to higher production costs and a smaller margin for the producer. The Netherlands also imports many raw materials. Approximately 75% of the imports come from European countries, but oil seeds, raw materials used in livestock feed, coffee and cocoa beans

are imported from countries outside of Europe. If products from these countries do not satisfy the increased safety standards, they cannot be imported. This has a negative effect on Dutch production capacity and thus on the economy. All in all, experts estimate that the Netherlands has an opportunity to increase the value of its exports by producing high-quality raw materials and foods.

Focusing on health and sustainability affects the economy

The total volume of a healthy and sustainable dietary pattern is smaller, this pattern includes fewer animal-based and more plant-based foods and less soft drinks, juice and alcohol, compared to the current diet of the Dutch population. In addition, the consumption of processed foods is smaller and the consumption of fruit, vegetables, legumes and nuts is higher. On the whole these changes have a negative effect on the Dutch economy. The total turnover from the meat-processing and dairy industry is slightly more than 19 billion euros compared to 4.8 billion from the fruit and vegetable-processing industry. Furthermore, the export of meat, dairy and processed products contributes 12.2 billion euros to the trade balance, compared to 3.7 billion for potatoes, fruit and vegetables (Wageningen UR 2016). The reduction in meat consumption is not expected to compensate the higher consumption of fruit, vegetables and legumes. However, the demand for food will increase in the coming decades as the global population grows. This is positive for the economy

Focusing on innovation offers prospects

In recent decades, the Dutch investment policy has contributed to an increase in productivity by the agricultural sector and the food industry. As described above, focusing on safer food leads to opportunities for economic growth in the Netherlands in the Dutch innovation sector. This also applies to focusing on a healthier or more sustainable diet. For example, there are high expectations for technological innovations that make the circularity of food production possible. Reuse of products, raw materials and waste can be made possible through biochemistry and intelligent systems in the production and distribution chain, such as more efficient inventory control. Precision agriculture, aquaculture and biotechnology are examples that can increase food production and reduce the negative consequences of agricultural activities on the environment. In addition, alternative protein sources can be developed, for example, seaweed and insects as sustainable sources of protein. The focus can also be placed on further improvement of legumes and nuts in order to increase production (also in the Netherlands). The agricultural system can respond to expectations related to 'personalised food', where nutritional advice is tailored to someone's personal genetic profile. Tying in with this is the quantified-self movement, in which people collect data themselves and are provided with feedback based on this information, as well as the development of functional foods. Packaging with biosensors, microtags and nanotags or polymer chemistry can contribute to food safety in the future. This also benefits ecological sustainability because it can reduce food wastage.

Technological innovation faces its own challenges

Nevertheless, technological innovations also have a downside. The reintroduction of residues in the food chain can also involve risks.

Furthermore, the potential health risks of certain nanomaterials are not yet fully understood. It is not only producers, but also consumers who have to embrace these technological innovations. This is still a significant challenge for some of the technology (Bearth, et al. 2016).

Tension: short versus long-term and distribution of costs and proceeds between various actors

Agricultural and processing companies adapt to changing conditions. Innovations offset changes. This means investing in the short term, but yielding the results in the long term. Besides this tension, there is also tension in the distribution of costs and proceeds. Focusing on healthy and sustainable diets benefits some sectors, but not others.

Furthermore, the tension we described for consumers versus citizens is also seen in businesses. Just as citizens want to consume a healthy and sustainable diet, as consumers the same citizens focus mainly on price, convenience and taste. In the same way, many businesses indicate that sustainability is important to them, but when it comes to purchasing and production of goods their priority is to maximise profit (van Dam 2016).

5.8 What's next?

Opportunities for integrated food policy

The previous section describes opportunities and dilemmas for an integrated food policy. Not eating too much, a diet with more plant-based and fewer animal-based products and with fewer sugar-containing and alcoholic beverages contribute to both health and ecological sustainability. Some of these modifications also have a positive effect on food safety. For example, the consumption of less meat leads to fewer foodborne infections. This creates opportunities for joint policy. There are also dilemmas. Not all measures aimed at safety and health are sustainable, and vice versa. Furthermore, there is an area of tension between abstract, long-term goals and concrete choices in the here and now. Many citizens and businesses consider health and sustainability important. But when value-driven citizens make purchases as consumers, habit, convenience and affordability are often the decisive factors. Businesses want to operate in a socially responsible manner, while also serving consumers and making a profit.

The strength of society

The Dutch government has expressed its ambition to take the lead in the food transition that is needed in order to achieve the Dutch, European and global ambitions with regard to health and sustainability (Rijksoverheid 2016). Making the most of the opportunities described in this report fits in with this perfectly. The analysis shows that an intensive and integrated approach is needed in order to achieve the change towards a healthier and safer diet that continues to be safe. Innovations are needed to address the dilemmas. Today's society provides opportunities for this. The Netherlands Environmental Assessment Agency (*Planbureau voor de Leefomgeving*) views today's energetic society as an opportunity to tackle the issue of sustainability. "Citizens and the business community are motivated by their wish for a clean economy and a pleasant living environment. A large group of citizens and businesses is willing to become actively involved in creating

a pleasant environment. If we are to tap into the strength of this society, citizens and the business community must be involved themselves.” (Hajer 2011). A parallel can be drawn with the challenge in the area of food. Many citizens want ‘pleasant food’ (delicious, affordable and convenient) that is safe, healthy and sustainable. Businesses want to contribute to this through smart solutions that allow them to make a profit.

And many initiatives have already been introduced. Examples range from very small (offering people in the neighbourhood a local, healthy and sustainable meal for a fee) to large initiatives (the City Deal ‘Food on the urban agenda’). In today’s network society, the initiatives are becoming increasingly professional and organised. Initiatives are combined on online platforms, which in turn creates new opportunities. There is also tremendous growth in opportunities for the collection and use of large amounts of data. This is something we can use to our advantage. Instruments such as open data and big data can significantly improve the establishment and implementation of initiatives. The main challenge in this respect is ensuring sufficient quality of the data. New forms of financing, such as crowdfunding, provide opportunities for funding a number of initiatives.

The role of the government

The government can provide even more encouragement for the necessary innovations. It is important to communicate a clear message that motivates and stimulates people. Incentives to reward innovation and the removal of regulations that stand in the way of innovation are also important, as is continuous interaction with parties in civil society in order to continue learning and adjust the process (Hajer 2011). By doing so, the government will provide direction and stimulate and facilitate initiatives of producers, industry, citizens, civil society organisations and other parties. This process has commenced with the Food Agenda (*Voedselagenda*)(Rijksoverheid 2013; Rijksoverheid 2016).

The tension between sustainable, healthy and safe diets in the long term, and convenience, affordability and the economy in the short term also necessitates tough choices and an active role by the government. This tension gives the government scope and legitimacy to work actively towards a healthier and more sustainable food supply based on the shared values. Financial instruments to discourage undesirable developments and stimulate desirable changes can play a role in this. An example is making animal-based products more expensive so that the costs of environmental damage are included in the price. Rules to only offer healthy and sustainable products in public spaces are also among the more binding measures.

Parties with a lot of power in the food network, such as purchasing organisations for supermarkets and retailers, will play a key role in the food transition. The government can work with these parties and focus its policy on these key organisations where possible, for example by finding solutions to barriers in competition legislation in order to achieve agreements between organisations that contribute to a healthier and more sustainable food supply. The retail sector has knowledge about effective marketing strategies to entice consumers to purchase and

consume specific products as well as a greater number of products. This also applies to fast food restaurants and food companies. Couldn't they contribute more than they do now towards healthier and more sustainable choices? Possibilities can be explored in dialogue, in which a level playing field for the various parties involved is likely to be important.

Another available tool is progress monitoring, making the results thereof available digitally and responding to them. This is already done under the Agreement to Improve Product Composition (Akkoord Verbetering Productsamenstelling 2017). A good set of indicators is needed for monitoring. The indicators used in this report can play a role in this. Additional, more specific indicators are necessary, such as indicators for performance in the area of health, sustainability and safety of the food production or the food offered by institutions and businesses. A good infrastructure is also important for the food transition. This could take the form of a knowledge platform in which food-related issues are tackled comprehensively. Government parties could cooperate on this with other partners in civil society. An example of such a platform is the platform for livestock farming and health (Kennisplatform Veehouderij 2017). The stimulation and pooling of open data on food can also facilitate the development of innovations. Apps are an example of this.

Knowledge agenda

There is a lot of knowledge available with regard to safe, healthy and sustainable diets. In order to tackle the challenges on our plate, this knowledge must be further developed. In addition, an integrated approach to a safe, healthier and more sustainable diet requires an interdisciplinary approach to these three fields, and to consumer behaviour and the economy. Scientific and civil society parties as well as citizens can contribute to this knowledge. Linking of knowledge about the various components of the food chain is also necessary, along with knowledge about the food network as a whole. After all, a measure in a particular step in the chain from farm to fork can have effects on other parts of that chain.

A number of knowledge gaps in the area of safe, healthy and sustainable diets are listed below. Afterwards, we address the knowledge development needed for the fields mentioned and for an integrated approach to the challenges on our plate.

Our food is mostly safe. Nevertheless, developments related to endocrine disruptors and exposure to mixtures of chemicals require additional research. Furthermore, research is desired on estimation of the harmful effects of chemicals in foods in the case of long-term high intake.

Because most effects of diet on health are not acute, innovative methods are needed to measure dietary patterns over longer periods of time. In order to provide more specific nutritional advice, more research is needed on the difference in effects of diets between individuals, for example based on genetic factors or by means of biomarkers. Research is also needed on optimal diets for specific population groups, such as the elderly, the chronically ill, pregnant women and children.

More knowledge is needed on the environmental impact of various steps in the food production chain from farm to fork and the relationship between products, such as dairy products and meat, in order to use calculation models (such as ReCiPe) to improve estimates concerning the environmental impact of processed and composite products. One of the reasons this knowledge is needed is to be able to study the effects of closing cycles. The development of circular systems at the right levels of scale also requires additional research.

The challenges call for innovations and interventions to achieve healthier and more sustainable diets and food consumption patterns without sacrificing food safety. Additional knowledge is needed to develop these interventions and innovations. This concerns questions such as: How can microbial contamination be prevented in sustainable agricultural production? How can the supplies and the product ranges of catering establishments and restaurants be optimised with regard to health, sustainability and wastage? Which information do supermarket buyers need in order to provide a sustainable and healthy range of products in their stores? How can consumers be encouraged to purchase healthier and/or more sustainable products and reduce wastage? How can mineral cycles be closed? How can we develop sustainable packaging materials that optimise food safety?

An integrated approach requires an interdisciplinary procedure as well as exchange of data from the different disciplines involved. Bringing together data on safety (e.g. contamination), health aspects (e.g. nutrient composition), sustainability indicators (e.g. land use) and other characteristics (such as price) concerning the same products is important in order to facilitate interdisciplinary research.

We must also assess the effects of innovations and interventions in terms of food safety, health, sustainability, economy and consumer values. An integrated assessment framework is needed in order to perform such assessments. This way social cost-benefit analyses (SCBAs) can be used to provide insight into the economic and social costs and benefits of e.g. circular systems or the reduction of meat consumption. The development of tools with a greater emphasis on what people consider important, such as multi-criteria analyses, can provide insight into the public support for innovations and interventions.

Finally, it is important to link the various stakeholders in the food chain, to enable them to communicate and to support or organise activities that can put the knowledge into practice and valorise it.

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Appendix B Background reports

The titles of the background reports on which this report is based are listed below.

E.M. Zantinge, M.C. van Bakel, A.J.M. van Loon, M.C. Ocké. Driving forces behind food consumption and the food supply (*Drijvende krachten van de voedselconsumptie en het voedselaanbod*). Background report to 'What is on our plate? Safe, healthy and sustainable diets in the Netherlands' (*Wat ligt er op ons bord? Veilig, gezond en duurzaam eten in Nederland*). Rapportnummer 2016-0194, RIVM.

M. Geurts, M.C. van Bakel, C.T.M. van Rossum, E.J. de Boer, M.C. Ocké. Food consumption in the Netherlands and its determinants. Background report to 'What's on our plate? Safe, healthy and sustainable diets in the Netherlands'. Rapportnummer 2016-0195, RIVM

M.J.B. Mengelers, L. de Wit, P.E. Boon, E. Franz, M. Bouwknegt, R. de Jonge, A.S. Bulder, A.H. Havelaar. How safe is our food? Background report to 'What's on our plate? Safe, healthy and sustainable diets in the Netherlands'. Rapportnummer 2016-0196, RIVM

J.M.A. Boer, E.M. Buurma, H.J. van Kranen, I.E. Milder, M.C. Ocké, J. Verkaik-Kloosterman, J.M.A. van Raaij. Health aspects of the Dutch diet. Background report to 'What's on our plate? Safe, healthy and sustainable diets in the Netherlands'. Rapportnummer 2016-0197, RIVM

A. Hollander, E.H.M. Temme, M.C. Zijp. The environmental sustainability of the Dutch diet. Background report to 'What's on our plate? Safe, healthy and sustainable diets in the Netherlands'. Rapportnummer 2016-0198, RIVM

I.B. Toxopeus, N. Hoeymans, M. Geurts, M.J.B. Mengelers, E.H.M. Temme, M.C. Ocké. What is on our plate? (*Wat ligt er op ons bord?*) Methodological background report. Rapportnummer 2017-0065, RIVM

Appendix C Newspaper headlines

Headline	Source	Date
Are beans healthy? (<i>Zijn bonen gezond?</i>)	Het Parool	12/10/2016
The myth of E-numbers (<i>De mythe van de E-nummers</i>)	Trouw	22/10/2016
How healthy are meat substitutes? (<i>Hoe gezond zijn vleesvervangers?</i>)	De Volkskrant	18/12/2016
Nearly half of tinned vegetables contain added sugar (<i>Bijna helft groenteconserven gesuikerd</i>)	De Telegraaf	28/12/2016
Intensive agriculture is a more urgent problem than global warming (<i>Intensieve landbouw urgenter probleem dan opwarming</i>)	Trouw	11/08/2016
Dutch onion taking over the world (<i>Nederlandse ui veroverd de wereld</i>)	Trouw	11/01/2017
One-fifth of the world's population obese by 2025 (<i>In 2025 lijdt een vijfde van de wereld aan obesitas</i>)	De Volkskrant	01/04/2016
Nuts are healthy, but not very sustainable (<i>Noten zijn gezond, maar niet zo duurzaam</i>)	De Volkskrant	14/11/2015
What counts: the chicken or the money? (<i>Wat telt: de kip of het geld?</i>)	Trouw	05/02/2016



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