MEAT SUBSTITUTION IN THE NETHERLANDS

How to further accelerate the green protein transition from an innovation perspective

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Executive Summary

This research paper is the final project for an MSc program Industrial Ecology of TU Delft and Leiden University. The research studies the Dutch meat substitution sector from an innovation perspective by applying theories from the field of sustainability transition studies: functions of innovation systems theory and multilevel perspective. This is done in order to gain in-depth knowledge on how the development of the Dutch meat substitute innovations system could be further fostered. The data presented is delivered primarily from expert interviews conducted among 14 actors connected to the field of meat substitution between November 2017 and May 2018. In terms of multilevel perspective, it was revealed that the meat production and consumption regime does not actively try to undermine the raising meat substitution niches, but rather obstruct their development by the deeply embedded rules and structures of the regime that it seems to be unwilling to change. As the landscape pressures of rising environmental concern, rising concern over animal welfare, changing health perceptions and quest for culinary novelty offer only soft pressure to the regime, the meat production, and consumption regime has time to reconfigure itself and adopt innovation from the meat substitute niches in a symbiotic manner. Due to this, the transition pathway that meat substitution is currently taking in the Netherlands is that of reconfiguration. The functioning of the innovation system was determined to be especially good in terms of entrepreneurial activities and knowledge development, and the greatest single bottleneck was detected in the functioning of market formation by the government. Investigation of the expectations of the producers of meat substitutes revealed that the expectations relating to social practices and technologies are especially diverse, due to which the actors develop varying strategies for operation. These varying expectations have likely results in the abundance of niches within the system. Based on the results of the analysis on functional dynamics, eight recommendations were given for action to foster the development of the system.

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Chapter 1: Introduction

Figure 1: Headlines of Dutch newspapers' online articles on October 20th, 2017. From top to bottom: De Trouw, NU, Het Parool, NOS and RTL Nieuws.

"After years of less, the Dutch are eating more meat again" (De Trouw), "The decreasing meat consumption has stopped: we still eat too much meat" (NOS) and "The Dutch are eating more meat again" (NU). These were the headlines of some of the Netherlands leading news outlets on the October 20th, 2017, when reporting the findings of a new study conducted by the Wageningen Economic Research on Dutch meat consumption (Terluin et al, 2017). Breaking the news threshold all around the Netherlands, the sudden halt in the Dutch meat consumption pattern after years of gradual decrease was clearly of great importance, but why exactly?

Globally, meat consumption has been vastly growing since the early 20th century due to population growth and increasing prosperity. However, since a couple of years, a few developed countries namely in Western Europe have undergone an opposite development by reducing their meat consumption, not due to economic restrictions but a sole willingness to cut down their consumption of animal protein. The growing adoption of a plant-based diet in these countries is a response to increasing awareness of animal welfare, sustainability and health and a willingness to act accordingly. In the Netherlands, the meat consumption began decreasing in 2010 and continued to do so on annual basis up until 2016 (Terluin et al, 2017). The Dutch were thus surprised when finding out that meat was once again gaining more popularity among the consumers. After all, the

movement of cutting down meat has been greatly supported by a growing group of Dutch entrepreneurs offering alternatives for animal protein - meat substitutes.

The Netherlands has since the early 2000's actively pursued the role of an innovation leader in the field of meat substitution: already in the 90's, the Dutch government commissioned a longitudinal study on meat substitution as part of its Sustainable Development Program, which spinoff multiple new studies and innovation projects on the field (Quist, 2007). Meat substitution is certainly a complex field not only to innovate but to integrate into the society, as its success depends on breaking down thousands of years old dietary patterns and fundamentally changing people's approach to food, something that is strongly embedded to our culture. Netherlands' prominence in the field of meat substitution makes it an excellent subject for the study of such sustainability transition. Therefore, this research studies the Dutch meat substitute innovation system in terms of recent developments to unravel the best strategies to help the further growth and prosperity of it. In this introductory chapter, humans' relation to meat through history is elaborated, after which the environmental, health and ethical dimensions of modern meat production and consumption are discussed to give arguments for the urgency of profoundly changing our meat consumption practices. Afterward, the way in which meat substitution could address these issues is demonstrated. Finally, the research objectives are elaborated more in detail, the research questions introduced and the topic's relevance in the field of industrial ecology discussed.

1.1 The development of human diet

The modern human has lived on this earth for 100 000 years and has naturally undergone some drastic changes within that time. Much like we do not use the same tools, language or customs as we did at the dawn of humanity, the modern human also has a diet rather distinct from that of its prehistoric counterpart. The diet of a prehistoric human was mostly based on fruits, leaves, and grains. The men engaged in hunting from the very beginning, but the importance of meat in terms of caloric intake was relatively insignificant (Flandrin et Montarani, 1999). This is largely due to the difficulty of acquiring meat and the ease at which fruits and vegetables could be collected. With the great ecological change brought by the cooling of the climate, the share of meat and fish in human diet grew significantly and has maintained its importance till the present day. During the Holocene Epoch, the current geological time that started about 12 000 years ago after the Palaeolithic Ice Age, three developments that fundamentally changed the human diet took place: the development of agriculture, the industrial revolution and the creation of global food economy.

As the climate warmed towards the end of the Palaeolithic Ice Age in 10 000 BCE, the big game disappeared, increasing the importance of smaller animals for meat (Flandrin et Montarani, 1999). Around the same time, agricultural practices started to develop, first in the Middle East and later in other parts of the world, thanks to the favorable climate. According to Flandrin and Montarani, the development of agriculture and animal husbandry was, in fact, a response to the increasing instability of food supply from the traditional sources of hunting and gathering due to the warming of the climate (1999). The domestication of grains and animals lead

to a fundamental change in human societies; hunter-gatherers became farmers, resulting in sedentism and decreasing uncertainty of food supply. As grains grew in importance, the human diet became more unilateral and, arguably, less nutritious. Due to the invention of animal husbandry, the supply of meat became more stable which resulted in greater reliance on meat from domesticated animals such as sheep, cow, and pig, fattier in composition than the game (Flandrin et Montarani, 1999). Agricultural revolution transformed the whole acquiring of food – no longer was the human bare dependant on nature but was now able to actively modify and deploy it to his advantage. Even though many societies, some of which are still alive today, have maintained their dependence on the game, the creation of animal agriculture was a shift towards a society with meat security.

Agriculture prevailed as the core of all human societies for thousands of years until industrialization took root in England in the late 18th century and quickly spread to the rest of the Western world. A vast increase in agricultural production of both plants and animals was experienced thanks to specialization and mechanization, which changed the composition of our diet once again: the amount of starchy foods decreased, while more fats and sugars entered the diet (Flandrin et Montarani, 1999). In the mid-20th century, the post-war political climate strived for more production, which increased the number of subsidies directed towards agriculture, leading to massive expansion of innovation capabilities and development of the cornerstones of modern industrialized agriculture such as fertilizers, pesticides, and antibiotics. For animals, industrialization of animal agriculture was the point when mistreatment and neglect truly began: as the size of farms grew and several mechanisms to further improve the productivity were deployed, animals became mere instruments of profit.

Towards the end of 20th century, the global food market arose in its modern extent. Globalization further advanced the idea of specialization in accordance with one's abilities, which has resulted in the best possible use of global resources and lead to the ever-expanding assortment of products that we witness in the developed countries today. Thanks to this overwhelming versatility, it is difficult to generalize about a human diet, as the people are not even able to agree on what that diet should be. The ease in which meat can be acquired today has resulted in a situation in which an average person in a developed country consumes 83 kg of meat a year, a 10-kg increase since 1980 (Thornton, 2010). This consumption is predicted to further grow in the future, reaching 94 kg a year by 2050 if the current trend continues (Thornton, 2010). The

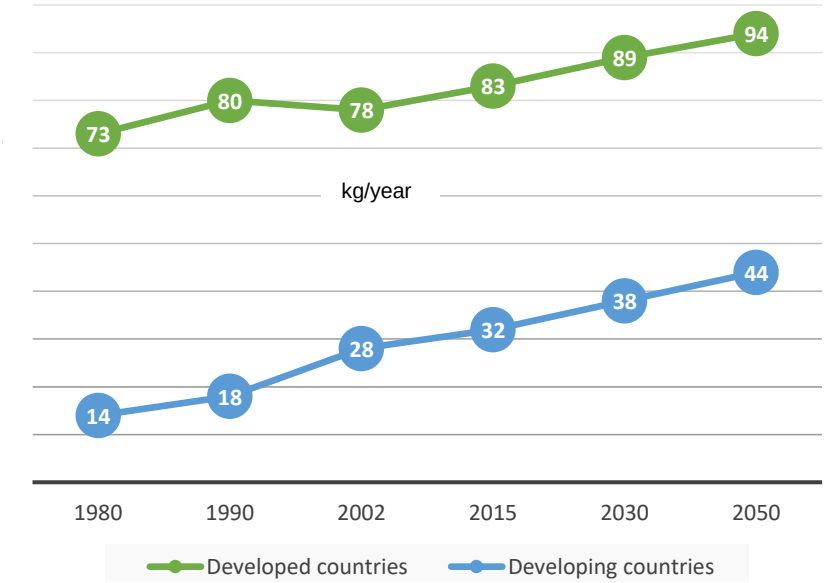


Figure 2: Meat consumption per capita in developed countries and developing countries (based on Thornton, 2010)

vastly increasing meat consumption of the late 20th century was, according to Popkin (2001), part of a greater nutritional transition which takes place when societies become more developed. The livestock products, that were previously considered as luxury products consumed in moderation, were being increasingly advocated on the account of grains and vegetables, a nutritional transition that is now taking place in developing countries such as China and Malaysia.

There is no doubt that agricultural, as well as industrial revolutions and the emergence of a global food market, have all redefined the relationship between humans and food. This blunt historical overview demonstrates that like everything else, also what we eat is a social construct and subject to change. It is in fact believed by many that we are living on an era with a fourth food revolution insight - one which will involve reconfiguration and re-evaluation of our relationship with food once again. This revolution will be posed by climate change, and it is already long overdue. A fundamental part of this new food paradigm is to decrease our meat consumption drastically primarily for environmental reasons, but also due to health and ethics, aspects which will be discussed more in detail next.

1.2 Why is meat problematic?

The shift in our nutritional intake is intriguing from the socio-economic point of view, but it is also an alarming development that has already led to a lot of problems and is likely to become ever-increasingly troublesome in the future if the trend continues. As the world's population increases, even rocket-like in parts of Africa and Asia, our planet's resources are facing scarcity. One of the great challenges of the projected 9 billion people the world will carry in 2050 is how to provide sufficient nutrition for everyone. The extent to which meat is consumed today and the way it is produced, especially in the developed world, is directly contributing towards the global environmental degradation, is hazardous for the health of the people and is increasingly perceived as problematic due to issues of animal welfare.

1.2.1 The ecological argument

The most critical task for humanity at hand is to reduce the amount of greenhouse gasses in the atmosphere and stabilize our living conditions to secure our well-being and prosperity in the (not so far) future. Climate change has been a topic of political debate for already four decades: the environmental impact of the human species came to limelight for the first time in 1972 with the publishing of The Limits to Growth by the Club of Rome and broke through to the international political agenda in the 90's in the United Nations Rio conventions. The inability of us to act on climate change in an adequate manner has led to an ecological situation which mere twenty years ago remained as an image of a distant future: the icecaps are melting at an alarming rate leading to rising sea levels and a serious threat to coastal communities; extreme weather events such as tropical storms and droughts are increasing in frequency and the sixth mass-extinction in the history of Earth has been set in motion.

In general terms, the environmental impacts of meat production appear in three dimensions: climate change, consumption of natural resources and environmental pollution (Djekic, 2015). The main contributor to the changing climate are greenhouse gas emissions, and the largest single source of these emissions is the livestock industry with 18% share of the global GHG-equivalent emissions (Livestock's Long Shadow: Environmental Issues and Options, 2006). The global livestock industry is in the top three main causes of environmental problems, together with the transportation and energy sector, even though its impact on the ecology has been long neglected by research and policy. Only since the publishing of Livestock's Long Shadow in 2006 became the overreaching environmental implications of raising livestock widely known and discussed upon. The study called for urgency the address the issue of livestock production on a global and local level to combat irreversible climate change, a task that inspired this research among many others.

Most of the emissions connected to livestock industry originate from biological processes that are difficult, if not impossible, to control or optimize, such as the nitrous oxide emissions from the land use and methane from the digesting process of ruminants (Röös et al, 2015). Therefore, the only possible solution for reducing the environmental impact of the sector is to drastically cut down on its size, which can be achieved by lowering the demand of products that are delivered from the livestock industry such as milk, leather, eggs and, most importantly, meat. Substituting these animal-based products with plant-based alternatives would result in remarkable savings of resources and cut down the greenhouse gas emissions of an individual consumer to about a half (Westhoek et al, 2014).

1.2.2 The health argument

Meat is an important source of protein and nutrients such as B12, zinc, and iron, all of which are crucial for healthy physical development of the humans (McAfee et al, 2010). Even if not exclusively, as there are other sources to get a necessary amount of these proteins and nutrients, meat can be an important part of a healthy, balanced diet. However, much as everything, also meat-eating must be kept in moderation to have a positive health impact. Several studies have concluded that overconsumption of meat increases the risk of several diseases, and is linked to obesity and a shorter life-span (McAfee et al, 2010).

In 2016 the World Health Organization shook the red meat world by revealing the conclusion of their latest research which concluded that consumption of processed meat increases the risk of cancer: 50g daily dose of processed meat increases the risk of colorectal cancer by 18%, due to which it is highly likely that consumption of other meats will lead to similar results (IARC, 2015). Consequently, the United Nations branch organization, which is arguably the world's most authoritarian health organization, placed processed meat in the Group 1 and red meat in Group 2A of categorization of carcinogenic substances to humans[1](IARC, 2015). Additionally, a link between processed meat consumption and type 2 diabetes, strokes and cardiovascular disease, for

[1] Substances in group 1 have sufficient evidence on being carcinogenic, whereas substances in group 2 have limited evidence of being carcinogenic. It must be noted that this grouping is different from a risk assessment, meaning that even if processed meat belongs to group 1, the risk factor of the substance is not automatically equally dangerous to human health with other substances within the category.

instance, has been proven repeatedly in the recent years (McAfee et al, 2010; Micha et al, 2010; Pan et al, 2012).

The problem with meat from the health point of view is thus that the population in wealthy industrialized countries over-consume it: on average a person in this surrounding consumes meat twice as much as it is considered healthy by the experts (Wellesley, 2015). In Europe, the World Health Organization has identified diet as a major health issue with high social and economic cost for both individuals as well as communities and governments. Therefore, we must find a way to decrease this consumption to moderation.

1.2.3 The ethical argument

Industrial agriculture with its modern practices neglects the well-being of animals. Of course, exceptions exist such as in organic animal agriculture, but these farms often have their own meat niche within which they operate, eg. fair, grass-fed cow meat, and thus they cannot be considered as the norm. The intensification of the production of meat is done in two ways: by optimizing space and resources use at the farm and by fastening the production. Ways to optimize space mean that the animals are tried to be fit in an area as small as possible. This stocking density is regulated in terms of a maximum number of animal per square meter, but it is arguable whether these densities consider the well-being of the animals. In the European Union, the maximum stocking density for broilers, for instance, is 42kg/m2 (Lappalainen, 2012). Fastening the production means basically that the time it takes for an animal to reach its prime age, meat-wise, is being artificially manipulated by using antibiotics. This artificially accelerated growth results in suffering and diseases, for instance, breathing difficulties (Lappalainen, 2012).

Whether this neglect is morally right or wrong depends on one's philosophy. There is an extensive number of theories about the ethics of animal welfare and health (Hurnik & Lehman, 1988). Animals are capable of conscious experience which makes them like humans and distinguishes them from plants, but what this means for the upkeeping of animals remains at the center of the debate. But as a growing trend in the developed countries, an increasing number of people recognize the ethical problems with the modern agriculture and the vegan movement goes even further by stating that killing and eating animals for our own pleasure and to accommodate our own needs is unethical altogether. With these ethics prevailing in the society, the debate over molarity of animal agriculture is increasing.

The extensive impact of meat production on the environment is a scientific truth that cannot be an oversight in the face of a changing climate. The science is also of the same mind when it comes to the health implications of overconsumption of processed meat. In contrast to the environmental and health arguments, however, the ethical implications of the industry are subjective, highly dependent on individual philosophies that vary vastly across and within different societies. The importance of ethical arguments for decreasing meat consumption should not be neglected, but the diverse nature of the three arguments is something to be aware of. The best manner to decrease the global consumption of meat, without dramatically interfering to the individual rights of the people to consume these products, is to alter the dietary preferences towards a more plant-based diet. The next part will elaborate why and how.

1.3 Decreasing meat consumption through substitution

Based on the information presented before, it is evidential that the global meat consumption must be drastically decreased, unarguably because of the environmental problems connected to the production of meat such as deforestation, water depletion, greenhouse gas emissions and soil contamination, but also due to the health application of overconsumption and the implications of animal welfare. The solution to the problem: meat demand can be drastically decreased and the environmental impact of our protein intake minimized by substituting meat with, for instance, plant, fungi, algae and insects based foods that offer the same culinary experience without spoiling the planet, our bodies or the welfare of the animals. These so-called meat substitutes aim to imitate meat not only in terms of nutritional value but also in terms of appearance, taste, smell, and texture. Researchers agree on meat substitutes, especially when based on plants or insects, to be a more sustainable source of protein than traditional animal farming (Blonk et al., 2008; Smetana et al, 2015). The Dutch Sustainable Technology Development program (STD) has estimated that meat substitutes could deliver protein with factor 20: twenty times more efficiently than pork-based protein (Quist, 2007). They also appear to be on average better for the health than meat products, even though this is not self-evidential. The environmental, as well as health profiles of different meat substitutes, will be discussed more in detail in chapter 4.

As the historical overview illustrates, the share of meat in our diets has grown to new heights thanks to the global food economy, and the taste for meat is strongly embedded into the human conscious. Whereas many people are happy to consume vegetarian foods without reference to meat, the reality is that most of us humans are resistant to change. Several studies have concluded that the most effective way of decreasing the share of meat in people's diets is to advocate substitutions of the meat products, rather than altering the diets more drastically (Apostolidis & McLeay 2016; Schösler et al, 2011). Meat substitutes make the changing of one's dietary habits more manageable, as they reduce the radicality of new behavior: one can stick to the safe and familiar meals and simply switch meat to its vegetarian counterpart. The importance of familiarity is underlined for instance by Schösler et al, who studied the attitudes of the Dutch towards different vegetarian meals. They concluded that lack of familiarity and cooking skills hindered the test subjects' willingness to adopt vegetarian meals in their diets, something that can be improved with meat substitution (2011). Considering this evidence, this paper treats meat substitution as an essential approach for altering diets towards more plant-based.

There are numerous terms used to describe foods that attempt to imitate meat: meat analogs, fake meat, faux meat, vegetarian meat and plant-based meat among others, but for this research, the term meat substitute was opted to increase uniformity. For this research, the term meat substitute is defined as *any other than traditional-Dutch meat substance which has the clear aspiration to replace meat in a meal due to similarities in texture, taste, nutritional value, smell and/or looks*. This definition includes products often referred to as meat

analogs[2] and novel protein foods[3] but is broader than them as it also includes more traditional substitution products such as tofu and falafel. On the other hand, it is narrower than the definition of meat alternatives, which refers to virtually any substance used instead of meat, such as baked beans or mushrooms. The figure 3 on this page illustrates how some of the different sources of protein can be placed on an axis in terms of their novelty and source. The texturized vegetable protein (TVP) category reaches partially to the traditional side as it includes products such as tofu, seitan, and tempeh, but mostly remains on the side of novelty as the variety of these products has dramatically expanded, especially in the Netherlands, as chapter 4 will illustrate. Roughly speaking, everything that falls in the axis of both traditional and plant-based protein substances can be potential bases for meat substitute products, with the addition of dairy and eggs from the animal-based axis. Based on the definition of meat substitutes and the categorization of different protein substances, six types of meat substitute groups have been identified that are most relevant for the Dutch: substitutes based on legumes (1), substitutes based on dairy (2), substitutes based on fungi (3), substitutes based on sea-vegetables (algae) (4), substitutes based on insects (5) and substitutes created with stem cell technology, eg. in vitro meat (6)[4]. Foods such as beans and sprouts, nuts or mushrooms without further processing are not considered as meat substitutes because they cannot be exquisitely identified by the consumer as products that should replace meat in a meal (Elzerman et al, 2011). These meat substitute groups, or niches, are better introduced in chapter 4.

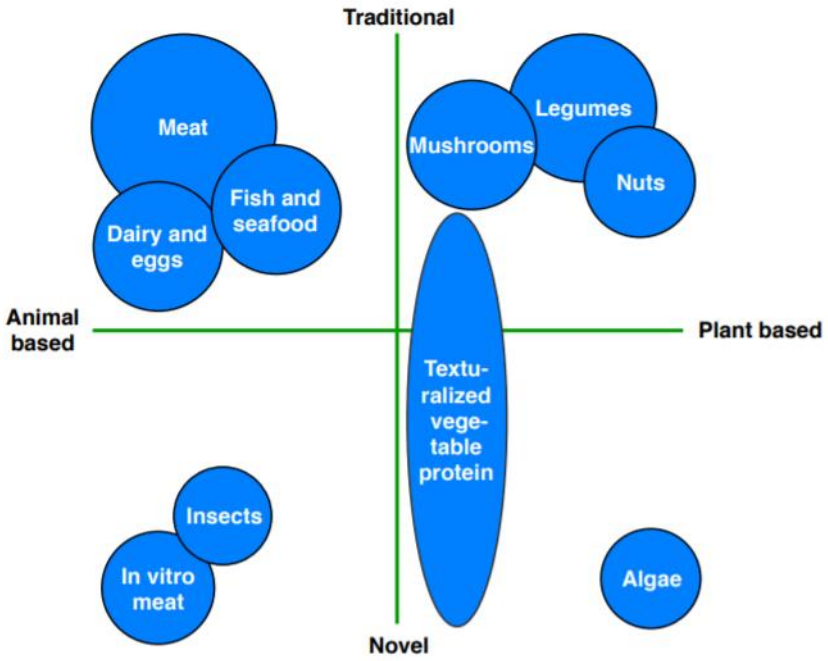


Figure 3: Illustration of substances that contain a lot of protein, from the Dutch perspective

[2] The term meat analogue is often used to refer to plant-based products that with an application of high-tech texturalization technology strive to be almost inseparable to real meat.
[3] The term novel protein foods is often used in research to refer to modern meat alternatives.
[4] Nuts or eggs are not considered as their own meat substitute groups to avoid unnecessary complexity and because these substances are often add-ons to improve texture of meat substitute products.

1.4 Research goal and questions

Meat substitution offers a viable strategy towards more sustainable food system worth investigating. The global meat substitute market is growing at a notable speed especially in the Western countries, including the Netherlands. To better enhance advocation of meat substitutes in our diets, it is beneficial to study the system from which these products sprang from for understanding the mechanism of the sustainability transitions. Thus, this research investigates the Dutch meat substitute innovation system and the context in which it emerges, with the aim of identifying the factors that obstruct and/or stimulate its development. Based on these findings, recommendations are given on how to further foster the development of the innovation system, and perhaps offer guidance for the development of equivalent systems abroad. The main research question this paper seeks to answer is:

What can be learned from the recent developments in the Dutch meat substitute innovation system to further foster its expansion?

Answering this question is expected to give valuable insight on the Dutch meat substitution innovation system that can be useful not only for a deeper understanding on sustainability transitions in general but also give guidance to the actors who work towards expanding the consumption of meat substitutes. To answer the main research question in a concise manner, the following sub-questions are posed:

1. What are the main developments in the field of meat substitution in the Netherlands since 2007?
2. What is the structure of the Dutch meat substitute innovation system?
3. What are the main functional dynamics of the innovation system and how do they influence its development?
4. What actions could stimulate further development of the Dutch meat substitute innovation system and growth of the meat substitution market?

1.5 Report outline

This research report is divided into four main parts. **Research design** includes chapter 2 on literature overview and chapter 3 on methodology. Research part 1 elaborates on the theory of sustainability transitions, explains in detail how these theories and different concepts are employed in the research design, and introduces the way the research has been conducted. **Research part 1: description of the innovation system** includes chapter 4 on the main developments in the Dutch meat substitution in the past 10 years and chapter 5 on a structural analysis of the innovation system. Research part 2, therefore, introduces the topic of meat substitution more in detail in the Dutch context and generates descriptive work upon which the analysis can be built upon. It will also answer research questions 1 and 2. **Research part 2: analysis of the functional dynamics of the system,** includes chapter 6 on the transition context, chapter 7 on the functional analysis and chapter 8 on the integrated analysis. In this part, the sustainability transition theories are applied in order to answer research question 3. Finally, **research part 3: reflection on results**, is composed of chapter 9 on discussion and recommendations, and a concluding chapter 10.

RESEARCH DESIGN

Chapter 2: Literature Overview

The scientific community has worked on the topic of sustainability transitions for nearly three decades. The topic has been approached from many different perspectives and several theories have emerged which aim to study this phenomenon. The field of sustainability transitions has currently four main theories: transition management (TM), strategic niche management (SNM), multilevel perspective (MLP) and technological innovation systems (TIS) (Markard et al, 2012). Meat substitution is about sustainability transition and therefore, this chapter introduces and discusses these four theories in order to get acquainted with the main concepts in the field. The chapter also seeks to determine through which of these frameworks the study of the Dutch meat substitute innovation system could be best conducted. First, the concept of innovation in relation to sustainability is elaborated more in detail, after which the different theories are introduced.

2.1 Innovation and sustainability

The development that is in the essence of achieving sustainability relays on innovation: finding new, better ways of doing things., A central characteristic of an innovation is that it profoundly changes, or has the potential to change, the system in which it arises. Technological innovation was the driving force of industrial revolution and it has become fundamental in how the modern societies measure progress. Today, the pace at which technological change takes place has speeded up tremendously and is arguably still accelerating, which means that our world is changing very fast. This notion of rapid change offers both visions of hope and despair for the future in which the human activities must be kept within the planetary boundaries. With a careful governing of this technological change to serve sustainable development, however, certainly, anything is possible?

The difficulty is that climate change is a wicked problem: it has numerous causes, is difficult to describe, has no stopping rule nor one right answer (Horst and Webber, 1973). But most of all what makes climate change a wicked problem is its overwhelming social complexity: to solve the problem numerous stakeholders must cooperate, stakeholders that do not even agree whether the problem exists in the first place. As we know, a complete reconfiguration of the way of producing and consuming is essential for achieving global sustainability. Considering the wickedness of climate change, it becomes evidential that adopting sustainable practices on a global scale is the most challenging part of solving the problem, as it requires a rearrangement of individual behavior, organizations as well as the society (Rip and Kemp, 1998). Therefore, researchers are increasingly interested in figuring out ways in which this adaptation of sustainable technologies can be done.

Sustainability transitions emerged as a research field at the end of the 90's for this growing need to understand how to enforce the advocation of sustainable practices in a society. Throughout the beginning of the 21st century, the number of publications in the field grew rapidly and it became more institutionalized with the launch of a journal Environmental Innovation and Social Transitions and the establishment of a research network STRN (Markard, 2012). The term transition refers to "a gradual, continuous process of change where the

structural character of a society (or a complex sub-system of society) transforms" (Rotmans et al, 2001). The field of sustainability transitions thus studies the "long-term transformation processes of established industries, socio-technical systems and societies to more sustainable modes of production and consumption" (STRN, n.d.). The central research goal is to explore and define ways in which (sustainable) innovation can be induced, diffused and accelerated and sustainable technological change promoted. It is assumed that for this change to take place, an innovation system through which information and technologies flow has to be in operation. It is therefore through the theory of sustainability transitions that the Dutch meat substitute system can be most suitably studied.

2.1 Transition management

As its name suggests, TM theory attempts to directly guide the direction and speed of sustainability transition. It relays heavily on governance, both participatory and reflexive, meaning it considers a wide variety of stakeholders from different levels and domains and values a collective, learning-based form of governance (Lachman, 2013). The long-term thinking approach that TM advocates are considered to be a valuable addition to the traditional policy-making which overwhelmingly relays on short-term thinking and thus has an inability to manage long-lasting sustainability transition. The approach is applied on three levels: strategic level, tactical level and operational level (Loorbach, 2010). On a strategic level, the problem is clearly articulated and a transition agenda formulated, whereas tactical level is where the agenda is realized. Operational level is where the realization of the agenda is evaluated and learning from these experiences takes place.

TM has been critiqued for its very founding principle: that sustainability transition is a linear process that can be managed (Lachman, 2013). The approach also fails to consider external developments that can affect the transition, for instance, the cultural setting in which the transition is fostered.

2.2 Strategic niche management

SNM, according to its name, aims to analyze how to purposively build momentum for the niche so that it can take over and replace the existing regime (Lachman, 2013). It, therefore, relates to the theory of MLP and is often applied together with it. The focus of SNM is in the study of how the prevailing user practices and regulatory structures would welcome the niche, and ultimately how they can be adjusted to allow the innovation to leave the protected space. It, therefore, analyses the technological change from a perspective of social change, as the presumption is that these two cannot be separated when it comes to radical transition (Loorback & Raak, 2006).

SNM theory is composed of three main elements: dynamics of expectations, network formation and learning from the experiments (Hoogma et al, 2002). The dynamics of expectations measures the extent to which the actors on the production side of the niche are aligned: how well their views correspond to each other in terms of shared vision and measures, what is the level of (monetary) support from these actors and how detailed is the plan towards realization of the vision. These factors are called robustness, quality, and specificness within

SNM. Network formation analyses the formation of the actor-network on both production and consumption side after the introduction of the innovation in question: what kind of actors are involved within the network and in what numbers, how do these actors interact with each other and how stable do these relationships appear. These factors of network formation are called variety and composition, interaction and complexity, and alignment. The last element of SNM, learning from the experiments, is used to analyze the mechanism through which knowledge is shared among the actors in the niche. The factors that constitute this element are technical development and infrastructure, development of user context, societal and environmental impacts, industrial development and lastly, government policy and regulatory framework. As these elements reveal, SNM theory concentrates on analyzing the developments in light of the actions taken by the production side of the innovation and it neglects the role of consumers in the equation. The SNM theory is useful when one seeks to gain more general insight into the process of breaking through a regime by learning-by-doing and Doing-by-learning (Lachman, 2013).

In recent years, there have been attempts to improve the approach. Considered primarily as a tool for policy, there has been a growing urge to bring the transition studies more to the realm of the entrepreneurs, who are the primary actors behind the niche innovations. For instance, Sushandoyo and Magnusson applied an adjusted SNM approach from the business perspective to a case of cleaner heavy vehicle industry (2014). In 2006, Geels and Raven made a distinction between global and local niches and conceptualized the interaction between them. They concluded that developments on a local level could be transformed into generic lessons and cognitive rules for the global niche, however noting that this development is not linear but complex and dynamic, making it difficult to grasp. Raven et al continued to study this complex interaction between the different niche levels in 2011, calling the concept of translation and distinguishing four different types of it. In the same paper, the authors elaborated on how the local-global distinction in the SNM theory relates to the levels in MLP, bringing the two frameworks closer to each other.

2.3 Multilevel perspective

The notion that climate change should be considered not independently, but in relation to complex and ever-evolving sociotechnical landscapes that guide the overall transformation of the society, is the starting point of the MLP theory. Rip et al's paper on technological change (1998) was the basis of MLP theory, work which Rotmans et al continued in 2001 with the addition of the concepts of landscape, regime and niche, and Geels et al in 2007 and 2008 with extending the notion of the technological regime to a socio-technological regime. The MLP has three levels of analysis: the landscape, the regime and the niche, and its core idea relay on the dynamics between these three levels (Smith et al, 2010). The necessity for an interaction between these levels explains why system transition is most of the time not easy.

The landscape level refers to the social context; the global events, trends, and values for instance. Landscape developments determine the needs and aspirations of the society, ultimately to which the regime, as well as the niche, try to answer. Changes within the landscape are often extremely slow, as they are strongly embedded into the culture and customs. The landscape, therefore, influences both the regime and the niches, but only the regime has an influence on the landscape.

The regime can be described as “the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artifacts and persons, ways of problems; all of them embedded in institutions and infrastructures” (Rip and Kemp, 1998). It, therefore, determines the practices and rules of the technological system in place which are composed of the culture, infrastructure, technology, market, sectoral policy, techno-scientific knowledge and industrial networks (Geels, 2011). It is important to understand that the regime is itself an outcome of an earlier change and it structurer of future change (Rip and Kemp, 1998).

The niche is an innovation that emerges outside of the existing regime. The innovation can either be sustained, meaning it has the potential to become part of the existing regime, or disruptive, meaning it has the potential to overthrow and fundamentally change the existing regime. Adaptation of the novel technology to the regime is challenged and hindered by the prevailing practices and rules in the sociotechnical regime which is resistant to change, especially in terms of disruptive innovation. The landscape developments determine also what happens in the niche, and it is often the existing regime’s contrariness to respond to the landscape developments which opens a window of opportunity for the niche to break through the destabilized regime and establish itself as the new norm (Geels and Schot, 2007).

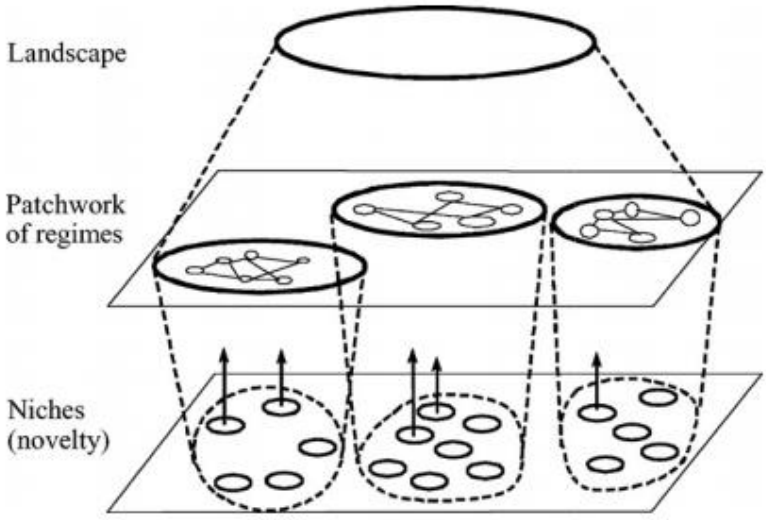


Figure 4: The multilevel perspective according to Geels et al (2008).

According to the MLP, a transition can take place when three things align with the dynamics between the different levels. One, the developments in the landscape level put pressure on the existing regime which is struggling to respond to these developments in an adequate manner. Two, the niche is building up internal momentum due to technological and market development. Three, the niche is capable to respond to the new landscape developments. When all of these three things take place simultaneously, the niche can reach the window of opportunity, offered by the inability of the regime to respond to the landscape developments, and can become the new regime.

Both regimes and niches have similar structures, but whereas regime is large and stable, a niche is small and prominent for change. Geels and Schot have distinguished between three different kinds of rules for coordination in both niches and regimes: regulative, normative and cognitive rules (2007). Regulative rules

refer to national laws, standards and regulations, whereas normative rules are behavioral and have to do with shared values and role relationships. Cognitive rules are beliefs, innovation agendas and problem definitions for instance. In niches, these rules are constantly changing and in the making, whereas in a regime the rules are deeply embedded in. Geels and Schot argue that these niches and regimes are not just rule followers, but rule makers and users, and a niche can become a regime once it has grown large enough for these rules to stabilize (2007).

MLP has been widely used in sustainability transition studies, and it has been praised due to its ability to analyze complex reality on a large scope. It can be used to study both past and the present developments which means it is a flexible theory with wide application possibilities. MLP is especially useful for detecting bottlenecks: possible barriers for the transition in the prevailing socio-technical regime. Lachman, however, criticizes MLP due to it overwhelming complexity: analysis requires attention to the dynamics of the levels as well as the actors between the levels (2013). The theory also takes into account both the production and consumption system and therefore, arguably, lacks focus. Additionally, the MLP has been criticized for its unclarity to translate the conceptual levels to an empirical analysis, neglection of the concept of agency and the bias that niche drives the transition which neglects processes on the regime and landscape level (Geels and Schot, 2007).

2.3.1 Extended MLP theory

Several attempts to improve the MLP theory has been taken. In 2005, Smith et al constructed the theory of transition context with a goal to bring the notion of agency and power more incorporated into the MLP approach and in 2007 Geels and Schot distinguished pathways through which a niche can break into the regime. Next, both of these theories to further improve the MLP are introduced.

According to Smith et al, niches face selection pressures and the context they emerge in determine the form and the direction of the transition as a response to these pressures (2005). Attention is given to the available resources and where they are located. Their theory of transition context was developed in order to change the underlying assumption of basic MLP theory that transition is a rational and monolithic process and to improve the application of the MLP to sustainable governance. They aimed to do so by directing attention towards agency and differentiating between different elements of the transition context, namely articulation of selection pressures and coordination of resources, which together form a quasi-evolutionary model of transition. Articulation of selection pressures refers to the developments in the landscape and the way these, in turn, modify the structure and rules of the prevailing socio-technical system and coordination of resources refers to the act of responding to these selection pressures through resource allocation. Based on these notions, the transition context can be determined from four distinguished contexts: reorientation of trajectories, endogenous renewal, emergent transformation and purposive transition. What is also important to understand is that as these two notions determine the transition context, it is through them that the government can influence it.

In the mapping of transition context, the articulation of selection pressures notion translates to determining the level of coordination of the transition: to what extent do the actors within the regime or on a higher governmental level attempt to steer the transition as a response to the landscape pressure, or whether they neglect these pressures completely. Analysing this dimension can reveal whether a transition is purposeful and intended or unwanted by the incumbent. The notion of coordination of resources, on the other hand, translates to

distinguish between resources that are delivered from the regime and outside of the regime. These resources are a response to the landscape pressures, and thus analyzing where the response to them spawns from within or outside can reveal the degree of structural change expected to occur. Figure 2 illustrates the mapping of these different contexts.

Geels and Schot argue that the transition pathway of a niche depends on two factors: the timing and the nature of interactions (2007). Constructing these pathways was a direct response to address the issue of niche-driven bias of the MLP, and its attempts to better incorporate the notions of landscape and regime to the theory by differentiating between the time and nature of transitions.

The timing plays a crucial role in determining the pathway, as only with a right timing can a window of opportunity open and the niche take an advantage of it. Thus, of utmost importance is the timing of the landscape pressure on the regime in relation to the development of the niche. The pathway of the transition will differentiate whether the niche is fully developed at the time of landscape pressure or not. Geels and Schot determined criteria with which to distinguish a fully-developed niche from an infant one. According to them, in a fully developed niche a) the learning processes have stabilized, b) the support network includes especially powerful actors, c) the price/performance ratio has improved and is expected to further improve in the future and d) the innovation is already in use in at least one market niche which receives 5% market share. These criteria offer a rather standardized approach in determining the state of the niche development, which in turn helps in determining the pathway of the transition.

The nature of the interactions between the landscape developments and niche-innovations in relation to the regime can either be disruptive or re-enforcing. A disruptive interaction means that the regime experiences pressure from the landscape, which creates an impulse for change within the regime. In a disruptive interaction, the niche-innovation can either act as a competing force, when it tries to overthrow the existing regime, or in a symbiotic relationship, when it can be adopted by the existing regime to enhance competence.

Based on these criteria on timing and nature of the interactions, Geels and Schot distinguished four different transition pathways as well as a sequence of transition paths which demonstrated how transition paths may change with time. These pathways, the mechanisms through which they come around and their main characteristics are presented in table 1 for easy comparison.

The transition can also take up multiple pathways, especially when disruptive. This sequence of transition pathways often begins with transformation followed by reconfiguration, and which can even eventually transform to substitution and de-alignment and re-alignment. Geels and Schot argue that this is because even after a transition pathway has been taken if the landscape pressure continues to grow, the regime actors may be willing to adapt more niche-innovations to re-establish themselves. If this results in the new architecture of the regime, the pathway has changed from the transition to reconfiguration. If the landscape pressure on the regime continues to grow even after the reconfiguration, it is likely that the regime actors start to lose faith while the niches see their window of opportunity opening, which may ultimately lead to substitution or de-alignment and re-alignment (Geels and Schot, 2007).

Table 1: The four pathways of transition, according to Geels and Schot (2007)

Pathway	Description	Mechanism	Characteristics
Transformation	No single technology is responsible for a regime change, but changes in the socio-technical system are an outcome of numerous simultaneous developments.	Moderate landscape pressure on the regime when the niche-innovation is **not** yet fully developed leads the regime actors to modify the direction of the development. The regime actors normally only respond to the landscape pressure and change the course of their development when the externalities are pointed out by outside societal pressure groups, as the regime actors themselves are often unable to see the fault in their system. This often leads to reorientation and transformation of the regime, in which niche-innovations might be selected by the regime, thus making them the front-runners.	Power struggle and conflict within the regime and a use of adaptive capacity by the regime actors, after which a new regime is born out of the old one through readjustment. The actors remain mostly the same, thus the niche is simply an addition to the regime, symbiotic, without disruptive implications.
Technological substitution	A novel technology brings about a radical change in the socio-technical system and replaces the existing regime.	Large landscape developments that the current regime is unable to answer disrupt it, while a niche-innovation gains internal momentum. However, the regime actors on a great part maintain their faith in the system and therefore disregard the niche developments. When the pressure by the landscape becomes too extensive, a fully developed niche rises and substitutes the old regime.	Competition and power struggle between the old regime that is unwilling to change and the niche that attempts to replace it. Regime actors try everything to remain incumbent and invest in system improvements, but the landscape pressure is too large and the niche too strong. If a niche replaces the existing technology, it will lead to further regime changes and thus result in a technology-push. New regime actors are established.
De-alignment and re-alignment	The existing regime cannot correspond to the changes in the landscape which leads to problems in the regime and creates momentum for niches, of which the superior technology prevails as the new regime.	Landscape developments that are rapid, large and divergent result in problems within the regime and ultimately the regime actors to lose faith in the system and thus de-align. If no niche-innovation is fully developed at this point, no clear substitute for the old regime exists which leads to the emergence of multiple niche-innovations and competition between them. The most successful of these niches becomes finally dominant and results in realignment.	Major internal problems within the regime, which the incumbent recognizes and acts upon by declining investment in R&D of the regime. Uncertainty towards the regime translates to uncertainty about the size of innovation efforts. As no fully developed niche that can fill the space of the old regime exists, multiple new directions are explored by a variety of niches, which in turn creates more uncertainty and prolongs this period.
Reconfiguration	Numerous system changes take place within the technologies as well as the governing institutions.	Like in transformation pathway, moderate landscape pressure and not fully developed niches result in the regime to modify the direction of the development by adapting symbiotic niche-innovations. However, unlike in transformation pathway, reconfiguration involves major changes within the basic architecture of the regime, eg. in user practices and perception of the technology.	New regime grows out of the old one and the regime actors remain in most part the same. Up-take of symbiotic niche-innovations by the regime and the novelty it brings, opens opportunities for more niche developments to support this re-established regime. Special relevance for sociotechnical systems with multiple technologies, where system change is a result of numerous simultaneous niche-innovations.

Budde et al strived to compose a conceptual framework that analyses the role of expectations in accordance with the structure of the MLP which is illustrated in figure 5 on the following page (2012). Their framework extends on the MLP theory and assumes that there are not only actors and institutions, but also expectations and visions about the future and the institutions related to them on different levels. Expectations related to the niche level include specific socio-technical aspects of a niche, e.g. expectations regarding the technological development of PV-cells, whereas expectations on a regime level have to do with the structure and rules. On a landscape level, the expectations to consider deeper structural trends that affect the interaction of the actors,

e.g. climate change. All of these expectations influence each other, and their dynamics impact the strategies of the actors involved, which again, in turn, influence the transition.

Applying this approach in practice means studying each actor of the niche independently in terms of their strategies, as these can reveal the underlying expectations that have shaped these strategies in the first place. The approach thus results in a broad overview of all the expectations that influence the niche and reveals whether the expectations vary and the impact of a possible variation to the actor strategies. Budde et al's approach are beneficial in investigating why actors who work in similar circumstances end up choosing different strategies for operation, something that neither MLP or TIS does. It, therefore, patches the shortcoming of taking into account the micro-level developments and complements the MLP and TIS framework.

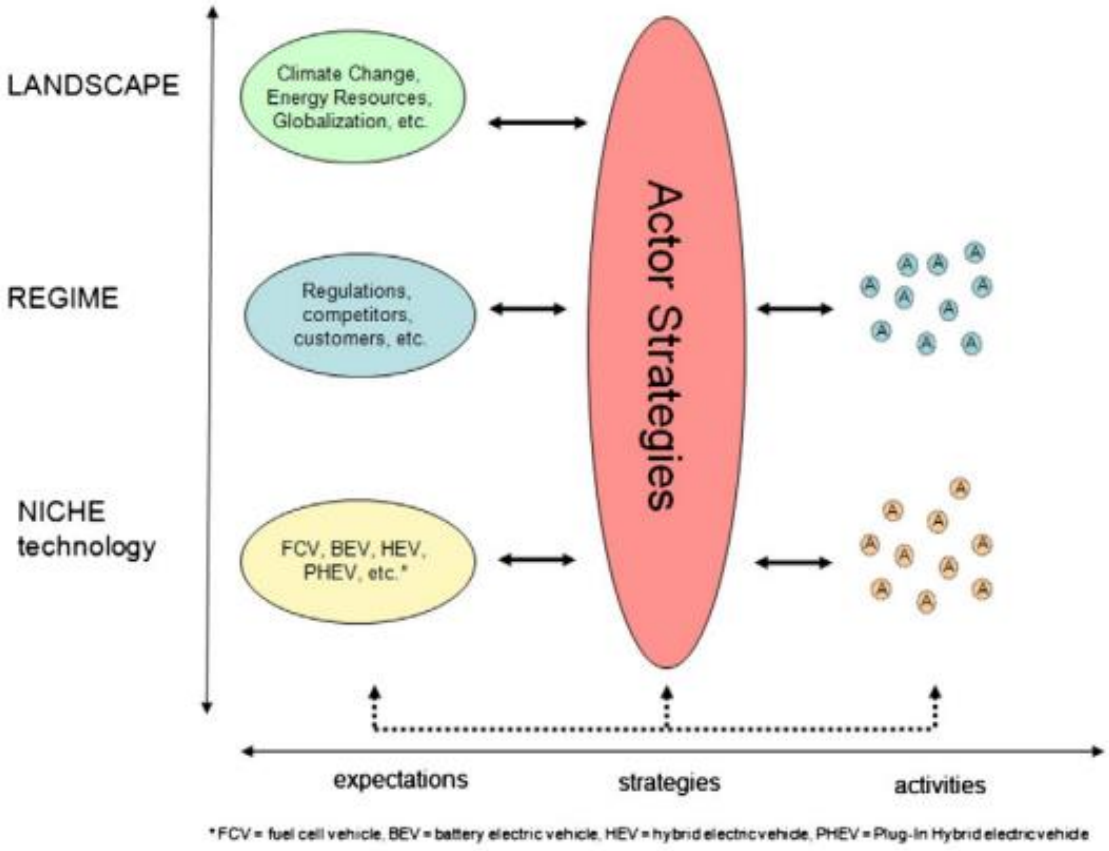


Figure 5: The conceptual framework of expectations and actor strategies as presented by Budde et al (2012)

2.4 Technological innovation systems

The technological innovation systems theory (TIS) was developed with the purpose of analyzing the causes for the success of sustainable innovations, but it can be also used for guiding the development of sustainable innovation systems (Smith et al, 2010). The central notion of the theory is its co-evolutionary stance: the direction and speed of a technological change is always the result of the surrounding institutional and economic

structures (Lachman, 2013). What TIS does is break down the innovation system and study which elements of the system do not fulfill their job. Determining the weaknesses that are connected to the creation of legitimacy, market formation and mobilization of resources, for instance, means that TIS approach can be favorable for designing policy options as it points out what is hindering the transition.

One of the shortcomings of the TIS approach, it has been pointed out, is its tendency to focus on simply detecting the weaknesses of the functioning of the niche rather than studying the system change itself or the reasons for these weaknesses (Lachman, 2013). Additionally, the approach tends to concentrate on the developments on the macro level, that is in the level of institutions and large companies, rather than paying attention to what is going on the micro level. Hekkert et al argue that TIS approach, in fact, suffers from institutional determinism as it neglects the impact of individuals, as well as inability to take into account the different dynamics (2007). Several scholars have attempted to improve the theory by analyzing the innovation system through the notion of functions (Hekkert et al, 2007), which constitutes the functions of innovation systems theory (FIS).

The central idea is that each innovation system has a set of assigned functions that should be fulfilled for a transition to be successful, and studying these functions can reveal the kind of activities that are fostering or hampering the development of the system. Through application of the FIS theory, one can unravel which functions are not effectively fulfilled and therefore find out the factors that are hindering the adaptation of the technology. Unlike TIS however, FIS concentrates on mapping the actions that are taking place, making it more adequate in terms of considering the dynamics of the system. FIS approach has pre-determined functions that are in the center of the analysis. The most recent functions by Hekkert et al (2007) build upon the previous work by Bergek et al (2005) and Chaminade and Edquist (2005), and constitute the seven functions introduced in the table 1 below.

Table 2: The functions that are in the center of analysis for FIS and description of these functions based on Hekkert et al (2007)

Function	Description
Entrepreneurial activities	Entrepreneurs are the actors that produce new knowledge on the application of a technology through trial and error, thus contributing greatly towards learning. It is crucial for implementing an innovation into a society and thus extensive entrepreneurial activities are often a product of a well-functioning innovation system. If entrepreneur activities are insufficient, the reason for this performance is likely to be found from the other functions.
Knowledge development	Who develops knowledge, how and about what. This includes both learning by searching and learning by doing.
Knowledge exchange	Refers to the degree to which different actors within the innovation system exchange information between one another. Large diffusion of information and knowledge can result in a system in which policy, norms and R&D investment are in line with the development of the specific technology.

Guidance of the search	Efficient allocation of resources towards the development of a technology. As resources are always limited, it is crucial that they are directed towards a specific focus point, which is determined by the society. This function can be seen as a process of selection as which niches have potential to further improve the system.
Market formation	To what extent the new technologies are presented in the already existing market. Competing against the established regime is likely to be difficult, due to which creation of a protected space is advisable, however not always necessary.
Resource mobilization	The amount of human, physical and financial resources available to improve the niche technology.
Creation of legitimacy	Actions taken to counteract the regime's resistance to change its practices by creating legitimation to the niche. This can be done through several types of schemes, but it is essentially about spreading awareness and embedding the established niche into the society.

The performance of this specific set of functions has been researched through several case studies, for instance by Hekkert and Negro on renewable energy technologies (2009). They concluded that this set of functions is indeed adequate for analysing the technological innovation system, as well as confirm the claim that interaction between the functions has a positive impact on the system emergence and growth.

To put shortly, TIS approach analyses the structure of the innovation system and FIS concentrates on mapping and analysing the variety of activities that take place in the system through the seven 'functions' (Hekkert et al, 2007). What is challenging when applying the FIS approach is to determine which actions to analyse and which to leave out, as including all the actions taking place in a large dynamic system is simply not possible. Hekkert et al state that only actions that are influencing the goal of the innovation system should be considered (2007). Several improvements to the TIS framework since the addition of the 'functions' has been suggested. Newer research on TIS has for instance attempted to conceptualize the context structures and extend the framework to fit a micro-level analysis.

2.4.1 Extended TIS theory

Bergek et al have developed an approach through which the context structures and interactions of TIS can be further elaborated (2015). They distinguish and discuss four types of contexts: technological, sectoral, geographical and political. The technological context analyses how the focal TIS interacts with other TIS's, a relation that can be either competitive or supporting. The sectoral context refers to the rules and cognitive frames in which several TIS operate together to serve a specific function or a product to the end user. Technological development and resources are obviously not evenly distributed over space, which analysis is referred to as the geographical context. Finally, the political context is the institutional setting within which the TIS emerges. By analysing the context in which the transition takes place more in detail, it is possible to detect the origins of system problems and therefore extend the awareness of the analysist of all the different issues that a TIS study can include (Bergek et al, 2015).

Planko et al attempt to extend the level of micro-analysis of the framework with applying entrepreneur's perspective on innovation. Entrepreneurs form strategies through which they hope to achieve their goals, and these strategies include shaping the technological field as well as constructing supporting socio-technological systems (Planko et al, 2017). Their case study on Dutch smart-grid technology developers revealed that the TIS framework corresponds rather well to the entrepreneurial perspective and it can be applied to analyze it, but suggested an improvement to the framework: separation of the function of market formation to government and entrepreneur side driven processes. Separating these two functions of market formation would give more emphasis on the role of small actors and therefore give more emphasis to the micro-developments, something that TIS has been criticized for before.

The role of expectations in shaping the actor strategies and their influence for the development of the innovation system has been more incorporated into FIS by Alkemade & Suurs (2012). Again, this has been done to address the lack of attention to micro-level developments. While TIS acknowledges the importance of expectations with the function of guidance of the search, it mainly analyses it in terms of how shared expectations influence the transition, not considering how these expectations may differ and lead to different dynamics. Alkemade & Suurs' approach deepens the analysis of the function guidance of the search (2012). By applying event history analysis, they analysed the expectations related to hydrogen and fuel cell vehicles. They analysed the events in terms of four variables: whether the expectations are positive or negative, general or technology specific, short-term or long-term and the type of actor who holds the expectations.[5] The results where then used to create visualizations of the patterns of expectations and how they might change overtime.

2.5 An integrated framework and response to criticism

The possibility of incorporating both MLP and TIS approach to a single theoretical framework has been explored by researchers since the late 2000's. Markard and Truffer developed the foundation for an integrated framework for the two concepts in 2008. Their framework has four main conceptual elements: the niche in which innovations emerge and mature; the technological innovation system that may include the niche and always involves the novel institutions and (shared) resources; the sociotechnical regime with established institutions that shapes the production structure and hinders the emergence of the niche; and the landscape that influences all of the above without being influenced in turn.

This integrated framework is by no means complete, but only lays the ground foundation for a development for such. The complete integrated framework should be superior to the basic MLP and TIS approaches and address the shortcomings of the both, namely the lack of attention to micro-level developments in terms of actors, actor strategies and interdependencies, as well as inability to compare the performance of different innovations, something that the develop framework so far does not fully address (Markard and Truffer, 2008). This approach developed by Markard and Truffer however does help to comprehend how the two distinct frameworks of MLP and TIS can be analysed parallel to one another, especially in terms of how the niches

[5] Additionally, they distinguished between expectations related to first-generation and second-generation technologies.

and technological innovation systems relate to one another. It therefore offers a valuable additional lens that can be applied in the analysis of sustainability transition research.

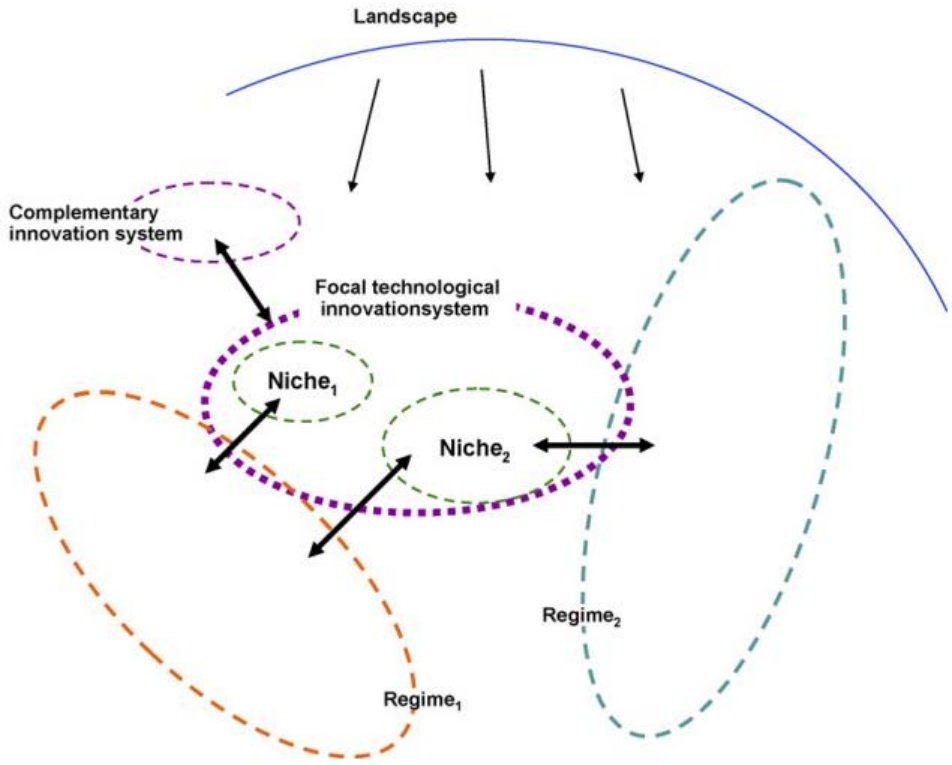


Figure 6: The conceptual integrated framework of MLP and TIS as illustrated by Markard and Truffer (2008).

2.6 Conclusion

Sustainability transition studies is a relatively new field of research that has four main bodies of theory upon which many extended sub-theories have been created to address their perceived short-comings. Transition management is especially useful for mapping the necessary steps that need to be taken in terms of governance to achieve the wanted sustainability transition. It takes a top-down perspective on transition and can reveal what is needed for transition to take place. Transition management is best applied after the deeper dynamics within the innovation system itself have been analysed. On a similar manner, strategic niche management concentrates on the governance and can be especially useful when one is interested in ways to foster the development of a specific niche technology. Multilevel perspective theory is especially useful for studying the larger socio-technical context within which the sustainable innovation takes place and for considering the complex dynamics between the niche and its context. Technological innovation systems theory, specifically with the addition of the concept of functions, concentrates on the developments inside the niche or niches and its application can reveal factors that are hindering or supporting the development of the system. These four theories all approach the topic of sustainability transition from different perspectives, due to which it is often advisable to apply them parallel to one another. For this research, the theoretical frameworks of MLP and FIS were chosen for application, a decision which will be reasoned in the following methodological chapter.

Chapter 3: Research methods and design

In this chapter the research methodology of the study is elaborated in detail. This essentially means describing the way the research has been conducted in terms of core concepts, scientific theory and design of the research process. The aim of the chapter is to carefully explain the ways in which the knowledge has been acquired, for the sake of transparency, to answer the main research question: *What can be learned from the recent developments in the Dutch meat substitute innovation system to further foster its expansion?*

Firstly, the conceptual and theoretical frameworks are introduced, after which the design of the research process is elaborated upon. Finally, the ways of acquiring data and the indicators used for the analysis are introduced.

3.1 Conceptual framework

The core concept under study is the innovation system of meat substitutes, as is apparent from the main research question. The concept of innovation system refers to a collection of technology and actors and the dynamics through which information flows and development takes places amongst them. It is thus composed not only of the producers and users of a specific technology, but also other relevant actors that influence the development and diffusion of technology in a way or another. The meat substitute innovation system is composed of different technology niches and social practice niches that contribute to the direction and speed of change of the innovation system as a whole. The concept of socio-technical regime refers to the structures prominent in the society and the rules they have created, which the innovation system actively attempts to change to some degree to allow it to break-through. For meat substitution, the ruling socio-technical regime is the meat consumption and production system. The inclusion of social practice niches is justified due to the nature of the transition which is strongly connected to changing social practices, as well as the defining the regime in terms of socio-technical characteristics. The concept of landscape refers to all the rules, believes and trends prominent in the society and developments within the landscape that contribute towards changing of these rules. The socio-technical regime can therefore be regarded as a specific set of rules and structures that have been composed of the larger set of rules determined in the landscape.

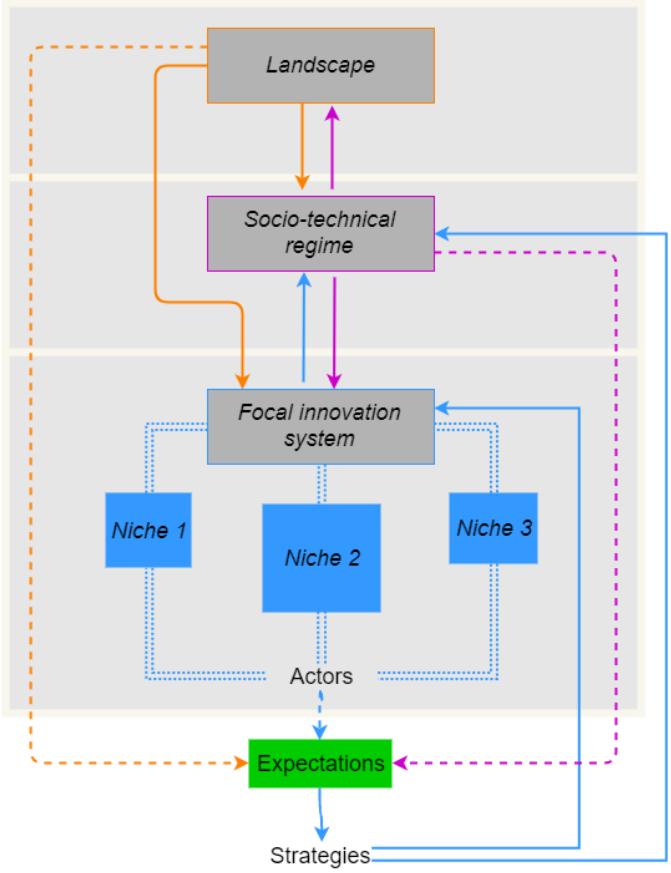


Figure 7: The conceptual framework generated for the research based on the core concepts of the literature review and selected theory.

The actors within the innovation system, even though operating in a similar setting, have different expectations regarding the future development of the niches, the ruling socio-technical regime as well as the landscape, which in turn leads them to develop varying strategies for operation. The strategies these actors develop will influence not only the innovation system itself, but also the ruling socio-technical regime, for instance by resulting in creation of counter-strategies by the regime actors to avoid regime change. The ruling socio-technical regime has become prominent due to (past) landscape developments, and the occurring landscape developments guide the development of the niches as well as the regime. These landscape developments can potentially enable the niches to take over the regime, if the landscape changes radically enough and the regime does not correspond to these changes effectively enough. The dynamics between the niches, the regime and the landscape influence and reflect the functioning of the innovation system.

It is assumed that studying these concepts in the context of meat substitution can reveal through what kind of actions and dynamics changes within the innovation system take place. The focus remains first within the transition context in terms of niche developments, the regime structures and landscape developments and the dynamics between them, after which the developments inside the focal innovation system are considered. The next part will elaborate on how these concepts will be studied.

3.2 Theoretical framework

To answer the main research question, an innovation system perspective was taken to concentrate on the creation, diffusion and spread of meat substitution technology and social practices. This approach is advocated by sustainability transition studies, which has generated several theoretical frameworks for the analysis of such systems. After careful orientation with each of these frameworks in chapter 2, the frameworks of strategic niche management and transition management were left out, as the most suitable theories for the purpose of this study are the (functions) of technological innovation systems theory and the multilevel perspective.

The application of TIS yields a detailed analysis of the innovation system in terms of functioning of its different aspects, and can thus reveal the exact factors that are influencing the system development, both positively and negatively. It can thus help the reparation and vitalization of the innovation system within inside, which is of course essential for the innovation's capacity to be adapted in the society. As TIS focuses only on the developments at the innovation system level, the addition of MLP to better embed the innovation within social context is crucial. MLP will consider the dynamics between the innovation system, the socio-technical regime and the landscape, which again will reveal developments that are influencing the system development positively as well as negatively.

In terms of TIS, the functions of the innovation systems theory by Hekkert et al (2011) forms the basic theoretical foundation. In addition, two extensions to the theory are applied to increase the focus on micro-level developments. Firstly, the role of expectations within the function guidance of the search is given more emphasis as proposed by Alkemade & Suurs (2012). Secondly, the function of market formation is split into sub-functions of government side and entrepreneur side driven processes as proposed by Planko et al (2017).

In terms of MLP, the framework of Rip and Kemp (1998) is extended with application of transition pathway theory by Geels and Schot (2007) to bring more structure into the analysis of the level dynamics.

This study tries to analyse the meat substitution innovation system in The Netherlands with an integration of these two main frameworks, an approach for which Markard and Truffer created a framework in 2008 as introduced in figure 6 in chapter 2. Integrating TIS with MLP and extending on these theories will address the shortcomings for which these frameworks have been criticized earlier. For example, concerns over MLP's lack of attention to micro-level developments are hoped to be patched with more focus on entrepreneurial side driven processess. Integration of the frameworks will also go one step deeper than the two theories by themselves: instead of solely analysing the functioning of the innovation system and the dynamics between it and the other levels, an integrated framework studies how these dynamics between the levels influences the functioning of the system.

3.3 Methodology

This scientific study is qualitative in nature as expanding the market of meat substitution is a topic that requires a profound understanding of the why and how of such system, rather than only the what and who. Choosing for qualitative approach will be likely to give elaborative and highly descriptive answers which in turn help in explaining and comprehending the phenomena under study.

The form of case study was chosen with the purpose of gathering detailed in-depth knowledge, which is reached most efficiently by concentrating on a specific case. Defining the case study in terms of geographical boundaries was a decision not much contemplated on, as the defining of an innovation system in terms of the market boundaries seemed natural. Haven taken a more global perspective would have yielded a study without the same level of detail, which could have resulted in incapability of truly understanding the phenomena and the mechanisms through which it develops. A more local perspective on the other hand, could have led to over-simplification of the system or to a situation in which the results are inapplicable to other cases.

At the beginning of the research, a descriptive study on the meat substitution system in the Netherlands is to be performed, in which the main actors of the system are identified as well as the linkages between them, and the development of the system in the past 10 years investigated. This part of the research is crucial to identify relevant actors for the innovation system, but also to get a picture of the system in terms of networks and activities and the way these have developed in the recent years. In other words, the research part 1 aims to deliberate what is happening at the innovation system and by who. The two research questions that this part strives to answer are:

1. What are the recent developments in the field of meat substitution in the Netherlands? (Chapter 4)
2. What is the structure of the Dutch meat substitute innovation system? (Chapter 5)

To answer the RQ1, all the significant social, technological, political, economic, environmental and legal developments that have taken place and influenced the Dutch meat substitution system during the roughly 10-year period are organized in the order of their occurrence. Prior to this however, the state of meat consumption

and meat substitution in the Netherlands are elaborated on. The recent developments are delivered from two separate, but reinforcing source types: expert interviews and literature. The literature will predominantly consist of news articles and other (social) media releases, with some additions found from prior scientific research. From a theoretical point of view, question one concentrates on the niche developments and disregards the larger developments at the level of the socio-technical regime and the landscape that do not directly influence the system. Answering RQ2 entails a generation of mapping of the system structure in terms of actors, institutions, networks and technological factors. This structure is created based on the findings of the RQ1, and thus chapter 5 can be thus regarded as a theorization of the chapter 4.

The second part of the research is more explanatory in nature, as it aims to establish links of cause and effect between different system components and dynamics, therefore identifying specific factors that hinder or stimulate the development of the system. This explanatory part of the research builds upon the descriptive part. Regarding this, it should also be noted that the study is non-experimental in nature, meaning that all the results are based on pure observation of the phenomena, without any attempt to influence the subjects under investigation. What research part 3 strives to do is to explain the functional dynamics of the system, that is, the interaction between the observed factors connected to the three levels of study. This part strives to answer the following research question:

3. What are the main functional dynamics of the innovation system and how do they influence its development? (Chapters 6,7 and 8)

After generating a description of the system in research part 1, the research part 2 is the point of analysis with the application of the theoretical frameworks which were elaborated in section 3.2. The RQ3 is answered primarily based on data gathered through expert interviews. Additionally, the results of the research part 1 can be used to verify or obviate the findings of the expert interviews. RQ3 seeks to find causal relations between the recent developments and the functioning of the innovation system, thus considering all the dynamics relating to the niches. Research part 2 is composed of three chapters, where chapter 6 studies the system in terms of MLP theory, chapter 7 in terms of FIS and chapter 8 with an integration of the two.

The final part of the study, research part 3, discusses and reflects on the presented findings and generates recommendations for actions that can further foster the system development. The recommendations will be based on the presented findings of the study and generated specifically for the Dutch system. Additionally, some actions proposed by the experts during the interviews are presented and considered. The research part 3 thus aims to answer the fourth research question before:

4. What actions could stimulate further development of the Dutch meat substitute innovation system and growth of the meat substitution market? (Chapter 9)

Ultimately, the research and its findings are presented in a concluding chapter that will answer the main research question.

3.4 Data collection

The research has two manners for acquiring information: semi-structured interviews and literature research. The interviews have been conducted in the Netherlands amongst the key actors in the field. These interviews are the primarily source of information especially on the functional dynamics. These key actors, or experts, were found whilst conducting research on the main developments of the system through media review. Over 40 requests for interviews were sent out during a period of 6 months and ultimately 13 actors closely connected to the topic of meat substitution were interviewed. Table 3 below summarises some core information about the interviews and interviewees in question. For the sake of anonymity, the interviews are referred to throughout the study in accordance with their interview reference number.

These actors have been categorized in terms of related field into 4 main categories: industry, science, policy and NGO. It was considered important to gather information from a variety of different actors, and therefore actors connected to all aspects of meat substitution were sought for interviews. However, as the primary focus of the study remains on the side of innovation, priority was given to actors operating on the field of industry and science. The interviews were primarily done face-to-face and lasted around an hour. All the interviews were later made a transcript of and analysed manually.

Two rounds of interviews were hold: first-round interview with three experts during the first month of the research and second-round interviews with 10 experts during the following four months of it. The question templates for these two rounds differed from each other, as the purpose of the first-round interviews was to orientate closely with the topic and the purpose of the second-round was to gather information on the functional dynamics. These question templates can be found from the appendix A1. The information acquired from these interviews will be complemented by literature research, which main sources will include media releases such as newspapers and company websites. Important are also scientific journals such as that of Food and Feed ;Appetite; Environmental Science and Policy; and Research Policy.

*Table 3: Summary of the interview participants. First round interviews are marked with a * behind the reference number.*

Reference number	Related field	Some characteristics	Manner of interviewing	Perceived degree of influence	Extra remarks
1.	**Science**	Technology developer / University researcher	On the phone	High	Prof.dr.ir.
2.	**Science**	University researcher	In person	Moderate	Prof.dr.
3.	**NGO**	Works with both meat and meat substitutes	Email	Low	Board member
4.	**Science**	University researcher	In person	Moderate	Dr.
5.*	**Science**	A researcher at a private the research institute	In person	Moderate	Senior consultant
6.	**NGO**	Works directly to foster meat alternative consumption	On the phone	High	Founder
7.*	**Industry**	Technology developer	On the phone	High	Co-founder

8.	**Industry**	Technology developer	In person	High	CEO
9.*	**Industry**	Producer	In person	Moderate	Co-founder
10.	**Policy**	Strong stance in favor of meat alternative consumption	In person	High	House of representatives
11.	**Industry**	Producer	In person	Moderate	CEO
12.	**Industry**	Technology developer and producer	In person	High	Commercial director
13.	**Industry**	Technology developer and producer	In person	High	CEO
14.	**Industry**	Producer	In person	Low	Founder

3.5 Indicators

This part introduces four sets of indicators which are used to measure and provide information on the state and conditions of important concepts. These concepts are delivered directly from the theory and their assessment is thus crucial for the analysis. Some of these concepts already have pre-determined indicators in prior scientific research, whereas some have been generated specifically for this research and some are a mixture between the two.

3.5.1 Structure of the innovation system

The core concepts of the innovations system structure have been delivered from a manual on how to conduct technological innovation system research by Hekkert et al (2011). The notion of governmental bodies and supportive organizations within the actor concept has been extended with the addition of non-governmental actors, as appropriate due to the extension of the function of market formation as earlier discussed. The concept of networks has been made more specific by distinguishing indicators for different types of networks. This has been done in accordance with network categorization provided by Carlsson et al (2002). The concept of technology factors has been further divided between old technologies and new technologies.

Table 4: Core concepts and their indicators for the structure of the innovation system

Concept	What	Indicator
Actors	Knowledge institutions	Actors that generate technical knowledge, business knowledge and/or non-technical scientific knowledge that is relevant for the system
	Educational organizations	Actors that purposefully strive to spread knowledge that is relevant for the system
	Industry	Actors that develop relevant niche technologies and/or products
	Market	Actors that bring relevant niche products to retail

	Governmental bodies and supportive organizations / Non-governmental bodies and supportive organizations	Actors that influence the system in varying direct and indirect ways through their actions or inactions
Institutions	Formal institution	Institution that generate rules and regulations within which the system has to operate
Networks	Buyer-supplier relationship	Collection of actors who exchange goods and/or services for money
	Problem-solving network	Collection of actors that collaborate and work together towards a common goal eg. R&D projects and formal organizations
	Informal network	Collection of actors that interact on a personal level through professional interaction
Technology factors	Related technology	Technologies that are used or developed by the actors of the system

3.5.2 Transition context

The core concepts of transition context; niche, regime and landscape, and their indicators are all based on the work of Geels and Schot (2007). Determining the level of niche development was considered an important element to include due to the number of different meat substitute groups that were already determined prior to the start. Geels and Schot offered these four indicators for a fully developed niche, but did not distinguish further between an undeveloped and underdeveloped niche. This further distinction was generated to differentiate between niches that are already in place in some parts of the market and thus influence the innovation system already, and niches that are not yet at the market but which prospects indirectly influence the system.

Table 5: Core concepts and their indicators for the transition context.

Concept	What	Indicator
Niche	To determine the niches connected to the innovation system	The niche develops, diffuses and utilizes innovation that contributes towards the growth of the innovation system, whether intentional or not
	To determine the level of the niche development Undeveloped niche: 0 indicators are fulfilled	Stabilization of the learning processes Inclusion of especially powerful actors in the support network Improvement and further expected improvement of the price/performance

	Developing niche 1-3 indicators are fulfilled Fully developed niche: all the indicators are fulfilled	Application in atleast one market where it receives a minimum of 5% market share
Regime	To determine the regime the niche is connected to	Serving of a same societal function/functions as the niche Prominent in the society Relative stability
Landscape	To determine the landscape developments connected to the regime and the niche	The development influences the perception of the regime by the outside actors and may influence the perception by the actors within the regime
Transition pathway	To determine the nature of the interaction between the landscape developments and niches in relation to the regime: Disruptive or re-enforcing?	Extent to which the regime experiences pressure from the landscape Extent to which the niche tries to overthrow the existing regime or become part of it Degree of conflict between the regime and the niche The degree of structural change within the regime due to adaptation of niche developments
	Transformation pathway	Moderate landscape pressure on the regime No niche is fully developed Struggle and conflict inside the regime due to different views on whether to and how to respond to the landscape pressures Niche innovations might be selected and taken up by the regime as an addition to it Regime actors remain mostly the same
	Technological substitution	Large landscape pressure The regime neglects the landscape pressure, unwilling to change Once the landscape pressure becomes large enough a fully developed niche replaces the old regime A lot of competition and power struggle between the niche and the regime New regime actors as a consequence
	De-alignment and re-alignment	Large and sudden landscape pressure The regime actors themselves lose faith in the system Declining investments in the regime No single niche is fully developed and ready to replace the regime Multiple niche directions are tested and they compete until ultimately one becomes dominant

		Characterized by uncertainty
	Reconfiguration	Moderate landscape pressure No fully developed niche Regime itself adapts symbiotic niche innovations Uptake of these innovations fundamentally changes the regime infrastructure Regime actors remain mostly the same Window of opportunity for many niche innovations to develop and become part of the new-born regime

3.5.3 Functions of innovation systems

Indicators for the functions of innovation systems have been mostly adapted from the work of Hekkert et al (2011). The indicators for the function of market formation though entrepreneurial side driven processes has been, however, based on the work of Planko et al (2017) who suggested the incorporation of such function to the FIS. Additionally, the *indicator Degree of alignment of the expectations and visions of governmental and industry actors* is based on Alkemade & Suurs (2012). Each of these individual indicators will be assessed in terms of the extent to which it is fulfilled. Distinction will be made between high, moderate and low fulfilment of an indicator. The total assessment of each function is then done by calculating the average functional level based on the individual indicators.

Table 6: Core concepts and their indicators for the functions of innovation systems

Function	Indicator
Entrepreneurial activities	Amount and type of entrepreneurs and the diversification of these types Level of experimentation and production Market presence of the entrepreneurs
Knowledge development	Amount and quality of knowledge that is being developed Efficiently of developing this knowledge Novelty of developed knowledge
Knowledge exchange	Quality of the network and the degree of interaction over time Presence of formal organized networks Level of collaboration across different actor-groups, eg. between the industry, knowledge institutes and the users Level of collaboration across geographical boarders
Guidance of the search	Presence and quality of specific targets set by the government and the industry Articulation of clear future visions

	Degree of alignment of the expectations and visions of governmental and industry actors
Market formation: government driven processes	Presence of schemes to create protected space for the niches Introduction of new standards that influence the existing regime
Market formation: entrepreneur side driven processes	Size of the current niche market in relation to the number of active entrepreneurs Creation of schemes to enter and secure position on different market clusters Quality and quantity of marketing
Resource mobilization	Availability of financial capital Availability of human capital Availability of physical capital
Creation of legitimacy	Degree of resistance towards the niches Degree of institutional barriers for the niche development Amount and quality of projects to create legitimacy for the niches

3.5.4 Expectations and actor strategies

The indicators for expectations are based on the work of Budde et al (2012).

Concept	Indicator
Expectations	Expectations relating to the future of the niche in terms of technological development, implementation, prominence in the society Expectations relating to the future of the current regime in terms of rules and structures Expectations relating to the future landscape developments in terms of trends and events
Actor strategy connected to expectations	A decision made by the actor based on an expectation about the future of the niche, regime or landscape

Research part 1

DESCRIPTION OF THE INNOVATION SYSTEM

The first part of the research takes a deeper look into the topic of meat substitution in the Netherlands. Chapter 4 discusses the topic in terms of consumption context and an overview of the recent developments on the field, whereas chapter 5 gives a detailed description of the innovation system structure in terms of relevant actors, networks, institutions and technologies. This research part will answer two first research sub-questions: *What are the recent developments in the field of meat substitution in the Netherlands?* and *What is the structure of the Dutch meat substitution innovation system?* The goal is to generate comprehensive descriptive work on the system that can be made use of in the second research part to analyse the functional dynamics of the system.

Chapter 4: Meat substitution in the Netherlands – A historical overview

Meat has been consciously substituted in the Netherlands with other protein rich foods, such as beans, legumes and soy, for decades by a small minority, but has only in the 2000's become a subject of wide discussion. The meat substitution products of the new millennium have characteristics such as imitational accuracy of substitution products in relation to meat, high availability and advocation of these products by meat-eaters. The Dutch meat substitute market has in the recent years grown from what was barely a small niche for vegetarians and vegans, mostly constituting of foreign products, to a dynamic, wide-ranging and immensely growing market in which Dutch companies are tenacious. The emergence of such a strong national market for meat substitutes was a process that was built of several independent developments which will be presented in this chapter.

Chapter 4 constitutes of two main parts: the first part discusses meat consumption and substitution in terms of gradual societal developments, whereas the second part offers a detailed description of the main developments and actions that have taken place in the country in the past 10 years. The aim of the first part is to put the meat consumption and substitution more in context and introduce the main substitute groups already mentioned in the introduction. The goal of the second part is to elaborate on the recent developments on the field in order to know what is exactly happening and to use this information later in the analysis. This chapter will strive to answer the first research question: *What are the recent developments in the field of meat substitution in the Netherlands?*

4.1 Consumption of meat and meat substitutes

4.1.1 Meat

In the recent years, several studies have been conducted concerning both the amount as well as frequency of meat consumption in the Netherlands. The most recent study on the amount of Dutch meat eating patterns, as referred to in the introduction, was done in cooperation by the University of Wageningen and the Dutch Ministry of Food and Agriculture in 2017. The study presented data of the Dutch meat consumption from 2005 to 2016, revealing a trend of decreasing meat consumption on a yearly basis from the peak year of 2009 until 2016, when the consumption increased again (Terluin et al, 2017). According to the findings, the Dutch consume now roughly the same amount of meat than they did ten years ago. Notable changes within the consumed meats include the drastically shrank consumption of horsemeat and the growth of poultry on account of all the other meats, as figure 8 on the following page illustrates. It can be stated that the Dutch meat consumption has experiences some mild fluctuations in the past 12-year period, but these changes have not been dramatic and therefore it is a bit problematic to argue based on this data that there is a deeper structural trend of decreasing meat consumption in the Netherlands.

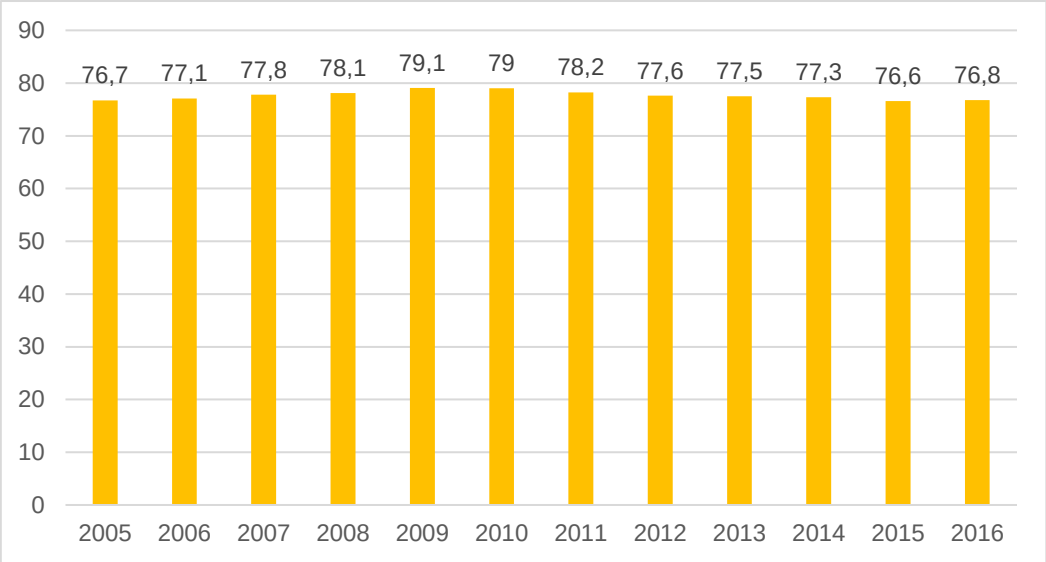


Figure 8: Total meat consumption in the Netherlands kg/per capita in 2005-2016. (Based on data from Terluin et al, 2017)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pork	37,2	37,4	37,6	**37,8**	37,7	37,7	37,7	37,3	37,1	36,7	36,6	36,5
Poultry	20,7	20,8	21,5	21,6	**22,5**	**22,5**	22,1	22,0	22,3	**22,5**	22,1	22,2
Beef	15,9	16,1	16,1	16,1	**16,3**	16,2	15,9	15,7	15,6	15,5	15,3	15,4
Veal	1,3	1,3	1,3	**1,4**	**1,4**	1,3	1,3	1,3	1,3	1,3	1,3	1,3
Lamb and goat	1,0	1,0	1,0	1,1	1,1	1,1	1,1	1,1	1,2	1,2	1,2	**1,3**
Horse	**0,6**	0,5	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Total	76,7	77,1	77,8	78,1	**79,1**	79,0	78,2	77,6	77,5	77,3	76,6	76,8

Table 7: Meat consumption in the Netherlands 2005-2016 by type, with the peak year(s) highlighted. (Based on data from Terluin et al, 2017)

Even though the scientific community has awoken to the environmental impact of meat, it seems that the standard consumer is still in the dark, which partially explains why the decrease in meat consumption has remained minimal. According to a systematic review of 38 articles published in the topic by Hartmann and Siegrist (2017), the extent to which consumers are aware of the link between meat consumption and environmental degradation remains very low, as did the willingness of the consumers to reduce their meat consumption for environmental reasons. The willingness to chance consumption differed rather greatly between the different studies, the ones conducted in Dutch setting showing results between 16-56%. Hartmann and Siegrist note that this variability is likely due to methodological decisions to whether offer or not information about the actual environmental impact of meat prior to answering the question, a decision that could lead to social desirability and thus overestimated results.

Several studies have strived to reveal more in detail the meat consumer patterns of the Dutch. Dagevos & Voordouw concluded in 2013 that there is no uniform meat consumption pattern, but in fact distinguished five different consumer groups based on the frequency of using meat products (excluding the continuous meat-avoiders: vegetarians and vegans). The main characteristics of these consumer groups are summarized in table 8.

Table 8: Different meat consumer groups, excluding vegetarians and vegans (Dagevos & Voordouw, 2013).

Name	The frequency of consuming meat	Relationship to meat	Main motives	Main characteristics of groups' members
Conscious flexitarians	1-2 days a week	Actively strive to decrease their meat consumption	Ethics, health, and personal norms	70% female, highly educated
Unconscious flexitarians	3-4 days a week	Do not associate meat with higher social status and do not actively avoid its consumption	Perceive vegetarian meals as simply tasty – no motivation for decreasing	Underrepresentation of the highly educated
Extravert flexitarians	3-4 days a week	Associates meat with higher social status but despite this strives to avoid it	Health and prestige	On average younger than conscious flexitarians
Disengaged meat-eaters	5-7 days a week	Consumes meat routinely but does not have a high attachment to it, sometimes unconsciously substitutes meat	None	
Meat lovers	Everyday	Do not intend to reduce their consumption of meat	Taste and customs	62% male

Dagevos & Voordouw's combination of cluster analysis and frequency distribution results is extremely useful in understanding the different consumer groups of meat. Maybe the most remarkable finding is the group of disengaged meat-eaters, as the people belonging to this group have the potential of drastically decreasing their meat consumption due to low attachment to meat in general. Another notable finding was that majority of the flexitarians identified themselves as meat-eaters, as only a minority of the participants were conscious about their consumption, or un-consumption, of meat. However, the term flexitarian has been increasingly advocated in the recent years, and if repeated today there might be a greater number of people who would be

conscious about their consumption pattern and thus self-identified themselves as flexitarian on the basis of this consciousness.

Meat consumption is deeply embedded into our society and it connects to not only human's perceived nutritional needs, but also things such as pleasure, personal identity and expression of social and economic status (Fiddes, 1992). People often express strong resistance towards reducing their meat consumption when inquired upon, even when connected to the environmental impact. Macdiarmid et al studied the reasons for such resistance towards meat reduction in the UK, and found out that the consumers perceived their meat consumption to have a minimal role in the global context of climate change and were not willing to chance their practices due to perception of meat as something pleasurable, social and traditional and because they consumed only small quantities of meat or had undergone prior reduction of their meat consumption (2016).

4.1.2 Meat substitutes

Meat substitution has been practiced for hundreds of years, primarily in Asia and the Middle East where it later spread to Europe through trade and colonialization. Historical documents show that the first time the word tofu was referred to, and mentioned in a context of reducing meat consumption, took place already in 965 in China during the Song dynasty (Shurtleff and Aoyagi, 2015). In the document, tofu was explicitly called "mock chop sticks". Based on this one could therefore argue that the earliest meat substitute products appeared with the precise purpose of mimicking and replacing it in a meal. Tofu found its way to Europe for the first time in the late 17th century from Indonesia thanks to the Dutch East Asia Company (Shurtleff and Aoyagi, 2015). In 1959's, the immigration wave from Indonesia to the Netherlands, upon the independence from the colonial power, drastically increased the demand for soy-based food products, among them tofu and tempeh, which production now began also in Europe. The gradual integration of Indonesian and Dutch cultures led the local population also to slowly adapt the taste for these meat substitutes. For the Europeans, tofu and tempeh were primarily marketed as part of a more economic meatless diet in the 70's, a marketing strategy that also involved organization of workshops on the preparation of these new foods (Shurtleff and Aoyagi, 2015).

It was not until the late 90's did meat substitutes become more popular in Europe due to growing vegetarian movement, however still remaining lucrative only in a small part of the society. This also meant that the selection of meat substitutes started to further develop from mainly soy-based products and plant-alternatives to substitutes made from fungi, lupine, dairy and wheat for instance. This was thanks to both innovation in textualization technology, which has resulted in more meat-like products, as well as grown awareness of the environmental and ethical dimensions of meat consumption. The trend of technological development and conscious consumption continues today, which has within the past few years resulted in an outright boom of the meat substitution sector and brought these products into a lime light of the Dutch. The industry is still expanding, trying the limits of the experimental consumers by development of products such as those based on insects and attempts to develop affordable laboratory grown meat. In 2014 the meat substitute market in the Netherlands had a 1% share of the total meat market, which by the end of 2017 had nearly tripled (Wild et al, 2014).

Meat substitutes based legumes, more precisely plants and pulses, are the most traditional and by far the most common type of substitutes in the Dutch market today, as a sole glimpse to the vegetarian meat section at any supermarket will reveal. Not only does every supermarket chain in the country sell atleast one type of plant based meat substitutes[6], a large amount of food joints and restaurants serve plant based meat alternatives in the Netherlands, including large multinationals such as McDonald's and Subway. Meat substitutes based on legumes include substances such as tofu, seitan and falafel. Even if plant-based meat substitutes have been around the longest, there has been an immerse technological development taking place to improve these products in the past years as the next part will illustrate.

Meat substitutes based on dairy have a clear advantage in terms of taste and texture in comparison to the other substitutes based solely on legumes, as dairy can be easily manipulated to produce a texture similar to that of meat (Smetana, 2015). The taste is also fulfilling and familiar to the consumer. The disadvantage of dairy based meat substitutes from the consumer point is that it is not suitable for lactose intolerants or vegans. At the Dutch market, dairy based meat substitutes are rather prominent mainly due to the products of Valess.

Enjoying meat substitutes based on seaplants is a newer phenomenal, which has not (yet) widely spread among the Dutch further than in association with sushi (House, 2016). It is only within the past 10 years that these products have found their way on the shelfs of supermarkets, however not nearly every store sells them still today[7]. Sea-vegetables such as seaweed are both cost-efficient to produce in the Netherlands, highly nutritious and have a favorable environmental profile, due to which the growth potential of these types of meat substitutes is extensive (Henchion et al, 2017).

Fungi based substitutes can be further divided into products based on mushrooms and products based on micro-organisms and fermentation technology. Tempeh has been made for hundreds of years using the ladder technique, whereas some next-generation meat substitutes such as Quorn relay on the use of mycoprotein, a single cell protein derived from fungi (Sadler, 2004). Mushrooms have a natural meat light texture and an umami taste, due to which texturalization of these products requires less attention as a comparison to plant-based substitutes for instance. This group of meat substitutes is largely available in the Dutch supermarkets, but the variety of these products remains rather narrow.

A newer development within the meat substitution sector is the attempt to introduce insects to the Western diet. Insects are packed with protein and have a texture very similar to meat, however, there is a stigma surrounding the topic of eating them in the Netherlands and elsewhere in Europe. According to a study on Dutch attitudes towards insects eating conducted by House, the interest towards the consumption of insects has greatly increased in the past few years, 33% of the participants naming the insects favorable environmental profile as opposed to meat as the main driver of curiosity (2016). House mentions in his study, that the availability of the insect products is not in line with the curiosity to try these products, hindering the development of demand for insect protein (2016). This curiosity, however, remains low as well as the willingness of people in the Benelux area to consume insects as a substitute for meat (Verbeke, 2015). Also, the Europeans seem

[6] The 10 largest Dutch supermarket chains all have minimum of 1 meat substitute product in their selection.

to be more open to consuming processed insects rather than unprocessed, such as fried crickets (Schösler et al, 2012), information that is vital in the development of insects based meat substitutes for the market.

Last, and the least developed, group of meat substitutes are the substitutes based on stem cell technology, in other words, meat that is grown in a laboratory. This meat is created by a combination of tissue engineering and culturing, a technology primarily developed by NASA (Chiles, 2012). The Netherlands is the leader in developing technology and knowledge to produce in vitro meat and served the world's first laboratory-grown burger patties in 2013. The commercialization and large-scale production of these high-tech products remain in the distant future, but several teams of scientists around the world are working towards making in vitro meat commercially viable (Chiles, 2012).

Much like the way automobile manufacturers are developing hybrid cars that utilize both gas and electricity, some food innovators have started to develop hybrid meat products. In a hybrid meat product, part of the meat is replaced by plant-based alternative, constituting for instance 20% of the final product. The idea is that the replacement improves the environmental performance and healthiness of the meat product without compromising on taste, texture, nutritional value or appearance. De Boer et al found out that the Dutch much prefer a hybrid meat snack over one based on lentils, seaweed, and insects for instance, but these people had low involvement in search and advocation of sustainable food products (2013). On the other hand, consumers who were invested in sustainability would be unlikely to choose a hybrid product over a pure one. The topic of hybrid meat remains controversial, as it merely decreases the amount of actual meat in a meat product rather than changing the demand for these products. Thus, within this research, the hybrid meat will not be treated as a product belonging to the meat substitution system, but rather as its own parallel system that to an extent supports the meat substitution industry.

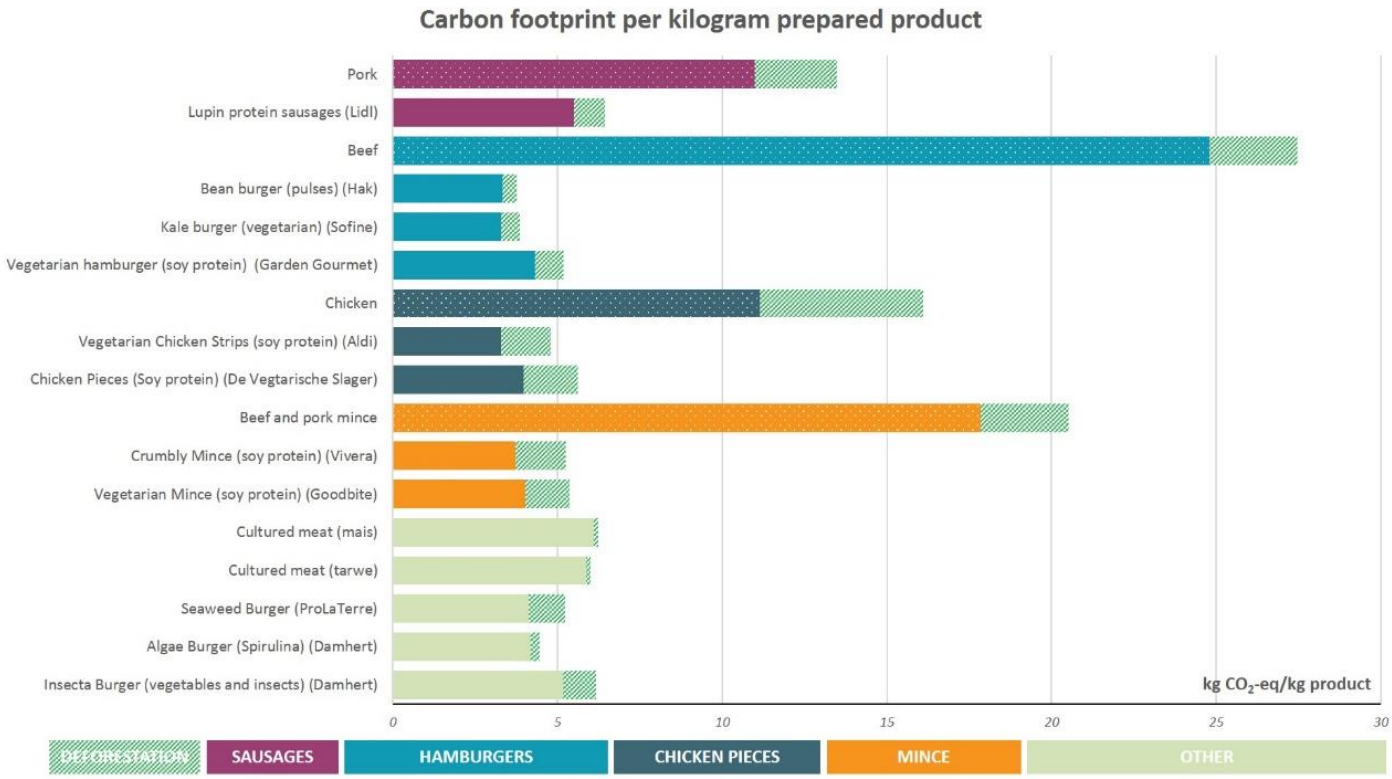
Several studies have investigated the attitudes towards consumption and adaptation of meat substitutes as part of one's diet. Some of the most prominent findings from the Dutch population conclude that familiarity of both plants- and insects based meat substitutes in terms of user experience, getting accustomed to consuming these products, is important in increasing the likability and willingness to try these products. Hoek at al found out that after consuming about 10 meals with tofu, the product tested as nearly as likable as chicken, a difference which was major at the beginning of the test before the established familiarity (2013). Neophobia can be a notable barrier especially for the acceptance of insect and laboratory-grown meat substitutes. This fear for novelty and experimentation in food is a barrier to trying these products, but once overcome and the products tested, the willingness to try the products again increases as the novelty is partially lost (Caparros Megido et al, 2014). For laboratory-grown meat, the lack of acceptance amongst the consumers has to do a lot with unfamiliarity with the technology and science of the production process, and connotation with negatively viewed processes such as gene manipulation.

As the introduction explained, meat is problematic due to the environmental problems connected to the modern production, its health implications and the questionable animal ethics of the industry. The types of meat substitutes that have been identified certainly perform better than meat in the category of animal welfare, at least meat substitutes based on plants, sea-vegetables, fungi and stem cell technology. Dairy-based meat substitutes still rely on animal agriculture and could thus be perceived equally unethical than meat from the

vegan perspective, whereas insects are technically also animals and should therefore not be consumed for food. As mentioned, the ethics of consuming animal products, in general, is of a great philosophical debate and thus making an objective conclusion about the ethical superiority of these meat substitutes in comparison to meat cannot be achieved. However, an objective comparison can be made for the environmental and health impacts of these foods. Both topics have been dealt with in research, even though the body of knowledge on them is by no means complete yet.

The environmental impacts of different meat substitutes have been researched for instance by Broekena and Paassen(2017) and Smetana et al(2015) through life cycle assessment. Broekena and Paassen compared traditional meat products with meat substitutes available in the Netherlands of similar attributes in the impact categories of climate change, water use and land use. In terms of all the impact categories, the meat substitutes performed better than the original products. Broekena and Paassen concluded that all the meat substitutes under investigation scored between 1.8 kg and 4.2 kg in terms of carbon footprint, in comparison to 6.2 kg carbon footprint for chicken and 22.1 kg for beef. The largest positive environmental impact was observed by switching beef burger to a plant-based alternative, with nearly five-fold in all the impact categories. The carbon footprint of in vitro meat was suspected to be 6.0 kg.

Figure 9: Carbon footprint of traditional meat products and corresponding vegetarian options (Broekena & Paassen, 2017).



Smetana et al performed a life cycle assessment on meat substitutes and based on their findings organized them in three categories: substitutes with high, medium and low impact. Expectedly, in vitro meat scored to the high impact category, together with mycoprotein based substitutes. Dairy-based on gluten-based substitutes were of medium impact, whereas soy-based and insect-based substitutes scored the lowest

(Smetana et al, 2015). Interestingly enough, chicken was included as a meat substitute for red meat, scoring with a medium impact. In general, Smetana et al's findings were in line with those of Broekena and Paassen.

The health impacts of meat substitutes vary greatly across the products, but in a nutshell meat substitutes are a good source of protein and dietary fiber and low in total and saturated fats. Many substitutes can even deliver substantial health benefits: substituting meat with soya can lower cholesterol, advocating mycoprotein can bring relief to a diabetic and consuming more vegetables in general can lower the risk of certain cancers (Sadler, 2014).

4.2 Recent developments and actions

This part discusses developments and actions in the field of meat substitution in the Netherlands in the past ten years, but it must be noted that many important instances, especially related to research and development, haven been undertaken already since the 90's (Quist, 2007).

4.1 2007-2010

During the late 00's, the long simmering realization that the way our bio-industry functions is not sustainable on a long run well up to the surface of discussion in the Netherlands. The period from 2007 till 2010 is overwhelmingly characterized by the spread of awareness about the environmental impacts of meat consumption on a consumer level. The Dutch researchers had already in the late 90's identified meat substitutes as a food-category with enormous potential to reduce the national greenhouse gas emissions when investigating the efficient ways to reach the mitigation targets of the Kyoto protocol, as a part of a Sustainable Technology Development (STD) program set up by the Dutch government. At the time, however, meat substitutes were mostly consumed solely for reasons connected to animal welfare and livestock's epidemics, rather than for environmental reasons (Quist, 2007). The STD program spin-off research and development on different meat substitute options, but the topic remained exclusive to the academic circles and was thus not translated into a shift in general attitudes towards meat or consumer behaviour. In the late 2006 however, the scientific knowledge started rapidly reaching the public. In the years of roughly 2007 until 2010, the awakening to the fact that our current meat consumption is unsustainable took place, slowly reshaping the Dutch relationship with meat and thus creating an opening for new solution to reduce this consumption.

The single most important event that lead to the development of rising consumer awareness was the publishing of Livestock's Long Shadow. This report identified bio-industry as one of the top three contributors to climate change, stating that the emissions connected to this industry are larger than that of all the transportation combined (United Nations Food and Agriculture Organization, 2006). As mentioned, the Dutch scientists and politicians already knew about the impacts of the bio-industry, but the extent and variety of these impacts was neither fully comprehended or acknowledged. Now, once the world's most prestigious organization connected to food and agriculture directly addressed the issues of the industry and revealed the in-depth impacts of it, the Dutch decision-makers could no longer belittle or bypass them. The massive 416 paged report concluded that to avoid irreversible climate change, we must reconfigure our whole livestock production. A month earlier in the same year, October 2006, the seriousness and overarching implications of climate change were brought

to the public attention infamously by Al Gore's documentary movie an Inconvenient Truth, which won two Academy Awards including best documentary at the 2007 Oscar gala. The film painted a grim picture of the degraded state of the global environment and called for immediate action. Maybe partly because of the buzz that Al Gore created with his film, even though conveniently disregarding the impact of livestock production, Livestock's long shadow gained so much attention. So, by the start of 2007, the international attention towards climate change and the role that bio-industry plays in it was rapidly rising. Due to this, two developments took place in the Netherlands: the research on sustainable food, including meat substitution intensified, as well as did the efforts by non-governmental organization and enlightened individuals to raise awareness about the impacts of meat consumption.

The Profetas program, a spin-off of the STD program which run from 1999 until 2004, studied whether a partial substitution of meat by plant-based alternatives in the North would be sustainable as well as socially and technologically feasible. After the completion of this program however, the Dutch government stated that meat substitute sector had been sufficiently financed and was ready to compete at the market, due to which no further financing would be directed towards its development (Quist, 2007). Nevertheless, in 2007 a new wave of government funded research on meat substitution took place, likely inspired by the Livestock's long shadow and growing public pressure to do something. In the end of 2008, a report on the environmental impact of protein rich food in the Netherlands was released. The study conducted an environmental comparison between a diet rich in animal- and plant-proteins and concluded that advocating a diet rich in plant-proteins instead of those delivered from livestock would lead to substantial improvements in terms of greenhouse gas emissions as well as land use (Blonk et al, 2008). This report confirmed that the message of Livestock's long shadow was applicable to the Netherlands. After its release, the Dutch government ordered another study, this time on the dietary effects of replacement of meat and dairy by more sustainable protein sources. The report was released in 2011 and concluded that a diet in which most of proteins are delivered from plants can be sufficient in terms of protein, vitamins and minerals, taken that a variety of different plants are consumed (Tijhuis, 2012), thus confirming that meat is not essential in maintaining a balanced and healthy diet. Simultaneously, private research on meat substitution diversified, often partially funded by the Dutch government. In the years before 2007 most of the private, as well as public in fact, research had concentrated on legumes, pulses and dairy as options for meat substitution. However, in the late 00's an interest towards more novel sources of protein arose, namely insects and seaweed. In 2010, TNO research institute started researching the potential of algae in meat substitution and in the same year Wageningen University Researcher Marcel Dicke held a TED-talk titles "Why not eat insects?", which on 12.3.2018 was viewed 1,126 million times online (TED, n.d.).

The role that technology could play in the development of meat substitutes gained also more interest amongst the scientist. Since 2005, the Dutch government had funded research on cultured meat, being the first national government to do so. As a joint project of several Dutch Universities, each specializing in one pillar of cultured meat production: tissue engineering, stem cell biology and culture media, and an industrial partner, the cultured meat project ran until 2009 with the lead of Utrecht University's Dr. Henk Haagsman (Datar, 2015). n 2008, Mark Post joined the research program from the perspective tissue engineering, and became shortly deeply invested in the project so that he continued the research efforts even after the governmental grand was finished. The goal of the initial cultured meat project was to investigate the mere feasibility of cultured meat production, whereas Post's goal thereafter was to develop a production process for cultured meat (Haagsman

et al, 2009). The start of the research efforts sprung from a general global quest to develop cultured meat technology, that had really taken off in 2005 with the publication of the first peer-reviewed article on the topic by the journal of Tissue Engineering. Impressed by the possibilities that this science fiction -like idea of producing meat would offer, PETA set up a competition with a 1 million $ price for the first company to deliver such a product to fuel development. Another notable development took place at the Wageningen University's Food Technology department. In 2009, an innovational spinoff from the Wateringen University Research was established under the name Ojah. The goal of the company was to make plant-protein extraction more practical: to scale-up the production and use of high moisture extrusion technology (Ojah, n.d.). Ojah showed fast results, making the creation of meat-like textures from plant-protein cost-efficient and easily scalable. This technology was in a key role in the expansion of the meat substitution market in the 2010's that is discussed in the next subchapter. Additionally, Phycom, Europe's first company to concentrate on algae cultivation, was founded in the Netherlands in 2009 with the aim of realizing microalgae cultivation in the Netherlands within the near future (Phycom, n.d.).

Also in the Netherlands, hand in hand with the fastening scientific research on meat reduction came the attempt to translate this new knowledge to the consumer in an understandable way to raise awareness. Inspired by the Livestock's long shadow and with the intention to bring its findings more to the attention of the Dutch, the Nicolaas G. Pierson Foundation produced a documentary called Meat the Truth. Narrated by Marianne Thieme, the documentary conveyed the message of the UN report in a simple and convincing way in Dutch. The documentary gained a lot of attention in the Netherlands, and was eventually remade as an English version, which was among else screened at the European Commission in Brussels (Nicolaas G. Pierson Foundation, n.d.). Simultaneously, blogging was gaining popularity which enabled also the enlightened individuals with little or no meat consumption, often long-term vegetarians or vegans, to share their ideas and philosophy with the world, contributing to the normalization of the idea that meat is not a fundamental part of a human diet.

In 2005 the Dutch dairy company Friesland Campina launched its new milk-based meat substitute Valess. The product was launched with a large marketing campaign, biggest one of the company to date (interview 9). The campaign was beneficial not only for Valess, but also for other meat substitutes that were already found in the supermarkets at the time. Likely due to the combination of the exposure that Valess gave to the meat substitution sector, its market started to grow, which in turn likely gave more boost to the research and development activities aimed towards meat substitution.

4.2 2010-2014

The turn of the first decade of the new millennium was when meat substitution started rapidly gaining more attention also among the consumers, slowly making meat reduction trendy and cool. The years 2010 until 2014 saw new mission driven companies pouring into the meat substitution market. Due to the awareness that was slowly spreading and the growing assortment of interesting new products, the meat substitute market started growing exponentially each year. Other important developments of the era include increase in the variety and consistency of the meat substitute products, technological leaps, unionizing of the producers and centralization of research.

There were a few Dutch companies producing meat substitute products long before the early 2010's. Most notably, Tivall's plant-based products since the late 1986, Vivera's plant-based products have been available in some Dutch supermarkets already since 1990, Goodbite's plant-based products since 2002 and Friesland Campina's dairy-based Valess products since 2005. These companies, except for Friesland Campina, remained relatively small until the late 2000's. During the early 2010's, many new companies emerged with substantially improved taste and texture due to new food texturalization technology, namely the high moisture extrusion technology developed by Ojah. Common to these companies was their start-up nature and a strong mission driven bias to create products that could reduce the consumption of meat. Of these companies, the Vegetarian Butcher and the Dutch Weed Burger will be given a closer look.

In 2010, the Vegetarian Butcher started selling their lupin protein based products that were developed by Ojah[8], and the following year the company opened a concept store in The Hague dedicated solely for selling meat substitution products. This store was the first one in the world of its kind, clearly indicating that a change was on its way. Since 2010, the imaginary that the Vegetarian Butcher used in their marketing was thought-provoking, equating the plants with meat. The message that the Vegetarian Butcher conveyed with these images, that also showed just how literally the name of the company was to be taken, was that their products[9] were no bare alternatives for meat but indeed imitated them in detail, making them as equals. Even though meat substitution was no new topic, the Vegetarian Butcher was the first company in the Netherlands, maybe even in the modern world, that so directly paralleled meat substitutes with meat. Since then, other companies have followed this marketing strategy that will be discussed more in the following subchapter. The impact of the Vegetarian Butcher for meat substitution market is undeniable due to the novelty of their products and approach, and it was systematically mentioned as one of the most influential actors of the industry in the interviews.

Figure 10: Press photo of the Vegetarian Butcher, in which the founder and CEO Jaap Korteweg poses in a setting representing that of a traditional butcher shop (The Vegetarian Butcher, n.d.)

Whereas the Vegetarian Butcher revitalized the meat substitution market at the consumer level, the Dutch Weed burger did something similar with a business-to-business approach. The seaweed based burger created by a long-term vegan advocate Lisette Kreischer was revolutionary with its use of seaweed as a "taste-maker" in these plant-based products, in combination with Ojah's vegetable protein. After launching the burger at a festival in The Hague in 2012, the Dutch Weed Burger was quickly found in over 90 restaurants all over the

[8] The Vegetarian Butcher was the first company selling products developed with Ojah's texturalization technology.
[9] First products include (vegetarian) chicken strips, (vegetarian) bacon and a (vegetarian) hamburger.

Netherlands by the end of 2014. Much like the Vegetarian Butcher, the Dutch Weed Burger branded themselves with care and unapologetically presented their product as something equal to meat.

Both the Vegetarian Butcher and the Dutch Weed Burger broke a lot of myths and prejudice around meat substitutes with their high product quality. Especially thanks to the Vegetarian Butcher, now the consumers that were aware and troubled about the impact of meat production had clear options for the traditional meat products available for them. The company ruthlessly entered some food competitions designed for meat products, performing extraordinary well for instance by coming 3rd on the best meatball competition, challenging the general conception that meat-products quality is unmatchable. Above else, these companies set the new standard for meat substitutes and functioned as inspiration for other entrepreneurs. They revitalized the market and indicated that in order to stay in business or gain their share of the vastly growing market, the existing meat substitution producers have to step up their game and invest in innovation and product development. From 2010, the Dutch meat substitution market doubled every year, reaching 1% of the market share of meat market by 2014 (Wild et al, 2014). Soon, the meat substitute shelves at the supermarkets began getting substantially larger and big corporations became interested in the growing market. In autumn 2013, the Netherland's largest supermarket chain Albert Heijn launched their own in-house line of meat substitutes.

The years 2010-2014 were characterized not only by growing production of ever-better meat substitutes, but also by continuous research and development of new sources of protein. Seaweed had proved to be a new protein source appealing for the customers for its novelty, nutritional value and taste, and many were trying to create the next revolutionary product. In these years, the consumption of insects as a worthy opponent to traditional gained also more interest, and in 2013 the world's first Insects for Food and Feed -conference was held in the Netherlands in collaboration with Wageningen University and the United Nations Food and Agriculture Organization. After the conference, Wageningen announced the publication of the first scientific journal that would be dedicated for this topic, which was eventually published in 2015 (Yen, 2015). Testing the Dutch supermarket giant Jumbo brought the Netherlands first insects burger to its shelves in 2014. Even though the burger was withdrawn from retail some months later, the bare fact that such a product was attempted to be launched in a large traditionalistic supermarket illustrates the search for novelty in the Dutch protein consumption and daring for experimentations.

As new companies were appearing to the market and the older ones experienced a regeneration, the first attempts for these companies to become more aligned were taken in 2012 with a creation of Het Planeet by one of the founders of Ojah, Jeroen Willemsen. This organization is composed entirely of producers of meat substitutes and meat alternatives, unique in the world at the time, and has the goal of fostering the so-called protein transition. Het Planeet aims to do so by inspiring the Dutch consumers to try and use more alternative protein sources and by exporting some of the knowledge that they have generated abroad. Simultaneously, the research on new protein-sources became more centralized with the creation of Protein Competence Center (PCC) in 2014 by the initiative of the Wageningen University. PCC is a joint effort by food researchers to find new and better alternatives for protein for both human consumption and animal feed. PCC is foremost a network of researchers and companies that deal with topics ranging from agricultural production to texturalization technology and marketing.The organization brought together both public research institutes

(Wageningen RU, Hanzehogeschool Groningen), as well as private research institutes (TNO, NIZO Food Research) and several companies of which some are active in meat substitution, such as Friesland Campina (PCC, n.d.).

In the early 2010's, the research on cultured meat took massive leaps in the Netherlands. Both the Maastricht University and a joint effort by the universities of Utrecht and Wageningen were convinced that they could turn the idea of cultured meat into reality, Maastricht's efforts funded by a new private partner and Utrecht and Wageningen's by the Dutch government. Ultimately, Mark Post from the University of Maastricht became the first in the world to serve a burger that was developed by using stem-cell technology in 2013. The burger, made out of 10 000 individual muscle strips, was flown to London and prepared and eaten in a live television broadcast in front of over 200 international journalists (Mosa Meat, n.d.). Expectedly, the news of this technological breakthrough quickly spread around the world, making its way to headlines of prominent newspapers such as the Guardian and the New York Times (footnote of the headlines). The exhibition of the world's first laboratory-grown meat was a revolutionary step, as it proved that the concept of creating meat with technology, without having to harm animals, was indeed possible. Despite the price tag of 250 000 euros, the enthusiasm towards cultured meat had reached new highs.

Simultaneously, further R&D in texturalization technology was undertaken. A group of researchers at the Wageningen University with the lead of Atze Jan van der Goot developed a technology that can create elastic structures to plant-based substances through the hierarchy, something characteristic for the texture of meat (Hamoen et al, 2013). The shear-cell technology allows the user to control the length and formation of these plant-fibers, thus enabling variation in product creation. What was also new was the small size of the technology, making it appealing for small-scale and decentralized manufacturing rather than mass-production. The research group presented their findings in 2013 under the translated title *Technology for the making of next-generation meat substitutes: the shear-call technology* (Hamoen et al, 2013). This technology was yet again a proof of concept and would require much more research until commercially viable. Later the same year, the Wageningen UR teamed up with commercial partners to further continue the development of the technology for the market application.

4.3 2015-2017

In the past years the companies producing meat substitutes as well as the variety of products has further expanded, increasing both the exposure and availability of these products, and even if the consumption of meat substitutes stabilized in 2015, the following years saw again an intense growth. The awareness of the environmental impact of meat production continues to increase as flexitarianism, vegetarianism and veganism are trending and becoming more normalized. The topic of meat reduction is more on the table also in politics, thanks to new dietary recommendations and further organization of actors advocating protein transition, amongst them meat substitute producers. Even though the market share of meat substitutes continues to grow it remains infant in relation to the meat industry. Some counter resistance from the meat industry is noticeable, but in general, the meat industry is increasingly seizing the opportunities of the new market.

In 2016, the Dutch meat substitute market grew by 9.5% in comparison to the year 2015 (Green Protein Alliance, 2017). The Dutch are more conscious than ever about their meat consumption, and in 2016 a study by Natuur en Milieu found that 67% of the Dutch are flexitarian (Natuur en Milieu, 2016). In 2015 the idea to

eat less meat for environmental and health reasons became even more persuasive as the Dutch Nutrition Center released its new national dietary recommendations based on the guidelines created for the government by the Health Council. These are the official dietary recommendations in the Netherlands and therefore have a substantial influence on people's perception of what constitutes as a good and healthy diet. The Nutrition Centre's recommendations included a maximum of 500g meat consumption a week, of which only 300g should constitute red meat due to its large environmental impact. The new recommendations also cut down consumption of fish from previous 2 times per week to 1 time a week. The guidelines created by the Health Council and the recommendations of the Dutch Nutrition Center both explicitly mention the importance of reducing meat consumption and underline that meat is not fundamental for a healthy and balanced diet[10] (Health Council of the Netherlands, 2015).

Table 9: Current market size and market growth of some the meat alternative products in the Netherlands (Green Protein Alliance, 2017)

	Turnover in retail in 2016	Growth in comparison to 2015
Meat substitutes	79 million euros	9.5%
Plant-based alternatives and dairy products	80 million euros	6%
Sea-vegetables	< 2 million euros	>200%
Canned legumes	62 million euros	12%

The past years have also seen a lot of rebranding of the old meat substitute products that were on the market already before the turn of the millennium. In 2014, Vivera became independent from the rest of the Enkco Food Group and simultaneously rebranded itself entirely. The next year Vivera introduced a new logo, a website and its new eye-catching packaging that is illustrated with pictures of the ingredients of the meat substitute presented in the same manner as meat traditionally (figure 11). The story these illustrations present is very similar to that of the Vegetarian Butcher, presenting their products as something identical to meat. In 2017, Tivall also rebranded itself entirely by changing their name to Garden Gourmet and introducing a new line of packaging. This was due to the fact that Nestlé bought the company. These long-term producers of meat substitute products are doing this rebranding in order to gain their share of the market and to distinguish themselves from the competitors. Naturally, the technologies that these producers use today are not always

[10] The Dutch Nutrition Centre states on their website under protein category: "In deze groep draait het om afwisseling tussen de dierlijke en plantaardige producten. Steeds meer mensen eten niet elke dag vlees. Ook kun je heel goed zonder vlees." which translates to "In this group it is all about variation between animal and plant products. More and more people do not eat meat every day. You can also do very well without meat." (Voedingscentrum, n.d.).

the same as in the past. The rebranding could also be a way to differentiate between the old products and the new products, to avoid negative connotations with the former.

Figure 11: New Vivera packaging next to a what represents a traditional meat packaging, indicating the part of the animal that the meat is delivered from (Vivera, n.d.).

Whereas Het Planeet was composed of solely the producers of meat substitutes, its branch initiative Green Protein Alliance (GPA) included a variety of actors that wanted to foster the production and consumption of alternative protein sources on account of meat. The GPA was officially registered as an organization in March 2017, with founding partners such as Vivera, Albert Heijn, Alpro, Garden Gourmet and the Dutch Weed Burger. Later that year, the GPA published its Green Protein Growth Plan where it declared its vision for the Netherlands: that by 2025 50% of the Dutch protein intake would come from non-animal products and 50% from animal products. In the report, a pathway and action through which to reach this vision was elaborated on. The formation of such an organization around the issue of meat reduction is clearly a benchmark. It unites the voices of both small and medium as well as large enterprises, which can be influential also in policy development.

The Wageningen University research group presented the new prototypes of its shear-cell technology in 2015, sparking the interest of the investors with its exquisite meat-like appearance. In 2017, the university and other commercial partners, meat substitute producer the Vegetarian Butcher among them, were joined by the corporate giant Unilever in a quest to realize a plant-based substitute for beef (Plant Meat Matters, n.d.). The the development of shear-cell technology continues still under the project name Plant Meat Matters, which is the largest public-private partnership in terms of technology development on the field of meat substitution in the Netherlands to date. Simultaneously, Mark Post's research team and an increasing number of international competitors are improving thethe production of cultured meat. In a spin-off of the serving of world's first cultured meat burger, Post co-founded Mosa Meats, a company which aims to commercialize cultured meat production. Post has declared that they have already succeeded to substantially cut down the cost of the burger, visioning it to be commercially available in the near future (Mosa Meat, n.d.).

Maybe due to the rise of flexitarianism in the Netherlands, many traditionally meat-bound companies have increasingly started to diversify their product portfolio to cover meat substitutes. Some older meat substitution companies, such as Vivera, have often been owned by a company that is also prominent in the meat industry, but the companies have often clearly separated these two product groups under separate brands. This seems

to have changed recently, as just like the consumers also companies can be flexitarian in nature. One example is Olijck established in 2013 in Haarlem. Already during the same year, the company began developing meat substitute products based on seaweed. In 2015, the seaweed burgers came to the market and in 2017 could be found for instance in Albert Heijn. Both product groups are sold under the name of Olijck. Also, companies that are technology or processing wise connected to the meat industry, have increasingly started to see the opportunities for the meat substitute market. For example, the WUR project Plant Meat Matters is done in collaboration with Meyn, one of the world's largest manufacturers of chicken processing technology (Plant Meat Matters, n.d.) As the demand for meat substitutes rises, more processing plants are required. As it would be extremely expensive and time-consuming to build a processing plant solely for plant-protein for instance, especially the starting meat substitute producers often turn to long-term meat processors for help. They already have the space, workforce and basic knowledge available to process these products, which often leads to a situation in which these processing factories have a mixed portfolio of processed products. This is, of course, no new development, but one that is rapidly growing. Friesland Campina's Valess products, for instance, are processed at a mixed facility of Dalco Food which started in 1975 as a meat producer and processing facility (Dalco Food). Simultaneously, many large meat substitute producers who have already secured their market position are opening their own production facilities. For instance, the Vegetarian Butcher outsourced its production until the end of 2017, when the company opened its first processing location (The Vegetarian Butcher, n.d.). The Vegetarian Butcher is also currently building a larger production facility in Breda that should be up and running in early 2020's, which illustrates a strong confidence for further growth in the future. Similarly, Vivera has opened its first processing plant dedicated 100% for meat-free products (Vivera, n.d.).

Since the 90's, the high density of bio-industry in the Netherlands has made is vulnerable to diseases such as bird and swine flu. According to Reuters, since 1997 a total of 40 million animals such as pigs, hens, and cows have been slaughtered in order to prevent the outbreak of the disease in the Netherlands (Escritt, 2014). Naturally, the meat of these animals has not been for consumption due to the fear of infection but has gone to waste. One of the country's latest disease control attempts took place in November 2016, when 190 000 ducks had to be slaughtered to prevent the spreading of bird flu (Payton, 2016). These news, however not new, are certifying the growing consensus that there is too much bio-industry in the Netherlands to secure a fair handling of the animals. It can, therefore, be speculated that these disease outbreaks influence the image of the meat sector negatively, and thus might make the meat substitutes more appealing to the concerned consumer.

The growing meat substitution market has not gone unnoticed by some meat producers that oppose the new development. Already in 2012, a Dutch member of Chamber Jaco Geurts objected to the use of words such as burger or schnitzel in meat substitute names, a remark which developed into a court case between the Vegetarian Butcher and a meat lobby over the use of these product names. In 2017 the case was closed with the ruling that The Vegetarian Butcher has to change these references from their product names by March 2018 (NU, 2017). The case gained a lot of publicity and the hashtag schnitzelgate was trending in Twitter vastly, gaining 300 000 tweets in just the matter of few days and the director of Vivera Heite Dommerholt commented the court case as "The best thing that could have happened to us" (Vivera, n.d.). A similar case took place at a European Union level also in 2017, in which the court banned the soya and tofu industry from using dairy-style names for their products such as milk or cheese (BBC, 2017). These developments show the resistance of the meat sector against plant-based substitutes that try to disguise themselves as meat.

In 2015, bringing innovative and new meat substitute products to the market in the European Union became easier due to an update of the European Novel Food Law. However, an update of this law also made consumption of insects in the Netherlands more complicated. The original law was put in force in 1997 and stated that novel foods are foods that have not been consumed within the EU in significant degree before May 15th, 1997 and included a mention of “food ingredients isolated from animals”. The interpretation of law had differed between the EU member states, which had resulted in a situation in which some countries allowed the sale of insects for human consumption and some countries did not. The Dutch interpreted the law in a way that wholesale of insects was indeed legal as they were complete animals, not just parts of it. To bring a novel food to a market, it must go through a careful pre-market authorization which is not only time-consuming, but also expensive. The update on the novel food law did not remove the authorization procedure of the novel foods but made this process more efficient and cheaper. The update also included an addition which clarified that insects are also considered a novel food, if not consumed in significant degree before 1997 within the EU. The updated novel food law can be seen in the Netherlands as a momentary setback in the consumption of insects but at the same time improvement of the process of bringing new foods to the market in a more general sense (European Commission, 2015).

The past years have also seen increasing efforts by the Dutch government to foster the Dutch meat substitution industry. In 2016, the Ministry of Economics announced a New Food Challenge for start-ups and young companies which called for ideas for plant-based protein products for human consumption. The challenge had a total budget of 1,8 million euros available to distribute to promising enterprises, with a maximum funding of 250 000 euros per idea (Rijksoverheid, 2017). Eventually, 83 companies participated, among which meat substitute producers such as The Vegetarian Butcher, SoFine Foods and Goodbite (Schouten Europa) gained funding for the development of new products. The New Food Challenge was part of the Dutch government’s Food Agenda generated in 2016. The Food Agenda has the aim of safe, healthy and sustainable food production and consumption in the Netherlands and it calls for a transition of the food system. As part of the new agenda, a National Food Summit was organized at the beginning of 2017 to make long-term agreements with the business community and other concerned parties about how to go about this transition (Rijksoverheid, 2016). This is the first time in the Netherlands that the government is seriously discussing with the private sector about a sustainable food transition. Starting from 2017, 20 million euros from the state budget is also to be reserved annually for funding new promising innovations from companies and civil society organizations connected to sustainable food production (Rijksoverheid, 2016). The primary document that introduced the idea of Food Agenda in the government explicitly referred several times to the Green Protein Alliance, due to which it can be assumed that the organization, even if only under formation at the time, has political weight.

4.3 Conclusion

The Dutch meat consumption appears today roughly at the same level as it did 10 years ago. However, studies show that the consumers are rather open to trying new alternatives for traditional meat. Meat substitution products have been consumed in the Netherlands by a small majority for a long time, but only recently have they gained more exposure and the interest of the masses.

By the end of 2010, there was a vastly growing group of people in the Netherlands who were aware of the environmental problems connected to the way bio-industry was functioning. This awareness was not yet large enough to translate to a growing demand for meat substitutes, however, it inspired a group of entrepreneurs and innovators who anticipated the future trends to develop new meat substitutes that could compete with meat in terms of sustainability, ethics, and health without compromising the culinary experience.

The early 2010's was revolutionary for meat substitutes in The Netherlands. The technologies that had been developed at the end of the previous decade were creating products that were able to imitate meat on a level not seen before. New mission-driven, innovative companies used successful marketing strategies and story-telling to make these new products exciting, thanks to which the consumers started developing a taste for these products. The research efforts of the Dutch universities also bear fruit, securing the position of the country as the world leader in meat substitution technology. The networking on both company and research level indicated clear attempt to become more organized to drive the protein transition. By the turn of the decade, it was clear that meat substitution was a market with huge growth potential, which inspired the activities to further expand.

Overall, development of the meat substitution system in the Netherlands in the past years has been rapid and seen an increase in support from the government as well as civil society. Some minor resistance from the meat industry can be sensed, but also clear willingness to participate in the growing market. By the end of 2017, the Netherlands has established itself as one of the world leaders not only in textualized vegetable protein technology and products but also cultured meat and algae cultivation.

Chapter 5: Structure of the innovation system

Whereas chapter 4 offered a detailed overview of the main political, economic, social, technological, environmental and legal developments in the field of meat substitution in the Netherlands, this chapter will concentrate on studying the structure of this innovation system more specifically. It can be thus regarded as the first step towards theorization of the innovation system. The goal is to generate a detailed description of the structure in terms of relevant actors, networks, institutions and technological factors, which can be used in the second part of the research for analyzing the functional dynamics. Only components that are perceived to be influential for the system development are considered, and therefore not all the actors mentioned in chapter 4 are included within the structure. It must be also noted that concentration remains within the boundaries of the Netherlands, and in case of larger global developments observed earlier, the Dutch representatives are considered in the structure. This chapter seeks to answer the second research question *What is the structure of the Dutch meat substitute innovation system?* The chapter is divided into subchapters according to the structural components. Finally, a structural map of the innovation system will be presented.

5.1 Actors

The innovation system component of actors refers to individual companies, organizations or government bodies that actively work in the field of meat substitution either directly or indirectly. The actors directly involved include technology producers and adopters such as meat substitute companies. The indirectly involved actors include for instance financers and regulators of the system. Therefore, the innovation system considers a wide range of different actors that presumably have the common aspiration for further growth of the meat substitute sector. The actors can be further divided into five actor-categories: knowledge institutions, educational organizations, industry, market actors and government bodies and supportive organizations (Hekkert et al, 2011). For this research, a sixth actor-category is created: non-governmental bodies and supportive organization. This is due to a need to distinguish between actors that are connected to government agenda and social pressure groups.

Knowledge institutions refers to actors that generate new knowledge on the topic of meat substitutes through research and development in several research fields. This knowledge can be technical knowledge, business knowledge or non-technical scientific knowledge. Knowledge institutes include both private and public actors, which generate both secret and publicly available knowledge. Research universities are the best example of public knowledge institutes, of which Wageningen and Maastricht are the most prominent in the Netherlands in the field of meat substitution. Wageningen University is specialized in agricultural production and in addition to generating knowledge on crop production and cultivation, they have a research project called Plant Meat Matters that work on realizing the large-scale application of shear cell technology. Maastricht University was where the stem cell technology for in vitro meat production took root, and the company Mosa Meat later sprang from that branch of research. Primarily, the knowledge developed at these institutions is publicly available. Private knowledge institutions, on the other hand, include independent research consultation companies. They are mostly connected to the innovation system by generating research ordered by the government or other

direct actors of the system. The information generated by the private knowledge institutes is most of the part publicly available and easily accessible to anyone.

Table 10: Actors of knowledge institutes

KNOWLEDGE INSTITUTES	
Relevance	**Who**
Research on several areas related to meat substitution, for example, texturalization technology, meat consumption, marketing, philosophy, and governance	Wageningen University
	Maastricht University
	TU Delft
	Utrecht University
	Free University of Amsterdam
Partners of the Green Protein Alliance	Has Hogeschool
	Foresight consulting
	Drift
Research on environmental implications of meat and meat substitution for example for the national government and the meat substitution industry	CE Delft
	TNO
	Blonk Consultancy
	New Foresight

Educational organizations differ from knowledge institutions in the sense that educational organization is not necessarily formal establishments. To some extent, the actors within the knowledge institutes also belong to this actor category. Educational organizations category includes schools, clubs and other organizations that have the direct aim of influencing the absorption of knowledge on meat substitution, for example by the standard consumers, students and/or institutions. Whereas knowledge institutes aim to generate new knowledge on the issue, the educational organizations try to pass the existing knowledge on. For this reason, universities can belong to both actor categories. Wageningen University is the most prominent educational organization in terms of texturalization technology, as the projects introduced in chapter 4 illustrate. In general, education of sustainable development is part of the national Dutch primary and high school agenda, due to which these actors play an important role in spreading the knowledge on the underlying reasons for meat substitution. It is, however, suspected that these educational activities often lack critique on meat consumption and its linkage with climate change, unlike the use of fossil fuels for example.

Table 11: Actors of educational organizations

EDUCATIONAL ORGANIZATIONS	
Relevance	**Who**
Education on several areas related to meat substitution, for example the environmental impact of meat and meat alternative products	Wageningen University
	TU Delft
	Maastricht University
	Free University of Amsterdam
	Utrecht University
National guidelines for a balanced and healthy diet which encourage the reduction of meat and the use of meat substitutes and other alternatives	The Nutrition Centre (de Voedingcentrum)
The inclusion of educational activities on climate change and sustainable development	Primary schools and high schools

Actors within the industry include companies that produce meat substitute products either from business to business or business to consumer. The distinction between companies by type of meat substitution production is not of importance but shows that meat substitution is still pretty much dominated by the products based on legumes. These actors are no knowledge institutions, but despite it are also actively developing knowledge connected to meat substitution as will be later discussed. The most notable industrial actors for the Dutch meat substitute innovation system are the three biggest ones in terms of market size: Vivera, The Vegetarian Butcher, and Garden Gourmet, as well as the three important business-to-business operators: Schouten Europa, Ojah, and Meatless. Schouten Europa is an exceptional company in a sense that they have their own meat substitute brand, Goodbite, but they also sell their products to other private labels. It must be noted that the list of industry actors is unlikely to be absolutely complete especially in terms of small and medium actors.

Table 12: Actors of the industry. See appendix for further information of the actors.

INDUSTRIAL ACTORS	
Relevance	**Who**
Producer of legume-based meat substitute products for the market	Vivera
	Goodbite (Schouten Europa)
	The Vegetarian Butcher
	Garden Gourmet
	HAK
	SoFine Foods

	Alpro Soya
	Vegafit
	Boon
	Purple bee hive
	Jumbo Veggie Chef
	Albert Heijn
Producer of texturized vegetable protein for business-to-business	Meatless
	Ojah
	Schouten Europa (Goodbite)
Producer of fungi based meat substitute	Quorn
Producer of dairy-based meat substitutes	Friedland Campina (Valess)
Producer of sea-vegetable-based substitutes	The Dutch Weed Burger
	Olijck
	Nutress
Innovator on cultured meat	Mosa Meat

The market actors include companies that are especially influential in delivering the meat substitute products to the consumer. Of the numerous Dutch supermarket chains, Albert Heijn and Jumbo are considered as the most important ones due to their excessive size and clearly indicated an aspiration to foster the consumption of meat substitutes and alternatives as they are members of the Green Protein Alliance. They also both employ their own large in-house brands of meat substitute products. Superunie is a large corporate in which several smaller supermarket chains belong to. The Dutch Weed Burger Joint and the Vegetarian Butcher Concept store are offer points of sale that derivate from the standard. Unilever and Nestlé are two large corporates which are both influencing, or expected to include, the availability of meat substitute products in the future: Garden Gourmet is a brand under Nestlé group whereas Unilever is investing heavily on meat substitution technology research and is likely to bring new products to the market soon.

Table 13: Actors on the market

MARKET ACTORS	
Relevance	**Who**
Large supermarket chain with its own inhouse brand of meat substitute products	Albert Heijn
	Jumbo
Large corporate with several supermarket chains such as Plus, Hoogvliet, Spar and Coop	Superunie
Private market area built around meat substitution products	The Dutch Weed Burger Joint
	The Vegetarian Butcher Concept Store
Large investor on meat substitution technology research	Unilever
Large multinational operating on the market	Nestlé
Introduces meat substitution products to new consumer groups	Caterers in Horeca, hospitals and other care-take facilities

Government bodies and supportive organization naturally include related ministries, but also government-funded organizations closer to the producers and consumers. The actors that belong to this category function mostly top-down. The ministries within the national government are actors which can influence the meat substitution system in different direct and indirect ways. The Ministry of Economics is responsible for the national budget and decides how much funding and subsidies are directed towards each sector. They are thus of uttermost importance for the innovation system because they decide whether and how much to finance meat substitution activities. This institution can influence the system in numerous ways, not only by directly supporting or opposing the system. No system exists in isolation, due to which the amount of support and/or opposition directed towards other sectors influences it in turn.

Table 14: Actors in governmental bodies and other supportive organizations

GOVERNMENT BODIES AND SUPPORTIVE ORGANIZATIONS	
Relevance	**Who**
Financing of the innovation system research and development for both public and private sector	Ministry of Economics
Authority on food safety	Ministry of Agriculture, Nature and Food quality

An authority on national health issues and financer of the Nutrition Centre	Ministry of Health, Welfare, and Sport
Organization created in 2017 for the realization of the New Food Agenda	DuurzaamDoor
Raises awareness of environmental problems, helped with the financing of the new production plant for the Vegetarian Butcher	Organization for Nature and Environment (Natuur & Milieu)

The non-governmental organizations are mostly non-profit in nature that aim at influencing the civil society and governmental organizations. These are organizations through which the individual consumers and activists try to influence the current system with a bottom-up approach. The Green Protein Alliance is directly involved with the topic of meat substitution by actively working towards increasing their share in the Dutch protein consumption, due to which they are the single most important non-governmental organization actor for the Dutch meat substitute innovation system. The several organizations based on the strong ideology of vegetarian or vegan eating are also important, but have a less direct impact on the system.

Table 15: Actors in non-governmental bodies

NON-GOVERNMENTAL BODIES	
Relevance	**Who**
Organization of companies producing meat substitute and meat alternative products	Het Planeet
Organization of meat substitute and meat alternative producers, knowledge institutes and market actors fostering the protein transition	The Green Protein Alliance
Organization promoting meatless diet on a consumer level	De Vegetariersbond
Organization against the bio-industry and for better animal welfare	Wakker Dier
Organization promoting Dutch kitchen in the Netherlands as well as abroad with the inclusion of meat substitutes	Dutch Cuisine
Food awareness organization promoting plant-based diet	VegPro

5.2 Networks

The actors within the meat substitute innovation system are organized in networks, either organically or purposively. The actors interact with each other in these networks in accordance with the formal and informal institutional rules that are prevailing in the society, in order to develop and diffuse technology. According to Carlsson et al (2002), technological innovation systems include three different types of networks: buyer-supplier relationships, problem-solving networks, and informal networks.

There are several buyer-supplier relationships within the Dutch meat substitution innovation system. Most of these relationships are naturally between the industrial actors that produce meat substitute products and the market actors who offer a point of sale for these products. To map all of the buyer-supplier relationships in terms of supermarkets and their suppliers is out of the scope of this study as it would lead to unnecessary complexity. Buyer-supplier relationships between the industrial actors are however of interest. These relationships are often between companies that sell for example texturized vegetable protein or algae protein and companies that use this material for further processing. Companies such as Meatless and Ojah operate solely on business-to-business. Such a business strategy is quite common in the food industry as the production costs strongly correlate with the mass. Worth special mentioning is Schouten Europa which operates in a buyer-supplier relationship not only with supermarkets through their own brand Goodbite but also with other meat substitute brands who they deliver products to, such as HAK, Jumbo Veggie Chef, and Boon. Vivera also has an exceptional buyer-supplier relationship with several hospitals and care-take facilities, who stock and serve their products to their customers.

Table 16: Buyer-supplier relationships and connected actors

BUYER-SUPPLIER RELATIONSHIPS	
Relevance	**Who**
Supplies meat substitute products directly to caterers for example in horeca and care-take facilities	Vivera with Huuskes, Bidfood, DeliFresh Food, Van der Wee Diepvries, Sligro and De Jong Diepvries
Subcontract between two actors in meat substitution industry	Schouten Europa and Boon
	Schouten Europa and HAK
	Schouten Europa and Jumbo Veggie Chef
	Ojah and The Dutch Weed Burger
	Ojah and The Vegetarian Butcher
	The Vegetarian Butcher and Meatless

Problem-solving networks are less straightforward to determine than the buyer-supplier relationships. Research projects are a good indication of these networks, and for meat substitutes, there is a large problem-solving network that builds around the project Plant Meat Matters of the University of Wageningen. This

network covers industrial actors such as the Vegetarian Butcher, market actors such as Albert Heijn and Unilever, as well as both governmental and non-governmental actors. Another large problem-solving network is built around the Green Protein Alliance, which actively strives to find how to foster the Dutch consumption of alternative protein sources, and is also includes actors from all the different actor categories. Het Planeet's network is composed largely of the same actors as that of the GPA, and thus the relevance of the network remains somewhat questionable, also due to recent inactivity. The Protein Competence Center is also a problem-solving network worth mentioning, even though its activity remains questionable due to lack of references in media and expert interviews. Additionally, the Dutch universities and private knowledge institutes have a high level of collaboration. These problem-solving networks are the most important ones from the point of an innovation, as they indicate how the system deals with socio-technical problems and where technical information comes from.

Table 17: Problem-solving networks and connected actors

PROBLEM-SOLVING NETWORKS	
Relevance	**Who**
Works towards the realization of new plant-protein texturalization technology (shear cell technology)	**Plant Meat Matters** Ministry of Economics, Wageningen University and Research, Food Processing Technology, Wageningen Food and Biobased research, Unilever, The Vegetarian Butcher, Nutrition & Sante SAS, Meyn Food Processing Technology
Works towards accelerating meat alternative consumption	**Green Protein Alliance** Albert Heijn, Alpro Soya, Schouten Europe (Goodbite), Vivera, Unilever, Garden Gourmet, Dutch Cuisine, Nature and Environment (Natuur en Milieu), Olicjk, SoFine Foods, Rotterzwam, Rabobank, Zeewaar, Bonduelle, Appel, Boon, Drift, Dutch Soy, The Dutch Weed Burger, GRO, HAK, HAS Hogeschool, Louis Bonk Instituut, Nextfoods, Purple Bee Hive, Intersnack, Quorn, Jumbo, Menken Orlando, Marley Spoon Het Planeet, New Foresight, Duurzaam Door Ministry of Economics Environment Centre (Milieu Centraal), The Nutrition Centre (de Voedingscentrum)
Network of producers of meat alternatives and meat substitutes	**Het Planeet** Ojah, Vivera, Dalco Food, Friesland Campina (Valess), Ingrepro, Meatless, Shouten Europe (Goodbite), Quorn, Garden Gourmet, Boon, SoFine Foods, The Dutch Weed Burger, Nutress, Barentz, De Kortenhof, Multiflour, Duplaco, ABC Kroos, Solanic, Van Haver Tot, SanoRice, GreenProtein BV, Bodeldijk Food group, Ruitenberg incredients, MFH pulses, Labeij
A network of researchers and industry actors connected to green-protein	**Protein Competence Center** Wageningen UR, AVEBE, Darling Ingredients, DSM, Duynie Group, Friedland Campina, Nutricia Research, VanDrie Group, Hanze University of Applied Science

The concept of informal networks refers to networks that are established mostly on a personal level through professional interaction. These networks get formed in the field of meat substitution for example in meetings, conferences and co-working situations in which different actors interact with each other occasionally without a longer commitment for doing so. Most notably, the GPA actively attempts to create a strong informal network between its members and the policy members. For example, in January 2018, the GPA organized a discussion evening for its members and political actors (Green Protein Alliance, 2018). An informal network is perhaps also built around the New Food Challenge, as the participants of the challenge have likely met each other during its course. There is also a lot of networking between the actors of different knowledge institutes, for example, TU Delft continuously collaborates with Drift and CE Delft. This network could perhaps also be regarded as a problem-solving network, but due to the fragmentary and uncertain nature of interaction in regard to the topic of meat substitution, these types of networks are categorized as informal.

Table 18: Informal networks and connected actors

INFORMAL NETWORKS	
Relevance	**Who**
Sharing and gathering information	Actors in both public and private knowledge institutes
	Start-ups who participated in the New Food Challenge
	The GPA and political actors

5.3 Institutions

The category of an institution refers to both formal and informal establishments that guide the development of the innovation system through a set of rules. Informal rules are unwritten and have to do, for instance, with the prevailing business culture. They are therefore difficult to map systematically and will be left out of the structural analysis, but will be considered and discussed extensively in the second part of the research. For now, concentration remains on formal institutions which create rules that are enforced in the society by the local authority in the form of laws, regulations, policies, and rights.

The most influential institution in the Netherlands on all fields of the society is the national government. The government prepares and decides on the national law which shapes every aspect of development also in the meat substitution system. It is the highest authority to execute power in the Netherlands. The European Commission is also of importance in generating regulations and rules that are enforced in the Netherlands, and in some issues, has power over the national government. In the topic of meat substitution, this got demonstrated for instance in 2015 with the update of national food law which ruled against the Dutch government's earlier interpretation, as was discussed in chapter 4. The European Commission is especially influential in generating binding targets in general terms, for instance about the amount of nitrogen that can be leached to the ground through agricultural activity, but leaves it up to the national government(s) to execute a plan through which these targets can ultimately be reached.

Table 19: Formal institutions

INSTITUTIONS	
Relevance	**Who**
Generates laws, regulations, and targets within which the meat substitution system needs to operate	The Dutch government
	European Commission

5.4 Technologies

Technology factors refer to the artifacts and the infrastructures in which they are embedded in. The technologies connected to meat substitution include plant-protein texturalization technology and stem cell technology. Especially the plant-protein texturalization technology is, in fact, an umbrella term for a collection of different techniques and technologies on that field, a notion which will be elaborated more in detail in section 6.1.1. It is impossible to even map systematically all the technologies that exist and fall within this field, as many of them are protected by company secrecy. This fact should be kept in mind when interpreting the map of the system structure: the actors connected to this technology are not all using, developing or diffusing knowledge on one single technology, but a variety of technologies within the same field.

Table 20: Main technologies

TECHNOLOGIES	
Relevance	**What**
Technologies already in place and under development through which meat-like structures can be created out of plant-protein	Plant-protein texturalization technology
Technology that has the potential to artificially create meat structures	Stem cell technology

5.5 Visualization of the system structure

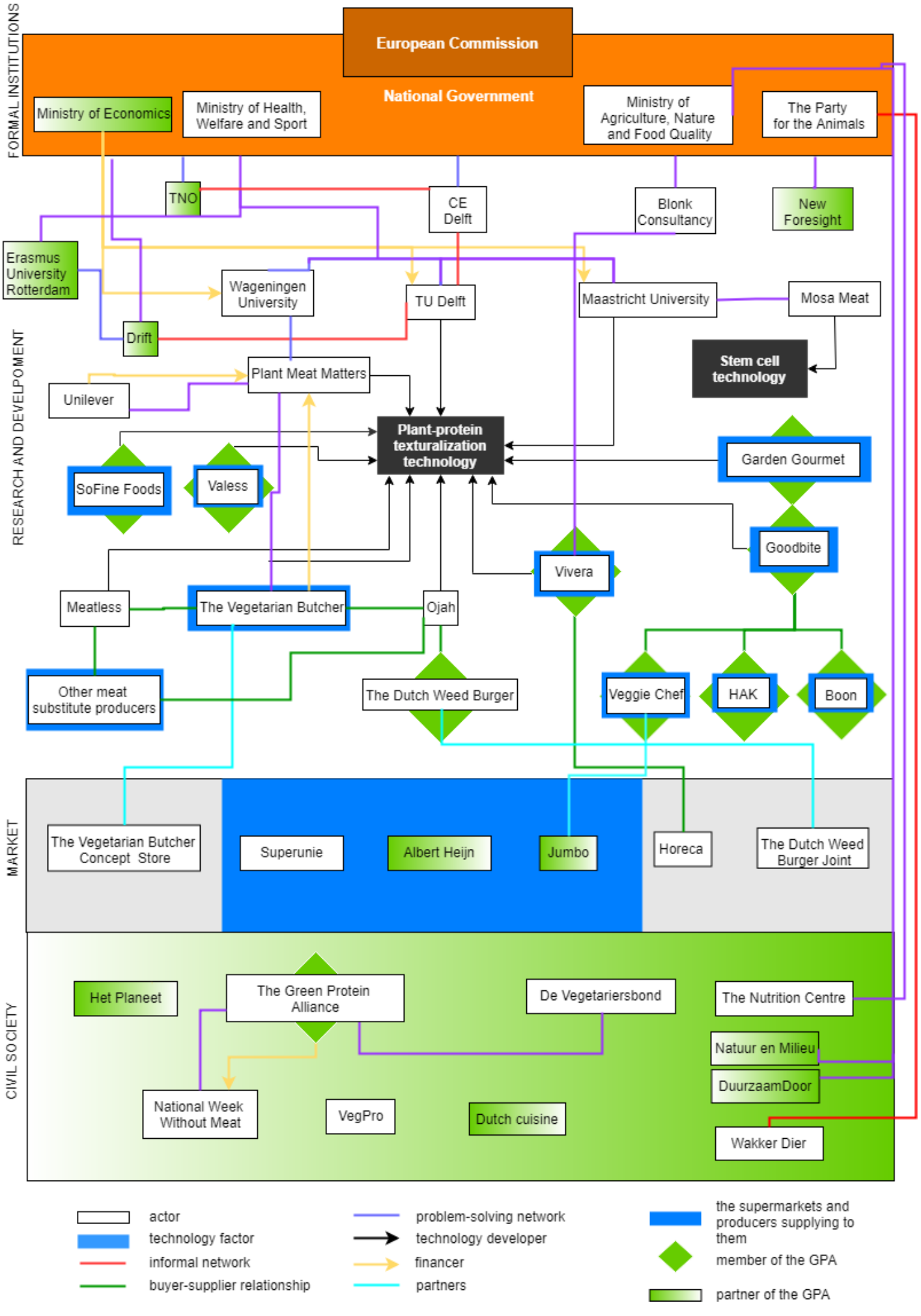
Figure 12 visualizes the structure of the innovation system described in this chapter. The mapping aims to make the innovation system structure more comprehensive, and therefore for the sake of clarity, not all the actors and networks mentioned during the research part 1 are included. The figure primarily aims to indicate the main actors of the system and the different networks between them. It also tries to visualize the realms within which these actors belong. These realms are loosely based on the categorization of type of actors in section 5.1: governmental actors belong to the realm of formal institutions, actors of educational organizations, knowledge institutes and industry within the realm of research and development, market actors naturally within

the market and the actors of non-governmental organizations belong to the civil society. Again, it must be noted that this structural map only includes the most notable actors and networks detected from the historical overview in chapter 4.

5.6 Conclusion

The structure of the innovation system is composed of actors, actor networks, institutions, and technologies. In the field of meat substitution, there is a wide variety of different actors connected to different realms in operation, and who are either organically or purposively organized in networks. The most prominent actors of knowledge institutes include Wageningen University and Maastricht University. Universities, in general, are important educational organizations, but also actors such as the Dutch Nutrition Center. The industrial actors with the most influence are large producers such as Vivera, The Vegetarian Butcher and Garden Gourmet, as well as industrial actors who operate business-to-business. The market actors offer a point of sale for the meat substitution products, such as Albert Heijn, Jumbo, and The Vegetarian Butcher Concept Store. Crucial governmental and non-governmental institutions include some ministries, such as that of economics, as well as organizations based on strong ideological movements, such as Wakker Dier and VegPro. There are three types of networks between the actors: buyer-supplier relationships, problem-solving networks, and informal networks. Most remarkable buyer-supplier relationships are formed between the industrial actors: ones through which texturized vegetable protein is subcontracted. Of problem-solving networks, the GPA and Plant Meat Matters are the ones of most prominence, whereas the activity of Het Planeet and PCC remains questionable due to lack of recent activities. Formal institutions pose regulations and rules within which the actors and networks must operate. These actors or networks are in a way or another connected to either plant-protein texturalization technology and stem cell technology, which are the two essential technological branches of meat substitution in the Netherlands.

Figure 12: Structural map of the meat substitute innovation system in the Netherlands



Wrapping up research part 1

The first part of the research had a two-fold purpose: (1) describing the main political, economic, social, technological, environmental and legal developments in the Dutch meat substitution industry in the recent past and (2) generating a structural description of the industry. The structural description of the innovation system was generated based on the findings of recent actions and developments within the field of meat substitution in the Netherlands. The structure includes a collection of actors that function in networks under a set of rules created by the formal and informal institutions in place that in a way or another influence the direction and phase of technological development of those related to meat substitution. Table 21 below summarizes the main actions and developments detected in chapter 4 and the actors who are affiliated with these actions and developments.

Table 21: Summary of the main developments and actions and the actors connected to them related to meat substitution in the Netherlands - organized based on PESTEL.

	Developments and actions	Affiliated actors
Political	**Action:** Generation of the Dutch Food Agenda	Ministry of Economics Ministry of Health, Welfare and Sport Ministry of Foreign Affairs Ministry of Infrastructure and Environment The Green Protein Alliance
	Action: New national dietary recommendations encouraging for less meat consumption	Ministry of Agriculture, Nature and Food quality Ministry of Health, Welfare and Sport The Nutrition Centre (De Voedingscentrum)
	Action: Coming together of the producers of meat substitutes and meat alternatives under Het Planeet	Ojah, Vivera, Dalco Food, Friesland Campina (Valess), Ingrepro, Meatless, Shouten Europe (Goodbite), Quorn, Tivall (now Garden Gourmet), Boon, SoFine Foods, The Dutch Weed Burger, Nutress, Barentz, De Kortenhof, Multiflour, Duplaco, ABC Kroos, Solanic, Van Haver Tot, SanoRice, GreenProtein BV, Bodeldijk Food group, Ruitenberg incredients, MFH pulses, Labeij
	Action: Creation of Green Protein Alliance	Albert Heijn, Alpro Soya, Schouten Europe (Goodbite), Vivera, Unilever, Garden Gourmet, Dutch Cuisine, Nature and Environment (Natuur en Milieu), Olicjk, SoFine Foods, Rotterzwam, Rabobank, Zeewaar, Bonduelle, Appel, Boon, Drift, Dutch Soy, The Dutch Weed Burger, GRO, HAK, HAS Hogeschool, Louis Bonk Instituut, Nextfoods, Purle Bee Hive, Intersnack, Quorn, Jumbo, Menken Orlando, Marley Spoon Het Planeet, New Foresight, Duurzaam Door Ministry of Economics Environment Centre (Milieu Centraal), The Nutrition Centre (de Voedingscentrum)

Economic	**Development:** Strong market growth of meat substitute sector on yearly basis since 2010 (excluding the stagnation of 2015) – doubling of the turnover in the past 10-year period	Primarily the meat substitute producers
	Action: Organization of the New Food Challenge to offer funding for promising plant-based protein start-ups	Ministry of Economics The Nutrition Centre (De Voedingscentrum) Wageningen University Research Blonk Consultants ASN Bank
Social	**Development:** Trending of flexitarianism, vegetarianism, and veganism	Civil organizations and non-profits encouraging meat reduction such as Wakker Diet, De Vegetariesbond, and ProVeg Global scientific community producing research on the multifaceted benefits of meat reduction Individual social activists and vegetarian advocates
	Action: Linking processed meat consumption with increased risk of colon cancer, heart attack, and diabetes	World Health Organization Dutch media
	Development: Growing understanding that meat is not an essential part of a balanced and healthy diet	The Nutrition Centre (De Voedingscentrum) Global scientific community Individual social activists and vegetarian advocates
Technological	**Action:** Realization of large-scale high moisture extrusion technology	Wageningen University Ojah
	Action: Intensifying research on shear cell technology	Ministry of Economics Wageningen University and Research, Food Processing Technology Wageningen Food and Biobased research Unilever The Vegetarian Butcher Nutrition & Sante SAS Meyn Food Processing Technology
	Action: Intensifying research on cultured meat	Maastricht Univeristy MosaMeat Ministry of Economics
	Development: General improvements in food processing technology including texturalization	The producers of texturalized vegetable protein (Meatless, The Vegetarian Butcher, Goodbite, Vivera, Garden Gourmet)

Environmental	**Development:** Strengthening scientific evidence on the environmental impact of meat production and consumption	The United Nations Food and Agriculture Organization Netherlands Environmental Assessment Agency Blonk Consultancy / New Foresight
	Action: Ratification of the Paris Climate Goals	The Dutch government The Dutch Scientific Council for Government Policy
Legal	**Action:** New regulation on the novel food law	The European Commission
	Action: Schnitzelgate	The Vegetarian Butcher Dutch Food Safety Authority (NWMA) Product board Livestock and meat (Productchap vee en vlees)

Research part 2

ANALYSIS ON THE FUNCTIONAL DYNAMICS OF THE SYSTEM

The second part of the research is composed of a qualitative analysis of the Dutch meat substitute innovation system. For this purpose, several theories from the transition studies literature are applied in order to study the system from different perspectives. First, in chapter 6, the transition context is elaborated on through application of MLP and transition pathway theory. Afterward, the level of analysis is limited to study the internal developments within the innovation system more specifically by applying FIS theory. Finally, the two approaches are integrated and extended with the consideration of actor expectations and strategies. By integration of the MLP and FIS theory, it is aspired to generate comprehensive and prevalent conclusions that can explain the phenomena in detail, and answer the third research question: *What are the main functional dynamics of the innovation system and how do they influence its development?*

Chapter 6: Transition analysis

This chapter studies the niches that are connected to the Dutch meat substitute innovation system and the broader context within which they emerge through the application of multilevel perspective theory (MLP). What is therefore studied are the dynamics between the meat substitution niches, the ruling socio-technical regime, and the landscape developments. The chapter structure is as follows: first the niches, regime and landscape developments are carefully defined and discussed. Afterward, the dynamics between all of these levels are analyzed. Ultimately, based on the findings of the MLP, a transition pathway is determined.

6.1 Defining the niches, the regime, and the landscape developments

6.1.1 The niches

Application of multilevel perspective theory is slightly more complicated for meat substitution than other sustainability innovations which are traditionally studied through the application of the theory. This is because meat substitution is essentially a social innovation. It can be, and currently is, significantly supported by technological development, but it is not solely dependent on it. Study of meat substitution innovation system can be compared to for example sustainable transportation innovation system, where niche developments include technological re-configurations such as hydrogen fuel cell, but also social practice niches such as swapping private automobile use to car-pooling, which does not involve technology but rather a change in people's mindsets and social practices. Keeping this in mind, there are several niches within the meat substitution innovation system which either intentionally or unintentionally contribute towards the expansion of the system. These niches can be assigned into two categories: the technological niches and the social niches. Both categories develop, diffuse and utilize innovation that on a way or another contribute towards the expansion of the meat substitution innovation system. The inclusion of social practice niches within the study is supported by the results of the expert interviews, all of whom categorized meat substitute niches in terms of social aspects rather than technologies.

Technological niches

The technological niches are technological innovations that support the creation of meat substitution products in terms of either improving the existing products or altogether creating (or haven created) new ones. The mixing niche is by far the most traditional one, a technique by which the first meat substitutes were created in East-Asia already in the 14th century. The mixing technique simply includes a shearing and mixing together of different meat-free ingredients which are finally formed to patties and ultimately prepared by applying different cooking and/or fermentation techniques (Krintiras, 2015). Mixing is an affordable low-tech technology which has more to do with cooking techniques than actual technological development. It's application often results in soft and doughy structures but the creation of more complex fibrous material has not yet been achieved.

Extrusion technology is the second oldest way of producing meat substitutes. The extrusion cooking technique is generally used for the creation of many commercial products such as pasta and cookies. Extrusion basically means pushing of a material, in this case, protein paste, through a die with a selected cross-sectional profile, often in high temperatures. The technology is used for texturalization purposes and there are many variations of it, for example, high-moisture extrusion technology and twin-screw extrusion. It is broadly applied and well-known technique which has been used for the creation of the early meat substitution products since the 1980's.

Spinning technology is a newer food processing technology which many of the 21st-century meat substitute products relay on. In spinning technology, protein paste is pressed through a spinneret, a type of a filter which is often covered by a cold liquid for fast solidification (Krintiras, 2015). Generally, spinning technology is regarded as a rather affordable way of producing fibrous material within the addition of expensive additives. It, however, requires a lot of water usage and is difficult to upscale.

Shear cell technology is very new and not applied to the market yet. It is currently under development mainly at the Wageningen University but has also been under study at the TU Delft in the past. This technology depends on the design of a cone and plate rheometer and a rotation of an outside cone while an inner cone remains stable. By applying a simple shear flow to this, the proteins can be aligned to form fibrous structures. There is a lot of interest towards this new technology as it promises to deliver meat-like textures from plant-protein like never seen before.

Finally, the cultured meat technology does not merely create meat-like structure from plant material, but it, in fact, generates actual meat-tissue from animal stem cells. The technology is technically viable, but possible commercialization still seems far ahead not only due to finances, but also legal issues. This technology is primarily being developed by the company Mosa Meat which is a spin-off from the Maastricht University. The scientist expects the technology to be commercially viable within the next decade, however, the idea of growing meat artificially seems distant to many.

Social niches

The social niches can be further divided into market niches and social-practice niches. In terms of market niches, roughly five main niches can be distinguished that belong to the meat substitute innovation system: the legume niche, the dairy niche, the fungi niche, the algae niche and the insects niche. Of these, the legume niche is the most traditional once, as the earliest meat substitutes were based on legumes, such as tofu, tempeh, and falafel. The dairy and fungi niche grew towards the end of the 20th century and are today with legumes the most well-established source-niches. Both algae and insects are ingredients that have been used in cooking in other cultures throughout history, but which are still uncommon to be advocated in the Netherlands. They are currently the most novel ingredients used in meat substitution. The ingredient-niches are social niches in a sense that they represent different ways of substituting meat. The ingredient-niches can be further understood as the base foundation of meat substitution as they provide the nutritional assimilation, whereas the technology-niches provide the texturalization assimilation. The source-niches are the ones more easily distinguishable and acknowledged by the consumer, retailers, and producers, whereas the technology-niches are considered rather exclusively by the producers and technological experts.

The single most important social-practice that has been the main contributor towards the growing consumption of meat substitutes is the flexitarian movement. The flexitarian niche is fundamentally social innovation on our dietary habits as it challenges the preceding idea that meat consumption is a fundamental part of every meal. In a similar manner, the vegetarian and vegan niches are challenging the perception of a healthy diet, even if more radically. These social-practice niches do not explicitly work towards the expansion of the meat substitution innovation system, but they unintentionally contribute greatly to the demand of meat substitute products which fosters supply and innovation.

These individual niches presented are the most prominent ones currently emerging in the meat substitution innovation system. These niches are however by no means at the same level of development, but in fact, some appear more infant and others close to fully developed. The table below categorizes these niches in terms of their level of development. Most importantly, it is the new combinations of the technological, source and social- practice niches that is yielding new innovative products, and by observing which of these niches are fully developed one can effortlessly distinguish the type of meat substitute products currently at the market. For example, a traditional modern Dutch meat substitute relays on fiber spinning uses legumes as its main ingredient and is flexitarian in a sense that milk or egg protein is often used for better taste and structure. The new technologies are being developed with the fully developed ingredient niches and they often apply ingredients of other animal proteins as well. In a similar manner, the algae niche is deploying the established technologies of extrusion and fiber spinning for the creation of its products.

Table 22: The main niches and their level of development within the Dutch meat substitute innovation system.

Innovation areas	Niche	Level of development
Technological niches	Mixing	Fully developed
	Extrusion cooking	Fully developed
	Fiber spinning	Fully developed
	Shear cell flow	Developing
	Stem cell technology	Developing
Social niches: market niches	Legume	Fully developed
	Dairy	Fully developed
	Fungi	Fully developed
	Algae	Developing
	Insects	Undeveloped
Social niches: social-practice niches	Flexitarian	Fully developed
	Vegetarian	Developing
	Vegan	Developing

6.1.2 The regime

The regime that has for long been established in the society and which the meat substitution innovation system essentially attempts to influence is the meat regime: meat substitutes try to influence the amount of meat consumed by offering meat-like alternatives with similarly high protein content and attributes similar to meat in terms of texture, smell, and taste for example. The function of the meat regime is ultimately to fulfill humans' nutritional needs and it was also once a collection of smaller niches that ultimately broke through and

established themselves as the norm. The previous regime that the current meat regime replaced is in itself a complex study that would need profound scientific efforts to determine and it is thus not of importance for the specific MLP analysis. Yet, this notion should be kept in mind as it demonstrates that the meat regime is also a subject for change (which of course, is the whole underlying dynamic enabling MLP study on the topic). The meat regime is a socio-technical regime, where the social part refers to the rules, both cognitive and regulatory, that are prevailing in the society and according to which also the niches must operate with. These rules are further composed of the culture, market, technology, techno-scientific knowledge, sectoral policy, infrastructure and industrial networks. The meat regime could be further specified as a meat production and consumption regime, as even though the primary focus of the study is on the production side, it is ultimately the consumption of meat that meat substitutes try to influence[11].

The meat production and consumption regime has most importantly created a culture in the Netherlands in which meat forms a fundamental part of people's diets and the consumption of these products is considered as a norm. The strength of the regime can be illustrated by pointing out the fact that diets with a contradictory stance on meat consumption are called "isms", such as vegetarianism, veganism and most recently, flexitarianism. The assumption is that if a person does not announce themselves as advocates of any of these isms, they consume meat. There is also a general perception that being healthy and strong requires a high protein intake, and that meat is the best source of this protein. Protein-deficiency seems to be one of the main health concerns of people when it comes to decreasing meat consumption or stopping it altogether. The dietary culture builds around meat consumption is therefore strongly shaping people's perceptions of our nutritional needs and the sources of these nutrients.

The market connected to the current meat consumption is one of the cheap prices and excessive availability. The generally low prices due to the industrialization of agriculture was one of the developments that enabled meat consumption to establish itself so strongly into the Dutch dietary culture in the first place. Prior to it, meat had already of course been consumed widely. However, it remained as a luxury product and it did not thus have such a substantial role in people's diets, nor was it perceived as a necessity. The low prices have contributed towards the widespread access to meat products and it is safe to say that every supermarket and restaurant has a selection of different meat products, if not a business based on one of the isms mentioned earlier. There are numerous small and medium enterprises that have built their whole business around meat, primarily butcher shops but also meat-diners for example. In 2017, there were 1757 butcher stores in the Netherlands, with accounted around 15% of the total food specialty store cluster (Detailhandel, n.d). Butcher stores are an old tradition and one could argue that they also are an important cultural heritage. The number of butcher stores is, however, decreasing: in 2015 there were 1952 such stores in the Netherlands and in 2016, 1839 of such stores[12](Detailhandel, n.d.).

[11] The meat production and consumption regime, much like the meat substitution niches, is composed of a complex network of different actors. It therefore includes not only the animal farmers, but also production facilities, supermarkets, the government and numerous supporting organizations and unions. Creation of a more detailed structural analysis for the Dutch meat production and consumption regime falls out of the scope of this study, but the extent of the system is important to consider.

[12] The decreasing number of butcher stores is not necessary explicitly connected to the (slightly) decreasing meat consumption, but might also have to do with changing nature of where sales take place.

The technology supporting meat consumption does not differ much from one of the meat substitutes. The regime relays mostly on distinctive techniques of preparing and cooking the meat, but also on solutions with more technical build up. These technologies have to do with processing and include technologies that are the same or similar to that of meat substitution production, such as mixing, extrusion cooking, and fiber spinning.

Agricultural policy is especially strongly supporting the meat production and consumption regime. The meat industry is heavily subsidized by the Dutch government, in fact, the capital expenditure on animal agriculture compromises 78% from direct payments, eg. subsidies, which is well above the EU28 average of 65%. In 2015, the Dutch government supported the whole agricultural industry with direct payments of nearly 800 000 million euros to the producers. These subsidies are essential for keeping the Dutch meat industry virtual, as they compensate the low commodity prices that are in place due to the increased competition. One would argue that it is inefficient to continuously subsidize a business that cannot make a profit on its own, as these subsidies keep the price of meat artificially low and thus distort competition. They also increase the tendency for overproduction, which in turn drives the prices lower. The Dutch government is thus in a deep lock-in with the meat production and consumption regime: the livestock farmers do not want to give up the subsidies which guarantee their income, and the politicians do not want to lose the support of the livestock farmers in order to remain in power.

The meat production and consumption regime does not only supply meat for the dinner table, but the industry creates a lot of by-products that contribute towards the profitability of meat industry. It is estimated that about 8% of the income of pork and 11% of the income for beef comes from the by-products (Jayathilakan, 2012). Maybe most self-evidential industry that relays on meat production is the leather industry. Most of the leather used today comes from the beef and dairy cows, and it is the most economically important co-product of the meat industry. More discretely, the meat industry produces by-products that enable the production of for example gelatine and insulin. It also goes without saying that employment and agricultural infrastructure that has been built around meat production is enormous

6.1.3 The landscape developments

The meat substitute niches and the meat production and consumption regime exist in a larger societal context, the landscape, which refers to the prevailing customs and ideas in the society. The landscape developments that are directly influencing the development of both the meat substitution niches and the regime are: growing concerns with the environmental and ethical implication of meat (over) consumption and changing health perceptions. These developments are changing the perception of the meat production and consumption regime by actors both outside and inside the regime and are enabling the growth of the niches. These developments have been introduced more in detail in the introduction section 1.2 in the description of the main problems connected to meat consumption. There is one additional landscape development that is more indirectly influencing the dynamics of the regime and the niches: the quest for culinary novelty.

The constant search for novelty in the culinary world is a rather new development. For most of the human existence, it has seemed that nobody was seriously pursuing novelty in the kitchen, whereas in the Western world it appears as if “cuisine today should reinvent itself without an end” (Beaugé, 2012). The culinary novelty has two dimensions: novelty in the production side and novelty in the consumption side, which interact with

each other constantly. This search for new foods and new ways to eat is without a doubt influencing all the areas of food.

6.1.4 Rules guiding the regime and the niches

In section 5.3 the formal institutions that influence the development of the meat substitution innovation system were identified. However, the structural analysis did not yet try and define the informal institutions that influence the system, nor further distinct between the nature of the rules these institutions pose. The formal institutions are the ones that pose regulative rules on the system. These rules are consciously manmade and have the potential to change rapidly. They are based on the cognitive and normative rules that are slower to change and deeper embedded into the society. In a way, all of these set of rules are articulated based on either past or present landscape developments, and thus they are more fixed in the regime and constantly in the making at the niches. The regulative rules that essentially form the written framework within which the systems can operate is mostly similar for both the meat regime and well as the meat substitution niches and it is based on both the national as well as EU law. When it comes to normative rules, major differences can be observed: whereas meat regime sees animals as property and meat as something essential, the meat substitution niche opposes both views. On a cognitive level, the most important difference between the rule set is that meat regime believes that it can transform into a more sustainable and ethical industry if properly supported, but the meat substitution niches see meat production as an inherently unsustainable practice that can only be improved by decreasing the size of the industry. The rules connected to the meat regime and the meat substitute niches are listed more in detail in the appendix.

6.2 Dynamics between the multiple levels

The dynamics between the meat substitution niches, both social and technical, and the meat production and consumption regime are complex and multifaceted. The main dynamic comes from the pressure that the landscape developments pose on the regime and how the regime responds to these pressures, and the opportunity this creates on the niches to expand. First, the dynamics between the regime and the landscape developments are observed and the nature of the relationship between the niches and the regime discussed. Afterward based on this analysis, the transition context and pathway are elaborated upon.

The meat production and consumption regime is to some extent trying to respond to the environmental, health and ethical concerns that its practices are raising, but it has and can only do so to a certain extent because of its practices are already long-established and thus slow to change. These rules that the regime would be willing to change, or not change, due to the landscape developments are the selection pressures. It is a difficult process to refigure the ways of the industry, and even though important steps have been taken to improve the environmental performance of the Dutch meat production, for example by implementation of regulations on use of antibiotics or wastewater treatment, the fact is that industrial animal agriculture is likely unable to become environmentally sound. Same is for ethics. The ethical landscape developments could be roughly divided between people who advocate humane treatment of animals but who do not explicitly oppose the slaughter and consumption of these animals and people who are against the idea of slaughtering and consuming animals under any circumstances. The regime can only try and address the concerns of those who

long for better treatment of animals but do not oppose meat consumption. There is a growing number of meat producers in the Netherlands who label themselves as fair and organic[13]. In terms of beef, the term grass-fed as a reference to cows that eat only organic grass has gained popularity in the Netherlands in the past years. Beef that is grass-fed is perceived as the ethical option as it guarantees that these animals live with their natural diet and spend a lot of time outside. The grass-fed beef is also perceived to be healthier than grain-fed. However, the environmental and ethical concerns are often difficult for the meat industry to combine: grass-fed beef might be better for the wellbeing of the animals, but it is also much more environmentally intensive as it requires more land use. Same goes in general to every type of animal agriculture: the better the living conditions of these animals are in terms of space and light, natural growth, food and activities, the more resources their production requires. It could thus be concluded that the meat production and consumption regime is selecting to softly respond to the environmental concerns, but is neglecting most of it due to the inherent unsustainability of meat production, as well as the developments relating to animal welfare and health. The search for culinary novelty is a landscape development the regime is also struggling to answer. This is mainly because the regime is so deeply embedded in its own practices: the types of animals that we consider moral to eat is, for instance, social construct and difficult to change. For example, eating dogs or whales are unethical practices in the Netherlands. Therefore, the extent to which the regime can respond to this landscape pressure is obstructed by animal ethics.

The level of coordinating a joint response to the environmental pressures of the livestock industry could be interpreted as being moderate. This coordination is still pretty much starting up and it is impossible to know the eventual impact of it, but there are clear signs of action on the governmental side to make the Dutch industry more sustainable. This coordination attempt does recognize the importance of meat substitutes but does not exclusively mention the decreasing the size of the meat sector at its expense, due to which there are some mixed signals in the air. More overwhelming than this soft coordination on the government part is the coordination of resources by the supermarkets like Albert Heijn and Jumbo, who play a crucial role in bringing the meat substitute products to the market. Many interviewees felt that especially Albert Heijn is an important resource coordinator in regards to this, as they are actively marketing meat substitution products, constantly experimenting with new products and overall giving a lot of exposure to meat substitutes as a product category. When it comes to the actual meat producers, their attempts to coordinate the transition can be regarded as minimal, as the majority of these actors do not embrace the possibilities of the new and growing sector. The resource coordination is thus mostly coming from the actors outside of the meat production and consumption regime, but there are signs of the regime actors getting more involved.

The landscape pressure on the regime and its attempts to respond to these pressures to some extent illustrates that the nature of the interaction between all three levels is disruptive rather than sustaining. The meat substitution niches are, with maybe except to the insects and dairy niche, responding to both environmental and ethical concerns that are raising in the society and thus directly challenging the meat production and

[13]Of all the farm land in the Netherlands, only between 3 and 4 % is used for organic farming, and the market share of organic products is mere 3,3% of total. Due to these low margins it can be concluded that organic farming is still in fact a niche of its own and does not represent the established meat production and consumption regime.

consumption regime[14]. They are most definitely not enabling the regime to stay in place unchanged, but are really pressuring it to transform, with the threat of meat substitution taking over as the new regime if no action is taken on their part.

It is however rather difficult to pin down whether the relationship between the niches and the regime is competing or symbiotic in nature. This is largely due to the fact that the meat substitute innovation system consists of many different niches who also have the diverse aspiration of its future. Some, such as the cultured meat niche and vegan niche, want the meat substitute products to make the whole meat production and consumption regime obsolete. On the other hand, the majority of the niches see meat substitutes as products that can coexist together with meat but also influence the operation of the regime. One meat substitute producer, interviewee 11, with a portfolio consisting of both meat and meat substitute products, saw meat substitutes as a way to change the quality of our meat and the consumption pattern. According to this person, meat substitutes provide variety in the kitchen and are especially good at substituting the low-quality meat that is consumed today, which is mostly highly processed products such as sausages and hamburgers. When meat substitutes cover these type of low-quality meat products, the meat industry can concentrate on producing premium meat products that not only are of better quality but which are also been produced in a more humane and environmentally sound way[15]. Of all the interviewed experts, nobody went so far as actually stating that meat substitutes will completely overthrow meat in the Dutch diet. It can, therefore, be concluded that the relationship between the niche and the regime is, at this point in time at least, symbiotic rather than competing. Rather than completely overthrowing the regime, meat substitutes could break through into the regime and replace parts of it, mainly the low-quality products. Some meat substitution technology could also to an extent be adopted by the meat industry to enhance its competence and environmental performance for example, as in case of hybrid meat products. Of course, this kind of dynamic is dependent on how the niches further develop. If cultured meat niche, for example, develops faster than expected and is able to break through within the next few years, it would definitely result in a more competitive relationship.

The structural change that the breakthrough of meat substitute niches would bring to the meat production and consumption regime would likely be moderate. Most evidently, the meat production would drastically decrease, as the new products would require part of its market share. Depending on the speed of the transition, this structural transition could either take place in a harmonious or dissonant way. If a niche breaks through rapidly and unexpectedly, it is unlikely that the actors within the regime have time to adapt to this development fast enough. This would thus lead to increasing unemployment within the meat sector, which in turn could lead to more resistance towards the new meat substitution sector. Whereas if the transition builds momentum more steadily over time, the actors have more time to adapt and coordinate resources, in which case the actors within the meat sector have the potential of experiencing less disruptive unemployment and thus resistance. This type of development can currently be observed especially regarding the shear cell niche and the fiber spinning niche as well as some ingredient niches. Examples of such businesses already expanding their

[14] Consuming insects is a niche directly responding to the environmental aspects of meat, whereas dairy is not in a strict sense answering to neither.
[15] The extent to which this is possible, as most of the environmental impact of meat production comes from biological processess that are close to impossible to control as mentioned earlier.

portfolio towards meat substitute niches includes Meatless and Olijck, as well as the in-house brands of supermarkets like Albert Heijn and Jumbo. Based on the data collected for this study, it is difficult to know for certain whether the Dutch meat sector is actively developing strategies to get involved with meat substitution. However, in general, many of the interviewees felt that an increasing number of actors of the meat sector are seeing the growth of the meat substitution industry as an opportunity rather than a threat.

The transition pathway that is currently being explored through these dynamics is reconfiguration. There is landscape pressure on the regime, but this pressure is yet to be translated only to the actions of a small part of the population. The niches connected to meat substitution are either fully developed but do not have the potential to transform the system by themselves at the given time, or still developing and thus in need of more resources and support to fully establish themselves. Of the niches that are fully developed, the legume niche offers tasty meat-like alternatives that can be used in the same way as traditional meat products, but to truly break through a deeper social change in the Dutch dietary preferences would be required. The flexitarian niche, on the other hand, is strong, but as it mediates between the meat production and consumption regime and the meat substitution system, it does not have a fully transformative power. These niches, however, do add pressure on the regime and make it subject to change, they just cannot bring the change themselves. Of the developing niches, the two developing technology niches have especially strong potential to greatly disrupt the regime as these technologies result in immerse improvements in texturalization of the meat substitution products. However, as none of these niches are fully developed yet, the regime has time to refigure itself and respond to the landscape developments by adapting symbiotic niche innovations. As stated, this is currently slowly happening and is illustrated for instance by the introduction of hybrid meat products at the supermarkets and large corporations expanding their portfolio to meat substitute products. The reconfiguration of the meat production and consumption regime and its uptake of meat substitute innovations is further fuelling innovation in the meat substitution system. Due to the adaptation of the niche innovations by the regime, the actors of the new regime are likely to partially stay the same and partially be replaced by the niche actors. Change of actors is likely to be most radically observed within the producers. The exploration of this path is at the very beginning, and it is impossible to say whether the development will continue and the regime reconfigures itself or whether other pathways are explored. Due to the lock-in between the government and the livestock industry as for the enormous subsidy scheme, to what extent the regime would actually allow the substitution niches to intervene remains a mystery.

Table 23: Summary of the characteristics of the current transition path.

Indicator	Characteristics of the aspect
Extent to which the regime experiences pressure from the landscape	**Moderate** The pressures of especially environmental and ethical concerns are there are growing, but this concern is not fully translating into a change of practices and thus not putting too much pressure on the regime.
Extent to which the niche tries to overthrow the existing regime or not	**Low**

	Different views between actors, but in general meat substitute niches see themselves as products that can decrease meat consumption and uplift the quality of meat products that remain.
The degree of conflict between the regime and the niche	**Low** There is general resistance from the regime part, especially government, but this is rather discrete and due to deep embedded rules and structures rather than actual clash.
The degree of structural change within the regime due to the adaptation of niche developments	**Moderate** Currently, the transition is taking up slowly and even though the structural change in terms of changing rules and practices is likely to be great, the physical structures will for the most part remain the same (with the largest change being observed in producers).

6.4 Conclusion

The niches that form the meat substitution innovation system consist of both technology niches and social niches and the social niches can be further divided between market niches and social-practice niches. These niches are all in a different level of development. Meat production and consumption regime is the prevailing system that these niches are trying to influence. There are four important larger societal developments that guide the development of the niches as well as the regime: concern over climate change and animal ethics, changing health perceptions and quest for culinary novelty. The pressure that these landscape developments pose on the regime remain small, but the regime has taken steps to respond to them especially by improving the sustainability of the meat sector. The interaction between the three levels of analysis is disruptive rather than sustaining, whereas the relationship between the niche and the regime is symbiotic since meat substitute products do not generally strive to make meat obsolete, but rather co-exist and replace parts of it. Thanks to the moderate landscape pressure that is not translating into a harsh change of consumer practices, the meat regime has time to reconfigure itself and it is thus actively strengthening its own establishment by adopting some meat substitution innovation, meaning that only medium structural change in terms of actors is expected. At this point in time, the reconfiguration seems to satisfy majority of the consumers, but it is not likely to yield the environmental improvements needed to combat climate change.

Chapter 7: Functions of the Innovation System

In this chapter, the functioning of the Dutch meat substitution innovation system is analyzed according to the theoretical framework created by Hekkert et al (2011). They distinguish seven system functions which analysis helps to discover the strengths and bottlenecks of the innovation system: entrepreneurial activities, knowledge development, knowledge exchange, guidance of the search, market formation, resource mobilization and counteract resistance to change. Their theory is extended with the work of Alkemade & Suurs (2012) by dividing the function of market formation further into government driven and entrepreneurial driven market formation, and the work of Planko et al (2017) by incorporating the role of shared expectations more closely to the functioning of guidance of the search. The analysis is to a large extent based on qualitative data gathered through the expert interviews, which are references in accordance with the table 3 in section 3.4.

7.1 Entrepreneurial activities

The Dutch meat substitution innovation system includes a wide variety of different types of entrepreneurs that operate in different segments of the market. The number of industrial actors that develop meat substitution products has grown rapidly in the 2010's stimulated by the strong market growth of meat substitution products. As much as the industry has grown, however, the market remains small: 79 million in the Netherlands in 2016 in comparison to the billions of the meat industry (Green Protein Alliance, 2017). The small but rapidly growing market contributes towards stimulating innovation as everyone is constantly searching for new and better production techniques, materials and business models to distinguish themselves from the competition and get their share of the growth. In this section, the entrepreneurial activities of the Dutch meat substitution system are analyzed in terms of (1) the amount and type of entrepreneurs and the diversification of these types, (2) level of experimentation and production by these entrepreneurs and (3) their market presence.

The structural analysis of the innovation system distinguished 22 industrial actors operating within the field of meat substitution. Of these actors, 19 companies have their brand's meat substitution product already on the market and 3 operate on business-to-business basics. Closer shot of the structural map of the innovation system includes 12 of these industrial actors (picture 4). The largest meat substitute producers under their own brands in terms of volume are Vivera, The Vegetarian Butcher, and Garden Gourmet. Majority of the interviewees also mentioned at least one of these three companies amongst the most influential actors within the system, and interviewees 6 and 8 even exclusive named all three of them as most influential. Ojah and Meatless are enterprises that produce texturized vegetable protein products solely from business-to-business. Ojah's texturized vegetable protein was used for example in the first Vegetarian Butcher's products as well as in the making of the Dutch Weed Burger. On top of having their own brand Goodbite, Schouten Europe also makes meat substitute products for other private labels. It must be noted that it is difficult to acquire more in-

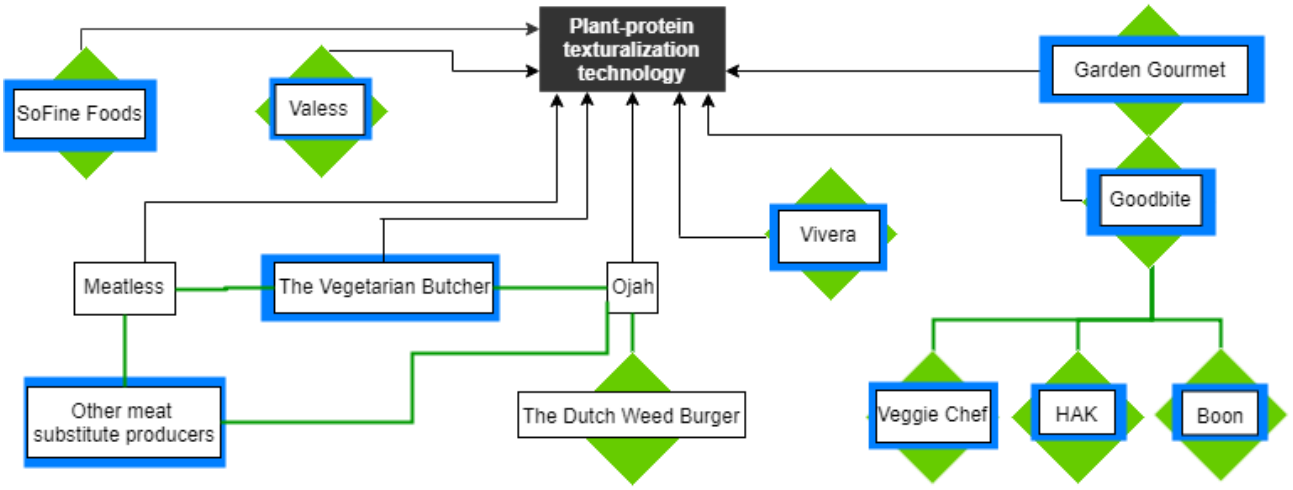


Figure 13: Snapshot of the industrial actors as presented in the structural analysis in chapter 5.

depth knowledge of the sub-contractor relationships between the larger industrial actors and smaller brands. However luckily, for the functioning of the innovation system, the importance lays within the entrepreneurs that themselves develop and use substitution technology. The smaller sub-contractor brands play a role especially from consumption side, as their product development in terms of use of ingredients and their marketing strategies can have a major influence on the consumption and market exposure of meat substitutes, as for example does the Dutch Weed Burger.

All the 13 meat substitution experts agreed that currently, there are enough entrepreneurial actors operating within the meat substitution market, due to which the amount of entrepreneurs is interpreted to be sufficient. Interviewee number 8 even strongly felt that there are way too many active entrepreneurs, stating that: “Everybody gets into vegetarian because everybody thinks there is a huge market and that there is a lot to sell and a lot to do. Well, it is not.” From an innovation point of view, there can never really be too many actors on a market as competition drives innovation and eventually, some actors will win and thrive and some will lose and cease to exist. Prior to 2015, all the producers of meat substitutes were relatively small actors, and it is only since then that there has been a clearer distinction appearing between the large meat substitute producers and the smaller ones. Currently, as many interviewees mentioned, the big money is getting involved in the sector as large multinationals the likes of Unilever are starting to invest, which is likely to further increase the gap between the small-and-medium and the large meat substitute producers (interviews 1,2,4,8,12 and 13). Interviewee number 12, a technology producer, stated that “when you are entering this market it is really difficult to get in and position yourself”, an observation that is likely to become even more difficult in the future. Of the meat substitution producers included in figure 12, Garden Gourmet is the only one owned by a large multinational corporation, Nestlé, who purchased the company from Tivall in 2015. Veggie Chef is part of Jumbo, which belongs to Van Eerd Group, a rather large and privately-owned company. Many of the companies have a strong connection to the bio-industry: Valess is owned by Friesland Campina, a large Dutch dairy production company and Vivera belongs to the Enkco Food Group, which is a large Dutch company primarily focused on meat. HAK and Goodbite are both Dutch family companies and the Vegetarian Butcher was set up by a group of two friends.

In addition to Friesland Campina owned Valess and Enkco Food Group owned Vivera, many other of the enterprises are owned by companies with a diverse portfolio on both meat and meat substitutes. The commercial director of Vivera stated the following concerning the portfolio of the Enkco Food Group: “December 2017 was the first time we were selling more meat substitutes. And now already we are selling 15% more meat substitutes than meat. The meat is going down a little bit and meat alternatives are going up. And in my opinion, we are only at the beginning of it.” Perhaps, as the meat substitution market experiences strong growth, these companies are more and more likely to increase their share of meat substitute products in their portfolio. Interviewee 8 mentioned that it is much more profitable to sell meat substitutes rather than meat, as it is easy to create added-value as oppose to meat products. For example, Meatless was an old meat processing facility that decided in 2003 to change their market strategy, and in 2007 began to sell off their meat assets. The enterprises operating in meat substitute production in the Netherlands thus includes not only a mixture of different sized companies but also companies with diverse backgrounds.

Of the 22 companies identified in the structural analysis, 16 operate within the legume niche. The three largest producers; Vivera, The Vegetarian Butcher and Garden Gourmet, also all belong primarily within this market niche. The two other mature niches, the dairy niche and the fungi niche, both have one substantially sized company on the market: Valess for dairy and Quorn for fungi. Up till now, these companies have not been seriously challenged for niche dominance. The sea-vegetable or algae niche has quite some advocation in the Netherlands, and there are at least three companies which produce these types of meat substitutes. In terms of market niches, the legume niche is clearly the most prominent one, however, there is a rather sufficient level of diversification between the types of niches, also from a technological and social practice point of view.

The level of experimentation and production by these entrepreneurs in another thing to consider. Everybody interviewed for this research surely agreed on one thing: the Dutch meat substitution innovation system is extremely dynamic and characterized by extensive efforts to innovate. Not only new technologies and products but also business models and strategies to increase the share of meat substitutes in the Dutch meat consumption. In a rapidly growing market with a lot of competition, innovation is the only way for the companies to maintain their market share and naturally for new companies to require any. As interviewee number 8 put it: “In dairy and meat, there are products that we have known for hundreds of years, but these types of vegetarian products have only appeared in the last 30-40 years and there is a lot to discover in there. So, everybody is looking for new textures, new raw materials, new ideas, new innovative food, everything.”

As the historical overview showed, in the past 10 years the technology to produce meat substitutes has taken giant leaps. Due to an active search for new ways to create products that represent meat in detail, technologies that rely on spinning and shear flow have emerged next to the traditional extrusion technology. These technological innovation activities take place both at universities and at commercial companies. The commercial companies can roughly be divided between large meat substitute producers that themselves take efforts to improve texturalization technology, such as the Vegetarian Butcher, Vivera, Goodbite, Ojah and Meatless, and small and medium meat substitute producers who purchase texturized material from the other companies, such as Boon and the Dutch Weed Burger. This division, however, is by no means definite, as many of the larger companies do or have done both and HAK, for instance, is a large company that sub-

contracts texturized vegetable protein from Schouten Europa[16]. Interestingly, it seems like some of the companies started up by purchasing texturized material from the larger companies and began to innovate themselves more extensively once the businesses grew, such for example did the Vegetarian Butcher.

Developing texturalization technology does not only require specific skillset, development of such is also expensive and time-consuming, therefore a task left most of the time either to the public fund Universities that don't have a financial risk or subsequently larger companies. However, the small companies are often the ones that can be more innovative in terms of material usage and business models. For example, the insects and algae of seaweed niches are still mostly explored by small companies such as the Dutch Weed Burger and Olijck. Here, of course, the differences between niche developments are important to consider: whereas plant-based meat substitutes are becoming more normalized the use of other substitution material is still not. Due to all of these factors, the level of experimentation and production can thus be regarded to be high.

When it comes to market presence, the sector could do a little bit better. Meat substitution products are almost exclusively sold at supermarkets, where they are positioned in close proximity to their meat counterparts, and where they occupy a lot of shelf space. One of the most direct ways to witness the growth of the industry is, in fact, observing the development of the amount of shelf space reserved for these products at supermarkets. Despite their strong presence at these stores, however, meat substitution products are not sold at the traditional butcher where many still go to require their meat. The substitution products are therefore not present at an important segment of the market and may thus be missing an opportunity. The Vegetarian Butcher Concept Store in The Hague is an innovative attempt to try and bring the meat substitute products to the consumer through a new way, such is also the company's new pop-up restaurant Meat Lobby. Garden Gourmet owns a Flexitarian food truck that travels around the Netherlands on festivals, also an interesting strategy to try and get more consumers to taste these products. The Dutch Weed Burger is not sold at the supermarkets but can be found from several restaurants across the country, as well as the company's own restaurant in Amsterdam, The Dutch Weed Burger Joint. Vivera is the meat substitute producer most notably involved also in the field of hospitals, caterers, and take-care facilities. Several actors operating in these fields purchase products from them, due to the relationships created when Enkco was solely a meat company.

Due to the high number of actors present at the industry, the diversity of these actors in terms of operational activities and their extensive efforts to innovate, the innovation potential of the entrepreneurial network is promising and therefore the functioning of entrepreneurial activity is interpreted to be high.

Table 24: Extent to which the indicators for the functioning of entrepreneurial activity are fulfilled

Indicator	Extent
1. Type and diversification of entrepreneurs	High
2. Innovation potential of entrepreneurial network	High
3. Market presence of the entrepreneurs	Moderate
Total functioning of entrepreneurial activity	High

[16]HAK purchases material from Schouten Europe likely due to the fact that meat substitution is not their core business, but meat alternatives.

7.2 Knowledge development

There are several types of knowledge which development is either directly or indirectly beneficial to the meat substitution innovation system. Important indicators for the functioning of knowledge development to consider are (1) the amount of knowledge being developed and the quality of it, (2) the efficiency of developing this knowledge and (3) the novelty of this knowledge. These indicators are assessed in terms of three different bodies of knowledge: technical knowledge, business knowledge, and non-technical scientific knowledge.

First, there is the generation of technical knowledge that, as mentioned earlier, is a joint effort between universities and large meat substitution companies. Remarkably, the knowledge generated at the universities often leads to commercialization of the technology afterward by parties involved in the primary development process. As an example, Ojah was founded in the late 2000's by a group of food scientists, including Jeroen Willemsen, who were "frustrated that the work they did on the academic level was not translated to the real world and thus not having any actual impact". In a similar manner, Mosa Meat span from the Maastricht University research group on in vitro meat after the introduction of world's first laboratory-grown burger. Traditionally, universities concentrate on the generation of theoretical knowledge whereas businesses work on more applied knowledge and solutions. This distinction, however, does not apply for technical meat substitution research where the universities are also strongly partaking in applied research activities of meat substitution technology. A lot of technological knowledge is also developed by companies that have a history of food processing and who have or currently are shifting towards meat substitute production. These companies have the required know-how when it comes to food processing as well as the ready infrastructure. For example, Meatless was originally such a meat processing company that extended their business to the texturalized vegetarian material. The technological knowledge is primarily developed at the universities and large meat substitution companies due to the sole fact that generation of the type of knowledge is often not only time consuming, but also expensive, as mentioned in part 6.1. Research done especially at the university level guarantees that the knowledge sought is novel, and that there is minimal overlap with these knowledge development activities. Naturally, commercial companies act different and it is likely that many are working towards similar type of solutions, however, unlike the universities, these companies operate with greater pressure to bring new solutions to the market and thus the efficiency at which this knowledge is developed is especially impressive. The introduction of the top-sector law[17] has increased the cooperation between universities and (large) meat substitution companies, which has likely made the knowledge development at the university level more efficient as the tying of these two together gives pressure on the universities to deliver results.

Second, there is the generation of business knowledge. Meat substitution in its modern essence is a new phenomenon that has not really taken root in the market yet and efforts to expand it are taken by several different parties. Interviewee 12 characterized the meat substitution market as "a really small market that does

[17] The top-sectors policy has changed the way scientific research gets funded, in effect so that its prerequisite is an interest of an outside public-party of the top sector. The top-sectors approach has increased the private influence on public research but simultaneously lead to alignment of strategies and more efficient use of resources. Part of the reason that such a new approach was taken was to stimulate the Dutch private investment in research. and development and to direct public resources towards the most relative issues at hand.

not have the full interest of the consumer", which illustrates the need to find a way these products end up in the hampers. Strategies to do this are constantly developed, tested and implemented. This again is done by both universities and companies, as well as research institutes to some extent. The generation of business knowledge by the companies has to do mostly with trial and error: for example, testing the borderlines of meat substitute products that the market is ready for by the retailers[18], experimenting with substitution of different meat products such as chicken, sausages or fish by the producers and trying out of different marketing strategies by both. One meat substitute producer explicitly mentioned testing the impact of different product names on consumers' willingness to try free samples of these products at the supermarket. The experiment yielded results that were then used in the branding and naming of these products. Generating of this type of business knowledge is crucial especially for the novel meat substitute products, as it can truly make the difference whether these products make it or not. The business knowledge created at the universities and research institutes is more analytical in nature and has to do for example with marketing strategies. Assessment of generation of business knowledge is trickier than that of technical knowledge, however, there is no reason to doubt the amount, quality, efficiency or novelty of business knowledge that is currently being developed, especially in the light of the growing market share of meat substitution products.

Thirdly, there is the generation of non-technical scientific knowledge that has to do with consumer acceptance, environmental impact, ethics and nutritional implications of meat substitutes for example. This type of knowledge is likely to have less direct added-value than technological and business knowledge, and it is thus almost exclusively done by universities and private research institutes. Often the generation of this type of scientific knowledge is ordered by the government when in need of scientific evidence to support decision making, or by meat substitute producers who wish for favorable conclusions to be utilized in marketing. Much like the added-value of this type of knowledge is less direct than the others, it is more problematic to evaluate this type of knowledge development. However, there are quite some people in the Netherlands working towards the generation of non-technical scientific knowledge, many to who I spoke, and there is no evidence pointing towards this knowledge development being insufficient in any way.

Table 25. Extent to which the indicators for the functioning of knowledge development are fulfilled

Indicator	Extent
1. Amount and quality of knowledge that is being developed	High
2. The efficiency of developing new knowledge	High
3. The novelty of developed knowledge	High
Total functioning of knowledge development	High

[18] As an example, an important experiment in this sense was done by Jumbo back in 2015 when they introduced the first insects based meat substitute sold at Dutch supermarkets. Even though the product was soon withdrawn due to lack of success, it gave important insight to what the market is ready for.

7.3 Knowledge exchange

The functioning of knowledge exchange is assessed in terms of the following indicators: (1) quality of the network and the degree of interaction over time, (2) presence of formal organized networks, (3) level of collaboration across different actor-groups and (4) level of collaboration across geographical borders.

Like any commercial company trying to maintain their market share and conquer more, the meat substitute producers are no different. These companies exist and thrive because they possess unique knowledge that they can effectively put to good account (interview 8). This knowledge is their existence due to which there is a lot of company-secrets in the industry especially in terms of technological knowledge and business knowledge. Besides the high level of competition between the producers, there is a lot of cooperation and a high level of networking in the industry, as the structural graph in chapter 5 demonstrates.

The Green Protein Alliance is the single most important formally organized network for the meat substitute innovation system, and it was mentioned in one context or another by all the interviewees except two (interviews 5 and 9). Its members are in constant cooperation with each other when generating plans on how to further foster the growth of the meat substitution sector. The members of this network share knowledge that relates to developments in the meat industry for example, but the network exists primarily as a lobbyist tool rather than a hub of knowledge-exchange. The members and partners of the GPA also include actors from all the actor groups.

The technological knowledge exchange between knowledge institutes and meat substitute producers has slightly increased since the implementation of the top-sectors approach that encourages public-private partnerships. Thanks to the top-sector policy the collaboration between private parties such as Unilever and the Vegetarian Butcher with the Wageningen University to further develop research on shear-cell technology started up with the project Plant Meat Matters in 2017. This type of research collaboration is also partially organized in a formal network of the Protein Competence Center. The organization brings together the knowledge parties that work on the fields of biorefinery and processing, proteins as ingredients, protein functionality and chain aspects of new protein sources with the commercial companies. As much as working as a platform through which the different parties can interact and set up cooperation, both the Plant Meat Matters and the Protein Competence Center are formal organizations that demonstrate the joint research efforts of the sector which include a variety of actor types.

However, not all the businesses exchange knowledge with the academic world. For example, Goodbite does not formally cooperate with public researchers but relays on their own research efforts. There is no proof of cooperation between the university world and the business world when it comes to generation of business knowledge. Not a single producer mentioned an instance in which they would have collaborated with this type of outside parties to for example generate new market strategies. Collaborating in this extent is not necessary essential for the functioning of the system, but it could potentially lead to more innovative business strategies as well as pique the interest of the business students towards the industry, thus functioning as an early stage of recruitment. The exchange of non-technical scientific knowledge is moderate and there is room for improvement. Research conducted by both universities and private research institutes that relates to meat substitution is not actively read and made use of by the producers if not explicitly ordered from their part.

Researchers from knowledge institutes that generate this type of knowledge all indicated that they interact frequently with both the producers as well as the government representatives who express interest in their research, but majority of the meat substitute producers indicated that they do not actively search this type of knowledge, nor is there a formal organization through which to do so. It could thus be that the actors from the knowledge institutes actively seek themselves actors to whom their work could be of interest, and if done so this work is often noted by these actors. However, without activity from the part of knowledge institutes in this instance, especially the producers are unlikely to reach the knowledge developed.

The Dutch meat substitution innovation system exchanges knowledge across international borders to a low degree, even though a similar trend of meat reduction and substitution is taking place also in other parts of the world, namely Belgium, Germany, The United Kingdom, Scandinavia, Canada and The United States. Of all actors in industry who were interviewed, only one indicated that they actively collaborate with international actors (interview 8). Interviewee 1, a technology developer, for example stated that: “That’s a thing, with the equivalent industries abroad, there is not much cooperation. The companies within our project are mostly Dutch companies.” Naturally, due to geographical proximity the interaction within Europe is expected to be more vivid when in place, except for cultured meat of which actors in the Netherlands are tightly collaborating with parties in the United States such as the Good Food Institute. There is, however, no formal organization in the European Union or elsewhere that brings together the actors of different meat substitution innovation systems across the region, apart from some pro-vegetarian organization who do not directly influence innovation activities. These organizations, such as ProVeg, act to raise awareness and exchange knowledge on how to promote a plant-based diet and reduce our consumption of animal products in more general sense.

It can be concluded that the actors within the Dutch meat substitute innovation system are well organized in networks and the different types of actors also interact with each other frequently. However, there is room for improvement especially when it comes to international cooperation and exchanging non-technical scientific knowledge.

Table 26: Extent to which the indicators for the functioning of knowledge exchange are fulfilled

Indicator	Extent
1. Quality of network and degree of interaction overtime	High
2. Presence of formal organized networks	High
3. Level of collaboration internationally	Low
Total functioning of knowledge exchange	Moderate

7.4 Guidance of the search

With so many actors involved, the vision of the future of meat substitution is a bit different depending on who you ask. At this point of research, the analysis of the functioning of guidance of the search focuses on shared visions. Individual actors’ expectations about the future are also of importance, and their impact on the shared visions is analysed more in detail later in chapter 9. The functioning of the guidance of the search is analysed through the following indicators: (1) presence and quality of specific targets set by the government and the

industry, (2) articulation of clear future visions and (3) degree of alignment of the expectations and visions of governmental and industry actors.

The most specific vision for meat substitution is set by the Green Protein Alliance who wants to bring the protein balance back to 50:50 by 2025. This refers to a situation in which 50% of our daily protein comes from plant-based sources and 50% of animal sources. In 2016 the protein balance was 63:37, where the 63% of the daily protein was delivered from animal products (Green Protein Alliance, 2017). This vision is agreed upon by the extensive member network that can be found in entire in chapter 5 and elaborated in detail on the official growth plan of the GPA. This vision is formally shared also with parties who are not primary producers of meat substitution products, such as Albert Heijn, Jumbo, and Unilever. In addition to the articulation of a clear vision, the GPA also has a strategy through which is aims to reach this vision based on increasing the demand for vegetarian products. When asked about a shared vision of meat substitution, the topic was commented by interviewee 13: “I think the way how we have worked together, starting with Het Planeet and then with Green Protein Alliance later, you see that we have a very clear vision as a total branch where we need to go with meat alternatives and how we are going to do that. It only needs to be done now.” Overall, GPA and their vision was mentioned in nearly all of the conducted interviews, especially in the ones with technology producers. The vision of GPA is, however, rather soft and one could argue that it lacks focus for meat substitution products as defined in this research, as it includes also other traditional protein sources such as unprocessed legumes and nuts. Their goal is thus inexplicit when it comes to how the 50% protein intake from green sources would look like and it does not give specific guidance to the development of the system, for example, the type of technologies or ingredients that could reach this vision. This is of course due to the commercial nature of the organization and wide variety of actors that are involved.

The government has not officially agreed on the GPA’s vision to bring back the protein balance of 50:50, but has with the creation of the Dutch Food Agenda officially committed to making the Dutch food supply more sustainable, healthy and safe. A problem with the Dutch political system from this point of view is the lack of continuity: with every election the government changes which means the generation of new goals and visions, sometimes at the expense of the old ones. However, meat reduction seems to fit well within the vision of the new Food Agenda in which the importance of increasing the consumption of plant-protein over animal-protein is clearly stated. This vision is at this point of course still soft as it does not include any specific targets for meat substitutes, but maybe as the agenda develops the vision becomes more concrete. Importantly, the New Food Agenda is a joint effort to bring sustainable food production amongst the important political issues of the current government, but much like the vision of the GPA, it does not explicitly mention how this could be reached.

The Nutrition Centre’s (Voedingscentrum) national dietary recommendations do neither mention the protein balance of 50:50. However, when orientating with those recommendations more carefully one notices that they, in fact, do encourage the Dutch to consume with the 50:50 protein balance. These dietary recommendations are the ones taught at the educational institutions for example. It could thus be stated that the vision of 50:50 protein balance is shared, even if not necessarily consciously, by the national health experts of the country.

These visions, goals, and recommendations are agreed upon by the level of businesses and ministries, which means that the generation of them has without a doubt been behind a long process of debate and compromise.

Therefore, it is sure that the individuals behind these businesses and ministries all share somewhat different visions in their own head. It is unlikely, though not impossible, that no entity that has agreed these formal vision does not actually want them to be fulfilled, but many actors vision a more drastic transition. In terms of these formal visions, it could be thus stated that they are as strong or wide as the most moderate vision amongst the members. As interviewee 2 pondered: “I think there are many visions, some far more radical than others. When it comes to meat, there are always actors that think the change should be far more radical than official policies go. And this is something that is characteristic of every big societal transition, that the official policies are not the most radical ones. At least not at this moment. And some actors are prepared to go and to think much further.”

In addition to the carefully articulated visions, expectations, when shared, also generate visions of the future. They as such are not as explicit nor necessary as directly connected to meat substitution as formal visions, but their existence can in turn support or undermine these greater visions. These expectations can be either positive or negative, general or unspecific and short term or long term. In chapter 4 the main developments and actions that have influenced the development of the meat substitution system in the near-past were listed. The table below presents again these events and the expectations, which are regarded as strategies on which expectations are based on. Therefore, the table below introduces expectations that have been identified relating to the developments and actions.

Table 27: Main expectations related to developments and actions in the past 10 years

	Developments and actions	Expectations	Characteristics of these expectations
Political	Generation of the New Food Agenda	Climate change will increasingly influence the Dutch agricultural system and meat substitution can partially contribute towards a more sustainable food system Consumers are becoming increasingly aware of the linkage between meat consumption and climate change and thus governmental action needs to be taken to secure the support of the people	Positive, general and long-term expectations by political actors, primarily governmental bodies
	New national dietary recommendations encouraging for less meat consumption	Decreasing the national meat consumption could have a positive influence on the health of the nation	Positive, specific and long-term expectation by health experts and governmental bodies
	Coming together of the producers of meat substitutes under Het Planeet	The meat substitution market will grow more rapidly with collaboration Meat substitutes are a product segment that the consumers will find increasingly appealing for environmental, ethical, health, and culinary reasons	Positive, general and relatively short-term expectation by meat substitute producers

	Creation of Green Protein Alliance	The meat substitution market will grow more rapidly with collaboration also with actors in retail, research and policy Meat substitutes are a product segment that the consumers will find increasingly appealing for environmental, ethical, health, and culinary reasons Decreasing meat consumption will only appear in the political agenda with strong lobbying	Positive, general and relatively short-term expectations by primarily meat substitute producers Negative, general and relatively short-term expectation by primarily meat substitute producers
Economic	Strong market growth of meat substitute sector on yearly basis since 2010 (excluding the stagnation of 2015) – doubling of the turnover in the past 10-year period	The meat substitute market will continue to grow strongly Meat consumption will slowly start decreasing again, since the stagnation of 2017	Positive, general and short-term expectations by meat substitute producers and retailers, as well as other individual actors in fields of research and policy for example
	Organization of the New Food Challenge to offer funding for promising plant-based protein start-ups	There are many innovative people and companies in the Netherlands who can contribute towards new solutions for green protein With little financial help these companies can thrive and their solutions eventually take root in the society	Positive, general and relatively short-term expectations primarily by the government
Social	Trending of flexitarianism, vegetarianism and veganism	These segments will continue to grow – flexitarianism most strongly There will be a growing need to substitute animal-based products not only in meat, but also dairy and eggs	Positive, general and both short-and long-term expectations by the meat substitute producers, retailers and civil organizations
	Linking processed meat consumption with increased risk of colon cancer, heart attack and diabetes	Meat consumption will decrease due to the found adverse health effects People will start consuming more plant-based foods, but still have a taste for meat and want to consume these type of products	Positive, specific and both short- and long-term expectations by meat substitute producers, retailers and civil organizations
	Growing understanding that meat is not an essential part of balanced and healthy diet	Meat consumption will decrease and people will start consuming more plant-based foods	Positive, specific and both short- and long-term by meat substitute producers, retailers and civil organizations

Technological	Realization of large-scale high moisture extrusion technology	People want to consume products that are familiar in terms of taste and texture and that are easy to use Products created with this technology can imitate meat in detail and pass to consumers as an acceptable alternative to traditional meat	Positive, specific, short-term expectations by the developers of the technology
	Intensifying research on shear cell technology	People want to consume products that are familiar in terms of taste and texture and that are easy to use Products created with this technology can imitate meat in detail and pass to consumers as an acceptable alternative to traditional meat	Positive, specific, short-term expectations by the developers of the technology, big investors and the government
	Intensifying research on cultured meat	Stem cell technology could replace animal agriculture altogether There is potential to realize the commercial application of cultured meat in the near future	Positive, specific, both short- and long-term expectation by the developers of the technology and hobby investors
	General improvements in food processing technology	People want to consume products that are familiar in terms of taste and texture and that are easy to use Products created with this technology can imitate meat in detail and pass to consumers as an acceptable alternative to traditional meat	Positive, general, short-term expectations by the developers of the food processing technologies, retailers and the consumers of meat substitution products
Environmental	Strengthening scientific evidence on the environmental impact of meat production and consumption	Meat consumption will to some extent decrease and people will start consuming more plant-based foods Concrete policies and regulations are needed to drastically influence meat consumption	Positive, general, short-term expectation by meat substitute producers, researchers, retailers and actors in the civil society Negative, general, both long-term and short-term by the meat substitute producers, researchers and actors in the civil society
	Ratification of the Paris Climate Goals	The Dutch government will take more extensive efforts to combat climate change	Positive, general, both short-term and long-term expectation shared by pretty much everyone
Legal	New regulation on Novel Food Law	It will become slightly easier to introduce novel foods in the European Union Selling of insects will be shortly slowed down due to the interpretation of the original law	Positive, specific, short-term expectation shared by the government and meat substitute innovators Negative, specific, short-term expectations shared by the government and the producers of (insects) based meat substitutes

	Schnitzel Gate	The Dutch meat sector will increasingly resist the development of the meat substitution sector through the government	Negative, specific, short-term expectation by the meat substitute producers and the advocates in civil society

Majority of the shared expectations presented are positive, and thus they can support the more explicit visions about the future of meat consumption and meat substitution in the Netherlands. Most importantly, no shared expectations were detected which would directly undermine these visions. Based on these three somewhat-similar visions of the GPA, the Dutch government and the Nutrition Centre, it can be stated that the guidance of search is moderate in the Netherlands. The most explicit common vision is by the GPA, but even that has to do mostly with the articulation of an overarching vision rather than a set of specific targets and thus its quality remains questionable. The GPA has a strategy on how it aims to achieve this vision, but it does not attempt to try and guide the type of niches for example that could or should fulfill this vision. It thus does not intervene with the innovation activities or the allocation of resources between the niches, but rather enables the whole innovation system to organically develop. Eventually, the market would be the one who decides towards which direction the development should go. It can be concluded that there is a commonly shared vision about the future of meat alternative consumption which is good from a consumer standpoint, but from an innovation perspective standpoint, it lacks focus.

Table 28: Extent to which the indicators for the functioning of guidance of the search are fulfilled

Indicator	Extent
Quality and type of specific targets set by the government and the industry	Low
Articulation of clear future vision by the government and the industry	Moderate
Alignment of shared visions	High
Total functioning of guidance of search	Moderate

7.5 Market formation

As much as is currently happening in the meat substitution industry, the market remains almost microscopic in comparison to the meat industry. The meat substitution market has grown steadily, except for 2015, since the turn of the decade, a development which could have been more strongly supported from the side of the government. The meat substitution market has for a large extent grown due to the expansion of flexitarianism rather than vegetarian or vegan niches. These flexitarians are actively choosing to consume less meat for varied reasons. Interviewee 2 discussed these different segments of meat substitution market as follows: “I think it is generally thought that vegetarians are not the solution because they will make use of animal products. So indirectly also help to produce meat. So, it is either eating less meat, perhaps more responsible meat, complimented with meat alternatives. Or going vegan. And I think the vegan movement is growing a little bit but it will never become that big. So, the real market is the people who want to eat less meat. The big middle

groups.” The growth of these social movements has without a doubt played a fundamental role in the development of the meat substitution market, so the formation has been bottom-up rather than top-down.

7.5.1 Government driven processess

The government side driven processess in terms of market formation are assessed with the following indicators: (1) Presence of schemes to create protected space for the niches and (2) introduction of new standards that influence the existing regime.

The growing awareness of primarily environmental and health implications of meat consumption can to some extent be traced back to the government, for example through the dietary recommendations and educational activities. One could thus argue that the government is indirectly influencing the growth of the market. This is however soft support which actual effect can only be speculated. There is a lack of more hard policies or schemes to support the market. Most crucially, the formation of the meat substitution market is constantly hindered by the existence of schemes to support the meat production and consumption regime. Even though there are no concrete obstacle, besides the novel food law in some cases, the fact that the meat market is so strongly supported for example in the form of subsidies keeps the meat prices artificially low which in turn affects the popularity of meat substitution products with higher prices due the lack of such. The support given to the meat industry is not necessary blocking the meat substitution market so that it cannot grow beyond a certain point, but it is rather a force obstructing the transition. On a similar manner there have been no introduction of new food standards that could be used to influence the meat industry. Of the 13 interviewees, only interviewee number 11 mentioned governmental action in meat substitution market in purely positive light. When asked about government’s contribution to the meat substitution market, interviewee number 10 for example characterized the development as following: “Well it is despite the governmental policy that meat substitutes are doing so well…I think the government is really old fashioned and really tries to protect the meat industry. So, despite this business as usual government, you see that start-ups and consumers really are changing they consumption methods and patters.”

On a more general innovation level there are several schemes in place which aim at enforcing innovation activities, for instance tax reduction for startups during their first years of operation. These general schemes contribute towards more innovation, but there are none especially targeted to actors operating in the meat substitution industry. It could be concluded that the Dutch government is primarily letting the market forces determine the direction that innovation will take. However, the current situation in terms of policy and law is favoring the meat industry which does not give an even play ground for meat substitutes, and therefore market formation can be perceived as a bottleneck for further expansion of the sector. The governmental protocols and restrictions can be especially harmful to the more novel meat substitution projects. “I think they have not contributed, I think they have made the things worse”, said interviewee number 9, which demonstrates that there is a sense that the government is really obstructing the development of the market.

Table 29: Extent to which the indicators for the functioning of market formation by the government are fulfilled

Indicator	Extent
Presence of schemes to create protected space	Low
Introduction of new standards that influence the existing regime	Low
The size of the current market	Moderate
Total functioning of market formation by the government	Low

7.5.2 Entrepreneur driven processes

The functioning of the entrepreneurial side driven processes are assessed in terms of the following indicators: (1) size of the current niche market in relation to the number of active entrepreneurs, (2) creation of schemes to enter and secure position on different market clusters and (3) quality and quantity of marketing.

As repeatedly stated throughout the study, the most prominent meat substitution niches in terms of the market is the legume niche. These products have been around the longest, and the application of new texturalization technology continues to develop this type of products even further in terms of resemblance to meat. Fungi and dairy-based meat substitutes are also fully developed market niches, but they are both dominated by a single company: fungi by Quorn and dairy by Valess. The products at the market constitute traditional meat substitution products such as tofu, falafel, and tempeh, but the number of modern texturized meat substitute products is rapidly growing. The Dutch meat substitute market was worth 79 million euros in 2016, and the growth continues rapidly. Considering a large number of entrepreneurs active in the industry, however, the market could be larger than it appears today, and therefore the size of the current niche market in relation to a number of active entrepreneurs is interpreted to be moderate.

Twenty years ago, meat substitutes were packed at the corner of supermarkets where vegetarian advocated would occasionally purchase them and cook at home (interview 8). Today, meat substitute products are not only available at supermarkets, but also served for example in restaurants, hospitals, and festivals[19]. The Vegetarian Butcher is doing remarkable work by partnering up with Albert Heijn to bring ready-made meals to their supermarkets, such as traditional Dutch mash potatoes with vegetarian meatballs and spaghetti Bolognese with vegetarian minced meat. Creation easy-to-use meal components out of the meat substitute products, the threshold to try these products decreases. As mentioned earlier, Vivera is actively supplying several caterers, hospitals, and care-take facilities, and the Dutch Weed Burger supplies their burgers to many restaurants with a focus on meat, such as Burgerz. Several producers are also expanding internationally, such as Vivera, Goodbite, Meatless and Garden Gourmet. Even though this does not directly contribute to the market size in the Netherlands, the expansion activities are likely to foster innovation and potentially increase

[19] Traditional meat substitute products originating from Asia have of course been found in Asian restaurants already before.

the profitability which would, in turn, impact the way the company operates on the Dutch market. The presence of schemes to secure market position is thus very high.

It is however not enough that the producers create innovative strategies to get their products close to the consumer, they also need to convince them to purchase these products – hopefully over meat. As discussed in the historical overview, the Vegetarian Butcher's marketing strategy in terms of branding was, of course together with their tasty products, a key to their success. Today, the efforts put into marketing in the industry are much more substantial than ten years ago. Garden Gourmet was likely the first meat substitute producer to have a TV commercial in the Dutch television a few years ago for example (interview 6). However, as the field is new and the producers are only slowly learning which strategies work the best, the marketing of these products, in general, is not yet at its height. Interviewee 6 characterized the situation as follows: "I think all the actors have done great work when it comes to products development and recipe inspiration and so on. So, they have done everything to try convincing the consumer. But I think it still lacks a lot in terms of marketing and communication so that it reaches the consumer and you are convincing them to try these products and keep them in their mind."

The size of the meat substitute market in the Netherlands is strongly growing but remains small especially when considering the number and type of actors operating on the field. The entrepreneurs are increasingly participating and creating more schemes to enter the market other than a traditional from-supermarket-to-consumer tale. The marketing strategies are getting better and more innovative, but there is still figuring out to do as how to best communicate information to the consumer and convince them to try these products.

Table 30: Extent to which the indicators for the functioning of market formation by the entrepreneurs are fulfilled

Indicator	Extent
Size of the current niche market in relation to the number of active entrepreneurs	Moderate
Creation of schemes to enter and secure position on different market clusters	High
Quality and quantity of marketing	Moderate
Total functioning of market formation by the entrepreneurs	Moderate

7.6 Resource mobilization

The functioning of resource mobilization is assessed in terms of the following indicators: (1) availability of financial capital, (2) availability of human capital and (3) availability of physical capital.

In terms of financial capital, the actors of the innovation system seem to have somewhat different perceptions of its availability. Especially larger producers did not see financial restrictions for their operation, whereas smaller companies struggled to receive sufficient funding from the government to realize their projects. In the past years, the government has increasingly directed funds towards the development of new meat substitute products for example through the New Food Challenge where 1,8 million euros was made available for

innovative meat substitution projects. There was a total of 83 companies who applied for the New Food Challenge and only 8 of them eventually got funding, which demonstrates that there are is more eagerness to realize new meat substitution projects than there is money available. As interviewee number 4, put it: “I think they - finances - still form a constraint here in Europe. I think in the United States there is a lot of money and now Silicon Valley has completely gone into food, but in the Netherlands, that’s still an issue.”

As stated earlier, to what public resources are spend in is increasingly dependent on private enterprises due to top-sector policy. For this reason, funding for research that is less commercial and more thought-provoking has become more difficult as more financial resources are directed towards topics that the market is interested in. The top-sector approach has thus, on the one hand, encouraged private enterprises to invest in research and development, but on the one hand, directed these funds increasingly towards a selected group of sectors and topics of commercial interest. As interviewee number 4 also stated: “Research finances, to the extent that they partly depend on science policies, I think could also be increased, because they are still too dependent on the companies that are now in the process of change.”

Many of the correspondents felt like there is not enough private investment in meat substitution projects. They compared the situation to the United States where companies such as Google and celebrities such as Leonardo di Caprio are investing in meat substitution business. It is, however, unclear how actively these companies have searched for outside funding. Of the Dutch meat substitute producers, the Vegetarian Butcher financed its new production plant through a sale of 2,5 million bonds. These bonds were sold at a promise of 5% interest in 7 years and it took mere 3 weeks of time to sell them all. It could thus be that there is money available, but not everyone knows how to require it to realize their projects. Interviewee number 8 stated: “. There is a lot of money at the moment if you know how to get it. But if you are a good entrepreneur you can get it. Money is not really the issue, of course, it always is a bit but not different from other activities.” Due to these factors, the availability of financial capital is interpreted to be moderate.

In terms of human capital, general perception among the interviewees was that there is no remarkable lack of labor that would be obstructing the development. However, three interviewees from the production side mentioned some hindrances in this regard. For example, interviewee 12, a technology producer, stated that: “Money is not a problem for us but people sometimes is, and I think this is going to be a threat in the future. Both on knowledge, so really educated people on this area, but also production personal, that will probably become a problem.” This concern with the production personnel is probably delivered from a more general phenomenon in developed countries with high-skilled labor, in which it is increasingly difficult to find people for low-income jobs.

Physical infrastructure in a similar manner yielded very different responses. In general, the existing food processing technology can support the development of the innovations system and the physical infrastructure from meat processing can in some cases even fosters the development, as when these infrastructures are being utilized to handle meat substitutes. Availability of base ingredients for meat substitutes can however sometimes be problematic if not based on local produce. For example, soya cannot (yet) be commercially grown in the Netherlands, which can make innovation more complex. When asked about the availability of physical resources, interviewee number 11 stated: “It is not a problem now, but it could become a problem in the future. But this development will be positive for vegetarian products. Because you need 5 or something

kilos of plant material to produce 1 kg of meat. So, if raw materials get scarce, meat and milk will suffer more than the vegetarian products"

Table 31: Extent to which the indicators for the functioning of resource mobilization are fulfilled

Indicator	Extent
Availability of financial capital	Moderate
Availability of human and physical capital	Moderate
Availability of physical capital	High
Total functioning of resource mobilization	Moderate

7.7 Creation of legitimacy

Creation of legitimacy is assessed in terms of the following indicators: (1) amount and quality of projects to create legitimacy for the niches and (2) degree of resistance towards the technology.

Actors are creating legitimacy for the meat substitution sector by raising awareness about the environmental, ethical and health implications of meat and by making meat-reduction something trendy that people want to be involved with. To a large extent, both actions are also taken by individual consumers: celebrities openly talking about their meat reduction efforts, organizers of such events such as the Vegan Challenge and National Week Without Meat, bloggers as well as ordinary consumers. Ordinary consumers, or so-called new heroes as interviewee 9 called them, can have an immense impact on the creation of legitimacy as they illustrate in practice how these products work in real life, for example by choosing a tofu dish when on a dinner with friends or making vegetarian burgers in a communal kitchen. Through this type of action, the ordinary consumers can help spread the niches further and thus create legitimacy for them. Important work is also done by non-profits such as de Vegetariesbond, Proveg and Wakker Dier who are actively working towards a plant-based revolution. As interviewee 10 from the field of policy stated: "You always need a pressing group to make change happen". The meat substitution producers are also taking a more active role in this: for example, Vivera is planning an educational program in schools which deals with meat and meat alternative consumption. Important is also to have a dialect with the regime members. Interviewee 8 stated that: "There is a general public discussion, with a lot of players: government, agricultural production actors, farmers, consumers, all kinds of people in health and environmental surroundings etc. It is not all based on solid knowledge, it is also largely based on emotion. But there is a large discussion." There are several ways in which the innovation system is attempting to increase its legitimacy, however, the quality of projects could still be improved and made more structured, due to which the functioning of this indicator is interpreted to be moderate.

Surprisingly, resistance towards meat substitutes by the meat industry was regarded rather low or neutral by most of the interviewees. Interviewees 12 and 13, however, believed the meat industry is against the development despite direct actions to undermine it, for example, interviewee13 stated that: "The meat industry is trying to resist and make it less important and less big". The meat industry is not trying to intervene or stop

the development, but the general perception amongst the interviewees was in fact that many actors of the meat industry saw the growth of the meat substitution market as an opportunity to expand their portfolio or change their business altogether (interview 11,5 and 7). Interviewee 5 for example stated that: “What I think you see is that more conventional players see this as a growing market and actually take part in it. “and interviewee 7 that: “In the past few years the meat substitute market is really seriously considered and strategically looked at also by meat producers”. The small size of the meat substitution market could partially explain the perceived low level of resistance: the mere market of 80 million euros is not exactly disrupting the meat industry. What was also discovered was that some producers with already diverse portfolio saw meat substitution as a way to indirectly influence the quality of the meat that we eat: increasingly substituting unhealthy processed meat with meat substitutes and eating the meat of higher quality when not consuming substitutes. This type of development it would require the meat substitute products become cheaper and meat to become more expensive. When asked about the presence of schemes to undermine the industry, interviewee 11 stated: “If there is an organization which is not happy with what we are doing, it should be the meat organization, but I do not see it. – And as far as I can see, operating in the business, I more get the feeling that people embrace us and try to lift us instead of bringing us down.”

There is some dissension between the meat industry and the meat substitute industry, however. Court case over the names of the meat substitution products of the Vegetarian Butcher, The Schnitzel gate, is probably the most prominent example of such. The meat industry has not so far tried to undermine the meat substitution industry by more direct means, for example through aggressive marketing strategies that attack the meat substitution industry. The meat industry is rather trying to maintain the existing power structure by keeping the current laws and regulations intact, as these laws and regulations hugely favor the meat industry. There has been some talk of a meat tax for example in the government, but the discussion shortly ended before it even really began (interview 10). The meat industry is so large in volume and strongly tangled with the Dutch politics, that it can still for now steadily hold the current system in place.

Table 32: Extent to which the indicators for the creation of legitimacy are fulfilled

Indicator	Extent
Quality and type of projects to create legitimacy	Moderate
The degree of resistance towards the technology	Moderate
Total functioning of creation of legitimacy	Moderate

7.9 Conclusion

A functions of innovation systems theory was applied to analyze the Dutch meat substitution innovation system to systematically investigate the system functioning from multiple perspectives. This was done with the purpose of revealing areas that might be hindering the development of the system and on the other hand areas that contribute towards a well-functioning system. FIS theory concentrates on the innovations system itself and does not actively consider the influences that might be delivered from the outside.

In terms of entrepreneurial activities, the Dutch meat substitution innovation system is extremely efficient and dynamic. The industry is filled with driven entrepreneurs from both business world and the academia who constantly strive to develop new products, technologies, and business models for meat substitution. These entrepreneurs are therefore the most important knowledge developers in terms of technological knowledge and business knowledge. Knowledge about texturalization technology tends to be created either at the universities or larger companies as the development of such is generally very expensive and time-consuming, whereas startups are more innovative to experience with different materials and business models, often accompanied by texturized material from the companies producing them form business to business. Universities and private research institutes are the most important actors developing non-technical scientific knowledge that has to do for example consumer acceptance, ethics or health implications of meat substitute products. This type of knowledge development is increasingly dependent on the interest of private parties due to the top-sector policy which is to some degree hindering its development. The knowledge exchange has gotten more organized in the Netherlands in the past few years with the formation of the Green Protein Alliance, which has members connected to production, retail, advocation and research, and the Protein Competence Center, which is bringing together technical researchers and businesses working with topics connected to meat substitution. The Green Protein Alliance has generated a vision to bring protein balance back to 50:50 by 2025 and tries to actively pursue this goal from the demand-side. The Dutch government has also generated a New Food Agenda for more sustainable food production with a specific vision to foster consumption of alternative protein sources and meat substitutes. There is thus a common perception at least between the government and the meat substitution business that the meat substitute market must grow and meat market decrease. There has however been very little help from the government to foster the meat substitution market so far. Some schemes to finance new innovative meat substitution projects have taken place, but no real efforts to influence the market has been taken. On the most part, the availability of financial, human or physical resources for the development of the innovation sector was not seen as a major obstruction, even though some frustration in finding funding was sensed. So far meat substitution has only received mild resistance in the Netherlands but this is likely due to the small size of the market and if the growth continues, especially if rapidly, more resistance could be anticipated.

Table 33: Summary of the main findings of chapter 7

Function	Level	Reasons
Entrepreneurial activity	High	- A high number of diverse type of actors - Extensive efforts to innovate in terms of product development, business models and finances
Knowledge development	High	- Development of sufficient amount of technical, business as well as non-technical scientific knowledge efficiently
Knowledge exchange	Moderate	- Presence of formal networks - Collaboration between different types of actors - Lack of international cooperation
Guidance of the search	Moderate	- Presence of a shared vision about the future and alignment of actors behind it - Presence of mostly positive expectations that softly support the vision - Unspecificness of the vision
Market formation by the government	Low	- Lack of concrete schemes to foster the development of the industry and create protected space - The absence of regulations to influence the regime
Market formation by the entrepreneurs	Moderate	- The current size of the market is moderate in relation to the number of entrepreneurs - Moderate quantity and quality of schemes to enter and foster the market - The process of creating effective marketing strategies still ongoing
Resource mobilization	Moderate	- Financial restrictions especially for startups - Some hindrances in terms of human capital
Creation of legitimacy	Moderate	- An ongoing societal discussion and several projects and actions in favor of meat substitution - Resistance from the regime mostly in terms of unwillingness to change – meat industry's perception on the industry was mostly regarded in a positive light

Chapter 8: Integrated analysis

Before attempting to analyze the results of the MLP and FIS, it is useful to revisit the conceptual framework presented in the methodology. This conceptual framework reveals how the core concepts of these theories are perceived in relation to one another, and thus how the findings of these two studies should be perceived in relation to one another. Chapter 6 distinguished the main niches connected to the meat substitution innovations system, and observed the dynamics between the niches and the prevailing meat production and consumption regime as well as the landscape developments of rising concern over the environment and animal welfare, changing health perceptions and quest for culinary novelty. Chapter 7 analyzed the functioning of the innovation system and thus concentrated on the internal developments of the innovation system, without considering larger trends in the society or events at the regime level that would not directly impact the system itself. What both FIS and MLP theories have in common are the following aspects: the importance of networks and processes, and the role of formal and informal institutions. This chapter will analyze the Dutch meat substitution innovation system with an integrated approach of the two frameworks in these aspects, as well as incorporate the role of expectations and actor strategies more closely within it.

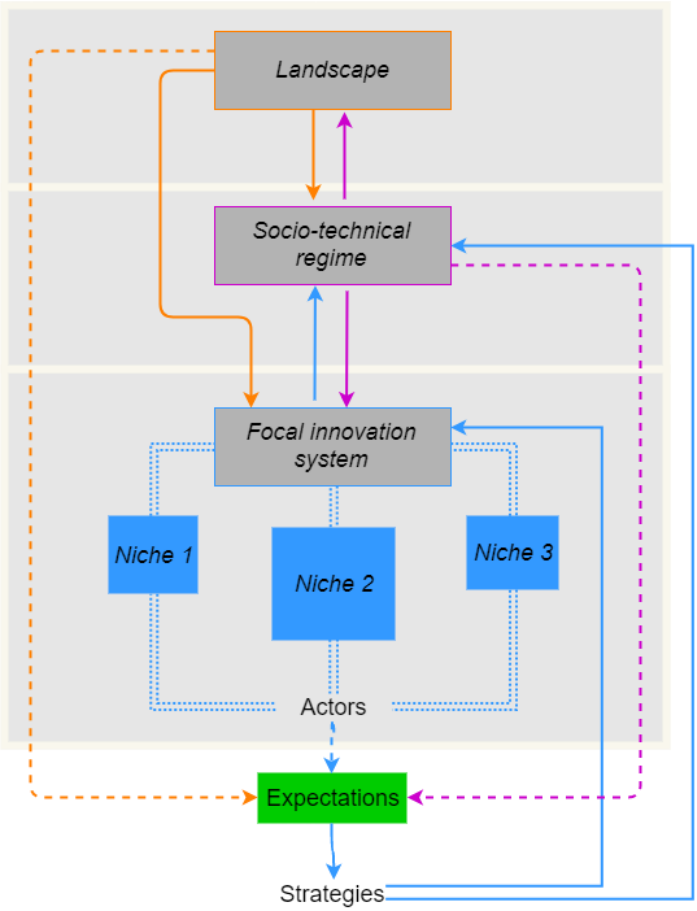


Figure 14: The conceptual framework of the research as presented in part 3.1 of the report

8.1 Networks and learning processes

Innovation is a process that takes place not in isolation, but through interaction between different actors. The structural analysis in chapter 5 mapped the most important actors and the networks that are either organically or purposefully created amongst them: buyer-supplier relationships, problem-solving networks, and informal networks. In these networks, different types of learning take place. Kamp et al (2004) distinguish four types of learning that are of importance for the development of an innovation system: learning by doing, learning by

searching, learning by using and learning by interacting[20]. Of these concepts, the learning by interacting is an important one that can be used to analyze the level of knowledge exchange within the networks. More precisely, learning by interacting has to do with contact and learning processes that take place between the producers and users of technology. Studying the prevailing networks of the system and the interactive learning within them by incorporating the structural analysis, function of knowledge exchange and knowledge development, and considering the actors' ties to different levels of the MLP, can illustrate the effectiveness of these networks from an innovation perspective. The function of knowledge exchange was perceived to be moderate for the Dutch meat substitute system, but this part will analyze further the type of knowledge that is being exchanged through these networks.

The function of entrepreneurial activities analyzed the buyer-supplier relationships more in detail, revealing that these types of relationships do not only exist between the market actors and the meat substitute producers, but also between the large meat substitute producers and smaller private-labels. These subcontractors supply the larger producers with information on the novelty in the field, in terms of source-proteins for example, as their small size makes them dynamic and prone for experimentation. The suppliers of the vegetable protein on the other hand exchange knowledge on the type of products that can be created with the use of their products. Thus, there is interactive learning taking place within these networks, but the nature of the interaction is limited and has largely to do with the development of business knowledge. When it comes to the buyer-supplier relationships between the market actors and the producers, the interactive learning has again to do mostly with the generation of business knowledge: the market actors supply the producers with information on their product performance for instance. The two can also learn a lot from each in terms of marketing, as the market actors perform actions and promotions which results can be used by the producers to further adjust their product pricing for example. It is notable, that the point of sale for most of the meat substitution products happens at supermarkets, which belong to the meat production and consumption regime. Thus, there is a high level of networking between the regime and the niches in terms of buyer-supplier relationships.

When it comes to problem-solving networks, the actors participating in them overlap all the three levels of MLP. The single most important such network that works towards the creation of legitimacy is the Green Protein Alliance, which grew from Het Planeet that is an organization of meat substitute producers. The fact that GPA was established with the purpose of including a wider variety of actors to work towards more balanced protein intake, and that several actors outside niches have partnered up with them, illustrates, that there are actors in the regime who want to be involved with this type of development. The GPA includes some actors connected to the landscape, namely Dutch Cuisine, Duurzaamdoor and Natuur en Milieu[21], and it collaborated extensively with the National Week Without Meat, also through financing. The interactive learning that takes place within this network includes the development of business knowledge, such as common strategies to increase the sale of meat alternative products, and development of non-technical scientific knowledge, such as exchanging information on new research that helps with the articulation of their message. There is no

[20] These are the ways of acquiring new knowledge, and the types of knowledge that can be developed through these mechanisms were introduced in section 6.2 and constituted of technical knowledge, business knowledge and non-technical scientific knowledge.
[21] Duurzaamdoor and Natuur en Milieu however have strong linkages to the national government.

exchange of technical knowledge as the core actors of the GPA, even if collaborating, are all competitors who do not want to share product specific knowledge (interview 8).

The problem-solving network of GPA virtually includes all the meat substitute producers, with two expectations. The Vegetarian Butcher does not participate in any of the official organizations driving meat substitutions, neither Het Planeet nor the Green Protein Alliance. In fact, two meat substitution technology producers, numbers 12 and 13, even explicitly stated that they collaborate with every actor in the system except with the Vegetarian Butcher. This company is the only one of the large meat substitute producers who has isolated themselves from the GPA's problem-solving network[22]. However, the Vegetarian Butcher is participating in another problem-solving network that works directly towards the realization of new meat substitution technology: Plant Meat Matters project by the Wageningen University. This is the single most important problem-solving network in terms of scientific research for the meat substitute innovation system, as it directly strives to generate new innovation on the area through interaction. Another problem-solving network that develops technical knowledge is the Protein Competence Center. Despite the larger size of the network in comparison to Plant Meat Matters, the number and quality of activities performed at the PCC appear uncertain. As the organization was not mentioned once by any of the interviewees, it is assumed that the PCC's current importance for the generation of technical knowledge is minimal.

In terms of informal networks, the ones within the Dutch meat substitute innovations system are impossible to map wholly. All the interviewees indicated a very high level of collaboration and contact between other actors. Especially the meat substitute producers are generally in close contact with each other, also outside of Het Planeet and the GPA, as do the researchers on the field (interviews 2,4,6,7,8,9,11,12,13). The most important informal network in terms of developing technical knowledge and non-technical scientific knowledge is between the knowledge organization of universities and private research institutes, such as TU Delft, CE Delft, and Drift. The informal networks also include actors connected to the policy and civil society. Many governmental actors, such as the former state secretary Martijn van Dam who was influential in the New Food Challenge and Niko Koffeman who is a Dutch politician and co-founder of the Vegetarian Butcher, seem to have strong ties to the sector and actively ask for guidance through these networks for generation of effective policies for example. The active attempts by the GPA to participate in informal networking with the policymakers, as the creation of the event Politiek GPA Café illustrates, are also remarkable. The interactive learning through these networks also constituting of governmental actors is thus expected to include mainly development of non-technical scientific research. The informal ties between the non-governmental actors within the civil society, such as Wakker Dier and VegPro, are not possible to map, as none of the interviewees neither mentioned an instance of collaboration nor denied it.

The interactive learning that takes place within the identified networks has to do mostly with the development of business knowledge and exchange of non-technical scientific knowledge, whereas the problem-solving networks of PCC and The Plant Meat Matters, as well as informal networks of the knowledge organizations, concentrate on the generation of technical knowledge. The high level of networking between the actors in different levels also verifies the conclusion of the MLP - the meat substitution system is currently on the path

[22] Meatless has also not yet joined the GPA, but it must be noted that their business model is rather different.

of reconfiguration. Figure 14 below illustrates to which levels the different actors primarily belong to. The most important networks and the types of knowledge development that take place through interactive learning are summarized in the table below.

Table 34: Summary of the networks and learning processes

Type of network	Network	Actors within the network	MLP levels connected	Type of learning activities
Buyer-supplier relationship	Large meat substitute producers and smaller subcontracting producers	Goodbite, Jumbo Veggie Chef, HAK and Boon	Niches	Learning through interaction in terms of business knowledge and non-technical scientific knowledge
	Meat substitute producers and the market actors	All the producers and the specific market actors who they supply	Niches and the regime	Learning through interaction in terms of business knowledge
Problem-solving network	Green Protein Alliance	Albert Heijn, Alpro Soya, Schouten Europe (Goodbite), Vivera, Unilever, Garden Gourmet, Dutch Cuisine, Nature and Environment (Natuur en Milieu), Olicjk, SoFine Foods, Rotterzwam, Rabobank, Zeewaar, Bonduelle, Appel, Boon, Drift, Dutch Soy, The Dutch Weed Burger, GRO, HAK, HAS Hogeschool, Louis Bonk Instituut, Nextfoods, Purple Bee Hive, Intersnack, Quorn, Jumbo, Menken Orlando, Marley Spoon Het Planeet, New Foresight, Duurzaam Door Ministry of Economics Environment Centre (Milieu Centraal), The Nutrition Centre (de Voedingscentrum)	Niches, the regime, and the landscape	Learning through interaction in terms of business knowledge and non-technical scientific knowledge
	Plant Meat Matters	Ministry of Economics Wageningen University and Research, Food Processing Technology Wageningen Food and Biobased research Unilever The Vegetarian Butcher Nutrition & Sante SAS Meyn Food Processing Technology	Niches and the regime	Learning through interaction in terms of technical knowledge

	Protein Competence Center	Wageningen UR, Avebe, Darling Incredients Inc, DSM, Duynie Group, Friesland Campina, Nutricia Research, VanDrie Group, Hanze University of Applied Science, Nizo, University of Groningen, TNO, The University Medical Center Groningen	Niches and the regime	Learning through interaction in terms of technical knowledge
Informal network	Knowledge institutes	Eg. TU Delft, Drift, CE Delft, TNO, Wageningen University, Maastricht University	The regime	Learning through interaction in terms of technical knowledge and non-technical scientific knowledge

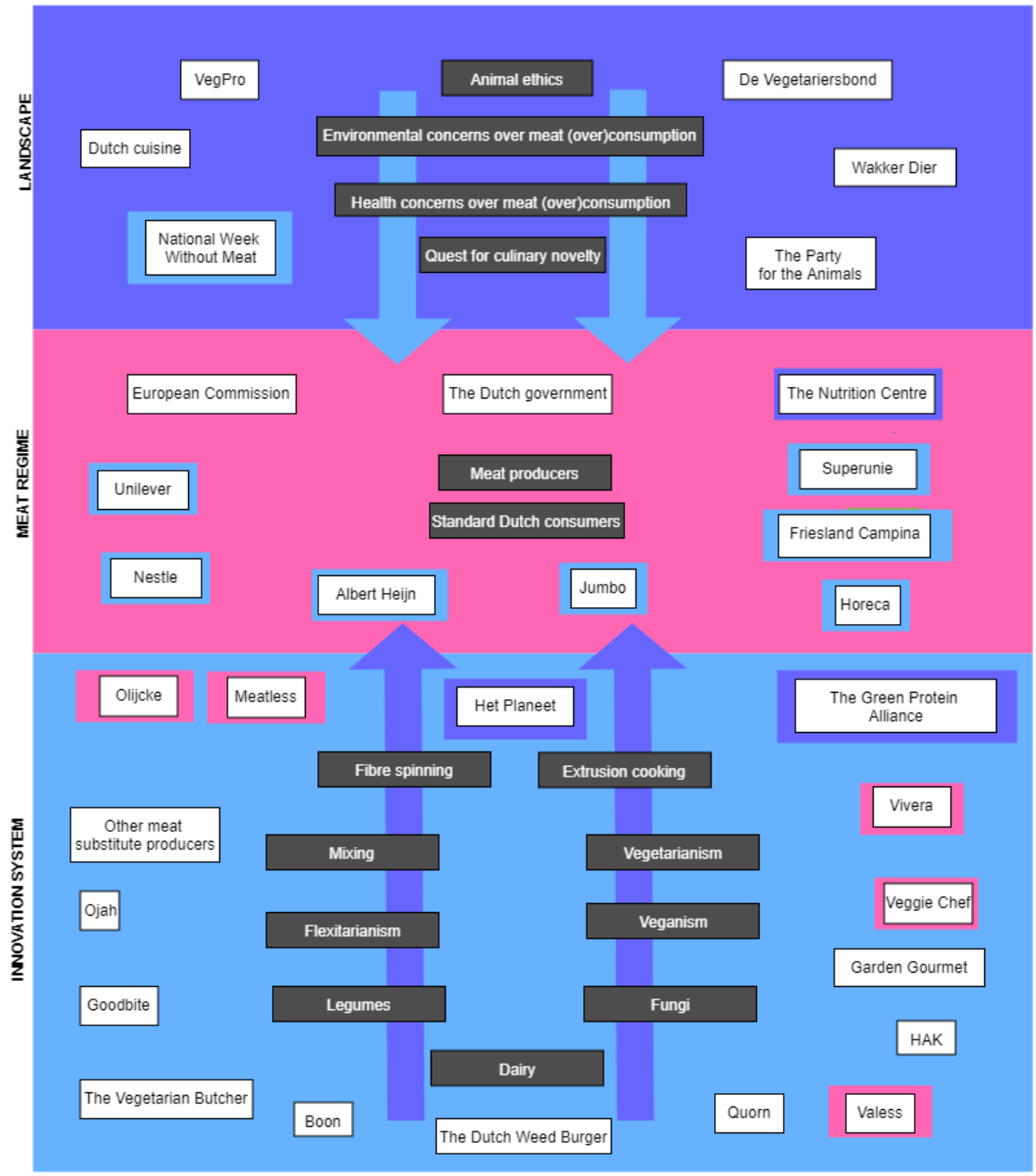


Figure 15: Visualization of the different MLP levels and how the different actors are positioned within them. Secondary membership is illustrated with a box with a corresponding color code of the secondary level.

8.3 Role of formal and informal institutions

These networks and learning processes that take place in and between them are shaped by both formal and informal institutions. The structural analysis revealed that the two most influential formal organizations that pose regulative rules on the system are the Dutch national government and the European Commission. The informal institutions, the values, and practices prevailing in the society, were identified within the MLP analysis of normative and cognitive rules.

The function of guidance of search by the government in the FIS analysis was perceived as the worst-performing function on them all, with a score of low. This is in line with the findings of the MLP on the dynamics between the regime and the meat substitute niches: the meat production and consumption regime is not directly undermining the meat substitute innovation system, but rather obstructing its development by its unwillingness to change the rules of the system. Currently, the government is responding to the growing landscape pressures to a low extent by creating action plans and setting up some schemes to foster innovation on the area of meat substitution, as the historical overview showed, which seems to be enough for now to satisfy the majority of the Dutch. The lack of stronger governmental action to try and foster the market of meat substitutes, in terms of creation of protected space or changing rules of the regime, anticipates that the transition might become more disruptive in nature if the government keeps on refusing more profound support.

Despite several companies getting involved with meat substitution industry from the meat production and consumption regime most of the innovation resources are still located in the niches. The availability of financial resources, which functioning was evaluated to be moderate, supports this view. Even though the government, who is a member of the meat production and consumption regime, has some schemes in place to create a budget for innovative protein producers to realize their projects, some interviewees felt that there were financial restrictions for their operations (interview 9 and). The meat substitute producers thus need to find funding outside of the regime, or at least outside the government, to realize their projects. For example, the National Week Without Meat tried to get funding for realizing the campaign week through government subsidy, but as none was made available the campaign was eventually funded collectively by the meat substitute producers through the GPA (interview 6).

The non-governmental regime actors are becoming more invested and interested in the meat substitution industry, as the involvement of large multinationals illustrates. A small group of actors within the regime is already embracing meat substitution, as for example Enkco Food Group with Vivera, Nestlé with Garden Gourmet and Olijck with their diverse product portfolio. Meatless, on the other hand, is operating in the intersection of the niches and the regime by supplying both meat producers and meat substitute producers with their texturized vegetable protein. Meatless was originally a meat processing company, due to which they can as well be regarded as a member of the regime. All these companies got involved with meat substitution because they saw opportunities in the new market, some at an earlier point than others. The formal institutions are not especially working towards encouraging this, neither are they discouraging it. The regime has shown very little flexibility in terms of changing the set of rules that they employ, something that is not necessary for the reconfiguration but could fasten the process and make the transition less disruptive and more coordinated. The reconfiguration would require a structural change of the system, whether it comes organically from the informal institutions or more purposefully from the formal institutions. Thus, the role of formal institutions in shaping the system can be perceived to be high, as the meat substitute niches have to currently operate within this set of regulative rules and changing these rules appears to be both difficult and slow.

8.4 Expectations and actor strategies

The study of shared expectations identified in the functional analysis demonstrated that the strategies used by a variety of actors connected to the Dutch meat substitute innovation system are mostly based on positive visions about the industry's future. Here, some interesting expectations from the functional analysis in terms of policy, economy, social, technology, environment and legality are chosen for closer analysis to identify the strategies that these expectations yield amongst the actors. Additionally, some new expectations are investigated that have been identified through the interviews. Concentration remain on the expectations that influence the strategies of the producers, but additionally also broader expectations shared by other relevant actors are considered.

8.4.1 Political expectations

Climate change will increasingly influence the Dutch agricultural system and meat substitution can partially contribute towards a more sustainable food system, is a long-term political expectation shared by many different actors. This expectation is officially believed by the Dutch government as it is stated in the New Food Agenda. However, it is unclear to what extent there is support for working towards realizing this vision in the government. The current government is perceived as very business-as-usual, and some interviewees felt like they actually do not take the topic of climate change and meat consumption seriously (interviews 9 and 10). All the actors from industry interviewed for this research mentioned the sustainability of meat substitutes and their relevance for combatting climate change (interviews 1,7,8,12,13), thus they strongly share this expectation. Additionally, all the actors within the civil society connected to the system share this vision, such as Wakker Dier, National Week Without Meat and VegPro. Virtually all the actors operating within the meat substitute innovation system realize the potential of these products, but whereas the producers actively strive to create a more sustainable food system with their meat substitutes and the non-governmental organization lobby for a meatless-diet, the government simply lets the market decide the course of the future and is unwilling to create profound strategy for realizing the vision. This means that the producers must actively work themselves to convince the government on the multilateral benefits of meat substitution – as they are trying most prominently with the GPA – as the expectation *Decreasing meat consumption will only appear in the political agenda with strong lobbying* illustrates. There is one expectation growing in the regime attached government which strengthening could potentially lead to more strategic action, that is: *Consumers are becoming increasingly aware of the linkage between meat consumption and climate change and thus governmental action needs to be taken to secure the support of the people.* Since the Party for the Animals gained seats in the parliament, the other parties are increasingly pressured to consider sustainability in their strategies and actions. It is difficult to estimate the number of governmental actors who share this expectation, but according to the interview 10 their number is growing. This expectation essentially has to do with the growing landscape pressure and the regime's need to answer to it in order to secure their own position in the transition, a believe that is also shared by many of the interviewees (9,10,13 and 14). Thus, it can be stated that the political expectations confirm the symbiotic nature of the transition.

Table 35: Political expectations and resulting strategies

Expectation	By who	Strategy
Climate change will increasingly influence the Dutch agricultural system and meat substitution can partially contribute towards a more sustainable food system	All the meat substitute producers	Develop products that could effectively replace meat in a meal
	The Dutch government	Inaction – let the market decide. Some indication of generation of more concrete strategies but this is in an early phase.
Decreasing meat consumption will only appear in the political agenda with strong lobbying	A majority of the meat substitute producers but not all	Working together as a collective to gain more weight in discussion - GPA
Consumers are becoming increasingly aware of the linkage between meat consumption and climate change and thus governmental action needs to be taken to secure the support of the people	The Dutch government	Incorporating the topic of sustainability in their agenda
	A minority of the meat substitute producers	Inaction in participation on lobbying activities as it is believed the government can transition itself

8.4.2 Economic expectations

In terms of economic expectations, the producers believe that the meat substitute market will continue to grow strongly (interviews 1,7,8,12 and 13), whereas the researchers are also positive but more reserved on the speed of the transition (interviews 2,4 and 5). The Interviewee 4, for example, stated that "I think it would have to do with resources. The resources will be getting much more expensive so it will not be economically viable and beneficial for parties to move on to this direction that meat production is based on. When it is not economically viable, well then maybe a shock will happen, something revolutionary. But otherwise, I think that it will be a gradual process". On a similar manner, the producers were more positive on the effect of meat substitution on meat consumption, all of them expecting that *Meat consumption will slowly start decreasing again, since the stagnation of 2017*, whereas the researchers were again more critical. It is assumed that the expectations relating to market growth shared by the actors in the industry are in general much more ambitious than those of the government. The government expects for example that *There are many innovative people and companies in the Netherlands who can contribute towards new solutions for green protein,* but this is an expectation relating more in general to alternative protein consumption rather than meat substitution per se. Due to this expectation, however, the government has realized the New Food Challenge to seek new solutions, of which the meat substitutes are part of. The moderate expectations of the researchers on the market growth of meat substitute can influence the expectations of the government, as they often turn for scientific advice on knowledge institutes. However, most importantly for economic expectations, all the producers believe in continuous market growth which stimulates them to participate in innovation activities, which in turn can result in spreading of these positive expectations about the industry wider, also to the government.

Table 36: Economic expectations and resulting strategies

Expectation	By who	Strategies
The meat substitution market will continue to grow strongly	Most of the meat substitute producers	Try and gain more share of this new growth for example through product development, re-branding, and marketing strategies
Meat consumption will slowly start decreasing again, since the stagnation of 2017		
The meat substitution market will continue to grow gradually and its impact on total meat consumption remains to be seen	Research institutes	More extensive research efforts on different ways to accelerate alternative protein consumption – including but not limited to meat substitution
There are many innovative people and companies in the Netherlands who can contribute towards new solutions for green protein	The government	Some efforts to stimulate new innovation and grand them funding for further development
	Meat substitute producers	More intensive efforts to innovate due to vast competition
	Research institutes	Diversification of research

8.4.3 Social expectations

When it comes to social expectations, the expectations of the producers are very diverse which partially results in the creation of different types of meat substitution products, the emergence of multiple niches if you will. Trending of flexitarianism, vegetarianism, and veganism are expectations that strongly determine the type of source-protein and other ingredients that can be used for production. Whereas some producers believe in the bright future of the vegan movement (interviews 9,12 and 14), others believe that this segment will remain insignificant and therefore do not attempt to create products that fit within this category or create these products simply to appear trendy. Interviewee 9 from the industry, for example, stated that: “The future status will be being vegan, and that will also break out. The word veganism at some point won’t exist anymore”. On the other extreme, interviewee 8 from production as well contemplated on veganism that:” In 2017 about 2/3 of growth in vegetarian production was a vegan concept. Now there are not many vegans as you know, about 0.3%, so how come. We did not see that coming. Totally not. Now, how come? Well flexitarians eating meat, eating twice a week vegetarian, think I guess that vegan is healthier than vegetarian. So, they decide to buy vegan products. They buy vegan because they think that is better than vegetarian. That is a hype. Because that is based on nothing. It is purely a hype.” A third producer, interviewee number 11, stated that: “The goal for our products is to make them vegan. And the next products we have they have to be vegan.” Another social expectation that divides the producers is the analogical accuracy of substitute products for meat. Especially the strong vegan advocates (9,12 and 14) did not think that the meat substitute products must taste or look exactly like meat, but what is important is the functional similarity, whereas producers such as interviewees number 8,12 and 13 believed that the successfulness of the sector depends on the imitational accuracy. These examples illustrate that there are varying expectations on how the meat substitution industry will look like in the future and the type of products that rule it.

Table 37: Social expectations and resulting strategies

Expectation	By who	Strategies
Flexitarianism, vegetarianism, and veganism are segments that will continue to grow	All the meat substitute producers	Create products in accordance with the requirements of the trend they believe most strongly in, keep on highlighting the multifaceted benefits of these diets to stimulate their growth
Veganism will become the new norm	A minority of the meat substitute producers	Produce vegan products, spread awareness on the benefits of a vegan diet
People will start consuming more plant-based foods but still, have a taste for meat and want to consume these types of products	Some meat substitute producers, especially advocates of high-tech texturalization technology such as Vivera, The Vegetarian Butcher, Meatless and Goodbite	Create meat substitute products with an as high analogy to meat as possible and to market these products as something equivalent to meat

8.4.4 Technological expectations

The technological expectations of the producers are similarly diverse as the social expectations. The opinions on cultured meat and whether its commercial realization will be viable in the near-future were divided. Some believed in the technology but did not expect it to play a major role in the development of the Dutch meat substitution system. None of the interviewees expressed strong positive expectations for cultured meat but were rather reserved on its possible impact. Interviewee 2 stated that: “It is quite possible that cultured meat will be successful mainly in a transition phase. It is more interesting for animal welfare purposes than for environmental purposes, it still takes a lot of resources to make it.” Interviewees 5 and 9 also expressed similar expectations on the transitional relevance of the technology from the awareness point of view. Interviewee 12 stated on cultured meat the following: “For me, it is really difficult to have an opinion on it, where it is going to go. On one side it might be very popular, but on the other hand, people might think it is too much technology and people are too scared to try that, but when lab-grown meat will be just as good as normal meat then I think that can be a very good route for the future”. The expectations of the Dutch government on cultured meat were interpreted to be positive, as they have largely funded the research on the area. The expectations on the potential of different texturalization technologies were also not aligned. Interviewee 13 stated, for example, that: “I don’t think you can imitate a whole steak. If you want to eat a steak you better eat a steak. Chicken pieces are possible more or less. Everything that is processed meat it is easier and possible.”, whereas interviewee number 12 strongly believed that this can be done.

Table 38: Technological expectations and resulting strategies

Expectation	By who	Strategies
There is potential to realize the commercial application of cultured meat in the near future	Mosa Meat, the Dutch government, some other meat substitute producers	Continue investment in the technological development
Cultured meat is interesting from a technical point of view and could play an important role in raising awareness on meat consumption, but will not offer a concrete solution to the problem of meat (over)consumption	Majority of the meat substitute producers	Disregard the development of the technology as no competitive threat is perceived

8.4.5 Environmental expectations

When it comes to environmental expectations, some of the interviewees explicitly mentioned that they expect the state of the environment to become much worse until it will get better. What they were initially saying with this is that they expect the landscape pressure of environmental concern to require more time to develop and grow large enough to result in drastic action on meat consumption. Overall, it was believed that the threat of climate change will eventually result in more meat substitution activities in the future. The producers were, however, largely divided in terms of expectations on future climate action by the government. Some contemplated (interviews 7 and 11) that the Dutch government already has extensive efforts to combat climate change and to realize new sustainability projects, whereas others (interviews 9 and 10) did not see this type of action being realized on a large enough speed and volume. The actors who did not think enough was being done are perhaps more likely to expect major environmental disaster to occur, whereas the actors who expected the climate action to remain sufficient might be more positive on the environmental outlook of the future. The actors mostly agreed that *Concrete policies are needed to drastically influence meat consumption*. However, interviewee number 7 recognized the benefits of concrete policies on meat consumption but believed that the plant-based movement can also continue to grow without them.

Table 39: Environmental expectations and resulting strategies

Expectation	By who	Strategies
The Dutch government will take more extensive efforts to combat climate change	Some meat substitute producers	Less participation in lobbying activities
Concrete policies and regulations are needed to drastically influence meat consumption	Majority of the meat substitute producers, but not all	Participate in lobbying activities

8.4.6 Legal expectations

The legal expectations have to do with the execution of the laws and regulations by the national government as well as by the European Union. Again, some contradictions appeared between the producers, namely actors who expected the meat production and consumption regime to resist and undermine the system, and actors who believed that the regime is working more for than towards them. An expectation *the Dutch meat sector will increasingly resist the development of the meat substitution sector through the government* was interpreted to be shared at least by interviewees 2,4,5,6,9,10 and 14. In contrast, interviewees 8 and 11 did not express such an expectation. Note that this expectation has to do with the resistance by the meat production and consumption regime that is strongly clustered with the Dutch government but which does not equal one another. It illustrates a growing anticipation by the regime side to try and maintain the prevailing power structures and set of rules in the society, an instance which Schnitzel Gate well illustrated.

Table 40: Legal expectations and resulting strategies

Expectation	By who	Strategies
The Dutch meat sector will increasingly resist the development of the meat substitution sector through the government	Some meat substitute producers	Realization of schemes to create legitimacy, participate in lobbying activities

All of these different expectations that the meat substitute producers have on the policy, economics, technology, environment, and legality demonstrated that the niches and their specific rules are still very much in the making. Most importantly, the varying expectations on social practices and technology have resulted in a situation in which many technology niches and social practice niche paths are being tested simultaneously, as the MLP in chapter 8 revealed.

8.5 Conclusion

Overall, the networks and the learning processes which take place in them have to do with the development of technical knowledge, development of business knowledge and development of non-scientific technical knowledge. The actors who belong to these networks cut through all the three levels of the MLP. The most prominent network that is extensive in terms of variety of actors, the Green Protein Alliance, interactively generates knowledge related to business and non-scientific technical knowledge. Cooperation in terms of technical knowledge has grown, perhaps thanks to the top-sector law that encouraged collaboration between the business world and the research world. The Protein Competence Center would offer another major network the interactively develops technical knowledge, however, the activity of this network remains questionable due to the lack of references to it in the expert interviews. The formal and informal institutions are posing rules which guide the activities in these networks, and the varying expectations between the producers result in taking up of different strategies. The expectations of the actors can be related to the networks: the participants of the GPA, for example, all share the same expectation about the growth of the plant-based movement. The expectations that relate to the social practices and technologies determine the type of projects in which the

actors participate in, for example, the Vegetarian Butcher, Vivera and Goodbite believe that the imitational accuracy of meat substitution products in relation to meat is crucial due to which they participate in innovation activities on the field. Yet again, the manners of going about these activities differ. Whereas Vivera and Goodbite relay on knowledge development within their company, the Vegetarian Butcher illustrates strong priority for collective knowledge development through the Plant Meat Matters project. It was found that the higher expectations an actor has about the impact of climate change, the more negative expectations they have about the ability of the government to respond to these pressures and the more radical was the societal transformation that they sought.

Wrapping up research part 2

The second part of the research constituted of the analysis of the Dutch meat substitution system primarily through an application of MLP and FIS theories and an integrated analysis of the two. The study revealed a lot of interesting factors that either directly or indirectly influence the development of the system. The combined analysis strived to answer the third research question: *What are the main functional dynamics of the innovation system and how do they influence its development?*

The most prominent functional dynamics comes from the meat production on consumption regime's openness to adapt some meat substitution practices. The niches are actively pursuing innovation in the field and growth of the meat substitution market as illustrated for example through the activities of the problem-solving networks of the GPA and the Plant Meat Matters. They are directly responding to the developments in the landscape due to which also the regime actors increasingly see potential in participating in meat substitution industry. This is illustrated for example through the creation of hybrid meat products, increasing number of enterprises operating in both meat and meat substitution fields, willingness of the market actors to offer and give exposure to the meat substitution products, and the government's investment and attempts to stimulate innovation in the field of green proteins. This is perhaps done due to the moderate landscape pressure of rising environmental concern, changing health perceptions and concerns over animal welfare. However, the regime seems unwilling to change the rules of the system and its current practices, as the government has not seriously tried to enforce the development of the meat substitution niches through market formation. The government is acknowledging the need for more sustainable food solutions as the creation of the Food Agenda illustrates, but it appears that the government is struggling to make a transition within itself. The meat substitute innovation system includes schemes which attempt to create more legitimacy to these products, however they have not managed yet to convey their message wide enough into the society. The innovation system is characterized by an abundance of different niches, which can be regarded as a result of the varying expectations of the actors.

Research part 3

REFLECTION ON RESULTS

Chapter 9: Discussion and recommendations

In this chapter, the main findings from the research are reflected on and recommendations that could further improve the development of the innovation system are given. Discussion will start with reflecting on the results of the descriptive work and the analysis and continue to contemplate on the effect of methodological choices and the limitations of the research. When it comes to generation of recommendations, the goal is to give advice that applies specifically to the system under study, but could also be suited to guide the development of other relevant systems abroad. This chapter answers the fourth research question: *What actions could stimulate further development of the Dutch meat substitute innovation system and growth of the meat substitution market?*

9.1 Discussion

9.1.1 Results

Descriptive work – Chapters 4 and 5

The overview of the recent history revealed many interesting actions and gradual developments related to politics, economics, social-practices, technologies, environment and legality in the field of meat substitution in the Netherlands. Due to the vast amount of information that was offered, the chapter was structured in terms of three time periods: 2007-2010, 2010-2014 and 2014-2017. With closer observation of the actions and developments that have taken place in the periods, perhaps a more concrete periodization of the field's development could be given. The period of 2007-2010 is characterized by growing environmental awareness globally among the scientific community and the civil society, which resulted the enlightened individuals and NGO's to act. This period could thus perhaps be titled as The Awakening of the Dutch meat substitution system: actors within the civil society and the food industry, as well as the government, began innovating more extensively with green-protein. The period of 2010-2014 is characterized by mission driven companies entering the market with their substitution products, as well as major technological leaps and efforts to unionize as a single front. As it was during this period that the meat substitute market in the Netherlands started growing exponentially, this period could be titled as The Big Pull: the new innovative meat substitution products were entering the small stagnated market and gave it a shock, which resulted in more companies aspiring to join. The period of 2014-2017 is characterized by expansion of entrepreneurial activities in the field and market entrance of larger multinationals, as well as attempts by the government to softly align behind the cause for the sake of sustainable food supply. As it seems like the meat substitution market has been transforming from a mere trend to a movement more deeply embedded within the social structures during this period, it could perhaps be titled as The Step Towards Normalization.

The amount of information in chapter 4 resulted in a rather detailed structural analysis in chapter 5. So many relevant actors, networks, institutions and technologies were detected that it made the mapping of the system structure a difficult task. Categorizing the actors in terms of the realms they operate in – formal institutions, research and development, market and the civil society – increased the ability to distinguish between different actor types, however this categorization was perhaps too simplified and not completely correct. For example, placing the GPA within the civil society undermines the organizations efforts to influence the formal institutions

and the market. It might in fact have been better to distinguish between actors who are part of the formal organizations and actors who attempt to influence them. If this visualization had been pursued, not only GPA but also Wakker Dier would have perhaps belonged to this realm. The structural analysis disregarded detailed buyer-supplier relationships between the meat substitute producers and the supermarkets they supply. Presenting this information was expected to lead to overwhelming complexity, but it might, in fact, have been useful for detecting possible affiliations which could play a role in the functional dynamics of the system.

Transition context – Chapter 6

Determining the niches in terms of technology niches and social niches was considered fundamental for a factual study of the system. Even though it made the analysis perhaps more complex, this decision underlines the fact that meat substitution is essentially a social phenomenon which is supported by technology. Including only technological niches would have likely neglected the importance of these social practices and given too much emphasis on the requirement of technological development. There are probably many more niches, especially within the market and the technology, that were not mentioned in the research, and the described niches should thus not be perceived as the absolute truth. It is interesting to note that these niches exist parallel to one another, and virtually every meat substitution product advocates one of the technology niches, one of the market niches and one of the social-practice niches. For example, the Dutch Weed Burger belongs to the fiber spinning niche, the algae niche, and the vegan niche, whereas Vivera's chicken strips belong to the fiber spinning niche, the legume niche and the flexitarian niche.

When it comes to the dynamics between the three levels presented in chapter 6, there is a lot of overwhelming complexity which makes it difficult to analyze adequately. There are certainly more dynamics in place which are either so small that they are not visible from the MLP or so discrete that they are difficult to spot and therefore the dynamics presented in this analysis should be perceived with certain criticism. Especially the dynamics that originate from the meat production and consumption regime might be over-simplified as the analysis is based largely on data collected from the actors of the meat substitute innovation system whose perception of the regime might be flawed.

The disruptive but symbiotic way in which the meat substitute niches are currently breaking into the meat regime and reconfiguring it raises a lot of questions. By taking up meat substitution niches in a symbiotic manner, the meat regime is reconfiguring itself, but also in a way strengthening its own establishment. For example, by embracing the new plant-texturalization technology hybrid meat products can be created which perform better in terms of environmental impact and health as all-meat products, but these hybrid products are still nevertheless meat. The creation of this kind of hybrid products would also be a response to the search of culinary novelty. It is difficult to estimate whether the introduction of hybrid meat products is eventually counterproductive for the whole meat substitution scheme. This would likely depend on whether these hybrid products were consumed instead of some traditional meat products or instead of other non-meat entailing meat substitute products.

It is slightly problematic to state that meat substitutes do not strive to make meat obsolete, but rather coexist with them in this symbiotic relationship, as the interviewed experts were slightly divided on this issue. Some in fact believed that meat substitutes could overthrow the regime altogether, especially with the realization of the

new texturalization technologies. In terms of transition pathway, this division could anticipate that the reconfiguration pathway is a good one, to begin with as it slowly transforms the industry from within and thus minimizes the resistance, but for many, this is not the end goal. In a way, this strategy would be about “killing them with kindness”: rather than harshly opposing the ways of the current regime it would be slowly persuaded to change from within.

The way in which the meat regime has addressed the environmental concerns of the sector in the past years has been soft, but it, however, seems to have worked as there has not been a drastic change in the meat consumption despite the growing environmental concern. As there only is a certain extent to which the environmental practices of the sector can be improved, if the environmental pressure grows stronger the regime might be unable to answer it. Due to the soft environmental and other pressures, the regime has been allowed to try and reconfigure itself slowly over time. This slow reconfiguration, however, might not be sufficient to have a profound impact on the environment in time. Some of the researchers interviewed (2,4) actually believed that what unfortunately may have to play an important role in this sustainability transition is crisis: environmental crisis such as immerse flooding due to intense rainfall, ethical crisis such as a reveal of bad-practices in animal upkeep and health crisis such as new dramatic scientific proof of the health impacts of meat (over)consumption for example. With the path that we are taking now with the slow reconfiguration of the meat regime, it would be optimistic to say that the environmental impact of the system will be sufficient to combat climate change and avoid the environmental crisis. It may thus be that the path of reconfiguration is advocated, until a major crisis hits, after which the other more radical pathways might be pursued. This is, of course, just speculation.

Functions of the Innovation System – Chapter 7

The application of FIS theory unraveled many interesting aspects that influence the functioning of the system. Functioning of entrepreneurial activities seems to be a topic with small contradiction amongst the interviewees. Everybody agreed that the entrepreneurs are most definitely active in the industry and they constantly engage in innovational activities, but one interviewee felt like the number of actors operating on the market might even be too high (interview 8). The fact that some might raise this type of concern could mean that there is insufficient coordination of these entrepreneurial activities. Lack of coordination could also prove an important aspect of knowledge development and exchange. Naturally, there is a lot of secrecy in the business world but lack of coordination of knowledge development between the industry and knowledge institutes is likely to lead to inefficient use of resources, for example in a situation in which both parties are researching the same topic. This is partially due to the fact that the universities are participating in the activities of the business world.

The innovation system efficiently develops new knowledge in several different areas, however, there are some limitations to this knowledge development and as well as knowledge exchange. The majority of the meat substitution producers in the Netherlands who participate in the development of technical knowledge are in fact striving to develop texturalization technologies with which new and better meat analogs can be created. As concentration remains within the development of the technological niches, only little is done in terms of improving, for example, the properties of beans or fungi to be used in a less technically intense way in meat substitution products. Naturally, scientific research is a time-consuming activity that requires the scientist to fully immerse themselves into the topic. To able this, their research must get funding. It is good to keep in mind

that knowledge development is partially an outcome of a selective process of a fight over research funds. Due to top-sector policy, the direction of research funds is increasingly in the hands of the private sector. The government is trusting the market to decide where research finances should be directed. Momentarily, this approach is beneficial especially for applied meat substitution research, but there is to fear that this will lead to less fundamental research aimed at understanding the meat substitution phenomena more in-depth. Simultaneously, the top-sector approach is stimulating knowledge exchange between the academic world and business world, arguably encouraging the business world to be more ambitious and expand its scope. This knowledge exchange, however, takes place mostly amongst the larger producers. This is probably due to finances: funding university research can be perceived as an investment with vague return prospects. For the same reason of vagueness, it is in general unappealing for companies to fund non-technical research which benefits the company are difficult to grasp. Thus, the government must make sure that there are enough resources available for this type of research and to be careful not to let the business world stir the research-focus too much.

In terms of guidance of the search, the main vision raises speculation. The vision of GPA to bring back the 50:50 protein balance is interesting as it does not directly seek people to stop eating meat but rather just increase the amount of other protein sources. It appears as a rather realistic goal behind which the government and the health experts, as well as other actors also on an individual level, can get without much resistance. This goal has without a doubt been extremely carefully generated by the GPA: to be ambitious enough to have an actual impact and modest enough not involve as many actors as possible. The vision has been generated on the level of a consumer and does not involve for example CO2 reduction targets. From the strict point of meat substitution rather than meat alternative consumption in general, it does not explicitly distinguish how much of the 50% could be delivered from meat substitution products. The Green Protein Alliance is an organization composed exclusively of producers of meat substitutes rather than alternatives, for which reason it might be beneficial for it to generate a more explicit vision for these products. This type of vision might be less comprehensive and less supported by outside parties and the partners of the GPA, but on the other hand articulation of a more precise goal could be very useful for business purposes.

The lack of concrete support for market formation by the government illustrates that the government is struggling to make a transformation within itself. Being heavily invested in the feedstock industry, meat substitution and meat alternative consumption appears as a topic that deserves some political attention but not on the expense of the meat market. There is some change in the air, but no concrete action. The meat substitute market has grown to the 2% of the meat market without projectionism or other schemes, but if the government really wants to see the market thrive it must change its current practices. For example, by international standards the Dutch laws on animal welfare are moderately-strict, but many would agree on them not to be strict enough. Revising these laws and other standards that influence the meat industry could be one way to impact the market. This, however, would likely require extensive political efforts. Withdrawing investment from the meat industry would be an even more drastic action, one that is difficult to do without provoking the farmers. As a side note, the fact that the meat substitution market is so small is hampering its development as it cannot use the economics of scale. The meat substitute prices have gone down in the past years, but that has been due to increasing competition rather than an exponential growth in production. With

more extensive support on market formation, the government could help the industry to tip over the point in which it could apply the economics of scale.

The 1,8 million euros distributed for the winners of the New Food Challenge as an attempt to stimulate innovation on meat substitution by the Dutch government is without a doubt positive news. However, the 83 participants and 8 funded projects shows that there are a lot of ideas but not enough money made available. Many of these projects were also generated by companies with already established market presence, such as the Vegetarian Butcher, Sofine and Schouten Europa (Goodbite). It seems a little bit unfair that these companies were competing from the same funds as start-ups. Of course, the government cannot offer monetary support for everyone and needs to pick the actors that they sense most potential in, but perhaps the realization of other schemes to help support the further development and fine-tuning of these projects could be of use.

Physical restriction posed by the availability of ingredients is an issue that many actors are already working to solve in the Netherlands. As an example, a lot of research is being done on the cultivation of soya and lupine in the Dutch climate. The availability of ingredients that cannot be grown locally is not currently constraining the industry, but it is likely to do so in the future with the growing pressure of global food resources. The Netherlands is taking important precautions by researching how these ingredients could be grown locally, and by creating meat substitute products that are based on local ingredients. Especially algae offers a lot of potential from this point of view, as the Netherlands has a lot of areas suitable for its cultivation.

It is impossible to know how the resistance to change will develop in the future. A continuous growth of the meat substitution market in a steady and moderate in a natural way without much government intervention could potentially lead to less-resistance than a fast transition that is reached through intervention to the market. Here lays the paradox of sustainability transition: a smooth and painless transition is likely to be too gradual to reach the benefits of the transition in time. In meat substitution, climate change is, of course, the issue that is putting time pressure on the realization of protein transition as quickly and efficiently as possible. Due to this time pressure, the government is also increasingly pushed to do more.

Integrated analysis – Chapter 8

An integration of the MLP and FIS and a more in-depth analysis of the shared expectations gave some interesting insight into the functional dynamics. Relating the findings of knowledge development and knowledge exchange to the three levels of analysis illustrated that the more expanded the network is in terms of these levels, the more influential they are for the system development in terms of learning by interacting. However, participating in these networks, as that of GPA and Plant Meat Matters, and thus gaining access to these learning processess requires money. This may result in a situation in which the start-ups cannot make use of this type of knowledge, especially the technological knowledge in the generation of which they could participate by funding university research. Thus, there might be a need to realize more projects that stimulate networking and learning by interacting amongst the actors without the necessary financial burden. The informal network that is presumed to appear thanks to the New Food Challenge, for example, could be formalized into a problem-solving network.

Whether the sub-contracting buyer-supplier relationships between the industrial actors actually contribute towards a system development or whether they hinder it remains to be seen. Essentially, the existence of these types of buyer-supplier networks between the producers has both advantages and disadvantages. The benefit is that also smaller brands can deliver high-quality products to the market that make use of expensive texturalization technology, which development would likely not be within their own resources. The downside is, that this limits the diffusion of technology and potentially innovation in the field, as these subcontractors do not possess any technology themselves. The emergence of these type of networks thus concentrates the possession of technology in the hands of a few.

It is of uttermost importance that networks include actors not only from the niches but also the regimes and the landscape, as any type of interaction between them is likely to bring these levels closer together. Excluding the regime actors and working solely with a non-governmental organization in the civil society would likely yield more ambitious visions due to the alignment of individual expectations, but the transformation potential of such approach at the point of only moderate landscape pressure is unlikely to have real transformative power. The networks, especially GPA, is working towards transforming the structures of the formal institutions and making them more favorable for meat substitutes. However, the inclusion of regime actors in the network can also limit the transformative potential of the niches as the ambitions and visions of the GPA must now be adjusted in accordance with all the actors. Presence of Ministry of Economics is especially important because this means that the GPA has a direct linkage to the high level of governance, but on the other hand, they may try to undermine the organization from within.

The fact that the Vegetarian Butcher has decided to exclude themselves from the problem-solving network of the GPA may have to do with varying expectations about the future of the industry. As the study on expectations and actor strategies demonstrated, the expectations of the producers are not completely aligned in terms of politics nor technology. Participating in the GPA as well as the Plant Meat Matters, however, requires money, and it can well be that the company had to make an executive decision in which project to participate in. Thus, the decision to refrain from the GPA by the Vegetarian Butcher might not have to do with diverging expectations on the need for more concrete governmental action for instance, but rather on the availability of resources that partially determine the type of strategy that can be employed in relation to them. Perhaps, the Vegetarian Butcher expectations on the shear cell technology surpassed other expectations connected to the potential of the GPA.

The closer study of the varying expectations and the related strategies can be used to explain the abundance of meat substitution niches that we witness today in the Netherlands. Perhaps most importantly, the expectations relating to the role which meat substitutes will play in the future shape the development of these niches. Expectations relating to the industry's future can both stimulate the development of new technology niches, as well as allow the fully developed niches to stay in place and grow in volume. For example, if an actor believes that imitational accuracy in relation to meat is increasingly essential for the success of meat substitutes in the future, they will perhaps continue pursuing innovation in new texturalization technology. But if they believe that meat substitutes are gateway products to step slowly from carnivorous practices to vegetarian or vegan diet, for example, they might put more efforts into creating substitution products that make use mere mixing technique and do not try to imitate meat in terms of taste or texture.

9.1.3 Reflection on methodology

The choice of theoretical framework is the single most influential factor that has shaped the course and results of the study. Applying both MLP and FIS theory was a methodological choice that proved to be beneficial for gaining an in-depth understanding of both the innovation system and the context within which it emerges. The integration of the two frameworks worked rather well in the end, but the inclusion of expectations and actor strategies might have made the analysis unnecessarily complex. The indicators that were used to analyze the functioning of the innovation system remained vague at times which gave a lot of room for interpretation. It might have been useful in fact to use more quantitative indicators at times. However, this would have perhaps required additional empirical research and undermined the importance of the expert interviews.

In the structural analysis, three types of networks were searched for buyer-supplier relationships, problem-solving networks, and informal networks. Distinguishing between these networks gave a critical indication of the type of learning processes that take place in them and the overall activities that they perform. However, the typology used was perhaps too simplified for this study due to one fundamental shortcoming: the absence of distinction between higher level and lower level networking. The analysis thus failed to distinguish between networks that work on an institutional level and on an operational level. Especially with regards to the importance of governmental action which has been highlighted throughout the study, it might have been beneficial to consider these levels more explicitly. The identified networks were also exclusively ones in favor of meat substitution. This was due to the research focus which remained largely on the niche level and did not attempt to analyze the meat production and consumption regime more in detail. Considering also networks that operate against the system is an interesting point for further research which will be discussed later in section 9.2.1.

According to the applied framework, actors' divergent expectations in regard to the niches, the regime, and the landscape development shape their strategies. This approach might again be too simplified. Even though these expectations shape the actor strategies, there are other factors that play a role in their generation. Perhaps most apparently, financial resources surely influence which type of strategies can be advocated, as the discussion on the Vegetarian Butcher's strategies demonstrated earlier. Other crucial factors could be for instance personal believes and restriction posed by actor's earlier strategies. Expanding the study of expectations to these areas would not have fitted within the scope of this study, but offers nevertheless an interesting remark.

The possibility of using a software for the data analysis, Atlas TI, was explored in an early phase of the study. However, due to difficulties with the integration of the software with the university's Citrix environment, using such a software was eventually disregarded and the data analysis was performed by hand. It was also observed that Atlast TI is not sufficient for analyzing the type of documents in question: as the interviewees all come from different backgrounds, speak from personal experience and communicate in a foreign language, the very little similarity in terms of the common glossary was detected which made it difficult to map things systematically. Additionally, not all information was given directly but it rather had to be interpreted based on the overall discussion and gesturing of the interviewees for example. Using such a software as Atlas TI for the data analysis would have likely yielded more elaborated analysis, but performing such was not perceived to be beneficial in relation to the amount of resources it would have required.

9.1.2 Research limitations

Both MLP and FIS had been criticized for their failure to take into account micro-level developments. This shortcoming was attempted to be solved by splitting up the function guidance of the search for government side and entrepreneurial side driven processes and by incorporating the notion of expectations. This resulted in more analytical attention to the individual actors, but perhaps not enough. Even though the conceptual framework would have allowed the mechanism through which to study these micro-level developments in detail, due to the extensive size of the innovation system and limits of time there was not a real opportunity to study the actors on an individual level Incorporating the role of expectations and actor strategies with these frameworks might have been a bit too ambitious also considering the authors previous research experience, as it brought in overwhelming complexity that was difficult to deal with.

Despite meat substitution innovation system being an extremely interesting subject of study, as this paper has hopefully proved, it would have been beneficial to focus on specific technological niches or social niches to gain a deeper understanding of their functional dynamics. The abundance of niches under study can be regarded as both a strength and a limitation. Due to the number of niches under study, attention had to be directed towards the niches that appeared most active. Therefore, the insects niche and stem cell technology niche, for example, did not get the attention they would have deserved.

The main concern with the results presented in this study has to do with the validity of results due to two aspects: the inability to personally interview all the connected actors and the skewed influence of individual opinions. As the study has illustrated, there are several actors operating in the field on different levels. The results of the research are strongly based on the expert interviews, and due to the restrictions posed by time and resources, it was impossible to discuss with all the influential actors. Overall, over 40 actors were approached for an interview through email or phone and eventually 13 of these interviews were held. Actors connected to the production as well as research and development of meat substitute products were preferred as they are the ones directly connected to the innovation activities. However, interviewing more actors connected to the government, non-governmental organizations and the market, for example, would have likely revealed more especially on the expectations and strategies of these actors. Therefore, one must keep in mind that there are probably more factors, both positive and negative than presented in this research which impacts the development of the Dutch meat substitution innovation system.

Due to the limited number of interviews, the skewness of data presents another point of concern. The results generated are strongly related to personal experiences and are therefore often subject to uncertainty. It is possible that some ideas and/or statements get more weight than they should due to this fact. For example, the fact that one producer feels like the government fund universities are wrongly intervening with the business world is an interesting observation but one that is not necessarily widely shared. Overall, the results presented should be taken earnestly, but some precaution should be maintained prior to basing any concrete action on them.

There are other obvious limitations to the study due to the scientific skills of the researcher as well as linguistic capabilities. Even if the research has been closely supervised and guided by two researchers with a doctorate degree, the study has been mostly carried out independently by an MSc student. Being the first semi-independently realized research project of the author, it is likely that some mishaps have occurred during the

course of the study. Majority of the information concerning the Dutch meat substitute innovation system is only available in Dutch, for example, company websites, newspaper articles and reports by the government. It must be noted, that as the researcher is not fluent in Dutch there is a possibility of misinterpreting information provided in these types of documents.

9.2 Recommendations

9.2.1 Actions to further foster the system development

The recommendations given for further expansion of the Dutch meat substitute innovation system are based on the results of the functional dynamics and the identified transition pathway – reconfiguration. Generating these recommendations based on the pathway is crucial, as it offers a vision of the type of regime that could appear due to the current activities of the actors. The recommendations are therefore also in line with many of the shared expectations of the actors. Overall, 8 recommendations were given for actions to help the system development.

1. **Extend efforts to mobilize the civil society**

The generation of new regulative rules and changing of the old ones is an action to which only the Dutch national government can have a direct impact. To foster the development of the Dutch meat substitution system, therefore, one needs to find ways to influence the government and direct their attention towards changing the current practices and regulations. As there is already an indication of a rising environmental concern among the politicians due to the growing pressures from the landscape, one-way to impact the politicians would be to attempt to strengthen these pressures. This would essentially mean mobilizing as many people, companies, and organizations as possible to point out the problems with our current meat consumptions and bring up the benefits of meat substitution. To do this more efficiently, the meat substitute producers should collaborate more intensively with the existing non-governmental organization or even create their own spin-off organization from the Green Protein Alliance that concentrates on operating on the level of the civil society rather than formal institutions. A spin-off organization from the GPA would perhaps be most effective due to the fact that most of the connected non-governmental organization advocate either veganism and vegetarianism, and might thus be too drastic for the average Dutch flexitarian.

2. **Realize more (semi)educational campaigns**

Stricter regulation on the meat production in the Netherlands paired together with excessive educational campaigns and programs to help farmers transform their product portfolio by the government could decrease the consumption of meat, and direct the consumers to choose local fair practice products when they do. The educational programs would directly address the functioning of the creation of legitimacy from the FIS theory which was detected to be moderate in its current state. Realization of educational programs by the government would likely be most influential, for example incorporating the topic of sustainable meat consumption into the national curriculum, but programs realized by the side of non-governmental actors could also be tremendously influential. National Week Without Meat is a great example of such a program by the private actors that yielded

tremendous results. These programs could follow the example of anti-smoking campaigns for instance and thus help in shaping the public opinion.

3. **Give transition support for meat producers**

Active support on meat producers who wish to make a transition is currently beyond the resources of the involved actors. Yet again, this would be most effective in terms of volume, speed, and acceptance if done by the government, but other actors can support this development. Discussing with meat producers on possibilities to diversify their portfolio, in terms of cultivating plants for meat substitutes, for example, could slowly transform their perception of meat substitution. This would also illustrate the meat production and consumption regime that the meat substitute industry is not looking to replace them and make them obsolete, but rather to offer them a new way to make a living, one in which their own well-being, as well as the well-being of their animals, would increase. As the government is in a lock-in with the meat industry due to the extensive subsidy scheme and the political support they get in turn, approaching the transition from the side of the meat producers could, in fact, be fundamental in breaking down these ties and removing the shelter around the meat production and consumption regime. To achieve this, a collaboration between the meat substitute producers and scientists could be beneficial. Together, these actors could, for example, make projections of the number and type of crops that are needed for meat substitution products as well as the development of the bio-industry, and help these farmers transition their farm slowly over time. Such transitional support is currently being offered for example in the UK by the Vegan Society.

4. **Give active support for startups**

The New Food Challenge left 75 participating start-ups and companies without funding to realize their projects. The government should re-generate a program aimed specifically at startups and smaller companies that are just looking to get started, not to finance them directly but to help them improve their products and business ideas. If the government is reluctant to do so, perhaps the GPA could create schemes, such as a green-protein conference for start-ups and students, to stimulate the exchange of knowledge and involve more people within their network. Support could also be given to these start-ups by helping them search for alternative ways of funding, namely experience with crowdfunding schemes that are hugely popular at the moment for example in the United States. Finding funding is necessary for getting started and one has to know how to get it, and for which reason the increasing cooperation between people connected to technology and people connected to business is so crucial for realizing ideas.

5. **Expand market presence to new selling-points**

Meat substitutes are currently absent in an important market location – butcheries. If these products, especially the ones that really strive to imitate meat, want to really intervene the meat market and merge with it there should be a minimal distinction between the two also in terms of where to get them. The meat substitute producers should thus innovate on products that do not only belong to the supermarkets, but which could be presented and sold fresh, and convince butchers to include them in their selection. One promises of the shear cell technology are its combat size which could mean that soon the butchers could even make their own meat substitution products in location. Exploring this type of development would also reveal the extent to which the meat production and consumption regime is open to adapt meat substitution niches.

6. **Improve joint knowledge development**

In the field of meat substitution, the top-sector law has resulted in the realization of one substantial join research project between the industry and the knowledge institutes, the Plant Meat Matters. With the expectation that multinationals are getting more invested in the industry and that the separation between small and large enterprises continues to grow in the future, it is crucial to secure that the small and medium-sized companies also have access to the problem-solving networks, participation in which often is expensive. With the top-sector law in effect, it is difficult to imagine how this could be done. Perhaps the government could for example rule that each joint research project must include at least one small or medium-sized enterprise. Another way would be for these smaller actors to form partnerships and collectively participate in these problem-solving networks. This would, of course, delimit the type of networks that these enterprises would participate in, which in turn could be counterproductive and make them more isolated.

7. **Use more extensive strategies for marketing**

As the meat substitution companies grow and become more successful, they should invest in requiring people with outstanding marketing experience and skills. Even though the strategies that are currently pursued have worked in favor and resulted in the expansion of the market, meat substitution products are still not familiar to all the consumers and thus more exposure is required. From a point of view of decreasing meat consumption through meat substitution, these marketing campaigns should be increasingly directed towards the meat consumers who have necessary not considered giving up their meat, and the efforts to address the vegan and vegetarian consumers specifically should be kept in minimum as these consumer groups have already been conveyed.

8. **Establish international collaboration**

The extent to which the actors of the Dutch meat substitute innovation system collaborate internationally remains very limited. Especially in terms of fostering technological development, learning by interacting with equivalent industries abroad could expand and foster these activities. Such collaboration would be especially useful with companies from other EU countries who operate in a similar institutional setting but not within the same market. The industrial actors should form partnerships with equivalent industries abroad who advocate the same niche as them or a niche towards which they are thinking of expanding and want to learn more of. Perhaps this would be most interesting for start-ups and small companies who have limited resources for knowledge development. Overall, it appears that several meat substitution innovation systems are developing in isolation from another, also within Europe, and it could be of interest to bring all the industrial actors together in a conference for example, in a similar manner that scientists do.

9.2.1 Further research

To validate the presented results, a more focused study of the functioning of the system should be done with a larger base of interviews and more in-depth analysis of the material presented in the media and on the governmental websites, perhaps by a native speaker. It would also be interesting to use the same methodology for studying another meat substitution innovation system abroad and make a comparison of the two studies to detect similarities and differences between the two.

Determining the regime in terms of meat production and consumption rather than larger protein production and consumption was a carefully thought choice which had an important impact on the analysis. The meat consumption was ultimately chosen for two main reasons: the difficulty of distinguishing between the niche and the regime developments for the protein regime and the necessity to include meat alternatives to the niche developments if chosen. Ultimately, the protein consumption would have been a more adequate choice if the whole study would have dealt with the broader topic of meat alternative consumption rather than meat substitution. Taking this perspective on MLP on meat substitution might be an interesting point for further study. Another interesting topic would be to study more in detail the meat production and consumption regime, in terms of structure for example, and based on these findings generate a more comprehensive analysis of the dynamics between the meat substitute niches and the regime.

One could argue that the Dutch government is now, in fact, participating in purposeful transition management with the creation of the Dutch Food Agenda, which can be regarded as the creation of strategy, the first step of the TM theory. As the concentration remained on the side of research and development within this study, researching the governmental action or inaction by both the national government and the EU could offer a useful lens through which the role of formal institutions could be better incorporated.

There is a lot of work that can be done in regard to expectations and actor strategies. This study considered primarily shared expectations and strategies, but to better understand the diversification of strategies in terms of niche markets, for example, a more detailed study on the individual expectations of the actors should be conducted. It would also be interesting to analyze the individual expectations of the governmental actors, as this could be useful in explaining the volatility of the current Dutch government.

Chapter 10: Conclusion

Global meat consumption is growing rapidly. In developed countries, an average person currently consumes 83 kg of meat per year, which is a 10-kg increase since 1980. Meat production and consumption is problematic due to the industry's immerse impact on the environment: The United Nations' Food and Agriculture Organization concluded in 2006 that the livestock industry is responsible for 18% of the GHG-equivalent emissions in the atmosphere, making it one of the top three causes of environmental degradation together with the energy sector and the transportation sector. Meat consumption is also increasingly criticized upon due to its recently discovered health impacts and the lack of attention to animal welfare. Taste for meat is deeply embedded in social practices, for example, in the dietary patterns people have grown up with, and it appears that a majority of people are reluctant to give up their meat and change these practices. Therefore, meat substitution offers a viable strategy towards decreasing meat consumption by the creation of products that represent meat in terms of taste, texture, looks, smell and/or nutritional content, making vegetarian practices easier for consumers to adapt due to the increased familiarity. Thus, this research aimed to answer the research question: *What can be learned from the recent developments in the Dutch meat substitute innovation system to further foster its expansion?* Six types of meat substitute groups were identified at the beginning of the research that appeared relevant for the Dutch: substitutes based on legumes (1), substitutes based on dairy (2), substitutes based on fungi (3), substitutes based on sea-vegetables (4), substitutes based on insects (5) and substitutes created with stem cell technology, eg. in vitro meat (6).

Meat substitution is a phenomenon that can be studied through the application of sustainability transition theory, which currently constitutes of four main theoretical fields: transition management, strategic niche management, multilevel perspective and technological innovation systems. In this research, the theories of multilevel perspective and functions of innovation systems were applied and extended with the notions of expectations and actors strategies on these three levels of analysis. The data used to study the meat substitution innovation system was mostly gathered through two-rounds of interviews with actors connected to the fields of industry, science, policy and NGO's. In total, 14 actors were interviewed, primarily from the fields of industry and science due to the research's emphasis on the production.

The first part of the research constituted of chapters 4 and 5 which generated a description of the innovation system. In chapter 4, the main developments in the field of meat substitution during the past 10 years, in the Netherlands were discussed. This detailed description of recent history shows that innovation within the field of meat substitution has accelerated since 2010. This has resulted in a wide variety of actors operating in the industry and related fields and providing a large selection of different meat substitution products available for the consumer. The market has experienced enormous yearly growth, with an exception of the stagnation perceived in 2015, for example, a 9.5% growth between 2015 and 2016. In the past 10 years, the awareness of the impact of the meat sector on climate change along with climate change itself has rapidly grown, which has likely resulted in both extensive efforts to innovate the meat substitution field and increase consumers interest towards such products. Two major technologies are under development in the Netherlands connected to meat substitution: shear flow technology by the University of Wageningen and stem cell technology by the

University of Maastricht. The majority of meat substitutes sold on the Dutch market are based on legumes, but there are some companies with strong branding with other substitution groups, such as Valess with dairy, Quorn with fungi and the Dutch Weed Burger with seaweed. Chapter 5 offered a structural description of the system under study and presented a structural map to visualize the actors, networks, institutions, and technologies that belong to it. The actors in the Dutch meat substitution innovation system are organized in networks of buyer-supplier relationships, problem-solving networks, and informal networks. Overall, the structural analysis revealed not only the abundance of actors connected to the innovation of meat substitution but also the way these actors are organized and the field that they belong to. The first part of the research described the system in detail in order to analyze it sufficiently in the following research phase.

The main findings of the analysis in the second part of this research create an image of a highly active innovation system that is versatile and above all else dynamic. Application of the multilevel perspective in chapter 6 shows that the meat production and consumption regime experiences low landscape pressure and is actively searching for innovation within the meat substitution niches to strengthen its own establishment, for example through new hybrid meat products and meat substitution products based on dairy. It was argued that the meat substitution niches currently explore the transition pathway of reconfiguration, as they do not attempt to make the meat production and consumption regime obsolete, but rather merge with it. However, the meat production and consumption regime seem reluctant to actually change its practices to enable such meat substitution niches to do this. The functional analysis in chapter 7 revealed that the main bottlenecks of the system currently have to do with governmental action, the shortcoming of the system is to legitimize itself for a larger audience, due to the lack of concrete shared visions and the availability of financial resources. Integration of the MLP, FIS and the expectations and actor strategies in chapter 8 allowed an identification of causal-effect relationships. It was discovered that the industrial actors have a common expectation that the plant-based movement will continue to grow, but they were not aligned in terms of what role meat substitutes would ultimately play in society, what kind of technological development is required nor the type of meat substitute niches that would carry the transformative power. The integrated analysis also discovered that the networks which develop knowledge through interaction often on several levels of the MLP, increasing their potential to pursue the path of reconfiguration.

Based on the results of the research part 2, chapter 9 presented eight recommendations or action points which could foster the expansion of the Dutch meat substitute innovation system.

1. Extend efforts to mobilize the civil society
2. Realize more (semi)educational campaigns
3. Give transition support for meat producers
4. Give active support for start-ups
5. Expand market presence to new selling-points
6. Improve joint knowledge development
7. Use more extensive strategies for marketing
8. Establish international collaboration

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Appendix

A.1 Semi-structured interview questions

A.1.1. First-round interviews

1. Why are you motivated for advocating meat substitutes and how are you involved in the topic?
2. How would you shortly describe the general development of the Dutch meat substitute sector in the past 10 years?
3. What are the main ___ developments that have affected the meat substitute sector in the past 10 years?
    a. Technology
    b. Policy
    c. Economic /market
    d. Social
    e. Environmental
    f. Legal
4. How do you perceive the attitudes of the Dutch meat sector towards meat substitutes now and 10 years ago? Has there been a change of attitude? If yes, can you try to explain why?
5. Do you think that meat substitutes are more normalized now than they were 10 years ago? Why is that?
6. The consumption of meat substitutes in the Netherlands was steadily growing from 2010 but stagnated in 2015, can you explain why?
7. Who do you consider to be the main actors involved with the ___ development of the meat substitute sector?
    a. Knowledge
    b. Policy
    c. Business
    d. Social
8. Do you think something could or should have been done differently by the actors of the innovation system in the past ten years?
9. What ___ developments do you expect to occur and impact the development of the meat substitute sector in the next 10 years?
    a. Technological
    b. Policy
    c. Economic/ market
    d. Social
    e. Environmental
    f. Legal

10. What role you think meat substitutes will play in the Dutch society in the next ten years?
11. Considering all the actors within the sector, to what extent do you think they share the same vision with you?
12. Considering all these developments within the past 10 years in the meat substitute innovation system in the Netherlands, are you optimistic about its' future and why?

A.1.2. Second round interview

1. How are you and your organisation involved in the topic of meat substitution?
2. What motivated you to work in that field?
3. What are your expectations regarding the future of (a) the Dutch meat substitute industry and (b) the Dutch meat industry? Please elaborate what your expectations are based on.
4. What are your / your company's goals with regards to meat substitution in the future and through which strategies do you strive to reach them?
5. Who do you consider to be the main actors for the Dutch meat substitute industry? Which of these actors are you actively in contact with and on what grounds?
6. What policies affect the development of the meat substitution industry?
7. In your opinion, is the number of actors in the industry and their activities sufficient for its further expansion?
8. How would you describe the quantity and quality of R&D activities at the industrial level and the academic level?
9. How would you describe the exchange of knowledge and joint knowledge development between firms, research institutes and users?
10. Is there a clear vision about the future of meat substitution in the Netherlands? If yes, what strategies are employed to realize it and by who?
11. Are there actors with contradicting visions? If yes, what strategies do they employ to realize them?
12. What are the main meat substitute niches in the Netherlands and who represents them on the market?
13. What is your opinion on meat substitutes based on insects and seaweed?
14. How do you expect these niche markets to develop in the future?
15. How would you describe the availability of human resources, financial resources and physical resources of the industry? Do they form constrains or opportunities for further expansion of the industry?
16. Are there any schemes in place to influence meat substitution projects at an institutional, organizational or consumer level? What impact do they have on the development of the industry?
17. In your opinion, what kind of activities and measures would be needed to realise a transition in which meat substitutes would have a significant share in meat consumption?

A.2. Rules connected to the regime, niches and the reconfiguration pathway

By visioning the rules which the advocation of the reconfiguration pathway would yield gives an idea of the type of regulative, normative and cognitive changes needed for the transition to take place, thus building towards the generation of recommendations for concrete actions.

The expected structural change due to reconfiguration of the current meat production and consumption regime has to do with institutions, or the transformation of these institutions to be more precise. It would essentially mean that the rules of the meat substitution niches, which are listed in table below, would become more stabilized and thus disrupt the rules of the regime. By following the path of reconfiguration, the rules of the current regime and the niches would form a base for a complete new set of rules that are an intermediate between the two. Probably most importantly, the belief that meat forms an essential part of a healthy and balanced diet is a rule that should be broken for meat substitutes to break through. Another crucial rule change would be the idea that animal welfare can be neglected at the expense of profits, which should take place both at the production and consumption side. For meat substitutes to succeed in breaking into the current regime and changing it in a symbiotic manner, several actions can be taken by a variety of actors to foster this development.

The set of rules presented in section 7.2 in the meat regime, the meat substitute niches and the new meat regime shows that some of these new rules are already for long in the making in the niches and the landscape. Rules of the reconfiguration path such as: “meat is an important part of the Dutch culture but it is not a necessity”, “meat substitutes can efficiently replace traditional meat in many dishes, especially processed low-quality meat, without sacrificing the culinary experience” and “meat is not a requirement for a healthy and balanced diet “are instances that a large part of the Dutch society would likely already accept. These rules do not reflect to the amount of meat consumption quite yet, due to the perseverance by the meat regime.

Type of rules	**Meat regime**	**Meat substitute niches**	**The new meat regime (co-existence of meat & meat substitutes through reconfiguration pathway)**
Regulative *Written rules and laws*	- Animal agriculture laws and regulations (both national and the EU) - European food safety requirements - Food safety regulations in the Dutch Commodities Act - The Animals Act - The Decree containing rules for keepers of animals	- Agricultural laws and regulations (both national and the EU) - European food safety requirements - Food safety regulations in the Dutch Commodities Act - Sanctions from neglecting to comply to these laws and regulations if observed	- All the rules listed for both the meat regime and meat substitute niches - Regulation to prevent artificially low meat prices (eg. meat tax, cutting of subsidies directed towards the bio-industry)

	- Sanctions from neglecting to comply to these laws and regulations if observed by the Food and Consumer Product Safety Authority - Individual Food Safety Plan for Businesses	by the Food and Consumer Product Safety Authority - Individual Food Safety Plan for Businesses - European Novel Food Law	- Revision and tightening of the animal agriculture laws and regulations - Increased sanction for neglections of these laws and regulations
Normative *Values and norms*	- Meat is an essential part of a Dutch diet and culture - Animals are property - Animals wellbeing is important but profitability is more important - There is no need to decrease meat consumption	- Meat is not an essential part of a Dutch diet and culture - Animals are not property OR animals are property but their welfare should be guaranteed even at the expense of profits - Importance of environmentally conscious practices	- Meat is an important part of the Dutch culture but it is not a necessity - Meat is a luxury product - Meat substitutes can efficiently replace traditional meat in many dishes, especially processed low-quality meat, without sacrificing the culinary experience - Animals are property but their welfare should be guaranteed
Cognitive *Underlying beliefs and assumptions*	- Meat is a requirement for a healthy and balanced diet - Certain improvements in the sector in terms of sustainability and animal welfare could and should be taken, however this would require greater financial support to make it profitable	- Meat is not a requirement for a healthy and balanced diet - Meatless diet has a high potential to improve the sustainability of food and animal welbeing - Meat production is inherently an unsustainable practice	- Meat is not a requirement for a healthy and balanced diet - Meat production is inherently an unsustainable practice and therefore the size of it should be drastically decreased, however there are several ways to

			improve the sector and produce environmentally sound meat

Table 41: Regulative, normative and cognitive rules connected to the meat regime and the meat substitution niches, and speculation on the rules of the new meat regime in an event of disruptive and symbiotic transition.