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**Title:** Developing a matrix framework for protein transition towards more sustainable diets

**Year:** 2021

**Version:** Published version

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**Please cite the original version:**

Paloviita, A. (2021). Developing a matrix framework for protein transition towards more sustainable diets. *British Food Journal*, 123(13), 73-87. <https://doi.org/10.1108/bfj-09-2020-0816>

# Developing a matrix framework for protein transition towards more sustainable diets

Protein  
transition  
towards  
sustainable diets

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Received 20 September 2020  
Revised 29 December 2020  
13 February 2021  
Accepted 13 February 2021

## Abstract

**Purpose** – The purpose of this study is to propose a matrix framework to understand the interdependencies of domains and scales of protein transition towards diets based on plants and alternative sources of proteins.

**Design/methodology/approach** – The abductive research approach is used in building the framework, and the proposed framework is illustrated using the regional food system in Central Finland as an example. Focus groups and interviews were used to collect qualitative data from 28 respondents.

**Findings** – This study provides a framework for protein transition, with five domains and five scale levels. Interactions between public and private governance activities at different scales, domains and governed niche and regime levels are discussed. The study shows how micro-level activities at individual or community levels are linked with broader governance activities.

**Research limitations/implications** – Due to the relatively narrowed set of empirical data, further research is required to test the framework in different regional and cultural settings.

**Practical implications** – This paper presents a practical illustration of the matrix framework, and considering this, the paper discusses the possible implications of matrix interdependencies for protein transition management.

**Social implications** – This study proposes that understanding the coevolution of domains and scales, with the help of accurate policies and business models, can lead to effective protein transition.

**Originality/value** – This study fulfils an identified need to study protein transition in a broader frame, which highlights the structural activity interdependencies between different scale levels and domains.

**Keywords** Protein transition, Sustainability, Domain, Scale, Food system, Governance, Niche, Regime

**Paper type** Research paper

## 1. Introduction

The general term “transition” is used to denote a society-wide system innovation with a focus on fundamental activities, such as renewable energy provision and food system activities. Protein transition in diets constitutes eating considerably less animal protein and more plant-based and alternative sources of protein (Ripple *et al.*, 2017; de Boer and Aiking, 2018). Both public health and the environment are threatened by the current dietary imbalance between plant and animal protein in the Western diet (de Boer and Aiking, 2018). The transition towards plant-based diets is broadly understood to be an urgent and necessary element of climate change mitigation. For example, the Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate Change and Land (SRCCCL) links climate change, land use

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This research was funded by the Strategic Research Council of Academy of Finland (ScenoProt, grant number 414243 and JUST-FOOD, grant number 327369). I am thankful to Dr. Antti Puupponen and Mr. Ville Tikka for their support in empirical data collection. I would like to thank Editage ([www.editage.com](http://www.editage.com)) for English language editing.



and social change to plant-based diets; the use of these links can help to reduce deforestation and also methane production by domesticated ruminants (Wolf *et al.*, 2019). Moreover, animal-based protein systems raise concerns around increasing soil and water pollution and the costs of animal health and welfare (Vermeulen *et al.*, 2012). A diet featuring wider consumption of alternative proteins, including plant-based proteins, underutilised fish, insects, mushrooms, algae and laboratory-grown protein is based on the rationale that these foods require (on average) less energy and other resources (Gravely and Fraser, 2018). The EAT-Lancet Commission has called for transformation of current diets to healthy diets by 2050, which includes more than a 50% reduction in the global consumption of unhealthy foods, such as red meat and sugar, and more than 100% increase in the consumption of healthy foods, such as nuts, fruits, vegetables and legumes (Willett *et al.*, 2019).

In literature on protein transition, the environmental and nutritional benefits are generally emphasised to persuade consumers to choose plant-based options. However, if the case for dietary change only involved the considerations of health, climate change, and animal welfare, plant-based diets would be the norm in the west (Beverland, 2014). As Jallinoja *et al.* (2016) note, attributes related to health and environmental benefits are not convincing enough for many people. One difficulty in understanding the protein transition is, as observed by Grigg (1995), that people do not eat “protein” or “calories”, rather they eat “food”; this means that people do not approach food as protein, calories or fats, rather they relate to food in the context of their culture, habits and environment. Thus, when developing proteins for human consumption, certain criteria need to be met (Boland *et al.*, 2013). As de Boer and Aiking (2011) stated: “What is primarily needed is a broader framework to capture the interconnections between protein-related issues in a way that is socially and environmentally acceptable”. Despite the printed and social media hype surrounding plant-based proteins and alternative protein sources, the share of meat in the Finnish diet is only minimally reducing (Natural Resources Institute Finland, 2020).

Transitions typically cross multiple domains and scales (Rotmans *et al.*, 2001). Previous studies have shown that the coevolution of economic, cultural, technological, ecological and institutional developments at different scale levels leads to transition, in this coevolution, various domains shift over each other and constantly influence each other (Rotmans and Loorbach, 2009). Transition management is one of the many different frameworks proposed in the transition literature to understand, guide and accelerate sustainability transitions (Goddard and Farrelly, 2018); it is a governance approach for adopting sustainable development used for the implementation of governance strategies and instruments (Loorbach, 2010). Loorbach (2010) emphasised on the need for new modes of governance and a new balance between the state (government), market (private sector) and society (civil). An essentially dual system of governance, including government-led public and corporate-led private governance, is augmented by the civil society organisations (Barling, 2007).

In the process of transition management, multiple actors with different interests and backgrounds represent multiple domains at multiple levels. Food systems encompass several activities, including the production, processing, packaging, distribution, retailing and consumption of food (Erickson, 2008). The power relationships among these activities shape food supply and food system (Lang and Heasman, 2015). Jallinoja *et al.* (2016) call for societal innovations to change prevailing practices, meanings and expectations across several domains of the food system. Hence, each transition is made up of processes of co-evolution involving changes in needs, wants, institutions, culture and practices (Kemp *et al.*, 2007). Transition management is a multilevel model of governance, which requires radical changes in current systems of governance (Kemp *et al.*, 2007).

Different types of domains and levels for food system transition have been identified in the literature. The Sustainable Development Commission (2011) presented an omni-standard framework for sustainable food, including five initial domains: quality, social values,

environment, health and economy. These domains are further improved through good governance (Sustainable Development Commission, 2011). There are several suggestions and frameworks in transition literature that focus on actors at different scale levels of transition. For example, the multi-level perspective MLP framework (Geels, 2012) is a systemic typology, which distinguishes three analytical levels: niche, regime and landscape. Fischer and Newig (2016) considered actors at different levels of governance in terms of institutional typology: local governance, regional governance, national governance and global governance level. In their protein-specific approach, de Boer and Aiking (2019) and Aiking and de Boer (2018) proposed a multiple-level protein transition framework having three levels: diets, dishes and dish ingredients.

This current study argues that protein transition requires the consideration of multiple domains and scales because any protein transition requires changes in all domains and at all scales. As Grigg (1995) noted, the scales present a difficulty because the explanations that appear reasonable at one scale are not valid at another. Hence, this study proposes a matrix of the domains and scales of protein transition to provide a broader framework and to capture the interconnections between protein-related issues. More specifically, the focus is on the interactions between public and private governance activities at different scales and governed niche and regime levels.

As every transition project is unique in terms of context and participants (Loorbach, 2010), this study illustrates the usefulness of matrix framework and importance of context-specificity using the regional food system in Central Finland as an example. According to Loorbach and Rotmans (2010), participants in a regional transition arena are often emotionally connected to the subject. In addition, transition arenas are full of tensions, both within the participants and between the environment and the arena (Loorbach and Rotmans, 2010). By systematically considering relevant domains and scales in advance, it might be easier to manage tensions, obstacles, barriers, and surprises that are inherent to the actual transition process. Hence, identifying the informal aspects of transition trajectory is also important for transition management.

The outline of this study is as follows. Section 2 presents the methods and data used in the study. Section 3 explains why and how knowledge regarding different domains and scales is important for our understanding of diet change, while focusing on the interactions between public and private governance activities at different scales and governed niche and regime domains; this framework is illustrated through empirical insights in the case of Central Finland. Section 4 discusses the possible implications for protein transition management.

## 2. Methods and data

In the process of building the framework, this study explores and synthesises the disparate literatures on protein transition, sustainable protein systems and sustainable protein consumption, while bridging and blending the perspectives of social science, natural science and nutritional science. Given the nature of the research objective, an abductive research approach was chosen because abductive research can explain, develop or change the theoretical framework before, during or after the research process. Abductive reasoning consists of a pragmatic approach through a process of systematic combining (Dubois and Gadde, 2002). The preliminary analytical framework consisted of articulated preconceptions on domains and scales of protein transition. This study relied on the multi-dimensional or “omni-standards” approach put forth by the Sustainable Development Commission (2011), including quality, health, social values, environment and economy as the domains for sustainable protein consumption (Lang and Barling, 2013). For the analysis of the scale levels, a multi-level framework proposed by de Boer and Aiking (2019), including the levels of ingredients, dishes and diets, was utilised. Over time, the framework was developed

according to findings through the empirical research in Central Finland. The major development was the inclusion of additional levels of regions and supply chains in the framework. Empirical observation, in turn, helped to understand the transition theory and vice versa. Finally transition management theory directed the framework towards the final stage of development, which consisted of inclusion of public and private governance as governing activities and inclusion of regime and niche levels as governed entities in the framework. The various ways in which micro-level activities at individual or community level and macro-level public and private governance activities may be directly or indirectly connected, became a focal interest concerning protein transition.

Abductive reasoning is based on matching the framework, theory, the empirical world and the case (Dubois and Gadde, 2002). The empirical case, the protein system of Central Finland, was used as a tool in building the framework, but it was also used as an essential element of the study's end product to illustrate the proposed framework empirically. The study was initially a single case study, but for illustrative purposes five embedded subcases were presented in order to illustrate five case-specific interdependencies. The empirical part of the research illustrates the domains and scales of protein transition in the case of Central Finland. The empirical illustration and related analysis are based on the qualitative data obtained by interviewing actors along the food system concerning the potential for a protein transition. The questions dealt with the challenges and opportunities associated with protein transition in Central Finland. The qualitative data obtained is presented in Table 1.

Thematic content analysis for a descriptive presentation of the qualitative data was used to organise the data. The data was transcribed and then initially classified according to domains and scales. The data was reorganised during the abductive research process according to transition management theory. Context-specific analysis related to sustainable protein production and consumption is also supported by the EAT-Lancet Commission (Willet *et al.*, 2019). As de Boer and Aiking (2017) noted, a regional approach may help researchers determine how sustainable protein consumption can be adequately framed and how those frames match the consumers' expectations and values.

Data collection method	<i>N</i>	Interviewees	Criteria/justification
Focus group 1	6	ScenoProt researchers of Natural Resources Institute Finland	Academic knowledge on sustainable protein systems in Finland (ScenProt is a research project on novel protein sources for food security)
Focus group 2	5	Actors involved in oil hemp supply chain (farmers, processors, clients)	Oil hemp is one of the most promising novel protein sources in Central Finland
Focus group 3	5	Adult students of sustainable gastronomy of Jyväskylä University of Applied Sciences	Practical knowledge on sustainable dishes and consumption with work experience in restaurants and supermarkets
Focus group 4	6	Experts on regional food system	Practical knowledge on regional food system of Central Finland and feed production
Semi-structured pair interview	2	Specialists of regional development project focusing on novel protein sources	Contextual knowledge on regional protein system and local protein sources
Semi-structured personal interviews	4	Members of the Finnish parliament (politicians)	Public policy-level insights from electoral district of Central Finland
Total	28		

**Table 1.** Data collection procedure and the justification of data

### 3. Matrix framework of protein transition and its illustration

This section describes the key components of the matrix framework: five different scale levels, public and private governance activities, five different domains as well as niche and regime levels of the protein transition. The potential of this approach to understand and manage interdependencies is empirically illustrated by considering Central Finland as the study area with five sub-cases. As it is not possible to cover all aspects of different levels and domains within a single paper, the applicability of the matrix framework is illustrated by focusing closely on five specific intersections so that each scale level and domain is discussed in different intersection. [Table 2](#) shows the multidomain, multilevel matrix elements for protein transition, wherein the domains appear in the rows and scale levels appear in the columns of the matrix.

#### 3.1 Matrix framework of protein transition

**3.1.1 Five scale levels.** The five scale levels represented in the matrix framework namely ingredients, dishes, diets, regions and supply chains, highlight the multilevel approach for protein transition. Each scale level provides its own piece of information about each of the different domains. Three scale levels (ingredients, dishes, diets) are more consumption-oriented levels, whereas two scale levels (regions and supply chains) are more production-oriented levels. Level of ingredients refers to food items accepted as separate entities ([Aiking and de Boer, 2018](#)) and protein ingredients, such as meat, fish, pulses, crops, insects, mushrooms, or lab-grown proteins. Level of dishes refers to food items accepted on a plate in combination with each other, revealing how and in what combinations foods are eaten ([Aiking and de Boer, 2018](#); [de Boer and Aiking, 2019](#)). Level of diets refers to the broad set of food items that is accepted by a population over a time period ([Aiking and de Boer, 2018](#)). Level of regions refers to specific spatial areas, where the food is produced and consumed,

Levels	Ingredients		Dishes		Diets		Regions		Supply chains	
	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private
<b>Domains</b>										
<b>Food quality</b>										
Niche domain										
Regime domain										
<b>Environmental</b>										
Niche domain										
Regime domain										
<b>Health</b>										
Niche domain										
Regime domain										
<b>Sociocultural</b>										
Niche domain										
Regime domain										
<b>Socio-economic</b>										
Niche domain										
Regime domain										

**Note(s):** Different transition levels (ingredients, dishes, diets, regions and supply chains) are governed by public and private governance activities. Governance activities interact with niche and regime actors within each of the different transition domains (food quality, environmental, health, sociocultural and socio-economic). Coloured cells represent the illustrative sub-cases in this study

**Table 2.** Multidomain, multilevel matrix for protein transition

revealing how and what foods are produced and consumed within a region. Finally, level of supply chains refers to commercial product chains from the field to the table, highlighting the collaborative interaction between primary production, food processing, delivery, retail, food services and consumption. Vermeulen *et al.* (2012) argue that “there is no global food system but rather a set of partially linked supply chains for specific products”. The development of a protein supply chain and the associated value chains can potentially reshape the retailers’ shelf and caterers’ dishes in the future. Many scale levels are inherently connected with interactions, such as dishes and diets or protein ingredients and dishes (de Boer and Aiking, 2019; Aiking and de Boer, 2018).

*3.1.2 Public and private governance activities.* Protein transition at each scale level is governed by public and private governance activities. Public governance is led by the government and aims to promote protein transition associated with ingredients, dishes, diets, regions, and supply chains. The multiple and important roles of governments at the food system level have been traditionally emphasised in the literature of transition management (Kemp and Rotmans, 2004). For example, governments can influence sustainable diets through public catering. At the diet level, change strategies, as presented by de Boer *et al.* (2014), include strategies to promote meatless days or small portions of meat. Private governance is led by large corporations and contributes to protein transition at different scale levels through novel business models, products and services. The food industry, supermarkets, and catering play a major role in the popularisation of new products, dishes, and ingredients among consumers. The corporate concentration up and down the food supply chain has increased; in particular, the role of supermarkets is rapidly increasing (Ericksen, 2008). For example, consumers are influenced by the marketing practices, messages and advertising of food manufacturers and retailers, as well as the structure of the food supply chain (Beverland, 2014; Ericksen, 2008). However, low level engagement of supermarkets to sell alternative proteins may create a tangible barrier to their mainstream integration (Gravelly and Fraser, 2018). The role of both public and private governance is crucial in protein transition. The governance addresses activities, functions, and processes to create and maintain an integrated governance framework (such as different types of policies and partnerships) for protein transition. Key aspects include evidence-based decision-making, transparency, accountability and fairness, for policy-making processes (Lang and Barling, 2013). According to de Boer and Aiking (2017), “policymakers in government, industry, and NGOs should take an active role in reducing the gap between science-based health and sustainability arguments for a diet change and the frames that guide consumer choices”.

*3.1.3 Five domains.* Five domains represented in the matrix framework, food quality, environmental, health, sociocultural and socio-economic, highlight the multidomain approach for protein transition. Food quality domain is central in protein transition because it encompasses taste, freshness, seasonality, cosmetic issues, authenticity and locality (Lang and Barling, 2013). Technical quality aspects, such as ease of extraction, absence of “co-passengers” (anti-nutritional factors), high solubility and suitable amino acid profile (Boland *et al.*, 2013), and food safety are also relevant. Food quality domain is important, because consumer acceptance deals with foods, not base ingredients, and therefore, the foods itself should be liked (Boland *et al.*, 2013).

The environmental domain addresses the environmental impacts of protein production and consumption, such as climate change, energy use, land, water use, soil, biodiversity and waste reduction (Lang and Barling, 2013). In the protein system, the most fundamental environmental question concerns the efficient use of land, water, energy and other inputs to produce feed for livestock instead of using these resources for direct human consumption (Vermeulen *et al.*, 2012). For example, 85% of the global cultivation of soybean is destined for animal feed and the remaining is intended for direct human consumption (Voora *et al.*, 2020).

The environmentally relevant choices are between animal-based protein sources, such as meat, dairy and eggs, and plant-based protein sources, such as pulses, oil crops and cereals. The transformation of plant-based ingredients into high-protein products, such as seitan, tempeh and tofu, from soya, wheat and other crops or pulses is a viable sustainable alternative. Besides plant-based protein sources, small pelagic fish rank low in terms of their environmental impact (Hilborn *et al.*, 2018). In addition, various mushrooms, insects, seaweeds and algae can potentially contribute to an environmentally sound food system (de Boer and Aiking, 2019). Moreover, lab-grown protein sources, such as *in vitro*/cultured meat and other biotechnological innovations, may have a role in the less resource-intensive protein system.

The health domain is facing several challenges regarding safety, nutrition, equal access, and availability of protein (Lang and Barling, 2013). From the nutritional standpoint, a balanced combination of plant proteins can supply enough essential amino acids for a healthy human diet (Pihlanto *et al.*, 2017). Moreover, most public health nutrition guidelines include positive recommendations for regular fish consumption (Lang and Barling, 2013). The value of livestock products for low-income consumers who have difficulty fulfilling the recommended intakes of protein and micronutrients is addressed by Vermeulen *et al.* (2012). Also, consumers perceive meat as generally healthy and important for providing protein and iron (Lazzarini *et al.*, 2016).

The sociocultural domain addresses the values, customs, and demographic characteristics of people that flow through their behaviour, engagement and critical choices. Social values may include aspects related to pleasure, identity, animal welfare, equality and justice, trust, choice and skills (Lang and Barling, 2013) or consumers' culturally accepted ideas of healthy foods (Vainio *et al.*, 2016). For example, specific protein sources may not be acceptable in some cultures because of religious taboos, local cultures, or neophobia (Boland *et al.*, 2013). In addition, the role of cultural, culinary and psychological factors in protein transition is important (de Boer and Aiking, 2018). Animal welfare, for example, is a strong societal issue associated in food production in Western countries (Aiking and de Boer, 2018) and a critical issue in animal-based protein production. Aspects related to the sociocultural domain of meat consumption include different attitudes towards meat, subjective norm, gender, the belief of human supremacy as a dominance ideology in the field of human–animal relations, eating habits and dietary identity (Graça *et al.*, 2015). In addition, Graça *et al.* (2015) found that the attachment to eating meat can be presented through hedonism (source of pleasure), affinity, entitlement and dependence. Additionally, a long-standing trust in the traditional food industry, food neophobia and food disgust sensitivity can influence the acceptance of *in vitro* meat (Siegrist and Hartmann, 2020).

Socio-economic factors may relate to the cost of production, level and variation of business income, price uncertainty, and distribution of risks along the value chain (Boland *et al.*, 2013). Westhoek *et al.* (2014) noted that diet-led change, for example cutting Europe's meat and dairy intake, would have a large economic impact on the livestock farmers, feed industry and meat-processing sector. In addition, the socio-economic domain considers aspects that include food security, affordability, efficiency, competition and employment (Lang and Barling, 2013). For example, the volume and type of protein production have an impact on society and food security (Aiking and de Boer, 2018). With respect to food affordability, the relationship between food price and income is one of the most important aspects to consider (de Boer and Aiking, 2019). Previous studies have shown that food choices are dependent on particular combinations of the economic, ecological and cultural conditions within a country or region (de Boer *et al.*, 2006). People in different countries experience a difference in the availability of proteins, and there are very marked spatial differences in the consumption of protein (Grigg, 1995; Aiking, 2014); these differences highlight the role of regional economic activities in food availability and consumption and a strong influence of location on protein diets (de Boer *et al.*, 2006). There are



profound differences in the sources of protein in both developed and developing countries (Grigg, 1995), and also within the European Union (de Boer *et al.*, 2006).

*3.1.4 Niche and regime levels.* Protein transition will evidently require a very long predevelopment phase in which there is a gradual build-up of pressure on a dominant regime at a meso-level (Loorbach and Wijsman, 2013), that is animal-based protein system, which may be understood as the dominant structure, culture and practices in a food system. Niches on a micro-level, in turn, are accelerated by innovative ideas, projects, technologies and niche actors associated with novel alternative protein sources (Loorbach and Wijsman, 2013). Hence, niche domains for protein transition refer to new structures and a small core of agents (Rotmans and Loorbach, 2009) emerging within the food system and promoting alternative protein sources. Accordingly, regime level refers to existing dominant structures promoting conventional protein sources, that is dairy and meat. Public and private governance activities should therefore acknowledge both niche and regime levels in order to fully understand the dynamics of the protein transition.

### *3.2 Empirical illustration for central Finland*

Matrix framework is empirically illustrated by focusing on five different intersections between scale levels and domains: (1) level of ingredients – environmental domain, (2) level of dishes – food quality domain, (3) level of diets – health domain, (4) level of regions – socio-economic domain, (5) level of supply chains – sociocultural domain.

*3.2.1 Intersection between the level of ingredients and environmental domain.* It is estimated that 55% of the dietary protein in Finland is currently provided by domestic animals (29% by dairy products and eggs, 26% by meat). Further, 36% of dietary protein is currently provided by plants (cereals, potato, and vegetables) and 9% by fish (ScenoProt, 2018). In Central Finland, the regime of protein production is dominated by meat and dairy ingredients. Consequently, plant-based and alternative protein ingredients represent the niche of protein production in the region. Hence, there is a trade-off between the current structure of protein production and the environmental impacts, as one politician stated:

It is a fact, that a red meat-based diet produces much more greenhouse gas emissions than that does a more balanced diet. Soon, we will not be able to produce any kind of food if climate change is not stopped.

Protein ingredients are closely associated with diets, as the excessive amount of protein ingredients in diets can be harmful for both the health and the environment, as a respondent from a regional development project noticed:

The majority of people get more than enough protein. Due to the protein boom over the past few years, protein is oversaturating the Finnish diet. From an environmental perspective, protein consumption has become a problem worse than ever.

From a governance point of view, the respondents emphasised the role of governance to support economically, the production of plant-based ingredients, and the role of private sector in developing new products from plant-based and other novel protein ingredients. The effectiveness of the agricultural subsidy system was commonly criticised, especially in the feed focus group:

Farming activities related to environmentally sound food production have not been supported. For example, there are no elements in the subsidy policy that aim to improve protein self-sufficiency or circular economy. There are no subsidies for improving the productivity of soil, which could benefit the production of protein-rich plants.

*3.2.2 Intersection between the level of dishes and food quality domain.* When eating out or at home in Central Finland, the regime of dishes is dominated by animal-based dishes, whereas

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dishes based on plants or alternative protein sources represent the niche. Food quality is one of the most important determinants for food choices. The respondents in this study emphasised the locality and taste of dishes as important food quality factors. As one respondent noticed from a regional development project noticed:

The primary agenda of municipalities is clearly to increase the consumption of locally produced food because it is perceived as sustainable.

Hence, it may be difficult to provide local plant-based dishes when most local production is focused on meat and dairy. Regarding taste preferences, cooks in restaurants are struggling with clients' quality expectations, as one adult student described:

I work as a cook and our clients are mostly men. I have tried to provide plant-based lasagne, and this lasagne itself is one of the favourite dishes, but then there's the word "veggie" in it. They hardly had the courage to taste it, although it was very tasty.

Another adult student had a similar experience as a cook:

I provided plant-based lasagne in a canteen and they said, "Are you trying to kill us?", but when I replaced part of the minced meat with pea protein in a patty, nobody noticed any difference. I only revealed the ingredients afterwards.

Hence, the role of public municipal catering services in the region to promote sustainable dishes in schools, hospitals and care homes is important. Similarly, the role of private catering services and restaurants in improving the taste of plant-based dishes was acknowledged.

*3.2.3 Intersection between the level of diets and health domain.* Association between diets and health outcomes was clearly acknowledged by the respondents. In particular, the nutritional aspects in diets were addressed. The regime of diets is dominated by animal-based protein sources consumed by omnivores and flexitarians, whereas diets followed by the vegans or vegetarians represent the niche. However, it was reminded that less protein is needed for health when multiple protein sources are used. Also, the affordability of plant-based diets matters; this is even more true if the prices of novel protein sources are higher than the prices of animal-based protein sources. There were concerns that people with low-income do not have equal opportunities and scope to eat healthily, as one ScenoProt researcher noted:

There is evidence about dichotomy in Finland, and there are certainly more societal classes emerging. The gap is increasing. How to reach those who would not be able to afford these fine novel plant-based convenience products because they still are more expensive. And if a person's life is burdened by all kinds of other problems, I do not believe that this person will start to think about soaking beans.

From the governance point of view, the role of private sector and food businesses in preventing further spread of nutritious plant-based diets was addressed by an informant in hemp focus group:

Price dominates so many food industry decisions. Nutritionally poor products provide better opportunities to make business. The most popular plants used in the western food industry are nutritionally the weakest plants. There are thousands of nutritionally better plants, but they are not used because large companies cannot make money from these.

*3.2.4 Intersection between the level of regions and socio-economic domain.* Currently more than 80% of total agricultural income in Central Finland is based on dairy and meat production. Hence, animal-based protein production represents the socio-economic regime in Central Finland. Protein production based on plants and alternative protein sources, in turn, represents socio-economic niche. Several informants emphasised the socio-economic

importance of the current animal-based regime for the region. For example, one ScenoProt researcher described a meeting with an agricultural authority:

We talked about a shift towards more diverse farming and more diverse diets, but their opinion was that farms' income is based on dairy and it cannot be changed. According to their view, milk is a more certain source of income, whereas other sources are uncertain.

In addition, the association between regional climate conditions and economic agricultural activities was acknowledged. The main concern was related to the challenging climatic conditions and suitability of small field parcels for cultivating plants for direct human consumption. This concern was linked with the profitability of farming in Central Finland and was highlighted by one politician:

Central Finland is not an optimal area for plant production. This is suitable area for grass production. It simply means that this a good region for growing animals' eating grass. Grass-eating livestock will be also be raised here in the future.

Regional animal-based production was also associated with national food security, as one politician addressed:

If we Finns want to feed us ourselves, it is not going to happen with any kind of production. Plants alone cannot ensure food security.

However, an emerging niche for alternative protein production and processing in Central Finland was also recognised. A new form of entrepreneurship began emerging regarding novel protein sources in farms led by "heralds" and "positive examples". Hence, the potential of rural entrepreneurs was acknowledged in promoting novel protein ingredients, as one informant from the feed focus group noted:

Alternative protein sources, plant proteins, lake fish, and insects... There are entrepreneurial, enormously innovative people in the countryside. They have the right attitude, and they want to make progress. They are kind of Gyro Gearlooses, and they are gold nuggets for us.

From a governance point of view, the role of the private sector in developing the regional industrial infrastructure for processing plant-based and alternative protein ingredients is vital. The lack of certain key processing phases, especially the lack of plant-based ingredient industry in Central Finland, was identified in the interviews, as one politician noted:

It is necessary to build consecutive processing and manufacturing steps in the food system. Otherwise, a farmer may have many thousands of tons of fava bean in a bin and then what?

*3.2.5 Intersection between the level of supply chains and sociocultural domain.* While most of the regional supply chains in Central Finland belong to the animal-based regime, national and global supply chains are increasingly providing a wider variety of products based on alternative protein sources, thus enhancing the socio-cultural niche of alternative proteins. For example, the retailers were acknowledged as important actors in improving the availability of novel protein products, as one adult student mentioned:

Our veggie department has grown like in every supermarket. And alternative protein sources have clearly been one of the growth areas during the last couple of years. Two years ago, there was basically nothing on the shelf.

However, many informants thought that plant-based and animal-based production were "not competitors" and "not mutually exclusive" in Finland because they have different target groups and because people have "different ethical approaches to food". In fact, some respondents called for socio-cultural balance between different protein sources, while acknowledging regional differences, as one ScenoProt researcher mentioned:

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Diversity and versatility are probably the key. Our agenda is not to drive everybody to veganism. . . and especially the role of grass (as animal feed) in the Finnish context matters. Finding balance is the key.

In terms of socio-cultural domain, the respondents reported prejudices towards plant-based food and alternative proteins, and in some cases, even neophobia. The demographic differences related to gender, age, and location were emphasised by many informants. For example, a couple of informants said that their husbands called them “germ-hippies” based on the former’s diet of beans and lentils. In contrast, dairy and meat have a “strong toehold” within the regional food culture in Central Finland, which was perceived as a culturally challenging environment for the protein transition.

From a governance point of view, the role of supply chains in improving the “media-sexiness” and reputation of alternative proteins and creating “selling stories” for alternative proteins was perceived important. For example, some Finnish companies have been successful in creating trendy convenience products, such as Pulled Oats (considered to be “a plant-based minced meat” made from a combination of fava beans and oats), which became a popular topic in some user-generated Facebook-groups. In addition, the modern food culture that favours easy and fast cooking and eating options was not seen favourable for using raw pulses, which were associated with slow and difficult preparation and required special skills, thereby creating issues with their consumption. Moreover, the poor reputation of certain novel protein ingredients was perceived problematic. For example, oil hemp suffers from prejudices, underrating, and demonisation (with attached fear) and is not preferred because of its reputation for being a drug. Another example is small lake fish, such as roach and bream, known to be nutritionally and ecologically excellent sources of protein, but mainstream consumers tend to undervalue these because they are not in trend. In general, food companies were described as curious actors in terms of product development and testing new products and ingredients, as one informant from ScenoProt focus group noted:

Companies have sniffed an opportunity in the markets. And I think they have a really strong enabler’s role in promoting and speeding up the process by introducing products based on new protein sources.

Concerning the private governance of food supply chains, there were suggestions for improving the placing strategies and increasing resources for the promotion of plant-based products in the retail sector. In terms of public governance, applying public procurement laws and regulations was viewed as a critical factor in promoting sustainable protein consumption. Moreover, there were concerns about the effectiveness of public food procurement and the associated ethical, ecological, and climate implications. Many respondents thought that competitive bidding and administrative processes in public catering could support the increased use of plant-based protein.

#### 4. Discussion and conclusion

A broader frame for grasping the whole protein transition requires a consideration of existing protein transition concepts, sustainable food system approach, and transition management theory. In this study, the central focus in tackling protein transition is on interdependencies between different scale levels and domains. More specifically, the focus is on linking public and private governance activities to regime and niche levels in different domains. This study proposes a matrix framework for understanding and managing protein transition. The main value of the framework lies in pulling the disparate elements of protein transition together and showing links between micro-level activities at individual or community level and macro-level governance activities.

Further studies on the domains and scales of protein transition are required because of the largely conceptual nature of this study, relatively low number of respondents, and temporally and spatially limited context. With these limitations in mind, the proposed framework and its empirical illustration add weight to the growing body of literature concerned with protein transition and sustainable protein consumption. With more sufficient empirical evidence, the framework proposed in this study could be used to build a database describing the intersections of protein transition in different contextual settings.

The possible implications for protein transition management are twofold. First, various domains are interconnected, and their context-specific importance should be acknowledged in transition management. In transition management, multiple actors, with different interests and backgrounds, represent multiple domains at multiple levels. A multiple domain approach can be especially useful in facilitating the interaction and collaboration between different food system stakeholders. Social learning about different actor perspectives and a variety of options is a necessary precondition for change (Loorbach, 2010). Moreover, the multiple domain approach might help to determine and integrate long-term governance issues, such as environmental concerns, into the realm of more short-term policymaking. Second, various levels (scales), from ingredient level to overall food system level, are interconnected and protein transition management should address these levels simultaneously.

The matrix framework proposed in this study differs from other studies in several ways. The most important differences are related to the focus on micro-macro connections, integration of consumption-oriented and production-oriented perspectives of protein transition, and utilisation of a broad framework of multiple values. Hence, this study extends the transition framework by de Boer and Aiking (2019) by adding new relevant levels of protein transition namely, region and supply chain. The levels of ingredients, dishes and diets are extremely relevant scales for restoring a healthy and sustainable balance in protein consumption. These levels, however, represent consumption-oriented or micro-level views of protein transition, whereas the levels of region and supply chain increase the understanding of production-oriented or macro-level protein transition. A broad matrix framework may help to manage the protein transition in a socially acceptable and desirable manner.

Rotmans and Loorbach (2009) noted that participants in the transition arena must have an ability to look beyond their own domain. Hence, a broad framework of multiple values and domains is useful in providing knowledge on different domains. It is also important to remember that the main food-system actors influence the system in a conservative and innovative way (Rotmans and Loorbach, 2009). Relying only on radical or disruptive innovations at all levels is not necessarily the most valid approach to achieve a sustainable balance in protein consumption. Furthermore, incremental or sustaining innovations (at different levels) may contribute to create a sustainable protein system as well.

As a conclusion, this study has provided a protein transition framework for addressing multidomain and multilevel challenges related to animal-based protein regime and the niche of alternative proteins. From a governance point of view, public and private governance should acknowledge at least the following crucial perspectives towards protein transition:

- (1) Perspectives of different levels of protein transition should be incorporated in public and private policies. Transition occurs simultaneously at different levels, including ingredients, dishes, diets, regions and supply chains.
- (2) Different domains of protein transition, including food quality, health, environmental, socio-economic and socio-cultural domains should be equally supported by public and private policies.

- (3) Public and private policies should influence both regime and niche developments, involving both mainstream consumers and incumbent food companies, and advocates of alternative protein sources.

The concept of multilevel and multidomain protein transition framework provides a broader perspective on protein transition, but still needs to largely prove itself empirically in such a manner that the framework can be further developed and used in broader variety of contexts.

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