WUR perspectives on agriculture, food and nature

Bos, A.P.[1], Breman, B.C.[2], De Wolf, P.L.[3], Van Meijl, J.C.M.[4], Geerling-Eiff, F.A.[4], Jellema, A.[4], De Jonge, E.L.[3], Dekker, J.[2], Fuchs, L.M.[3], Puente-Rodríguez, D.[1], Van Ree, M.[2], Van Wassenaer, L.[4], Wesselink, M.[3] and Wigboldus, S.A.[3]

[1] Wageningen Livestock Research
[2] Wageningen Environmental Research
[3] Wageningen Plant Research
[4] Wageningen Economic Research

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Foreword

The future of both agriculture and nature in the Netherlands deserves a long-term strategic perspective. A lot of attention is being paid in the Netherlands to the nitrogen crisis, but the climate crisis and the dramatic global decline in species are, if anything, even more urgent, and the era of complacency is over. It is time to make choices and choose a course of action.

However, those choices are neither simple nor one-dimensional. They are linked to deep-seated normative assumptions, and people have very wide-ranging opinions about these. Moreover, food systems and nature are global systems. If we just consider individual aspects in isolation, we might easily come to the wrong conclusions. So we need knowledge, facts and scenarios; but as a society, we also need to engage in a dialogue that goes beyond the immediate crisis.

As one of the world's leading research institutes for agriculture, food and nature, Wageningen University & Research (WUR) wants to play a part in that conversation. Not merely as an independent supplier of knowledge, but also as a co-creator of successes and as a stakeholder with shared responsibility for the negative side effects of our existing agricultural sector. Individual scientists at WUR contribute to the public debate in many ways, both visibly and less visibly. They all add value in their own way, often based on their own specialism. Bringing together all these insights, from different perspectives, is precisely what will place us on the path of actual solutions.

It was at my request that a group of colleagues set out to identify the visions and perspectives on agriculture, food and nature that we have here within our own organisation, and the general principles that can be drawn from them. Recognising how urgent this is to our society, the group agreed to take on the project. The initial results of this work prompted some valuable discussions during the first half of 2023. This report elaborates on and explains those results, based on six dilemmas.

These six issues are by no means an exhaustive list, but they are topics that we should absolutely be discussing if we are to develop a long-term strategic perspective for the Netherlands. Not solely for agriculture and food, and not solely for nature, but in the way they all relate to each other. Of course, these issues are in turn linked to other major national issues, such as spatial development, water management and the energy transition.

I am certain that this report can serve as an important launching pad for that urgent conversation. We need new perspectives, not just for farmers and nature, but for the Netherlands and the world as a whole.

Sjoukje Heimovaara
President of the Executive Board
Wageningen University & Research

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Summary

The social debate on agriculture, food and nature often focuses on halving the livestock population and on whether we should meet nitrogen targets in 2030 or 2035. But are these the right issues to focus on? A team of researchers at Wageningen Research has identified six dilemmas based on a variety of WUR studies. The choices we make as a society regarding these dilemmas will partly determine the future of agriculture, food and nature in the Netherlands.

The lack of a long-term perspective

We need a long-term vision. As the global population continues to grow, it will need to be fed in a sustainable way, and the Netherlands can contribute to this through the quality of its entrepreneurship, the quality of its natural conditions (climate and soil) and a logistically favourable location. If not through primary production, then at least through knowledge, technology and propagation materials. At the same time, here in the Netherlands we are coming up against the agronomic, ecological, economic and social limits of our agricultural system, which means we cannot assume it will be business as usual as we go forward. While we have made all kinds of plans and agreements in the Netherlands on, for example, the future of housing and of our energy supply, we lack a long-term perspective for agriculture.

Six dilemmas

As part of the WUR Perspectives on Agri-food and Nature (WPAN) project, we have collated and analysed a variety of studies and visions produced by Wageningen scientists on the future of agriculture, food and nature. Our purpose in this is to contribute to the social debate around agriculture, food and nature and to place it in a broader perspective. Considering current issues and developments from a broader and longer-term perspective enables us to unveil the underlying dilemmas. In our view, the social and political debate should be focused on those dilemmas. We are not suggesting that these dilemmas are an exhaustive list. However, we do know that for every issue there are choices to be made, and every choice has its advantages and disadvantages.

It is important for society to identify the long-term role and characteristics of agriculture and nature in the Netherlands, bearing in mind some of the major challenges we face. How do we ensure food security while also tackling climate change and biodiversity loss? How can we adapt to the effects of climate change that are already unavoidable? How do we ensure the vitality of our rural environments, as well as better water quality and higher standards of animal welfare? The Dutch government has already signed up to robust international agreements on biodiversity and climate targets, including the EU Green Deal. But the government has to make choices within those frameworks on how Dutch agriculture can develop.

Dilemma 1: How will the Netherlands contribute to the global food supply?

By 2050, the global population is expected to have reached 9.7 billion people (UN, 2022). How can this growing population be fed, and how do we do it in a sustainable way? There are also 800 million people suffering from hunger at present, and 2.3 billion people still lack food security. As one of the world's most innovative countries in the agriculture and horticulture sectors, and a major net exporter of agricultural and horticultural products, the Netherlands can play an important role in the global food supply. But how exactly do we want to contribute to the global food supply? Will we continue to prioritise the production and export of products, or will we become more focused on supplying propagation materials and on the export of technology, innovation, knowledge and overseas production, for example?

Dilemma 2: What is the purpose of animal husbandry in the Netherlands?

Will our animal husbandry sector continue to serve the European and global markets for high-quality proteins? Or will our animals become mere processors of grass and waste streams? In the latter scenario, we would stop importing fodder (soy, grain). This would lead to a reduction in our livestock population, and the surplus of manure would disappear. This would help us meet climate goals, but we would also need to alter our consumption patterns so that we consume less meat, and at the very least change the kind of meat we consume (see dilemma 6). Otherwise we will be exporting the climate impact.

Dilemma 3: What is the moral position of animals in our food supply?

What rights will we grant animals? To what extent may we exploit animals for our food supply, and under which conditions? What would a humane livestock sector look like?

Dilemma 4: How many of the future climate and nature goals do we want to achieve within the Netherlands?

The Netherlands has agreed to drastically reduce greenhouse gas emissions from agriculture and industry by 2050. How will the Netherlands compensate for its remaining emissions in order to become climate neutral? Furthermore, under the Biodiversity Convention, the Netherlands wants to introduce additional environmental policies, such as having 30% of its nature protected by 2030. Will the Netherlands plant lots of additional forests and designate nature reserves to meet both these goals, or will we, as a densely populated delta, trade climate and/or nature goals with other countries? For instance, it would be conceivable for the Netherlands (with its higher agricultural productivity) to trade goals with other countries in Europe or beyond (where there is more space for forests) in order to achieve climate, nature and food objectives together, at lower joint costs which can then be shared equitably. Or, given the urgency, do we just opt to maximise our own efforts to achieve climate and nature goals?

Dilemma 5: Agriculture and nature: sparing or sharing?

Separating ('sparing') land-based functions (e.g. nature reserves separate to high-yield agriculture) requires different measures and forms of spatial planning compared to integrating or 'sharing' them (nature-inclusive and regenerative agriculture), and also has different effects in terms of land use, local and global biodiversity, and productivity, for example. Should the Netherlands move towards a system where we protect nature reserves but conduct high-yield agriculture in other areas? Or are more extensive forms of agriculture combined with nature a better solution?

Dilemma 6: How do we manage consumer behaviour?

Do we continue to insist on relative freedom of choice in a market where adverse impacts on nature and the environment are not fully reflected in the price of food? Or will we restrict and influence consumer choice for the sake of nature and environmental goals while also combating social inequality and improving public health? In the latter scenario, consumers might pay a higher price for food that is bad for our health and has negative impacts on the environment and our living environment, while paying a lower price for healthy food that has positive impacts on the environment and our living environment. Would we need to make agreements on this at the EU level? And would supermarkets still be allowed to sell unsustainably produced foods? And to what extent will we be limiting the choices available to the next generation if we do not formulate a food policy?

Anticipated developments

In and of themselves, the dilemmas might suggest that we can still pursue any number of directions. However, it is important to emphasise that the six dilemmas are interrelated, so that choices regarding one of them might constrain the options available to us with regard to other dilemmas. But even if we take each dilemma individually, we still do not have unlimited room to manoeuvre. International agreements, the position of the Netherlands in an economy with open borders, and the many other claims on space in the Netherlands all play a part in making certain options more obvious and others less so. Based on our analysis, we therefore anticipate the following developments.

1. The most significant way for the Netherlands to contribute to the global food supply will be by concentrating even more than we do already on propagation materials, technology and knowledge (dilemma 1) and placing less emphasis on production volumes.
2. It makes sense for animal husbandry to focus much more than it does now on making use of raw materials and waste streams that are unsuitable for human consumption. We should make this sector much less dependent on primary fodder production on arable land in the rest of the world than it is now (dilemma 2).
3. In conjunction with the previous point, we need to actively steer our consumption patterns towards a plant-based, healthier and less polluting diet (dilemma 6).
4. Our international obligations already require the restoration of existing natural environments in the Netherlands, but doing so is in any case in the interest of the country and of the agricultural sector.
5. In conjunction with the previous point, it seems wise for the Netherlands to avoid either strictly separating ('sparing') or integrating ('sharing') its nature and agriculture (dilemma 5).

Carefully considered choices

As a society, we need to make carefully considered choices on these six issues, because these choices will determine our future agricultural system, nature policy, and the quality of life in our physical environment. These choices are about the way the Netherlands is organised, the international position of Dutch agriculture, the role and scale of the livestock sector and the relationship between agriculture and nature. We must move towards an agriculture and food system that operates within planetary boundaries and is based on an equitable distribution of wealth ('Safe & Just Operating Space'). In doing so, each choice will have advantages and disadvantages and there may be a number of issues to weigh up. Delaying these decisions will only exacerbate the challenges. If we do dare to take these decisions, the Netherlands could lead the way in the future provision of sustainable food supplies.

As in all other domains, this is one where our knowledge is constantly evolving. As our understanding continues to develop, WUR itself will continue to share its knowledge to ensure that the social debate is based on scientific insights.

1 Introduction

The future of agriculture and nature is a guaranteed topic of heated debate in the Netherlands. What are our perspectives of the future? What are the possible transition pathways, and which ones do we want to take? What choices need to be made? If we are to design a future system of agriculture and nature, we need perspectives of the future. We need perspectives of how to drive the necessary transitions to sustainable agriculture and resilient food systems in a greener world. Wageningen University & Research (WUR) has a special position as an internationally renowned research institute in the field of agriculture, food and nature. But what is WUR's vision? Over the past few years WUR has produced a variety of studies, scenarios and perspectives on agriculture, food and nature. The WUR Perspectives on Agri-food and Nature (WPAN) project brought these ideas together as a way of trying to understand various dilemmas. The idea is that the project will help build a body of knowledge on how agriculture and nature might be developed in the Netherlands.

What the WPAN project therefore hopes to do is to feed into the current political and social debate around agriculture and nature by providing scientific insights and providing perspective. If we consider the issues and developments we are facing today from a broader and longer-term perspective, we can see how the topics that dominate the social and political debate today often obscure other challenges. Rather than discussing how many cows there should be or how many farmers need to leave the sector, the debate then shifts to the underlying question of what the role and position of the Netherlands could be in the international agri-production system. Instead of discussing ammonia emissions down to the decimal point, we would be talking about our place as human beings in the natural landscape, and what we want that relationship to be. And that, in turn, is linked to the question of what we are willing and able to eat, and whether we are able and willing to change our economic system. For decades now, cheap food has put us in a position where we can let other economic sectors flourish. Moreover, transitioning away from the use of fossil fuels also means that an increasing proportion of our raw materials for clothing, interiors, buildings and other items will have to come from agricultural/forestry/marine systems. What does that mean for the future of the agri-food system? Asking different questions also creates space for different conversations and answers. And it is precisely these that are essential if we are to shape the future of agriculture and nature in the Netherlands. The WPAN project takes both 2030 and 2050 as horizons. The year 2030 is not very far off and is tied into the goals set out in the EU Farm to Fork strategy.

This emphasises the sense of urgency. The year 2050 was chosen for the purposes of designing and analysing longer-term transition pathways.

The WPAN project focuses on the Netherlands within the global context of the Sustainable Development Goals (SDGs) and the Paris Climate Agreement, and within the European context of the Green Deal, the Farm to Fork strategy and the Biodiversity Strategy. It takes a national-level approach because of all the current challenges related to agriculture, nature, water quality and climate change that our densely populated delta is currently facing. Given the Netherlands' international position in the trade and production of both food and non-food products, it is essential to take into account the European (EU) and global context and agreements.

The study is based on an initial analysis of various WUR visions and perspectives (see Appendix 1), and that analysis has been described and further developed in this report. Our work has resulted in the identification of six dilemmas that can inform the debate in the Netherlands. We are not claiming that the dilemmas we face are limited only to these six. What we mainly want to achieve is to kickstart the debate about how to make Dutch agriculture more sustainable and future-proof. The six dilemmas as presented in this report are the starting point for this. We would like to build on this by engaging in dialogues with farmers, the general public, supply chain actors, civil society organisations, governments and knowledge institutes to work together towards a sustainable future.

2 Coherent visions of the future of agriculture, food and nature in the Netherlands

The public debate about what we want the future of agriculture, food and nature to look like in the Netherlands is heated and full of complex considerations. Not just because there are different, often conflicting interests at play, but also because stakeholders come at it from different perspectives and have different values. There is also the fact that the Netherlands is tied to its neighbours and the rest of the world in many ways: biophysically, culturally, economically, and through European agreements and international treaties. These links partly determine the bandwidth available to us for shaping the future of agriculture and nature. In addition, other parties often have different time horizons, which also leads to different ideas about what is critical in the short term and what will play more of a role in the medium and long term.

These different perspectives, value systems, scales, and time frames lead to different visions of the future of agriculture, the fishing industry, food and nature in the Netherlands and further afield, and of how that future might be achieved. The same is true within WUR itself. Nevertheless, these different ideas do often take a common point of departure. One example is that we need to move towards an agriculture and food system that operates within planetary boundaries and is based on an equitable distribution of wealth ('safe & just operating space').

In this chapter (2), we elaborate on this complexity, and from there we outline the broader frameworks that determine preferences and choices around visions and associated milestones. This can help us better understand the possible ways of looking at the complexity of agriculture, the fishing industry, food and nature, and how those views lead to specific stalemates and dilemmas. This then forms the framework for the choices made in the next chapter (3). There, we discuss a selection of issues important to the Netherlands and related dilemmas and options.

2.1 Agriculture, nature and the food system

Agriculture and nature are the foundations of our food system. Ever since prehistoric humans started cultivating the land, agriculture has been a permanent attempt to bend nature to our will. During the post-war era of agricultural modernisation, a wealth of knowledge and technology helped to massively boost productivity and basically provided sufficient and affordable food for a rapidly growing world population. The Netherlands contributed significantly to this. However, that modernisation process also led to agriculture and nature becoming increasingly polarised. This was evident in agricultural practice – with an ever-growing need for crop protection agents and antibiotics, for example – as well as in our perceptions and the way we thought about the relationship between agriculture and nature. Today's nitrogen debate is also characterised by this apparently diametric opposition between agriculture on the one hand, and other human activities and nature on the other.

The various visions within WUR about the future of agriculture and nature in the Netherlands also tend to have an emphasis on either agriculture and its development or on nature. There are only a few examples of a much more systematic connection (see, for example, De Boer & De Olde, 2020; Breman et al., 2022).

The visions considered in this WPAN study focus on different issues around the theme of agriculture, food and nature. For example, they include researchers focusing on circular agriculture (De Boer & Van Ittersum, 2018; Focker et al., 2022), the digitisation of the food system (Wolfert, 2021), the protein transition (Pyett et al., 2019), the Dutch spatial planning conundrum (Bakker et al, 2021), our relationship to the earth and ecology (Blok, 2022), 'small wins' (Termeer et al., 2019a), nature-inclusive visions of the future (Breman et al., 2022), the international and 'greening' dimension (Van Zeist et al., 2021) and nature-based solutions (Snep et al., 2020). This diversity is often seen as a 'unique selling point' (USP) of WUR. By drawing on this diversity, WUR – as a knowledge institute – can ensure that in its positioning, its strategic plans, investments and policy advice, it weighs up all the relevant social, ecological, economic, spatial, technological, ethical and other issues, and that these are taken into account and given due consideration. Education and research at WUR need to reflect this and cohere with national and international challenges and agreements. As a top university and research centre, WUR has a responsibility to make a significant contribution to the provision of responsible future-proof visions related to agriculture, food and nature. The diversity of insights put forward by WUR also provides a wealth of opportunities for evaluating and doing justice to the different views and wishes expressed by society as a whole.

The strategic context (Figure **2.1**) outlines the strategic context within which choices will have to be made when formulating visions for agriculture, food and nature. This is specific to the Netherlands, but takes into account the broader international context. As shown in the figure, this context is determined by:

- major global challenges related to issues such as climate change, biodiversity loss, reducing hunger and poverty, income inequality and improving health;
- international agreements related to these issues (the UN Sustainable Development Goals, the Paris Climate Agreement, the EU Green Deal, etc.);
- the translation of these international agreements into binding EU laws and regulations (Water Framework Directive and Climate Act);
- Dutch policy choices and laws and regulations (circular agriculture);
- the social debate around agriculture, food and nature;
- knowledge and skills;
- room for manoeuvre (agronomic, ecological, technical, legal, etc.).

The strategic context is crucial as we go about formulating and implementing perspectives of the future. After all, whatever idea you may have about the future of agriculture, food and nature, the bandwidth available to us is largely determined by the opportunities and boundaries offered and set by our broader environment. This chapter (2) outlines this context. As part of this, we consider major challenges such as climate change and biodiversity loss, biophysical space and international agreements.

2.1.1 Major challenges

Humanity is facing some really enormous challenges. Key challenges include ensuring global food security for a growing world population, climate change, and loss of biodiversity.

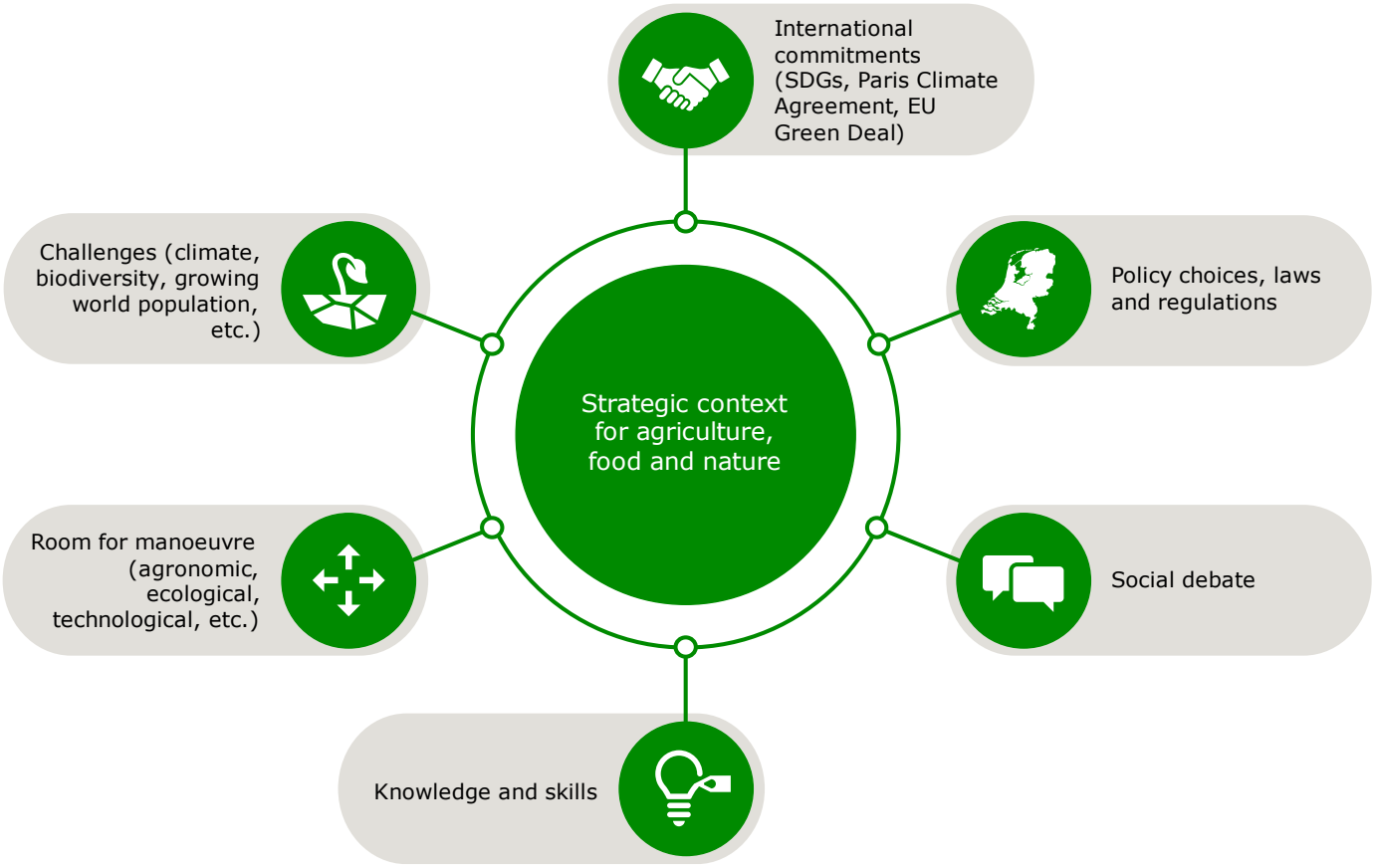


Figure 2.1 *The strategic context for formulating visions for the future of agriculture, food and nature.*

The global population is expected to see significant growth as we head to 2050, and an estimated 9.7 billion people (UN, 2022) will need to be properly fed, clothed and housed. All of those global citizens will also become more affluent, and in the absence of any further interventions we can expect this to lead to more animal protein being consumed (Fresco & Poppe, 2016), which in turn will increase the pressure that our agricultural system exerts on the planet. Meanwhile, malnutrition is still a major problem right now, as is obesity. There are 800 million people suffering from chronic hunger, and two billion lack essential micronutrients, while on the other hand obesity is reaching epidemic proportions (FAO, 2023). Providing the global population with sufficient and healthy food, within our planetary boundaries, is thus already a huge challenge and will become even more so as we head towards 2050. At the same time, we know it is possible to feed the world's growing population in a healthy and sustainable way (EAT-Lancet Commission, 2019), but doing so will require substantial modifications to production and consumption patterns.

Climate change and biodiversity loss only add to the challenge of producing sufficient, healthy food. Higher temperatures and more frequent prolonged droughts – or conversely, extreme flooding – are putting pressure on agriculture all over the world. Agriculture, forestry and land use change account for 19% of anthropogenic greenhouse gas emissions, while the food system as a whole accounts for 25% (Our World in Data, 2019a). Agriculture and food production therefore have a key role to play in reducing these emissions.

Biodiversity is also under pressure all over the world. The Global Assessment Report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) stated that the rapid decline of biodiversity is at least as great a threat to humanity as global warming (IPBES, 2019). Biodiversity loss is mainly attributed to human activity. Again, agriculture plays a key role in this and will have to play an important part in efforts to turn biodiversity loss around and instigate a recovery.

Alongside these challenges there are of course many other global developments at play that will affect the future state of agriculture, food and nature. These developments include rising economic and social inequality, increasing migration (partly due to climate change), environmental pollution, geopolitical tensions, an ageing population in major economies, uncertainties about the impact of artificial intelligence (AI) and extensive digitalisation.

Figure 2.2 *The 2015 United Nations Sustainable Development Goals (adapted by the Stockholm Resilience Center, 2017).*

2.1.2 International agreements

The Netherlands is bound by numerous international treaties. Below, we highlight the most important and recent treaties relevant to agriculture, food and nature, along with relevant EU policies.

Sustainable Development Goals (SDGs)

In 2015, the Netherlands committed to the 17 *Sustainable Development Goals* (see **Figure 2.2**), which are the core element of the United Nations' *Agenda 2030 for Sustainable Development*. While almost all the goals are relevant to the domain of agriculture, food and nature, Goal 2 (zero hunger), Goal 6 (clean water), Goal 11 (sustainable cities and communities), Goal 12 (responsible consumption and production), Goal 13 (climate action), Goal 14 (life below water) and Goal 15 (life on land) are particularly important. There is also a link to poverty (Goal 1), health (Goal 3), clean energy (Goal 7) and decent work and economic growth (Goal 8).

Paris Agreement (climate)

In 2015 almost every country in the world also signed the Paris Agreement at COP21 (UN, 2015), which stated an agreement to reduce greenhouse gas emissions to the point where the global temperature increase would remain below 2°C and as close as possible to 1.5°C. This was followed in 2021 by other agreements such as the Global Methane Pledge (2021), at COP26 in Glasgow. This Pledge calls for member countries (including the Netherlands) to reduce emissions of the potent greenhouse gas methane by 30% by 2030 compared to 2020. The livestock sector (and cattle farming in particular) is a major source of methane emissions.

Montreal Agreement (biodiversity)

This was followed in late 2022 by the Montreal Agreement at the UN Conference on Biodiversity (COP15), where far-reaching agreements were made on safeguarding and strengthening global biodiversity. The agreement included a pledge to protect 30% of the world's surface area (land and sea) as nature reserves and to halt and reverse the rapid loss of biodiversity.

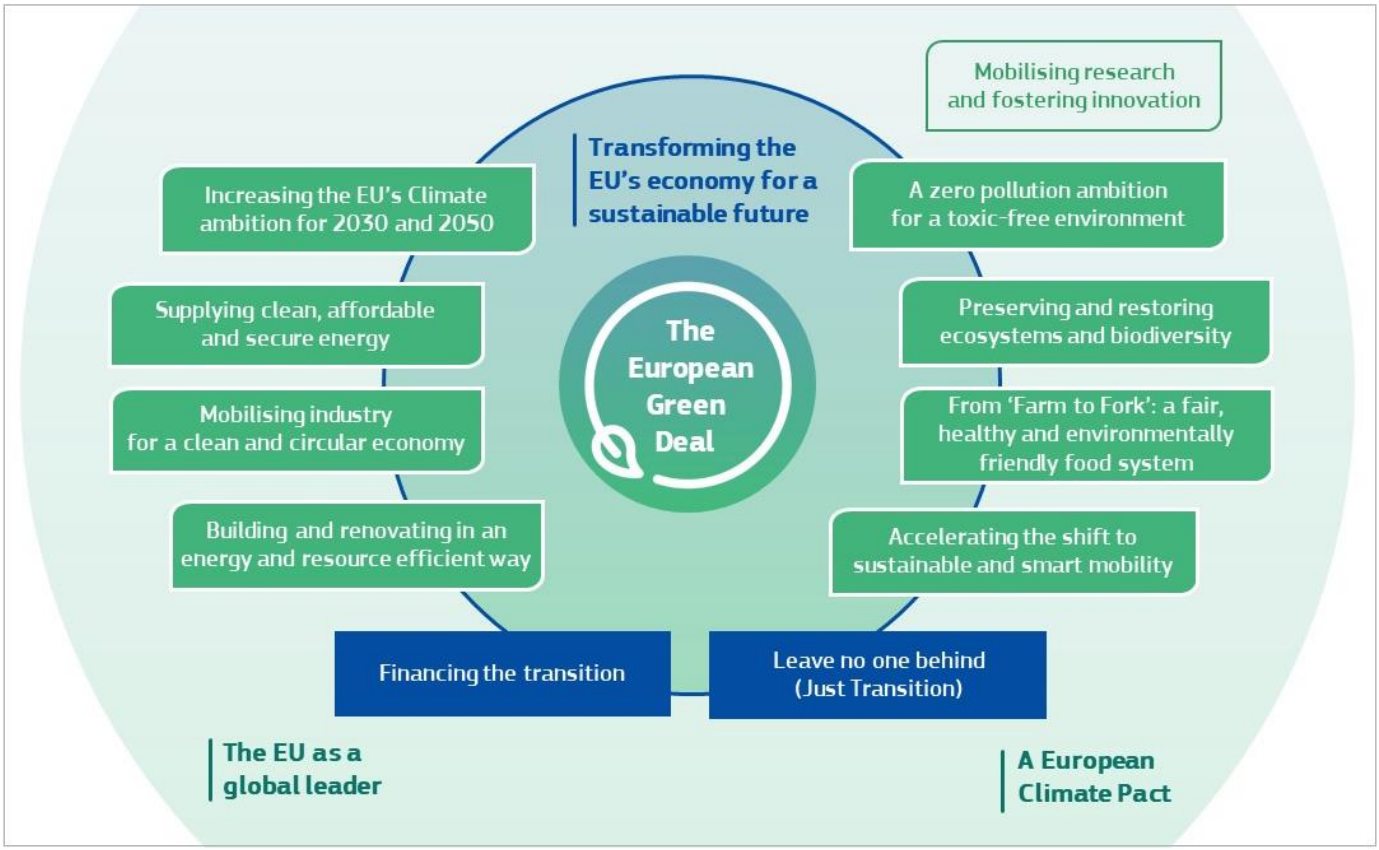


Figure 2.3 *The European Green Deal and its components (EC, 2019).*

EU policies and regulations

The European Union's Common Agricultural Policy (CAP) has traditionally been one of the pillars of European cooperation, and it still accounts for a substantial part of the EU budget, amounting to 31% in 2021-2027 (EU, 2021). The CAP has evolved from a production support instrument (price support) to a production-independent instrument with area payments, in which environmental, food safety and animal welfare cross-compliance have become more important. Since 2023, the CAP has been modified to bring it in line with the European Commission's sustainability ambitions. Part of the income support that farmers can receive from the CAP now depends on the efforts they make to enhance the sustainability of their operational management.

However, there is a potentially significant about-turn contained within the European Green Deal, an ambitious package (**Figure 2.3**) of policy intentions from the European Commission with the overarching goal of making the EU fully climate neutral by 2050. The Green Deal is made up of components such as the Farm to Fork strategy, the Bio-economy Strategy and the Biodiversity Strategy, which aim to accelerate the transition to a sustainable agri-food system. From the EU's perspective this means ensuring that the food system delivers food security, health and affordability, while at the same time having a neutral or even positive impact on the environment, reversing biodiversity loss, contributing to the Green Deal's climate targets and adapting to the already unavoidable impacts of climate change.

When it comes to nature conservation, European regulations such as the Birds and Habitats Directives already play a significant role in framing spatial development options and economic activity in the Netherlands. The current nitrogen crisis is clear evidence of this. The same applies to policies on water quality and groundwater recharge set out in the Water Framework Directive (WFD) and the Nitrates Directive. Some final key components are the idea that no one be left behind (a 'just', or equitable transition) and aspects of distribution among people (food, health, income, education, etc.).

2.1.3 Room for manoeuvre

The aforementioned international agreements and treaties determine the available bandwidth when it comes to interventions in agriculture, food and nature in the Netherlands. This bandwidth is further limited by the physical, climatic, agronomic (including soil), hydrological and natural circumstances of the Netherlands (with policy often based on the 'water and

soil guiding' principle[1]). That bandwidth will also often vary between one area and another, for example due to differences in the suitability of soils for particular forms of agriculture or differences in the vulnerability and resilience of different ecosystems.

Furthermore, food production in the Netherlands is structured in a variety of ways: technologically, economically, institutionally and spatially. Once a certain path has been chosen (such as highly specialised production or a focus on export markets) there will be ramifications for subsequent choices, i.e. path dependence (Vink & Boezeman, 2018). This, too, has an impact on how much room there is for manoeuvre by actors in the agriculture, food and nature space.

2.1.4 National policies, laws and regulations

Global challenges (such as climate change and biodiversity loss) are being addressed through international and European agreements. These agreements are then translated into national and/or international laws and regulations. For the purpose of this report, we do not elaborate on the influence of national regulations, not least because this report is mainly intended to serve as a contribution to the national debate.

2.1.5 National circumstances, knowledge and skills

National circumstances may affect the strategic space for alternative visions for the future of agriculture, food and nature in our country. In **Figure 2.1** we refer specifically to existing national policy choices and laws and regulations, the knowledge, technology and skills available to us, and the social debate. But cultural preferences, for example with regard to food and nature, could equally be included. Here, we consider these national circumstances to be more influential than the international component and the broader challenges mentioned above. They may change over time, possibly as an outcome of us exploring perspectives of other food systems.

2.2 Conceptual frameworks: ways of looking at agriculture, food and nature

A variety of dilemmas – some smaller, some larger – come into play when we consider the need for a future-proof system of agriculture, food and nature. The following chapter highlights some of the more prominent dilemmas and discusses them in more detail. In this section, we consider agriculture, food and nature in a generic way by looking at:

1. *cultural mindsets*: this is about the different paradigms and attitudes that exist around agriculture, food and nature;
2. *the theory of aspects,* which allows for a better understanding of complexities regarding agriculture, food and nature;
3. *safe and just operating space,* which provides a way of thinking within the two essential dimensions of sustainability: biophysical boundaries and social justice.

Together, these concepts provide a framework for understanding how different positions and choices arise within the social debate. The selection of these three concepts is not meant to be exhaustive (there is much more available in the literature), but rather as a complementary trio to help us maintain a broad overview of the possible values and issues at stake. By doing this we want to reduce the risk of us disregarding prominent but less topical issues and values, or overlooking possible trade-offs.

2.2.1 Cultural mindsets with regard to agriculture and nature

The way that people think about agriculture and nature is often based on a variety of cultural mindsets. These mindsets are similar to the concept of paradigms in science. They consist of fundamental principles, standards and values by which we try to understand the world around us. Different mindsets thus lead to different frames and discourses in literature, media and the social debate. Every type of mindset looks at agriculture and food issues in its own way, comes up with its own diagnosis and offers its own solutions. A variety of mindsets might co-exist within individual cultures and communities. Moreover, they are not static: they can change over time under the influence of social, economic and political changes.

[1] https://www.rijksoverheid.nl/actueel/nieuws/2022/11/25/kabinet-maakt-water-en-bodem-sturend-bij-ruimtelijke-keuzes

The following are some examples of possible cultural mindsets with regard to agriculture and nature.

I. **Productivism** – agriculture as a means of achieving prosperity. This can lead to intensive farming methods that can be productive and efficient on the one hand, while on the other hand also depleting natural resources or causing high levels of local emissions. The Dutch agricultural sector is known for its innovative and efficient production methods, drawing on technology and modern farming techniques. This is often seen as an important way of strengthening the competitive advantage of Dutch farmers and of contributing to the economy (low food prices create added value).
II. **Agrarianism** – this is a mindset that emphasises the importance of a healthy and sustainable agricultural community as a foundation of a healthy society, and also strives to achieve a harmonious relationship between agriculture and nature. Agriculture and rural life are central to this. People with an agrarian mindset often have a deep respect for agriculture and the people who do the work, and they may feel a strong connection with the land and nature.
III. **Conservatism** – agriculture is practised with respect for nature and the environment. Farming practices are often aimed at maintaining long-term soil fertility. Conservatism in agriculture can be seen as a reaction to the modernisation of farming, with more and more technology and science being used to improve agricultural crops and animals.
IV. **Stewardship** – this signifies our responsibility as human beings to manage and conserve the natural environment and natural resources. As stewards of the planet, we have a responsibility to use natural resources in a sustainable manner and to protect them. This means working to reduce our ecological footprint and focusing on the use of renewable energy sources, reducing waste and pollution and protecting endangered species and their habitat.
V. **Holism** – the holistic approach to agriculture and nature emphasises the importance of a balanced relationship between humans, animals and the natural environment and aims for sustainable agricultural practices that make a positive contribution to the health of the planet and of its inhabitants. An important aspect of holism in agriculture is the use of ecological principles to improve and maintain soil health and fertility, and avoiding the use of external inputs as much as possible.

2.2.2 Fifteen aspects of agriculture, food and nature

According to the theory of aspects by the philosopher Herman Dooyeweerd (1894-1977), there are a number of very different types of questions (aspects) that can be applied to phenomena in real life. Dooyeweerd's guiding principle is that all aspects are important. No particular aspects are presumed to be more deserving of attention than others. This is an important guiding principle in the debate about agriculture, food and nature, where there is a tendency to be absolutist about some of these aspects at the expense of paying attention to others. We have slightly adjusted the aspects to better reflect the theme of agriculture, food and nature. The aspects have been organised in such a way that they move from the quantitative and physical to the moral and metaphysical. Each aspect has a specific focus on the various scientific disciplines, from mathematics to philosophy and theology. This framework has been widely used over the past few decades: it has been used as a simple checklist, but also as an evaluation framework with regard to sustainable development in the built environment (Brandon & Lombardi, 2010) and for the creation of a systems perspective for scaling up agricultural innovations (Wigboldus et al., 2016).

The framework consists of 15 aspects and related issues to consider with regard to visions of the future of agriculture, food and nature in the Netherlands, and also outlines a number of related questions. For each issue, there are specific things to consider. For example, when questioning the extent to which agriculture and nature should be separate ('spared') or integrated ('shared'), spatial considerations are particularly relevant. But that is certainly not the only consideration. Each issue will involve a variety of considerations. The nitrogen issue is also not solely about ecological considerations: it also involves numerical (how much nitrogen) and formative considerations around the desirability and feasibility of other practices (such as 'innovations') and legal considerations around assurance and enforcement. See (**Figure 2.4**).

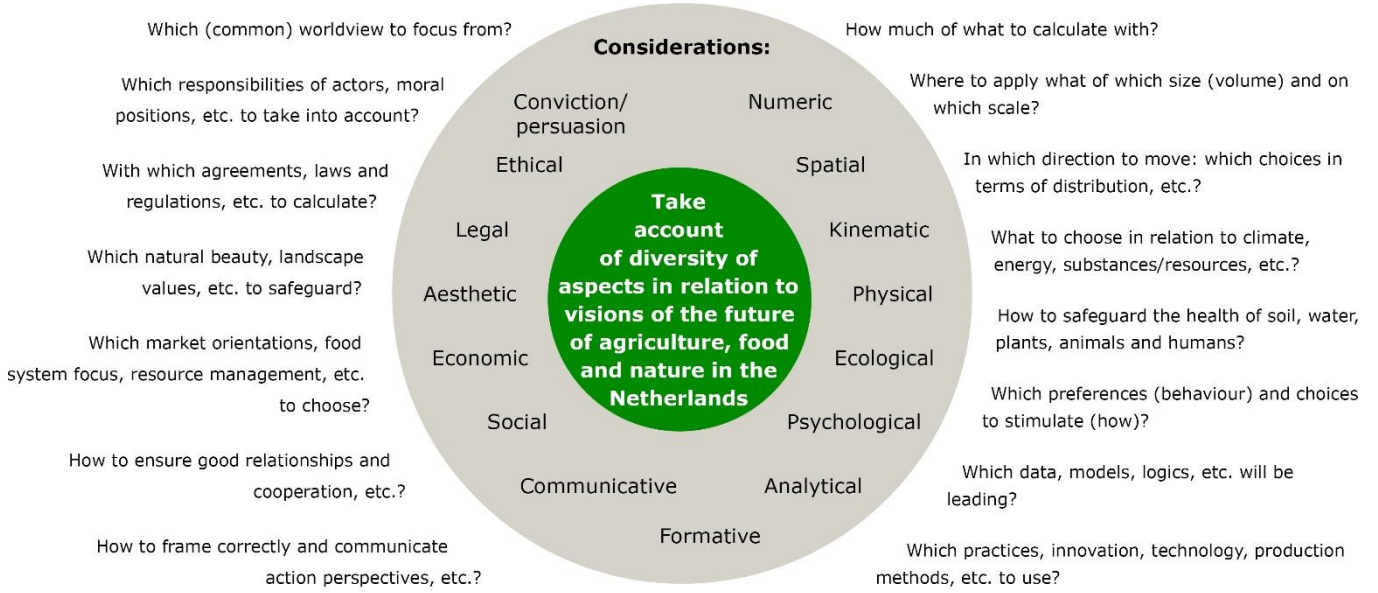


Figure 2.4 *Aspects of visions of the future in relation to agriculture, food and nature in the Netherlands, with some examples of the types of questions that arise.*

In practice, it is common for visions of the future to emphasise only a limited number of aspects, and to overlook other important considerations. This might be because the people involved all work within a particular discipline. This creates the risk of other important disadvantages and trade-offs being left out of the picture. The structure of the 15 aspects can help build a more comprehensive perspective that does justice to all these different considerations (Wigboldus & Jochemsen, 2021).

2.2.3 Towards a Safe & Just Operating Space

Dooyeweerd's theory of aspects (see **Figure 2.4**) addresses both physical and quantitative issues (right-hand side) and social, economic and spiritual ones (left-hand side). This corresponds to contemporary approaches to sustainability, where the concept is broken down into two types of boundaries: planetary and social. Many will be familiar with how Raworth (2017) expressed this in terms of a donut model, essentially saying that human activities should stay within planetary boundaries as well as ensure an equitable distribution of wealth among current and future generations. This is in contrast to focusing excessively on economic growth and income. Economics literature has also explored this approach through the concept of the 'Safe and Just Operating Space'. The term refers to the 'sweet spot' of human communities, where everyone's needs are met ('just') within the physical and ecological boundaries of the planet ('safe'). That is not straightforward. As **Figure 2.5** shows, although industrialised countries such as Germany, the Netherlands and the United States of America have reached high levels of prosperity and well-being, this has been achieved by substantially exceeding biophysical boundaries (quadrant C on the top right). Conversely, while other countries such as India and Indonesia remain within planetary boundaries, they are a long way from achieving prosperity and well-being for all (quadrant A on the bottom left). There are also countries that do not reach social well-being thresholds but do still exceed planetary boundaries (China, Russia, Mexico, Turkey: quadrant B). The development path we have seen in recent decades is from A to B to C, with almost no progress from C to D. This ABC path brings us to improved human well-being, but it also means we substantially exceed planetary boundaries.

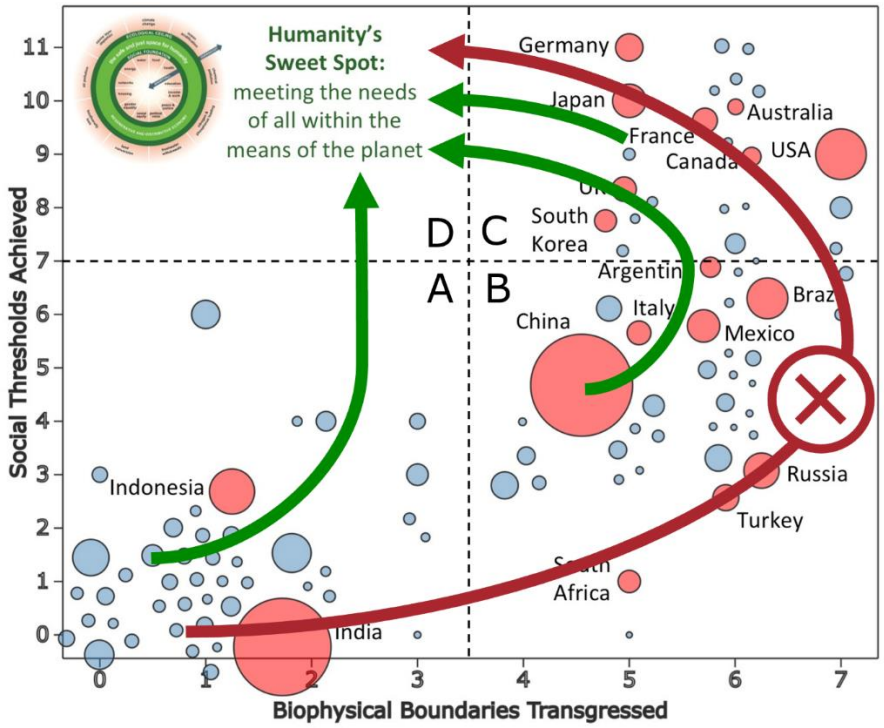


Figure 2.5 *The Sweet Spot of human communities (Raworth, 2018).*

Figure 2.5 shows that as yet no countries have reached 'humanity's sweet spot'. The red arrow indicates the historical development path of different countries. The green arrows indicate how countries should ideally reach the Sweet Spot. A major challenge for countries in the Global North is to redirect their development paths to stay within planetary boundaries (this would partly involve reducing consumption, as well as changing the nature of consumption). For countries in the Global South, the challenge is to avoid following blindly in the footsteps of the Global North. Instead, the Global South could learn from the experience of the Global North and the insights gleaned there, as a way of leapfrogging over the most damaging development steps. The field of sustainability transition research (Köhler et al., 2019) and thinking about leverage points for shifting systems (see Meadows, 1999) can help with that.

2.3 Perspectives on agriculture, food and nature

2.3.1 Analysis of existing WUR visions and perspectives

Wageningen's perspective on agriculture, food and nature is informed by a range of visions developed within and beyond WUR by scientists from very different disciplines. These visions were analysed on a number of aspects, including the central challenges, the solutions proposed or studied, and the envisaged future situation.

With regard to the challenges, the visions overlap quite substantially in terms of both their nature and scope. The key challenges that a future food system must address are regularly cited as being climate change and the need to mitigate it, restoring biodiversity, ensuring sufficient good food and other raw materials for a growing world population, and the importance of healthier consumption patterns for global public health.

However, the solutions proposed for these visions differ somewhat, and this mainly stems from an emphasis on one particular challenge or another, the perspective of the study (e.g. nature, agriculture, health), the scale (global, European, national or regional) as well as the time horizon (e.g. 2030, 2050, 2120) and associated visions of the future.

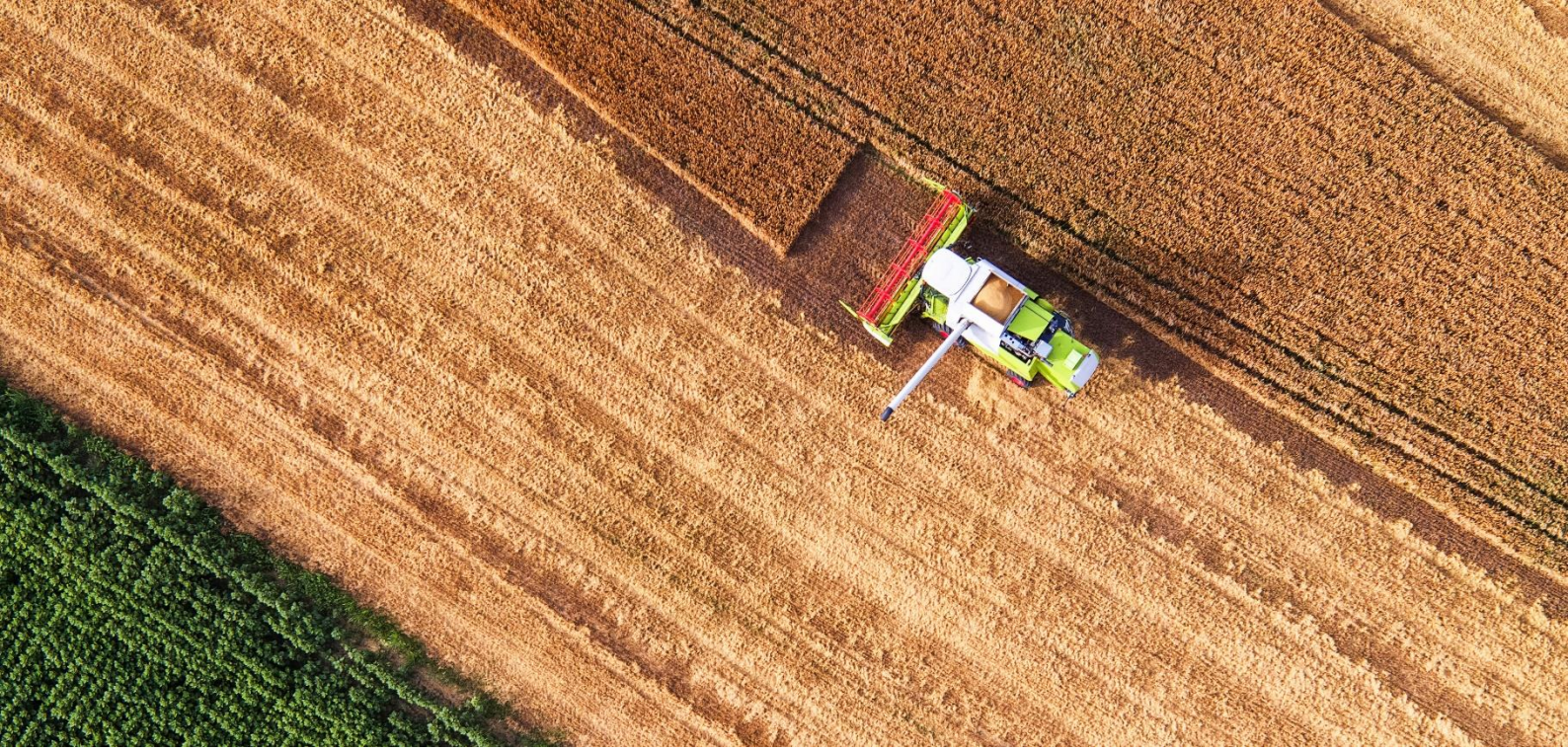
For example, it is striking that the visions of the future expressed in studies and visions with a distant time horizon are much more ambitious and disruptive, because our current circumstances and associated lock-ins provide less of a constraint. In addition, the perspective and expertise underlying the vision often also determine which challenges are emphasised. For instance, visions based on the nature and ecology angle tend to focus on biodiversity restoration and climate change, with food production being an additional requirement. They also often focus more on nature-based solutions. Visions based on the agriculture and production angle often have a clear emphasis on sufficient and high-quality food production for a growing world population, with a minimal or positive impact on

the climate and biodiversity and often with a focus on more technological solutions. Applying such a focus makes perfect sense as the visions and perspectives have often developed out of a more specific issue. However, the challenge now is to successfully bring all this together into a broad and comprehensive perspective.

The different visions often feature some of the following lines of thought:

- a focus on humane food production (rather than animal feed production) and a shift in the global diet from animal to plant-based (the protein transition), as a way of reducing our impact on the climate and on biodiversity while also enabling sufficient space for food production for a growing global population. In this context, we also see an increasing emphasis on multiple forms of biomass valorisation (e.g. for food as well as non-food applications);
- regenerative, agroecological and/or nature-inclusive agriculture, in which the agroecosystem is also used for nature-based solutions to make it resilient and to bring about a positive impact on the climate, biodiversity and living environments. Such visions often refer to the use of technology to support these natural processes (agroecology and technology);
- high-tech and data-driven farming systems to increase resource efficiency, thereby reducing impacts on the climate, biodiversity and living environments, while contributing to high-quality food production for a growing global population;
- behavioural change among consumers (voluntary or otherwise), so that they make better choices with positive environmental impacts;
- nature-based solutions to address challenges related to climate change (mitigation and adaptation) while also contributing to improvements in people's quality of life.

In the following chapter, we elaborate on this based on six main dilemmas. While our initial analysis of WUR visions and perspectives have revealed these six dilemmas to be the most pertinent (as shown in Appendix 1), we do not claim they are exhaustive.



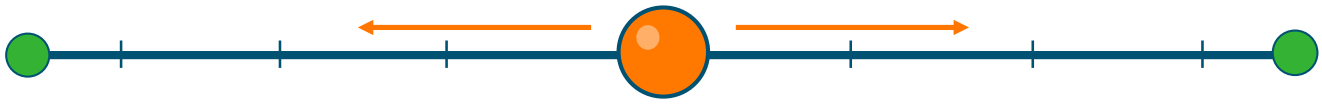
3 Six fundamental dilemmas

Based on a review of WUR studies and visions related to the nexus of agriculture, food and nature, we identified six dilemmas. We do not claim that these are the only dilemmas. However, they are six fundamental choices and they will have a major impact on the future of agriculture, food and nature in the Netherlands. See Fout! Verwijzingsbron niet gevonden..

Figure 3.1 *The six dilemmas based on WUR studies and visions (illustration: Clasp Visuals).*

3.1 Dilemma 1: How will the Netherlands contribute to the global food supply?

How will the Netherlands contribute to the global food supply?



Food **Knowledge and innovation**

By 2050, the global population is expected to have reached 9.7 billion people (UN, 2022). How can this growing population be fed, and how do we do it in a sustainable way? There are still 800 million hungry people, and the number is growing again, partly due to the COVID-19 and Ukraine crises. On top of that, 2.3 billion people still lack food security, while at the same time overweight and obesity are reaching epidemic proportions, partly due to a lack of access to quality food. As such, the global food issue is also largely a distribution issue. The Netherlands has favourable natural conditions and is one of the most innovative countries in the agriculture and horticulture sectors, and a major exporter. This means it can play an important role in the global food supply. The Netherlands is also a transit country with large volumes of imports and exports of agricultural and food products, and its agricultural complex contributes substantially to national income. This then raises the question of what contribution we want to make to the global food system and its related issues. At present, many primary and processed products (meat, dairy, eggs, fruit & vegetables) are produced in the Netherlands and exported to our neighbouring countries. We have a much more international scope when it comes to propagation materials and ornamental plant products, as well as knowledge and technology. So another question must be: at what scale do we want to contribute? Do we target the Dutch market, north-west Europe (currently our largest market) or the global market? And which products do we focus on? Do we concentrate mainly on primary production or on propagation materials, technology and knowledge?

Meanwhile, some choices are also intertwined: for example, scenario studies show that even with a substantial change in our consumption patterns, the Netherlands has barely enough agricultural land to be self-sufficient in food (autarky). In other words: given its current patterns of consumption, the Netherlands is already not in a position to be self-sufficient in food, and is far too small to make a substantial contribution to the food supply on a larger scale (at the EU or global level) through direct food production alone. The most significant way for the Netherlands to contribute to the global food supply will be by concentrating even more than we do already on propagation materials, technology and knowledge. This might mean that the Netherlands will become even more dependent on food imports than it is now. To mitigate the associated geopolitical and economic risks, the Netherlands (and the EU) could also focus on developing production units abroad.

3.1.1 The importance of this dilemma

The Netherlands is ideally suited for agriculture and horticulture, partly because of its geographical features (a flat landscape and fertile soils), its mild climate, and its location (a central position in north-west Europe, with access to major waterways). But land in the Netherlands is relatively scarce, and the Netherlands is one of the most densely populated countries in the world, with an important role in international trade and in the processing of raw materials brought in via seaports. These factors, combined with its knowledge, innovation and the incentive to intensify production, have meant that for decades now the Netherlands has made a substantial contribution to meeting global food demand.

However, we note that most exports are destined to remain in Europe, with Germany and Belgium being the main export countries, followed by France and the UK. Moreover, the position of the Netherlands as a major exporter of agri-food products is based on export value, and not primarily on volume. About a third of exports are also actually re-exports of imported products, with two thirds being based on products actually produced in the Netherlands. Finally, the Netherlands has a sizeable food processing industry, which relies heavily on imported raw materials. That processing produces a wide variety of waste streams, which in turn serve as an important raw material for intensive livestock farming in the Netherlands (Jukema et al., 2023).

There are a number of reasons why the Netherlands should consider its position as it plans for the future. On the one hand, agriculture in the Netherlands is facing a variety of significant sustainability challenges, such as climate change mitigation and adaptation, biodiversity restoration, housing, urbanisation and energy (Baptist et al., 2019). At the same time, the impacts of climate change are likely to lead to an increase rather than a decrease in the relative and strategic importance of the Netherlands as a producer country. While the effects of climate change are being felt in temperate zones such as north-west Europe, it is in southern Europe (along with other parts of the world) that food production is already being much more affected by worsening water shortages and higher temperatures (EEA, 2019).

For the Netherlands, then, there is an increasingly pressing question about what role the country wants to play in supplying food to Europe and the rest of the world. On top of that, the biobased economy is also dependent on raw materials from agriculture and forestry, putting further pressure on land use. The other side of the coin is that there is only a limited amount of available space in the Netherlands, and that space is under pressure with nature, housing, infrastructure and energy production all making claims on it. This means that there will be less space available for agricultural purposes in the future. The export of agricultural and horticultural products is also important to the Dutch economy, and contributes to prosperity and employment. In considering this issue, we must therefore also weigh up the impact on the Dutch economy. Finally, as part of the EU, the Netherlands has to comply with a number of rules, including European agricultural, environmental and climate policies (e.g. the Green Deal), as well as open trade borders within Europe. There is a limit to the choices available to the Netherlands.

So the question is: what contribution is the Netherlands willing and able to make to the world food supply, based on less available land and the need to operate within ecological boundaries? Which products and/or services would we focus on, and on what scale are we willing and able to contribute?

3.1.2 Examples of options

The Netherlands could opt to fully maximise its contribution to the world's food supply on a global scale. By supplying propagation materials, innovation and knowledge development through international partnerships, the Netherlands could contribute to the development of sustainable food systems in other countries. This strategy would require less agricultural land within the Netherlands, as the cultivation of propagation materials requires relatively little land. At the same time, the production of high-quality propagation materials does require a relatively large level of inputs, including good soil, skilled labour, crop protection agents, energy and technology. This strategy therefore translates to an intensification of the agricultural sector within a smaller area.

At the same time, innovative companies and research institutes in the agri-food sector would also need some assurance of a domestic market. This means that the domestic agriculture and horticulture sector would need to still operate at a certain scale, as would the supply and processing chains in the Netherlands. In this scenario, while a certain level of primary production would remain on Dutch soil, the Netherlands would become even more dependent on food imports.

This also calls for a focus on the business and innovation climate in the Netherlands, and sufficient support for international partnerships. It is important also to note here that innovations and knowledge within the Netherlands emerge out of a Western context, which is not necessarily equivalent to other countries and continents. This pertains not just to climatic or soil differences, but also to cultural differences. For example, there may be divergent views on animal husbandry and the use of technology (including genetics), but there may also be differences in partnership styles, power dynamics and the role of the government.

A totally contrasting position would be one based on a vision in which the Netherlands more or less withdraws from the international playing field in terms of agricultural production. In its current form, the agriculture and horticulture sector in the Netherlands is difficult to sustain, and this is due in part to environmental and biodiversity issues in the Netherlands, the need for land for non-agricultural functions and a lack of succession planning and labour (including seasonal labour). The pursuit of innovation as a way of resolving this would also lead to significant cost increases, making the Dutch sector uncompetitive compared to other countries. Whatever agriculture we are then left with would need a different revenue model, focused on local markets and short chains, supported by payments for ecosystem services and social functions. This may lead to the Netherlands becoming much more dependent on food imports from other countries than it is now. It would also mean losing the agri-food trade and export sector, which at present is a significant contributor to the Dutch economy. In addition, the Netherlands would be passing on some of its problems to other countries, with production needing to be based in those places and generating the associated impacts on the environment and local surroundings.

There is a third position, and this one is based on a European agricultural food strategy. This centres on the question of how Europe could become more self-sufficient in the face of global geopolitical instability. That question raises a number of complicated tensions: on balance, the amount of available agricultural land is decreasing, partly due to climate change, nature development and urbanisation, while at the same time agricultural productivity is also decreasing due to climate change. However, this does not apply everywhere. There are in fact regions that are benefiting from climate change and the trend for the extensification of agriculture. In addition, agriculture relies quite heavily on a number of inputs that will not necessarily continue to be available and affordable:

- fossil energy, which is currently also crucial for nitrogen fertiliser production;
- phosphate and potash, for which Europe currently relies heavily on other countries such as Belarus and Morocco;
- labour and water.

The question, then, is about where in Europe we can produce enough food and how we can make available the necessary inputs. Some obvious candidates would be the temperate zones (the Atlantic coast, and north and north-west Europe), because the effects of climate change are less profound in those areas than they are in southern Europe. In short, the Netherlands is likely to become relatively more important rather than less important when it comes to assuring Europe's food supply. This also requires us to make some importance choices, including about whether to keep agricultural land available for agriculture, whether to prioritise food over ornamental plant cultivation or biobased raw materials, and whether to choose sustainable intensification over extensification.

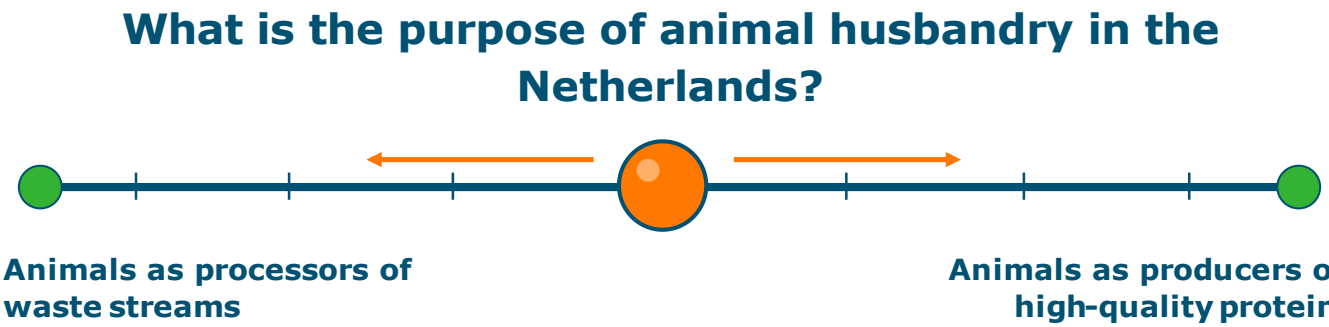
3.1.3 The debate in the Netherlands

The potential role of the Netherlands in the global food supply has been the subject of debate for many years. The number of hungry people in the world keeps going up, while a large proportion lack access to sufficient, affordable and good-quality food, and global food markets have become much more unstable (FAO, 2023). In the past, this discussion was often about identifying the most effective approach. Development aid therefore became development cooperation. The role of Western businesses also increased, not just because of the economic importance of the West, but also because it was thought that this would deliver more lasting impact.

The debate now is more about the moral issues: there is no longer an assumption that society as a whole takes pride in the Dutch agri-food sector. This has also called into question the assumption of serving as an international role model. The public debate now questions the way the Dutch model emphasises agricultural and technological innovation, productivity and efficiency, and the dissemination of this model to other countries. There is also criticism of the neo-liberal world order, weakening the strength of the social argument that favours exports and economic value. Furthermore, the public debate about the colonial history of the Netherlands has also reinforced the question of how the country (and the West in general) contributes to the global food supply. Is there a moral obligation for the Netherlands to contribute substantially to the world food supply, and is it therefore right to export food and propagation materials to countries that do not produce enough food for their own people and where people are hungry? Or does this in practice lead to the imposition of Western values and to social injustice; and by exporting Dutch products, are we actually constraining the development of food production in these countries? Another highly morally charged discussion is about what we want to use Dutch agricultural land for. If we scale down and extensify agriculture in the Netherlands, production (assuming consumption remains constant) will move abroad, where production methods are often less sustainable and animal-friendly. At the same time, this is also often used as an excuse to preserve Dutch agriculture in its current form. Do we want to use high-quality Dutch agricultural land for food, fodder, ornamental plants, solar energy or biobased applications (such as bioenergy and biomaterials)?

Finally, there are a number of reasons why it makes sense to approach this debate at a north-west European scale and to place it in the context of Europe and the world as a whole. The Netherlands is part of an open European market and most of its trade in agricultural and horticultural products is done with its neighbouring countries. Many supply chain actors also operate on this scale. There is also a more or less level playing field for agriculture and food within the European context. If we seek solutions on a national or regional scale, this will rapidly lead to all sorts of conflicts within this European context, and on a larger scale to trade-offs with the rest of Europe and the world.

3.2 Dilemma 2: What is the purpose of animal husbandry in the Netherlands?



Here in the Netherlands we share a relatively small country with 99.9 million chickens, 11.4 million pigs, 3.8 million cattle, 850,000 sheep and 480,000 goats (CBS, 2021). This is made possible through the import of raw materials for fodder and the availability of large quantities of waste streams from the food-processing industry, which uses some raw materials from the Netherlands but mainly relies on imports from other countries. The size of the livestock population has a major impact on people, the climate, the environment and biodiversity. For decades now there has been a long-standing question about how we might improve the design of animal husbandry, and how large the sector should be. Do we continue to use our animal husbandry sector primarily to respond to the European (and global) demand for high-quality animal proteins and use high-quality feed for this purpose, when it would be more efficient for some of that to be consumed directly by humans? Or do we choose to feed our animals solely with available raw materials that people either cannot or do not want to eat, such as grass, waste streams and by-products? The answer to that question will partly determine the size of the livestock population.

3.2.1 The importance of this dilemma

Given the expected growth in the global population and rising prosperity, historical and current trends tell us that, in the absence of any interventions, the global demand for animal proteins will also increase (Fresco & Poppe, 2016). For example, the economic growth that many countries in Africa and Asia have experienced in recent decades has increased the size of the socio-economic middle class in those countries, and with it the consumption of animal proteins (Van 't Veer et al., 2017). Traditionally, animals were fed with crops and food scraps that people had no use for, but these days global livestock farming competes heavily for agricultural land and water, in order to grow feed ingredients such as soy, maize and grain to meet global demand. Of the globally available agricultural land, 75-80% is used for animal protein production (Our World in Data, 2019b). About 45% of that land area is arable land that could also be used to produce food directly for human consumption. Fodder production for livestock also leads to significant land use change (such as deforestation) in other parts of the world. In addition, animal husbandry has negative impacts on the climate, environment and biodiversity through, for example, greenhouse gas and nitrogen emissions. There are also concerns about the spread of animal diseases and antibiotic resistance. High densities of livestock near people also increase the public health risk from zoonotic diseases (Hagenaars et al., 2022). At the same time, dairy farming in particular is very important for the management of grassland which, if managed properly, can actually also make a positive contribution to climate goals, biodiversity and nitrogen emissions, and provide other ecosystem services (Louis Bolk Institute, 2023).

In the Netherlands, land-based livestock farming, including dairy farming, is found in every province and on all soil types (peat, sand, clay, and loess). Intensive livestock farming (pigs, poultry, goats) is concentrated more on the sandy soils of the east and south of the country and is not really land based. Both conventional dairy farming and intensive livestock farming rely heavily on fodder imports from elsewhere in Europe (mainly grain) and the rest of the world (mainly soya). But even in the Netherlands, fodder crops and grass for livestock are grown on soils (sand and clay) that are also suitable for growing crops for human consumption.

3.2.2 Examples of options

The Netherlands could opt to remain an important exporting country for animal proteins, especially given its strong position in terms of knowledge, logistics, infrastructure and supply chains. If it did, those exports would also continue to be matched by large imports of

feed ingredients, which automatically means a substantial level of manure production in the livestock sector. Reducing the ecological impact on the climate and biodiversity without reducing the livestock population would require major adaptations to technology and feed systems, including feed additives and new stall systems and forms of manure processing, for example. In practice, the impact of many of these innovations is often disappointing. These husbandry systems are also more difficult to reconcile with the idea of animal dignity, as advocated by the Council on Animal Affairs (RDA, 2021). In addition, the cost of these technological adaptations leads to an uneven playing field compared to livestock farming in other countries. High livestock densities also increase the public health risk of zoonoses and their potential to cause pandemics, as currently seen with avian influenza in poultry and wild birds. The production of feed ingredients in the Netherlands (and especially elsewhere) for the Dutch livestock industry will also continue to compete with the production of crops suitable for human consumption.

One alternative vision of the function of animal husbandry in the Netherlands is based on the availability of raw materials and waste streams that do not compete with human consumption, and uses this as a starting point to determine the scale of the sector. Other than the aforementioned break crops and co-products, these can also include other waste streams from the food industry and retail sector, such as products past their sell-by date. In this more circular system, the primary function of animals becomes the upgrading of those waste streams, and the number of animals to be kept within a given region is determined by the availability of those waste streams, rather than by the global demand for animal products (De Boer & Van Ittersum, 2018; Van Zanten, 2016; Van Hal, 2020). In such a circular system, animal husbandry could provide a meaningful but smaller proportion (9-23 g/per person) of our daily (50-60 g/per person) protein requirements (Van Zanten et al., 2018). This system requires much less agricultural land to produce fodder, and that land can instead be used to produce food for human consumption or for other, non-agricultural purposes. The consequence of applying this principle globally would be a need to reduce the current daily intake of animal proteins in high-income countries (currently 59 g/per person) so that low-income countries can also meet their animal protein needs. This could be achieved by partially switching to plant-based proteins in high-income countries.

However, this does not change the fact that even in an arable system fully geared towards human consumption, relatively large amounts of feed ingredients would still be produced, either directly or indirectly. These would include break crops like grass/clover and the many co-products that come out of the food-processing industry, such as sugar beet, hard wheat, malting barley, chipping potatoes and vegetables. However, those product flows are nowhere near enough to match the current size of the Dutch livestock sector.

Under this scenario we would also need to take into account that there will be greater competition in the future for the production and waste streams of biomass unsuitable for human purposes. These include raw materials for construction and, to a lesser extent, energy (Pyett et al., 2019). This could further limit availability for fodder.

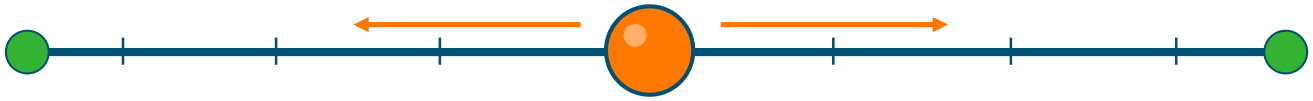
Finally, some dairy farming is carried out in peatland areas. This covers about a third of the total land area of the Netherlands. Grass is just about the only thing that can be grown on peatlands. In the context of the perspective described above, these areas would be highly suitable for animals, given that humans cannot eat grass. Also, given our climate commitments, the water levels need to be raised in many of these polders as a way of combating peat oxidation (as well as subsidence). However, raising the water level puts pressure on the long-standing practice of dairy farming in its various forms, as do related ecosystem services such as meadow bird management.

3.2.3 The debate in the Netherlands

The scale and structure of animal husbandry in the Netherlands had already been a topic of debate for some time, but ever since the emergence of the 'nitrogen crisis' it has become a major issue for politicians and society as a whole. There are all kinds of underlying issues at play in this debate, such as animal welfare, the impact on the health of local residents, the impact on nature and the environment, the economic pros and cons, etc. As far as we are concerned, it is important to start by interrogating the purpose of animal husbandry in the Netherlands. The answer to this question will largely determine the size and structure of the livestock sector. At the size it is now, if the livestock sector were to rely on technological means to mitigate undesirable environmental impacts it would have a major challenge in terms of international competitiveness and animal dignity. If the sector were to focus primarily on feed ingredients based on products unsuitable for humans, it would by definition be much smaller than it is today, but also less likely to exceed environmental boundaries. The consequence then would be that animal products would become scarcer and more expensive, and we would need to see substantial changes in consumption patterns (and hence cultural behaviour).

3.3 Dilemma 3: What is the moral position of animals in our food supply?

What is the moral position of animals in our food supply?



Animals as beings with feelings, consciousness and rights

Animals as subordinate to humans; man's duty of care

The domestication of animals is an integral part of human history, with animals being kept to fulfil various needs, including consumption by humans. There has been a growing focus over the past few decades – both in the Netherlands and in other parts of the western world – on the quality of life of animals, i.e. animal health and welfare. These concerns have also increasingly become translated into legislation and into market concepts designed to deliver improvements. Recently, the RDA (2021) proposed the concept of 'animal dignity' as a moral lower limit, and this principle was also adopted in the coalition agreement. However, the underlying assumption remains that it is morally justified to keep and take the lives of animals for the benefit of humans.

But there is a growing school of thought (both within philosophy and ethics as well as among wider society) that goes a step further by challenging that assumption too. One of the founders of this school of thought is Peter Singer, who in his book *Animal Liberation* (1975) elaborates on the argument that there is no reason to treat humans differently from other animals in terms of their right to happiness. This work underpins the idea that animals have specific rights too, and that we should incorporate those into our legal system. The place of animals in our moral, legal and democratic system has been more closely scrutinised since then, and there is now even an established party in parliament that aims to speak up for animals.

While the previous dilemma focused mainly on the function of animals in our food system, this dilemma concerns the more fundamental, underlying ethical question of whether animals and their functions are something that humans can consider to be at their own disposal.

3.3.1 The importance of this dilemma

The welfare of animals kept as livestock has improved in many ways over the past 25 years. But in most instances, animals in the livestock sector cannot yet be said to have a life that complies with all the principles of humane animal husbandry, as articulated by the RDA (2021). There is still strong social and political pressure to make further improvements, and as part of that process the political debate is also shifting from incremental improvements to more systemic changes in the way animals are kept. For example, the adopted amendment to the Animals Act put forward by the MP Leonie Vestering (Parliamentary Paper 35 398), strengthens the ban on animal cruelty to the extent that it is no longer permissible to hurt or cause injury to an animal, or impair an animal's health or welfare, where the purpose is to enable the animal to be housed in a particular way. The public perspective on animal welfare thus continues to evolve, and there is a gradual but structural shift towards recognising the intrinsic value of animals and assigning them greater autonomy. To the extent that this trend continues, the role of animals in our food system will be increasingly scrutinised, and under the most radical scenario animals would be removed from the food system entirely. This will have repercussions on the structure of the food system.

3.3.2 Examples of options

All over the world, animals in general are still seen as creatures that are useful for human purposes, including consumption. From that point of view, it is valid to use them in the food system. The duty of care for the animal therefore remains with humans. In the Netherlands and in other western countries, this duty of care now also includes a sustained focus on improving the welfare of the animals we keep.

The more we regard animals as being equal to humans, and as creatures with feelings, consciousness and an absolute or perhaps even an equal right to happiness (Singer, 1975) and rights, the less we are able to justify using them for our own purposes. Under that scenario, it is even questionable whether animals can continue to play a role in the food system as processors of waste

streams made up of products considered unsuitable for human consumption. Those waste streams would then have to be upgraded in some other way (e.g. via refining) to avoid them being lost altogether, or quickly downgraded to compost or energy. Obviously, under such a scenario our consumption of animal proteins would necessarily be drastically reduced or eliminated.

3.3.3 The debate in the Netherlands

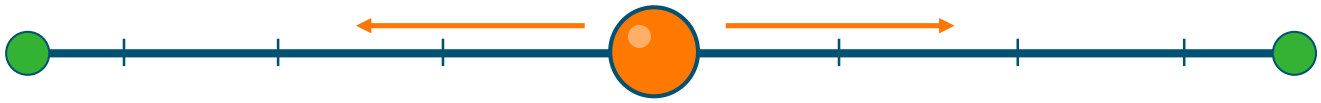
As mentioned above, Dutch society has over the years become increasingly vocal in calling for further improvements to animal health and welfare. There is also a fairly broad consensus on the duty of care we have over the animals we keep, and this duty is indeed enshrined in law.

Right now, the debate in the Netherlands is focused on what the RDA refers to as 'humane livestock farming' (RDA, 2021). This concept proposes six principles. The idea of animal dignity goes beyond preventing *negative* well-being, such as pain and illness, and focuses instead on the conditions required for a *positive emotional state*. This perspective is in line with growing scientific evidence on the importance of animals having some autonomy, control and positive experiences. Achieving this would require animal husbandry systems to be developed from an animal-based perspective and not primarily from the perspective of affordable animal production. The concept of animal dignity was included in the coalition agreement for the fourth Rutte cabinet (now the demissionary cabinet, at the time of writing).

It is worth noting that there are big differences around the world and even within Europe in the way that people think about the role of animals and the importance of animal welfare. The countries of north-west Europe (including the Netherlands) have led the way in terms of market concepts for non-statutory animal welfare requirements, but the trend is growing in the US and Canada too. Highly developed western economies are gradually working towards higher animal welfare standards. Elsewhere, the emphasis remains, for now, on using animals as efficiently as possible to keep costs down.

3.4 Dilemma 4: How many of the future climate and nature goals do we want to achieve within the Netherlands?

How many of the future climate and nature goals do we want to achieve within the Netherlands?



Trading goals **No trading of goals**

How might we achieve those future climate and nature goals? Should we try to achieve them within our own borders (no trading) or would approaching this at a European or global scale present opportunities for more effective and cost-efficient solutions (with trading)?

3.4.1 The importance of this dilemma

The Netherlands is legally committed to several climate and nature targets for the next 10 to 15 years, including those from the Climate Agreement, the Birds and Habitats Directive and Nature Network Netherlands. This dilemma is not about these established targets and agreements, but about climate and nature goals that have not yet been established or which are focused on the years beyond 2035. These would include the future climate and nature goals to emerge out of the Green Deal with the aim of being completely climate neutral by 2050. Or the Nature Restoration Act currently under development, which is aiming for all ecosystems to be restored by 2050, and at least 20% of them by 2030.

Although no frameworks have been established yet to determine whether this will including the trading of goals, this dilemma could ultimately be crucial in determining the development opportunities for both agriculture and nature in the Netherlands. For example, the study by (Lesschen et al., 2020) found that if European member states were able to differentiate their goals as part of efforts to achieve climate neutrality, the Netherlands would barely need to reduce its livestock population, if at all,[2] in order to reduce greenhouse gas emissions. But if the Netherlands needed to become climate neutral within its own borders, it would mean reducing the livestock population by between 20% (stricter productivity scenario) and 40% (stricter nature-inclusive scenario). The principle of trading goals means that targets can be set at the EU or global level and countries contribute to those targets to the extent that they can be achieved in the most effective and cost-effective way. This enables some trading of goals. If such trading were not possible, one country would not be able to compensate another.

Trading/compensation will not be possible for all targets. Many of the nature goals in the European Birds and Habitats Directives are linked to species and habitats specifically associated with the Netherlands. A good example is the importance of the delta environment in the Netherlands for birds (including migratory birds) and fish. Climate change and shifts in climate zones are expected to amplify the relative importance of this type of habitat in the Netherlands (Van Hinsberg et al., 2020).

At the same time, not all species and habitats covered by current EU regulations are actually unique to the Netherlands, and we know that some nature goals will be extremely difficult to achieve in the future in the Netherlands, partly as a result of climate change. Some of the nature goals will also have major impacts on other objectives that are currently a priority for the Netherlands (e.g. housing and infrastructure). The focus on the conservation of specific habitat types can also sometimes be at odds with a broader overall focus on the fundamental quality of the natural environment. The review of nature-inclusive future scenarios (Breman et al., 2022) showed that while not all of the nature objectives set out in the Birds and Habitats Directives can be achieved by applying nature-inclusive design to the Netherlands, it would substantially increase the fundamental quality of the natural environment and all kinds of related ecosystem services.

For those species and habitats that are also common beyond the Netherlands, it could be worth exploring whether and how they might be better protected there, and in a more effective and cost-effective way.

[2] These targets are based on the Paris Climate Agreement and not the Climate Neutral Europe targets set out in the Green Deal.

3.4.2 Examples of options

The dilemma has *trading goals* at one end of the spectrum and *no trading of goals* at the other end of the spectrum. Trading goals opens up opportunities to exploit the specific geographical, biophysical and socio-economic qualities of a country or area. For example, the Netherlands has far fewer options than Sweden when it comes to carbon sequestration in forests. That is why carbon sequestration in the sparsely populated and forested landscapes of Sweden rather than the densely populated Netherlands makes more sense from a cost-effectiveness perspective (Grafton et al., 2021). On the other hand, the Netherlands has peatland regions which also provide opportunities for carbon storage and possibly even additional carbon sequestration.

There is nothing new about countries trading climate goals. Since 2005, the EU Emission Trading System (ETS) has enabled companies and organisations based in European Union member states, plus a few additional European countries, to exchange emission allowances as part of efforts to reduce greenhouse gases. A similar system would need to be developed for trading related to other types of goals. A system like the ETS would provide flexibility and a way of implementing measures in a more effective and cost-efficient way.

However, the ETS system is also often seen as a complex system with a lot of regulations (Tang et al., 2020). It requires many mutual agreements and rules and can result in trade-offs and new forms of dependency. An example of such a trade-off is large-scale forest planting as a climate-effective measure, which can actually have disastrous effects from a biodiversity perspective.
Meanwhile, achieving climate and nature goals also has positive effects on our health and on the quality of our living environments, for example. A green living environment rich in biodiversity is important for a whole range of ecosystem services. Trading goals may also lead to undesirable consequences for our quality of life in the Netherlands.

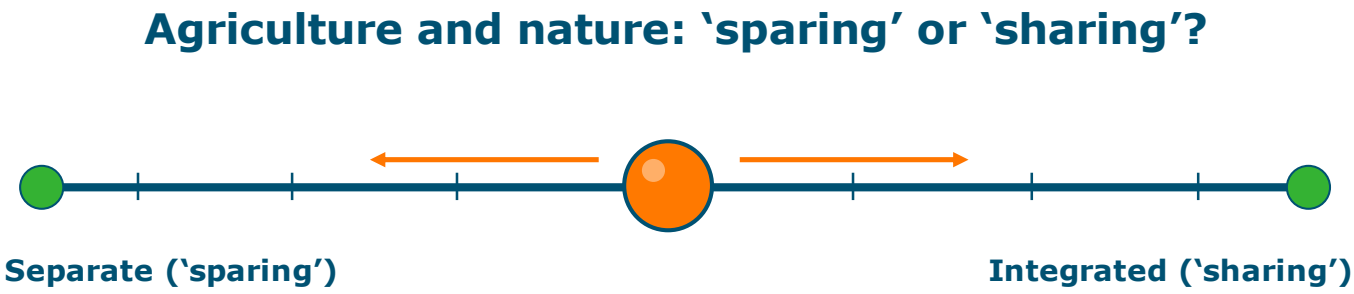
If we exclude the trading of goals in principle, then the achievement of any existing or future climate and nature goals will require us to design and organise the Netherlands in a fundamentally different way. This is in fact the path being pursued within the National Strategy on Spatial Planning and the Environment (NOVI) and the National Programme for Rural Areas (NPLG). European and national policies based on these comprehensive policy goals related to climate, water and nature provide points of departure for the Netherlands to make the transition to a nature-inclusive society with a climate-robust soil and water system. This is described in the parliamentary letter on the role of water and soil in spatial planning (Rijksoverheid, 2022). In their future perspective for the Netherlands in 2120, Baptist et al. (2019) describe the positive impact of nature-inclusive design on health, biodiversity and quality of life in our country. These potential benefits of a nature-inclusive design of the Netherlands are further substantiated in the Nature Outlook 2050 (Breman et al., 2022), which includes a calculation that the supply of ecosystem services would increase substantially.

3.4.3 The debate in the Netherlands

Currently, the debate in the Netherlands is still very much about the climate and nature goals that are in place for the next 10-15 years, and specifically about nitrogen. Meeting these goals has already proved to be a major challenge so far, and is currently a priority (LNV, 2022). The economic costs of these solutions tend to be very high. The focus on achieving short-term goals means that in practice there is still too little attention to long-term transitions, which then results in potentially undesirable effects and lock-ins. For example, the acute nitrogen challenge means that innovations are now in the pipeline that take little or no account of the water challenges that lie ahead (whether in relation to the EU Water Framework Directive or climate change). The availability of freshwater is one such issue.

Additional and related nature and climate goals are still under development, which means we do not yet know what trades might be possible and what the prerequisites would be. So this option is not on the table yet. Also, any potential trade would not need to be limited to climate and nature goals, but could also involve other goals such as healthy and sufficient food for all (see dilemma 1).

3.5 Dilemma 5: Agriculture and nature: sparing or sharing?



The question of whether we should separate agriculture and nature (land 'sparing') or integrate them (land 'sharing') is an important debate in the context of the restoration and conservation of nature and biodiversity. Both options are seen as ways of increasing food production and preserving nature and biodiversity (Bosch et al., 2020). However, opinions are strongly divided as to which is better (Paz et al., 2020). Is it better to perform agriculture on the most fertile and agriculturally suitable soils and protect large areas home to valuable natural life (land sparing)? Or are more extensive forms of agriculture combined with nature and transition zones a better solution (land sharing)?

3.5.1 The importance of this dilemma

The current intensification and expansion of agricultural land is expected to continue in order to satisfy the growing global demand for food (Bosch et al., 2020). However, there are serious concerns about the negative impacts this will have on the climate, environment and biodiversity. Over the past few decades, there has therefore been a great deal of debate about how to ensure we produce enough food while also reducing the impact of agriculture on the climate, environment and biodiversity. Land sparing and land sharing have been suggested as possible solutions.

3.5.2 Examples of options

Land sparing and land sharing sit at opposite ends of a spectrum. And in fact, that is how the debate around this topic is often framed: it is one or the other. But that is a little reductive. There is a growing body of research in which it is argued that such black-and-white thinking does not do justice to the complexity of the rising demand for agricultural products on the one hand, and the conservation of nature and biodiversity on the other (Grass et al., 2019). Indeed, land sharing and land sparing are not mutually exclusive. Systems of agriculture and nature are not uniform and there are many gradations between extensive, wild nature at one end of the spectrum and large-scale, intensive agriculture at the other (Van Doorn et al., 2016). Many researchers therefore believe that a combination of land sparing and land sharing is the preferred option. For example, land sparing is necessary as a way of conserving specific flora and fauna that are incompatible with agriculture (Paz et al., 2020), while land sharing is an effective strategy to promote ecosystem services that are essential for agricultural production, e.g. functional agrobiodiversity (Silvis et al., 2022). Moreover, multifunctional landscapes require both land sparing and land sharing measures (Ekroos et al., 2016). The combination of sharing and sparing also enables us to better respond to local circumstances, as proposed in the zonal model suggested by Bakker et al. (2021): high-yield agriculture (sparing) on good soils with a good water supply, with less productive soils being used for more nature-inclusive agriculture (sharing) and soils unsuitable for agriculture used for nature development (sparing).

The interdependence of agriculture and nature is also complex and not always well understood. For example, agriculture can have negative impacts on nature and biodiversity, but it can also contribute to improvements in nature and biodiversity by creating or preserving wildlife habitats (Bosch et al., 2020). An example of this can be seen in meadows, which, if managed extensively enough, can provide an important habitat for herb-rich grasslands, insects and meadow birds such as the black-tailed godwit. Conversely, adequate biodiversity is also very important for agricultural production, for example in relation to pollination and pest control, soil fertility and resilience to weather extremes. It is precisely this potential synergy that provides the argument in favour of taking a landscape-level perspective when assessing functions that may or may not go well together (see **Figure 3.2**). This is in line with some of the key design principles contained in the National Strategy on Spatial Planning and the Environment (NOVI), such as: 'no offloading of responsibilities to other times and places', 'plural rather than singular forms of land use' and 'focus on the identity and characteristics of a region' (Ministerie van BZK, 2020).

The debate about sharing versus sparing should not focus exclusively on the agri-food production service, and should instead include a much broader palette of ecosystem services. With 'sparing', there is often an emphasis on specialising in a particular function or service in a specific location (food in one place, nature in another). 'Sharing' often involves multiple land uses and combinations of functions that can deliver a basket of services. Given that functions can be mutually reinforcing, this can also contribute to more efficient land use. For example, water buffering on low-lying grasslands, extensive management with grazing animals and a high degree of biodiversity can all coexist in one place.

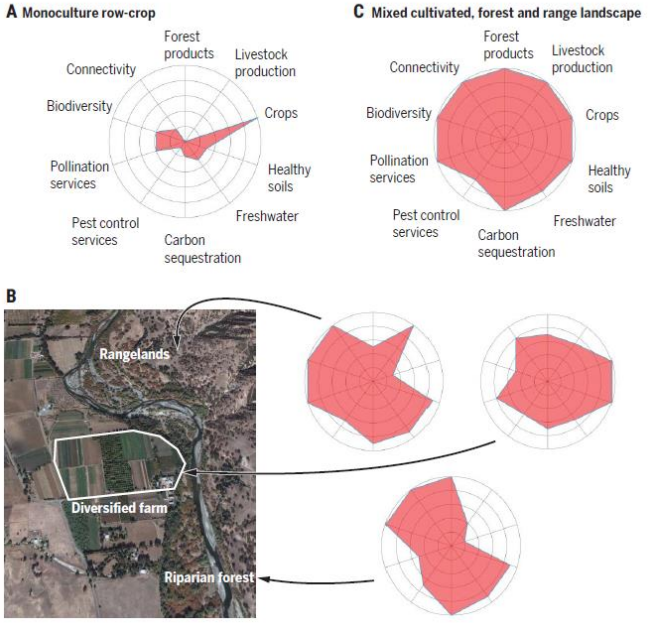


Figure 3.2 *The trade-off of ecosystem services with respect to land use (Kremen et al,. 2018).*

3.5.3 The debate in the Netherlands

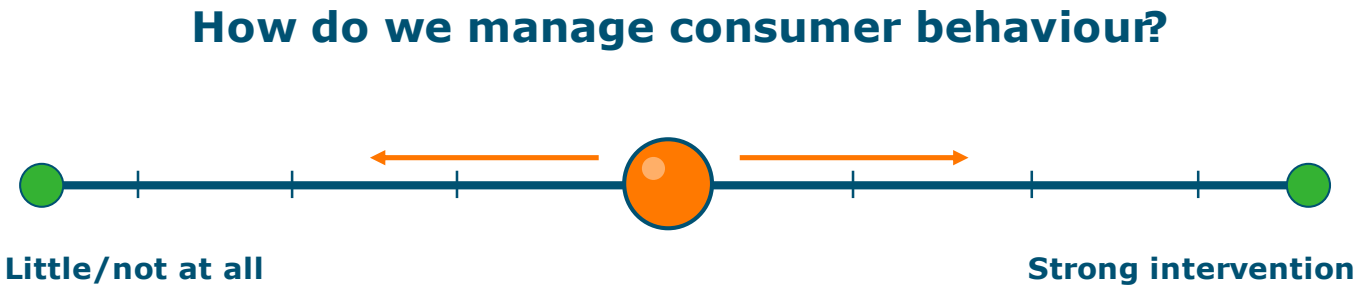
The principles of land sparing and land sharing have received plenty of attention in the Netherlands. This is particularly evident in the debate on agriculture in and around nature reserves (such as Natura 2000 areas) and the concept of 'landscape land' (part of the 2021 coalition agreement). This concept has not yet been further developed but the idea is that it is an intermediate form of agriculture and nature (i.e. a form of land sharing with an extensive form of agriculture). It is thought that 'landscape land' around Natura 2000 areas in particular could provide a more nature-friendly transition zone between agriculture and nature.

This school of thought retains an emphasis on productive land-based agriculture in agricultural zones. Of course, these agricultural areas always include some degree of sharing, as land-based farming by definition provides space for general biodiversity and for specific species, such as meadow and grassland birds. The actual outcome does depend largely on what specific farmers and livestock keepers actually do, and how the area is designed. Relatively simple measures – such as improved landscaping of verges, ditch edges, field margins and farmyard planting – are enough to achieve significant results without the loss of productive land. The same applies to the introduction of greater crop diversity in terms of time (cropping plan) and space (mixed cropping, strip intercropping). Combining ecosystem services with a high-yield farming system is also one of the goals of the Farm of the Future in Lelystad. This requires not just agroecological solutions, but also the technology to put them into practice.

Bakker et al. (2021) recently came up with a more elaborate and more radical idea for zoning agriculture in the Netherlands, using nine steps to identify the most suitable places for three types of agriculture in the Netherlands. Those three types are intensive land-based agriculture (A), non-intensive agriculture (B) and non-land-based agriculture (C). The nine selection steps pertain not just to the agricultural suitability of the soil and proximity to nature (Nature Network Netherlands, formerly the National Ecological Network), but also, for example, the risk of peat oxidation, sensitivity to leaching, the value of the landscape and the implications for water management and drinking water extraction. Based on the nine selection steps, this leaves 42% of existing agricultural areas for type A farms, with a sharp increase in the space available for type B farms. The aforementioned intermediate form of 'landscape land' best fits this type B. Based on this perspective, non-land-based agriculture is only feasible in a very limited number of places. Note that exclusive use for nature (sparing) in this perspective pertains only to the areas included in the National Ecological Network (now Nature Network Netherlands). These areas are not expected to expand.

Overall, both the National Strategy on Spatial Planning and the Environment (NOVI) and the recent debate around the National Programme for Rural Areas (NPLG) have brought renewed attention to spatial policy in the Netherlands, and have facilitated a comprehensive analysis of which challenges most deserve our attention, and where.

3.6 Dilemma 6: How do we manage consumer behaviour?



Food production goes hand in hand with food consumption. A transition to a sustainable food system can therefore only be achieved if the entire food system undergoes a transition, including consumer behaviour. The question this raises is how and to what extent we should intervene to encourage consumers to make more sustainable, but also healthier choices in the supermarket and elsewhere.

3.6.1 The importance of this dilemma

If we are to create a future-proof global food system, it is not just agriculture that has to change: consumers have to do their bit too. The nature and scale of consumer behaviour have a substantial impact on the climate, environment and biodiversity. Animal proteins (and especially red meat) play an important part in this. Their impact is certain to grow as a result of the growth in the global population, along with greater prosperity and urbanisation. Western consumption also goes hand in hand with food shortages in less prosperous countries and food surpluses in prosperous countries like the Netherlands. Furthermore, our consumption patterns are unhealthy, with relatively high levels of fat, sugar and salt (Onwezen et al., 2017).

A transition to healthier and more sustainable consumption patterns is therefore necessary, but it is certainly not easy to achieve. We need our food to be sustainable and healthy, but it also has to be safe, affordable and culturally appropriate if it is to be fully accepted. Consumption is also driven by preferences and habits that are often deeply ingrained. The relationship between food consumption, behaviour and social, cultural and economic factors (such as status, origin, ethnicity, financial positions and education levels) is complex.

In addition, prices do not always reflect the true social cost of a product, as a large part of the cost is externalised and therefore not reflected in the cost and price. This means that supply chain partners and consumers are not exposed to the necessary incentives. The externalised effects that occur can be both positive and negative. In general, the food system comes with substantial external costs. Supply chain partners and consumers are not exposed to appropriate incentives and it is difficult to achieve a sustainable food system when sustainably produced food for a healthy diet is more expensive and less profitable than unsustainably produced and less healthy food.

Intervening in behaviour, especially when it involves something as fundamental as nutrition, is also socially and politically sensitive. Here in the Netherlands, we prefer to give consumers freedom of choice, supported wherever possible by quality labels and kitemarks. While these are meaningful (see, for example, the success of the Beter Leven ('Better Life') quality label for animal welfare or the EKO label for organic production), their impact on volumes is limited. More substantial interventions on the part of the government are apt to be met with resistance: the mere mention of a 'meat tax' in a policy paper is enough to cause uproar and front-page news. This is in spite of the fact that we are aware of how much our behaviour is already manipulated now, including by the agri-food industry itself (through advertising, shop fixtures, etc.). It is these interventions that help shape our preferences for fat, sugar and salt. For years, supermarkets used special offers on meat as a way of luring in customers so that they would then buy other products with real profit margins.

If we really want to move towards more sustainable and healthier consumption patterns, there is no avoiding the question of whether or not we want to be more interventionist. This might be through direct measures such as price incentives, information (labelling), regulations and bans, or indirectly, e.g. through binding agreements with the agri-food industry and supermarkets.

3.6.2 Examples of options

There may still be gaps in our knowledge, but a lot of experience has already been built up both within and beyond our national borders when it comes to interventions and communication strategies aimed at

changing our consumption patterns. Examples include communication campaigns, sustainability labels, education programmes, and subsidies and taxes on unhealthy products (e.g. sugar and fat taxes).

On the whole, the literature is unanimous on the need to intervene more in consumer behaviour (Fresco & Poppe, 2016; Pyett et al., 2019; Van 't Veer, 2017). But how far do we want to go in steering consumer behaviour? And what fundamental values do any possible interventions need to be based on? This matters because the freedom to choose one's own food is seen as a social right and as an individual responsibility. However, the problem is that from a public health point of view, prices and advertisements incentivise the wrong things.

The idea that we should minimise interventions in consumer behaviour assumes that consumers themselves will make sensible choices regarding sustainability and health. This gives consumers a relatively large degree of freedom to choose. But the question is whether consumers are always able to make wise choices. The impact of our choices on climate, biodiversity and health, for example, often get put to one side when we are standing in front of a supermarket shelf or perusing a menu in a restaurant. Price and convenience, on the other hand, are often the factors that sway us when we buy a particular product or dish. So if we want a sustainable and healthy food system, minimal intervention will not get us there.

A wide range of options are available if we do choose to intervene, and they vary in terms of their intrusiveness but also therefore in terms of how effective they are. A classic approach – and one that is minimally controversial – is the use of behaviour-change campaigns. Price interventions, such as specific levies (e.g. a meat tax) or bans, can be very effective but also politically controversial. However, both these interventions ignore the food environment in which people make choices. In the absence of any intervention to reduce economic incentives to produce, offer and promote less healthy food, a focus on individual consumer behaviour will also be less effective. If we are to genuinely change consumer behaviour, we therefore need interventions that address the incentives that market actors (producers, supermarkets) respond to. This could include ensuring that prices reflect the externalities of products *(true and fair pricing*) and facilitating sector-wide sustainability agreements or collective changes to the product ranges offered by supermarkets, without falling foul of cartel bans.

Technology can also play a role. Personalised diet programmes based on biometrics (data about our bodies) can make it easier for people to make sustainable and healthy choices at the supermarket.

Whatever road we go down (more intervention, or more hands-off), we cannot regard our own consumer behaviour as being an issue that is somehow separate from the rest of the food system. The complexity of the food system requires a coherent and coordinated approach (FAO, 2018). Bearing in mind the need to consider our food system from a global perspective, we should not be restricting our gaze to our own country. Much of the food produced in the Netherlands is exported. So what we produce here is partly determined by the demands of consumers abroad. If the demands of those consumers have a negative impact on climate, biodiversity, health, etc., then we are ourselves playing a part in encouraging unsustainable behaviour in other countries.

3.6.3 The debate in the Netherlands

Governments in many countries are reluctant to intervene in consumer behaviour. They do not wish to restrict consumer choice, preferring to let consumers decide to what extent they will eat a sustainable and healthy diet. This is true in the Netherlands too. There is little political support for intervening in our food consumption choices. This is evidenced, for example, by the fact that there is no majority in the House of Representatives for a meat tax. We also are not seeing any interventions to prevent retailers offering special discounts on unsustainable and/or unhealthy products. However, there is support in the House of Representatives for the abolition of VAT on fruit and vegetables. But the technical difficulty of implementing this has been a stumbling block, partly due to a lack of capacity at the tax authority and its outdated ICT systems.

This reluctance to intervene in our food choices contrasts with the fairly widely accepted use of pricing tools to drive down demand for fuels and, in particular, tobacco and alcohol.

4 How the dilemmas are connected

4.1 Importance of interconnectedness

The dilemmas described in the previous chapter are not all isolated issues. On the contrary, they are connected in many ways. This interconnectedness means it is important to look at all the dilemmas as a whole. Any choices made within the context of one dilemma could limit the options available to address another dilemma and to steer that issue in a certain direction. See **Figure 4.1**.

The six dilemmas formulated here are linked in numerous ways. To illustrate this interconnectedness, the six dilemmas are visualised in **Figure 4.2**, showing some of the links between them.

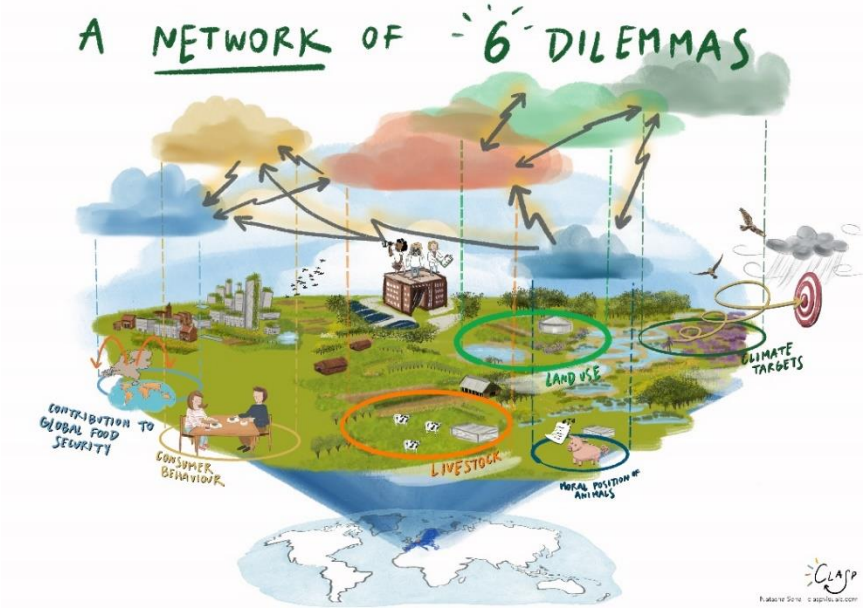


Figure 4.1 *The dilemmas are connected in numerous ways (illustration: Clasp Visuals).*

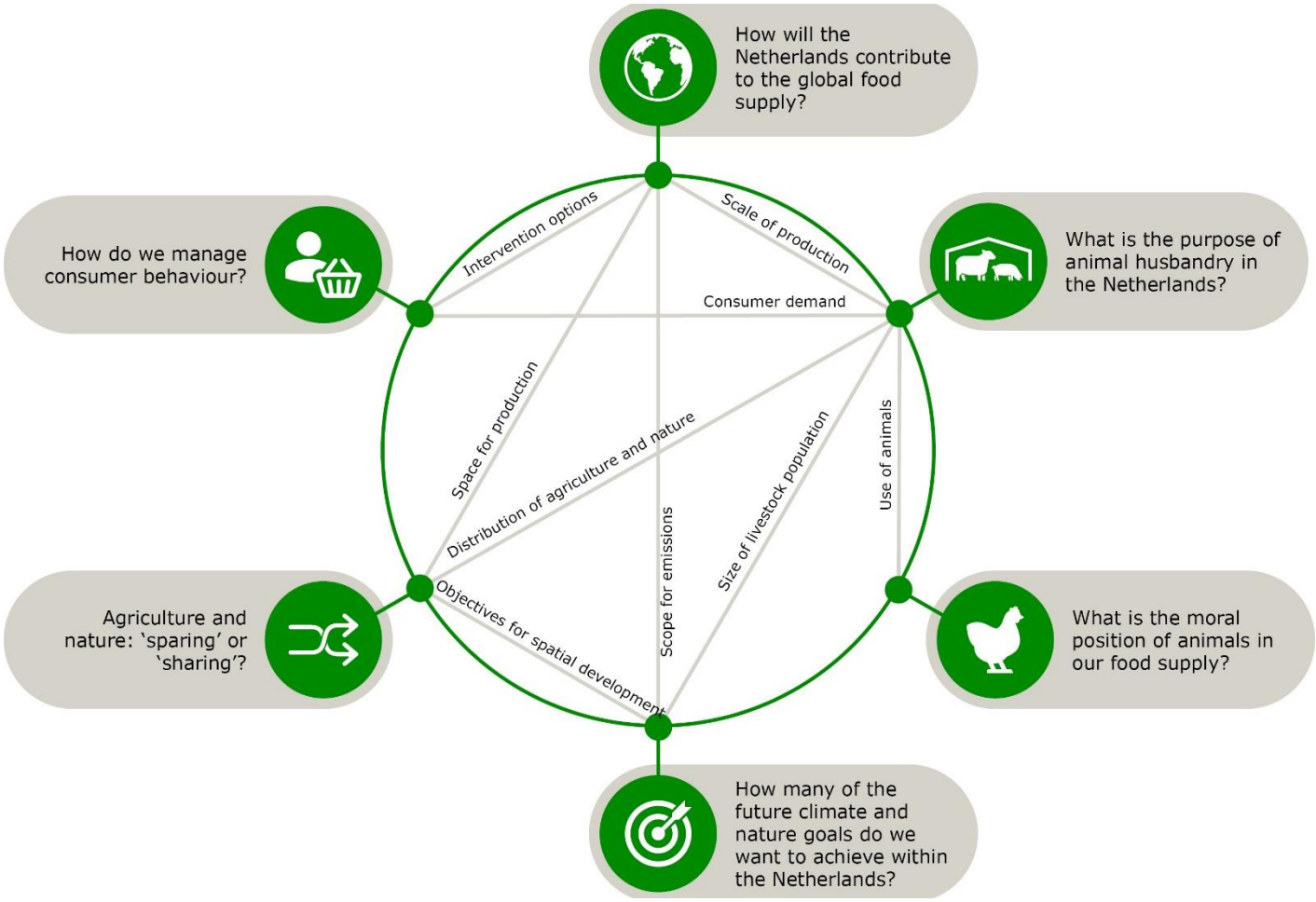


Figure 4.2 *Links between the different dilemmas.*

An obvious approach would be to start with one dilemma and then consider how the choices you make would affect other dilemmas. By way of illustration, let us look at dilemma 1. The choices regarding dilemma 1 (the contribution of the Netherlands to the global food supply) will have implications for the amount of agricultural land required and the intensity of the agriculture performed there. This means that achieving nature and climate goals in the Netherlands will become easier, or more difficult, depending on which way that choice goes. And if the livestock sector primarily becomes a processor of waste streams, the sector will become significantly smaller in a number of regions. This would also help achieve nature and climate goals. Another example: opting to produce propagation materials means we would need less land than we would for food production, which in principle leaves more space for nature. At the same time, the quality requirements for propagation materials are much higher and there is less margin to tolerate any incidence of diseases, pests and weeds. So this fits well with the 'land sparing' idea: intensive, high-quality agriculture in places where that can be done and, alongside it, space for 'real' nature. But that also means that the fundamental quality of the natural environment in agri-food production areas would generally be lower than it would be if the model was one of 'sharing'.

There are a number of cases where making a significant choice under one dilemma would have really big implications for others. Regarding the moral position of animals, one could take the view that keeping animals is inherently unacceptable. This would effectively make the dilemma about the function of animal husbandry irrelevant. By contrast, a very ambitious nature and climate policy would have major implications for the contribution that the Netherlands can make to the world's food supply. By definition, this contribution would shrink, as there would be little space left for intensive animal and plant-based production.

All of the dilemmas come with some moral decisions that will be painful for society to deal with. Major social investments, e.g. through significant public expenditure or the compulsory curtailment of economic sectors in order to meet nature and climate goals, would create higher public debt and reduce the financial resources available for other social functions such as care services and education. At the same time, delaying these social investments is not an attractive option either. Social

costs are increasing, partly because climate change itself is also causing greater economic impacts and environmental costs (e.g. for purifying drinking water). What this highlights is that the choices we make regarding these six dilemmas by definition call for political rather than scientific decision-making. Science can give us a clear idea of the short and long-term consequences of choices in many areas so that we can weigh up the social and political issues. This also requires knowledge institutes to take an interdisciplinary rather than a siloed (monodisciplinary) approach to looking at issues.

4.2 Interconnected dilemmas in three WUR studies

WUR has developed dozens of scenarios and visions of the future based on a variety of perspectives, time scales and knowledge domains. The six dilemmas formulated here have been distilled from these studies. Three studies are outlined here to show in more detail how they articulate the choices within the dilemmas, and the interconnectedness of the dilemmas themselves. For each study we explain which specific dilemmas are identified, how the study perceives their interconnectedness, and the proposed pathways for solutions.

4.2.1 A more natural future for the Netherlands in NL2120 (Baptist et al., 2019)

Which dilemmas are identified?
The choice to be made within the sparing or sharing dilemma is fundamental to the future. As the title suggests, the study by (Baptist et al., 2019) focuses on a nature-based approach to designing and organising the Netherlands. Nature-based solutions are seen as a pathway to solve the various transition issues and challenges related to the climate, biodiversity, agriculture, housing, circularity and energy and more. In their vision of the future, (Baptist et al., 2019) make a case for the 'sharing' option, in which nature is fully integrated with all other sectors, including agriculture.

Such a choice would have ramifications for the choices to be made under other dilemmas. The study by Baptist therefore suggests how to handle choices contained within the dilemmas of 'consumer behaviour', and 'the achievement of future climate and nature goals within the Netherlands or elsewhere'. The choices to be made also implicitly shape how this vision of the future considers the dilemmas of 'the contribution of the Netherlands to the global food supply' and 'the role of animal husbandry'. For example, it would mean the Netherlands no longer being the third-largest exporter within the agricultural sector. In this vision of the future, the agricultural sector is fully circular and production is mainly geared towards the local, domestic and regional market (north-west Europe). Consumers will also have changed their diets, becoming more vegetarian and flexitarian, in turn driving producers to modify their offerings. The emergence of different types of agriculture, combined with improved technology and a partial relocation of food production out to sea, would lead to agricultural land requirements being reduced by half. The requirement for all agriculture to be nature-inclusive would also create sufficient space to address nature and climate issues, and would even provide the necessary conditions for the Netherlands to be a climate-positive country.

What are the perceived links between the dilemmas and choices?
Choosing a nature-based approach to the design and organisation of the Netherlands, with nature and agriculture highly integrated, means this vision of the future proposes a framework both for how much agriculture is performed, and the intensity of the sector. Opting for a nature-based approach to the Netherlands means that the choices that pertain to other dilemmas are funnelled into a specific decision-making framework.

This implies a significant change to the function of animal husbandry as we currently know it. Animal husbandry in the Netherlands will be fully nature-friendly and nature-inclusive. This includes a reduction in the livestock population, low-emission livestock sheds and additional technical and management measures. In addition to this change in intensity, the amount of land allocated to agriculture will also be cut by at least half. This will be partly because of changes to the nature of food demand, with some food production moving out to sea. Food production will also be focused on local, national and regional (north-west European) markets. With less agricultural land needed for fodder production, more space will be available for meeting climate and nature goals. For example, the amount of forested land will be double what it is today. This vision of the future suggests that processes of innovation will have provided us with new technologies to produce more nutritious and more resilient types of food. The study does not tell us whether the Netherlands will have had a leading role in developing the relevant knowledge and innovation.

What are the proposed pathways for solutions within the context of the dilemmas as a whole?
By focusing on nature and natural solutions, and taking the limits of the water and soil system as their starting point, Baptist et al. (2019) propose a pathway for many other dilemmas as well. In this vision of the future,

therefore, all policy choices will need to be assessed in terms of nature and biodiversity. The proposed pathways for solutions based on these guiding principles are:

- a circular agricultural system (circular agriculture, nature-friendly animal husbandry, precision agriculture, energy-efficient greenhouse horticulture and climate-smart and nature-inclusive management of fens, forests and fields);
- with technical developments and a partial relocation of food production out to sea, more land will be freed up, providing the space to invest heavily in nature and climate and to make living environments greener.

4.2.2 Towards a common agricultural and food policy (Kampers & Fresco, 2017)

Which dilemmas are identified?

In 'Food Transitions 2030', Kampers & Fresco (2017) share their views on how a transition to a sustainable, affordable, reliable and high-quality food system could be achieved in the coming decades. In doing so, the authors stress that many of the goals designed to achieve a sustainable food system are closely linked. This makes an integrated approach essential. Their vision is based on four overall goals – derived from the EU's Food 2030 agenda – that need to be solved to achieve a sustainable food system (EU, 2022).

- **Sustainable and healthy diets**
  This goal includes tackling malnutrition and obesity, promoting the consumption of alternative proteins (such as plant-based proteins) and improving food traceability and safety.
- **Food systems that enhance the climate, environment and biodiversity**
  This goal focuses primarily on reducing greenhouse gas emissions, restoring and preserving biodiversity and promoting sustainable agriculture and aquaculture.
- **Circularity and resource efficiency of food systems**
  This goal focuses primarily on reducing food waste, more efficient use of biomass unsuitable for human consumption, avoiding or reusing waste, and reducing water and energy consumption.
- **Innovation and strengthening communities**
  This goal focuses primarily on encouraging innovation that makes the food system more sustainable, improving access to sustainable and healthy food and increasing people's involvement in local food policy.

These four goals also indirectly touch on many of the six dilemmas identified in this study. For example, the goal of 'sustainable and healthy diets' touches on the dilemma of 'do we dare to intervene in consumer behaviour?'. Kampers & Fresco (2017) argue that more intervention could help consumers better tailor their diets to individual needs, for example by matching food intake to personal genetic make-up. Another example relates to the goal of 'increasing circularity and resource efficiency' which touches on the dilemma of 'what is the purpose of animal husbandry in the Netherlands?' The authors indicate that in spite of the impact of animal husbandry on the climate, environment and biodiversity, animals can also be part of a sustainable food system, partly because of their ability to consume biomass unsuitable for human consumption.

What are the perceived links between the dilemmas and choices?

The goals that Kampers & Fresco (2017) address in their vision are interconnected and therefore cannot be achieved in isolation, the authors stress. Take, for example, the goals of 'sustainable and healthy diets' and 'food systems that enhance the climate, environment and biodiversity'. Our current Western diet, and in particular the consumption of animal protein, negatively impacts our health (overconsumption) and the climate, environment and biodiversity in many ways. If we are to actually achieve a food system with the lowest possible impact on the climate, environment and biodiversity, we will have to assess and make changes to our existing diets. This will mean consuming more plant-based proteins and fewer animal proteins, for example. This shows how closely the goals of 'sustainable and healthy diets' and 'food systems that enhance the climate, environment and biodiversity' are linked. These goals are in turn also linked to the 'circularity and resource efficiency of food systems' goal. A circular food system therefore can make a positive contribution to the goal of 'food systems that enhance the climate, environment and biodiversity', by using water and energy more efficiently, for example.

The goal of 'innovation and strengthening communities' plays a key role in the three aforementioned goals. Innovation can, for example, help us achieve a diet that is both healthier and more sustainable. New alternative proteins and technologies to help us adapt our diet to our physical needs would be an example of this. But innovation can also help us achieve a circular food system.

What are the proposed pathways for solutions within the context of the dilemmas as a whole?
A number of different pathways for solutions are proposed by Kampers & Fresco (2017). One such solution involves a protein transition, in which a partial switch is made from animal proteins (dairy and meat) to alternative proteins, including both plant proteins from arable farming and insects, seaweed and algae. This transition could potentially contribute to meeting the demand for protein from a growing and increasingly affluent global population, using both animal and plant-based proteins. However, this would require a reduction in the average daily intake of animal protein in high-income countries. Meanwhile, such a transition could also significantly reduce the impact of our food system on the climate, environment and biodiversity.

4.2.3 Re-rooting the Dutch food system: from more to better (De Boer & De Olde, 2020)

Which dilemmas are identified?
The vision put forward by this study touches on all six dilemmas, but there are five that really stand out and in which clear choices have been made. First, there are 'the function of animal husbandry' and 'the moral position of animals in the food system'. This vision clearly opts to use animals as processors of waste streams, which means that animals can be kept, but on the condition that the health, natural behaviour and comfort of the animals are prioritised and that animal housing systems reflect this.

In terms of the dilemma of 'agriculture and nature – sparing or sharing', a choice is clearly made here for the 'sharing' or integrating of agriculture and nature, so that the agriculture system includes space for measures that encourage and restore biodiversity. This explicitly includes room for technology to support the diversity of farming systems and to produce food efficiently.

The dilemmas of 'intervening in consumer behaviour' and 'the contribution of the Netherlands to the global food supply' also stand out. Regarding the latter and market orientation in particular, this vision clearly opts for production geared towards the regional market, with a strong connection between consumers and producers, and short supply chains. This aligns closely with efforts to raise the consciousness of consumers, both in terms of production and health. To some extent this is expected to happen naturally through the strengthening of links between consumers and producers. But this vision also refers to incentives to promote 'good behaviour' – through education and setting new

standards, for example – and to avoid promoting 'bad behaviour' by banning the advertising of unhealthy products, for example.

There is less of an emphasis on the other two dilemmas because there is no specific reference to the international scale. However, there is a reference to a shift in priorities in favour of high-quality production, rather than just focusing on quantity. This does echo dilemma 1, concerning the contribution of the Netherlands to the food challenge.

What are the perceived links between the dilemmas and choices?
There is a strong link between the two dilemmas in terms of animal husbandry. But with livestock being fed solely from waste streams, and higher standards being set to ensure animal dignity and their ability to express natural behaviour, this also has major implications for animal protein production. Such production would have to be drastically reduced, which will then automatically also lead to a substantial reduction in animal protein exports. The vision also predicts a halving of our consumption of animal products. This will be partly due to lower levels of production, but also due to changes in consumer behaviour, resulting in part from interventions made to that effect. In this scenario, consumers will feel more connected to food production and more conscious of the way they deal with animals. So there is a clear link here between the dilemmas around animal husbandry (and associated choices) and the dilemmas around *intervening in consumer behaviour* and *the contribution of the Netherlands to the food challenge*.

Another thematic overlap is the integration of agriculture and nature with climate and nature goals. Agricultural production systems will be designed to be much more focused on diversity, with no use of pesticides and herbicides, and agriculture more aligned with the natural vegetation of the environment, so that the systems contribute to achieving nature goals in the Netherlands. This vision specifically mentions biodiversity and, to a lesser extent, climate change.

As mentioned above, a strong link is also anticipated between the dilemmas of 'intervening in consumer behaviour' and 'the contribution of the Netherlands to the global food supply'. It is anticipated that a greater connection between consumers and producers will lead to both a change in consumer behaviour, and a change of market orientation to focus on the Dutch market and short supply chains.

What are the proposed pathways for solutions within the context of the dilemmas as a whole?
The pathways for solutions we see in this vision and set of interconnected dilemmas are:

- maximum circularity at a national scale, with a focus on human consumption, animal as processors of waste streams and the recycling of human and other waste streams;
- consumer-producer connections through short supply chains, education and links between urban and rural environments;
- government intervention with the active involvement of supply chain actors and market participants, taking collective responsibility.

5 Conclusions and recommendations

5.1 Conclusions

The social debate on the future of agriculture in the Netherlands is still heavily focused on the most acute short-term issues, such as nitrogen. We advocate broadening that debate, as there are a number of interrelated questions that need to be answered as part of a longer-term perspective. Our contemplation of long-term changes or transitions should not become eclipsed by a focus on short-term solutions and targets – but that is what we often see happening now. Through this report and the exploration of the six dilemmas, we offer some launching pads for public debate, based on the analysis and synthesis of a series of current visions of the future and studies from different disciplines within WUR. The report contributes to the formulation of a long-term perspective for the entire system of agriculture, food and nature in the Netherlands. By approaching it from this perspective, we can make choices that will provide solace not only now, but also 30 years from now, and give stakeholders a roadmap for investment and the development of knowledge and technology.

In and of themselves, the dilemmas might suggest that we can still pursue any number of directions. As we have explained, the six dilemmas are interrelated, which means choices regarding one of them might constrain the options available to us with regard to other dilemmas. But even if we take each dilemma individually, we do not have unlimited room to manoeuvre. International agreements, the position of the Netherlands in an economy with open borders, and the many other claims on space in the Netherlands all play a part in making certain choices more obvious and others less so. We therefore anticipate the following developments.

1. The most significant way for the Netherlands to contribute to the global food supply will be by concentrating even more than we are already on propagation materials, technology and knowledge (dilemma 1) and placing less emphasis on production volumes. This makes sense from both an economic and ecological perspective. The main costs of production (land, labour) are scarce and expensive in the Netherlands, and agriculture will also have to become less intensive in a number of regions in order to reduce local environmental pressures related to nature goals and water quality. Technical solutions to reduce environmental pressure are not effective enough, and they raise the costs of production.

2. It makes sense for animal husbandry to focus much more than it does now on making use of raw materials and waste streams unsuitable for human consumption, thereby making the sector much less dependent than it is now on fodder produced on arable land in other parts of the world (dilemma 2). This will cause the livestock sector in the Netherlands to shrink, which is useful as a way of bringing nature goals (nitrogen) and climate agreements (reduction in methane emissions) closer together. The climate targets for 2050 (95% reduction in greenhouse gases) will particularly affect the size of the dairy farming sector – and this impact will be amplified by current attitudes around the idea of animal dignity, in which grazing plays an important role. Technical solutions will be more limited in their effectiveness, and they raise the costs of production. Offsetting the remaining emissions through forest planting places huge demands on space. On the other hand, reducing the size of the dairy farming sector can also lead to conversion of grassland to arable land, which actually causes a large one-off release of CO_2. So it is important to carefully consider which regions are most suited to specific purposes, bearing in mind the various challenges (food supply, climate, nature).
3. In conjunction with the previous point, we need to actively shift our consumption patterns towards a healthier, plant-based, and less polluting diet (dilemma 6), even if only to avoid 'exporting' our emissions and other externalities to other countries that would then take on the role of production for our animal-based, unhealthy and polluting consumption habits. Direct and indirect interventions should be used to convey the social costs and benefits of food consumption and thereby help shape consumer behaviour (e.g. through information, labelling and true and fair pricing).
4. Our international obligations already require the restoration of existing natural environments in the Netherlands, but doing so is in any case in the interest of the country and of the agricultural sector. There is likely to be only limited scope to expand our protected natural landscapes, given all of the other demands for that space, and it is particularly unrealistic for nitrogen-sensitive habitats, even in the unlikely event that all Dutch sources of nitrogen were to drop to zero. Enhancing the fundamental quality of the natural environment is something that can actually go hand in hand with more nature-inclusive forms of land use. From an efficiency and effectiveness point of view, the trading of climate goals with other countries in Europe and the rest of the world would be an option for specific species and habitats that are found both in the Netherlands and elsewhere. The question then becomes whether such a trade could also include climate goals and other challenges (SDGs), for example by using large-scale forestry elsewhere in Europe to offset our residual emissions (dilemma 4). A fair distribution of costs and benefits between countries and stakeholders within countries would require compensation and redistribution measures to be integrated into an overall policy package.
5. In conjunction with the previous point, it seems wise for the Netherlands not to either strictly separate ('spare') or integrate ('share') nature and agriculture (dilemma 5). High-yield agriculture is still a conceivable option on good soils with good water supply ('land sparing'). In such settings we might not aim to simultaneously work towards nature goals, though even then there are still limits on, for example, the use of crop protection agents because of issues such as water quality. In a larger part of the Netherlands, integration ('land sharing') will be the best way to conserve the fundamental natural environment and typical agrarian landscapes while still practising agriculture. In those areas, this will have consequences for the nature and intensity of any such agriculture, either in the form of extensification or organic farming, or in new practices such as strip intercropping, pixel farming, agroforestry and food forests. There are still plenty of opportunities for technical, social and institutional innovations in both the high-yield zones and the integrated ('sharing') zones, and these innovations could be significant from an international perspective too. Additional and exclusive nature development ('land sparing') would then be allocated to the land least suitable for agriculture.

A logical next step would be to use these dilemmas as a starting point for social and political dialogue and to make some initial decisions – and from there, come up with some plausible visions of the future. Those visions could then be used to make political choices. There will only be a limited number of possible visions, because for some of the dilemmas there is already an obvious choice. This might be because the boundaries of physical systems have already been reached or because the frameworks set out in international laws and regulations are becoming sharper and clearer. Other options will require further research to better understand the consequences of certain choices.

The dialogue will need to face up to the fact that there are no easy and painless choices. Whichever direction is chosen, there will always be winners and losers.
A useful conversation about the future of agriculture, food and nature in the Netherlands will have to start by transparently and honestly identifying the pros and cons of certain pathways, and weighing them up against each other. A solution that may seem like a good idea on a

national scale (such as robust self-sufficiency) may turn out to be a lot less promising or attractive from an international perspective. This might be because it would mean 'moving' some of our emissions to other countries, for example. In a world where food insecurity is on the rise, the Netherlands faces the challenging task of finding the 'right mix of national, European and global policies'.

Once the advantages and disadvantages of certain choices are clearer to see, it will be possible to better consider how any negative effects can be mitigated and how sectors/stakeholders that benefit from certain choices can also be actively involved in enabling a transition.

5.2 Recommendations

The main recommendation of this study is to place the social and political dialogue on the future of agriculture much more emphatically in a long-term perspective, and to come up with serious and cross-cutting answers to the question of how agriculture, our food system and nature can prosper and contribute to the major challenges of the coming decades. That dialogue must explicitly address the opportunities for synergies as well as the need to make uncomfortable and painful choices. We can continue to have faith in knowledge, technology and innovation (whichever pathway we choose), but we can no longer rest on our laurels as a country and hope that technology will come to the rescue. Bold political choices and behavioural changes are both necessary and urgent.

We also recommend the following.

- Be open and honest about the fact that there are no easy or painless options. Show what the possible trade-offs and synergies of different choices would be.
- Explicitly refer to the choices within the six dilemmas in foresight studies.
- Ensure that all foresight studies explicitly include the international dimension, given the open nature of the Netherlands' economy and possibly undesirable knock-on effects on other countries, and base this on international agreements (SDGs).
- Deepen and broaden the conversation with other stakeholders in society. We have outlined some initial issues/dilemmas here, but we do not claim that these are exhaustive.
- Develop institutional-level capacity to systematically address long-term issues. This can include strategic prognoses (foresights) and quantified future scenarios, based on a wide range of objectives. This is in fact one of the recommendations made in a recent OECD (2023) report on the future of agriculture in the Netherlands. It is important that different stakeholders and parties work together on this. It will be essential to use methods that strategically assess the implications of alternative, future-focused actions and developments (scenario planning) as a way of delivering results that are broadly supported.

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Wageningen University & Research
PO Box 47
6700 AA Wageningen
T +31 (3)17 48 07 00
wur.nl

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Wageningen University & Research Droevendaalsesteeg 4, 6708 PB Wageningen PO Box 9101, 6700 HB Wageningen T 0317 480100, 2023