

Institutional work as a key ingredient of food innovation success: The case of plant-based proteins

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ABSTRACT

In this paper, we use the theory of institutional work to understand how plant-based meat substitutes emerge and successfully diffuse in the context of a dominant meat regime in the United States (US). We observe that institutional factors such as norms, habits, values, and beliefs play a more vital role than previously identified. Therefore, we utilize institutional work theory combined with insights from technological innovation systems to create a holistic understanding of this transition. We study the American plant-based protein industry from 1978 to 2019. We conduct a qualitative event-history analysis based on 2345 events from the Nexis Uni database. We observe that by strategically deploying institutional work strategies aimed at creating, maintaining, and disrupting institutions and innovation system-building strategies, innovation system actors created a favorable environment in which meat alternatives can flourish.

1. Introduction

Global environmental problems have prompted societies to search for more sustainable methods of production and consumption in multiple societal domains. Transitions literature has contributed to a systemic perspective of how these radical shifts in society unfold (Geels, 2002; Kohler et al., 2019; Markard et al., 2012). The most examined topics in transitions literature include the mobility, energy, and water sectors (Markard et al., 2012; Tziva et al., 2020). The food sector, however, has received less attention despite being a substantial contributor to several global environmental problems (Aiking, 2011; Kohler et al., 2019). Within the food sector, the meat industry is responsible for a large majority of adverse impacts, including increasing CO₂ emissions, species loss, land use change, and distorting both the nitrogen and water cycle (Van der Weele et al., 2019). And, while the meat industry is already a significant contributor to several health and environmental problems, the challenges are likely to increase due to a rising global population (Aiking, 2011).

This article specifically focuses on the United States, which can be characterized as a meat-oriented society. In the United States meat is seen as a symbol of masculinity, freedom, economic status, and as an essential part of a nutritious diet (Van der Weele et al., 2019; Modlinska and Pisula, 2018; Sobal, 2005). Also, American meat culture is perceived as a “social norm” and is deeply embedded due to its cultural acceptance, price accessibility, and widespread availability. For example, several American fast-food chains offer beef products to consumers for just one dollar. Healthier options, nonetheless, are often expensive and only largely accessible to the elite (Happer and Wellesley, 2019). As a result, per capita meat consumption is remarkably high and increasing annually (Frank, 2007;

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Godfray et al., 2018).

Recently, however, despite the United States' strong meat orientation, we observe a significant rise in the diffusion of plant-based meat alternatives (PBMA), i.e., food innovations with a similar appearance, taste, and texture to meat. From the early 2010s onwards, several novel startups have entered the United States plant-based meat substitute market. These startups have coined *second-generation* meat substitutes (substitutes that mimic animal meats) or "plant-based meats" and have successfully seen their plant-based products placed on the menu at several of the US' most popular retail outlets. Since these new firms and other industry advocates have entered the market, the United States PMBA industry has grown exceptionally. In 2019, the plant-based meat alternative industry reported nearly \$800 million in yearly sales (Plant Based Food Retail, 2019), and in 2020 alone, sales of plant-based meat grew close to 280%¹ (Keeve, 2020).

This observation creates the main puzzle for this paper: how are entrepreneurs that develop plant-based meat alternatives able to create so much innovation success in a society that is so strongly focused on meat? To solve this puzzle, we utilize insights from two perspectives. First, we use the technological innovation systems (TIS) framework as a conceptual starting point since this framework is highly suitable for creating a holistic understanding of the innovation dynamics of a specific technology.

The TIS framework explains the development and diffusion of systemic innovations such as PBMA as an outcome of collective efforts by multiple actors. A TIS analysis focuses on creating insight into the structure of the innovation system (actors, institutions, and networks) and how the innovation system is functioning. The latter is measured through several key processes that are deemed essential for innovation success (Hekkert et al., 2007; Negro et al., 2008; Markard and Truffer, 2008).

In the food sector, however, we observe that socio-cultural changes such as changes in norms, values, and behavior play a more distinctive role than in other industries. This is because dietary changes are strongly dependent on deeply personal and cultural mechanisms which impact consumer choice (Modlinska and Pisula, 2018). Therefore, we argue that to fully understand the development and diffusion of food innovations like PBMA the TIS framework needs to be enriched by socio-institutional theory.

Literature on transitions in food systems has also highlighted the importance of institutions for the diffusion of meat and dairy alternatives (Lonkila and Kaljonen, 2021; Mylan et al., 2019; Fuentes and Fuentes, 2017; Hundscheid et al., 2022; Tziva et al., 2020). These studies highlight the importance of framing and the construction of promissory narratives which influence consumers' perceptions of plant-based alternatives (Sexton et al., 2019; Lonkila and Kaljonen, 2021). Also, scholars have used social practice theory to examine how transitions to new consumption practices, e.g., veganism, arise through the interactions between shifting competencies, materials, and meanings (Twine et al., 2017; Fuentes and Fuentes, 2021). In the literature on performative economics, scholars have highlighted the importance of consumer-driven marketing strategies which stimulate the diffusion of meat alternatives (Mouat and Prince, 2018; Sexton et al., 2019; Lonkila and Kaljonen, 2021, 2022). For example, Sexton et al. (2019) highlight the role of discourse in creating a market for alternatives. Lonkila and Kaljonen (2022) have also shown that to gain market traction for meat alternative products in Finland companies aim to connect their products to the dominant values, practices, and cultural meanings associated with the meat regime.

Nonetheless, while these studies provide useful building-blocks needed to construct a holistic view of the role of institutions in the PBMA transition, we argue that a more comprehensive perspective of the institutional strategies aimed at PBMA diffusion is still lacking. This is in line with recent calls in the literature on transitions to analyze the role of institutions in transitions more "systematically" (Yang et al., 2022; Hoogstraten et al., 2020; Löhr et al., 2022). For this purpose, we deem the framework of institutional work especially suitable.

The institutional work framework focuses on the collective efforts of actors aimed at achieving institutional change (Lawrence and Suddaby, 2006; Battilana et al., 2009; DiMaggio and Powell, 1983). The inclusion of institutional work theory enables us to gain a more fine-grained perspective into the socio-cultural changes in an innovation system, i.e., it allows us to delve deeper into how innovation system actors influence the institutional environment to accelerate the diffusion of PBMA products.

Incorporating institutional (work) theory with innovation systems is not new per se, as a handful of studies to date have also applied this combination of theories. In most of these studies some of the key processes from TIS theory have been replaced by institutional work categories (see e.g., Yap and Truffer 2019; Binz et al. 2016). Others have only selectively applied parts of institutional theory to innovation systems, e.g., the concept of institutional agency (see e.g., Sotarauta and Mustikkamäki 2015; Wirth et al. 2013; Rogers et al. 2015). We go beyond these existing studies since our starting point is that the institutional work strategies deployed by innovation system actors impact all key processes in an innovation system. We therefore aim to strengthen the institutional perspective in all dimensions of the TIS framework.

We study the plant-based protein transition in the United States from 1978 to 2019. The research question is as follows:

How does combining institutional work with the innovation systems framework result in a better understanding of systemic innovation processes with a strong socio-cultural change component?

The remainder of this article is structured accordingly, Section 2 will introduce and delineate the theoretical framework underpinning this analysis. Section 3 outlines the methods used to guide this study. Section 4 presents the results derived from this analysis. Finally, Section 5 is the discussion and conclusion.

¹ Accounting for the same time period in the prior year.

2. Theoretical framework

2.1. State of the art: the technological innovation systems framework and the role of institutions

The technological innovation systems framework is a prominent framework within transitions literature used to explain the development and diffusion of an innovation (Markard et al., 2012, 2015). By employing a systemic perspective, it explains the mechanisms supporting path-creation for a new technology, technological development processes, and the non-linearity of the innovation process (Hekkert et al., 2007; Kohler et al., 2019; Markard and Truffer, 2008; Bergek et al., 2008). Furthermore, the TIS framework systematically analyzes the influence of structural elements, i.e., actors, institutions, and infrastructure, on an emerging technological field (Hekkert et al., 2007; Markard and Truffer, 2008).

Apart from the structural elements, the TIS framework focuses on several key processes which influence the successful diffusion and implementation of a novel technology. The framework recognizes seven key system processes, i.e., structure-building processes which influence technology development, diffusion, and implementation. These processes enable the build-up of the innovation system surrounding and supporting the novel technology. Namely, entrepreneurial activities [F1], knowledge development [F2], knowledge diffusion [F3], guidance of the search [F4], market formation [F5], resource mobilization [F6], and creation of legitimacy [F7]. These key processes also interact with each other, resulting in positive or negative interactions that can incite or hamper the build-up of the innovation system and institutions. For a complete overview see Hekkert et al. (2007).

Nonetheless, recently, the technological innovation systems approach has been criticized for lacking insight into the institutional structure-building processes. Because the TIS takes a meso-level approach, the framework has been criticized for analyzing institutions somewhat indirectly, with institutions being only a minor aspect of technological change (Bergek et al., 2015; Binz et al., 2016; Fuenfschilling and Truffer, 2016; Kukk et al., 2016; Rogers et al., 2015). Furthermore, scholars have argued that *how* actors actually change institutions in an innovation system remains insufficiently captured as the TIS framework primarily focuses on materiality and does not explicitly examine the micro-level actor strategies aimed at achieving institutional change (Kukk et al., 2016; Binz et al., 2016).

In recent years, this has led to several attempts to further conceptualize the role of institutions in innovation systems (Rogers et al., 2015; Sotarauta and Mustikkamäki, 2015; Wirth et al., 2013; Kukk et al., 2016). Notably, however, literature on institutions in innovation systems to date has predominately focused on conceptually deepening a specific system function (see e.g., Dewald and Truffer 2012; Markard et al., 2016; Yap and Truffer 2019) or has only selectively applied parts of institutional theory to innovation systems, e.g., the concept of institutional agency (see e.g., Rogers et al. 2015; Wirth et al. 2013; Sotarauta and Mustikkamäki 2015).

Binz et al. (2016) have utilized insights from institutional work in order to conceptualize *legitimacy* in an innovation system as an active process in which actors strategically aim to shape, alter, and modify their institutional environments to support a novel innovation. Through the case of California's potable water reuse industry, the authors highlight that legitimization can be differentiated into several phases in which sub-processes (i.e., institutional work activities) are key to building a supportive environment for potable water (Binz et al., 2016).

Like Binz et al. (2016), Markard et al. (2016) have opened-up the process of *legitimation* in an industry to account for processes of institutionalization. The authors convey legitimization in the German biogas industry as a product of shifting institutional context structures, the changing problem agendas of actors, and the emergence of different technology-specific institutional structures over time. Finally, Pelzer et al. (2019) have utilized institutional theory to explain how Uber tried (and ultimately did not succeed) to achieve legitimacy in the Dutch taxi regime by deploying several institutional change strategies targeted at the regulatory environment surrounding taxis in the Netherlands.

Other scholars have further conceptualized the role of institutions in *market formation* processes. For example, Dewald and Truffer (2012) and Moors et al. (2017) take a micro-level perspective on market formation by conceptualizing it as a set of sub-processes, namely, market segments, market transactions, and user profiles, in order to account for actors' active and passive shaping of (local) institutions when attempting to form markets (Dewald and Truffer, 2012; Moors et al., 2017). In addition, Kukk et al. (2016) have utilized insights from the literature on institutional entrepreneurship to convey how institutional entrepreneur Roche was able to strategically undermine the regulatory landscape in England in order to create a market for personalized cancer medicine.

In addition, scholars have further conceptualized *directionality* in innovation systems by introducing insights from institutional theory (Yap and Truffer, 2019; Yang et al., 2022). For example, Yap and Truffer (2019) use insights from institutional entrepreneurship to convey how actors in China's urban water management sector influence the direction of the transition from the bottom-up. Furthermore, the authors conceptualize *guidance of the search* as an institutionally laden process in which actors' visions and expectations, technology standards, and policies influence the direction of innovation.

As a final point, scholars have also selectively applied parts of institutional theory to innovation systems. For example, Wirth et al. (2013) examine how the professional culture and personal identities of farmers influence the diffusion of biogas in Austria. Also, Sotarauta and Mustikkamäki (2015) utilize insights from institutional theory, in addition to the concepts knowledge and power, to convey how innovation system actors were able to institutionalize regenerative medicine in Finland. Finally, Rogers et al. (2015)

utilize the category of creating institutional work in order to explain the emergence and development of diverse water systems in Melbourne.

Nonetheless, while these existing studies have conveyed the importance of a greater understanding of institutions in innovation systems, we argue that a framework to increase the institutional sensitivity of the complete TIS framework (all system functions) is still lacking. This is especially relevant for understanding changes in food systems. We posit that institutional dynamics in the food sector are different than institutional dynamics in the fields that have been covered in the literature thus far - e.g., energy (Markard et al., 2016), pharmaceutical (Moors et al., 2017; Kukk et al., 2016), and the water sector (Binz et al., 2016; Rogers et al., 2015). These sectors are arguably technology-driven and coupled with radical technological innovations (Kuokkanen et al., 2019). Thus, innovation in these sectors is characterized mainly by technologies that must position themselves within strict regulatory environments and also depend on diverse forms of government intervention (hard institutions), e.g., subsidies and feed-in tariffs, for technology diffusion (see e.g., Yang et al. 2022; Moors et al. 2017).

The plant-based meat substitute industry, in contrast, exhibits little government intervention and has been characterized as a low-tech industry where “soft” institutions such as values, belief systems, and everyday routines play a more vital role (Tziva et al., 2020; Fuentes and Fuentes, 2017; Sexton et al., 2019; Lonkila and Kaljonen, 2022; Kuokkanen et al., 2019). Therefore, we expect that innovation system actors in the PBMA industry must rely on different institutional mechanisms in order to establish legitimacy and ultimately diffuse plant-based meat substitutes in the US. We therefore introduce literature on institutional theory to complement insights from the technological innovation systems framework. As opposed to these existing studies, we include the institutional work framework in all functions of the TIS framework.

2.2. Institutional work as an enabler of agency in sustainability transitions

Institutional theory is a central approach in organization science that examines the relationships between organizations and the fields in which they are situated (Battilana et al., 2009; Meyer and Rowan, 1977). While traditional approaches to institutional theory have focused primarily on using institutional contexts as the rationale for organizational similarities, in recent years, attention in the academic community has shifted to examining the role of actors in changing rigid institutional structures (Lawrence and Suddaby, 2006; Battilana et al., 2009; Lawrence et al., 2010). Particularly, emphasis has been placed on actors as “embedded agents,” which are constrained yet enabled by the institutional structures in which they operate (Battilana et al., 2009; DiMaggio and Powell, 1983; Fuenfschilling and Truffer, 2014; Lawrence and Suddaby, 2006).

A prominent approach that examines how actors challenge dominant rule structures is the theory of *institutional entrepreneurship*. The work on institutional entrepreneurship provides the rationale for understanding how actors challenge socio-technical regimes through conscious micro-level strategies. It examines the role of actors’ agency in effectively maneuvering through path-dependent systems and challenging these dominant belief systems (Battilana et al., 2009; DiMaggio and Powell, 1983; Kohler et al., 2019; Meyer and Rowan, 1977). While institutional entrepreneurship is a dominant framework in studies of institutional theory, it primarily focuses on a central “heroic” actor or “heroic” actor group.

Other elaborations, however, have focused on the notion of “distributed agency” which encompasses the vast array of actors that work to change institutions (Lawrence and Suddaby, 2006; Lawrence et al., 2010). Specifically, the *institutional work* framework focuses on the strategic collective efforts of actors aimed at institutionalizing new structures and de-institutionalizing those that are dominant. In order to capture the totality of actors and activities aimed at changing institutions in the United States plant-based protein industry, we draw upon the institutional work (IW) framework of Lawrence and Suddaby (2006).

Since the sole purpose of institutional theory focuses on changing existing institutional structures, it is also important to bring the concept of socio-technical regime on board. The regime constitutes the “rules of the game” in a socio-technical system (Geels, 2004) or “the ‘deep structure’ that accounts for the stability of an existing socio-technical system. It refers to the semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems” (Geels 2011, p.27). In most TIS studies, the regime is not explicitly conceptualized. However, Markard and Truffer (2008) argue that this combination is, in fact, analytically very strong. Therefore, in our empirical case we distinguish between the innovation system and the existing meat-based regime to highlight how actors use institutional work activities to strengthen the innovation system and weaken the regime. Also, we are able to show how regime actors use institutional work strategies to defend existing regime structures.

Lawrence and Suddaby (2006) recognize three broader categories of institutional work, namely, *creating*, *maintaining*, and *disrupting institutions*, see Table 1. Creating institutions encompasses activities aimed at the creation of new formal and informal rule structures, i. e., hard and soft institutions. This is usually (but not exclusively) done by niche actors who seek to legitimize and diffuse their novel alternatives (Geels, 2004; Yang et al., 2022; Löhr et al., 2022). Creating institutions relates to activities that focus on, for example, mobilizing support for new institutions through advocacy campaigning and educating the public, changing dominant belief systems by constructing new meanings, and also asserting property rights that legitimize new institutions (Lawrence and Suddaby, 2006; Zietsma and Lawrence, 2010). Furthermore, by creating institutions actors can both weaken the current regime and support the build-up of a new regime.

Table 1
Forms of institutional work (creating, maintaining, and disrupting) from Lawrence and Suddaby (2006).

Forms of institutional work	Definition
Advocacy (creating)	Mobilizing both political and regulatory support through deliberate efforts and tactics of social suasion.
Defining (creating)	Constructing specific rule systems that create status hierarchies, boundaries for membership or grant status identity.
Vesting (creating)	Creating rule structures which grant property rights.
Constructing identities (creating)	Defining relationships between actors and their organizational field.
Changing normative associations (creating)	Re-making and/or redefining the link between sets of practices and their cultural and moral underpinnings.
Constructing normative networks (creating)	Manipulating the relationship between accepted norms and the institutional field in which they are created.
Mimicry (creating)	Associating new sets of practices with those “taken-for-granted” sets of practices to stimulate adoption and diffusion.
Theorizing (creating)	The development and classification of abstract categories in addition to the elaboration of cause-and-effect chains.
Educating (creating)	Educating individuals to support the new institutions created.
Enabling work (maintaining)	Creating rules that support or reinforce existing institutions, such as creating authorizing agents or redirecting resources.
Policing (maintaining)	Guaranteeing compliance by actors through activities such as enforcement and monitoring.
Detering (maintaining)	The establishment of coercive barriers to change in institutions.
Valorizing and demonizing (maintaining)	Providing the public with both positive and negative examples that convey the normative foundation of specific institutions.
Mythologizing (maintaining)	Maintaining the normative underpinnings of institutions by effectively sustaining the myths of its history.
Embedding and routinizing (maintaining)	Actively incorporating the normative underpinnings of an institution into individual’s day-to-day routines and activities.
Disconnecting sanctions (disrupting)	Institutional work directed at the state (i.e., government bodies) working to disconnect rewards and other government sanctions from a technology, practice, or rules.
Dissociating moral foundations (disrupting)	Activities leading to dissociation of old norms, practices, rules, or technologies from their moral foundation within their specific cultural contexts.
Undermining assumptions and beliefs (disrupting)	Activities which strategically undermine core assumptions and beliefs and result in decreased perceived risks associated with innovation.

Maintaining institutions, on the other hand, refers to institutional work strategies which result in the preservation of existing structures, i.e., the existing dominant institutions that encompass the regime. This category of institutional work is arguably most related to regime agency as regime actors have often been conceptualized in the literature on transitions as having vested interests and supporting the “status quo” (Smink et al., 2015; Penna and Geels, 2012). Furthermore, maintaining institutions relates to activities aimed at sustaining hard institutions, by, for example, introducing sanctions to ensure compliance to existing rules and also “soft” institutional processes such as discursive efforts by powerful actors which denounce new institutions and ultimately motivate actors to stick to the current “way of doing things” (Lawrence and Suddaby, 2006; Fuenschilling and Truffer, 2016).

The final category, disrupting institutions, refers to activities that result in the deterioration of existing institutions and, thus, further weaken the regime (Lawrence and Suddaby, 2006; Zietsma and Lawrence, 2010). The category disrupting institutions comprises activities aimed at, for example, undermining dominant regime-based institutions by conveying them as “unethical” or “morally inadequate” and working to disconnect favorable support schemes from dominant regime technologies and/or practices (Lawrence and Suddaby, 2006; Lawrence et al., 2010).

Each category represents specific forms of work carried out by actors aimed at achieving one of the three goals. By utilizing each category, we can classify the types of institutional work activities deployed by actors in the US plant-based protein innovation system and the counter strategies deployed by the American meat regime.

The inclusion of institutional work enables us to gain a rich understanding of the institutional processes contributing to the diffusion and acceptance of PBMA as a viable alternative to meat in the US. For example, the category *creating* institutional work enables us to explore how PBMA actors create institutions surrounding meat alternatives, e.g., by changing cultural norms which emphasize eating a meat-based diet as routine. *Maintaining* institutional work activities allows us to understand how existing institutions are upheld. For example, lobby efforts by meat industry actors which successfully revoke new institutions supporting PBMA. Finally, the category *disrupting* institutions allows us to examine how innovation system actors disrupt and deteriorate institutions upholding the meat regime, by, for example, debunking the idea that eating meat should be seen as “normal” in American culture.

We thus integrate the IW framework with the technological innovation systems framework. Specifically, we examine what types of institutional work have a major influence on each function of the TIS in order to capture the influence of purposeful institutional change on the diffusion of PBMA in the US.

3. Methods

3.1. Case selection and system boundaries

We employ a descriptive qualitative event analysis by means of a single-case study of the US plant-based protein innovation system from 1978 to 2019. A single-case study is deemed appropriate for this research as it allows for extensive in-depth analysis of a phenomenon (Bryman, 2016). More specifically, it allows us to capture the micro-level processes of institutional work and innovation system-building. We conduct a longitudinal study since it enables the analysis of a phenomenon over time (Menard, 2002).

Furthermore, it allows us to carefully trace developments in the plant-based protein innovation system since the industry's beginnings.

System boundaries are delineated to focus on the plant-based meat substitute food processing sector. This includes product manufacturers which are non-US based but sell their products in the United States meat substitute market, as we expect them to hold influence on the plant-based protein innovation system.

The United States has been selected as a case for this research for several reasons. First, the US currently serves as one of the world's largest exporters of meat (FAO, 2018) and while meat consumption is already high, per capita consumption continues to rise (Kruse, 2019). Also, eating meat is deeply embedded in the US' socio-political context and culture and is often coined as "America's favorite pastime" (Frank, 2007; My Beef with Beef Consumption, 2013). Nonetheless, recently, the plant-based meat sector has exhibited rapid market acceleration. Despite decades of stagnation, the plant-based protein industry has recorded sky-rocketing sales from 2016 onwards. In 2019 alone, over 208 million units of plant-based meat were purchased, totaling the market at 939 million in dollar sales that year (Gaan, 2020). Furthermore, given that the US plant-based protein industry began in the twentieth century and the meat industry is still prosperous, the recent and rapid market acceleration of plant-based proteins remains unexplained.

3.2. Data collection and analysis

The first step of our analysis consisted of mapping the relevant actors, institutions, and networks pertinent to the plant-based protein TIS in the US. This involved collecting secondary data from firm and industry association websites, prominent plant-based protein news outlets, research reports, and scientific literature.

Thereafter, we conducted a qualitative event-history analysis between 1978 and 2019. Data was collected using the Nexis Uni database. The Nexis Uni database is a data source with a wide variety of data from news outlets around the world, including patent data, journals, news articles, press releases, trademarks, and conference call manuscripts (Tziva et al., 2020). The database has been utilized and tested for its accuracy in a myriad of other transition studies and it is specifically suitable for conducting a longitudinal analysis (Negro et al., 2007; Negro and Hekkert, 2008; Suurs and Hekkert, 2009; Tziva et al., 2020).

The database contains some limitations. First, it mostly includes high-profile events reported by the media. As a result, events that gained less visibility may be overlooked, such as activities by more marginal actor groups or activities in knowledge development processes that are deliberately kept secret. Future research could, therefore, conduct additional interviews in order to gain complementary insights. In our specific case, however, this risk of omission is limited, as the PBMA transition in the US is highly politicized and the American meat regime is highly active in the media. Second, some of the data sources could hold biases and also differ in terms of their length and quality. Reporting in US newspapers, for example, could be influenced by the political affiliations linked to the respective region of news coverage. Also, reporters must make choices with regards to what to report and which details to omit. Nevertheless, the strength of the database is that it not only includes several different types of data (e.g., newspaper articles, patents and conference calls) but also a wide variety of sources within each type (e.g., regional and national newspapers). We thus posit that this extensive database provides a sufficiently reliable overview of the institutional work activities deployed in the United States PBMA transition.

To find data specific to the plant-based protein transition, we conducted a preliminary search sample of approximately 100 Nexis Uni sources in order to identify the most used terms for the PBMA transition in the US. This resulted in the following predefined keywords: "meat substitutes", "plant-based proteins", and "plant-based meats" which were used with Boolean operators "OR". The year 1978 was selected as a starting point given that it was the first cited event in the database. While all data sources were read thoroughly, those pertaining to plant-based dairy products were filtered out and deemed not relevant to answer the research question. Additionally, statements reporting the rise and fall of stocks were removed from the search results as they did not provide direct information on institutional work activities or system functions. This resulted in approximately 3900 search results and 2345 relevant and detailed event accounts stored in the database.

As an intermediary step, after the data was collected, the events were classified as ideal event-types. Beginning with the first event in the database, each event was classified until no new event-types were detected. This signified that saturation was reached and resulted in approximately 37 event-types. The inclusion of event-types allowed us to observe which event-types most influenced PBMA innovation system build-up.

As a next step, each event-type was classified according to the system function it fulfills or to one of the institutional work categories. The description of system functions as seen in Hekkert et al. (2007) was utilized as a heuristic tool to properly identify each

Table 2

Examples of how event-types were allocated to TIS functions and forms of institutional work (for a more detailed description see Appendix A).

Event Category	Description	Function	Predominant forms of institutional work
Campaign/awareness initiative	The launch of a cultural, public health, or awareness initiative related to plant-based proteins (e.g., the Meatless Monday Campaign).	7	Advocacy, Educating
Educational program, talk, or workshop	When an educational program related to PBMA is launched. This includes the establishment of courses at universities (e.g., UC Berkeley), webinars, and informational talks.	3	Advocacy, Educating
Survey, study, or report outcome	Studies, reports, surveys, or white papers which provide scientific evidence supporting plant-based proteins.	4	Theorizing
Product launch	The introduction of a PBMA product or ingredient on the market.	1, 7	Mimicry

event in the database. For example, the event-type “campaign/awareness initiative” was allocated to events that discussed a particular cultural, public health, or awareness initiative related to plant-based proteins (e.g., the United Nations International Year of Pulses Campaign and Meatless Monday Campaign) and also linked to function [7] legitimacy and to the institutional work strategy *advocacy* or *educating*, depending on the specific nature of the event. As another example, the event-type “product launch”, e.g., the launch of a meat mimicry product was labeled as the institutional work activity *mimicry* and to function [1] entrepreneurial activities and/or function [F7] legitimacy (see Table 2). For a full overview of how event categories were linked to functions and institutional work activities, see Appendix A.

All events were coded once in order to obtain an accurate overview of the number of events that contributed to PBMA diffusion in the US. A data source could, however, contain multiple events. Duplicates appearing more than once in the database were coded as duplicates. An intercoder reliability check was conducted to ensure the codes were accurately classified. Trademark data was included as an additional indicator for function [F1] entrepreneurial activities, as in the US trademarks can serve as an indicator of both new entrants and products. Events related to regime actors were labeled separately as “regime response” in order to identify the counter strategies deployed by the regime.

Events were then classified as positively (+) or negatively (-) contributing to the diffusion of plant-based meat alternatives. Positive events were classified as positively influencing the build-up of the plant-based protein innovation system while negative events were classified as hindering the development of the system.

4. Results

First, we describe the American meat regime. Thereafter, the results chapter has been divided into three distinct periods within the US protein transition. The periods are divided based on the occurrence of a major development (e.g., significant market growth of plant-based proteins) or the appearance of a key technological breakthrough in PBMA. Each period begins with a brief description of any outstanding developments surrounding plant-based proteins and is followed by a description of the institutional work and innovation system processes present. Finally, the periods that exhibit “regime interaction” include a separate section describing the institutional work dynamics between PBMA actors and the regime.

US Plant-based Protein Innovation System Development (1978-2019)

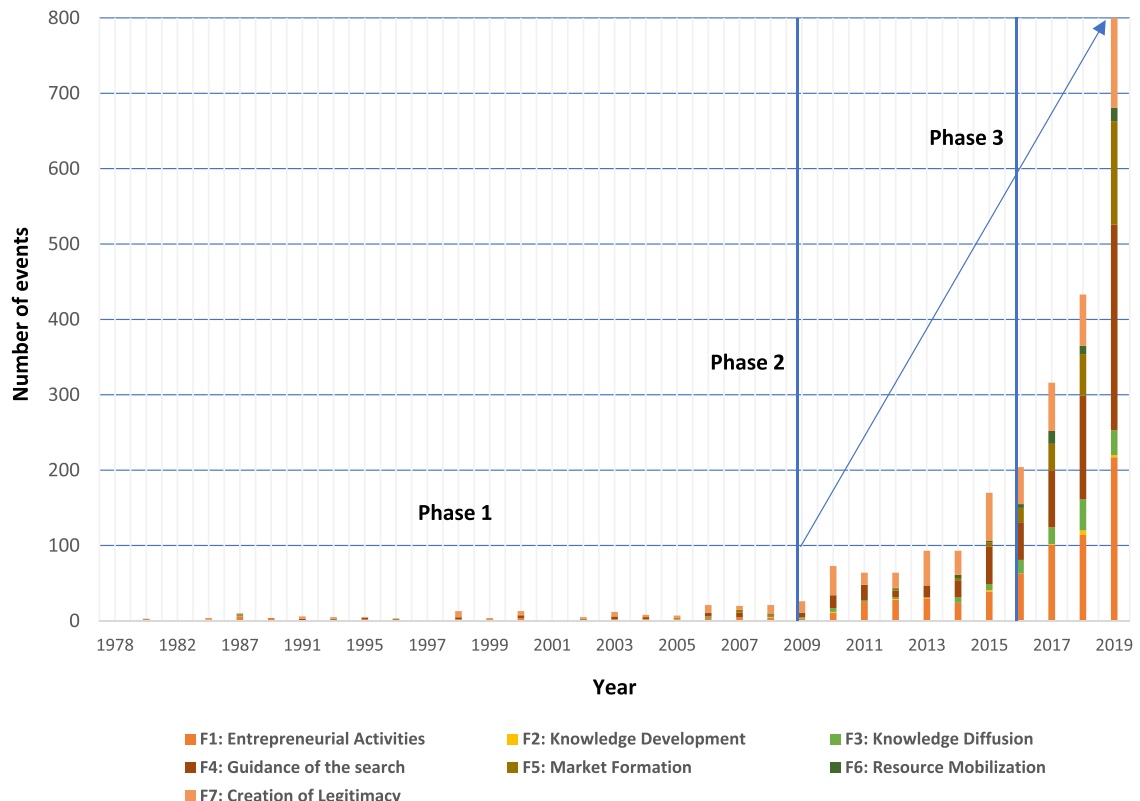


Fig. 1. United States plant-based protein innovation system function fulfillment from 1978 to 2019.

4.1. The American meat regime

For centuries, the meat sector in the United States has been characterized by a highly stable regime. The American meat industry began in colonial times and has since been established as a secure part of American culture (Boyle and Estrada, 1994). In its beginnings, the industry was driven by American family farms located across the country which each had the special tasks of supplying meat to a few thousand citizens. Since then, the industry has developed into a myriad of billion-dollar corporations with massive market power and societal influence (Lisa, 2020).

Today, the meat industry comprises several of the world’s largest meat processors, including Tyson, Hormel, Cargill, and Smithfield Foods. These influential meat producers have contributed to increasing meat consumption numbers in the US. From the 1960s to 2017, meat consumption in the US increased by over 40% (Christen, 2021). In 2018, the average American was expected to eat over 220 pounds of meat yearly (Durisin and Singh, 2018). Since the American meat industry’s beginnings, these companies have exercised immense institutional leverage, playing an active role in influential meat lobby groups. This includes the United States Cattlemen’s Association (USCA), the North American Meat Institute (NAMI), and several others. In addition, these organizations have been extremely successful in allowing the meat industry to evade several of the United States Department of Agriculture (USDA)’s institutions related to meat safety regulations (Johnson, 2002; Shanker, 2015).

Additionally, several informal institutions uphold the American meat regime. First, meat-eating is highly routinized in American society and is perceived as a key part of national identity. For the typical American consumer, eating meat is a regular day-to-day activity and the “default” choice of diet (Bateman et al., 2019; Happer and Wellesley, 2019). Second, meat is associated with freedom of choice and privilege, i.e., eating meat is seen as a privilege to those who can afford it (Frank, 2007; Potts, 2016). Third, meat-eating is also linked to being an expression of masculinity and is associated with stamina, endurance, and vitality (Frank, 2007; Sobal, 2005). Fourth, eating meat is linked to status. This includes status in terms of wealth and prosperity and also status in the hierarchy of food, i.e., meat is seen as an elite food source (Aiking, 2011; Chan and Zlatevska, 2019). To conclude, these institutions have remained the basis for the meat industry since its colonial beginnings.

4.2. Overview of institutional work and innovation system build-up in the American PBMA industry

From 1978–2019 the United States plant-based protein innovation system grew immensely. By January 1st, 2020, 2345 events related to the development of the PBMA industry of which 1564 were institutional work strategies.

Fig. 1 shows the number of events over time. In the first phase (1978–2008), the plant-based protein innovation system exhibited minimal institutional work consisting mainly of *advocacy* and some *educating* activities. This resulted in low function fulfillment. In the second phase (2009–2015), however, actors engaged in increasing institutional work activities aimed at mostly *educating*, *advocacy*, *mimicry*, and *theorizing*, but also new institutional work strategies like *constructing normative networks*, *valorizing*, and *changing normative associations*. These strategies resulted in increasing function fulfillment, especially in legitimacy, guidance of the search, knowledge diffusion, and market formation (see Figs. 1 and 2).

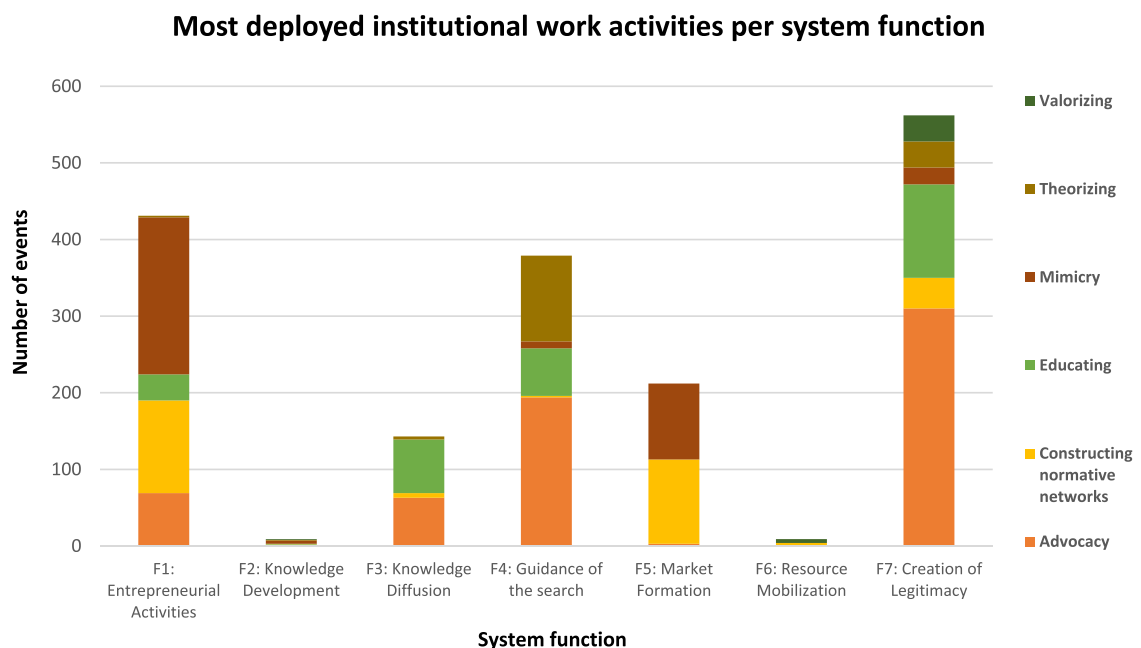


Fig. 2. Graph conveying how institutional work activities contribute to system function fulfillment in the United States plant-based protein innovation system.

Simultaneously, in the second phase (2009–2015), PBMA actors attracted several investors which led directly to resource mobilization for plant-based meat alternatives. This resulted in even more institutional work strategies and was followed by the appearance of regime actors who deployed counter-institutional work strategies (see Fig. 4). In the third phase (2016–2019), we observe that both function fulfillment and institutional work strategies are relatively high and, resultingly, regime actors increased their institutional work strategies (ibid.). The most important institutional work strategies that contributed to PBMA diffusion in the third phase included *constructing normative networks*, *advocacy*, *mimicry*, and *theorizing*, and also the debut of new institutional work strategies such as *constructing identities*.

In the following section, we will investigate these phases in-depth in order to explain how PBMA actors use institutional work strategies to accelerate the diffusion of plant-based proteins and how regime actors aim to strategically counter the diffusion of PBMA.

4.3. Phase 1: the era of meat substitute technology development (1978–2008)

In this period, the first activities related to *creating* institutions were deployed. Despite the strong informal institutions upholding the American meat regime, in the late 1900s the American meat regime exhibited the first signs of vulnerability. In 1992 the US Government engaged in *creating* institutions and released a Food Guide Pyramid (i.e., dietary recommendations to the American public) which placed meat substitutes next to meat (*The Battle of the Pyramids*, 1994). This *educated* the public on the nutritional properties of meat substitutes. Following in 1998, the Food and Drug Administration (FDA) recognized soy, a key ingredient in meat substitutes, as potentially reducing the risk of contracting heart disease. Furthermore, this allowed PBMA producers to include “heart healthy” labels on their soy meat substitutes (*defining*) and contributed to PBMA’s increasing legitimacy in the American market [F7] (*FDA Proposes to Allow*, 1998; *Heart Healthy Labeling*, 1999).

In this period, a few first-generation meat alternative producers were already on the market [F1]. These first-generation product producers engaged in little institutional work activities which were mainly devoted to *advocacy* strategies targeting the “vegan” or “vegetarian” consumer with their products, i.e., those individuals who eliminated (all or most) animal-made products from their diets. First-generation meat substitutes, or textured vegetable protein (TVP) products, are defined as products made from low-moisture extrusion methods and characterized by their rather hard and chewy consistency, i.e., very distinguishable from products made from animal meat (Lin et al., 2000; Tziva et al., 2020). Active first-generation producers at this time included Tofurky, Gardenburger, Morningstar Farms, Lightlife foods, and several others [F1].

During the period, the first signs of *disrupting* institutions were also observed. Although small-scale, first-generation actors deployed strategies that called attention to the meat industry’s negative effects on animal welfare. For example, Tofurky and the People for the Ethical Treatment of Animals (PETA) challenged the highly routinized American tradition of Thanksgiving. Furthermore, these organizations highlighted the benefits of a vegetarian thanksgiving and the cruelty of celebrating the holiday with real turkey meat. PETA launched a strategic TV campaign to *advocate* for a vegetarian thanksgiving and *dissociate the moral foundations* of the traditional American holiday by linking the holiday to murder (Watson, 1998).

Apart from the first signs of institutional work strategies deployed by PBMA actors, several innovation system processes aimed at technology development also demonstrated future industry potential. In 2004, for example, researchers at the University of Missouri (UM) developed a groundbreaking high-moisture extrusion process [F2] which resulted in the creation of meat substitutes with the preferred fibrous structure and meaty flesh-like texture (*Quality Control Adjusted on the Fly*, 2004). This technological breakthrough led to the development of *second-generation* meat substitutes and paved the way for several new entrants and new products [F1].

To summarize, in this period, we witness plant-based protein producers begin to challenge the legitimacy of meat by *creating* PBMA institutions and *disrupting* meat institutions. For example, this was the first time American citizens were confronted with the nutritional value of plant-based proteins and urged to reconsider meat as being healthy, nutritious, and humane (*educating, dissociating moral foundations*). Nevertheless, institutional work activities in this period were rarely deployed (see Fig. 1) and only limited to a handful of key actors. Finally, at the end of the period, we observe actors in the innovation system focusing on knowledge development [F2] related to meat extrusion technology, which paved the way for the next period.

4.4. Phase 2: the era of “plant-based meat” market formation (2009–2015)

This period was coined by the emergence of the “flexitarian”, i.e., individuals seeking to reduce but not eliminate meat consumption (Orgel, 2006). This implied that institutional work strategies stray away from condemning meat consumption, as meat-eaters were the target of this new market (*theorizing*). Accordingly, this period saw the emergence of *second-generation* meat substitutes. Furthermore, due to the previous period’s activities aimed at technological development [F2], *second-generation* meat substitutes now acquired a texture, flavor, and look that closely resembled real meat (Lin et al., 2000; Tziva et al., 2020).

Following the appearance of extrusion technology for *second-generation* meat substitutes, an essential event in this period was that entrepreneur Ethan Brown founded Beyond Meat [F1], a company whose technological expertise stemmed from the high-moisture extrusion research [F2] at UM. Moreover, Beyond Meat coined *second-generation* “plant-based meat” (*theorizing*), something the industry had never seen before. In 2011, following suit, Impossible Foods was founded [F1], Beyond Meat’s soon-to-be top competitor and industry rival. These new entrants began challenging the American meat industry by debuting new forms of *creating* institutions.

Firstly, Beyond Meat and Impossible Foods theorized their novel meat analogs as meat products without the negative effects associated with animal proteins (*Beyond Meat Plants*, 2015). This increased the legitimacy [F7] of PBMA and raised expectations surrounding their future potential [F4]. For example, from 2009 to 2015 the number of events related to legitimacy increased from 66 in the prior period to 235 in this period. The number of events related to guidance of the search increased from 37 to 142, respectively

(see Fig. 1).

These novel entrepreneurs conveyed to the American public that consumers could enjoy a beef burger without contributing to climate change and that these new products would only get better. By using these *theorizing* strategies, Beyond Meat and Impossible Foods attracted many flexitarian consumers as they made the transition from animal meat to plant-based meat seem effortless (*mimicry*). In 2012, Beyond Meat debuted its first *mimicry* strategy bringing plant-based chicken strips to the American market [F1] (*Plant Based Meat, 2021*). The goals of these disruptive plant-based meat producers were to perfectly *mimic* animal attributes [F1], e.g., muscles and blood (*Steven and Voorhes, 2015*). The first successes of the *mimicry* strategy were demonstrated to the American public when profound New York Times food critic, Mark Bittman, characterized Beyond Meat’s chicken strips as almost indistinguishable from real chicken. Furthermore, this further raised expectations regarding the future of the PBMA industry [F4] (*Bonner, 2012*).

During the period, several other entrepreneurs entered the market and also deployed *mimicry* strategies, which directly increased legitimacy and entrepreneurial activities [F1, F7]. For example, the number of entrepreneurial activities increased from 43 events in the prior period to 160 events in this period (see Fig. 1). New entrepreneurs during the period included Sweet Earth, No Evil Foods, and even plant-based seafood companies. This signified that the PBMA innovation system was growing and, as a result, created increasing opportunities for PBMA actors to further *create* institutions. These second-generation producers were seen *mimicking* popular meat and fish products, including burgers, bacon, and tuna [F1]. In addition, some entrepreneurs even went as far as to *mimic* popular flavor profiles often applied to meat products such as BBQ, Tuscan, and Chipotle (*Sweet Earth Natural Foods, 2015*).

Amidst obvious signs of increasing product quality [F1, F2] and potential consumer interest [F5], Beyond Meat and Impossible Foods were able to engage in additional innovation system activities. Throughout the period, both firms received a continuous influx of investments [F6] from high-profile individuals and venture capitalists, including the founders of Twitter, Bill Gates, and Google Ventures (*Chiu, 2015*). This signified that even the US’ most successful businesses sought to participate in the growing plant-based protein industry’s promising future. Furthermore, this increase in resources was followed by even more research and technological development [F2] as new and better products entered the market [F1, F5].

Aside from this, the period also featured increased government support for plant-based proteins which led directly to knowledge diffusion [F3] and legitimacy of PBMA [F7] (see Figs. 1 and 2). For example, the US Department of Agriculture launched a novel icon to help Americans plan healthier diets and *educated* consumers on the nutritional value of plant-based proteins as opposed to meat-based products. Known as “MyPlate”, the website *advocated* for plant-based protein consumption by allowing consumers to create mock meals which included many plant-based proteins (*Heart Healthy Grilling, 2011*).

With the intentions to continue creating a market and enhancing the legitimacy [F5, F7] of PBMA, novel entrepreneurs were also seen deploying activities aimed at further *creating* and *maintaining* institutions. This included engaging in strategic partnerships with high-profile athletes, restaurants, and some grocery chains. Beyond Meat, for example, formed strategic partnerships with elite athletes (*constructing normative networks, valorizing*), which directly increased the legitimacy of PBMA [F7]. This included athletes from the National Basketball Association (NBA), Women’s National Basketball Association (WNBA), Major League Baseball (MLB), and the World Surf League (WSL), all of which were highly respected American organizations traditionally known to promote and help

Most deployed institutional work strategies by PBMA innovation system actors (2009-2015)

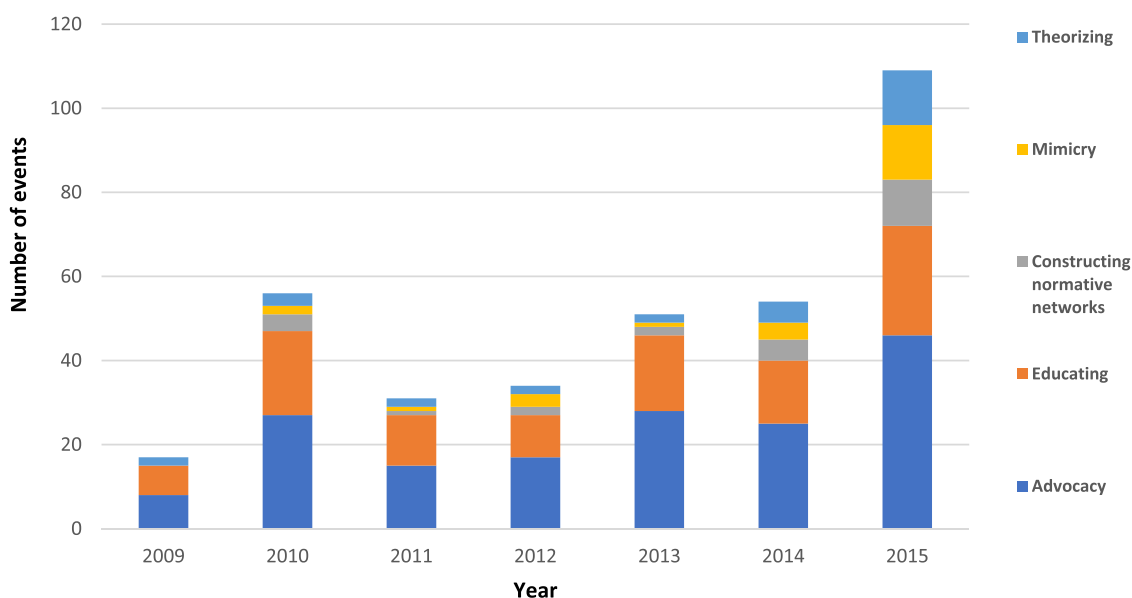


Fig. 3. The most frequently deployed institutional work strategies by PBMA innovation system actors per year (2009–2015).

advertise for the meat industry. Also, Beyond Meat and Impossible Foods were added to the menu at several high-profile restaurants and grocery chains such as Whole Foods. Whole Foods, for example, offered these novel products to consumers in prepared formulations, ultimately leading to increased market access [F5] for PBMA products (see Figs. 1 and 2).

Innovation system actors were able to leverage these *new networks* and engaged in enhanced campaigning (*advocacy*) throughout the period which reinforced the legitimacy [F7] of PBMA in the American market. Beyond Meat, for example, launched a global campaign, The Future of Protein, and deliberately aimed to *change normative associations* for the first time. The campaign featured several high-profile athletes (*valorizing*) stating how eating plant-based meat has given them increased performance, strength, and agility, arguably qualities linked to meat consumption. The campaign deployed a communicate-by-example strategy, which featured several photographs and videos of professional athletes exploiting their masculinity and talking about how switching to a plant-based diet has drastically impacted their athletic abilities (*changing normative associations*) (Beyond Meat Plants the Future, 2015). Furthermore, these campaigns meticulously brought into question meat as a symbol of masculinity (i.e., *disrupting institutions*) all the while creating legitimacy for the PBMA industry [F7] (see Fig. 1).

Similar *advocacy* campaigns continued to spread throughout the period and further added to the innovation system’s legitimacy [F7] (see Figs. 1 and 2). For example, in preparation for the 2014 United Nations Climate Summit, Beyond Meat *created* institutions and joined a collaboration with the (global) Meat Free Monday Campaign and Meatless Monday Campaign (*constructing normative networks*). The actors held a Meat Free Monday Pledge Brunch in which they urged consumers to take part in the battle against climate change (and the meat industry) and *advocated* for PBMA (Pledge Brunch Spotlights U.N., 2014).

During the period, the PBMA industry also gained recognition from universities, which led directly to knowledge diffusion [F3] and legitimacy [F7] of PBMA (see Fig. 1). Throughout the US, universities were seen *creating* institutions and adopting the Meatless Monday campaign (*advocacy*). By 2011, nearly 80 universities across the United States had incorporated plant-based proteins into their menus, including UC Berkeley, UC Davis, Harvard, and Stanford (Going Back to School, 2010; Where’s the Beef, 2010).

The Meatless Monday campaign called attention to the adverse environmental impacts stemming from meat production and strategically targeted environmentally conscious millennials (*educating*). The campaign actively swept through numerous college campuses across the US *advocating* for the plant-based industry and *educating* students on the importance of promoting sustainable food systems. Aside from *educating* students, universities also engaged in chef-training initiatives. One of which was the “Menus of Change Initiative”, founded by Stanford University and the Culinary Institute of America, in which chefs across the US were strategically trained to shift their menus away from focusing primarily on meat and instead trained to include plant-based proteins (*educating*) (Culinary Institute of America, 2015; Krummert, 2016). By the end of the period, hundreds of American universities and colleges were seen adopting the Meatless Monday campaign (*advocacy*) and engaging in chef-training initiatives. Furthermore, these actors fully

Regime institutional work strategies: Phase 2 and 3

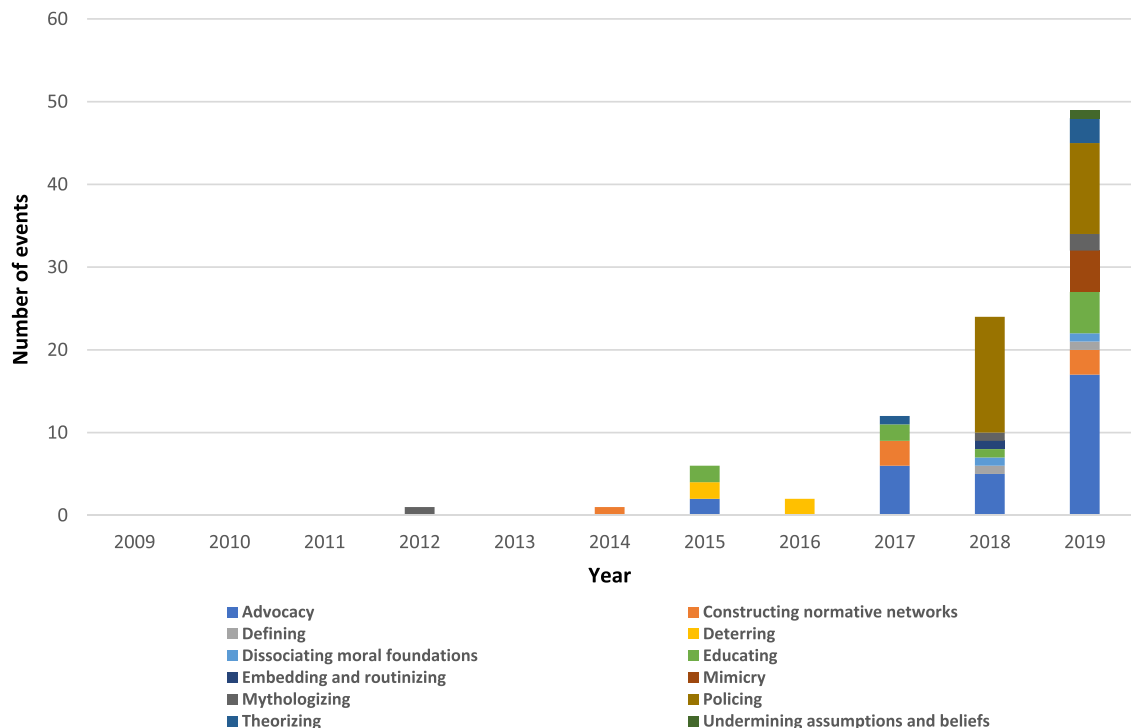


Fig. 4. Institutional work strategies deployed by regime actors in phase 2 and phase 3 (2009–2019).

welcomed the soon-to-be macro-trend sweeping across the US.

To summarize, overall, we observe a distinct pattern between the increasing number of institutional work activities and function fulfillment. As opposed to the prior period, in this period we observe the appearance of new *types* of institutional work strategies and the appearance of new actors who were able to contribute to the number of institutional work strategies deployed. For example, the number of most deployed institutional work activities increased from 82 events in the prior period to 352 in this period (see Fig. 3). This resulted in a sharp increase across almost all functions (see Fig. 1).

To elaborate, the beginning of this period was marked by the emergence of even better technological aspects [F1, F2] which resulted in a new category: “*plant-based meats*” (*theorizing*). As actors latched on to this *theorizing* strategy, they raised expectations [F4] regarding the potential of plant-based meat alternatives and increased their legitimacy as a viable alternative to animal meat [F7]. As a result of this new category, new entrepreneurs [F1] were able to enter the plant-based space and contribute to the rise in the number of plant-based meat products on the market [F5]. Simultaneously, this rapidly growing category and enhanced product technology resulted in immense investor attraction [F6]. This, in turn, positively influenced technological development [F2] and market creation [F5] as novel entrepreneurs were awarded additional resources [F6] to invest in enhancing and scaling-up their products and, therefore, could *construct normative networks* with retailers. By *constructing normative networks*, actors were able to gain increasing legitimacy [F7] for PBMA by engaging in large-scale campaigns (*advocacy*) which featured high-profile athletes demonstrating the successes associated with adopting a plant-based diet (*changing normative associations, valorizing*). Finally, knowledge diffusion [F3] increased during the period due to *educating* strategies aimed at educating millennials and universities on how to incorporate PBMA into their day-to-day routines [F3].

4.4.1. Interaction with the regime

As a response to the rising success of PBMA, the second period was marked by the debut of clear regime resistance strategies in which regime actors worked to *re-create* meat-based institutions and *maintain* meat’s position at the center of the American diet. This is shown in Fig. 4. The period witnessed regime actors engage in several institutional work activities aimed at countering the diffusion of PBMA. The most important counter strategies in this period were *advocacy, deterring, educating, and mythologizing*.

In the wake of Beyond Meat’s strategic partnerships, the Washington Cattlemen’s Association (WCA) voiced their concerns about the growing competition from PBMA actors. The association was featured in the news stating that these “fake meat entrepreneurs” would face trouble with the American public. Furthermore, they assured the public that given meat’s long history in the US, real meat was undoubtedly what was to remain on plates now and in the future (*mythologizing*) (Banse, 2012).

Meat industry trade groups also participated in *creating* efforts aimed at maintaining meat’s embeddedness in the US. This included launching several consumer-targeted *advocacy* campaigns such as the 30-day Protein Challenge. The 30-day Protein Challenge, created by the National Cattlemen’s Beef Association (NCBA), focused primarily on making consumers feel positive about consuming meat and highlighted aspects such as meat’s nutritional qualities (*educating*). Furthermore, these campaigns strategically utilized targeted marketing to encourage millennials, those highly driving the plant-based protein transition, to continue eating meat (Dudlicek, 2015). Furthermore, these initiatives signified that the threat to the longstanding meat industry was real.

Regime campaigning was also accompanied by *maintaining* institutional work strategies which exemplified the meat industry’s long-held legitimacy in the US market. In 2015, the USDA released another draft of its Dietary Guidelines (i.e., the USDA’s food recommendations for the American public). This time, in a lengthy report based on thousands of scientific studies, the guidelines strictly advised consumers to switch to plant-based diets and reduce their meat intake. Once again, the meat industry did not stay quiet, resulting in a fierce lobby. The meat industry called on the USDA to revise the final report, which would *not* suggest that consumers change their meat consumption habits and instead would further *embed* meat into American’s everyday diets. The published report did not denounce meat eating, yet only recommended not exceeding 26 ounces. Furthermore, the meat industry experienced a dramatic win as it successfully convinced the USDA to suppress its plethora of scientific findings and remove the recommendations from the report (*deterring*) (Silver, 2016; Duhaime-Ross, 2016; Meat Industry Wins, 2016). Nevertheless, by the end of the period, the US plant-based meat substitute industry was estimated to be the world’s largest, valued at over 850 million dollars (The Plant-based Foods Association, 2019).

4.5. Phase 3: the era of “plant-based meat” market acceleration (2016–2019)

While the previous period focused on PBMA market formation, this period is marked by the massive market acceleration [F5] of PBMA fueled by additional forms of *creating, maintaining, and disrupting* institutions (see Fig. 1). By the beginning of 2016, products introduced and marketed as plant-based proteins saw a 98% increase, indicating that industry potential was real (Tolchard, 2017).

The market acceleration that marks this period was also visible in the expansion of the innovation system and a stark increase in the number of institutional work activities. During this period, public environmental awareness increased and resulted in several new entrants joining the scene and further *creating* institutions, e.g., the Herbivorous Butcher and NewWave Foods [F1] (Kennedy, 2017; Watson, 2018a). Strikingly, the number of events related to entrepreneurial activities increased from 160 in the prior period to 494 in this period (see Fig. 1).

In the prior periods, the innovation system was sustained by a handful of key entrepreneurs, however, in this period new *types* of PBMA producers, industry advocates, and lobby organizations contributed to the growth of the plant-based innovation system. In this period, not only did the PBMA innovation system significantly expand, but these new entrants also acquired new roles which resulted in several new institutional work strategies.

By the middle of 2019, the industry showed signs of a more-than-promising future reinforced by several market breakthroughs

[F5]. In May 2019, Beyond Meat made its Initial Public Offering (IPO) market debut and was established as the first vegan company to go public on the American stock market ([Beyond Meat Goes Public, 2019](#)). Additionally, the period featured novel entrepreneurs substantially increasing their market access [F5] through a myriad of partnerships and co-promotions with prominent American fast-casuals and Quick Service Restaurants (QSRs), e.g., Burger King, Taco Bell, and Kentucky Fried Chicken (KFC) (*constructing normative networks*). This was seen as another significant win for the plant-based industry as these food service providers offered their own versions of Beyond Meat and Impossible Food's products. For example, Burger King reformulated its star product, the Whopper, and introduced a plant-based "Impossible Whopper" (*mimicry*) ([Taylor, 2019](#)). These institutional work activities contributed directly to legitimacy [7] and market formation [F5] during the period (see [Figs. 1 and 2](#)).

While *advocacy* strategies in prior periods were primarily deployed by entrepreneurs and universities, in this period, highly respected American organizations such as doctors and food safety organizations also joined the battle against meat. For example, the Physicians Committee for Responsible Medicine (PCR), a nonprofit health organization consisting of approximately 12,000 US doctors, protested in front of the White House calling on Americans to break their meat-eating habits (*dissociating moral foundations*) ([Doctors Rally at Whitehouse, 2016](#)). Furthermore, these activities resulted directly in the legitimacy of PBMA [F7], as this time American doctors (those formerly supporting meat consumption) were going against the deeply entrenched meat industry.

The period also featured *new* forms of institutional work strategies which also led to increasing industry legitimacy [F7] and raised expectations [F4]. For example, the number of events related to legitimacy increased from 235 to 340, respectively. Also, the number of events related to guidance of the search increased from 142 in the prior period to 536 in this period (see [Fig. 1](#)).

The *construction of identities* debuted as an additional form of work deployed by plant-based protein actors. New types of actors entered the market and established themselves as plant-based "butchers". This included the Herbivorous Butcher, Bauhaus' Atlas Meat-Free Delicatessen, and several others ([Kennedy, 2017](#); [Tran, 2016](#)). These new entrants deployed enhanced *mimicry* tactics and were seen replicating distinct cuts of animal meat. Furthermore, due to additional technological development [F2], these plant-based "butchers" further challenged the meat regime by *theorizing* that butcher meats could indeed be plant-based.

Additionally, organizations acquiring the *identity* of plant-based protein industry advocates and trade organizations joined the scene. For example, the Good Food Institute was established to mobilize government research funding [F6] and provide strategic support to PBMA actors (*constructing normative networks*) ([The Good Food Institute, 2017](#)). The Good Food Institute engaged in immense resource mobilization strategies during the period [F6] by, for example, allocating funding to universities to research PBMA. Also, the organization offered courses at UC Berkeley (e.g., "the Plant-Based Meat Challenge Lab") which trained the next generation of students to create plant-based meats (*educating*) ([Tolchard, 2017](#)). As a result, these *educating* strategies led to increasing knowledge diffusion [F3] during the period (see [Figs. 1 and 2](#)).

Another prominent organization that joined the industry during this period was the Plant Based Foods Association (PBFA). The PBFA is an organization working to represent the interests of plant-based protein actors in the US and specializes in activities such as lobbying, networking, and providing consumer insights (*constructing normative networks*) ([Plant Based Foods Association, 2019](#)). The Plant Based Foods Association was the first organization to attempt to *define* what it meant to be part of the plant-based category. The organization drafted its own voluntary labeling standards for plant-based food producers. Furthermore, the PBFA made adherence to these labeling standards a specific requirement for its plant-based label, a certification only available to products that were solely made of plant-based proteins, also directly increasing the legitimacy [F7] of PBMA products ([Plant-Based Food Retail, 2022](#)).

Apart from creating the industry's own form of standards, PBMA entrepreneurs were also seen adhering to existing FDA, Non-GMO, and GRAS standards ([Beyond Meat Announces, 2018](#); [White Castle Now Sells, 2018](#)). For example, Impossible Foods gained Food and Drug Agency (FDA) approval, which deemed its "bleeding" plant-based meat alternative as safe to be sold and also granted the company several new market opportunities [F5] (*defining*) ([White Castle Now Sells, 2018](#)). These standards had long been established in the food industry as indicators of safe and quality foods. Furthermore, during the period it became increasingly clear that while PBMA actors aimed to create their own terms of compliance, a necessary component of industry legitimacy [F7] was also fitting into existing standards.

Novel entrepreneurs also greatly contributed to guidance of the search [F4] during the period through new forms of *disrupting* and *creating* institutions (see [Fig. 1](#)). Beyond Meat and Impossible Foods engaged in activities that reduced the *perceived risks* associated with transitioning to a plant-based diet. For example, Beyond Meat published its products' protein content, conveying to the American consumer that plant-based meat alternatives offered a nutritious amount of protein ([Just in Time, 2018](#)). Also, Impossible Foods *theorized* the effects of shifting to a plant-based diet. The startup engaged in scientific studies which conveyed that producing plant-based meat requires fewer resources than traditional methods. In 2019, Impossible Foods published its first sustainability report addressing the company's rigorous environmental mission. The report highlighted that producing an Impossible Burger requires nearly 80% less water, releases approximately 90% less greenhouse gas emissions, and requires over 90% less land than a traditional beef patty ([Impossible Foods Launches Sustainability, 2017](#)). These entrepreneurs also appeared in the media pledging that within the next decade plant-based meats would be equivalent to the price of animal meats. Furthermore, this debunked the idea that plant-based proteins would remain more costly than animal meat and raised expectations of PBMA [F4] (see [Figs. 1 and 2](#)) ([Taylor, 2019](#)).

To summarize, in this period actors engaged in even more institutional work strategies leading to immense market access [F5], entrepreneurial activities [F1], guidance of the search [F4], legitimacy [F7], and resource mobilization [F6] (see [Fig. 1](#)). The most important strategies in the period were *advocacy*, *constructing normative networks*, *theorizing*, and *mimicry*, while *constructing identities*, *defining*, and *undermining assumptions and beliefs* also contributed to system acceleration. Unlike the prior periods, this period saw the innovation system maturing through the entrance of new types of actors deploying *mimicry* strategies [F1, F7] and additional resource allocation [F6]. As a response to increasing legitimacy, novel entrepreneurs also gained substantial market access [F5] by *constructing normative networks* with prominent food service providers. In addition, the entrance of highly respected American organizations which

advocated for the PBMA industry and new types of innovation system actors which acquired *new identities* and *defined* the category led to increased industry legitimacy [F7]. Finally, by *theorizing* and *undermining the assumptions and beliefs* of PBMA actors also contributed to guidance of the search during the period [F4] (see Figs. 1 and 2). As a result, by 2019, plant-based protein consumption was estimated at approximately \$4700 million (United States Plant Protein, 2020).

4.5.1. Interaction with the regime

In response to the increasing market success of PBMA, in this period some of the meat industry's top meat processing companies joined the plant-based space. For example, incumbent meat producer, Tyson Foods, invested a 5% stake in Beyond Meat [F6]. This made Tyson the first major incumbent meat producer to invest in a PBMA company (Lee, 2016; Yaffe-Bellany, 2019). A few years later, the meat producer even pulled out its stake in the company to launch its *own* plant-based protein brand [F1], Raised and Rooted (Nutrition Capital Network, 2017). Following suit, several other Big Food incumbents, i.e., multinational incumbent food producers, also entered the market and deployed *mimicry* strategies (see Fig. 4) [F1]. Furthermore, this indicated that even the meat industry's own organizations were beginning to doubt the future of meat in the United States.

While several meat regime incumbents joined the plant-based space, the plant-based industry was, nevertheless, still met with resistance. The period also featured several counter-institutional work strategies deployed by the American meat regime. The most important regime institutional work strategies during the period were *policing*, *advocacy*, and *educating* (see Fig. 4). For example, Arby's, a prominent fast-food beef retailer, engaged in alternative campaigning efforts and introduced the "Marrot" (*advocacy*). The Marrot was a carrot made from turkey breast (i.e., a vegetable made from meat) which aimed to convey to consumers that meat should replace vegetables. Furthermore, the campaign included promotional videos which *advocated* for the meat industry and *educated* consumers on how to create their own Megetables (Arby's Boasts the Merits, 2019).

Another actor strategy heavily deployed by regime incumbents during this period included *policing* in which regime actors aimed to restrict the labeling of PBMA products (see Fig. 4). These strategies resulted in numerous labeling laws being passed in nearly 20 US states, including Montana, South Dakota, Mississippi, Arizona, Arkansas, and Missouri (Dominique, 2019; Judge Declines to Block, 2019; Malone, 2019). The rationale behind these laws was that a label such as "plant-based meat" could be deceiving to consumers and dissuade them from purchasing animal meat. The first state to pass the "truth-in-labeling" law charged PBMA companies 1000 dollars for violating these terms with the possibility of jail time (Missouri Meat Law Increases, 2018). However, the meat industry was divided. The attempts made by meat industry groups to regulate PBMA labels were condemned by NAMI. NAMI members such as Tyson and Cargill were seen in the media stating that the industry's calls to ban the use of the term meat on plant-based products were "ill-considered". In other words, these regime incumbents were seen going against their former allies (Watson, 2018b).

Despite the new policy put into effect in some states, the plant-based meat industry did not stand down and proceeded to deploy institutional work strategies. This resulted in the *construction of normative networks* between parties not previously seen to work together. For example, in Missouri, the Animal Legal Defense Fund, Tofurky, the American Civil Liberties Union of Missouri, and the Good Food Institute came together to sue the state of Missouri for the law (Watson, 2018b). Other states saw similar efforts and lawsuits filed because of the First Amendment and free speech. The meat industry was again taken by surprise, as these actors were able to utilize their resources and legitimacy to fight for the PBMA industry. In November 2019, the plant-based protein industry scored its first win in the state of Mississippi resulting in its labeling ban being lifted. Soon after, the Arkansas state legislature also temporarily retracted its ban (Judge Blocks Law, 2019; Sibilla, 2019).

Amidst labeling wars, regime actors also participated in several additional *creating* activities. For example, meat industry actors created a website called FactsAboutBeef.com. The website not only *advocated* for meat consumption but also published science-based evaluations of the nutritional content in animal and plant-based proteins. The website aimed to convey to consumers that consuming lean meats was nearly as nutritious as plant-based proteins (*educating*, *theorizing*). Posts similar to these were not only shared on the website but also on several other social media channels such as the @BeefFacts Twitter page (Shutting the Gate, 2017).

5. Discussion and conclusions

We argue that the development and diffusion of PBMA in the United States can best be explained by combining technological innovation systems with the institutional work framework. Combining both perspectives helps to understand the co-evolutionary interplay between purposive institutional work strategies by innovation system actors and the build-up of the PBMA innovation system.

In this conclusion, we formulate five contributions this paper makes by combining technological innovation systems with the institutional work framework.

As a first finding, we found that each system function is supported by a wide variety of institutional work activities. As opposed to most existing studies which incorporate TIS with institutional (work) theory, we found that without the full integration of both frameworks we do not sufficiently capture the role of institutional change in innovation diffusion. In our case, we observe that, for example, *constructing normative networks* leads to the formation of a market for PBMA. Also, activities such as *mimicry* result in both legitimacy and entrepreneurial activities. Therefore, by only focusing on parts of institutional work or technological innovation systems we fail to fully understand the institutional processes which result in the fulfillment of system functions and thus, the diffusion of PBMA in the US.

As a second finding, we observe that institutional work activities which result in the fulfillment of one function may lead to the fulfillment of several different functions over time. For example, in the US PBMA transition, actors deployed *mimicry* strategies which almost instantly led to the increasing legitimacy of PBMA in the American market. As a result, this increasing legitimacy enabled PBMA

actors to engage in other forms of institutional work, e.g., *constructing normative networks*, as they were able to form partnerships with prominent QSRs. Resultingly, these new partnerships also contributed to the creation of a market for meat substitutes as these QSRs began to offer PBMA products on their menus. Furthermore, without a comprehensive view of the institutional change processes in all functions, we would fail to observe the interactions between institutions and functional processes.

As a third contribution, we observe that in the PBMA transition “soft” institutional work activities lead to plant-based protein actors building the innovation system around PBMA. In the US PBMA industry, we see that several of the most deployed institutional work activities were *mimicry*, *theorizing*, *advocacy*, *educating*, and the *construction of normative networks*. In other words, activities that aim to alter “soft” institutions, like belief and meaning systems (Löhr et al., 2022). This is in line with Tziva et al. (2020) who also highlight the importance of cognitive and normative institutions in the diffusion of plant-based proteins in the Netherlands. Furthermore, as opposed to existing literature on the role of institutions in transitions which highlights the importance of “hard” institutions in stimulating innovation diffusion (e.g., Pelzer et al. 2019; Yang et al. 2022) our case conveys that in the food sector strategies aimed at changing “soft” institutions may be more important.

As a fourth contribution, we observe that the types of institutional work that matter for PBMA diffusion may vary in different phases of the transition. For example, in the first phase, we observe that *advocacy* and *educating* strategies are key to stimulating knowledge diffusion and legitimacy of PBMA. These findings counter Binz et al. (2016) who find that in early stages innovation system actors benefit from *constructing normative networks* and *theorizing*. We therefore hypothesize that in the food sector *advocacy* and *educating* strategies may be key to innovation diffusion in early stages, as without sufficient knowledge of the benefits of adopting plant-based diets consumers may be hesitant to change their deeply engrained eating patterns. Furthermore, in our case we observe that it is not until knowledge diffusion and legitimacy are sufficient that actors can engage in other strategies such *constructing normative networks*. Thus, these strategies become important in later phases of the PBMA transition.

As a final finding, by combining institutional work with the technological innovation systems framework we observe that niche and regime actors deploy largely different strategies. In our case, we observe that innovation system actors mostly *create* and *disrupt* institutions. These institutional work strategies are primarily focused on changing “soft” institutions, i.e., values, beliefs, and cognitive associations. On the other hand, regime incumbents mainly deploy *maintaining* strategies in the form of, for example, *policing* and *detering* but are also observed diverging from the “status quo” in attempts to *create* institutions. This is in line with Löhr et al. (2022) and Yang et al. (2022) who have also conveyed that regime actors do not always aim to uphold existing institutions and, therefore, may also attempt to *create* or *disrupt* institutions. In our case, we see that once PBMA are relatively close to breaking out into the regime, some regime actors resort to *creating* institutions and also proactively support the transition to PBMA in the US. As an addition, we also observe that some regime actors also *re-create* institutions related to meat. For example, in our case we see that as PBMA rise in popularity, regime actors aim to defend meat’s position in the US by engaging in *advocacy* and *educating* strategies. Furthermore, these *creating* strategies are not targeted towards the diffusion of PBMA but instead are aimed at further embedding meat in American culture.

With regards to the implications of our findings, the case of PBMA diffusion in the US highlights the importance of altering belief and meaning systems while also still reinforcing the current “way of doing things”. Compared to other transition trajectories such as the unprocessed plant-based protein route, the *mimicry* strategy deployed by PBMA actors seems to be much more aligned with existing regime practices as plant-based meat substitutes still aim to replace meat. In the unprocessed plant-based protein trajectory, however, actors are forced to learn completely new sets of practices, e.g., cooking methods and shopping routines (Fuentes and Fuentes, 2021). Therefore, because the PBMA transition allows many actors to transition to plant-based food consumption and production with only minor inconveniences, we question whether the *mimicry* strategy will prove beneficial to the transition in the long run and also its viability in terms of stimulating real transformative change. Future research should therefore examine alternative trajectories more closely and analyze the role of institutional work in these trajectories.

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Declaration of Competing Interest

The authors declare no competing interests.

Data availability

Data will be made available on request.

Appendix A

(Table 1)

Table 1
Event categories, description, and function/institutional work allocation.

Event Category	Description	Function (+/-)	Predominant forms of Institutional work	Number of events
1. Product Launch	The introduction of a PBMA product or ingredient on the market	1	Mimicry	87
2. Award Received	An award given to PBMA innovation system actors (e.g., Beyond Meat and Impossible Foods win the United Nations highest environmental honor: <i>Champions of the Earth Award</i>)	7	Valorizing and demonizing	33
3. Restaurant Expansion or Launch	When a restaurant serving PBMA has launched or has expanded to other locations	1	Mimicry	20
4. Patent	When a patent is published	2	Vesting	3
5. Positive Press	Positive media posts reporting on the protein transition	4, 7	Advocacy	63
6. Consumer Feedback	Media posts voicing personal/subjective opinions on PBMA or the protein transition	7	Advocacy	89
7. Campaign/Awareness Initiative	The launch of a cultural, public health, or awareness initiative related to plant-based proteins (e.g., the Meatless Monday Campaign)	7	Advocacy, Educating	131
8. QSR (Quick Service Restaurant) Partnership	New partnerships between PBMA actors and Quick Service Restaurants (e.g., Burger King, KFC, or Little Caesars)	1, 5	Constructing Normative Networks, Mimicry	76
9. Menu Extension/ Partnership	When PBMA are added to the menu of an established restaurant (e.g., Beyond Meat is added to the menu at Fatburger)	1, 5	Constructing Normative Networks, Mimicry	97
10. Funding/Investment	When a PBMA company has received funding or when an investment in PBMA has been made	6		60
11. Product Testing or Product Sample	The launch of "limited" time PBMA products on the menu of a retailer	1	Mimicry	19
12. Grocery Chain Partnership	A partnership between a grocery chain and a PBMA company (e.g., Beyond Meat partners with Whole Foods)	5	Constructing Normative Networks, Mimicry	39
13. Big Food Product Diversification	The introduction of a PBMA product/brand by an incumbent (also known as "Big Food")	1, regime	Mimicry	12
14. Expert/Authority news statement	News statements made by experts (e.g., scientists, physicians, dietitians) or authorities (e.g., FDA members) which promote plant-based diets or educate consumers on the benefits of plant-based diets	4, 7	Advocacy, Educating	103
15. Market/Sales Growth	Market or sales growth of plant-based protein products	5		57
16. Acquisition	Acquisition of a PBMA company by an established firm	1, regime	Constructing Normative Networks	10
17. Lobby	Lobby activities carried out by actors in the PBMA innovation system or events stating that a lobby group supporting the protein transition has been founded	7	Advocacy, Constructing Normative Networks	63
18. Celebrity/ Athlete Endorsement	Events relating to news of celebrities or professional athletes becoming brand ambassadors, ads featuring celebrities/athletes promoting products, as well as media statements made by celebrities	7	Advocacy, Constructing Normative Networks, Changing Normative Associations	34
19. Government Support	Events related to departments of US government supporting plant-based proteins or stimulating the transition to plant-based diets	4, 7	Advocacy, Educating	23
20. Website Launch	The launch of a website dedicated to plant-based proteins	1, 7	Advocacy, Educating	8
21. Trend Spotting and Market Forecasts	Plant-based protein market forecasts or predictions of future industry trends	4		237
22. Strategic Announcement	When a company board member, employee, or founder speaks on behalf of the company with regards to its goals, targets, or future expectations	4	Advocacy	174
23. Survey/Study/ Report Outcome	Studies, reports, surveys, or white papers which provide scientific evidence supporting plant-based proteins	4	Theorizing	163
24. Trademark	When a trademark relating to PBMA is published	1		209
25. Production Expansion	When an additional production facility has been opened, or additional infrastructure has been made available to support the development of PBMA	6		23
26. Summit	When a summit dedicated to plant-based proteins is held	3	Advocacy, Educating	20
27. Certification	When a PBMA product/ingredient has received a certification (e.g., GRAS certified, or FDA approved)	7	Defining	15
28. University Foodservice Expansion	The expansion of a university's current menu offerings to include plant-based proteins (e.g., Stanford offers Beyond Meat products)	1	Advocacy, Constructing Normative Networks	69
29. Educational Program, Talk, or Workshop	When an educational program related to PBMA is launched. This includes the establishment of courses at universities (e.g., UC Berkeley), webinars, and informational talks.	3	Advocacy, Educating	90
30. Food Festival, Expo, or Show	A food festival, expedition, or show dedicated to showcasing plant-based products	1	Advocacy, Educating	62

(continued on next page)

Table 1 (continued)

Event Category	Description	Function (+/-)	Predominant forms of Institutional work	Number of events
31. Research Grant	When a research grant has been awarded (e.g., the Good Food Institute awards a university with a grant to research PBMA)	6	Valorizing and demonizing	3
32. Promoting Product Awareness	Media reports discussing the diverse types of meat substitutes available and where to find them	7	Advocacy, Educating	47
33. Conference	When a conference is held on the protein transition or PBMA	3	Advocacy, Educating	35
34. Research and Development	R&D activities and other advancements in research related to plant-based proteins	2		14
35. Company Founded	When a PBMA company is founded	1	Mimicry	33
36. Nutrition, health, or sustainability claims	Claims about the impacts of plant-based proteins on aspects of nutrition, health, or sustainability	7	Advocacy, Educating	33
37. Regime Response	Events related to regime actors, e.g., the United States Cattlemen's Association, acting in opposition to the development and diffusion of PBMA	7, 4, regime	Policing, Deterring, Educating, Advocacy	91

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