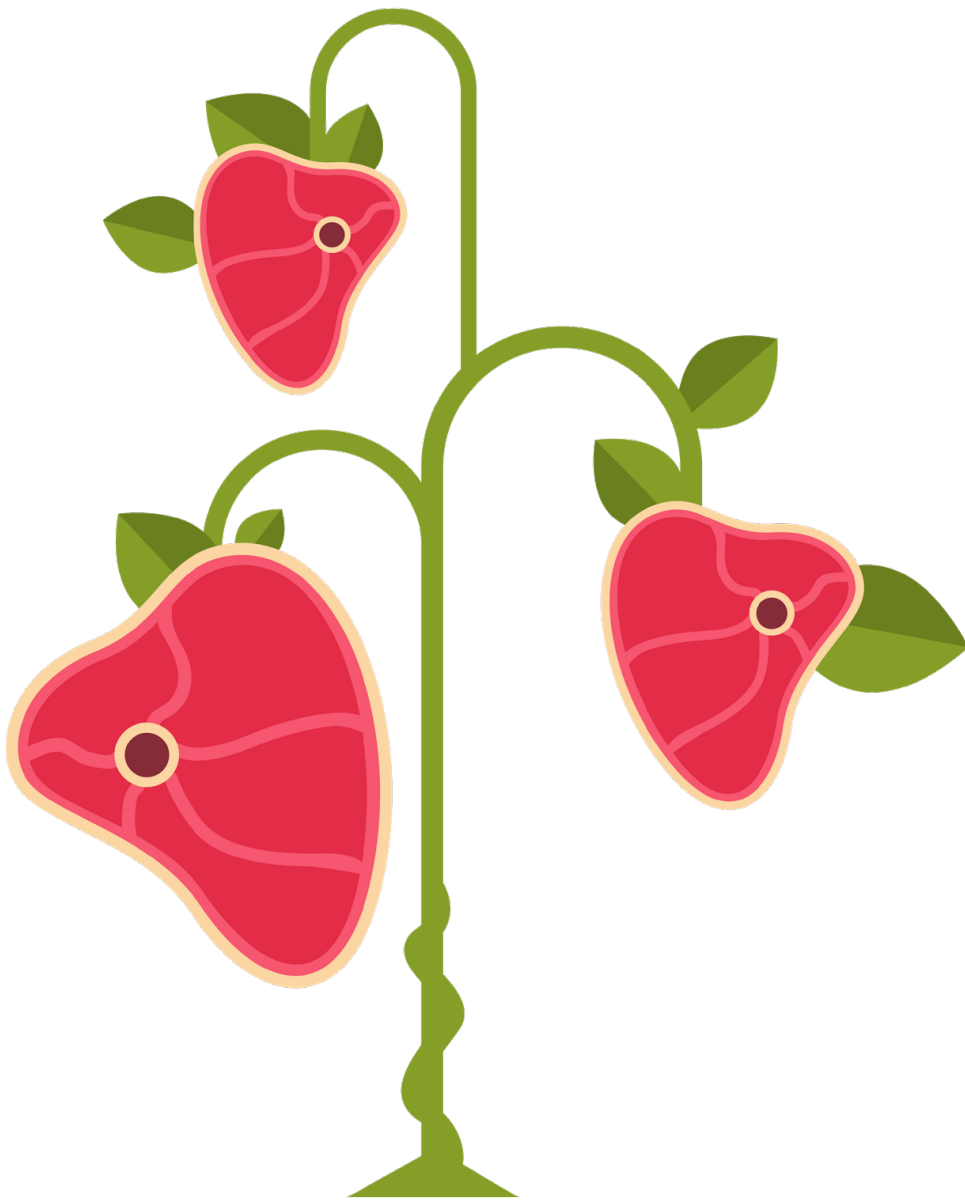


# Transitions towards sustainable food systems

The case of the protein transition



Maria Tziva



**Transitions towards sustainable food systems:  
The case of the protein transition**

**Transities naar duurzame voedselsystemen: de eiwittransitie**

(met een samenvatting in het Nederlands)

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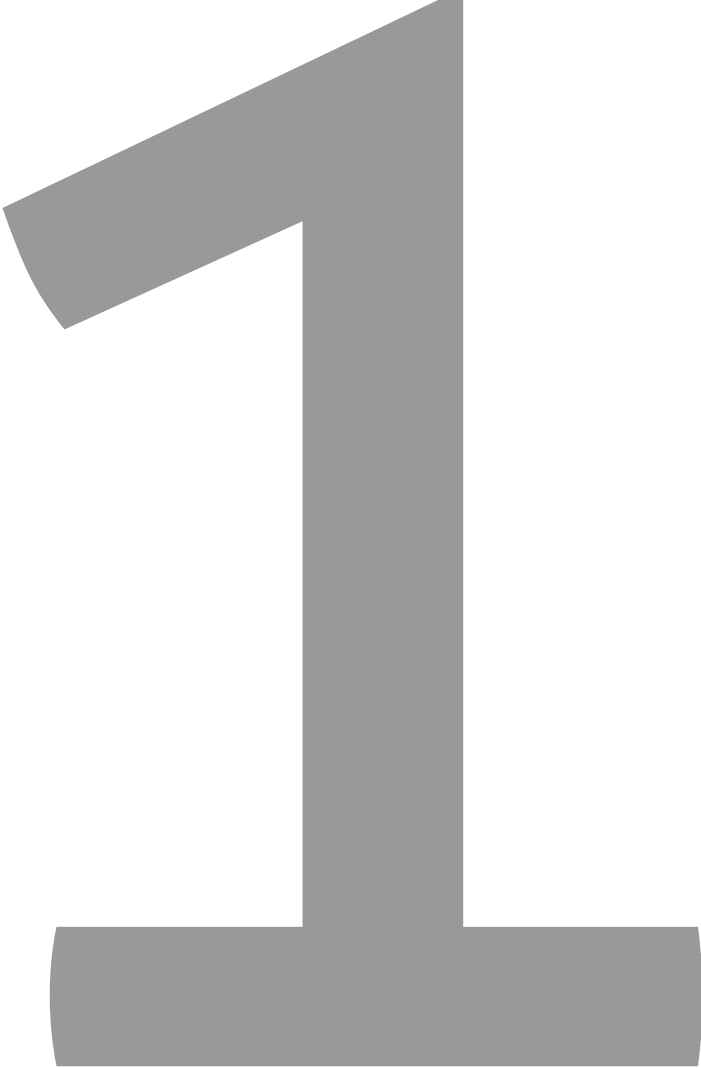
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**CHAPTER 1**



# Introduction

## 1.1 Sustainability transitions in the food system

Food is essential to human life, yet the current food system is threatening the environment by significantly contributing to climate change and a range of other impacts, including biodiversity loss, terrestrial ecosystem destruction, freshwater consumption, and water pollution (Rockström et al., 2020; Springmann et al., 2018). In particular, the sustainability of meat and dairy production has become a concern because of the negative environmental impact of livestock agriculture. The Food and Agricultural Organization (FAO) of the United Nations has estimated that livestock agriculture accounts for about 14.5% of global greenhouse gas (GHG) emissions, with beef and cattle production accounting for most of the emissions (Gerber et al., 2013; Steinfeld et al., 2006). Feed production and the expansion of pasture and feed crops into forests also significantly contribute to the sector's emissions (Gerber et al., 2013). In addition, livestock agriculture is a major driver of biodiversity loss and serious deterioration of water quality (Steinfeld et al., 2006). Such pressures are expected to intensify with global population growth, growing affluence, and the increasing demand for meat (Díaz et al., 2019; Gerber et al., 2013; Godfray, 2018).

The global average per capita consumption of meat and the total amount consumed are rising (FAOSTAT, 2018; Godfray, 2018). While meat is an important component of the human diet as a rich source of essential nutrients, scientific studies show adverse health impacts for individuals with high intakes of red processed meat, such as an increased risk of certain cancers and diet-related diseases (Bouvard et al., 2015; Rubio et al., 2020). Data indicate that red meat consumption exceeds nutritional recommendations worldwide, with the exception of specific regions, including sub-Saharan Africa and South Asia (Willet et al., 2019). Moreover, all forms of malnutrition, including obesity and the associated noncommunicable diseases, have been estimated to constitute some of the most important risk factors for the global burden of disease (LPE, 2017). Taking the environmental and health implications of livestock agriculture and meat consumption into consideration, the importance of diets in determining food system sustainability is paramount (Béné et al., 2020; Dagevos & Voordouw, 2013; Hedenus et al., 2014; Godfray, 2018).

The role of diets in food system sustainability is also becoming a widely-recognized topic in policy (IPCC, 2019; Willet et al., 2019). The authoritative EAT-Lancet Commission report on “healthy diets from sustainable food systems” highlighted the links between environment and human health and called for diets rich in plant-based foods and fewer animal-derived foods (Willet et al., 2019). Similarly, the recent high-level report on climate change and land by the Intergovernmental Panel on Climate Change (IPCC, 2019) describes diets centered primarily on plant-based foods as a major opportunity for mitigating and adapting to climate change. The report also includes a policy recommendation to reduce meat



consumption in high-income countries. However, while policymakers are increasingly aware of the need to transition to plant-based diets, they also face a complex problem.

The shaping of dietary consumption patterns is not limited to developments in economic growth and urbanization (Layman, 2014; Spaargaren et al., 2013; Popkin, 2011). The evolution of the food-processing sector into an industry that manages a dynamic and complex flow of materials and combines them into durable, standardized, mass-distributed food products has been central in determining the multiple food choices available to consumers (Layman, 2014; Spaargaren et al., 2013). At the same time, food choices are shaped by societal aspirations, responses to new identities and preferences, and the expression of cultural meaning (Vermeulen et al., 2020). Therefore, the study of changing diets and mitigation options for a sustainable and healthy food system requires insight into the “elements” that contribute to technological and cultural shifts in food production and consumption.

Sustainability transitions literature emerged to conceptualize evolutionary (social) innovation dynamics as a response to complex environmental problems (Köhler et al., 2019; Savin & van den Bergh, 2021). According to this literature, issues such as climate change and biodiversity loss are underlain by unsustainable patterns of production and consumption in electricity, heat, water, agro-food, and other systems (Köhler et al., 2019). Sustainability transitions are required to address these problems, involving radical interlinked shifts in technologies, infrastructures, organizations, markets, regulations, and user practices (Elzen et al., 2004; Geels, 2004; Grin et al., 2010). Thus, sustainability transitions literature seeks to understand innovation, which can ultimately lead to more sustainable systems for the provision of societal needs.

The distinct characteristics of sustainability transitions have been conceptualized in the main sustainability transitions frameworks, the multi-level perspective (MLP), the technological innovation system (TIS) perspective (Rip and Kemp, 1998; Geels, 2002; Smith et al., 2010; Hekkert et al., 2007; Bergek et al., 2008), and several theoretical elaborations, such as transitions management, strategic niche management, and strategic system building (Loorbach, 2010; Musiolik et al., 2012; Schot and Geels, 2008). Transitions are long-term processes involving multiple elements. Therefore, these frameworks assume an evolutionary perspective to investigate non-linear processes involving interdependent developments, including the interplay of technology development, institutional change, cultural processes, and social dynamics. Moreover, the relationship between the stability of current, unsustainable systems and change dynamics toward sustainability are central to sustainability transitions. These frameworks provide concepts to examine lock-in crescendos, such as investments, sunk costs, existing resources and capabilities,

and change mechanisms, such as knowledge development, learning, and legitimation processes.

Empirical studies on sustainability transitions have mainly focused on the electricity and mobility systems (Köhler et al., 2019). More recently, researchers have investigated other empirical domains, including heat, water, buildings, and waste (Savin & van den Bergh, 2021). Focusing on these empirical domains has led to particular insights into how sustainability transitions can be achieved.

To start with, industrial knowledge production dynamics in sustainability transitions mainly follow innovation patterns that have been observed in industries described as science-based or advanced knowledge providers (Castellacci, 2008; Pavitt, 1984). New technologies and products that aim to address environmental problems are radical in nature, and scientific advancements are developed in universities and public research institutes. Firms mainly rely on creating knowledge through these scientific advancements and in-house R&D. Therefore, transition studies frequently carry an unintentional technological paradigm bias in which knowledge is codified in models, patents, and reports. There are close industry-university links, and repeated scientific breakthroughs are necessary for the development of commercial products.

On the demand side and in terms of the users of innovations, users have undifferentiated preferences and primarily base their choices on price signals because products in the electricity and mobility systems markets, such as mature solar photovoltaics and renewable energy or electric vehicles, are relatively standardized (Binz & Truffer, 2017). Therefore, the early diffusion of products primarily depends on creating protected market niches through fiscal regulations that even the price playing field with unsustainable products (Suurs and Hekkert, 2009). Less attention has been given to the cultural dimension of the demand-side and user groups adopting products to articulate socio-cultural choices (Köhler et al., 2019).

Moreover, because of the high risk associated with sustainable innovation and products in the energy and mobility sectors, sustainability transitions literature has long been characterized by a bottom-up bias (Sovaccol et al., 2020). Change is primarily driven by alternatives emerging from “outsiders.” Established or incumbent actors have limited incentives to engage in innovations because they are related to “common goods” and threatened sunk investments (Geels, 2014). Studies often assume the introduction of coercive regulations as necessary for the reactive engagement of incumbents in sustainability transitions, and they tend to neglect the possibility of the proactive engagement of incumbent actors due to economic opportunities emerging from changing consumer preferences (Penna and Geels, 2012).

Therefore, sustainability transitions literature assumes a “lifecycle” of innovation. Change processes start in niches where independent pioneering actors develop radical technologies and products to address sustainability problems (Penna and Geels, 2012). These new technologies and products remain in niches and go through a long formative phase during which experimentation and learning occur (Bento and Wilson, 2016; Geels and Penna, 2012). Incumbent firms initially resist radical innovation (Geels, 2014; Penna and Geels, 2012; Roberts et al., 2018) by adopting discursive strategies, forming industry associations to protect vested interests, and symbolically engaging in incremental innovation processes (Smink et al., 2015). When increasing public attention leads to the involvement of policymakers and the introduction of regulations such as industry standards, incumbent firms take substantive action in the form of opposing regulations, but also through diversification and increased investment in R&D (Wesseling et al., 2015). The meaningful reorientation of industries occurs following a mixture of exogenous pressures, including introducing radical regulations and changing consumer preferences (Geels and Penna, 2015). Finally, new technologies and products become embedded in societies, and sustainability transitions culminate in a mature stage.

Sustainability transitions literature also focuses on the transformative potential of specific actors. During transitions, agency is seen as a struggle by individual and collective actors to shape technical and institutional structures that influence the extent, pace, and direction of change in systems (Duygan et al., 2019). The efforts of pioneering entrant firms, researchers, and related networks and associations as agents of change have been the primary focus of the transitions literature (Turnheim and Sovacool, 2020). Policymakers have also been studied thoroughly, as technology-push policies and regulatory action are anticipated to support niche development and the growth of niche markets (Farla et al., 2012). Furthermore, incumbent firms and established industry associations have been explored, mainly in the context of stability and continuity in transitions (Turnheim and Sovacool, 2020). There has been less emphasis on the users of innovation—even though they are identified as exerting selection pressures for the embeddedness of innovations in societies—or on other civil society actors such as NGOs that can be crucial in the governance and political dimensions of transitions.

While there are many empirical studies on transitions in electricity and mobility systems, research on agro-food systems is relatively limited. Relevant publications primarily explore agriculture, grassroots movements such as alternative networks for the provision of food, and food consumption practices (Grin, 2012; Hinrichs, 2014; Randelli and Rocchi, 2017; Seyfang, 2006; Spaargaren et al., 2013). Such studies have provided valuable insights into systemic innovation in agriculture centered around adopting sustainable agricultural practices and have examined micro and macro facets of innovation, such as consumer behavior and macro-level factors shaping consumer practices. However, less is known

about meso-level sustainability transition dynamics in the food-processing industry (Bilali, 2019; Mylan et al., 2018). This gap is significant when seeking to understand shifts in food production and consumption, because differences in the properties of industrial sectors lead to diverse technological paradigms and, consequently, variances in the co-evolution of innovation processes (Castellacci, 2008; Malebra, 2002; Pavitt, 1984). In general, there is a likelihood of distinct innovation dynamics in the food-processing industry that the sustainability transitions literature has not addressed. There are two reasons for this expectation.

First, technological change in food processing often emerges through a supplier-dominated innovation trajectory (Castellacci, 2008; Pavitt, 1984). Advanced knowledge is acquired from different segments of the economy to adjust inputs and processes for the development of new products. The implication is that processes regarding radical innovation, which are mainly discussed in current sustainability transitions literature, are not always required. Instead, commercially viable products are developed primarily through incremental innovation processes within firms; hence, the dynamics of the formative phase of innovation can vary from existing conceptualizations.

Second, there are crucial differences between the demand-side of the food system and the energy and mobility systems, which have mainly inspired sustainability transitions theories. In the food system, there is an almost complete absence of regulatory intervention in the form of favorable taxation schemes for sustainable consumer products. National governments have been reluctant to adopt such regulations due to barriers erected by international regulatory institutions, uncertainties related to the impact of such tools, and strong industry opposition (Bødker et al., 2015; Fellmann et al., 2017). Overall, the degree to which policymakers have the societal license to influence food consumption is a highly-contested issue, and there is uncertainty about which interventions might be effective (Godfray, 2018). Therefore, the introduction of government-supported market formation regulations such as consumption tax exemptions for sustainable products, which is assumed to be a precondition for the progress of sustainability transitions, is not yet relevant to the food system.

Instead, innovation dynamics in the food industry can be driven by social innovation, such as dietary behavior shifts (Mylan et al., 2019). Niche consumer markets emerge when individuals look for products with specific characteristics, often sustainability-related (Hundscheid et al., 2022). Norms upheld by consumers are crucial in changing consumer behavior and driving firms' innovation attempts. Hence, in terms of shifts in the demand side of the food sector, "norm-entrepreneurship", which highlights specific issues and challenges the appropriateness of norms and behaviors (Finnemore and Sikkink, 1998), has been more crucial than regulation in instilling change.

Recent studies on the food-processing industry offer indications of these distinct characteristics in the co-evolution of innovation processes (Hundscheid et al., 2022, Lonkila and Kaljonen (2022); Mylan et al., 2019; Strøm-Andersen, 2019). In particular, Mylan et al. (2019) and Hundscheid et al. (2022) underline the crucial role of cultural meaning in the growth of plant-based product markets. Mylan et al. (2019) and Lonkila and Kaljonen (2022) offer evidence of incumbent firms' proactive diversification strategies, which are driven by economic opportunities due to changing consumer preferences. However, there are still knowledge gaps that preclude sustainability transitions literature from adequately conceptualizing transitions in the food system, particularly regarding sustainable diets.

Overall, the comprehensive conceptualization of sustainability transitions in the food system requires a new focus on innovation dynamics in the food-processing sector. It is essential to investigate institutional developments that trigger change processes—particularly social norms, which are pivotal in consumer behavior and dietary patterns. In addition, crucial issues concerning the food industry's behavior regarding healthy and sustainable diets must be addressed. This need arises because typical food industry firms' strategies, such as mergers and acquisitions (M&As), provide examples of incumbent firm engagement with niches that can potentially contribute to the scaling of innovations and enable sustainability transitions.

## 1.2 The protein transition case

The “protein transition” is a distinct case of transitions regarding healthy and sustainable diets. In recent years, as a response to the environmental and health implications of the production and consumption of animal products, several plant-based meat substitute products—items that replace meat in the human diet and have an appearance, texture, and taste similar to meat products—have been introduced. These substitutes are currently at the point of breaking into mainstream food consumption. Therefore, scientists increasingly recognize the growth of the plant-based meat substitute market as contributing to a transition to plant-based diets (Aiking and de Boer, 2018; Mylan et al., 2019; Herrero et al., 2020).

While the diffusion of plant-based meat substitutes is often perceived as a new trend, commercial products in this category have existed for several decades. The variety of currently available products results from innovation in several different food-processing technologies that structure raw materials into products that resemble meat. Technological development in the sector can be conceptualized by distinguishing between first- and second-generation meat substitutes. First-generation products have existed in European markets since the 1990s. They were mainly based on the intermediate product, textured

vegetable protein (TVP), produced with low moisture cooking extrusion. Second-generation meat substitutes reached European markets in the early 2000s following advances in cooking extrusion technology, such as the introduction of high-moisture cooking extrusion and the deployment of processes from other (food) sectors, including the utilization of hydrocolloids. This progress allowed the development of better-performing products in terms of taste and texture and the use of a broader range of raw materials.

This thesis studies the emergence and diffusion of plant-based meat substitutes in different countries, including the Netherlands, the United Kingdom, and the United States. It specifically focuses on institutional change processes regarding the emergence and diffusion of plant-based meat substitutes and the behavior of firms in the food industry.

In terms of institutional change, changing consumer demand and cultural processes have been crucial in protein transition. The adoption of meat substitutes is linked to changing norms regarding meat consumption and complex processes of legitimation and social embeddedness. The role of early vegetarians and vegans was pivotal in challenging the appropriateness of meat consumption and initiating normative contestation. Because of their negative view of meat consumption, these pioneers also supported the consumption of meat substitutes. Increased awareness of the meat industry's adverse impacts on the climate, the environment, animal welfare, and human health led to amplified normative contestation around the issue. This trend changed the way meat substitution was understood. As the frame of meat substitution evolved from altruistic and ethical considerations to broader sustainability considerations, it resonated with more consumer groups; hence, the process contributed to the mainstreaming of meat substitute products.

In recent years, plant-based meat substitutes have been coupled with policy efforts to promote plant-based diets in national contexts. However, because food consumption presents a particularly complex regulatory dilemma for governments, promoting the consumption of plant-based products has been limited to the broader sphere of governance, including private governance institutions such as alliances. The Green Protein Alliance (GPA) is a distinct example of an alliance operating in the sphere of plant-based diets and meat substitutes. The GPA is a network of firms, government organizations, and NGOs that has implemented collective strategies for promoting plant-based protein consumption in the Netherlands, such as raising consumer awareness and running educational campaigns.

Despite the market growth of plant-based meat substitutes, the issue of whether the rise of plant-based protein products is beneficial to human and planetary health is still contested (Sexton et al., 2019; Morris et al., 2019). First, there is significant uncertainty regarding

the health implications of dominant innovation trajectories for the development of meat and dairy substitutes and, therefore, the envisioned coupling with calls for a transition to “healthy” plant-based diets (Santo et al., 2020). Second, the various meat and dairy substitutes’ environmental footprint, manufacturing processes, and ingredients can vary significantly, adding to the contestation (Potter and Rööös, 2021). Third, scholars debate the broader economic and social implications of the expansion of plant-based protein products, such as propagating inequalities in the food system and normative concerns for the consumption of food products that resemble animal parts (Broad, 2019; Newton & Blaustein-Rejto, 2021; Goodman et al., 2012).

In terms of firm behavior, incumbents have been important in transforming the meat substitute sector into an established market segment by engaging with niche—for example, by introducing new products in major retail stores and implementing M&As (FAIRR, 2020; Lonkila & Kaljonen, 2022). Recently, the diversification toward plant-based protein products has become a key component of strategies of large food firms, meat processors, and incumbents across the supply chain, including retailers and food service firms (FAIRR, 2020). Additionally, companies in the food industry, including incumbent firms, increasingly participate in private governance institutions, such as the GPA, and implement strategies that aim to create a favorable environment for the development and distribution of plant-based meat substitutes.

### 1.3 Thesis contribution

This thesis builds on sustainability transitions literature and the central notion that the determinants of innovation can also be found in the broader social structure around entrepreneurs (Carlsson and Stankiewicz, 1991; Lundvall, 2010). The chapters in this thesis draw insights from different sustainability transitions frameworks and other streams of social science literature.

The TIS framework, one of the main frameworks within sustainability transitions literature, explores the conditions for the success of emerging sustainable technologies and products (Hekkert et al., 2007; Bergeek, 2015; Markard et al., 2015). Complex interactions among networks of actors and institutions in the system contribute to the generation, diffusion, and utilization of variants of these new technologies and products (Markard and Truffer, 2008). The specification of seven TIS functions for assessing the development and diffusion of new technologies and products (Bergeek et al., 2008, Hekkert et al., 2007) is valuable in analyzing the emergence of novel innovations. In addition, the notion of feedback loops, or cumulative causation, is central to the emergence process (Bergeek et al., 2008a, 2008b). Positive feedback contributes to the acceleration of the emergence

of innovations, while negative feedback might result in problems and stagnation (Suurs and Hekkert, 2009; Suurs et al., 2010). Within TIS, the typology of “motors of sustainable innovation” is important in identifying patterns of feedback loops, known as motors, and thus further investigating the functions and actors involved in the emergence of innovation.

While early TIS studies indicated that innovation processes around new technologies and products are created without strategic coordination—for example, because of new entrepreneurs joining an emerging field—more recent studies in the system-building literature have recognized the role of the intentional activities of innovating actors (Binz et al., 2016; Musiolik et al., 2012; Planko et al., 2017). System building studies analyze the role of actors, organizations, and networks in the strategic creation of favorable conditions for the development and diffusion of new technologies and products. Therefore, the concept of system-building is important in investigating the efforts of individual actors or networks to direct complex processes, such as the development of a broader supportive social environment for innovations.

The other main perspective in sustainability transitions literature is the multi-level perspective (MLP), which views sustainability transitions as driven by interactions between three analytical levels: niche, regime, and landscape (Geels, 2019). The MLP recognizes that change processes toward sustainability occur through the alignment of processes within and between these three analytical levels. Unlike the TIS, which mainly focuses on the emergence of innovation, the MLP is important for understanding the relationship between change and stability. Various studies utilizing the MLP have provided insights into the behavior of firms. For example, the “greening” of industries in reference to societal problems is conceptualized in the Dialectic Issue LifeCycle (DILC) model (Penna and Geels, 2012; Geels and Penna, 2015). The DILC highlights the temporal dynamics of social, cultural, and political mobilization processes around a problem that gradually pressure industries to reorient toward innovations. Therefore, the MLP provides important insights into firm behavior regarding sustainability, particularly how incumbent firms engage with niches during transitions.

To investigate institutional change processes and firm behavior, this thesis also mobilizes theories from other disciplines. First, recent articles on regulatory intermediaries originating in organization science explore the intermediary roles of diverse actors in regulatory processes, ranging from hard rules to voluntary initiatives (Abbott et al., 2017a; Abbott et al., 2017b; Kourula et al., 2017). Regulatory intermediaries assist regulators and rule-takers, often regarding the promotion of innovation (Abbott et al., 2017a; Peterman et al., 2014). These intermediaries operate in a broader sphere of governance, the “collective means to give direction to society” (Kourula et al., 2019; Peters, 1996). Several



articles have identified the interrelated factors, including resources, motives, activities, and relationships, that influence the formation and activities of networks. These alliances are composed of firms, government, and civil society organizations (Abbott et al., 2017a; Kourula et al., 2017; Peterman et al., 2014). These articles complement sustainability transitions literature by identifying the interrelated factors that influence the formation and activities of networks and thus contribute to understanding the alliances' role in sustainability transitions governance.

Second, this thesis employs the concept of "entry modes" originating in international business literature. Entry modes are defined according to firms' international activities, such as exports, contractual modes, joint ventures, and wholly-owned operations (Werner, 2002). Generally, the international business literature conceptualizes firm engagement in new markets as a step-wise process in which entry modes are characterized in terms of "level of commitment" (Ferreira & Serra, 2008; Mori, 2021; Dong et al., 2008; Penderson & Penderson, 1999). The literature highlights that firms aim to reduce uncertainty when engaging in foreign markets. Thus, their approach begins with low-commitment entry modes, such as exports, with a gradual move to more high-commitment forms of entry, such as wholly-owned operations (Ferreira & Serra, 2008; Ashan & Munsteen, 2011). In this thesis, the concept of entry modes contributes to conceptualizing firms' engagement in sustainable niches by employing activities ranging from collaborative R&D activities to M&As and wholly-owned operations.

Third, this thesis engages with the concept of media frames originating from discourse theories (Hajer and Versteeg, 2005). Such theories assume the existence of multiple realities and emphasize how language is used to socially contract those realities (Hajer and Versteeg, 2005; Scheufele and Tewksbury, 2007; Van Gorp, 2007). Frames in general are seen as structures through which people perceive physical and social phenomena and communicate about them (Candel et al., 2014; Van Gorp, 2012; Richardson, 2006; Van Gorp, 2007; Van Gorp, 2012). Media frames reflect broad public and political discourses shaped by a heterogeneous set of actors (Boykoff, 2007; Boykoff, 2008). Because they influence perceptions, they significantly impact ongoing public understandings of societal problems and associated emerging technologies and products by making certain facets of an issue seem more important (Boykoff, 2007; Wilson, 1995; Lyytimäki, 2018; Sengers et al., 2010). Therefore, the study of media frames contributes to building insights aiming to inform actors involved in innovation processes, such as technology developers, government agencies and civil society groups, on which issues and facets around technologies and products are highlighted in public discourses. These insights also offer an indication of societal expectations and potential reactions.

Overall, this thesis aims to advance the conceptualization of transition dynamics in the food system by building insights into the protein transition case. The following research questions guide the study:

- *What are the transition dynamics of the shift to plant-based meat substitutes?*
- *How do these transition dynamics differ from insights in previous transitions literature?*
- *What are the implications for transition theory?*

## 1.4 Methodology

This thesis is rooted in the interpretive research paradigm, which uses theoretical variables to explain cases and understand the world from a subjective point of view within the frame of reference of the research participants (Bennett, 2004; Burrell and Morgan, 1979). Information for this thesis was gathered from several data sources. Data were collected from online secondary sources, including news articles, firms' and industry associations' websites, policy reports, research reports, and scientific literature. Data were also collected systematically through the Lexis Nexis Database. Lexis Nexis collects legal and business information and news from thousands of print and online international and national news sources. Finally, 30 semi-structured in-depth interviews were conducted with actors across the meat substitutes supply chain, government, research and educational institutes, and NGOs.

The research data were analyzed in several ways. Qualitative event history analyses were performed to organize information in chronological order in databases (Van de Ven et al. 1999). A central part of this thesis was the analysis of these databases to understand how the situation evolved and why. We used the method of process tracing, an analytical tool for drawing descriptive and causal inferences from a temporal sequence of events (Brady and Collier, 2010; Langley, 1999). Different process-tracing strategies were employed, including grounded theory, narrative development, and temporal bracketing strategies (Langley, 1999). Additionally, a frame package analysis was conducted to analyze media discourses, which offers a heuristic tool for identifying variables that indicate the presence of a discursive frame (Van Gorp, 20005; Van Gorp, 2012).

## 1.5 Outline of this thesis

**Chapter 2** takes a meso-level view to map the development of key innovation dynamics in the protein transition and highlights significant deviations from current sustainability transitions literature. The chapter investigates how plant-based meat substitutes were historically diffused in the Netherlands. Over the past decades, the Netherlands has become a frontrunner in plant-based meat substitute innovation, hosting some of the industry's leading start-ups, global agri-food incumbents involved in the meat substitute sector, and key knowledge and educational institutes. In addition, the country is one of the world's largest and fastest-growing national markets for meat substitutes. Regarding theory, the chapter departs from the TIS framework. It applies sustainable innovation typology to identify patterns of feedback loops that have contributed to the development and diffusion of plant-based meat substitutes. A database comprised of historical events relevant to innovation processes was constructed for this chapter, and 30 semi-structured in-depth interviews were conducted. Process tracing was employed to reconstruct the narrative of the development of the meat substitute industry in the Netherlands and offer insights into the main dynamics of sustainability transitions in the food-processing industry.

**Chapter 2** highlights the crucial role of emerging norms, as well as technological innovation processes within firms, in the development of the meat substitute industry. This chapter also illustrates the role of actors, including firms, public actors, and NGOs, in the legitimization of the industry. **Chapter 3** focuses on collective action between firms, public actors, and NGOs that aim to foster favorable institutional conditions for the meat substitute industry. It adopts a single case study approach and investigates the GPA, a unique example of an alliance network that has implemented collective strategies for promoting plant-based diets in the Netherlands. The chapter combines the TIS system-building perspective with literature on regulatory intermediaries to identify factors that enable or disable network formation between diverse actors. In addition, the chapter investigates the role of alliances in regulating food consumption and potentially accelerating sustainability transition processes, particularly in the absence of hard regulation. Data for this chapter were gathered from news articles, GPA reports, websites of actors relevant to the GPA, and 30 semi-structured in-depth interviews. The material was analyzed using grounded theory and an explanation-building approach to infer causal links between factors contributing to alliance formation, strategies, and the development of structures facilitating the protein transition.

**Chapters 2 and 3** demonstrate that contrary to the evidence of current sustainability transitions literature, incumbent firms—including giant food firms such as Unilever and Nestle and meat processors such as Tyson—became engaged in the plant-based

meat substitute sector shortly after the arrival of new entrants. Building on this theme, **Chapter 4** studies firms' behavior, particularly incumbent firms' strategic responses to the emerging meat substitute industry. The chapter includes insights from the international business literature and introduces the concept of entry modes to examine when and how incumbents enter markets for sustainable products. Data on different incumbent strategies were gathered for three frontrunner countries in the protein transition: the USA, the Netherlands, and the United Kingdom. The data were analyzed according to process tracing, particularly temporal bracketing, to demonstrate alternative incumbent entry modes, timing dynamics, and the commitment level of the various incumbents in the protein transition.

**Chapter 5** focuses on media frames, because the diffusion of plant-based meat and dairy substitutes is still a contested issue in public discourses. The chapter aims to inform actors involved in innovation processes (e.g., technology developers, government agencies, and civil society groups) of important aspects of diffusion, including controversy and unexpected risks concerning societal reactions. Hence, the chapter comprises a media frame analysis of three UK broadsheet newspapers (the Telegraph, the Guardian, and The Times) between 2010 and 2020 and identifies frames for plant-based diets and plant-based protein products. Additionally, the chapter articulates recommendations for actors involved in plant-based protein innovation to contribute to the embeddedness of meat substitutes in society. Table 1.1 provides an overview of the chapters in this thesis.

**Table 1.1 Overview of chapters in this thesis**

	<b>Cases</b>	<b>Theoretical approach</b>	<b>Data</b>	<b>Analytical approach</b>
Chapter 2	The protein transition in the Netherlands	TIS	Grey literature, news articles collected through the Lexis Nexis Database, secondary data, 30 semi-structured interviews	Process tracing & narrative building
Chapter 3	The Green Protein Alliance	TIS system building & regulatory intermediaries	Grey literature, news articles collected through the Lexis Nexis Database, secondary data, 30 semi-structured interviews	Grounded theory & explanation building
Chapter 4	Incumbent entry modes in the USA, NL, and UK markets	MLP & international business strategy	News articles collected through the Lexis Nexis Database	Process tracing & temporal bracketing
Chapter 5	Media frames in the UK	Media frame packages	News articles from three newspapers (The Telegraph, The Guardian, and The Times)	Frame package analysis

## CHAPTER 2



# Understanding the protein transition: The rise of plant-based meat substitutes

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## Abstract

Even though the food system is responsible for a significant part of global greenhouse gas (GHG) emissions and a transition to a sustainable food system is needed, the growing body of literature on sustainability transitions has paid little attention to the food processing sector. We expect transition dynamics in the food processing sector to differ from the typical dynamics portrayed in transitions literature due to particularities in required technological knowledge and government intervention. To better understand dynamics in the food processing sector we apply the Technological Innovations Systems (TIS) framework to an in-depth case study of the plant-based meat substitutes industry in the Netherlands. Results illustrate that, contrary to many other transitions, consumers and changing informal institutions are the driving forces of this process. We show how strengthening cognitive and normative legitimacy can lead to growing markets for sustainable products.



## 2.1 Introduction

Transitions literature has provided critical insights into the dynamics of systemic change that can lead to sustainable pathways for the economy (Markard et al., 2012). These insights have mainly been based on findings from case studies focusing on low carbon transitions related to energy, mobility and water sectors (Bergek, et al., 2015; Markard et al., 2012). Among the strand of food transitions literature, studies primarily explore agriculture, grassroots movements, such as alternative networks for the provision of food, and food consumption practices (Grin, 2012; Hinrichs, 2014; Randelli & Rocchi, 2017; Seyfang, 2006; Spaargaren et al., 2013). Although this literature has developed valuable knowledge relevant to transitions in food systems, it has relatively neglected regime shifts in the food processing industry, including the increasing turn towards substitute products (Bilali, 2019; Mylan et al., 2018).

Over the past decades, the food processing industry has evolved into a dynamic and complex blend of flows of materials, which are combined into durable, standardized food products and are mass distributed to consumers (Spaargaren et al., 2013). Technological innovation is often employed to address pressing sustainability challenges and firms reorient (incrementally) by adjusting inputs and processes to offer new products (Garnett, 2014). It is therefore imperative to develop insights into the mechanisms of endogenous change in the food processing industry in order to contribute to a more comprehensive view of transitions in food systems.

The key question is whether the same mechanisms derived from previous transitions literature also hold for transitions in the food processing industry. There are a number of reasons why we expect different dynamics. First, technological change in food processing often emerges through a supplier dominated innovation trajectory (Pavitt, 1984; Castelacci, 2008). Advanced knowledge is acquired from different segments of the economy in order to adjust inputs and processes for the development of new products (Pavitt, 1984; Castelacci, 2008). The implication is that we witness hardly any radical technological breakthroughs. Second, there is an almost complete absence of regulatory intervention in the form of favorable taxation schemes for sustainable consumer products. National governments have been reluctant to adopt such regulations due to barriers erected by international regulatory institutions, uncertainties related to the impact of such tools and strong industry opposition (Bødker et al., 2015; Fellmann et al., 2017). Instead, niche consumer markets are supported by conscious individuals who are willing to pay a relatively high price for products with specific characteristics (Akaichi et al., 2019; Hughner et al., 2007).

In this paper, we study the emergence of the plant-based meat substitutes industry in the Netherlands in order to explore how key innovation processes develop in the food processing sector. Plant-based meat substitutes are products that take the place of meat in the human diet and have an appearance, texture and taste similar to meat products. Vegetarian and vegan diets have been practiced for thousands of years (Ruby, 2012). Consequently, despite being perceived as a new trend, plant-based meat substitutes have existed in markets for several decades (Asgar et al., 2010). In recent years, European markets for meat substitutes are experiencing unprecedented growth. Based on data from Euromonitor, in 2016, in Denmark and Germany, the market for meat substitutes showed an annual growth of between 15-20% and in the Netherlands, Sweden and the UK 5-10% (Changing markets foundation, 2018). Due to general awareness of the adverse impacts of meat and dairy production and consumption, several groups of actors, including activists, NGOs and scientists, support the widespread diffusion of meat substitutes. We aim to understand how these developments evolved and which processes and actors were important.

We apply one of the main frameworks in the field of sustainability transitions, the Technological Innovation Systems (TIS) framework due to its use in studying the emergence of novel technologies and products (Bergek et al. 2008a; Hekkert et al. 2007). TIS literature highlights key processes that are needed in well-functioning innovation systems. Dynamics in innovation systems are attributed to interactions between these key processes, leading to virtuous or vicious cycles. These cycles are coined as motors of innovation (Suurs & Hekkert, 2009). However, the motors of sustainable innovation typology is fully based on case studies from the energy and mobility sectors. Due to the particularities of the food sector, we expect to identify different motors of innovation. Therefore, our research question is shaped as follows: What are the dynamics of the plant-based protein innovation system in the Netherlands and how do they inform the motors of sustainable innovation typology?

## **2.2 Theoretical background**

Transitions literature, has been very influential in analyzing the complex dynamics of systemic change as a response to pressing sustainability challenges. It is comprised by a number of different perspectives, including the multi-level perspective, the technological innovations systems framework, transitions management and strategic niche management (Geels, 2002; Hekkert et al., 2007; Loorbach, 2010; Schot & Geels, 2008). Within transitions literature, the TIS framework explores conditions for the success of emerging sustainable technological fields or products/product groups (Bergek et al., 2008a; Markard & Truffer

2008). It has therefore been used to provide policy recommendations to support the diffusion of these technologies and products (Hekkert et al., 2007).

A TIS is defined as “a set of networks of actors and institutions that jointly interact in a specific technological field and contribute in the generation, diffusion and utilization of variants of a new technology and/or new product” (Markard and Truffer, 2008, p.611). Therefore, a TIS consists of structural components like actors, networks and institutions (Bergek et al. 2008a; Markard & Truffer 2008) and the boundaries of the system are set around an emerging technological field or a product/product group (Bergek et al., 2008a; Markard & Truffer 2008). Complex interactions among the structural components underlie the development process of a TIS (Jacobsson, et al., 2004).

TIS actors engage in a wide variety of activities that are enabled and constrained by networks and institutions in which they are embedded (Bergek, et al., 2015). These activities lead to the emergence of key processes – or system functions – during the development of an innovation system (Bergek et al. 2008a; Hekkert et al. 2007). These are entrepreneurial experimentation (F1), knowledge development (F2), knowledge diffusion (F3), guidance of the search (F4), market formation (F5), resource mobilization (F6) and legitimacy creation (F7) (Hekkert et al. 2007). For in-depth description of the seven system functions see Hekkert et al. (2007).

Previous studies have shown that the development process of a TIS goes through a formative phase before it switches to growth and eventually culminates in a mature stage (Bento & Wilson, 2016; Bergek et al., 2008a; Jacobsson, et al., 2004). During the start of the formative stage, innovation systems are mainly structured by a variety of ideas and concepts for technological development and a small number of actors participating in knowledge creation (Bento & Wilson, 2016). As the TIS emerges, new entrants partake in entrepreneurial experimentation and bring more knowledge and financial resources in the industry (Bento & Wilson, 2016; Bergek et al., 2008b). Firms and other actors start to form learning and political networks and become involved in institutional alignment strategies (Hellsmark and Jacobsson, 2009; Musiolik et al., 2012). The formative phase changes to a growth phase as the system becomes increasingly structured through a rapidly developing market. Technologies and products form a dominant design, production capacity increases, markets expand and technologies and products become adopted by users (Bento & Wilson, 2016). Finally, TISs in a mature state are highly structured systems that deliver standardized products across mass markets (Bento & Wilson, 2016).

The development of an innovation system is not a linear process. Central to the development process is the notion of feedback loops, or cumulative causation (Bergek et al., 2008). Feedback is created through the co-evolution of structural components

and system functions (Suurs & Hekkert, 2009). Positive feedback contributes to the acceleration of the build-up of a TIS (Suurs & Hekkert, 2009). For example, the introduction of government supported market formation activities, such as tax exemptions, can lead to reinforcing patterns of positive expectations and entrepreneurial experimentation (Suurs & Hekkert, 2009). Negative feedback might result in struggles and decline of the build-up process of a TIS (Suurs et al., 2010). For example, exit of industrial actors can contribute to reinforcing patterns of negative expectations and discouragement of potential new entrants (Suurs et al., 2010).

Suurs (2009) proposes the typology “motors of sustainable innovation”. The typology identifies four patterns of feedback loops – known as motors – which are characterized by the presence of different structural components and system functions. Motors emerge more or less in an order as TISs go through phases of development (Suurs et al., 2010). Feedback loops are described as a sequence of events through which system functions materialize and influence each other, mediated by innovation system actors (Suurs et al., 2010). The Science and Technology Push Motor (STP) is mainly dominated by patterns where research outcomes [F2], positive expectations [F4] and resources mobilisation [F6] reinforce each other. The entrepreneurial motor is triggered by new entrants who partake in more commercially oriented projects [F1] and lobby for resources [F7]. Depending on the outcome of the projects, there is feedback into the dynamics of the system, which incentivizes or discourages [F4] the initiation of more projects [F1]. In the system building motor, entrepreneurs increasingly organize themselves into networks and platforms [F7]. They participate in activities, such as lobbying, that aim to strengthen the industry as a whole. If they are successful, they lead to positive expectations [F4] and increased availability of resources [F6] and in turn, an increased number of new entrants [F1]. Finally, the market motor, is assumed to be triggered by the setting of formal institutional structures that facilitate solid commercial demand [F5] and this contributes to a boost in all system functions.

The typology was advanced through the aggregation of results from case studies within the energy and mobility sector and particularly in biofuels, hydrogen and fuel cell technologies, automotive natural gas and biomass gasification (Suurs, 2009). However, different industrial sectors follow different innovation patterns (Malebra, 2002). Taxonomies of innovation in different industries (Castelacci, 2008; Pavitt, 1984) have described the characteristics of different sectors and their influence on innovation trajectories. Pavitt (1984) distinguishes between supplier dominated, production intensive (scale intensive and specialized suppliers) and science-based industries. This categorization offers useful insights into the ways in which sectoral characteristics can influence the development of TISs.

Technologies and products in the context of energy and mobility sectors mainly follow innovation patterns that have been observed in industries described as science-based or advanced knowledge providers (Castelacci, 2008; Pavitt, 1984). Firms in science-based sectors mainly rely on the creation of knowledge through in-house R&D and scientific advancements by universities and public research institutes (Pavitt, 1984). Because technologies and products are radical in character, existing technical and institutional structures are not yet aligned with their needs. Therefore, their diffusion also depends on the build-up of new infrastructures and the creation of market niches (Bergek et al. 2008a; Hekkert et al. 2007). Because the risk associated with these technologies and products is high, the government typically needs to take the initiative of creating niche markets by a diverse set of policy instruments, such as favorable taxation for consumer products (Bergek et al. 2008a; Hekkert et al. 2007). Finally, the breakthrough of these technologies and products is intertwined with the formation of new institutions and user practices (Bergek et al. 2008a; Hekkert et al. 2007).

The food processing sector can be characterized as a supplier dominated industry when using the Pavitt taxonomy (Castelacci, 2008; Pavitt, 1984). Several indicators which measure dominant innovation trajectories, including orientation towards process innovation and investment share for the acquisition of advanced machinery and equipment from suppliers, reveal that the food processing sector has a lower technological content relatively to science-based or advanced knowledge providers and a large share of firms with limited ability to develop processes and products internally (Castelacci, 2008; Cuerva et al., 2014; Pavitt, 1984). Therefore, sources of innovation are usually external and lead to incremental improvement of efficiency of processes and quality of products (Castelacci, 2008; Pavitt, 1984). Moreover, contrary to sectors typically studied in TIS literature, in which niche markets are created through supportive government policies, in the food processing sector a wide variety of consumer groups which hold diverging norms support niche markets through their willingness to pay relatively expensive prices (Akaichi et al., 2019; Hughner et al., 2007).

## **2.3 Method**

### **2.3.1 Case selection and boundaries**

In order to explore the development of TISs in the food processing sector, we selected the case of the plant-based meat substitutes industry in the Netherlands. Already in the 1990's, a few domestic meat substitute firms were active in the Netherlands. More recently, the country has become a frontrunner in plant-based meat substitute innovation. It is home to the first industry association, which is composed of 18 firms, including leading firms Vivera and Meatless (Planeet, n.d.). The region of Wageningen has developed a food innovation

cluster which involves a large number of food firms, global agri-food incumbents and leading knowledge and educational institutions, including Wageningen University and Research. Additionally, plant-based meat substitutes are aligned with social structures to a certain extent. The 2015, the updated Dutch dietary guidelines include plant-based meat substitutes (CR, 2015). Further, the Netherlands is one of the largest and fastest growing national markets for meat substitutes globally (Changing markets foundation, 2018). According to data from the market research agency IRI, in 2017, the total retail turnover of plant-based protein products, including meat substitutes, was estimated at 368 million euros (Distrifood, 2017). Therefore, the case allows for the analysis of the development of innovation processes over time on both the supply and demand sides.

We define plant-based meat substitutes as products that take the place of meat in the human diet and have an appearance, texture and taste similar to meat products (Osen et al., 2014). Meat substitute firms depend on inputs which mainly stem from the agricultural commodities and biotechnology industries. These industries depend on several processes, such as plant breeding, protein isolation and functionalization. For the purposes of this paper the focus is kept on the food processing sector, but the analysis considers interdependencies that stem from the supply chain of meat substitutes.

### **2.3.2 Background of case: The meat substitutes industry**

The supply chain of plant-based meat substitutes can be described in four broad steps. In the first step, a variety of protein crops are cultivated globally. In the second step, crops are procured and processed into protein ingredients, such as protein concentrates and isolates (Jones, 2016). In the third step, firms in the food sector purchase protein ingredients, formulate and process them into texturized intermediary products for the development of final meat substitutes. In the last step, products reach consumers through retail and food service.

The development of plant-based meat substitutes includes several different food processing technologies to structure raw materials into products that resemble the texture and taste of meat. We conceptualize technological development in the sector by drawing a distinction between first and second generation meat substitutes. First generation meat substitutes have existed in European markets since the 1990's (Aiking et al., 2006). They were mainly based on the intermediate product, Textured Vegetable Protein (TVP), which is produced with low moisture cooking extrusion (Asgar et al., 2010). The basis of extrusion is a screw system within a barrel. In the barrel, raw materials are compressed, heated to high temperatures and conveyed through a die/dies in order to expand into a final shape (Riaz, 2011). The resulting product is further processed for the development of final meat substitutes. Second generation meat substitutes reached European markets in the early 2000s due to advancements in cooking extrusion technology, such as the

introduction of high-moisture cooking extrusion, and the deployment of processes from other (food) sectors, such as the utilization of hydrocolloids. Such advancements allowed the development of better performing products in terms of taste and texture and the use of a broader range of raw materials. For example, with high moisture extrusion, resulting products are characterized by well-defined fiber formations that closely resemble meat structures and have enhanced taste sensation (Lin et al., 2000; Yao et al., 2006).

Common raw materials are industrially produced protein ingredients based on plants (oilseeds, cereals, legumes, pulses and aquatic plants) such as soybeans, rapeseed/canola, wheat, rice, oats, peas, beans, lupines and algae. Different raw materials are in different phases of development ranging from experimentation to maturity. Selecting raw materials for product development depends on availability, cost, functional and physiological properties and nutritional value of different products (Smetana et al., 2015; Osen et al., 2014).

### **2.3.3 Data collection and analysis**

The first step of this study was mapping the structural components of the TIS by identifying relevant actors, institutions, technologies and materialities. Data were collected from secondary sources, which were identified online and included news articles, firms and industry associations' websites, policy reports, research reports and scientific literature. In order to identify secondary sources, we used a set of predefined keywords, including meat substitutes, plant-based protein, protein transition and protein innovation (translated in Dutch). Then, we followed up on particular leads by adding more keywords, which included names of specific actors, networks, policies and events.

Afterwards, we conducted a qualitative event-history analysis between the years 1990-2017. Empirical data for the event analysis were first collected through the Lexis Nexis Database. Lexis Nexis is a database which collects news, legal and business information from thousands of print and online international and national (including Dutch) news sources. The accuracy of Lexis Nexis Database for this purpose has already been established in previous studies (Negro et al., 2008; Sours & Hekkert, 2009). We used the same set of predefined keywords as for the structure analysis. The identified secondary sources were analyzed and events relevant to the development of the industry were organized in a database in chronological order. We also identified more sources, by using the same indicators in Google and three agri-food industry news outlets (distrifood.nl, evmi.nl, foodnavigator.com) and searching through the websites of relevant industrial, governmental and non-governmental organizations. The database contained approximately 450 events. The description of key system functions (Hekkert et al., 2007; Negro et al., 2008) was used as a heuristic for the identification of events, as well as codes in the database. This process allowed the re-construction of the narrative of the

development of the meat substitute industry in the Netherlands and of the development of system functions. In the analysis section, each function was attributed a corresponding reference code: entrepreneurial experimentation [F1], knowledge development [F2], knowledge diffusion [F3], guidance of the search [F4], market formation [F5], resource mobilization [F6] and legitimacy creation [F7].

Following the event-history analysis, we conducted 30 semi-structured in-depth interviews with stakeholders in order to deepen our understanding of innovation dynamics and discuss emerging insights from the event analysis. We interviewed actors across the supply chain of meat substitutes as well as actors from the government, research and educational institutes, and NGOs. In the interviews, we explored the build-up of the system according to the different interviewees perspectives, their views on milestone developments and the importance of the different system functions. All interviews were recorded and transcribed. These transcripts were coded using the system functions. The interviews took place between June 2017 to February 2018. To encourage an open discussion, all interviewees were granted anonymity. In the analysis section, each actor was attributed a corresponding reference code. Table 8.1 in Appendices provides more information about the interviews and the reference code of each interview.

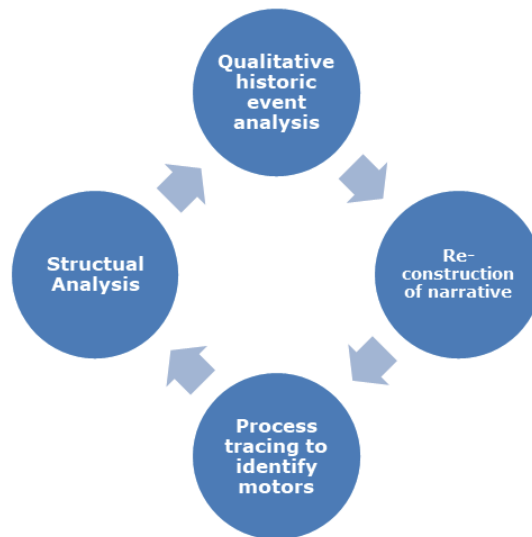
Between February 2017 and January 2018, we updated the database by employing the same method of qualitative event analysis. The coding of the database was verified by a second researcher in order to increase the validity of the study. Minor differences in interpretations were discussed and resolved. The results of the two rounds of event analysis and interviews were compared and analyzed in order to finalize the narrative of the development of the Dutch meat substitute industry. Finally, during December 2018, a small number of important events were added in the database.

We used the method of process tracing to analyze whether motors of sustainable development could be identified. Process tracing is an analytical tool for drawing descriptive and causal inferences from qualitative data that are of a temporal sequence of events (Brady & Collier, 2010). A key step in process tracing is the development of detailed descriptions of key events in several points in time (Brady & Collier, 2010; Bennett, 2010). While it is impossible to present these descriptions in full, their development significantly contributed to understanding unfolding processes and analyzing change. We mainly highlight the findings relevant to understanding the overall dynamics of the innovation system and to show the presence of motors of innovation.



Figure 2.1 summarizes the analysis of this paper as a cyclical process of iterative steps. Previous literature has also highlighted the iterative nature of methods employed for analysis of TISs (Wieczorek & Hekkert, 2012).

**Figure 2.1 Illustration of analysis steps adapted from Wieczorek & Hekkert (2012)**



## 2.4 Results

### 2.4.1 Early formative phase (1990-2006)

#### *I. TIS Development*

During the early 1990's, the meat substitutes industry was already comprised of users, a few firms and commercial but low-performing products. European vegetarians and vegans, driven by ethical, cultural or religious factors already consumed early meat substitutes [F5]. In the Netherlands, two international firms Quorn and Tivall dominated the market. A few Dutch firms, including Schouten Europe and Vivera, were established [F1]. They offered a narrow assortment of plant-based meat substitutes, mainly based on traditional preparations, such as tofu, and available intermediary products, such TVP. The market share remained very small because the products did not yet appeal to a wide range of consumers and there was no urgency for a healthy and sustainable agri-food system in public discourses.

Meanwhile, within environmental policy, attention on long-term environmental robustness was emerging, influenced by the publication of the Brundtland Report and the first Dutch National Environmental Policy Plan (Straaten, 1992). In 1993, the Ministry of the Environment initiated the interdepartmental Sustainable Technology Development (STD) program to assess the feasibility of technologies that could contribute in meeting human needs more efficiently (Vergragt & Grootveld, 1994; Weaver et al., 2000). After an initial assessment, meat substitutes were identified as a potential sustainability pathway within the theme of nutrition [F4]. The Novel Protein Foods (NPFs) of the Sustainable Technological Development program was initiated [F6]. It assessed available non-animal protein sources and processing technologies for the development of the next generation of meat substitutes that could better satisfy consumer expectations [F2] (Quist, 2007). The results illustrated that the substitution of components of assembled or processed end-foods, such as minced meat, was feasible, but still knowledge was needed to manage a satisfactory texture and taste and large-scale production (Quist, 2007). Therefore knowledge development programs continued in the following years.

“The first initiatives have happened in the ‘90s, collaborating with the Wageningen and Amsterdam universities who did an initial analysis. They did research into what would be necessary for the protein transition... it ran for multiple years.” (PE4)

The most notable consequence of the NPF program was the establishment of the subsequent research program Profetas (Protein Foods, Environment, Technology and Society) (Aiking & Boer, 2006). In 1999, various ministries and academic bodies funded Profetas with 3 million Dutch Guilders (around €1.4 million) [F6] (Aiking & Boer, 2006). The program delivered knowledge on technological feasibility, sustainability, consumption opportunities and barriers regarding meat substitutes based on a single crop, pea [F2] (Aiking & Boer, 2006). In terms of technological feasibility, the results were equivocal. They illustrated that research in texturization processes was needed and it could not yet be assessed whether new products would better satisfy consumer preferences [F4] (Vereijken et al., 2006). Although five industrial firms, including incumbent Unilever, were involved in the program, no commercially oriented projects followed (Quist, 2007). Due to increased competition in the food sector, one meat substitute firm involved in Profetas, exited the TIS (Quist, 2007).

A few years later, between 1996-2006, crises related to livestock supply chains and increased public concerns over health and safety aspects of food were driving developments in the TIS. The outbreak of bovine spongiform encephalopathy (BSE) crisis, referred to as Mad Cow disease, the dioxin crisis<sup>1</sup> and the outbreaks of avian influenza, known as the chicken flue,

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1 The dioxin crisis refers to media reports in 1999 regarding elevated dioxin levels in poultry, eggs and pork (Verbeke et al., 1999)

led to the mass media reporting numerous messages linking meat consumption to health risks (Morabia et al., 1999; Sans et al., 2008; Verbeke et al., 1999). Consequently, consumers increased demand for meat substitutes [F5]. Market research showed an increase in retail sales during particular months of crises and reproduced positive expectations for further growth [F4]. For example, according to data published in the newspaper NRC Handelsblad, during November and December 2000, the retail turnover from meat substitutes of three leading retailers in the Netherlands increased 10% on average (NRC, 2001). Entrepreneurs quickly responded to the increased consumer attention on meat substitutes. This led to the introduction of more meat substitutes by new brands [F1]. Still, the products were based on available inputs and conventional processes [F5].

Positive expectations about future market growth also contributed to additional experimentation [F1]. Two important projects led to the establishment of the firms Meatless and Valess.

Meatless was established by a new entrant originating from the meat processing sector. The crises in the meat sector and the promise of value-added hybrid and vegetarian products incentivized the founder of Meatless to explore the development of plant-based meat substitutes [F4]. Because the range of commercially available intermediate products was limited, the project started by acquiring a process that utilized hydrocolloids for texturizing plant material that had been developed by an agro-industrial incumbent firm [F1]. As a result, in 2005, the firm Meatless introduced textured intermediary products based on wheat and rice that could be further processed into hybrid meat products or meat substitutes [F1]. This proved to be an important breakthrough in the development of the TIS.

Valess was established by the Dutch incumbent dairy cooperative Friesland Campina. Friesland Campina acquired a process for the texturization of dairy protein that had been developed by an individual a few years earlier [F1]. In 2005, the brand Valess was introduced to the Dutch market. Friesland Campina rolled out a €3 million marketing campaign [F6] (De Volkskrant, 2005a). The higher perceived quality of the product in terms of taste and promotion efforts led to further increases in sales of meat substitutes [F5]. Additionally, Valess received the annual award from the food innovation network Food Valley as the “healthy variation for meat” [F4] (Food Valley, n.d.). This indicates that the main driver of entrepreneurial experimentation and accordingly the main framing of products was still substitution due to health risks from crises in meat supply chains.

*“You have to understand that in 2000, 2002, 2003, there were no thoughts about sustainability and livestock. It was a different world, nobody was thinking about sustainability. We were thinking about healthy food.” (IF11)*

The introduction of Valess and rising popularity of meat substitutes also triggered, for the first time, dissent. A dispute started between Friesland Campina and the animal welfare NGO Wakker Dier over the origin of the eggs used [F7] (De Volkskrant, 2005b). Additionally, the Dutch meat information office filed a lawsuit against Valess [F7] because the promotional campaign directly compared the meat substitute with meat (ANP, 2005). The Dutch Nutrition Center issued a statement which clarified that dairy based substitutes do not have the same nutritional value as meat [F7]. The court ruled against Valess, which had to modify information on their website [F7]. This shows that the dominant cognitive institutions were well aligned with meat consumption and not shifting towards plant-based substitutes.

An independent development during this period was the introduction of the EU Novel Food Regulation. In 1997, as a result of efforts to harmonize food laws and pressure stemming from public concerns over uncontrolled imports of genetically modified soy, the European Commission adopted the Novel Food Regulation (Vogel, 2003). The regulation dictates a very expensive and time-consuming authorization procedure for the introduction of foods and ingredients into EU markets, which have not been consumed in EU to a significant extend before 1997. Since it applies to a number of potential raw materials for meat substitutes, it worked as a major barrier for firms to experiment with certain ingredients.

## ***II. Motors of sustainable innovation***

During the early formative phase, the emerging norm of meat substitution was crucial for the development of the TIS. Early users, vegetarians and vegan consumers, were the ones who first called attention to the idea of meat substitution and were willing to consume meat substitutes because they resonated with their anti-meat notions [F7]. Therefore, they created niche markets [F5] and incentivized early entrepreneurial experimentation [F1]. In this phase, exogenous influences contributed to positive expectations for the potential of meat substitutes and/or growth in markets, and drove the build-up of the TIS and the development of other system functions.

First, emerging sustainability awareness within a small group of policy makers and scientists led to expectations for the environmental improvement potential of the wider diffusion of meat substitutes [F4]. This led to the introduction of the NPF program [F6] [F2]. The NPF program illustrated research pathways for the development of the next generation of meat substitutes that could appeal to a broader range of consumers [F4] and led to further research activities [F2][F3] including the funding of the research program Profetas [F6][F2].

Second, crises in meat supply chains incentivized non-vegetarian and non-vegan consumers to adopt meat substitutes for the first time [F5]. Entrepreneurs saw an opportunity [F4] and experimented with the acquisition and scale-up of processes to develop better performing products [F1]. New products in the market and accompanied marketing efforts reinforced consumer demand [F5].

At that time, meat substitution was not yet a pressing topic in political or public discourses. Important actors that could contribute in strengthening legitimacy for meat substitutes, such as the Dutch Nutrition Center, demonstrated resistance. Consumption of meat substitutes from groups, other than vegetarian and vegans, had been activated due to temporary health concerns. Market growth was unstable and, due to high competition in the food sector, firms exited the TIS. Therefore, feedback creation between functions was limited, the TIS was developing slowly and there is no indication of a presence of a motor of sustainable innovation.

### **1.1.2 Emerging TIS (2006-2010)**

#### ***I. TIS Development***

From 2006 onwards, the adverse impact of livestock production on sustainability and animal welfare became an important issue in public discourse for the first time. The publication of “Livestock’s Long Shadow” (Steinfeld et al., 2006) from the FAO was a turning point regarding wider awareness of the link between livestock, climate change and environmental degradation. In the Netherlands, the publication was used as a reference from political parties and societal organizations in emerging discourses regarding the sustainability of meat production. Coupled with the introduction of the political party “Party for the Animals” and the release of the documentary, *Meat the Truth* in 2007 narrated by the leader of the party (NGPF, n.d.), meat production and consumption became an increasingly contentious issue.

The negative attention on livestock influenced the meat substitute industry in several ways. First, increased urgency in public discourse triggered the legitimation process for meat substitutes. A broader group of actors became involved in the TIS. Apart from NGOs solely focused on vegetarianism, organizations from health, animal welfare and environmental perspectives also started to support meat substitutes [F7]. For example, in 2007, the Dutch Association for Animal Protection gave the highest ranking to meat substitutes in a certification scheme that provided a ranking to meat products according to animal welfare standards (DBFlevoland, n.d.) [F7]. In 2011, the environmental NGO Nature & Environment started promoting meat substitutes as part of the organizations “I am a Flexitarian” campaign [F7].

Because these actors were also attempting to convince others to embrace meat substitutes, they contributed to the build-up of knowledge regarding the nutritional value and the environmental impact of meat substitutes. Various assessment studies were conducted [F2] (Blonk 2008; CR, 2011; Pluimers & Blonk, 2011; RIVM, 2011; Westhoek et al., 2011). An important outcome of this was that in 2011, the Health council of the Netherlands (CR) published the “Guidelines for good nutrition, the ecological perspective”, (CR, 2011). The publication led to the conclusion that less animal-based and more plant-based diets would benefit both public health and the environment [F7]. For the first time, it promoted the consumption of plant-based products, including meat substitutes [F7]. Therefore, cognitive and normative legitimacy for the TIS strengthened [F7].

*“There was more and more science-based information and support from society, enough support from society as well from the government and NGOs and consumers [...] So, this was a very important milestone, kind of consensus, scientific consensus” (PE7)*

Second, contestation and increased awareness regarding the adverse impacts of meat production, as well as increased policy attention on sustainability in general, practically forced the ministry of Agriculture, Nature and Food Quality to introduce the Sustainable Food memorandum (LNV, 2009). The promotion of innovation in protein products offered an opportunity to address sustainability issues in the food system although without directly confronting the meat sector and meat production capacity. Therefore, between 2007-2010, the Sustainable Food memorandum [F7] had a focus on protein innovation [F4] (LNV, 2009) and consequently triggered the development of system functions. Table 2.1 summarizes programs in the context of the memorandum.

**Table 2.1 Programs in the context of the memorandum Sustainable Food (LNV, 2009)**

Program	System functions	Resources
Innovations in Protein Chains program: broad focus on isolation processes for the introduction of novel protein sources with applications in both feed and food	Knowledge development (F2)	€ 6 million (F6)
Small Business Innovation Research (SBIR) subsidy scheme with the call replacement of animal proteins	Entrepreneurial experimentation (F1)	€ 1.7 million (F6)
Protein dialogue program: provided space for stakeholders, such as NGOs, experts and food firms, to discuss the possibilities for plant-based protein production and consumption	Knowledge diffusion (F3)	

Third, increased urgency contributed to growing consumer demand for meat substitutes and renewed positive expectations for market growth [F4][F5]. Established firms, such as Vales, Vivera and Schouten Europe expanded their portfolios [F5]. Retailers became more involved by increasing shelf-space and introducing private labels [F5]. New firms entered the industry; for example the plant-based drinks firm Alpro introduced a meat substitutes line [F1].

The enabling political environment significantly benefited entrepreneurial experimentation, particularly in SMEs. For example, in 2006, professionals in TOP BV, a technology provider for the agri-food industry, explored the potential of applying principles of high-moisture extrusion on the development of an intermediary plant-based meat substitute [F1]. The founders of Ojah successfully lobbied for financial resources to fund activities such as a scaling-up tests and the developing a production facility [F7][F6]. The recently established company, Meatless, received project-based subsidies [F6][F1].

“We were struggling to move on, fairly high losses and an uncertain future. You need money for that, ... but the government was also helping to keep us going. And that was especially in the year 2006 to 2009. That was very important” (IF11)

The establishment of innovative firms, and particularly Ojah and Meatless, was a milestone in the diffusion of products referred to as the second generation of meat substitutes. Both firms received a number of innovation awards and recognition [F4]. More importantly, they allowed the entrance of several other firms [F1] in the TIS. This is because many food firms do not develop products internally. They typically acquire products and focus on marketing and sales. Access to higher quality intermediary products allowed end-product firms to supply higher quality meat substitutes in terms of taste and texture. End-product firms employed innovative marketing strategies that draw from the emerging norm of meat substitution. For example, in 2010, the Vegetarian Butcher, which was the launching customer of Ojah, opened its first store with a public event during Animals Day (The vegetarian butcher, n.d.).

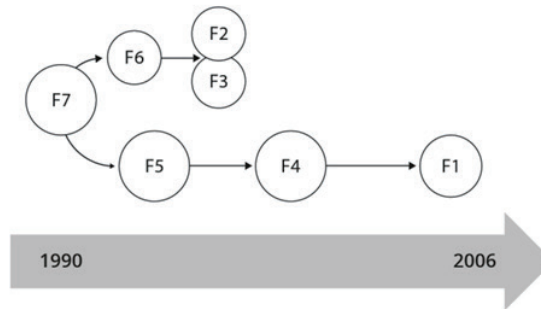
## ***II. Motors of sustainable innovation***

During this period, the main trigger of the development of system functions was normative contestation regarding the adverse impacts of meat and dairy production and consumption, which served as a driving force for the accelerated legitimation of the TIS. For the first time, actors which represented perspectives beyond vegetarianism and veganism supported the TIS. Diverse consumer groups started purchasing meat substitutes and contributed to more stable market growth. These developments led to feedback mechanisms, which indicate the emergence of a legitimacy-led motor. The legitimacy motor is characterized by a powerful double feedback loop. Figure 2.2

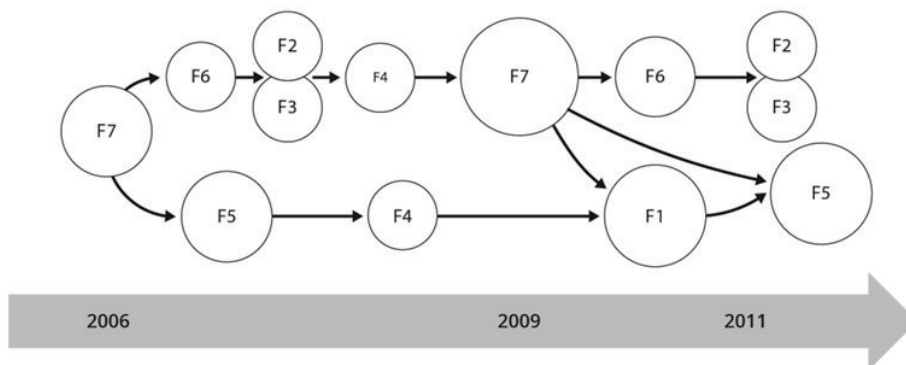
illustrates the interaction between functions during the two phases of development of the TIS and the dynamics of the legitimacy motor during the second phase.

**Figure 2.2 System functions dynamics during the legitimacy motor**

Phase 1: 1999-2006



Phase 2: 2006-2011



The motor started with a range of actor groups and organizations from various perspectives, including sustainability and health, embracing the norm of meat substitution and advocating for the wider diffusion of meat substitutes [F7]. The attempt of these actors and organizations to convince a critical mass to embrace meat substitutes contributed in the allocation of resources [F6] for the build-up of assessment studies regarding the nutritional value and the environmental impact of products [F2]. Positive results urged more actors and organizations to support the TIS and therefore strengthened its normative and cognitive legitimacy further [F7]. The support of government actors and the inclusion of the promotion of meat substitutes in the governmental agenda led to increased availability of resources. This led to the initiation of knowledge development programs across the supply chain and entrepreneurial projects that aimed to improve the performance of meat substitutes [F6][F2][F3][F1].

At the same time, urgency regarding meat production and consumption positively influenced consumer demand. Apart from vegetarians and vegans, the idea of meat substitution started to resonate with a broader range of consumers [F5]. The growing



market led to positive expectations for further growth [F4] and incentivized firms to enter the TIS [F1]. This time, public funding [F6] reduced the risks of experimentation and contributed to the successful establishment of the firms Ojah and Meatless. These firms introduced higher quality intermediate products in the market [F1][F6]. The introduction of intermediary products was a cascading force for entrepreneurship. More end-product firms delivered new, better performing meat substitutes [F1]. Renewed supply and marketing reinforced consumer demand further [F5].

### **II.0.3 Towards growth (2011 onwards)**

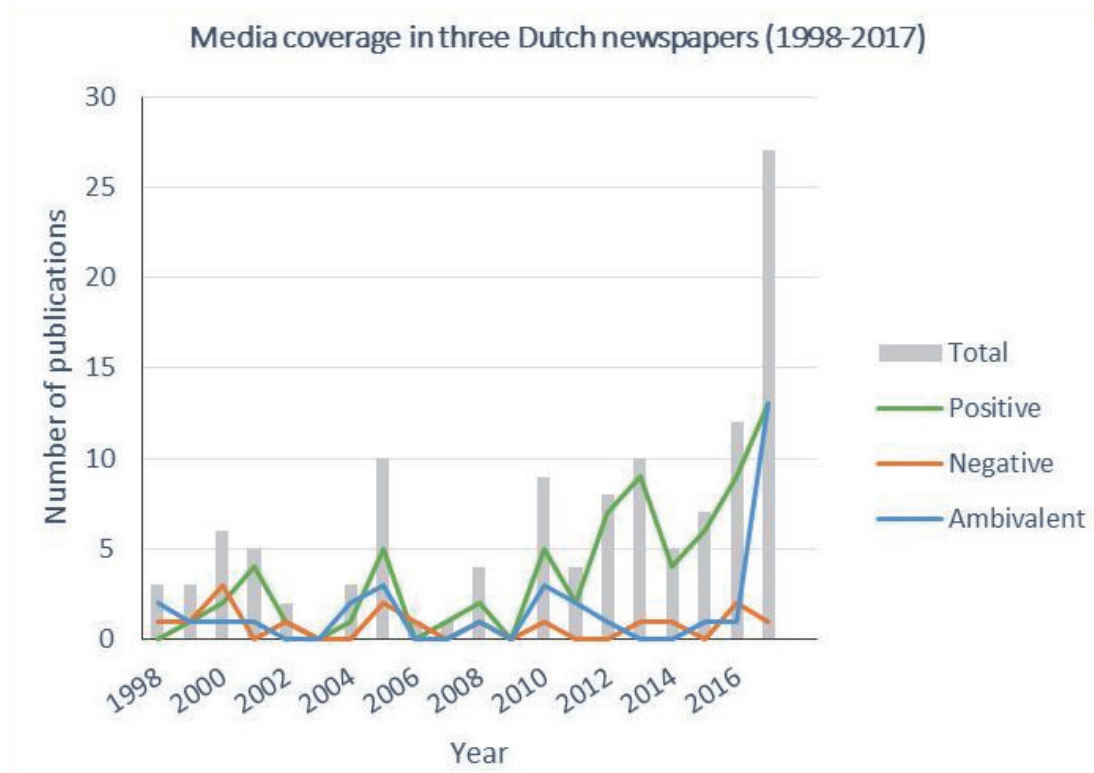
#### **I. TIS Development**

Internationally, recognition of the adverse health impacts of meat (over-) consumption was growing. A milestone was the acknowledgment of the link between the consumption of processed meat products and cancer from the World Health Organization (WHO) (Bouvard et al., 2015). Also, the livestock sector was becoming more prominent in EU climate mitigation policies. Milestones included the inclusion of agriculture in the EU roadmap towards a low carbon economy and the Paris Agreement (EC, 2011; UNFCCC, 2015).

In the Netherlands, legitimacy for meat substitutes continued to strengthen. In Figure 2.3 the analysis of articles in three Dutch newspapers between 1998-2017 illustrates that public discourses were becoming increasingly positive [F7].

A decisive development came in 2015. Building on knowledge developed in the previous years, the Dutch Nutrition Centre revised its official dietary guidelines (CR, 2015). For the first time, the advisable consumption of meat decreased and the guidelines included meat substitutes [F7]. Because the Nutrition Centre is the formal authority for the provision of reliable and independent information regarding food products, embracing meat substitutes was a breakthrough for the institutionalization of products as a pathway to a healthy and sustainable food system.

**Figure 2.3 Media analysis of three Dutch newspapers (De Volkskrant, NRC, Algemeen Dagblad) between 1998-2017**



The activities of the meat substitute industry were also crucial to the growing legitimization of the TIS. Firms started to collaborate in formal associations and networks. In 2012, the 13 key industrial actors of the sector came together in the first industry association, The Planet (Het PLaneet) [F7]. In this case, in order to develop the market for meat substitutes, firms in The Planet did not mainly focus on lobbying in favor of supportive regulations but they sought to further normatively and cognitively associate products with the meat substitution norm. An important example of such strategies was the establishment of the Green Protein Alliance (GPA) in 2016. The GPA is a multi-stakeholder platform comprised of several members and partners including meat substitute firms, the Nutrition Center and the NGO Nature and Environment [F7]. The aim of the GPA was to change the protein consumption balance in the Netherlands from 37:63 to 50:50 protein (plant:animal) by 2025 [F4] (GPA, 2017). The formal association between firms and organizations representing the perspectives of health and sustainability, as well as the commitment to the goal of changing the protein consumption balance and the activities that followed fed back into the legitimization of the TIS [F7].

*“Finally, there is also a role for government authorities and NGOs. Let’s call them credible influencers. They have to convey the serious, rational message and educate the public.” (IF12)*

*“Collaboration on this topic usually also means, that they can [...] and work together with government agencies or semi-government, such as the Dutch Nutrition Centre, which gives them a lot of credibility because the Dutch nutrition center would never work with just one company but they will work together with a number of companies that work together with the government.” (PE3)*

Moreover, once again, contestation regarding the adverse health and sustainability impacts of meat production and consumption and strengthened legitimacy for meat substitutes contributed to the renewed enthusiasm in the government to accelerate the protein transition. The publication of the critical report “Towards a Food Policy” (WRR, 2014) from the Netherlands Scientific Council for Government Policy (WRR) heavily criticized the food related regulatory framework and triggered the introduction of the Food Agenda for Safe, Healthy and Sustainable Food (EZ, 2015). The Food Agenda included aims relevant to the meat substitutes industry and was followed by allocation of resources through a number of subsidies and programs for knowledge development and entrepreneurial projects [F6] [F2] [F1].

This period also demonstrates incidences of significant financial resources becoming available directly from users. One example is the successful employment of crowdfunding for research into shear cell technology. Researchers in Wageningen and Delft Universities had been exploring the possibilities of shear cell technology as a manufacturing process for plant-based meat substitutes. Shear cell, or coquette cell, technology offers the benefit of allowing to replicate complete muscular parts of animals, such as chicken breast or beef meat (Krintiras et al., 2016). In collaboration with the founders of the Vegetarian Butcher, a foundation was established which attracted financial resources from crowd funding in order to fund ongoing research [F6]. Another striking example is that in 2015, the Vegetarian Butcher issued a bond loan for consumers to help finance the construction of a new production plant. As a result, the firm managed to raise 2.5 million Euros [F6][F1] (The vegetarian butcher, n.d.). These examples illustrate ways in which users were among the main actors participating in the fulfilment of system functions, as well as the exceptionally strong normative and cognitive legitimacy of the industry. The developments described in these phase led to an overall enabling environment for the TIS.

*“And why the time was right, I think within society there was in the Netherlands the Party for the Animals, more and more pressure ..., more and more companies who offer interesting alternatives, there was the report from the WRR, the scientific council for policy, ... that was an important one for this government” (PE6)*

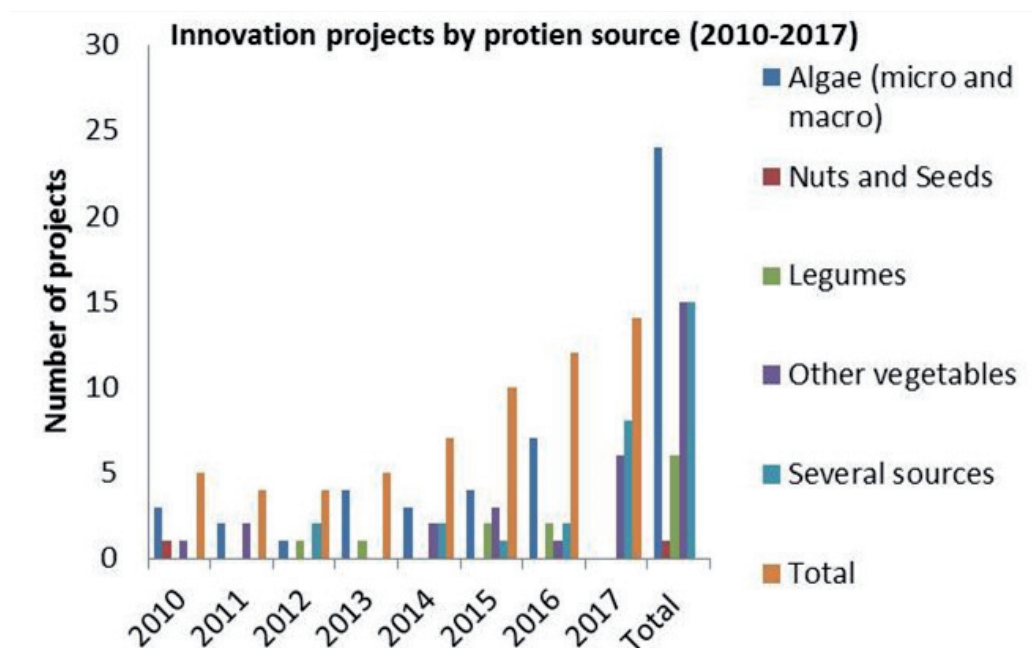
Market demand for meat substitutes started becoming an important trend. According to data from the market research agency IRI, the average yearly turnover growth of meat

substitutes in Dutch retail stores between 2014-2017 was 8,1% (Distrifood, 2017). For example, the Vegetarian Butcher grew from one store in 2010 to products being present in more than 3000 sales outlets in 14 countries by 2015 [F5]. This led to increasingly positive expectations for the future of the market[F4].

*“All signs are green at the moment for us, yeah consumers are very enthusiastic and what is also important is that there are very negative rumors about meat production and that influences people also.” (IF3)*

Positive expectations [F4] also contributed to experimentation and knowledge development across the supply chain of meat substitutes [F1][F2]. The growing trend of entrepreneurial experimentation is illustrated in the number of projects that received financial support from 7 Dutch subsidy programs and financial instruments between 2010-2017 (Figure 2.4). Successful projects downstream the supply chain led to the introduction of new raw materials, including rapeseed, quinoa and algal ingredients [F1] and renewed technological opportunities. Additionally, firms across the supply chain had started to build learning networks and platforms. Examples include the introduction of the trial facility Green Protein Accelerator for joint development of end-products and the Green Protein Cluster for knowledge sharing between industrial actors [F3].

**Figure 2.4 Number of projects that received financial support from 7 subsidy programs and fiscal instruments in the Netherlands (2010-2017) adapted form (Hielkema et al., 2018)**



By 2016, agri-food incumbents had started acquiring successful meat substitute firms around the world (Changing markets foundation, 2018). In 2017, Kerry group acquired Ojah and the following year, Unilever, one of the largest agri-food firms globally, acquired the Vegetarian Butcher (Evmi, 2017, 2018). This indicates that the meat substitutes industry offered interesting opportunities for incumbents and was becoming closely related to the agri-food sector.

*“You often see that when small companies give the good example, and show that it is not just the sustainability part, but also the commercial part [...] that actually people can make money then you see that also the bigger companies are interested. And that’s what happening right now, and that is a very good development. It’s not just about sustainability, it is also very commercial” (PE8)*

Finally, as a response to the rising popularity of meat substitutes, direct resistance in the form of contestation regarding the naming of meat substitutes and whether they could use animal terms, such as vegetarian chicken or sausage, re-surfaced. In 2017, the Vegetarian Butcher modified the description of a number of products on its website as a response to an investigation from the Dutch Food and Consumer Product Safety Authority (NVWA), which was brought by “complaints” (NRC, 2017). Similar developments in other European countries led European livestock industry groups to begin calling for legal restriction in the labelling of substitute products [F7] (Food Navigator, 2018).

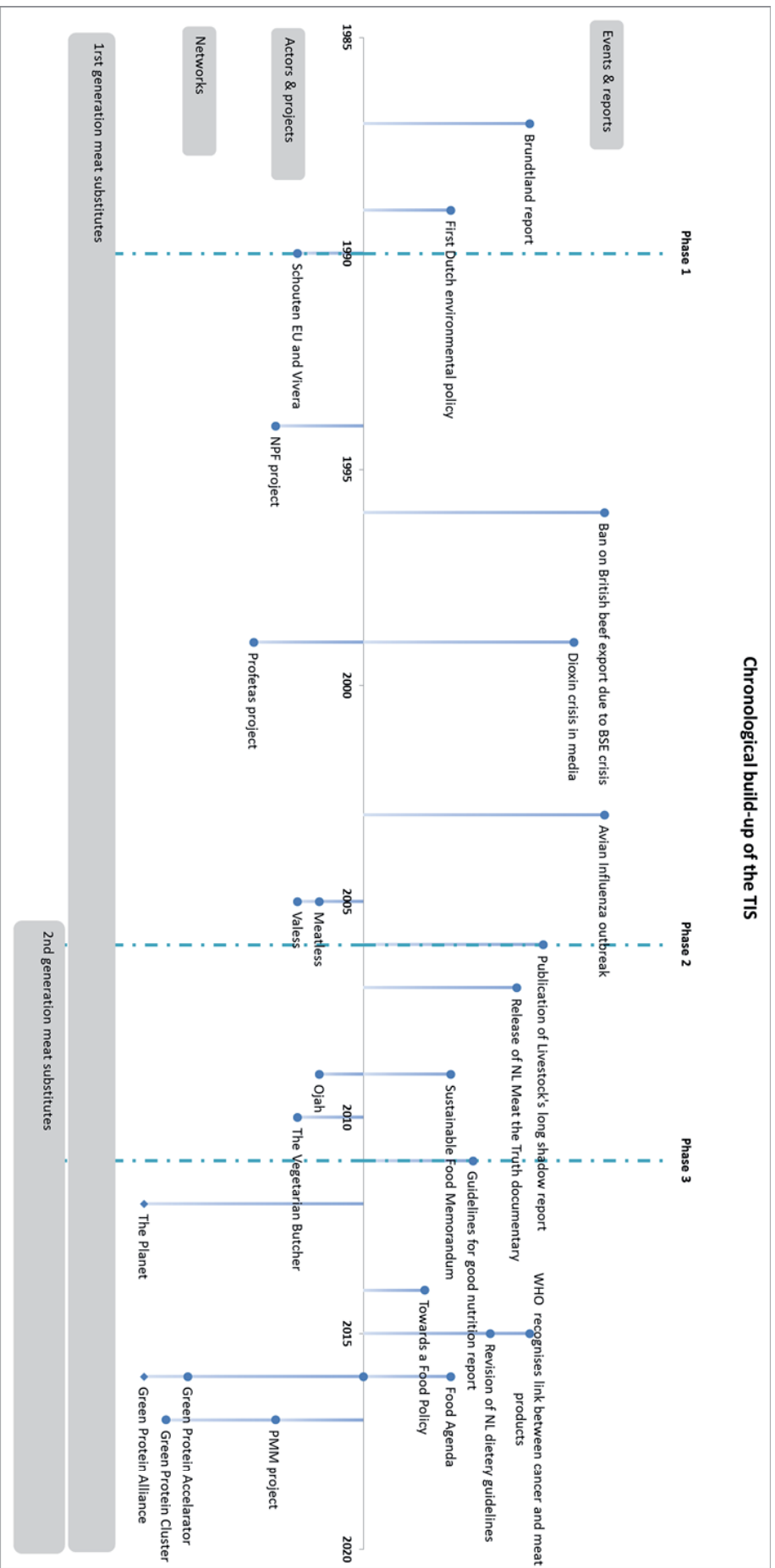
## **II. Motors of sustainable innovation**

This period indicates that the system was moving towards the growth phase. The TIS was becoming closely tied to the food sector and the market was growing rapidly. Rapid entry rates and the increasing trend of incumbents acquiring meat substitute firms indicates that the system was driven by the market motor in which the growing market pulls the strong fulfillment of all system functions.

At the same time, the activities of the meat substitute industry played an important role in these developments. Firms organized in networks and associations. Relevant patterns of activities and/or events that followed have been coined as the system building motor (Suurs, 2009). For example, firms initiated the Green Protein Cluster [F3]. They managed to draw in the (financial) support of the local governments [F7][F6] and this incentivized more new entrants [F1]. A distinctive aspect of the case in terms of the system building motor is that activities that aimed at the development of the market mainly aimed at further strengthening normative and cognitive legitimacy for the sector by becoming formally associated with independent organizations from health and sustainability perspectives.

Figure 2.5 summarizes the chronological development of the plant-based meat substitutes TIS in the Netherlands.

Figure 2.5 Summary of the key events during the development of the plant-based meat substitutes TIS in the Netherlands<sup>23</sup>



2 Figure 2.5 is not a comprehensive depiction of all relevant events, but an illustration of the key events discussed in the results section.

3 Figure 2.5 illustrates the (approximate) date of the establishment of firms.

## II.4 Discussion and conclusion

The case illustrates the crucial role of users and emerging norms for the build-up of TISs in the food sector. The role of such groups of actors, coined as 'norm-entrepreneurs', has been discussed in political change literature (Finnemore & Sikkink, 1998). Norm entrepreneurs first call attention to specific issues and challenge the appropriateness of alternative norms and behaviors (Finnemore & Sikkink, 1998). In this case, the role of vegetarians and vegans was pivotal in challenging the appropriateness of meat consumption and initiating normative contestation. Moreover, because of their strong notions against meat consumption, they also supported the consumption of meat substitute products. This way, they first triggered the emergence of the meat substitute TIS by creating markets in which consumers were willing to pay expensive prices for early meat substitutes. Already before the 1990's, they had incentivized a small number of firms to enter the TIS. For many decades, the TIS was composed of norms, users, niche markets, a few firms and low-performing products. This early market and the presence of profitable firms would become a key component for other actors to move in later phases.

During the early formative phase, mainly exogenous influences contributed to the development of system functions. Crises in meat supply chains were important in triggering temporary health concerns and in turn patterns of increased consumer demand, positive expectations for market growth and entrepreneurial experimentation with new inputs and processes. However, at the time, the structuration of the TIS was low; important actors including the Dutch Nutrition Center did not support it and therefore functional fulfillment was unstable and relatively independent. In the second phase, increased awareness regarding the climate, environment and animal welfare led to amplified normative contestation around meat in public discourses. This changed the way meat substitution was understood. As the frame of meat substitution evolved from altruistic and ethical considerations to broader sustainability considerations, it resonated with more actor groups and organizations. Accordingly, more actors accumulated in the meat substitutes TIS. This led to a growing degree of normative and cognitive legitimacy and accelerated the build-up of the TIS.

The types of interactions between functions that were observed during the second period have not been described in the motors of sustainable innovation typology of Suurs (2009). Therefore, in this paper, we introduce the legitimacy motor. The core dynamics of the motors are characterized by a double feedback loop.

The motor starts with groups of actors and/or organization, including NGOs and independent organizations, which embrace an emerging norm and support the promotion of products with certain characteristics because they resonate with this norm [F7]. Therefore, they start to shape normative and cognitive legitimacy for the TIS. The



attempt of these actors and organizations to convince a critical mass to also support the TIS contributes to the development of assessment studies [F2]. Positive results urge more actors and organizations to partake in the TIS and therefore strengthens normative and cognitive legitimacy further [F7]. When government actors become involved, they contribute financial funds through subsidy programs to facilitate the improvement of the performance of products. This leads to initiation of entrepreneurial and knowledge development projects.

At the same time, growing legitimacy for products positively influences market growth. The growing market leads to positive expectations for further growth [F4] and incentivizes the initiation of more projects [F1]. Availability of public funding reduces the risks of experimentation and contributes to the successful results of projects. Firms introduce higher quality products in the market. Renewed supply and marketing reinforce consumer demand further.

The legitimacy motor contradicts the motors of sustainable innovation typology (Suurs, 2009) in terms of the structural build-up of the TIS and the sequence that different system functions emerge. The motor started with users and societal organizations who drove the fulfillment of cognitive and normative legitimacy and created niche markets. This early cognitive and normative legitimacy as well as the presence of markets amplified the involvement of policy makers, knowledge institutions and entrepreneurs in resource mobilization, knowledge development and entrepreneurial experimentation processes. In that respect, contrary to the motors of sustainable innovation typology, societal contestation and actors, including users and NGOs, provided an early “incubation ground” for industrial innovation.

The dynamics of the legitimacy motor could potentially apply to other supplier dominated industries and producers of consumer goods, particularly because large scale individual collective action as a response to sustainability challenges becomes a more important trend (Bennett, 2012). However, we suggest that the successful realization of consumer demand as a driver in the early build-up of the TIS is closely related to the concept of customer benefit (Kammerer, 2009; Horbach et al., 2011). The rationale of the customer benefit concept is that “green” products that have private benefits for consumers will generate stronger consumer demand and create incentives for firms to introduce innovations (Kammerer, 2009). Our analysis illustrates that meat substitutes have had strong perceived customer benefits linked to health. Growing legitimacy for meat substitute products is determined to a large extent by perceptions that substituting meat consumption is beneficial for personal health. Due to this added-value, consumers are more willing to pay a high price for low-performing products and as a result firms are more motivated to introduce innovations. Therefore, we argue that the legitimacy motor



is more likely to be observed in industries which offer consumer goods with perceived private benefits.

Technological change and the development of higher performing products was crucial for appealing to potential user groups beyond dedicated vegetarians and vegans and ultimately achieving market expansion. The impact of the legitimacy motor on the availability of public resources significantly contributed to offsetting the risk of experimentation, particularly in SMEs. It was very important for the successful introduction of new intermediary products. Because a large share of food firms does not develop products internally, this was a key precondition for the breakthrough of the second generation of meat substitutes. Therefore, although intervention in the form of hard regulations was missing, policy was still pivotal for the development of the TIS.

We argue that governmental actors chose to support innovation in meat substitutes partly because it was an opportunity to address pressure without directly challenging the meat sector. In general, the promotion of innovation is politically more feasible than the promotion of reducing consumption or decreasing production capacity of established sectors. Therefore, on the one hand, it offers a leeway for surpassing political lock-ins but on the other it can also become an averting strategy and inhibit the rapid development of transitions.

During the third phase of the development of the TIS, the market started to drive the fulfillment of system functions, indicating the presence of the market motor. Since the market had been triggered by normative and cognitive legitimacy, politics remained important, which is in contrast to Suurs et al. (2009), who argue that legitimacy and political activities lose their importance with the emergence of the market motor. Therefore, the third phase also indicates the emergence of the system building motor, in which actors attempt to strengthen the TIS. In this case, they aimed at supporting the legitimation process for meat substitutes. Indeed, as recent TIS literature has demonstrated, the legitimation process of a TIS is not just the direct consequence of accumulation of actors in a system, but also the result of deliberate actors' strategies (Binz et al., 2016; Kukk et al., 2016). The case illustrates an interesting strategy that aimed at developing the market. Meat substitute firms initiated formal associations with NGOs and organizations from health and sustainability perspectives. This way, they managed to further strengthen cognitive and normative links between meat substitutes and the emerging norm of meat substitution by earning the official endorsement of independent organizations.

Direct resistance to the TIS was connected with the emerging norm of meat substitution. During the early formative phase, when the need to substitute meat consumption was highly contested, important actors, such as the Dutch Nutrition center opposed

the meat substitutes industry. As the norm of meat substitution was becoming more institutionalized, the same actors started to support the TIS. Additionally, in line with Mylan et al., (2018) who studied the diffusion of plant-based milk in the UK, this case illustrates that farmers are more locked-in to livestock production and therefore, contrary to manufacturing firms as the TIS was growing, they opposed it directly.

The aforementioned observations confirm that the growth of the meat substitute industry is an example of endogenous enactment in transitions. Early transitions literature was mostly focused on the efforts of new entrants who struggled against incumbent firms to introduce radical innovations, which necessitated fundamental changes in organizations, technologies, infrastructures, markets, regulations and user practices (Geels, 2002; Loorbach, 2010). More recent studies also acknowledge the important role of incumbent firms and incremental reorientation, which can contribute to the enhancement of the performance of the system (Geels et al., 2016). Indeed, this case illustrates an example of push and pull factors for the reorientation of the food processing industry and possible levers for sustainability transitions. Nevertheless, the directionality of these processes and their contribution to sustainability should be examined with caution.

To sum up, this case illustrates that, contrary to TISs in the energy and mobility sectors even during the formative phase, TISs can be composed of firms, niche-markets and commercial products. Second, it highlights the crucial role of users in the food sector, who hold norms about appropriate behavior and consequently provide niche markets and trigger early innovation processes. Third, it shows how the gradual institutionalization of norms can lead to growing normative and cognitive legitimacy for TISs and contribute in the acceleration of its build-up in the absence of supportive tax schemes for sustainable consumer products. Overall, it emphasizes the role of users and cognitive and normative institutions as leverage for sustainability in the food sector and possibly in other supplier dominated industries which manufacture consumer goods.

Future research could further unpack the relationship between emerging norms and the legitimation process of TISs. Such research could investigate the political context in which TISs develop, why and how particular norms emerge and which conditions are important for them to be embraced by different actors. Moreover, future research could more closely investigate the system building activities of actors. Although this paper indicates interesting examples, its aim is to explain the dynamics on the system level. Therefore, it does not systematically analyze micro-activities. An interesting research avenue would be to explore the discourses of a broad variety of actor groups and how they change as a TIS develops.



**CHAPTER 3**

# 3

# Alliances as system builders: On the conditions of network formation and system building in sustainability transitions

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## Abstract

The technological innovation systems (TIS) literature and the strand of system building studies explain the role of networks in the strategic creation of favorable institutional conditions for sustainability transitions. To better understand collective system building, it is important to delve into the formation of networks composed of diverse organizations, including firms, as well as government and civil society organizations, such as alliances. In this paper, we propose an analytical framework for the study of factors that influence the formation of alliances, as well as the contribution of alliances to system building. To illustrate our analytical framework empirically, we conduct a case study of the Green Protein Alliance (GPA), a distinctive example of an alliance network aiming to promote the transition to plant-based diets in the Netherlands. The results highlight the importance of organizational motives, organizational resources, and relationships for the formation of alliances. These factors also influence the type and course of system building strategies, as well as the creation of system-level resources. Moreover, we argue that alliances between diverse types of organizations can provide opportunities to accelerate transitions by promoting the adoption of potentially beneficial innovations and sustainable consumption.

### 3.1 Introduction

Sustainability transitions require profound technological, organizational, and institutional changes (Köhler et al., 2019). These changes are often the result of purposeful strategies. Within sustainability transitions literature, the technological innovation systems (TIS) framework and the strand of system building studies (Hellsmark and Jacobsson, 2009; Musiolik et al., 2012; Musiolik and Markard, 2011) analyze the role of actors, organizations, and networks in the strategic creation of favorable socio-technical conditions, as well as in the development and diffusion of new technologies and products. The creation of favorable conditions, referred to as “system-level resources”, is a complex process that is rarely the result of individual action. Instead, it requires the coordinated efforts of several organizations within networks (van Lente et al., 2003; Musiolik et al., 2012; Planko et al., 2016).

Therefore, system building studies often choose networks as units of analysis (Musiolik et al., 2012, 2020; Planko et al., 2017). While these studies provide valuable insights for sustainability transitions, they do not explore factors that influence the formation of alliances, networks composed of diverse types of organizations, including private, government, and civil society organizations (Peterman et al., 2014; Rondinelli and London, 2003). For example, such studies do not identify the factors that encourage firms to participate in collective action, which often involves costs, the introduction of voluntary rules, and cooperation with competitors (Lin and Darnall, 2015; Smith and Fischlein, 2010). Additionally, these studies do not investigate why government and civil society organizations might join forces with businesses to promote social and environmental goals (Austin, 2007; Reynolds et al., 2007; Peterman et al., 2014). Therefore, to better understand collective system building within sustainability transitions, it is crucial to study the formation of alliances, as well as the potential contribution of alliances to system building.

In this paper, we combine the literature regarding system building and regulatory intermediaries. The literature on regulatory intermediaries (Abbott et al., 2017a; Abbott et al., 2017b; Kourula et al., 2017) explores roles of organizations in regulatory processes, which span from hard rules to voluntary initiatives, including alliances relevant to sustainability transitions. This literature identifies factors, including: 1) organizational resources, 2) organizational motives, and 3) relationships of organizations, that influence the formation and activities of alliances (Abbott et al., 2017a; Kourula et al., 2017). The literature addressing regulatory intermediaries complements system building literature by recognizing key factors involved in the formation of alliances and can contribute to conceptualizing the role of alliances in system building. Therefore, our research questions are formulated as follows:

- *How do organizational motives, organizational resources, and relationships influence the formation of alliances?*
- *How can alliances contribute to the development of system building strategies and the creation of system-level resources?*

To answer these research questions, we explore transitions in the food system and, particularly, the transition toward (mainly) plant-based diets. The Food and Agricultural Organization (FAO) of the United Nations estimates livestock agriculture to account for about 14.5 % of global greenhouse gas (GHG) emissions, as well as to significantly contribute to land degradation, water pollution, and biodiversity loss (Gerber et al., 2001; Steinfeld et al., 2006). Taking these issues into consideration, scientists have increasingly recognized the reduction of animal products consumption and the diffusion of plant-based products, as potential mitigation options (Aiking and de Boer, 2018; Hallström et al., 2015; Herrero et al., 2016). We conducted a case study of the Green Protein Alliance (GPA), which aims to change the protein consumption balance in the Netherlands to 50:50 (plant:animal) protein by 2025 (GPA, 2017). The GPA is a unique example of an alliance network composed of firms, government organizations, and nongovernmental organizations (NGOs) that has implemented collective strategies for the promotion of the plant-based protein innovation in the Netherlands, such as inspiring new product development partnerships, raising consumer awareness, and running educational campaigns (GPA, 2017).

## **3.2 Analytical framework**

This section introduces the proposed analytical framework. It starts by describing existing literature on regulatory intermediaries (Abbott et al., 2017a; Abbott et al., 2017b; Kourula et al., 2017). We have chosen literature about regulatory intermediaries because it identifies factors, organizational motives, organizational resources, and relationships that influence the formation of alliances relevant to sustainability transitions. Then, the technological innovation systems literature and the strand of system building studies are introduced (Hekkert et al., 2007; Musiolik et al., 2012; Binz et al., 2016) in order to conceptualize alliances as system building networks as well as to outline the concepts of system building strategies and system-level resources. Finally, the section illustrates how the different concepts have been combined for the analytical framework.

### **3.2.1 Organizational motives, organizational resources, and relationships**

Recent articles on regulatory intermediaries explore intermediary roles of diverse organizations in regulatory processes, which range from hard rules to voluntary initiatives (Abbott et al., 2017a, 2017b; Kourula et al., 2017). Regulatory intermediaries provide



assistance to regulators, rule-takers, or both, often regarding the promotion of innovation (Abbott et al., 2017a; Peterman et al., 2014). They therefore operate in a broader sphere of governance, that of “collective means to give direction to society” (Kourula et al., 2019; Peters, B.G., 1996). A number of articles have identified different interrelated factors that influence the formation and activities of networks, including alliances, which are composed of firms, government and civil society organizations. Abbott et al. (2017a) have argued that the organizational capabilities, authority, and legitimacy are involved in the formation and activities of such networks. Peterman et al. (2014, 2015) supported the notion that the roles and activities assumed by governmental organizations in an alliance are influenced by resources, motives, activities, and relationships. Kourula et al. (2017) illustrated that these factors also influence the roles and activities of other organizations, such as NGOs, in a variety of governance networks and programs, including alliances. Building on these articles, which introduce the theory behind regulatory intermediaries, we focus on three factors identified as important in the formation of alliances: 1) organizational motives, 2) organizational resources, and 3) relationships between organizations.

Motives refer to why an organization participates in regulatory processes, including those of alliance networks. They have been defined as reasons to join a network in terms of stakeholder pressure, strategic advantage, regulatory pressure, ethical motivations, or a combination of these (Bansal and Roth, 2000; Heijden, 2017; Peterman et al., 2014). Motives vary significantly according to the type of organization, its interests, its mission, and its culture (Abbott et al., 2017a; Heijden, 2017). The interests of an industry might be in line with the goals or outcomes of regulation (Heijden, 2017). Some firms might be motivated to participate in alliances because of stakeholder pressure, regulatory pressure, and economic opportunities (Bansal and Roth, 2000). Other private organizations, such as consultancies and auditing firms, may be motivated purely by compensation (Lytton, 2017). NGOs and civil society groups usually uphold strong values and promote them through their actions (De Silva, 2017). Understanding the motives of individual organizations is important to the study of network formation processes and the activities of alliances.

Resources are essential competencies or capacities for regulatory processes (Abbott et al., 2017a; Bres et al., 2019; Kourula et al., 2017; Heijden, 2017; Nasiritousi, 2014). Collaboration within alliances becomes necessary when individual organizations lack the necessary resources to govern (Abbott et al., 2017a; Heijden, 2017; Nasiritousi, 2014). For example, firms engaging with emerging technologies, products, or both might need research facilities, knowledge, or public funding (Planko et al., 2016). Alternatively, they might be constrained when engaging in regulation (e.g., through corporate social responsibility (CSR)) due to skepticism (Romani et al., 2016). Government organizations might require more data, information, technical expertise, and human resources (Peterman et al., 2014). They may also be hesitant to employ formal regulatory tools in the governance of domains

such as consumption (Peterman et al., 2014). Consequently, these organizations employ intermediaries and/or engage in alliances, to benefit from the complementary capabilities of those entities (Abbott et al., 2017a; De Silva, 2017; Gerber et al., 2001). Therefore, the tangible and intangible resources available to individual organizations provide a dual explanation of the motives for the formation and activities of alliances.

Relationships refer to the formal and informal relationships of organizations within an alliance (Kourula et al., 2017). For example, firms might participate in an alliance in order to collaboratively develop new technologies, products, or both. They might cultivate strong relational ties with other firms, which can then encourage organizational learning and innovation processes (Lin and Darnall, 2015). A government organization is often in a position of central governance due to its formal mandate as a regulator (De Silva, 2017; Kourula et al., 2019). Within alliances, the relationship between government organizations and other members of that alliance can become more or less formal, depending on agreements and contracts (Kourula et al., 2017). In turn, relational ties impact the give-and-take of resources and the activities of the alliance (Kourula et al., 2017; Peterman et al., 2014). Civil society organizations are characterized by independence from regulators and legitimacy to meet social norms (Abbott et al., 2017a; De Silva, 2017; Gerber et al., 2001). Their relationship with firms in alliances can indirectly enhance the legitimacy of other organizations (Shumate and O'Connor, 2010). However, such relational ties can be weak or merely symbolic (Arya and Salk, 2006; Austin, 2007). Thus, understanding the differences in the relationships between organizations is crucial for the formation and activities of alliances.

Organizational motives, organizational resources, and relationships that organizations have comprise the three factors involved in the formation and activities of alliances in regulatory processes (Kourula et al., 2017). In the following section, we conceptualize the activities and contributions of alliances in relation to sustainability transitions by employing the concepts of system building strategies and system-level resources (Musiolik et al., 2012, 2020).

### **3.2.2 Technological innovation systems and system building strategies**

The term system building originates from literature about technological innovation systems (Hekkert et al., 2007; Musiolik et al., 2012; Planko et al., 2017). The main idea behind innovation system (IS) approaches is that determinants of technological change can also be found in the broader social structure around entrepreneurs (Carlsson and Stankiewicz, 1991; Lundvall, 2010). The TIS framework has been valuable in analyzing the successful emergence of new technologies and products in the context of sustainability transitions (Köhler et al., 2019). A TIS is a set of networks of actors and institutions, in a specific technological field, that contribute to the generation, diffusion and utilization of

variants of new technologies and/or new products (Markard and Truffer, 2008). Therefore, a TIS is structured by actors (most commonly referring to organizations), networks, and institutions, which determine innovation processes relevant to emerging technologies, and/or new products.

Apart from structural components, the TIS framework also identifies sets of key processes or system functions (Bergek et al., 2008; Hekkert et al., 2007; Markard et al., 2015). According to Hekkert et al. (2007), the key system functions observed in TIS are entrepreneurial experimentation, knowledge development, knowledge diffusion, guidance of the search, market formation, resource mobilization, and legitimacy creation. Complex interactions between the structure of the system and system functions can create positive feedback and lead to the acceleration of the development of TISs and increased opportunities for the diffusion of emerging technologies and new products (Suurs and Hekkert, 2009; Tziva et al., 2020).

TISs are assumed to develop—without strategic coordination, for example—as a result of new entrepreneurs joining this emerging field, as well as through the intentional activities carried out by innovating organizations (Binz et al., 2016; Musiolik et al., 2012; Planko et al., 2017). System building literature emerged to explore the latter (i.e., activities which aim at the strategic creation of favorable institutional and organizational factors for TISs; Hellsmark and Jacobsson, 2009; Musiolik et al., 2012; Musiolik et al., 2020). Some studies have examined system building processes initiated by individual organizations (Cetindamar and Laage-Hellman, 2002; Kukkk et al., 2016). However, because system building often entails complex processes, including the creation or reconfiguration of value chains and the development of a broader supportive environment, it is more often associated with coordinated efforts of networks of diverse organizations (van Lente et al., 2003; Musiolik et al., 2012; Planko et al., 2016). In that sense, system building is a collective approach involving bilateral or multilateral interactions, the development of formal networks, or both (Musiolik and Markard, 2011; Planko et al., 2016).

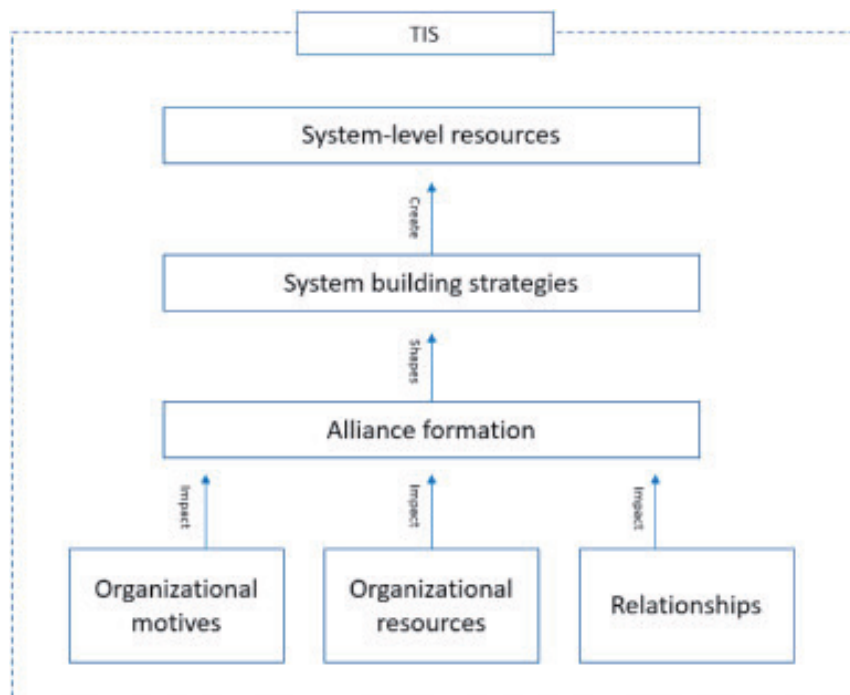
TIS literature argues that the development of system building strategies and their influence on TIS depends heavily on the availability of resources at the organizational, network, and system levels, as well as within the socio-technical context (Farla et al., 2012; Musiolik et al., 2020). Depending on organizational and network resources, system builders engage in different activities to address problems in the performance of the TIS and eventually create new system-level resources. System-level resources refer to tangible and intangible assets of strategic value that are non-excludable to any organization in the TIS (Musiolik et al., 2020). Once developed, these resources support the embedding of the emerging TIS in its socio-technical context as well as create opportunities for the diffusion of technologies and products (Musiolik et al., 2020).

This view partly sheds light on the factors contributing to the success of system building. However, when analyzing formal networks, according to this literature, the unit of analysis should be at the system level (Musiolik et al., 2020; Planko et al., 2017). Studies have not delved into factors involved in the formation of networks, which are composed of firms, government organizations, and NGOs, such as alliances. Therefore, they do not adequately explain how alliances between diverse organizations can contribute to system building. For these issues, the literature on regulatory intermediaries can offer valuable insights. Therefore, in the following section, we illustrate the analytical framework of this paper, which combines an understanding of the literature concerning regulatory intermediaries and system building.

### 3.2.3 Analytical framework

Fig. 3.1 offers a visualization of the analytical framework of this paper. We depart from the factors—organizational motives, organizational resources, and relationships—that originated in the literature about regulatory intermediaries (Abbott et al., 2017a, 2017b; Kourula et al., 2017). These three factors are involved in the formation of alliances. In turn, alliances shape system building strategies. As a result, they contribute to the creation of system-level resources, which can be used by everyone and provide more favorable opportunities for the promotion of the emerging technologies or products (Musiolik et al., 2020).

**Fig. 3.1 Visual representation of analytical framework.**



### 3.3 Method

In this paper, we employ a case study approach. A case study “explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information ... and reports a case description and case themes” (Creswell, 2013, p. 97). Within the general definition for case studies, there are different types. We adopt an interpretive case study approach (Bennett, 2004; Ponelis, 2015). An interpretive case study uses theoretical variables to provide explanations for a case (Bennett, 2004). It is rooted in the interpretive research paradigm, which understands the world from a subjective point of view and seeks an explanation within the frame of reference of the participant (Burrell and Morgan, 1979; Ponelis, 2015). An interpretive approach is best suited for the emerging research field of sustainability transitions, as it can lead to an understanding of key issues and develop both relevant and theoretical knowledge (Andrade, 2009; Ponelis, 2015). We have chosen the single case study approach because it offers more observation time and allows the study of the perceptions of multiple actors connected to the case. This approach is therefore suitable for working within the interpretive research paradigm. Moreover, it allows the generation of more in-depth insights, compared to the multiple case study approach, and can thus facilitate the exploration of new theoretical relationships (Gustafsson, 2017), including the identification of factors that are involved in the formation of alliances and the contributions of alliances in system building.

The GPA case serves as a good example to analyze for two reasons. First, as discussed in the introduction, we are interested in studying transitions in the food system—and particularly, the protein transition. The diffusion of plant-based protein products can play an important role in sustainability transitions within the food system because it can accelerate broader innovation processes, such as dietary change (Tziva et al., 2020). The GPA constitutes one of the very few networks that has implemented collective strategies for the promotion of plant-based protein innovation, such as inspiring new product development partnerships, raising consumer awareness, and running educational campaigns (GPA, 2017). Second, the GPA brings together organizations, including businesses, knowledge institutes, government organizations, and NGOs, and can therefore provide insights into the factors that are involved in the formation of alliances between diverse organizations.

Information was gathered from several data sources, including gray literature and semi-structured interviews. The first stage in conducting this research was a gray literature review. Secondary Dutch sources, which included news articles, the websites of firms and industry associations, policy reports, and research reports, were collected online to define the boundaries of the plant-based meat substitutes TIS and preliminarily explore the case. These sources were analyzed to identify the structural components of the TIS,

including relevant organizations, institutions, and technologies, as well as to develop an initial narrative for the development of the GPA and its strategies.

The second stage of the research was a qualitative event history analysis, a compilation of information relevant to the development of the Dutch meat substitutes industry and the GPA (for the years 1990–2017), organized in chronological order. Empirical data for the event analysis were collected through the Lexis Nexis Database. The accuracy of the Lexis Nexis Database has already been established in previous studies (Negro and Hekkert, 2008; Suurs and Hekkert, 2009). We identified more sources by using the same indicators in Google and finding three agri-food industry news outlets (distrifood.nl, evmi.nl, foodnavigator.com), as well as searching the websites of the GPA, its members, and its partners. We used a set of predefined keywords, including meat substitutes, plant-based protein, protein transition, protein innovation (all translated into Dutch), Green Protein Alliance, and GPA, to identify relevant articles in newspapers, websites, and industry publications. We coded each source according to the key TIS functions (Hekkert et al., 2007), which were identified using a set of predefined indicators (Negro et al., 2007). Each source was used to identify “events” fulfilling one or more TIS functions. The encompassing nature of the key TIS functions facilitated the development of a comprehensive narrative for the growth of the TIS of Dutch meat substitutes, the establishment of the GPA, the strategies for the alliance, and the created system-level resources. The final event database contained approximately 450 events.

In the third stage of the research, between June 2017 to February 2018, we conducted 30 semi-structured in-depth interviews to explore the formation, strategies, and impact of the GPA, according to interviewees’ perspectives. We employed purposive sampling to identify interviewees who could provide relevant information and increase the external validity of our results (Tongco, 2007). We interviewed representatives of the three organizations directly involved in the development of the GPA, nine representatives of GPA members and partners, and 18 representatives of stakeholders in the meat substitutes industry. A sample of the different organizations involved in the GPA participated in the interviews, including an incumbent firm, new entrants, government organizations, and knowledge partners. The rest of the interviewees included stakeholders of the Dutch meat substitutes industry, such as food firms, a retailer, a policy organization, and an NGO involved in the promotion of sustainable diets. During the interviews, we scrutinized the formation of the GPA according to the different interviewees’ perspectives, their interpretations regarding important factors involved in the formation of the GPA, as well as the GPA’s activities and impact.

The computer software package NVivo was used to code the interviews according to a coding process based on grounded theory (Bryant and Charmaz, 2007). We first analyzed

the transcripts of the interviews using the TIS functions (Hekkert et al., 2007; Negro et al., 2007; Wieczorek and Hekkert, 2012) in order to compare the results to the event history analysis with the perspectives of interviewees, as well as perform an initial categorization of the material. Afterward, we coded each interview according to organizational motives, organizational resources, relationships, alliance formation, system building strategies, and system-level resources. We analyzed the material, employing an explanation building approach (Yin, 2003) to infer causal links between the factors, alliance formation, system building strategies, and system-level resources. All interviewees were granted anonymity. In the analysis section, each organization was given a corresponding reference code. Table 8.2 in Appendices provides more information about the interviews and the reference code for each interview.

## 3.4 Results

This section analyzes the GPA case according to the abovementioned analytical framework. The analysis starts by briefly introducing the GPA and the organizations involved in it. It continues by examining the factors of the framework, motives, resources and relationships, and their impact on the formation of the GPA. Furthermore, it explores the system building strategies of the GPA and the created system-level resources.

### 3.4.1 The Green Protein Alliance (GPA)

The GPA was initiated by the Dutch industry association for plant-based protein firms, the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland [RVO]), and the consulting company New Foresight. In 2015, on behalf of the industry association, a former entrepreneur, Jeroen Willemsen, approached the governmental agency RVO, to discuss the possibility of a collaboration within the context of the sustainability program Doorzaamdoor. As a result, the consulting company New Foresight was chosen to coordinate exploratory research into the progress of the protein transition in the Netherlands. Innovation in plant-based protein products was deemed important for the protein transition. Therefore, early exploratory work involved the identification of barriers that inhibited innovation in plant-based protein products. These barriers are summarized in Table 3.1.

**Table 3.1. Summary of barriers for plant-based protein innovation (PE1;PE2;IO1;IF1;IF3;IF8)**

<b>Barrier</b>
Limited range of available plant-based protein ingredients
Costly and time-consuming pre-market authorization process for the introduction of novel protein products due to the European Union (EU) Novel Foods Regulation
High costs for scaling up pilot projects
Insufficient and ineffective subsidies for food processing firms, particularly small-medium enterprises (SMEs)
Incoherent policy frameworks across the agri-food system
Lack of common vision for the future development of the meat substitute industry
Limited cooperation between firms across the supply chain of meat substitutes
Uneven bargaining power of meat substitute firms relative to retailers
Low consumer demand
Negative consumer perceptions regarding, taste, price, and quality of meat substitutes
Lack of awareness among consumers regarding the health and sustainability aspects of food

The coordinated efforts of diverse organizations, including businesses across the supply chain, knowledge and government organizations, and NGOs, were assumed to be necessary for overcoming barriers to plant-based protein innovation. The idea for establishing the GPA was suggested by New Foresight. In 2016, the GPA was founded as an alliance which aimed to further the protein transition in the Netherlands. Initially, it was composed of 14 members (GPA, 2017). The government agencies for the provision of independent information, Nutrition Center (Voedingscentrum) and Environment Central (Milieu Centraal), were knowledge partners, and the Ministry of Economic Affairs (EZ) officially supported the initiative (GPA, 2017). The goal of the GPA was to change the protein consumption ratio in the Netherlands from 36:63 (plant:animal) to 50:50 by 2025 (GPA, 2017). By 2018, the GPA had grown to a network composed of 25 members, including Unilever and international meat substitute incumbent Quorn, as well as 10 other partners, and was supported by the Ministry of Agriculture, Nature, and Food Quality and a foundation (GPA, 2018). Table 3.2 summarizes the organization constellation of the GPA.



**Table 3.2 Overview of organizations involved in the GPA (GPA, 2017; GPA 2018)**

Year	2016	2018
<b>Initiating organizations</b>	<b>Industry association:</b> The Planet <b>Governmental organization:</b> The Netherlands Enterprise Agency (RVO), <b>Consultancy:</b> New Foresight	
<b>Members and Partners constellation</b>	<b>Founding Members and Partners:</b> <b>Primary production firms:</b> Rechtstreef, Rotterzwam <b>Food firms:</b> Boon, GoodBite, HAK, Bonduelle, Valk Vers, Vegafit, Vivera <b>Retail and food service firms:</b> The Dutch Weed Burger, Marley Spoon, Albert Heijn <b>NGOs:</b> Nature & Environment <b>Government organizations:</b> Nutrition Center, Environment Central <b>Supported by</b>  Ministerie van Economische Zaken (Ministry of Economic Affairs)	<b>Members and Partners:</b> <b>Primary production firms:</b> Dutch Soy, Next Foods, Zeewaar, Rotterzwam <b>Food firms:</b> Alpro, Appel, Bonduelle, Boon, Garden Gourmet, GoodBite, GRO, HAK, Intersnack, Menken Orlando, Next foods, Olijck, Purple Beehive, Vivera, Quorn, So Fine Foods, Unilever <b>Retail &amp; food service:</b> Albert Heijn, Jumbo, Marley Spoon, The Dutch Weed Burger <b>Government organizations:</b> Nutrition Center, Flevoland province <b>NGOs:</b> Nature & Environment <b>Financial institutions:</b> Rabobank <b>Knowledge institutions:</b> Prof. Kersten (Wageningen University & Research), Drift for transition, IRI, Louis Blonk Consultants, PS in food service <b>Educational institutions:</b> Dutch Cuisine, HAS School of Applied Sciences <b>Supported by</b> Ministerie van Landbouw, Natuur en Voedselkwaliteit (Ministry of Agriculture Nature and Food Quality) Doen Foundation

### 3.4.2 Organizational motives

#### I. Industry

The industry association and plant-based protein firms were motivated to initiate the GPA to address barriers to plant-based protein innovation [PE1;PE2;IO1]. Cooperation with other organizations offered several advantages. First, on the supply side, the sector is mainly comprised by SMEs, which have been characterized by a limited ability to develop new processes and products internally. Therefore, cooperation offered benefits in cost sharing and knowledge exchange for research and development (R&D) [IF7;IF8;IF13]. As one of the interviewees indicates, cooperation was particularly useful in facilitating

experimentation with, for example, new ingredients and the implementation of pilot projects: “Quite simple. because with more people in the same direction you get quicker results, and because we had very little experience in algae, so we had to find people who are experienced in it” [IF8].

Second, cooperation with a diverse set of organizations presented an opportunity to overcome constraints regarding the capabilities of food firms. According to various interviewees, government organizations and NGOs are better able to communicate unbiased information regarding food choices [PE2;PE3;IF1;IF12]. The following quote from a representative of a firm stresses the importance of a shared message between diverse types of organizations in communicating credible information: “What we can see is that it is very difficult as a manufacturer to educate the public about the benefits of plant-based protein, health-related or otherwise, and remain credible. People will not believe us because we are a commercial company trying to make money... There is also a role for government authorities and NGOs. Let’s call them credible influencers. They have to convey the serious, rational message and educate the public” [IF12].

Similarly, regarding overcoming organizational constraints, interviewees perceived that retailers were better positioned to influence food choices [PE1;PE2;IF12]. One interviewee illustrated the thought process for food processing firms: “it means you have to change the consumer’s behavior. But it’s not a lot of use to try to change behavior by just setting up campaigns... So instead of trying to change the consumer, why don’t we go a step back and see what can we do to get retailers and food service companies to change what they offer to the consumers” [PE1].

Third, cooperating with several organizations, including government and independent organizations, was perceived as a way to further legitimize the industry as a pathway to healthy and sustainable diets, as well as to leverage political power [PE1;PE5]. The following interviewee highlighted the importance of being associated with an organization such as the Nutrition Center: “Working together with the government and government agencies or semi-government agencies, such as the Dutch Center for Nutrition, gives them a lot of credibility because the nutrition center would never work with just one company, but they will work together with a number of companies that work together with the government” [PE1].

Finally, a few firms saw the GPA as a way to follow the developments of the industry and influence the strategies of the network [IF1;IF9;IF12]. For example, the following interviewee argued: “This is why I joined the GPA. To see what they are doing, and this is my way of talking to them and having some influence” [IF9].

Retailers that joined the alliance were sustainability frontrunners, which had already adopted relevant campaigns and programs. For instance, Albert Heijn had already committed to promoting the theme of healthy living (Ahold, 2015). The target of this theme was to increase the sales of healthy products as defined by criteria from leading health authorities to at least 25% of total food sales (Ahold, 2015). At the time of the establishment of the alliance, plant-based protein products had already been included in the dietary guidelines of the Dutch Nutrition Center (CR, 2015). Therefore, joining the GPA was an appropriate initiative in the context of the established CSR targets of the organization.

## II. Government organizations

The Netherlands Enterprise Agency (RVO) is responsible for the implementation of the policies of the Ministry of Economic Affairs, mainly with regard to entrepreneurship. Over the past decades, in the Netherlands, there have been several policies relevant to the “protein transition,” coupled with the topic of innovation in plant-based protein products (Vergragt & Grootveld, 1994; Weaver et al., 2000, Quist, 2007; LNV, 2009). In this context, RVO had introduced the theme “protein transition” in the sustainability program *Duurzaamdoor*. However, RVO’s efforts to involve businesses from the food sector had not been successful and progress had stagnated. One interviewee remarked that efforts to promote cooperation with businesses had not been successful: “because businesses didn’t find them [those meetings] interesting enough” (PE2). Therefore, the GPA was an opportunity to give a new impulse to the protein transition theme.

Moreover, due to policy pressure and timing, government organizations were even more incentivized to join the GPA. The publication of the critical report “Towards a Food Policy” from the Netherlands Scientific Council for Government Policy (WRR, 2014) had heavily criticized the food related regulatory framework and triggered the introduction of the Food Agenda for Safe, Healthy and Sustainable Food (EZ, 2015). Renewed political interest in the protein transition motivated participation in the alliance. One interviewee mentioned the favorable political agenda at the time: “Timing-wise, we had lot of luck because the Dutch state secretary was a proponent of sustainability, especially on the topic of food” [PE1].

Similarly, regarding the motivation of the Dutch Nutrition Center, the need to reduce meat consumption and the potential benefits of consuming meat substitutes had already gradually become embedded in health policies (Tziva et al., 2020). An important milestone was the publication of the report “Guidelines for good nutrition: the ecological perspective” from the Health Council of the Netherlands (CR, 2011). This publication led to the conclusion that less animal-based and more plant-based diets would benefit both public health and the environment. For the first time, the Health Council of the

Netherlands argued for the consumption of plant-based products. A few years later, the Dutch Nutrition Center revised its official dietary guidelines (CR, 2015), in which the advisable consumption level for meat decreased, and plant-based protein products were included. Therefore, the GPA was aligned with the mission and the guidelines of the Nutrition Center. One interviewee explained the favorable direction of health policies in the Netherlands and their relationship to the protein transition: “In the government, it’s not really clear what they want with the animal production... but there is clear strategy for health, what are the health goals, that’s the reduction of animal products, increase of plant-based products and vegetables” [PE3].

### III. NGOs

NGOs that became partners in the GPA had already been implementing campaigns that promoted the consumption of plant-based protein products. This development illustrates the legitimacy of the plant-based protein industry in Dutch societal and policy domains, as discussed earlier. As the following interviewee argues, NGOs perceived their participation in the GPA as a means of creating social value: “We asked him [referring to the GPA representative], what the purpose and goals with the GPA are. When he told us that it was 50:50 plant: animal proteins until 2025, that fits perfectly” [NGO3]. Table 3.3 summarizes organizational motives.

**Table 3.3 Summary of organizational motives**

Organizations	Motives
Firms	<ul style="list-style-type: none"> <li>· Cooperating in experimentation</li> <li>· Cooperating in communicating a shared, unbiased message</li> <li>· Cooperating to shape food choices</li> <li>· Supporting legitimacy</li> <li>· Leveraging political power</li> <li>· Participating in the shaping the strategies of the alliance</li> <li>· Engaging in a CSR initiative</li> </ul>
Government organizations	<ul style="list-style-type: none"> <li>· Addressing political pressure to address adverse impacts of livestock agriculture</li> <li>· Propagating existing policy programs</li> <li>· Cooperating to encourage the engagement of the industry</li> </ul>
Consulting firms and knowledge institutes	<ul style="list-style-type: none"> <li>· Financial interest</li> <li>· Working on topics relevant to the scope and mission of organization</li> </ul>
NGOs	<ul style="list-style-type: none"> <li>· Propagating existing programs and goals to create social value</li> </ul>

### 3.4.3 Organizational resources

Interviewees expected that different types of organizations offered different resources necessary to achieve the goal of the GPA. Regarding the initiating organizations, the industry association offered a vast network in the plant-based protein sector, as well as valuable knowledge regarding drivers of and barriers to innovation. New Foresight offered experts, heuristic models for the strategic development of the GPA, and the reputation for having supported change in other food sectors (Simons, 2014). In the words of one of the interviewees: “I think it’s a good model and I personally support the Green Protein Alliance because there is the thinking [(Simons, 2014)] of Lucas Simons [CEO of New Foresight]. I’ve seen it in the past, with the chains with coffee etc., that it worked” [PE3]. Finally, the RVO contributed financial resources and the legitimacy of a government organization.

Producing and processing firms that were members of the GPA contributed financial resources through membership fees. They supported collaborative innovation processes by making their food processing facilities, expertise, and knowledge available to other members of the GPA. For example, one firm representative explains how the development of a new product was facilitated by the GPA: “We do not possess the proper equipment to make this kind of product. They have been doing this kind of work for 25 years, and now we have combined our own vision and ideas with their expertise” [IF12]. As discussed earlier, retailers and food service firms brought in capabilities for influencing food consumption through, for example, communication materials.

The retailer Albert Heijn and the food firm Alpro, which are organizations with more than 1,000 employees, as well as the Dutch Weed Burger, a small plant-based burger start-up, are members of the GPA. Diversity in the types of businesses involved was perceived as beneficial due to differences in legitimacy and representativeness [PE5;IF9]. On the one hand, incumbent firms contributed political influence, a valuable resource for lobbying activities, and on the other hand, smaller firms were perceived as important for innovation. For instance, one of the interviewees comments: “They had a retailer, Albert Heijn, which is very important. But also, small enterprises joined the GPA. So it was a mixture of innovative and old companies, retailers, producers—a very interesting mix” [PE5]

Moreover, the scope of different producing and processing firms in the GPA spanned from meat and dairy substitute firms to businesses that do not necessarily produce substitutes but rather plant-based products, such as products made of mushrooms and legumes. Businesses of products other than meat and dairy substitutes represented producers of more “natural” and “healthy” food choices. Therefore, their participation contributed to promoting plant-based diets in general and not just the consumption of particular “processed” products [PE1; PE3]. In turn, this was important for a few members. For example, as one interviewee illustrates: “We do not support all those products [referring to

meat substitutes], but also there are a lot of producers of pulses and nuts, and they are fully supported by us" [PE3]. Thus, the participation of firms with a wide scope led to greater legitimacy for the GPA in promoting plant-based diets.

Government organizations, such as the RVO and ministries, brought in organizational capacities and legitimacy [PE1;PE2;PE3;;PE5;IF12]. Partly enabled by the development of the GPA, €1.8 million were allocated to a call for the development of plant-based protein products in the context of a subsidy scheme: "Small Business Innovation Research (SBIR)" (RVO, 2017). Additionally, the involvement of government organizations offered legitimacy to the alliance, enabling the participation of a diverse set of organizations.

Other government organizations and NGOs, such as the Nutrition Center and the NGO Nature and Environment, offer capabilities and legitimacy in terms of expertise and communication of credible knowledge regarding the health and sustainability aspects of food products [NGO3;PE3]. Finally, financial, knowledge, consulting, or educational organizations contributed operational capacities, such as expertise in different fields, knowledge regarding nutritional and environmental characteristics of products, necessary funds, or a combination of these [R1;PE4]. Table 3.4 summarizes organizational resources.

**Table 3.4 Summary of organizational resources**

Organizations	Resources	
	Tangible resources	Intangible resources
Firms	<ul style="list-style-type: none"> <li>· Artifacts and infrastructure (e.g., food processing facilities)</li> <li>· Membership fees</li> </ul>	<ul style="list-style-type: none"> <li>· Tacit knowledge (food processing)</li> <li>· Skilled professionals</li> <li>· Capacity to implement entrepreneurial projects and partnerships</li> <li>· Power of incumbent firms</li> <li>· Representativeness of innovative start-ups</li> <li>· Representativeness of providers of “natural,” “healthy” products</li> </ul>
Retail and food service	<ul style="list-style-type: none"> <li>· Artifacts and infrastructure (e.g., store facilities)</li> <li>· Membership fees</li> </ul>	<ul style="list-style-type: none"> <li>· Tacit knowledge (food purchasing choices)</li> <li>· Power of incumbent firms</li> <li>· Proximity to consumers in the supply chain</li> </ul>
Government organizations	<ul style="list-style-type: none"> <li>· Artifacts and infrastructure (e.g., national dietary guidelines)</li> <li>· Financial instruments (e.g., subsidy schemes)</li> </ul>	<ul style="list-style-type: none"> <li>· Capacity to direct financial funds and communicate credible information</li> <li>· Power of government organizations in agenda setting and implementation (e.g., designing subsidy schemes, developing official guidelines for nutrition and sustainability)</li> <li>· Reputation of organizations as credible knowledge providers</li> </ul>
Consultancy firms & knowledge institutes	<ul style="list-style-type: none"> <li>· Artifacts and infrastructure (e.g., models for sector transformation strategies, models for environmental footprint of diets)</li> </ul>	<ul style="list-style-type: none"> <li>· Skilled experts, working groups, and their knowledge (e.g., strategy, sustainability indicators)</li> <li>· Knowledge for the development of the alliance</li> <li>· Reputation of expertise</li> </ul>
NGOs	<ul style="list-style-type: none"> <li>· Artifacts and infrastructure (e.g., communication channels and events)</li> </ul>	<ul style="list-style-type: none"> <li>· Skilled experts and their knowledge</li> <li>· Capacity to advocate for plant-based diets</li> <li>· Reputation of independent, credible influencers</li> </ul>
Financial institutions	<ul style="list-style-type: none"> <li>· Financial funds</li> </ul>	<ul style="list-style-type: none"> <li>· Expertise in finance</li> <li>· Power of providing funds</li> </ul>
Education institutions	<ul style="list-style-type: none"> <li>· Teaching facilities</li> </ul>	<ul style="list-style-type: none"> <li>· Teaching professionals and expertise</li> <li>· Education capacities</li> <li>· Reputation of expertise</li> </ul>

### 3.4.4 Relationships

The GPA was established as a non-hierarchical network that promoted relationships between members and partners for the development and diffusion of plant-based protein products. This case illustrates three important facets of relationships with regard



to the formation of alliances in sustainability transitions. First, as discussed in the previous sections, the involvement of diverse types of organizations and potential relationships allowed the formation of the GPA. For example, because governmental organizations and NGOs have a mandate to remain relatively independent from corporate interests, they could only join the GPA when it was comprised of a diverse set of organizations.

Second, weak relationships between organizations can lead to conflicts and hinder potential system building strategies. Regarding the subsidy for plant-based protein innovation discussed earlier, a change in the political agenda led to a reduction in the number of projects that would receive funding. Consequently, firms that had devoted resources to the development of proposals were significantly discouraged [IF7;PE4]. Moreover, a few members contested the choice of firms that were successful in the first round of subsidies [IF7; IF9;PE4]. For example, one interviewee expressed his disappointment with the choice of incumbents over small firms: "I was so disappointed in the SBIR. It is nice, but don't call it a small business innovation; don't call it that if you give it to the big companies... I think the government had a really good chance in supporting a lot of small businesses that don't already have 10 people in R&D or funding for R&D to really give them the chance to develop really nice things ... I think it's a totally missed opportunity" [IF9].

In general, because private firms and government organizations have different mandates, they hold different views on the social value of the alliance and therefore the extent of public funding needed. For example, one industrial firm argued that more public funding should be allocated to the alliance: "Last year, we got a little bit of money but nowhere near enough. At this moment, it is all drops in the bucket. It is very frustrating because we really have ideas about what would work" [IF12]. Opposing this view, a policymaker stated that: "In my opinion, they are going over the top. How much money can you expect from the government?... Through investing in the GPA, you are investing in the market because you open the market. You communicate about the advantages of green proteins. That's my opinion. Also, the private parties could invest more in the GPA. I think that's the strength, of working together. Especially in the market you want to develop" [PE5]. This underlying tension in the relationships between firms and government organizations has hindered the allocation of resources and therefore potential system building activities.

Third, relationships between organizations in the GPA and a broader set of stakeholders from the agri-food system can influence the relationships in the alliance. For example, the common goal of achieving a 50:50 (plant:animal) ratio in protein consumption by 2025 was strategically chosen. One reason was that it was already aligned with the established goals and campaigns of many of the members and partners. However, it was also chosen because it does not directly challenge meat production and consumption and therefore follows the relationship of organizations in the GPA with their broader context [PE1;PE2].



For example, one interviewee commented: “For the retailers, 75% of their customers are traditional eaters. They don’t want to scare off these shoppers, understandably. They want to move forward, but they cannot force products to people that are not yet ready for them” [IF12]. Another interviewee illustrated the thinking of government organizations: “From the perspective of the Dutch government, ... the Dutch government... should represent all entrepreneurs, plant-based entrepreneurs, but also the animal industries” [PE1].

Similarly, because the different members and partners are formally associated with each other in the GPA, certain standards for appropriate conduct, which satisfy the mandate of the different organizations, needed to be established. In the case of the GPA, the dietary guidelines of the Dutch Nutrition Center were set as standards for the development of plant-based protein products. New product development pilots had to adhere to these standards to be eligible to participate in the aforementioned subsidy program.

### **3.4.5 System building strategies**

#### **IV. Introducing the alliance**

Motives, resources, and relationships were crucial considerations for early system building strategies. Ensuring the participation of firms in the GPA was a necessary precondition for securing public funding. The following interviewee illustrated this thinking: “We got the green light from the government but one of their criteria was: if the industry is committed to this, then they have to show that commitment by investing their time and investing their money” [PE1]. However, encouraging firms to invest was a challenging, iterative process. Therefore, the initiators had to appeal to the motives of firms. Because they were initially reluctant to invest, the first step was convincing a few important firms to sign a letter of intent. Afterward, in order to realize the intent of firms, the initiating organizations organized a public event to introduce the alliance and invite firms to officially participate. Ultimately, in 2016, 14 firms, including the incumbent retailer Albert Heijn, invested in the GPA and officially became members.

The involvement of Jeroen Willemsen and Lucas Simons from New Foresight was pivotal to the successful recruitment of members and partners. First, the reputation of these individuals was important for certain members. Second, these individuals had the necessary experience in business and strategic thinking, which allowed them to effectively communicate with professionals from the industry by “speaking the same language” [PE2;PE3]. In the words of one interviewee: “I think that one success factor was that there were two company-minded people on board because, both Jeroen and Lukas really understand the attitude of companies, because they are companies themselves. I think that was a success factor, and the strategic insight of Lucas was really a success factor” [PE2].

## **V. Knowledge creation, exchange, and diffusion**

Following the recruitment of initial members and partners, the first strategic plan of the GPA, the Green Growth Plan (GPA, 2017), was finalized. The overarching vision of a healthier and more sustainable food system was chosen to guide the activities of the members in the alliance. The goal of changing the protein consumption ratio in the Netherlands to 50:50 (plant:animal) protein by 2025 was officially set (GPA, 2017). Another strategy of the initiating organizations was the choice of an overarching vision and goal that was based on perceptions regarding the motives of members and partners. As one interviewee explains: “Because we knew that the Dutch government had a food agenda, which is basically something that they are committed to doing, [...], so using that as well as what’s already in the market, instead of trying to come up with something completely new, we were using the agendas that people already had on this topic, using their language, making sure that what we do helps them reach the goal that they have set” [PE1].

Moreover, because the GPA was partly initiated by the association of the plant-based protein industry, even from its early phase, it was focused on innovation. The Green Growth Plan charged the GPA with setting specific standards for plant-based products in order to comply with the dietary guidelines of the Nutrition Center (GPA, 2017). All members of the GPA committed to efforts that aimed to make plant-based products an “easy” choice for consumers. Producers of plant-based protein products committed to scaling up new products. Business to consumer firms pledged to introduce more plant-based products and meals to the market. Knowledge partners undertook the task of providing consumers with credible information that was relevant to plant-based products. Additionally, the Green Growth Plan introduced two initiatives for the long-term development of the sector. The first one was the SBIR subsidy scheme for the development of innovative plant-based protein products (RVO, 2017). The second one was the partnership between two producers of plant-based protein products and a university of applied sciences (EVMI, 2017). Together, they developed a program that trained students for professions relevant to the entire supply chain for plant-based products.

## **VI. Marketing and communication**

As the GPA developed, more attention was placed on communication activities. Examples of these activities included the involvement of the GPA in the first “National Week Without Meat” campaign and the employment of social media influencers for the promotion of products and plant-based diets (GPA, 2018).

## **VII. Lobbying**

The GPA started to actively lobby for the interests of the protein transition toward more plant-based protein consumption. Lobbying activities were mainly aimed at enticing financial funds from the government, engaging in open dialogues with political parties, as

well as contributing to and criticizing the government’s food related policies. Through the course of the development of the GPA, the topic of the circular economy became more important in the national political agenda (IenW, 2016). Accordingly, the GPA attempted to represent the interests of the protein transition in the context of the newly relevant framework of the circular economy: the “Transition Agenda Biomass and Food” (GPA, 2018).

**Table 3.5. Summary of system building strategies between 2016–2018**

Strategies	Activities
Establishing the alliance	<ul style="list-style-type: none"> <li>· Effective communication and engagement with potential members and partners</li> <li>· Development of a shared vision and goal</li> </ul>
Knowledge creation and information exchange	<ul style="list-style-type: none"> <li>· Information exchange between firms</li> <li>· Collaborative pilot projects for new product development</li> <li>· Pilot projects for the cultivation of protein plants</li> </ul>
Knowledge diffusion	<ul style="list-style-type: none"> <li>· Development of sector-wide standards for the nutritional aspects of products</li> <li>· Diffusion of market data</li> <li>· Diffusion of sustainability and health-related information</li> <li>· Educational program to train professionals for the industry</li> </ul>
Marketing and communication	<ul style="list-style-type: none"> <li>· Coordination and production of content for the communication materials of different members and partners</li> <li>· Employment of social media influencers</li> <li>· Consumer campaigns (e.g., National Week Without Meat)</li> </ul>
Lobbying	<ul style="list-style-type: none"> <li>· GPA public meetings for open dialogue with political parties</li> <li>· Transition Agenda Biomass and Food</li> </ul>

### 3.4.6 System-level resources

Through system building strategies, the GPA motivated several firms across the food supply chain to collaboratively engage in the development and promotion of plant-based protein products. The alliance managed to create an environment that fosters cooperation between producers, retailers, and the food service industry. One interviewee emphasized that this was an important step: “It is an important role for them to join all producers and retailers together because they can do a lot.” [PE5]. Moreover, interviewees stressed the importance of the accumulation of incumbents in the alliance [PE1;PE2;PE5;IF9;IF12;NGO2]. For example, PE5 argues that: “If you have Unilever as one of the participants, it’s a very powerful company with a lot of money; if they start to communicate about it, it will have a huge impact.”

The GPA committed its members and partners to the development of necessary innovation processes for the successful increase of plant-based protein consumption. This triggered the development of knowledge-sharing programs between firms and of product

development partnerships, as well as the introduction of new products and meals in the market (GPA, 2016; 2018). Therefore, the GPA contributed to a renewed supply of products that could better appeal to consumers. The GPA led to the development of standards for plant-based protein products to ensure that products comply with specific health-related criteria (GPA, 2016; 2018). This is important, as many consumers who choose plant-based protein products are motivated by health considerations. Moreover, the GPA led to the mobilization of public resources for innovation and the establishment of an educational program to train students in order to support the long-term development of the plant-based protein product industry (GPA, 2017).

A significant contribution of the GPA, according to interviewees, was publicity and awareness for plant-based protein consumption [PE1;PE5;NGO2;IF1;IF12]. Many members generated greater awareness through their activities. For example, one interviewee argues: "First, they only had Albert Heijn, and now they also have Jumbo; they are creating a lot of buzz" [NGO2]. The GPA, as a network, also adopted new communication strategies. Examples of related resources that were developed include the first National Week Without Meat, which reached more than 30,000 consumers; the GPA also coordinated communication through social media influencers with a potential reach of 100,000 individuals (GPA, 2018). Therefore, the GPA not only supported innovation processes on the supply side, but also actively promoted demand-side processes.

In terms of system-level legitimacy, the GPA encouraged several important organizations, including firms, government organizations, and NGOs, to share the common goal of facilitating the protein transition. As one interviewee argued: "So, but I've already seen a lot of benefit just in terms of, symbolism, that they are just showing that this is really a big thing and they are growing... But I think there is a really great benefit in communicating as a group and saying, this is what we are going to do" (NGO2). Therefore, the development of the GPA further legitimized plant-based protein production and consumption as a sustainability pathway for the food system. In fact, in 2018, the "Transition Agenda Biomass and Food" from the Dutch government introduced the first official target relevant to the protein transition: "The ratio in the consumption of animal and vegetable proteins will be reversed from 60:40 to 40:60 by 2050" (IenW,2018). The choice of this goal, coupled with the goal of the GPA, suggests that the development of the alliance had a certain spillover effect in the introduction of governmental policy.

Finally, the GPA impact assessment (2018) argues that the GPA influenced the consumption of plant-based products in the Netherlands as well as the availability of financial resources. First, market data from the IRI consulting firm state that in 2017, there was a 3.2% increase in supermarket sales of plant-based protein products. Second, the impact assessment states that the GPA influenced the distribution of 14,100,000 euros

to the promotion of the protein transition through the “Transition Agenda Biomass and Food”. Table 5 summarizes the system-level resources that have been created, providing a more favorable institutional context that can be employed by any organization interested in the promotion of plant-based protein consumption.

**Table 3.6. System-level resources created by the GPA (2016,2018)**

System-level resources	
Accumulation of organizations in the TIS	<ul style="list-style-type: none"> <li>· 25 members</li> <li>· 10 partners</li> <li>· Partnership with Rabobank</li> <li>· More than 120 entrepreneurs participated in GPA events</li> <li>· 40 students participated in the HAS minor</li> </ul>
Financial resources	<ul style="list-style-type: none"> <li>· Partnership with Rabobank</li> <li>· €14.1 million reserved through the Transition Agenda Biomass and Food</li> </ul>
Knowledge	<ul style="list-style-type: none"> <li>· Development of two reports on sustainability and health aspects of diets</li> <li>· Development of market data for the industry</li> </ul>
Products	<ul style="list-style-type: none"> <li>· More than 12 partnerships for product development</li> <li>· More than 70 new products introduced by retailers</li> </ul>
System-level legitimacy	<ul style="list-style-type: none"> <li>· Prizes for new products from GPA members</li> <li>· Coordinated communication through social media influencers with a potential reach of 100,000 individuals</li> <li>· More than 40 interviews and press releases in relation to the GPA</li> <li>· More than 30,000 consumers took part in National Week Without Meat</li> <li>· NRC live Agri-Food and Tech event</li> <li>· Introduction of a target relevant to the protein transition in the Transition Agenda Biomass and Food</li> </ul>

### 3.5 Discussion

This paper contributes to previous work on system building (Musiolik et al., 2020; Planko et al., 2016; Planko et al., 2017) by illustrating that the formation of alliances between firms, government organizations, and NGOs depends on organizational motives, organizational resources, and relationships between organizations. To begin with, diverse motives were observed, ranging from contextual developments to perceptions regarding the creation of strategic advantages. In terms of contextual developments, this case illustrates that innovation in plant-based protein products was already aligned with norms and policies in the Netherlands. The GPA was partly initiated by the industry association from the plant-based protein sector. Even from its inception, the goal of the alliance was coupled with promoting plant-based protein innovation. The relative legitimacy of the sector in the Netherlands, as well as increased stakeholder pressure and the political agenda at the time, incentivized governmental organizations and NGOs to participate in the alliance as

well. Regarding the creation of strategic advantages, firms were mainly motivated to join the GPA to accelerate technological developments and build the market for plant-based protein products by pooling risks, creating new competencies, and enhancing legitimacy. Therefore, our findings suggest that the study of organizational motives in alliance formation processes should consider both contextual developments, such as in the political context (Yang and Liu, 2015), and the strategic goals of individual organizations (Lin & Darnall, 2015; Wassmer et al., 2017).

The different organizations involved in the alliance offered diverse tangible and intangible resources, which were important for the strategic buildup of the plant-based protein TIS. Organizations, including producing and processing firms, as well as knowledge, consulting, and educational organizations, contributed resources for supply-side collaborative innovation processes. NGOs, retailers, and food service organizations offered resources for the adoption of plant-based protein products. Government organizations, such as the RVO and ministries, brought in organizational capacities and financial resources. The legitimacy and representativeness of individual organizations were perceived as being among the most important resources for the promotion of plant-based protein consumption. For example, interviewees stressed the importance of the legitimacy of government organizations and NGOs in advocating for healthy and sustainable diets. Similarly, the representativeness of start-ups and producers of “natural” products was considered advantageous for the promotion of plant-based protein consumption because of social norms.

The GPA inspired non-hierarchical relationships between members and partners, which aimed to develop and diffuse plant-based protein products. This case illustrates that relationships between members that aimed to develop specific competences and were often observed in corporate alliances (Lin & Darnall, 2015), such as relationships for new product development, ultimately created structures that promoted innovation processes. On the other hand, weak relationships between government organizations and firms led them to contest certain decisions about funding and hindered the allocation of resources as well as potential system building strategies. Thus, the type and degree of relational ties between organizations is critical for the development of system building strategies. The case also shows that the relationships of organizations in an alliance and a broader set of stakeholders in the agri-food system ultimately shaped relationships within the alliance. A broad goal for the alliance was then defined and did not directly challenge meat and dairy production and consumption because of the intra-alliance relationships between members and partners.

Early system building strategies were largely focused on bridging the varying motives, resources, and relationships of different organizations. Interviewees stressed the

importance of mimicking established interests and goals of organizations in encouraging the participation of members and partners. This case also illustrates the role of “charismatic” individuals, who can maneuver diverse motives, resources, and relationships for the successful formation of an alliance. In later stages, system building strategies continued to be characterized by motives, resources, and relationships. For example, standards developed for plant-based protein products were based on already established standards of the Dutch Nutrition Center and aimed at bridging organizational differences and promoting relationships between diverse members and partners. Therefore, the case illustrates that system building strategies of alliances involve the motives, resources, and relationships of organizations in the alliance, as well as that the realization of system building strategies necessitates processes of negotiation and compromise.

Ultimately, the system-level resources that have been created led to the buildup of important structures for innovation processes as well as the growth of the TIS for plant-based protein. The GPA allowed firms to develop new competencies and introduce new products in the market. More importantly, the diversity of organizations involved in the alliance led to the creation of system-level resources that could not have been created through strategies undertaken by more homogeneous networks, such as industry associations. The GPA coordinated the communication efforts of organizations, which ranged from firms across the supply chain to NGOs and government organizations. As a result, a shared vision for the transition to plant-based diets was conveyed, which included the consumption of plant-based protein products. In turn, this contributed to the further legitimization of the plant-based protein sector. Moreover, the diversity of organizations involved in the GPA was particularly important in reaching beyond the supply side of innovation processes to the demand side, which has constituted a challenging field in transitions literature (Geels et al., 2018). Therefore, we argue that alliances can lead to opportunities to accelerate sustainability transitions by promoting the adoption of potentially beneficial innovations and sustainable consumption.

Moreover, regarding the potential contribution of alliances in the protein transition, the GPA has provided alternative governance tools, which are argued to have contributed to a 3.2% increase in retail sales of plant-based protein products (GPA, 2018). Therefore, we argue that alliances with a focus on innovation can facilitate the governance of the demand side of the food regime, a complex domain due to the lack of fiscal measures for sustainability (i.e., in the form of consumption taxes).

Finally, because motives, resources, and relationships are not only involved in alliance formation processes, but also in system building strategies, and the creation of system-level resources, they can promote transition pathways that deviate across several dimensions, including the dominance of specific organizations, technologies, and institutions (Geels,

2016; Lindberg et al., 2019). We argue that alliances, which mainly involve regime actors, can contribute to promoting a transformation pathway comprised of incremental improvements in products, but limited institutional change (Geels, 2016) in, for example, dominant dietary practices and/or the structure of the food system.

### 3.6 Conclusion

In this paper, we combined the literature concerning system building and regulatory intermediaries in order to propose an analytical framework for the study of factors involved in the formation of alliances, as well as the contribution of alliances to system building. The first question of this study pondered how organizational motives, organizational resources, and relationships influence the formation of alliances; we have illustrated the many ways in which the GPA was formed through compromise between these three factors. Therefore, the formation of alliances and ultimately the development of system building strategies as well as the creation of system-level resources are not merely instinctive outcomes of the involvement of new actors in a TIS, but are contingent upon diverse factors relevant to actors. Second, regarding the contribution of alliances to system building, it can be clearly seen that a multiplicity of actors involved in alliances can provide opportunities for accelerating transitions through promoting the adoption of potentially beneficial innovations and sustainable consumption. We also show that the transformative potential of alliances varies according to the type of actors involved.

The single case study approach in the Netherlands was valuable in facilitating an in-depth analysis of an alliance. However, it inevitably entails limitations in terms of the replicability of the research and its generalization of results. We suggest that further research should analyze other national and international alliances in the context of sustainability transitions to accumulate more generalizable results.

Finally, although alliances offer advantages, their formation and enactment can be challenging. This case illustrates that organizational motives, organizational resources, and relationships can also contribute to conflict and obstruct potential system building strategies. Therefore, we suggest that further research could focus on how power is exercised in order to navigate diverging motives, resources, and relationships between organizations in alliances.





**CHAPTER 4**



# Incumbent Entry Modes in Sustainable Niches: An Analysis of the Plant-based Protein Transition in the United States, the Netherlands, and the United Kingdom

This chapter has been submitted to *Environmental Innovation and Societal Transitions* as Tziva, M., Bula, B., Bidmon, C.M. & Hekkert, M. P. (2022). Incumbent Entry Modes in Sustainable Niches: An Analysis of the Plant-based Protein Transition in the United States, the Netherlands, and the United Kingdom

## Abstract

While literature on sustainability transitions has mainly portrayed incumbent firms as reluctant to engage with new sustainable technologies and products, as well as primarily employing strategies that aim to limit niche growth, in many cases incumbents contribute to accelerating scaling-up and diffusion processes. In this paper, we mobilize insights from organizational literature, and particularly the concept of entry modes from the international business literature, to investigate incumbent firms' engagement in sustainable niches through the introduction of new products, collaborative efforts with new entrants, the introduction of new brands, mergers & acquisitions, and investments. We focus on entry modes of incumbent firms, including food firms, meat processors, retailers, and food service firms, in meat substitute markets in the United States (US), the Netherlands, and the United Kingdom (UK). The results show that contrary to previous literature, in this case incumbents quickly engaged with niche products incentivized by economic opportunities stemming from changing consumption patterns, which preceded any regulatory action. We identify distinct entry mode patterns for the four firm types. We show that the entry modes of different types of incumbent firms vary in their timing and commitment towards the meat substitute sector, as well as how the evolution of these diverse entry modes affects scaling processes in the protein transition.

## 4.1 Introduction

Addressing contemporary environmental problems, such as climate change, food security, and biodiversity loss, requires radical shifts in socio-technical systems, including shifts in the electricity, heat, mobility, and agro-food sector. Sustainability transitions literature has provided valuable insights into such systemic transformations (Köhler et al., 2019; Savin and van den Bergh, 2021). According to this literature, change processes start in niches (i.e., protected spaces which support novel technologies) in which pioneering actors work largely independent from established incumbent firms to introduce radical technologies and products (Penna and Geels, 2012). These new technologies and products remain in niches for a relatively long-time while experimentation and learning takes place (Bento and Wilson, 2016; Smith and Raven, 2012). Incumbent firms initially resist radical niche innovations (Geels, 2014; Penna and Geels, 2012; Roberts et al., 2018). The reorientation of incumbents only occurs after a mixture of exogenous pressures which include the introduction of regulations, such as industry standards, and changing consumer preferences (Geels and Penna, 2015). The embeddedness of new technologies and products in societies can ultimately lead to sustainability transitions, such as those towards renewable energy, circular economy, and sustainable food systems.

Nevertheless, sustainability transition scholars have recently criticized the prevailing conceptualization of incumbent actors as resisting change and delaying sustainability transitions (Ampe et al., 2021; Sovacool et al., 2020; Turnheim and Sovacool, 2020). For instance, Turnheim and Sovacool (2020) stress that incumbents can employ a wide range of positioning strategies when engaging with niche technologies and products, such as diversification activities (Steen and Weaver, 2017), and call for more attention to the potentially enabling role of incumbents in transitions. Other studies illustrate that incumbents can significantly contribute to accelerating scaling-up and diffusion processes of new technologies and products (Hockerts and Wüstenhagen, 2010; Wadin et al., 2017). Moreover, due to awareness that there are economic opportunities in “green growth”, incumbents have been observed as becoming more proactive when engaging with sustainable product innovation (Hockerts and Wüstenhagen, 2010; Steen and Weaver, 2017). Therefore, transitions literature should be able to account for a more nuanced view of incumbent behaviour and their engagement with niches.

With regard to the different phases of sustainability transitions, transitions literature to date has mainly focused on the transformative potential of pioneering actors and their efforts to introduce radical innovations in the formative phases of transition (Geels, 2021; Markard et al., 2020). However, scholars have highlighted the increasing importance of further also investigating the diffusion phase of transitions including the strategic reorientation of incumbent firms (Geels, 2021; Markard et al., 2020). Because in the diffusion phase

of transitions, innovations exhibit far more traction with regards to consumer demand and societal needs, change processes can transpire (Markard et al., 2020). Incumbent behaviour can change as a response to accelerated innovation processes which give way to new economic opportunities and thus, strategic reorientation can start taking place swiftly (Turnheim and Sovacool, 2020). Thus, building insights into the diffusion phase of sustainability transitions can provide alternative explanations on the timing dynamics of incumbent engagement in niches.

Finally, the interest in incumbent behaviour in sustainability transitions has been to a large degree limited to producing and manufacturing industries (Geels and Penna, 2015). Sustainability transition scholars now recognize that it is important to study the multiple incumbent actor types which make up industry regimes in transitions (Turnheim and Sovacool, 2020; Sovacool et al., 2020). In terms of firm types, it is useful to recognize the multiplicity of actors across supply chains. Producers, retailers, and other supply chain actors are diverse types of organizations involved in achieving the upscaling conditions of innovations (Lambin et al., 2020; Mylan et al. 2019). Particularly in the diffusion phase of transitions, the engagement of firms across supply chains is crucial for promoting the adoption of new technologies and products, and for ultimately achieving the embeddedness of innovations in societies (Lambin et al., 2020; Mylan et al., 2019).

The behaviour of incumbent firms has been studied extensively in organizational literature. While organizational literature generally confirms that incumbent firms are often reluctant to engage early with new products and markets (Christensen, 1997; Dosi, 1982; Nelson and Winter, 1982), especially the strategy literature also recognizes that incumbent firms may do so tempted by several incentives, such as pre-empting market space and controlling emerging industries (Lieberman and Montgomery, 1988; Suarez and Lanzolla, 2007). Studies illustrate that incumbent firms are important for the transformation of markets towards sustainability because they often engage with new entrants by employing different strategies ranging from participating in alliances with new entrants, mimicking innovative business models or availing in friendly or hostile take-overs (Schaltegger et al., 2016; Perreira et al., 2021). Such strategies can contribute to the mainstreaming of innovation processes, including diffusion in mass markets (Hockerts and Wüstenhagen, 2010; Schaltegger et al., 2016; Perreira et al., 2021). Therefore, exploring these strategies is important in building insights into an alternative and potentially more enabling role of incumbents in sustainability transition.

In this paper, we mobilize insights from the organizational literature and specifically, the concept of “entry modes,” in order to investigate modes through which incumbent firms engage with new sustainable technologies and products, ranging from collaborative efforts with new entrants to mergers and acquisitions (M&As) and wholly owned

subsidiaries. We aim to open the 'black-box' of incumbent behaviour by delving deeper into types of entry modes of incumbent firms in sustainable niches. We investigate the timing dynamics of incumbent engagement, as well as the behaviour of different type of incumbent firms across the supply chain, in order to contribute to a more nuanced view of the transient nature of incumbent behaviour.

Empirically, we focus on entry modes of incumbents in meat substitute markets in the United States (US), the Netherlands, and the United Kingdom (UK). As a response to environmental concerns and potential health implications of the production and consumption of livestock products, multiple plant-based meat substitute products have recently been introduced to these markets. This growing trend towards plant-based substitutes is such that these products are at the point of breaking into mainstream food consumption. Therefore, scholars increasingly recognize the diffusion of plant-based meat substitutes as contributing towards a transition to plant-based diets (Mylan et al., 2019; Herrero et al., 2020). In contrast to other sustainability transitions, such as transitions in the electricity and mobility sector, incumbents have not shown significant resistance, but have been important in transforming the meat substitute sector to an established market segment (Tziva et al. 2021; Lonkila and Kaljonen, 2022). In addition, recently the diversification towards plant-based protein products has become a key component of strategies of large food firms and meat processors, as well as incumbents across the supply chain, such as retailers and food service firms (FAIRR, 2020). Therefore, the protein transition is a suitable case in exploring incumbent entry modes in sustainable niches which promises to offer alternative explanations to dominant models of incumbent behaviour in sustainability transitions. Therefore, the research questions of this paper are shaped as follows:

- *What are the different entry modes incumbent firms across the supply chain of plant-based meat substitutes employ to enter sustainable niches?*
- *What are the entry timing dynamics of incumbent engagement in the protein transition?*

## 4.2 Theoretical Background

### 4.2.1 Incumbent behaviour in sustainability transitions

Literature on sustainability transitions has provided insights into the behaviour of established or incumbent firms as a response to radical innovation (Bergek et al., 2013; Penna and Geels, 2012; Turnheim and Geels, 2019; Steen and Weaver, 2017; Van Mossel et al., 2018). Within this literature, incumbents are predominantly seen as supporters of established technological trajectories and advocates of incremental innovation as means to address societal problems, while they remain reluctant to engage in radical innovation

(Penna and Geels, 2012; Geels and Penna, 2015). This is because incumbents are “locked-in” in the existing industry regime which comprises existing technical capabilities and routines, industry beliefs and mind-sets, mission and identity and formal policies and regulations (Geels, 2014). Radical innovation involves risk and significant costs, while at the same time threatening sunk investments (Klitkou et al., 2015). Moreover, incumbent firms have limited internal incentives to address societal problems because they are related to common goods (Geels, 2011). Thus, radical innovation presupposes the imposition of policies and regulation, for instance the introduction of new industry standards, and/or changing consumer preferences which comprise economic opportunities (Bento and Wilson, 2016; Elzen et al., 2011).

Nonetheless, the literature on sustainability transitions sees incumbents as critical to accelerating transitions. Incumbents have the power to steer change in socio-technical transitions given aspects such as their massive market power, political leverage, and capabilities, which has also frequently been named as argument for the need to further understand incumbent engagement in sustainability transitions (Ramanauskaite, 2020; Van Mossel et al., 2018; Kattirzi et al., 2021; Magnusson and Werner, 2022).

#### **4.2.2 Incumbent engagement and entry timing in sustainability transitions**

Transitions literature has examined how and why incumbents reorient towards radical innovation (Penna and Geels, 2012; Geels and Penna, 2015; Wesseling et al., 2015; Smink et al., 2013). Holistically, studies have shown that incumbent engagement is largely influenced by civil society, policies and consumers where exogenous pressures coevolve to ultimately motivate incumbent engagement in new industries.

Most generally, in the literature on transitions incumbent entry timing is linked to a phase model in which incumbent engagement follows a stepwise procedure. In these models, during niche emergence, incumbents lobby against novel technologies and work to denounce their market readiness. In later phases, incumbent engagement is largely provoked by government coercion. Several studies have found that it is not until governments impose strict regulations which aid the development of new technologies that incumbents move-in (Geels and Penna, 2015; Wesseling et al., 2015; Smink et al., 2013; Kungl et al., 2013). For example, drawing on institutional isomorphism, Bohnsack et al. (2020) make the argument that coercive pressures such as regulation trigger first-movers within group of incumbents to invest in sustainable product innovation which then gives rise to mimetic and normative pressures that make followers jump on the bandwagon. The authors highlight the importance of these ‘first-movers’ in exerting divergent behaviour which supports new sustainable niches and creates a ‘band-wagon’ of followers that ultimately accelerates a transition (Bohnsack et al., 2020).



In a similar light, Wesseling et al. (2015) reinforces the importance of government coercion on incumbent engagement in sustainability transitions. The authors find that in the automobile industry, incumbent car manufacturers were hesitant to engage with novel sustainable vehicles i.e., Zero emission vehicles (ZEV) until California policymakers introduced a strict ZEV mandate. Moreover, only after the appearance of the mandate incumbent car manufacturers were seen converting a small fraction of their fleet to ZEVs. The study further highlights that even though incumbents experimented with the new technology shortly after its appearance on the market, they continued to lobby against the new technology and due to reputational reasons and market unattractiveness quickly deserted their attempts to engage (Wesseling et al. 2015).

Also, studies on transitions in the energy sector have reinforced these points. For example, Smink et al. (2013) show that incumbents did not engage with biofuels until the appearance of the 2003 EU (European Union) Biofuel Directive which made the blending of biofuels obligatory in the fossil fuel and international commodity industry. Even thereafter, the authors highlight incumbents' use of institutional strategies to keep the biofuel market as small as possible (Smink et al., 2013). Kungl (2015) show that incumbents in the transition towards renewable energy in the German energy sector were strongly influenced by the appearance of government interventions such as the 1998 revision of the Energy Act and the Renewable Energy Sources Act. The authors highlight that it took over a decade for large incumbent energy companies to stop opposing renewables and to engage with novel energy technologies (Kungl, 2015).

Overall, the literature on incumbent entry and incumbent entry timing in transitions highlights incumbents as followers as opposed to newcomers in sustainable niches (Geels and Penna, 2012; Smink et al., 2013; Wesseling et al., 2015; Geels and Penna, 2016; Geels and Penna, 2015). Moreover, current literature posits that incumbents do not introduce radical innovations first but engage when exogenous pressures leave them no choice to move and follow into niches. Entry timing and engagement is thus regulated by the introduction of regulatory mechanisms which coerce incumbents to engage in novel technologies (Geels and Penna, 2012; Smink et al., 2013; Wesseling et al., 2015; Geels and Penna, 2016; Geels and Penna, 2015).

In contrast, more recent studies on entry timing and incumbent engagement have also shown incumbents can 'go first' and start engaging in sustainable niches without coercion. For example, Turnheim and Geels (2019) make the argument that incumbents can act as 'first-movers' and accelerators of transitions when they do not operate in the threatened regime. Moreover, the scholars highlight that, opposed to studies in the transport and energy sector, in the emergence of common trams in France, incumbents have been driving the development of the industry. Notably, however, their operations

and established competencies were not directly threatened by the new technology (Turnheim and Geels, 2019). To conclude, these divergent findings spark many questions about incumbent engagement in sustainability transitions:

Firstly, the dominant 'phase-model' views of incumbent engagement with niche technologies cannot explain why some incumbents may move-in to new industries more quickly and act as enablers of sustainability transitions. Moreover, existing models have focused largely on the 'formative' phase of sustainability transitions where novel technologies require monetary, technological, and institutional mechanisms for protection (Geels, 2021; Markard et al., 2020). In the diffusion phase, however, technologies are increasingly intertwined with common practices, routines, and wider society which may result in incumbents engaging earlier in transitions (Markard et al., 2020; Geels, 2021). Thus, scholars highlight the importance of a deeper understanding of incumbent entry timing as novel sustainable technologies exhibit far more traction with regards to consumer demand, institutional readiness, and regime engagement (Markard et al., 2020; Geels, 2021).

Secondly, with regards to the group of incumbent firms, these models do not distinguish between types of incumbents. Thus, it remains open whether a firm's position in the value chain influences its decision to engage with a new technology (Steen and Weaver, 2017). Existing models stress the 'monolithic' nature of incumbency in which incumbents are holistically seen as defensive regime actors. Thus, the literature on incumbents in sustainability transition has called for more insight into 'pluralising' incumbencies (Turnheim and Sovacool, 2020). In other words, scholars have stressed the need for a deeper understanding of the heterogeneity of incumbent actors (Steen and Weaver, 2017; Van Mossel et al., 2018; Berggren et al., 2015; Magnusson and Wener, 2022).

Thirdly, these existing studies of incumbents in transitions also do not examine in depth how incumbents engage when they do. Moreover, we posit that the manner in which incumbents engage e.g., through investments or new products is also crucial to understanding incumbent engagement in new industries and incumbent impact on transitions overall. We thus aim to strengthen the literature on incumbent engagement in transitions by examining incumbent entry timing dynamics, entry modes, and type of incumbent organization.

Organizational literature has been increasingly recognized as fruitful tool for understanding why incumbent firms may exert heterogenous behaviour when engaging in transitions. It offers explanations for why some firms may be incentivized to engage more quickly than others (Van Mossel et al., 2018). Therefore, we combine literature on

incumbent engagement in transitions with literature on organizations to better capture both incumbents' terms of engagement and engagement strategies.

### **4.2.3 Explanations on incumbent entry modes and entry timing in the organizational literature**

To deepen insights on incumbent engagement in transitions we complement literature on transitions with literature on firm strategies, especially entry modes and entry timing. Recent transition studies have brought insights from organizational and strategy theories to the transitions field in order to examine micro-level explanations of incumbent behaviour (e.g., Planko et al., 2016, Van Mossel et al., 2018; Werner et al., 2022). These scholars have argued that the role of incumbent actors in transitions is under-conceptualized and have highlighted the importance of organizational literature to explain which factors (exogenous and firm-specific e.g., capabilities, competitive advantage) may cause heterogenous behaviour by incumbents in transitions (Van Mossel et al., 2018).

Like literature on transitions, organizational literature in general has long recognized that large and incumbent firms have little incentives to engage early with new products and markets, not only due to sunk costs and existing resource and capability configurations, but also because incumbents meet behavioural barriers (routines, procedures) and cultural-cognitive barriers (industry mindset, core beliefs) that keep them from sensing and seizing radical innovation (Teece et al., 1997; Christensen, 1997; Dosi, 1982; Nelson and Winter, 1982). However, this literature also portrays a mixed picture, as it recognizes why incumbent firms may deviate from this pattern and engage early in new markets.

A key factor in explaining early incumbent response is the possibility to reap first-mover or follower advantages (Lieberman and Montgomery, 1988; Suarez and Lanzolla, 2007). For example, the literature on first mover and follower advantages holds that pioneering firms can achieve first-mover advantages in terms of economic profit. In a growing market, incumbents may move into niches before new entry becomes profitable, to establish their position in market space (Lieberman and Montgomery, 1988). Also, firms may choose to follow in order to reap additional benefits as first-movers have often already made large investments in the new technology which results in less uncertainty. Furthermore, followers can benefit from a rapid growth phase, in which they use their capabilities e.g., distribution channels and marketing tactics, to gain a foothold in the market (Lieberman and Montgomery, 1988).

Recent literature has also considered these dynamics in the specific context of sustainable innovation. Such work has, for instance, shown that both newcomers and incumbents are important for the sustainability transformation of markets (e.g., Hockerts and Wuestenhagen, 2010; Schaltegger et al., 2016). Hereby the interaction between these

firm types is interesting as studies show that incumbents often copy business models of newcomers when they enter sustainable niches. On the other hand, studies also make the claim that incumbents and newcomers are so fundamentally different that incumbents cannot simply copy new business models. For instance, Schaltegger et al. (2016) explore the co-evolution of business models of sustainable start-ups and incumbents. They find that incumbents engage in sustainable markets through four strategies: growth, replication, mimicry and or mergence. Growth refers to processes which aim to scale sustainable business models that are developed within the own organization. Replication refers to the replication of pioneering business models and technologies by other firms, individually or though collaboration and partnerships. Mimicry refers to the copying of sustainability pioneers within the constraints of existing business models. Finally, mimicry and mergence refer to the integration of sustainable niche players into organizations through e.g., acquisitions, friendly or hostile take-overs. Similarly, Perreira et al. (2021) identify sustainable energy related activities of incumbent energy utilities by investigating activities of incumbents which aim to either add novel activities to their business model, link activities in novel ways, or change the actors involved in performing any activities. They conceptualize the modes by which incumbent can enter into sustainable niches as mergers and acquisitions (M&As), joint ventures (JVs), and strategic alliances (SAs).

This directs attention to the entry modes that incumbents chose to engage in sustainable niches. In the international business literature entry modes is a common concept used to refer to the international activity of firms. Entry modes are defined as e.g., exports, contractual modes, joint ventures, wholly owned operations (Werner, 2002). Generally, the international business literature conceptualizes firm engagement as a step-wise process in which entry modes are characterized in terms of 'commitment' to new markets (Ferreira and Serra, 2008; Mori, 2021; Dong et al., 2008; Penderson and Penderson, 1999). The literature highlights that firms aim to reduce uncertainty when engaging in foreign markets. Thus, firms may engage in a step-wise manner beginning with low-commitment entry modes e.g. exports and gradually move to more high-commitment forms of entry e.g. wholly-owned operations (Ferreira and Serra, 2008; Ashan and Munsteen, 2011). Also, international business literature has highlighted the importance of firm-specific factors in engagement in new markets. Furthermore, literature has shown that based on individual firms e.g., experiences, capabilities and organizational culture, incumbents may diverge in their entry modes (Mori, 2021). The literature has attributed incumbents' quest for 'control' as a factor motivating entry mode choice in new industries. Because firms seek to control new markets and without control cannot, for example, coordinate their activities internationally, they may engage in high-commitment entry modes despite the presence of high risks (Dong et al., 2008). Finally, the literature on firm entry modes has suggested that firms may diverge from a step-wise manner of engagement to deploying 'mode additions' and 'within-mode changes'. For example, within mode changes are when a

firm does not change its prevailing entry mode, but instead expands its current activities. Mode addition refers to when a firm engages in a new entry mode yet also continues to deploy its current mode of entry (Penderson and Penderson, 1999). Thus, entry mode choice is not static and can also be conceived as a portfolio of activities.

Concluding, strategy and international business literature highlights that firm engagement and entry timing is influenced by both firm-specific and exogenous factors. We use the term “entry mode”, not to refer to activities of firms entering foreign markets, but to investigate entry modes in sustainable niches. In the following, we aim to investigate the heterogeneity of incumbent engagement and entry timing in the plant-based protein industry by drawing on this concept.

## 4.3 Method

### 4.3.1 Design and case selection

We investigate incumbent firms' entry modes in meat substitute markets in the United States (US), the Netherlands (NL), and the United Kingdom (UK) markets. We choose to study entry modes in meat substitute markets for two reasons. First, because plant-based meat substitutes aim to disrupt meat markets and often depict negative impacts associated with animal products, resistance could be expected from incumbents, particularly meat processors. However, in the case of meat substitutes, incumbents have been pivotal in transforming meat substitutes from a minority niche into an established segment in food markets (Tziva et al. 2021; Lonkila and Kaljonen, 2022). As this contrasts what current theory would predict, the protein transition case could offer interesting insights into alternative explanations of incumbent behaviour in transitions. Second, diversification towards plant-based protein products has become a key component of strategies of giant food firms and meat processors, such as Nestle, Unilever and Tyson (FAIRR, 2020). Other incumbents across the supply chain of meat substitutes, such as retailers and food service firms also increasingly introduce meat substitute products in their stores and menus. Therefore, the protein transition case allows for the study of several instances of entry modes of different types of incumbent firms.

We adopt a multiple case study approach in the USA, the Netherlands, and the UK. A multiple case study approach is useful in analysing the data both within each situation and across situations (Yin, 2003). Therefore, results of multiple case study research offer higher potential for generalizable results (Gustafsson, 2017). By exploring cases in three of the fastest growing markets for meat substitutes globally, we focused on cases that offered a high probability of observing the phenomenon of interest. On top of this, pioneering new entrants, such as Beyond Meat, Impossible Foods and the Vegetarian Butcher, operate in

these three countries. Therefore, the cases also allowed the study of the co-evolution of new entrant and incumbent entry modes.

### 4.3.2 Data collection and analysis

To identify incumbent entry modes, we conducted a qualitative event-history analysis of events relevant to high visible incumbent entries in the plant-based protein niche in the USA, the Netherlands, and the UK between 1990-2020. Empirical data for the event analysis were collected through the Lexis Nexis Database. Lexis Nexis is a database which collects news, legal and business information from thousands of prints and online international and national news sources (Negro et al., 2008, Hekkert and Negro, 2008). Nevertheless, the databased mainly includes events from mainstream media and therefore some more low-profile events may not have been included. However, we posit that due to the substantial number of events in our database we provide an accurate overview of highly visible, i.e., the most important, incumbent entry modes in the protein transition.

For the USA and NL case, we used a set of predefined keywords. This included the terms meat substitutes, plant-based protein, protein transition and protein innovation, in order to identify events across all sources in the database. For the UK case, we, again, used a set of predefined keywords. However, we focused primarily on three sources including the online archives of the print version of the Guardian (London) and the Times (London) and the online version of the Telegraph (telegraph.co.uk), also accessed through the LexisNexis database, in order to narrow down results of the search. Generally, we used the Boolean operator "OR" to compile all available data relating to the protein transition. Moreover, specific terms were included for country. For example, the term "plant-based meat" was used in the United States case and the term "protein transition" was used in the Netherlands case as they are common terms used to describe the shift from animal proteins to plant-proteins in these countries.

A database was compiled which included 677 events relevant to incumbent entry modes in the three countries. To analyse the results, the researchers employed an abductive coding method. First, concrete events reported in sources, such as M&As and investments, were identified. Next, also incumbent activities, such as the announcement of new corporate strategies, were extracted in order to provide contextual information for the cases. Events were then coded, and the different events aggregated under entry mode labels, using labels existing literature offers to describe entry modes. A set of 5 entry modes, described in table 4.1, was finally used to analyse the case. Once all the events in the database were re-coded along these 5 categories a sample of the events was sent to an independent researcher. Thereafter, an intercoder reliability check was performed. Codes that were contested were then discussed with the researchers and an agreement was made.

**Table 4.1. Description of selected codes for incumbent entry-modes in sustainable markets**

Entry mode code	Definition	Example of events coded
New product	The introduction of new product or the expanding of existing operations e.g., scaling, within an incumbent actor	Retailer Sainsbury's has trademarked a meat substitute product
Collaboration/Co-promotion	Collaborative efforts between incumbent actors and new entrants e.g., joint R&D, joint promotion of products	Retailer Jumbo introduces new entrant's Vegetarian Butcher products
New brand or product line	The introduction of new brands by incumbent actors	Meat substitute brand Vales is established by food firm Friesland Campina
Merger & Acquisition (M&A)	The integration of new entrants through e.g., acquisitions, joint ventures in incumbent actors	Food firm Nestle USA acquires new entrant Sweet Earth Foods
Investment	Investments of incumbent actors in new entrants	Meat processor Tyson invests in new entrant Beyond Meat

In addition, to develop an overall understanding of the cases and explore how contextual developments affected incumbent entry modes, we also included secondary data on the chronological occurrence of new entrants, important technological developments, market developments, and other trigger events for incumbent entry modes. Particularly, we drew information from Tziva et al., (2020;2021) and Bulah et al. (forthcoming) which are studies that already provide detailed timelines regarding the development of the protein transition, mainly in the Netherlands and the United States.

In order to analyse the results, we employed a process-tracing approach, which is an approach suitable for the analysis of event data that are of a temporal sequence (Langley, 1999; Brady and Collier, 2010). First, in order to reduce the complex mass of information we analysed the data according to the selected entry mode codes and types of incumbent actors. We chronologically ordered and counted codes, which made us recognize initial patterns of incumbent entry modes. Concretely, we observed two distinct temporal phases of low and higher engagement of incumbents (1990-2006, 2006-2020). Therefore, we decomposed the information into two successive "temporal phases" in order to break down patterns and connections between entry modes.

After the initial analysis we chose four types of incumbent actors to include in our results: 1. food firms, 2. meat processors, 3. retailers, 4. food service. Firstly, food firms i.e., food businesses dedicated at the production, processing and distribution of food product were chosen because they represent a collective of diverse firms which is central in determining the multiple food choices in the current food regime. Thus, entry modes of incumbent

food firms are key in understanding the reorientation of industry in the protein transition. Second, we chose to separately analyse incumbent meat processing firms because they represent the food industry actors with “more to lose,” e.g., in terms of sunk investments in the meat industry. Finally, in order to advance the understanding of incumbent behaviour in transitions by investigating multiple types of incumbent actors, we also chose to analyse retailers and food service firms. The entry modes of these intermediary actors, which sit between the industry and consumers, are important in understanding selection pressures on the industry and explaining the overall evolution of incumbent behaviour. Finally, we zoomed-in on case examples of specific incumbent actors to verify the broad patterns we observed and understand them in context. While it is beyond the scope of this paper to present these descriptions in full, based on this analysis, we provide several examples to illustrate important variances between and within entry modes.

## 4.3 Results

### 4.3.1 Entry mode timing dynamics in context

Plant-based meat substitutes have existed in European and USA markets for decades. To conceptualize technological development in the meat substitutes sector we distinguish between first-generation and second-generation products. During the early 1990 s, the meat substitutes industry was mainly comprised by a few firms which offered first generation products, a narrow assortment of plant-based meat substitutes based on available processes and ingredients, for example tofu. Second generation meat substitutes started reaching markets in the early 2000s due to advancements in extrusion technology, such as the introduction of high-moisture cooking extrusion, and the deployment of processes from other sectors, such as the utilization of hydrocolloids. Second generation products more closely resembled the taste, texture, and appearance to animal meat. In recent years, a few pioneering processing firms which processed and marketed second generation products, as well as innovation across the supply chain of plant-based protein, have contributed to the availability of a large assortment of higher quality meat substitutes which aim to mimic animal meat.

The popularity of meat substitutes over the years has risen exceptionally and has grown hand in hand with increasing interest in vegetarian, flexitarian, and vegan diets. Moreover, these changes in consumer preferences have been sparked by increasing awareness of animal welfare, health, and environmental sustainability. Retail sales of meat substitutes in Europe have risen by almost 10% per year between 2010 and 2020 (ING, 2020). According to sales data from the US, dollar sales of plant-based meat grew 19% in 2018 and 45% in 2019 (The GFI, 2020). Additionally, in 2020 plant-based meat substitutes grew 152%



over the prior year for the week ending March 15, while animal-based meat grew only 80 percent over 2019 for the same period (GFI, 2020).

In terms of incumbent entry modes, two temporal phases can be distinguished. Figure 4.1 illustrates the chronological development of incumbent entry modes in reference to the initial occurrence of new entrants and important contextual and technological events.

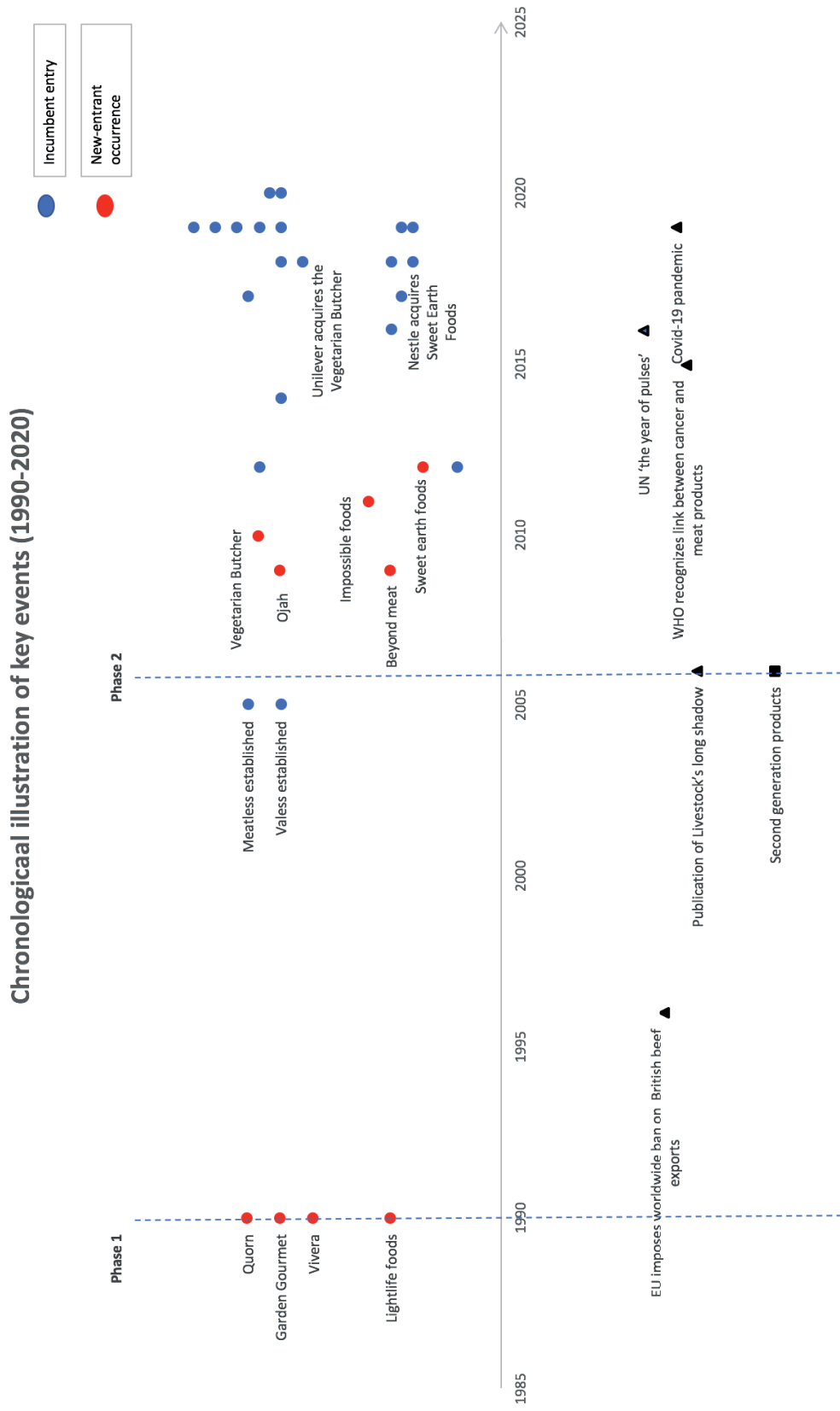
**Phase 1:** In the first phase, (1990-2006), crises related to livestock supply chains, most notably the (Bovine spongiform encephalopathy) BSE crisis, had led to periods of increased public concerns over health and safety aspects of livestock products and jolts in the small markets for meat substitutes. Individual incumbents were incentivized to introduce new plant-based brands to pre-empt market space and/or address potential issues in the resilience of livestock supply chains. Two important examples are Valess which was established by the Dutch dairy giant Friesland Campina and Meatless which was established by a firm originating from the meat processing sector. Nevertheless, the sector remained very small, other incumbent entry modes were very limited and/or short-lived. For example, food firm Unilever had participated in a joint research project which aimed to deliver knowledge on meat substitutes based on peas. However, no notable commercially oriented projects followed (Quist, 2007).

**Phase 2:** In the second phase (2006-2020), the influential publication of the “Livestock’s Long Shadow” from the Food and Agricultural Organization (FAO) of the UN (Steinfeld et al., 2006), which estimated the contribution of livestock agriculture to climate change, marks the start of growing awareness on the adverse environmental impacts of the livestock sector. Around the same time, a few pioneering new entrants explored new processes and ingredients for the development and commercialization of second-generation meat substitutes. From 2009 onwards, food firms including Ojah and the Vegetarian Butcher in the Netherlands and Beyond Meat, Impossible Foods and Sweet Earth Foods in the USA, introduced novel second generation products. These new entrants were key to the beginnings of rapid growth of the meat substitutes market in the US, UK, and NL as they offered base ingredients for several incumbent firms. Almost immediately after their appearance, prominent incumbent retailers, such as Whole foods, quickly launched these products in mass markets.

In 2015, rising concerns over the health impacts of meat and dairy (over)-consumption rise in public discourse. An important contextual development was initiated by a study published by the World Health Organization (WHO) which identified a link between certain types of cancer and particular processed meat products (WHO, 2015). This resulted in increasing public awareness of the negative effects arising from of meat consumption and as a result, the popularity of vegetarian, flexitarian and vegan diets started rising.

These contextual developments were also followed by increasing awareness of the potential of second-generation product technology. Giant food firms, such as Unilever, Nestle as well as meat processors such as Tyson, became engaged in the plant-based sector by several investments in new entrants and high-profile acquisitions. By 2019 two of the most established incumbents, Nestle and Tyson introduced their own plant-based burgers and major fast-food chains, including Burger King and Taco Bell started including popular meat substitute products in their menus. Table 8.3 in appendices illustrates the most visible events between 1990-2020 in a chronological order.

Figure 1. Chronological illustration of key new entrant occurrences, incumbent entry modes and events, in USA, NL and UK markets (1990-2020)<sup>45</sup>



4 Figure 4.1 is not a comprehensive depiction of all relevant new entrant occurrences, incumbent entry modes and events. Figure 4.1 illustrates the (approximate) date of the establishment of firms.

5 Prior to 2017 Garden Gourmet was called Tivall

Overall, it becomes apparent that after the occurrence of pioneering new entrants and growth in markets for meat substitutes, incumbents moved in the sector fast. Key events that seem to have shaken up the industry in the Netherlands were the introduction of Ojah, a firm producing intermediary meat substitute products, and the launch of the Vegetarian Butcher, a brand which commercialized Ojah's products. In the USA, key events were the occurrence of meat substitute firms Beyond Meat, Impossible foods, and Sweet earth. Retailers engaged with the industry most quickly in efforts to pick-up these newcomers' novel products. For example, we observe that in the Netherlands, it took only two years for the major retailer Jumbo to launch the Vegetarian Butcher's products. Shortly after, second mover Albert Hein followed suit and also quickly introduced the Vegetarian Butcher products in stores. In the US, we observe that the first mover was even more agile. Whilst founded in 2009, Beyond Meat only introduced its first commercial product in 2012 and within months the newcomer announced its partnership with Whole Foods. Quickly following, second mover and major retailer Walmart announced the launch of Beyond Meat frozen products in 2015.

Whilst retailers are observed as being 'frontrunners' in engaging with plant-based meat substitutes, we also observe that food firms and meat processors were rather quick to engage. Notably, in 2010, less than one year after the appearance of the Vegetarian Butcher, Unilever announced its R&D endeavours in plant-based proteins. In the US, however, we see that food firms take relatively longer to engage. However, when they do engage, this is directly with the introduction of multiple new products or product lines. For example, in 2018 Kellogs visibly launched two new meat-free burgers, a vegetarian chorizo, and meatless chicken nuggets. Less than a year thereafter, Nestle launched meat-free pizzas under its Sweet Earth Foods brand.

For meat processors, even more strikingly, it took only two years for the first firms to engage with meat alternatives. Given sunk costs and heavy asset base in the meat processing industry, this seems exceptionally fast and at odds with what theory predicts. In the Netherlands, for example, we observe that already in 2012, less than two years after the appearance of the Vegetarian Butcher in the Dutch market, Vion, a prominent Dutch meat processor with nearly 30 meat producing factories spanning across the Netherlands, Belgium, and Germany, introduced minced meat substitutes. In the US, only five years after

the emergence of Beyond Meat, Tyson Foods, one of the world’s largest meat processors also introduced its own line of plant-based bowls.

These first movers were also quickly followed by other meat processors. Notably, these forms of entry modes were largely influenced by the introduction of semi-finished products. However, this required a monumental “identity shift” as these incumbents were most known for their vast and ever-growing portfolio of meat products. Furthermore, diverging from this image was largely unheard of.

In all countries, results indicate that food service incumbents are the most hesitant to move into the market. However, once the first food service incumbent moves in, others quickly follow. Specifically, within months. In the US, BurgerFi, a fast-casual burger restaurant, introduced the Beyond Burger five years after Beyond Meat’s first product. Only three months after, in 2017, TGI Fridays, popular American rib and burger house, announced the addition of Beyond Meat products to the menu at several of its US locations. Similarly, in the Netherlands, fast-food chain Smullers launched its first vegetarian burger in 2018 and less than one month after, Febo, also introduced its first vegetarian burger.

The following table (4.2) shows for selected, highly visible events, how long it took until the first incumbent responded to a new entrant. The table further indicates how long it took the second incumbent to ‘jump on the bandwagon.

**Table 4.2. Incumbent first mover and follower response times in reference to the occurrence of new entrants in the Netherlands, United Kingdom, and United States markets**

UK-NL	Retailer responses			
New entrant occurrence	First mover	Time lag between first mover – new entrant	Follower	Time lag between follower – First mover
Ojah (2009) Vegetarian Butcher (commercialized Ojah products in 2010)	Retailer Jumbo introduces Vegetarian Butcher products (2012)	2 years	Retailer AH introduces Vegetarian Butcher products (2014)	2 years
<b>Meat processor responses</b>				
	Vion Food Netherlands introduces minced meat products (2012)	2 years	Meyn Food Processing joins collaborative effort to develop meat alternatives (2017)	5 years
<b>Food service responses</b>				



UK-NL		Retailer responses		
New entrant occurrence	First mover	Time lag between first mover – new entrant	Follower	Time lag between follower – First mover
	Smullers offer vegetarian burger (2018)	9 years	Febo offers a vegetarian burger without meat (2018)	<1 month
Food firm responses				
	Unilever begins R&D into plant-based proteins (2010)	<1 year	Bobeldijk join Green Protein Accelerator to accelerate market introduction of plant-based products (2016)	5 years
USA				
Retailer responses				
Beyond meat (2009)	Retailer Whole Foods introduces Beyond meat product (2012)	<6 months	Retailer Walmart introduces Beyond meat products (2015)	3 years
First Beyond meat commercial product (2012)				
Meat processor responses				
	Tyson Foods develops protein bowls made with plant-based proteins (2017)	5 years	Don Lee Farms launches Organic Plant-Based Raw Burgers (2018)	<1 year
Food service responses				
	BurgerFi tests Beyond meat at 8 locations (2017)	5 years	TGI Fridays adds Beyond Meat to the menu at several locations (2017)	<3 months
Food firm responses				
Sweet Earth Foods (2011)	Kellogg's launches two new vegetarian products (2018)	<8 year	Nestle launches meatless pizza and lasagne with Sweet Earth's Awesome Grounds (2019)	<1 year

The timeframe between the establishment of new entrants and entry modes of incumbents is between 2-10 years. In addition, a few short years after the mass introduction of second-generation products in major retail stores, food firms and slaughterhouses/meat processors started engaging with new entrants. In fact, between 2015-2021 meat substitute firms discussed in this section received investments from incumbents or were part of M&As. We observe that between 2015-2021 major incumbent food firms mainly

deployed M&A's as an entry mode. Moreover, instead of introducing their own products/ product lines, food firms are observed directly taking over new entrants (Table 4.3). For example, in 2017, only 6 years after the company was founded, Nestle USA acquired new entrant Sweet Earth Foods.

**Table (4.3). Most visible examples of investments and M&As in NL-UK, USA markets (2015-2021)**

Year	Entry mode	Description
2016	Investment	Meat processor Tyson invests in 2nd generation new entrant Beyond meat
2017	M&A	Food firm Nestle USA acquires 2nd generation new entrant Sweet Earth Foods
2018	M&A	Food firm Kerry group takes majority share in 2nd generation new entrant Ojah
2018	M&A	Food firm Nestle acquires meat substitutes Garden Gourmet
2018	M&A	Food firm Unilever acquires 2nd generation new entrant the Vegetarian Butcher
2021	M&A	Meat processor JBS acquires meat substitutes firm Vivera

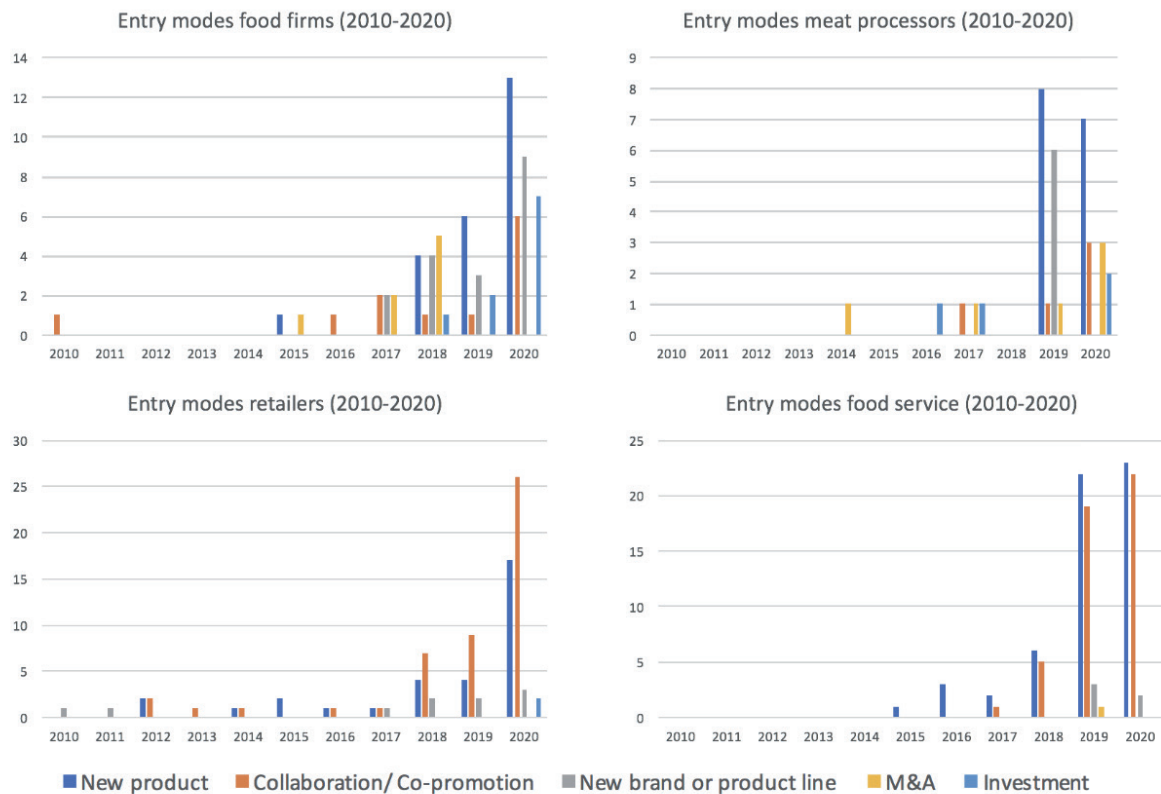
With regards to meat processors, in 2016, the largest poultry processor in the United States acquired a 5% stake in new entrant Beyond Meat. Not long after the incumbent increased its stake to 10%. Finally, in 2021 the worlds' largest meat processor JBS acquired Vivera for over 300 million euros. Furthermore, these high-stake forms of engagement convey the agile nature of incumbents.

Nonetheless, we observe a clear difference in entry modes both based on firm types and types of entry modes deployed. While food firms and meat processors do take longer to engage with new entrants once they do so this is immediately with a newcomer takeover or high-stake equities further signifying the growing potential of the plant-based meat alternative industry. Food service firms, however, take the longest to engage and deploy only low-commitment strategies. This is striking, as to engage with the plant-based meat substitute market these incumbents must merely adopt a plant-based alternative which is arguably less challenging. Nevertheless, these firms are most hesitant.

Concluding, this section introduced incumbent entry modes in reference to the occurrence of new entrants and contextual events. In the following section we focus on the various entry modes per four types of incumbent organizations: food firms, meat processors, retailers, and food service firms.

### 4.3.2 Entry Modes food firms, meat processors, retailers, and food service

Figure 4.2. Entry modes of food firms, meat processors, retailers, and food service in USA, NL, and UK markets (2010-2020)



#### I. Retailers

Despite the early engagement of retailers with meat substitutes, retailers almost exclusively employed entry modes characterized by non-equity and/or low control. Between 2012-2020, they increasingly introduced new available meat substitutes or expand private labels in order to introduce vegetarian/vegan versions of animal products. In addition, even in cases where retailers introduce their own meat substitute brands, they do so through private labelling, meaning they distribute products that third parties produce and thus, take on lower risk relatively to manufacturing food firms.

For example, Albert Heijn, one of the largest retail chains operating in the Netherlands and Belgium, has offered a limited range of meat substitute products for decades. After the emergence of new entrants in the second phase, Albert Heijn quickly enlarged its range of offered meat substitute products by introducing new brands in stores. Around the same time, Albert Heijn launched and expanded its own dedicated meat substitute ranges, such as the brand AH Vandaag Vegetarish (AH Today Vegetarian). However, because Albert Heijn's entry modes were mainly comprised by collaborations, the organization



could also easily discontinue brands and products that do not performed as expected and thus mitigate risk.

## **II. Food firms**

Contrary to retailers, food firms are observed employing a more diverse set of entry modes. Figure 4.2 indicates that food firms start to substantially engage with meat substitutes around 2017 and already rely on equity and high control entry modes. Particularly, in 2017 and 2018 incumbent firms engaged in several high-profile M&As, discussed in the previous section, and/or started launching their own meat substitute brands. Other entry modes, in the form of adding plant-based meat substitutes to existing product ranges or introducing brands and products to new markets, seem to chronologically follow M&As.

For example, Nestlé the largest food firms in the world, started to substantially engage with meat substitutes in 2017 with the acquisition of plant-based meat substitute producers Garden Gourmet and Sweet Earth Foods. Following these acquisitions, the company expanded the brands, as well as the product portfolios of its other existing brands to include new plant-based products. As the market and competition in the meat substitute industry grew, Nestlé's strategies also exhibited direct competition with new entrants. Particularly, the company was accused of trademark infringement by Impossible Foods, after launching the "Incredible" plant-based burger, because the two firms have had meetings in the context of a potential partnership.

As another example, in 2018, massive Dutch food firm Unilever acquired new entrant the Vegetarian Butcher. This was followed by a number of new product launches under the Vegetarian Butcher brand. Not long after, however, the food giant also began to experiment with meat substitute products under its own brand Unox. After almost a century of producing solely meat-based sausages, in 2019, Unilever announced that it would offer a new vegetarian sausage under the Unox brand, a move which signified the promising potential of the growing meat substitutes industry.

## **III. Meat processors**

Similarly, to food firms, overall, meat processors also engage in entry modes characterized by equity and/or high control. Figure 4.2 indicates that meat processors engaged in several M&As around the same period as food firms. However, meat processors' brand and product portfolios are significantly less diverse than large food firms. Therefore, relatively to food firms, whose entry modes indicate addition and diversification of operations, the coupling of meat processors' operations with the production of meat substitutes might ultimately lead to a form of cannibalization.

For example, Tyson Foods the largest American food company and a multinational meat processor, entered plant-based meat substitute markets with an equity entry mode, an investment in the new entrant Beyond Meat. Between 2016 and 2017 Tyson invested over 20 million dollars in Beyond meat acquiring a 5% stake at the company. Initially, Tyson remained reluctant to integrate meat substitute brands in the organization. However, similarly to Nestlé, as meat substitute markets and competition grew, the company also exhibited direct competition with new entrants. In 2019, the company announced the development of its own meat substitute brand and almost simultaneously sold its stake at Beyond meat.

#### **IV. Food service**

The food service industry seems to substantially engage with meat substitutes relatively later than the other types of incumbents. Figure 4.2 indicates that like retailers, food service firms also almost exclusively employ non-equity, low control entry modes. They either expand their menus to offer plant-based meat substitutes or collaborate with manufacturing firms to introduce products in their stores. Introductions of meat substitute products at popular global fast-food chains, such as the introduction of the Impossible burger in Burger King, start around 2018. Such fast-food chains initially conduct time-limited tests in specific locations before committing to introducing a meat substitute in a national market.

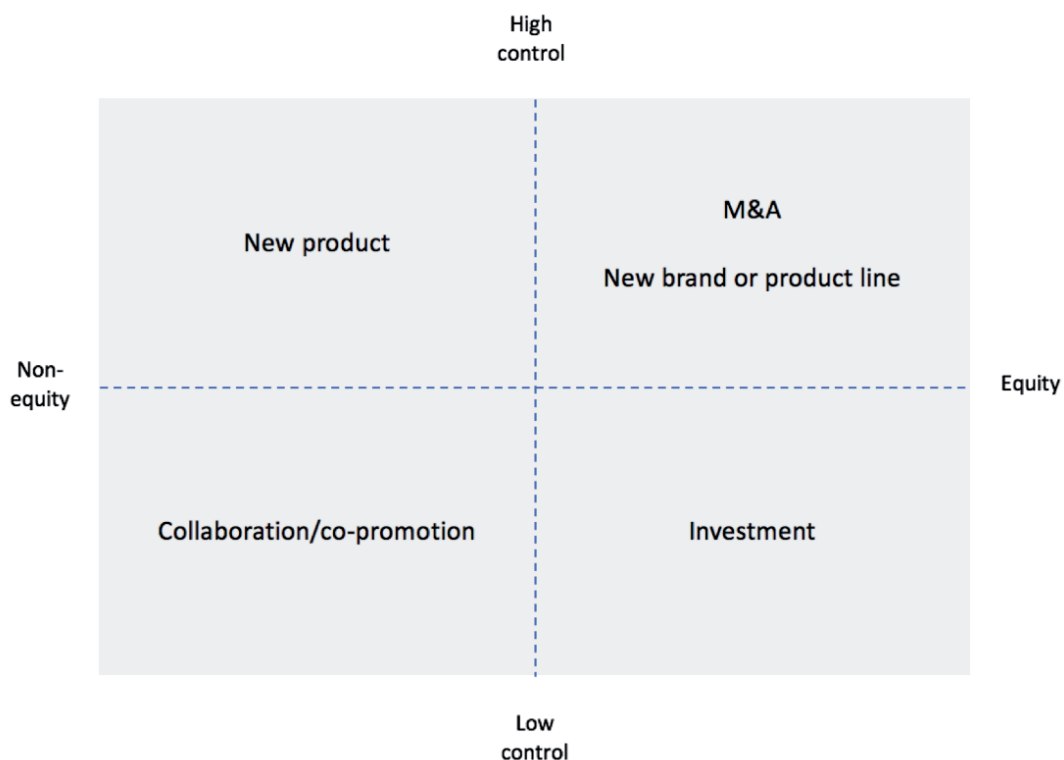
For example, McDonalds a multi-national fast-food organization with 40,000 locations across the globe, has made attempts with vegan and vegetarian products over the years, but has strayed away from incorporating plant-based meat substitutes in multiple markets until very recently. In 2018, McDonalds introduced a plant-based “chicken” burger made in collaboration with Valess in European locations. Around the same time, the company participated in several other collaborations, including a collaboration with Beyond Meat in USA, and Nestlé’s Garden Gourmet in Europe. However, these attempts were swiftly discontinued for different reasons, including lack of expected demand and the legal battle between Nestlé and Impossible foods. Nevertheless, as the market of meat substitutes continued to grow, McDonalds announced more collaborations. In 2020, McDonalds announced the introduction of the first McPlant and it was later revealed that it would be produced in collaboration with Beyond meat. Rollout tests in specific locations are expected in the coming year.

### **4.3.3 The co-evolution of high and low commitment entry modes across the supply chain**

While all the diverse types of incumbents studied in this paper increasingly engaged in the plant-based sector, they also employed distinctive patterns of entry modes. The most notable difference seems the ‘directness’ of commitment their activities indicate, for

instance whether their brand name becomes visibly associated with a meat substitute product, or whether they merely make a strategic investment in a newcomer. Drawing on the literature on entry modes in international business, entry modes can be characterized as high and low commitment modes according to level of control and whether they are equity or non-equity based (Ahsan and Musteen, 2011). We import these dimensions to classify the entry modes we observed in the case of incumbent responses' to the plant-based protein transition in NL, UK, and the US: A full acquisition is an equity entry mode which allows high control and can therefore be characterized as a high commitment entry mode. On the opposite side of the spectrum, collaboration/co-promotion entry modes, such as joint promotion initiatives, can be characterized as non-equity and low-control entry modes. They can thus be seen as low-commitment entry modes. The following figure (4.3) illustrates the level of commitment of the five entry modes we identified.

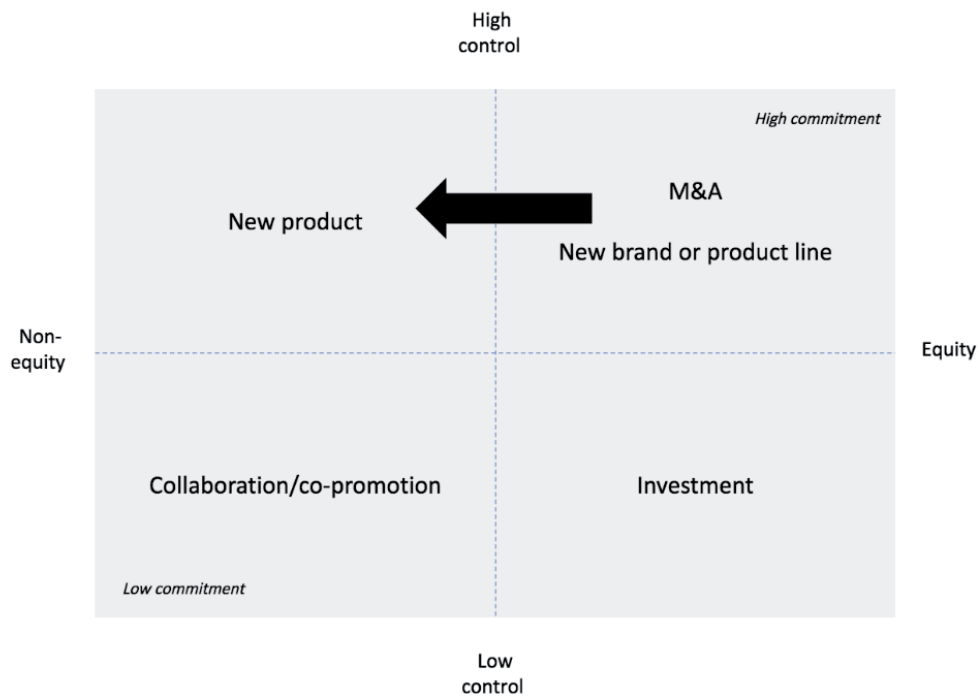
**Figure (4.3). High- and low-commitment entry modes of incumbents in the protein transition based on Ahsan and Musteen (2011)**



Next, we match this classification with the firm types and the evolution of their entry modes over time. Two patterns of entry modes can be distinguished. Figure 4 illustrates that food firms and meat processors predominately employ high-commitment entry modes and follow-up with lower commitment modes, such as expanding product lines by adding new products and introducing brands in new markets. This pattern indicates that

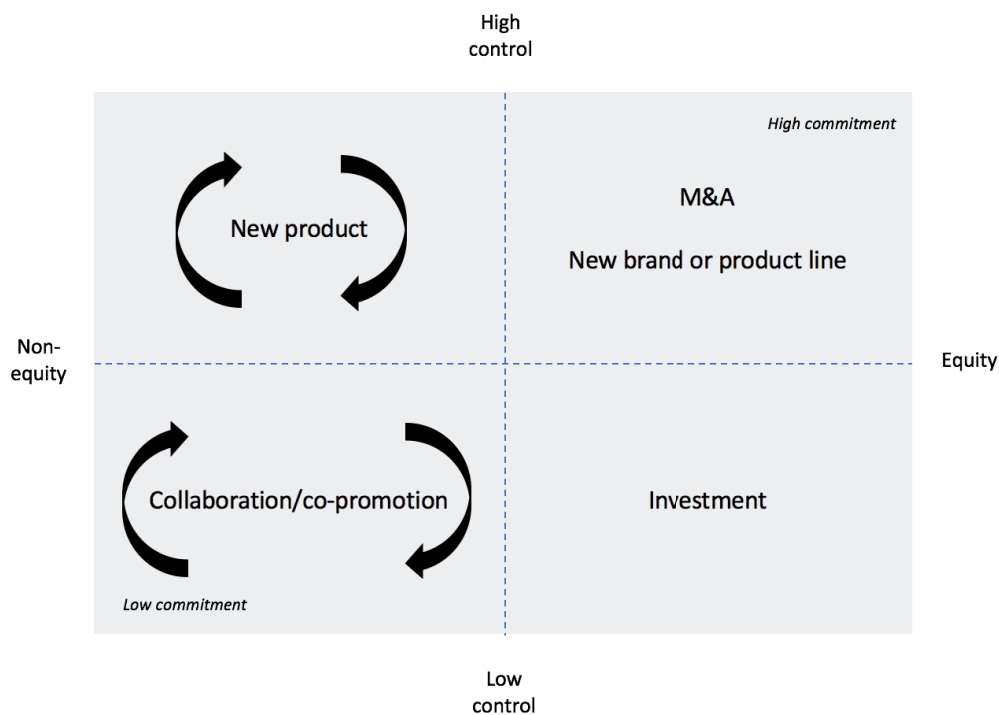
rather than relying on lower commitment equity modes, food firms and meat processors seek to further expand their engagement with the meat substitute sector.

**Figure (4.4). Entry modes food firms and meat processors**



Contrary to food firms and meat processors, retailers and food service incumbents almost exclusively pursue low commitment entry modes throughout the time period studied in this paper (Figure 4.5). This is coherent with the business models of these industries, as in general retailers and food service firms do not commit to their suppliers, through for example M&As. Nevertheless, because particularly retailers are the first type of incumbent firms to engage with meat substitutes and introduce products of new entrants in mass markets, these low-commitment, collaborative entry modes, might have served as market tests. Nonetheless, without the deployment of these low-commitment entry modes and their successful introductions the meat substitute industry might not have seen the entrance of food firms and meat processors which directly employ high-commitment entry modes.

**Figure 4.5. Entry modes retailers and food service firms**



In terms of food service incumbents, and particularly fast-food chains, like retailers, their entry modes remained low commitment. However, there is a difference between the visibility and cultural meaning of entry modes of fast-food chains and retailers. Retailers have diverse brand and product portfolios and therefore, the introduction of a new supplier can be seen as move with limited implications (cf. meat processors refurbishing entire machineries or buying new equipment). For food service firms, however, the brand is directly coupled to the products they offer. For instance, the brand of major fast-food burger chains is closely associated with a meat product, the burger. Such differences in visibility might explain the relatively late engagement of fast-food chains with meat substitutes, for example the introduction of the “Impossible Whopper,” which carries both the names of the Impossible foods and Burger King. Because such firms are ‘front-stage’ actors with a face to the customer and a brand coupled with meat consumption, they might be more hesitant to associate themselves with disruptive products.

## 4.5 Discussion and conclusions

This study aimed to explore incumbent engagement and entry timing in the plant-based protein industry. By investigating the cases of the Netherlands, UK, and the US we aimed to unravel how incumbents engage with plant-based meat alternatives and their terms of engagement in the diffusion phase. We also aimed to open-up the ‘black-

box' of incumbents by delving deeper into the type of incumbent organization and the engagement strategies per incumbent type. Current literature on sustainability transitions makes contradictory claims about incumbent behaviour in transitions. While some see them as opponents of change, others credit this actor group willingness to support change. While our study confirms that incumbents are not the first to enter sustainable niches, they do support a view of incumbents as proactive participants in transitions that do not wait-and-see or remain myopic. Our findings can thus support the set-up of a broader explanatory framework that resolves apparent contradictions about incumbents' role in transitions.

First, our findings clearly show that incumbent entry timing is not solely influenced by coercive pressures. In this case, regulation was still absent at the time incumbents became active. Much rather, our case indicates that entry timing is influenced largely by market demand and a 'bandwagon' effect that newcomer entry triggers. Moreover, in our case we observe that after the first incumbent moves in, several others seemingly follow the 'bandwagon.' This contrasts with early findings of incumbent engagement in transitions where regulation is a predecessor for incumbent engagement (Bohnsack et al., 2020; Geels and Penna, 2016; Geels and Penna, 2015; Wesseling et al., 2015; Smink et al., 2013). In the plant-based protein industry, we observe that almost directly after the appearance of newcomers' incumbents move in. Moreover, they work in conjunction with newcomers in order to gain increased market access for plant-based meat alternatives. This implies that in demand-based transitions incumbents may be more agile if they perceive market opportunities as significant.

Second, our findings corroborate earlier claims in the transition literature that incumbents and their strategies of engagement cannot be simplified to a monolithic block (Turnheim and Sovacool, 2020). In other words, when studying transitions, scholars must be wary of the heterogeneity of incumbents and how this heterogeneity may influence their strategies/terms of engagements. Diverse types of incumbent firms across the supply chain differ in their strategic responses in terms of commitment and the organizational literature offers explanations that can help to predict such differences. Overall, we observe that because the different incumbent organizations engage earlier or later with meat substitutes, a pattern from low to high commitment entry modes can be seen. Earlier entry modes are defined as collaborative efforts or the introduction of new products by retailers. The introduction of a novel product or providing shelf-space to a novel brand precedes higher forms of commitment, such as introducing an own product line. High commitment, equity-based entry modes, such as M&As, appear a few years later with food firms and meat processors leading the way.

Also, our case highlights that in addition to high commitment and low commitment entry modes, visibility and cultural meanings seem to play a significant role in incumbent engagement. For example, we observe that whilst food service firms mainly deploy low commitment entry modes and are the last to move-in, their terms of entry are coupled with giving the novel product strong visibility in the public. Thus, their entry modes may be interpreted as more impactful despite being characterized by low control and non-equity stakes. Our case shows that when food service firms collaborate with newcomers, they often reformulate their “star” products (e.g. Burger King introducing the Impossible Whopper). This is striking as their star products are often consumer favourites normally made from animal meat. This implies that whilst these incumbents deploy low commitment entry modes, their entry modes have strong reach as they are highly visible to the public masses. This comes in contrast to, for example, food firms which move-in rather quickly and with high-commitment. In comparison to food firms, such as Nestle or Unilever, which already contain a broad portfolio of products and brands, the entrance of food service firms may thus signify a significant step towards the transition to plant-based proteins.

Altogether, with regards to low and high commitment strategies we argue that in terms of importance both are critical in the diffusion phase of transitions. Whilst low commitment strategies may be deployed more easily, they reduce uncertainty for other incumbent types and thus, may lead to higher-commitment strategies. In our case, we observe that low-commitment strategies are mostly engaged in by retailers which do not have to commit significant resources to engage in the plant-based meat substitute market. Retailers are first seen adopting newcomer’s product lines and do not produce products themselves. Nonetheless, these low-commitment entry modes act as “test-beds” and incentivize other incumbents to join the industry. By acting as “test-beds” we observe that followers can engage in higher-commitment strategies. In other words, followers are largely seen introducing their own products/product lines which requires new capabilities, routines, and considerable investments in the novel technology. For example, we observe that whilst meat processors would be expected to be the last to ‘move-in’ these incumbents move in fairly quickly (between 2-5 years). Literature on incumbent engagement in transitions highlights that those with the most to lose will be more likely to continue developing and investing in existing regime technologies given aspects such as their technological know-how and set customer base (Geels and Penna, 2015; Geels, 2014). In other words, investing in novel technologies is associated with risk, uncertainty, and high switch over costs. In our case, however, we see that once retailers enter the plant-based industry, prominent meat processors quickly followed with their own plant-based products and thus a certain willingness for proactive cannibalization of their core product.

Third, regarding niche-regime interactions we observe that incumbents may not always act in accordance with new entrants. For example, we found that in some cases, while incumbent organizations engage with new entrants to promote niche innovations almost immediately after they appear on the market (e.g., through investments), they are quick to drop newcomers in support of their wholly owned operations. This, therefore, brings into question the strategic motives of incumbents and the transformative potential of their reorientation for the structure of industries and newly forming regimes. For the plant-based protein industry we observe that whilst incumbents first seem to work in synergy with new entrants, they later seek to control the market, and thus may disrupt transitions as new entrants are left on their own. Thus, further research could reconsider the impact that incumbent engagement strategies has on transition dynamics and newly forming regimes. Here, interesting questions emerge around the power that incumbents execute in transitions, in terms of keeping strategic control over newcomers, but also in terms of shaping dominant designs and business models.

With regards to policy implications, our analysis has shown that in the plant-based protein industry consumer demand plays a critical role. In transitions in the energy, water, and transport sector policies are usually targeted towards creating subsidies for novel technologies, feed-in tariffs, or taxing regime technologies (Geels and Penna, 2016; Geels and Penna, 2015; Wesseling et al., 2015; Smink et al., 2013; Wells and Nieuwenhuis, 2012). Judging from the case of the plant-based protein sector, however, we posit that policymakers would instead benefit from taking into account the type of markets where transitions take place. This is because in our case we see that the type of market directly influences the strategies of incumbents.





**CHAPTER 5**



# Plant-based protein products in the news: mind the gap between innovation and public discourses

This chapter is under review in PLOS Sustainability and Transformation as Tziva, M., Kalfagianni, A., Negro, S. O., & Hekkert, M. P. (2021). Plant-based protein products in the news: mind the gap between innovation and public discourses.

## Abstract

Markets for plant-based protein products are experiencing unprecedented growth. However, the extent to which the wider diffusion of plant-based protein products is beneficial to human and planetary health is still a contested issue in public discourses. The study of media frames for plant-based protein products can serve as a basis for approaches of technology assessment, which aim to inform actors involved in innovation processes of important aspects of diffusion, including controversy and unexpected risks regarding societal reactions. In this paper, we conduct a frame analysis of three U.K. broadsheet newspapers (the Telegraph, the Guardian, and the Times) between 2010–2020 to explore how media frame plant-based protein products. The results show that overall media coverage for plant-based diets has adopted a positive stance. However, there is variation in how plant-based protein products and particularly meat and dairy substitutes are portrayed. The biggest stumbling block appears to be potentially adverse health implications associated with the consumption of meat and dairy substitutes. We therefore argue that the scope of strategic choices regarding product design should also focus on the development of products analogous to whole plant-based foods. Moreover, we argue that the long-term resilience of the plant-based protein sector will require strategies that convincingly align with policy goals for food security and broader food system sustainability.

## 5.1 Introduction

Achieving food system sustainability is one of the most pressing contemporary challenges. Global food production and consumption, particularly of meat and dairy products, have significantly contributed to climate change and ecosystem degradation (Steinfeld et al., 2006; Hedenus et al., 2014). At the same time, all forms of malnutrition, including obesity and the associated noncommunicable diseases, have been estimated to constitute some of the most important risk factors for the global burden of disease (LPE, 2017). Consequently, the importance of diets in determining food system sustainability has become a widely recognized topic (IPCC, 2019; Willet et al., 2019). The recently authoritative EAT-Lancet Commission report on “healthy diets from sustainable food systems” highlighted the interlinkages between environment and human health and called for diets rich in plant-based foods and fewer animal source foods (Willet et al., 2019).

Plant-based protein innovation and the diffusion of plant-based protein products can contribute to accelerated change in consumption patterns towards plant-based diets and to wider transitions in the broader food system (Aiking and de Boer, 2020; Mylan et al., 2019; Tziva et al., 2021). In response to concerns about health and sustainability, markets for plant-based protein products are experiencing unprecedented growth. According to research from ING (2020), retail sales of plant-based protein products in the EU and the UK have grown by almost 10% per year between 2010 and 2020 and are expected to be able to maintain their growth. However, despite high growth rates, for the time being, meat and dairy remain the dominant protein source in Europe (ING, 2020). Therefore, the question is how to foster a broader transformation in which plant-based protein products acquire a larger market share and eventually replace a consequential share of global meat and dairy consumption, as well as capture some of the anticipated growing demand for protein (Henchion et al., 2017).

In this context, media can play an important role. Media frames for emerging technologies and products, such as plant-based protein products, not only reflect broad public discourses and societal expectations but also shape them (Hermwille, 2016; Lyytimäki, 2018). The study of media frames for plant-based protein products, then, can inform actors involved in innovation processes, such as technology developers, government agencies and civil society groups, of important aspects of diffusion, including controversy and unexpected risks with regard to societal reactions (Böschen et al., 2006; Kuhlmann et al., 2019). A media frame analysis can serve as a basis for approaches aiming to evaluate the broader dynamics of innovations and their trajectories (Kuhlmann et al., 2019; Matthews et al., 2019; Rip, 2018). The study of media frames can also inspire interventions that broaden technology development according to societal expectations and contribute to the embeddedness of innovations in society (Rip, 2018).

This is especially important in the case of plant-based protein products, which, despite the market growth noted earlier, have also been the target of critique. Indeed, whether the diffusion of plant-based protein products is beneficial to human and planetary health is still a contested issue (Sexton et al, 2019; Morris et al., 2019). First, recent advances in food science and manufacturing processes have led to an emphasis on the development of meat and dairy substitutes, plant-based products which mimic the taste and texture of livestock products (Tziva et al., 2020). However, currently, there is still uncertainty as to whether the substitution of livestock products with meat and dairy substitutes offers comparable nutritional or chronic disease reduction benefits, as with whole plant-based foods, such as legumes (Santo et al., 2020).

Hence, dominant innovation trajectories for the development of meat and dairy substitutes might contradict calls for a transition to “healthy” plant-based diets. Likewise, the environmental footprint of the various different meat and dairy substitutes, as well as their manufacturing processes and ingredients, can vary significantly (Grant and Hicks, 2018). Finally, adding to these critiques, there has been controversy over the legal definition of meat and dairy substitutes, which has led to a number of proposed measures that would ban substitutes from being referred to by the names of livestock products (Sexton et al, 2019; Morris et al., 2019).

Previous studies have not systematically explored media frames for plant-based protein products. Scholars have investigated narratives employed by academics and industrial firms (Lonkila and Kaljonen, 2021; Morris et al., 2019; Jönsson et al., 2019; Sexton et al., 2019), sustainability transition dynamics in the food system (Mylan et al., 2018; Tziva et al., 2019), and consumer acceptance and practices (Lemken et al., 2019; Schösler et al., 2012; Slade, 2018). Little is known regarding how plant-based protein products have been framed in media and what can be learned from these frames to further the development of plant-based protein products.

In this paper, we conduct a frame analysis of three U.K. broadsheet newspapers (the Telegraph, the Guardian and the Times) between 2010–2020. We identify frames for plant-based protein products to conceptualize the current broader dynamics of technological development and articulate recommendations for actors involved in plant-based protein innovation, in order to contribute to the embeddedness of innovations in society. Our research questions are formulated as follows:

*Which frames can be identified in media discourses regarding plant-based diets and plant-based protein products?*

*What can be learned from media frames about future plant-based protein innovation?*

In the following section, we briefly discuss media frames and their potential role in the development of plant-based protein innovation. We then describe the method employed for the collection and analysis of data. Subsequently, we present the results of the study. Finally, we discuss the results, and articulate recommendations for future plant-based protein innovation.

## 5.2 Media frames and plant-based protein innovation

The concept of framing originates from discourse theories, which are rooted in interpretive or social-constructivist traditions (Hajer and Versteeg, 2005). Such theories assume the existence of multiple realities and put emphasis on how language is used to socially construct those realities (Hajer and Versteeg, 2005; Scheufele and Tewksbury, 2007; Van Gorp, 2007). Frames in general are seen as structures through which people perceive physical and/or social phenomena and the way they communicate about them (Candel et al., 2014; Van Gorp, 2012). Hence, frames provide different socially constructed meanings to particular phenomena.

Frames in media are seen as the construction of the meaning of problems and solutions (Richardson, 2006; Van Gorp, 2007; Van Gorp, 2012). While making sense of particular issues, media take on a certain perspective against other alternatives (Richardson, 2006). They communicate selected meanings to problems, as well as their cause and solutions (Richardson, 2006). This has been defined as framing “to select some aspects of a perceived reality and make them more salient in a communicating context, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described” (Entman, 1993: 52). Media frames reflect broad public and political discourses, shaped by a heterogeneous set of actors (Boykoff, 2007; Boykoff, 2008). Because they influence perceptions, they significantly impact ongoing public understandings of societal problems, as well as associated emerging technologies and products, by making certain facets of an issue seem more important (Boykoff, 2007; Wilson, 1995; Lyytimäki, 2018; Sengers et al., 2010). For example, Lyytimäki (2018) illustrates how media frames for biogas produce overly optimistic impressions of the current significance of biogas, while at the same time do not challenge the centralized energy system.

Therefore the study of media frames for new technologies and products can inform actors involved in innovation processes, such as technology developers, government agencies and civil society groups, which issues and facets around these technologies and products are highlighted in public discourses and offer an indication of societal expectations and/or potential reactions. This information is relevant because the development and diffusion

of new technologies and products follows a non-linear cycle of activities, in which actors involved have limited control (Van de Ven et al., 1999; Van de Ven, 2017). They face a “flexibility” dilemma, meaning they may foreclose certain options of technology development at a moment when a sufficient knowledge is missing (Verganti, 1999). However, the adoption and diffusion of technologies and products is not up to them but contingent upon societal interests and expectations (Verganti, 1999; Rip, 2018). This “asymmetry” of timing, knowledge and/or power, between actors involved in innovation processes and outsiders, as well as experiences with former emerging technologies (e.g. genetically modified organisms, nuclear technology) which faced societal resistance, have highlighted the importance of reflexive approaches to technology assessment (Kuhlmann et al., 2019; Matthews et al., 2019; Rip, 2018). By employing insights from media frames analysis as input for such approaches, actors involved in innovation processes can navigate the aforementioned uncertainties and develop interventions that potentially contribute to the embeddedness of innovations in society (Rip, 2018).

In the next section of this paper, we present the method of this paper. First, we introduce how we collected data and then we discuss how we analyzed them to identify media frames for plant-based protein products.

## 5.3 Method

### 5.3.1 Data collection

Data from three U.K. national newspapers, the Telegraph, the Guardian (London), and the Times (London), were gathered. We chose to focus on one country, the UK, because the UK is one of the largest markets for plant-based protein products in Europe and therefore, we expect extensive media coverage (ING, 2020). We selected the most widely read “broadsheet” newspapers due to their high circulation and because they are seen as primary influencers of policy (Boykoff, 2008; Carvalho, 2007). Additionally, we chose three newspapers that are perceived as embodying diverse political ideologies to avoid merely exploring media frames employed from a single perspective. We accessed the online archives of the print version of the Guardian (London) and the Times (London) and the online version of the Telegraph (telegraph.co.uk) through the Lexis Nexis Database.

Terms used to identify plant-based protein products vary significantly (Lonkila and Kaljonen, 2021). To identify relevant material, we used a set of seven predefined keywords, including plant-based product/food, meat substitute, plant protein product, meat-free product/food, protein transition. Data were collected between 2010–2020 in order to accurately reflect the development of present-day discourses. We included both opinion pieces and reported material, such as articles found in news, environment, business, and



health sections. We chose to include both articles referring to meat and dairy substitutes and articles referring to plant-based protein products that do not necessarily aim to substitute livestock products; this allowed us to more comprehensively explore relevant frames. We excluded articles focusing on products other than food, such as bioplastics, articles on cultured meat and articles featuring food and restaurant reviews, recipes, or simply mentioning plant-based protein products. The complete dataset of articles studied in this paper included 574 items (Table 5.1).

**Table 5.1. Materials for the study gathered from three U.K. newspapers between 2010–2020**

Data source	Number of items included
Telegraph.co.uk	205
The Guardian (London)	234
The Times (London)	135
Total	574

### 5.3.2 Data analysis

In this paper, we employed an inductive approach in order to identify media frames regarding plant-based protein products. We conducted a frame package analysis, which facilitates the identification of a “cluster of logical organized devices that function as an identity kit for a frame,” which is also referred to as a package (Van Gorp, 2007:64). Thus, frame package analysis offers a heuristic tool of variables, framing devices, and reasoning devices that indicate the presence of a frame (Van Gorp, 20005; Van Gorp, 2012).

Building on Van Gorp (2007), Van Gorp and van der Goot, (2012) and Candel et al., (2014), first, we focused on exploring *reasoning devices* that reveal the argumentation of the articles. We studied each article to identify problem definitions, proposed solutions and non-solutions, as well as concepts that were deemed not possible, not desirable, or both. We explored the broader premises upon which each article proposed “to act” (e.g., environmental sustainability, health, animal welfare) and whether research items were characterized by an overall positive, negative, or ambivalent tone toward the transitions to plant-based diets and plant-based protein products. Moreover, in line with Candel et al., (2014), we identified *framing devices*, key concepts, and phrases used repeatedly, as well as metaphors used to support arguments, to better identify linguistic elements that indicated the presence of a frame. After the classification of reasoning and framing devices, we investigated the dataset in order to identify patterns that signified frames. We developed an initial code-book of 13 individuals frames. Afterwards, we studied each article again in order to determined which frame it employed. A single article could have involved more than one frame. Finally, we evaluated the initial frames and arrived at 15 individual frames (a detailed description of all frames can be found in the results section).

To facilitate the analysis and presentation of results, we grouped frames under the three broader scientific discourses around plant-based protein products and the tensions underlying these: 1. Health, 2. Environmental sustainability, and 3. Innovation trajectories. First, regarding health, studies explore whether and how plant-based protein products can mitigate the prevalence of certain chronic diseases and potential public health risks associated with the (over-) consumption of meat (de Boer et al., 2014; Kumar et al., 2017; Ritchie et al., 2018; Santo et al., 2020). Second, research focusing on meeting the rising global demand for livestock products with minimal environmental impacts, often exploring the development and diffusion of plant-based protein products as more efficient alternatives to livestock products (de Boer et al., 2014; Hoek et al., 2004; Lemken et al., 2019; Nijdam et al., 2012; Potter & Rööös, 2021). Third, more recently, scholars explore current innovation trajectories in plant-based protein products as well as debated their broader economic and social implications (Broad, 2019; Newton & Blaustein-Rejto, 2021).

Inductive qualitative frame analysis inevitably requires interpretations by the researcher, which might be interfered with by the researcher's own mental constructs. To limit such interference, the researcher scanned and compared the data multiple times (Strauss & Corbin, 1997). The frame package analysis approach benefits the reliability of results because it offers a heuristic to analyze data systematically. Additionally, an independent researcher analyzed 25 research items. Differences in interpretations were evaluated and resolved through the formulation of additional coding instructions. A limited number of research items was used to illustrate the results of this research. Each item was given a specific reference code (i.e., #1). Table 8.4 in appendix lists the reference codes for illustrative research items.

The next section starts by briefly presenting the overall media coverage for plant-based protein products from the telegraph.co.uk, the Guardian (London), and the Times (London) between 2010–2020. It continues by describing the frames identified for plant-based protein products with regard to: health, environmental sustainability, and innovation trajectories. The discussion follows in the subsequent section.

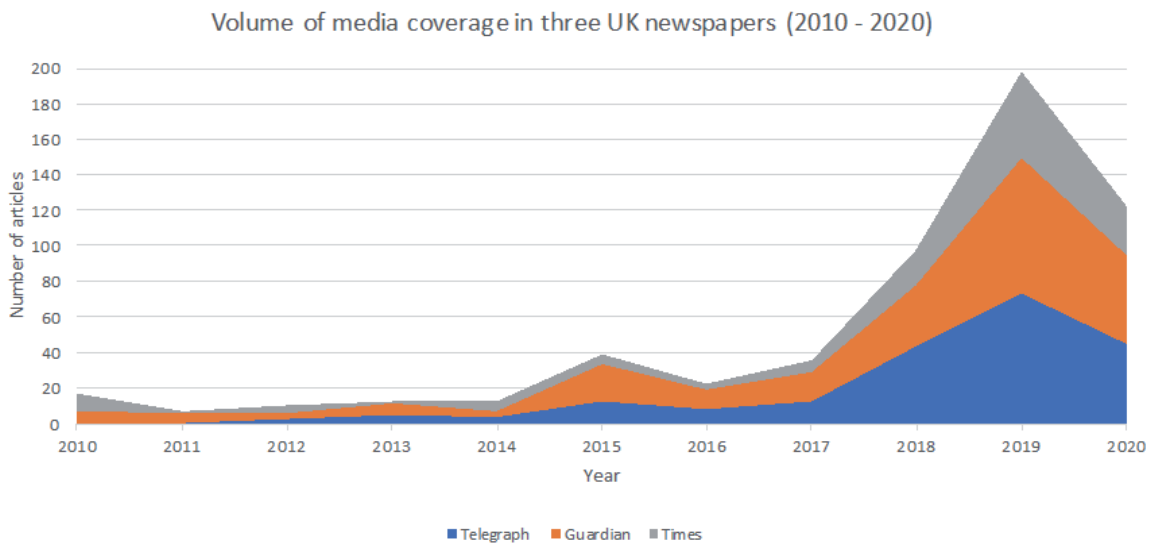
## 5.4 Results

### 5.4.1 News coverage for plant-based protein products

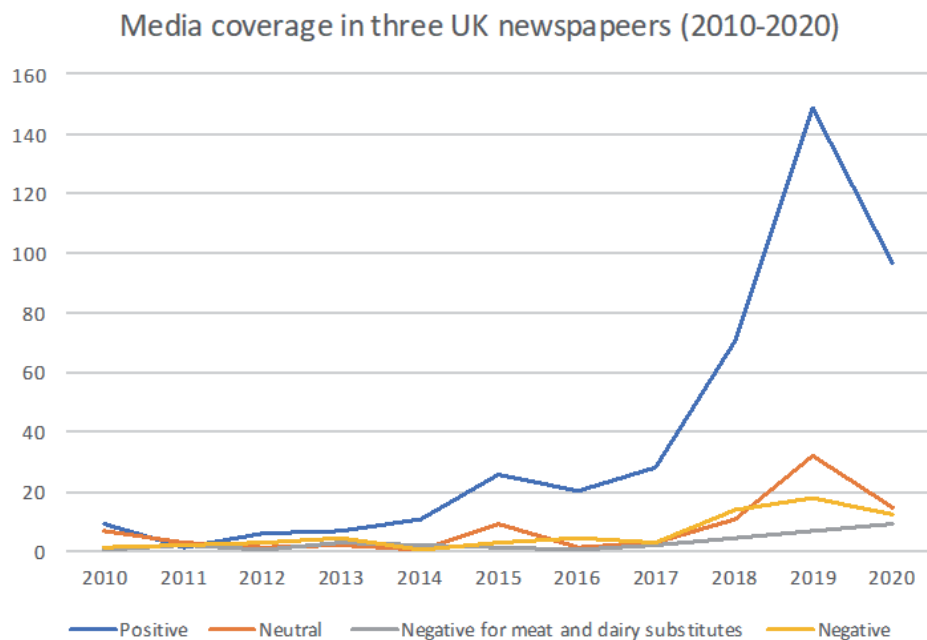
Media attention increased during 2010–2020 (Figure 5.1). The majority (79%) of articles included in this study were published between 2017–2020, reflecting the recent interest on topics relevant to plant-based food. More than half (64%) of the articles studied referred to meat and dairy substitutes, products which mimic the taste and texture of meat and dairy products. The rest of the articles referred to plant-based diets or plant-based products that do not necessarily aim to substitute meat and dairy products, such as legumes and nuts.

Media coverage towards the transition to plant-based diets was mostly positive (Figure 5.2). From the articles studied, 71% were characterized by a positive tone, 14% were neutral, and only 10% were characterized by a negative tone. However, 5% of the articles, while supporting the transition to plant-based diets in general, explicitly cautioned against the consumption of meat and dairy substitutes, mostly due to health reasons.

**Figure 5.1. Number of articles about plant-based protein products in the telegraph.co.uk, the Guardian (London), and the Times (London) between 2010–2020**



**Figure 5.2. Analysis of articles about plant-based protein products in the telegraph.co.uk, the Guardian (London), and the Times (London) between 2010–2020**



Most articles included health (44%) and/or environmental sustainability-related arguments (39%) when discussing the need for a transition to plant-based diets and/or plant-based protein products. The argumentation of several articles (28%) was based on the unprecedented, soaring demand for meat and dairy substitutes. A few articles discussed arguments regarding animal welfare, cost and accessibility of food products, the rising demand for meat, and truthful labeling. Finally, other arguments were related to business and investment, farmers' livelihoods, and issues of broader ethics.

We identified 14 different frames for plant-based protein products. One article could include more than one frame. We continue by discussing the individual frames in detail under the three broad themes of health, environmental sustainability and innovation trajectories.

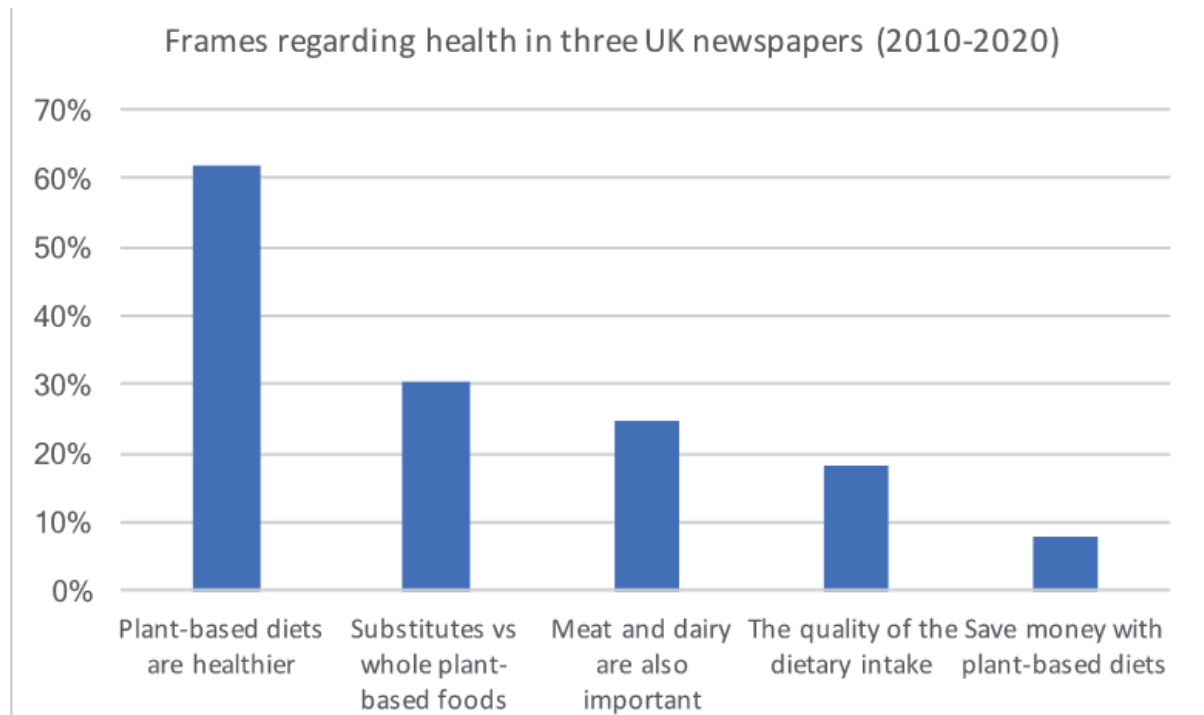
## 5.4.2 Health

We identified 5 different frames about the broader theme of health. Table 5.2 describes each health-related frame according to the identified proposed problem definitions and solutions. The relative share of each individual frame in the health theme is illustrated in Figure 5.3 and discussed in detail below.

**Table 5.2. Frames for plant-based protein products regarding health**

Frame	Problem definition	Possible solutions
<b>Plant-based diets are healthier</b>	Adverse impacts of meat and dairy overconsumption for public and personal health/ Positive impact of (mainly) plant-based diets on public and personal health / Increase global consumption of meat and dairy as a health risk/ Food safety risks (e.g. outbreak caused from zoonotic transmission)	Limited consumption of livestock products/ Promotion of plant-based diets through hard and soft regulation
<b>Meat and dairy substitutes vs whole plant-based foods</b>	Adverse impacts of meat and dairy overconsumption for public and personal health/ Positive impact of (mainly) plant-based diets on public and personal health/ Nutritional value of highly processed meat and dairy substitutes	Maintenance of healthy, balanced diet, including “whole” and “unprocessed” plant-based protein foods/ Removing processed meat and dairy substitutes from diet
<b>Meat and dairy are also important in a healthy diet</b>	Prevention of nutrient deficiencies caused by vegetarian/vegan diets	Acknowledgement of the nutritional value of livestock products in public discourses/ Credible information from experts to maintain a balanced diet
<b>The quality of the dietary intake of vulnerable individuals and populations must be safeguarded</b>	Food security/Undernourishment in low-income countries/ Cost of plant-based products	Safeguarding of the dietary intake of people in low-income countries/ low-income population groups in high income countries
<b>Save money with plant-based diets</b>	Cost of maintaining a healthy diet/ Adverse impacts of meat and dairy overconsumption for public and personal health/ Positive impact of (mainly) plant-based diets on public and personal health	Limited or no consumption of livestock products

**Figure 5.3. Frames for plant-based protein products regarding health from the telegraph.co.uk, the Guardian (London), and the Times (London) between 2010–2020**



The largest part (62%) of the newspaper coverage with regard to health focused on the potentially positive impact of (mainly) plant-based diets on public and individual health. As part of this frame, articles mainly presented scientific studies that examined various alleged health benefits of plant-based diets or research results on adverse health impacts of meat and dairy overconsumption. Thus, these articles adopted a positive stance toward the transition to plant-based diets and commonly suggested that individuals limit consumption of livestock products. Often these articles emphasized the importance of choosing a healthy, balanced diet, including “whole” and “unprocessed” plant-based protein foods.

However, many articles (30%) adopted a frame which included arguments from a health perspective but did not discuss environmental sustainability and explicitly criticized the nutritional value of popular meat and dairy substitutes. For example, one article [#1] elaborates on the health benefits of vegetarian and vegan diets, employing the following quotes of experts to caution against the consumption of processed substitutes: “A well-planned vegan or vegetarian diet that includes plenty of whole plant foods (in contrast to processed vegetarian foods) is likely to be lower in saturated fat” and “Those opting for a plant-based lifestyle should also steer clear of unhealthy, greasy foods that are marketed as healthy.” Therefore, these articles were also characterized by an overall negative tone toward the consumption of meat and dairy substitutes.

A few articles (25%) stressed that meat and dairy products have important nutritional benefits or that unbalanced plant-based diets can lead to adverse health impacts, such as nutrient deficiencies. For example, one article [#2], entitled “Vegans could be lacking crucial nutrient for brain health, warns expert,” reported on research regarding a nutrient commonly found in meat and dairy products and included a scientist’s call for attention to potential nutrient deficiencies because of the popularity of plant-based diets. In one quote, the expert argues: “This is now more important than ever given that accelerated food trends toward plant-based diets/veganism could have further ramifications.” A few of these articles were produced as a response to high-impact policy reports supporting plant-based diets or discussed the viewpoint of the meat and dairy industries’ interest groups. For example, one article [#3] reported the following opinion from an expert: “Meat and dairy have known health benefits, and consumption of animal-based food during early life has been linked with lower levels of malnutrition and improved health outcomes... High-profile movements such as EAT-Lancet and Veganuary gain widespread press coverage, yet the fact that the World Health Organization rejected the EAT-Lancet recommendations was largely unreported.”

Another frame under the theme of health, found in 18% of articles studied, discussed the quality of dietary intake of people in middle- and low-income countries, or of vulnerable individuals and population groups in high-income countries. For example, [#4] discussed a letter from experts urging governments around the world to introduce “peak meat by 2030,” a peak in livestock production, as a climate change mitigation option. In regard to health, the article includes the following quote: “But the transition will need to be managed fairly... In poor countries, where over 800 million people are still undernourished, priorities obviously differ.” A similar argument with a more negative undertone is found in [#5]: “The war on meat has begun, and there are many reasons to join the resistance.” This article argues against calls to urgently reduce the consumption of livestock products and claims: “Throughout the developing world, when people get access to dairy products and meat, their stature and IQ tend to shoot up. Denying this opportunity to the many people who are vegetarians through poverty rather than choice would be grotesque. The United Nations posturing about meat abstinence sounds like ‘let them eat cake.’”

Articles in regard to the quality of dietary intake of vulnerable individuals and population groups in high-income countries criticized the high price of healthy food products, including plant-based protein products. For example, the article [#6] “A meat tax need not to hit the poor” argued: “The revenue from such a tax [referring to a future tax on meat products] could be used to make nutritious plant-based food more affordable. To the extent that higher prices might still be necessary, welfare and wages will need to increase. We need a food system where the price of food reflects the true cost of production, and an economic system where everyone can afford a healthy diet.” Similarly, the article [#7] “The

shock of redundancy: ‘Food is a massive issue’ explored the viewpoint of a low-income British family that could not afford to purchase food products they perceive as healthy, such as the popular meat substitute “Quorn,” and relied on cheaper livestock products instead.

Finally, opposing the aforementioned frame, 8% of articles employed a frame which discussed the cost of diets and proposed adopting a (mainly) plant-based diet as a cost-saving measure. For example, [#8] argues that “However, this research proves there is actually a lot of money that could be saved by making a veggie or vegan commitment. I believe in showing people how to make delicious, affordable food, and meat-free options are just the same; it doesn’t need to be expensive or fancy to be satisfying and tasty.”

### 5.4.3 Environmental sustainability

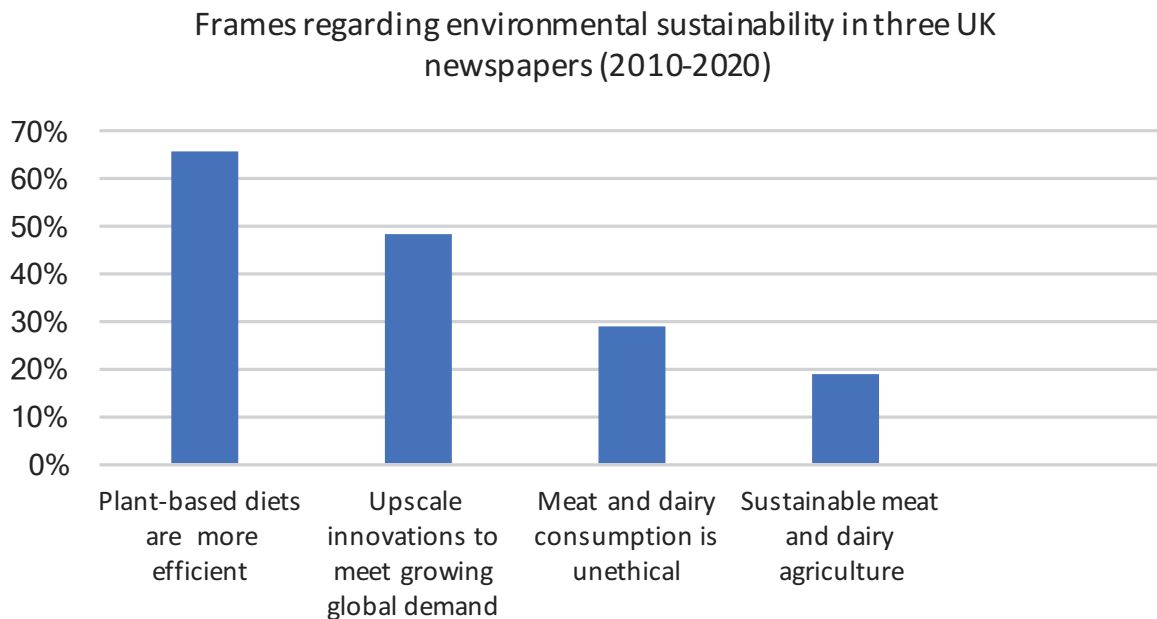
We identified 4 different frames regarding the broader theme of environmental sustainability. Table 5.3 describes each frame according to the identified proposed problems and solutions. The relative share of each individual frame in the broader environmental sustainability theme is illustrated in figure 5.4 and discussed in detail in the text below.

**Table 5.3. Frames for plant-based protein products regarding environmental sustainability**

Frame	Problem definition	Possible solutions
<b>Plant-based diets are more efficient for environmental sustainability</b>	Adverse environmental impact of meat and dairy production / Increasing global demand for meat and dairy	Limited consumption of livestock products/ Promotion of plant-based diets through hard and soft regulation
<b>Upscale innovations to meet growing global demand for protein</b>	Rising global demand for meat and dairy/ Adverse environmental impact of meat and dairy production	Development of novel plant-based protein products/ Introduction of novel protein ingredients/ New or improved manufacturing methods/ Scale up and commercialization of innovative meat and dairy substitutes
<b>Sustainable meat and dairy agriculture is part of the future</b>	Rising global demand for meat and dairy/ Adverse environmental impact of meat and dairy production/ Environmental footprint of plant-based protein products/ Greenwashing	Promotion of sustainable livestock agriculture through hard and soft regulation/ Promotion of ‘better’ produced meat and dairy products through hard and soft regulation/ Development and promotion of plant-based products with relatively low environmental footprint
<b>Meat and dairy consumption is unethical</b>	Adverse impact of meat and dairy production on animal welfare / Ethical concerns regarding meat and dairy consumption	No consumption of livestock products/ Promotion of plant-based diets through hard and soft regulation



**Figure 5.4. Frames for plant-based protein products regarding environmental sustainability from the telegraph.co.uk, the Guardian (London), and the Times (London) between 2010–2020**



The most common frame (66%) regarding environmental sustainability included articles which presented scientific studies arguing for plant-based diets as means to mitigate the adverse environmental impacts of livestock agriculture. Sustainability arguments were often complemented with health-related arguments to argue for the promotion of “healthy and sustainable diets.” For example, [#11] summarized suggestions for maintaining sustainable and healthy diets by employing the following quote: “Eat food. Not too much. Mostly plants.” However, a few articles promoted specific plant-based products as options that were more sustainable, healthy, or both, compared to other products. For example, one article discussed the qualities of lupin over soy products, arguing: “It’s vegan, gluten-free, high in protein, and said to be more sustainable than soy” [#12]. Therefore, multiple and sometimes conflicting pieces of advice about what food products should be part of a sustainable (and healthy) diet were found.

A second common frame (48%) discussed the rising global demand for meat and proposed the development of innovative meat substitutes as more efficient. Articles that fell under this frame discussed ways in which firms have attempted to find novel ingredients, improve manufacturing methods, scale up production, and commercialize innovative meat substitutes. These articles often adopted the perspectives of food firms, which have argued that the development and diffusion of innovative products have become an undisputable solution for a sustainable food system. For example, [#13] quotes the CEO of Impossible Foods, arguing: “Meat production is a ‘ridiculous’ and ‘inefficient’ industry which is causing global ecological collapse. Weaning consumers off meat was a ‘no-brainer,’ calling it ‘the

absolute most important task in the world.” Additionally, this frame often describes meat substitute firms as technology businesses that develop innovative sustainable products, rather than merely food firms. For example, [#14] reports on an event that showcased new gadgets and included Impossible Foods’ burger, “Burger 2.0,” in a list of 10 standout gadgets.

A small number of articles (29%) included a counter frame, which opposed the need to transition to plant-based diets, as well as the development and diffusion of meat and dairy substitutes. These articles argued that the development of substitute products can also involve adverse environmental impacts. For example, one article [#15] described the benefits of free-range livestock agriculture: “Free-range livestock fertilize the soil, and the pastures they graze on soak up surplus water and prevent soil erosion”; furthermore, the article argued: “In the process of squaring up to the challenge of climate breakdown, we seem to have forgotten that plant foods too can be either badly or well produced. [...]. It’s a pity that the public food discourse has become so binary: animal foods bad, plant foods good.” Similarly, another article [#16], when comparing livestock and plant-based protein products, claimed: “A switch from beef and milk to highly refined livestock product analogues such as tofu could actually increase the quantity of arable land needed to supply the UK.”

Other counterarguments in this frame discussed the perspectives of supporters of livestock farming. These articles questioned the sustainability promises of meat substitute firms. For example, one article [#27] discussed a campaign launched by European Livestock Voice, an interest group for livestock farming, which aims to raise awareness for the overall benefits of livestock farming. In this article, the European Livestock Voice group is quoted: “The consequences of a drastic reduction on consumption of animal products by replacing them with ‘meat substitutes’ or other activities could well be worse than the benefits of meat consumption, without leading to a significant environmental or health improvement.” In an opinion article [#10], a farmer questioned the motives of plant-based protein firms, arguing: “Rather than being seduced by exhortations to eat more products made from industrially grown soya, maize and grains, we should be encouraging sustainable forms of meat and dairy production [...]. We should, at the very least, question the ethics of driving up demand for crops that require high inputs of fertilizer, fungicides, pesticides and herbicides, while demonizing sustainable forms of livestock farming that can restore soils and biodiversity, and sequester carbon.”

Finally, 19% of articles adopted a frame which discussed ethical concerns related to meat and dairy consumption, such as animal welfare concerns, and supported the adoption and promotion of plant-based diets. For example, one article [#18] argues that: “For both the billions of animals raised and killed each year and for ourselves, that day cannot come soon enough. There is nothing natural or inevitable about factory farms, which have transformed human agriculture into a monstrosity which would be unrecognizable to previous generations.”

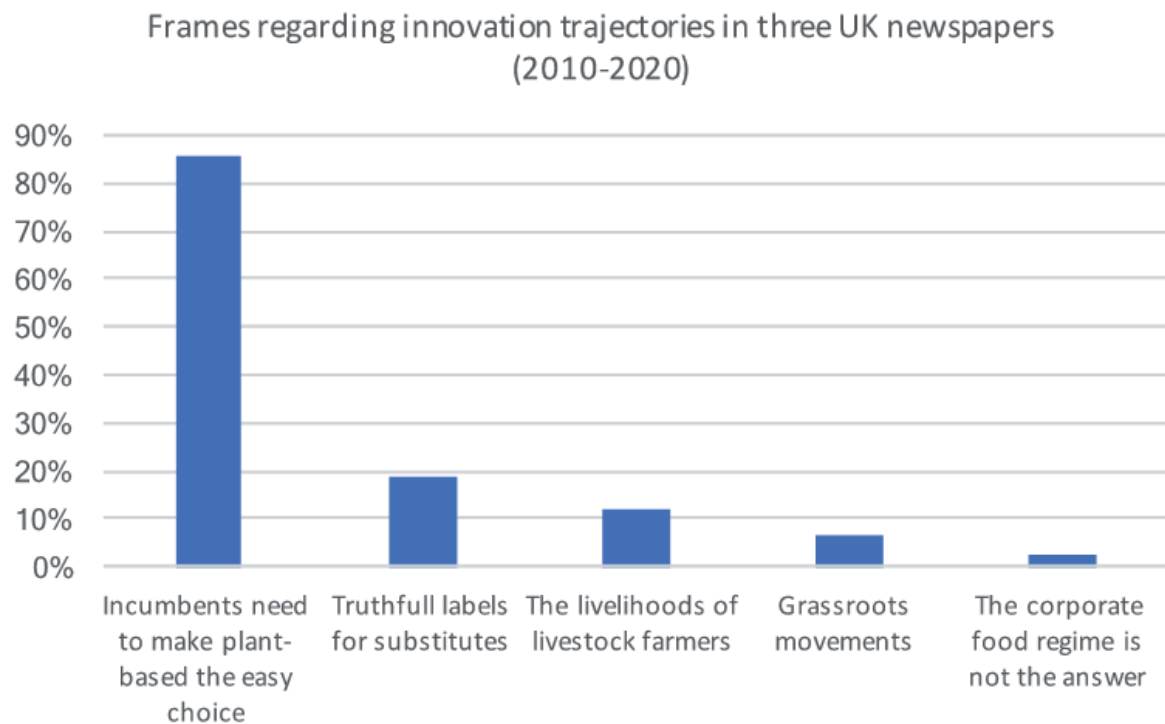
### 5.4.4 Innovation trajectories

We identified 5 different frames regarding the broader theme of innovation trajectories. Table 5.4 describes each frame according to the identified proposed problems and solutions. The relative share of each individual frame in the broader innovation trajectories theme is illustrated in figure 5.5 and discussed in the text below.

**Table 5.4. Frames for plant-based protein products regarding innovation trajectories**

Frame	Problem definition	Possible solutions
<b>Incumbents need to make plant-based the easy choice for consumers</b>	Fast-growing demand for meat and dairy substitutes/ Adverse environmental impact of meat and dairy production / Increasing global demand for meat and dairy	Wide diffusion of plant-based protein products in regime structures e.g. fast-food chains, retail shops, menus at events, cookbooks/ promotion of plant-based meat and dairy substitutes by prominent individuals/Investments in plant-based protein firms
<b>Labels for substitutes</b>	Truthful labelling for meat and dairy substitutes/ Misleading advertising	Regulation the names of meat and dairy substitutes/ Regulating nutrition facts labels
<b>The livelihoods of livestock farmers must be safeguarded</b>	Adverse environmental impact of meat and dairy production/ Diminishing livelihoods of livestock farmers	Promoting sustainable livestock agriculture through regulation and fiscal policies/ Policies to compensate livestock farmers
<b>Grassroots movements supporting plant-based diets</b>	Adverse environmental impact of meat and dairy production/ Increasing global demand for meat and dairy/ Unequal power structures in current food regime	Civil disobedience actions e.g. protests, blockages etc.
<b>The corporate food regime is not the answer</b>	Greenwashing strategies of incumbents (e.g. biochemical firms, fast-food chains etc.)/ Unequal power structures in current food regime/ Health impact of meat and dairy substitutes	Broader considerations for sustainability in the food system/ sustainable livestock agriculture

**Figure 5.5. Frames for plant-based protein products regarding innovation trajectories from the telegraph.co.uk, the Guardian (London), and the Times (London) between 2010–2020**



The largest part (85%) of the news coverage regarding innovation trajectories for plant-based protein products discussed the visibility of the fast-growing demand for meat and dairy substitutes in the U.K. market and globally. These articles mainly reported the ways in which incumbent food firms, retailers, and food service providers responded to changing consumer demand patterns by modifying their assortment of products, menus, or both. For example, [#19] discussed the strategies of the retailer Tesco and the food service firm, Pret a Manger: “Tesco says demand for vegetarian and vegan ready meals and snacks has soared 40% in the past year, prompting the UK’s biggest supermarket to introduce new labelling to flag up all its vegan products. [...] Pret A Manger, the London-based coffee shop chain, has just opened its second veggie-only outlet after double-digit percentage rises in sales of vegetarian food.”

Such articles argued that the wide diffusion of plant-based protein products in regime structures would contribute to making the adoption of plant-based diets “the easy choice” for consumers and thus accelerate the transition toward sustainability. Therefore, they were characterized by an overall positive tone toward incumbents increasingly adopting plant-based protein products. For example, in [#20], entitled “Laugh if you want, but the ‘McPlant’ burger is a step to a greener world,” the author explained the rationale behind this supportive position by quoting an animal protection organizer, who argued that “by making humane and sustainable proteins affordable and accessible, initiatives like the

McPlant could contribute to a reduced market for factory-farmed meat." Another article [#21] reflected on the transformative potential of this development versus more "radical" efforts of civil society groups, arguing: "The paradox here is that the heroes of the story are science and capitalism - normally seen by the green-minded as the arch-villains. [...]. In the end the big food giants' muscle (after they buy some of the upstarts) will be what turns niche products into mass-market ones. The militant vegans of Animal Rebellion aim to disrupt London for two weeks, starting today, under the slogan 'Kill capitalism, not animals.' They are ordering from the wrong menu."

Under this frame, articles also often discussed the role of celebrities or prominent individuals (e.g., Bill Gates) in promoting plant-based diets and plant-based protein products. These articles argued that the involvement of celebrities and prominent individuals constituted an indication that the transition to plant-based diets has been accelerating. For example, [#22] claimed that: "While once vegans were viewed as largely Guardian-reading sandal-wearers, they have now gone almost mainstream. [...]. There are also plenty of glossy celebrities shunning all animal products, from Pamela Anderson, [...]. Tennis star Novak Djokovic has his own vegan restaurant." Another article [#23] described Oatly, a popular plant-based milk firm that sold a 10% stake to investors including celebrities, such as Oprah Winfrey, Jay-Z's entertainment company, and Natalie Portman. The firm's chief executive argued: "We are a grassroots brand and wanted to bring in people who are generational voices." The article continued: "Jay-Z and Beyoncé have encouraged fans to try plant-based foods, as has Winfrey, while Portman is a high-profile advocate of veganism." Other articles under this frame discussed ways in which the diffusion of plant-based protein products in regime structures, e.g. cookbooks, popular events, television programs, can facilitate dietary change towards sustainability.

Another frame, identified in 18% of articles, focused on labelling issues regarding meat and dairy substitutes. Articles mainly discussed recent EU proposals to regulate the use of meat and dairy names to prevent plant-based protein products from being described as milk or burgers, for example. Out of these articles, most took a positive or ambivalent stance toward the plant-based protein industry. Proponents of the plant-based protein products industry, such as nongovernmental organizations promoting vegetarianism and veganism, have argued that proposals to regulate the use of names are motivated by vested interests of the meat and dairy industry and aim to hamper a growing movement toward more sustainable and ethical food consumption. One article, [#24], discussed the viewpoint of a "green" member of the European Parliament (MEP), who argued: "The suspicion is that this has come from the meat industry out of panic at the fact that young people are moving away from eating meat. It is a clear indication that they are worried about their market being undercut – and that's quite a good sign." Moreover, a few articles claimed that a regulation against the use of meat and dairy names could comprise an

opportunity for the plant-based protein industry. For example, in the previous article, the same MEP hoped that a regulation against the use of meat names from plant-based protein products could lead food producers to abandon attempts to mimic livestock products. Particularly, the MEP argued: “you can have a very nice cuisine that starts with vegetables and not a meat substitute. I think this could unlock a lot of creativity.” A small number of articles adopted the position of livestock agricultural lobby groups and argued that regulations against the use of “meat and dairy names” from substitute products should be introduced to protect consumers from untruthful labeling. Other labelling issues regarding plant-based meat and dairy substitutes discussed vegetarian and vegan labels and the accurate identification of ingredients and nutritional value of products.

A different frame identified in a small number of articles (12%) discussed the rising popularity of plant-based diets and plant-based protein products in relation to the future of the meat and dairy industries and particularly the livelihoods of livestock farmers. Articles under this frame questioned the socioeconomic impact of policies promoting the transition to plant-based diets for livestock farmers. For example, in an opinion article [#6], entitled “A meat tax need not hit the poor,” a green politician recommends the introduction of a meat tax but nevertheless argued: “There is no single magic bullet for avoiding climate catastrophe while improving people’s health and securing farmers’ livelihoods... Any tax would need to be phased in, and give farmers the financial support and time to transition to more sustainable methods of rearing animals.”

Contrary to news coverage focused on incumbents, a very small number of articles (7%) employed a frame which featured the activities of civil society groups advocating for food system sustainability. These civil society groups aim to increase the sense of urgency for the transition to plant-based diets by destabilizing regime structures that support livestock agriculture as well as the meat and dairy industries. For example, articles have discussed the activities of the advocacy group “Animal Rebellion,” which orchestrated a two-week blockade of the UK’s largest meat market [#24]. This article also included a quote from the spokesperson of Animal Rebellion, who argued: “We expect people to be angry that we are challenging their comfortable and ‘normal’ way of life around what they eat. But unfortunately, drastic times call for drastic measures if we are to have any hope of limiting the ravages of climate change. We’re sorry in advance for the disruption this causes.” Moreover, because some of these articles mentioned the broader mission of such groups, issues of procedural justice and participation with regard to transitions are discussed. For example, the aforementioned advocacy group supports calls to the U.K. government to advocate for “creating a citizens’ assembly on climate and ecological justice to decide policy” [#24].

Finally, only very few articles (2%) adopted a critical stance toward the reorientation of incumbents. For example, one opinion article, [#25], questioned the degree to which public discourses have embraced the diffusion of plant-based protein products, arguing: “Supermarkets, global food manufacturers and biotech and chemical companies have enthusiastically embraced Veganuary. Fast-food enterprises, formerly seen as the nemesis of public health and the environment, have recast themselves as their saviors. [...] As long as we demonize animal foods and eulogize plant foods, any prospect of a natural food supply is shattered. We are left to depend for sustenance on the tender mercies of the techno-food corporations that see a little green V and the word ‘plant’ as a formula for spinning gold from straw through ultra-processing.”

## 5.5 Discussion and recommendations for the future of plant-based protein innovation

A clear majority of the articles that were studied from the three UK newspapers, the Telegraph, the Guardian (London), and the Times (London), were in support of the need to promote a transition towards plant-based diets. This overall positive coverage signals that plant-based diets have been widely assumed to be beneficial and their mitigation potential, primarily for health and sustainability, has been taken for granted. Nonetheless, the results also illustrate that while plant-based diets have found widespread acceptance, plant-based protein products, including meat and dairy substitutes, are portrayed through different and often conflicting frames with regard to health, environmental sustainability, and innovation trajectories.

To start with, regarding health, we find that support for plant-based protein diets both for individuals and public health is high in most articles. At the same time, it appears that the consumption of meat and dairy substitutes is not necessarily required to support a shift to a healthy diet. Instead, whole plant-based protein foods, such as legumes, are considered superior in that respect. This is an important finding of this study because, in part, favorable health-related perceptions have been driving the increasing consumer demand for plant-based protein products (Tziva et al., 2020). In turn, firms producing meat and dairy substitutes position their products in contrast to livestock ones as “healthier” (Sexton et al., 2019). However, there is still high ambivalence and uncertainty in the public debate on what constitutes a healthy plant-based diet, which may influence consumer attitudes towards meat and dairy substitutes.

Therefore, we argue that to realize the envisioned association of substitutes with “healthy and sustainable diets,” actors involved in their development should broaden the scope of strategic choices regarding product design. Product developers should not only

focus on mimicking the taste and texture of meat and dairy, but also invest in activities for the development of products that are more analogous to whole plant-based foods. This direction can also satisfy normative concerns regarding the appropriateness of consuming substitutes, e.g. due to the propagation of the conceptualization of animals as food products. Thus, it can resonate with new segments of consumers who hold such ethical considerations and broaden the market for plant-based protein products.

We also find that questions of inequality in nutrition are important, which is a current focal topic within the sustainable development goals of the United Nations (2015). Scholars have emphasized that transitioning to plant-based diets should involve food justice considerations (Béné et al., 2020). We argue that the accessibility and affordability of plant-based protein products will likely become increasingly important, particularly regarding meat and dairy substitutes which are often perceived as expensive or elitist. Therefore, actors involved in the plant-based protein innovation should try to address such questions on equitable access to food products.

The benefits of the transition to plant-based diets and adoption of plant-based protein products, including meat and dairy substitutes, for environmental sustainability is also a common framing in media discourses. Articles studied mostly characterized plant-based protein products as more sustainable and efficient compared to livestock products. The majority of the news articles studied under the theme of environmental sustainability, champion product innovation and technological advancements. This frame of technological determinism has been identified in broader discourses regarding sustainability in the food system (Garnett, 2014). However, some articles criticized the potential contributions of plant-based protein innovations to sustainability and instead advocated for the benefits of sustainable livestock agricultural practices, whole food products, or both. Moreover, these articles often raised equity questions about the impact of the transition to plant-based diets on food production at the farm level, especially as it pertains to the livelihood of farmers. Finally, the few articles that contested the environmental friendliness of plant-based products adopted arguments against specific ingredients, such as soy, due to issues in their supply chains.

Thus, we argue that the focus of research and development in plant-based protein products, particularly in the UK and EU countries, should increasingly be laid on the adoption of protein ingredients with relatively transparent and local supply chains. This direction has the potential to address issues of equity at the farm level, as well as holds a competitive advantage in terms of societal acceptance. It is also aligned with visions for food security that have emerged in recent agricultural policy domains and can be important for the long-term resilience of the plant-based protein sector (EC, 2018). Relevant strategies could involve the promotion of cross sector initiatives between e.g.



actors in the food processing industry and farmers for the development and promotion of plant-based protein crops.

Another critical tension identified in media discourses revolves around the recent reorientation of food regime actors towards the promotion of meat and dairy substitutes. This development has overwhelmingly been framed as a positive. However, a few articles have emerged which contest this frame by arguing against the appropriateness of supporting the current corporate food regime. Overall, such articles bring together normative, health, and food security objections against the capitalist ideas of progress. In general, as innovations diffuse, their potential market expands, and they are then brought into the mainstream (Bergek et al., 2008). However, this mainstreaming process, particularly regarding the food system, can reinforce existing unequal power structures (Barrientos & Smith, 2007) and thus, lead to contestation. We expect that as the plant-based protein industry grows and substitutes increasingly become part of the existing food regime, these products may also face more resistance from actors normatively opposing market-based changes (Goodman et al., 2012). Therefore, we argue that the lasting appeal of plant-based protein firms may involve a balancing act between growth and protection of their mission and representativeness.

Finally, the frames identified in this study, which touch upon several important topics in the food system, such as health and equity, show that the regulation of the transition to plant-based diets should not only be left on private actors. Public actors and civil society organizations, which hold the mandate and legitimacy to work on such topics, should increasingly become involved in this unfolding transition and attempt to address and regulate emerging controversies and concerns.

# CHAPTER 6



# Conclusion

## 6.1 Main findings and contributions

This thesis sought to analyze innovation dynamics in the protein transition case to advance the conceptualization of sustainability transitions in the food system and explore conceptual contributions to the sustainability transitions field. The following research questions provided valuable insights:

*What are the transition dynamics of the shift to plant-based meat substitutes?*

*How do these transition dynamics differ from insights in previous transitions literature?*

*What are the implications for transition theory?*

In the following sections, the thesis's insights and its contribution to and differences from the sustainability transitions literature are analyzed, and the relevance of these insights in terms of accelerating sustainability transitions and the broader transformation of the food system is discussed.

### 6.1.1 Dynamics of incremental innovation, scaling and diffusion

On the meso-level, this thesis illustrates that protein transition is a market-driven phenomenon facilitated primarily by changing norms regarding meat consumption and technological innovation processes within firms (**Chapter 2**). The emergence and early growth of new technologies and products in the formative phase of the protein transition were marked by some key events. In particular, the formative phase of plant-based meat substitutes began with problem articulation around meat consumption by users and the creation of niche markets for substitute products (**Chapter 2**). Technological innovation in the food industry, involving improvements in products through the adoption of new processes and inputs from other sectors, allowed the introduction of new commercial meat substitutes. Amplified normative contestation around meat consumption and the evolution of the discussion of meat substitution from altruistic and ethical considerations to broader health and sustainability considerations led to cascading developments involving multiple actors, further process and product innovation, and the scaling-up and mass commercialization of the second generation of meat substitute products which met consumer expectations in terms of taste and texture.

While empirical sustainability transition studies have over-emphasized the bottom-up dynamics of radical innovation processes in the energy and mobility system, known as the substitution transition pathway (Geels et al., 2016), the protein transition case highlights the importance of endogenous change enacted by users and incremental improvements in existing products. This understanding can be the starting point for analyzing system change from a different angle, which is not necessarily technological but involves the interaction of civil society, politics, and businesses. **Chapter 2** introduced

the “legitimacy motor of sustainable innovation” to highlight political change processes as a lever for sustainable firm innovation. The motor starts with actors, including individuals and NGOs, who embrace an emerging norm and support the promotion of products with certain characteristics because they resonate with this norm. The attempts of these actors to convince a critical mass of people to support the emerging norm contributes to knowledge development, entrepreneurship, and market growth. Renewed supply of products reinforces consumer demand further and eventually leads to the scaling of innovations.

The dynamics of the legitimacy motor could potentially apply to other food sectors, as well as other supplier-dominated industries and producers of consumer goods. This is because large-scale individual action in response to sustainability and societal challenges becomes a more significant trend, and businesses recognize “green growth” as a valuable economic opportunity. Nevertheless, this thesis also illustrates that the successful realization of consumer demand as a driver of innovation in protein transition is linked to perceived health benefits. Therefore, the above considerations call for a more nuanced view of the development of innovation processes in sustainability transitions according to the characteristics of products, the ways in which consumers evaluate them, and the properties of industries.

Moreover, this thesis illustrates the crucial role of users in sustainability transitions. As discussed earlier, early users of plant-based meat substitutes drove innovation processes in the formative phase by creating niche markets for products that satisfied normative considerations (**Chapter 2**). Later, mainstream users, beyond dedicated vegetarians and vegans, assumed pivotal roles in upscaling innovations. For example, **Chapter 2** described the role of users in financing R&D projects and entrepreneurial activities through crowdfunding. These insights contradict the typical portrayal of users in the sustainability transitions literature. In general, the literature recognizes two main roles for users. Early niche users contribute to learning processes concerning the development of new technologies and products, and mainstream users follow regime rules and conventions and become passively involved in transitions after mass commercialization. However, this thesis shows that in the food system, there is an important intersection between systemic change and processes of individual behavior. Accordingly, the conceptualization of users should account for variations that allow individuals to meaningfully contribute to the upscaling of innovations.

This thesis also refines the understanding of the role of civil society, including advocacy groups and NGOs, and policy makers, in sustainability transitions. The protein transition case illustrates two different facets of civil society. First, civil society exerts significant selection pressures on innovation by shaping public discourse on problems and backing

problem definitions and solutions. Therefore, innovations that are part of the proposed solutions attain cognitive and normative legitimacy. **Chapter 2** described how NGOs in the Netherlands embraced the promotion of plant-based meat substitutes and thus contributed to linking sustainable and healthy diets with the consumption of particular products. Second, the protein transition case illustrates the important role of NGOs in covering formal regulatory voids through their participation in an alliance network aimed at promoting the consumption of plant-based meat substitutes (**Chapter 3**). Similarly, this thesis illustrates policymakers' role in exerting selection pressures by which innovations can be deemed as possible solutions to societal problems. In this way, policymakers contribute to providing financial resources for developing niches and advancing legitimacy for certain meat substitute products (**Chapter 2, Chapter 3**).

What can be learned overall is that users, civil society, and public actors play interconnected roles in political change processes that contribute to the legitimation of innovations regarding societal problems. In turn, this legitimation process can be pivotal for driving other (technological) innovation processes and embedding innovations in society.

In terms of protein transition governance, hard regulation has not played a significant role in change processes. As discussed in this thesis, although policy has recognized the importance of diets in food systems' sustainability, various factors exclude the possibility of regulating the demand side using formal regulatory tools. Instead, governments largely rely on existing private sector market-based tools, such as food and agricultural certification schemes and logos. While this is not necessarily negative, it is not adequate for strategically creating the favorable institutional conditions needed in sustainability transitions. Alliances can mobilize resources and instruments to instigate change on the demand side of food. **Chapter 3** described how the Green Protein Alliance brought together the resources of different actors to address barriers in the adoption of plant-based products and imparted changes in the broader institutional environment of the Netherlands. This case illustrates how private regulatory institutions can provide alternative governance tools for the demand side of the food regime.

Finally, this thesis provides insights into the multiple frames regarding plant-based substitutes in public discourses. **Chapter 5** showed that despite overall media coverage of plant-based diets taking a positive stance, there is still broad controversy in public discourse about health. The biggest barrier appears to be the potentially adverse health implications of consuming meat and dairy substitutes. Additionally, questions in the broader sphere of sustainability are also important topics in public discourse, including questions of inequality in nutrition and normative considerations regarding the current corporate food regime. This research shows that as the protein transition evolves, its directionality becomes an increasingly important topic.

On the micro-level, this thesis shows that new entrants or challengers in sustainability transitions still hold crucial roles, even in the more incremental endogenous transition pathway. The protein transition case illustrates that technological change and the development of higher-performing products, mainly introduced by new entrants, were crucial for appealing to potential user groups and ultimately achieving the expansion of markets (**Chapters 2, 4**). Nevertheless, this thesis also illustrates that new entrants interacted with incumbent firms early in the process to expand their operations, which contradicts existing conceptualizations of early niche-regime interactions.

In the protein transition case, the reorientation of incumbent firms toward the meat substitute sector occurred quickly after the appearance of pioneering new entrants due to the growing demand for plant-based products (**Chapters 2 and 4**). Global agro-food firms were involved in several M&As, which contributed to the expansion of new entrants' operations (**Chapter 4**). Thus, reorientation did not follow the main temporal models described in transition studies in which incumbent firms reorient after long-term pressures, including the introduction of coercive regulations. Instead, the case highlights the role of changing consumer preferences in prompting incumbents' engagement with niches. Hence, the scaling of innovations is largely determined by economic viability, which can also be achieved through market dynamics.

**Chapter 4** also illustrated how different strategies can be identified for different types of organizations when investigating the behavior of incumbent firms across the plant-based meat substitutes supply chain. In particular, retailers generally exhibit low commitment toward products they introduce because they are not involved in manufacturing and can easily discontinue products that do not perform well. However, this low-commitment strategy allowed retailers to engage with niches earlier than food firms, creating a bandwagon effect for the engagement of the complete supply chain. Therefore, this research supplements the view of incumbent firms by bringing in a supply chain perspective and highlighting the crucial role of the strategies of mediating actors between producers and consumers.

This thesis also offers significant insights into the formation of alliances. **Chapter 3** illustrated how individual actors' motives, resources, and relationships influence the formation of alliances. For example, diverse motives of actors involved in the GPA were observed, ranging from perceptions regarding contextual developments to perceptions regarding the creation of strategic advantages. The successful formation of the GPA depended on bridging these diverse motives through compromise. Therefore, the formation of alliances, and ultimately the development of collective action for institutional change in transitions, are not merely instinctive outcomes of the engagement between

actors and a new technology, product, or market but are contingent upon diverse factors relevant to the actors.

Overall, this thesis presents a unique example of systemic change in the food industry that responds to calls to analyze “a wider variety of transition pathways involving combinations of mechanisms and interactions between different structuration levels” (Turnheim and Sovacool, 2020). In particular, it diverges from the intensively studied bottom-up substitution transition pathway in which radical innovations substitute existing technologies and products. In its place, it offers insights into the dynamics of incremental innovation, scaling, and diffusion, which are also important in system transformation and the embeddedness of sustainable innovation in societies.

### 6.1.2 Accelerating transitions

In light of international policy targets, such as the two-degree limit set by the Paris agreement, scholars in the sustainability transitions field increasingly call for insights into accelerating transitions to contribute meaningfully to climate change mitigation efforts. This thesis argues that the rapid expansion of technological systems concerned with plant-based meat substitutes in several countries offers opportunities to accelerate the pace of change in food systems.

In general, this thesis argues that promoting innovation is politically more feasible than promoting regime destabilization policies, such as those aiming to reduce consumption or decrease the production capacity of established food sectors. For example, **chapters 2 and 3** elucidate how in the Netherlands the promotion of meat substitutes as a mitigation option for the adverse health and environmental impacts associated with meat products worked as a vision for the engagement of multiple actors in transition processes. The protein transition process gained political support partly because it offers an opportunity to address environmental pressures in the food system without directly challenging the meat sector. Hence, it comprises a leeway for bypassing lock-ins, such as formal regulatory lock-ins in the Common Agricultural Policy (CAP), which contribute to the promotion of meat production and consumption.

Therefore, the protein transition case, along with other market-based transitions that present economic opportunities, can play a crucial role in deliberate transition acceleration efforts. However, because sustainability transitions in the food system touch upon several important topics, such as health, the contested nature of transitions should also be considered. To realize the envisioned association of substitutes with “healthy and sustainable diets,” actors involved in promoting the protein transition, such as technology developers, government agencies, and civil society groups, should include such considerations in the scope of strategic choices regarding technology and product



design. Therefore, reflexivity regarding evolving public discourse should remain a focal element of deliberate acceleration efforts to avoid unexpected risks regarding societal reactions.

Moreover, the success of deliberately accelerating transitions will also require inclusivity, in the sense that attention should be paid to a broad range of topics from different viewpoints. In **Chapter 5**, a critical tension was identified regarding plant-based meat substitutes and the recent reorientation of regime actors, such as global food firms and fast food chains. While this development has overwhelmingly been framed in a positive tone, emerging articles argue against supporting the current corporate food regime. Overall, such articles bring together normative, health, and food security objections to the capitalist ideas of progress and market-based changes. This finding indicates that as transitions unfold and increasingly become part of the existing regimes, they might face resistance from actors holding normative observations. Therefore, inclusive governance and reflexivity remain vital for the ultimate embeddedness of innovations in societies.

### 6.1.3 Transition vs. transformation

This thesis would not be complete without reflecting on the notion of “system transformation.” The increasingly recognized need for system transformations toward sustainability highlights the scale of changes needed and places an explicit normative focus on building “better systems” for more sustainable and equitable futures (Patterson et al., 2017). Although this thesis argues that the protein transition case offers opportunities for accelerating change processes, the innovation dynamics of the case, incremental innovation in products, and regime reorientation underwrite limited institutional change in the structure of the current systems. In other words, the adoption of meat substitutes and the consequent rise of plant-based diets in certain countries has limits in terms of its transformative potential for the structure of the food system.

The food system is characterized by extreme concentration of power in a few global agro-food firms and retailers (Friedmann, 2005). This trend has several questionable effects in terms of broader sustainability and equity. For example, **Chapter 4** illustrates that the mass commercialization of plant-based meat substitutes is largely driven by incumbents and several mergers and acquisitions. The latter contribute to scaling and the increasing control of emerging industries by incumbents, thus perpetuating the existing unequal structure of the food industry (Clapp, 2021). Additionally, **chapter 4** shows that as incumbents become more engaged in niches, they begin to compete directly with new entrants. This development has an uncertain effect on the growth of alternative niches and more radical innovation trajectories.

Moreover, the concentration of power leads to inequality in shaping governance arrangements (Fuchs & Kalfagianni, 2010). Although this thesis argues for multi-stakeholder governance arrangements to tackle political lock-ins in formal regulations, there is an imbalance of power in the voices of incumbent firms and public or civil society actors. **Chapter 3** and the case of the GPA show that multi-actor collaboration in private regulatory arrangements, such as alliances, necessitates compromises to address different motives, resources and relationships. Because of power imbalances, alliances that involve incumbent firms can promote the advancement of regime interests. In addition, such imbalances might indirectly inhibit the development of more radical innovation or alternative transition pathways that do not necessarily entail the production of products, such as a transition to diets based on “whole” plant-based foods.

The protein transition case also entails interlinked equity issues that are important for transforming the food system. **Chapter 5**, which focuses on public discourses around plant-based diets and meat and dairy substitutes, identifies several emerging equity considerations. First, questions regarding the accessibility and affordability of plant-based meat substitutes in the context of nutrition inequality are becoming increasingly important. Second, the impact of the transition to plant-based diets on food production at the farm level, especially concerning farmers’ livelihoods, is another emerging topic. Such discourses represent the viewpoint of actors with vested interests in livestock agriculture and meat production and proponents of other innovation trajectories, such as regenerative agriculture or diets mainly based on “whole” plant-based foods.

Therefore, the main point is that while the urgency of transforming the food system due to accelerated climate change is not in doubt, protein transition’s increasing links with regime interests make it essential to aim for system transformation toward more equitable systems. This goal will require normatively assessing the interaction between different transition pathways and the broader sustainability impacts of transitions.

## 6.2 Limitations and further research

The evolution of dietary patterns is a multidimensional and complex phenomenon influenced by diverse factors relevant to national contexts. This fact inevitably entails limitations in the generalizability of the results that comprise single case studies in one country (**Chapters 2, 3, 5**). The Netherlands (**Chapters 2, 3**) is a frontrunner in food innovation and home to many food firms, global agro-food incumbents, and leading knowledge and education institutions. In addition, the country has a long tradition of consensus-decision-making regulatory institutions promoting innovation processes. Although the single case study approach (**Chapters 2, 3**) was valuable for facilitating

an in-depth analysis, the results might not be directly generalizable in other countries. Similarly, the media frame analysis chapter (**Chapter 5**) focuses on one country, the UK, so the results do not necessarily reflect public discourses regarding plant-based diets and substitute products in other national contexts.

Data availability might also have constrained this thesis to a degree. The fast diffusion of plant-based meat substitutes is a very recent phenomenon. Research for this thesis started before the availability of reliable market size data. Although this thesis is rooted in the interpretive paradigm, and data were gathered systematically from several sources, information on the development of markets over the years could have added to the robustness of chapters that focus on the evolution of the protein transition (**Chapters 2, 4**). Similarly, although the chapter on the entry modes of incumbents in plant-based meat substitutes (**Chapter 4**) illustrates overall patterns of the engagement of incumbents with niches, it could have benefited from more comprehensive data regarding firms' activities.

This thesis identifies three main avenues for future research. First, while the chapter on the development of the protein transition in the Netherlands (**Chapter 2**) elucidates the crucial role of users and civil society throughout transitions, it focuses mainly on dynamics at the system level. Therefore, it does not systematically analyze the different roles of these actors and how they relate to the legitimation process of new products. Future research could include political change literature and further unpack the relationship between users, civil society actors, emerging norms, and the legitimation process of new products. This approach would contribute to developing insights regarding the political and cultural dimensions of sustainability transitions and the relationship between individual behavioral change and system change.

Second, while alternative plant-based protein meat substitutes are emerging rapidly in the Netherlands, the UK and the USA, contributing to a rise in low-meat diets, these trends are locally embedded. In general, the transition to plant-based diets does not necessitate the consumption of meat substitutes. Future research could explore the dynamics of dietary shifts in regions with culinary cultures involving more whole plant-based protein foods—for example, Italy and Greece. The role of technological development and the scaling of meat substitutes in promoting plant-based diets in these countries could be compared with studies in this thesis. This approach would give broader insights regarding the role of technological change in sustainability transitions.

The protein transition is a continuously evolving process. Future research could focus on several dimensions of this transition's transformative potential and directionality. A particularly insightful avenue relates to the relationship between the wide diffusion of plant-based meat substitutes and more radical (social) innovations. The main question

here is whether incremental innovation pathways enable or constrain the development of other sustainable niches.

Third, in terms of transformative potential, the normative elements of this transition are important topics for research. Such research could focus on the intersections of the protein transition, food security, health, and equity to contribute to a broader view of sustainability in the transitions field.



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## Appendices

### 8.1 Chapter 2

**Table 8.1: Information about the interviews**

Type of organization	Interview details	Code
Consultancy	Interview conducted in person in October 2017	PE1
Consultancy	Interview conducted in person in November 2017	PE2
Consultancy	Interview conducted in person in June 2017	PE3
Farm	Interview conducted in person in November 2017	IF1
Firm	Interview conducted in person in October 2017	IF2
Firm	Interview conducted via Skype in October 2017	IF3
Firm	Interview conducted in person in October 2017	IF4
Firm	Interview conducted via Skype in October 2017	IF5
Firm	Interview conducted in person in October 2017	IF6
Firm	Interview conducted via Skype in November 2017	IF7
Firm	Interview conducted in person in November 2017	IF8
Firm	Interview conducted in person in November 2017	IF9
Firm	Interview conducted in person in November 2017	IF10
Firm	Interview conducted in person in November 2017	IF11
Firm	Interview conducted in person in November 2017	IF12
Firm	Interview conducted in person in December 2017	IF13
Government	Interview conducted in person in November 2017	PE4
Government	Interview conducted in person in February 2018	PE5
Government	Interview conducted in person in July 2017	PE6
Government	Interview conducted in person in September 2017	PE7
Industry organization	Interview conducted in person in December 2017	IO1
Industry organization	Interview conducted via telephone in June 2017	IO2
NGO	Interview conducted in person in June 2017	NGO1
NGO	Interview conducted in person in June 2017	NGO2
NGO	Interview conducted in person in November 2017	NGO3
NGO	Interview conducted in person in November 2017	NGO4
Research	Interview conducted in person in September 2017	R1
Research	Interview via telephone in November 2017	R2
Research	Interview conducted in person in December 2017	R3
Indepoendent Expert	Interview conducted via telephone in December 2017	PE8

## 8.2 Chapter 3

**Table 8.2: Information about the interviews**

Type of organization	Interview details	Code
NGO	Interview conducted in person on June 2017	NGO1
Industry association	Interview conducted via telephone on June 2017	IO1
NGO	Interview conducted in person on June 2017	NGO2
Consultancy	Interview conducted in person on June 2017	PE1
Government	Interview conducted in person on July 2017	PE2
Research	Interview conducted in person on September 2017	R1
Government	Interview conducted in person on September 2017	PE3
Firm	Interview conducted via skype on October 2017	IF1
Consultancy	Interview conducted in person on October 2017	PE4
Firm	Interview conducted in person on October 2017	IF2
Firm	Interview conducted via skype on October 2017	IF3
Firm	Interview conducted in person on October 2017	IF4
Firm	Interview conducted in person on October 2017	IF5
Firm	Interview conducted via skype on November 2017	IF6
Firm	Interview conducted in person on November 2017	IF7
Firm	Interview conducted in person on November 2017	IF8
NGO	Interview conducted in person on November 2017	NGO3
Firm	Interview conducted in person on November 2017	IF9
Consultancy	Interview conducted in person on November 2017	PE4
Firm	Interview conducted in person on November 2017	IF10
Firm	Interview conducted in person on November 2017	IF11
NGO	Interview conducted in person on November 2017	NGO4
Government	Interview conducted in person on November 2017	PE5
Firm	Interview conducted in person on November 2017	IF12
Research	Interview conducted in person on November 2017	R2
Independent expert	Interview conducted in person on December 2017	PE6
Firm	Interview conducted in person on December 2017	IF13
Research	Interview conducted in person on December 2017	R3
Industry association	Industry conducted in person on December 2017	IO2
Government	Interview conducted in person on February 2018	PE8

## 8.3 Chapter 4

**Table 8.3: Chronological illustration of most visible events in USA, NL and UK markets (1990-2020)**

Year	Country	Event type	Description
1990	NL-UK	New entrant occurrence	Quorn already in European markets
1990	NL-UK	New entrant occurrence	Garden Gourmet already in European markets
1990	NL-UK	New entrant occurrence	Vivera was established
1996	GLOBAL	Contextual event	EU imposes worldwide ban on British beef exports due to BSE outbreak
2006	GLOBAL	Contextual event	Publication of Livestock's long shadow creates awareness on environmental impact of livestock agriculture
2006	GLOBAL	Technological event	Second generation products start becoming available in markets
2005	NL-UK	Incumbent entry mode: New brand	Meatless was established by a former meat industry actor
2005	NL-UK	Incumbent entry mode: New brand	Valess established
2009	NL-UK	New entrant occurrence	Ojah
2009	USA	New entrant occurrence	Beyond meat
2010	NL-UK	New entrant occurrence	Vegetarian Butcher
2011	USA	New entrant occurrence	Impossible foods
2011	USA	New entrant occurrence	Sweet Earth
2012	USA	Incumbent entry mode: Collaboration/co-promotion	Whole foods introduces beyond meat
2012	USA	New entrant occurrence	Sweet earth foods
2012	UK-NL	Incumbent entry mode: Collaboration/co-promotion	Vegetarian Butcher at Jumbo
2014	UK-NL	Incumbent entry mode: Collaboration/co-promotion	Vegetarian Butcher at AH
2015	GLOBAL	Contextual event	WHO recognizes link between cancer and meat products
2016	GLOBAL	Contextual event	UN names 2016 'the year of pulses' creating awareness for plant-based diets
2016	USA	Incumbent entry mode: Investment	Tyson invests in Beyond Meat
2017	USA	Incumbent entry mode: Acquisition	Nestle acquires Sweet Earth Foods
2017	NL-UK	Incumbent entry mode: Acquisition	Nestlé acquires Garden Gourmet
2018	USA	Incumbent entry mode: Collaboration/copromotion	Del Taco is the first major fast-food chain to serve Beyond Meat



Year	Country	Event type	Description
2018	USA	Incumbent entry mode: Collaboration/copromotion	White Castle major US fast-food restaurant partners with Impossible Foods to serve the Impossible Slider
2018	NL-UK	Incumbent entry mode: Acquisition	Unilever acquires the Vegetarian Butcher
2018	NL-UK	Incumbent entry mode: Acquisition	Kerry Group enters joint venture with Ojah
2019	GLOBAL	Contextual event	Covid-19 pandemic
2019	USA	Incumbent entry mode: New brand	Tyson foods introduces own plant-based burger
2019	UK-NL	Incumbent entry mode: New brand	Nestle introduces own plant-based burger "Incredible"
2019	UK-NL	Incumbent entry mode: Collaboration/co-promotion	McDonalds introduces Valess for chicken burger
2019	UK-NL	Incumbent entry mode: Collaboration/co-promotion	AH introduces beyond burger
2019	UK-NL	Incumbent entry mode: Collaboration/co-promotion	Vegetarian butcher at Tesco
2019	UK-NL	Incumbent entry mode: Collaboration/co-promotion	Tesco launches Beyond burger
2019	USA	Incumbent entry mode: Collaboration/co-promotion	Burger King introduces plant-based burger impossible
2020	UK-NL	Incumbent entry mode: Collaboration/co-promotion	McDonalds introduces first plant burger based on Nestle's Incredible
2020	UK-NL	Incumbent entry mode: Collaboration/co-promotion	Burger King introduces the Rebel Whopper in Europe, a vegetarian burger created by 'The Vegetarian Butcher'.

## 8.4 Chapter 5

**Table 8.4: Reference codes of selected research items used in the results section**

Reference code	Reference
#1	Telegraph (2019). The definitive guide to a plant-based diet - but is veganism really the healthiest way to eat? (Accessed 31 January 2021)
#2	Telegraph (2019). Vegans could be lacking crucial nutrient for brain health, warns expert (Accessed 31 January 2021)
#3	Guardian (2020). Can lab-grown food save the planet? (Accessed 31 January 2021)
#4	Guardian (2019). 'Reach 'peak meat' by 2030 to tackle climate crisis, say scientists; Reducing meat and dairy consumption will cut methane and allow forests to thrive. (Accessed 31 January 2021)
#5	Telegraph (2019). The War on Meat has begun, and there are many reasons to join the resistance. (Accessed 31 January 2021)
#6	Guardian (2019). A meat tax need not hit the poor. (Accessed 31 January 2021)
#7	Guardian (2012). The shock of redundancy: 'Food is a massive issue' (Accessed 31 January 2021)
#8	Times (2020). Cutting back on meat saves billions from shopping bills (Accessed 31 January 2021)
#11	Guardian (2019). The diet for a healthy planet: what should environmentalists eat? (Accessed 31 January 2021)
#12	Guardian (2018). Lupin is never going to set Instagram alight – and this made me like it more. (Accessed 31 January 2021)
#13	Telegraph (2020). "Ridiculous" meat production industry is causing global ecological collapse, says Impossible foods (Accessed 31 January 2021)
#14	Guardian (2019). CES 2019: from beer tech to a banned sex toy – 10 standout gadgets. (Accessed 31 January 2021)
#15	Guardian (2020). Veganuary is huge. But is it really as simple as animal foods bad, plant foods good?; We seem to have forgotten that, just like meat, vegan food can damage the plane. (Accessed 31 January 2021)
#16	Times (2010). Giving up red meat may not be as green as it seems. (Accessed 31 January 2021)
#17	Guardian (2019). Don't blame meat for the climate crisis, say European livestock farmers; An EU without farmed animals would see a loss of biodiversity and spark a rural exodus, new campaign group claims. (Accessed 31 January 2021)
#18	Guardian (2020). The pandemic highlights the gruesome animal abuses at US factory farms. (Accessed 31 January 2021)
#19	Guardian (2017). More tofu? Supermarkets flesh out their vegan credentials as clean eating grows. (Accessed 31 January 2021)
#20	Guardian (2020). Laugh if you want, but the 'McPlant' burger is a step to a greener world. (Accessed 31 January 2021)
#21	Meat is off the menu as hi-tech rivals thrive; New plant-based substitutes for animal protein will be much cheaper, healthier and greener. (Accessed 31 January 2021)

Reference code	Reference
#22	Guardian (2017). More tofu? Supermarkets flesh out their vegan credentials as clean eating grows. (Accessed 31 January 2021)
#23	Guardian (2020). Oatly gets a sprinkling of stardust as it rides the wave of alt-milk. (Accessed 31 January 2021)
#24	Guardian (2019). Animal Rebellion activists to blockade UK's biggest meat market. (Accessed 31 January 2021)
#25	Guardian (2020). Veganuary is huge. But is it really as simple as animal foods bad, plant foods good?. (Accessed 31 January 2021)

## Summary

Food is essential to human life, yet the current food system is threatening the environment by significantly contributing to climate change and a range of other impacts, including biodiversity loss, terrestrial ecosystem destruction, freshwater consumption, and water pollution. The sustainability of meat and dairy production has become an important concern because of the negative environmental impact of livestock agriculture. Moreover, while meat is an important component of the human diet, scientific studies show adverse health impacts for individuals with high intakes of red processed meat. Taking the environmental and health implications of livestock agriculture and meat consumption into consideration, the importance of diets in determining food system sustainability is paramount. The shaping of dietary consumption patterns has been intertwined with the evolution of the food-processing sector. At the same time, food choices are shaped by societal aspirations, responses to new identities and preferences, and the expression of cultural meaning. Therefore, a change of dietary consumption patterns towards sustainability requires a sustainability transition, radical interlinked shifts in technologies, infrastructures, organizations, markets, regulations, and behavior.

This thesis builds on sustainability transitions literature to advance the conceptualization of transition dynamics in the food system by developing insights into the protein transition case, i.e. the recent reorientation of the food industry towards plant-based meat substitute products. While there are many empirical studies on sustainability transitions in electricity and mobility systems, research on meso-level sustainability transition dynamics in the food-processing industry is limited. This gap is significant when seeking to understand shifts in food production and consumption, because the properties of industrial sectors lead to particular technological paradigms. Consequently, the conceptualization of innovation dynamics derived from previous transitions literature does not necessarily hold for transitions in the food processing industry. This thesis specifically focuses on institutional change processes regarding the emergence and diffusion of plant-based meat substitutes and the behaviour of firms. The chapters in this thesis draw insights from different sustainability transitions frameworks, as well as other streams of social science literature, including organizational science and communication literature.

Chapter 2 maps the development of key innovation dynamics in the protein transition and highlights significant deviations from current sustainability transitions literature. The chapter investigates how plant-based meat substitutes were historically diffused in the Netherlands. The chapter departs from the TIS framework. It applies the motors of sustainable innovation typology to identify patterns of feedback loops that have contributed to the development and diffusion of plant-based meat substitutes. It illustrates that protein transition is a market-driven phenomenon facilitated primarily by

changing norms regarding meat consumption and technological innovation processes within firms. While empirical sustainability transition studies have over-emphasized the bottom-up dynamics of radical innovation processes in the energy and mobility system, the protein transition case highlights the importance of endogenous change enacted by users and incremental improvements in existing products. The chapter introduces the “legitimacy motor of sustainable innovation” to highlight political change processes as a lever for sustainable firm innovation.

Chapter 3 focuses on collective action between firms, public actors, and NGOs, that aims to foster favourable institutional conditions for the meat substitute industry. It adopts a single case study approach and investigates the GPA, a unique example of an alliance network that has implemented collective strategies for promoting plant-based diets in the Netherlands. The chapter combines the TIS system-building perspective with literature on regulatory intermediaries to identify factors that enable or disable network formation between diverse actors. In addition, the chapter investigates the role of alliances in regulating food consumption and potentially accelerating sustainability transition processes. It illustrates that the formation of alliances and ultimately the development of system building strategies as well as the creation of system-level resources are not merely instinctive outcomes of the involvement of new actors in a TIS, but are contingent upon diverse motives, resources and relationships relevant to actors. Moreover, this case shows how private regulatory institutions can provide alternative governance tools for the demand side of the food regime, particularly in the absence of hard regulation.

Chapter 4 studies firms’ behavior, particularly strategic responses of incumbent firms to the emerging meat substitute industry, in the USA, the Netherlands, and the United Kingdom. The chapter includes insights from the international business literature and introduces the concept of entry modes to examine when and how incumbents enter markets for sustainable products. The results show that contrary to previous transitions literature, in this case incumbents quickly engaged with niche products, incentivized by economic opportunities stemming from changing consumption patterns, which preceded any regulatory action. This chapter identifies distinct entry mode patterns for four firm types, including food firms, meat processors, retailers, and food service firms. It shows that the entry modes of different types of incumbent firms vary in their timing and commitment towards the meat substitute sector, as well as how the evolution of these diverse entry modes affects scaling processes in the protein transition.

Chapter 5 comprises a media frame analysis of three UK broadsheet newspapers and identifies frames for plant-based diets and plant-based protein products. It informs actors involved in innovation processes (e.g., technology developers, government agencies, and civil society groups) of important aspects of diffusion, including controversy and

unexpected risks concerning societal reactions. The results show that overall media coverage for plant-based diets has adopted a positive stance. However, there is variation in how plant-based protein products and particularly meat and dairy substitutes are portrayed. The biggest stumbling block appears to be potentially adverse health implications associated with the consumption of meat and dairy substitutes. The chapter therefore argues that the scope of strategic choices regarding product design should also focus on the development of products analogous to whole plant-based foods. Moreover, based on emerging discourses regarding substitutes, this chapter argues that the long-term resilience of the plant-based protein sector will require strategies that convincingly align with policy goals for food security and broader food system sustainability.

## Samenvatting

Voeding is essentieel voor het menselijk leven, maar het huidige voedselsysteem bedreigt het milieu doordat het in aanzienlijke mate bijdraagt aan de klimaatverandering en daarnaast een reeks andere negatieve effecten heeft, zoals het verlies van biodiversiteit, de vernietiging van terrestrische ecosystemen, zoetwaterconsumptie en watervervuiling. De duurzaamheid van de vlees- en zuivelproductie is een belangrijk aandachtspunt geworden vanwege de negatieve milieu-effecten van de veehouderij. Hoewel vlees een belangrijk onderdeel is van de dagelijkse voeding van mensen, tonen wetenschappelijke studies echter aan dat er nadelige gezondheidseffecten zijn voor mensen die veel verwerkt rood vlees consumeren. Als we kijken naar de milieu- en gezondheidsimplicaties van veeteelt en vleesconsumptie, blijkt de duurzaamheid van het voedselsysteem in belangrijke mate bepaald door de dagelijkse voeding van mensen. Hoe voedingsconsumptiepatronen tot stand komen is nauw verweven met de opkomst van de voedselverwerkende sector. Tegelijkertijd worden voedingskeuzes gevormd als gevolg van maatschappelijke ambities, als reactie op nieuwe identiteiten en voorkeuren, en als uitdrukking van culturele betekenis. Een verandering van voedingsconsumptiepatronen in de richting van duurzaamheid vereist daarom een duurzaamheidstransitie met radicale, onderling verbonden verschuivingen in technologieën, infrastructuren, organisaties, markten, regelgeving en gedrag.

Dit proefschrift bouwt voort op de literatuur van duurzaamheidstransities om de conceptualisering van transitiedynamiek in het voedselsysteem te bevorderen door inzichten te verkrijgen in de recente heroriëntatie van de voedingsindustrie in de richting van plantaardige vleesvervangers, met andere woorden de eiwittransitie-casus. Hoewel veel empirische studies handelen over duurzaamheidstransities in elektriciteits- en mobiliteitssystemen, is er slechts in beperkte mate onderzoek gedaan naar de dynamiek van de duurzaamheidstransitie op mesoniveau in de voedselverwerkende industrie. Onderzoek naar dit onderwerp is echter van belang om verschuivingen in voedselproductie en -consumptie te begrijpen, aangezien de eigenschappen van industriële sectoren tot bepaalde technologische paradigma's leiden. Hierdoor is de conceptualisering van innovatiedynamiek zoals die gevonden wordt in de transitieliteratuur niet noodzakelijkerwijs van toepassing op transitie in de voedselverwerkende industrie. Dit proefschrift richt zich specifiek op institutionele veranderingsprocessen met betrekking tot de opkomst en verspreiding van plantaardige vleesvervangers en het gedrag van bedrijven hierbij. De inzichten die worden gepresenteerd in de verschillende hoofdstukken van dit proefschrift komen voort uit verschillende kaders voor duurzaamheidstransities, evenals uit literatuur van andere richtingen in de sociale wetenschap, waaronder de organisatie- en communicatiewetenschap.

Hoofdstuk 2 brengt de ontwikkeling in kaart van de belangrijkste innovatiedynamiek in de eiwittransitie en laat zien waarin deze transitie afwijkt van de huidige literatuur op het gebied van duurzaamheidstransities. In dit hoofdstuk wordt onderzocht hoe plantaardige vleesvervangers zich in het verleden in Nederland hebben verspreid. Het hoofdstuk gaat verder dan het TIS-raamwerk. Het gebruikt de motoren van duurzame innovatietypologie om vast te stellen welke patronen van feedback loops hebben bijgedragen aan de ontwikkeling en verspreiding van plantaardige vleesvervangers. In dit hoofdstuk wordt aangetoond dat eiwittransitie een marktgedreven verschijnsel is dat voornamelijk mogelijk wordt gemaakt door (1) veranderende normen met betrekking tot vleesconsumptie en (2) technologische innovatieprocessen binnen bedrijven. Hoewel empirisch onderzoek naar duurzaamheidstransities teveel nadruk heeft gelegd op de bottom-up-dynamiek van radicale innovatieprocessen in het energie- en mobiliteitssysteem, laat de eiwittransitie-casus duidelijk het belang zien van endogene veranderingen die door gebruikers worden doorgevoerd en ook van geleidelijk toenemende verbeteringen in bestaande producten. Dit hoofdstuk introduceert de “legitimitetsmotor van duurzame innovatie”, waarin politieke veranderingsprocessen worden beschouwd als een hefboom voor duurzame bedrijfsinnovatie.

Hoofdstuk 3 richt zich op gezamenlijke acties van bedrijven, overheidsactoren en NGO's, die gericht zijn op het bevorderen van gunstige institutionele omstandigheden voor de vleesvervangende industrie. Het hanteert een single case study-benadering en onderzoekt de GPA. GPA is een uniek voorbeeld van een alliantienetwerk dat collectieve strategieën heeft doorgevoerd voor het bevorderen van het gebruik van plantaardige voeding in Nederland. Het hoofdstuk combineert het TIS-perspectief met literatuur over regulerende tussenpersonen, om vast te stellen door welke factoren netwerkvorming tussen verschillende actoren mogelijk wordt gemaakt of juist wordt tegengegaan. Daarnaast wordt in dit hoofdstuk onderzocht welke rol allianties spelen bij het reguleren van voedselconsumptie en het mogelijk versnellen van transitieprocessen naar duurzaamheid. Dit hoofdstuk laat zien dat het vormen van allianties en het uiteindelijk ontwikkelen van systeembouwstrategieën alsmede het creëren van hulpmiddelen op systeemniveau niet slechts het resultaat is van de betrokkenheid van nieuwe actoren bij een TIS, maar dat dit afhankelijk is van verschillende motieven, middelen en relaties die relevant zijn voor actoren. Bovendien laat deze casus zien hoe particuliere regelgevende instellingen alternatieve bestuursinstrumenten kunnen bieden voor de vraagzijde van het voedselregime, vooral als er geen harde regelgeving is.

Hoofdstuk 4 bestudeert het gedrag van bedrijven, met name de strategische reacties van gevestigde bedrijven op de opkomende vleesvervangende industrie, in de Verenigde Staten, Nederland en het Verenigd Koninkrijk. Dit hoofdstuk beschrijft inzichten uit de internationale bedrijfsliteratuur en introduceert het concept van toetredingsmodi



om te onderzoeken wanneer en hoe gevestigde bedrijven de markt voor duurzame producten betreden. De resultaten laten zien dat, in tegenstelling tot wat er in eerdere overgangsliteratuur wordt gesteld, in dit geval gevestigde ondernemingen zich al snel bezighielden met nicheproducten, hiertoe gestimuleerd door economische kansen als gevolg van veranderende consumptiepatronen die er eerder waren dan regelgeving. Dit hoofdstuk identificeert verschillende toetredingsmodi voor vier bedrijfstypen, waaronder voedingsbedrijven, vleesverwerkers, retailers en foodservicebedrijven. Het laat zien dat de toetredingsmodi van verschillende soorten gevestigde bedrijven variëren in hun timing en toewijding aan de vleesvervangersector, en ook hoe de evolutie van deze verschillende toetredingsmodi van invloed is op de schaalprocessen in de eiwittransitie.

Hoofdstuk 5 bevat een mediaframe-analyse van drie serieuze Britse kranten en laat zien welke frames er zijn voor plantaardige diëten en plantaardige eiwitproducten. Dit hoofdstuk bevat informatie voor actoren die betrokken zijn bij innovatieprocessen (zoals technologieontwikkelaars, overheidsinstanties en maatschappelijke organisaties) over belangrijke aspecten van diffusie, waaronder controversie en onverwachte risico's met betrekking tot maatschappelijke reacties. De resultaten laten zien dat de media-aandacht voor plantaardige voedingspatronen over het algemeen een positieve invalshoek heeft. Er zijn echter verschillen in de manier waarop plantaardige eiwitproducten en met name vlees- en zuivelvervangers worden afgeschilderd. Het grootste struikelblok lijken de mogelijke nadelige gevolgen voor de gezondheid te zijn die verband houden met de consumptie van vlees- en zuivelvervangers. Het hoofdstuk stelt daarom dat de strategische keuzes met betrekking tot het productontwerp ook rekening moeten houden met de ontwikkeling van producten die analoog zijn aan volledig plantaardige voedingsmiddelen. Op basis van het opkomende debat over vleesvervangers, betoogt dit hoofdstuk ook dat er voor de langdurige bestendigheid van de plantaardige eiwitsector strategieën nodig zijn die op overtuigende wijze aansluiten bij beleidsdoelen op het gebied van voedselzekerheid en de bredere duurzaamheid van het voedselsysteem.

## Dankwoord

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## List of publications

Tziva, M., Negro, S. O., Kalfagianni, A., & Hekkert, M. P. (2021). Alliances as system builders: On the conditions of network formation and system building in sustainability transitions. *Journal of Cleaner Production*, 318, 128616.

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