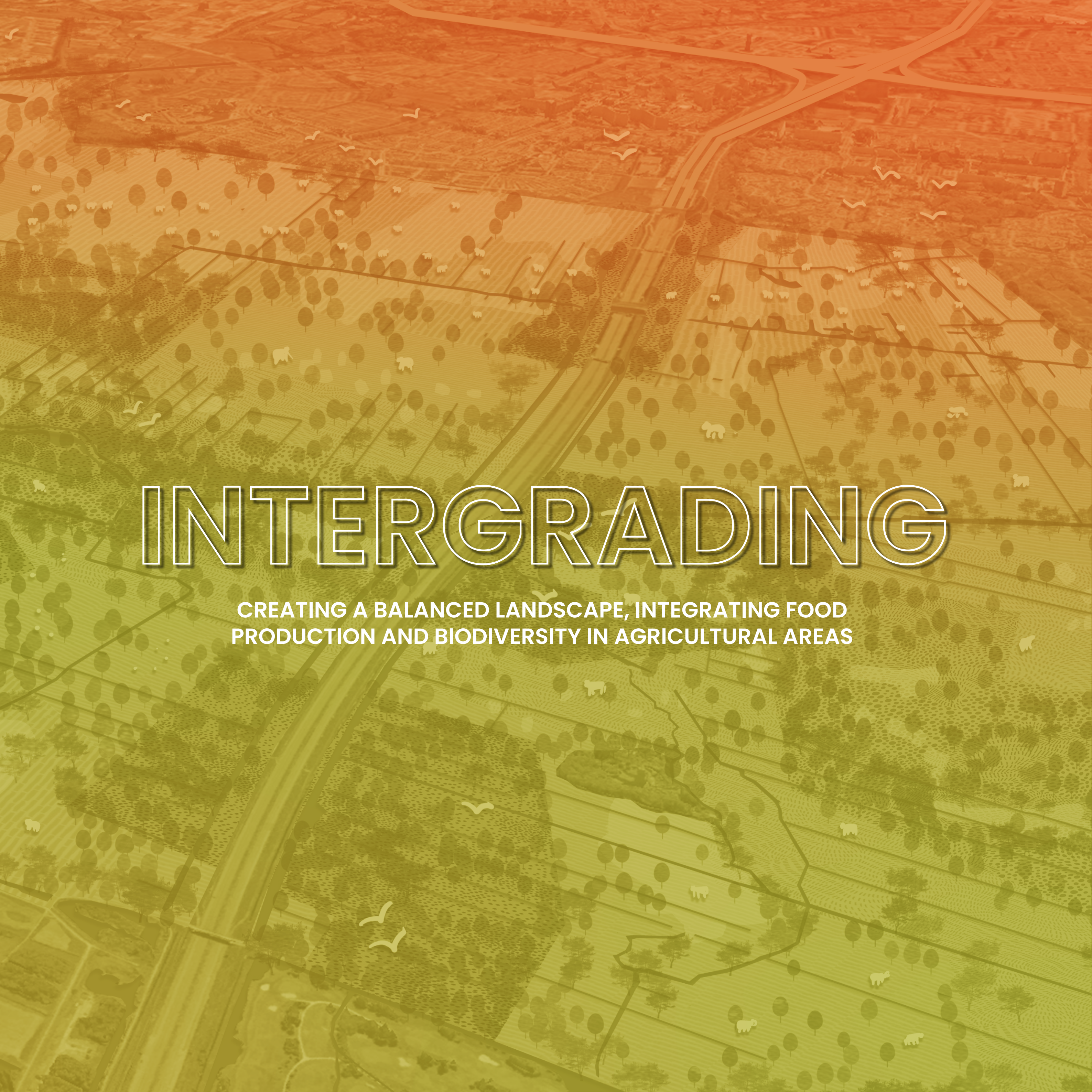

INTERGRADING

CREATING A BALANCED LANDSCAPE, INTEGRATING FOOD PRODUCTION AND BIODIVERSITY IN AGRICULTURAL AREAS

INTERGRADING

AR2U086 R & D Studio : Spatial Strategies for the Global Metropolis
AR2U088 Research & Design Methodology for Urbanism

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February-April 2024

TU Delft Department of Urbanism
BK Bouwkunde

in·ter·grade

verb | in(t)ərgrād | [no object] Biology

pass into another form by a series of intervening forms: they have several forms that intergrade with each other.

Farmer's Roel Cows

ABSTRACT

The Netherlands has created a large nitrogen pollution problem in its soils, which is harming biodiversity. By intensifying and industrialized farming, by importing animal feed for dairy production and fertilizer for crop farming, too much nitrogen has accumulated in the soil. Consequently, ecological processes are disturbed due to eutrophication (over-feeding of nutrients), from which only a few species profit, causing other species to lose the competition and cease, with detrimental effects on reliant other species.

This project explores how this intensive/industrial farming can be substituted by more sustainable alternatives in which creating and maintaining biodiversity is key. An alternative system is proposed based on the spatial intergrading between cities and protected natural areas with typologies that focus on balancing food production and biodiversity creation. This alternative system is then detailed concerning the small-scale effects it has, the necessary process of policy creation and the necessary systemic changes as preconditions for a successful execution. The transformation design is developed along a framework of values which are reflecting on current best practices in the discipline of urbanism touching on issues of planetary boundaries, justice and transitional thinking.

Our key takeaways are to keep the city and adjacent areas productive, close to where consumption of goods is high but also where functions like education and food markets can be sensibly integrated. Further from the city and closer to already biodiverse and protected areas of the Nature Network Netherlands (NNN), the gradient leans more towards focussing on the creation of biodiversity. Humans and non-human species can find their thriving space on the gradient, food production is still an integral part as well. By creating a system in which farmers are working together, and are guided to create this balance on their farms and are paid for their efforts and the services they provide to society, they can be encouraged to change their farming practices for the better.

Keywords: Biodiversity Conservation, Food Production, Nitrogen Pollution, Farmers, Land Use, Land Sharing, Gradient, Peri-Urban Areas.

Korhonen, M. (2019). [Picture of Aerial view of countryside in Netherlands]. Unsplash. https://unsplash.com/photos/aerial-photograph-of-village-eside-river-4_oiI70Vy_E

CONTENTS

01 Introduction

WHAT'S THE FUSS?

1.1 UNPACKING CONCERNS: NITROGEN POLLUTION FROM AGRICULTURE

Agriculture is a driving force behind biodiversity loss in the Netherlands (Kok, et al., 2022), as a major producer of nitrogen pollution in the soil (CBS, 2020). The current industrial, intensive way of farming causes disturbance to many plant and animal communities through processes of eutrophication and acidification, in such a way that planetary boundaries are exceeded because of food production (Schulte-Uebbing, et al., 2022). Meadow birds disappear, soil and water quality deteriorate, and insects die out (Bos, et al., 2013; Westerink, et al., 2021), while the Netherlands keeps feeding the world (Viviano, 2017).

Seeing this unsustainable direction of the current system of agricultural production, it is high time to design a new balance between necessary food production and much-needed biodiversity by bringing down nitrogen pollution (Kok, et al., 2020).

Furthermore, this problem highlights the bigger crisis caused by humans overexploiting resources from their environment with disregard for natural processes. We believe we have to turn farming processes around together with farmers themselves - and start rewarding both food production and biodiversity conservation to offer a sustainable perspective for farming.

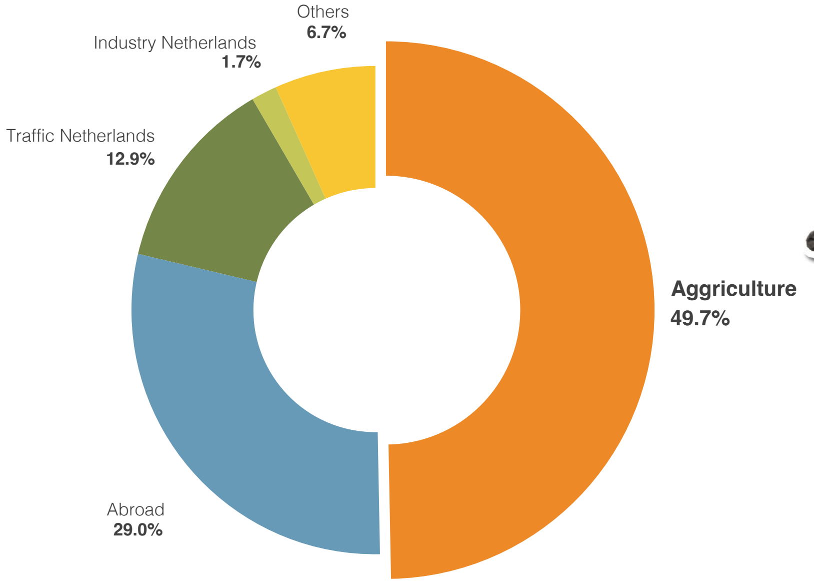


Figure 1.1: Nitrogen Deposition by Origin 2021
Source: CBS, RIVM

Figure 1.2: The Tention between Human and Nature in Nitrogen Discourse
Source: in chapter Image Reference

1.2 WHO ARE THESE FARMERS?

The Netherlands is a small country with large ambitions. It is densely populated and it is also the biggest exporter of food worldwide (Viviano, 2017). Nature is sometimes ignored in these competing spatial claims (Van Berkum, et al., 2012). Farmers largely shape the Dutch cultural landscape (Janssen, et al., 2022), as more than 66% of the Dutch soil is used for dairy and arable farming. However, only 2% is now used for farming in a more nature-inclusive way, such as through organic farming (Verburg, et al, 2022). Organic farming, so far, is the most common way to bring down nitrogen pollution, while keeping food production up, in the Netherlands (Tuomisto, et al., 2012). These farmers, as emerging innovators, have found various practices that bring biodiversity to their farms and that avoid nitrogen pollution. This is done by banning the use of fertilizer, additives in animal feed, pesticides (Kamsma, 2023; Aan de Burgh & Kamsma, 2020), and extensification of food production (Van Grinsven, et al., 2015).

We got inspired to look for ways of nature-inclusive farming in the Midden-Delfland area, between the cities of Delft and Rotterdam in the West of the Netherlands. On a windy Monday morning, we took our bikes and visited farms that take care of their natural environment, and welcome guests to their farm and shop. And so we met farmer Roel in Maasland on his Farm Landlust. He runs a dairy farm with Jersey cows and a store for his and other local products. He showed us his cows and told us his story, about inheriting his family farm and tirelessly looking for ways to work more with nature. For example, instead of keeping a monotonous grassland, he introduced clover in his meadows for its nitrogen-fixating properties, higher protein value for his cows, and source of nectar for pollinators (Roel, personal communication, February 19, 2024).

Figure 1.3: Farmer's Roel Story
Source: in chapter Image Reference

CHALLENGES IN ORGANIC FARMING

However, Roel and other organic farmers also run into challenges. Roel explained to us that he is held back by zoning laws, forcing him to keep the landscape the same. He also explained that the switch to organic farming is hard, which discourages his neighbors from doing the same. This reinforces his biggest challenges: the lower profit due to the lower production that he has, as well as the fact that he does not get rewarded for conserving biodiversity on his farm. Lovingly, he showed us the nesting meadow birds in his fields, which are indicative of the healthy soil and water system he has created (Roel, personal communication, February 19, 2024). These elements became central to our search for a new balanced system.

Also in research, it is established that Roel is not the only pioneer with financial challenges. Organic farming innovations are systematically underfunded and restricted, mainly due to the allocation of subsidies and funds to further development of the industrial farming practice (De Vos, 2023; NOS, 2023). Government support and adequate policy are needed to mainstream sustainable farming (Verburg, et al., 2022).

Organic Farmers Challenges:

- *Keeping the landscape looking the same (monocultural grasslands)*
- *Switching to an organic way of farming is too large a transition to be done easily*
- *Producing less food due to extensification means less profit*
- *Conservation efforts of biodiversity are not (financially) rewarded*

Figure 1.4: Other Organic Farmer Location in Netherland
Source: Google Earth

1.3 AGRICULTURAL POLICY EXPLAINED

The policy context is built up on several levels, starting from the most important agreements on the international level of the European Union, continuing on a national level, which is then implemented on a local level.

International Context

On the EU level, three main policies influence farming and its environmental management practices in the Netherlands. First, t**he Common Agricultural Policy (CAP)** is a general framework to (financially) support farmers and ensure a stable and healthy food supply. The recent version also puts a great emphasis on environmental sustainability in farming practices and limiting nitrogen pollution (European Commission, n.d.). Secondly, **Environmental Policy** sets standards and boundaries for land management. For example, the Water Framework Directive determines the minimum water quality that member states have to adopt, on which in the Netherlands farmers have a large impact (Bieroza, et al., 2021). Other examples are the Birds and Habitats Directives that aim at the protection of nature and specific natural areas such as **Natura2000**. They ensure that the quality of biodiversity does not deteriorate there (for example by excessive nitrogen deposition) (Hofs, 2024; Kort, 2022). The third policy is the **European Green Deal**, which intersects with all environmentally related policies of the EU and steers towards a climate-neutral Europe. It focuses on limiting pollution, more circularity, innovation, and biodiversity, whilst leaving no one behind (Prandecki, et al., 2021). **The Farm to Fork strategy**, as part of the Green Deal, is especially relevant as it is set to transition agriculture to have less impact on nature, which translates into less fertilizer, pesticides, packaging, food waste, pollution, and more innovative ways of farming (European Commission, 2019; Gargano, et al., 2022). In short, EU policy guides sustainable farming by setting boundaries and encouraging innovation for new ways of farming.

National Context

In the Netherlands, these EU policies are directly shaping national policy through legislation on protecting nature The Dutch Government itself also developed stepping stones to build on a sustainable vision for the balance between agricultural production and healthier ecosystems, as since 2022 all interventions undertaken by the government has to **take soil and water into account.** Essentially, the Ministry of Infrastructure and Waterstate (2022) wants to enhance the natural power of the soil to store nitrogen and build resilience to climatic impact. Sustainable land management offers space for more diversity in animal species, thus a healthy ecosystem can be expressed in more biodiversity. This is in line with the **Dutch Nitrogen Strategy (Ministry of General Affairs, 2024)**, which focuses on collaborations between the different government levels (provincial, municipal, and water authorities) and managers of natural sites for local tailor-made solutions, and buying out polluting farmers close to natural areas.

However, the Dutch way of farming is still mostly done in a very industrial and intensive way, causing too much nitrogen emissions according to the EU's critical deposition values. It has led to discrepancies between EU policy and the way the Dutch state enforces these, as the state wants to leave space for farmers to grow their businesses and further intensification of food production, even though it is unsustainable. Such as in 2015 with the introduction of the **Integrated Approach to Nitrogen (PAS)**, which was a program to 'level out' nitrogen emissions with uptake, by giving out permits to emit nitrogen when other activities were undertaken to remove nitrogen at the same time (NOS, 2019). But in 2019 the Dutch Council of State cancelled this policy and ruled this was not cohering to the European Habitat directives (as it could not prove to not deteriorate Natura2000 areas), and many farms were suddenly illegally depositing nitrogen, which had been tolerated for the previous five years (Hofs, 2024). This ruling created a deadlock and is illustrative of the disbalance between the health of nature, government policy, and the current way of farming. Currently, policies are being developed to combat the nitrogen crisis, **but a clear strategy is lacking.**

Figure 1.5: Agriculture Policy in Different Scale
Source: in chapter Image Reference

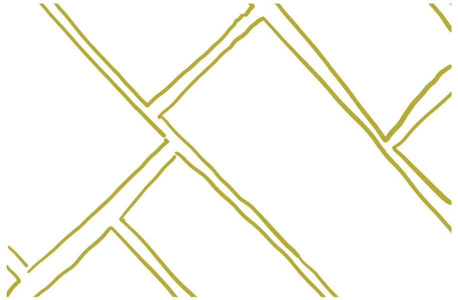
FARMERS' PROTEST

The court ruling and consequent measures limiting nitrogen pollution stirred up protests in 2019. Dutch farmers took their tractors to the parliament building to express that the regulations inhibit their line of work disproportionally (NOS, 2022). The outrage over nitrogen was just the last straw for farmers, as the dissatisfaction with government interference had been growing due to ever-changing and unrealistic regulations in which the farmers themselves do not have a say. Next to that, the financial pressure has also been increased for farmers who seemingly can only keep their business alive by intensively producing food, resulting in more pollution (NOS, 2020). In 2024 similar European-wide farmers protests erupted. While the problems were more diverse, farmers agreed on their dissatisfaction with the ever-increasing bills and more regulations. This further highlights the urgency for a perspective: a structural vision of sustainable farming (Henley, 2024).

Figure 1.6: Farmer's protest across europe
Source: in chapter Image Reference

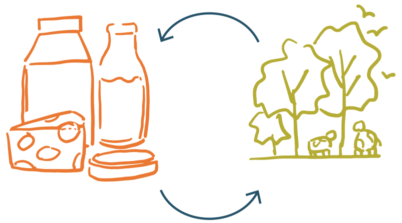
1.4
ACADEMIC DEBATE

The disbalance between food production and biodiversity conservation in farming, exemplified by the nitrogen pollution crisis, is the core problem of this research. In literature, this problem has been approached as a trade-off between production and conservation, by multiple academics. Biodiversity conservation here is defined as management (on agricultural land) to counteract the loss of habitats (Wang, et al., 2023).



FOCUS ON LAND USE

Kok, et al. (2022) assessed the effect of both targeted and general nature conservation on the food produced and the plant species potentially saved in a Dutch dairy farming setting. This resulted in changed land use, less food production, and more biodiversity, especially in the general conservation approach. Martinet and Barraquand (2012) calculated for a similar simulation. They attributed this trade-off between land uses to habitat loss, which drives biodiversity loss. It requires either integration of biodiversity with agriculture **(land sharing)** or creating more space for biodiversity and clearly separate it from further intensifying food production **(land-sparing)**. They calculated both outcomes, with a focus on the social choice and policy implementation of this idea (subsidy and taxes as a factor), from an economic perspective and concluded that land sharing can only be possible with good policy. Fastré et al. (2021) urges the need for an integrated spatial planning approach for both biodiversity and food production, to adhere to global biodiversity conservation goals.They simulated three different scenarios on the trade-off on a global scale: no protection of nature and nature integrated into agriculture too; only focus biodiversity conservation on certain protected areas; and combining both approaches. This third approach resulted in the most biodiversity and highest agricultural yield.



FOCUS ON THE SOCIAL SETTING

Placing the trade-off in a broader setting and connecting the simulation to **social effects**, Hanspach, et al (2017) researched the trade-off in the Global South and concluded that taking a more holistic view, from a **social-ecological systems perspective**, can help identify more synergies between food security and biodiversity conservation. Lastly, Simelton, et al. (2022) also focused on the social side of the trade-offs, by integrating the principles of **Nature Based Solutions (NBS)**. This focuses on improving ecosystems and livelihoods in a just way over various temporal and spatial scales by including social and cultural functions.

FOCUS ON INTEGRATION

All-in-all, integral to the trade-off is the effect on land use, as exemplified by the debate on land sharing and land sparing (Fastré, et al., 2021; Kok, et al., 2022; Martinet & Barraquand, 2017), which results for all these papers in a comparative research approach on the polarized options of full land sparing or full land sharing. Looking beyond this divide and following Fastré, et al. (2021) optimizing for both food production and biodiversity, conservation is best done with an integration of the different land use types (agriculture-nature) while keeping nature areas protected. Yet, from this research, there is no understanding of how exactly this integration should look. The integration of food production and biodiversity conservation has not been made spatially tangible.

Also, from this brief overview of the academic debate, it is crucial to realize a more holistic approach of considering social processes connected to agriculture and the significance of policy (Hanspach, et al., 2017; Simelton, et al., 2022). However, a clear gap is identifiable in combining this systems approach in simulating the integration of land use types with smart spatial interventions and policy creation, on a local scale.

1.5 PROBLEM STATEMENT

In the current biodiversity crisis, caused by agricultural nitrogen pollution in the soil, it is unavoidable to prioritize nature within farming (Schulte-Uebbing, et al., 2022). Currently, farming is heavily industrialized as food production in arable and dairy farming is done intensively, with a focus on strictly separating nature from farmland (Bos, et al., 2013). The resulting nitrogen pollution is only partially addressed by creating fragmented natural areas which might or might not at some point absorb some of the pollution (Reidsma, et al., 2006; Kok, et al., 2022).

However, the effects of current industrial farming practices are not in line with EU policy targets (Prandecki, et al., 2021). It is causing societal turmoil and farmers' protests (NOS 2019, 2020, 2022). Also, the current system is not empowering innovative farmers who do want to farm sustainably even substantially impeding their development at times (Aan de Burgh & Kamsma, 2020; Kamsma, 2023; Verburg, et al., 2022).

Objective of the research and design task

Therefore, integrating nature into human-dominated agricultural practices and land use seems like an opportunity to optimize both food production and biodiversity conservation for a future-proof scenario and a more balanced system (Fastré, et al, 2021). In this research, we want to know how this can be done. Achieving this balance can be done by designing a system in which farmers are rewarded for biodiversity conservation, thereby transforming the role of farmers to stewards of the Dutch landscape, which would be a means of giving farmers a meaningful perspective (Westerink, et al., 2021).

Figure 1.7: The Major Problem of Nitrogen from Aggriculture
Source: in chapter Image Reference

1.6 RESEARCH QUESTION

We want to test this hypothesis by answering the following research question:

What should the future balance between production and biodiversity look like spatially?

What mechanisms are needed to make the future balanced system economically feasible?

What kind of agricultural practices thrive on this balanced system?

"How can agricultural land use be optimized to balance food production and biodiversity conservation in the Green Heart, and which changes in the contextual systems are needed for the implementation to succeed?"

How to ensure justice for farmers when they have to transition their farming practices?

What is the effect of our future balanced system on biodiversity, and what does it spatially look like?

Figure 1.8: Dutch Farm Landscape
Source: Van Oijen, C. (2019, 20 september). white and black grazing cow. Unsplash. https://unsplash.com/photos/white-and-black-grazing-cow-Md1Fk5K9F7c

1.7
VALUES

This research is situated in broader processes of society and natural processes. We want to address certain boundaries, or rather said personal values, that enframe this research and design project.

The human species is part of the ecosystem we call world!

No species has made a larger impact on its environment than humans (Vitousek, et al., 1997) We have altered it to suit our ever-growing needs. Something that seems to be forgotten is that we as a species are also part of the ecosystems we are in. This also means that destroying these ecosystems means destroying ours and our livelihood. If humans would understand that they are just as much a part of an ecosystem as the insects that live there, they should understand that this system should be protected en reinforced. A theoretical notion that addresses this responsibility of the farmer for the health of the land that they maintain, which extends into the ethical notion of sustainable planning of resources (Goodale, et al., 2015). We use this term in our project to define the new role of farmers.

Distributive justice is also key to this value, as in that a healthy earth is a public good and should be accessible to everyone. A public good means that if someone benefits from this public good, it won't lessen its value for others (Taylor, 2014). Biodiversity forms the base of a healthy planet, as mentioned before, and creates ecosystem services such as clean air, clean water and beautiful landscapes (Austin, et al., 2016) that are public goods. Currently, Dutch farmers are using nature for their benefit: exploiting it to overproduce food, whilst deteriorating biodiversity, so that other humans and non-human entities can enjoy a healthy planet less. In this sense, this public good is not just distributed, farming should produce healthy ecosystems in which nature gets more priority.

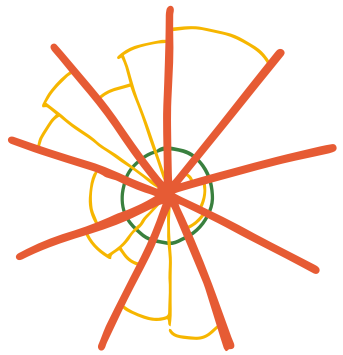
Moreover, realizing that humans are part of the ecosystem, as stewards, requires a broad approach towards conservation efforts, that takes into account less pollution, and more biodiversity for everyone (Wilts Jansen, 2023).

For our design effort, there is no real natural state of the Green Heart to refer back to due to the Dutch water engineers, so making it more natural trough creating nature, is a step in the right direction.

Any big transition has to be just in order to be successful!

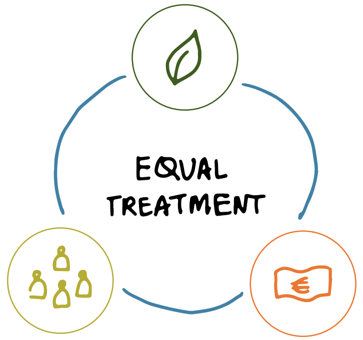
For farming to be sustainable (inherently future-proof), a transformation needs to take place. But this can not be done without the support of the key actors: farmers Therefore, the transition has to happen in a just way, in which farmers are empowered, instead of misunderstood and pushed into non-sustainable practices (Gargano, et al. 2021; Prandecki, et al., 2021) This is also an important aspect in the EU Farm to Fork strategy. (European Commission, 2019; Wilts Jansen, 2023). An emerging theoretical topic that touches closely upon our project is that of Nature Based Solutions, in which justice is also a central theme (Simelton, et al., 2021, Cohen-Shacham, et al., 2016).

In our project, we address spatial justice as being just in distribution (benefits and burdens are equally distributed), procedures (just planning, design and decision-making processes) and recognitional (of all social groups, perspectives and heritage) (Rocco, 2022). For farmers, their work also largely influences their identity (Westerink, et al., 2021), meaning that extra care needs to be taken for the effect of the project on their livelihood and distribute prosperity to them. Also, in our design, we need to make farmers be heard in all administrative procedures. Lastly, when addressing farmers, we have to recognize their diversity too, also within their societal group.



Planetary boundaries are binding!

As of now the planetary boundaries are not binding. This has resulted in humankind overstepping these boundaries (Schulte-Uebbing, et al., 2022; (Röckstrom, et al., 2009). One of these boundaries is the pollution of nitrogen that is overstepped in The Netherlands, forming the start of our project. This pollution is deteriorating our living environment and could lead to one that is unlivable. Within this project, we are focussing on a more resilient system, that does not overstress our planet and creates and protects a safe environment for humans. We take the planetary boundaries as binding.



Sustainability is a state of equilibrium and thus cannot be reached before achieving equilibrium

Sustainable development is an act of balancing all the different goals it can have. No project is able to reach all of these perfectly. Therefore a balance has to be found, based on which goals are the most important and which will be given less or no attention. Within our project the focus is on food production and biodiversity, two cornerstones of human life. Only by finding a balance between these two a sustainable future can be realized. We can't have just one and neglect the other.

International cooperation is not inherently bad, but has to work for both parties equally

As of now the Netherlands is one of the largest food exporters in the world (Viviano, 2017). This means that part of the world is relying on our agriculture and its related industries. At the same time, this large-scale production of food is causing environmental struggles in the Netherlands, affecting nature as a whole. This distribution of consumption and production should therefore be changed. Having fewer exports will decrease the pressure on the Dutch landscape and this is needed to ensure a livable future for the Dutch population (Kok, et al., 2020).

SDG’s Relevance

The UN Sustainable Development Goal from important checkpoints in any development, and so also in our project. The SDGs we touch upon are the following.

Food production is a central element of our research should be kept up to feed humans, but done nature-inclusively, for which we design solutions.

Ecosystem services, based on biodiversity, and a healthy environment attribute greatly to this goal. We design for a healthier environmental system

Valuable work that fosters inclusive economic growth is what we strive for in this project.

In this project, we steer on sustainable innovation in the farming industry.

We promote the livelihood of farmers by financially empowering them.

Making communities and peri-urban areas more resilient and sustainable through empowering farmers.

As a result of our project all food will be produced healthy and nature-inclusively, making it responsibly produced, so always responsible to consume.

We want to halt nitrogen pollution and thus make ecosystems more resilient for climate change, but also combat climate change by making ecosystems better functioning.

One of the results of our project is cleaner waters, less eutrophication due to no nitrogen pollution.

This is closest connected to our project as our goal is to protect, restore and promote sustainable land use, and halt soil degradation and most importantly: biodiversity loss

As developers, we will be working closely to the farmers and form meaningful partnerships.

Figure 1.9: SDG Relation to The Project
Source: Wikipedia contributors. (2020, May 5). File:Sustainable Development Goals.png - Wikipedia. https://en.m.wikipedia.org/wiki/File:Sustainable_Development_Goals.png

02 Methodology

NAVIGATING FRAMEWORK

2.1
RESEARCH STRUCTURE

This is the outline of the research, showing the process in a structural way. Starting with our discovery of the problem through the field trip and research. Coming to the definition of the problem, and answering to it with the vision of our desired future, and the strategy of how to get there - on which we then reflect.

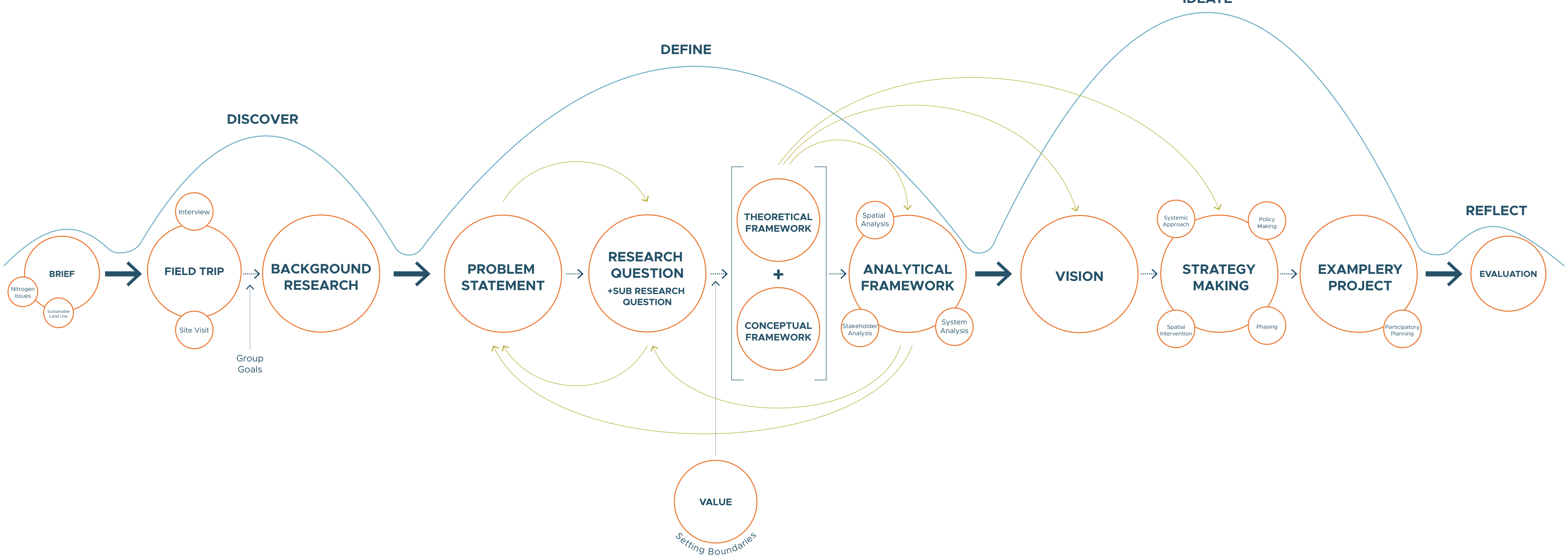


Figure 2.1: Research Framework

2.2 CONCEPTUAL FRAMEWORK

In this research we link concepts together and apply them in an innovative way (Jabardeen, 2009). We derived the conceptual framework from our literary exploration, our site visit and the interview with farmer Roel as previously introduced. The guiding concepts that we identified are visible in our conceptual framework, in Figure 2.2.

We want to balance food production and biodiversity whilst recognizing the farmers' key role. These three concept mutually influence each other, which forms the basis of literary research. The three concepts are related to the sustainability triangle: social (the farmers' role), environment (biodiversity), and economy (food production) (Rodrigues, et al., 2023. Furthermore, the design challenge lies in connecting all three elements into a balanced system of gradients of integration of food production and biodiversity, one based on intergrading. This means "to merge gradually one with another through a continuous series of intermediate forms" (Merriam-Webster, n.d.).

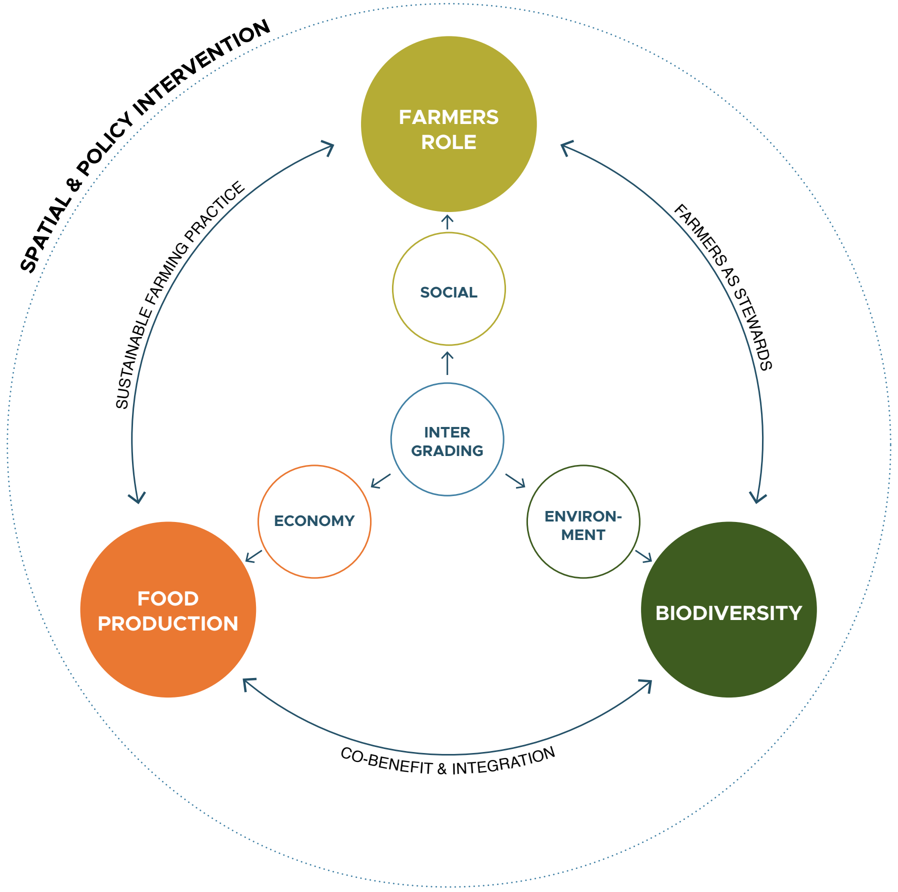


Figure 2.2: Conceptual Framework

2.3 THEORETICAL FRAMEWORK

The conceptual model applied to our project, means that we first have to research the three concepts of food production, biodiversity and the farmers role, while relating the concepts to each other as well. This can be seen in figure 2.3.

We do that by diving into different theories. First, relevant to biodiversity and the farmers' role, this is economical biodiversity, taxonomical biodiversity (explained in 3.1 & 3.2), and provides our vision on the future role of farmers, for farmers as stewards (explained in 4.5). Secondly, relevant to food production and the farmers' role, are the farmers' practices, as explained in the current situation (3.3 & 3.6), and future more sustainable practices (explained in 4.5), as well as the farmers' role in the web of stakeholders currently (3.4) and the future (5.1). Thirdly, we integrate biodiversity conservation with food production by providing spatial interventions: the gradient, and the related reward system on how to make this new landscape profitable through rewarding biodiversity conservation and co-benefits.

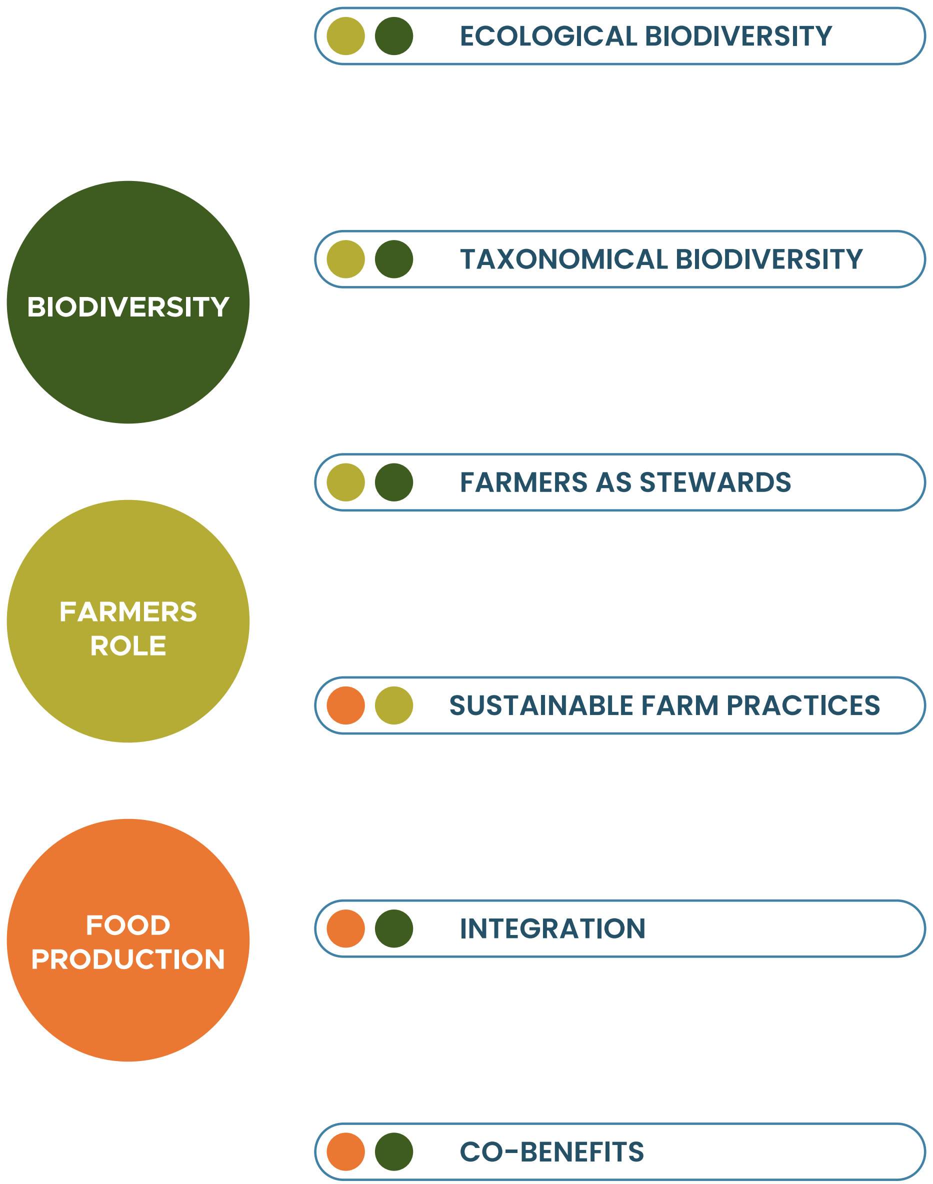


Figure 2.3 Theoretical Framework

2.4
RESEARCH METHOD

In this project, we are using several methods of research. In figure 2.4 these methods have been linked to the different subquestions of our project. Most of these methods have been implemented to better understand the problems we are dealing with and the spatial context of these problems.

The interview and **site visit** kickstarted our project. The input we got from local organic farmer Roel was used as a base for our project.

We extensively used **literature review**, in which academic sources, news articles and policy documents are selected that further informed us on the nitrogen problems, the biodiversity crisis, the societal discourse and the farming practices that are used currently and can be used in the future.

The **spatial and environmental analyses** were used to position the region (the Netherlands and the Green Heart) within the debate on farming and nitrogen. We used mapping to visualize the problems as well.

The **stakeholder analysis** was used to understand the different stakeholders that are part of the problem and its solution, like farmers, institutions, industries and governments. For the latter, a **policy review** was done to understand their position in the discourse.

Finally, **the participatory workshop** and **multi-criteria analysis** were used for the development of the strategy. The concepts behind these methods were used to construct parts of the system that serve as a basis for further development of the project in the future.

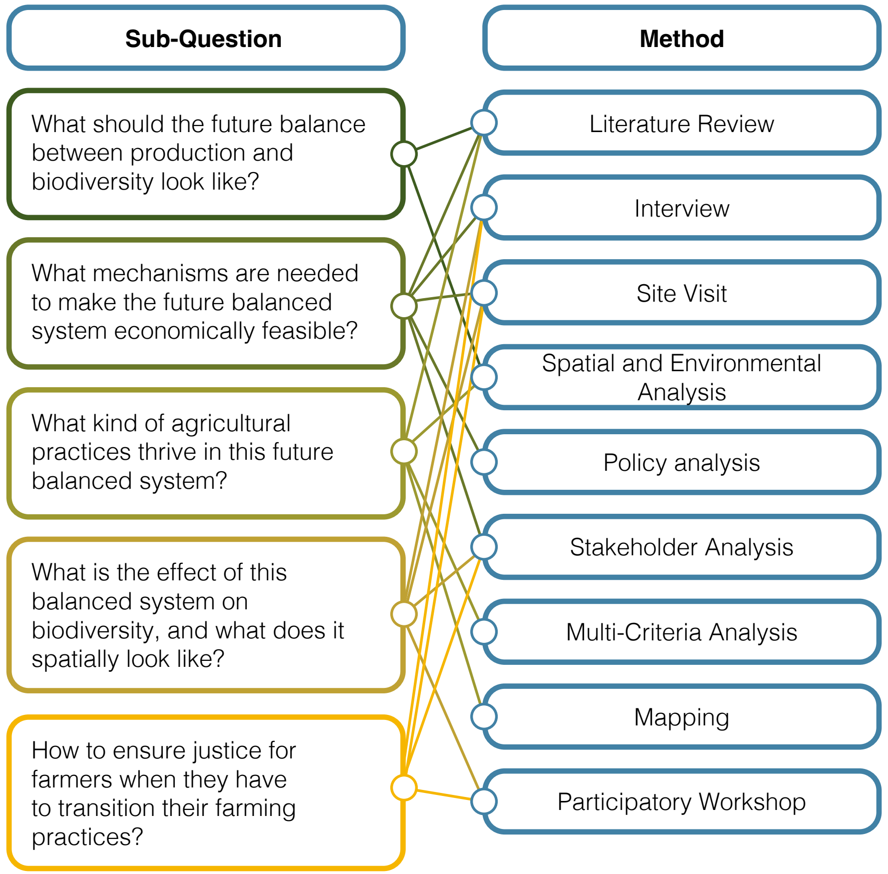


Figure 2.4: Research Method

Fig 2.5
Inside the farm
Source: Author Photographs

03 Analysis

UNPACKING THE PROBLEM

3.1
WHAT IS BIODIVERSITY

Biodiversity is crucial to human well-being and our economic and social systems rely heavily on it (EEA, 2020). It is also the basis of a myriad of ecosystem services, like climate regulation, water filtration, and flood protection. By assessing relevant definitions of biodiversity we select the definition we will use for this project.

A common way to explain and measure biodiversity is by assessing three types of diversity (English, 1992). These types are: genetic diversity (within-species diversity); species diversity (number of species); and ecosystem diversity (diversity of communities). Together they give an indicator of the overall condition of biodiversity in an area.

Genetic diversity relates to the differences within a species on a genetic level (Reed & Frankham, 2003). This genetic diversity is considered the cornerstone of biodiversity because it makes a species resilient. Without genetic biodiversity, a species can not adapt to environmental changes.

Species diversity relates to the number of distinct species in an area and their relative abundance (Gray, 2000). A larger number of distinct species increases the species diversity if the average population size of these distinct species is somewhat proportional. For example, an area that has 250 distinct species with similar population sizes would be more biodiverse than an area with the same number of species but in which a single species constitutes 90% of the overall population.

Ecosystem diversity is the abundance of different habitats, the communities they support, and the ecological processes in a certain area (Pearce & Moran, 1994). An area that has multiple different habitats can support more communities that relate to one or more of these habitats.

In this project, we are focussing on spatial interventions in the Dutch agricultural landscape. From the types of biodiversity presented, two relate to spatial interventions, namely species and ecosystem diversity.

Ecological Diversity

Ecosystem diversity can be realized by creating variation in habitats. Habitat is defined as the abiotic characteristics of an area and its biological community (EEA, 2023). With spatial interventions, it is possible to force changes in the biological community by introducing different types of vegetation or changes in the abiotic characteristics e.g. by changing the water structure of an area. For example, flooding a piece of land would change the abiotic characteristics of an area. By then introducing new species that can live in these conditions, like reeds and duckweed, the biological plant community is changed. This altered situation is then able to support different animal species.

The municipality of The Hague (2020) roughly separates the common Dutch habitat types into 7 types. Forest, thickets, herbs, fauna grassland, flora grassland, pond and water. These can be condensed into 5 major types: forest, thickets, herbs, grassland, and water. By creating multiple of these habitat types an area can support multiple types of species, thus increasing the ecosystem biodiversity.

An important thing to note is that having multiple different types of habitats can create even more interhabitats. These interhabitats, also called ecotones, refer to the transition zone between two habitats (Senft, 2009). The number of potential interhabitats grows even more as the number of habitats increases. For example, creating habitats A and B can also result in interhabitats AB. Creating a third habitat, C, can result in interhabitats AC and BC also being created. The following graphs show the potential habitats and interhabitats that

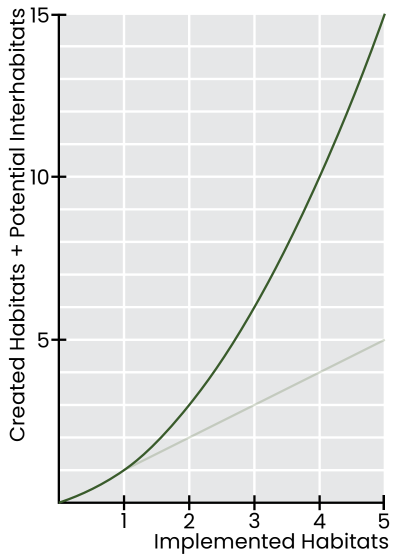


Figure 3.1: The relationship between added habitattypes and potentially created habitats.

Taxonomic Diversity

are created by creating a certain number of habitats in an area. In short, the more habitats created, the more interhabitats it could result in.

When implementing the different proposed habitats, the size also has to be considered. Introducing a single tree does not result in a new habitat. The major theory that explains the relationship between the size of an area and the diversity of the species in it is the species-area rule (Conner et al., 2024). It states that a larger area will have a larger number of different species. This relationship has been observed with most animal groups, ranging from insects to mammals, and can be used for habitats in different situations, like islands, grasslands, and habitat patches in agricultural areas.

An important aspect of the species-area rule is that the relation between the area size and the number of species is logarithmic (MacArthur and Wilson, 2001). An area that is 10 times larger holds about twice the number of species. When plotting this relationship in a graph you can see that especially the first part of the graph holds the most change in the species count. If the 'ecosystem diversity'-spatial changes would be introduced they would perform best if

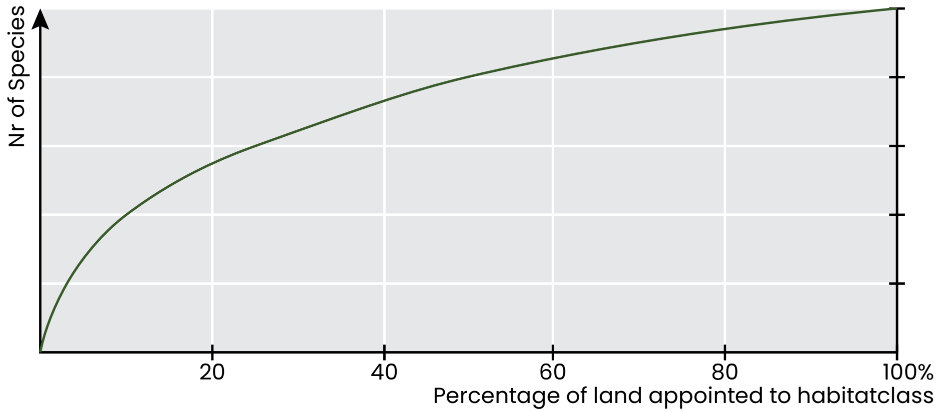


Figure 3.2: The relationship between the area of a habitat and the number of species it contains. Based on MacArthur and Wilson (2001).

Co-Benefits of Biodiversity

they are larger. To increase the chances of something like that happening a system should be constructed in which larger habitats are either forced or promoted.

Biodiversity creation and conservation efforts impact more than just the ecological and taxonomic diversity. Often these efforts also result in other benefits (Austin et al., 2016). These efforts also result in benefits for improved wild species diversity, climate regulation, crops, livestock, and fish, detoxification, and purification of air, soils and water, and permanent vegetation. If during the implementation of biodiversity efforts co-benefits are taken into account, the result can perform better on multiple fronts. his is also where the project can supply public goods, by increasing the quality of living in the region. This chapter will discuss these co-benefits and will relate them to the project.

In our project, wild species diversity is part of the biodiversity effort, which is why we will focus more on the benefits related to crops, permanent vegetation, and detoxification and purification of air, water, and soil.

Biodiversity efforts could force farmers to look into different crops to grow or different animals to keep. This diversification of agricultural production has multiple benefits (Deogharia, 2018). It leads to a more resilient farming practice because it eliminates the reliance on a single species of crops. Furthermore, a larger part of the local diet can be produced locally. This reduces the dependency on other countries for food and also the associated CO2 emissions due to transportation. These two benefits combined result in increased food security.

Part of the vegetation types that have been introduced like trees and shrubs, require long-term maintenance to retain their biodiversity purpose. This creation of permanent biomass will subsequently increase the amount of carbon that is captured within it (Zhou, 2008). The carbon sinking is a way in which the project could help reduce the amount of greenhouse gasses in the atmosphere. Because of this, carbon sinking would be an important co-benefit.

Finally, Austin et al. (2016) mention the detoxification and purification of soil, water, and air. The increase in biodiversity forces a drop in the use of fertilizers, this reduces the pressure from farms on the nitrogen levels in soil, water, and air. In the end, this will lead to a decline in nitrogen levels to an amount that is better for the ecosystems. Besides that, many plants and combinations of plants have proven to be able to reduce the number of pollutants in soil, water, and air (Kafle, 2022). These three types should therefore also be regarded as co-benefits.

In short, there are multiple co-benefits related to biodiversity conservation. These are crop diversification, carbon sinking, soil services, water services, and air services. These should be taken into account when assessing the biodiversity improvements and they should be rewarded as part of this effort.

3.2
WHAT IS THE PROBLEM WITH NITROGEN?

The vast surplus of nitrogen is a problem, but what is it and why is it a challenge?

The Netherlands and Europe as a whole are dealing with a major nitrogen crisis. The excess of nitrogen is slowly taking its toll on biodiversity, through eutrophication, acidification, and other side effects. (Dise et al, 2011; WUR, 2019).

Eutrophication is the process in which the overall availability of nitrogen increases. This is mainly due to increased nitrogen levels in soil or water. In the short term, this increase will accelerate the growth rate of plants. But at some point, certain plant species can no longer use the extra nitrogen that is available, while other species still can. For these plant species, the increased nitrogen levels limit the growth of plants. This is especially problematic in habitats that originally had relatively low nitrogen levels. The low-nitrogen plants with limited growth are not able to compete with the plants that thrive on higher nitrogen levels, and are therefore pushed out. This process could lead to the extinction of the low-nitrogen plants (WUR, 2019).

Acidification is a side effect of increased nitrogen levels in the soil. Some of the nitrogen compounds influence the acidity of the soil. This again results in plants that are less able to deal with the increased acidity being outcompeted.

The mentioned changes in plant life can also subsequently lead to a higher susceptibility to external stresses. Increased nitrogen levels decrease the resistance of plants towards changes in water availability, temperature fluctuations, and animals like insects. In short, the increase in nitrogen leads to less diverse and less resilient plant life, which results in a loss of biodiversity (Disce, et all., 2011).

But at the same time, plants need nitrogen compounds to grow (Hellmuth & Hochmuth, 2015). A lack of nitrogen will lead to less crop growth and a smaller harvest, as the specific plant species used for farming thrive on higher levels of nitrogen. To boost the level of nitrogen in the soil most farmers spread manure and chemical fertilizers containing the nitrogen compounds as shown in the diagram, in 2020 the imported nitrogen was about 669 million kg (CBS, 2020). Through natural processes, different compounds are created, which are used by the plants to grow. While part of these additives is used for crop growth, another part runs off into water bodies or natural areas. In 2020 the total excess of nitrogen was about 307 million kg (CBS, 2020). As shown in the nitrogen cycle the Netherlands is a major contributor to nitrogen pollution (Klein et al. 2018). The majority is in the form of ammonia (NH3) from farming practices. The farmers introduce extra nitrogen into their soil, through industrially produced nitrogen or feed for livestock, the manure of which is used on the land.

Even though having nitrogen is somewhat necessary, the farming sector is the largest nitrogen polluter in the Netherlands. It is accountable for 58% of the nitrogen pressure on water bodies and natural areas (Oenema et al., 2019). The Netherlands is especially vulnerable to an excess of nitrogen because there are a lot of habitats that originally had low nitrogen levels like peatlands, forests, and heathlands. These are heavily influenced by the rising nitrogen levels. Because farming is a large-scale nitrogen polluter, we can assume that the current mainstream farming practices are unsustainable as they are creating a decline in biodiversity. A change should therefore be made to reduce the nitrogen import due to farming and to reduce the current high levels of nitrogen in air, soil, and water, while also reinforcing the existing biodiversity, to make it more resilient.

Figure 3.3: A chalk grassland vegetation (Mesobromion erecti) in the Netherlands (left) without N addition and (right) after three years of N addition (100 kg N ha −1 y −1 as NH 4 NO 3) (from Bobbink, 1991).

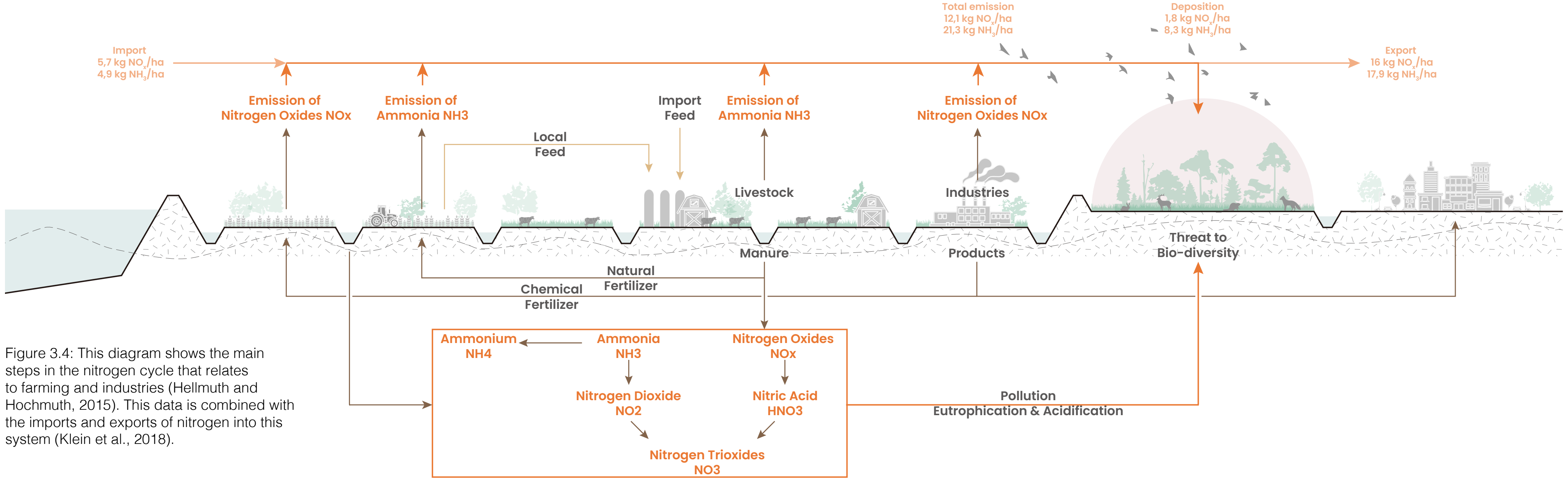


Figure 3.4: This diagram shows the main steps in the nitrogen cycle that relates to farming and industries (Hellmuth and Hochmuth, 2015). This data is combined with the imports and exports of nitrogen into this system (Klein et al., 2018).

3.3
CURRENT FARMING FLOW

After the last Dutch famine, in the last winter of WWII, the Dutch government promised "never hunger again" and started transforming the system into the intense way of farming that it is today. An important spatial intervention was re-parcellation to create bigger farms. Together with the green revolution: the introduction of artificial fertilizer, and with the mechanization of farming techniques, intensive farming was being developed in the Netherlands. This practice is still being upheld by large subsidies and global trade (Van Grinsven, et al., 2020).

But what is so unsustainable about these current intensive farming practices? We unpack this highlighting the flow of nitrogen, products, and information that degrade the system, relating to the farmers' role and food production.

Flows of goods

Fertilizer, as mentioned before, is essential to food production. However, its use today creates an excess of nitrogen in the soil and waters surrounding farms. This is mostly due to the introduction of artificial fertilizer (of which the creation is one of the most energy-intensive processes) and importing animal feed. This animal feed, mostly relevant for dairy and meat farming, consists mostly of protein-rich crops, such as corn, grass, and soy, to boost the production of e.g. milk (Vingerhoets, et a., 2023). Corn and grass are often produced by the farmers themselves, on monocultural acres and meadows. Soy, however, is imported mostly from North and South America (Selten & Silvis, 2020), where monocultural plantations have overtaken indigenous natural areas, such as the Amazonian rain forest.

In the EU 'Farm to Fork'-strategy, this practice has been identified as highly unsustainable (European Commission, 2019). For arable farming, fertilizer is also frequently used (Silva, et al, 2021). Further following the flows, the imported nitrogen (as captured in soy and fertilizer) accumulates in Dutch soils and is exported as manure, to become the base of new products (WUR, 2021).

Flows of products and information

Agricultural products, such as dairy, meat, fruit, and vegetables are mass-produced and distributed in a centralized way, in which most products are exported to other EU countries, and few are also Dutch supermarkets (Berkhout, 2018). However, in the current system, chain coordination (where food ends up) is not in the role of the farmers themselves but is often done by large retailers. These retailers also determine the price of farming products, thus holding financial power over the farmer (Visser, et al., 2013). This system pushes farmers to produce more and thus industrialize and intensify further. This can only be done by further mechanization and innovation of farming technology, as is the narrative developed by technology companies working closely with farmers, perpetuated in the curriculum of the single Dutch farmer school too. This narrative makes farmers dependent on technology, instead of on nature (Kuiper, et al., 2023).

Furthermore, the current intensive farming system also alienates consumers from their food, as there is little information on where the food one buys in the supermarket is from (Burich & Williams, 2020). This might further strengthen the disconnect between the business and role of farmers and the consumers' perception of that (also theorized as the urban-rural divide). However, after the recent farmers' protests, there is still more support for the concerns of farmers than for climate activists (NOS, 2024).

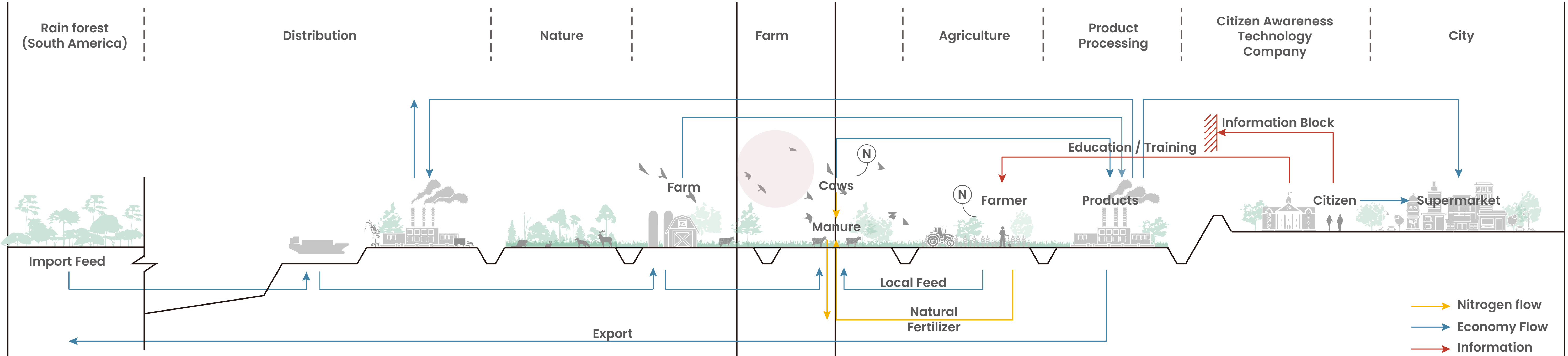


Figure 3.5: Flows of nitrogen, economy and information in the current situation

3.4
STAKEHOLDERS IN THE NITROGEN DISCOURSE

In order to be able to work out an implementation strategy which is tailored to the local circumstances, it is necessary to understand the context of stakeholders surrounding the transformation we want to achieve.

To do this we plotted the stakeholders in a three-dimensional matrix, depicting the most relevant factors. How powerful is a stakeholder? Is the stakeholder more in favor of the project or more opposed to it? How much does the stakeholder care about the project? By plotting this it becomes clear which stakeholders present themselves as major potential blockages and which can maybe help bring the project to a successful completion. This informs on the different ways to integrate the stakeholders in the process design.

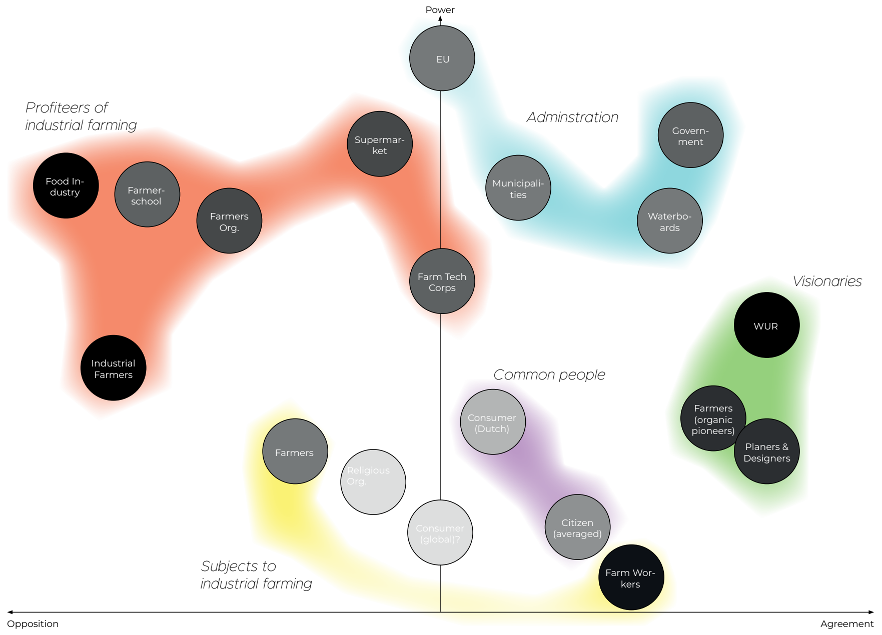


Figure 3.6: Power, interest, willingness matrix

Stakeholder positions

Stakeholders with low power, high agreement, and high interest should be empowered by our process to be able to unfold their transformative potential. Stakeholders with high power, high agreement, and low interest should be activated as the potential they bring to the process does "just" need to be tapped. Stakeholders of high power, low agreement, and high interest pose the biggest risk to our project, so either their power should be contested or their agreement to the transformation should be increased. According to our clustering of the stakeholders based on their position in the matrix as well as their position in the farming system this means the "Administration" needs to be activated to tap their power, the power of the "Profiteers" needs to be contested or they have to be convinced on other grounds, the "Visionaries" have to be empowered as their high interest can drive the process, the "Subjects" (low power farmers and workers) need to be activated with good reasons as they are to a large degree the people executing the transformation.

Derivation of power from dependencies

In order to better understand how the power of certain stakeholders is derived we created an abstraction of the monetary dependencies in the industrial farming system. As the stakeholders are themselves comprised of actors it is relevant roughly how many or few actors are cumulated in "a" stakeholder. Keeping this in mind we can now understand that there is a significant concentration of monetary flows along the supply chain of industrial farming happening mainly from many consumers to some supermarket chains to even fewer giants of the food industry. From this concentration, the flows start to slightly spread again. However as the food industry is the point of these flows, there lies significant power in the direction of the flows from the food industry. The industry is inherently mostly concerned with keeping the prices of the materials they need low in turn making productiveness the main deciding factor of the feasibility of a farmer's endeavour (Visser, et al., 2013). The current system of EU agrarian subsidies is mostly further manifesting the importance of productivity for farmers (Wilts Jansen, 2023).

So if we want farmers to take other factors into account in their way of using their land, we have to make it a feasible option to do so by disrupting

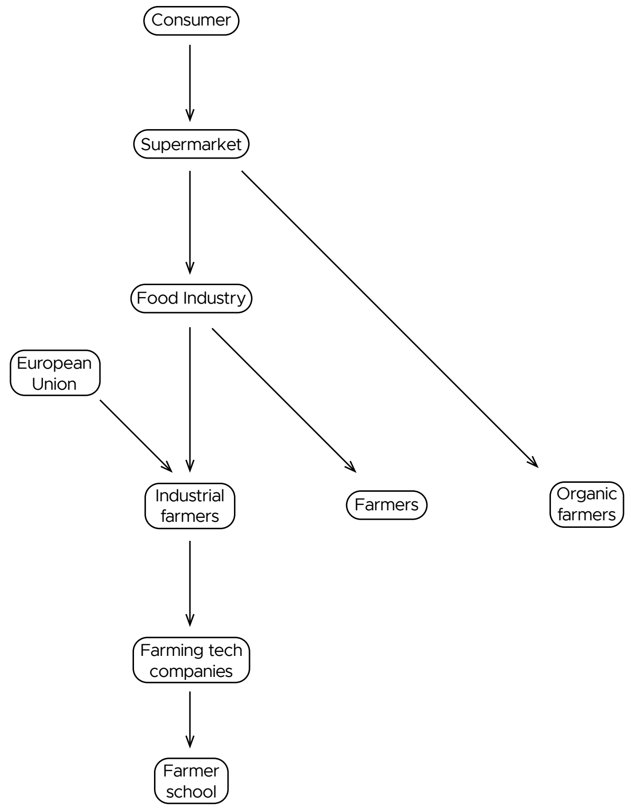


Figure 3.7: The monetary relations between different stakeholders

their dependency on productiveness as a consequence of their monetary dependency on the food industry, thus empowering them in a new role. This can be achieved by diversifying the way they monetize food production and by diversifying the way they gain value from their land (not just by means of food production)

3.5
SPATIAL ANALYSIS

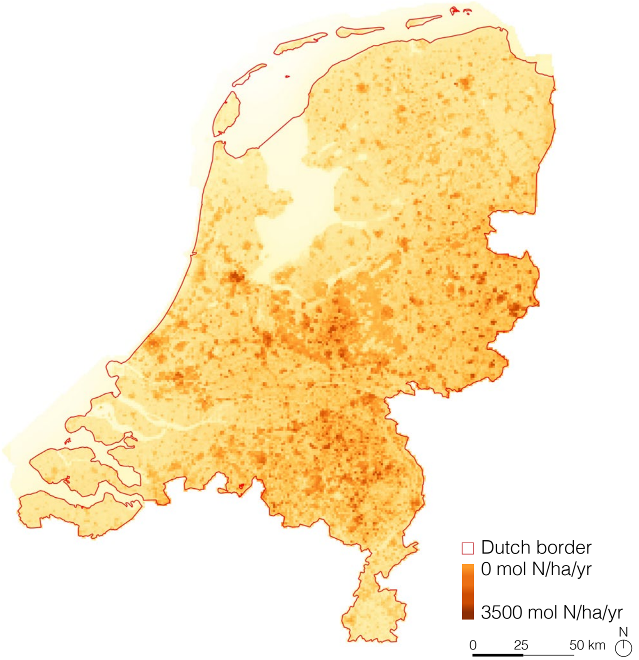


Figure 3.8: Nitrogen Deposition in the Netherlands (RIVM, 2015)

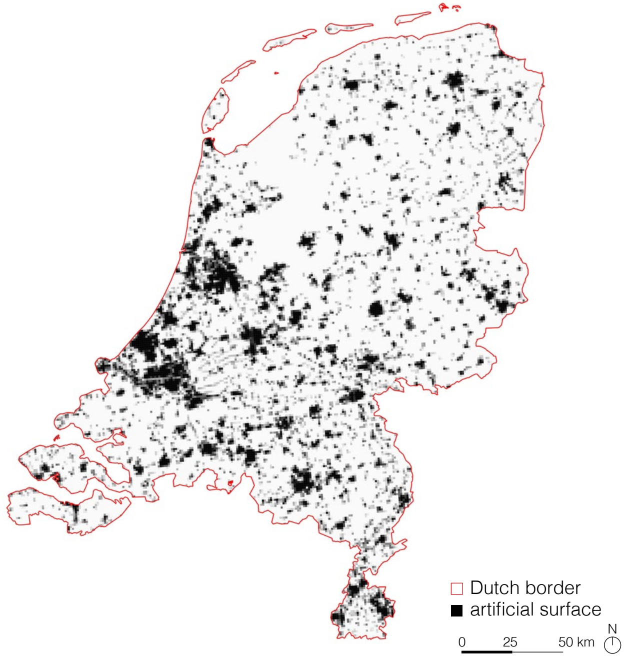


Figure 3.9: Density of artificial surfaces, based on Copernicus (2019)

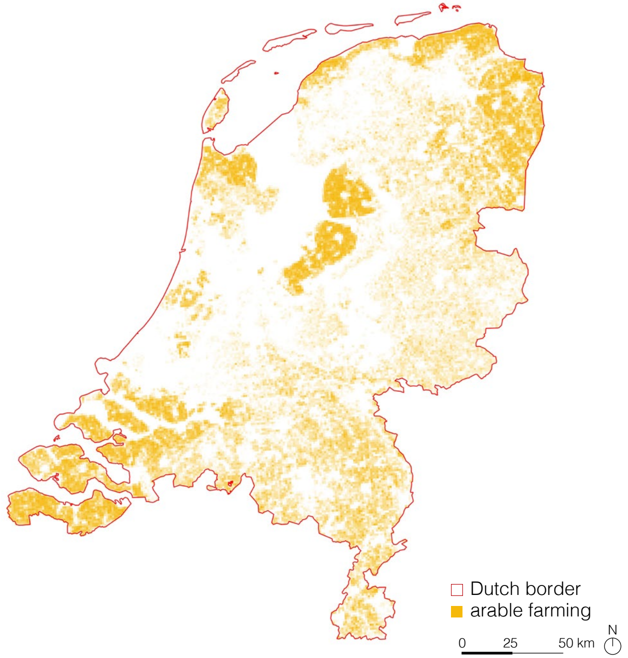


Figure 3.10: Density of arable farming, based on PDOK (2023a)

Figure 3.11: Density of grass production, based on PDOK (2023a)

Figure 3.12: Density of protected natural areas, based on PDOK (2023b)

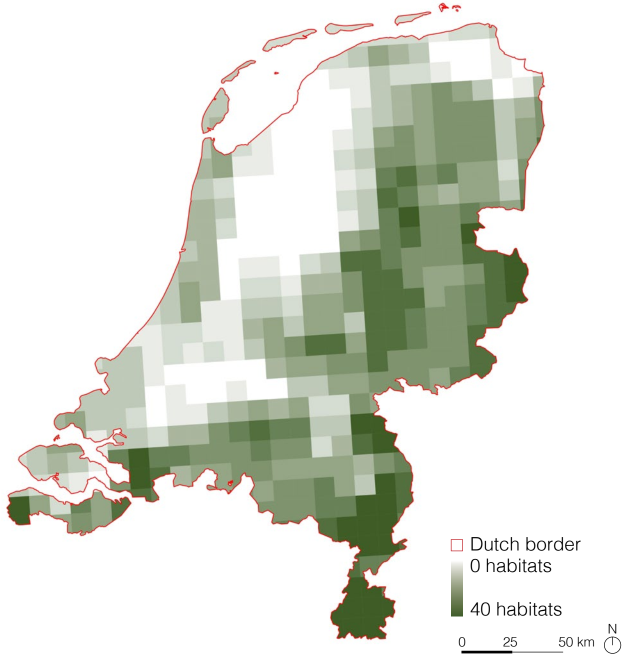


Figure 3.13: Ecological Biodiversity, based on Geodesk WUR (2014)

Nitrogen and food production

As previously discussed, the Netherlands is dealing with a nitrogen crisis. Figure 3.8 shows the nitrogen deposition in the Netherlands the overall deposition is relatively high (dark red color), with some exceptions (blank space). When taking into account that a deposition over 2000 mol N/ha/yr is considered extremely high (RIVM, n.d.), we can see that the pressure is severe. The deposition peaks are largely close to the urban areas (figure 3.9), because of their high level of industrial and transportation activity. The deposition map also shows large areas with moderate deposition.

When compared to data about agricultural land use (Figures 3.10 & 3.11), we can see a clear overlap between these. Another interesting conclusion is the relatively strict separation between the two most common agricultural land uses, grass fields, and arable fields. Large-scale arable farming is mainly constricted to Zeeland, Groningen, Flevoland, and the most northern part of Noord-Holland. Grassland is the most dominant agricultural land use, almost fully covering Friesland, Drenthe, Overijssel, Gelderland, and the Green Heart region. Especially the Green Heart region is interesting as it largely overlaps with the high deposition in the Randstad region.

Nature

The Netherlands also has an extensive network of natural areas, which is shown in figure 3.12). With large areas, like the Veluwe and the Waddenzee, but also many smaller areas that are located all over the country. Their main purpose is the protection of nature inside the areas.

When compared to the ecological biodiversity (figure 3.13), there is a clear correlation between areas like the southern Brabant and the Veluwe. They exhibit a high degree of biodiversity. But at the same time, there are a lot of areas in the west of the country that have a relatively low degree of biodiversity, despite their protective status. When also comparing this with grassland agriculture (figure 3.11), another correlation can be shown. The east of the country, which is predominantly grassland, is also part of a large band of little biodiversity stretching from the Randstad region to Friesland and northern Groningen. This correlation reinforces the notion that especially cattle farming practices tend to limit biodiversity.

Tension area

There is a clear tension visible between nitrogen deposition, farming as a main land use type, and natural areas in the showcased maps. Where farming goes, nitrogen deposition goes too, as opposed to high biodiversity areas, where there is little to no nitrogen deposition. This strengthens our findings so far, that nitrogen pollution is strongly related to farming, and harms biodiversity.

An area where this comes together is the Randstad area: high deposition, high degree of farming and low biodiversity while harbouring various natural areas. Moreover, the region is also the most densely populated area of the Netherlands, therefore subject to a large tension in spatial claims. Also, this area is characterized by many types of farming on different types of soil (Stuurgroep Nationaal Landschap Groene Hart, 2020). Therefore, the Randstad region is most representative of the rest of The Netherlands whilst providing the most challenges. Since we look specifically at peri-urban areas, we focus on the farming-dominated fields in between the four big cities of Amsterdam, Utrecht, Rotterdam and The Hague - also called the Green Heart and its surroundings.

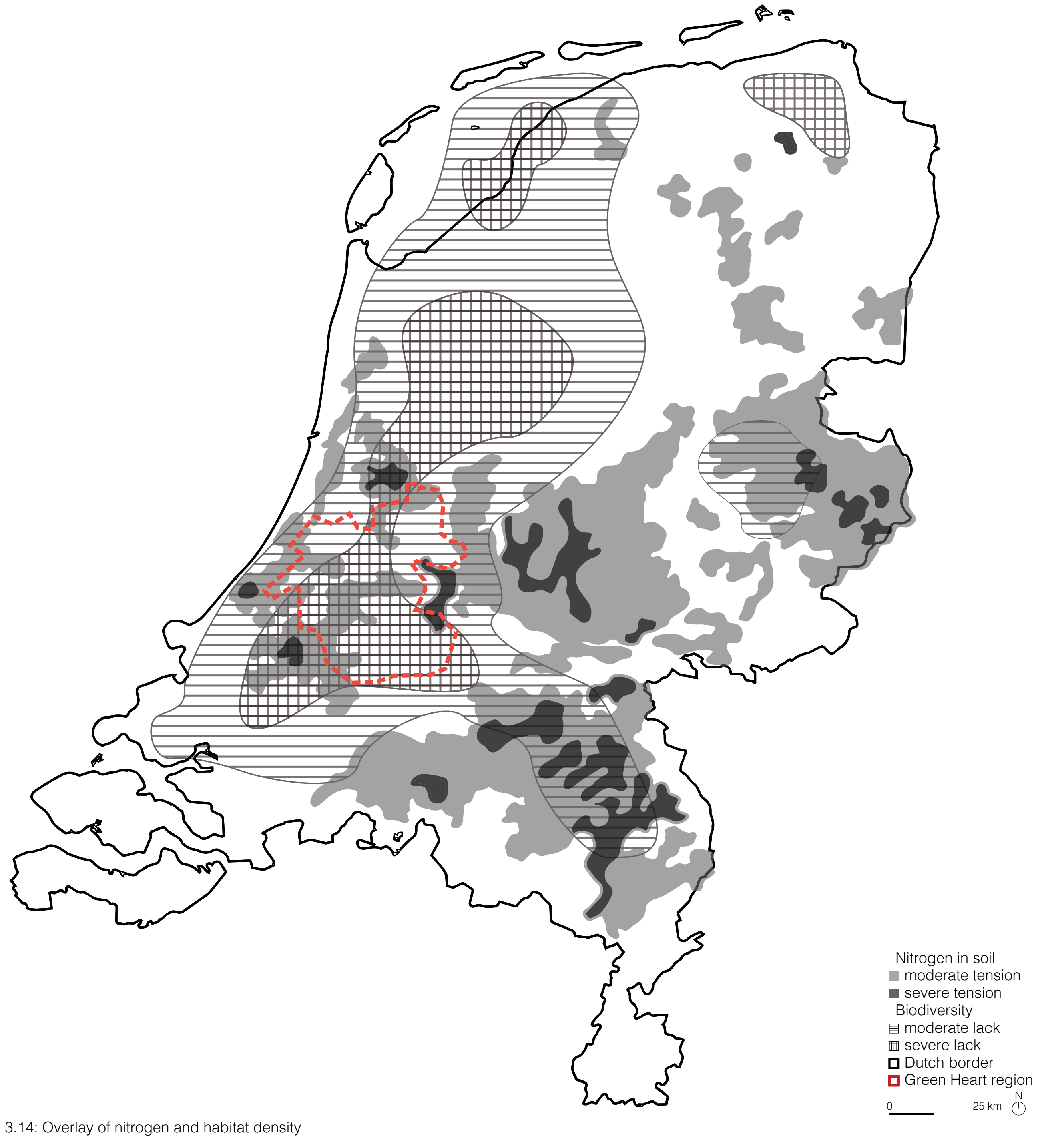


Figure 3.14: Overlay of nitrogen and habitat density

The Green Heart

The Green Heart is a purposeful open area in the middle of the Randstad, with a long agricultural tradition. A few analyses are needed to clarify the view of the Green Heart, on what nature is there, and how what the soil and water situation is.

There are multiple types of soil and differing levels of groundwater to be found. This situation is important to take into account, as it is the basis of all natural developments of environmental management, certain species of plants and animals only thrive on certain soil and groundwater combinations. Thus also forming the limitations of what type of intervention can be done where.

According to the Dutch Ministry of Infrastructure and Waterstate (2022) the key to a more sustainable and well-balanced system. Figure 3.15 shows what soil types are in the green heart. Figure 3.16 shows the water heights in the area. By combining these (figure 3.17) we can see what water-soil combinations are in the Green Heart. The colors give the soil type, and the intensity of the color shows the level of groundwater (the higher the water, the darker the color).

There are four types of soil in the Green Heart: peat, swampy, sandy and clay soil (figure 3.15). All four have different ways of retaining water, resulting in different groundwater levels (figures 3.16 & 3.17). Groundwater, as measured in the winter mode (lowest), in centimeters creates the intensity of the color of the map. Peat soil (red for low water and dark red for high water), has the highest level of groundwater and generally is found below sea level. Then follows swampy soil (yellow for low groundwater, dark yellow for higher groundwater). After that, clay soil retains groundwater good as well (blue for lower values and dark blue for higher) and forms the bottom of (old) waterbodies. Lastly, sandy soil is mostly found in the higher areas of the Green Heart, it is less able to retain groundwater (green for low values and darker green for higher values).

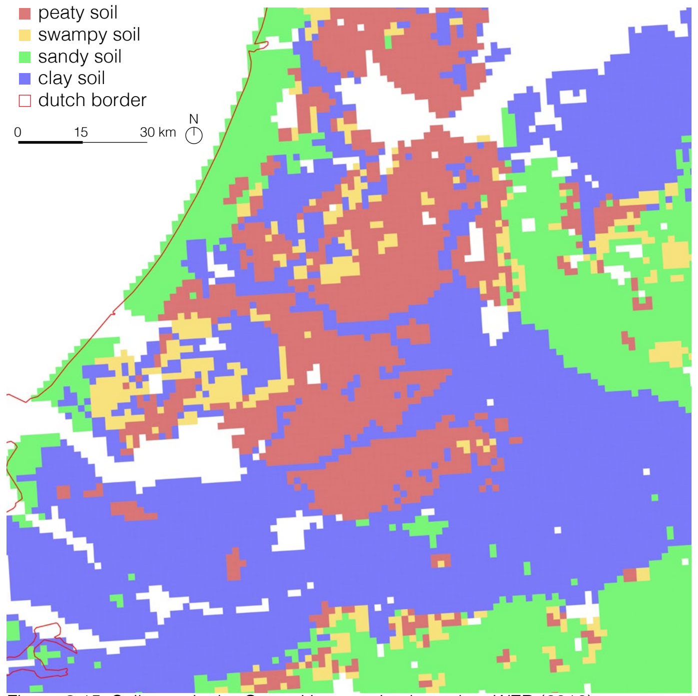


Figure 3.15: Soiltypes in the Green Heart region based on WER (2016)

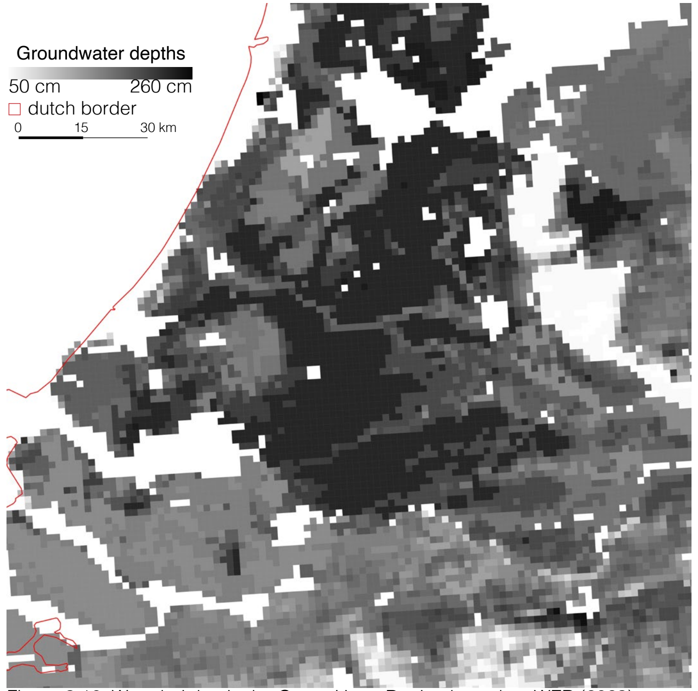
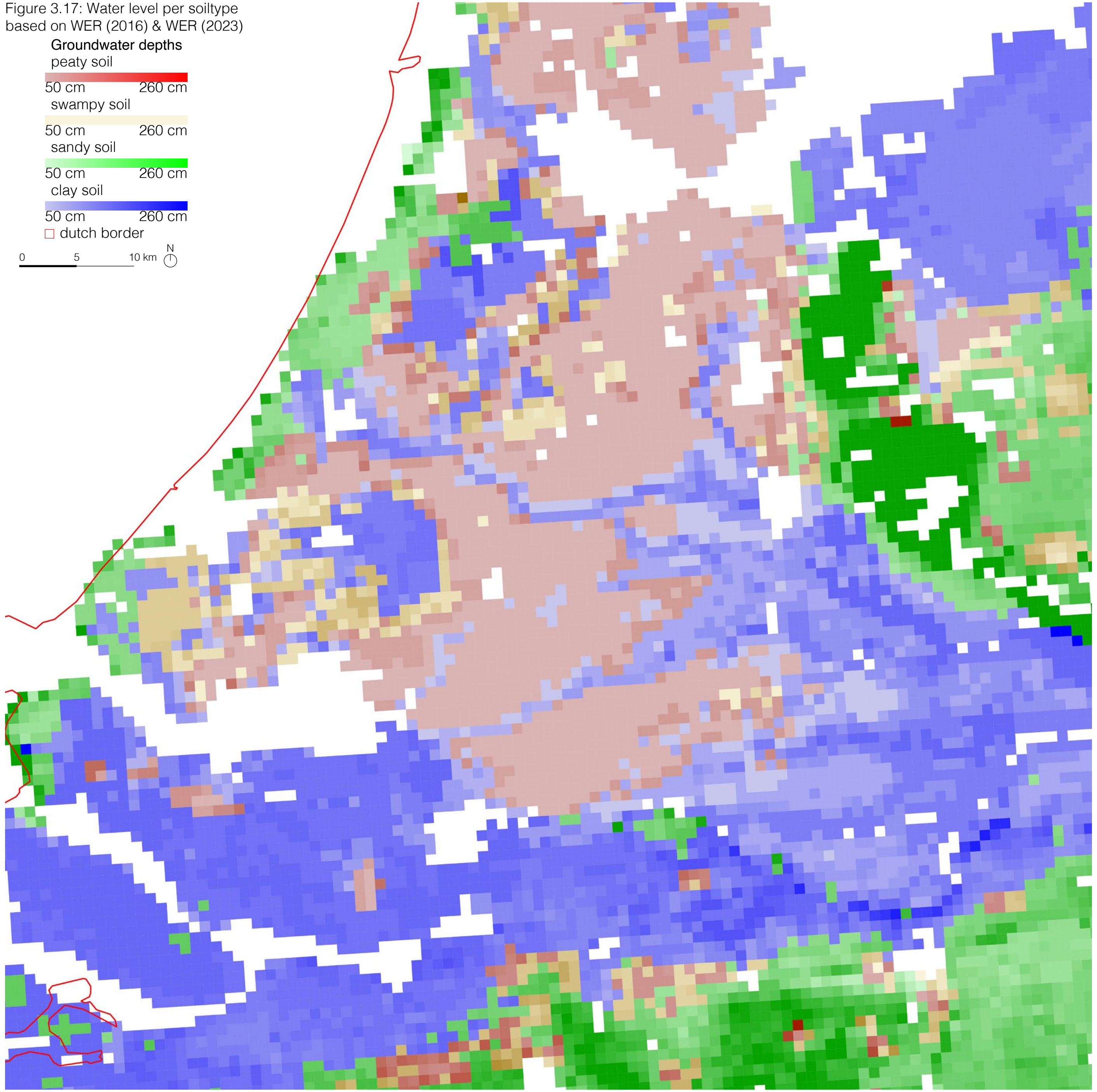


Figure 3.16: Waterheights in the Green Heart Region based on WER (2023)

Figure 3.17: Water level per soiltype based on WER (2016) & WER (2023)



3.6
WHAT FARMING GOES WHERE?

Since the soil type and the determine the natural interventions, it is essential to map out what type of farming is now done where. The characteristics of crops are best suited in certain areas, as seen in figure 3.18. This Figure shows a transect between The Hague and Utrecht, with the local soil types and the corresponding water levels in centimeter GLG. Data used is on soil types (WUR, 2016), water levels (Bodemdata, 2023) and crop data (Overheid.nl, 2024).

Sand
Starting at the left side, in the Hague, we can find a low groundwater table of 200 cm GLG, on which the city of The Hague is built. Then we transition to a mix between sand and sea clay, with a table of 100-150 cm. It is perfect for cultivating the famous tulip flower bulbs. Also, cabbage and grassland can be found here.

Sea Clay
Then moving to sea clay, with the same water table (100-150 cm GLG), perfect for onions, root vegetables such as beet, and wheat in drier areas.

Peat
Then the switch to the large peat fields, what used to be swamps accumulating partly decayed plant material, are now fertilized meadows with a very high water table of 0- 50 cm GLG. Due to the high water table, not many species with deep roots can find enough oxygen in the soil, so trees do not get very tall and rooted vegetables would rot. Only grass and corn thrive here, meaning that the area is mostly used for grazing and feeding cattle.

Swampy
A mix between clay, sand and organic matter with a relatively high water table (50-100 cm GLG), is perfect to farm more cattle and some potatoes. Thus forming the ideal place to find the standard Dutch cuisine. Also, on the edge with some river clay areas, fruit orchards appear adding some vitamins to the menu.

River Clay
Integrated in the peat and swampy areas are places where old rivers used to run, leaving fertile and nutrient-rich clay behind. The groundwater table is lower, similar to sea clay (100-150 cm GLG), ideal for fruit orchards, beets, potatoes, corn and more kettle.

Sand
We are moving more east into the mainland of the Netherlands. Here, old glaciers have pushed moraines of sand. Generally, this area is a bit higher and thus the water table is lower (more than 150 cm GLG). Arable crops here are fruits on the ground and wheat. Moving beyond the city of Utrecht is the driest area, such as the Utrechtse Heuvelrug, where forests form the main type of vegetation.

Figure 3.18: The soiltypes between The Hague and Utrecht with their characteristic watertables and vegetations.

04 Vision

THE FUTURE OF FARMING

4.1
VISION STATEMENT

Our vision is to **reduce nitrogen pollution** by creating a system in which farmers are stewards, empowered to cultivate not just nutritious foods but to also maintain a biodiverse landscape, by balancing out food and biodiversity production into a resilient system that that offers farmers a sustainable perspective.

Figure 4.1: Creating a balance between food production and biodiversity (source in chapter 8.1)

4.2
PRINCIPLE OF BIODIVERSITY AND FOOD PRODUCTION

As we have already discussed in the analysis (Chapter 3.1), there are a few ways in which spatial interventions can improve biodiversity. First of all, creating multiple different habitats can accommodate more distinct species. And therefore increases (ecological) biodiversity. Our project should therefore focus on creating these differences.

Another aspect that must be taken into account is that making these new habitats larger also improves the (taxonomic) biodiversity. A larger area can accommodate more distinct species. So along with the focus on creating differences, there should also be a focus on creating large habitats.

Furthermore, we have seen that improving biodiversity has co-benefits. These are not the direct goal, but they still provide information on the increase in biodiversity and they provide services to nature and society.

These three focuses are all indicators of the quality of biodiversity. As part of our project, these three should be rewarded. So farmers can produce biodiversity and get paid for that. This is also an important way in which farmers can be convinced to alter their practices because, with this new practice, they will still be able to pay their bills.

Principle 1

BIODIVERSITY AS A PRODUCT

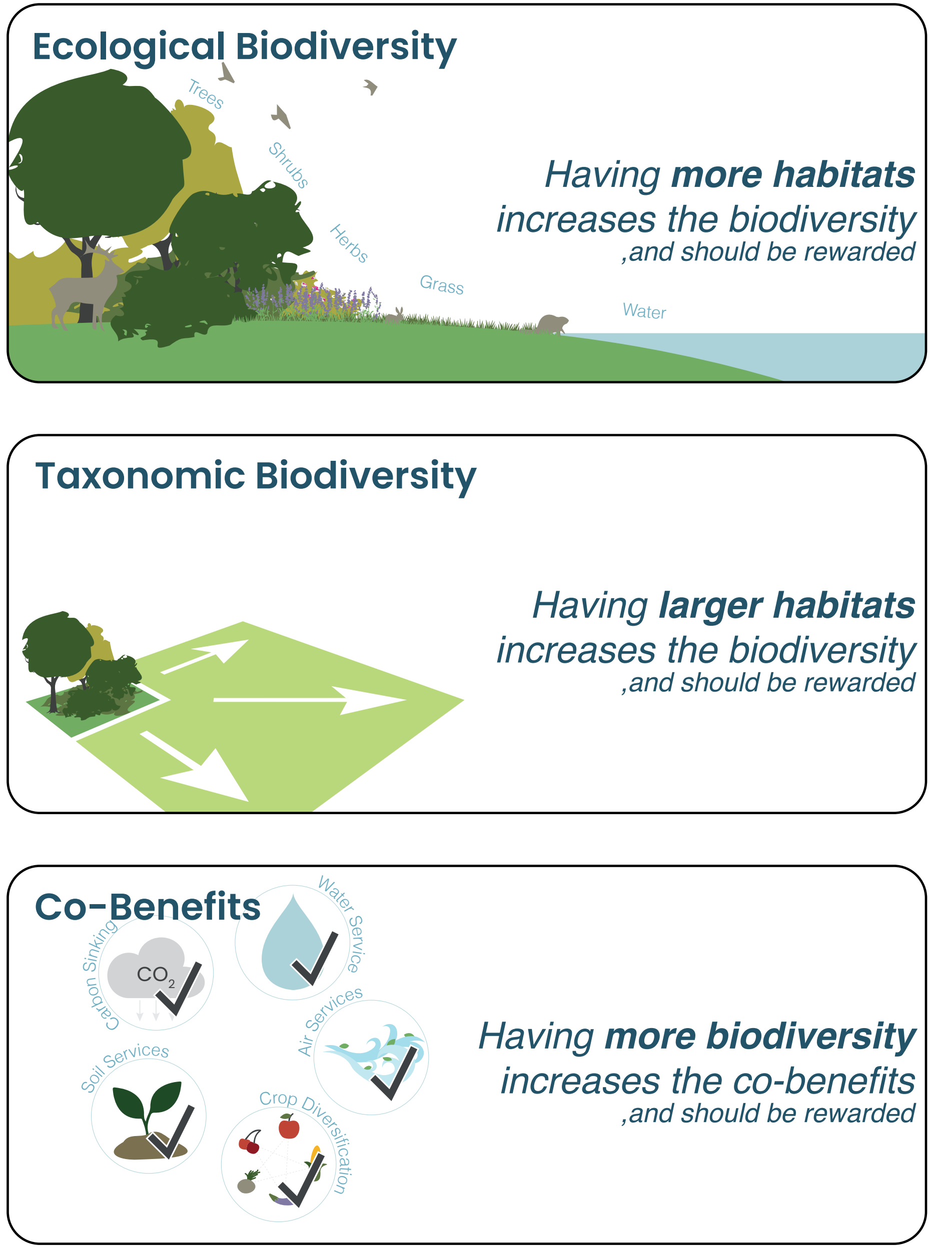


Figure 4.2: Diagram of the first principle, highlighting ecological diversity, taxonomic diversity and co-benefits.

Principle 2

INTEGRATING BIODIVERSITY AND PRODUCTION

The second principle for our strategy is the integration of biodiversity and production. As shown in the academic debate (Chapter 1.4), the integration of biodiversity conservation efforts and food production could lead to higher rewards. Figure 4.3 is an abstract representation of the relation between those two. In the status quo (red line) there is little integration. There is either production or there is biodiversity. The other outer line shows the ideal, a situation in which production and biodiversity are fully integrated without limiting either of them. In reality, this balance is more likely to be somewhere in between.

In this project, the aim is to improve the overall integration of these factors, into a shared situation in which they are more balanced.

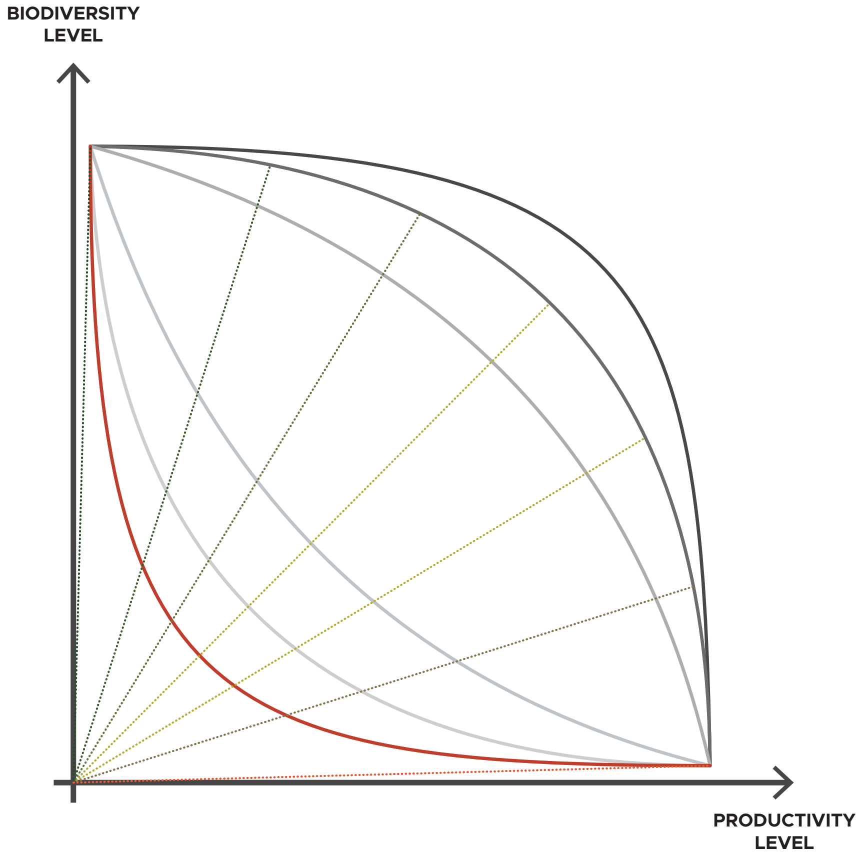


Figure 4.3: Relationship between production and biodiversity, taking into account different levels of integration.

4.3
VISION : GRADIENT

Our project is centred around the idea of fostering a harmonious relationship between human activities and nature on the ground. Currently, there is a hard barrier between these two domains, which prevents them from coexisting and thriving together. To overcome this challenge, we have developed a gradient system that allows us to create an area where production and biodiversity can coexist in a balanced manner.

To do this, we have divided the level of human intervention and biodiversity level into different scales. This enables us to fine-tune the balance between the two in a way that is sustainable for both. We aim to create an environment where human activities can thrive without harming the surrounding biodiversity, and where biodiversity can flourish in the presence of human activities.

Our approach is based on the principle that human activities and biodiversity are not mutually exclusive and that it is possible to strike a balance between the two. By breaking down the hard barrier that currently separates them, we hope to create a model that can be replicated in other areas, and that can help promote a healthier and more sustainable relationship between humans and the environment.

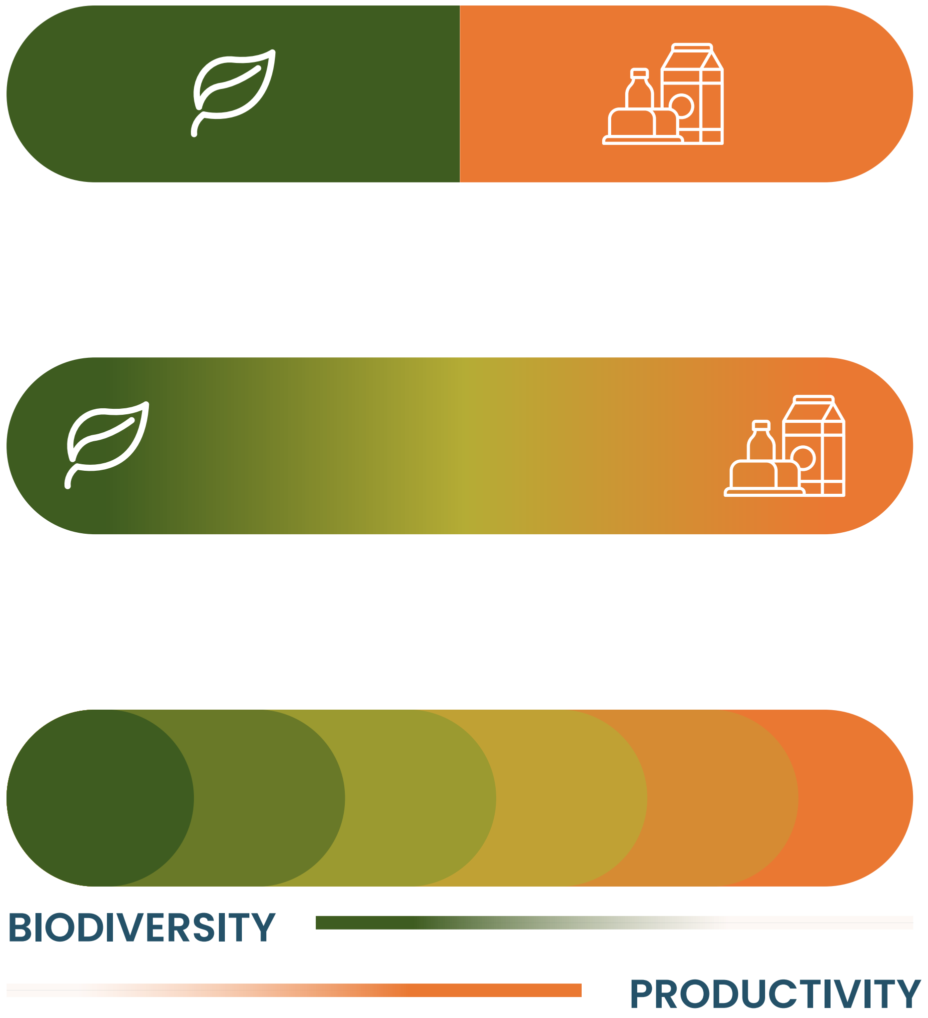


Figure 4.4: The principles behind the gradient.

The process of introducing the base gradient is done with a couple of steps as shown in figure 4.5.

First, The two opposites of the gradient have to be defined, which are the location of urban areas: the existing Dutch urban fabric, and natural areas: the Nature Network Netherland (NNN). The NNN is already identified by the state to be of high importance to biodiversity and is already protected (figure 4.5b). Defining the urban areas was done by aggregating urban land use classes of the Corine Land Cover dataset, dissolving them to form continuous areas and filtering the resulting areas by a minimum size to only take into account the continuous fabric of a size relevant to the scale of the green heart (10ha) (figure 4.5c).

The second step is to calculate the distance at each point from the closest urban and biodiversity pole and further aggregate these distances to one measure depicting where each point is situated relative to both (figure 4.5d). By doing this all the land is given a preferred value of biodiversity versus production. From the city towards the nature area, this values change towards a prioritizing of biodiversity and less focus on production. The resulting gradient was then separated into classes, resulting in our vision map (fig. 4.6) forming the base for the further development of our project.

Figure 4.5a: Satellite image of the Green Heart (Beeldmateriaal Nederland, 2017)

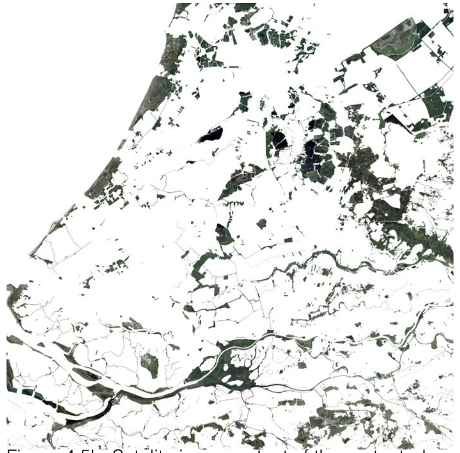


Figure 4.5b: Satelite image cutout of the protected nature based on Copernicus (2019)

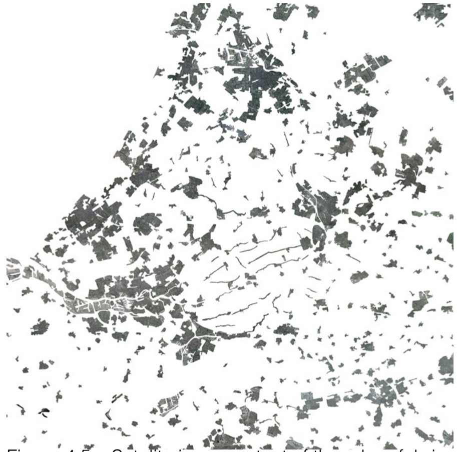


Figure 4.5c: Satelite image cutout of the urban fabric based on Copernicus (2019)

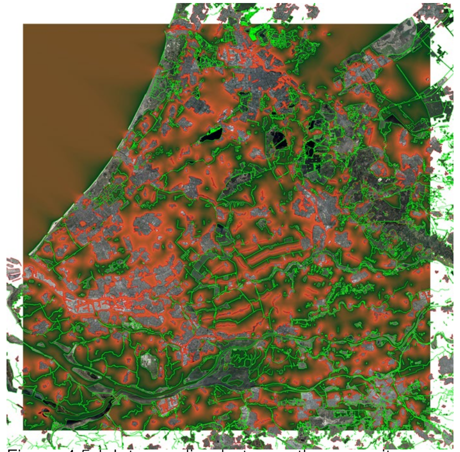
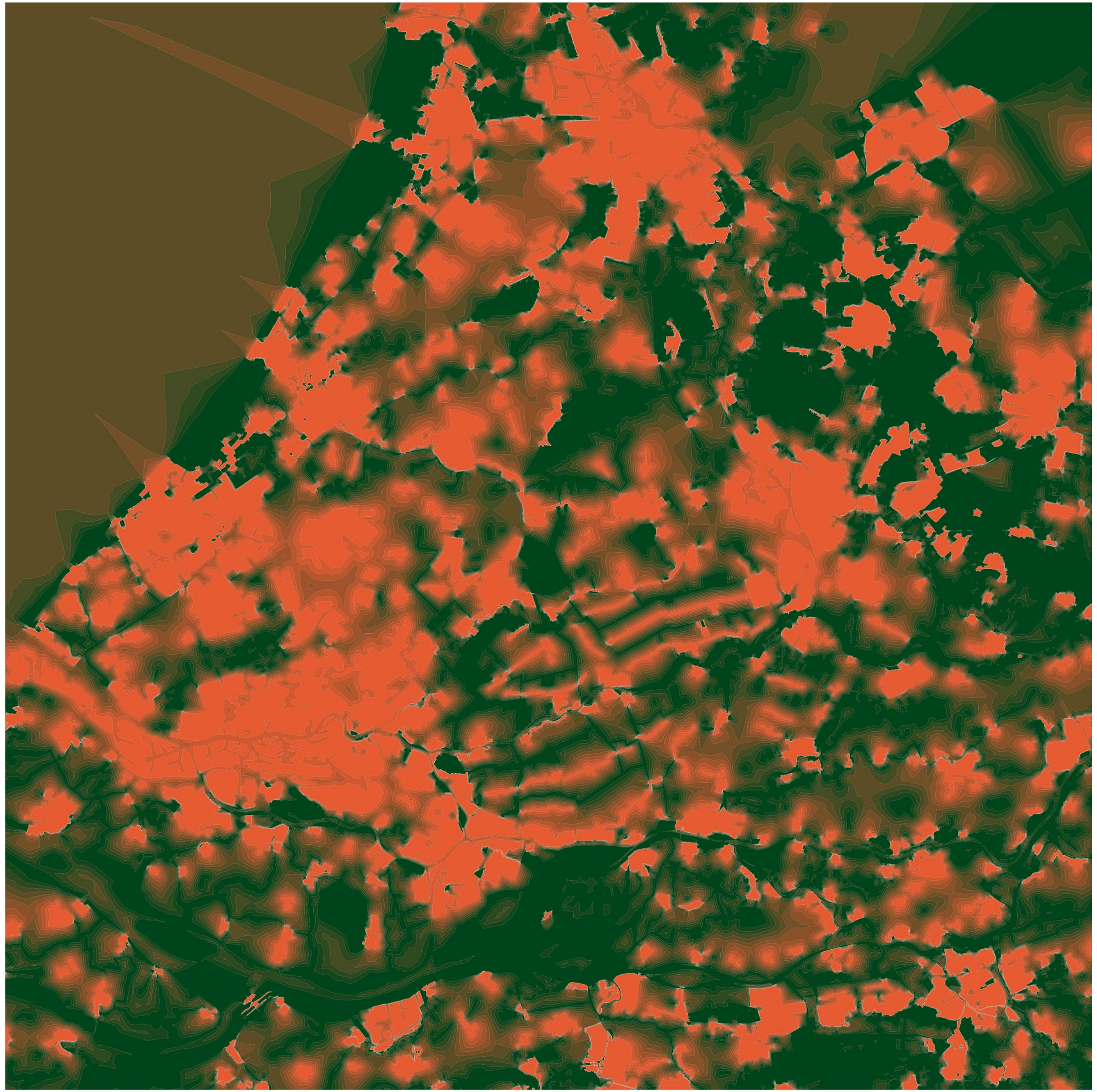


Figure 4.5d: Intergrading between the opposites

Figure 4.6: The gradient of biodiversity and production.



Within the gradient, the human habitat and nature are situated on opposite ends, with four groups in between. Human habitat, being dense and multifunctional, represents the highest level of productivity. On the other hand, nature serves as an ecological gathering place, characterized by remote wilderness that few people can explore.

The gradient closest to the city represents an area with integrated productivity. Leveraging the advantages of economic agglomeration due to its proximity to human habitat, farms within this gradient exhibit greater concentration and sufficient production activities. Additionally, being close to the city, these farms can serve as destinations for leisure and education for citizens, enhancing interaction between citizens and agricultural activities.

The next gradient is dedicated to general farming and agriculture, where farmers adopt individual and collaborative business models aimed at ecological farming and animal husbandry. Following that is the agricultural landscape gradient. Here, farmers not only engage in production activities but also undertake a greater quantity of biodiversity renovation activities. Finally, the last gradient focuses on ecological regenerative agriculture, where the areas are mostly natural spaces with low productivity, such as berry picking and fishing. These areas also serve as migratory destinations within the wild nature.

Figure 4.7: abstract representation of the gradient in a plan.

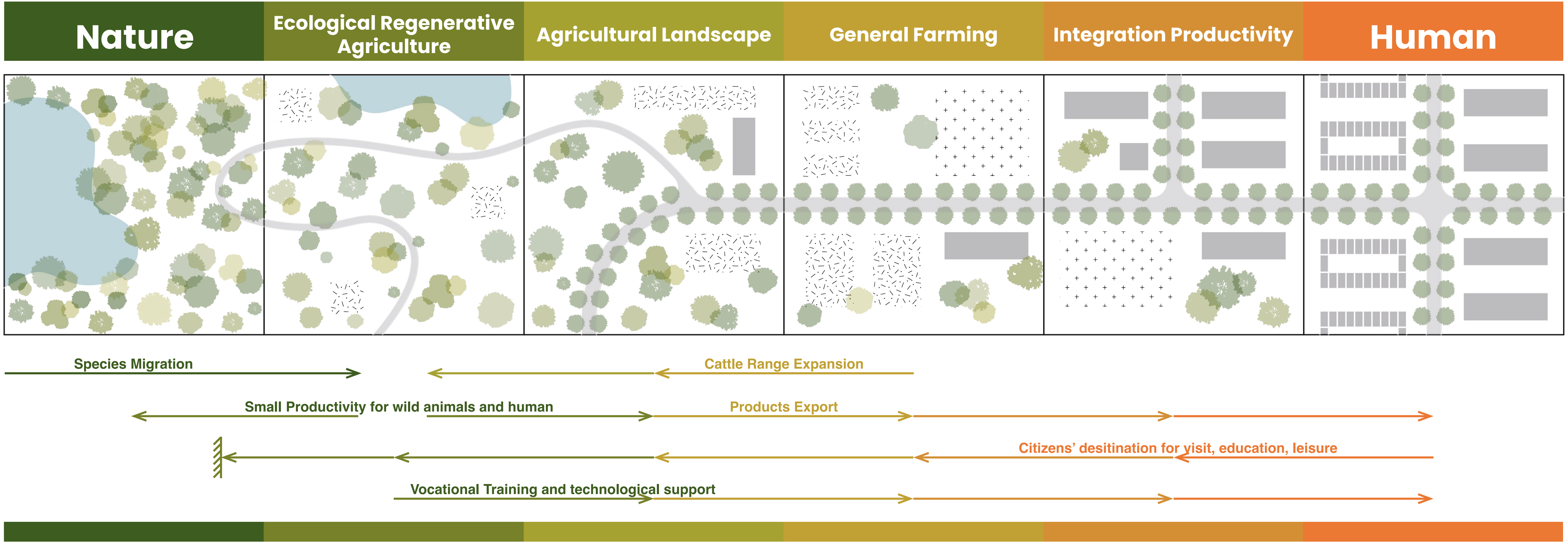
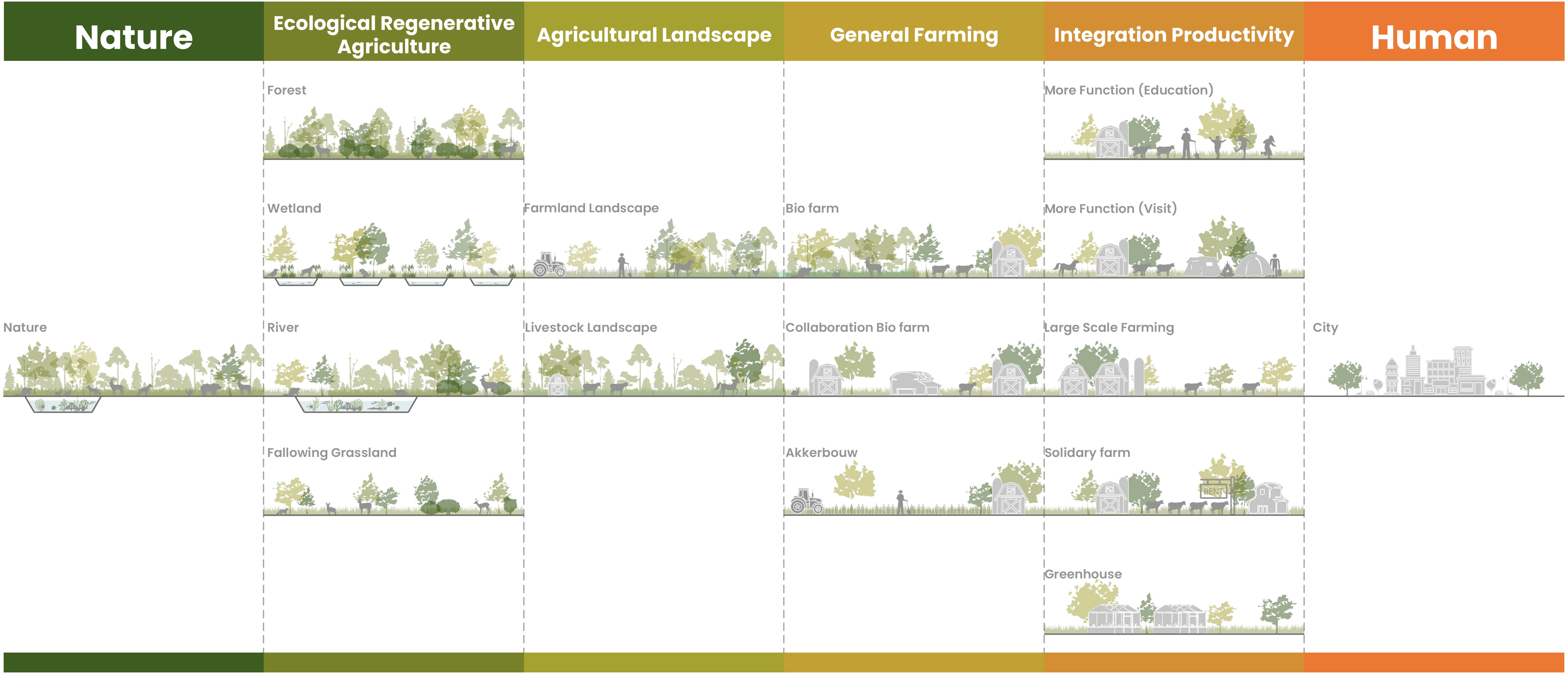


Figure 4.8: abstract representation of the gradient in a section.



4.4
FUTURE FARMING FLOW

In the future system, farming has to change and become more sustainable. Therefore a selection of nature-inclusive farming practices are given here that fit our vision to foster biodiversity and bring down nitrogen pollution. We determine a set of principles, following the European Farm to Fork strategy (European Commission, 2019). The new role of the farmer is to safeguard these principles and be a steward of the landscape (Linnartz, et al., 2023).

Circularity of nutrients
This means no introduction of artificial fertilizers, animal manure can be used as natural fertilizers and stays within Dutch farms. Animal feed is not imported, highly processed and filled with antibiotics and an excess of protein, but is cultivated and grown on Dutch farms (European Commission, 2019).

No use of pesticides or herbicides
A large share of biodiversity exists of insects, of which a crucial group are pollinators. A thriving ecosystem cannot miss insects, thus they should not be mass-murdered by substances such as pesticides. The same goes for herbicides, products that kill all plants except the grown crop. This is the main cause of the monoculture, we want to avoid (European Commission, 2019).

Maintain a healthy soil
To keep the soil healthy, crop rotation and crop diversification (no to monoculture) on a field can combat soil depletion by enhanced absorption and retention of groundwater, along with an increased number of beneficial soil organisms (Shah, et al., 2021). Soil tillage, which is the ploughing of the soil, has to be decreased to not disturb soil microorganisms and soil erosion (Land van Ons, n.d.). Similarly, more crops have to be cultivated that protect the soil such as cover crops (that keep the soil covered, also in winter), another key is to leave crop residues and other plantrests on the ground for natural fertilization. Another technique to cover the soil with organic matter (e.g. wood chips) is mulching, which also functions as a natural fertilizer (decomposing of the organic matter) and prevents invasive plants from growing (WWF, 2021). Also, the use of heavy machinery has to be limited as tractors compress the soil, leaving less vital oxygen for plant roots.

Use beneficial plant species
Here, plant species are meant that are beneficial to the natural environment. Starting with the use of native species, preferably with original genetic composition, or cultivating 'forgotten' edible species. These plant species are more beneficial to the local ecosystem because the animal species that take nutrients (nectar and pollen) are already present in the area. Similarly, natural processes are already adapted to the reproductive cycle of the native plant specimen (Land van Ons, n.d.). This also means planting crops and plants that provide nutrients to animals year-round, starting with early flowering plant species that provide pollen in the early spring, as well as plants that carry berries for birds throughout the winter (Department of Agriculture, Food and the Marine, 2023). The types of vegetation, and what stands next to each other, also matter. For example, deep-rooting species (like trees) are key, as they suck up water in the soil for neighbouring plants. Also, planting in layers, having differences in the height of vegetation (grass-herbs-shrub-trees) creates more biodiversity in a single area (Keena, 2021).

Focus on maintenance
Creating new biodiversity by constructing a new landscape type, or by planting trees is wonderful, but it cannot be forgotten what type of biodiversity is already there and what type has to be maintained. For example, trees start to efficiently sink carbon only after 10 years (Fairs, 2021), meaning they have to first be maintained for 10 years before trees make carbon into new energy and clean air. Also, the relationships formed between the species in an ecosystem, that make the system resilient, have to be taken into account and have to be maintained. For grassland, maintenance is also key. Practices such as strip grazing leave the grassland to mature by preventing kettle from grazing all flowers in the meadow and leaving some for pollinators, by setting a (moving) fence.

Take good care of animals
Good animal welfare, mainly of farm animals, makes them healthier and improves the quality of the food they produce. It means they need less medicine and helps protect different types of animals and plants. From a human ethics perspective, this is also fundamental (European Commission, 2019).

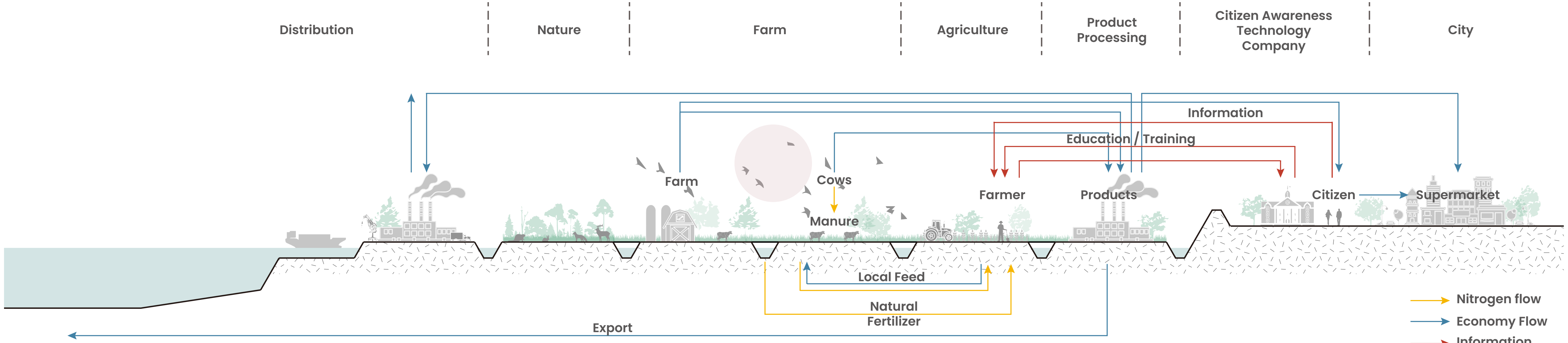


Figure 4.9: Flows of nitrogen, economy and information in the future situation

05 Strategy Making

HOW TO ACHIEVE IT?

5.1
HOW TO MOVE THE STAKEHOLDERS?

Having explained our vision and goals for this transformation leaves us with the practical question on can this vision be achieved. To answer this we will start by looking at what part of the system is blocking the transformation the most in the status quo as shown in chapter 3.4.

The factor that is by far the most pressing is the current monetary dependency of the farmers on the food industry. As shown earlier, it produces a system in which the farmer has no choice but to make productiveness the leading goal of their business. If we want farmers to be able to make biodiversity a leading goal, they have to be able to make a living from the incorporation of biodiversity conservation in their line of work. By monetizing the production and management of biodiversity for the farmer, we make that possible and break the sole dependency on the food industry. This diversifying of income streams for the farmer counters the accumulation of monetary flows and should ideally supported by additional measures like more direct selling from farmers to customers, which is a form of decentralization of the food industry as well. An abstract diagram of the shifted monetary flows further exemplifies this development in figure 5.1.

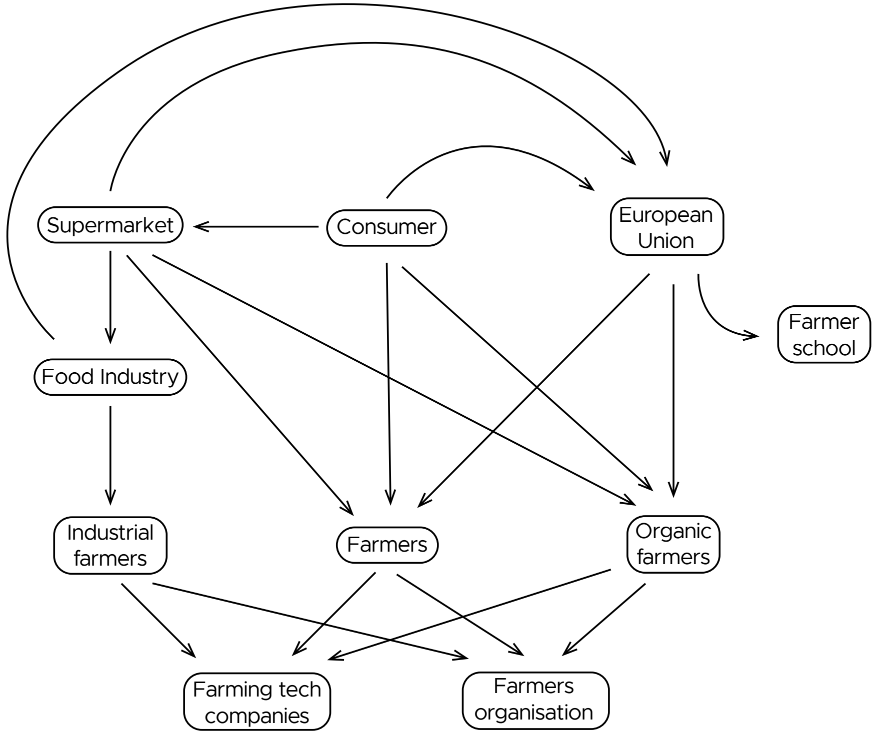


Figure 5.1: The future monetary relations between different stakeholders

Additionally, we played out how these large system changes in conjunction with policy would shift the weights in the power-agency-interest matrix (figure 5.2). In the previous cluster of the "Profiteers" the immediate accumulators of monetary flows lose power as they do not anymore hold a systemic chokepoint. The stakeholders of this cluster that were profiteering out of monetary dependency are more in favour as their monetary dependencies change. The farmerschool is financed by the public instead of the farming tech companies and the main income of the body of members is shifting away from industrial farming toward biodiversity production. The pioneers are empowered by the new policies and their role in shaping them. The EU is in favour, as the reduction of nitrogen is high on its agenda. This sentiment is also changing in member states such as The Netherlands. Farm workers get a stronger position as skilled labour is more needed in the biodiverse stewardship model and as mechanization on an industrial scale is less possible. Maybe most importantly in a change in farming, the common farmer will be empowered by diversifying their income streams, by getting a substantial say in the creation of new policy and subsequent revisions, especially on a local scale, and by having increased

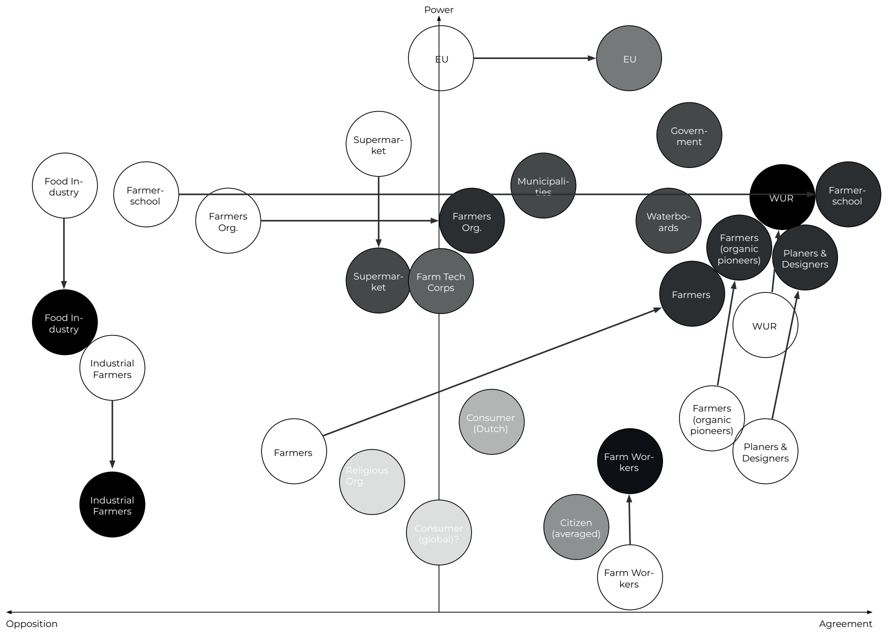


Figure 5.2: The future power, interest, willingness matrix

agency on their land using more flexible zoning needed to realize complex ecological functions. As they will be able to earn money by producing biodiversity their view on it is also very likely to change to a more positive, nature-inclusive way. The interest of all stakeholders in the topic will rise as a result of the focus on policy and the resulting disruption in the framework of farming.

5.2
SYSTEM INTRODUCTION

The main part of the strategy is a system with 3 elements (figure 5.3).

First of all, there is **program development** in which the base conditions are created for the system to function, like new policies and setting up a pilot project.

After this, the system enters the **implementation.** Here, farmers are transforming their farms and their lands to correspond with their place in the gradient.

This part of the system is closely linked with the **monitoring and evaluation**. It is responsible for constant feedback on the results of the implementation and provides an income for the created biodiversity.

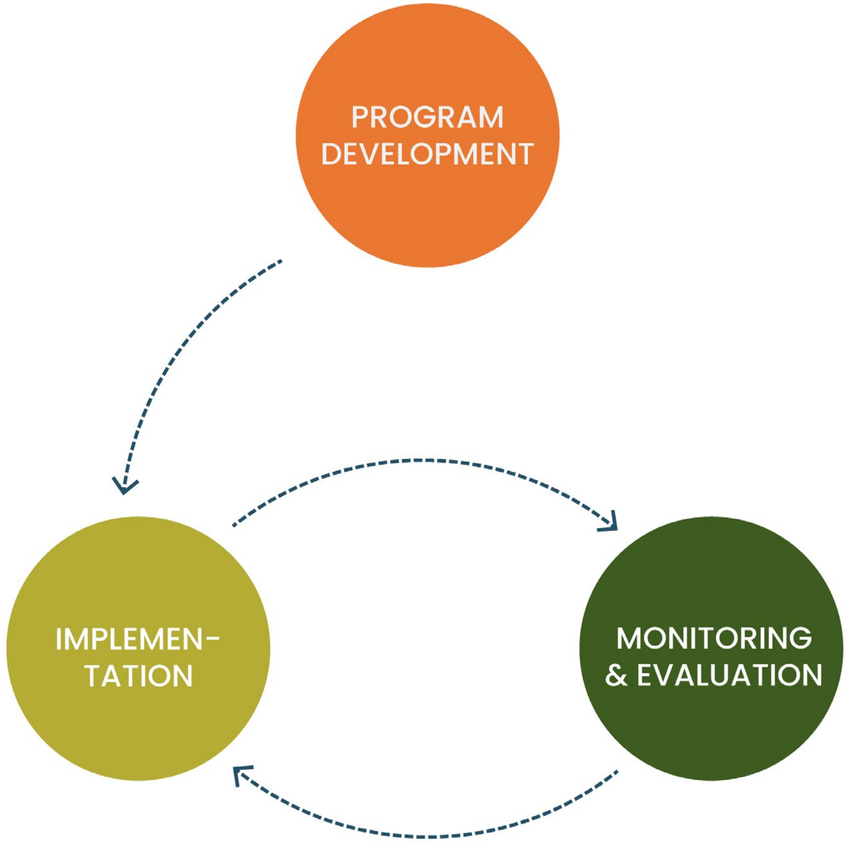


Figure 5.3: The phases of the project

5.3
PROGRAM DEVELOPMENT

The program development involves so many factors that it would be naive to think that one can design the entire thing from a desk in one go and finalize it before even thinking about starting the implementation. Even though the structure can be designed beforehand and one can start thinking about the implementation, the details will have to be worked out with the people who know the practical details, the local circumstances, and who have an insight into potential executive limitations. This is not only a matter of making the resulting design feasible but is also an issue of procedural justice as it is only right and fair to involve the people deeply affected by the policy in its creation. This also has the potential of initiating an amicable working climate in the execution phase. That being said, we designed our program development process in three parallel lines of action.

The first line is concerned with the work the administrative body has to accomplish alone. This concerns mainly setting up the administrative structure across the scales, clearly defining who is responsible for what. This includes also setting up the fundamental plans needed to start working on the details, mainly translating the vision map into applied gradients taking into account all the specific structures present at the local scale.

The administrative body is also in charge of organizing an R&D Pilot the goal of which is collecting and integrating all the relevant knowledge of different stakeholders. Here, the administration and the farmers with the help of scientists and planners work out together how a policy that achieves the societal goals and works for the executing farmers looks like. This is achieved by combining a co-creation phase in which the participating parties set up an initial plan of action and a closely monitored implementation feedback loop, which is adjusted with each loop to reflect on the most recent findings.The farmers involved will have to contribute a lot of effort as the pilot is a long process that produces a lot of knowledge and is a key part of working out the policy. Thus we want people who are motivated visionaries to participate. To achieve this an application process is set up where interested entities can apply to be part of shaping their future. To enable this, the participating farmers will be paid for their time and as they are taking part in executing on potentially not working policy the risks they take will be heavily have to be compensated by the administration if needed.

The R&D pilot is a way of taking into account the farmers' perspective and their situated knowledge, at a depth that would not be possible at a large scale. Still, we have to make sure that we do not overlook farmers' issues which are slipping through the pilot as surely not every issue can be represented by the farmers involved in the pilot. In order to keep all farmers in the loop there will be a constant broadcast of information about the status of things. When there start to be significant results the farmers involved in the pilot will function as ambassadors and keep in touch with the common farmers through regular meet-ups according to their place in the gradient system where feedback can be given on whether the status of the pilot is taking into account all relevant issues or not. When the pilot policy detailing phase is practically finished, there will be a more formal participation format in which the pilot checks if there are issues left which have been completely overlooked. This entire process is culminating in the first annual Dutchscape-Con which is a national operative symposium with representatives of the farmers, the administration, and academia. At the first Dutchscape-Con, there will be working groups according to the different biodiversity classes and regarding meta-processes. These will work out the final draft of the policy.

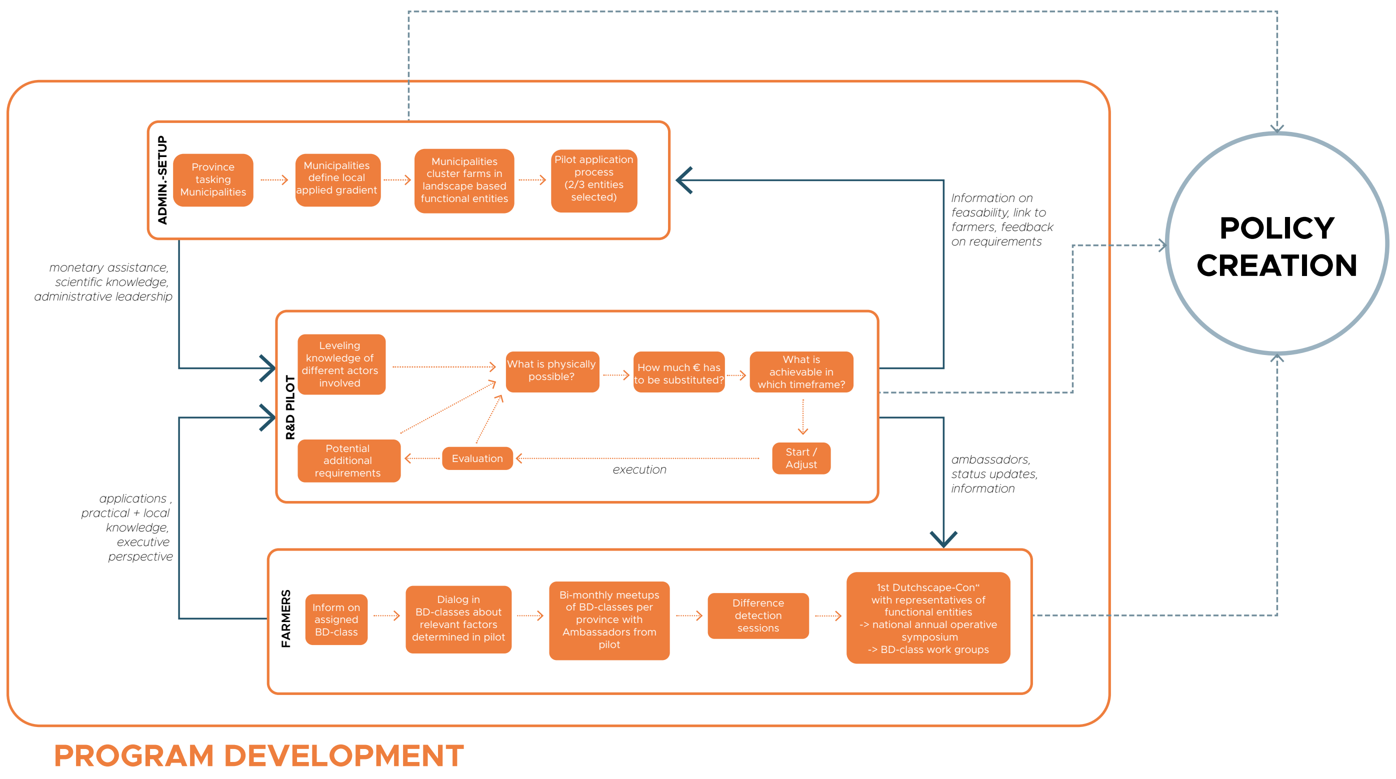
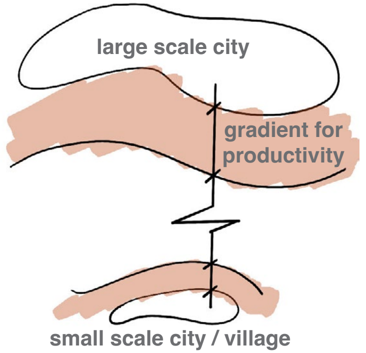


Figure 5.3: Process-chart of the program development

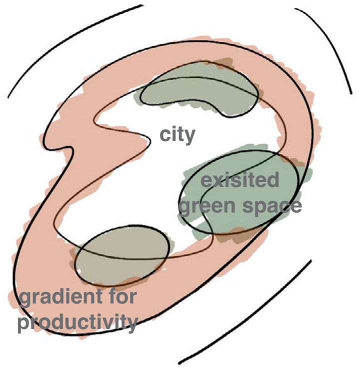
SPATIAL PRINCIPLES FOR DEFINING THE GRADIENT

Based on the actual conditions such as built environment, infrastructure and waterbody, rules are formulated for the generation and morphology of gradients

city & nature



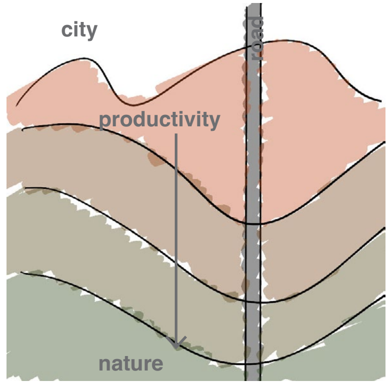
The larger the city's scale is, the larger the productivity gradient will be.



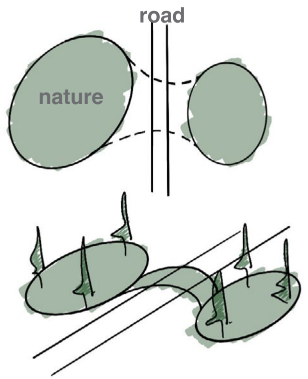
Keep the exisited green space

Based on NNN, keep the area as fully nature

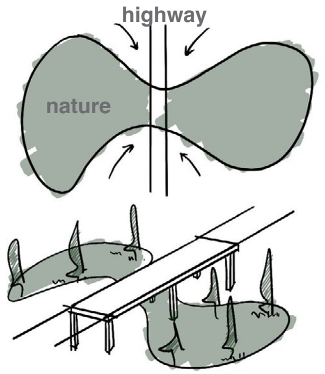
infrastructure



The productivity gradient is larger near the road

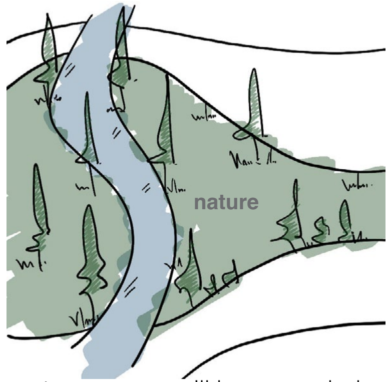


The nature spaces will be connected along the roads

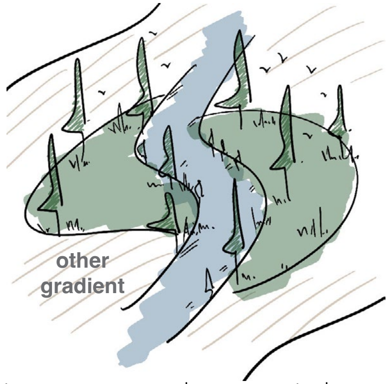


The nature spaces will be shrinked but connected along the highway

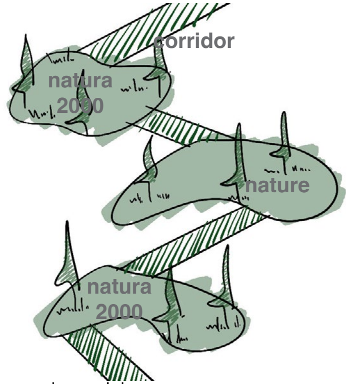
waterbody



The nature spaces will be expanded along the waterbody

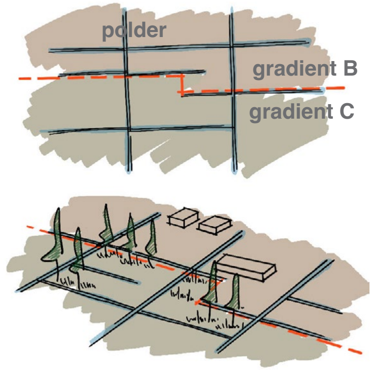


Nature spaces can be generated near waterbody

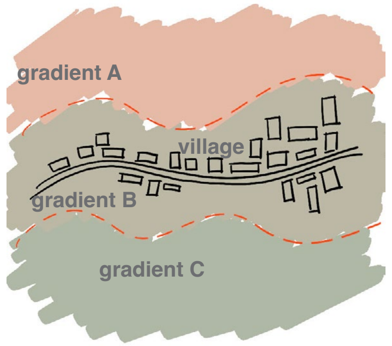


Patch and corridor

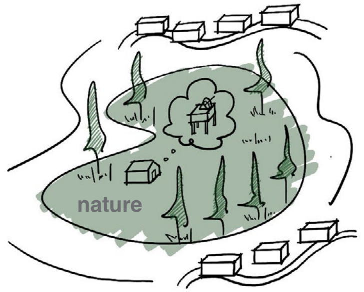
gradient shape



The division of gradients is based on the polder fabric



The division of gradients is based on the village fabric



The built environment functions of the nature areas will be replaced

Figure 5.4: Spatial principles for defining the gradient

5.4 IMPLEMENTATION & MONITORING

The process behind the execution of the policy is divided into the subprocesses “administration”, “implementation” and “monitoring”. The administration contains all the administrative processes needed to translate the transformation into law and structures. The implementation concerns the execution of the policy at the lowest level, the farmers. The monitoring concerns the oversight needed to quantify the results as well as physical systemic observations. These three processes interlink to form a persistent system executing the previously decided policy.

More on administration

The administration regulates the farmers to ensure a level playing field and gets organizational and scientific assistance as well as financial assistance in special cases. The farmers also get paid for the produced biodiversity by the administration. The farmers inform the administration of their perspective and give feedback on the effects of the administration.

More on monitoring

The farmers are monitored by the waterboards which are responsible for physical monitoring of the biodiversity production, the changes to the water systems that are caused by the transformation as well as the usual water-related monitoring such as measuring nitrogen pollution of groundwater and streams. To achieve this the farmers have to work together with the waterboards, this is incentivized by giving the data back to the farmers who are thus directly benefiting from the monitoring. The waterboards work together with academia to find the best ways of monitoring and to make the most sense of the data. The waterboards give the biodiversity production data to the administration as the basis for the payouts. The waterboards give the administration water-focused policy advice.

Under these conditions, the farmers start building the new Dutchscape. This involves initiating the process with a co-creation session where farmers are assisted with the body of knowledge developed in the R&D Pilot in planning out the future of their endeavours. Apart from practical questions about the fundamentals of biodiversity class, soil, water etc. this co-creation session also involves the choice of every farmer whether to run their business as an individual or in a cooperative configuration. Choosing a cooperative configuration unlocks opportunities to gain more from biodiversity production as the monitoring works in a way in which high levels can be best reached by combining efforts. This results in a higher biodiversity production per area than in individually run endeavours. The co-creation phase culminates in the farmers setting up mixed-calculation business cases which are financially based on food production as well as biodiversity production. These are then implemented and regularly reevaluated by the farmers and if needed adjusted.

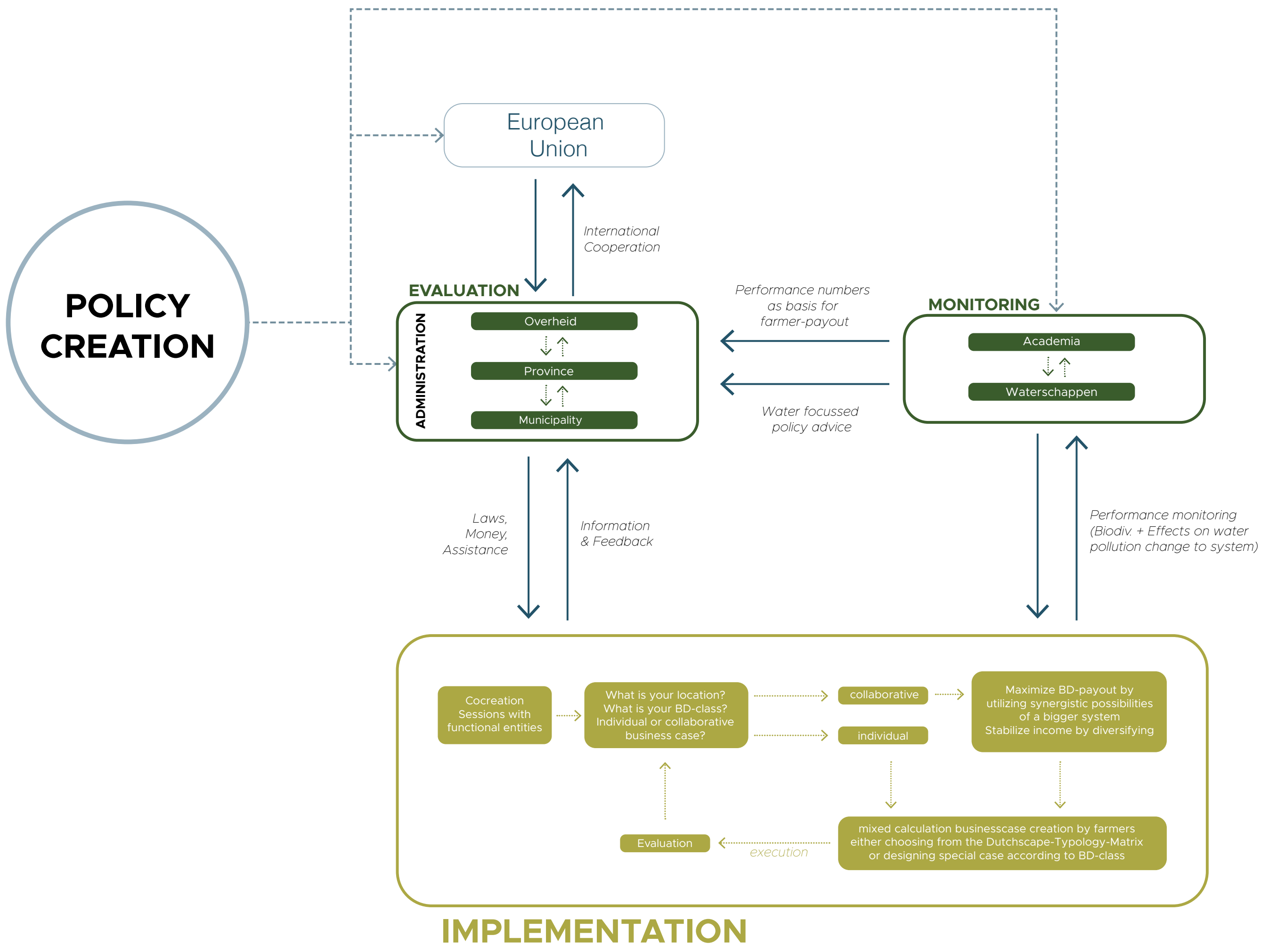


Figure 5.5: Process-chart of the administration, monitoring and implementation

SOIL AND WATER TYPOLOGY MATRIX

This matrix explains what farming practices can go where, according to the type of soil, the groundwater table (in centimetres GLG), and where on the gradient a farm is. On the right the gradient is more focussed on high biodiversity, and on the left more on food production. Visible on the right are the existing crops that are cultivated currently, which can continue to be grown taking the future farming principles (explained in 4.5) into account It also shows different animal species that can be used in different conditions.

The mechanism works in such a way that if the farm is not integrating much biodiversity in its food production, it can still choose interventions from further up the integration spectrum (the options on the left). However, if the farm is further on the gradient and thus integrates more biodiversity with food production, the farming practices that come right of it, have to already be incorporated.

Furthermore, the matrix focuses mostly on spatial interventions (as prescribed by Assis, et al., 2021; Department of Agriculture, Food and the Marine, 2023; Keena, C., 2022; Kok, et al., 2020; Land van Ons, n.d.; Linnartz, et al., 2023 & WWF, 2021).

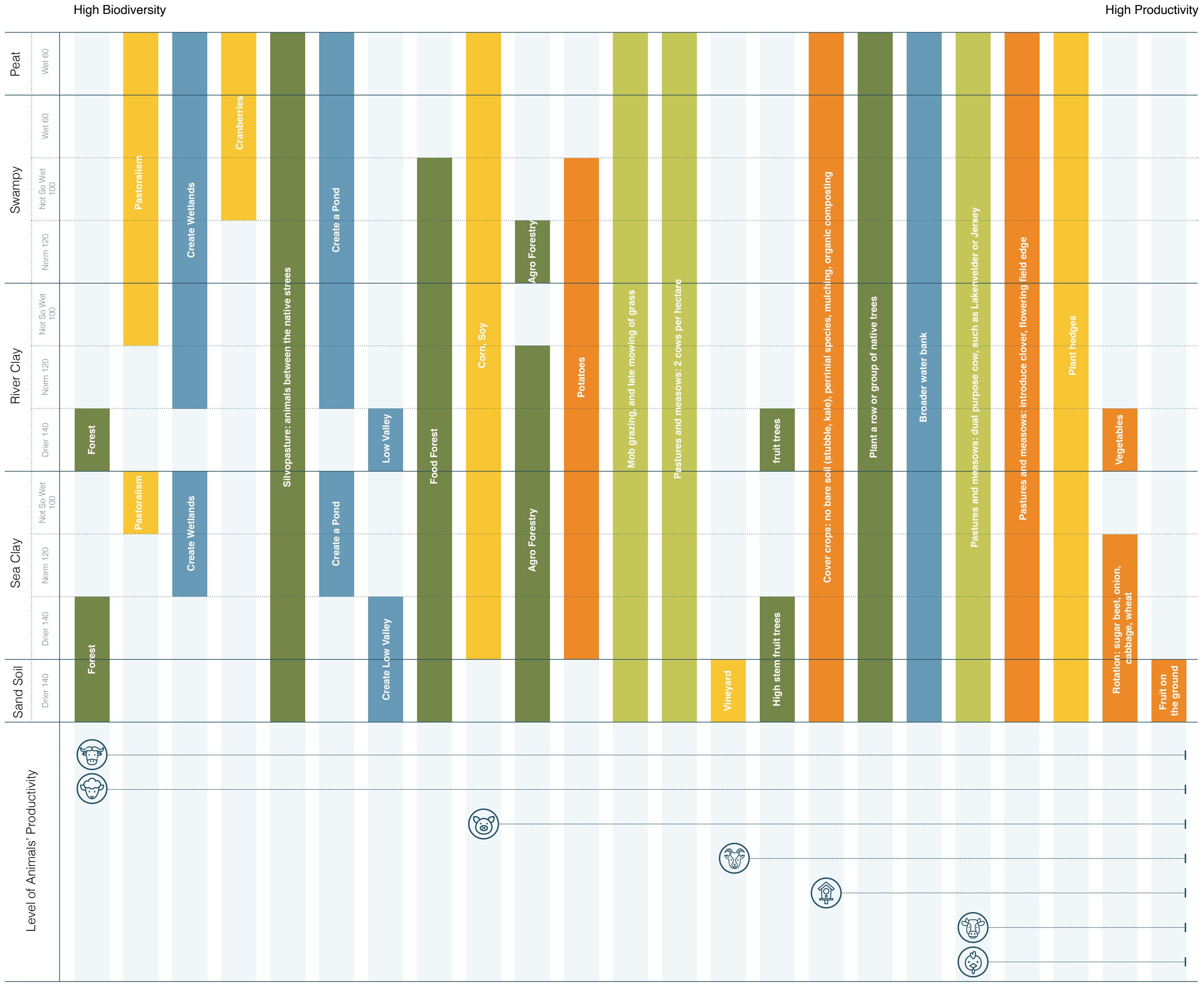


Figure 5.6: Matrix showing which practices are possible on which soil and related water conditions.

MONITORING AND EVALUATION

An important part of the project is the subsidy system. As we have discussed in Chapter 4.2, there are multiple spatial ways in which farmers can produce biodiversity. But to incentivize farmers to start producing it we need to get them on board. Because an important reason not to change is the lack of monetary reward for this change. For this reason, a reward system has been created, that not only pays farmers for their biodiversity but also guides them into the best ways to create this diversity, so which spatial interventions to undertake and eventually which management actions to take for upkeeping this biodiversity. Figure 5.7 shows the basic components of this system: ecological biodiversity, taxonomic biodiversity, overall biodiversity, co-benefits, subsidies, and agricultural output. On the following pages, these will be explained. Also, how they guide farmers in the right direction is shown

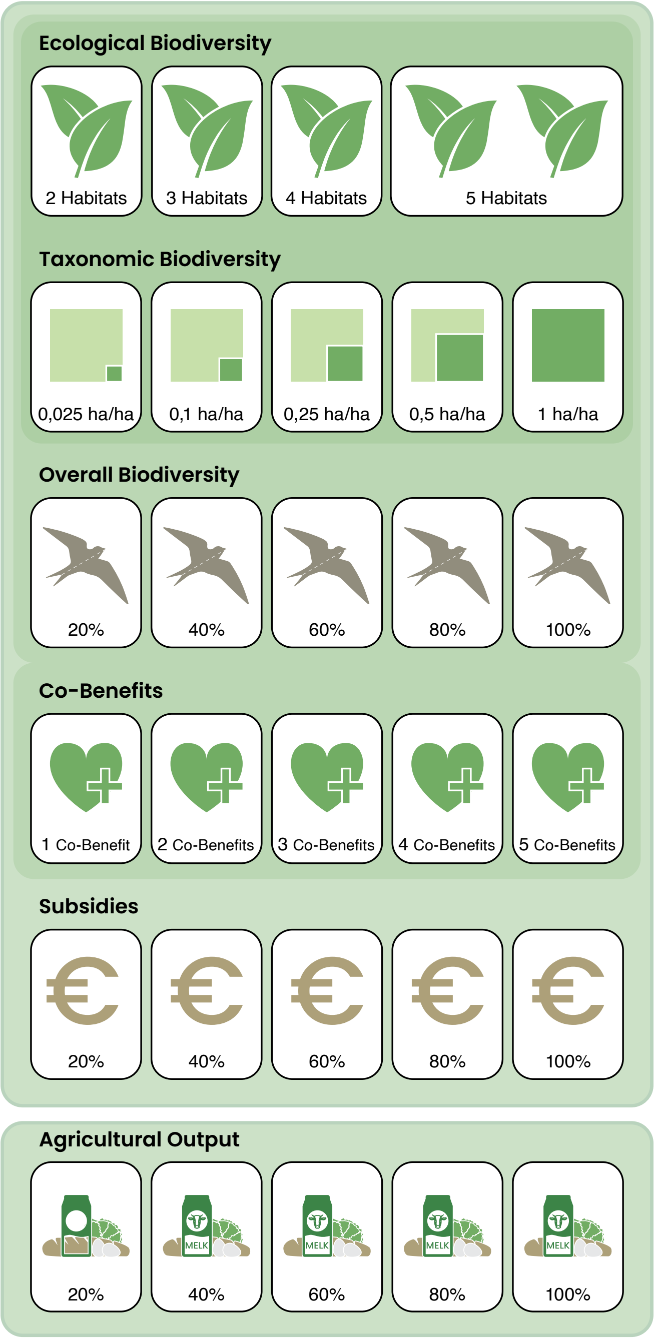


Figure 5.7: Subsidy system overview

Ecological Biodiversity

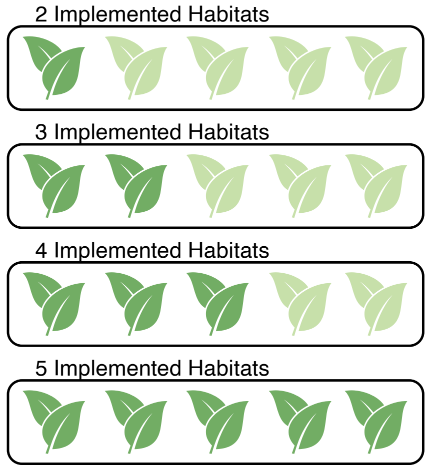


Figure 5.8: Ecological diversity points

As previously discussed in Chapters 3.1 and 4.2, ecological biodiversity means that having more different habitats in an area results in more different species that can live in this area. In our project, the major determinant of habitat type is the vegetation types and water structures that are there. By increasing the number of vegetation types or adding a water feature biodiversity increases.

In the system these elements are simplified into 5 classes:
Trees: tall vegetation
Shrubs: medium-tall vegetation
Herbs: low to medium vegetation
Grasses: low vegetation
Water

The number of points the farmer gets is based on the number of habitats and interhabitats he creates (figure 5.8). As shown in Figure 5.9, this number increases progressively with the number of habitats implemented. For the farmer, this would mean that having just one monotonous habitat type is not profitable. Having multiple is better. And because adding the fifth habitat type also greatly increases the number of interhabitats, it results in 2 extra points. By doing this the farmer is encouraged to create as many habitats as he can by allocating more of his land or by integrating the different types.

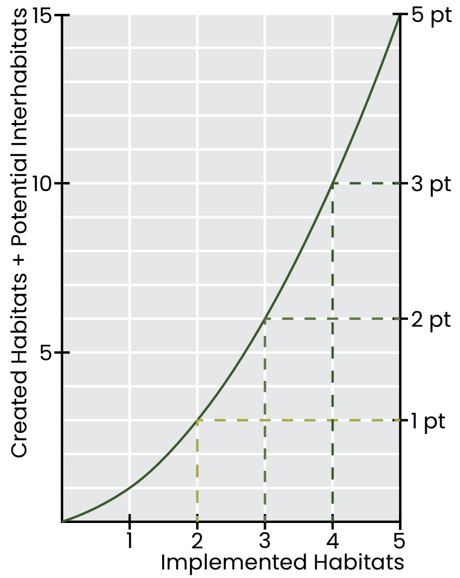


Figure 5.9: The relationship between added habitattypes and potentially created habitats and the point a farmer gets for implementation

Taxonomic Biodiversity

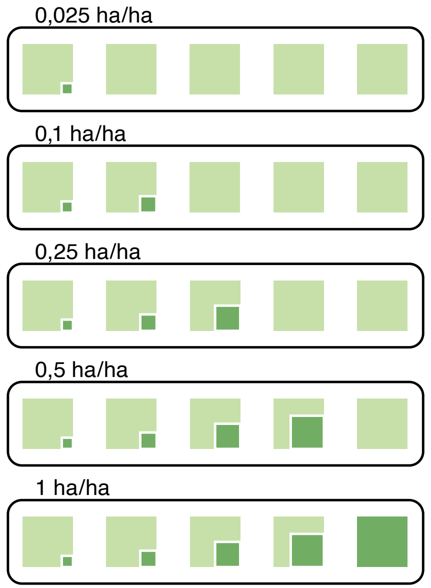


Figure 5.10: Taxonomic diversity points

As previously discussed in Chapters 3.1 and 4.2, taxonomic biodiversity means that having more species increases biodiversity. The number of species increases when the area of a habitat increases, this is the species-area rule. Because of this, the farmer is awarded points for the size of the different habitat types that are created for ecological biodiversity (figure 5.10). This is measured based on the amount of land that is allocated to these habitats per hectare. By doing it this way the system can be used for both small farms, large farms, and farms that are working together in a collaborative approach.

As shown in figure 5.11 the number of species an area can accommodate increases degressively. This means that the first part of the graph holds the most change in biodiversity. Similar to ecological biodiversity, this system looks at the results of implementations. For taxonomy, this means that the small step at the beginning of the graph should be awarded the same amount of points as the giant leap at the end. These small steps encourage the farmer to get up to an average land allocation of about 25% per habitat. This also means that having a monocultural landscape is undesirable because it takes a lot of effort and rewards little points. It is way more desirable to have multiple habitats with somewhat smaller sizes, that integrate biodiversity in the land or share the agricultural land with nature. This inspires farmers to balance ecological and taxonomic biodiversity.

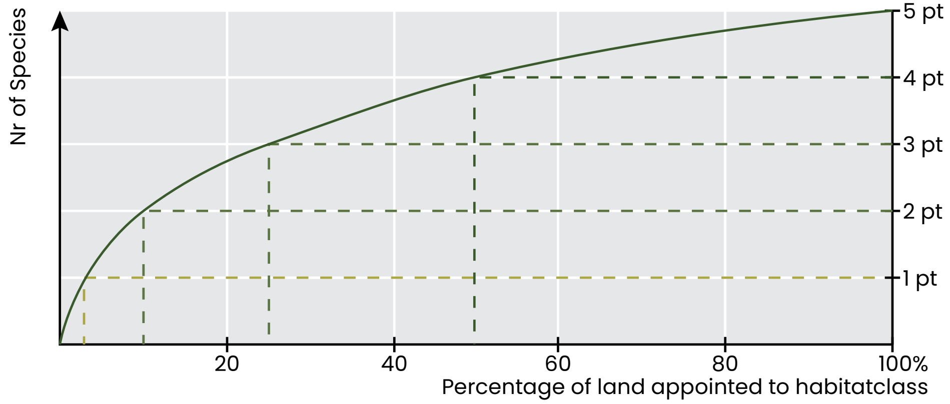


Figure 5.11: The relationship between average percentage of land allocation to habitats, the resulting number of species, and the point a farmer gets for implementation

Overall Biodiversity

For the subsidy system the previous two types of biodiversity are combined into a single indicator (figure 5.12). This indicator can more easily show the result of the interrelation between the previous two indicators. The points for the overall biodiversity are later used for the calculation of the overall reward.

Calculating the points for overall biodiversity is done by adding up the previous ones. This resulting number between 0 and 10 is then divided by two to bring it back to a 5-point scale

Figure 5.12: Calculating overal biodiversity points

Co-Benefits

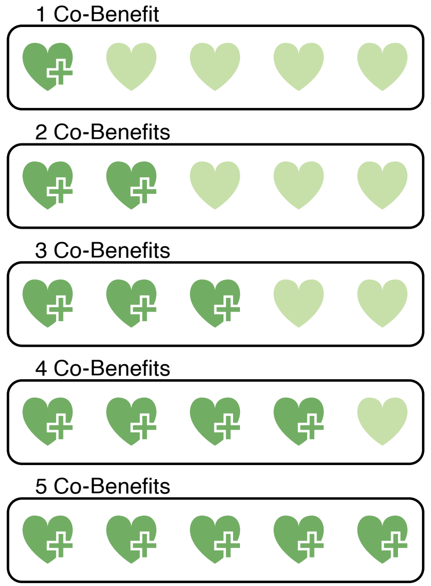


Figure 5.13: Co-benefits points

As already discussed in Chapters 3.1 and 4.2, co-benefits are the natural processes that improve the environment but don't necessarily relate to biodiversity, rather are the result of more biodiversity (thus, indicative of a healthier ecosystem). These benefits have been classified into 5 categories.

Water Services: water quality, water availability, infiltration capacity
Air Services: air quality, nitrogen reduction
Soil Services: soil, quality, nitrogen reduction
Carbon Sinking: Long-term biomass creation
Diversification of crops: increased local food production, and increased food security.

A farmer is simply awarded points for the co-benefits he can produce on his farm (figure 5.13). The minimum requirements can be adjusted according to the amount of improvement that is wanted by legislatures. This is done as part of the monitoring and evaluation part of the system.

Subsidies

With the points from the overall biodiversity and the co-benefits the amount of subsidies can be calculated. This is done by putting it into the formula shown in Figure 5.14. The formula is progressive, which means the amount of subsidies rises progressively with the points (figure 5.15). This works similarly to the graph for ecological biodiversity. It encourages farmers to get more points because the subsidies get progressively higher. This inspires farmers to integrate the different elements of the implementations as efficiently as possible.

The amount of subsidies shown in the graph is relative. During the pilot, the actual value and minimum compensation for implementation can be determined. This amount can be adjusted over time to account for inflation, rise, or decline of the costs for implementation. It is also possible to increase the amount of subsidies at the start of the project to get the farmers to participate.

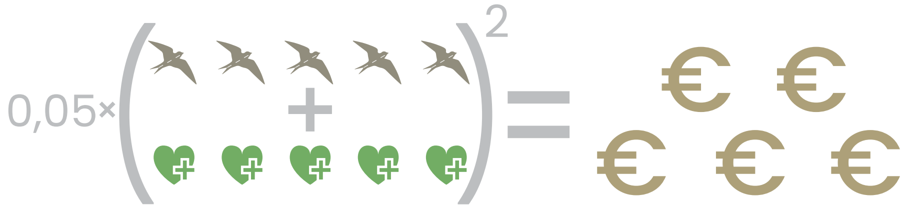


Figure 5.14: Calculating overal biodiversity points

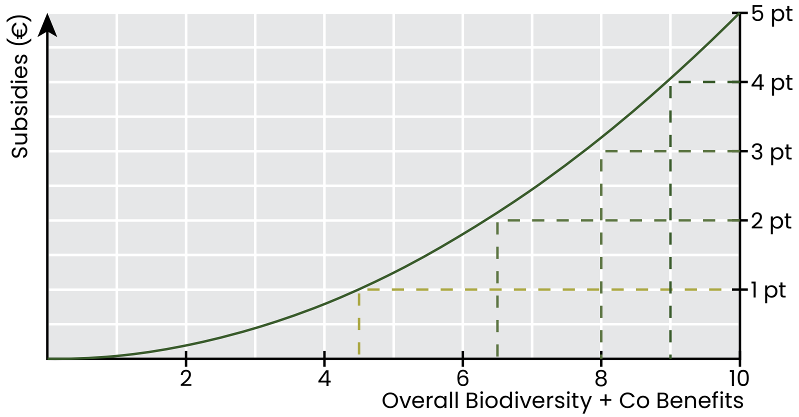


Figure 5.15: Relation between overall biodiversity and co-benefits-points, subsidies and subsidy points

Agricultural Output

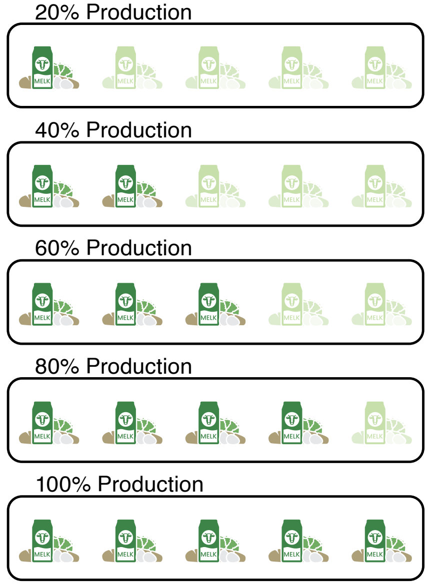


Figure 5.16: Agricultural output points

The final metric is not part of the subsidy system. It is meant to show the farmer the amount of productivity they can have on a farm or with a certain implementation. It is measured based on the amount of productivity there could be on 100% productive land (figure 5.16). By doing this it accounts for situations in which biodiversity and production are integrated. For example in situations in which a farm can have 3 points for biodiversity reward and 4 points for production, as they are not mutually exclusive.

5.5
PHASING

The phasing reflects the parallel approaches and translates them into the temporal dimension. As this process is at a fairly large scale, spatially as well as with regards to the number of affected people, actors, stakeholders, disciplines etc. and given the fact that due to the urgency of the situation we cannot afford to start over again in some years, it is of utmost importance to plan in a reliably executable way. The urgency of the situation needs to be carefully balanced with the time needed to properly do the individual steps and the requirement to be able to stick with the time plan to produce predictability which is a basis for societal stability.

Generally, there is a program development phase up to the 1st Dutchscape-Con which is kicked off by the institutional levels subsequently setting up the administration framework and initiating the R&D Pilot. The R&D Pilot sets itself up until starting the implementation feedback loop during which the common farmers will be gradually more involved.

After the 1st Dutchscape-Con, where a draft of the policy is created. The legislative institutions subsequently translate it into laws and structures at the appropriate scales. The pilot continues its implementation and serves as an "early warning system" as it is at least 5 years and in the most extreme case imaginable under our system circa 13 years ahead of the upscaling of the policy. The administration gradually starts phasing in the payout and monitoring mechanisms until the policy takes effect 100% around 8 years after the 1st Dutchscape-Con with the first specific draft and around 15 years after the process is initiated by the state. There will be continual policy monitoring and adjustment at regular intervals.

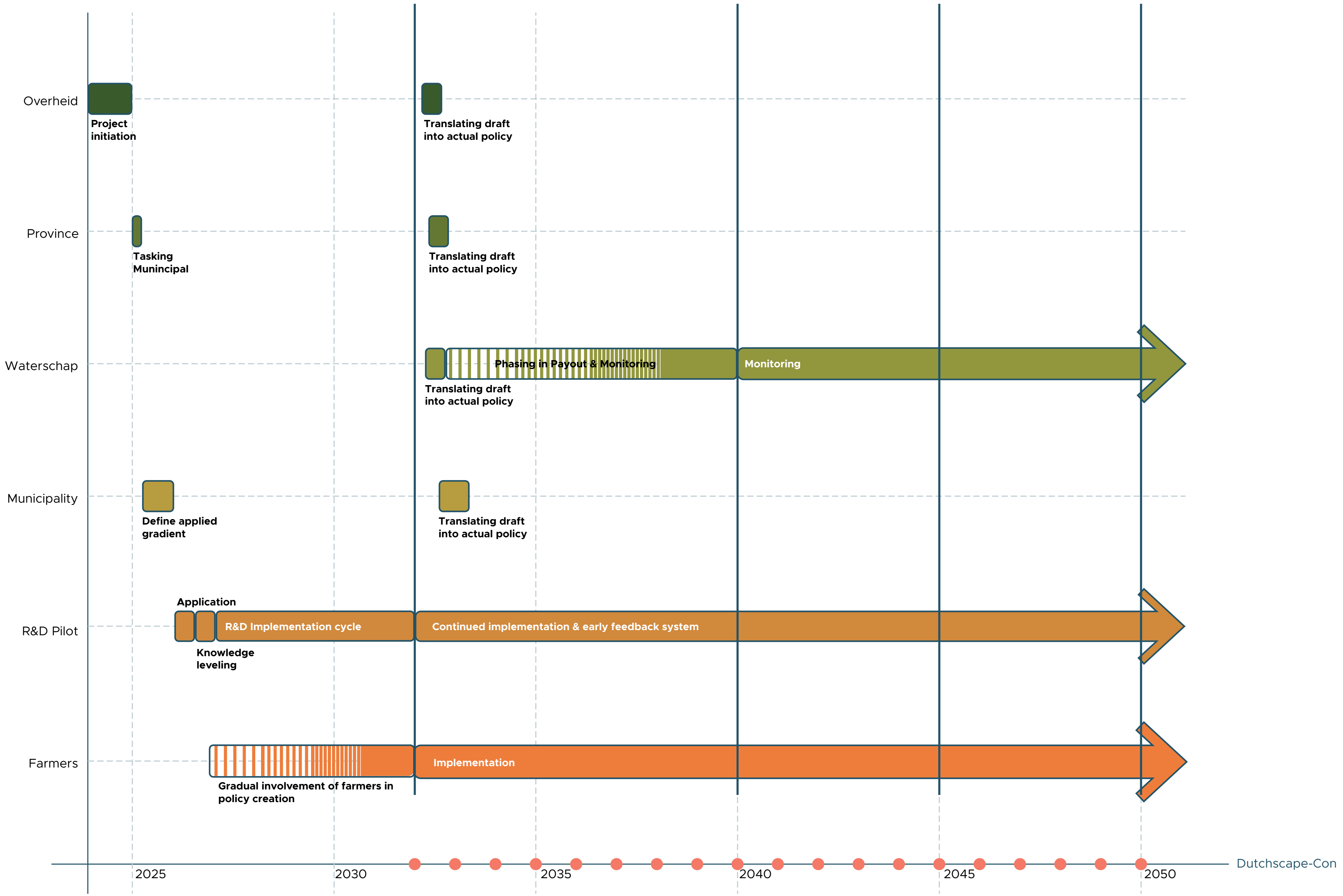


Figure 5.17: Project phasing

Overview System

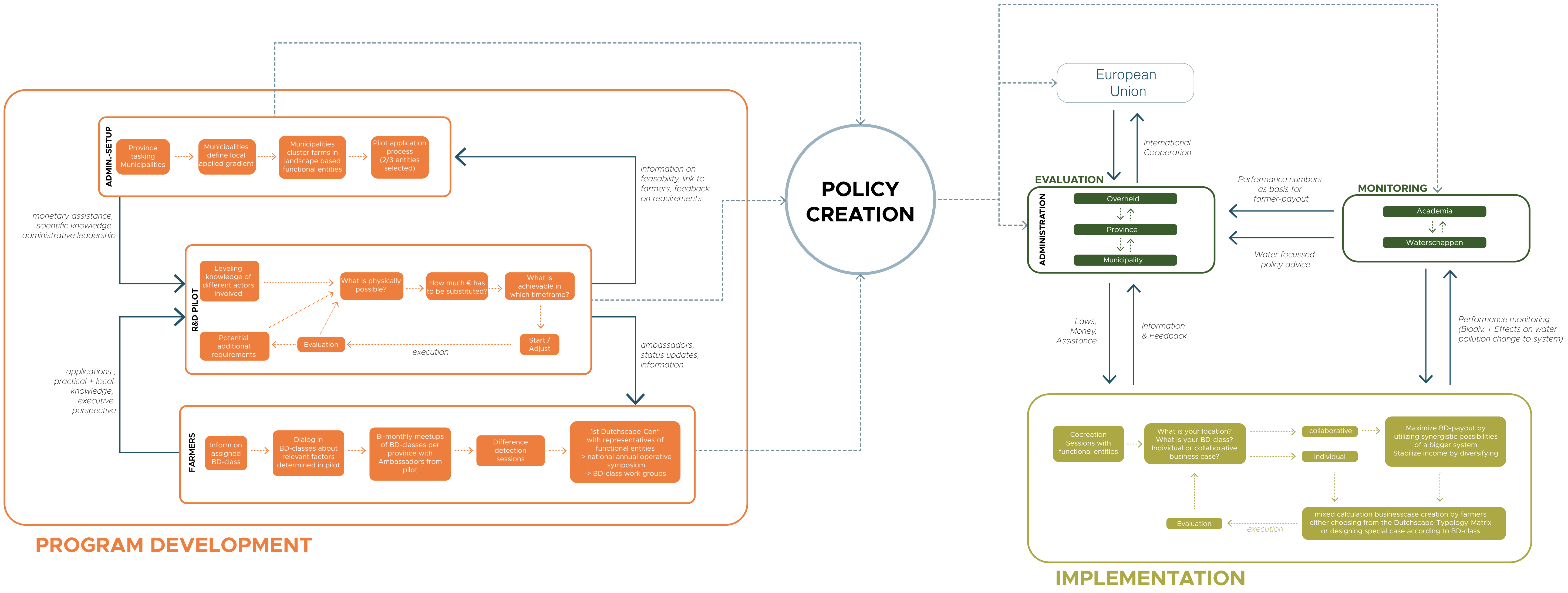


Figure 5.18: Process Chart of The System in Detail

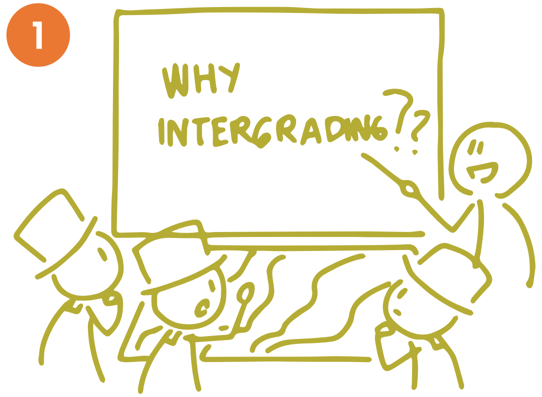
06 Example Project

WHAT DOES IT LOOKS LIKE?

6.1
INTRODUCTION TO CO-CREATION SESSION WITH FUNCTIONAL ENTITIES

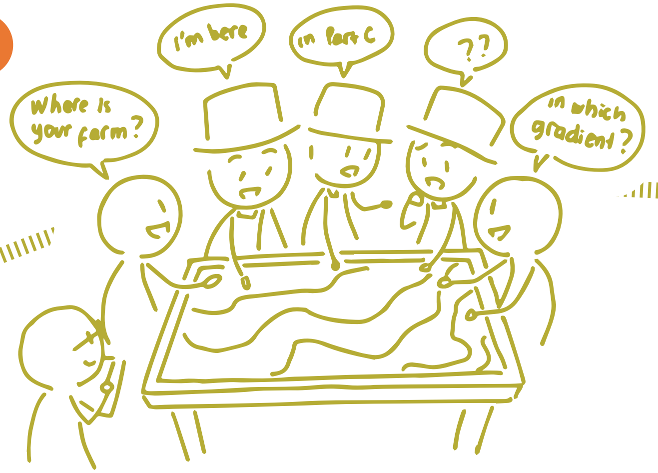
The co-creation process is a collaborative journey that involves farmers contributing their valuable insights and experiences to help develop innovative solutions. Through this process, farmers take an active role in shaping the outcomes, and their journey is marked by a deep sense of discovery and exploration.

1



Introducing the Intergrading Program to the farmers and workshop participants will help them share the urgency of balancing food production and increasing biodiversity.

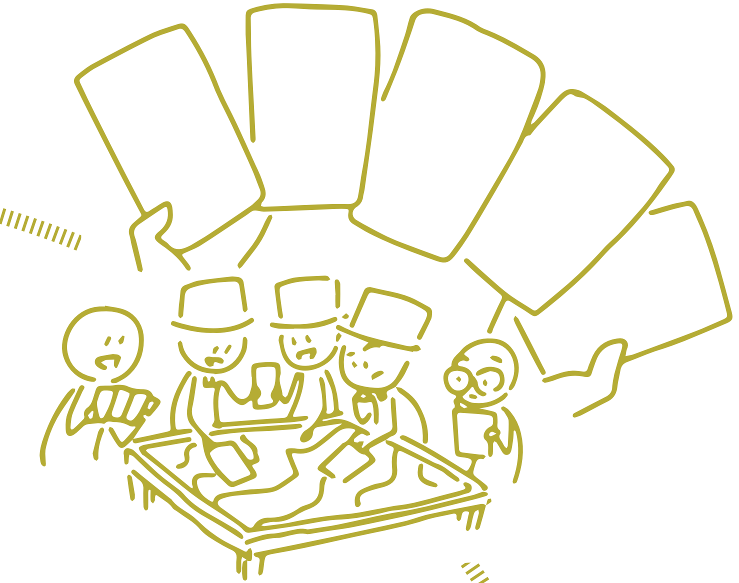
2



Coming to the table where the gradient map is laid out, farmers find where their farm is located and in which gradient it sits.

3

After that, farmers find the best farming practices through suggestion cards that suit their farm in the gradient and also start to discuss the possibilities of collaborating with nearby farmers or neighborhoods to achieve a larger impact.



4

The next step will be the technical aspect, in which farmers discuss the time frame and the financial system to launch the project and introduce the reward system.

Execution

5

After implementing the project, the farmers will evaluate their performance regularly to see if there are improvements. This is also the part where the reward will be calculated and paid.

6.2
PREPARATION

Figure 6.1: Satelite Map of Delft-Rotterdam area (Midden Delft)
Source: Google Earth

To verify our planning vision and strategy, Delft-Rotterdam area(Midden Delft) has been chosen as an example project.

The site presents complex conditions, situated between the varying urban scales of Delft and Rotterdam. It contains abundant natural spaces and water bodies, alongside diverse built environments and infrastructure. Moreover, the area hosts both organic farming and traditional intensive farming, making it highly representative as a practical example.

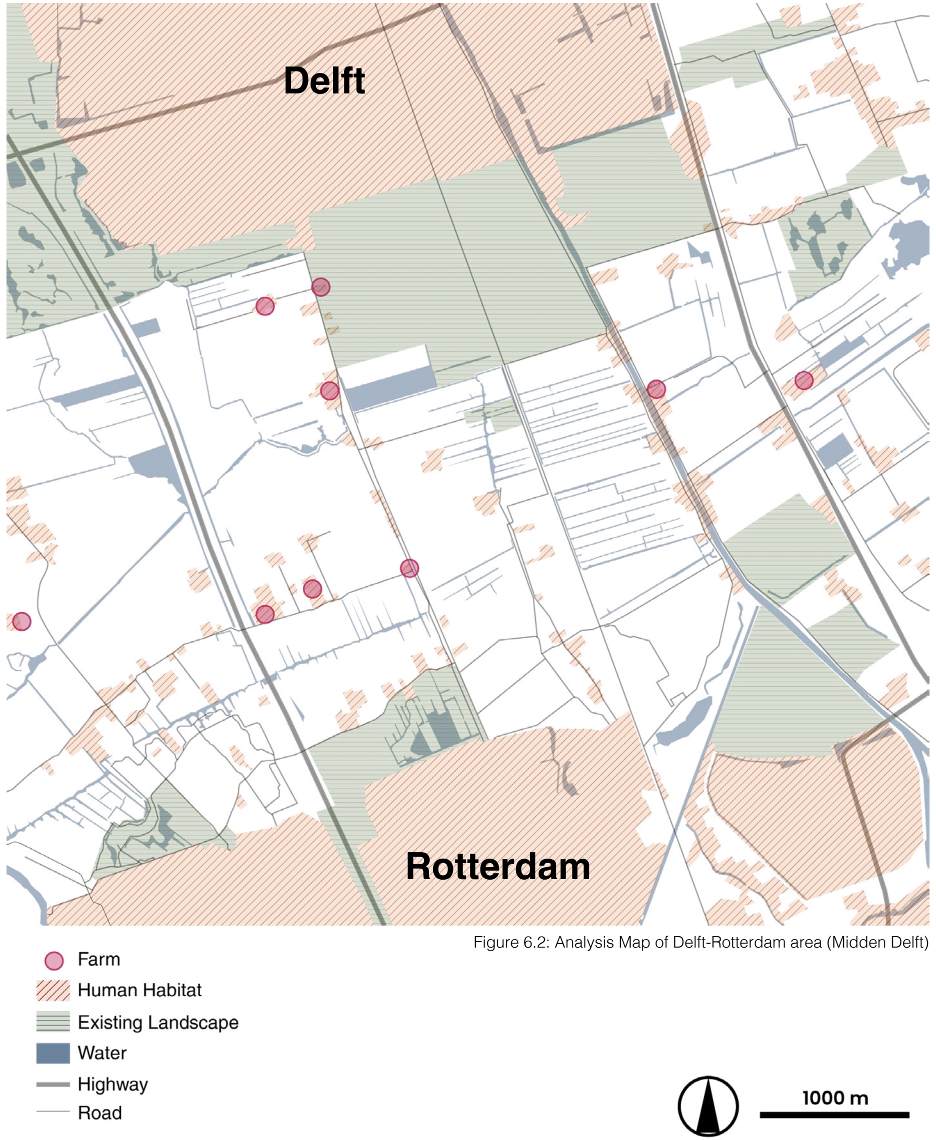


Figure 6.2: Analysis Map of Delft-Rotterdam area (Midden Delft)

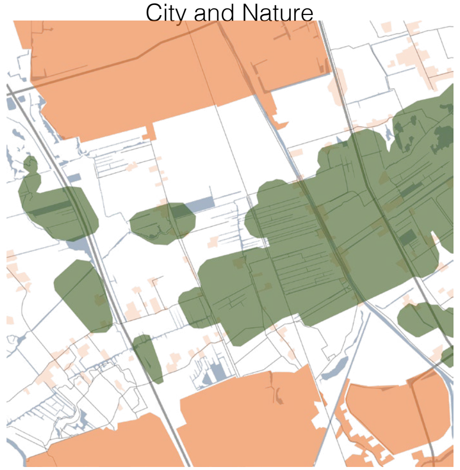
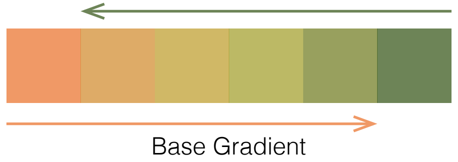


Figure 6.3: City and Nature Map of Delft-Rotterdam area (Midden Delft)



Based on NNN, this area features abundant nature spaces. By buffering the city and nature areas, the initial gradient shape is created. Each gradient represents a different potential for biodiversity and productivity.

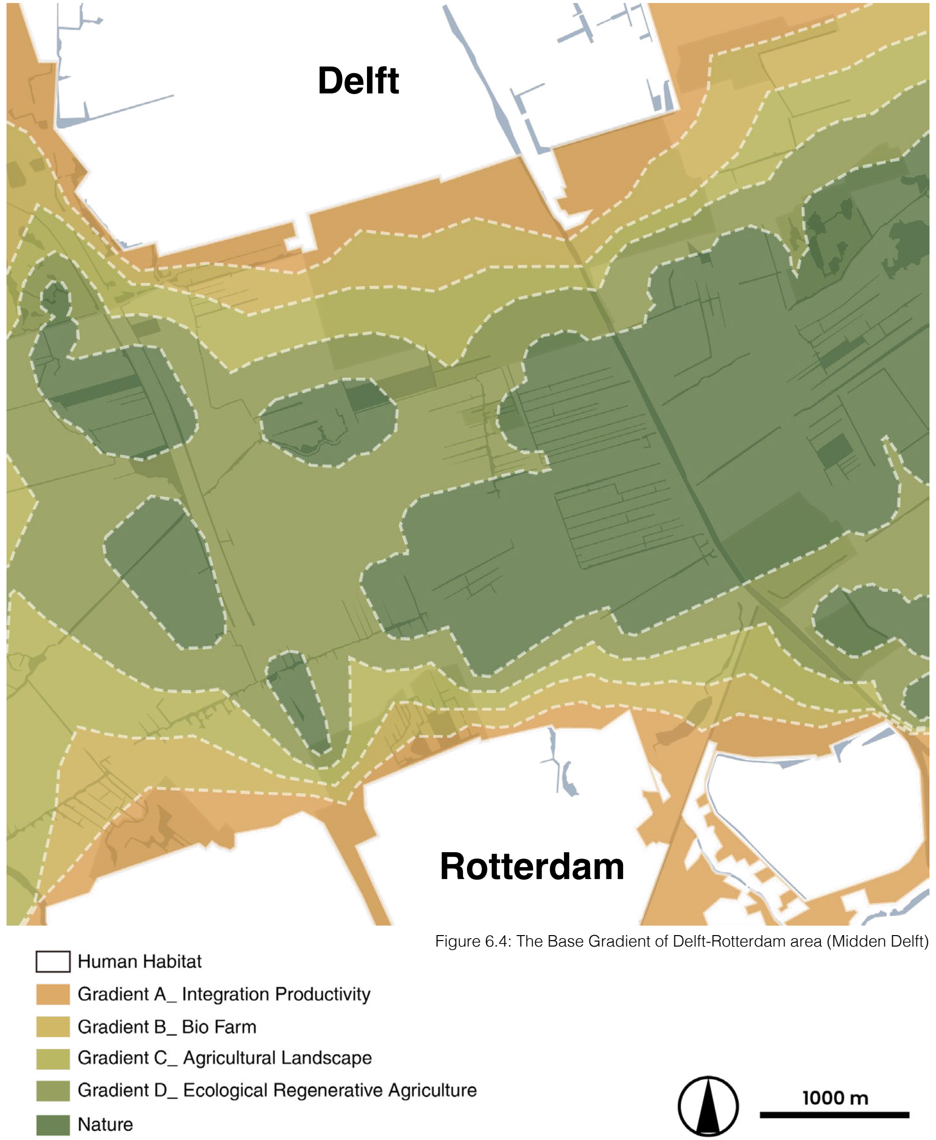


Figure 6.4: The Base Gradient of Delft-Rotterdam area (Midden Delft)

Overlapping

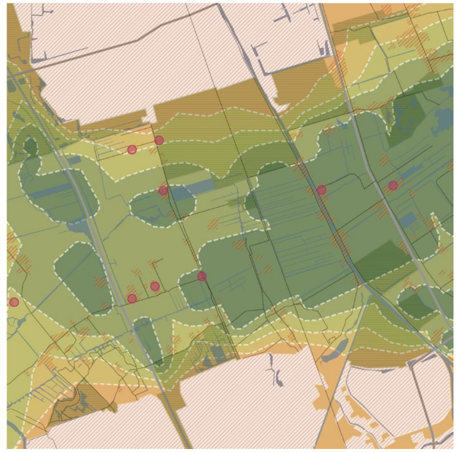


Figure 6.5: The overlapping map of Base Gradient and Existing Condition of Delft-Rotterdam area (Midden Delft)

Based on the current site conditions and the principle of gradient, re-divide this area into new gradients.

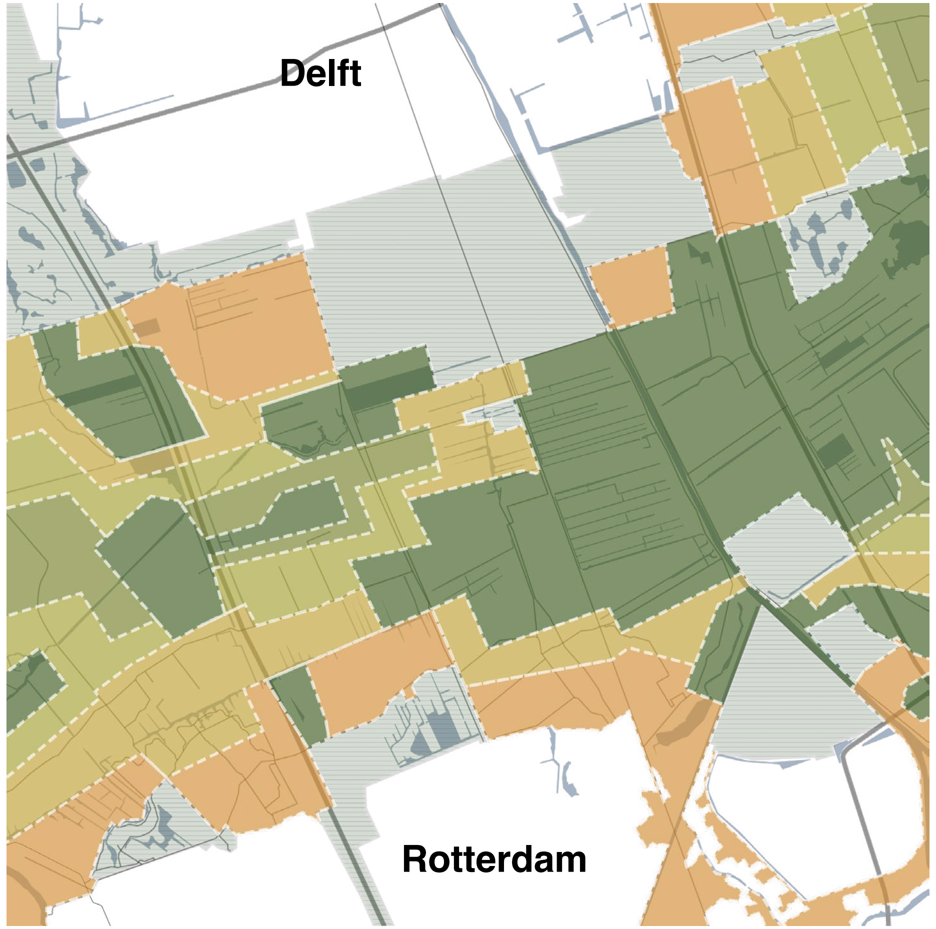


Figure 6.6: The Defined Gradient of Delft-Rotterdam area (Midden Delft)

As a result, Rotterdam, being a large-scale city, has a greater productivity potential, hence its production gradient accounts for a larger proportion. On the other hand, Delft has more existing park landscapes and a smaller scale, resulting in a more evenly distributed gradient division. Based on the NNN and principle, nature patches form a complete ecosystem.

Figure 6.6: Analysis Map of Major Infrastructure Map

6.3 PARTICIPATORY WORKSHOP

Option Card

Title

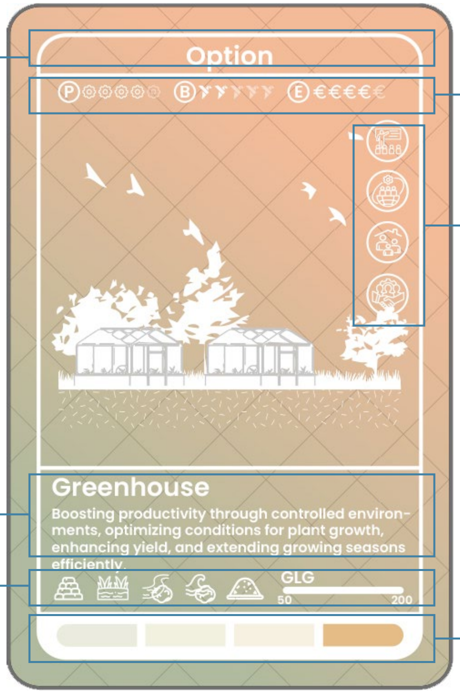
There are three types of cards: base cards for farmers to select the business mode, option cards for farmers to choose the input strategy, and function cards for farmers to add additional social functions.

Introduction

Basic introduction to the strategy and the implementation that will be undertake.

Soil and Water Type

The environmental conditions such as soil and water suitability for the implementation of the strategy.



Performe

Predicting the evaluation of the given strategy by employing productivity, biodiversity, and economic value.

Stakeholder

Description of the stakeholders who will participate in this strategy, including farmers who can also seek suggestions and guidance from them

Suggestion on Gradient

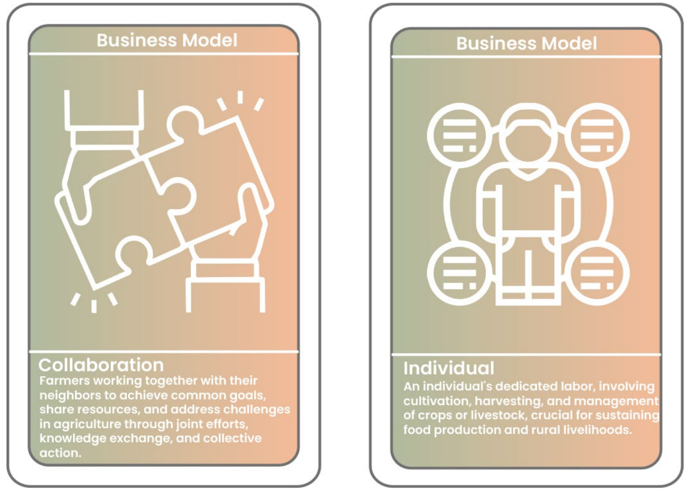
Suggestion on inputting strategy in which gradient

Example Card

After the gradient planning based on the status quo, a participatory workshop for farmers will be held. In this workshop, farmers will first independently choose a business model. Then, based on the gradient their farm is situated in, they will select the pasture option they wish to pursue. Finally, they will choose additional functions for their farm based on the provided guidelines.

Base Card, Farmers' Choice for Business Model

Farmers initially select a business model card, followed by discussions on choosing the option card based on consultations with various organizations and stakeholders.



Function Card, Farmers' Choice for Additional Social Function

Title

Social Function

Suggestion for a social function to overlay onto the existing farm.

Introduction

Suggestion on Gradient

Suggestion on inputting strategy in which gradient

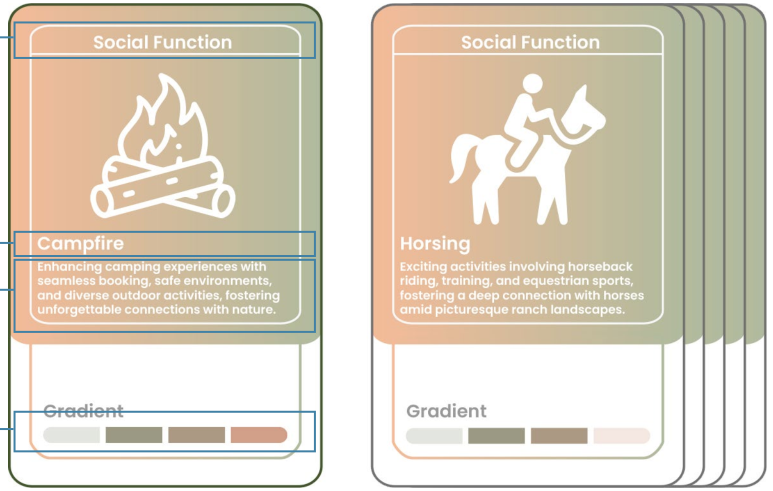


Figure 6.7: Application of The Typology Option Card
Source Base Map: Google Earth

6.4
SCENARIO

Individual Business Model

This page shows two different possible ways the gradient can be used by farmers. In the first scenario, farmers join the project individually. This results in a network of farms with their implementations and functions and relation to the city.

Figure 6.8: Individual Scenario Plan

- Human Habitat
- Existing Landscape
- Water
- Highway
- Road
- Gradient A_ Integration Productivity
- Gradient B_ Bio Farm
- Gradient C_ Agricultural Landscape
- Gradient D_ Ecological Regenerative Agriculture
- Nature

200 m

Collaborative Business Model

The second scenario, the farmers form collaborations with each other. By doing this they can work together on biodiversity creation and maintenance, while also being able to focus on efficient production. The main benefit of this approach is in the scale. The larger combined area gives more room to experiment and can result in even more biodiversity.

Figure 6.8: Collaborative Scenario Plan

- Human Habitat
- Existing Landscape
- Water
- Highway
- Road
- Gradient A_ Integration Productivity
- Gradient B_ Bio Farm
- Gradient C_ Agricultural Landscape
- Gradient D_ Ecological Regenerative Agriculture
- Nature

200 m

Figure 6.9: Intergrading Example Project in Between Delft and Rotterdam

07 Evaluation

INSIGHTS & TAKEAWAYS

7.1 DISCUSSION

The project started from the big modern challenges of biodiversity, nitrogen pollution and keeping food production up. Then, the farmers' concerns were highlighted, from the narratives of organic farmer Roel's, media and policy. This brings us to the big goal: how to balance food production with biodiversity conservation. Enframed by our personal values, boundaries for a safe operating space based on ecological values, and the societal reality of current farming practices and stakeholder relations, we set out to design.

To summarize the results, the sub-questions are answered.

1. What should the future balance between production and biodiversity look like spatially?

The design of our desired future, as represented in the vision map (Figure 4.6), explores a new landscape forming a gradient from cities to existing natural areas. The gradient is based on the integration of food production with biodiversity conservation, thus integrating nature into agricultural practices. The balance is thus intergraded and step-wisely merged depending on the needs of the location. Depending on the gradient, the soil type and groundwater, spatial interventions are suggested that foster nature-inclusive farming practises, which are then rewarded.

2. What mechanisms are needed to make the future balanced system economically feasible?

One of farmer Roels' largest concerns was that he wanted to be a steward of the landscape that he maintains and better the environmental processes in there (Goodale, et al., 2015), such as the conservation of meadow birds and soil-dwelling creatures, however, Roel was not financially rewarded for this service. As described in the stakeholder analysis and the current farming practices, our current market-driven society it is hard to take goals into account of economic activity which are not represented as monetary value. This also holds true for biodiversity and as we start assigning it a monetary value in our project, we make it easy for farmers to integrate it into their way of running their businesses. Thus, making biodiversity conservation financially rewarding by treating it as a product sold to the state is key to our proposed transition, as this helps break the economic dependency of farmers on intensive farming practices (highest possible food production) reinforced by the current type of consolidation of monetary flows in the agricultural sector.

3. What kind of agricultural practices thrive on this balanced system?

Agricultural practices that integrate nature, are thriving the most in our proposed balance. This was predicted by Fastré, et al. (2021), and through developing the indicators on biodiversity, also proven in our theory. Referring back to the divide between land-sharing versus land-sparing (Kok, et al., 2020; Martinet and Barraquand, 2012), we explored ways of creating a landscape based on land-sharing of human users an nature, while taking into account the societal setting and its actors. Therefore we made a constructive contribution to the academic debate to favor the integrated approach of land-sharing.

Biodiversity is based on a variation of habitats and sizes of these habitats. In our project, we create both more diversification in type and create more space for nature by integrating it in agricultural areas. Specific practices that thrive in this system, dependent on soil type, groundwater table and rate of integration (which part of the gradient), are spatially presented in the typology matrix of agricultural practices (Figure 5.6). The bottom line is here, that the practices should be based on bettering nature through keeping to the principles: circularity of nutrients, no use of pesticides or herbicides, maintaining a healthy soil, use beneficial plant species, focus on maintenance, and take good care of animals.

4. What is the effect of our future balanced system on biodiversity, and what does it spatially look like?

The current landscape of the Green Heart holds mainly farming functions (Stuurgroep Nationaal Landschap Groene Hart, 2020), with few natural areas in between (Janssen, et al., 2022; Verburg, et al, 2022). By integrating nature with the food production process, we spatially transform this landscape. Stepping in the lowest proposed gradient of integration, this already changes the current monocultural farming practices to be more diversified. Following the gradient, we see a further integration and thus more nature appears, with more diverse habitats and the size of natural areas as biodiversity "hubs" that replace a lot of industrial farming typologies until the focus is purely on nature and connected to other natural areas. The size of the transition area, the whole Green Heart, brings about a big shift and a huge potential for biodiversity. The integration of land use will let a more harmonious and less fragmented landscape of a new type emerge - the Dutchscape. It is still an engineered approach to landscape in the Dutch tradition based on high population pressure but a brand new approach as well.

5. How to ensure justice for farmers when they have to transition their farming practices?

As we can see from the current urgency of the biodiversity crisis, we as a society have to change our ways into a more sustainable path regarding agriculture (Bos, et al., 2013; Kok, et al., 2022; Schulte-Uebbing, et al., 2022; Westerink, et al., 2021). However, innovative farmers who want to participate in this change, are not supported in the current system of farming (De Vos, 2023). Designing a system that is just and empowers farmers is thus key (European Commission, 2019; Schulte-Uebbing, et al., 2022).

Defined into distributive, procedural and recognitional justice (Rocco, 2022). First, we addressed distributive justice by letting the burden of biodiversity conservation (a healthy environment as a public good) not only fall on farmers but also on society by letting the state, and thus the people, pay the societal share. Secondly, for procedural justice, we designed a system based on the concerns of farmers (Kamsma, 2023; Aan de Burgh & Kamsma, 2020) with a participatory workshop as a cornerstone for the decision-making, thus taking the farmers' perspective fundamentally into account. Thirdly, for recognitional justice, the farmers' perspective is the red line through the report, but also for the future, as they will play a very important role in keeping the Netherlands healthy and future-proof by being stewards of the natural landscape

Limitations

In our project, there are some limitations that we need to address. First, we have no means to research if the nitrogen cycle is closed in our future system, and we cannot measure nitrogen values so neither to what extent it declines and thus, if pollution stops. Similarly, there is no mean fo testing out if the co-benefits (clean air, water and healthy soil) are also effects of the system. Second, due to time constraints, we could not work out multiple outcomes of the participatory workshop, nor could we test this system out with farmers in real life. Thirdly, in our future spatial system, there is no clear role defined for farm animals, and we did not delve into the ethics of animal keeping at all.

Further research

The most interesting further research to us, is to test out the system in reality and see how we could better it since this is only the first part of the full strategy: the design. Other research could be on the effect of the better connectedness of the Nature Network Netherlands, on plant and animal species for example, on abundance or migration patterns. The same goes for the effect of more nature on citizens especially farmers, to see if their perception of farming and biodiversity has changed.

7.2 CONCLUSION

In the conclusion, the main research question is answered.

The question was: "how can agricultural land use be optimized to balance food production and biodiversity conservation in the Green Heart, and which changes in the contextual systems are needed for the implementation to succeed?"

Agricultural land can be used for biodiversity conservation by intergrading food production and biodiversity into the landscape, following the shapes of the urban areas (production prioritized) and natural areas (biodiversity prioritized). By shifting this balance based on the relative position between both of these areas a gradient is constructed. By creating a system in which farmers are helped to create this balance on their farms and are paid for their efforts and the services they provide to society, they can be encouraged to change their farming practices for the better. An important requirement for the system to work is participation from the farmers, both in developing the system as well as implementing and maintaining it thus making it imperative to involve them as early as possible and as much as possible.

7.3
GROUP REFLECTION

With our project, we tried to find ways in which the nitrogen pollution and the deterioration in the Dutch landscape can be reduced or even eradicated. The result is promising, as it shows a path forward in which these problems are countered in a sustainable way.

From the early stages of our project, we have focused on giving farmers a good perspective for their future. For us, this started with trying to accomplish a bottom-up approach and steering away from the top-down approach that is nowadays more prevalent. But at the same time, we must acknowledge that a fully bottom-up approach would not result in a coherent regional structure, which is important for our way of creating biodiversity. To a certain extent, we have to rely on top-down governance. To include this top-downness we have based our project on a lot of assumptions concerning the actual feasibility and enforceability. An important aspect is still that we are forcing farmers to change. In our proposed future, it would not be allowed to practice farming in the way it is done nowadays. By this we are somewhat impeding the freedom of choice the farmer has in exercising their profession. On the other hand, we must also acknowledge the way they are farming now is unsustainable and can result in a future in which farming will no longer be possible. To ensure long-term agricultural prospects and food availability, we think it is acceptable to enforce this change on them.

For this project, we have assumed that the farmers will be a strong component in the development and implementation of the system. The interview with farmer Roel has served as a valuable input for our project. At the same time, we must acknowledge that it is only a single opinion against thousands more. To a certain extent, we have been able to prove that there are a lot of similar sentiments out there. It would have been better to also interview farmers with opposing or slightly different views on these matters. Within our approach, they are only given a minor say in things.

In the end, our project could pave the way to a more inclusive approach to the transformation of our landscape. Farmers are encouraged to not just ensure food availability and food security, but also biodiversity, and public goods such as good water quality, good soil quality, good air quality, and carbon sinking. All of these will improve the ecosystem that we call home, making it more livable for us but also future generations. But our project also underlines that this change does not just happen with farmers. As a society we must get our priorities right and invest in our future and the future of humankind by providing these farmers with the things they need to enact this change. Without mutual support, systematic change is going to be incredibly hard.

Authors Photograph

Authors Photograph

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Figure 4.1

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CASPAR RAAP

At the regional scale it becomes apparent, maybe more than on any other scale, how non-spatial systemic relationships can shape entire landscapes. During this project, it fascinated me how we started from a fairly spatial and physical goal of how a biodiverse and productive landscape could look like and in further and further specifying the implied spatial transformations achieved an understanding which lead to the current state. A state which is not designed but emerged out of mostly economic reasons and mirrors in its logic the power dynamics at play with one key factor governing the systemic logic: monetization. We discovered that the historic shortcomings of trying to increase biodiversity by making it a goal solely through policy without taking into account the economic position of the farmers led to social unrest, as this was not perceived as a just transformation. Our deduction was that processual justice was going to have to be a key feature of our project as otherwise, it would produce similar social unrest. Through the process of backcasting what changes would need to happen in order to arrive at our desired transformation, it became clear quickly, that some level of top-down policy (e.g. zoning) would be necessary to achieve a spatially coherent outcome. As we tried to combine these findings about processual justice, systemic monetary forces and the need for some top-down policy it was helpful to consider the input we got from the accompanying lectures as around the time those thoughts really started entering my head, we learnt about the broad spectrum of governance models and types of planning. My key takeaway from that was something I was aware is possible and did in past projects but so far had not deliberately used as a tool: combining different levels of governance and types of planning (policy, strategy, investment and zoning). In the past, I did it when needed, but this time in our project we made a real point out of using a combination to be able to get a grip on the multidimensional nature of our project. There was also another specific tool, which I knew but maybe only now fully understood the importance of the Power-Interest-Agency matrix as a tool not only to plot the stakeholder context but also to make deductions on the way of handling different stakeholders as well as a starting point to find stakeholder clusters. In the end, I believe our strategy to be heavily influenced by this tool.

In general, I found this quarter to be valuable not necessarily by introducing a lot of fundamentally new concepts to me but by letting me think a lot more specifically about some of those concepts, mostly relating to the topics of justice. I am proud of our group as I feel that this project takes the participatory approaches the farthest I have managed so far in a group project. Another more personal learning I accomplished this quarter was to learn more to trust the people I´m working with at upholding their end without constant checks, which might also be based on the very intelligent and professional people I got to work with this quarter.

DEBORAH VAN DER VLIST

This quarter has inspired me enormously in many ways. As a student of Metropolitan Analysis Design and Engineering, the methodology course was very recognizable as Roberto has previously enlightened us with his sharp visions and knowledge. However, I arrived here to delve into the world of designers and architects. To put the 'Designing' in MADE, which has been exactly what I got. Coming from a background in Human Geography and Spatial Planning, I already had a little peek into spatial developments, but the grandeur of this project was very new.

I feel very passionate about our project because it creates a solution for working more nature-inclusively in agriculture, which is still the main land use type in the Netherlands. Farming has an enormous impact on nature, but not so much on society other than sharing the landscape. Coming from a small town in the center of the Green Heart and a long family history of farming, I recognize the frustration of farmers having to comply with rules without having a perspective. In this project, through the bottom-up process that we designed, these main actors are being heard and offering sustainable solutions themselves. The landscape and the farming practices that come out of this project is certainly the landscape I would like to see for my region.

About the development of the project, this went very organically. In the group there was no clear leader nor a clear ideator. I felt like we were all coming up with great ideas that were needed at the moment, and everyone was heard. All group members were genius and very sweet and smart, I was happy to be surrounded by them every day and they taught me a lot. Despite not having an architecture background, I felt very empowered to think like a designer. I also felt like I could put my skills to use, writing and researching (especially the theoretical and ecological connotations), and the understanding of spatial implications.

Then a word about the teaching materials. The way we were guided through the lectures, workshops, and feedback studio sessions, felt really safe but encouraging. It felt high-paced but challenging, but I felt competent as well, even without an architecture background. Furthermore, the lectures of the Capita Selecta were familiar to my Bachelor's but gave a very new design perspective on the spatial processes that take place. The SDS were informative too, and it was fun to learn new software in mapping and web scraping. Being able to do a discourse analysis with R will be something I love to do in the future. Having the tools now is nice, thanks. Moreover, the methodology lectures were very handy to get everyone in the group aligned. Coming from all backgrounds and teaching methods, everyone learns how to write a rapport differently.

Overall, I am very happy about this experience, and I am looking forward to work with designers in the future.

JASPER KOOIKER

The Netherlands has an extensive agricultural history. And where most people nowadays do not have any (close) ties left to the agricultural practice, this is different for me. Born and raised on a farm in the east of the country, farming used to be part of my day-to-day life. Even though I have moved to Delft to study urbanism, these ties have never been severed. It is one of the reasons this course was quite complex for me, as it also touches on a more fundamental and emotional side of who I am. This is why initially I was having some struggles finding my way in this course. Especially when our project started aiming at finding a solution for farming practices in the Netherlands. It created high expectations from my project group, who somewhat relied on my knowledge of Dutch farming. In the first weeks, this was at times difficult, particularly when it felt like I was held against a wall. This clash of urbanism and emotional attachment to the project case is new to me. On the one side, it can be intimidating, while on the other side, it forces you to have a strong opinion. But I still do not fully know if, in the end, it would be a good or a bad thing.

The personal attachment to the case made me quite reluctant, mainly because the current debate has largely been focused on reductions and limitations without offering a positive perspective for farmers. It largely coloured my perception of what legislators, academics and planners thought of farmers. Only through more research, lectures (like the Capita Selecta), and discussions with my group, did I begin to see that there might also be more promising ways of viewing the spatial debate. An important aspect for me was the perspective that farmers would be given by our project. But still falling into the trap of creating top-down propositions and decisions kept being a possible pitfall. In hindsight, it would be something I would have liked more guidance on. But in the end, it also showed that determination and a strong opinion on a matter can be a driving force in creating a change that is better than those proposed by others.

In the end, I think that the project that we created, has integrated this well enough. Even though it is not explicitly in the vision, it is there. And it has guided our way through the project. Whenever discussions were held or decisions were made, we could reflect on what perspective it would or could offer.

JULIA SUMARTHINNINGRUM DAHLAN

The journey of this quarter has been a great source of inspiration and motivation for me. The well-structured lectures provided a comprehensive understanding of regional planning. Despite my previous experience in urban design and planning projects, the Quarter 3 project offered me a deeper insight into spatial issues. I found the methodology lectures and SDS Capita Selecta particularly enlightening, as they reshaped my perspective on these issues. The class discussions were also very informative and resonated with me on a personal level, as they encompassed perspectives from the global north and acknowledged the challenges in the global south.

My group's project was super interesting, and I wish we had more time to dive into more detail. After visiting the site and being interviewed and taught by the organic farmer, we came away inspired but also saddened by the reality of what the farmers were facing. This process was essential for our group, as it gave us a whole new perspective and valuable lesson. It also led us to consider the farmers' views in every step we took, especially in terms of giving them the rights to be part of the system change.

I realized that only a few groups had done deep interviews like ours. I find this a bit unfortunate, as I feel that as planners and designers, we need to be closer to the people and public sector. They are the ones who will use what we plan and design in the future. Therefore, academic institutions should teach their students not only to work inside the studio but also to go out into society to listen and communicate.

Another thing that I found interesting is the importance of incorporating a systematic approach to the spatial design process. To realize and make the vision into reality, it not only needs a beautiful spatial design but is also accompanied by a set of policies, system procedures, and actors and stakeholders who play important roles in different stages. Through the process of unpacking the problem, we found the injustice system created by how our world economy shaped the market, which we found needs to be changed. We believe that inviting farmers to collaborate is crucial to achieving sustainable development by integrating it not only as food production but also as the guardian of biodiversity in the new farming business model.

Our project was super complicated, and my group was earnest and gave much attention to how our vision could be realized. The discussions were so intense that sometimes there were disagreements, but this situation is a lesson in real life because we, as spatial planners and designers, will work for the rest of our lives with different people and multidisciplinary teams. We also noticed that we had different strengths from one another, so we tried to distribute our roles in the group.

Lastly, in this quarter, I learned much about how the Netherlands and most European countries are doing in regional planning and design. They are driven by a vision and strategy, which is entirely different from the practice in Asia. In Asia, land use planning is usually done first, and the vision comes later, which I sometimes find shallow as it limits the generation of more options.

Overall, I am super happy with this quarter's learning process and hope to apply it in the actual project.

YU DUAN

This quarter's studies have been my first exposure to spatial planning and the topic of farming, which significantly differed from my previous focus on construction and economy development topics in my bachelor program. The entire design process has facilitated a deeper understanding and awareness of nature and social justice. Moreover, our group had a lot discussions in policy making and implementation strategies. From that, I've found particular interest in exploring bottom-up engagement and collaborative planning. Additionally, the theoretical lectures on planning, especially the engagement component, have further ignited my passion and interest in this field.

One aspect of this project that greatly fascinated me was the integration of top-down and bottom-up planning approaches, encompassing spatial planning, policy-making, and the design of participatory workshops. In discussions about social justice, I believe it's essential to focus more on actual human needs rather than perceived demands. During the design research phase, our interactions with practitioners of organic farming, the farmers themselves, provided valuable insights into their true aspirations and the challenges they face in implementing organic farming practices. Consequently, in the subsequent design process, we emphasized providing farmers with understandable and gentle choices through a card game after our initial planning, allowing them to select their strategies and expressing hopes to achieve biodiversity through subsistence methods. I vividly recall the farmer expressing that, as an individual farmer, his influence seemed insignificant, yet he persisted in practising organic farming despite the hardships. He expressed a genuine desire for planners like us to attempt to change this situation positively. I believe this encapsulates the essence of why I study this discipline: to genuinely help and effect change.

Besides that, the SDS workshop greatly contributed to my understanding of spatial relations and how to approach planning and design. It provided numerous perspectives for analyzing projects. This semester also taught me how interconnected research and design are, and methods for conducting design-based research. Additionally, the workshop on tools for community engagement and AI enriched my perspective by utilizing computing to explore various dimensions. I also believe that technology, as a tool, can play a significant role in planning and social participatory approaches by analyzing vast datasets to discover basic human needs. It can effectively facilitate the understanding and addressing of their needs. I also intend to further learn about this part and bring it into practice.

Overall, this planning experience has taught me a lot. I hope to apply the knowledge and skills acquired from this experience to delve deeper into design experiments focusing on collaborative planning and social participatory approaches in the future.

Authors Photograph

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