Sociology of Agriculture and Food

# The International Journal of Sociology of Agriculture and Food

Volume 30 | Issue 2 | October 2024

Journal of the Research Committee on the Sociology of Agriculture and Food (RC40) of the International Sociological Association (ISA)

ISSN 0798-1759 (print) | 2524-1982 (online)

# The International Journal of Sociology of Agriculture and Food



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**Abstracting and Indexing Information:** *Agricola (USDA), CAB Abstracts, SocINDEX (EBSCO), Scopus, SCImago*

The journal articles are included in the LOCKSS archival system.

# Factors leading to differences in the internal structures of French agricultural quality groups: A Typology

Paper first received: 09 August 2024; Accepted: 25 November 2024; Published in final form: 21 December 2024
https://doi.org/10.48416/ijsaf.v30i2.542

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## Abstract

In France, agricultural quality signs, such as Protected Geographical Indications and Label Rouge, are managed by "quality groups" (QGs) — collective associations made up of farmers and other value chain actors. We conducted intensive interviews and document analysis with 12 diverse French QGs to better understand the types of actors and value chains involved in these organizations, their decision making structures, and their farmers' voting power relative to other value chain actors. We also utilized publicly-available documents for numerous other French QGs to inform our overall analysis. The value chain segments QGs capture vary substantially from group to group. While some are focused solely on farmers, others include businesses all the way from genetics through processing and packaging. Their product scopes range from meats and cheeses to fruits and vegetables, and further to flowers and other non-food agricultural products. We identified important factors that led to differences in the value chain structure involved in QGs: production chain length, processing mode, and distribution mode. We also identified different decisionmaking bodies and systems, and combined these with the above factors to develop a typology. We found that QG voting power ranges from fully controlled by farmers, to evenly split between upstream and downstream actors. Where value chains are focused on a supermarket or national specialty market scope, downstream actors have substantial power within the QG. Our typology may be useful for predicting relationships between value chain actors and for developing more equitable decisionmaking systems in future QG and geographical indication rural development efforts.

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## INTRODUCTION

Quality, either high quality or distinctive quality or both, has long been a strong tenet of farmers' collective action strategies in Europe (Schermer et al., 2011). European quality sign programmes such as Protected Geographical Indication (PGI), Protected Denominations of Origin (PDO),[1] and France's Label Rouge all provide strong institutional support to farmers and other value chain actors, who work together to produce foods and other agricultural products along a set of production standards. The focus of Geographical Indications (GIs) is to provide differentiation through the provenance of a product, using a label as intellectual property. GIs can be found in many countries around the world, having varying levels of institutional support. For countries that are signatories of the World Trade Organisation TRIPS agreements, GIs must provide at least a minimum level of intellectual property rights, enabling producers both inside and outside of the country to register and protect their mark.[2] The well-known PGI and PDO programmes are the European-wide GI programmes that comply with TRIPS. France's Label Rouge programme is functionally similar to GIs, but is based on high quality, especially sensory quality, rather than provenance. To obtain the label, Label Rouge products must have above average levels of taste and texture, proven by regular consumer and organoleptic testing (Westgren, 1999).

Extensive research has been carried out on the intellectual property aspects of these quality sign programmes (Marie-Vivien and Biénabe, 2017; Schermer et al., 2011) and their potential for sustainable rural development (Cei et al., 2018; Crescenzi et al., 2022). However, few studies have focused on the internal arrangements of groups involved in quality sign production: how they are organised, what specific processes are used to make important decisions, and the balance of functional decision-making power among the actors. This leaves open the important question of whether quality sign programmes are serving the farmers involved. In this article, we describe the different types of quality sign groups we found and the different weights that farmers have among other decisionmakers in those groups. Our results show that the groups we studied were indeed either farmer-centric or had a 50/50 decision making balance between farmers and downstream actors.

This article continues with a literature review, statement of research questions, and description of our methods of data gathering and analysis. Our Results and Discussion section presents the factors we identified that affect internal value chain structure: product chain length, mode of processing, and distribution mode. The decision-making systems we found are also described, with a focus on the relative voting power of the different actors. We then present the main types of QG structures we discovered, along with variations and outliers. The article concludes with a review of key points and potential applications.

### Literature Review

Quality sign programmes vary across international contexts. Many of the groups taking advantage of quality signs are organised privately by the industries involved, but within legal boundaries set out by governments. At European Union level, the minimal requirement for GIs is that applicant groups must be 'mainly composed of producers',[3] but additional requirements exist in some of the member states. For example, in France, both GI and Label Rouge applicants must organise a nonprofit business entity, called an Organisme de Défense et de Gestion, to engage in the management of the quality sign (Bardenhagen et al., 2021; Marie-Vivien et al., 2019; Pick and Marie-Vivien, 2021). In the United States, GIs are held by state-level commodity groups that have farmer, packer, and processor representation (e.g. Idaho Potatoes). In other contexts, quality signs are organised by the state and simply provided to farmers and their industries for use (Marie-Vivien and Biénabe, 2017; Marie-Vivien et al., 2019).

[1] Regulation No. 1151/2012 of the European Parliament and of the Council of 21 Nov. 2012 on Quality Schemes for Agricultural Products and Foodstuffs, 2012 O.J. (L. 343), page 8. The French-specific requirement can be found in the Code rural et de la pêche maritime [Rural and Maritime Fisheries Code] art. L642-17 (Fr.).

[2] https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R1151

Despite their country-level variations, each quality sign effort involves a group of producers and typically additional actors at other stages in the value chain. A variety of terms are used to describe the actors involved in quality signs, but an agreed upon name has not so far emerged in the literature. Descriptions are elaborated on in various ways. Quinones-Ruiz et al. (2016) describe the actors involved in 'collective efforts' (p. 104, inter alia) with firms using 'representative bodies' (p. 114) for management. Pick and Marie-Vivien (2021) refer to 'producers' groups' and 'collective organisations' (p. 3). Sometimes quality sign groups are referred to simply as the 'brand owner' (Raynaud et al., 2005). Sauvee (2013) notes that defining the governance structure can be difficult, given the complexity of networks and organisational structures, and further describes the 'coordination architecture' as the authority that helps manage relationships between actors. Raynaud et al. (2009) note that the governance structure is the result of numerous contractual agreements that effectively develop a vertical coordination along the value chain. In defining governance, Vandecandelaere et al. (2020) describe '... some form of organisation (formal or informal) which collectively takes decisions on aspects related to the GI (at least those linked to production, but maybe also to marketing), and brings together all those involved in the value chain.' (p. 6). They go on to describe GI management as necessitating '... a local association of stakeholders in the value chain' who are collectively involved with the production rules (Vandecandelaere et al., 2020: 6). Additionally, 'stakeholder groups' is the term used in recent work from the FAO on GI systems (FAO & Origin, 2024).

For this study, we seek a unit of analysis that will allow us to investigate collectives engaged in quality sign production more broadly, to include existing quality sign production beyond that of GIs. Such collectives have been described by others as 'quality groups' (Bardenhagen et al., 2021; Westgren, 1999). Quality Groups (QGs) are associations of farmers and agricultural businesses involved in producing branded quality products. QGs develop intellectual property for a quality product by creating a set of specific production rules that will be used across the value chain (Westgren, 1999). Multiple categories of value chain actors, including farmers, packers, and processors, have the opportunity to provide input into the development of the initial rules and the ongoing management of the quality product's label (Bardenhagen et al., 2021).

Quality group, as a concept, captures much of the GI world but is also applicable to other quality sign efforts such as Label Rouge. As a more universal concept, it affords researchers the ability to analyse any group of farmers and value chain actors working together along a set of standards and intellectual property to promote and defend their product. The term quality group is, in fact, used regularly by practitioners in the French and international contexts (Personal comment, Chris Bardenhagen, 2024), adding support to its use in the scholarly research context.

QGs are considered to be a hybrid form of governance (Peterson, 2001; Menard, 2018; Menard and Valceschini, 2005). This is because they combine relational alliances (Gereffi et al., 2005) between value chain actors on the one hand, with a high level of control over production practices on the other. Menard (1996) identified Label Rouge QGs as hybrids early on. In QGs, inter-organisational contracts are made (e.g. the production rules), decision-making structures are created, and enforcement measures are built between the businesses involved — all of which are integral to hybrid arrangements (Menard, 1996; Menard, 2022). QGs would fit in the third-party type of hybrid described in Menard's (2022: 306) typology of hybrids because they are separate entities that coordinate rules and confirm compliance with the different businesses involved. Relatedly, because certain 'specific' assets are needed to transform a product to its final form (Muller et al., 2021), the value chains involved in QG hybrid arrangements include actors that have those specific assets.

It is however important to understand where a QG starts and where it stops. Because a QG association's purpose is to develop and manage the group's production and transformation rules and associated intellectual property, QGs do not themselves engage in commercial activity. Rather, their focus is to ensure that quality levels are maintained across the value chain. It is the business actors within QGs — farmers, processors, and

private slaughterhouses for example — that engage in the commercial activities of the value chain, buying and selling the product at different stages (Bardenhagen et al., 2021). In fact, many of these actors are in competition with one another, such as packing companies and cooperatives that frequently sell within the same supermarket channels (Menard, 2017, 2022). As such, QG associations are meso-institutions (Menard, 2024) that help farm and food businesses implement the rules of quality sign programmes or take advantage of intellectual property regulations.

In terms of value chain structure, branding and quality enforcement strategies on broader value chains have been studied by institutional/transaction cost economists (Menard, 2017; Raynaud et al., 2005; Raynaud et al., 2009), who note that perishability is a factor influencing whether a value chain will have a more vertical or a more market-based arrangement. Sauvee and Coulibaly (2008) identified external forces such as competition and consumer preferences as affecting the governance structure of branding alliances, of which QGs are a subset. But while Reviron and Chappuis (2011) found that several legal forms and organisational structures (interprofessional associations, professional associations, and cooperatives) can be utilised for GI QGs in Europe, the internal details of QGs have just begun to be uncovered.

In relation to organisational design, Quinones-Ruiz et al. (2016) have taken a deep look at the 'black box' of GI registration processes for several QG cases, comparing the time spent by various actors and the duration of the registration process, and considering differences across legal/international contexts. Guerrieri and Marie-Vivien (2022) investigated how control plans affect collective decisions and QG governance, concerning one similar type of agricultural product produced by different groups under different quality sign programmes. In both of the above studies, comparative legal methods were utilised, including document analysis of statutes (bylaws), product specifications, and control plans (Guerrieri and Marie-Vivien, 2022; Quinones-Ruiz et al., 2016). These methods present an effective approach at QG analysis because each of these documents is developed collectively by the actors involved in the QG.

## Research questions

There is still a large gap in knowledge on the internal structures and decision-making systems of QGs. The relative positions of value-chain actors within these hybrid arrangements need investigation to identify arrangements that are more or less functional for farmers' interests. This information can assist farmers, practitioners, and researchers working on value-chain development efforts to build more equitable systems. As GIs are touted as an equitable rural development tool (Crescenzi et al., 2022), it is important that we begin to analyse the power dynamics involved between farmers, processors, and other actors within them.

An explanation of factors leading to differences in structures between groups is also needed, to better understand why groups are organised the way they are. Relatedly, the points at which involvement in a quality sign production begins and where it ends need to be defined. This is because the farmers and downstream operators in these groups are often involved in other production modes (conventional production systems, non-labeled production, related products etc.). Knowledge in this area will help practitioners better understand where and how a quality group effort could be a good fit.

To fill these knowledge gaps, we used the following research question to guide our study of QGs:

- What are the decision-making systems in QGs, and the relative decision-making weight of the farmers and other actors within the QGs?
- Important sub-questions to address this main research question are:
- Which value chain actors are involved in QGs; in other words, what part of the value chain is captured in the QG, and what part is external?
- What major factors affect QG structure?

Using these questions, our research contributes knowledge on the types of decision-making structures and

the power differentials found between different actors in QGs. Applying these questions to QG cases enabled us to develop a typology of QGs, based on their different internal value chain structures and organisational decision-making systems. By analysing a number of cases of production of quality products, we identify categories of QGs having similar characteristics. A typology can help to predict the internal characteristics that are likely to be found in QGs experiencing common factors or circumstances. The identification of different types of QG can provide starting points for local investigation, and can enable practitioners to strategise ahead on development projects to achieve more equitable outcomes.

## METHODOLOGY

For this study, we mix qualitative research with legal methods, including document research and comparative legal analysis. Our focus on legal analysis follows methods used by Guerrieri and Marie-Vivien (2022) and Quinones-Ruiz et al. (2016). We consider the QG to be defined by its membership and by who is contractually obligated. This information is found in the organisational documents of the QG, including the statutes (a similar document to bylaws in the United States), the product specifications, and the control plan. A QG's decision-making processes and the level of different actors' voting rights are codified in these documents.

Additionally, quality signs, including GIs, are intellectual property rights based in country-level legal frameworks which are harmonised to a large extent by international agreements. This intellectual property is owned by or licensed to QGs, which use it collectively to promote their product and defend against usurpation. Because QGs are fundamentally about organising to develop collective intellectual property rights, a legal/qualitative mix affords deep insight. Our legal/qualitative approach resonates with concepts presented in Williamson's (1991) analysis of 'discrete structural alternatives' of governance forms, which recognises the influence of law on business organisation (e.g., company law, contract law, intellectual property regulations). We use qualitative methods to investigate QGs, because they each represent a different approach to economic organisation that has emerged to deal with unique market and production challenges.

### *Context and Case Selection*

To begin to answer our research questions, we conducted research on French quality groups across a diversity of product types and value-chain characteristics. France was chosen as the context for several reasons: it has a voluminous food quality product industry, with nearly 6 billion euros of sales of geographical indication (PGIs and PDOs) and Label Rouge products in 2020 (INAO, 2021), covering in total about 1,200 different quality products. This enabled us to work with products across a wide variety of agricultural sectors. French law is also well-developed in regard to both quality sign programming and the regulation of quality group organisations, providing consistency across cases that facilitates structural comparison. The following are a few examples of French mandates: French QGs must have their full body of members (assemblée générale) vote annually on the fee levels that will be imposed on producers and other actors;[4] only certain business entities may be used for QGs to keep them non-profit in nature (Bardenhagen et al., 2021); and the French Institut national de l'origine et de la qualité (INAO) regulations impose a level of democratic functioning and balance in industry representation so that QGs are not exclusionary.[5]

Our multidisciplinary research design utilised a case study approach (Sterns et al., 1998; Yin, 2013) to comprehensively assess internal structure and value chain operation, taking the quality group as the unit of analysis. We chose a sample of cases in consultation with French officials who work with QGs at both local and national level, as well as with researchers who study French food value chains. In this way, we were able to identify cases that would represent the breadth of QG types across products, value chain volumes, and market scopes. While there was potential for bias in case selection due to our purposeful sampling, our process of identification and consultation was intended to develop a representative cross-section of QGs.

[4] See Code rural et de la pêche maritime art. L-642-25.

[5] See Code rural et de la pêche maritime art. L-642-18; see also Institut National de l'Origin et de le Qualité, INAO-DJR-1009-03 Rév. 1, Suivi des conditions de reconnaissance ODG [Monitoring of ODG recognition conditions] (2011).

*Data Gathering and Sampling*

To collect data, we conducted semi-structured interviews with quality group managers, farmers, and other value-chain actors. Semi-structured interviews allowed us to obtain in-depth information from the perspective of the actors themselves, in a way that would leave ample room for both expected and unexpected answers, and allow for comparison among interviewees' responses. Interviews were generally held at the interviewees' place of business, in the different French regions. We gathered organisational documents from the QG managers, including the statutes, product specifications, control plan, and internal rules (règlement intérieur) as applicable and available.

We obtained organisational documents and conducted interviews with actors from 12 QGs, with a total of 31 managers, board members, and farmers interviewed. Six QGs were based in southern France and six in central France.[6] Furthermore, 18 key informants were also interviewed, including French officials, regional agents, researchers, and professional support, including one attorney. Our interviewee sample enabled us to reach a saturation of concepts, as our final interviews added very little additional information, substantially reiterating concepts previously identified.

Our analysis was also informed by studying numerous other cases in France, including reviewing publicly available filing documents from INAO's website. These documents often state information about the value-chain actors involved and the rules for production. QGs' promotional websites often provide detailed information about their members, and in some cases provide the statutes of the organisation.

*Analysis*

We used qualitative analysis techniques, including concept identification, coding, theming, and summarising (Chung, 2000). Inspired by the grounded theory approach (Glaser and Strauss, 1967; Peterson, 2011), we explored the data throughout the interview period, using it to inform and improve our interviewing. During the analysis, we focused on listening to the data in order to develop salient concepts and metrics. This allowed us to identify recurring aspects of internal structure and decision-making systems within QGs, as well as the factors that might lead to different organisational characteristics. We incorporated legal metrics into our qualitative analysis techniques (coding, theming, and summarising) to assess each QG is organised and how its value chain functions. Comparative analysis was further used to analyse differing organisational design aspects found in the QGs' statutes.

To help categorise and better understand the complex relationships we found (Taran et al., 2015; Margiono et al., 2018), we identified a number of emergent types of QGs in our data. To do so, we synthesised the factors that led to different value chain structures (product chain length, mode of processing, and distribution mode) with the different decision-making systems we found.

## RESULTS & DISCUSSION

There was a wide product range in our sample of QGs, including poultry, red meats, cheeses, fruits, vegetables, and horticulture products such as flowers. Market scopes were also varied. In certain QGs, actors focus on national distribution through supermarket chains, while in others, they focus on local and direct markets. The value chains involved in many QGs have a regional scope and/or a mix of local, regional, and national markets. Table 1 below illustrates the variety of markets that are utilised by the actors within the QGs that we studied in-depth.

[6] Note that our sample did not include wine and spirit QGs which, as a sector, has unique rules and structural characteristics.

*Table 1. Number of QG value chains engaging in various markets (sample of 12)*

| | **Direct Market** (farmer's markets, restaurants, on-farm) | **Specialty Market** (cheese shops, butcheries, etc.) | **Supermarket** |
|---|---|---|---|
| **Local** | 5 | 6 | 2 |
| **Regional** | 3 | 6 | 9 |
| **National** | - | 5 | 5 |

The processes used to transform the product to sellable form also varied. In some cases, high volumes of a product are aggregated through packers, processors, and slaughterhouses, while in others there is a focus on on-farm processing or packing. Some groups had a mix of both.

*Value Chain Actors*

The scope of QG membership varies. While some have only farmers as official members, others have farmers, first processors, second processors, including fruit and vegetable packers, cheese makers, cheese ripeners, and abattoirs (slaughterhouses) as members. Cooperatives play a big part in many QGs. They can help aggregate raw products or live animals to get to the next step, and in some cases they perform downstream activities such as packing and cheesemaking. The total number of farmers involved in each of the QGs we sampled ranged from 7 to about 2500, with most of the groups having between 75 and 280 farmers.

In most cases, businesses that are upstream from farmers are not involved in the QG as a member. Feed millers and chick hatcheries, for examples, will provide feed and genetics that meet the requirements of the product specifications, but the transactions are at arms-length. We did find an example where upstream actors were voting members of the QG, but this is uncommon.

Distributors and retailers are rarely involved as members at the QG level, but we did find a number of strong connections. First, we found one example of a retailer being involved as a member at the QG level, for non-food agricultural products, and in this case the retailer was performing a step outlined in the product specifications. In a second example, we found a QG that required specialty retailers to sign a brief contract detailing the presentation of the product in their stores, to ensure the products were marketed with the proper promotional materials. Furthermore, while there is a substantial amount of marketing of QG products through retailer brands in France, from our sample these seem to be mainly private label contracts, such that the retailer does not have a place inside the QG membership. However, in the cheese industry, there are processors involved in some QGs that are subsidiaries of large retailers.

*Factors Affecting Quality Group Makeup*

The factors we found to be consistently associated with differences in structure were: a) product type/chain length; b) production mode; and c) distribution mode. Individually, these factors do not fully explain the structure of a value chain within a QG. However, when we applied them in combination to the QGs in our sample, the categories in our typology began to emerge. We first describe these factors.

a) Product type/chain length

Product characteristics are critical, albeit often overlooked, factors for organisational structure. The number of steps needed to move from a raw product to a sellable form helps determine which value chain actors will be involved in the production. Food safety considerations and the perishability level of a product influence this element. Here we consider two main categories of product type: long production chain, where a higher

number of processing steps is required to achieve a sellable form, and short production chain, where only one or two steps are needed to market the product.

Long production chain. Meats and especially cheeses require several actions and processes before they can be marketed. Cheeses, for example, must go through a multi-step process after milk is collected, including curdling, shaping, and ripening. With meats, they need to be procured, processed, and cooled within a short period of time. While in some QG cases these processes are completed on farm, in many QGs multiple, separate downstream value chain actors are necessary (e.g. processors, ripeners).

Short production chain. Fruits and vegetables require grading, packing, and storage, but do not require further processing or transformation to be sold in their highest value form7. Downstream processing and transformation actors are therefore not necessary, and so do not need to be members of the QG. Commercialisation of the products is conducted either by farmers individually or by the packers who sell to distributors.

b) Processing mode

The processing mode predominantly used in a value chain affects the QG's type significantly. The two main modes we find are on-farm processing, where steps are conducted by the farmer, and off-farm processing, where raw products are brought to downstream operators for processing or packing. Some QGs have actors engaging in both.

On-farm processing. The QGs that include farmers engaged in on-farm processing are, in the cases we studied, all focused on artisanal production. This type of production utilises traditional methods and often requires high levels of management per unit. Additionally, on-farm processing requires all the equipment and other specific assets needed for production to be located on the farm, including the processing equipment (such as for slaughtering), storage equipment (such as for cooling or drying), and sorting equipment, as well as all of the facilities needed to house that production in a food-safe manner. For example, farm-based cheese producers conduct all the steps from animal rearing and pasturing to milk gathering, cheese making, and cheese ripening. The equipment used for on-farm processing is normally smaller scale, which generally limits the volume of output.

Off-farm processing. Off-farm processing can enable higher levels of volume. Off-farm processing businesses, some of which are farmer-owned cooperatives, invest in larger-scale equipment and facilities that can efficiently process, pack, and store the product. These assets enable the product uniformity and volumes demanded by large retailers. Due to their strong involvement in the production steps, these businesses become QG members and are involved in the decision making, especially regarding the product specifications and control plan. Note that in most of these cases, ownership of the product is transferred from the farmer to the processor and, where relevant, from the first processor to the second processor at delivery. Generally, the most downstream business commercialises and markets the product. Consequently, farmers in QGs that are engaged in mostly off-farm processing are dependent on their downstream actors: processors, ripeners, and abattoirs (James, Hendrickson, and Howard 2013).

Hybrid. We found several hybrid QG cases whose value chains included both on-farm and off-farm processing. This existence of downstream actors enables artisanal farmers to enter new markets or produce higher volumes of a product. For these farmers, fewer resources are spent on on-farm processing, leaving more resources and time available for production of the raw product.

[7] Processed fruit and vegetable products such as applesauce can be important as secondary products, but do not obtain the highest values.

c) Distribution mode

The channels and venues through which the products in a value chain reach customers have a large impact on QG type. Here we identify three modes of distribution: supermarket focused, specialised-market focused, and local distribution.

Supermarket-focused. The main marketing venue is supermarkets, sold regionally or nationally through larger-scale distributors or directly to retailers. Large volumes of product are linked with this marketing mode, to satisfy the scale of distribution.

Specialised market-focused.[8] Products are delivered nationally, but to smaller retailers focused on meats, cheeses, or fresh fruits and vegetables, often in urban areas.

Local distribution: Farmers sell their products directly to consumers at farmers' markets or on their farms, and/or to local retailers, including specialised-marketers such as cheese shops.

Note that these modes are not mutually exclusive. For example, farmers in supermarket-focused groups often sell a portion of their products at farmstands or farmers' markets. That said, the bulk of the production of a quality product in a QG will tend to be distributed through one of these modes. The exception is the hybrid chains, where the QG actors include both on-farm and off-farm processing, and where there is a more even split between national, specialised markets and local markets.

*Decision-making Systems and Farmers' Weight*

Each of the QGs we studied had both a General Assembly and a Board of Directors (Conseil d'Administration). These two decision-making bodies are fundamental to membership-based associations in France (Association Loi de 1901, Syndicates), similar to membership-based non-profit associations and cooperatives in common-law systems such as the United States. The General Assembly is the larger body, where members are able to express their voice and vote on fundamental decisions. QGs are structured such that annually, the members elect their board members and vote on user fees (cotisations).

Farmers are often direct members of the General Assembly, but in a fair number of cases, especially where large numbers of farmers and product volumes are present, farmers will be represented by their cooperatives or other producer groups. In certain situations, the population of the General Assembly can be largely similar to that of the Board of Directors, with the same individuals serving on both. However, depending on the case, this might speak to a lack of farmer engagement rather than issues with the overall organisational structure. Farmer engagement is robust in some QGs, but a challenge in others.

The board of directors, elected from the membership, does most of the ongoing organisational work and provides oversight to the paid manager of the ODG. Often in the statutes of the organisation, the board is given fairly broad powers to manage the ongoing matters of the business. In practice, the board will also spend time and effort developing strategies, which they will present to the members for approval. Annually, the board will provide updates on volumes, sales, and other key figures.

Many QGs are divided into colleges that are natural, given their membership. Some colleges are as simple as 'upstream' and 'downstream', grouping those actors together for common meeting and decision-making purposes. In other cases, those categories are broken down further, for instance, farmers doing on-farm versus off-farm processing; or cheesemaker processors (transformateurs) versus ripeners (affineurs). Often the colleges will each have a number of board seats allocated to them, detailed in the statutes. This number is often set by a formula based on production volumes, with limits to ensure that a balanced representation of farmers exists.

[8] 'Specialised' refers to small, upscale vendors selling only particular products (cheeses, meats, or fruits and vegetables.)

The decision-making systems of QGs can therefore range from simple to quite complex. However, in each QG the upstream or farmer side had at least 50% of the vote in both the General Assembly and the Board. Again, the upstream side might include cooperative representatives versus the farmers themselves, but those cooperatives have their own democratic decision-making structures. We did find several QGs where farmers had 100% of the vote in both bodies. The decision-making systems and levels of farmer voting power we found in the different QGs seemed to track several types, which we describe in the typology below.

*Typology*

In applying the structural factors and decision-making systems described above to the QG cases we studied, we identified several types. These types matched with the themes we discovered through our coding process, as well as those observed through our in-person meetings and from general information gathering about the QGs. The four main types we observed were large-volume animal product QGs, large-volume short production chain QGs, artisanal animal product QGs, and producer-focused QGs. These and some variations on these types are presented below.

Large-volume animal product QGs. This type of QG is concerned with production of meats, cheeses, eggs, and other animal products. While we did not observe any in our sample, additional milk products such as yogurt could fit in this type. Long production chains are involved due to the product type. High volumes are processed and marketed through off-farm processors and other downstream actors. These efficient downstream actors can provide the product uniformity, packaging expertise, and volumes per order that are needed to work with supermarket chains, regionally and nationally.

On the farm side, there is enough aggregate volume between the farmers involved to necessitate downstream actors and supermarket buyers, to move their products. While the focus is on quality production, industrial processes and marketing channels are utilised.

The decision making is often split in these groups, 50% farm side (upstream), and 50% downstream. This is true for both bodies, the General Assembly and the Board. The voting power is usually determined based on volumes, for example one vote for so many head of animals. On the upstream side, cooperatives are often involved, aggregating farmers' products and negotiating on their behalf. In many cases, the cooperatives are the voting members of the QG, representing their farmers. On the downstream side, the processors and packers play a very important part and have a large stake in the outcome of the quality product, often marketing the product to distributors and retailers. This provides negotiating power during the organisation of the QG, leading to substantial voting weights.[9]

Figure 1 illustrates an example of an organisational decision-making schema, built drawing from several examples of meat-focused QG cases. France has many of these types of QGs, due in large part to the Label Rouge programme.

Large-volume short production chain QGs. This type of QG has actors producing large volumes of products with shorter production chains. These products include fruits and vegetables, but may also include grains (wheat, flour) and horticultural products such as flowers. Many farmers work together, often through cooperatives, to produce the volumes needed to sell to supermarket buyers regionally and nationally. Grading and packing are the only steps needed to prepare the product for sale. However, volumes necessitate modern, large-scale equipment capable of grading and packing to supermarket standards. The packing and cooling equipment is located off-farm to facilitate space and distribution via semi-trucks. Cooperatives can be the packer, in which case they are both an upstream and a downstream actor.

[9] Note, however, that farmers and cooperatives can be part owners of these downstream operators, especially seen with slaughterhouses (Paybou, 2000).

Downstream actors can have a substantial amount of decision-making power in these QGs. However, these QGs are more farmer-centric than the large-volume animal product QGs, because fewer downstream actors

*Figure 1. Large-volume meat quality group organisational structure*

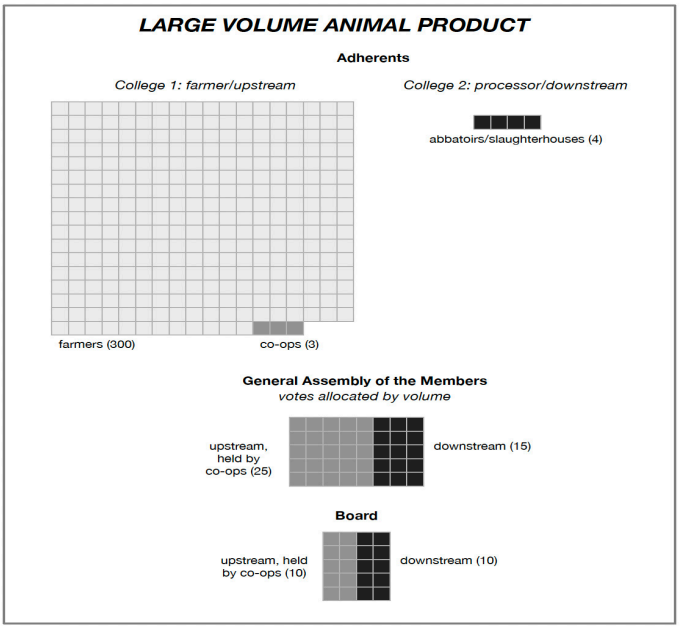
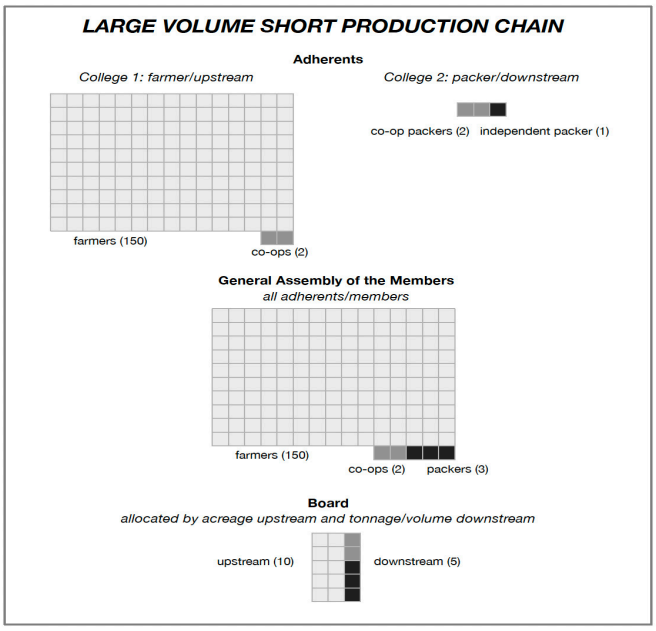



*Figure 2. Large-volume, short production chain quality group organisational structure*




are involved. Furthermore, where packing is done by the farmers' cooperatives, the farmers have even more voice in the aggregate, through their vote in the cooperative.

The farmers themselves can be members of the General Assembly and vote in it directly. In our sample, farmer/upstream board seats were determined by acreage, and board seats allocated by tonnage on the packer side. Minimum proportions of farmers on the board can be implemented, for example a rule that two-thirds of board seats must be held by farmers. Although we had only a small sample, this type has a very balanced decision-making system and value-chain structure, potentially replicable by groups with large numbers of farmers organised in cooperatives in both developed and developing contexts.

Figure 2 illustrates an example structure for a fruit or vegetable QG, drawn from our sample.

Artisanal animal product QGs. This type of QG concerns animal products such as raw meats and cheeses. The production within these QGs, at its base, is artisanal, meaning it is produced with customary, passed-down methods, often with smaller-scale equipment and traditional technologies. Due to the nature of the products, multiple steps are needed, for example milk processing, cheesemaking, and ripening. Volumes of artisanal products, while substantial, are mid-scale or lower.

The marketing scope includes both local sales and distribution through specialty retailers, including meat and cheese markets around the country. Farmers focused on local sales do the processing steps on-farm. However, to develop the mid-scale volumes and product consistency needed for national specialty distribution, downstream actors are involved. In our sample, farmers tend to engage in either on-farm processing or off-farm processing, but not both. This is likely due to the relatively high cost of processing equipment and the food-safe building space needed to use it. Farmers presumably either maximise their use of the equipment, or else maximise the amount of artisanal products they produce, rather than buying the equipment.

Farmers had a strong majority of decision-making power in our sample of QGs of this type. The farmers

can be split into colleges, based on whether they engage in on-farm processing or not. Farmers are direct members in the General Assembly, as are downstream actors, but given the 1member 1vote setup, the very large balance of voting power in this body is with the farmers.
As downstream actors are an important part of the value chain, they are involved as members in the QG. They have less of a presence than the downstream actors in large-volume animal product QGs, and consequently less voting weight as well. However, at the board level, processors are still provided a substantial amount of voting power, for example one-third.

Figure 3 shows an example organisational structure for an artisanal-focused QG, averaged from some of the QGs in our sample. This type of QG may be most prevalent in southern Europe, where PDOs are abundant.

***Figure 3. Artisanal animal product quality group organisational structure.***

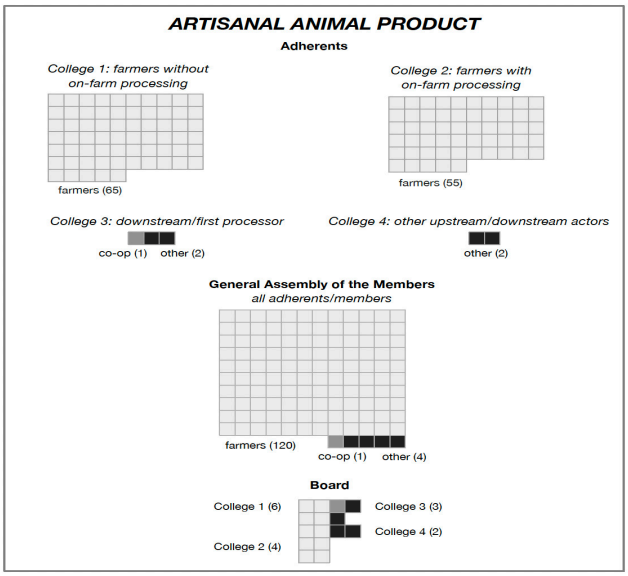
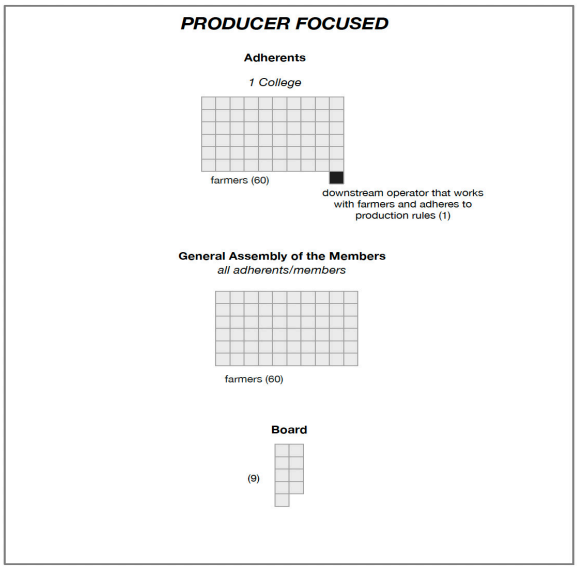



***Figure 4. Producer-focused quality group organisational schema***




Producer-focused QGs. Producer-focused QGs can potentially concern any product type, for examples meats, vegetables, cheeses, and fruits. We saw examples of both long and short production chains. Processing and packing steps can be both on-farm and off-farm, and our sample included groups engaging in strictly local production as well as those working with national-level specialty distribution by contracting with local packers. Production was artisanal in most of our cases of this type, but larger-volume farmers could also potentially utilise this organisational design.

The entire membership of all of these producer-focused QGs is made up of farmers. The General Assembly follows a 1member, 1vote rule. Members of the board are all farmers selected from the General Assembly. Decision-making was 100% farmer based in the QGs in our sample of this type.

Figure 4 illustrates an example producer-focused QG. While simplified in terms of value-chain actors, the QG association itself will still perform the same functions as other types of QGs: development of specifications, promotion of the product, oversight of actors, and defence of the quality sign.

*Variations*

Some variations were seen from these main types. We also hypothesise about a number of other variations.

It is not unusual for QGs to manage more than one quality sign, for example a poultry QG might cover related chicken, duck, and egg labels for its members. In our sample, we also studied two QGs that work

with different groups of producers to cover different products. At face value, these groups are outliers, but in reality the difference may not be that big. This is because essentially these are just multiple quality groups working under one organisational umbrella. The difference in the cases in our sample is that the production is carried out by a smaller number of value-chain actors working with larger-volume retailers. Members include processors and farmer-packers.

A variation that we hypothesise will be seen is producer-focused QGs having one or more downstream operators as per-se members. In such a situation, the operator would have a vote, though it would be a small percentage of the overall decision-making power. This situation may occur because the product specifications often place requirements on a downstream step with which that operator must comply. However, such an inclusion in the structure would not be likely to substantially change the dynamic, compared to producer-focused QGs where farmers work with packers by contract.

Finally, GI-related handicraft production is carried out by artisans across different contexts. We did not have handicraft QGs in our sample but would expect them to have a producer-focused organisational design. A QG of this type might include an important marketer or a producer cooperative. Such an actor might be a voting member as mentioned above, or work with producers by contract.

*Limitations and Suggestions for Future Research*

In order to provide a consistent and structured context, this study focused on QG cases in France. Our efforts to develop a representative cross-section of QGs did produce robust differences, but there was a potential for bias in our sampling methods. Our 12 in-depth cases and more limited review of numerous other QGs in France provide a wide breadth of diversity in value-chain structures and decision-making systems, but this typology would benefit from testing on more cases for validation, across different countries and contexts. We nevertheless suggest that value chains have similarities across international contexts, due to the practices necessary for producing specific products (Lee et al., 2010), even where production infrastructure is lacking or in need of upgrading (Trienekens, 2011). Relatedly, as meso-instutions (Menard, 2024), QGs are bound to have many similar characteristics due to their effort to negotiate between farmers and production businesses, and their applicable macro-institutions. Therefore, it is likely that our typology will be useful and apply as a starting point for groups in other contexts, especially for identifying the types of value chain actors involved or not within them, and for identifing QGs' basic activities. Our caveat is that the decision-making power is likely to vary by context, based on the level of property rights enforcement, background instututions, and power differentials that exist.

Future research efforts related to QG types should consider factors that might cause differences across such contexts. For example, development efforts can experience differing levels of state involvement in development and management (Marie-Vivien et al., 2019; Pick and Marie-Vivien, 2021). How does this affect decision-making systems and outcomes for farmers? Another factor to consider is how the existing political economy of the region at the time of development affects the shape of the value chain structure, potentially influencing which actors became involved in the QG. These are important policy considerations to help guide future GIs and other agricultural value chain development research and efforts.

Our research did not include QGs focused on wines and spirits. Such QGs are somewhat unique due to the structure of their industries and certain legal requirements. While much of this study will apply to wine and spirit QGs, the typology may not be completely transferrable.

## CONCLUSIONS

Through the development of a typology, we discovered various combinations of value-chain structures and decision-making weights found between actors in QGs. The types we identified are: large-volume animal

product QGs; large-volume short production chain QGs; artisanal animal product QGs; and producer-focused QGs. Our results also illustrate different types of decision-making structures and areas of power differentials involved in QGs. Our typology serves as a potentially valuable tool for future research and analysis of QGs, especially for investigating governance design and the negotiating power of farmers in relation to other actors. We identified several key factors contributing to differences between QG's internal structures and decision-making systems. Although certain contextual factors, such as in situ competition levels or a country's contract enforcement levels, can potentially result in differences, we expect the following factors to affect QG types across broader contexts: a) product type/chain length; b) processing mode (on- or off-farm processing); and c) distribution mode. These factors are embedded in our typology, which is the main contribution of this paper.

We found that organisational decision-making systems range from evenly split between upstream and downstream actors, to fully controlled by farmers. For QGs whose members work with substantial volumes of products, cooperatives often comprise a substantial part of the QG structure, along with downstream actors such as abattoirs. These results align with those of Paybou (2000), who conducted comprehensive interviews and analysis of six important QGs in the French Label Rouge poultry industry, and Quinones-Ruiz et al. (2016), who found a similar set of value-chain actors in their study of quality-sign registration efforts. Similar to Guerrieri and Marie-Vivien (2022), we found that QGs working with similar products can have differences in organisational design, based on which actors are involved and who leads the initial quality-sign effort.

The identification of product type as a major factor in value-chain organisation is consistent with the conclusions of Raynaud et al. (2005) and Raynaud et al. (2009). More perishable products generally require either short production chains to move them quickly, or additional value chain actors to enable processing into storable form. Our results are also consistent with Gereffi et al. (2005) and Muller et al. (2020), because we found that specific assets, and the value chain actors that own those assets, to be strongly determinant of both production-chain length and processing mode.

Our research contributes to the literature stream on hybrids and new institutional/transaction-cost economics because we help to identify why QGs do not usually correspond to the strategic centre zone of the typology presented by Menard (2022). As separate, third-party entities, QGs must comply with the legal rules for non-profit business associations, which are generally required to have purposes that are not pecuniary per se. Furthermore, certain member-state regulations (e.g. France) stipulate that QGs themselves cannot engage in commercial activities such as producing, buying, or selling quality products. Regulations on GI certification marks in the United States have the same prohibition10. That is not to say that such formal strategic investments are not pursued similarly to those of other value chains. Instead of utilising the QG association for this, value-chain actors in these groups can invest in commonly held strategic assets using cooperatives, joint ventures, and other vehicles. We found several cross-ownership situations where farmers and/or their cooperatives have some percentage of ownership in downstream operators, including abattoirs (Paybou, 2000). In these cases, dual hybrids are being used: the third party type (QGs) and the strategic centre type (joint ventures in specific assets).

Finally, an important contribution of this research is to establish the quality group as a practical and useful unit of analysis. As a unit with legal boundaries, the QG provides a common structure for analysis of different economic actors' influences and rights, both inside groups and between groups. The QG unit also has potential for comparatively analysing groups between various country contexts, as meso-institutions negotiating underlying national, federal, international laws (Menard, 2024).

To conclude, our research provides an important next step for analysis of GIs and other quality labels, which together present a specific type of value-chain organisation. While much value-chain research applies to GIs

[10] See the United States Patent and Trademark Office's Trademark Manual of Examining Procedure, §1306.01(a)

generally, the QG is a unique and important unit of analysis that is core to the operation of GI projects. Our typology should help predict value-chain actor relationships for GI development initiatives, and inform efforts to optimise work with existing GI quality groups.

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## APPENDIX A.

Quality Group Actor Interview Guide

*PART I. QG Members and Production*

A. Who are the members of [QG] ?

B. Can you tell me about the farmers involved in [QG] ?
What is the diversity in the size of the farms in the QG?
What other products are commonly produced by farmers producing [insert product name] ?
[If group has multiple SIQO products:] Do the same farmers participate in producing the different products, or are they distinct groups?

C. Can you describe the rest of the supply chain? Describe the Value Chain (from farm to fork!)
Which supply chain actors are not in the QG?
Are there any cooperatives involved?
Are there any Organisations de Producteurs inside or outside the QG?
What are the functions of each of these other value chain actors?
What are the day-to-day relationships among operators, both formal and informal?

*Part II. QG Legal Structure*

D. How are decisions made? My interest is especially the legal domain.
Composition of the General Assembly? Are delegates used? Engagement (%)?
What decisions are made by the GA? Voting process?
Composition of the Conseil d'Administration? Election process?
What decisions are made by the Conseil? Voting process?
Do you have a 'règlement intérieur'?
Confirm legal entity used.
[If there are one or more cooperatives:] Are there any farmer members that are outside/not part of the cooperative(s)?
Does your QG adhere closely to the statutes? Are there any differences between what is written in the statutes and what is practised?

E. Have there been any changes over time in the structure/configuration of [QG]?
Which? How have these affected [QG]?
Why did these changes take place?
What is your experience with reporting/dealing with the INAO on the changes?

F. What is the weight or place of farmers within the decision-making structure?
How strong is their position within the overall group, in terms of decision-making rights?
Level of farmer engagement/ participation by farmers?

G. What are the rules and procedures for bringing in new operators (farmers, other VC actors)?

H. Are there any associate members in your QG? If so, please list/describe these members.
Which decisions do they participate in?
Which decisions are they not allowed to participate in?

I. During the process of creation of a QG, the INAO must evaluate the following elements: représentativité

des opérateurs, fonctionnement démocratique, et caractère équilibré de la représentation des différentes catégories d'opérateurs. In your situation, how does your QG meet these criteria?
How could it better meet these criteria?
In other words, what is the fairness of the composition and voting structure:
within the QG, and
within the larger value chain?

J. Do any actors/operators within the value chain set a base price for farmers? If so, what is the process for this?
For example, does the cooperative set a price or margin regularly?
What methods are used by operators to regulate quantity within the value chain?

*PART III. QG Operations*

K. What does your QG do? What does its management involve? In other words, how does [QG] work with these operators to coordinate production?
What are the critical points in the production process for [insert name of product]?
What types of unexpected issues come up, and how do you deal with them?

L. Are there any particular pieces of equipment/ other [specific] assets [or labour types] that are important for the production process for [insert name of product]? If so, please describe.
How is their use secured within the value chain (e.g. purchase by the cooperative, lease out)?
Is there cross ownership of these assets by different operators?
Are there any issues with labour at one or more points in the production process (harvesting, processing, packaging, etc.) that affect [QG]?

M. What property is owned or leased by the QG, if any?

N. Control. How does [QG] ensure compliance with the specifications?
Is technical assistance one of the missions for helping farmers to adapt to the CDC? If so, what types of outreach and assistance are given?
What does a 'batch' consist of for testing purposes?

O. How are costs of certification covered (the ongoing payments to the Organisme de Contrôle ) ?
Do the fees cover the costs?
Do farmers pay by volume?

P. What type of marketing is done by the QG, if any?
Modes of advertising?
Budget? How is it financed?

Q. What do you do to protect your sign/product?
Litigation frequency? Approximate costs?
Perspective on INAO effectiveness in this area?

*PART IV. QG History, Development Process, and Institutional Support*

R. How did the [QG] get started?
What (type of) operators were behind the beginning of the effort?
How did you get involved in working with [QG]?

S. Can you describe the process of development, of construction of the QG?

Specifications
Delineation of the geographic area [if applicable]
Did an outside expert help, using site visits for example?

T. What institutional support was there during the development process? [If not answered above]
INAO support
Other governmental or non-governmental consultants? For what specific points?
Researchers, and if so, from what disciplines? For what specific points?

U. How has the production of [name of product] evolved over time?
Growth or decline in number of farmers participating, and reasons?
Growth or decline in sales volume/revenue, and reasons?
Growth or decline in number of other operators participating, and reasons?
Market evolution (national/international)?

*PART V. External Influences*

V. Do government subsidies or other support (besides INAO services) encourage/incentivise farmers or other operators to use this or other SIQO labels?
Why are farmers joining in to produce [name of product]? [If applicable]
Are there any other policies or laws that affect SIQO adoption (e.g. rural property laws, the Common Agricultural Policy (CAP))?

W. What is the level of competition in the marketplace with [insert name of product]?
Competition with conventional?
Competition with other quality labels?
What level of price premium is there?

## APPENDIX B.

Farmer Interview Guide

*PART I. Production and Value Chain Operation*

1. How long have you been doing this, producing [product]?

2. Please describe the different steps involved in your production of [product].
Genetics
Production
Harvest

3. Please describe what happens to your product after it leaves your farm.
What are the next steps in the value chain?
Who buys, processes, sells, delivers, et cetera?

4. Are there any improvements that could be made in the production process/value chain steps? If so please describe?

*PART II. Implications of Working with the QG*

5. What are the implications for you and your business of working with [QG/product]?
What changes did you have to make to work with the specifications?
You joined in [year stated above]; why did you not join before that?

6. What are the advantages for you and your farm of working with [QG/SIQO]?
What are the financial benefits, price premiums, markets, other?
What are the advantages for your farming style, way of life?
What other benefits do you find?

7. What are the constraints and disadvantages of working with [QG/SIQO]?
What are the financial costs?
Equipment/materials/supplies
Control
Fees
Paid labour
What extra time is involved?
Meetings (how far are they, time spent), communication with ODG, working with others
Your labour: what do you do that takes extra time?
Time spent on control aspects?
Are there any other implications/constraints/disadvantages?

8. What differences in specifications would you like to have, if you could have your wish?
How would you produce differently, if you could receive the same price for your product?

9. Generally, what types of challenges do you encounter when working with other farmers and businesses on a quality label?

10. What government subsidies are available for farmers who want to work with [QG] or other SIQOs?

*PART III. ODG Decision making and Value Chain Arrangement*

11. Much of my research focus is on how decisions are made within QGs. Please describe the process of [example decision].
How did voting work/ who made the decisions?
Was the outcome equitable?
Do you have any other thoughts on how decisions are made, or examples?

12. Are there any power struggles between operators or businesses within the QG? Please describe.
What is the underlying reason for the struggle(s)?
How could this/these conflicts be remediated?

13. Do you think the arrangement between operators in the QG is equitable/balanced?
Is it equitable to the farmers? Why yes or no?
Is it equitable to non-farm operators? Why yes or no?
Have the benefits eroded to downstream actors over time?

14. What improvements could be made in the arrangement between operators/structure of the QG?
What could have made the distribution of value more equitable?

# Underutilized or undervalued? The role of restaurants in valorizing agrobiodiversity

Paper first received: 13 March 2024; Accepted: 25 November 2024; Published in final form: 15 December 2024
https://doi.org/10.48416/ijsaf.v30i2.609

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## Abstract

Agrobiodiversity has been at risk for the past decades and many calls have been made to reverse the trend, not only through conservation measures but also by increasing the use of agrobiodiverse crops. This article focuses on the role of the retail sector – and particularly restaurants – in revitalising consumer demand for neglected and underutilised crops (NUCs). Given the commercial orientation of private sector actors such as restaurants, it aims to better understand how (medium-priced) restaurant owners go about giving value to NUCs while at the same time keeping their business going economically. To this end, it explores the two 'moments' of evaluation and valorisation highlighted by valuation theory, using the categories elaborated in the business model canvas. The results of in-depth interviews with seven restaurant owners in Rome who use NUCs in their menus shows an 'interrupted' valuation process. In this process, the value co-constructed by restaurant owners during the evaluation moment is not passed on to consumers in the valorisation moment as much as it could be, thus limiting consumers' ability to learn about NUCs and potentially increase NUC demand. The overall cultural and institutional context that values 'locality' above other aspects related to sustainability plays a role in limiting the valorisation of NUCs, thereby making the case for the need to revise such dominant standards to better reflect the value of NUCs.

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**Dalia Mattioni** has worked on topics related to food policy, food environments and food security for the past 20 years. She has collaborated extensively with the Rome-based UN agencies carrying out different tasks ranging from direct project management in the field to research and training on various topics such as sustainable livelihoods, project impact assessments and gender. At the UN Food and Agriculture Organization (FAO) she worked with the Nutrition and Food Systems Division on a Food and Green Environment Project implemented in Dar es Salaam, Lima and Tunis and, more recently, as a research associate with the University of Cardiff on an EU-funded project on urban food systems in Europe. She is currently a researcher at the Department of Agriculture, Food and Environment, University of Pisa (Italy).

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**Acknowledgements**

This article received some funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement No. 101000383 (DIVINFOOD project).

## Introduction

There is ample evidence today that agrobiodiversity, that is, the domesticated and undomesticated plants, animals and microorganisms that contribute to food and agriculture, is severely at risk (FAO, 2019). Numerous calls for action have been made in the past decades to increase efforts at agrobiodiversity conservation, not only through conservation measures such as the use of germplasm banks, but also through the use of agrobiodiversity (Jones et al, 2021), with suggested interventions that span the entire food chain from farm to consumer. Here we will focus on crops, and particularly on Neglected and Underutilised Crops (NUC) which include wild, domesticated, or semi-domesticated plants, 'whose potential to improve people's livelihoods is not fully realised because of their limited competitiveness with commodity crops in mainstream agriculture' (Ulian et al, 2020:422). In designing pathways to reverse the current trend, much emphasis is placed on the production end of the food chain, with very little attention paid to what occurs post farmgate and the importance this has in revitalising consumer demand for NUCs (Baldermann et al, 2016). In this, the retail sector, that is, supermarkets, grocery stores, and the HORECA (Hotel, Restaurant and Catering) sub-sector, has been particularly marginalised (Zimmerer et al, 2021).

This article aims to contribute to answering questions around how to increase the consumption of agrobiodiverse products by focusing on the retail sector, and particularly on the role of restaurants. In the last decades, eating out has come to take on a very relevant role, especially in the industrialised Global North (Diaz Mendez & van den Broek, 2017). While eating out used to be a special activity, today it has become normalised, and people use about 40% of their food budget on eating out (US Bureau of Statistics, 2018; Eurostat, 2022). Chefs, along with restaurant guides, are also increasingly considered as 'taste-makers' and much research has been carried out on the role of (especially high-end) chefs in influencing taste and preferences (Richardson & Fernqvist, 2022). For these reasons, restaurants can represent important arenas where consumer appreciation and demand for specific food items are shaped, thus potentially contributing to an overall increased demand for NUCs.

Very little however is known about how restaurants go about giving value (or not) to NUCs, and the aim of this article is to contribute to filling this gap by exploring the valuation process of restaurants that choose to use NUCs. To do so, we draw upon the body of valuation studies enriched by the use of the business model canvas. The article progresses in the following way. The next section summarises what is known so far about how restaurants can contribute to food system sustainability, and highlights how agrobiodiversity and NUCs do not form part of the 'language' around sustainability. We then develop our conceptual framework, drawing from valuation studies and the business model canvas. In the following section we present our methodology and the empirical findings around who the actors involved in constructing value for NUCs are, what is being valued and where, and what tools are mobilised to evaluate and valorise NUCs. We discuss our findings in Section 5, pointing out that while value is constructed for NUCs together with farmers in the sourcing stage of a restaurant's business, it is not (entirely) passed on to consumers through valorisation as much as it could be. We conclude by noting how, with a view to expanding the overall demand for NUCs, to generate an incentive for farmers to increase agrobiodiversity in their fields, there seems to be a missed opportunity in the role that restaurants can play.

## Restaurants and agrobiodiversity

Very little research has been carried out on the role of restaurants in valorising NUCs. There has been an emerging literature on sustainable restaurants in the general realm of hospitality and tourism that provides context and some evidence on what some restaurant owners are doing to make their restaurants more sustainable, specifically with respect to food (Higgins-Desbiolles et al, 2019). A number of voluntary labels have emerged that define food-related standards to be reached in order to obtain the label, such as the Green

Key certification in the Netherlands, the Food Made Good label in the UK and the Green Dining logo in the USA. In all cases, no mention is made in the key criteria of the use of agrobiodiversity or NUCs. In other words, ensuring the presence of one or more NUCs on the menu is not considered as an important criterion for a restaurant to be contributing to sustainability.

Another relevant strand of literature is the one that focuses on restaurants that choose to source part of their products from local food systems (Sims, 2010; Sharma et al, 2014) mainly in large cities in the USA and in Europe. Restaurants that buy local do so because they perceive local products to be fresher, tastier and generally of higher quality, and they consider these products to be more sustainable because they are produced using certain production and artisanal methods, which helps support the local economy (Trivette, 2019). Of course, while they show high levels of motivation and commitment to the above aspects, it is also a way of differentiating their product and giving them a reason to place a premium on price (Duram & Cawley, 2012). In terms of profit margins however, not all restaurants rely on price premiums: some restaurant owners find ways to offset the higher costs of local products or of increased labour time by using other strategic pricing initiatives, and in some cases buying local can actually be cheaper (Inwood, 2009).

Although the proportion of local foods sourced is quite low compared to what restaurants source overall, deciding to buy fresh or processed foods from small, artisanal local producers can present a number of difficulties related not only to timeliness and consistency, but also, for example, to order processing time, that is, the time it takes to find and order the products from the local farmers and suppliers. Compared to large intermediaries, local farmers often do not have extensive product catalogues and sales order processing systems, and are thus unable to process orders quickly (Sharma et al, 2014). In spite of the above, restaurants that buy local have devised organisational strategies to 'make it work'. For example, considerable effort goes into fostering and nurturing direct relationships with local producers and suppliers, especially at start-up phase (Murphy & Smith 2009; Nelson et al, 2017). In terms of in-house organisation of restaurants that buy local, having a trained kitchen and waiting staff is important for several reasons. The first is that using local food requires more in-house processing steps, such as the time and skills required to wash, chop and prepare fresh products, which also leads to less waste. Secondly, local farmers are usually unable to guarantee precise delivery bundles (of items) and timing, so kitchen staff need to be trained enough to be able to improvise menu offerings and be flexible in planning kitchen tasks (Nelson et al, 2017). There is evidence that chefs, in particular, adapt their menu to the variety and seasonality of the available offer (Duram & Cawley, 2012).

What emerges so far is a clear appreciation of and commitment to sustainable food. Yet very little evidence exists in this literature of any particular attention paid to NUCs. A handful of articles do focus on specific examples of (gourmet) restaurants around the world that use NUCs with an aim to make these more well known to the public (Pereira et al, 2019; Luziatelli et al, 2020), and there is evidence that chefs look for unconventional varieties of fresh products that allow them to create innovative menu items (Strohbehn & Gregoire, 2003). Yet, in light of a call to 'advance biodiversity in food and agriculture through a collaboration with chefs' (Moreau & Speight, 2019: 2381) the strategies used by the restaurants to give value (or not) to NUCs are not described and analysed.

This article explores this gap by focusing on restaurants that choose to use NUCs. We investigate specifically how restaurant owners go about giving – or not giving – value to NUCs while at the same time keeping their business going economically. The focus is on medium-priced restaurants that are accessible to a wider public and thus have the capacity to influence the consumption preferences – and raise the awareness about NUCs – of a larger number of individuals compared to high-end or Michelin-starred restaurants. The valuation process used to construct NUCs' value is analysed using insights from valuation studies and particularly those that come from the realm of food. Specific sub-questions concern who the actors involved in constructing value for NUCs are, the relevance of context therein, what is being valued and where, and what tools and devices are mobilised to evaluate and valorise NUCs. The description of the tools and strategies used in the valuation

process is enriched by drawing from the building blocks of the Business Model Canvas, as illustrated below.

## The process of building value: who, what and how

Valuation studies have shown that the process of valuation, whereby a good is evaluated and said to 'have value', is a dynamic and socially constructed process that involves a variety of actors (Aspers & Beckerts, 2011; Kjelberg et al, 2013). The different views and interests around what value consists of is what leads to a dynamic process of contestation, negotiation and compromise where actors can 'adapt, extend or alter the meaning of quality' (Arnold & Dombrowski, 2022: 151). Nowhere has this been observed more clearly perhaps that in the realm of food, where Alternative Food Networks (AFNs) have introduced a new notion of 'good' food. Products are no longer (only) qualified based on product qualities, such as aesthetics or taste, but also on criteria related to the environment or social justice such as fair trade and organic (Dowler et al, 2010; Dubuisson-Quellier, 2013). In other words, new orders of worth have been introduced,, alongside the dominant industrial and market conventions, creating spaces governed only by civic or 'green' conventions (Boltanski & Thévenot, 2006; Evans, 2011), such as Farmers' Markets or, more often than not, spaces where conflicting conventions co-exist (Varga, 2019).

Judgement devices that consumers use to identify and evaluate products in the market reflect different orders of worth, as various actors – be they retailers, manufacturers or a network of farmers – make a range of devices available to consumers to orient them towards their products. Examples include personal networks used to access credible and trustworthy information, critics and restaurant guides, rankings, and third-party labels, such as Geographic Indications (GI) or Slow Food Praesidia (Karpik, 2010; Dubuisson-Quellier, 2013). Value is not a static attribute of products but is constructed across time and space. In their temporal and spatial analysis of organic product qualification in Germany, Arnold and Dombrowski (2022) use the case of Bioland to show how the meaning of 'organic' changes in time as external actors located along the food production and distribution chains contest its meaning. Bioland has thus been led to modify the qualifications linked to organic. Spatiality also points to the relevance of context, highlighting how the construction of value is conditioned by the cultural, social and political characteristics of the societies in which it is embedded. This 'situated character of value determination' (Corvellec & Hultman, 2014: 358) becomes clear when international standards around food are valued (or not) depending on the geographical context where they are 'put into action' (Loconto & Arnold, 2022).

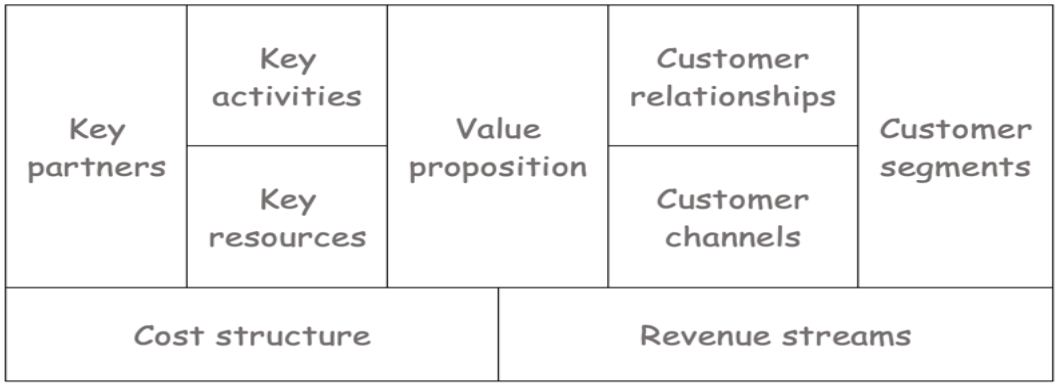
In terms of the temporal dimension, a distinction that is particularly useful for our research is the one between the evaluation and valorisation 'moments' of the valuation process. This is a difference that stems from how this process is experienced by consumers on the one hand, who need to compare goods offered in the market and make judgements on their desirability, and producers on the other, who need to demonstrate the value of their products compared to other products (Aspers & Beckerts, 2011; Vatin, 2013). While judgement devices are used in the evaluation moment to establish what qualifies as quality, other tools are used during the valorisation moment to create or add value to goods (Bessy & Chauvin, 2013). Such valorisation activities include product differentiation, lower costs, offering goods considered of superior quality, or creating narratives or 'stories' in a more declarative way through communication or advertising, for example (Richardson, 2008; Varga 2019).

In relation to the above considerations, restaurants hold a particular place insofar as they are both buyers and sellers of NUCs. In unpacking the specific question of how restaurants create (or not) value for NUCs, an interesting area of investigation about restaurants is thus, on the one hand, how they evaluate the goods – in this case NUCs – being sold to them by producers, and on the other, as sellers to final consumers, how they valorise NUCs. Delving into this area of inquiry will allow us to answer our questions not only on how valuation occurs but also on who evaluates what, and where the valuation occurs.

In order to investigate tools and strategies used by restaurants in the valuation process, the authors use the

Business Model Canvas (BMC) for its reported capacity to facilitate a clear and simple description of how a business works (Osterwalder and Pigneur, 2011). A BMC (see Fig. 1 below) is made up of nine components.

***Fig 1: The Business Model Canvas***



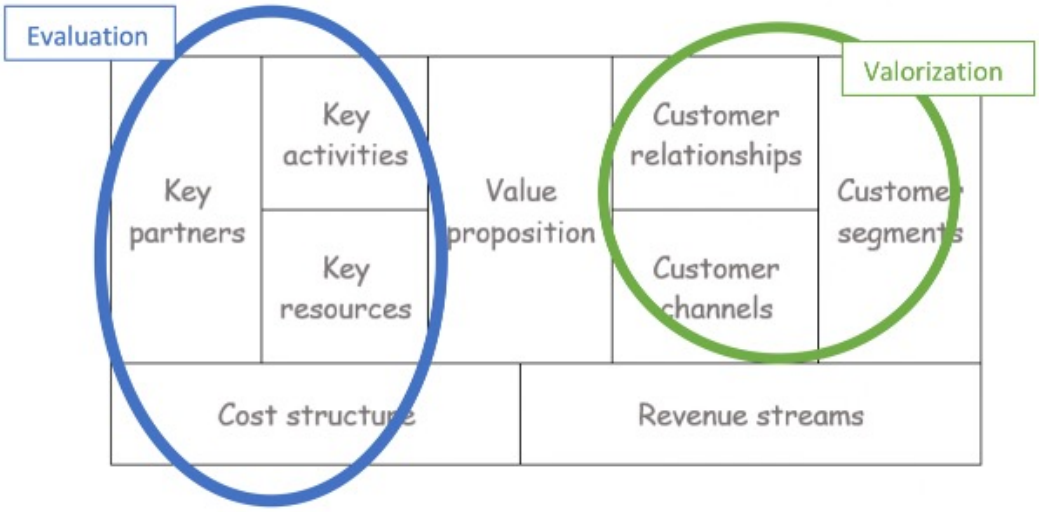

(adapted from Osterwalder & Pigneur, 2011)

Central to the BMC is the value proposition (VP) developed by the firm owner/s that refers to the reasons a customer may value the offerings of a specific firm rather than another. Three of the components focus on customers, and specifically on how the VP(s) – or the order(s) of worth – are communicated to customers/clients. It is important to note here that, as Corvellec and Hultman (2014) point out, more than one VP can co-exist in the same business – a finding from their research that resonates with the observation of different (at times conflicting) orders of worth governing the same market spaces. The Partnerships component describes the network of suppliers and partners that make the model work, while Activities and Resources refer respectively to the most important things a firm must carry out to make its model work and the key physical, financial, or human resources it will need to make that happen. Lastly, in terms of value capture, revenue streams and cost structure refer to how a firm generates revenue and monetary profit.

The authors used the nine categories of the BMC to separate, albeit artificially and only for the static purposes of analysis, the two 'moments' of evaluation and valorisation, where the central figure of evaluator and valoriser is the restaurant owner (RO). As shown in Figure 2 below, as purchasers of NUCs, an analysis of the evaluation 'moment' (BMC components contained in the blue circle of 'Evaluation') helps to better understand which providers restaurant owners choose to partner with, given the specific VP(s) that govern the way that they manage their restaurant. Given the choice of partners, other relevant BMC components relate to how the restaurant adapts its activities (or not) to interact with them (logistics for example) and how it adjusts its resources to live up to the values underpinning its choice of each specific partnership.

It is equally important for sellers of NUCs to understand how the valorisation process of NUCs occurs. Relevant components to analyse here are those contained in the green circle: those related to customer relations, and particularly the channels used to valorise NUCs (written/oral communication for example) and the relationships built with consumers (formal or personal for example). Key activities, such as those that occur inside the kitchen and in the dining hall, and key resources, such as waiting staff skills, and cost considerations will also be analysed to better understand how the restaurant adapts its internal 'workings' to make valorisation happen. In terms of financial viability of the firm, we assume here that all restaurants are viable, as we have chosen restaurants that have been running for at least five years.

*Fig 2: An adjusted Business Model Canvas*




(authors' elaboration)

## Context and methodology

*Context and sample*

To address the above questions, and given the exploratory nature of the research, in-depth interviews were carried out with seven restaurant owners in Rome that used NUCs[1] in their cuisine. Rome is the largest city in Italy and, after Milan, the city with the most restaurants in Italy: about 15,000 (FIPE, 2024). It is one of the top capitals of gastronomic tourism, appreciated particularly for its national and local cuisine (Lupsa-Tataru et al, 2023), which is why many restaurants – especially those in the highly frequented city centre – offer dishes that belong to traditional Roman cuisine. Rooted in the culinary traditions of the poorest classes in Rome, this is a simple cuisine made up of hearty pasta dishes and the well-known 'quinto-quarto', the poorest meat cuts, usually animal entrails (Duscio, 2014). Most restaurants rely on large commercial providers that do not have NUCs in their catalogues (personal communication) and there is no statistical/formal information on which restaurants in Rome use NUCs. Identifying restaurants that use NUCs therefore required the use of key informants – namely a small retailer specialised in the sale of NUCs and two intermediaries/providers that specialise in the sale of sustainable food products in Rome and who therefore know the context of food retail provision well. A purposive approach was thus followed to select restaurants with a diversity of characteristics and market positions.

All the restaurants selected were located in the city centre and were therefore frequented by both locals and tourists, except for one which was located in the neighbouring countryside and was frequented mainly by locals. Three of the restaurants selected belonged to the category of typical Roman restaurants, one was an Enoteca, specialised in the sale of wine but where it was also possible to eat, and three offered a menu that was freely inspired by Italian cuisine but where the creativity of the chef was greater (see Table 1). In terms of price range, most of these restaurants could be considered as medium-range, except for one which was mid/high-range. No high-range restaurant was chosen purposefully, as one of the aims of the research was to understand the extent to which restaurants could be a platform for an increased demand for NUCs.

[1]Given that the definition of NUCs includes wild plants, in some cases these restaurants also include wild edibles in their menu.

*Table 1: List of restaurants[2] included in the sample*

| *Restaurant* | *Type of cuisine* | *Price range[3]* |
|---|---|---|
| A | Italian cuisine | € 35 - 100 |
| B | Italian Cuisine | € 10 - 25 |
| C | Enoteca | € 20 - 35 |
| D | Roman cuisine | € 20 - 40 |
| E | Roman cuisine | € 20 - 40 |
| F | Roman cuisine | € 25 - 45 |
| G | Italian cuisine/Agrituris-mo | € 20 - 45 |

All the restaurant owners were also chefs and had been chefs for at least ten years, starting first of all by working in restaurants managed by other people, and eventually opening their own restaurant. Two of the chefs were women and the rest were male, and their ages ranged from 35 to 65.

*Data collection*

Given the nature of the research question focused on better understanding how ROs give value to NUCs, the authors used a suite of qualitative methods. First, ROs were interviewed in depth for an average of 45 minutes, after having received their informed consent. The guiding questions for the questionnaire were built around the components of the BMC, with a view to then reassemble the data around the corresponding areas of 'evaluation' and 'valorisation'. Secondly, to collect information on VPs and valorisation, the authors chose two tools. First, they analysed all written material, both physical and digital. This included the menu and other written material found in the restaurant, as well as information posted on social media, such as Instagram and Facebook, and the restaurant's website. Second, given that communication was also given orally by waiters in the dining hall, the authors also used observations in all the restaurants; they specifically chose to have a meal there and asked the waiters for further information on specific items of the menu that they knew were made up of NUCs. This information was used to double check and complement insights obtained with the other tools (Foster, 2006).

*Data analysis*

All oral communication was fully transcribed and coded based on the components of the BMC they referred to. For example, relevant words and sentences that were related to 'key partners' were coded as such, and the authors further coded the category to reach a description of types of partners, such as farmers, intermediaries, or social networks for example. Data to 'populate' the different categories of the BMC was also taken from the written material reviewed and from the notes taken just after the observations. The data was then sorted, based on the components that belonged to the 'evaluation' and 'valorisation' categories, as illustrated by the blue and green circles in Figure 2. They were analysed to have a better understanding of who the actors involved in each moment were and where the valuation occurred. In order to correctly identify NUCs, the authors cross-checked the contents of the restaurant's written material, as well as the transcripts, with Italy's National Registry of Biodiversity of Agricultural and Food Interest (from now on: National Registry)[4] to make sure that what was being signalled (or not) as a NUC, was in fact a NUC.

It is important to note that, given the exploratory nature of the research and its intention to shed light on the qualification mechanisms that a specific group, such as ROs, use in the case of NUCs, it lends itself to laying

[2] All restaurant names have been changed (and simplified to a letter) to guarantee their anonymity.
[3] Based on information from TripAdvisor and a review of the menu by the authors.
[4] In 2015 Italy set up a National Register of Biodiversity of Agricultural and Food Interest within the Ministry of Agriculture, Food and Forestry Policies, with a view to protect and enhance agro-biodiversity. The Register contains a list of local genetic resources related to food and agriculture of plant, animal or microbial origin subject to the risk of extinction or genetic erosion.

the ground for larger studies in the same area of research. Additionally, the similarity of the overall context in which the interviewed ROs operated and the homogeneity of the characteristics of ROs generally who decide to source differently explains why seven interviews were sufficient to yield "rich" data, that is, data that allows us to identify generalities rather than information on individual cases, thus suggesting data saturation (Baker & Edwards, 2012; Morse, 2015).

## Results

*Restaurants as evaluators – appraising the value of NUCs*

There are mixed orders of worth that shape the way that ROs evaluate the food they source and particularly NUCs. First, we find the same civic conventions that underpin AFNs. ROs wish to contribute to a food system that protects the environment and runs counter to the prevailing industrial and standardised system, whether this is couched in terms of sourcing from farmers who only use agroecological methods or whether it means sourcing from local, small-scale farmers:

> *[People will say] I would like a super-green, super-pointy broccoli… well, yes, maybe you'll find it once, but then the farmer can't make it again, like an industry. […] [That's why] our menus are born out of a desire to choose a producer upstream who does healthy work, in the field and on the soil [A].*

This quote alludes to why these ROs appreciate NUCs – they are a way of adjusting to Nature's rhythms, rather than the other way round. This is reflected not only in forms of production but also in processing, where raw or minimally processed items are preferred to systems that may alter the food's taste and essence or be harmful in terms of health: 'There is something that unites wine, and cheese and cold cuts for example: so [I choose] natural wine and raw milk cheese, and cold cuts without preservatives' (C). Care about health is another ethical value upheld by ROs that goes beyond legal considerations about food safety, and it is the desire to provide a varied diet that drives ROs to appreciate and seek NUCs whenever they can. Social aspects, especially tied to supporting local farmers, the local economy and traditional ways of processing and cooking are another aspect of care that is prominent. Ethical values however co-exist with more commercial values: ROs are also business people who pursue profit and commercial ends, and their effort lies in trying to 'square' profit and purpose:

> *If you think you only want to earn you are wrong, because then you become like the others: commercial. Your role is not only to be commercial, but also to preserve [Nature], to do research… (G)*

The mix of values underlying their valuation practices gains clarity when we observe the types of judgement devices they use. First and foremost, in terms of key partners, all the ROs have a direct relationship with farmers, and in some cases source all of their fresh produce directly from farmers without using intermediaries. The reasons are mixed. In some cases, this choice is driven by a desire to support very small farms that would not survive if they lost the restaurant as a market outlet:

> *The work I do with Maurizio [the forager] is an important supplement to his salary ... [....] It is important to give those who are in the area and work there the opportunity to stay there. At the moment there is a strong outmigration... (F)*

Other ROs search for 'unique' products that farmers can provide only at specific times of the year. Yet others consider it important to source products that are grown using agroecological methods, and trust is the basis for selecting a farmer who does not rely on a certification. Within this general frame, there are two ways in which NUCs end up on the restaurant table: there is either a specific search and 'research' carried out by ROs for 'unique' products that leads them to find specific farmers, or – and this is most often the case –the farmers themselves propose NUCs:

> *Some [farmers] have carried out their own research on ancient seeds and do trials. For example, he told me about a cabbage he tried to plant, it's an old variety. He brought it to me and explained why it has a bigger leaf. It's more delicate in flavour, it goes very well with fish. (B)*

It is therefore the direct relationship with farmers that allows ROs to learn about NUCs and to place them on their menus. The relationship with farmers is therefore not a classic 'one-way' relationship aimed simply at obtaining a raw product for the kitchen, but becomes a two-way and iterative relationship whereby ROs learn from farmers, and restaurants become outlets for farmers' experimentation. There seems however to be a limit as to how much ROs learn about NUCs from farmers, or know about NUCs altogether. The authors compiled a list of all the NUCs sold (or mentioned) by the restaurants during the period of the interviews and compared it with the contents of the National Registry. They found that in some cases, what is called a NUC by a RO, is in fact not in the Registry. Interestingly, when the NUC is actually not a NUC, what matters for the RO – and what has value for him/her - is the geographical belonging of the item, that is, it being GI certified.

Compared to a classic model based on a specific order placed with an intermediary, dealing directly with (small) farmers entails a different type of logistics. On the one hand it provides greater flexibility to deliver smaller quantities of food, especially horticultural products that, in the case of restaurants that do not have a cold room or a large storage room, represent a way to better handle their stocks and cash flow. On the other hand, dealing directly with farmers can sometimes mean untimely delivery and receiving volumes that are different from those initially ordered. What distinguishes the interviewed ROs however are the efforts that are made to adapt their personal rhythms and menus to the types and timing of the products received.

> *When you're dealing with these people, it's useless to make specific requests - 'bring me 20 kg of...', 'just the chrysanthemum', it's impossible. It's not really correct to call them suppliers... you can't establish a commercial relationship like a large-scale HORECA intermediary (F).*

In other words, ROs put in place key activities to adapt to the specificities that dealing directly with farmers entails. Devising a menu is a key activity that allows ROs to adapt to what the farmers have to propose, which is why ROs have flexible menus that change every day or that may include 'off menu' items. Restaurant C, for example, does not have a paper menu but has kept a QR code system introduced during the Covid emergency. Even though some customers complain, the owner has kept the QR code system because 'it allows me to change the menu when I want, based on what I manage to get from the farmer that day'. Restaurant A owners have designed a menu where they only indicate the main ingredient in the dish without specifying the type, so that if a farmer proposes a NUC, they can insert it easily into the menu, without being tied to a fixed menu:

> *The good thing about writing 'chicory' is that you can then propose any chicory. Sometimes it can be the pink one from Gorizia. The more detailed you are in the menu, the harder it is to find. (A)*

Other ways of adapting and minimising the risks posed by dealing directly with farmers is to have a wide range of farmers to choose from – and this is made possible thanks to the 'alternative' food network that both farmers and restaurants belong to and that enable them to expand their range of providers. In deciding to deal only with some farmers, it helps to set up an internal order processing organisation that facilitates the flow:

> *It is possible to deal only with farmers – it's a matter of knowing how to organise yourself. I delegate. There's someone who just takes care of the vegetable orders, or the meat orders, someone who collects them all and sends them out. It is difficult yes.... it is an extra effort. (B)*

While what the above adaptation efforts show is a strong ethical base underpinning the choices ROs make in terms of sourcing, other judgment devices based on more commercial or monetary considerations are used, such as standards like GIs, price and taste. It is therefore essential that the chosen items taste good, based on the RO's own standards: 'I taste, and if they pass my judgment then it's good. I am a chef, a cook with a very refined taste, and I recognise good things' (E), even though in the case of the interviewed ROs this comes with a desire to 'know what is behind the plate' (F). Being business people, placing 'unique' products on the menu that allow them to differentiate the restaurant from other (competing) restaurants is also a consideration, as are affordability and profit margins:

> *Here quality also means somewhat higher prices. ... I now pay more for bread than before because it is organic and sourdough, but I do it gladly. I didn't charge for bread before. Now it costs 2 euros. (C)*

Lastly, ROs use their own knowledge of raw and processed food items in terms of texture, taste and visuals to judge where to source a specific item and from whom. Restaurant B, for example, only buys from mills that are also bakeries because 'that way the supply chain is short, and I know that they only use their own flour made of ancient grains'. The RO is able to know this because bread made only from ancient grains is 'firm and without alveolation' whereas bakeries that claim to offer bread made from ancient varieties, in fact mix in improved flour and the bread is alveolate. It is therefore the ROs' own knowledge of what a processed item made of an ancient variety tastes like that guides them in their evaluation of the best source.

*Restaurants as building value – valorising NUCs*

While ROs show a certain interest and willingness to use NUCs in their kitchen, and find ways to do so, the presence of NUCs in their dishes is not – or marginally – communicated to the customers. When analysing the restaurants' websites and social media, what comes across is the picture of restaurants that propose menus grounded in the local cuisine and that also pay attention to the environment and to the origin of the products they source. All the restaurants refer to aspects of sourcing and cooking that 'respects Nature', such as seasonality, the use of poorer cuts of meat in an attempt to avoid waste, simple 'natural' cooking that prefers raw products or products that have gone through artisanal/mild processing, such as making bread with sourdough, an attention to animal welfare, and in four cases, the use of organic or Slow Food products. They almost all refer to the territory, that is, the use of local products, often sourced from small local farms, foragers or businesses. What this illustrates is the VP of these restaurants that is grounded – to different degrees – on an appreciation of sustainability. In this overall self-portrayal or 'restaurant identity' there seems to be little space for NUCs. NUCs are indeed never mentioned on the restaurant websites, except for the case of Restaurant A, where it is clear that they offer wild edibles collected by local foragers. They are mentioned sparingly on Instagram or Facebook, where only 1 – 2 posts overall are specifically dedicated to NUCs, such as ancient cereal varieties to make bread or pasta at Restaurant B and pictures of wild edibles by Restaurants C and E.

The same is true for their written menus. Restaurants C and F have a menu which starts off with a small paragraph explaining the 'philosophy' of the restaurant based on attention to small producers, Nature, seasonality, traditional recipes and ways of cooking. Yet, while they both sell dishes or drinks that use NUCs, these are mentioned sparingly or not at all. This happens in other restaurants as well. Restaurant D, for example, sells the Conciato di San Vittore. On the menu, its 'value' lies in it being a cheese made in Lazio (local) with milk from sheep that roam freely (animal welfare) and is processed in a traditional way. The fact that the sheep belong to an almost extinct breed (Sopravvissana sheep) is not given any weight. In fact, the menu does not even contain anything written on the special nature of the cheese; it is just noted as being 'local cheese'.

When ROs were asked why they did not specify in their menu that they were using NUCs, a couple of them simply mentioned forgetfulness; a RO admitted to 'having flaws in our internal communication… I don't sponsor it [NUCs] enough' (D). The main reason presented was related to the type of customer relationship they wanted to foster, based on trust and the creation of an atmosphere of conviviality in the restaurant. In the latter case, their responses were linked to commercial considerations concerning what a consumer expects to experience when they eat out: 'a good time' and a 'distraction', not being 'bored':

> *[Describing NUCs in the menu] makes everything too boring, pedantic and didactic. You become annoying. We mustn't pollute the good time spent at the table by being a know-it-all and boring. (A)*

In describing their restaurant on their website, some ROs used the word 'conviviality', highlighting the importance of promoting an atmosphere or 'mood' of conviviality in their work, in line with typical communication modes of more commercially oriented restaurants. It is for this reason that ROs often prefer to communicate the

value of the NUCs orally, and will do so 'if asked' and not systematically, because: 'I'm not an educator – I just want to pass on my passion'. Orally describing the dishes and 'storytelling' are strategies the ROs use to build their clientele over time, as well as making sure that what the client eats is balanced and healthy:

> *I want a clientele that is known and trusts what I put in their stomachs, and that happens with trust over time not with what I write on social media. (G)*

Orally communicating what the menu contains is usually carried out by the waiters, as ROs do not always have time to do so. The observational data collected by the authors during their eating out visits to some of the restaurants show that waiters do not always correctly inform customers when a product is a NUC. Only in the case of wine did waiters explicitly mention local or indigenous varieties, otherwise NUCs were often confused with typical products, that is, typical of a specific region, or with 'types of vegetables', that is, with a different variety of vegetable but not necessarily a NUC; or they only described the artisanal process in the case of processed products such as cheese or bread, but not the origin of the raw material. As we saw above, this same confusion is shared with ROs themselves with respect to knowing how to recognise a NUC as such.

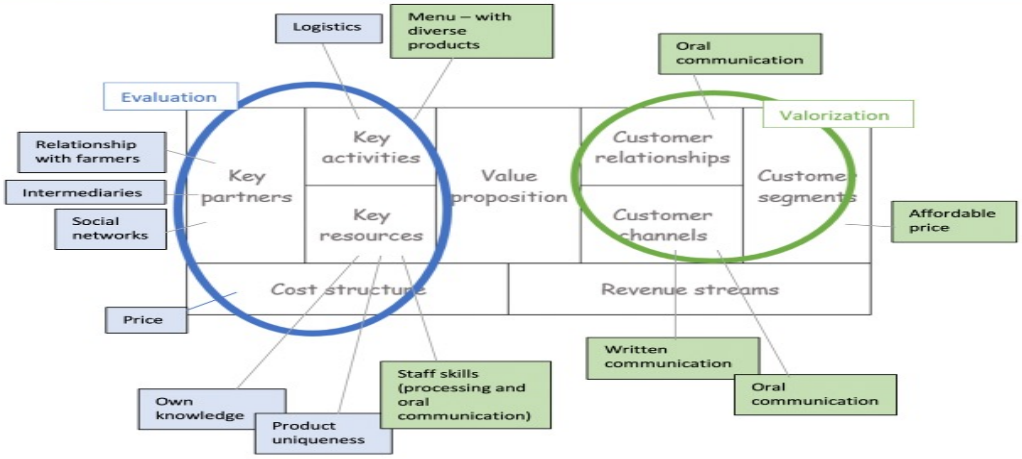
Price is a well-established way of signalling commercial value (Aspers & Beckerts, 2011), and price premiums are typical ways of valuing non-standardised products or differentiating oneself on the market, as in the case of Michelin-starred restaurants. In the case of the interviewed ROs, while they do indicate that NUCs can cost more because it takes more time and 'creativity' to process them, and therefore more human resources, they make a conscious decision not to pass this cost on to consumers in an explicit attempt to 'make such products more affordable'. Various pricing strategies allow them to do so; for instance, some will cut costs in other areas of their business to make up for the higher cost of NUCs:

> *Then of course to have a high price you have to have an image, gadgets, waiters in uniform, etc. So what do we do: we take away the plating, we take away the cool tableware, we take away something else – and you save on that. (E)*

Restaurant A, where average costs are higher, has thought of a differentiation strategy based on location: right next door to the pricier restaurant, they have opened a smaller enoteca where dishes cost less but are made in the same kitchen (and with the same ingredients) as in the costlier restaurant. Theirs is also a strategy to be more competitive: they 'apply different costs to give two market segments a way to get to know us'. Others still, increase the cost of their medium-priced items, in order to decrease that of a pricy unique NUC item.

To sum up, and following on from the analytical categorisation proposed in Figure 2, the below figure is a graphic representation of what has been described above. Specifically, it is a static description of the evaluation and valuation 'moments' using the building blocks of the BMC. In the next section we use these blocks to better understand the valuation process and specifically how valuation occurs, who evaluates what, and where the valuation occurs.

***Figure 3: A description of the evaluation and valuation moments using the building blocks of the BMC***



## Discussion – an 'interrupted' valuation process

In endeavouring to answer our main research question as to how restaurants construct value for NUCs, the main finding is that the restaurants we analysed do not give value to NUCs, or rather, the value that they do construct in part of the valuation process is 'interrupted' and becomes 'invisible' to the consumers who (mostly) do not know that what they are consuming is a NUC, even though it actually is one. Specifically, what we observe is that while NUCs are positively appraised during the evaluation moment, they seem to lose value in the valorisation stage. In other words, and to use a more dynamic metaphor, value does not 'travel' from the evaluation stage on to the valorisation moment as much as it could (Muniesa, 2011).

*Figure 4: The construction of value during the valuation process of a NUC in a restaurant*

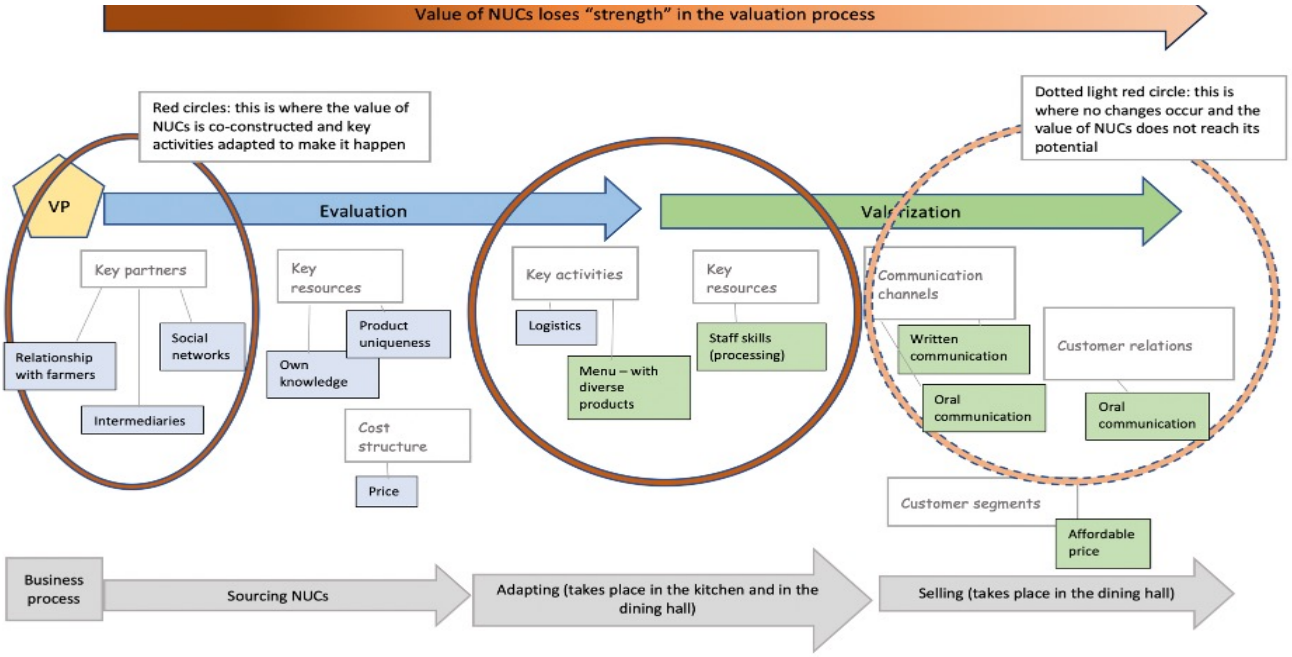



Figure 4 above is a graphic depiction of this 'interrupted' process which builds on Figure 3 by adding the processual nature of valuation depicted with arrows, in this case a blue arrow for the evaluation 'moment' and a green arrow for valorisation. At the root of the process of constructing value is the value proposition (yellow pentagon), while the red circles indicate where value is created around NUCs: a full red circle indicates a strong construction of value while a light red circle with a dotted outline illustrates the loss of 'strength' of the value, which is also depicted by the top red arrow that fades into light red. To better explain the diagram and how the 'loss' of value occurs, we will explore it in more detail, bearing in mind the sub-questions of our research: how value is co-constructed and with whom, its spatial and temporal characteristics and the importance of context.

Value propositions are central to the restaurant business, and what we note in the case of the restaurants that we examined is their multidimensional and dynamic nature (Corvellec & Hultman, 2014) reflecting the co-existence of different orders of worth. On the one hand the VPs reflect civic and 'green' orders of worth, that to some extent include NUCs, while on the other hand, given that ROs are also business people, they also base their strategy partly on 'market conventions'. This is why issues of affordability, aesthetics and 'pleasing the consumer' are considered and 'weighed' when choosing to place a NUC on the menu. Defining what is 'good' and 'quality', including a NUC, depends on a series of considerations that are grounded not only in ethical values but also market-based criteria.

There is a spatial aspect in the 'distribution' of these orders of worth between the evaluation and valorisation

moments. More precisely, there is a 'spatiality of value' (Corvellec & Hultman, 2014: 358) where NUCs are given value in the space that precedes their transformation in the kitchen (see grey line at the bottom of Figure 4) because these 'spaces' are dominated by civic and 'green' conventions where NUCs are given value, while the convention that dominates the 'space' of the dining hall is a market one.

To explain what happens in the 'space' that precedes the kitchen, we need to observe more closely the use of judgement devices. ROs that value NUCs change the key partners they deal with and – to varying degrees – rely on social networks, rather than consolidated large distributors, to source (some of) their food. Here, in line with the literature that situates retailers within Value-based Territorial Food Networks where they play a role in keeping local food networks in place (Trivette, 2018; Smaal, 2022), we too note how in the evaluation 'moment' ROs, as purchasers of food, rely strongly on a network of local farmers, 'virtuous' intermediaries and a broader alternative food network to (jointly) evaluate value (personal communication). As Karpik points out, these 'act as guideposts for individual (and collective) action' (Karpik, 2010: 44). This is confirmed by the literature on small and peasant farms in Italy, showing how they tend to rely quite substantially on direct sale and personal contacts as well as on consumers interested in territorial products (Prosperi et al, 2023). It is partly ROs' trust in their networks and in farmers' knowledge around 'different' crops, as well as the iterative nature of their relations with farmers, that leads them to use NUCs. To the extent that 'values are conceptions of the desirable that are learned' (Loconto & Arnold, 2022: 603), ROs learn to value NUCs through these very networks.

Just as we observed from the literature on farm-to-table initiatives, here too ROs make an effort to adjust their key activities accordingly, both in terms of logistics, to fit in with the ordering processing times and deliveries of small local farmers, and in terms of their menus, to make space for daily changes that include NUCs. Further adjustments concern the resources they use, with more training of their kitchen and waiting staff, for example, on processing and communication, respectively.

So far we have noted that NUCs are valued by ROs in the evaluation moment. The extent to which NUCs are valued as such, rather than as local and seasonal products, is however not as strong as it may seem and would partly explain why value does not 'travel' to the valorisation moment. All the restaurants we have examined portray themselves as caring for sustainability, whether this is couched in terms of solidarity with farmers and foragers, an attachment to their 'territory', an attention to organic products and artisanal ways of processing, or 'natural' cooking. It is these aspects, and particularly the direct relationship with local farmers, that prevails in ROs self-portrayal, thus leaving a small role for NUCs to play. In other words, just as agrobiodiversity does not emerge as a strong indicator to be considered in sustainable restaurant logos, even in the case of ROs, having a NUC on their menu is not the strongest qualifier of their being 'virtuous'. This is manifested in their 'confusion' and limited knowledge about what is and is not a NUC. In other words what is being valued is (more) their being local and seasonal, and less their being part of agrobiodiversity.

The value of NUCs is therefore somewhat 'diluted' before reaching the 'space' of the dining hall, where it loses almost all of its value due to limited written and oral communication (on NUCs) and the prevalence of a market-based convention concerning the type of customer relations to be built. We note in this phase that ROs do not build a reputation or use 'declarative' actions to build a 'story' about themselves based on the value of having used a NUC (Varga, 2019). In fact, while many AFNs are constructed together with consumers to jointly settle 'shared uncertainties' (Lamine, 2005), going back to the question of who ROs build the value of NUCs with, a missing actor in the examined restaurants is certainly the consumers.

An important role in this process of loss of value is played by context, that is, the 'institutions that stabilise, objectify, and generalise valuation processes' (Heinich, 2020:6). In the case of Rome, and Italy overall, geographic indications and organic labels are the dominant institutions that frame valuations around sustainability. Here too, we note how the confusion that ROs express is often related to an association of sustainability with

'territory' and locality, which is very much influenced by the predominance of geographic indications. Hence, even among ROs that use NUCs, they are to a certain extent under-valued because what prevails in RO's judgment criteria and in the context that in part forges their values, are social relations and a macro context that do not value NUCs. In other words, given that standards 'construct' value, the dominance of a narrative based on GIs and locality is what makes the value of NUCs 'invisible' and leads to their 'valuelessness' (Loconto & Arnold, 2022). A further contextual consideration to make relates to geography. As Rome is a large city, ROs are at a relative geographical and cultural distance from farmers (Bricas et al, 2013). They are therefore less likely to know what happens in the field compared to citizens of smaller cities where finding NUCs on restaurant menus is more common, given ROs closeness – both geographical and socio-cultural – to surrounding farmers.

## Conclusions and policy implications

Exploring how value is constructed (or not) for NUCs in value chains where restaurants co-construct the value propositions for them is important insofar as 'the value that is offered has consequences for the wider society' (Corvellec & Hultman, 2014: 368). In our case, we observe that there has been a missed opportunity in generating this wider benefit: on the one hand, the restaurants analysed in this article are medium-priced venues, accessible to a large portion of society, and the pricing policies that ROs have practiced in keeping NUC prices down, potentially contributes to making NUCs more well known within the wider public; on the other hand, however, while consumers may be exposed to an 'experiential valorisation' in the restaurants, their learning potential is limited by the lack of written and oral communication.

The exploratory nature of the study does not allow these conclusions to be generalised, and there are areas that would merit further exploration in larger studies carried out in the same area of research. For example, with respect to communication on food within restaurants, while still confined to the world of high-end restaurants, extensive research is being carried out in the realm of food design on how to make NUC-based foods more palatable and 'normal' (Celi & Rudnick, 2016). The extent to which these foods may be inspirational to and adapted by other restaurants warrants further attention. From a theoretical perspective, this research has not investigated the link between the response (if any) that consumers give – explicitly or tacitly – to the revision of a restaurants' VP and valuation process. Further research into consumer food practices within restaurants would need to be carried out to fill this gap.

Notwithstanding the above limitations, the study does provide policy insights to outline opportunities and challenges in the use of restaurants as a platform to increase NUC consumption. A recent survey of European consumers on awareness about NUCs shows that most consumers, while sensitive to sustainability issues, are unaware of and marginally interested in issues related to agrobiodiversity, and that if they do know about NUCs, they learnt about them in Farmers Markets and in restaurants (Chiffoleau et al, 2024). These are therefore important venues not only for producers to find a suitable outlet for their products, but also for consumers to learn about NUCs and potentially increase NUC demand overall.

A major barrier to increasing restaurants' potential to be a springboard for more appreciation and consumption of NUCs is the institutional one, related in particular to the dominant role of GI standards. The value of the interviewed ROs' work in Rome has been their attempt to contest normalised ways of procuring food in the dominant food procurement context of the city and, in so doing, to have contested normalised 'discourses' justifying the marginalisation of NUCs in defining what is 'sustainable' (Bernardi & Tridico, 2021). The reality of a general institutional context that maintains the 'valuelessness' of these products (Loconto & Arnold, 2022) is however still prevalent. Work would need to be carried out to modify the existing rules of the game by, for example, making the presence of NUCs more clear in GI labels and/or creating special labels for NUCs, or introducing wider contextual changes such as creating special Farmers Markets for NUCs, and supporting the work of small/medium intermediaries that specialise in agrobiodiversity and local/organic products.

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# Novel Foods: a Technological Pathway to Food System Transformation? An Introduction

Paper first received: 15 October 2024; Accepted: 02 November 2024; Published in final form: 22 December 2024
https://doi.org/10.48416/ijsaf.v30i2.659

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## Abstract

This Special Section intends to contribute to the debate within the social sciences on 'novel foods', broadly understood as foods providing proteins alternative to animal proteins. These are derived from a variety of new bioscientific and engineering technologies spanning cell tissue development; organisms covering plants, fungi, algae and microbes, and insects. The articles gathered in this Special Section are the outcome of the biennial 2023 Conference of the Center for Food Studies of The American University of Rome. Novel Foods are discussed from different disciplinary perspectives and their various configurations, regulatory challenges and degree of social acceptance are considered in a variety of economic, political, social and cultural contexts. Taken together, the articles reveal the array of social science questions to be tackled if 'novel foods' are to be part of a transition towards food system transformation, or whether they will ultimately accentuate 'high-tech solutionism' and associated narratives that work to the detriment of deeper and more democratic analyses and solutions.

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**ACKNOWLEDGEMENTS**

The Editorial Team thanks the reviewers for their time in providing their constructive comments to the articles.

As part of its biennial programme of conferences, the Centre for Food Studies at The American University of Rome convened a one-day conference in March 2023 under the patronage of the European Society for Rural Development, and with practical support provided by students on the Master in Food Studies, entitled 'Novel Foods and Novel Food Production: a Solution to Food Systems Sustainability?'. The event – and the present Special Section that brings together a selection of invited papers from the Conference – follows the success of a similar previous initiative on sustainable diets (Sage et al., 2021). The decision to convene a conference on the topic of novel foods was taken in light of the rising public interest in meat, fish, and dairy alternative products that are increasingly finding their way onto supermarket shelves and the menus of mainstream food service establishments. It seemed appropriate and timely to take stock of developments within a food studies milieu.

The Conference allowed for a generous interpretation of the term 'novel foods' stretching from the development of enclosed plant growing systems (controlled environment agriculture) to the field of 'alternative proteins'. Statutorily within the EU, the term 'novel foods' refers to any food that has not been consumed to a significant degree by humans in the EU before May 1997. However, we recognise an emerging consensus that novel foods are most closely associated with providing alternatives to animal proteins, although the bioscientific and engineering technologies embraced here span cell tissue growth, plants (including fungi and algae), insects and micro-organisms.

The rationale of the Conference was the realisation that an unparalleled wave of food product innovations is sweeping through the global food system, pushed by a new generation of food start-ups which, with the help of a novel innovation ecosystem, are introducing products which are increasingly independent of their original raw materials. The central focus is on producing substitutes for the animal protein food/feed chains since these are seen as the principal source of biodiversity loss, climate change and land utilisation by agricultural activities. These innovations depend heavily on the so-called disruptive technologies of big data analysis, machine learning and artificial intelligence for the identification of new molecules with precise physical and functional characteristics. They also draw on advances in biotechnology for gene editing, precision fermentation and cellular cultivation. At the same time, there are considerable developments in indoor farming systems and vertical farming, integrated into urban life and aimed at freeing fresh produce production from the risks and rhythms of the natural environment.

Food security and food sustainability as the key global challenges of a world that combines continued population growth with accelerating urbanisation and rapid depletion of natural resources are claimed as high on the list of motives of the food start-ups also associated with 'mission-oriented' entrepreneurs. The leading players in the food systems are themselves now investing in and exploring these new product lines. From the initial domination of U.S. firms and finance capital, the phenomenon has now become global with a proliferation of high-tech food hubs, often stimulated through public policies and funding, especially in countries with abundant capital, but limited natural resources.

At the Conference, the positive aspects of novel foods and their potential 'to feed the world without devouring the planet' were emphasised by the first keynote speaker, George Monbiot (journalist and environmental activist). A global geo-political and economic perspective was given by John Wilkinson (Federal Rural University of Rio de Janeiro), illustrating the increasing importance of new players of the Global South, especially Brazil and China, in the adoption of agrifood innovations, despite the persisting centrality of the Global North (Wilkinson, 2024). A European perspective on novel foods, including their definition and regulations was given by Andrea Germini (the European Food Safety Authority, EFSA). The state of the art of controlled environmental agriculture was presented by Luca Nardi (Italian National Agency for New Technologies, Energy and Sustainable Economic Development, ENEA), drawing on the Agency's applied research. The final keynote speech was provided by Larissa Zimberoff, a freelance journalist, who unveiled the social reality and hype characterising the start-up world. Her intervention was based on the ethnographic account of her

investigative reporting and encounters with the food entrepreneurs of Silicon Valley (Zimberoff, 2021). Colin Sage then wrapped up proceedings drawing together some of the issues raised by the keynote speakers as well as highlighting several of the themes addressed by the 29 papers presented across the four parallel sessions of the day.

Out of the papers presented, the Editorial Team selected the articles that constitute this Special Section. The articles cover a range of topics drawing upon the social science disciplines of political economy, anthropology, history, and public policy. This Special Section, and each article individually, raises searching questions about these novel innovations in food production, particularly the question of whether they can be part of the universally anticipated food systems transition. The academic community has a role to play, particularly in trying to integrate the knowledge and tools of analysis from different epistemologies and disciplinary fields, spanning the biological, ecological and the social dimensions. Social scientists are particularly well suited to connecting policy making and civil society at large; and we hope that the articles presented here will contribute to this interdisciplinary endeavour stimulating a broader debate on the place of novel foods in the context of food system transition.

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# The Innovation Ecosystems of Novel Foods: Hype and Incumbent Hijacking or Components of a Sustainable Transition

Paper first received: 04 February 2024; Accepted: 15 July 2024; Published in final form: 16 December 2024
https://doi.org/10.48416/ijsaf.v30i2.587

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## Abstract

This article offers an interpretation of the significance and dynamics of current food product innovations, especially those focused on providing alternatives to animal proteins. We first describe the complementary and competing technology routes being explored to develop alternatives for the full range of meat, fish, seafoods, dairy, egg, and generic protein, products. We then draw attention to the original features of current innovation in agrifood and particularly to the nature of its globalization, questioning the dominant focus on the "Silicon Valley" model. The sustainable transitions literature has recently turned its attention to agrifood, and, in the following section, we interrogate its ability to capture the full dynamic of the innovations underway. Political economy approaches, highly influential in both academic and "grey" contributions, which are then discussed, focus on the unsustainability of current innovations and their co-option by incumbent actors. While recognising these possibilities, other authors highlight the modular, decentralized, potential of these innovations with positive impacts for more diversified agricultural development. In the final section, we discuss demand side dynamics with a particular focus on the complex intermediations influencing consumer behaviour, not captured in many of the attitudinal studies. These include retail and food service strategies, labelling and regulatory conflicts, media framing, and the social and cultural factors informing eating practices. In our concluding comments, we provide a brief summary of the principal arguments insisting on the disruptive potential of innovations which propose to radically reduce the various hoofprints of our animal protein diet.

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## INTRODUCTION

This article, inspired by the presentations and discussions at the American University of Rome Conference on Novel Foods in March of 2023, first describes current food product innovations, especially focused on providing alternatives to animal proteins. It then offers an interpretation of their significance and dynamics through a critical engagement with the varied academic responses to these innovations. Animal proteins have become a key concern for a combination of health, climate, and animal welfare considerations, to which should be added their centrality in the dietary transitions of many increasingly urban developing countries. The systemic nature of these innovations is highlighted, together with the financial, economic, and political power of the constellation of new actors engaged in their promotion. While initiated in the global North, these innovations are now firmly established in States and regions where rapid economic growth and urbanisation face a grave lack of the traditional natural resources for guaranteeing food security. Given the variety of the intermediations influencing consumers' behaviours – amply documented in the academic literature –, their responses are still uncertain. The underlying factors which have given rise to these innovations nevertheless persist and, with time, have only become more pressing.

A rich and diversified agrifood and innovation literature, both academic and 'grey', has emerged to deal with the many questions which these new protein products pose: the nature of the current innovation process, its implications for the restructuring of the global agrifood system, societal responses, and ethical issues, together with the complexity and variety of intermediating factors influencing demand and consumer behaviour.

The following section first describes the complementary and competing technology routes being explored to develop alternatives for the full range of meat, fish, seafoods, dairy, egg, and generic protein products. Attention is then drawn to the original features of the current innovation ecosystem in agrifood, and particularly to the nature of its globalization, questioning the dominant focus on the 'Silicon Valley' model. The sustainable transitions literature has recently turned its attention to agrifood, and in the following section its ability to capture the full dynamic of the innovations underway is examined. Political economy approaches, highly influential in both academic and 'grey' contributions, which are then discussed, focus on the unsustainability of current innovations and their co-option by incumbent actors. While recognising these possibilities, other authors highlight the modular, decentralised potential of these innovations with positive impacts for more diversified agricultural development. The final section discusses demand-side dynamics, with a particular focus on the complex intermediations influencing consumer behaviour, not captured in many of the attitudinal studies. These include retail and food service strategies, labelling and regulatory conflicts, media framing, and the social and cultural factors informing eating practices. The concluding comments provide a summary of the principal arguments, insisting on the disruptive potential of innovations which propose to radically reduce the various hoofprints of our animal protein diets.

## ALTERNATIVE PROTEINS: MANY TECHNOLOGY ROUTES AND MANY PRODUCTS

In 2013, the public tasting of a tiny portion of cell cultured meat, produced at the cost of over US$300,000, was received with the respect and admiration accorded to outstanding scientific achievements (Shapiro, 2018). Ten years later, over 150 cell culture protein companies, only a third of which are in the United States, have emerged out of a finance-driven global innovation ecosystem, comprising startups, individual investors, venture capital firms, investment and sovereign funds which will be discussed in greater detail below. Regulatory approval came first from Singapore (2020), which has adopted high-tech agrifood strategies as its key to meeting food security goals, and then from the US for two chicken products from leading alternative protein firms, Upside, and Just Food (2023). Brazil´s Sanitary Control Agency (ANVISA) has also authorised the production of cell cultivated and fermented proteins (2023). The Netherlands, for its part, permitted public tastings of cultivated meat and fish in 2023 (ATOVA Consulting, 2022; Compre Rural Noticias, 2023; Poinski, 2023; Mridul, 2024).

On the other hand, for many of the Associations representing traditional meat producers, what was once viewed as a scientific achievement is now considered a commercial threat, and livestock lobbies are demanding exclusive labelling rights to traditional animal protein categories (Bollard, 2022). More than this, legislation banning the production and marketing of cell-culture products came into effect in Italy in 2023 (Galbo, 2023), with similar legislative proposals under discussion in most other major livestock producing countries, including Uruguay (Beefpoint, 2023), Brazil (Walendorf, R. 2023) and the United States (Myskow & Hedgepeth, 2024).[1] While meat has been the central focus, all animal proteins, including milk and dairy products, egg products, and all types of fish are currently the object of cell cultivation and initial market launchings.

Cell cultivation is itself only one of the technology routes being explored to provide a protein diet free of animal products. Amy Bentley, in her article in this issue, recounts the historical persistence of vegetarian protein alternatives, whether for religious or secular motives. A multiplicity of now well-documented factors has led to a questioning of animal food consumption in recent decades, creating a potential consumer market beyond the niches of committed vegetarians and vegans. Unlike the latter, potential consumers, 'flexitarians', are considered to be those who are already disposed to reducing meat consumption, and would be willing to adopt alternative proteins to the extent that they are not only nutritionally but also sensorially 'as good as' the animal products they aim to replace (Dagevos, 2021). The convergence of advances in big data digitalisation and genetics have convinced both scientists and the various components of finance capital that make up today´s innovation ecosystem, that these goals are now viable commercial objectives (Shapiro, 2018; Luneau, 2021).

Plant proteins based on new extrusion techniques and biological ingredients identified through big data screening and artificial intelligence have led to the emergence and rapid globalisation of a new generation of food firms. In less than half a decade these firms advanced from product launches to global players: Beyond Meat, Impossible Foods, Eat Just, and Upside in the United States; Omnifoods in Asia; and Fazenda Futuro, plus NotCo in Latin America. Although meats have been the centre of attention since they condense all the factors influencing the shifts in consumer preferences (demography, climate, animal welfare, health), alternatives to milk have achieved greatest market penetration. In seafoods, tuna fish has been the favourite for imitation. The switch to plant proteins breaks down the traditional distinction between protein categories and the same firms are now able to launch products in all the different protein categories (the Chilean company NotCo is a perfect example here in its marketing of alternatives to meats, milk, and fish (Hirtz, F. 2022).

New genetic screening and editing techniques have transformed the traditional fermentation industry, making it possible to tailor microorganisms to produce the desired proteins. The 'heme' produced by Impossible Foods to replicate the visual and sensorial characteristics of meat juices has attracted most attention (Pointing, C., 2023). The same mass screening techniques, however, make it possible and economically viable to identify microorganisms which already possess the desired characteristics, allowing for their large-scale production with traditional methods of fermentation. These varied fermentation processes generally result in a high protein substance which can be transformed through ingredients into various types of meat and fish. Precision fermentation is also being used to reproduce bio-identical milk components which can then be used for a variety of dairy products (Precision Fermentation Alliance, www.pfalliance.org ). Perhaps the most original form of fermentation is the production of protein rich flour from naturally occurring bacteria in a culture of the elements of the air, and which, with the help of chosen ingredients, can then be transformed into a wide range of food products.

Except for 'air protein'[2] all these routes imply novel relations with agriculture: animal cells from select breeds in the case of cell culture; a varied assortment of pulses for plant-based meats; or a mix of agricultural ingredients for the different culture mediums. Molecular agriculture introduces a radically new route which,

[1] Now also implemented by the Governors of Florida and Alabama in the USA.
[2] See www.airprotein.com for details of one of the firms producing protein from air.

with the aid of genetic engineering, introduces animal cells directly into plants. Currently tobacco and soy are being tested, and while the production cycle is longer than the fermentation routes, the animal protein, once extracted post-harvest, can reap the benefits of a consolidated global supply chain (Southey, F. 2020).

Proteins from insect sources, a route legitimised and popularised through authoritative international Reports by the FAO-WAGENINGEN (2013) and the World Bank (2021), have attracted significant investments on all continents. Cultural acceptance as a human protein source is globally uneven and it is unclear to what degree animal welfare sentiments extend to insects. Cultivation for human consumption is a tradition in many countries of Asia and Africa and in some regions of Latin America. High protein insect flour, again with recourse to varied ingredients, is mostly transformed into protein snack bars in Northern countries. Production, however, is increasingly oriented to animal feed and petfood where cultural rejection is less evident, although negative sentiments may emerge even there. Large-scale production in this case often takes the form of vertical agriculture with different agricultural sources serving as food, or, as in the case of mega farms in China, food waste from urban consumption creating a circular economy.[3]

Many different questions have been raised in the decade since Mark Post launched the first alternative protein public tasting: marketing projections and consumer trends, carbon footprint, ethical issues, food quality, economic concentration, and implications for the future of agriculture. Academic considerations were preceded by consultancy projections, then quickly accompanied by civil society grey literature, and more recently by lobbying, parliamentary debate, and public regulatory measures. The significance of many of these individual issues becomes clearer once they are situated within an understanding of the originality of the movement which gave rise to these innovations in the agrifood system, and the nature of its globalisation.

## THE ORIGINALITY OF CURRENT INNOVATION IN THE GLOBAL AGRIFOOD SYSTEM

The modern agrifood system has periodically been revolutionised by the diffusion of system level innovations: railways, steamships, telephony. Radical agrifood specific innovations, on the other hand, have been led either by public sector agricultural institutions, as in the Green Revolution, or by traditional upstream agrichemical players, as in the diffusion of genetic engineering. In both cases, the issue was the promotion of agricultural productivity, an increase in the existing supply side of the food system.

In the present innovation wave, similar preoccupations prevail (feeding the 'more than 10 billion'), but the perception of and the solution to the problems identified are radically different. The entrepreneurial perspective is distinctively urban, focused on consumption, and oriented to radical food product innovation based on the opportunities of the new technological frontier (Zimberoff, 2021). In fact, urban consumer-driven innovation has become progressively stronger since the last quarter of the twentieth century. The force of demand-side opinion first became apparent in the rejection of genetic engineering in final foods. In a similar fashion, significant refusal of full-cream milk, refined sugar, and trans fats not only led to major adaptations by the established players (corn-derived sweeteners by ADM and artificial sweeteners by Monsanto and others), but also created opportunities for product and process innovations by new entrants: milk from almonds or oats (White Wave Foods, Oatley), plus a whole range of alternative processing techniques for the elimination or reduction of trans fats (Wilkinson, 2024).

[3] In a recent contribution Guthman and Biltekoff, (2023) talk of a third generation of alternative proteins which are characterised by their agnosticism as regards sources and by the ubiquitous availability of protein now liberated from its association with agricultural products. Protein using air or plastics as inputs are certainly outliers but they both use the prevailing fermentation and genetic technologies. Algae are traditionally included in the category of plant-based protein alternatives. Insects are certainly a challenging category from a cultural and perhaps a moral perspective, but they also rely on the same underlying technologies. Rather than generations, we are dealing with different and complementary/competitive technological routes developed within the same innovation ecosystem and often within the same firms.

Health and climate concerns in Northern countries, combined with perceptions of the negative implications of the global dietary transition underway towards animal protein, have transformed animal protein and above all meats into the central target for product substitution. While radical product innovation in the 20th century was primarily the result of isolated individual initiatives and only rarely escaped capture by the incumbent players (Rich Foods, Chobani), the innovation environment for alternative proteins has benefitted from the full force of the Silicon Valley innovation model, which has been researched in depth by Julie Guthman and Biltekoff (2023), and by Alexandra Sexton (2020).

The remarkable profiles of the new entrants – largely individuals at the cutting edges of the scientific and technological frontier and often vegetarians and/or vegans, but with ambitions to challenge the mainstream markets – are vividly captured from widely differing perspectives by Paul Shapiro (2018), Larissa Zimberoff (2021), Gilles Luneau (2021), and Romanos (2022). The speed with which these scientists/innovators created companies, launched products, and reached global markets was made possible once food became the privileged object of a financialised innovation system consolidated through the promotion of successive waves of info, digital, and fintechs. While the future remains uncertain, the four leading startups in plant and cellular proteins – Beyond Meat (2009), Impossible Foods (2011), Eat Just (2011) and Memphis Meats/Upside (2015) – have all become global players and are themselves the vanguard of a universe numbering some 1,800 alternative protein firms according to Protein Directory ( https://proteindirectory.com/ ).

Leading agrifood research has focused on the Silicon Valley model of innovation and extensive fieldwork has been carried out by Guthman & Biltekoff (2023), Fairbairn, Kish & Guthman (2022), and Sexton (2020). The focus here is on agenda setting and discourse analysis. A startup with a project but no product and certainly no product marketable at scale becomes investible to the extent that its narrative can capture investors´ imagination as a point of entry to their pockets. These studies provide a rich sample of interview citations and website promotions showing how problems are framed so that proposed solutions appear plausible. In the absence of eaters, convincing 'fictional expectations' à la Jens Beckert (2017) serve as a proxy for the promised food.[4]

In their most recent work, Guthman and Biltekoff (2023) identify protein as the central actor in these narratives; the only macro nutrient, they claim, to emerge unscathed while carbohydrates and fats have been successively framed as responsible for a range of diet-related illnesses. While this may be true, protein´s main embodiment in meat, and especially red meat, has by no means been immune from critique. On the contrary, more than the products which exemplify the other two macronutrients, meat has condensed dietary, environmental, climate, and animal welfare critiques, which precisely allow for alternative protein routes to be presented as all-embracing solutions (Willet et al., 2019).

Hype is a central component of the 'pitching' game that startups need to play, and the above authors provide perhaps the most detailed account of the discourse framing process. It is nevertheless important to situate the discourse and pitching phase within the broader innovation ecosystem structure equipped with well-defined reality checks that can quickly weed out unfulfilled hype. The initial 'angel' investors, be they family, friends, or wealthy patrons, may be moved mainly by hunch or blind trust, but startups progress only with the help of venture capital firms which establish business plans to negotiate with investment funds. These funds' support is carefully monitored in successive rounds of financing with a view to an eventual public launching or acquisition within a specific timescale of seven to ten years (Lerner & Nanda, 2020).

Innovation driven by finance capital is subject to bubbles of enthusiasm and funding may quickly dry up as

[4] On my reading of Beckert, fictional expectations are intrinsic to capitalism and not restricted to the hype of Silicon Valley-style financialisation since all investment is directed to an uncertain future which needs to be made minimally predictable through framing.

targets are unfulfilled and attention diverted to other investment opportunities, or as funding is negatively affected by macroeconomic factors. Even so, information, digital, and financial waves of startups have all resulted in products, processes and platforms which have radically transformed societal practices, and there is no a priori reason why this should prove not to be the case for food.[5]

Academic studies on alternative foods have focused on the Silicon Valley model of innovation and this has certainly provided the institutional environment in which the leading firms have emerged. While the ideology of Silicon Valley is that of individualism and diversity, Alexandra Sexton´s research has shown how its predominant institutional setting imposes a highly homogeneous trajectory on would-be startups, which marginalises more collaborative open-source initiatives.[6]

## INNOVATION MOVES TO THE GLOBAL SOUTH WITH GOVERNMENT POLICY MORE CENTRAL

Less research has been carried out on the diffusion of the Silicon Valley model – broadly understood as a system which integrates research, startups, angel investors, venture capital and investment funds – to Europe, the Middle East and Asia. In each of these regions government policy assumes a much greater role (Wilkinson, 2024). The European Union and individual European Governments (especially Denmark and the Netherlands) invested some US$477 million in alternative proteins in 2022 (GFI, 2024).[7] Israel has declared alternative proteins to be one of its top five priorities for investment and promotion, and the Israeli Innovation Authority has invested heavily in building an innovation hub and promoting a consortium for alternative proteins. Israeli firms captured 15% of global funding but lack of financing for scale-up and the need to access global markets has led their leading firms to set up factories outside of Israel (Buss, 2022). Arab States, by contrast, have focused on attracting the new global players to establish plants in their own territories.

Singapore has become the reference for government promoted alternative proteins as part of an integrated high-tech food security strategy aimed at reducing import dependence, historically at 90%, to 70% by 2030. In addition to promoting finance via Temasek, a State supported investment fund with a portfolio of a little under US$300 billion, the Singapore Food Agency approved the marketing of cell cultivated meats as early as 2020. A range of State Institutions have combined to produce an integrated innovation ecosystem to promote local startups and attract the new global players. All the leading global players – Eat Just, Beyond Meat, and Impossible Foods – are present in Singapore, as is the leading precision fermentation company Perfect Day. Local and regional leaders include Next Gen Foods with its popular brand TINDER, Shiok Meats which despite its name specialises in seafood, and the Hong Kong based Omni Foods. In all, Singapore sports some 60 alt food startups, including 11 cell culture firms, and is now the leading food innovation hub in Asia, if not globally (Stevens & Ruperti, 2024).[8]

Smaller hubs are also being consolidated in Hong Kong, Shanghai and Beijing, complete with startups, venture capital, accelerators, and local dedicated investment funds. Much has been made of Xi Jinping´s declarations in favour of alternative food routes and the inclusion of alternative proteins in China´s most recent five-year

[5] The above authors make the important point that only some 20% of total funding, according to sources such as the Good Food Institute, is dedicated to alternative foods. The vast majority is invested in more predictable digital technologies which are geared to increasing the efficiency of dominant agricultural practices. A large proportion is also directed to food services which are adopting well tried platform technologies, although their impacts are yet to be fully understood. The fact that, even so, most academic contributions have focused on alternative foods points to the radical nature of the questions – cultural, philosophical, economic, geopolitical, and social – that these innovations raise.

[6] The exception she discusses is the Real Vegan Cheese open-source project (Sexton, 2020).

[7] As we have seen above, however, there is also strong organised opposition to alternative proteins in the European Union. For a comparison of EU and EUA ecosystems for cultivated meat, see Schimanietz & Lukacs, 2020.

[8] See also Reis at al., 'The interplay of entrepreneurial ecosystems and global value chains; insights from the cultivated meat entrepreneurial ecosystem of Singapore', Technol. Soc. 71 102116

plan. For Singapore, China, and much of Asia it is not the hype that makes alternative proteins attractive but the evident scarcity of domestic traditional food resources, and the uncertainties and risks of large-scale dependence on imports for basic foods in the case of States whose legitimacy depends heavily on guarantees of food security. The hope of alternative protein leaders such as David Yeung, founder of Omnifoods, is that in the case of alternative proteins the Chinese State will reproduce its promotion of solar energy and electric transport (Yeung, 2022). They argue that only with such levels of State support – a position shared by the global non-profit Good Food Institute (GFI) – can these protein routes provide a viable alternative to the traditional protein sources whose continued growth is widely considered unviable and undesirable (Willet et al, 2019).

Within a decade, alternative proteins have been transformed from a remarkable 'stunt' to a highly integrated network of innovation hubs constituting a global ecosystem, whose centre of gravity is shifting from Silicon Valley to the Middle East and Asia. Over 10,000 food startups had been identified globally by 2022, with 980 angel investors, 3,260 venture capital firms, financed by dedicated investment funds, to which we should add sovereign funds worth many billions of US dollars.[9] In the decade from 2012-2021 some US$170 billion were invested in the agrifood tech sector. Guthman and Biltekoff calculate that some 20%, or over US$30 billion, of this total was directed at the FoodTec sector.

While these figures impress, they pale in the light of the global subsidies for conventional agriculture which a FAO/UN Report (2021) calculated at US$540 billion per year, increasing if unchanged to US$1.8 trillion per year by 2030. Beef and dairy were the sectors identified as receiving the largest shares. Only plant-based alternatives and mycoprotein, with its banner brand Quorn, are currently being marketed at scale and make up around 1% of a global market worth US$1.4 trillion, to which we should add a further US$300 billion for the global fish and seafood market (www.statistica.com). Lack of regulation for products which use precision fermentation, as in the case of Impossible Foods, limits their expansion in Europe and China. Regulation, therefore, will be a key determinant of market penetration, particularly in the case of cultivated animal proteins. The size of the markets targeted also makes clear the limits of this predominantly private-actor dominated innovation ecosystem. The decisiveness of State-supported innovation is starkly apparent when we consider the importance that small States such as Israel and especially the tiny city-State of Singapore have assumed.

## ALTERNATIVE PROTEINS AND THE SUSTAINABLE TRANSITIONS LITERATURE

While the academic literature referred to above focuses almost entirely on the specifics of the Silicon Valley model, many researchers have turned to the sustainable transitions literature to understand the broader implications of alternative proteins for the restructuring of the agrifood system. This approach associated with the work of F.W. Geels (2002, 2004, 2007, 2011), which in turn draws on earlier neo-Schumpeterian analyses (Freeman & Perez, 1988), has been influential in interpreting the adoption of renewable energy (Geels and Raven, 2006) and electric vehicles (Krätzig, Franzkowick & Sick, 2020). Based on a threefold, multilevel distinction between niche challengers, regimes (the dominant structure), and the landscape (the broader socio-economic and institutional structure), it explores transitions as the result of engagements and negotiations between the different levels. There is now a considerable literature applying this approach to agrifood (Smith, 2007; Bui, Cardona, Lamine & Cerf, 2016; Bilali, 2019) and to alternative proteins (Janssen, Zunabovic & Domig, 2014; Boukid, 2017; Moraes, Claro & Rodrigues, 2023; Bulah, Tziva, Bidmon & Hekkert, 2023; Dueñas-Ocampo, Eichhorst & Newton, 2023; Mylan, Morris, Beech & Geels, 2023).

Without doing justice to the richness and variety of this literature which has applied the framework to different country contexts, it can be said that the focus of attention has been on the diversity and the

[9] These data were culled from the FoodTech ( https://foodtechconnect.com/ ) and Tracxn (https://tracxn.com/ interactive platforms

complexity of the pathways from niche to mainstream. Interaction and bidirectionality between niche and regime have been highlighted, as has the need to incorporate a range of societal actors seen not to be adequately specified within the niche-regime framework. The global ecosystem supporting alternative protein innovation, as described above, would however suggest the need to go beyond this fleshing out of the transition.

Plant-based proteins have from the outset been directed at the mainstream mass market of burgers, nuggets, and minced meats with the conviction that they could immediately engage the mainstream flexitarian consumer. In this endeavour they found an early ally in large-scale retail which placed their products alongside the existing category offerings. It is not by accident that critics have characterised these products as yet another example of junk food (IPES, 2022), an issue to which we return below. From the outset, these products were also promoted by the dominant sectors of global finance capital, which enabled an unprecedentedly rapid transformation of mission-oriented startups into mass producers and global players.

It is the force of this movement which explains the early entry of the dominant incumbent players into these markets emulating finance capital by acquiring, funding, and promoting the ecosystem of startups. In the 2021 ranking of leading food firms by Food Engineering, all the first 12 had created venture capital firms, a number which rose to 29 in a 2022 survey by Just Food (Costa, 2022). The willingness of retail giants – themselves new entrants, such as Amazon, via Whole Foods – to promote these products led all the incumbent meat producers, which repositioned themselves as protein companies, traders (ADM, Cargill) and final foods (Nestlé, Unilever) to develop plant-based product lines individually or in association on a global scale (Wilkinson, 2024). The notion of a regime, which suggests a considerable degree of stability and coherence, is unable to capture the speed and diversity of the leading actors' responses.

While niche and regime are too schematic for analysing the emergence of alternative proteins, the notion of landscape is difficult to apply to a situation which demands a radical reappraisal of national and global market regulations. In addition, national states and international organisations are increasingly involved in the promotion of research, funding, and the provision of innovation environments on the one hand, and in the redirecting of traditional forms of protein production and consumption on the other (Buss, 2022; Stevens & Ruperti, 2024). Not even the continued predominance of funding for traditional protein production can be interpreted as a landscape effect since it is preserved through increasingly vocal and organised lobbies from regime actors. Most notable, perhaps, is the continued uncertainty regarding consumer disposition. Is the flexitarian hypothesis being confirmed? Is the condition for the adoption of alternative proteins an ability to reproduce the sensorial characteristics of the animal product? Or will the pleasures of eating become emancipated from traditional animal referents?

## DISRUPTIVE INNOVATION OR HIJACKING BY THE INCUMBENT PLAYERS?

The early involvement of the incumbent players, the global corporations of the agrifood system, in the development of alternative protein markets, in the acquisition of startups, and in joint ventures or in-house investments in alternative proteins, has already been mentioned. This has been interpreted as co-option by critical think-tanks such as IPES (2022) and ETC (2019), which see it as further reinforcing economic power and concentration in the global agrifood system. Early critiques in this direction focused on plant-based proteins, characterised as reproducing the junk food model of ultra processed foods. While this view misinterprets the strategy behind producing hamburgers, chicken nuggets, and minced meat, which was to reach the mass market with the available technology, initial nutritional comparisons showed higher levels of sodium in early versions of Beyond Burger. Six months after these tests, a 2.0 Beyond Burger was launched with sodium reduced below the level of equivalent traditional meat burgers (Pomranz, M, 2020).[10] This ability

[10] In February 2024 Beyond Meat launched its burger 4.0 https://investors.beyondmeat.com/news-releases/news-release-details/

to redesign food products was captured by the think tank RethinkX (Tubb & Seba, 2019), in the phrase 'food as software', with innovation now focused on the molecular level and readily adjustable.

Cellular agriculture[11] has been analysed in a similar vein by Howard, Ajena, Yamaoka & Clarke (2021) and Howard (2022), focusing on its reinforcement of power asymmetries, traditional feedstock supply chains, and 'centre-of-plate' dietary patterns. These articles includes a detailed figure mapping the extent of incumbent firms in cultivated meat and fish startups. In a recent book, Goodman (2023: 94) concludes in a similar vein: 'The key premise of this book is that the current wave of innovation driven by the convergence of digital and molecular technologies has been contained within the hegemonic industrial model of agriculture and food'. As commented in footnote 5, this would seem to be the case for upstream technologies which are tailor-made to reinforce largescale agriculture. In food services the situation is more complicated, leading to a yet unresolved redefinition of the relative weights of supermarkets, home delivery, and traditional restaurant services.

Alternative foods[12] and especially the animal protein sectors may also become similarly contained. As we have documented, dominant actors throughout the agrifood system are currently investing in alternative proteins, from DuPont upstream to ADM and Cargill in primary processing, to all the leading firms in meats – JBS, Tyson, BRF, Marfrig, Charoen Pokphand Group –, final foods – Unilever, Nestlé –, and even retailers, which not only promote plant-based products but launch their own brands.[13] Given, however, the origin of these innovations outside the traditional actors of the agrifood system, the support they have received from the global resources of finance capital, and the extraordinary speed and scope of their development and diffusion, a more plausible interpretation is that the incumbent players are engaged in 'catching up' strategies faced with a movement which is currently beyond their control. This would seem to be particularly the case in light of the global dimensions of these investments and the increasing involvement of rich States in their promotion, for whom these innovations offer the promise of food security in the face of drastically insufficient domestic conditions for food self-provisioning.[14]

Different actors may well prevail, but it can be argued that the same patterns of economic concentration and power will become consolidated, and these seem in fact to be emerging as the leading new entrants globalise and scale-up, all claiming to be building the world´s largest factories whether for plant-based foods (Beyond Meat), cell cultivation (Upside, Eat Just), fermentation (Quorn), or insects (InnovaFeed/ADM, Ynsect). On the other hand, in each case alternative possibilities are being envisaged. Plant-based proteins hold the promise of dethroning soy as a range of pulses (beans and peas) suited to different edaphoclimatic conditions are being incorporated and promoted. This is particularly the case in Europe where the European Plant-based Foods Association (ENSA) has been formed to promote public policies to increase the continent´s plant protein self-sufficiency. The emergence of shorter supply chains from this endeavour would encourage more decentralised production (Magrini et al, 2018).

A similar argument has been made in the case of cell-cultured proteins as captured in the title of Weele & Tramper´s 2014 article, 'Cultured Meat: Every village its own factory'. Here again it is argued that local crops

beyond-meatr-unveils-its-beyond-iv-platform-fourth-generation/

[11] There is no single agreed definition of cell cultured proteins. Cellular agriculture is a proposed generic definition. See Stephens et al. (2018).

[12] Precision fermentation can in principal produce bio-identical molecules for all kinds of foods and drinks. For coffee see: www.compound-foods.com.

[13] In their efforts to establish themselves rapidly as global players, the alt protein startups also actively negotiate associations with incumbent retail and food services to ensure rapid diffusion, and in other cases have recourse to established food industry players to achieve adequate production scales.

[14] In The Agrifood System in Question: Innovations, Contestations and New Global Players published by Bristol University Press in 2024, the current author argues that as from the 1980s rural and urban social movements, the scientific community and public policies both national and international have converged around a food agenda which has placed the food industry on the defensive, successively adjusting to their varied demands.

could be combined with bioreactors of varying sizes in accordance with local demand. The same model would apply to micro-organism fermentation for protein production. In Europe, the Respect Farms initiative, with prototypes in the Netherlands, Germany and Switzerland envisages the integration of cultivated meats within the dimensions of the traditional family farm (Ettinger, 2023). The farm would have a select herd to guarantee the genetic quality of the meat cells, cultivate feedstocks for the growth medium, and ferment the cells in small-scale bioreactors.

The leading cell culture firms Upside and Eat Just are engaged in or have already constructed huge factories with a view to large-scale production. Serous doubts, however, have been raised about their ability to scale-up to very large bioreactors. Ex-employees at Upside have claimed that the giant bioreactors on show in its San Francisco factory are still not operational. A recent declaration by the CEO of Meatable, Krijn de Nood, reinforces these doubts (Watson, 2023). He argues in favour of small bioreactors, currently at 500 litres, with rapid throughput – as little as eight days in their case. This scale-out rather than scale-up strategy converges with the Respect Farm model and could be integrated into existing decentralised marketing and food consumption practices.

Insect protein would seem to have fewer technical problems for production at scale where the model is similar to that of vertical farming without the same energy (temperature) concerns. Such a model may be more appropriate when the animal feed market is envisaged. On the other hand, where the integration of insects into food consumption practices is customary, more decentralised production is likely to prevail as in many countries of Asia whose insect farms number in the thousands. Protein bars, on the other hand, are tailor-made for the portfolios of the leading snack-food giants.

While the leading new entrants are currently betting on volume and global reach, technical problems of scale, the modular nature of alternative protein processing, and the demand for more diversified protein sources all indicate the persistence of windows of opportunity for more diversified outcomes.

## HAVE ALTERATIVE PROTEINS RUN OUT OF STEAM? DEMAND SIDE DYNAMICS.

It might be thought that with all the relevant incumbent players also embarking on alternative proteins, the market at least for plant-based alternatives would be experiencing exponential growth. The sector seemed to be on this track from 2019-2021 but as from 2022 sales have become sluggish, the leading new entrants, Beyond Meat and Impossible Foods, have been cutting back their operations, and references to the Gartner cycle of innovations has suggested that the sector has hit the 'trough of disillusionment' (Terazono & Evans, 2022).[15] These observations are limited to plant-based proteins in Western markets, and the situation in Asia is less clear. Nevertheless, current uncertainties point to the need for a closer look at demand dynamics.

While most studies equate demand issues directly with consumer dispositions and preferences, agrifood studies focus on the intermediation of retail which is regarded to have assumed a hegemonic role in the formatting of food demand. A Brazilian study has examined how the two leading retail firms market plant-based meats in the major consumer centres of São Paulo and Rio de Janeiro (Reis et al, 2023). Its main conclusions are that the plant-based products of the established meat firms tend to have an advantage over the new entrants in terms of price and the range of products on offer. In addition, sales of plant-based products must compete with the promotion of traditional meat products which make up the overwhelming bulk of these meat firms´ sales and corresponding spaces in the gondolas. An earlier study of plant-based products and Canadian retail reached broadly similar conclusions. They found that while retail enabled the availability of plant-based alternatives, these were not actively promoted and consequently were relatively

[15] The Gartner cycle was created by the U.S, consultancy firm Gartner and is used here not for its intrinsic value but because it is used by these authors in relation to alternative proteins and vertical agriculture.

invisible in the gondolas (Gravely & Fraser, 2018).

In her auto-ethnographic study of plant-based meats, Alexandra Sexton (2016) mentions encountering Beyond Meats´ chicken strips in the diet products aisle of Whole Foods, now Amazon, in a Los Angeles retail outlet. The positioning of these alternative protein products has been a central concern of this emerging sector, including also dairy products where market penetration is greater but where less research has been carried out. In their study of plant-based milk within a sustainable transition framework, Mylan and colleagues (2019) draw attention to retail´s positive promotional positioning of alternative milks. The 'non-stuff' (less fats, no fats) of milk, to adapt Sexton´s image (2016), has of course a longer history as a marketing strategy in dairy products, which had established their place in supermarket gondolas prior to the arrival of the new generation alternatives (Oatly, NotCo and others).

Positioning implies messaging, which in turn requires labelling, subject to public regulation. Naming and labelling and have provoked conflicts in the food industry at least since the invention of 'butterine', now margarine. Their importance can be gauged in the current battles to prohibit the use of the words meat, milk, cheese, and yoghurt, for plant protein alternatives, which at one level seems simply to reflect the fears of entrenched lobbies in animal protein producer countries. No-one, it seems, is confused about the origin of the protein when they buy a hot-dog!

In the case under discussion, however, alternative protein firms do claim that their products are meat or milk. Sexton (2016: 67) cites Ethan Brown, Beyond Meats´s CEO, as saying: 'Meat is really made up of five constituent parts: the amino acids, lipids, carbohydrates, minerals, and water. They´re all actually present in plants. What we´re doing is building a piece of meat from those plants, and so the compositions are basically the same. And in that case, we are delivering meat.' Perfect Day, which uses precision fermentation to produce milk components, makes the same affirmation from a different perspective, that of meaning: '"I want the definition of milk to be based on its cultural significance, on the way people use it and interpret it, not on what´s in it necessarily. And the reason is obvious. I mean soymilk is milk, almond milk is milk, cow´s milk is milk' (cited in Jonsson, Linné & McCrow-Young, 2019). To this one could add 'Animal-free Milk', which appears on Perfect Day´s labelling. While the Beyond Meat CEO argues for molecular equivalence, Perfect Day adopts the view that usage leads to various versions of the same product. Oatly, discussed by these same authors, goes even further, and claims that its product is better than milk, in the slogan: 'It´s like milk, but made for humans' (apud Jönsson and colleagues, op. cit.), which recalls here the values attributed to the 'non-stuffs' of Sexton´s analysis.

Research drawing on the social studies of science literature (Stephens & Ruivenkamp, 2016; Kramer, 2016; Jönsson, 2016; Lonkila & Kaljonen, 2021) has exposed the major ambiguities at stake in naming and labelling, and which go beyond, but radically affect, the economic interests of groups with entrenched political clout. In claiming the status of meat, or milk, for plant-based, cell cultivated, or precision fermented alternatives, traditional meanings are being stretched, based on new technological possibilities. Do new knowledges recreate existing realities or forge new realities? In Sexton´s analysis, the bottom line would be 'as good as' in sensorial terms, a route she explores through 'visceral' auto-ethnographic research, and, 'better than' in the values of its 'non-stuffs' (be these, climate, animal welfare, or health externalities).

'Better' in this sense assumes clearly normative connotations, and an important additional line of analysis focuses on the ethical implications of the current wave of protein innovations. Dutkiewicz captures this most provocatively in his title to a 2021 article: 'The Sadism of Eating Real Meat over Lab Meat'. The slaughter of animals and the systematic cruelty involved in mass industrial production might by justified when they can be arguably defended as the only means of ensuring an adequate supply of all the necessary proteins. But once this is no longer necessary, how can the persistence of these practices be justified?

## RISING OPPOSITION AND CONSUMER AMBIVALENCE

The closer cultivated meats, fish, and precision fermented proteins reach to market launches, the more juridical, legislative, and ethical and 'defence of traditions' questions come to the fore (Bhat et al., 2019). Even in the case of plant-based alternatives, Jönsson and colleagues´ study of the legal battle over Oatly´s marketing strategies, which lasted some fourteen years, interestingly reveals the uncertain consequences of legal appeals. While the traditional dairy associations won on almost all counts (whether 'equivalence' or 'better than' claims), Oatly repeatedly turned these adverse decisions into marketing opportunities and emerged a much stronger company.[16] It should be remembered that while initially focused on the Nordic markets, Oatly then established itself in the US, and has become a successful global player.

In the case of cultivated meat, opposition has not been limited to court battles over labelling. The Italian Chamber of Deputies passed a law on 16 November 2023, banning the marketing of cultivated proteins, punishable with fines ranging from €10,000 to €60,000. In addition, the use of 'meat' terms in the labelling of alternative proteins was also prohibited. The campaign leading up to this ban was organised by the leading representative farming organisation, Coldiretti, which claimed to have collected 2 million signatures for a petition to ban cultivated meat, with the support of 2,000 municipalities and all the farming regions of the country. The justification in this case was posed in terms of the threat to Italy´s traditional farming products (Galbo, 2023). Other major animal protein producers, Uruguay, the United States, and Brazil, all have similar legislative proposals in the pipeline, but the latter two countries´ regulatory bodies are to date playing an enabling role.

The mass media and social media have also become more 'vocal' as market realities emerge. A review of leading daily papers in Britain suggests that confidence in meat has already been shaken by repeated scandals in recent decades, providing a favourable climate for the introduction of plant-based alternatives, especially given their association with the positive press that veganism has received (Veness, 2023). The reputation of these alternatives however quickly became tarnished by their categorisation as just another round of junk-food. Cultivated meat, by contrast, was presented as 'fake', 'lab', or 'artificial' and this framing coincided with efforts to improve the image of traditional British meats.

Alternative proteins were introduced in the age of social media and several studies have registered their growing presence in on-line conversations (Specht, Rumble & Buck, 2020; Pilarova et al, 2022). A large-scale analysis of X (Twitter) by Ripple Research examined 285 million messages and identified over 400,000 distorted or false claims regarding cultivated meats. Half of these had their origin in a small number of influencers and appeared to be associated with science and climate denial messages, although there was no evidence of an organised campaign by established animal protein interests (Meddah, 2023).

Although there are many intermediations on the demand side before the consumer is reached, social science theory neither reduces demand dynamics to a combination of these intermediations, nor does it attribute 'sovereignty' to the consumer. Alternative proteins have provoked many studies on the consumer in a wide range of countries, aimed above all, and quite naturally, at capturing consumer attitudes and willingness to purchase (Baum, Bröring & Lagerkvist, 2021; Bryant & Barnett, 2019; Liu +4, 2021; Palmieri, Perito & Lupi, 2020; Chriki et al., 2021; Wilks & Phillips, 2017). In general, their conclusions suggest favourable conditions for market growth, but with price emerging as a continual qualifier.

Much social science would question the value of stated intentions as guides to action, particularly in the absence of widely available products. A focus on eating as a social practice (Warde, 2016) would give priority to the way alternative proteins are becoming incorporated into existing eating practices. Alternative milks are

[16] In 2014, Unilever filed a lawsuit against the use of the name Just Mayo by what was then Hampton Creek (now Eat Just), but later withdrew its charges, choosing instead to launch its own 'no egg' mayonnaise.

interesting here since they have been marketed over a longer period. Studies by Mylan et al. (2018) mentioned earlier in our discussion of sustainable transition approaches, and by Buchs, Mylan & Stevens (2023), show that we are not necessarily dealing with a simple product substitution. The latter study found that consumers who bought alternative milks continued to buy traditional milk since the new products did not combine well with hot tea or coffee, although they were excellent substitutes in the case of morning cereals. The innovation strategies of the leading alt protein companies seem to be very much aligned with the notion of eating as a social practice, with its accompanying inertias and rituals. Their stated aim is to reproduce the characteristics of the original meats and other proteins within their habitual eating settings. Hence the relevance of the visceral auto-ethnographic research à la Sexton. The bold flexitarian consumer hypothesis may nevertheless still be faced with the predominance of a reductionist flexitarian argument to simply abstain from meat on certain occasions rather than opt for alternative meat substitutes.

## FINAL CONSIDERATIONS

In this article the focus has been on questions directly related to the dynamics of the current innovations in protein food products, and on the academic and 'grey' literature which subjects them to analysis. The analysis has been developed through a critical engagement with this wide-ranging literature. As regards the innovation process itself, the predominant focus on the Silicon Valley model obscures the increasing centrality of new actors as innovation assumes a more global dimension, including States rich in capital but poor in natural resources and for which food security is central. In addition, the brilliant descriptive and interview material, focusing on the hype of the pitching ritual, fails to appreciate the extraordinary results achieved in the space of a decade as startups became global players, and products moved from the lab to the gondola. The hybrid zone between academic and engaged grey literature is dominated by the view that the wave of food startups has been consolidated under the control of the incumbent global players, reinforcing their economic and political power. We have tried to show that this view is at least precipitate, although it is clearly a possible outcome. And while market concentration is being actively pursued by the newly global players, the potential for decentralization is built into the modular architecture of fermentation technologies.

The emerging literature on the myriad factors influencing demand has effectively exposed the inadequacy of much of the consumer literature focused on attitudes and willingness to purchase, and makes vividly evident the depths of the interests and values at stake. It was not possible in the space of this article to do justice to the discussions on the content of the new food products proposed. These have been variously dismissed as junk food, as the reduction of food to nutrition, and as a perpetuation of the meat-centred food plate. These may all be valid observations in themselves, but they forget the central importance of the promise of Sexton´s 'non-stuff': no cruelty to animals, no deforestation, no exhaustion/destruction of natural resources, and no dangers to personal and public health. In this sense, a shift to alternative proteins would indeed be disruptive.

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# Food that Acts Like Other Food: A History

Paper first received: 09 February 2024; Accepted: 29 June 2024; Published in final form: 18 December 2024
https://doi.org/10.48416/ijsaf.v30i2.595

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## Abstract

What is the history of animal product substitutes, and why have humans created and consumed them? How long has this practice existed and in which cultures? This history of these novel foods, plant-based protein alternatives, notes a shift over time from predominantly religious to largely secular motives for avoiding meat and dairy. In recent decades plant-based meat and dairy substitutes have grown in number and use, even as Western countries have experienced a decline in organized religion. The impetus behind their production and consumption today is now predominantly secular, rather than religious, specifically environmental and animal welfare issues. This paper charts the transformation of motives and purposes behind the uses of these foods. This historical survey, while not geographically or chronologically exhaustive, is told mainly from a UK/US point of view, two societies with entrenched animal meat and dairy consumption habits. Providing examples from different cultures and periods, it divides the use of plant-based product substitutes into several periods: early to medieval civilizations; nineteenth century Western industrialization; the early twentieth century; late twentieth-century United States; and to conclude, the present day. The historical and cultural contexts provide important perspective on the current proliferation of novel plant-based meat and dairy substitutes.

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## Introduction

Mock duck made of wheat gluten; nut milk coagulated to form mock eggs; butter substitutes made from vegetable oils; and soy-based meat substitutes of both the early (tofu) and modern eras (Protose, Garden Burgers, textured vegetable protein). What are the histories of these plant-based meat and dairy substitutes? Why have humans created and consumed them, given that animal-derived meat and dairy have been readily available, desired, and consumed by the majority of humans over time and across cultures?

The history and practice of food substitutes—food acting like other food—is wide-ranging and pervasive. While plant products have been substituted for other plants (using crackers for apples in mock apple pie), and animals for other animals (ex: surimi, a fish paste imitation crab), most such novel food creations have been plant-for-animal product substitutions. This article focuses on the motives behind plant-based animal product substitutes, specifically for meat and dairy.

These novel plant-based alternatives have diverse origins but commonalities as well, including the motivations behind their development, and their meanings over time, from predominantly religious to largely secular motives for avoiding meat and dairy. In recent decades plant-based meat and dairy substitutes have grown in number and use, even as countries have experienced a relative decline in organized religion (Pew Research Center, 2022). While religious reasons for avoiding meat still exist, today the impetus behind the production and consumption of meat and dairy alternatives is predominantly secular rather than religious, specifically environmental and animal welfare issues. This paper charts the transformation of the motives and purposes behind the production of these foods.

This brief historical survey highlights examples from different cultures and periods, though mainly tells the story from a United Kingdom/United States orientation. Furthermore, it focuses mostly on societies where animal-derived meat and dairy are prominent features in their cuisines (though perhaps not readily available to all people because of cost or accessibility). Cuisines relying primarily on plant-based sources of protein would have a different relationship with novel plant-based meat and dairy substitutes, and there may perhaps be less of a need to develop them. While the early Asia example discussed below is perhaps one such society (at least with regard to animal-derived dairy), it would be interesting to explore in more depth the question of whether cuisines less reliant on animal products are compelled to create plant-derived meat and dairy substitutes.

The discussion divides the use of plant-based product substitutes into several periods: early to medieval civilizations (Asia and Europe); nineteenth-century western industrialization (UK and US); the early twentieth century; late twentieth-century United States; and briefly concludes with the present day. While such a short paper cannot provide geographically or chronologically exhaustive examples, these historical and cultural contexts still provide important perspective on the current proliferation of novel plant-based meat and dairy substitutes.

## Meanings and Motives of Food Taboos

As omnivores, the human digestive system can accommodate both plants and animals as food. Yet individuals and groups have avoided eating meat and other animal products, usually as a response to religious or cultural prohibitions. These rules, often codified as taboos, become deeply embedded in cultures (Fiddes 1992).

Nearly all religious traditions use food consumption or its absence in rituals, as symbols that impart meaning, and to drive group identity and cohesion. Many of these food practices involve eschewing animal products, specifically meat. Some avoid all animal flesh (Seventh Day Adventists, Buddhists) and others focus on a

particular kind (Judaism, Islam, Hinduism). Others have provided restrictive rules regarding the consumption of these products (Catholicism). While these proscriptions and practices have changed over time, for many orthodox practitioners, these food rules are deeply embedded within their identity and religious practice, to the point that the thought of consuming the forbidden animal flesh creates deep feelings of disgust. This discomfort can remain even if a person no longer practices their childhood faith (Rozin and Nemeroff 2002). In response, cultures have developed plant-based meat and dairy substitutes, which take on their own meanings and uses as they become embedded in culinary foodways.

There are numerous reasons groups avoid eating animals and their byproducts, and individuals often have mixed motives for doing so. When examining historical food habits, it is impossible to know exactly what people's motives were, although archaeologists and historians are able to draw conclusions about historical food habits' function and meaning. Moreover, religious and secular ethical reasoning are themselves interwoven. While religion and secular ethics are main drivers, a number of other factors can come into play, including demonstration of power and hierarchy, technological innovation, economic hardship, taste preferences, group dynamics and involuntary feelings of disgust. For example, some avoid eating animals for religious reasons that are intertwined with national allegiances (India), political/historical context (Germany), or even national security (Israel, Singapore) (Jain 2019; Torella 2022; Spence 2021; Rozin 1982; Stevens and Ruperti 2023). Someone may eat tofu instead of meat for multiple reasons: animal welfare ethics, for example, but also attempts at weight loss, or to conform to group norms. Meanings and uses can moreover change over time; that is, people start out avoiding meat for one reason (religious taboo) and it later turns into another or is expanded to include other motives (environmental awareness, health concerns). While this research examines the historical past for clues regarding the development of and humans' response to proscribing animal consumption, it focuses on the product substitutes that arise as a result.

## Mock Duck and Almond Milk: Early Religious-Based Substitutes in Buddhism and Medieval Christianity

Buddhism, with its proscriptions against eating animals, has had a significant effect on the food cultures of Asian countries. China's early adoption of plant-based meat products is closely linked to its long history of Buddhism. Buddhism began in India and migrated to east Asia, reaching significant influence between the fifth and eighth centuries CE (Lauden 2015). Original Buddhist teaching did not entirely prohibit the eating of animals, and Buddhist sects have varied on their practice with regard to meat eating (Daly and Thakchoe 2023). It has, though, encouraged abstaining from meat through *ahimsa*, the virtue of non-violence. *Ahimsa*, also a key tenant in Hindu, Jain, and Sikh thought, advocates doing the least harm to others possible, which includes all living beings (Chapple 1993).

The religious proscription gave rise to meat product substitutes serving a variety of constituents and needs. Monasteries in Asia became prominent centres of not only religious thought and practice but also commerce, agricultural, and technological innovation. Traveling merchants, explorers, wealthy patrons, and religious pilgrims sought lodging and hospitality, and monastery kitchens providing food for all became centres of cuisine and product innovation. While Buddhists monks were for the most part non-meat eaters, travellers—many of whom were wealthy patrons—consumed and expected meat. As a result, Buddhist temple food traditions produced meat analogues, including tofu and wheat gluten, also called seitan (Lauden 2015; Erway 2018; Wei 2021). Wheat gluten, the protein-rich substance remaining after rinsing wheat, was especially developed as a mock meat, as they were called, formed into shapes and cooked deliberately to resemble meat. Its texture being somewhat similar to cooked poultry, mock duck was an early popular product made from wheat gluten. The gluten, formed and dimpled to resemble a plucked bird's skin, was cooked and served to enhance its appearance compared to actual duck. Mock duck became a mainstream product in China and elsewhere in Asia, and continues to be a popular dish today (Erway 2018; Lott-Lavingna 2019; Dunlop 2023).

Similar to Buddhist influences in Asia, in Medieval Europe Catholic religious dietary restrictions led to plant-based substitutes, in particular for dairy. Monasteries similarly were centres of wealth, agricultural and culinary ingenuity, as well as religious thought. Most followed the Rule of Saint Benedict. Benedict's writing, codified in the sixth century CE, preached simplicity as a reflection of divinity, and advocated prayer, work, and *lectio divina* (scripture study and pondering). The Benedictine Rule advocated simple living, including avoiding extravagant eating, and at the same time extending hospitality to strangers. Some Catholic monastic orders abstained from eating meat entirely, limiting their meals to one or two a day (even while some monasteries became famous for their rich food and drink traditions) (Lauden 2015; Albala 2011a; Albala 2011b). Ordinary people were not beholden to such a strict regimen, but did have rules to follow regarding meat and dairy consumption during fast days.

Fast days, comprising at least half of the calendar year, were decreed by the church and enforced to a certain extent by the state as well as by social norms during the Middle Ages, when Christians had to observe them. On these days, no animal products, including eggs, dairy and meat, could be eaten, though anything from water was permissible. The reasoning was that land beasts had had to shelter from the Flood on Noah's ark, but fish were exempt, and therefore permitted (Henisch 1976; Frost 2017). Much debate went into what defined which animals were exempted from the fasting rules; beaver and the Barnacle goose, for example, were categorized as waterfowl and thus allowable. While people near water had greater access to seafood as meat substitutes, most did not. Salt cod, which stored well and could be kept over long periods of time, was a popular fasting alternative to pork and beef.

Nuts served important purposes as fasting food alternatives. Rich, filling and meaty in texture, nuts could in some measure satisfy meat cravings. Nut milks and cheeses became important stand-ins for dairy milk and cheese (Spencer 1993). Cooks poured water through crushed almonds to develop a milk product useful in cooking as well as for drinking, and thickened it to form a cheese-like product (Henisch 1976; Lauden 2015; Frost 2017). Medieval cookbooks even contained a recipe for a mock egg made with almond milk-based jelly with an almond centre dyed yellow with saffron (Napier 1888). A popular recipe of the time, blanched ground almonds were simmered in boiling water and the liquid drained away. The remaining soft puree was sweetened with sugar and divided. One part was left white and the other coloured yellow with saffron, ginger and cinnamon. Carefully stuffed in an empty eggshell and gently roasted, it was served up as a hardboiled egg (Henish 45). Such an item made with expensive ingredients and requiring laborious processing was however available only to the elite.

Most medieval Christians endured with monotonous diets of bread, salted fish, and root vegetables as fasting foods for extended periods of time until the rules became more relaxed in the early modern period. Albala notes that the scholars adhering to Galenic humoral theories of the body took issue with the Church's fasting rules but rarely openly challenged them. They argued that consuming mostly fish and vegetables—fasting foods categorized as cold and moist—in the winter/early spring Lenten season, for example, was exactly the opposite of what the body needed. Humoral theory dictated that warm and dry meats and cheeses were much more suitable to the human body's needs (Albala 2002).

### Protose and Granola: A Religious Basis for the Emerging Ethics of Animal Welfare in Nineteenth-Century Britain and United States

While some religious fast days were still observed among Christians in nineteenth-century industrializing Europe and United States, the Catholic church's power and influence over food habits, especially in Protestant countries, diminished. Emerging, however, were secular organizations that employed more ethical considerations of animal treatment, as well as small groups of Protestants whose theology included meat abstinence. As the industrialization of the food supply commenced in the late nineteenth century, commercial products such as Protose and granola became mainstream alternatives to meat and affected mealtime food habits.

Philosophers have long examined the ethics of eating animals, but in Victorian-era Britain and the United States increased attention focused on the topic. English vegetarianism, the word first formally used in the 1840s, began to coalesce around a number of ideas and was spurred by various factors. Ideas about meat-eating were contested in Christian theology. Traditionalists pointed out that God had assigned humans dominion over animals, when Adam and Eve were commanded to 'be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth' (Genesis 1:28). A small group of theologians, however, argued that meat-eating was the result of Adam and Eve's original sin, and that the true Christian's avocation was to return to the pre-downfall state of perfection and harmonious relationship with all creatures. This 'prelapsarian' theology provided a philosophical base for vegetarianism that made sense to a growing number of British citizens. Adherents established Vegetarian Societies in London, Manchester and elsewhere (Stuart 2006).

Meat abstinence in the nineteenth century was furthermore directly influenced by Eastern religions. Travelers to India and elsewhere in the East were exposed to millions of non-meat eaters, and viscerally understood that people could be healthy without consuming meat (Stuart 2006; Hauser 2020). Moreover, that so many existed without meat shook the European travellers' belief in sanctioned human dominion over animals. As Stuart notes, 'News of Indian vegetarianism proved a radical challenge to Christian ideas of human dominance, and it contributed to a crisis in the European conscience. [I]t encouraged people to imagine that broadening the sphere of ethical responsibility was beneficial for humans as well as for nature itself' (Stuart 2006, xxi).

This was a radical cultural concept for most UK citizens, given the centrality of meat and the symbolic importance of beef in Britain. While probably more people ate pork at the time, beef was symbolically important to this nation of 'beefeaters' who took 'John Bull' for its national mascot (*Anglomania* 2006). In this era before the discovery of vitamins, meat and cereals were thought to be the most strength-producing foods, while vegetables and fruits were pleasant but more an afterthought. They were even considered to be potentially dangerous, given their reputation as laxatives, along with their connection to cold and moist values through the ancient humoral theory that still held vestiges of influence. Malthusian fears of overpopulation stoked a broad national conversation that featured anxieties about not having enough meat to feed the civilized classes. What became known as the Great Food Question focused on meat and spurred action to secure a steady supply of beef and lamb from colonial outposts, including Ireland, Australia and New Zealand (Belasco 2006; Gregory 2009).

The vegetarians were partly reacting to the worst aspects of industrialization, the British 'Satanic mills' that were choking the air with billowing smoke from factories, exposing men, women and children who worked in those factories with few safeguards and meagre pay. Reformers saw vegetarianism as the means to improve the diet of the working classes. While there was a small contingency of working-class vegetarians, labourers mostly wanted what the elites had: a stable safe supply of meat on their tables. Furthermore, in addition to arguments for vegetarianism as being more healthful, vegetarians contended it was more economical, allowed better use of the land, was more in line with pacifism, and was morally preferable. As animal slaughter became concentrated and visible in dense urban cities, groups such as London's Society for the Prevention of Cruelty to Animals (SPCA) protested animal cruelty and advocated avoiding meat eating. Literary figures such as Percy Blythe Shelley, George Bernard Shaw, and Leo Tolstoy joined the movement and wrote treatises and poems advocating vegetarianism (Gregory 2009; Stuart 2006; Lauden 2015). As the nineteenth century turned into the twentieth, English suffragettes linked vegetarianism to their oppression as they strove to win votes for women (Ewbank 2018).

The United States was going through its own vegetarian awakening in the nineteenth century. While there were small groups forming to protest animal cruelty, emerging Protestant religious traditions such as Seventh-Day Adventism prohibited meat consumption as a central tenant to its theology and religious practice. Andrew Shprintzen (2013) effectively traces the intellectual and commercial growth of vegetarianism as a

reform movement, including the roles of Presbyterian minister Sylvester Graham, through to the Seventh Day Adventist John Harvey Kellogg's Battle Creek Sanitarium, the latter being central to the promotion of meat substitutions in the United States. Meat (along with alcohol) was thought to inflame humans' dangerous 'animal instincts', and was therefore to be avoided at all costs. A vegetarian diet was considered healthier in a number of ways. Based on a combination of religious treatise and alternative health reforms, the 'San' as it was colloquially known became a popular place for the striving middle classes to take their health treatments. Kellogg combined his religion's penchant for fresh air, exercise, and avoidance of alcohol and meat with his medical training to create a health regimen which included lectures, classes, electrotherapy, hydrotherapy, and a plain vegetarian diet emphasizing whole grains, fruit, vegetables, and nuts.

Since most of the visitors to the Sanitarium were used to eating meat in quantities, Kellogg and the Sanitarium kitchen – not unlike the Asian monasteries of old – strove to create meat substitutes that somewhat simulated the textures and tastes of meat. He experimented with existing twice-baked hard cereal recipes, making them softer and easier to chew. This 'granola' was softened with milk and eaten as a porridge. Kellogg experimented with nuts as well, creating dense meat-like loaves that, while tasting only minimally like animal flesh, when sliced and plated could appear as an adequate visual and textural substitute for meat (Prichep 2017). Kellogg also developed other nut and cereal products with various names such as Nuttose, Nuttolene, Granose, and Protose. The latter, as Shprintzen (2013: 131) put it, 'set the standard for meat substitutes'. Protose, a combination of wheat gluten, cereal, and peanut butter, was packed in tin cans and marketed as 'vegetable meat'. An advertisement for Protose claimed it 'looks, smells, and tastes like meat and can be used in many ways as meat, yet has none of the harmful toxic effects' (Shprintzen 2013: 133). While these products would never financially compete with animal-derived meat, they were sold commercially, and did provide options for the small but growing number of vegetarians who sought substitutes. Moreover, as the Kellogg's brand of products grew and developed, such cereal and milk options gained in popularity and in the later twentieth century eventually overtook the traditional eggs and bacon breakfasts in the United States.

Vegetarianism spurred a number of commercial products as meat substitutes on both sides of the Atlantic Ocean. Dozens of cafes, lunchrooms and restaurants openly catered to British vegetarians. In London and elsewhere in England, vegetarians imported Kellogg's products and developed their own, with such names as Nutter, Albene, Nut Cream, Meatose, Vejola, Nut-vego, Savoury Nut Meat, and Nutton (Gregory 2009). Scientists at this time were synthesising flavours and new ways of preserving and manufacturing food. Chemist Justus von Liebig's experiments had yielded a meat extract in 1865 and had led to concentrated grain extracts from brewer's yeast, including Marmite in Britain and Vegemite in Australia, and the fruit concentrate Emprote (Gregory 2009) which vegetarians could spread on toast or use to add flavour to recipes.

## TVP and Margarine: Technological Innovation and Novel Plant Product Substitutes of the Early Twentieth Century

As vitamins were discovered in the early twentieth century, fruits and vegetables came to have more value and importance. They had previously been considered pleasant meal additions at best and even regarded with some suspicion, given their place in the humoral system as discussed above. The fact that modern science revealed that fruits and vegetables were packed with nutrients heightened their importance to human health and nutrition. This new understanding occurred at the same time as the food supply was becoming more industrialized. As canned food became more affordable, safe, and palatable, manufacturers and advertisers promoted them in new ways (Bentley 2014; Zeide 2019).

By the early twentieth century advances in science and technology had led to the development of several plant-based meat and dairy alternatives that came to function as industrial commodities (textured vegetable protein), or products that eventually became a valued item in their own right (margarine). The genesis of these products was less about religion or secular ethics, than about technological innovation, modernity, and human mastery over nature (though they proved valuable to religious groups, as discussed below). These early

twentieth-century plant-derived products included margarine (a butter replacement), vegetable shortening such as Crisco (a lard replacement), non-dairy creamers such as Coffee mate, textured vegetable protein (TVP), and soy-based infant formula.

Advances in chemistry radically transformed twentieth-century global food systems, a transformation particularly evident as regards the soybean. Soybeans had been part of Asian diets for thousands of years and consumed as a wide array of products. As soybean production expanded in the West, however, particularly in the United States, they were transformed not into tofu, mock duck, and other edible dishes, but into cattle fodder and a hyper-processed ingredient in industrialized food products. US agricultural stations first experimented with soybeans as cattle feed in the late nineteenth century. By the 1930s, as the soy-processing technology advanced, the beans would be crushed, their oil removed for domestic and industrial uses, and the remaining high protein meal fed to livestock. As Matthew Roth (2018: 12) notes, 'By the 1960s the soybean was a fixture of American life but in a way entirely distinct from its role in Asia. The bounty of its protein did not sustain people directly; it did so indirectly through the massive expansion of meat production'. Millions of people across the globe were then sustained by soybeans, though in different forms: those on one continent by products made from soybeans, and those on another by animals fattened with soybeans. Soy cooking oil appeared in grocery stores and household pantries; by the 1970s seventy percent of all edible oils in the US were derived from soy (Lauden 2015). Soy-based textured vegetable protein (TVP) became a widely used meat extender, especially in government subsidized school lunches and processed hamburger mixes (Bentley 2021). While US vegetarians and Asian-Americans consumed soy in more recognizable forms, soy increasingly made its way into ultra-processed food products as lecithin and other chemical derivatives (Roth 2018).

As soybean and other vegetable-based oils were becoming more popular, in the same period the use of animal fats was declining, largely due to the development of margarine. A solid fat designed as a butter substitute, margarine was originally made of beef tallow, but as technological advances created hydrogenated oils (turning the liquid into a semi-solid product) margarine as a plant-based butter substitute proliferated in the twentieth-century US. Margarine proved useful during World War II, when rationed butter was scarce and expensive. The dairy industry, fearing that Americans would become so comfortable with margarine that butter sales would diminish after the war, succeeded in passing a law that required margarine to be sold white, accompanied by a packet of yellow food colouring that the consumer would have to knead into the product (a law that was repealed years later) (Bentley 1998).

Marketed as better and healthier than butter, margarine was a mainstay of American pantries for decades. It proved especially popular among Jewish Americans who could use the non-dairy margarine—as well as the lard substitute Crisco (vegetable shortening) and Coffee mate non-dairy creamer—with meat-based meals and still keep kosher (Kirshenblatt-Gimblett 1990). Initially regarded as healthful, these ultimately became mainstream, even beloved products, all made with hydrogenated vegetable oil, which in the early 2000s was found to be among the most harmful of fats (Nichols 2023; O'Leary 2023).

## Boca Burgers and Tofurky: Secular and Eastern-Religion Influenced Approaches to the Earth and Its Inhabitants in the Late Twentieth-Century United States

The 1960s/70s United States counterculture movement, with its emphasis on challenging mainstream practices and beliefs, spawned a variety of meat substitutes and popularized such foods as tofu and yoghurt. First produced and marketed mainly to vegetarians in health food stores and coops, large food manufacturers eventually picked up on the trend and created more products, which were eventually commercialized and entered the mainstream food culture. While some groups still advocated meatless diets for religious reasons, including a new-found interest in non-Western forms of religion and spirituality, the prevailing ethos was not only concern for animal rights but also the environment, all part of the oppositional reaction to the excesses of mainstream American culture. New ideas about health and wellness also played a part.

In United States, the post-World War II demographic cluster known as baby boomers came of age in the 1960s and 1970s and made their mark on society. A small but powerful group of educated, mainly white, young adults created an influential subset known as the counterculture. Disillusioned with mainstream politics (Watergate, Vietnam War), misuses of science and technology (Agent Orange, DDT, the military-industrial complex), and unfettered capitalism, the counterculture deliberately sought out new ways to live. The counterculture generation were attracted to and influenced by Eastern religious traditions, including Buddhism, in part as a protest against global human and animal violence. Regarding eating as a political act, they looked to other cultures' food habits that contrasted with the American emphasis on meat, those that were more global in orientation and seemingly more environmentally friendly (Belasco 2006).

By looking into the past (the nut loafs of Battle Creek) as well as at other cuisines (Asian, Mediterranean), the counterculture developed a set of eating ideas and practices that mirrored standard American cuisine, but meatless. In the mid-twentieth century, most Americans' assumptions about a proper meal (vegetarian and omnivore alike) still conformed to the 'A + 2b' structure: an unspoken assumption that 'dinner' conformed to a meal grammar of 'A' being a large portion of animal flesh at the centre of the plate, and '2b' being smaller portions of usually one green or orange vegetable (peas, carrots) and one starchy vegetable or grain (potatoes, rice) (Douglas 1972; Bentley 1998). Counterculture vegetarians wanted to eat differently, but aside from some soups, stews, and pasta dishes, had not had a great deal of experience with non-A+2b types of meal structures. Thus, early vegetarian cookbooks featured some non-Western recipes which followed a core (starch)-fringe (sauces/meat as flavouring agent)-legume (beans, peas) culinary grammar (CFL). It was difficult to venture much beyond A+2b, however, as Americans were simply not used to other types of meal formation. While there were vegetarian chili recipes, for example, many early meatless recipes (e.g. walnut and cottage cheese casserole or baked tofu) mimicked the large portion of meat at the centre of the plate. While meat was the main concern, counterculture vegetarians also experimented with non-animal-based milks, including soy, coconut, and nut milks (Lappe 1971; Katzen 1974).

In the late twentieth century, creative entrepreneurs began to create and manufacture plant-based meat products, most of which were chopped meat patties and sausages that could easily mimic the real thing. Manufactured plant-based meat products first came on the market in the 1970s, including Garden Burger, Boca Burger, and the British VegeBurger, a dry mixture to which consumers could add liquid and create a patty at home (Smith 2014; Prichep 2017; Watrous 2018). Tofurkey, the tofu and seitan mixture formed into a turkey shape popular at American Thanksgivings, came on the market in the late 1990s though the founder, Seth Tibbot, had been creating plant-based meat products under the name Turtle Island Foods for a couple of decades prior to that (Kauffman 2017). Boca Burgers, Tofurkey, tofu hot dogs, and other commercially prepared items were marketed mainly to vegetarians and sold in health food stores and coops. Not actively promoted to the broader population, it was thought that mainstream American omnivores would not be interested in these products—why would they, the thinking went, when they could get the more flavourful (the vegetarian meat substitutes were not necessarily valued for their taste), more familiar animal protein products they knew, loved and felt little reason to avoid.

A growing number of people in the United States and other Western countries, who would not necessarily call themselves vegetarians, were however interested in consuming more fruits and vegetables, largely for health reasons. Late twentieth-century scientific studies had begun to question the healthfulness of meat in large quantities. Restaurants and food businesses began to cater to this growing trend, evidenced in the rise of self-serve salad bars in restaurants. As Belasco points out, companies eventually co-opted these counterculture plant-based meat and dairy substitutes. Marketers, picking up on the health-halo auras of some counterculture foods, created similar products but more directly catering to mainstream American tastes: heavily sweetened yoghurts, sugary granola cereals, and salty, cheese-laden frozen 'ethnic' meals that could quickly be reheated in a microwave. The popularity of these foods grew as Americans became more comfortable and familiar with non-A + 2b meal configurations from non-Western cuisines, especially Asia (Belasco 2006).

## Alt-Meat and Dairy: Novel Plant Product Substitutes of the Twenty-First Century

By the twenty-first century a confluence of push and pull factors—incontrovertible evidence of human-generated climate change, intensified concern for animal welfare, as well as a huge infusion of investment capital—led to a new generation of commercialized plant-based substitutes (Zimberoff 2021; Kennedy 2023). The rapidly proliferating, dizzying array of plant-based—and increasingly cell-based—substitutes for conventional meat and dairy products were marketed now to the general population, who were on average more aware of the environmental and health costs of meat consumption (Wurgaft 2019; Guthman and Biltekoff 2021). A plant-based burger so reminiscent of the real thing that it could 'bleed', for example, could help reduce one's meat consumption without necessarily giving up the pleasures, rituals, and tastes of a hamburger. They were also attractive to Silicon Valley investment bankers, many of whom were vegetarian or vegan, and whose worldview deemed technology the ultimate problem solver as well as profit generator. At present, as the novelty of these meat and dairy substitutes may have reached a plateau, the ultimate successes and failures remain to be seen. Olestra, an earlier industrially manufactured, plant-based, and calorie-free fat, decidedly failed with consumers (Rossen, 2023). Furthermore, while there is no doubt that these meat and dairy alternative products are more friendly to animals, it remains to be seen how nutritionally and environmentally advantageous they can be over animal products. There are also ethical questions to be reckoned with. What are the moral implications, for example, of wealthier developed nations aiming to set the agenda or send down virtuous proclamations about animal consumption to developing nations that wish to increase their meat consumption, or maintain long-held cultural food habits involving animal meat and dairy? How do hierarchies of power, wealth and privilege affect these dynamics?

These questions aside, there are other reasons beyond those discussed here, for which foods that act like other foods have been developed and become integrated into culinary cultures, including deprivation, creativity and artifice. Hunger has always driven humans to create edible stand-ins for beloved foods and dishes, as is evident, for example, in the Cuban dish *bistec de toronja*, thought to have originated in the so-called 'Special Period' of the 1990s, a time of substantial food and fuel shortages. Cubans would bread and fry grapefruit pith, the white spongy substance between the fruit and the outside peel. With its resulting taste and texture reminiscent of fried chicken or breaded beefsteak, the dish has since remained in Cuban foodways (Ferran 2017). Furthermore, chefs throughout history as well as in the current period have employed playfulness and creativity in dishes, disguising foods as other foods to entertain and perhaps gently tease their guests. The ancient Roman elite with such recipes as 'patina of anchovy without anchovies', as well as dishes of the twenty-first century's modernist cuisine, such as a tiny bagel and lox made of ice cream, are humorous displays of skill (Apicius, 2006; DuFresne 2017). Creativity and artifice are also on full display, for example, when cake is employed in *trompe l'oeil* object deception. A recent internet sensation (and US spin-off show, *Is it Cake?)* plays tricks on viewers, who think they are seeing a human arm, or a boot, for example, that turns out to be a cake when cut with a knife. The inanimate (or in the case of a human arm, animate) object is always cake, an arguably 'frivolous' or luxury food, but the overall effect is both unsettling and humorous (Cao 2022).

## Conclusion

This admittedly incomplete exploration of the history of plant-based meat and dairy alternative products focuses mainly on societies with robust existing meat and dairy consumption habits. As mentioned earlier, perhaps this is not a coincidence but a catalyst. Societies with meat and dairy as central fixtures in cuisine are likely to sense an acute absence and deficiency when animal products are restricted for whatever reason, be it religious, ethical, or health-related.

There have always been, of course, societies, regions, and cultures which do not feature meat and dairy prominently in their cuisines. Those relying more heavily on legumes and grains for primary sources of protein perhaps have had a different experience or trajectory with plant-based meat and dairy alternatives. If a cuisine has long-produced nutritious, delicious and culturally satisfying food without a heavy reliance on animal

proteins, perhaps there was no need to develop any substitutes, at least not until animal proteins became a fixture of modern cuisine transformation. Not being necessary to begin with, perhaps they might not appear at all.

But in heavy meat- and dairy-consuming cultures, both historically and today, non-animal eaters likely welcomed substitute products as alternatives to the real thing, though not necessarily for flavour, texture, or even nutrition reasons. Perhaps a main importance and function has been to make cuisine and commensality 'whole' again, to be able to eat with others eating meat, for example, without targeted comment or feelings of differentness, of estrangement. Such plant-based meat and dairy products, especially if granted an aura of modernity, as in the case of many industrially-processed products, have made eating together, one of the most important social activities, feel more culturally possible and socially comfortable. As mentioned in the introduction, it would be interesting to explore in more depth whether cuisines less reliant on animal products experienced any necessity or pressure (political, religious, or economic) to turn to plant-derived meat and dairy substitutes.

Finally, a paradox exists in that while there is growing percentage of the population interested in avoiding eating animal products, there is also a growing number of people, often but not exclusively in developing economies, who seek to increase their consumption of animal products. Religion will remain a factor driving food taboos, contributing to the use of plant-based protein alternatives. A greater factor driving the development of novel foods, however, will be the continued stresses on the earth's capacity to feed itself justly and sustainably. A foray into the past can help illuminate the motives and values for these products today.

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# Food Innovations for Sustenance and Sustainability across Asia

Paper first received: 31 August 2024; Accepted: 29 September 2024; Published in final form: 31 October 2024
https://doi.org/

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## Abstract

The development of novel foods in Asian contexts reflect distinct approaches to alternative proteins beyond North American and European contexts. While proponents in the Global North emphasize the significance of animal welfare and climate issues for the development of alternative proteins, by contrast, the openness to novel foods and innovative proteins across Asia engage values that consider food and health as central to the adoption of new food sources. Daily practices of eating, especially consuming foods for health, reflect long held cultural beliefs about functional foods and care. Such practices have deepened in significance throughout pandemics in addition to facing dual concerns for food safety and food security. This article examines how the introduction of novel foods, especially alternative proteins such as cultivated meats, are framed by ongoing concerns for sustenance and food security in changing food systems in the region. Moreover, beyond replicating dominant protein sources that reflect conventional agricultural animal proteins such as beef, chicken, and pork, alternative protein research and cultivated meat innovation in this region also explore aquaculture, algae, insect protein, and rice-meat hybrid platforms. Such technological innovations in recent years offer important opportunities to examine potential food futures.

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**ACKNOWLEDGEMENTS**

I am most grateful for the American University of Rome Food Studies Team who hosted the incredible Novel Foods conference in 2023 and significant work to edit this special journal issue.

## Introduction

Novel food development in this present decade of the 2020's has expanded from plant based proteins readily available in markets to the exploration of cultivated meats across regional hubs for research and production. This article examines how novel foods, specifically alternative proteins, are being assembled beyond North America and Europe in Asian contexts especially amidst growing concerns of food security related to climate change and global food chain disruptions. Novel foods may be understood to be framed by newly approved ingredients or processing as well as on shifting social norms and foodways. The cost of innovative foods and consumer willingness to try new formations of functional foods and alternative proteins are also key to the adoption of novel foods. In these contexts of transforming food systems from industrial agricultural production based on plants, animals, and land, this article asks how might alternative proteins promoted as a solution to impending food security and "good for the environment" be reframed also as "good to eat" for discerning consumers in diverse Asian contexts? While discourses about alternative proteins from the Global North have emphasized the significance of animal welfare and climate issues, food innovation across Asia have focused on food and health issues especially in securing enough food as well as creating novel foods as reliable platforms for enhanced nutrition. Another difference from the Global North entails creating alternative proteins from aquaculture and edible insects that are already part of foodways in this region rather than beef, chicken, or pork.

The category of novel foods has been engaged by multiple global regulatory agencies since the policy (EC number 258/97) was released in 1997. The term was initially defined by the European Union (E.U.) Novel Food Regulation Council as any foods or ingredients not consumed primarily by humans in the E.U. prior to May 15, 1997 (Bragazzi et.al. 2017). Such legislation was introduced to address food safety concerns concerning the introduction of genetically modified organisms (GMOs) into foodways. Beyond the E.U., other nations have also considered this category as a regulatory framework to assess chemicals, technologies, and processes in food production for overall safety and nutritional quality (Hendrich 2016). The category of Novel Foods continues to grow especially with increased funding to develop alternative proteins in recent years. Moreover, a certain subset consists of foods or ingredients with a long history of consumption beyond the EU especially in Asian foodways which are submitted for recognition and introduction to markets. What may be considered as novel in the E.U. context might well have been consumed elsewhere long before 1997. Novel foods regulatory structures across Asia utilize the E.U. category as well as local contexts of governance that navigate food safety issues with regional food security concerns.

Earlier analyses of alternative proteins by food geographers, social scientists, and science, technology studies (STS) scholars have focused on start-up food companies based in Silicon Valley (Sexton 2020, Guthman & Fairbairn 2024). The convergence of venture capital investments and novel food researchers facilitated the development of plant based meat substitutes and "post animal" cultivated meats using cell lines that bypass growing whole animals for such production (Jonsson et.al. 2019). In the process of making alternative proteins, the focus of producers and investors in these spaces, according to these authors pursued the entrepreneurial ethos of "disruption" and "dematerialization" whereby novel foods would be created without the need for extensive agricultural dependence on land or farm animals to produce nutritional products for human consumption (Guthman and Biltekoff 2021). Moreover, such efforts promised to create novel foods by "upcycling" former waste products from other industrial processes to create a new "protein economy" (Landecker 2019: 536). This article builds upon the extensive work of these scholars by shifting the nutrient gaze towards novel food producers in Asia. Public policy entities and food industries across the Asia Pacific region have been engaged in addressing the dual issues of food safety and food security. In this region with the world's largest number of inhabitants, ensuring enough food has been a significant task while also dealing with the emergence of fake goods especially food processed with unsafe materials throughout the 2000's (Yan 2012). Over the past decade, namely 2013-2023, the exploration of new food sources primarily focused on products that emphasize functional health claims for Asian consumers. In what follows, I first address the role

of functional foods in this region followed by the turn to alternative proteins and cultivated meats.

Asian cuisines and eating cultures are extensive with long histories of recipes reflecting local contexts and flavors. Regional foodways include a broad range of functional foods and beverages based on long standing consumer interest in healthy lifestyles with accompanying wellness and supplemental products. In recent decades, growing middle classes throughout Asia with more income than prior generations have experienced transformed dietary patterns as globalized food systems and transportation facilitated access to more food varieties. Two countries in this region, China and India, each have over 1.4 billion in population with growing numbers of aspiring middle class consumers. The impact of changing affluence across Asia has also increased protein consumption such that global intake of protein has risen. Overall dietary patterns have expanded to include more processed food products with snacks, fast foods, and prepared foods across Asia. In addition to rising rates of diabetes, obesity, and other chronic disorders, food systems of this region face significant changing climates that further impact food scarcity. In contexts of growing consumption, yet declining landscapes and natural resources with climate disasters that lower yields of grain or protein, policy makers, research institutes, and even food industry stakeholders have considered the impact of food security as a leading global concern to spark the development of new foods to sustain populations (World Bank 2024). When major cities throughout the Asia Pacific region followed COVID-19 public health protocols with stay at home lockdowns or limited outdoor activities in public spaces, urban dwellers turned to indoor activities that included remote work, parenting, exercise, virtual gaming, and other leisure activities. Food became a common focus for mainstream media as well as social media as these platforms swelled with recipes or stories of limited food access. Creativity with food preparation reflects longstanding cultural practices of eating manifold foods in a variegated region with distinctive food sources, tastes, and preferences. While the Asia Pacific region is incredibly diverse with distinguished national and local cuisines, historic regional trade routes, distinctive foodways, and discerning eaters, it is also an area where vulnerable communities face widening food insecurity and experiences of hunger. Nearly two thirds - 60% - of the world's population resides in this vast region that spans the Asian continent as well as island nations across the Pacific (UNDP 2023).

The significance of food access during the global pandemic of 2020 was elevated around the world when food supply chains were disrupted with limited transport systems as well as labor shortages. The World Food Programme (WFP) documented these impacts for deepening vulnerability especially in South and South-East Asian contexts as a result of interwoven climate disasters, food supply chain disruptions, increased food prices, and income loss (WFP 2022). Food insecurity throughout the Asia Pacific region deepened during the global pandemic especially for vulnerable households, smallholder farmers, and informal workers (Kim et. al. 2020). The scarcity of certain foods was aggravated by supply chain disruptions, growing populations, conflicts, fiscal uncertainty, and increasing impacts of climate change which altogether deepens food insecurity and rising rates of hunger. The United Nations Sustainable Development Goals (SDG) prioritized zero hunger by 2030 as a second global goal along with ending poverty as it's first goal. In Asia, the SDG goals have been significantly revised by the United Nations Development Program (UNDP) to acknowledge the "multiple global crises" which have "further derailed the Asia-Pacific region from achieving the SDGs by 2030" which even prior to the pandemic would not have reached all seventeen SDG goals until 2065 (UNDP 2023: i). These studies reflect the dire contexts for which feeding families, households, and communities remain a significant concern for policymakers and state entities as well as non-profit organizations moving forward.

The projected need to produce enough food to sustain human populations around the world animates much of the stated goals of novel foods research that is being explored by food industry start-ups, academic researchers, and state research entities often in collaboration. Alternative proteins such as soy based foods have been produced and consumed for millennia. However, much of the soy being consumed in Asia has been imported from north and south America with increased production of soy for animal feed . Recent technological innovations that encompass precision fermentation, cellular meat fabrication, biofoundries,

3D food printing, and biological manufacturing are facilitating the development of new products such as cultivated fish, pork, and beef (Liang and Lee 2022). Collectively referred to as alternative protein, these forms are explored as alternatives to meats grown from conventional animal livestock. While animal cell lines are foundational to initial production, the alternative proteins are cultivated in experimental growing environments, usually stainless steel tanks sometimes referred to as vats, that do not require industrial animal slaughter or harvesting to transform cows, chicken, or fish into beef, poultry, and seafood for human consumption. The ongoing development of novel foods are intended to modify food systems by reframing the role of conventional plants, animals, and insects in human foodways. As protein engineering technologies emerge from labs and commence scaling up for consumer markets, the acceptance of these different forms of alternative protein will rely heavily on social mediation and cultural formations of food and practices of eating.

This article draws on several sources to contextualize the role of novel foods in Asia - via the intersection of earlier ethnographic research on medicinal foods, regional food industry reports, and research literature on alternative protein production infrastructure. In what follows, I commence with addressing the broad spectrum of functional foods in everyday life in Asia through which many novel foods and formulations are introduced. Then I turn to the development of the technologies that facilitates the production of cultivated meats. We examine recent research that focus on Singapore's expansion of alternative proteins with approved cultivated meats (CM) for the general public. Singapore poses a unique case regarding the engagement of alternative proteins especially in addressing concerns about risk, cost, taste, and the ethics of these novel lab grown meats. We examine other countries in Asia that are also engaged in alternative protein, specifically cultivated meat research. The development of CM ecosystems in Asia offer insights nto the "post animal bioeconomy" (Jonsson et.al., 2019) that builds upon initial investments in CM in Silicon Valley creating new food products based on disrupting existing material relations between land, animals, agriculture (Guthman and Fairbairn 2024; Guthman and Biltekoff 2021). Beyond diverse biotechnologies that utilize plants, insects, microbes, and cells to create foods which simulate or are promoted as better than animal meat, the shift to proteins that do not rely on animals continues to promote the premise that alternatives may best feed the world's growing population (Sexton 2019).

## Functional Foods as Everyday Living and Care

Studying novel foods in Asia presents key opportunities to reflect on certain societal and technical contexts that facilitate innovations in the production of alternative proteins as well as the acceptance of new foods in response to food security concerns. While most research literature focus on the technical innovations that produce alternative proteins or sustainability issues of protein consumption, it is crucial to situate the cultural practices and social lives of eating that animate the reception of foods especially as novel foods become more widely available. Food in everyday life remains significant for affirming social relations and identities throughout Asian societies. Moreover, longstanding practices of medicinal foods continue to be engaged across generations in this region. Whether transmitted as beliefs and recipes within families or readily found on street market stands as nourishing broths, porridges, or tea, the connections between food and medicine especially food as medicine remains vibrant in this region. Rather than solely study novel foods from the lenses of food insecurity, climate change induced scarcity, or sustainability as primary incentives for the development in this region, paying close attention to cultural notions of food that reflect forms of care or preferred tastes as well as creative practices that promote innovative dishes and products may offer additional insights as to why novel foods may appeal to a wide range of ages, incomes, and diverse consumers.

Food scholars who have conducted ethnographic research in Asian societies find that cultural practices of eating and the meanings of food, especially for younger generations, are influenced by spatial locations of gathering (Yan 1997, Lozada 2004) as well as shared meanings of foods (Watson 2014). Gendered roles of food preparation and caregiving are also crucial to understanding differences in consumption (Kimura 2011).

The considerable role of social media, influencers, and marketing strategies is a global phenomenon as well as specific to Asian markets. As an ethnographer studying cultural practices of food and medicine, I visited public markets, pharmacies, supermarkets, restaurants, shopping malls, and festivals in addition to home kitchens throughout Asia for over a decade. I observed new brands of food items whether organic or biofortified on store shelves that were being promoted as "health" foods. I also visited museums that focused on the history of food, gastronomy, agriculture, and medicine. Throughout the pandemic and thereafter, I continued to trace the rise of contemporary forms of self-care, medicinal foods, and transformative foodways in the region. Contemporary practices of eating and food cultures resonate with long held beliefs about food as medicine whereby eating is considered to be integral to achieving well-being. Moreover, the preparation of foods and social eating practices reflect forms of self-care and caregiving that are crucial to the role of foods in the promotion of well-being.

Asian foodways already include a diverse range of fermented foods and drinks such as soy products, fish sauces, vegetables, yogurts, and teas. Soy based foods and beverages as well as other forms of mock meats made out of gluten have circulated in Asian foodways for centuries (Du Bois 2010; Fu 2018; Joshi and Kumar 2015). New food and beverages also abound in this region with innovative food trends and production that reflect the expansive tastes and food cultures that shape markets. Growing and aspiring middle classes embrace wellness by incorporating enhanced foods and beverages that claim to support both mind and body rather than maintaining the separation of physical and mental health. Many households participate in dietary practices that include fermented foods, probiotics, and supplements to enhance overall health. Moreover, nutritional enrichment and biofortification are key elements of industrial food practices and state policies in vulnerable areas of this region to address hidden hunger and malnutrition (Van der Straeten et. al. 2020, Ofori et.al. 2022).

While Asian consumers are known for focusing on eating for health and fitness, it is also possible to find food trends that are not considered as healthy in the region. Despite longstanding foodways that include a significant variety of plant based foods, it is easy to find markets and street stalls filled with foods high in sugars, unhealthy oils, or processed snacks. The majority of processed food products in Asian markets tend to be sweetened beverages or prepared snacks often packaged mostly aimed at younger urban consumers (Solomon 2016). Rates of obesity and diabetes in this age group over the past two decades rival other regions (Farrell et.al. 2021).

With lively presence of both healthy food trends as well as processed foods across Asia, the recent pandemic has drawn attention to the production of innovative functional foods and alternative proteins with comprehensive interest in new products by consumers across generations. Functional foods have been recognized as a category for over four decades, however, their definition and regulation vary between Asia, Europe, and the U.S. This term refers to foods or food components that have health promoting functions. Sometimes used interchangeably with the term nutraceuticals, these forms of processed food surpass earlier forms of fermented foods and probiotics due to their industrial production (Vignesh et.al. 2024, Damien et.al. 2022).

Innovative foods or beverages may emerge when chefs, celebrities, or food brands introduce new recipes or combine elements to create different approaches to food especially health foods. Sometimes, new food trends commence from consumers themselves among certain age groups. A recent practice in Asia referred to as "punk nutrition"(□□□□ pengke yangsheng in Mandarin) combines medicinal ingredients with contemporary food practices such as drinking coffee or tea at urban cafes. Originating in China in the early 2020s, a younger generation of consumers who worked extensive hours would seek out foods or beverages that infused coffee, alcohol, or energy bars with medicinal ingredients such as goji berry, ginseng, or more rare items such as donkey gelatin (Zhang 2020). While such items are not new, the combination of flavors or ingredients create distinctive items such as wolfberry lattes. Tong Ren Tang, the centuries old Chinese herbal

medicine pharmacy, now features a coffee shop that includes such medicinal items in it's beverages.1
In addition to combining old ingredients with new foods and beverages, national food research institutes in China, Japan, Korea, and Singapore have also been exploring food and energy sources which extend Asian cultural foodways beyond traditional land based domesticated animals and plants as nutrient sources.2 Aquatic based plants and organisms also reflect the above trend of finding new ways to create food items with local sources. Seaweed (also known as marine or macro algae) is readily available as a food or medicinal food ingredient in Japanese, Chinese, and Korean foodways. Chinese seaweed dishes include up to 74 species of edible algae fried or added to dishes and soups while Japanese consume seaweed mostly as cold dishes in over a fifth of meals; also Korean consumers may eat seaweed in a multitude of soups, salads, pickles, or snacks (Figueroa et. al. 2023). Beyond Asia, many processed foods may contain ingredients processed from seaweed as preservatives in the form of carrageenan or alar. While seaweeds are multicellular marine plants, microalgae are unicellular and microscopic and have been utilized as a protein source in certain foods as well as in the form of biomass produced for animal feed via precision fermentation. Current forms of microalgae are utilized as enrichment additives and supplements in addition to long established uses as stabilizing ingredients by food industry, and new fermented algae products are being developed as alternative proteins and therapeutic applications (Matos et.al. 2022; Ścieszka & Klewika 2019).

Functional foods and beverages are a vibrant category in Asian markets because of their association with health promotion and enhancing daily life. Most supermarkets, pharmacies and convenience stores stock extensive items promoting health for ready consumption. Whether for addressing daily fatigue and stress, recovering from illness, or enhancing brain function, the ways in which functional foods and supplements are embedded in everyday life across the region is informative. Longstanding cultural practices of self-care and familial or social relations may shed light on the vibrant role of functional foods in Asia. Framing novel foods especially alternative proteins as part of eating sustainably for better futures and health outcomes may transform the reception of certain food products. Simply focusing on sustainable or ethical notions of lab grown meats might not appeal to all consumers in this region especially as they consider whether a novel food is worth the cost or potential risk. However, engaging novel foods with health specific goals, biofortification, or care practices, may be key to facilitating cultures of eating innovative foods in coming decades. Framing novel foods within already established practices of eating, sharing, and caregiving may facilitate the likelihood of new protein sources becoming acceptable and consumed for more immediate satisfaction rather than solely for the sake of building better futures.

## Alternative Protein Infrastructure in Asia

On a different scale, the development of novel foods reflects specific intersections of food security, climate change, sustainability goals, and economic policies throughout Asia. As recently developed food products arrive in markets and restaurants, the contexts of research, development, and regulatory approvals that enable the production and scale up of such notable foods are crucial to understand.. Alternative nutrients especially proteins rely on specific infrastructures of bioengineering, production, and governance (Marinova & Bogueva 2022). Moreover, multiple contexts of consumption, fitness, calculations of risk, and metrics of exposure also contribute towards the uptake of these new foods.

1 https://global.chinadaily.com.cn/a/202008/05/WS5f2a144ca31083481725e52c.html accessed on September 28, 2024.
2 https://ifst.caas.cn/en/
https://www.naro.go.jp/english/laboratory/nfri/index.html
https://www.nst.re.kr/eng/contents.do?key=167
https://www.a-star.edu.sg/sifbi
accessed on September 28, 2024.

Novel foods and alternative proteins have histories of production and consumption in Asia that differ significantly from U.S. and European contexts. Biotechnological advances over the past two decades based on the reduced costs of genomic sequencing and synthesis have facilitated new industrial applications of synthetic biology and engineering biology. In addition, highly automated facilities have been developed for processing biological samples known as biofoundries, which facilitate more standardized processes but also require significant investments (Holowko et.al. 2021: 2). Such assemblages entail significant capital, space, and trained personnel (Sunder Rajan 2006). Since the early 2000's, Singapore was a global center for recent Ph.D. degree holders from leading world universities who contributed towards "cosmopolitan" biosciences especially genomics (Ong 2016). Beyond the concentration of Ph.D.s, Singapore took on a leading role in the novel food space with it's commitment to innovative research, ambitious food policy goals, and favorable regulatory frameworks that attracted alternative protein companies to create a global hub. The infrastructure of cell biology research and development in place in the early 21st century enabled protein assembly for the present nascent novel food industry.

In 2019, the Global Biofoundry Alliance was launched as a collective to share knowledge and protocols in order to build collaborative efforts in this new field.3 According to this Alliance, biofoundries are located across the Asia Pacific in China, Japan, South Korea, Australia, and Singapore. In Japan, microbial applications in fermentation are already utilized in the production of many foods that are longstanding in Japanese foodways. The role of biofoundries in precision fermentation enable the development of different compounds that are used to catalyze biological engineering and production.

The initial surge in pursuing cultivated meat initiated in labs as the latest iteration of alternative proteins has been driven predominantly by private corporations which have placed significant investments in the infrastructure and start-up companies for alternative protein. Wider global markets often look to Asian markets to study how novel food acceptance may be promoted. Singapore has devoted significant resources towards building up an ecosystem for novel food research especially as it currently imports many primary foods for consumption at home due to limited land resources for agricultural purposes (Teng et. al. 2019). The allocation of resources from primarily state funding in Singapore is notable compared to the development of alternative protein research elsewhere in Europe or North America which tend to be private capital sources. According to the Singapore Food Agency (SFA), the city state imports over 90% of it's food with less than 1% of land designated for agriculture.4 Provisions in such extenuating circumstances entail significant reliance on global food chains as well as concerns for food safety. In such a context, Singapore has become a global hub for many corporate entities that rely on industrial research, development, and testing for novel foods. According to the non-profit think tank Global Food Institute (GFI), Singapore is referred to as an "innovation testbed" with "over 200 alternative protein startups" (GFI 2023: 8). As the leading center in the early development of alternative proteins in Asia, recent products such as plant based luncheon meats are launched in Singapore and then sold as food exports to Malaysia and the Philippines. Subsequent expansion to Indonesia and Australia illustrate how localized flavors are a key strategy for growing markets in alternative proteins.

Cultivated meats (CM) has been referred to with a wide range of terms including cultured, cell based, lab grown, vat, or clean meats in the industry. The different terms may signal distinct practices of cultivation such that eventual harmonization of these terms will be a significant effort as well as indicator of the acceptance of these novel foods. The production of CM entails extraction of stem cells followed by cultivating the cells into muscle tissue referred to as cellular agriculture. Such procedures it is argued by CM´s proponents remove the need for intensive resources such as land, water, and livestock feed for the industrial production of animals, although the extensive investments in lab equipment, energy usage, and intensive processing techniques also require extensive resources. A decade after their introduction, plant based proteins simulating the taste of animal meats are now widely available and offered by global fast food chains as an option for burgers or meat

3 https://www.biofoundries.org/about accessed on January 19, 2024.

4 https://www.sfa.gov.sg/ accessed on August 1, 2024

nuggets. Lab grown meat may seem far from this current level of acceptance for plant proteins. Yet, there has been much progress in CM technology, different techniques, and food safety approvals for these alternative proteins.

In December 2020, Singapore was the first nation to approve cultivated meat for sale and consumption in the city-state. Singapore is renowned for it's diverse foods and residents who "live to eat". Whether in hawker food centers, shopping malls, or upscale restaurants, the food scene is lively and filled with distinctive flavors and spices. In a recent study of Singapore's novel foods landscapes, researchers noted that the ongoing "smart nation" focus on economic and social planning with digital technologies meant that new foods were already "linked to technology in multiple ways" (Stevens & Ruperti 2023: 6). State investments in food start-ups and high tech innovation generated immense interest not only in the development of novel foods, but also the intellectual property and data that lies behind such endeavors. In their comparison of Singaporean and U.S. cultural contexts that shape the acceptance of lab grown meats, other researchers noted the colloquial term of "kiasuism" in Singapore, a local concept of competitiveness or concern for missing out on a trend (Chong et. al. 2022: 2). By taking the lead in alternative protein by creating a research and production hub, this competitive approach how novel proteins could be brought from lab to market before other regions.

While media coverage may shape attitudes towards new foods and brands, the role of social influence might be even more persuasive in promoting acceptance of alternative proteins by consumers.. Initial studies of consumer perceptions for cultured meats with the general public and CM expert focus groups in Singapore found convergence between these groups in terms of perceived benefits of CM such as better for the environment, economy, and food security as well as concerns for impacts on human health and affordability (Ho, Ou, & Ong 2023). With the combination of advancing infrastructures for a bioeconomy as well as being the first nation to approve cultivated meats for consumption, Singapore has situated itself to be a key hub for alternative protein production to ensure food security as well as reducing demand on land based resources. While emphasis has been placed on forward thinking approaches to address concerns of future security , notions of acceptability are not solely defined by lab techniques but also by cultural and ethical framings. At present, for instance, there are debates as to whether it may be possible to certify cultivated meats as halal which have important implications for Asian markets (Ho, Zhou, & Vijayan 2013). Recent consideration by the Majlis Ugama Islam Singapura (MUIS), a government board that addresses Muslim matters, noted that if the stem cells came from halal cows, then the cultivated meats would also be considered to be halal.

Cellular agriculture may approach price parity more quickly with recent developments in the production of growth factors which account for the significant costs of production. With modified stem cells, engineered fibroblast growth factors bind to cellular receptors that then signal cells to grow or differentiate into meat (Cell 2024). The cultivation of tissue engineered meat proteins also entails assessments of large scale production, food safety governance, and overall harmonization throughout the Asia Pacific region.

In addition to biofoundries, another technology for creating CM includes three dimensional (3D) printing. This technology begins with biopsied stem cells then proliferated in vitro to create a bio-ink consisting of fat and muscle. Following computer aided design, the bio-ink is extruded from a nozzle in layers to replicate the growth of the desired meat which is then incubated until ready to be consumed. These experimental and technical innovations offer ways to reformulate CM production without extensive reliance on biofoundries which require equipment, space, and electricity to maintain.

While Singapore has been the first to approve CM for general consumption and is available in markets, other countries mostly in East Asia have also been engaged with research and development of alternative proteins especially CM as meat plant hybrids. Recent research in South Korea has proposed creating meat using rice as a scaffolding material to grow the meat rather than eggshell membranes, soy, or nut ingredients which may also have allergenic properties. Rice grain is coated with bovine cells and gelatin coating to create a new

hybrid referred to as "rice grains containing animal nutrients" (Park et.al. 2024: 1299). Such hybrid foods are envisioned as having applications in regions of food scarcity whether due to climate disasters, warfare, where food is not sufficiently available with land based agriculture. Research in China has explored multiple aspects of CM especially with regard to the industrialization required for scale up, marketing strategies to increase acceptance, and technological developments needed to cultivate meat beyond the lab (Cai et. al. 2024; Zhu & Begho 2022). Researchers emphasize the significance of food safety such that "the scientific community must come together to discuss the food safety of cultivated meat". (Cai et. al. 2024: 125) Moreover, they identify key characteristics that producers will need to address for CMs with consumers in mind which include "richer taste, more nutritious value, and a more affordable future of cultivated meat" (Cai et.al. 2024: 125). While CM technology is available throughout Asia, the continuation of research development in this space requires significant funding from public and private investors.

A recent trend in CM development has been the rise of startup companies that engage in business to business (B2B) relations especially in selling ingredients, cell lines, or manufacturing platforms across the region. Such strategies reflect differentiation along distinct stages of production to align with a growing CM value chain as the product rather than producing a final CM product for markets. According to Good Food Institute's inaugural state of the industry report in the Asia Pacific, the rise in regional startups that commenced in 2022 relied on this B2B network of start-ups that facilitated CM production for other start-ups (Morton et. al. 2024). While media coverage tends to focus on the final CM products in the forms of cultivated chicken, beef, or fish, the growing ecosystem of companies that specialize in fermentation, bioreactors, CM ingredients, growth factors, cell lines, and contract manufacturing reflect the possibilities for diverse production as well as the creation of CM supply chains in the region.

While cultivated meats tend to be promoted as the lead focus of alternative protein, another alternative protein source explored for further development is derived from insects which are already present in human food chains by way of animal feed. Edible insects appear in foodways across the Asia Pacific as well as in Latin America and Africa. (Liceaga et. al. 2022). Novel forms of insect protein produced from crickets, mealworms, and even black soldier flies have been studied for their nutritional content which is not only high in protein but also omega-3 and minerals (Wood and Tavan 2022). The acceptance, or non-acceptance, of alternative proteins depends upon both external factors such as processing or internal factors such as consumer perceptions safety or health risks. Consumer views on novel foods might range across a spectrum of affective responses such as skepticism, distrust, or disgust which may shift with the engagement of information, shared values, or acceptance of food technologies. Comparative reviews of consumer perceptions of novel food technologies suggest that while negative individual preferences are common initial responses to novel foods, the role of heuristics or engaged learning to understand unfamiliar technologies may shift to possible acceptance (Siegrist and Hartmann 2020). Addressing neophobia, or barriers to the acceptance of new foods, entails a range of possible interventions that include education, socialization, and exposure through labels, samples, and building trust (Siddiqui et.al. 2022).

Alongside barriers to acceptance of CM, the transition of cultivated meats from the lab to market in the Global North entails not only technological infrastructure but also significant work to embody "promissory narratives" that feature better food futures for animals, humans, and environment (Sexton et. al. 2019). Alternative proteins have been promoted by many new food start up companies as facilitating more clean, ethical, and sustainable forms of food production. The production of such entities rely on large inputs of electricity and other resources in order to produce relatively smaller amounts of cultivated meat. Nonetheless, the Global Food Institute notes that goals of decarbonization and addressing global warming are not possible without moving forward with alternative proteins as new food sources. The promise of better environmental futures through lowering carbon emissions is emphasized as an incentive for public sector funding and investment in cultivated meats. Even while facing similar concerns for environmental impact, CM hubs are nonetheless supported throughout Asia as the opportunity to develop new platforms for local or regional self sufficiency

in food production especially with dense populations in highly urbanized areas.

Despite the intensive concentration of capital and research on developing alternative proteins, there are few actual places where consumers may access cultivated meat to taste and experience CM worldwide. The availability of consumer ready CM commenced 2023 in Singapore with cultivated chicken containing 3% animal protein together with plant protein (Reynolds 2024). The production costs of CM remains quite high even with the "harvesting" or collection of alternative proteins from biofoundries. The Singaporean focus on innovative food technology especially with regard to CM has been mostly considered as a proof of concept for investors as well as consumer willingness to try novel foods. Such motivations may outweigh concerns for costs and incentivize the role of state involvement in producing alternative proteins in Singapore as well as other countries in East Asia.

## Cultural Framings of Cultivated Meats

The initial wave of CM foods has been aimed towards flexible eaters curious about novel foods and willing to pay more than comparable portions of conventional meat. Contexts matter in understanding behaviors. Anthropologists and food scholars have long noted the significance of food across the spectrum of sourcing, preparing, offering, sharing, or eating. Writing on meat eating and dietary paradigms over three decades ago, Nick Fiddes noted that meat, in particular, holds multiple meanings because it's value "is symbolic as well as nutritional" (Fiddes 1994: 274). The consumption of meat may reflect different frameworks of status, gender, ideology, religion, or belonging. Moreover, even if cultivated meat may be prepared to look like conventional meat, the meanings of CM may be quite different. Paying careful attention to the role of CM for sustenance or for social value may shape not only the acceptance but also the normalization of alternative proteins as part of nutritional possibilities.

A key element that distinguishes CM meat in the APAC region from European and North American counterparts is the research and development emphasis on aquaculture rather than primarily land based agricultural products. There is a vibrant network of aquaculture across Asia that goes beyond Singapore as the primary global hub. There have also been "multi-stakeholder national aquaculture technology and innovation platforms in Bangladesh, Vietnam, and Thailand" with European technology contexts transferred to Asian technology contexts of aquaculture. (Bush et. al. 2021).

Animal Protein consumption across the Asia Pacific region primarily consists of seafood (Liang and Lee 2022). Beyond cultivated beef, pork, or chicken, Asian startup firms place more emphasis on creating cellular fish, lobster, and shrimp as well as algae for scaffolding. While conventional aquaculture and fisheries have doubled production over the past decade, there are many concerns for the sustainability of this industry that include overfishing, pollution, high waste, lack of traceability, and food safety concerns (Bush et.al. 2021). Cell based aquaculture, similar to other forms of CM, suggests promissory futures of clean meat that may be pathogen free as well as reduce the impact of ocean ecosystem collapse that is widely predicted by 2050. Despite these promotional features of cellular aquaculture, there are at present limited seafood cell lines despite the immense diversity of seafood species (Goswami et.al. 2022). Another limiting factor is the cost of growing media to enable the proliferation and growth of cell cultures. According to the non-profit Good Food Institute, in 2023 for the APAC region there were over 170 companies devoted to CM and seafood development while 88 companies were active in related business realm (GFI 2023 , p.11). The growing number of firms as well as publications related to the development of CM across the Asia Pacific region reflects substantial investments on the part of both state and private entities.

Beyond aquaculture, meat consumption in China especially of pork, chicken and beef has risen since sharply the 1990s as it's economy grew and with increased imports of beef as well as animal feed (Zhu & Begho

2022). While initial media coverage has focused on Singapore as a global CM hub, how China proceeds with alternative proteins may greatly influence the rate of CM development and it's availability beyond research labs. Every five years since 1953, the People's Republic of China has released a comprehensive plan for development in its planned economy. The most recent fourteenth plan for 2021-2025 focuses on the innovation of China's agricultural system to address it's food supply and sustainability (ADB 2021). This policy is notable for its focus on innovation to improve living standards with support for alternative proteins as part of reducing carbon footprints and shifting to smart agriculture. From the private sector, the cellular agriculture startup company CellX based in Shanghai has been working to develop a hybrid CM based on plant combined with animal cells from the Chinese black pig, a local breed that has been domesticated to produce pork. The company website in English states "Eat Meat, Not Animals: Welcome to the future of animals" accompanied by short videos that move from animals grazing, to cellular cultivation tanks, to a table with dishes that feature the alternative protein.5 The development of cellular agriculture across Asia depends on a longstanding infrastructure of public funding and private investment similar to the genomic industry that grew from cellular biology research (Ong and Chen 2010).

Access to food in contexts of food insecurity will vary with the stability of food chains as well as the ability to forage or fish for sustenance in coastal regions. Policy makers across Asia acknowledge the potential of CM to meet the needs of growing populations as well as reduce carbon, create new food sources, and enhance sustainability (Liang & Lee 2022). Yet, who will have access to CM foods or want to consume these novel foods? Will it be the flexitarian, middle class, younger, urban dwellers who have been projected as the most receptive to CM foods in focus groups? Might subsistence farmers, fishing villagers, or agricultural communities be willing to forego generational practices of farming, pastoral grazing, hunting, or fishing for protein? How might the most vulnerable populations who already face extreme heat, reduced food access due to high cost or low yields, and located peripherally to larger markets be able to access CM?

Such reflections on changing diets in relation to different material conditions but also longstanding issues of access are especially important in Asia. The move to CM may also reflect both environmentally determined necessity in the context of climate change and diminishing natural resources and consumer driven choices based on cultural preferences for meat consumption. While state investment is crucial to the growth of CM industrial production, the broader context of vulnerable food supply chains remain a key concern across Asia.

## Conclusion

This article offers insights onto the recent development of novel foods in Asia with regard to several specific features. First, functional foods and the lively role of food as part of health in this region is a significant context to understand how new alternative proteins will be considered by consumers. Examining the ways in which food is not solely consumed for sustenance, but also for wellbeing and pleasure may facilitate how to create new foods that engage these cultural notions of food for health and well being and not just survival. Second, the role of CM infrastructure in this region commenced with a global hub that introduced not only lab to market pathways but also a regional ecosystem with B2B or specialized cellular agriculture companies that serve as resources for production companies with growth factors, mediums, cell lines, equipment, or technical knowledge. Finally, the diversification of cultivated meats is shaped largely by cultural preferences and available cell lines. Rather than simply reproduce seemingly generic beef, pork, chicken, or fish, it may be possible to create different CM based on unique cell lines across the Asia Pacific region.

Feeding, nourishing, and fortifying have been distinctive elements of defining national identity and state power across Asia for several centuries, if not longer. Following the care and discernment of this wide base of consumers in Asia, new protein possibilities enable researchers to assess notions of sustenance, health, and sustainability as well as possible governance structures for alternative proteins and cultivated meats. Such

5 https://cellx.co/en accessed on August 8, 2024.

novel foods offer specific insight onto how state concerns for food security and market segmentation give shape to different audiences and notions of consumption. Whether in the form of enhanced meals for toddlers, special foods for high school students, or energy foods for athletes and aging seniors, these material and semiotic interventions offer significant windows onto how notions of wellbeing are being reshaped for the majority of Asian populations. For aspiring middle class consumers, in particular, practices of wellbeing which have already led to the acceptance of nutraceuticals might be the key to the introduction of alternative proteins in many Asian contexts.

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# Inform, Invest, Incentivize: A Menu-Driven Approach to Reduce the Environmental Impact of Meat in the United States

Paper first received: 18 February 2024; Accepted: 03 August 2024; Published in final form: 12 January 2025
https://doi.org/10.48416/ijsaf.v30i2.601

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## Abstract

Human food systems, especially livestock production, contribute significantly to environmental degradation. The meat industry has an outsized political influence in the United States (US) and in other countries, which makes system-level changes, such as government policies to reduce meat production and consumption, difficult to enact. In this perspective article, we propose an all-of-society approach, outlining potential actions, not just by government but also by industry and the non-profit sector, to promote sustainable diets through reduced and less impactful meat consumption. Given current political realities in the US, we argue that government incentives such as subsidies are more likely to be implemented than disincentives such as taxes. The food industry has a role to play in developing meat alternatives, in promoting new dishes focused on plant protein foods, and in reducing the impact of current meat production. The non-profit sector can contribute research and advocacy to study and promote relevant actions. In articulating this approach, we seek to enhance dialogue between food system stakeholders and to increase actions across various sectors. To this end, we provide concrete examples of such actions, organised into three broad categories, which: (1) inform the public about the environmental impacts of foods; (2) invest in alternative meats and plant protein foods; and (3) incentivise consumers, producers, and suppliers to reduce their impact by consuming, producing, and supplying more of these alternatives. We argue that this approach of simultaneous synergistic actions could ultimately lead to broader system-level change.

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## Introduction

Human food systems contribute substantially to environmental degradation, accounting for a third of all human-caused greenhouse gas emissions (GHGE) (Crippa, 2021). The largest share of this impact comes from the production side of agriculture and includes land use and land use changes needed to support agriculture's expansion. Agricultural production is also responsible for about 70% of global freshwater withdrawals (UNESCO, 2020) and has caused serious problems of land deterioration (FAO, 2011). Within agriculture, the livestock sector has a particularly large footprint. GHGE associated with the meat and dairy sector account for 14.5% of global emissions (Gerber et al., 2013). A more recent analysis found that meat and dairy will be responsible for about 60% of food system impacts on global warming through 2030 (Ivanovich, 2023).

The importance of reducing the environmental impact of meat production by reducing its consumption has been articulated in several studies and international reports (Dumas et al., 2022; Breewood and Garnett, 2023). The EAT-Lancet Commission report has developed dietary guidelines to support health and sustainability, which emphasise plant protein consumption and include meat consumption targets that are much lower than current levels in high-income countries (Willett et al., 2019). In its mitigation of climate change report, the United Nations Intergovernmental Panel on Climate Change (IPCC) called for an increased share of plant-based protein sources as a dietary shift that could help mitigate food system emissions (IPCC, 2019). Reducing food system emissions is essential for achieving our climate targets, and a key aspect of this is adopting a plant-rich diet to reduce meat and dairy consumption (Hedenus et al., 2014; Clark et al., 2020; Agyemang, 2022). Much of the discussion surrounding reduction in meat consumption has focused on beef, since its impact on emissions is eight to ten times that of chicken and other meats from non-ruminant animals (Heller et al., 2018; Poore and Nemecek, 2018).

The United States (US) is the world's largest beef producer (Brower, 2022; Cook, 2023); in 2023 it produced 27 billion pounds of commercial beef (USDA ERS, 2024), an average of 58 pounds of beef consumed per capita. Of the total produced, 3 billion pounds were exported and valued at 9.3 billion US dollars (USDA ERS, 2024). The 'cattle-beef' complex, that supports this production, has developed in the US over the past 150 years and has been shaped by technological innovations such as railroads and refrigeration, as well as by capital investments and government policies (Specht, 2019). Throughout this time, industry influence in policymaking has strengthened, supported by a consumer base that prizes inexpensive beef. This has resulted in a policy bottleneck in which potentially effective sustainable dietary policies to reduce beef's footprint are politically unpopular and difficult to enact in the US and elsewhere (Dutkiewicz, 2021).

This paper outlines an approach that supports the reduction of meat production and its impact in the US with four defining characteristics. First, the approach encompasses diverse solutions to reduce meat's current impact, by reducing both its consumption and the impact of what gets consumed. This is achieved either by replacing meat with plant-based alternatives or lower-impact meats, or by reimagining consumer meals. Second, it focuses government policy on incentives, like subsidies, rather than disincentives, like taxes. Third, it is an all-of-society approach involving not just government, but also the food industry (including meat suppliers), the non-profit sector, and consumers. Fourth, it deliberately seeks to promote synergies and positive feedback loops between these actors, to accelerate transformation. In articulating this approach, we seek to enhance dialogue between food system stakeholders and to increase actions by those in local, state, and federal governments, the food industry, non-profit organisations, advocacy groups, and research centres. To promote this dialogue we provide examples throughout the paper of existing policies and actions consistent with this approach. We refer to this as a menu-driven approach because of the diversity of actions that can be taken by different food system actors and because the optimum choice of such actions will vary, depending on their specific political, cultural, and economic context. The following sections describe each of the components of this approach.

## Reduce, Replace, Re-imagine: Consumer Actions to Reduce Impacts

Consumers, through their purchase behaviours, can send signals back up the supply chain, and upstream actors, including retailers, distributers, manufacturers, and producers, can respond by modifying production and distribution behaviours to meet consumer demand (IOM, 2015). What can consumers do to reduce the overall impact of their food choices on greenhouse gas emissions? Meat is the largest share of this dietary carbon footprint (Heller et al., 2018), so it is an obvious place to begin.

Eating less meat can be a relatively easy way to lower impact because it does not require giving it up entirely. Reduction can refer to either the frequency or the amount consumed. Meatless Mondays were developed with the former in mind (The Monday Campaigns, 2003) and have been studied more recently in various contexts (Sheldon, 2021; Rayala, 2022). On any given day, meat, particularly beef, is the most environmentally impactful item that Americans consume (Rose et al., 2022). Reducing the amount consumed would clearly reduce their overall dietary carbon footprint, as evidenced in simulated substitutions in which reducing the meat consumed per day by one quarter resulted in an average decrease in dietary footprint of 12% (Willits-Smith et al., 2020).

Assuming individuals are at a steady state in their diets with respect to energy intake, reducing the consumption of specific foods will be accomplished by replacing them with something else. In the above example, the reduction of meat was achieved by substitution with plant-based protein foods of the same energy value. Rose, Grummons, and colleagues (2022, 2023) have studied single-item substitutions – replacing just one item in one meal a day – and found that the replacement of beef with poultry resulted in an average decrease in the dietary carbon footprint among US consumers of about 50%. Substituting with plant-based protein foods would result in a larger decrease, while at the same time reducing other environmental impacts and addressing concerns about animal welfare. Alternative meats, such as those developed by Beyond Meat and Impossible Foods, are examples of other foods that can replace currently consumed meats (Capritto, 2019).

These calculations, as well as the rest of our discussion around consumer changes, are based on the idea of substitution with nutritionally similar foods. According to the Dietary Guidelines for Americans, the 'protein foods' group includes beef, pork, other meats, poultry, eggs, fish, as well as plant proteins such as dried beans and peas, nuts, and seeds (USDA & DHHS, 2020). Thus, we argue for substitutions that reduce environmental impacts by consuming less beef, but that preserve the basic nutritional quality of the diet by selections from the same nutritional food group. The studies cited above simulated these types of substitution and showed that diet quality actually improved with substitutions for beef (Rose, 2022; Grummons, 2023).

A key aspect of reducing meat intake is shifting cultural norms about the concept of a meal. The traditional US steak and potatoes dinner could be reimagined as a much more interesting mixed-dish plate, in which meats are used in sauces that complement the flavours of a vegetable dish (FoodPrint, 2023). There are rich culinary traditions throughout the world that provide such examples, many of which are already employed in the US (Rogers, 2020; Tekiner, 2021). These traditions can also be used to promote plant-based main dishes that are not meat analogues, but are hearty, flavourful, and nutritious dishes in their own right.

It is likely that some consumers will continue to eat beef, regardless of which health, environmental, or animal welfare reason is raised. This is because changing consumer behaviour is very difficult. Although not related to dietary behaviours, this difficulty has been well-documented in the tobacco control literature where even after 60 years of anti-smoking campaigns – from information, persuasion, and changing social norms to taxes and anti-smoking ordinances – state-level adult smoking rates still range from 8-24% in the US (World Population Review, 2023). Acknowledging this, it would be wise to focus on reducing the impact of beef production. For example, intensification in the US beef industry has reduced its carbon footprint since the 1970s due to improvements in productivity and efficiency (Capper, 2011), and certainly additional strides can be made (Hyland et al., 2017). However, intensification is problematic, in part because of the overall increase

in production, but also for both health and animal welfare concerns (Bernstein and Dutkiewicz, 2021). Given that it produces cheaper beef, intensification is likely to increase rather than decrease its consumption. Trewern and colleagues (2022) have studied a 'less and better meat' approach to reduce consumption, through regenerative agricultural production of higher quality and less environmentally impactful beef. This niche approach, and pathways to promote it, will be important going forward.

Throughout the above section we have discussed changes that individual consumers can make. We began our approach with individuals because many people are frustrated with the slow pace of government action on climate change and want to take action themselves; changing eating patterns is a personal and direct type of action. However, individuals do not operate in isolation. They are part of a social structure that influences their behaviour, as do elements of larger economic and political systems, including economic agents, such as corporations, and government policies, which we discuss next.

## Government Policies to Inform, Invest, Incentivise: Carrot vs. Stick

Can government policy influence food system actors, such as consumers, discussed in the previous section? In 2007, the Nuffield Council on Bioethics published a seminal report on government policy interventions to promote public health (Nuffield, 2007). The report outlined policies and interventions that can affect people's choices on a continuum of least to most intrusive. For example, providing information to consumers is not very intrusive, whereas eliminating choice is the most intrusive.

In the US, resistance to government intervention is often a rallying cry for those who oppose interventions in the field of public health. This has been seen in issues as diverse as efforts to reduce obesity (Véliz et al., 2019), the ban on trans fats (Resnik, 2010), and mask-wearing regulations (Bazzi et al., 2021). Anti-government advocates are particularly bothered by actions that seek to guide consumers using disincentives (e.g. taxes), restrictions, or elimination of choices; in other words, the extreme end of the Nuffield continuum of policies. Given this resistance and the polarising national political climate in the US, these types of policy are not likely to be implemented at the federal level (Dutkiewicz, 2021). This is particularly the case for restrictions on meat, which has been termed the third rail of American climate politics and which has provoked strong responses from conservative media, activists, and lawmakers, even when such restrictions are not being contemplated (Atkin, 2019; Smith, 2021; Cunningham, 2022).

Accordingly, in this paper we focus on positive incentives, such as provision of information or subsidies, which are more realistic for implementation in the current US political climate. We organise potential interventions using the metaphor of a menu, and we include actions across several sectors, consolidated into three broad categories: inform, invest, and incentivise. We use incentivise in the broadest sense of the word, that is, to encourage, lead or make someone want to do something. See Table 1 for generic examples of such actions. Recognising the importance of the earlier framing of government policy interventions in the field of public health, we also provide a crosswalk between our menu topics and the policy continuum of the Nuffield group, as well as others (see Supplementary Table 1 at the end of our paper).

Specific examples of government policies to reduce the impact of meat using our typology of inform-invest-incentivise are given in Table 2 or are mentioned in the text below. Governments can inform individuals about the environmental impacts of different food items through dietary guidance and food labelling. For example, the Netherlands included sustainability in their government dietary guidelines, a publication that describes the health benefits of food choices (Brink, 2019). Similar work has been or could be undertaken in many countries (Rose, 2019). Food labelling on environmental impacts is another way to inform consumers, and governments could provide guidance to industry. An example of local government action is New York City (NYC), which partnered with the American College of Lifestyle Medicine to roll out the largest lifestyle medicine training

in the world, aiming to educate up to 200,000 NYC healthcare practitioners in six pillars of lifestyle health, including in plant-based eating patterns (City of New York, 2022).

*Table 1. Generic menu examples to accelerate the transition to lower meat consumption and lower impacts, by type of intervention*

| Type of intervention | Example Actions | Actors and Instruments |
|---|---|---|
| Inform | Include sustainability in DGA | Government publications |
| | Food labelling | Industry actions and government regulations |
| | Menu labelling | |
| | Information campaigns, including new recipes | Government, industry, non-profits |
| Invest | Alternative plant-based meat development | Increased R&D funding from government, industry |
| | Lab-cultivated meats | |
| | Reduced carbon beef | |
| | Plant-protein farming | |
| Incentivise | Increase availability of plant-protein alternatives | Government subsidies, institutional food services, including schools, universities, hospitals, prisons, and the governing bodies that regulate these services |
| | Develop tastier alternative protein recipes | |
| | Make alternative proteins the default | |
| | Provide discounts for plant-based choices | |
| | Transition to Meatless Mondays | |

*Table 2. Examples of policies for governments*

| Type of intervention | Federal | State | Local |
|---|---|---|---|
| **Inform** | Canada's 2018 Dietary Guidelines for Health Professionals and Policy Makers advocates for increased consumption of plant-based protein (Government of Canada, 2019-b) | California free webinar for school food service staff on topic of plant-based menu planning (CDE, 2018) | NYC practitioner lifestyle training on topics such as plant-based eating (City of New York, 2022) |
| **Invest** | Canadian government invests $153M in plant-based protein supercluster (Government of Canada, 2019-a) | California invests $5 million in alternative protein research at three state universities (Budget Act of 2022, 2021) | Pittsburgh Public Schools passed the Good Food Purchasing Policy, a local procurement model that supports environmental sustainability (GFPP, n.d.) |
| **Incentivise** | US House passed a bill requiring the US navy to pilot a program for offering plant-based protein options at bases for Navy members (National Defense Authorization Act, 2022)<br><br>USDA GusNIP and Produce Rx program to provide matching funds for additional fruit and vegetable purchases (Nutrition Incentive Hub, n.d.) | AR Grown Grant pilot program for farmers to produce more F&V (Arkansas Department of Agriculture, 2022) | NYC Plant Powered Fridays in schools make plant-based meal default choice (NYC DOE, 2023)<br><br>DC's Healthy Students Amendment Act of 2018 encourages plant-based meals (DC Law Library, 2019) |

Governments can invest in research, development, and/or support for the mass production and distribution of meat alternatives (Smith et al., 2021). For example, the Canadian government invested $153 million in a plant-based protein supercluster, an initiative to connect companies, non-profits, and academic institutions to bolster the development of plant-based products (Government of Canada, 2019a). In the US, a bill called the Peas, Legumes, and Nuts Today (PLANT) Act was introduced in July 2023 in Congress to support farmers, food companies, and research focused on plant-based food production (McGovern, 2023). The bill was initially referred to the House Committee on Agriculture and a year later has yet to be considered (PLANT Act, 2023). Additional investment in plant protein foods could lead to better and less expensive food products and ultimately, over the long term, influence consumer demand.

Governments can also incentivise, promoting meat alternatives directly by ensuring their availability at government facilities, as in the US Navy's pilot programme to offer plant-based protein options at forward operating bases (National Defense Authorization Act, 2022). In the State of California, legislation to ensure the availability of plant-based meal options was passed in 2018, requiring all state institutions, including hospitals and prisons, to offer at least one plant-based option per served meal (California State Senate, 2018). Beyond just ensuring availability, governments can further promote a shift to plant-based foods with subsidies. For example, in the US, the Gus Schumacher Nutrition Incentive Program (GusNIP) provides grants to local organisations that aim to increase fruit and vegetable purchases by low-income consumers, by providing additional funding for this (Nutrition Incentive Hub, n.d.). Although this has not been oriented around plant-based protein foods, or alternative meats, it certainly could be. In addition to incentivising consumption of plant protein foods, government can incentivise their production. The PLANT Act, mentioned above, seeks to invest in research and development of such products, but also to incentivise their production through loans and grants (PLANT Act, 2023).

The above section has described examples of government policies that might influence food system actors. However, the social, economic, and political forces that influence which policies get implemented is crucially important. Corporate actors have used political influence, for example through lobbying, to promote their goals (Mialon et al., 2015). In addition to political polarisation and the general dysfunction of the US Congress, agricultural committees are often dominated by legislators that come from rural and conservative states. The interaction of political conservativism with industry influence has contributed to the dominance of animal food policies in major farm legislation in the US (Sewell, 2020). At a state level, this can be seen in a spate of recently introduced bills that ban the production and/or sale of cell-cultured meat (Mattox, 2024), all with the intent of protecting livestock sales. Thus, reducing subsidies to animal agriculture, let alone taxing their production, will be difficult (Vallone and Lambin, 2023). In this environment, increases in subsidies to plant-based foods are more likely to be accepted. This is the hope for the PLANT Act, yet it has not moved since its introduction, likely because of the conservative-controlled US House of Representatives.

## An Approach for All of Society's Sectors

Food system change requires much more than government action, which is why we, like other proponents of a transformation, propose an all-of-society approach (Rust et al., 2020; Dutkiewicz 2021; Espinosa-Marròn et al., 2022). Food companies are already innovating in the alternative meat space, both in plant-based options such as Beyond Meat or Impossible Meat, (Beyond Meat, 2023; Impossible Foods, Inc., 2023), and in cell-cultured, or lab-grown, meat (Upside Foods, 2023; Aleph Farms, 2021). These actions can be reinforced by other supply chain actors, such as restaurants or retailers that promote these products (Table 3), and supported by government actions as mentioned above.

*Table 3. Examples of actions for industry*

| Type of intervention | Trad Meat Producer | Alt Meat Producer | Restaurant / Cafeteria | Grocery |
|---|---|---|---|---|
| **Inform** | Voluntary restriction of advertisements aimed at children | Beyond Meat sustainability course for students (Beyond Meat, 2020) | Just Salad puts 'carbon labels' on menus to indicate carbon footprint of each meal (Just Salad, 2022) | Lucky Supermarket's 'Fall in Love with Plant Based' education campaign (PBFA, 2018) |
| **Invest** | Tyson Foods Launches Plant-Based Meat (Raised & Rooted, 2022)<br><br>Elmhurst Dairy (now Elmhurst Milked) completely transitioned from cow- to plant-based milks (Elmhurst, 2023) | Beyond Meat partners with restaurant chains to increase plant-based supply (Reinicke, 2019) | Foss dining hall at Colby College sources locally to increase vegan and vegetarian food options (Colby College, n.d.) | Kroger supermarket announces new Simple Truth plant-based protein line (The Kroger Co. 2020) |
| **Incentivise** | Tyson Foods offers $15/case rebate on plant-based pepperoni (Tyson Foods, 2022) | Impossible announced cutting suggested prices by 20% for grocery stores and supermarkets to get closer to their goal of price parity with beef (Woodside, 2021) | Hong Kong's Pay-A-Vegan app gives a $1 coupon per vegan meal for use at participating restaurants (PayVegan Hong Kong Limited, 2021) | NYC Fine Fare independent grocery store "Get the Good Stuff" SNAP incentive program (WGB, 2019) |

Going forward, it will be important to monitor the impacts of alternative proteins, especially lab-grown meats, as some have argued that they require similar energy consumption as does traditional meat production (Guthman & Biltekoff, 2020). This technology is relatively new, so there is potential for the alternative protein sector to improve their practices as investment and demand grow. A lifecycle assessment published by the Good Food Institute (2021) foresees that by 2030, if clean energy is used, cultivated meat would have a 92% lower footprint than traditional beef.

Restaurants and cafeterias can inform consumers through eco-labelling of menu items. A randomised control trial in the US studied the consumer decision-making effect of green low-climate impact labels on menu items compared to red high-climate impact labels on red meat items. Results showed that both labels encouraged the purchase of sustainable menu items more than the control group (Wolfson et al., 2022). Eco-labelling can be seen in practice with Just Salad, the first restaurant chain that utilises 'carbon labels' on their menus to indicate the estimated carbon footprint of each meal (Just Salad, 2022). Grocery stores can also increase consumption of plant-based products through information. Lucky, a retail grocery store chain in Northern California, launched an in-store campaign to inform shoppers of the numerous plant-based options in the grocery store (PBFA, 2018).

Not only is investing in plant-based meat alternatives commonplace, it is also happening among traditional meat and dairy producers. For example, Tyson Foods started its own plant-based chicken, sausage and burgers brand called Raised & Rooted, which can be purchased in select grocery stores throughout the country (Raised & Rooted, 2022). In response to consumer demand for health-conscious and sustainably produced proteins, another of the largest US agri-food companies, Cargill, created its own plant-based brand of alternative meats

called Crave House, producing burgers, grounds, crumbles, sausages and meatballs (Cargill, 2021). While this is a step toward more alternative protein production, the involvement of such large corporations could lead to significant harm across the food system, including potential negative impacts on small-scale farmers and producers, reduced competition, and limited consumer choices (Howard, 2021). However, assuming anti-trust laws are enforced and the plant-based movement continues to grow, meat producers of various sizes can remain competitive in the alternative protein market. Government investment in research and development, as well as in procurement at government facilities, as mentioned in the previous section, can help facilitate this process. Forward thinking meat producers also have a role to play by investing in technologies to reduce meat's current environmental footprint, particularly for beef (Hyland et al., 2017; EPA, 2018; Trewern et al., 2022).

Incentivising consumption of meat alternatives would further increase activity in this area. For example, Impossible Foods announced a 20% price drop on their products in grocery stores across the nation (Woodside, 2021). The company's goal is to reach parity with conventional beef products and eventually to become more affordable than conventional beef. While the prices of alternative protein foods are still higher than traditional meat products, this price cut paves the way for greater access to alternative meat options.

The non-profit and philanthropic sectors also have a role to play in this movement (Table 4). Information campaigns from the non-profit sector about the environmental and health benefits of alternatives to meat can help promote public demand. For example, an advocacy coalition associated with the UN Sustainable Development Goal to end hunger, launched the 'Beans is How' campaign to inform consumers about various nutritious, affordable, and climate friendly beans (Beans is How, 2022). To increase the availability of alternative meats and dairy foods, several philanthropists and business executives invested in the Nature's Fynd startup, which plans to use fungi as the primary ingredient in their products (Woods, 2021). Researchers also have a role to play in these activities; a field experiment in the Netherlands tested whether menus with plant-based products as the default option increased purchase of those items compared to traditional meat options, which were also available on the menus. Making the alternative protein meals the default option successfully nudged more consumers to choose that option (Taufik et al., 2022).

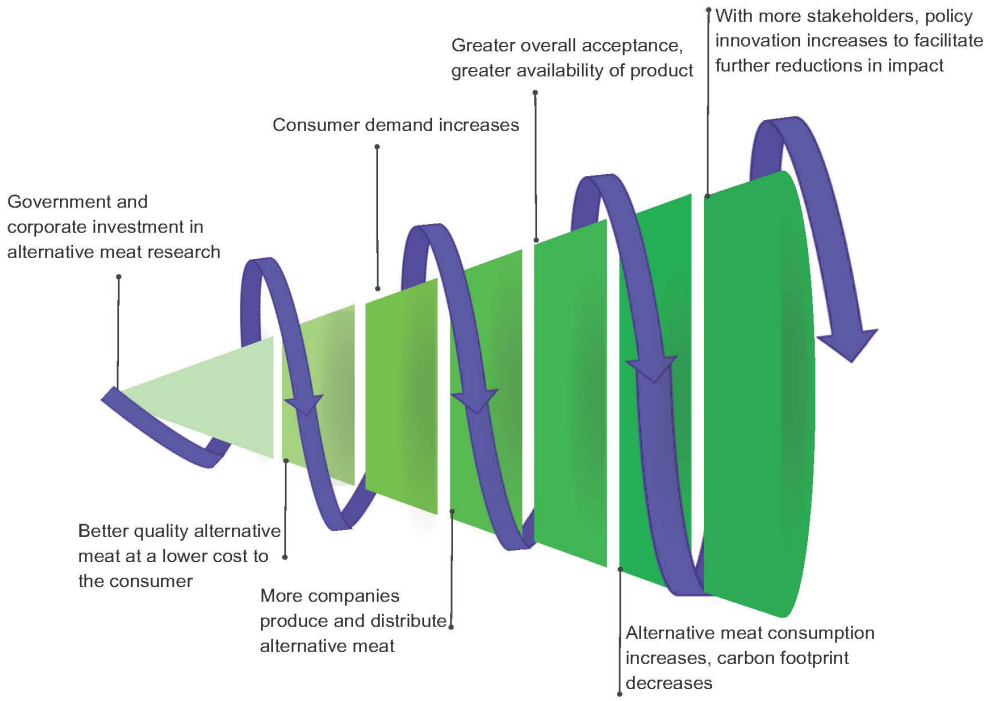
*Table 4. Examples of actions for non-profit and philanthropic organisations*

| Type of intervention | Funder | Advocate |
|---|---|---|
| **Inform** | Bill & Melinda Gates Foundation committed $250,000 to the Good Food Institute (Bill & Melinda Gates Foundation, 2018) | Beans is How campaign (Beans is How, 2022)<br>World Resources Institute's initiative of Cool Food Meal labels for restaurants to indicate low-carbon footprint meal options (WRI, 2023)<br>Foundation Earth works with brands to put front-of-pack sustainability labels on products (Foundation Earth, n.d.)<br>Meatless Monday Messaging (Rayala, 2022) |
| **Invest** | Jeff Bezos, Bill Gates, Al Gore and others invest $158 million in Nature's Fynd, an alternative meat and dairy start up using fungus as primary ingredient (Woods, 2021) | One Meal A Day's North Carolina Pilot Program for increased plant-based school lunch options (OMD, 2023) |
| **Incentivise** | INGKA Foundation provides plant-based dishes at all IKEA restaurants and bistros and Swedish Food Markets (Ingka Holding, 2020) | Greener By Default empowers institutions to serve plant-based food as default option (GBD, n.d.)<br>Netherlands field experiment demonstrated that plant-based default menu items nudged more consumers to choose those options (Taufik, 2022) |

## Spiral Up, Spiral Down: A Synergising, Positive Feedback Loop Approach

Several authors have described a cycle of inertia in which governments are afraid to act and the public, not seeing government action, underestimates the extent of the problem. This lack of public awareness, in turn, facilitates government inaction, since there is no pressure to intervene (Bonnet et al., 2020, Wellesley et al., 2015). This contrasts with what could happen when the actions proposed above create positive feedback loops or when they create synergies with other actions. Kelsey (2021) has described a 'green spiral' to explain the interaction between government policy and industry investment to reduce chlorofluorocarbons (CFCs) for protecting the ozone layer. In this example, the first international policies by governments to restrict CFCs led to major investments by some industries, which then became committed and lobbied governments for stronger regulations, which in turn led to more industry investment. This is the essence of a positive feedback loop, where government policies influence industry actions, which then reinforce government policies. This process has also been applied and expanded to describe increases in climate-saving technologies in the energy and automotive sectors (Meyer, 2021), as well as in the alternative meats sector (Smith, 2021; Dutkiewicz, 2021).

***Figure 1. An alternative meats spiral offers an example of how positive feedback loops accelerate the acceptance of alternative meats among the general public and industry stakeholders, which can lead to additional policy actions. These concepts were inspired by Kelsey (2021), Meyer (2021), and Smith (2021).***




In Figure 1, we outline the characteristics of a positive feedback loop as applied to meat alternatives. We include consumers in the feedback loop, since they will demand more of these foods as they get tastier and cheaper, which prompts expanded industry investment and innovation, leading to even tastier and cheaper products, which eventually can build coalitions for enhanced government actions, including enforcement. As alternative meats improve in taste and cost, producers of traditional meats may reduce their environmental impact, to better compete in this respect. The net result is likely to be increased consumption of alternative meats, decreased consumption of traditional meats, and reduced footprints for those traditional meats that are consumed. As this process unfolds, more stakeholders in the alternative meats sector will mean increased

political power. This may eventually lead to a realignment of US farm subsidy policy, which has historically favoured animal agriculture and its supporting industries, rather than a plants-for-humans approach (Sewell, 2020). This is just one example of an alternative meat spiral. There could also be a plant protein spiral that is not modelled on traditional meats, but rather emphasises the culinary and cultural aspects of legumes, nuts and seeds. Investing in tasty and economical recipes using these foods could increase their availability in restaurants, which could nudge consumers to choose them more frequently, furthering the spiral as with meat alternatives. Whether initiated by government, private industry, or the non-profit sector, these spirals are not guaranteed and depend on actions by more than one sector that reinforce one another. In the CFC example above, government policies started the spiral and were followed by industry investments. With alternative meats, several companies have already invested in research and development, but their uptake has stalled, likely due to price and quality issues for consumers. Government support, similar to that proposed in the PLANT Act, could address this and reinvigorate the spiral.

## Conclusions

In summary, the approach we outline incorporates a diversity of actions undertaken by all of society, including government incentives, and focuses on building synergies and positive feedback loops to reduce meat consumption and production. The focus on incentives is due to the political difficulty of enacting disincentives or restrictive policies in the US, given the political strength of the agricultural sector (Vallone and Lambin, 2023). This is not a universal barrier, and other countries – including Spain, Switzerland, New Zealand, Germany and the Netherlands – have formally proposed and/or introduced a tax, levy, or tariff on meat in recent years, all designed to reduce individual consumption of meat (Remmers, 2021). However, such taxes may require considerably high levels to be effective at achieving climate targets (Latka et al., 2021), indicating a trade-off between effectiveness and feasibility.

Our exclusion of restrictive policies does not mean that they are never warranted; rather, they were left out of the discussion due to our focus on the current US national political context. Supplementary Table 2 (at the end of this paper) provides example actions that may be appropriate in other situations, which is important given the context-specific requirements of successful policies (Rust et al., 2020). Even within the US, some policies that are not currently possible at federal level, like taxes on sugar-sweetened beverages, could be successfully implemented at state or local level (Falbe, 2020; Espinosa-Marròn et al., 2022).

We have argued for the importance of food industry involvement in this overall approach, and have suggested that government information, investment, and incentivisation schemes could help to encourage its adoption by industry – and consequently by consumers. However, the food industry's prime concern is with profitability, and there is a growing body of literature that describes how corporations have used political influence to promote their goals, often at odds with health or sustainability (Mialon et al., 2015; Lazarus et al., 2021; Rose et al., 2021; Vallone and Lambin, 2023). Thus, government enforcement will become an important tool to ensure that industry follows through on actions that were previously incentivised. This process was seen in the CFC example described above, as well as in the US transportation sector, where incentives to purchase electric cars (The White House, 2023) were later followed by new rules for emissions targets (Dawson, 2023) and fuel economy standards (Domonoske, 2023). This carrot-before-the-stick approach can work because some industry actors are more likely to adopt a clean technology if there are government incentives to do so, and then, once invested in the technology, are less resistant to new regulations because their new technology already makes them compliant. In other words, becoming more involved in a technology and moving further along the spiral enables such enforcement to become politically feasible (see Figure 1).

Our commentary has focused solely on reducing meat's impact through alternative production and consumption strategies. Clearly there are other important avenues for making our food systems more sustainable, most notably the reduction of food waste (Clark et al., 2020), which was beyond the scope of the present article.

Another important consideration that has not been addressed here is the equilibrium between supply and demand. Reduction in meat consumption by American consumers will not lessen environmental impacts if the commodity is still produced in the same volume but exported instead. The reduced impact on production due to the potential for meat exports has been described by several European investigators (Lehtonen and Irz, 2013; Tukker et al., 2011) and highlights the importance of global solutions to this problem. Winders and Ransom (2019) also emphasise that the global meat industry operates as an interconnected system, where changes in one region can have ripple effects worldwide. This interconnectedness demonstrates the necessity for international cooperation and policymaking to address the environmental impacts of meat production effectively, ensuring that efforts are not limited to the US but are part of a global strategy. Lastly, this review has not addressed the food access inequities that are a significant part of the US food system (Ayazi & Elsheikh, 2015). We recognise that access to sustainable diet choices can be due to factors beyond an individual's control (Giancatarino & Noor, 2014), and that the feasibility of adopting this approach may vary.

A key aspect of our approach is its all-of-society perspective, which resonates with the writing of Rust and colleagues (2020), who argue for actions across the whole supply chain. The positive feedback loop embodied by a spiral is also essential to our approach. This is similar to the concept of positive tipping points to drive sustainability, as advanced by Lenton and colleagues (2021), in that small changes can trigger self-reinforcing feedback to accelerate change. All of these approaches share a common optimism that changes implemented by actors across the food system can create the needed momentum towards achieving sustainability goals.

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*Supplementary Table 1. Crosswalk from our menu to previous policy intervention ladders*

| Type of intervention | Nuffield Intervention Ladder[1] | Balanced Intervention Ladder[2] | SUSFANS Policy Ranking[3] |
|---|---|---|---|
| **Inform** | Provide information | Provide information<br>Educate for autonomy | Provide information<br>Educate for autonomy<br>Compulsory information on products<br>Ban marketing to children[4] |
| **Invest** | | Ensure choice is available | Ensure health choices are available |
| **Incentivise** | Enable choice<br>Guide choice through defaults<br>Guide choice through incentives | Guide choice through defaults<br>Enable choice<br>Guide choice through incentives | Nudge through defaults<br>Enable choice through programs[5]<br>Guide choice through incentives |
| **Not on the Menu** | Do nothing<br>Monitor the situation<br>Guide choice through disincentives<br>Restrict choice<br>Eliminate choice | Do nothing<br>Monitor the situation<br>Guide choice through disincentives<br>Collective self-binding<br>Restrict choice<br>Eliminate choice | Do nothing<br>Guide choices through disincentives<br>Restrict choice through regulation<br>Eliminate choice |

*Supplementary Table 2. Examples of actions not included in our menus*

| Type of Intervention | Sector | | |
|---|---|---|---|
| | Government | Industry | Non-Profit & Philanthropic |
| Disincentivise | Removing meat and dairy subsidies (Sewell, 2020)<br><br>Estimated environmental benefits of a meat tax in the Netherlands (Broeks et al., 2020) | | |
| Restrict Choice | Bengaluru, India restrict holiday meat sales (Sabarwal, 2022) | German supermarket chain Lidl announced plans to decrease meat and animal product offerings in favour of plant-based alternatives (Buxton, 2023) | Epicurious (online magazine) no longer publishing new beef recipes (Tamarkin & Hoffman, 2021) |
| Eliminate Choice | Helsinki no longer serving meat at seminars, receptions, and other events (Tanner, 2021)<br><br>Karnakata bans slaughter of cattle (PRS Legislative Research, 2021) | Eleven Madison Park restaurant transitions to fully plant-based menu (Anderson & Gross, 2021) | UK Students demand 100% plant-based universities (Achuthan, 2023) |

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[4] (..) and other agents with limited decision-making

[5] behavioural change programmes

# Analysis of the Narrative Grammars of Cultured Meat in UK Food and Farming Media

Paper first received: 29 April 2024; Accepted: 15 July 2024; Published in final form: 31 December 2024
https://doi.org/10.48416/ijsaf.v30i2.684

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## Abstract

Cultured meat (CM), meat produced through animal-derived cell cultures, has garnered considerable media attention. At the moment, there is a set of 'loud' voices and particular 'grammars' that primarily dictate the current media framings of CM. To date, very little research has attempted to understand what the food and farming sector think of CM and, moreover, its potential impacts on farmers, their livelihoods and the farming sector more broadly. This study looks to bring to the fore these more marginalised and understudied food and farming voices, in the form of their legacy media and social media narratives, to explore and analyse the construction and circulation of the grammars of CM in digital, online spaces. To this end, through an iterative sampling procedure, we collected and qualitatively and quantitatively analysed the framing grammars of 147 pieces of online discursive and visual media discussing CM from 2017 to 2023. Analysing the discursive grammars of CM suggested three prominent grammars of CM: 1) CM is a 'solutionist' technofix for the UK and explicitly Britain post-Brexit, 2) CM is a 'virtuous' technology given its environmental and food security possibilities, and 3) CM is 'in tension' with the farming sector as well as consumers' health and taste buds. Farmers in particular perceive CM as an existential threat to their livelihoods and livestock farming, with some of these grammars verging on the conspiratorial. Yet, some farmers did not see CM as a realistic or potential threat. A final grammar surrounded the affordability of CM.

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ISSN: 0798-1759 | This Journal is double blind refereed.

## Introduction

Although not yet widely available as a commercial product, cultured meat (CM),[1] meat produced through animal-derived cell cultures, has garnered considerable media attention. A great deal of this coverage has focused on the 'possibilism' of 'clean meat' (e.g. Dutkiewicz and Rosenberg, 2021), fuelled in large part by the headline-grabbing sums of mostly private capital investment in the technology – which as of 2022, reportedly totalled $2.8 billion (GFI, 2023) –, as well as the science-fiction-like future visions of eating 'slaughter free' meat (Reis et al, 2020) grown in bioreactors. The United Kingdom's (UK) Food Standards Agency (FSA), the institution tasked with ensuring food safety, added its voice to the public conversation when it published a series of 'news alerts' in 2022 reporting that 'a third of UK consumers are willing to try lab-grown meat' (FSA, 2022). When the California-based company Eat Just launched its cultured chicken products at a high-end Singapore restaurant in 2020 – the world's first ever commercial sale of a CM product –, its 'no-kill, lab-grown meat' was described as a 'landmark moment across industry' (Carrington, 2020). According to Josh Tetrick, the CEO of Eat Just, the approval of these CM products was, rather spectacularly, '. . . one of the most significant milestones in the food industry in the last handful of decades'.

There is currently a set of 'loud' voices and particular 'grammars' – i.e. the discursive frames through which media narratives are constructed and circulated (Goodman and Jaworska, 2020; Jaworska et al, 2024) – that primarily dictate the current media framings of CM. Specifically, the majority of the elevated media voices pronouncing on CM are those of CM scientists, financial investors, CEOs and/or industry-related promotional organisations (e.g. The Good Food Institute), in addition to organisations like the FSA that give voice to 'potential' CM consumers via public surveys. These contemporary media grammars of CM are those that, almost without exception, extol the future, 'promissory' virtues, 'magical disruption' and virtuous markets of CM (Guthman and Biltekoff, 2021; Sexton et al, 2019).[2] Through this framing, the transition to CM is said to address the 'matters of concern' (Latour, 2004) surrounding animal protein production and consumption and their association with climate change, environmental pollution, biodiversity loss, food 'scares', and detrimental human and animal health (Willet et al. 2019). As Sexton and Goodman (2022: 176) argue, CM is heralded because of

> *. . . its revolutionary potential in dealing with the ongoing and increasing crises of the Anthropocene, particularly those related to conventional livestock's impact on the environment. [These products] promise to be 'good for people, animals and the planet' (Clara Foods, cited in Sexton et al 2019) [through] a total fix that replaces the perceived inefficiencies of biology with the control and efficiency of technology.*

Since the early 2010s, however, the media hype bubble surrounding CM has at times been punctured by counternarratives. More recently, these have come increasingly from institutional voices (e.g. IPES-FOOD) and a small number of high-profile exposés that hint at an industry built too much on promises rather than on scientific reality about to be caught out by its own technofix-fuelled hubris (e.g. New York Times, 2024). The longest-standing counternarratives have come from the incumbent food and farming industry, a group of actors for which CM's success poses potentially existential threats. Early examples include livestock industry lobby groups in Australia and the United States (US) and holistic farming organisations like the Sustainable Food Trust in the UK (Sexton et al, 2019). The reactions have not been unanimous, however. Sexton et al (2019) highlight that the dividing lines between buy-in – sometimes literally through investment and corporate acquisitions – and opposition to CM from agri-food stakeholders often correspond to size of operation, business model, and place within the food supply chain. In other words, as a general rule, companies operating on larger (i.e. multinational) scales, with industrialised business models, and in the middle to end of the food chain (i.e. processing, retail) have been much more likely to show interest and support for CM. Farmers and food producers, especially those with smaller to medium-sized businesses and operating more holistic

[1] While we discuss the differential naming of cultured meat by different media below, in this paper, we use the term 'cultured meat' and its abbreviation of 'CM' to denote meat that is created through animal-derived cell cultures.

[2] This is a similar phenomenon to the promises of precision made in discourses of agriculture or food 4.0, which tend towards making grand, epochal claims of revolution. See Miles et al (2019) and Kuch et al (2020) for more.

agricultural practices, have been less visible as supporters of CM. This overall lack of support from farmers can in part be attributed to their disproportionate absence from both academic debates and mainstream media stories on CM. Despite potentially having the most to lose (or benefit) from CM, farmers are one of the biggest missing voices from public conversations about CM.

To date, very little research has attempted to understand what the food and farming sector thinks of CM and, moreover, its potential impacts on farmers, their livelihoods and the farming sector more broadly. Our research and analysis look to bring to the fore these more marginalised and understudied food and farming voices, in the form of their legacy media and social media narratives, to analyse the construction and circulation of the grammars of CM in digital spaces. In this paper, we narrow our field of focus to that of the media produced by the UK food and farming sector, as well as online farmers' forums, and look to analyse how CM has been framed in the UK. This complements our earlier research that engaged with UK farmers from different agri-food sectors about the potential impacts and/or benefits they perceived in the development of a large-scale CM sector (Manning et al, 2023). In this current paper, we are specifically interested in how CM has been framed as an 'opportunity' and/or a 'threat' in the grammars of the UK's food and farming sector, and by 'online' farmers, through the key print and digital media platforms they use to report on, represent, discuss and debate CM.

Understanding the media grammars of CM in the UK is important because of the dearth of studies on the food and farming sector's framings of CM and the wider lack of attention paid to the mediascapes produced by food and farming actors. Our analysis of the grammars of CM in the UK looks to situate these influential voices and their framings of CM within the broader context of: the contemporary cultural politics of food (e.g. Goodman and Jaworska, 2020) and of alternative proteins and CM specifically (e.g. Sexton and Goodman, 2022; Driessen and Korthals, 2012; Dickson and Clay, 2024; Dilworth and McGregor, 2015; Van der Weele and Driessen, 2013; O'Riordan et al, 2017; Chiles, 2013); the 'reconfigurations' of animals within food systems (Holloway, 2022); the shifting political economies of food production (e.g. Goodman, 2023; Rose et al, 2022); and the politics of food sustainability in the face of the climate crisis (e.g. Sage, 2022). In short, understanding the mediated framings and grammars of CM provides crucial insights into the position of the UK's food and farming sector as to the potential impacts of CM on the future production and consumption of food in an increasingly climate-changed world.

## Situating the Media Grammars of Cultured Meat

### *Food media and mediated food*

Recent research has sought to explore various important aspects of the media narratives and dynamics – and the relationships of power, inequality and intersectionality they produce and circulate – surrounding food. Started in earnest through Signe Rousseau's ground-breaking work on social media (2012a) and celebrity chefs and food (2012b), work by Leer and Paulson (2018: 17) has sought to capture the 'heterotopia' of food media to illuminate the 'complex vision of the politics of media food' in such a way that it 'pluralises' its 'relations to [audiences'] identities and practices of many sorts'. Phillipov and Kirkwood (2018) explore the ways in which narratives of 'alternative food networks' (Goodman et al, 2012) have moved into more 'mainstream' mediascapes across television cooking programmes, digital foodscapes, food justice projects and the advertising and labelling strategies of major food retailers and manufacturers. As they argue, '[a]t the intersection of food politics, media texts and everyday material practices, we are seeing media's increasing power as a key actor in food systems debates and as a motor of food system transformation' (Phillipov and Kirkwood, 2018: 2).

Goodman, Johnston and Cairns (2017), and an accompanying array of papers in Geoforum, spotlight the 'mediated biopolitics' of food and eating. As they state, food media is not just mere 'spectacle', for

> *the concept of mediated biopolitics enables a critique of the ways that food media solidify, facilitate and*

> *govern 'the politics of [food] life itself'. (162) [Thus], '[an] analysis of the mediated biopolitics of food examines how particular food discourses come to be legitimated as "truths" and sheds light on aspects of the foodscape these truths obscure' (163).*

Specifically, as they and others (e.g. Barnes, 2017; Hollows, 2022) have argued, nowhere are the power and politics of food truths, narratives and discourses more fraught than in the form of 'food celebrities' (Johnston and Goodman, 2015), such as celebrity chefs and food influencers who seem to multiply, spread and intensify their influence across both legacy and social media.

Given its increasingly powerful significance and almost inescapable presence, food across digital media landscapes, or 'digital foodscapes', has come in for particular scrutiny and analysis. Through Digital Food, an all-encompassing treatise on everything from social media's 'ordinary food imagery' and amateur food and cooking videos, to gendered performances of online food culture, to digitally-mediated ethical food consumption and the 'doings' of food politics, Lewis (2020) shows how food, the digital world and everyday life are 'thoroughly intertwined'. In earlier writing, Schneider et al (2018: 1) and other colleagues worked to '…contemplate what happens when food, this visceral and enlivening matter, goes digital – and particularly what happens when activism surrounding food moves into the digital domain'. Digital food activism, they argue, foregrounds 'connective action' rather than 'collective action', such that the 'ontological experiments' of digital foodscapes '…have the potential to reclassify food, shift accountability relations and disrupt prevailing market framings' (21). Bringing to bear both cultural studies and food studies in order to foreground and examine 'digital food cultures', both Lupton and Feldman (2020) and Feldman and Goodman (2021), as well as the authors of their joint collections, explored the contemporary imbrications of the digital world, food cultures, power and inequality, and everyday lives, livelihoods and lifestyles. From the gendered, raced and classed politics of digitally-mediated 'healthy' eating (e.g. Conor, 2021; O'Neill, 2021), to online representations of various forms of 'good food' (Feldman, 2021), food and digital culture are 'mutually implicated in the contemporary processes of, and debates around, knowledge production and power distribution' (Feldman and Goodman, 2021: 2) within agri-food systems and societies more broadly.

Expanding on the mediated productions of the politicised constructions of digital foodscapes, Goodman and Jaworska (2021) analysed the so-called good food grammars created and circulated by UK-based 'digital food influencers' (DFIs). These DFIs included both more established influencers such as Jamie Oliver, Gordon Ramsay, Nigella Lawson and Lorraine Pascale who have expanded into digital foodscapes, and newer influencers such as Ella Mills (known as Deliciously Ella), Izy Hossack, Madeleine Shaw and 'The Body Coach' Joe Wicks, who all rose to prominence in online spaces as digital food 'originalists'. From their analysis, DFIs have produced a series of 'good food' grammars, the notion of which we are directly building on here with our analysis of mediated CM grammars, that are defined as '. . . a set of [language, discursive and narrative] norms and practices that . . . interact with wider audiences and . . . dominate the digital foodscape' (184).

Goodman and Jaworska (2021) found that the grammars of the DFIs they analysed produced the stable, 'normalised' and highly shared notion that 'good food' was constructed as 'clean' or 'free from', and part of a wider fitness regime that supported a much broader, heathy, aspirational, 'good' lifestyle. As they argue, 'DFIs as our consciences and our muses give us not just instructions on how to cook up good foods but how to cook up the perfect, caring, "normal" and "right" lifestyle" (192). The outcome of these grammars, the authors argue, is to re-enforce and strengthen the already-hegemonic 'whiteness' and middle- and upper-class aspirational proclivities embedded in the digitally-mediated narratives of 'good food' put forward by DFIs. Building on these findings, in this paper we analyse the CM grammars that have been created by and circulated across the UK's food and farming media landscapes and the media outlets and influencers inhabiting them.

*Cultured meat media grammars*

Previous research on the multiple framings of CM has explored its 'promissory narratives' pushed by the sector and its boosters (e.g. Sexton et al, 2019), the visual representations of CM (e.g. Stephens and Ruivenkamp,

2016), and the public perceptions and (future) acceptability of this 'alternative protein' (e.g. Errmann et al, 2023; Tsvakirai et al, 2024). Parallel outputs have explored the views of farmers (e.g. ProVeg International, 2024), meat scientists (Choudhary et al, 2023), and CM actors and organisations (e.g. Broad and Biltekoff, 2023), as well as the regulatory and policy narratives that currently surround it (e.g. Evans and Johnson, 2021).

To date, only a few studies have considered the framing of CM in the media, and the use of discursive analysis of CM framings has been limited. Early media framing research (Goodwin and Shoulders, 2013) sought to get a snapshot of how CM was being framed in US and EU news outlets between 2005 and 2011. Only 34 articles in the news mentioned 'Cultured Meat,' focusing mainly on its potential benefits, history, and methods of production, as well as how long it would take to come to market, and concerns over livestock production, including a sense of scepticism about the technology. The authors (Goodwin and Shoulders) concluded:

> *[c]urrently, the support of [CM] in print media is outweighing the opposition. Therefore, it is likely that consumers will also develop favourability toward the product if support continues to be demonstrated by the media. The meat industry and larger agricultural industry should work to create effective media strategies and continue to monitor how [CM] and other agricultural topics are being covered in the media. As with the issue of [CM], it is important that the agricultural industry make strides toward communicating in a proactive manner. (449)*

Hopkins (2015) explored media coverage in the US, Canada and UK of the infamous London CM tasting event in 2013 where Google's Sergey Brin spoke about the £250,000 he had invested in the five-ounce CM burger, created by Professor Mark Post of Maastricht University. The tasting was covered live by several TV channels and made quite a splash across international media. Looking at online news, magazine coverage and advocacy sites, the analysis suggested that concerns over taste and flavour were prevalent in the coverage, in addition to narratives around the rationale for the development of CM, its benefits in relation to the environment and the so-described 'world food crisis', as well as the potential health impacts of eating CM versus livestock protein. In his analysis, Hopkins (2015) suggests that there was also an over-representation of the narratives and voices of vegetarians and vegans commenting on the many animal, or animal-free, related aspects of CM in the coverage of the tasting event. He suggested that future coverage should be targeted at including meat eaters' perspectives to promote the 'positive image' of CM.

More recent analysis of the media grammars of CM from Painter et al (2020) looked at six years of news coverage in the US and UK 'traditional media' from 2013 to 2019. This resulted in a total of 255 articles on which they performed quantitative and qualitative analysis. Importantly, they analysed the sources quoted in the articles, suggesting that there was an 'over-representation' of industry actors quoted. They found that 222 industry representatives were quoted '… compared to the second highest number, academics or scientists at 91 (2388), and government, government bodies and politicians appearing in only 13% of the articles (2389). Significantly, they noted that 64% of the articles had positive narratives associated with CM, such as its potential to lower greenhouse gas (GHG) emissions, to contribute to animal welfare, and to 'feed the world'. Counternarratives on consumer rejection (23%), higher cost (19%), and a combined series of framings (18%), ranging from CM's potentially negative nutritional impact to its being a distraction to wider transitions to a plant-based diet, and to arguments over whether or not CM is vegan, were also present in the articles (2391). Their sentiment analysis of the tone of the framings showed that 49% of the articles had a positive or promotional tone, '…compared with just 3%...which showed a negative or oppositional tone', with the remainder (48%) being neutral or balanced (2392). The authors argued that

> *[t]he industry dominance in news coverage of CM found here is a concern. On [the] one hand, it fails to provide the public with a realistic account of the current capabilities of this emerging technology. On the other, it may have unintended consequences on public sentiment if CM is slow to realise its promise or if the public begins to lose trust that start-ups and established meat companies will protect consumers' interests and produce a healthy and safe product. (2392)*

This media analysis of CM by Painter et al (2020) has been taken forward by Helliwell and Burton (2021), who analysed 455 traditional and sectoral news media articles between January 2011 and September 2020, 26 hours

of online video materials from a range of CM and protein companies (e.g. Memphis Meats, Finless Foods, Bond Pet Foods), as well as 49 different CM-sector company websites and online promotional materials. Building from 2016 onwards, their analysis suggests that CM is framed across the following categories: (1) replacing 'inefficient' animal bodies, (2) replacing livestock farming as an '… environmentally destructive and ethically problematic system…' (184); (3) working to 'restore' nature and biodiversity by removing large numbers of animals from landscapes, (4) fulfilling the protein demands of the future; and (5) relocating and localising the sites of protein production to urban areas and, in doing so, supposedly (re)connecting people to the food they eat. The authors also stressed the 'narrative silences' of CM in this media coverage and industry-produced material. In terms of the loudest voices, similar to Painter et al's (2020) findings, Helliwell and Burton (2021: 185) found that news media coverage was dominated by 'industry-affiliated scientists, advocates, and company representatives', while oppositional voices were represented far less, particularly around environmental and rural narratives. But what narratives did they find were 'silenced' or missing from the media they analysed? First, there was very little on what a transition to CM might mean for rural communities and their potential de-population through the '…disruption, rural decline and desertion' (186) of these landscapes, driven by the delivery of CM's environmental promises and its potentially much smaller footprint in terms of land use and animal-derived inputs. Second, there was very little on the potential impacts of CM on biodiversity conservation, sustainable agriculture, agroecology and regenerative farming (see Klerkx and Rose, 2020) as well as the management of rural cultural heritage and landscapes that are produced through livestock farming. In short, they ask 'what would the decline of animal agriculture mean for these landscapes, the tourists and recreational activities that they support?' (186).

## Researching Cultured Meat in the UK's Food and Farming Media Landscape

Our methodological and analytical approach combined both quantitative and qualitative media data collection and analysis of the grammars of CM in UK food and farming media. We first developed a list of media outlets, profiles and organisations we felt would best capture the CM-related grammars being communicated both within, and to, the UK food and farming sector. This list was developed: (a) iteratively through online searches that allowed us to target where these grammars were appearing within a UK context; (b) through reflective discussions about what outlets we thought might be playing historical and/or current host to these grammars and media constructions of CM; and (c) through the expertise of the research team, several of whom have previously worked closely with UK food and farming media outlets where these narratives have taken shape. For legacy media outlets that started (and have also continued) as print media magazines, e.g. Farmers Weekly and The Grocer, we used the digital versions of the publication to facilitate our searches and access to the material. We did likewise with online newspapers such as The Guardian and Daily Mail which have hosted a considerable number of these grammars as national news outlets. In addition, we included an online discussion forum frequented by UK farmers, known as the 'The Farming Forum', to capture any conversations about CM by these 'online' farmers, and thus to bring their voice into the conversation and allow us to consider their perspectives on CM. Early on in the data collection process we removed CM and alternative protein advocacy groups from our list as we felt they might bias our sample too much towards overtly positive constructions of CM. The full list of media outlets and profiles is in Appendix 1. The final set of media outlets in our study cohort consists of those voices that are the most significant in creating, framing and sharing the grammars of CM within the UK food and farming sector and, specifically, UK farmers.

Each outlet, profile and forum was then searched in detail using the following set of terms to identify articles, posts or grammars on or around CM: Vat Meat, Cell Ag, Cellular agriculture, Cultivated meat, Cultured Meat, Clean meat, Lab meat, Lab-grown meat, Lab grown meat, In vitro meat, In-vitro meat, Cell-based meat, Cell based meat, Cellular meat, Artificial meat, Synthetic meat, Frankenmeat, Franken-burger, Franken burger. This search yielded a total of 259 'pieces' of media from 2017 to late 2023, across all media formats and platforms on our list.[3] These individual outputs discussing CM (169 online articles, 76 tweets and 14 Farming Forum

[3] These data were collected by Wylie from 14 February 2023 to 5 March 2023, with data from the Farmers' Forum collected between 1 and 3 June and again in October 2023.

posts) were entered into a spreadsheet and attributed to an outlet and date of publication. Texts were extracted and analysed both quantitatively and qualitatively to portray the prevalent media grammars of CM within the individual and collective narratives.

We tallied the number of outputs about CM by outlet or profile to get a general sense of the differential 'volume' of CM-related voices and grammars on our list. This analysis was designed to understand the greatest and/or relative size of the media 'footprint' of the grammars of CM across the broad swath of the UK's food and farming digital mediascape. In short, this analysis allowed us to understand and determine who or what was the loudest voice in producing the greatest number of statements and narratives about CM in this media landscape. Yet, equally importantly, we wanted to know what was being said about CM and how these grammars were being produced to frame the ways audiences should understand CM. Thus, our analysis, based on grounded theory (Flick, 2018), draws on the techniques of content analysis (Krippendorff, 2019), and linguistic narrative and discourse analysis (Jones, 2019). Through these forms of analysis, we manually coded the 259 'utterances' about CM through an iterative, inductive and reflective coding process that brought to the foreground what we found to be the most prevalent grammars of CM. These dominant codes, messages, narratives and meanings surrounding CM where then grouped into a series of predominant, broad themes that then began to outline and define the grammars of CM appearing in UK food and farming media. We describe, discuss and further analyse these voices and themes – and the media grammars that they create and define – below.

## Quantitative analysis: relative volumes and predominant terms used to name and discuss cultured meat

### *Outlet and profile volume*

Overall, legacy food and farming media in the UK (e.g. *The Grocer, Farmers Guardian* and *Farmers Weekly*) produced the largest volume of articles and other material about CM. These outlets were thus the loudest, and they spoke about and constructed the media grammars of CM within the UK. This included 68 online articles and 17 tweets, most of which were announcements about, and links to, existing articles in their magazines that discussed CM. The second loudest set of outlets was made up of the category of general food and farming media outlets (e.g. Farming UK, New Food, and Food Ingredients First), which included 48 online articles and 44 tweets that, yet again, provided links to existing published articles. Other outlets, such as The Farming Forum (14 posts) and the FAO on Twitter (9 tweets) produced much less content about CM.

George Monbiot, a high-profile and well-known UK journalist for The Guardian, author, and environmental and social progressive, published three opinion articles and numerous tweets, all of which generated extensive engagement and debate across the entire UK food and farming mediascape (more on this below). The 'quietest' outlets and online profiles discussed CM very little, if at all. These included farming organisations and associations (e.g. National Farmers Union, National Beef Association, National Sheep Association), meat sector organisations (e.g. British Meat Processors Association) and the UK government (e.g. FSA and DEFRA), although the latter are often tagged in tweets and other forums where debates over CM are happening. They did not respond when tagged or mentioned.

### *The naming of Cultured Meat*

As linguistic and critical scholars articulate (e.g. Lakoff, 2010; Goodman et al, 2016), and what most people attuned to media will already know and experience, is that the way something is 'named' and narrated is fundamental to how it is understood by audiences. Equally importantly, and as articulated in this paper, its naming can work to outline the grammars through which a topic is, might be or, indeed, should be narrated and discussed. Thus, it is crucial that we understand how CM has been named and framed in the grammars being produced by the UK food and farming media as the sector talks to itself, as well as wider audiences.

To this end, we found that the most predominant terms used to name CM were 'cultivated meat' (268 times), 'cultured meat' (205 times), 'lab-grown meat' (145 times) and 'cellular agriculture'. The latter is an umbrella term originally coined by the sector, that encompasses CM, along with dairy and other animal food products made via cell culture (New Harvest, nd), and was used only 38 times. Seen another way, when CM was being discussed across these mediascapes, the term 'cultivated meat' was used 36% of the time, cultured meat 28%, lab-grown meat 20%, and cellular agriculture 5%. The terms 'clean meat', 'in-vitro meat' and 'synthetic meat' were used very little across the UK food and farming mediascape. See Appendix 2 for a more detailed breakdown of the terms used to describe CM, and their prevalence. Importantly, constructing CM through the predominant grammars of cultivated meat, cultured meat or lab-grown meat has the potential to signal very different sets of meanings, understandings and imaginaries to the audiences of these media.

## Qualitative analysis: the narrative grammars and predominant voices of cultured meat

*Discursive analysis of cultured meat grammars*

Through our qualitative discursive analysis of the UK mediascape regarding CM, a series of three predominant, iterative themes emerged. These themes and their related 'nested' sub-themes are explored in turn.

The first and most predominant theme that emerged in our analysis was defined by the proposed 'solutionist' technofix (e.g. Guthman et al, 2022; Guthman and Butler, 2023) that CM can provide for the UK, and explicitly Britain. This solutionist grammar followed two different but related storylines and appeared primarily in the legacy and industry food and farming media. Specifically, coverage pushed CM as an innovative solution that could support and boost economic growth, especially post-Brexit, within the UK and British food sector. For example, Food Ingredients First (Green, 2023) interviewed a co-founder at a cultured fat company, who stated that they 'thought the UK has this amazing opportunity now to push forward and become a world leader in alternative protein'. Markets for UK-based CM companies needed to be 'opened up' with the deregulation of food safety protocols and, echoing pro-Brexit narratives, a drive to cut EU 'red tape' to allow more CM products to be produced in Britain. As one particularly strident piece published in February 2023 in The Grocer proclaimed:

> *The UK's novel foods approval process currently matches the EU's: lengthy and complicated. Could the FSA's new, Singapore-inspired approach cut red tape and allow British innovation to thrive? (Warner, 2023).*

A representative from Ivy Farm Technology, a British CM startup, articulated the same ambition in clear boosterist, patriotic terms in New Food Magazine: 'We believe our technology is among the best in the world and that we can fly the flag for Britain' (Parrett, 2021). Broadly speaking, the tone, affect and language used in this grammar was saturated with the imprimatur and terminology of neoliberal capitalism in the service of the British and UK CM industry. For example, terms and phrases we repeatedly observed included: deregulation, investment and investment opportunities, the future, market nimbleness and competition, entrepreneurial spirit, pushing markets forward, market development and market 'players', global market leader and market potential, stepping up 'the game' and innovation.

A second prominent grammar within the broader solutionist storyline of CM extolled the technology's virtues along environmental and food security grounds. Most often combined with the neoliberal language mentioned above, CM's environmental grammar comports closely with the promissory narratives of CM described by Sexton et al (2019), and with the pronounced, contemporary narratives of sustainable development and green capitalism that support the 'three P's' of people, planet and profit (see e.g. Fletcher, 2023). For example, The Grocer, in both an article and a tweet, quoted the food multinational Nestlé saying that: 'CM tech could ultimately lead to more environmentally friendly products' (White, 2021a). New Food Magazine, similarly, wrote and tweeted about how '#CultivatedMeat could cause 93% less #globalwarming than its conventional counterpart' (Minchin, 2021; New Food Magazine, 2021). Current regulatory mechanisms were identified

as a key bottleneck of 'novel foods' innovation in the UK, with the stated effect of stopping British CM companies and their backers from '…investing in solutions to the environmental and hunger crisis' (The Grocer, 2023). Other articles featured more positive tropes, suggesting that '…there are some really exciting developments in CM, that [deliver] in terms of food security and sustainability…' and that 'there are some fantastic opportunities about [CM as a] future [solution] to feeding the nation' (White, 2021b).

A third set of related grammatical themes that emerged from our analysis was made up of those that constructed CM as being 'in tension' with the farming sector, as well as with consumers' health outcomes and taste buds. In these themes, CM was presented as a possible threat to UK farmers in their 'stewardship' of British landscape management and, again in a post-Brexit UK economy, something that should or might be resisted as a future normalised food for consumers. In particular, from 2021, Farmers Weekly played host to many of these grammars. For example, in an article asking the question "Is lab-grown meat a threat to traditional livestock farming?", the magazine quoted Glyn Roberts, president of the Farmers' Union of Wales (FUW), who argued that '…advocating an "industrial route" out of the climate crisis, where food is produced in factories, should not replace natural farming and food production' (James, 2021). The article continues:

> *'Our beef and lamb [are] grown naturally, sustainably and consumers can trust in the knowledge of our farmers to deliver a product of excellence' says Mr Roberts of the FUW. 'Look at the family farms here in Wales, they produce food in a non-intensive way and have done so for centuries. I think this is what most people want: beautiful farms with thriving nature producing excellent food' (James, 2021).*

In a quote from the representative of the National Beef Association in Farming UK magazine, UK beef was said to be

> *… one of the most sustainable methods of food production. … We are all aware that processed food as we know it today is not good for us, so it is illogical to believe that highly processed chemical-based lab outputs will be our nutritional answer (FarmingUK, 2023).*

Indeed, one of the key tropes was an attempt by farmers and their institutional and media advocates to subvert the current 'good food/bad food' narratives that have been pushed by CM advocates, framing CM as 'good food' given its supposed low carbon intensity, less use of water, lack of 'complication' through animal welfare concerns, potential food safety and control benefits, and ability to feed growing populations. Instead, farmers and their advocates have worked to present livestock farming as 'good food' that is sustainably produced, maintains and conserves the countryside, supports the small-scale and 'traditional' farming sector, families and communities, and most importantly, is not processed and is 'healthy' and 'natural'. These tensions and arguments over what 'good' and 'bad' food is have played out extensively across the CM, alternative protein and livestock sectors for a while now (e.g. Sexton, 2018). Such narratives not only precede those explored here, but, as we show, have now become the established grammars of how actors within and beyond the CM industry feel the technology should be narrated and framed in public debates.

Farmers, when quoted in media and through The Farming Forum, generally perceive CM as an existential threat to their livelihoods, and livestock farming as a business and substantial part of the food system in the UK and Britain. For example, a farmer commented that 'It is the biggest threat we will ever face, I bet 50% of us are not farming in ten years' time due to this' (TFF (1), 2022). Others critiqued CM as 'lab-grown factory slop' and stated they would '…not [eat] 100% adulterated food to hand more profits to food giants' (TFF (1), 2022). One claimed that CM was made of 'tumour cells that keep dividing forever, at a much faster rate than healthy cells' and quipped, with apparent sarcasm, that this 'sounds delicious' (TFF (2), 2023). Statements about the potential threats of CM to farming livelihoods and farmers' positions within the food system focused on the ways that it, and other powerful actors, might push them out of business:

> *Once removing every last penny of profitability they will snap up the farms for the real goal of greenwashing and all the profit that entails. Bill Gates, cough. (TFF (2), 2022).*

> *Big massive business is behind it all with government support. Follow the money and thou shall see. (TFF*

*(2), 2022).*

This 'threat' grammar aligns with our findings in our previous research with UK farmers (i.e. Manning et al. 2023). Historically justifiable, imaginary, or (n)either, these and many other similar grammars verged on the conspiratorial. It was repeatedly suggested that farmers were being purposefully pushed out of business through green, rewilding and other regulatory measures coming from government or high-net worth individuals like Bill Gates, a frequent 'bogeyman' in conspiratorial narratives, but, importantly, also one of CM's highest profile early investors. Within our sample, CM was framed by several farmers as one of the latest threats to their livelihoods and to everyone across the farming sector. A poster compared CM to the plot from the 1973 ecological dystopian thriller Soylent Green:

> ***Puts on tinfoil hat** Whenever I hear about lab meat, I think of Soylent Green. The film was set in 2022, where 'the cumulative effects of overpopulation, pollution and global warming have caused severe worldwide shortages of food, water and housing'. It's all starting to make sense..... (TFF (1), 2022)*

Another poster brought Soylent Green into the discussion about the environmental imaginaries of George Monbiot:

> *Basically, he wants the UK to look the way it was before the dark ages, possibly back to prehistoric times while food is provided to the masses from massive factories producing in the same sort of scale and system as projected in the great classic film 'Soylent Green'. This would, of course, concentrate food production into the hands of giant conglomerates rather than diverse small businesses competing with each other and providing overall food security. (TFF (3), 2022)*

One of the farmers shared a digital article entitled 'Synthetic meat investor Bill Gates calls for rich countries to shift entirely to synthetic meat', which they introduced with the comment: 'Here's one of many articles on this megalomaniac and his agenda'. In response to the article, another poster remarked 'that's fine Mr Gates if you don't like beef, soylent green anyone?' (TFF (4), 2022).

In addition to direct mention of Bill Gates, many of the TFF posters engaged with and critiqued opinion pieces, statements and tweets directly produced by Monbiot. In the face of the climate crisis, Monbiot has been a vocal supporter of rewilding to address biodiversity collapse, turning farmland into more biodiverse and forested landscapes, facilitated by the production of large-scale, plant-based, vat-produced fermented meat-analogous protein (Monbiot, 2022).[4] To be clear, Monbiot's current advocacy is not for CM per se (although it has been in the past), but rather for protein analogues that can be 'brewed' through fermentation at large-scale. In addition to 'triggering' reactions from many in the farming sector with this push for rewilding and/or alternative proteins, many of those in TFF use Monbiot as a 'foil' around which to argue against CM and for continued livestock farming. For example, based on a 2023 piece in *The Guardian* by Monbiot (2023) arguing for alternative proteins, a poster on the Forum stated that:

> *… having read the article, it's clear he wants us all to eat lab-grown factory slop and ban farming of any sort. … Much the better for it George? So you think people are better off eating processed food than real food? You might wanna check with the medical professionals on that one George. Even they're starting to work it out. (TFF (2), 2023)*

This grammar aligns with the emerging and growing contested narratives of natural foods versus ultra-processed foods. These debates with and against Monbiot have spilled over onto X/Twitter with Gareth Wyn Jones, a Welsh celebrity farmer whom the BBC has called 'the nation's favourite farmer' and who has, amongst many other media appearances and coverage, been one of the presenters on BBC's The Family Farm. While, as of February 2024, Jones had 66,000 followers and Monbiot had close to 600,000, they have had several different X/Twitter 'wars' most often prompted by statements from Monbiot, that Jones then responds to and tags, with Monbiot then replying and tagging Jones, etc. They have, in effect, become the hyper-polarised 'muse-like' stand-ins for the supposed environmentalist-versus-farmers debates that roil from time to time, with both deploying different and/or controversial scientific data to either boost their arguments or debunk

[4] See the Reboot Food campaign for more on this and Monbiot's involvement: https://www.rebootfood.org/.

the points made by the other.

A subsequent set of tropes put forward by farmers were those that *did not* see CM as a realistic or potential threat. This position is articulated in the following two quotes from a TFF conversation:

> *It is not something I would consider a threat to agriculture. I am sure CM will have some major challenges soon enough. (TFF (1), 2022)*

> *I don't see it taking over […] they will come up against lots of problems and can't really compete with Ag when it comes to volume of food produced. (TFF (1), 2022)*

In this vein, one particular article from the New Scientist in 2023, stating the relatively controversial position that 'Lab-grown meat could be 25 times worse for the climate than beef' (Klein, 2023), got a great deal of traction and attention on TFF. Responses and discussion around this article allowed many to cement their narrated position that livestock farming is more sustainable than CM and that its production should be supported rather than that of new markets and businesses for CM.

The final grammar that came to the fore was that of the affordability of CM in light of its current high costs to produce, the need to 'scale-up' to reach economies of scale, and the promissory narratives promulgated about its climate change, environmental, health and hunger-reducing benefits. Food Ingredients First, Food Navigator Europe and New Food led these grammars with quotes and statements by CM company representatives, as well as their own statements. 'Affordable,' 'affordability' and 'cheap' are used with companies, funders and researchers seeking to make their CM products accessible and viable on the consumer market. For example, the CEO of Multus Biotechnology (formerly Multus Media) stated that

> *… while cultivated meat promises to benefit human and planetary health, there is also a significant financial opportunity. … Our goal is to make cultivated meat the affordable and sustainable choice for everyone (Davies, 2023).*

The co-founder and CEO of Aleph Farms stated:

> *[w]e are taking steps to drive economies of scale and achieve price parity with conventional meat products, including developing specific technological modules in our production platform and establishing strategic agreements across our supply chains (Poole, 2023).*

Food Ingredients First spoke to Ed Steele, the co-founder of Hoxton Farms which is attempting to make cultured animal fat. As they put it,

> *Steele says that flavourings are 'a huge cost and given the flavour that you get from cultivated fat, you no longer need significant flavourings in plant-based products. So, all of that will allow us to reduce the cost of meat alternatives in the long term, especially given the circumstances around inflation and the cost of living crisis,' he comments. 'And if we're going to make the dent that we want to make as a company, we can only do that by enabling people to buy it, and people can only buy it if it's cheap enough' (Green, 2023).*

## Understanding the Grammars of Cultured Meat in UK Food and Farming Media

Reflecting on our findings above, we wish to make several notable points. First, much like previous research, some of which is close to a decade old, we found that there is relatively little media coverage of CM in quantitative terms in the UK. In the coverage that does exist, there is an ongoing narrow set of voices and storylines constructing the grammars of CM. The persistent and growing ossification of grammars, voices and stories is apparent in the predominance and relatively high 'volume' CM-industry boosters promoting the economic, environmental and social benefits of CM or the ways it could be made more cost-effective through further market and scientific developments. Crucially, this narrowing of voices and stories about CM has itself been boosted by the use of the same set of stories and/or direct press releases, that were either copied and published verbatim or slightly edited across numerous different outlets in our sample. Furthermore, the 'facts'

or data, mostly generated by the CM industry with varying levels of transparency, presented in the majority of these industry aligned articles, are those predominantly about industry investment, size and potential for market growth and/or models of the potential environmental benefits of CM. In some senses, this is industry 'self-talk' and/or continuation of 'hype-like' public relations campaigns that have been at the forefront of CM grammars for a long time, largely devoid of rigorous public debate. Thus, in our sample and analysis, and based on a direct comparison to previous studies (e.g. Goodwin and Shoulders, 2013; Hopkins, 2015; Painter et al, 2020; Helliwell and Burton, 2021), the overt media grammars about CM in UK food have continued mostly to replay the predominant boosterist voices and 'promissory narratives' of its industry-led champions. This has been to the exclusion of other voices, such as those from the IPES-Food, broader food systems, and food justice perspectives, the majority of farmers, or even from outside the Minority World.

The growing 'push back' to the miracle of CM by non-farming sector organisations and farmers, both 'offline' (Manning et al, 2023) and online, suggests that we might be entering the next phase of the 'hype cycle' of CM. Here we are referring specifically to the Gartner Hype Cycle, a graphical representation created by the American IT firm Gartner that plots five phases of a new technology's maturation ('Technology Trigger', 'Peak of Inflated Expectations', 'Trough of Disillusionment', 'Slope of Enlightenment', and 'Plateau of Productivity') (Gartner, 2024). We might characterise the last decade of largely positive media grammars as part of the 'Peak of Inflated Expectations'. Recent high-profile media pieces, such as in The Counter (Fassler, 2021), New Scientist (Klein, 2023) and New York Times (Fassler, 2024), represent the tentative beginnings of a broadening of media grammars on CM to include more sceptical takes on CM's potential to deliver on its many grand promises. It is too early to say conclusively, but such shifts in tone may signal a tipping from peak hype about CM to Gartner's so-called 'Trough of Disillusionment,' a period defined by waning public and investor interest, expressions of public backlash to aspects of the proposed technology, and the first round of mass attrition (or acquisitions) amongst the sector's start-ups. At present, however, the overtly optimistic discussion about CM that conspicuously continues to fully foreground and normalise the industry and its boosters' loud positive spin on CM, remains the dominant framing that is shown here to be replicated across the UK's food and farming mediascape. This lack of a 'deeper', critical discussion of the potential benefits and drawbacks of CM is concerning, given the UK food and farming sector's continuing vulnerability to the climate-change-driven ecological crises, an unstable political and regulatory landscape, a volatile post-Brexit and post-Covid global economy, and the directive influence of venture capital funding.

Second, the debates about CM and the extant grammars that facilitate them across the wider UK food and farming mediascape are becoming increasingly polarised and siloed. This is particularly acute due to the desire of different CM-factions to define, or re-define, CM through the simplistic narratives of either 'good' or 'bad' food, based on their economic, social and material position with respect to the technology, its promises and its potential future. Some of this is a function of how media outlets work to gain attention in an increasingly diffuse and overwhelming communications environment by reporting on and 'manufacturing' conflict to gain audience share. Given his controversial views and communication style, there is little wonder that the anti-CM campaigns of the 'celebrtised' farmer (Phillipov and Goodman, 2017) Gareth Wyn Jones have gained so much media attention and traction. With Jones' celebrity status and growing platform, the particular CM grammars he advances have been amongst the loudest in UK food and farming circles, further amplified by a media format that promotes more extreme opinions. Crucially, these particular views of CM should not be seen as necessarily representative of the whole of the UK farming community. This polarisation of grammars is driven by the ways in which social media tends to select, either purposefully through algorithms, or psychologically by amplifying extreme voices, conspiracy, anger and outrage. These more extreme positions are very often devoid of subtlety as they are purposefully designed for maximum affective engagement (cf. Rose-Stockwell, 2023) which accelerated in breadth and depth during the Covid-19 lockdowns and is now embedded in the post-Covid world. These broader technological, cultural and political shifts may explain the louder, more extreme, and sometimes conspiratorial views expressed about CM and alternative proteins in online food and farming communities.

Thus, to summarise, the UK food and farming media grammars about CM, and the debates, discussions and politics they define, are distinguished by two extremes: on the one hand, the continuing loud voices of industry boosters singing the promissory praises of CM; on the other, an emerging and increasingly loud selection of voices of a relatively small, but vocal, slice of farmers articulating the threats (or non-threats) of CM to their livelihoods and their consumers. At the latter end, some of the most extreme grammars are reinforcing beliefs from established and highly influential conspiracy theories.

Our third observation is that many of the articles and grammars of CM have coalesced around the increasingly stable and hegemonic name of 'cultivated meat'. Specifically, the cultivated meat moniker is one that has been developed and promoted by the CM industry to associate the CM sector and its products with the 'normal', 'natural' and longstanding 'cultivation' of food products. Through this naming convention, cultivated meat is 'cultivated' just like other more 'natural' foods, such that it is propagated and grown like any other 'naturally produced' food product or produced through a fermentation process similar to that of wine or beer. To cultivate a plant or animal through farming brings the act of care to the forefront of the imaginary and is often associated with the rural idyll full of vibrant, deeply verdant, fecund farming landscapes, producing a bounty of food for all to eat. And while these equally socially constructed, wholesome images of farming should themselves be critically evaluated and questioned in a contemporary context (i.e. Sage, 2022), the association of the notion of 'cultivated' with CM is, we argue, attempting to normalise, naturalise, de-mystify and reframe it as a 'good', 'cared for', and/or 'cared about' food, produced by a 'considerate' and 'growing' industry for the everyday consumer. A possible alternative interpretation here involves the ways that 'cultivated' is a synonym for everything from artistic, to enlightened, civilised, educated, refined, sophisticated, scholarly and intellectual. Could it be that with the industry-led, purposeful naming of CM as cultivated rather than 'cultured' meat, consumers may identify with and construct themselves through these very positive and expansive characteristics if they buy and eat CM? This is certainly a possibility and one worth pursuing through more dedicated and detailed consumer and 'eater' studies focused on CM (Cf, Hart Research Associates, 2017).

Another important component of the naming grammars in our sample narratives was the usage by different media of the terms 'cultured meat' and 'lab-grown meat'. Both stand in relative contrast to the 'natural' meanings conferred by the term 'cultivated' to describe CM, and to the notion of 'naturally' derived animal protein using existing farming methods. Cultured and lab-grown convey the imaginaries of meat being 'grown' and/or 'created' through the use of synthetically-driven, 'less-than-natural' scientific processes. More specifically, CM is defined by, and situated in, its process, that is, cell-culture conjuring up the image of meat being grown in a petri dish or flask in an artificial medium and/or culturing substance. The same could be said of the use of the term 'fermented meat'. In the early days, this emphasis on process was a reason many involved in the technology's development were in favour of the term, on the grounds that it communicated to various publics (e.g. consumers, regulators) a sense of transparency over the origins of CM (Stephens et al, 2019). Moreover, in parallel to the broader definitions of 'cultivated', there is also the possibility to read 'cultured' to mean a sense of refined or 'good' taste as well as its associated synonyms of educated, intelligent and sophisticated, a further benefit recognised by proponents of the term within the CM industry.

Alternatively, the term lab-grown meat is situated in the location of the production of CM in the generic 'lab', conjuring up an imaginary of a formal, sterile and pristine environment facilitated by the precepts, materialities and processes of a nebulous but hegemonic 'scientific process'. And while there is perhaps less chance of lab-grown being associated with erudite or culturally sophisticated tropes, it does convey a particular sense of formalistic control and power, combined with care and flourishing, reminiscent of that communicated by both the notions of cultivated and cultured. For many of the advocates of CM, the fact that it can be cultured and cultivated in the lab, that is, devoid of the 'contamination' and 'uncontrollability' of natural landscapes, environments and food chains, is one of the key benefits of CM as a 'good' food worthy of further investment, of more predictable financial returns, and of a friendly regulatory regime (Sexton et al 2019).

## Conclusions

This paper represents an important step in the quest to understand what agri-food system actors – and specifically those located in the UK – think about CM. Media grammars around CM focus on both opportunity and threat, with the potential for greater economic growth, environmental benefits and food security, as well as disruption to farming communities and perceived lack of affordability.

If 'just' agri-food transitions are to be achieved with substantive stakeholder inclusion, they must include accessible fora for a variety of diverse voices within and outside of the food industry. Our analysis of media grammars surrounding CM illustrates that the voices of CM-industry actors tend to dominate, with farmers' voices tending to be absent from debates, apart from selective loud, celebritised individuals,. On the one hand, these findings could be partly explained by our research approach, with specific farmers' views investigated on the basis of social media reach. We acknowledge that our research approach in this article has foregrounded the views of some farmers over others, and that it highlights the need for further studies seeking to capture the views of 'harder-to-reach' (Hurley et al., 2022) actors from both within and outside of food systems. Capturing a greater diversity of views may help to shine a spotlight on less frequently discussed topics around CM, which could include issues related to access, affordability and food security, beyond the dominant contexts of increases in food production, whether cultured or not.

## Acknowledgements

This research was funded through the Transforming the UK Food System for Healthy People and a Healthy Environment SPF Programme, delivered by UKRI, in partnership with the Global Food Security Programme, BBSRC, ESRC, MRC, NERC, Defra, DHSC, OHID, Innovate UK and FSA. The authors would like to thank the editors of this special issue (and especially Colin Sage) for their encouragement and patience in the production of this paper as well as their detailed feedback. We also wish to thank the reviewers and their feedback that improved our arguments. We would also very much like to thank Alex Arnall, Anna Jackman, Nathan Salvidge and Max Boykoff for their insightful feedback on earlier drafts of the paper. Their critical reading and guidance were invaluable although we did not have the space to take up all their helpful suggestions. All remaining errors and omissions are those of the authors.

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## Appendix 1

**Sectoral Farming organisations and associations**
National Sheep Association
National Beef Association
National Pig Association
British Poultry Council

**General food and farming magazines, organisations and associations**
Food Navigator
Red Tractor: Assured Food Standards
Campden BRI
Leatherhead Food Research
Fera science
AgFunder News
Food & Drink Federation (FDF)
Institute of Food Technologists (IFT) and/ or Institute of Food Science and Technology (IFST)
Food Ingredients First
Food Manufacture
Food and drink network uk
Euractiv (section 'Agri food')
Meat Management
New Food
Scotland Food and Drink
Scottish Craft Butchers
SRUC (academic)
SAC Consulting

**Sustainable farming organisations and associations**
Green Alliance
Sustain
British Pig Association
Rare Breeds Survival Trust
Soil Association
Linking Environment and Farming (LEAF)
The James Hutton Institute
Pasture for Life
Nature Friendly Farming Network
Sustainable Food Trust
Nourish Scotland
Wicked Leeks

**Farmer/farming forums**
Farming Forum
Farming UK
Farmers Guide
Farm Business
Farming Monthly Magazine
Indie Farmer

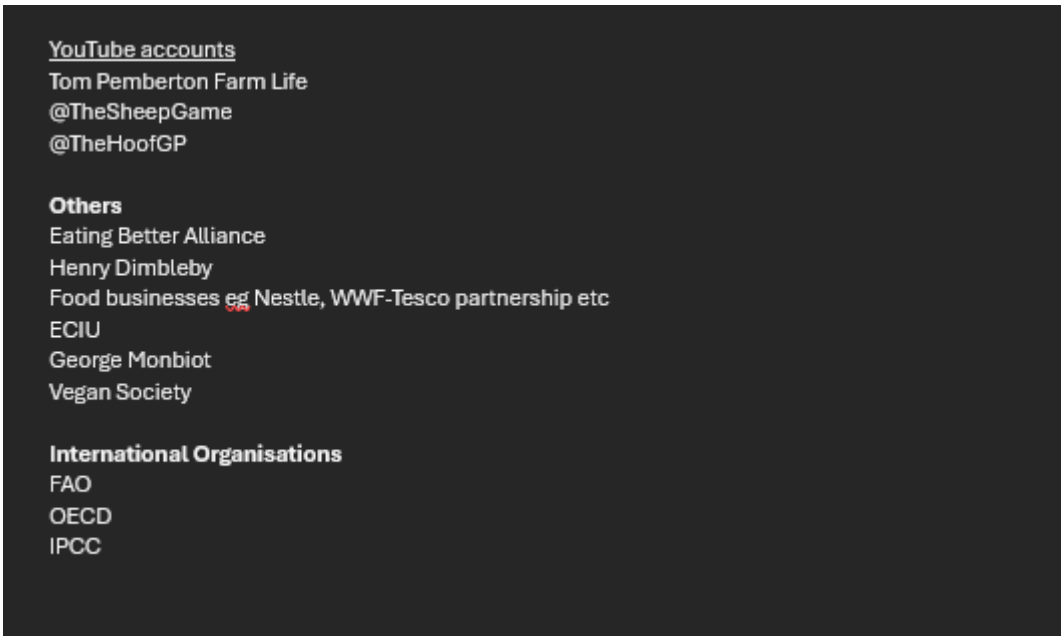
AgriChat (Twitter)
#Club Hectare (Twitter group)
The Farming Community Network (FCN)
The DPJ Foundation

**Government**
Food Standards Agency
DEFRA
HSE (health and safety executive)
BEIS (business, energy and industrial strategy)

**Other national media organisations**
BBC - @BBCBreakfast

**UK Celebrity Farmers and/or key farmer UK Celebrity Farmers and/or key farmer influencers**
Twitter accounts
@herdyshepherd1
@FarmersOfTheUK
@1GarethWynJones
@IrelandsFarmers
@redshepherdess
@willpenrievans
@wheat_daddy
@No1FarmerJake
@Farmer_Tom_UK
@agricontract
@theblackfarmer
@farminghub
@WyeFarm
@ProagriLtd
@GeorgeMonbiot

Instagram accounts
@girlaboutthefarm
@thechiefshepherdess
@globetrottingfarmgirl
@bentheoandrews
@emmafoot724
@adamhenson
@thehoofgp
@thefemalehooftrimmer
@cooper_kaleb
@mel_irvine
@thesheepgamevlog
@emmagrayshepherdess




## Appendix 2

Quantitative analysis of search terms – most used

| Search Term | Times used | Where | Who - Twitter | Who- online |
|---|---|---|---|---|
| **Cultivated Meat** | 268 | Online 233<br>Twitter 35 | General Food and Farming; Sustainable Farming UK Celebrity Farmers and Influencers; Monbiot; International organisations; Others. | Food and Farming Legacy Media; Sectoral Meat General Food and Farming; Sustainable Farming Government; International organisations; Others. |
| **Cultured Meat** | 205 | Online 181<br>Twitter 24 | Food and Farming; Legacy Media; General Food and Farming; Influencers; Monbiot; Farmers and Forums; UK Celebrity Farmers; Others. | Food and Farming Legacy Media; Sectoral Meat; General Food and Farming; Sustainable Farming; Farmers and Forums; Government; International organisations; Others. |
| **Lab-grown meat** | 145 | Online 122<br>Twitter 23 | Food and Farming Legacy Media; Farming Organisations and Associations; General Food and Farming; Sustainable Farming; UK Celebrity Farmers and Influencers; Monbiot; Government. | Food and Farming Legacy Media; Sectoral Meat; Sectoral Farming; General Food and Farming; Sustainable Farming UK Celebrity Farmers and Influencers; Monbiot; Farmers and Farmers forums; Government; International Organisations; Others. |
| **Cellular agriculture** | 38 | Online 34<br>Twitter 4 | UK Celebrity Farmers, Influencers, Monbiot. | Food and Farming Legacy Media; General Food and Farming; Sustainable Farming; International organisations. |
| **Cell-based meat** | 29 | Online 29 | | Food and Farming Legacy Media; Sectoral Meat |
| **Lab grown meat** | 20 | Online 14<br>Twitter 6 | General Food and Farming<br>UK Celebrity Farmers, Influencers, Monbiot. | Food and Farming Legacy Media; Farmers and Farmers Forums; Government |

Quantitative analysis of search terms – least used

| Search Term | Times used | Where | Who - Twitter | Who- online |
|---|---|---|---|---|
| **Lab meat** | 8 | Online 5<br>Twitter 3 | UK Celebrity Farmers; Influencers; Monbiot. | Food and Farming Legacy Media; Sustainable Farming. |
| **Synthetic meat** | 8 | Online 7<br>Twitter 1 | General Food and Farming. | Sectoral Meat; General Food and Farming; Sustainable Farming. |
| **Cell Ag** | 3 | Online 2<br>Twitter 1 | UK Celebrity Farmers; Influencers, Monbiot. | Food and Farming Legacy Media; Sustainable Farming. |
| **Clean meat** | 3 | Online 3 | | Food and Farming Legacy Media; Sectoral Meat. |
| **Cell based meat** | 3 | Online 1<br>Twitter 2 | UK Celebrity Farmers; Influencers, Monbiot. | General Food and Farming; Others. |
| **Cellular meat** | 2 | Online 2 | | Food and Farming Legacy Media. |
| **In vitro meat** | 2 | Online 2 | | General Food and Farming. |
| **In-vitro meat** | 2 | Online 2 | | Sectoral Meat; General Food and Farming. |
| **Artificial meat** | 2 | Online 2 | | General Food and Farming; Sustainable Farming; International organisations. |
| **Franken-burger** | 1 | Twitter 1 | Sectoral Farming | |

# Navigating Food Transition: European Policy Tools for Novel Foods and the Italian Debate on Cultured Meat

Paper first received: 23 April 2024; Accepted: 31 August 2024; Published in final form: 21 June 2025
https://doi.org/10.48416/qyznch63

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## Abstract

The global food system—encompassing production, consumption, and disposal—has been widely recognized as unsustainable, contributing significantly to environmental degradation and social disparities. In response to these challenges, the transition toward more equitable food systems has become imperative. Despite the widely acknowledged need to change Western eating habits, the transition toward more sustainable diets appears as a "false wicked problem" being characterized by intricate trade-offs between economic, ethical, societal, and environmental issues. This paper examines the crucial role of policy interventions in steering the shift and in considering the role that the emergence of novel foods and alternative proteins – such as cultured meat – might play within it. By employing a qualitative methodology, the study maps the policies governing novel foods in Europe, with a specific emphasis on the three tools of regulations, informational campaigns, and incentives. This paper gives particular attention to the cultured meat debate in Italy as a case study for approaching not only the multifaceted nature of food—an interplay of cultural values, economic interests, and political decision-making—but also the staunch resistance that such transition is likely to encounter. The main highlights underscore the need for a comprehensive and balanced approach to integrate regulatory measures, consumer education, and inclusive stakeholder engagement while stressing the importance of evidence-based choices, transparent communication, and the recognition of the socio-cultural dimensions in shaping food policies.

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**ACKNOWLEDGEMENTS**

This article has been published within the project funded by the European Union – NextGenerationEU, Mission 4, Component 1, under the Italian Ministry of University and Research (MUR) National Innovation Ecosystem grant ECS00000041 – VITALITY – CUP: C43C22000380007.

## Introduction

Our global food system—all the activities from production to consumption and disposal of food—is widely recognized to be unsustainable, inequitable and responsible for negative environmental and social impacts (Aiking, 2019; Oliver et al., 2018). The constantly growing demand for food over the past seventy years – and the associated intensification of processes of agricultural production – have had significant repercussions on the integrity and regeneration of environmental resources (Sage, 2022), particularly in relation to meat and dairy production. Since the 1960s, global meat production and consumption have steadily risen by a factor of four, with 360 million tonnes now consumed annually (Roser, 2023). In its reports, the Intergovernmental Panel on Climate Change has recently highlighted that current use of the land for food production, and the related industrialized food systems, contribute significantly to environmental degradation and climate change (IPCC, 2022; Mirzabaev et al., 2023).

In recent years, scientific literature has pointed out how the environmental impact also extends to issues such as water pollution, deforestation and biodiversity loss (Benton et al. 2021) caused by the extensive use of land for livestock and feed production. Livestock raising for meat and dairy cover an estimated half of the world's habitable land; were we to shift towards plant-based diets, our overall agricultural land use would decrease significantly, shrinking from 4.1 billion hectares to just 1 billion hectares – a 75% reduction in land use (Poore and Nemecek, 2018; Ritchie, 2021).

Transitioning toward more sustainable and equitable food systems is essential for addressing these interconnected environmental and social challenges, and a reduction in meat consumption in most western countries is widely recognized by scientists as a way to mitigate climate change (IPCC, 2022). This shift would not only reduce the environmental footprint but also address nutritional and ethical concerns (Springmann et al., 2018) while promoting more sustainable diets (Watts et al., 2021; Willett et al. 2019). Such a transition entails a complex array of changes across the entire food chain, through the agency of governmental and scientific institutions, as well as the private sector. How to effect more sustainable food systems (Spaargaren et al. 2012), therefore, is a complex and multi-faceted debate. Mazac et al. (2022) assert that replacing animal proteins with novel or plant-based foods in European diets would reduce the environmental impact from agriculture by over 80%. If we acknowledge the need to change our eating habits, the question becomes: What should we transition towards? As we reduce our meat consumption, how might we replace it to ensure balanced nutrition?

Environmental, social, and nutritional challenges require us to adapt. Novel foods, technologically advanced alternative proteins and, recently, cultured meat (Rubio et al. 2020) are directly in line with necessary—yet complicated and interconnected—changes. Mazac et al. (2022) assert that by replacing animal proteins with novel or plant-based foods in European diets would reduce environmental impact from agriculture by over 80%.

These new food developments then reflect the need to find more sustainable and ethical solutions in response to environmental, social, and nutritional challenges. These solutions though, are part of important changes that are supposed to happen throughout the global food systems at different levels. In order to analyze the crucial role of policy-making in such a transition, this paper will analyze relevant policy tools (as described in the methodology section).

## Food transition as a "false wicked problem"

The introduction of new food technologies and novel foods (Monteiro et al. 2019; Sadler et al. 2021) able to address the need for more sustainable diets would be a crucial evolution of our food systems (European Environment Agency, 2022). Yet, effecting such change poses challenges – as environmental issues, global

consumption demands, human health, economic implications, social as well as cultural factors, and ethical concerns all must be taken into account (Béné and Lundy, 2023).

On one hand, there are those advocating for a "win-all narrative", viewing the shift towards novel foods as a "total fix" (Béné and Lundy, 2023; Guthman and Biltekoff, 2021; Jönsson, 2016; Post 2020). This group includes not only biotechnology researchers, but also vegan consumers and large companies producing technologically processed alternative proteins, which see these innovations as a way to control and monitor environmental impact through technological efficiency (Sexton and Goodman, 2022). Various stakeholders, including institutions, international organizations, and the scientific community, have consistently promoted the adoption of alternative proteins (Béné and Lundy, 2023). These encompass a diverse array of options, ranging from the introduction of novel foods like insects and algae to innovative processing methods for already common proteins, such as plant-based meat alternatives (Lähteenmäki-Uutela et al., 2021). Global alternative meat as well as dairy alternatives are steadily increasing – and are expected to reach a value of $162 billion US dollars by 2030, up from $29.4 billion US dollars in 2020 (FAO, 2022, p.34). According to the Good Food Institute (2023), a total of 156 companies are already developing cultured meat, with an investment of 2.8 billion dollars and 679 unique investors in total. Against this backdrop and within the broader context of European policies towards novel food introduction, cultured meat has also gained attention as a promising solution for meeting the demands of a growing global population while reducing animal suffering and alleviating pressure on planetary resources (Böhm et al., 2018).

On the other hand, the predominantly positive narrative around the multiple benefits of alternative proteins (APs) has encountered significant resistance from 'no-change' proponents, particularly the pro-livestock camp, which includes enthusiastic meat consumers, small and medium-sized breeders, as well as large meat-producing corporations. As clearly highlighted by the Italian case, these groups advocate for preserving traditional livestock production and the conventional meat industry. This opposition is based on concerns that the widespread adoption of alternative proteins and cultured meat would necessitate a major technological overhaul and could trigger substantial economic and social transformations, disrupt the entire meat industry (Treich, 2021), and ultimately distance people even more from the idea of food as coming from nature. Despite the potential for technological innovations to partially solve the environmental and ethical issues of intensive meat production (Hartmann and Siegrist, 2020), such as water usage, pollution, greenhouse gas emissions, land use, animal welfare, and slaughter—and also to mitigate safety concerns like the risk of infectious diseases, pathogen contamination, and antibiotic resistance, challenges still remain. Environmental issues may persist due to high energy demands in large-scale production. Additionally, economic issues include high production costs, industry consolidation, and negative impacts on rural communities and farmers' livelihoods within the food system's value chain (Reigada and De Castro, 2022; Sexton and Goodman, 2022).

As a matter of fact, the biggest world players within the meat processing industry (Cargill, Tyson Foods, PHW Group, Nestlé), along with major food retailers (i.e. Tesco) and Fast food restaurants (i.e. McDonalds', KFC) are either making investments in alternative proteins – including cultured meat –or joint venturing with other specialized big companies such as Beyond Meat and Impossible Foods (Béné and Lundy, 2023; Sexton and Goodman, 2022). Consequently, Sexton and Goodman (2022) assert that "the self-proclaimed fixers are the real ones who significantly contributed to the current social and environmental conditions of food systems". As the polarization surrounding the transition of food systems intensifies, it becomes clear that the binary nature of the discourse may exacerbate the problems it seeks to solve, often by oversimplifying nuanced trade-offs. The antagonism inherent in these debates is not surprising, as the concept of transition itself embodies complex and multifaceted issues. These trade-offs are particularly pronounced when considering the intricate web of social, political, and economic factors that influence food systems transformations. Yet, the situation is not black-and-white; there is significant grey area in which the interests of both camps overlap. In this paper, we aim to delve deeper into the transition process, exploring how changes in food systems can be better managed through targeted policy interventions. By integrating political science with a sociological

lens, a comprehensive perspective on social transition is given focusing on the role of policymaking in steering it. The study employs a qualitative methodology aimed at mapping the policies that govern novel foods in the European context, given the official definition of novel food as "any food that was not used for human consumption to a significant degree within the Union before 15 May 1997, irrespective of the dates of accession of Member States to the Union and that falls under at least one of the categories" mentioned by the art. 3 of the Regulation (EU) 2015/2283. In particular, the research focuses on key policy tools—regulatory tools, informational campaigns, and incentives—to capture the state-of-the-art in the relationship between novel foods, broader food transitions and sustainability.

Given its paradigmatic significance in the field of food transition, a specific focus on the debate surrounding cultured meat has been added for several compelling reasons:

- When compared to traditional meat, cultured meat is one of the most contentious inventions in the food industry because of its uncertain nature – can it even be considered "meat" if it does not originate directly from a slaughtering process, and will it prove to be a panacea to the environmental and ethical challenges posed by excessive consumption of animal proteins?
- It represents the intersection of diverse economic, cultural, and political interests, making it a focal point for broader discussions around food innovation and technology.
- It has raised widespread concerns among a heterogeneous group of stakeholders, including traditional farmers, breeders, farmers' associations, environmentalists, and agroecologists in relation to political economy, environmental and social justice (Dal Gobbo and Bertuzzi, 2024).

Furthermore, the choice to analyze the Italian case has been driven by the intense political debate that unfolded throughout 2023. Largely due to ideological positions, the introduction of cultured meat was banned in Italy while still merely a concept. This highlights the importance of food systems in social transition issues. By placing this specific case within a wider European framework, the analysis provides a more comprehensive understanding of how various policies are interacting within the rapidly evolving domain of novel foods, offering valuable insights into the trajectory of food system transitions.

It is becoming increasingly evident that contemporary eating habits and the industrial methods of food production are no longer seen merely as economic or technological issues. They have emerged as critical social issues that demand necessarily coordinated actions. The challenge lies not only in managing the transition in a way that ensures food safety but also in crafting policies that can mediate the conflicts among various stakeholders—scientists, producers, consumers, and institutions (Morais-da-Silva et al., 2022). Moreover, these policies could guide conscientious consumers towards choices that are safe in terms of mitigating risks and more aligned with both their personal values and nutrition concerns (Dupont and Fiebelkorn, 2020; Lupton and Turner, 2018; Shaw and Mac Con Iomaire, 2019; Tucker, 2018).

As some literature on transition has consistently highlighted (Kemp et al., 2007; Rotmans et al., 2001), although the ultimate objectives of a transition are often shaped by conglomerates of governments, institutions and organizations (macro level), public policies can have a unique role in assisting societal changes in relation to interests, rules and beliefs. Thus, they operate on a *meso level* since they can guide changes in both private and institutional actions. This "intermediation", however, is not without its challenges (Rotmans et al., 2001). While public policies can be instrumental in fostering gradual and systematic change, they also possess the power to impede progress, as seen in the case of Italian regulatory approach to cultured meat.

## Methodological notes

By adopting the framework of food transition, a comprehensive map of policies related to novel foods in general and cultured meat in particular has been outlined to offer an in-depth assessment of the current related European landscape. This approach has provided a structured reference for understanding how

different European countries are addressing the challenges of transitioning their food systems towards more sustainable practices. Through the lens of food transition, the analysis identifies some key policy tools, regulatory measures, and strategic initiatives in place across the continent, offering insights into the effectiveness and gaps in the current efforts. Ultimately, this mapping exercise aims to highlight the state-of-the-art policies and practices that are shaping the future of food systems in Europe, while also emphasizing areas where further innovation and policy intervention may be needed to achieve long-term sustainability goals.

Although there are many ways to approach the analysis of policy making, an instrument-based approach (Capano and Howlett, 2020) can be very useful to better understand the policy dynamics, and to reveal where policymakers need to take action in order to achieve their goals in transforming the global food system (Capano et al., 2020; Hood, 1983). Accordingly, this section explains and provides a definition of the categories that have guided this explorative research, i.e. the extraction of policy tools, and their subsequent classification. The map has been outlined looking at the following typology of policy tools:
Regulatory tools: namely, regulations, laws and standards meant as the primary tools for the formulation, implementation and subsequent monitoring of the respective policies (Neuwirth, 2014: 15). Regulatory tools concern governments' coercive power, and how it is used to influence and direct the behaviour of receivers, in accordance with what is ordered in such rules and directives (Bemelmans-Videc et al., 2011). Drawing from the literature, we broadly define regulations as the application of public authority to foster the "public interest" (Eisner et al., 2020).

Information tools: there are different ways in which governments (or other actors in the policy field) use data, facts and information to support the behaviour of policy targets. Referring to the meso level of any transition, this has to do with the so-called nodality, i.e. the property of being in the middle of a social network, which provides governments with a range of information for a panoramic overview (Hood, 1983). Policymakers may give out information directly or require others to disseminate certain types of communication. For the purpose of this paper, we consider these tools as means for governments to leverage available knowledge and data to guide both consumers' and producers' behaviour in a way that aligns with wider goals and objectives (Howlett, 2009).

Incentives and economic measures: generally referred to as "carrots" or "treasure", this category of tools includes measures aimed at incentivising a specific trend of actions or behaviour of the policy targets, which is deemed necessary to fulfil the policy goals. Economic measures can take the form of rewards and benefits, including grants, tax exemptions, and facilitative measures (Bemelmans-Videc et al., 2011). Consistent with the literature, we describe incentives in the sector as instruments to try to influence the world outside and then to set 'money-moving' in a wider context (Hood, 1983).

The above-mentioned tools were identified through desk research, including a comprehensive analysis of the existing literature and an exploration of grey literature. These two approaches should not be seen as sequential but as parallel and complementary. For the analysis of the literature, data sets on Google Scholar were examined using keywords related to the food and social transition (food transition, social transition), novel food sector (novel food, new food, cultured meat, cell meat), and to policy tools (policy, regulation, legislation, instrument, framework, incentive, information, education, investment, service). In relation to the grey literature, in the need of performing exploratory research covering existing policies on novel foods, pertinent documents were selected concerning policy tools such as regulations, strategic papers, information and incentives. The research was conducted on FAOLEX, EFSA Journal and FAO websites (mainly on regulatory and information tools within the domains of 'food and nutrition', 'agricultural and rural development' and 'new foods'); CORDIS EU database, NOP "Innovation and Research" website, and EU CAP Network database were explored to examine incentives as well as financing on novel food and innovative food production programs. Given the current nature of its development, the analysis of the Italian case history has predominantly relied on a diverse range of grey literature sources in relation to the different policy tools. These sources have

included position papers from civil society organizations, official documents related to legislative debates at both the national and EU levels, as well as press releases and news articles. This approach allows for a comprehensive understanding of the evolving dynamics in Italy, drawing insights from key actors involved in the debate. By incorporating multiple non-academic sources, this methodology ensures a nuanced analysis that captures both formal and informal perspectives, reflecting the complexity of food transition discussions within the Italian context.

## Discussion: policy tools for novel foods within the European context

Based on the policy tools framework and the research methodology described above, the following discussion will analyze the application of regulatory, informational, and economic instruments within the European context of novel foods before moving on to specifically examine the Italian case.

*Regulatory tools*

Referring to the regulatory tools of policy making, in recent years, EU authorities have implemented a legislative framework under the Novel Food Regulation (Regulation EU 2015/2283) to address the emergence of innovative food products. The EU's authorization process requires that products receive safety clearance, overseen by the European Food Safety Authority (EFSA), when an application to legally process and sell the food product is submitted to the Commission.

Despite this, the debate around cultured meat remains theoretical, as it has not reached the market yet (Southey, 2022). However, after the recent initiatives taken by EFSA (EFSA, 2023), the first application was presented by a French company in July 2024 under the Novel Food regulation, whose evaluation process will require a period of at least 18 months (Eunews, 2024). A recent report by the FAO and WHO (FAO and WHO, 2023) highlights safety considerations for cell-based meat, stressing the need for enhanced data generation and sharing to guide international regulatory actions. The EU has acknowledged the importance of thoroughly assessing the environmental and sustainability impacts of novel foods alongside safety considerations. However, safety clearance alone is not sufficient, as novel foods must also gain public acceptance before becoming a part of mainstream diets (Frewer, 1998; Palmieri et al., 2020). Thus, the potential and hypothetical benefits and challenges of cultured meat continue to be actively debated, not only at the procedural and scientific levels but also within the public sphere. Through regulations, policymakers face the dual challenge of protecting public health from potential risks associated with novel foods while simultaneously fostering the societal shifts necessary for systemic change in the food sector (European Environment Agency 2022).

Because food practices and diets are deeply intertwined with national and cultural identities, specific and strategic food policies will be crucial in changing perceptions and – ultimately – persuading consumers to choose alternative proteins. Intricate factors come into play when examining the connection between social change and the transition to more sustainable diets. These issues—while encompassing human and animal well-being alongside the preservation of planetary resources—reveal a complex web of interconnected elements, including market dynamics, economic considerations, cultural values, ethics, philosophy, geopolitics, and societal structures (Mason and Lang, 2017).

Drawing from Mary Douglas' cultural theory, Tansey and Rayner (2020) emphasize that any societal change, particularly when involving exposure to risks, requires both individual awareness and institutional support. While little prevents individuals from behaving in ways that may at times be considered inappropriate by other individuals or simply driven by a highly personal interest, institutions remain constantly responsive to change according to a wider system of rules/norms that have defined their framework of actions collectively. In the field of environmental policy-making, these issues have been addressed in the forms of policy dialogues, face-to-face deliberations, stakeholders' engagement in problem-solving processes and consensus-building

(Beierle, 2002). An interesting case of participatory policymaking related to food transition comes from the development of the Novel Foods Regulation in the Netherlands as an example of approaches that address uncertainty about new foods and new technology (biotechnology-produced foods in this case) by prescribing the interaction of consumer organizations, food industry and regulators (Hillers and Löwick, 1998). One outcome was the Advisory Report on Biotechnology, which the Dutch Government requested from the Food and Nutrition Council (i.e., the scientific advisory board to governmental bodies). This report highlighted the need to develop transparent regulations, informational and educational programs and activities to foster consumers' informed decisions. The procedure for authorizing new foods required a prior safety assessment conducted by businesses applying for authorization and then evaluation by Dutch scientists. If the scientists provided positive feedback, a committee including representatives of industry and trade, consumer and environmental organizations, and scientists was to be consulted to address societal aspects of the potential authorization.

*Information tools*

Given the above-mentioned intertwined dynamics, a key area for public intervention is the use of information tools (b), which would benefit from a more participatory and inclusive approach, also in connection with the regulatory framework. Instead of relying on one-way transfers of expert information to citizens, which have proven relatively ineffective (Pidgeon et al., 2005), engaging citizens in more collaborative policymaking processes through specific information tools would better address societal concerns, values, and expectations. Multi-stakeholder engagement and participation are usually enough to reduce disinformation and construct an open-minded attitude to innovation as well as a more conscious critique. As suggested in literature (Frewer, 2004; Frewer et al., 2003; Wynne, 2006), such inclusive processes may facilitate the development of information and communication strategies, eventually reaching wider groups of individuals. Including different perspectives, concerns, and preferences will help ensure that novel foods are developed and introduced in a manner that aligns with societal values and addresses the needs of different socio-economic actors.

Together with public policy-making processes, the social acceptability of cultured meat may also be tackled through the provision of broad public outreach. Institutions are thus called into action to create adequate education policies (Amato et al., 2023) with the aim of conveying more complete sets of information. When in front of a novel food, people need to be particularly reassured about their selection; they may want to know more about its concrete attributes, such as nutritional value and more generally all "label information". Barrena and Sàchez's findings (2013), for example, show that the more reticent people are towards new foods, the higher their interest is in product information. Similarly, Siddiqui et al. (2022b) emphasized in their literature review that individuals with extensive food knowledge may exhibit lower levels of neophobia compared to those with less information and less commitment to public debate about food.

Our desk research into policy tools, particularly information tools at the European level, has highlighted a critical issue. Although the widespread adoption of novel foods depends heavily on consumer acceptance and approval, there remains a significant gap in available information specifically tailored to address consumers' needs. This gap reveals that consumer education and awareness are not currently prioritized as central objectives within European policy frameworks. Moreover, the lack of focus on knowledge dissemination seems to suggest that these areas have not been effectively integrated into the strategic goals of policymakers. In the specific case of cultured meat, its correct labelling becomes a key element in consumer acceptance (Camilleri et al. 2019). As reported by the FAO and WHO (2023), there are several possible nomenclatures for cultured meat, as there is no internationally harmonized terminology to indicate this type of product. This has created the potential for confusion (Bryant and Barnett, 2019). For this reason, FAO calls for national authorities to use terminology regarding cultured meat that is more transparent and informative for food labelling, clearly communicating that the products produced through the new technology are different from the conventional ones.

Another terminological matter concerns the use of the word meat in itself. While general EU regulations govern food product marketing (Reg. (EU) 1169/2011), there is a gap within the existing European framework concerning cultured and plant-based meat alternatives (Lähteenmäki-Uutela et al., 2021). In the present absence of a European legal status, member State legislations and customary names come into force, leading to potential case-by-case judicial decisions and causing uncertainty for companies operating in the common market. The French government addressed this gap by proposing in 2022—initially in a generic way—the prohibition of labelling plant-based products with the term "meat". The decision was suspended by the French government, and then reintroduced by decree in September 2023. Italy has followed this path, even though the French law applies only to products made and sold in France, with the indication of a positive list of twenty-one meat names exclusively for use in meat products.

*Incentives and economic measures*

Another way for governments to guide change is through specific incentives and economic measures (c) that align with sustainability goals. For example, the cultured meat industry is gaining traction in public investment policies at an international level, as seen in the US, Singapore, and Israel. Although only two companies with patents (out of the top ten globally) are based in Europe—Mosa Meat in the Netherlands and Biotech Foods in Spain—several European countries are allocating substantial funding for research in this emerging field. The Netherlands, the European country most engaged in cultured meat development, recently announced a €60 million investment to support the creation of a national cellular agriculture system (Morrison, 2023).

However, within the European framework, there are significant barriers to advancing food technology innovation, with political commitments facing resistance from livestock breeders and agricultural operators. It is important to note that 50% of breeders' revenue comes from EU subsidies. A major shift towards novel food production, moving away from conventional animal farming, could lead to significant job losses for those currently employed in livestock breeding (Bryant, 2020). Technological innovation raises crucial concerns about the social reproduction of labour forces, which could be disrupted or replaced. Given that one of the key challenges identified by the OECD (2022) is to support farmers' livelihoods throughout the food supply chain, policymakers must carefully consider these social and economic issues when determining economic support for technological innovation.

Several factors have thus far impeded funding and incentives to researching alternative options to traditional meat. These challenges include current livestock farming practices, deep-rooted food traditions, and the interests of various stakeholders (Moritz et al., 2023), including those who advocate for an agroecological transformation of food systems. Agroecology, which emphasizes sustainable farming practices working in harmony with nature, seeks to promote biodiversity, regenerate soil health, and reduce the environmental impact of agricultural activities. Proponents of this approach argue that, rather than focusing on technological innovations such as cultured meat, incentives should centre on improving traditional farming systems through organic practices, polycultures, and local food sovereignty (Martins et al. 2024). This approach represents yet another vision for the future of food production, one that prioritizes maintaining rural livelihoods, enhancing ecosystems, and supporting small-scale farmers. This perspective actually conflicts with the push for high-tech food alternatives, such as cultured meat, which mostly rely on scientific advancements and industrialized processes. For many, the idea of replacing livestock farming with lab-grown alternatives seems incompatible with the goals of agroecology – which values community-driven approaches to food production while prioritizing ecological integrity and cultural traditions. Navigating these competing visions will require careful consideration of the social, economic, and environmental impacts of each approach, ensuring that solutions to the food system's challenges are both equitable and inclusive.

## Food policies and cultured meat: the Italian case

In order to concretely illustrate the dynamics and challenges related to the adoption of novel foods within

the European context, the following section will analyze the Italian case, characterized by an intense debate and specific policy initiatives that reflect some of the tensions also present at the Communitarian level.

The concept of food transition as a "false wicked problem" (Béné and Lundy, 2023) is particularly fitting for the Italian context, given Italy's internationally recognized role in promoting food culture (e.g., the Mediterranean Diet and its numerous renowned designations of origin). Italy also stands out due to the positions held by influential civil society actors, such as the Slow Food movement, farmers' unions, and environmental organizations, alongside Italian governmental institutions. The Italian case raises important questions about various aspects of policy making, particularly by challenging the political and decision-making processes at the national level and examining the relationships between Member States and the European Union. This occurs within a framework where regulatory tools are governed by a multilevel European system. Additionally, the analysis brings to light the tension between ensuring accurate public information through specific information tools and the dynamics related to political consensus-building.

The discussion focuses on the recent stance taken by the Italian government regarding the prohibition of cell-based foods and feeds, both in terms of production and market placement. However, the core of the debate centres on defending the existing meat production system, with its supporting policies shaped by political, economic, and cultural factors. Three main positions have emerged in the debate: *(1)* defenders of the current meat production system, which is regarded as highly valuable by certain groups (including farmers' unions, political parties in power, and some designation of origin consortia); *(2)* critics of both the current system and the cultured meat alternative who mostly advocate for an implementation of agroecology perspective (such as Slow Food, environmental organizations, and organic producers); and *(3)* advocates for cultured meat, who are also critical of the current system (including animal welfare groups, certain environmental associations, and the Green Party).

1. Farmers' organizations strongly oppose the introduction of cultured meat into the market, firmly defending the existing production system. Italy's largest and most influential producers' organization, namely Coldiretti, launched a public campaign against cultured meat in 2022, gaining widespread support from citizens and local public administrations. In response to this growing opposition, and in line with other producers' organizations, the Italian government introduced a draft law in March 2023, effectively blocking any attempts to produce or sell cultured meat. The scope of this law goes beyond cultured meat, aiming to protect Italy's agricultural and food heritage—particularly meat production—due to its strategic importance for national interests. An endorsement from the Grana Padano Cheese Consortium, which represents one of Italy's most economically significant PDO products, further underscores the motivations behind this law. In its statement, the consortium emphasized that "the draft law represents a serious protection for Italian consumers and producers at a time when Italian food and its application to the UNESCO World Heritage List is under attack" (press release, La Repubblica, March 2023).
2. Not all parties of Italian agriculture are united in defending the traditional livestock industry. A broad coalition called "Cambiamo Agricoltura" ("Let's Change Farming") —which includes various environmental and consumer associations, as well as national representatives of organic and biodynamic farming—advocates for a transition in farming practices towards agroecology. The coalition also calls for a comprehensive revision of the European Common Agricultural Policy. Cultural aspects and a shift in the food paradigm are central to the position paper recently published by Slow Food Italia (2023)—a globally recognized association advocating for "good, clean, and fair" food since the 1980s. While acknowledging the unsustainability of the current meat production model, both in terms of productive processes and consumption habits, they argue that "food is, first and foremost, a cultural expression, a language". As an integral part of people's identity, shaped by the exchange of knowledge and traditions, food, according to Slow Food, cannot be reduced to a laboratory product. From this perspective, cultured meat would lose its essential value as food—its connection to the land and local communities. Slow Food Italia contends that shifting from intensive farming to lab-based production does not address the core issues of

a food system increasingly dominated by multinational corporations. Instead, the organization advocates for a radical cultural shift in meat consumption, promoting what they term a "protein transition". This transition emphasizes the importance of plant-based diets while also recognizing the vital role of legumes, particularly for small-scale farmers in mountainous regions (Slow Food Italia, 2023). Other environmental associations have also highlighted the socio-economic costs and environmental impacts associated with current agricultural practices. In response to the challenges posed by intensive livestock farming, a coalition of environmental organizations, led by the Italian branch of the World Wide Fund for Nature (WWF), presented a legislative proposal in March 2024. The proposal calls for the temporary prohibition of new intensive livestock farms and a cap on increasing the number of animals—excluding small-scale farms. Additionally, it advocates for the agroecological transformation of the Italian livestock sector through a National Plan for reconversion (Act of the Deputy Chamber n°1760, March 6, 2024).

3. While all environmental associations agree on the need for a paradigm shift in livestock farming, opinions diverge when it comes to the introduction of cultured meat. Animal welfare organizations and WWF are in favour of exploring the potential of cultured meat, whereas other grassroots movements—such as consumer organizations, certain Catholic community groups, and many national-level environmental associations (including Federparchi and Italia Nostra)—remain more critical (Raimo, 2024). The left-wing parties, currently in opposition in Parliament, are similarly divided over the issue. Some members are reluctant to cede leadership on agricultural matters to the current right-wing government, contributing to the ongoing debate over cultured meat. Researchers in biological and biotechnological sectors have expressed a strong opposition to the law. They highlighted, in the official documents produced during the legislative process, the ineffectiveness of a prohibition based on the precautionary principle, given that robust safety assurance procedures are already in place at the European level under the Novel Food Regulation. They argue that such a ban could have detrimental consequences for Italian research, including reduced funding, the creation of an environment unfavourable to research-driven industries, and the risk of brain drain among researchers in the sector. Ultimately, these factors could lead to Italy's marginalization in a rapidly developing and promising field (Biotecnologi Italiani, 2023; Conti et al., 2023).

Despite the ongoing debate, the law was swiftly and definitively approved by the Italian Parliament in November 2023 (Italian Law 1st December 2023, n.172) with a significant majority, sparking further political controversy and widespread media coverage.

*The regulatory process*

From a regulatory perspective, the rationale behind the law is based on the precautionary principle (Regulation (EC) No. 178/2002) and includes a ban on producing and marketing foods and feeds derived from cell cultures or tissues of vertebrate animals. Additionally, it prohibits the use of the term 'meat' for processed products containing only plant proteins, with the stated goal of protecting both the national livestock industry and ensuring consumers' right to accurate information. This law represents a "rushed approach" —not only in relation to the public debate, but also from a regulatory standpoint. It seeks to preemptively ban a product that has yet to reach the market, in a domain largely governed at the EU level, where both market regulation and safety clearance are already subject to broader oversight. Various non-profit organizations focused on animal welfare, groups promoting cultured meat, certain political parties, and researchers in the field have expressed strong opposition to the law. The main criticalities can be summarized as follows:

- The redundancy of the law, given that the existing European safety evaluation process, which is already built upon the precautionary principle, is sufficiently robust.
- Potential conflicts with the European common market regulations, particularly if cultured meat products are approved by EU authorities.
- A lack of transparency in the parliamentary decision-making process, as not all relevant stakeholders were given the opportunity to present and discuss their positions.
- The negative impact on Italy's research and industrial sectors, as the law hinders the development of this promising technology—potentially stifling innovation and competitiveness.

*Information tools*

As part of the current Italian government's broader effort to preserve national identity the approved law emphasizes protection of the domestic livestock sector, which is regarded as having "significant cultural, socio-economic, and environmental value" (Art. 3). In terms of information, the introduced restrictions on the use of the term 'meat' for the production and marketing of plant-based protein products expanded the scope of the law—yet seems to have remained in the background, hidden in the debate by the stronger discussion on cultured meat. Terms traditionally associated with meat products, as well as specific terminologies used in butchery, charcuterie, and fisheries, are prohibited for products made solely from alternative proteins.
The terminology used in the law to describe cultured meat was "products based on cell cultures" (referred to as "synthetic foods" in the draft law). The debate over the naming of the product highlights how terminological choices are ideologically based and meant to negatively impact consumer perception, given the technical complexity of the topic and the general lack of clarity in informed communication and in public opinion making. A recent survey of Italian citizens revealed that the acceptability of cultured meat is influenced by respondents' political and ideological affiliations—with higher levels of opposition among government supporters. Additionally, a potential priming effect has been hypothesized which suggests that opposition to cultured meat among government supporters may have increased following the government's decision (Dotti Sani et al., 2024).

*Incentives and economic measures*

Regarding incentives and economic tools, while the law does not explicitly ban research on cultured meat, it is expected to have an indirectly negative impact on research funding from both public and private sources. In particular, the potential decrease in public research funding raises concerns for several reasons. Firstly, the existing uncertainties regarding the safety of cultured meat necessitate further study and evidence. Secondly, the actual contribution of industrial cultured meat production towards a more sustainable food system remains to be demonstrated (see Dal Gobbo and Bertuzzi, 2024). The FAO and WHO report (2023) emphasizes the importance of continued investment in research and development to fully assess whether the claimed benefits in terms of sustainability can be achieved.

In January 2024, the European Commission rejected the notification of the law (Notification: 2023/675/IT) since it violates the Article 6 of EU Directive 2015/1535, which requires submitting to the member states for review, through the TRIS procedure, any bill that is potentially not in line with the European single market – a step that Italy did not fully comply with. Given this procedural fault, no judgement of value has been given and, therefore, the law can be judged unenforceable by the national courts (Cappellini, 2024).

At the same time, on January 23, 2024, a communication titled "The CAP's Role in Safeguarding High-Quality and Primary Farm-Based Food Production" (Information n° 5469/1/24 rev1) was presented to the European Council Agriculture and Fisheries (Agrifish) by the Austrian, French, and Italian delegations, with support from the Czech, Cypriot, Greek, Hungarian, Luxembourgish, Maltese, Polish, Romanian, Slovakian, and Spanish delegations. The communication argued that "new laboratory-cultivated food production raises numerous questions that require thorough discussion among Member States, the Commission, stakeholders, and the general public." These questions span ethical, economic, sustainability, social, public health, transparency, and legal concerns. Consequently, the communication calls for a "transparent, science-based, and comprehensive approach" that adheres to dedicated EFSA guidelines, similar to those applied to new pharmaceutical products. It also requests a "comprehensive impact assessment by the Commission, considering all relevant issues, including the views of EU consumers and citizens" before any authorization for sale and consumption is granted. The position expressed in the communication is highly critical of this innovation. However, it marks a shift toward a more institutionalized approach to the debate, advocating for further research, public consultation, and participatory decision-making—political steps that the Italian law had previously bypassed entirely.

## Conclusions

The transition towards more sustainable food systems is a pressing issue that necessitates careful balancing between environmental sustainability, economic viability, and social equity. While the rise of novel foods and alternative proteins, such as cultured meat, may present promising solutions to some of the challenges posed by traditional livestock production, it also introduces complex trade-offs. Some of the challenges include concerns about the high energy demands of new technologies, potential economic disruption, and the socio-cultural implications of changing food systems. Because of these complexities, the management of transition in food systems requires a comprehensive approach that integrates different policy tools (regulation, information and incentives) into a wider framework along with consumer education and inclusive stakeholder engagement. Public food policies play a crucial role in driving societal changes in food consumption patterns and promoting the adoption of novel foods. By adopting and developing more inclusive processes of change, governments could incentivize industries aligned with sustainability goals, regulate food technologies, ensure transparency in communication, all while addressing social values, cultural norms, and economic implications (Ares et al., 2023; Graça et al., 2022). Public awareness campaigns, education initiatives, and transparent communication are essential for shaping consumer perceptions and fostering trust in novel food technologies (Rombach et al., 2022; Siddiqui et al., 2022a).

The Italian case highlights the complexity of such transitions, where political decisions can either facilitate or hinder progress. In 2023, Italy enacted a law banning the production and sale of cultured meat, citing precaution and concerns about food safety as well as consumer information accuracy. This decision, supported by farmers' unions and cultural organizations like Slow Food, reflects broader resistance to lab-grown alternatives in favour of traditional livestock or plant-based protein sources. However, this move has sparked debate and criticism from various stakeholders – including animal welfare groups, cultured meat advocates, and researchers. The European Commission's rejection of the Italian law in 2024 due to violations of EU directives underscores the need for harmonized regulatory frameworks within the EU.

As seen in Italy, the absence of a unified European position on cultured meat and alternative protein labelling creates uncertainty for companies and researchers operating within the common market. A balanced approach, combining evidence-based policymaking with grassroots engagement, is needed to navigate these challenges. Clarity in food labelling, transparent communication, and inclusive decision-making processes are crucial for building consumer trust and promoting informed decision-making. Continued investment in research and development is essential for closing knowledge gaps, evaluating safety, and assessing the potential benefits of cultured meat in achieving a sustainable food system. Ultimately, consumer acceptance and behavioural change will require innovative policies driven by bottom-up engagement involving key stakeholders—consumers, scientists, and producers. These policies must bridge the information gap surrounding new food technologies while recognizing that food extends beyond its nutritional or commodity value. Therefore, an effective management of the food transition requires an integrated approach that consistently utilizes regulatory, informational, and economic tools, also taking into account contextual specificities like the Italian case has been underscoring.

Through a nuanced approach that accounts for the unique social, cultural, and economic contexts of each situation, policy makers could finally realize that "one size does not fit all" and design more tailored policy frameworks that hold the promise of greater sustainability for the years to come.

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# Novel Food Case Study in the EU: Exploring the Interplay Between Risk Assessment and Societal Insights for Communication

Paper first received: 09 February 2024; Accepted: 15 July 2024; Published in final form: 07 January 2025
https://doi.org/10.48416/ijsaf.v30i2.594

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## Abstract

Recent advances in science and consumer demand for new or alternative food products boosted innovation in the food industry, stimulating the production of ever newer foodstuff. In the European Union (EU), when these lack a significant history of consumption, they may qualify as novel foods (NFs) and require a risk assessment by the European Food Safety Authority (EFSA) before they can enter the EU market. In this context, risk communication is crucial in ensuring the public understands any associated risks and requires different approaches according to societal knowledge and risk perception. We identified effective risk communication options for different NFs, accounting for societal insights, media analytics, and technical features. We applied an adapted version of EFSA's approach for planning risk communication of risk assessments' incoming requests on cell culture-derived foods and previously assessed NFs. The study included: categorization according to NF's nature, assessment of their mandates for their risk communication potential, identification of shared features across NF categories potentially triggering societal interest, and gathering of societal insights from literature and media analysis to map elements for risk communication. We recommend enhancing individuals' knowledge of risks through awareness-raising for NFs derived from microorganisms, fungi, or algae, produced with precision fermentation, derived from insects, or plants. For cell culture-derived foods, where public knowledge is higher, communication approaches should instead aim to build trust and resolve differences in views. We further highlight the importance of continuous dialogue between EFSA and stakeholders to ensure tailored risk communication that considers both scientific and societal factors.

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## Introduction

Recent advances in science and consumer demand for new or alternative food products have boosted research and innovation in the food industry, stimulating the production of ever more new foods, food ingredients, and food supplements. Under European Union Regulation (EU) 2015/2283[1], foodstuffs that were not consumed to a significant degree before 15 May 1997 qualify as novel foods (NFs). NFs can be produced using new technologies and processes, derived from new sources, be newly synthesised or isolated substances, or foods traditionally consumed in non-EU countries.

To protect European consumers from potential health risks linked to the consumption of such products, the current EU framework requires food business operators to seek premarket authorisation for their NF products before these can enter the EU market. The European Food Safety Authority (EFSA) is the EU body responsible for providing independent scientific advice to decision-makers during the NFs authorisation process. EFSA performs scientific risk assessments and communicates the outcomes. Each risk assessment follows a structured, multidisciplinary, and evidence-based approach (EFSA NDA Panel, 2021a; Ververis et al., 2020). All EFSA's assessments are then communicated through scientific opinions published in the *EFSA Journal*[2]. In addition to the scientific publication, some risk assessments may be accompanied by targeted risk communication activities, depending on the topic and the findings.

As defined by the Codex Alimentarius (2003), risk communication is "the interactive exchange of information and opinions concerning risk and risk-related factors among risk assessors, risk managers, consumers, and other interested parties". EFSA's risk communication aims to support EFSA stakeholders,[3] risk managers and the public in understanding the reasoning behind science-based assessments and subsequent decisions. Consumers are thus able to make informed choices and control the risks they might encounter, according to their interests and values. Risk communication by EFSA is not intended to persuade people to adopt specific views on risk tolerability or acceptability. It rather serves to promote safe product use, build and enhance trust in risk assessment and risk management, improve public understanding of food safety, and empower consumers to make informed decisions.

Consumers' knowledge and perception result in purchase choices, which may or may not lead to the consumption of NFs. Individual consumption decisions are the outcome of multiple cognitive response layers (see Boehm et al., 2021 on insects; Camarena et al., 2011; EFSA Scientific Committee, 2022). For example, European consumers prioritise food safety and traceability, but personal values and beliefs play a crucial role in affecting food risk perceptions. These factors have been the focus of social research studies on NFs perception and food neophobia (for an overview, see Donadini et al., 2021; Rozin and Vollmecke, 1986; Pliner and Salvy, 2006; Tuorila and Hartmann, 2020). In this context, effective risk communication requires the integration of social science research findings, which consider individual and culturally specific values when raising consumers' awareness, and which support appropriate knowledge and perception of the risk.

For this reason, in the area of risk communication, and in line with the International Risk Governance Center's (IRGC) conceptual framework for understanding risk governance (Florin and Bürkler, 2017; Florin and Parker, 2020), EFSA developed a two-phase approach: Pre-Assessment (Screening), and Appraisal (Risk Perceptions and Social Concerns Assessment). This approach is based on the use of societal insights, analytics, and professional knowledge for assessing incoming risk assessment requests and optimising the planning for its subsequent risk communication (Vrbos et al., 2023). The risk communication's Pre-Assessment phase consists in screening and filtering risk assessment requests using a checklist to determine risk characteristics,

[1] Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods, amending Regulation (EU) No 1169/2011 of the European Parliament and of the Council and repealing Regulation (EC) No 258/97 of the European Parliament and of the Council and Commission Regulation (EC) No 1852/2001.

[2] https://efsa.onlinelibrary.wiley.com/

[3] https://www.efsa.europa.eu/en/engage/stakeholders

public awareness and knowledge, and institutional/market context. A decision tree prompts future risk communication preparations. The Appraisal phase involves gathering societal insights from social research and media analysis to chart elements for risk communication and evaluate the overall sensitivity of the topic. These two phases identify risk communication topics and clusters of interest, create communication objectives and strategies, and, ultimately, aim to lead to standardised communication responses on specific topics.

In the present work, we applied an adapted version of the two-phase risk communication framework described in Vrbos et al. (2023), to NFs that have already been assessed by EFSA and for which published risk assessment outputs are available. These include NFs derived from: microorganisms, fungi, or algae; insects; and plants as well as NFs with modified molecular structure. We were thus able to implement an intermediate phase beyond the standard Pre-Assessment step, by also examining the scientific content of final scientific opinions on NFs. This enabled us to attempt to identify the scientific characteristics of potential public interest.

Additionally, with a view to developing effective risk communication approaches for upcoming NFs, our analyses also considered rapidly evolving fields for food production in areas such as cell culture-derived foods (i.e., food production by the reproduction of animal or plant cells, assisted by tissue engineering techniques) and precision fermentation (referring to the use of engineered microbial cell factories in the production of foodstuffs).[4]

The overall scope of our work was to explore and identify risk communication options that could be effective in addressing the respective observed levels of knowledge and perception for different categories of NFs. To ensure that these communication approaches are tailored to NFs that have shared technical characteristics (e.g., source material, production process) and risks, we considered the interplay between societal insights and media analytics, as well as scientific aspects.

## Methodology

*Novel food mandates - collection and categorisation*

We retrieved NF mandates (i.e., EFSA's incoming risk assessment requests from the EC) falling under Regulation (EU) 2015/2283 and related scientific outputs published from 1 January 2021 to 8 May 2023 (the date on which the data extraction was performed), from the OpenEFSA Portal.[5] The search keywords included "Novel Foods" for the food domain and "Novel Food Authorization" for the authorisation type. By selecting the appropriate status filter, we considered only published NF outputs for which the risk assessment had been completed. We excluded ongoing risk assessments, withdrawn applications, and notifications for traditional foods from third countries.

We classified the resulting NFs according to their nature or that of their source, following the most recent classification described in Article 3 of Regulation (EU) 2015/2283. In brief, each NF was classified using a simplified terminology: a) "Modified molecular structure"; b) "Derived from microorganisms, fungi or algae"; c) "Mineral origin"; d) "Derived from plants or their parts"; e) "Derived from animals or their parts"; f) "Derived from cell or tissue culture"; g) "Derived from novel production process"; h) "Engineered nanomaterials"; i) "Vitamins, minerals and other substances", and j) "Foods other than food supplements".

*Societal insights in risk communication*

We assessed the retrieved NFs by applying an adapted version of the two-phase approach developed by EFSA and described in Vrbos *et al.* (2023) as follows:

[4] https://www.efsa.europa.eu/en/events/efsas-scientific-colloquium-27-cell-culture-derived-foods-and-food-ingredients
[5] https://open.efsa.europa.eu/.

Phase One: mandates assessment of novel foods

**Mandates assessment**

In the mandates assessment step, we evaluated the requests for scientific risk assessments with a "yes/no" answer to the checklist criteria listed in Table 1 below.

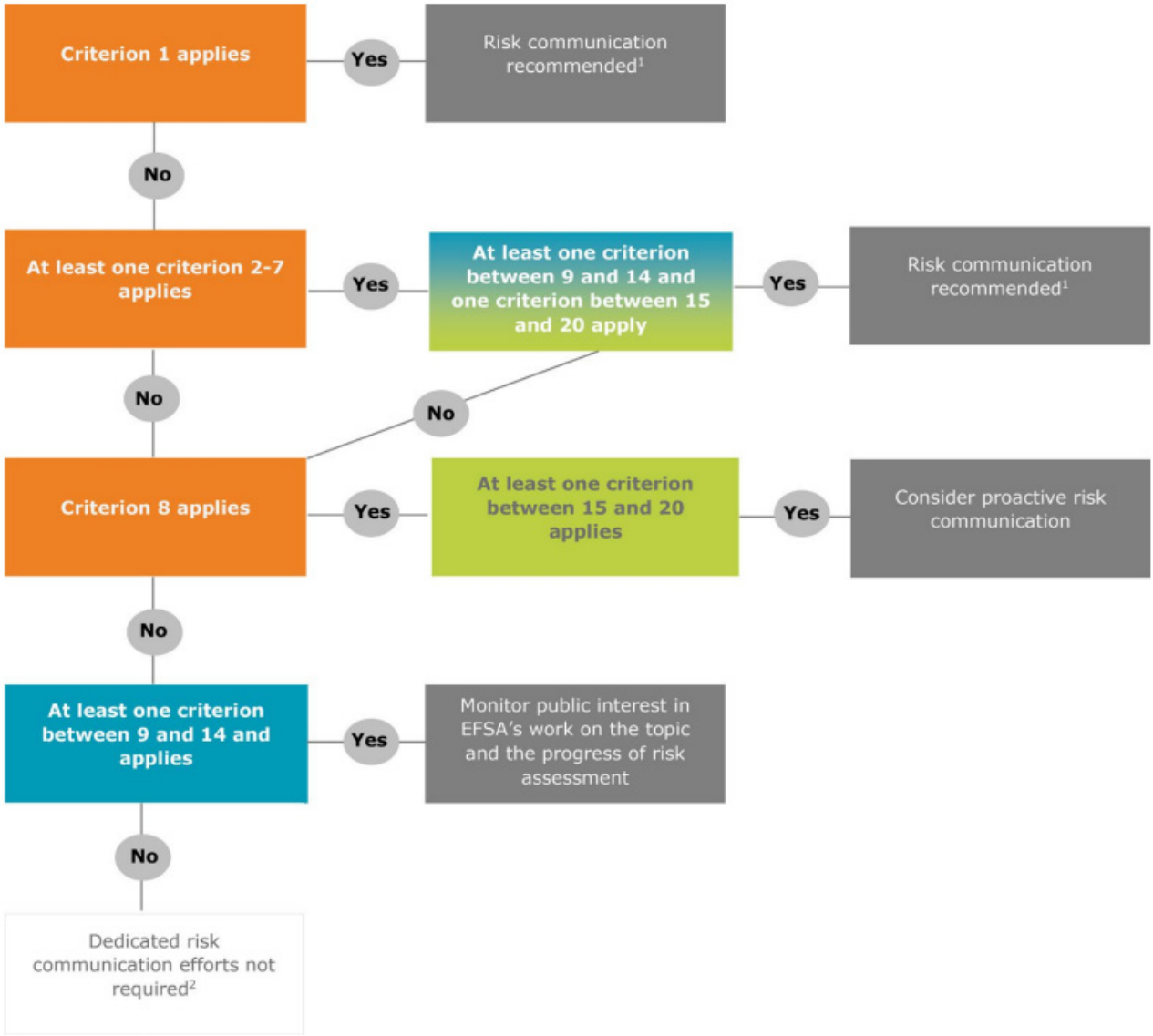
*Table 1 – EFSA Checklist for assessing incoming mandates. From Vrbos et al. (2023)*

| Criterion | Yes/No |
|---|---|
| **i. Nature of the topic** | |
| **1.** Is there (potentially) a significant concern for public health and/or does the risk affect specific vulnerable groups (e.g. pregnant women, children)? | |
| **2.** Is there (potentially) a significant concern for animal health, animal welfare, plant health or the impact on the environment? | |
| **3.** Is the risk man-made (as opposed to naturally occurring)? | |
| **4.** Is the risk emerging/unknown? | |
| **5.** Is this the first time EFSA will assess the risk? | |
| **6.** Is this an urgent request or a Rapid Outbreak Assessment? | |
| **7.** Is this an assessment of a risk that is commonly present in everyday diets or in general a ubiquitous substance? | |
| **8.** Does this topic have the potential to communicate the benefits of EFSA's work (highlighting one or more of its values) or the importance of the EU's food safety system? | |
| **ii. Knowledge and perceptions** | |
| **9.** Has the topic gained significant visibility based on media exposure to date or is it a prominent topic in social media? | |
| **10.** Is there a known pre-existing societal concern around this topic? | |
| **11.** Are there known disagreements or diverging views on this topic (among scientists, within society groups, between scientists and society)? | |
| **12.** Are there known uncertainties related to this topic? | |
| **13.** Does this topic have the potential to negatively affect EFSA's reputation (i.e., could EFSA be questioned in terms of conflict of interest or level of transparency etc.)? | |
| **14.** Does available social research evidence (e.g., EU Insights, Eurobarometer, other recent studies) highlight the topic as an area of concern? | |
| **iii. Institutional and stakeholder interest** | |
| **15.** Is this topic of interest or concern for the European Commission and/or does it have risk management implications? | |
| **16.** Is this topic of interest or concern to the European Parliament? | |
| **17.** Is this topic of interest or concern to Member States' authorities? | |
| **18.** Is this topic of interest or concern to civil society (e.g., consumers, NGOs, or other interest organisations)? | |
| **19.** Is this topic of interest or concern to the scientific community? | |
| **20.** Can the assessment result in policy changes and/or have market impact? | |

Ascertaining knowledge and perceptions regarding specific topics posed a significant challenge in our study due to the limited media exposure and lack of sociological research insights. This was primarily because these topics were predominantly related to new technologies only recently introduced to the EU. Media coverage

existed for crickets and ground mealworms, the sole items featured in EFSA's risk communication activities over the previous five years because they were among the first completed insect assessments in the EU. No other NFs showed more than limited evidence of a societal interest or concern. To address this lack of data, we included an additional step for criterion 9 in our protocol. This involved passing the NFs through a social media monitoring tool[6] by inserting a search string consisting of the NF denominations in English. Examples of keywords used for this step included "novel food" AND "mealworm" OR "shiitake mushroom" OR "mung bean protein". We ran these search strings using a feature in monitoring tools that enables the identification of social media trends. The aim of this step was twofold: first, to determine if the online discourse about certain NFs was more prominent than that about others; and second, to identify NFs within each category that had a relatively high volume of social media activity.

***Figure 1 - Incoming mandates decision tree. From Vrbos et al. (2023). Instructions: Complete the checklist (Table 1), assessing the mandate across all 20 criteria. Then follow the decision tree below, considering 'Nature of the topic' (criteria 1–8) as the starting point.***




[1] *Follow-up required with Scientific Unit for familiarisation with the mandate and planning of risk communication activities. This may result in deployment of one or more tools from EFSA's communication toolkit.*

[2] *Staff are encouraged, however, to promote EFSA outputs such as those they are involved in, via social media, to reach niche audiences and build peer-to-peer networks.*

Following the decision tree for incoming mandate assessment displayed in Figure 1 (Vrbos et al., 2023)

[6] https://www.efsa.europa.eu/sites/default/files/documents/legal/dp/dp-COM5.pdf.

according to the answers provided in the checklist (Table 1), we identified those NFs warranting the potential consideration of risk communication activities and we further investigated them in the successive phases of the evaluation. We note that in practice EFSA does not proactively communicate on assessments of individual NFs submitted as part of an EU market authorisation procedure, other than publication of the final scientific opinion. However, for the sole purpose of this research, we ignored this common practice and assessed individual NFs and their mandates as if supplementary proactive communication were possible.

Intermediate phase: Shared features triggering societal interest

We further screened the NFs that were identified as requiring risk communication activities, based on the outcome of the decision tree presented in Figure 1. This screening aimed to identify shared technical and/or scientific features that could potentially explain the relatively high volume of social media discourse observed for some NFs compared to others.

This analysis had three main objectives: i) to allow for examination of discourse on the NFs most featured on social media, from among all those retrieved in phase one; ii) to identify common features within the same NF category that might contribute to social media prominence and public sensitivity; and iii) to select keywords that could enrich the subsequent analysis (see phase two: appraisal phase).

Phase Two: Appraisal phase

The appraisal phase had two objectives: first, to map the elements to consider for risk communication; and second, to identify the overall degree of sensitivity of the subject matter, considering concerns, expectations and risk perceptions.

NFs that warranted risk communication activities according to Figure 1 were considered in the phase two analysis. However, in the appraisal phase, due to the granularity of available data, and to draw more general conclusions, we focused on NF categories as described in Article 3 of Regulation (EU) 2015/2283 and/or the key shared characteristics identified in the intermediate phase, rather than on individual NFs. We assumed that NFs share common features in terms of public sensitivity across the same category. Therefore, we used proxy keywords for the category itself (see the social research data and public discourse sections).

Furthermore, assuming a potential increasing prevalence of NFs in the coming years, the "Derived from cell or tissue culture" NF category was included and further analysed.

Finally, in phase two, we also investigated NFs in general. Importantly, we included "alternative proteins" (i.e., those not derived from traditional sources such as animals or legumes) in the research activities. While they may not necessarily fall into a specific category of NFs, we considered them as they have the potential to qualify as such. Additionally, we noted that these alternative proteins are often the subject of social media discourse as they can impact consumption behaviours and have societal implications related to animal welfare and climate change (Siegrist and Hartmann, 2023). It should be noted that the term "alternative" was used for literature search purposes only and does not imply any judgment or bias regarding the suitability of alternative proteins as substitutes for traditional protein sources in diets. "Alternative proteins" was used as a proxy for "Novel proteins" due to its more widespread usage and representation in the existing body of published literature. It was also assumed that the term "alternative", would also cover "novel proteins" – thus retrieving relevant literature.

**Social research data**

To explore public perceptions of NFs, we performed a scientific literature search on Google Scholar using the following keywords: "novel foods" OR "alternative proteins" OR "cell culture derived food" OR "cultured meat" OR "lab-grown food" OR "edible insects" OR "plant-based food" OR ("precision fermentation" OR

fungi OR algae AND food) AND "risk perception" OR "attitude" OR "concern". Google Scholar was used as it is a free access literature search engine, ensuring that our search is transparent and can potentially be replicated by other scientists without restriction due to access to paid databases. We focused on recent literature published in the last ten years in scientific peer-reviewed journals, and we assessed the first 20 pages of the search. The decision to include the first twenty pages was based on the authors' experience conducting similar reviews and the assessment of the relevance of the identified papers for this specific work. We selected the articles based on title screening first, and the abstract as the second selection criterion.

**Public discourse**

We conducted the social media analysis with the social media monitoring tool,[7] however using a feature that allows tracking of a topic over time. Our analysis of the social media discourse related to NFs covers the same timeframe as the collection of NF outputs (i.e., 1 January 2021 to 8 May 2023), and includes data from the social media network X in all EU countries.[8] The social media query on NFs is available in Annex A. It includes keywords in English related to novel food, translated into French, German, Italian and Spanish.

The social media monitoring tool provides the social media volume, that is, the exact number of posts in a given period. Likewise, it provides social media engagement. An engagement is considered as a reaction to a post such as a repost, a share, a reply or a comment. Additionally, the tool presents information on the sentiment over a given period. The sentiment is rated by the social media monitoring tool on a scale from -50 to +50, where a score from -50 to around -15 indicates negative sentiment, from -14 to +14 indicates neutral, and from +15 to +50 indicates positive.

Filters could be applied in the social media monitoring tool to select specific segments of the data, for instance, those focusing specifically on one subtopic of the query or data coming from a specific geographical area.

**Risk communication advice**

Once the topic profiling was finalised, we calculated a value of concern by positioning the topic on a two-axe graph with knowledge on the x-axis and risk perception on the y-axis.

'Knowledge' includes four types of information gathered through the assessment: 1) self-reported awareness; 2) self-reported knowledge; 3) objective knowledge; and 4) social media volume. Based on the findings of the assessment, a value of −1 (low), 0 (medium), or +1 (high) was assigned through expert judgment to each type of information.

The same system was applied for 'Risk perception', which also includes four types of information: 1) self-reported concern; 2) self-reported importance; 3) self-reported interest; and 4) social media sentiment. Mirroring the process explained above for 'knowledge', a value of −1 (low), 0 (medium), or +1 (high) was assigned through expert judgment to each type of information.

## Results & Discussion

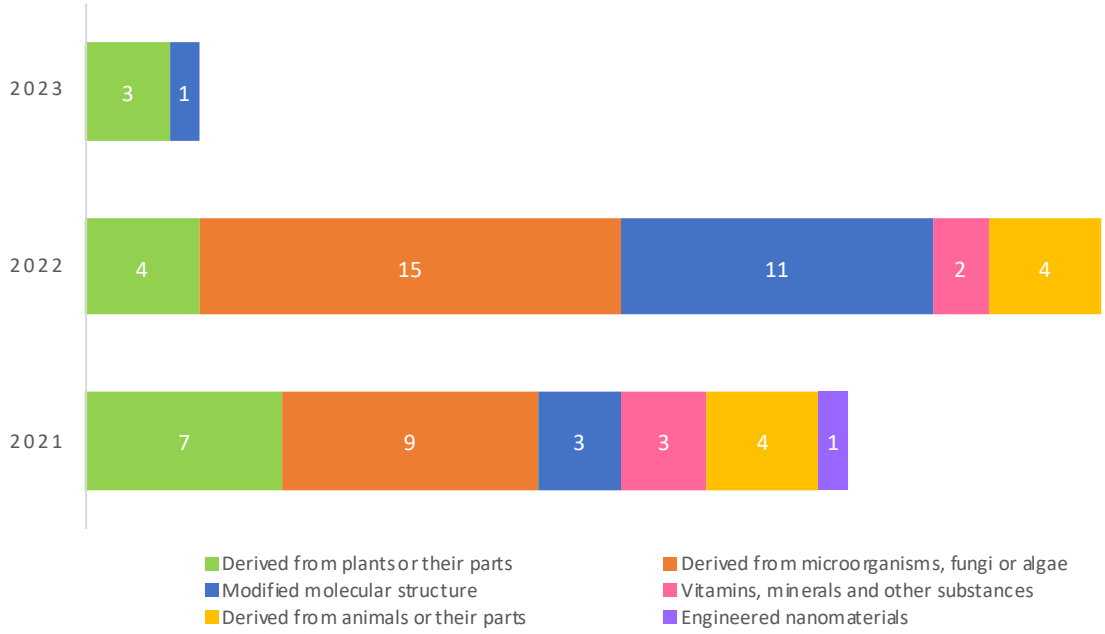
*Novel foods mandates - collection and categorisation*

Fifty-four NF mandates met the inclusion criteria (described in phase one). Mandates and respective scientific opinions retrieved from this search are provided in Annex B together with their respective categorisation. A summary of the results is reported in Figure 2. A NF may fall under one or more categories. In the latter case, the NF was assigned a double categorisation accordingly (see Annex B). Over the period studied, the highest number of outputs was observed for the following categories: "derived from microorganisms, fungi or algae" (n=24); "modified molecular structure" (n =15); "derived from plants or their parts" (n=14); and "derived from

[7] https://www.efsa.europa.eu/sites/default/files/documents/legal/dp/dp-COM5.pdf.
[8] Previously twitter. https://twitter.com/

animals or their parts" (n=8). Five scientific opinions were published for the NF category "Vitamins, minerals, and other substances" in 2021 and 2022, and one for "Engineered nanomaterials" in 2021. No NF opinions were published in the analysed timeframe for the following categories: "Mineral origin", "Derived from cell or tissue culture", "Derived from novel production process", and "Foods other than food supplements".

***Figure 2*** *- Number of NF outputs published per year (1 January 2021-8 May 2023) and per category for mandates received by EFSA falling under Regulation (EU) 2015/2283*




*Societal insights in risk communication*

Phase One: mandates assessment of novel foods

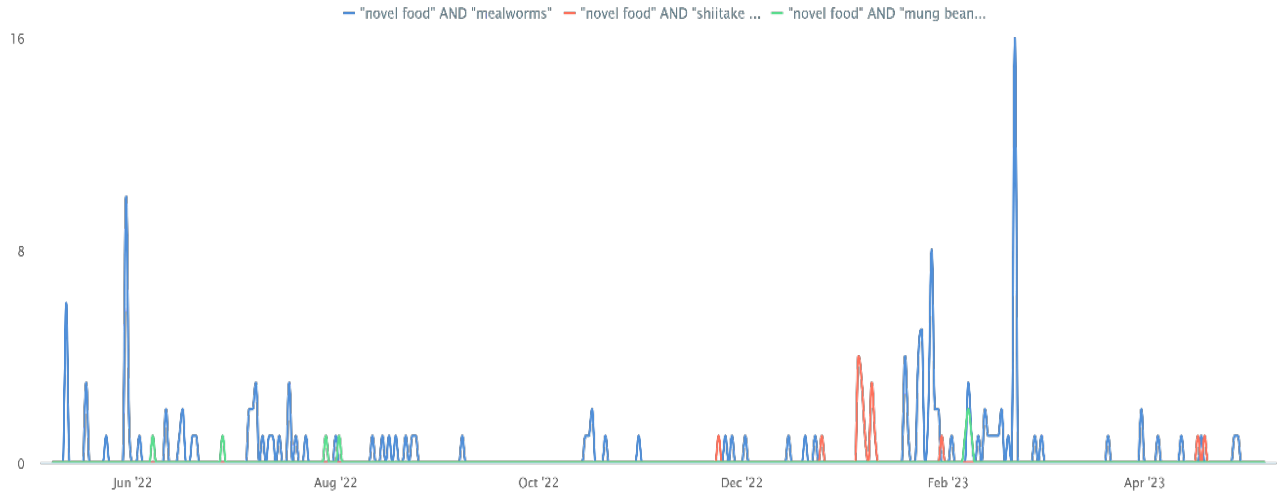
**Mandates assessment**

Based on our evaluation of scientific risk assessments related to NFs using the 20-criteria checklist (Table 1), we found that for all retrieved NFs (Annex B), the specific topic related to a NF had not been previously evaluated by EFSA (criterion 5 was met), and the authorisation of these NFs for entry into the EU market could have a market impact (criterion 20 was met).

In addition, we used a social media monitoring tool[9] to perform an analysis for criterion 9. Figure 3 shows an example from a one-year timeframe on the x-axis, from 8 May 2022 to 8 May 2023. The y-axis indicates the number of posts collected on that date; for instance, the highest peak with sixteen social media posts was reached on 21 February 2023 for mealworms. This analysis revealed that the specific topic of only thirteen NFs across four categories (i.e., "derived from microorganisms, fungi or algae", "modified molecular structure", "derived from plants or their parts", and "derived from animals or their parts") was prominent in social media (criterion 9 was met). Based on these findings, risk communication is recommended for these thirteen NFs, listed in Table 2 along with their respective NF categorisation, as they met three criteria (i.e., 5, 9, and 20).

[9] i.e., https://www.efsa.europa.eu/sites/default/files/documents/legal/dp/dp-COM5.pdf

***Figure 3 – An example search in one-year timeframe (8 May 2022-8 May 2023) performed for "mealworms", "shiitake", and "mung bean" as NFs on the social media listening tool to check the social media volume of NF mandates***




In summary, our analysis of published NF assessments by EFSA in phase one revealed that, regardless of their category, NFs are a sensitive topic due to institutional and stakeholder interests. However, NFs in the categories of "modified molecular structure", "derived from microorganisms, fungi or algae", "derived from plants or their parts", and "derived from animals or their parts" had a relatively high level of social media activity compared to other categories. These indications guided our investigation into the factors behind this activity, to inform potential risk communication strategies.

It is important to note that although EFSA did not publish any scientific opinions on NFs "derived from cell or tissue culture" during the timeframe of our analysis, this category of NFs generated significant interest on social media in terms of the number of posts and engagement. This indicates a high level of societal interest in this category of NFs.

Intermediate phase: Shared features triggering societal interest

To identify potential technical and/or scientific similarities across NFs belonging to the same category that may be responsible for triggering social media prominence, we examined the content of the thirteen NF scientific opinions listed in Table 2.

**Modified molecular structure + Derived from microorganisms, fungi or algae**

Lacto-N-neotetraose (EFSA NDA Panel, 2022a) and Lacto-N-tetraose (EFSA NDA Panel, 2022b) are categorised as "Modified molecular structure" and "Derived from microorganisms, fungi or algae" NFs. They are human identical milk oligosaccharides (i.e., identical in structure to oligosaccharides naturally present in breast milk) produced through fermentation with engineered microbial cell factories, i.e., genetically modified strains of *E. coli* K-12 BL21, and BL21 (DE3), respectively. The EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA Panel) concluded that they are safe for human consumption under the proposed conditions of use, as they are chemically and structurally identical to human milk oligosaccharides and do not contain viable cells, DNA, or toxicologically relevant effects.

These NFs share similar production processes, which are referred to as precision fermentation in the context of this publication.[10] Additionally, both Lacto-N-neotetraose and Lacto-N-tetraose are intended for uses in infant formula. These factors could have contributed to societal interest, but precision fermentation is the aspect that sets them apart as NFs. Therefore, precision fermentation was a key aspect investigated in phase two.

[10] https://www.efsa.europa.eu/en/events/efsas-scientific-colloquium-27-cell-culture-derived-foods-and-food-ingredients

*Table 2 - List of NF mandates holding three criteria according to the EFSA checklist (Table 1) and selected for their relatively high social media prominence*

| Mandates | NF Category | Reference to the scientific opinion |
|---|---|---|
| Request for a scientific opinion on Lacto-N-neotetraose as a novel food (NF 2019/1359) | • Modified molecular structure<br>• Derived from microorganisms, fungi or algae | (EFSA NDA Panel, 2022a) |
| Request for a scientific opinion on Lacto-N-tetraose (LNT) as a novel food (NF 2020/1809) | | (EFSA NDA Panel, 2022b) |
| Request for a scientific opinion on Yarrowia lipolytica yeast biomass as a novel food (NF 2020/1950) | • Derived from microorganisms, fungi or algae | (EFSA NDA Panel, 2022c) |
| Request for a scientific opinion on pea and rice protein fermented by Shiitake mushroom (Lentinula edodes) mycelia as a novel food (NF 2019/1459) | | (EFSA NDA Panel, 2022d) |
| Request for a scientific opinion on Galacto-oligosaccharide as a novel food (NF 2020/1607) | | (EFSA NDA Panel, 2021b) |
| Request for a scientific opinion on dried mealworms (Tenebrio molitor) as a novel food (NF 2018/0241). | • Derived from animals or their parts | (EFSA NDA Panel, 2021c) |
| Request for a scientific opinion on whole and ground grasshoppers (Locusta migratoria) as a novel food (NF 2018/0803). | | (EFSA NDA Panel, 2021d) |
| Request for a scientific opinion on whole and ground crickets (Acheta domesticus) as a novel food (NF 2018/0804). | | (EFSA NDA Panel, 2021e) |
| Request for a scientific opinion on whole and ground mealworms (Tenebrio molitor) larvae as a novel food (NF 2018/0802). | | (EFSA NDA Panel, 2021f) |
| Request for a scientific opinion on defatted whole cricket (Acheta domesticus) powder as a novel food (NF 2019/1227) | | (EFSA NDA Panel, 2022e) |
| Request for a scientific opinion on frozen and freeze-dried formulations of the lesser mealworm (Alphitobius diaperinus larva) as a novel food (NF 2018/0125) | | (EFSA NDA Panel, 2022f) |
| Request for a scientific opinion on mung bean protein as a novel food (NF 2020/1651) | • Derived from plants or their parts | (EFSA NDA Panel, 2021g) |
| Request for a scientific opinion on whole seeds of oilseed rape as a novel food (NF 2018/0590). | | (EFSA NDA Panel, 2023) |

**Derived from microorganisms, fungi or algae**

Dried and heat-killed biomass of *Yarrowia lipolytica* is a NF derived from microorganisms. In 2019, the NDA Panel had already concluded that the NF was safe (EFSA NDA Panel, 2019). Hence, when in 2022, EFSA assessed the request for its extension of use as a food ingredient in single meal replacement products for weight reduction, no toxicological studies were required. No other concerns arose from its composition or nutritional assessment (EFSA NDA Panel, 2022c). It was therefore concluded that *Yarrowia lipolytica* yeast biomass was safe under the extended proposed conditions of use.

Similarly, the risk assessment of pea and rice protein fermented by Shiitake (*Lentinula edodes*) mycelia (EFSA NDA Panel, 2022d) did not raise safety concerns, and no toxicological studies were required given the history of safe use of the individual components. Microorganisms were used in the production process to improve the organoleptic properties of plant proteins. Neither the presence of contaminants nor the nutritional profile

raised safety concerns. Potential sensitisation of individuals or induction of allergic reactions in individuals allergic to pea, rice and Shiitake mushrooms could not be excluded but did not raise safety concerns, and no toxicological studies were required given the history of safe use of the individual components.

Galacto-oligosaccharides (GOS) produced enzymatically by two β-galactosidases had previously been authorised for the EU market to be used as food ingredients, infant and follow-on formulae, baby foods and food supplements[11] as replacements for sugars. In 2021, EFSA assessed the change in their conditions of use with a proposed new use level increasing that previously authorised for use in food supplements (EFSA NDA Panel, 2021b). The NDA Panel concluded that the proposed changes did not raise safety concerns.

No common element could be established across these NFs in the "derived from microorganisms, fungi or algae" category to explain why they could have triggered public discourse, besides the fact that they are derived from microorganisms.

**Derived from animals or their parts**

Out of eight NFs in the "derived from animals or their parts" category assessed by EFSA, six were insect-derived. Specifically, these NFs were derived from lesser mealworm (*Alphitobius diaperinus* larva) (EFSA NDA Panel, 2022f), house cricket (*Acheta domesticus*) (EFSA NDA Panel, 2021e; EFSA NDA Panel, 2022e), yellow mealworm (T*enebrio molitor* larva) (EFSA NDA Panel, 2021c; EFSA NDA Panel, 2021f), and migratory locust (*Locusta migratoria*) (EFSA NDA Panel, 2021d), and were proposed for use as whole foods (i.e., the whole insect) and/or as food ingredients in diverse food products. Their allergenicity potential was consistently indicated in all six scientific opinions. Due to the cross-reactivity of the insects' proteins to other allergens, these NFs might induce allergic reactions in individuals who are allergic to crustaceans, mites, and molluscs. Moreover, insect proteins might trigger allergic reactions due to primary sensitisation, and the presence of allergens from the animal feed could not be excluded. Allergenicity apart, the NDA Panel concluded that all these insect-derived NFs were safe under the proposed conditions of use.

All six insect-derived NFs resulted in a recommended risk communication in phase one, and the nature of their source (i.e., insect) was considered a key factor in the relatively high level of engagement on social media.

**Derived from plants or their parts**

Mung bean protein is a NF in the "derived from plants or their parts" category. It is extracted from seeds of the *Vigna radiata* plant and was proposed for use as a food ingredient in protein products. Considering the composition of the NF and the proposed conditions of use, the NDA Panel concluded that consumption of the NF was not nutritionally disadvantageous, and while caution was warranted due to its potential to cause allergic reactions in individuals allergic to legumes and birch pollen, it was deemed safe for consumption under the proposed conditions of use (EFSA NDA Panel, 2021g).

Whole seeds of oilseed rape (*Brassica napus* L emend. Metzg.) were proposed as a food ingredient in bread and rolls and gluten-free bread (EFSA NDA Panel, 2023). For this NF, the NDA Panel could not establish their safety because of the significant presence of antinutrients, which would lead to the consumption of high levels of glucosinolates (EFSA NDA Panel, 2023).

No common elements that could have triggered public discourse, besides the category itself, could be established across NFs "derived from plants or their parts".

Overall, the screening of NFs identified in phase one revealed that production processes involving precision fermentation were a distinguishing factor for NFs categorised as "Modified molecular structure + Derived

[11] Commission Implementing Regulation (EU) 2017/2470 of 20 December 2017 establishing the Union list of novel foods in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. OJ L 351, 30.12.2017, p. 72–201.

from microorganisms, fungi, or algae". Similarly, insects as source material were identified as the key factor of the significant engagement on social media within the category of NFs "derived from animals or their parts". Therefore, precision fermentation and insect-derived foods were further investigated within their respective categories.

On the other hand, no common element generating relatively high volumes of social media discourse could be established across NFs "derived from microorganisms, fungi or algae" alone and "derived from plants or their parts", apart from the category itself.

This underscores that while it may be possible to develop a risk communication strategy based solely on a NF category, there are cases where it is essential to comprehensively screen the specific and technical features that could affect the public interest. This approach is necessary to avoid over-generalising communication approaches.

Phase Two: Appraisal phase

After analysing the results from phase one and the intermediate phase, in phase two we investigated NFs in general and focused only on the following NF categories and aspects:

- Derived from microorganisms, fungi or algae
- Derived from plants or their parts
- Derived from animals or their parts based on insect-derived foods
- Modified molecular structure based on precision fermentation
- Derived from cell or tissue culture.

**Social Research Data**

Our scientific literature search resulted in twenty-eight relevant papers, out of which ten were literature reviews and eighteen were experimental research papers (Annex C).

Sociological research data on NF technologies (Siegrist and Hartmann, 2020a; Siddiqui et al., 2022) show that consumers' acceptance is influenced by two main factors: the characteristics of the food technology, i.e., if it is perceived as natural, under one's control, not dreaded, and exposure is perceived as voluntary; and the individual's characteristics, such as disgust sensitivity, food technology neophobia, and cultural values. These factors have an impact on the heuristics that consumers adopt, specifically "affect heuristic", "natural-is-better heuristic", and "trust heuristic" (for a definition of these heuristics see Siegrist and Hartmann, 2020a).

On the one hand, aspects like nutritional quality, novelty effect, low price, environmental impact, sustainability, and animal welfare could trigger consumers' interest in NFs, particularly in alternative proteins. Health reasons, rather than sustainability, environmental, or animal welfare concerns, are the most influential motivations for trying NFs. On the other hand, the sensory appeal, high price, and perceptions about the safety of NFs are barriers that prevent consumers from accepting these products (Tso et al., 2020). Perceptions vary, based on the type of NF. For example, for alternative proteins, consumers' perception and acceptance of plant-based proteins (including legumes and pulses) is more positive than for insect-based and cell culture-derived NFs, which are seen as less positive and the least accepted (Faber et al., 2021; Onwezen et al., 2021; Possidónio et al., 2021; Siegrist and Hartmann, 2023).

European consumers' perception and acceptance of insect-based meat alternatives have received extensive attention in the social science literature in recent years. Research shows that human consumption of insects, i.e., entomophagy, is influenced by a variety of factors. In particular, food neophobia and disgust are the most influential psychological barriers affecting the willingness to try insects (Verbeke, 2015; Tan et al., 2016; de Koning et al., 2020; Ardoin and Prinyawiwatkul, 2021). On the other hand, more neophilic individuals, younger generations, and people who have already heard of entomophagy or eaten insects in their life are more open

to adopting insects as meat substitutes (Hartmann and Siegrist, 2016; Wendin and Nyberg, 2021; Caparros Megido et al., 2016). The degree of processing can have an impact on acceptance, as studies have shown that the less recognisable insects are, e.g., presented as flour or as ingredients in burgers instead of whole, the more positive reactions are reported by study participants (Gmuer et al., 2016). A recent study has shown that the use of attractive packaging can also influence consumers' acceptance of insect-based food, pointing out that abstract or stylistic representations of insects are less repulsive than realistic images (Marquis et al., 2023).

Another alternative protein that has been researched from a social science standpoint is cell culture-derived meat. A study conducted in Belgium, Portugal, and the United Kingdom (Verbeke et al., 2015a) showed that the perception of potential personal and societal risks outweighs the perceived benefits, as these are believed to affect global society rather than the individual, meaning that they are seen as distant. In terms of social risks, consumers are concerned about the loss of culinary traditions, rural livelihood, and the preservation of livestock. A cross-country study revealed that there are cultural differences in acceptance, with lower levels in countries like France and higher levels in countries like Mexico, South Africa, and the United Kingdom (Siegrist and Hartmann, 2020b).

Other barriers that affect the consumption of cell culture-derived meat are repulsion/disgust, the so-called "yuck factor" or the perception of unnaturalness and the unknown. It is also linked to consumers' uncertainty about safety issues, e.g., nutritional deficiencies, potential adverse effects, and long-term health consequences (Verbeke et al., 2015b; Tomiyama et al., 2020; Wilks et al., 2021). Factors facilitating acceptance are high concern for the environment and animal welfare, as well as previous consumption of meat substitutes.

Some research in the United States explored the impact of the name used to refer to cell culture-derived meat on acceptance and found that "lab-grown meat", "animal-free meat", and "cultured meat" were perceived as negative due to associations with artificialness and unnaturalness, whereas the term "clean meat" was perceived as positive, associated with healthiness and tastiness (Bryant and Barnett, 2019). In terms of frames, more technical frames were perceived negatively, while frames focusing on the societal benefits and presenting the product as "same meat" were perceived more positively (Bryant and Dillard, 2019).

Few recent papers have focused on NFs produced by precision fermentation (Broad et al., 2022, Banovic and Grunert, 2023). Broad et al. (2022) investigated consumer perceptions of "animal-free dairy" during a virtual focus group of potential "early adopters" of alternatives to animal dairy from Germany, United Kingdom, United States, and Singapore. The study revealed concerns about the potential health risks to humans. The authors concluded that consumers' acceptance of "animal-free dairy" products will probably increase if advantages related to the safety of these products, sensorial characteristics and nutrition, along with environmental effects and animal welfare, can be clearly demonstrated compared to conventional alternatives. A quantitative study on a representative sample of the Danish, German, and Polish populations confirmed the qualitative findings, showing that framing this technology as natural and similar to traditional fermentation increased acceptance, trust levels, and perceived benefits (Banovic and Grunert, 2023).

Research on perceptions of microorganisms, fungi, and algae is still in the early stages. One study (Van der Stricht et al., 2023) assessed consumers' willingness to buy food made with microalgae proteins in five EU countries (Germany, Hungary, Italy, Spain, and the Netherlands). Results showed that willingness to pay was affected by the product label; it was the highest for organic labels, followed by labels indicating that it was healthy and nutritious, and it was lowest for a vegan label. It is noteworthy that one in six respondents decided to opt out of choosing a product made with microalgae due to high cost or lack of familiarity or sensory appeal.

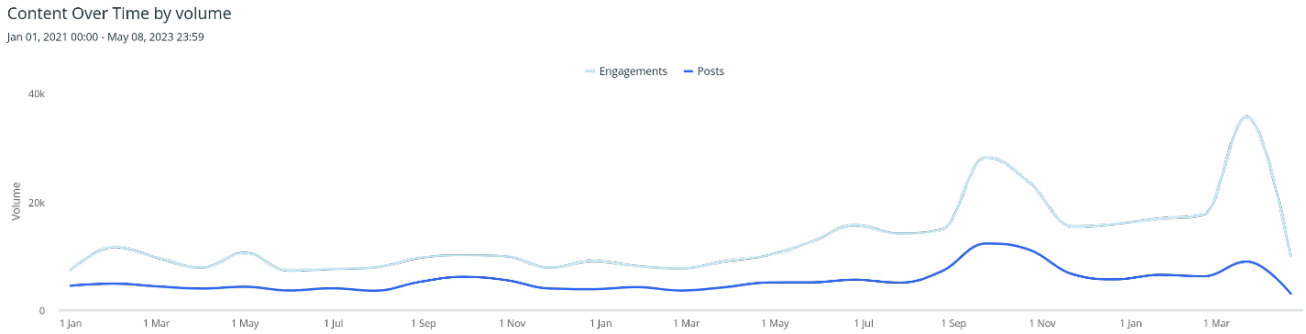
Finally, NFs "derived from plants or their parts" have been studied when comparing perceptions of insect-

based versus cell culture-derived versus plant-based proteins. A recent review (Siegrist and Hartmann, 2023) providing an overview of perceptions and acceptance of these alternative proteins in Western countries showed that plant-based proteins are perceived as healthy and acceptance as meat replacement is high. By contrast, insect-based and cell-culture-derived proteins are perceived as unhealthy, and acceptance as meat replacement is low.

**Public discourse**

The social media discourse on NFs was tracked through 429K posts spread across the selected timeframe i.e., 1 January, 2021 - 8 May 2023 (Figure 4).

***Figure 4 - Overview of social media on NFs, 1 January, 2021 to 8 May, 2023, with indication of number of posts and engagement level (i.e., likes, shares) in the period 1 January, 2021 to 8 May 2023***




Such results refer to the discourse about NFs in general. Table 3 presents an overview of the metrics for NFs and each NF category separately, along with a summary of the peaks in their volume of discussion.

***Table 3 - Overview of the metrics for NFs in general and each category separately, including an overview of the peaks in volume***

| | **Novel foods based on alternative proteins** | **Of which Derived from animals or their parts based on insect-derived foods** | **Of which Derived from microorganisms, fungi or algae** | **Of which Modified molecular structure based on precision fermentation** | **Of which Derived from plants or their parts** | **Of which Derived from cell or tissue culture** |
|---|---|---|---|---|---|---|
| Volume (posts) | 429K | 4K | 1.7K | 329 | 10K | 57K |
| Sentiment (-50 to 50) | 3.2 | -5 | 3.8 | 11 | 5 | -2.8 |
| Peaks (number of posts)/ topic | March-April 2023 (37K)/ cell-culture-derived food | July-August 2022 (647)/three insects approved as novel food in the EU | August-September2022 (137)/ new research studies on algae | June-July 2022 (22)/discourse related to precision fermentation applied to plants and fungi | July-August 2022 (552)/ discussions on banning the use of names like "steak" for plant-based protein products | April-May 2023 (12K)/ discussions around ban |

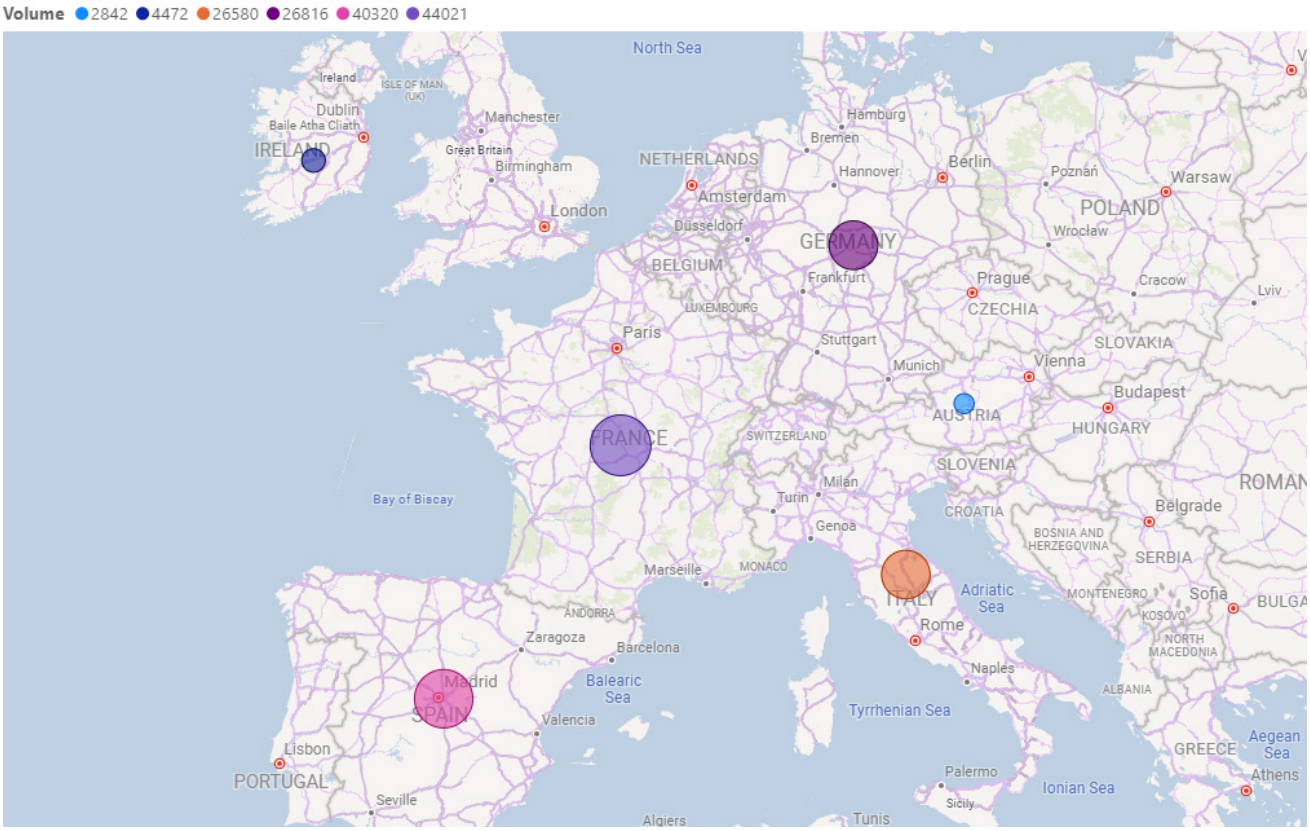
In the area of NFs as alternative proteins, among the NF categories with the highest social media prominence, cell culture-derived food was the most discussed, with a social media volume of 57K out of 429K of the total social media posts on NFs. The least discussed NF category was "Modified molecular structure" with only

329 posts identified.

Overall, the sentiment was neutral across the EU, independently of the NF category, i.e., scores included between -14/+14 scores. Nonetheless, NFs "Derived from animals or their parts" and "Derived from cell or tissue culture" were the only two categories with a sentiment scoring below 0 (i.e., -5 and -2.8 respectively). Notably, the NF category with the lowest social media volume (i.e., "Modified molecular structure"), showed the highest sentiment score, with a 11.

For the analysis of the geographical distribution of the discourse in the period 1 January 2021 to 8 May 2023, we focused on countries where English, French, German, Italian, and Spanish are predominantly spoken, given that the keywords in the query were translated into these languages. The top countries talking about NFs were France (30.4%), followed by Spain (27.9%), Germany (18.5%) and Italy (18.4%). The social media discourse on NFs was the lowest in Ireland (2.8%) and Austria (1.8%) (Figure 5).

***Figure 5 - Differences in social media volume between European countries included in the analysis in the period 1 January 2021 to 8 May 2023***




On the topic of insect-based NFs, Germany was the only country with more positive than negative discourse, whereas all other EU countries talked about them in either a neutral or a more negative than positive way. Furthermore, the sentiment for cell culture-derived foods was more positive than negative in Austria, France, Ireland, and Germany (average of 36% positive vs 25% negative and 39% neutral). On the other hand, it was more negative than positive for Spain (33% negative vs 16% positive and 51% neutral) and Italy (30% negative vs 20% positive and 50% neutral). No geographical differences were noted for all the other NF categories, for which the discourse was neutral throughout all the countries included.

Such differences in terms both of engagement and of sentiment may be due to cultural diversity, as also indicated in the publicly available literature. Hence, the overall 'neutral' perception of NFs and their categories may also be associated with a polarised discussion.

**Risk communication advice**

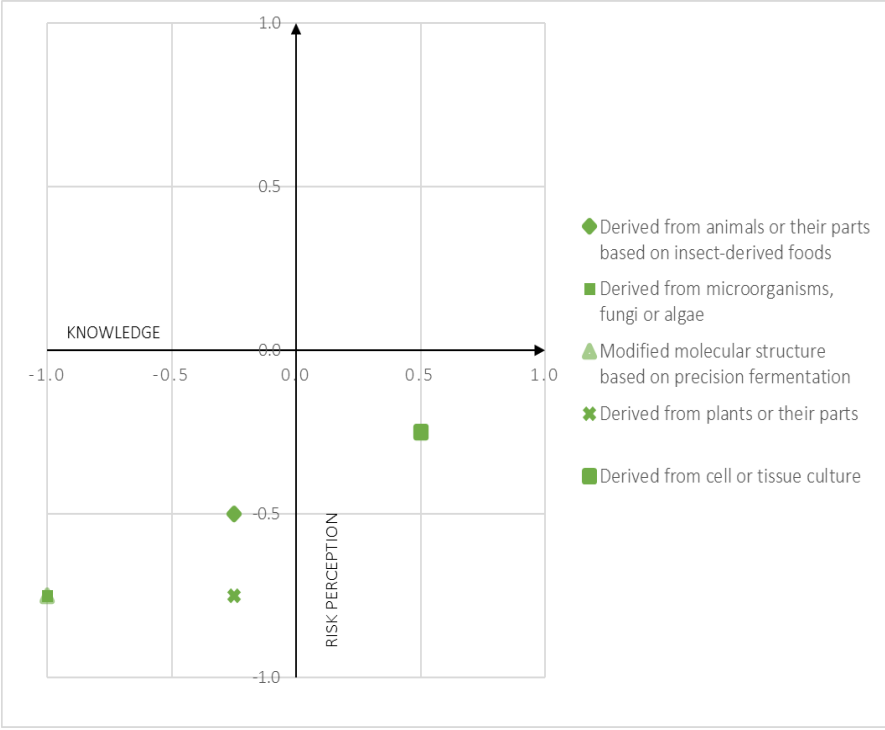
Based on the analysis of secondary social research data and primary social media discourse data, we assigned a value of -1 (low), 0 (medium) or 1 (high) to each component of knowledge and risk perception for each NF category (Table 4).

*Table 4 - Overview of assigned values for each NF category and the average for knowledge and perception*

| | Derived from animals or their parts based on insect-derived foods | Derived from micro-organisms, fungi or algae | Modified molecular structure based on precision fermentation | Derived from plants or their parts | Derived from cell or tissue culture |
|---|---|---|---|---|---|
| **Self-reported awareness** | 0 | -1 | -1 | 0 | 1 |
| **Self-reported knowledge** | 0 | -1 | -1 | 0 | 1 |
| **Objective knowledge** | 0 | -1 | -1 | 0 | 0 |
| **Social media volume** | -1 | -1 | -1 | -1 | 0 |
| **KNOWLEDGE** | **-0.25** | **-1** | **-1** | **-0.25** | **0.50** |
| **Self-reported concern** | 0 | -1 | -1 | -1 | 1 |
| **Self-reported importance** | -1 | -1 | -1 | -1 | -1 |
| **Self-reported interest** | -1 | -1 | -1 | -1 | -1 |
| **Social media sentiment** | 0 | 0 | 0 | 0 | 0 |
| **RISK PERCEPTION** | **-0.50** | **-0.75** | **-0.75** | **-0.75** | **-0.25** |

The intersection between knowledge and risk perception results in a four-quadrant system displayed in Figure 6. The categories "Derived from animals or their parts", "Derived from microorganisms, fungi or algae", "Modified molecular structure", and "Derived from plants or their parts" fall in the low-knowledge/low-risk perception quadrant, while cell culture-derived food falls in the high-knowledge/low-risk perception quadrant.

*Figure 6 - Representation of the position of each NF category in the knowledge-risk perception plot*




All the collected information allowed us to place NF categories on the knowledge-risk perception plot

and analyse them from a risk communication standpoint. Out of the four risk communication objectives (EFSA 2021; Renn, 2009; Vrbos et al., 2023), "enlightenment" is deemed most appropriate for the categories in the low knowledge/low risk perception quadrant (i.e., "Derived from animals or their parts" based on insect-derived foods, "Derived from microorganisms, fungi or algae", "Modified molecular structure" based on precision fermentation, and "Derived from plants or their parts" NF categories). On the other hand, "confidence-building" and "cooperative decision-making" are the most appropriate for the high knowledge/low risk perception quadrant (i.e., NFs derived from cell or tissue culture).

The "enlightenment" objective aims at enhancing the individual's understanding and knowledge of risks through awareness raising or presentation of risk assessment findings. As an example, when EFSA published a series of scientific opinions on NFs, including the first completed assessment of a proposed insect-derived food product, the "news story" presented the assessment findings while acknowledging public perceptions and potential societal concerns derived from social and cultural experiences (i.e., the "yuck factor").[12]

The "confidence-building" objective aims at establishing or enhancing trustful relationships between the sender and the receiver of the communication while the "cooperative decision-making" objective involves stakeholders in resolving existing or potential differences in views on the matter. As an example, EFSA published a "news story" on the safety of cell culture-derived foods, providing insights from experts in this field to illustrate some of the scientific issues involved and the social and economic backdrop.[13] This was done to highlight EFSA's readiness to evaluate these potential NFs and to gather views and insights on the latest scientific and technical developments in the field. Furthermore, as regards these communication objectives, EFSA organised a scientific colloquium in May 2023 to: identify sectors in the agri-food sector relevant to potential cell culture-derived foods of animal or plant origin and food ingredients produced through precision fermentation; review the state-of-the-art of relevant concepts, technologies, and derived products; and discuss emerging safety and methodological aspects and their impact on EFSA's risk assessment approaches.[14]

## Conclusions

One crucial objective of risk communication is to take account of societal knowledge and risk perception of NFs for effectively informing all interested parties of risk assessment outcomes. While it may be tempting to design a risk communication strategy based solely on the category of the NF, our analysis shows the importance of thoroughly screening the scientific features that may affect the public interest, to ensure that communication approaches are tailored to NFs that possess shared characteristics and risks. Our research indicates that NFs derived from microorganisms, fungi, or algae, produced with precision fermentation, and derived from insects and plants, resulted in low-knowledge/low-risk perception. Therefore, risk communication approaches should aim to enhance individuals' understanding and knowledge of risks through awareness-raising. For cell culture-derived foods, where public knowledge is greater, communication approaches should aim to resolve existing or potential differences in views on the matter and to establish or enhance trustful relationships between the sender and the receiver of the communication. By tailoring risk communication strategies to the technical features, societal knowledge and risk perception of NF, all interested parties can be effectively informed of the risk assessment outcomes.

## Future perspectives

Based on the experience built on NFs assessed by EFSA in the past three years, it is important to establish and promote a continuous dialogue with stakeholders, aimed at understanding levels of knowledge and perceptions towards NFs. This will enable the design of tailored risk communication approaches. In this regard, proactively seeking and providing information on the most recent scientific and technological developments

[12] https://www.efsa.europa.eu/en/news/edible-insects-science-novel-food-evaluations
[13] https://www.efsa.europa.eu/en/news/safety-cell-culture-derived-food-ready-scientific-evaluation
[14] https://www.efsa.europa.eu/en/events/efsas-scientific-colloquium-27-cell-culture-derived-foods-and-food-ingredients

should be considered, especially for NFs that are expected to become increasingly important in the coming years and of public interest (e.g., "precision fermentation" and cell culture-derived foods and ingredients). It is worth noting that the present research focused on social media data that provide a limited picture of public knowledge and risk perceptions. Future studies should include primary data collected through surveys targeting representative samples of the EU population, to help ensure that results can be applied more broadly and to more diverse audiences in terms of socio-demographic characteristics. Importantly, the findings show that a tailored approach is needed and future communication on NFs by EFSA needs to take NF categories into account and to develop ad-hoc messages addressing citizens' knowledge and perceptions. Ultimately, this approach would contribute to fostering a social environment where stakeholders are aware of the risk assessment outcomes and prepared to make informed decisions about NFs.

## Disclaimer

The authors Giorgia Zamariola, Domagoj Vrbos, and Anthony Smith are employed with the European Food Safety Authority (EFSA) in the Communication Unit. The authors Andrea Germini, Maria Glymenaki (trainee from November 2022 to November 2023), Marcello Laganaro, Vânia Mendes (trainee from November 2022 to November 2023), Alejandra Muñoz González (trainee from October 2022 to October 2023), Irene Nuin Garciarena, Gabriela Precup, Ruth Roldán-Torres, and Ermolaos Ververis are employed with the European Food Safety Authority (EFSA) in the Nutrition and Food Innovation Unit that provides scientific and administrative support to the Panel on Nutrition, Novel Foods and Food Allergens in the area "Safety Assessment of Novel Foods". Likewise, the author Esther Garcia Ruiz is currently employed by Randstad (c/o EFSA) in the same EFSA Unit. However, the views expressed in this publication are those of the authors and should not be interpreted as representing the official position of the European Food Safety Authority (EFSA). Therefore, the present article is published under the sole responsibility of the authors, and may not be considered as an EFSA scientific output. EFSA cannot be held accountable for any errors or inaccuracies that may appear.

To know about the views or scientific outputs of EFSA, please consult its website at http://efsa.europa.eu/. Note to the reader: The information provided in this manuscript refers to the activities of EFSA in the area of Novel Foods up to 8 May 2023. Future risk assessments of NFs by EFSA will be available on the OpenEFSA portal at the following link: https://open.efsa.europa.eu/.

## Abbreviations

| | |
|---|---|
| DNA | Deoxyribonucleic acid |
| EC | European Commission |
| EFSA | European Food Safety Authority |
| EU | European Union |
| GOS | Galacto-oligosaccharides |
| IRGC | International Risk Governance Center |
| NDA Panel | EFSA Panel on Nutrition, Novel Foods and Food Allergens |
| NF | Novel Food |

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## Annex A

Social media query used for monitoring public discourse on novel foods.

(LOCATION (AT OR BE OR BG OR HR OR CY OR CZ OR DK OR EE OR FI OR FR OR DE OR GR OR HU OR IE OR IT OR LV OR LT OR LU OR MT OR NL OR PL OR PT OR RO OR SK OR SI OR ES OR SE)) AND ("novel food" OR "alternative proteins" OR "novel proteins" OR "meat substitutes" OR "meat alternatives" OR "plant-based proteins" OR "insect-based proteins" OR "edible insects" OR "cultured meat" OR "synthetic meat" OR "lab grown meat" OR "in vitro meat" OR "cell-based meat" OR "precision fermentation" OR (fungi OR algae AND food) OR "nuovi prodotti alimentari" OR "proteine alternative" OR "nuove proteine" OR "sostituti della carne" OR "alternative alla carne" OR "proteine vegetali" OR "proteine a base di insetti" OR "insetti commestibili" OR "carne coltivata" OR "carne sintetica" OR "carne da laboratorio" OR "carne in vitro" OR "carne a base di cellule" OR "fermentazione di precisione" OR (funghi OR alghe AND alimenti) OR "nouveaux aliments" OR "protéines alternatives" OR "nouvelles protéines" OR "substituts de viande" OR "alternatives à la viande" OR "protéines végétales" OR "protéines à base d'insectes" OR "insectes comestibles" OR "viande cultivée" OR "viande synthétique" OR "viande de laboratoire" OR "viande in vitro" OR "viande cellulaire" OR "fermentation de précision" OR (champignons OR algues AND aliments) OR "nuevos alimentos" OR "proteínas alternativas" OR "nuevas proteínas" OR "sustitutos de la carne" OR "alternativas a la carne" OR "proteínas vegetales" OR "proteínas basadas en insectos" OR "insectos comestibles" OR "carne cultivada" OR "carne sintética" OR "carne de laboratorio" OR "carne in vitro" OR "carne a base de células" OR "fermentación de precisión" OR (hongos OR algas AND alimentos) OR "neuartige Lebensmittel" OR "alternative Proteine" OR "neue Proteine" OR "Fleischersatz" OR "Fleischalternativen" OR "Proteine auf Pflanzenbasis" OR "Proteine auf Insektenbasis" OR "essbare Insekten" OR "kultiviertes Fleisch" OR "Laborfleisch" OR "synthetisches Fleisch" OR "im Labor gezüchtetes Fleisch" OR "In-vitro-Fleisch" OR "zellbasiertes Fleisch" OR "Präzisionsfermentation" OR (Pilze OR Algen AND Lebensmittel))

## Annex B

Novel food mandates retrieved from OpenEFSA

| Mandates | Date of publication of the Scientific Opinion | Scientific opinion | NF Category |
|---|---|---|---|
| Request for a scientific opinion on dried mealworms (Tenebrio molitor) as a novel food (NF 2018/0241)a | 13/01/2021 | https://doi.org/10.2903/j.efsa.2021.6343 | Derived from animals or their parts |
| Request for a scientific opinion on Cistanche tubulosa extract as a novel food (NF 2019/1318) | 18/01/2021 | https://doi.org/10.2903/j.efsa.2021.6346 | Derived from plants or their parts |
| Request for a scientific opinion on Schizochytrium sp. oil as a novel food (NF 2019/1046) | 18/01/2021 | https://doi.org/10.2903/j.efsa.2021.6345 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Schizochytrium sp. oil as a novel food (NF 2019/0825). | 13/01/2021 | https://doi.org/10.2903/j.efsa.2021.6344 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Galacto-oligosaccharide as a novel food (NF 2020/1607)[a] | 27/01/2021 | https://doi.org/10.2903/j.efsa.2021.6384 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on UV-treated mushrooms (Agaricus bisporus) as a novel food (NF 2019/1237) | 08/04/2021 | https://doi.org/10.2903/j.efsa.2021.6516 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on dried fruits of Synsepalum dulcificum as a novel food (NF 2018/0709) | 11/06/2021 | https://doi.org/10.2903/j.efsa.2021.6600 | Derived from plants or their parts |
| Request for a scientific opinion on 3-fucosyllactose as a novel food (NF 2019/1321) | 30/06/2021 | https://doi.org/10.2903/j.efsa.2021.6662 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Calcidiol as a novel food (NF 2018/0402) | 01/07/2021 | https://doi.org/10.2903/j.efsa.2021.6660 | Vitamins, minerals and other substances |
| Request for a scientific opinion on UV-treated baker's yeast (Saccharomyces cerevisiae) as a novel food (NF 2020/1778) | 01/07/2021 | https://doi.org/10.2903/j.efsa.2021.6602 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on whole and ground grasshoppers (Locusta migratoria) as a novel food (NF 2018/0803)[a] | 02/07/2021 | https://doi.org/10.2903/j.efsa.2021.6667 | Derived from animals or their parts |
| Request for a scientific opinion on Calcium Fructoborate as a novel food (NF 2019/0998) | 05/07/2021 | https://doi.org/10.2903/j.efsa.2021.6661 | Modified molecular structure |
| Request for a scientific opinion on cetylated fatty acids as a novel food (NF 2020/1828) | 21/07/2021 | https://doi.org/10.2903/j.efsa.2021.6670 | Modified molecular structure |
| Request for a scientific opinion on whole and ground crickets (Acheta domesticus) as a novel food (NF 2018/0804)[a] | 17/08/2021 | https://doi.org/10.2903/j.efsa.2021.6779 | Derived from animals or their parts |

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| Request for a scientific opinion on whole and ground mealworm (Tenebrio molitor) larvae as a novel food (NF 2018/0802)[a] | 25/08/2021 | https://doi.org/10.2903/j.efsa.2021.6778 | Derived from animals or their parts |
| Request for a scientific opinion on pasteurised Akkermansia muciniphila as a novel food (NF 2019/1366) | 01/09/2021 | https://doi.org/10.2903/j.efsa.2021.6780 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on mung bean protein as a novel food (NF 2020/1651)[a] | 20/10/2021 | https://doi.org/10.2903/j.efsa.2021.6846 | Derived from plants or their parts |
| Request for a scientific opinion on Galacto-oligosaccharide (NF 2019/1154) | 27/10/2021 | https://doi.org/10.2903/j.efsa.2021.6844 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on nicotinamide riboside chloride as a novel food (NF 2020/1613) | 12/11/2021 | https://doi.org/10.2903/j.efsa.2021.6843 | Vitamins, minerals and other substances |
| Request for a scientific opinion on water lentil powder from Lemnaceae as a novel food (NF 2018/0430) | 15/11/2021 | https://doi.org/10.2903/j.efsa.2021.6845 | Derived from plants or their parts |
| Request for a scientific opinion on IHAT (Iron Hydroxide Adipate Tartrate) as a novel food (NF 2019/1417) | 10/12/2021 | https://doi.org/10.2903/j.efsa.2021.6935 | - Vitamins, minerals and other substances<br>- Engineered nanomaterials |
| Request for a scientific opinion on Wolffia globosa powder as a novel food (NF 2019/1223) | 22/12/2021 | https://doi.org/10.2903/j.efsa.2021.6938 | Derived from plants or their parts |
| Request for a scientific opinion on Eurycoma longofolia (tongkat ali) root extract as a novel food (NF 2018/0169) | 22/12/2021 | https://doi.org/10.2903/j.efsa.2021.6937 | Derived from plants or their parts |
| Request for a scientific opinion on tetrahydrocurcuminoids from turmeric (Curcuma longa) as a novel food (NF 2020/1526) | 22/12/2021 | https://doi.org/10.2903/j.efsa.2021.6936 | Derived from plants or their parts |
| Request for a scientific opinion on edible Jatropha curcas L. kernels (Chuta) as a novel food (NF 2018/0177) | 21/01/2022 | https://doi.org/10.2903/j.efsa.2022.6998 | Derived from plants or their parts |
| Request for a scientific opinion on Schizochytrium sp. oil as a novel food (NF 2019/1213) | 31/01/2022 | https://doi.org/10.2903/j.efsa.2022.7083 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on dried coffee husk (Cascara) from Coffea arabica L. as a novel food (NF 2018/0192) | 25/02/2022 | https://doi.org/10.2903/j.efsa.2022.7085 | Derived from plants or their parts |
| Request for a scientific opinion on 2'-Fucosyllactose/ difucosyllactose mixture as a novel food (NF 2019/1457) | 03/03/2022 | https://doi.org/10.2903/j.efsa.2022.7140 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Lacto-N-tetraose (LNT) as a novel food (NF 2019/1456) | 03/03/2022 | https://doi.org/10.2903/j.efsa.2022.7140 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Galacto-oligosaccharide (GOS) as a novel food (NF 2020/1606) | 30/03/2022 | https://doi.org/10.2903/j.efsa.2022.7203 | Derived from microorganisms, fungi or algae |

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| Request for a scientific opinion on pea and rice protein fermented by Shiitake mushroom (Lentinula edodes) mycelia as a novel food (NF 2019/1459)[a] | 06/04/2022 | https://doi.org/10.2903/j.efsa.2022.7205 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Beta-lactoglobulin as a novel food (NF 2020/1707) | 08/04/2022 | https://doi.org/10.2903/j.efsa.2022.7204 | Derived from animals or their parts |
| Request for a scientific opinion on 2'-Fucosyllactose as a novel food (NF 2019/1350) | 04/05/2022 | https://doi.org/10.2903/j.efsa.2022.7257 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Lacto-N-neotetraose as a novel food (NF 2019/1359)[a] | 04/05/2022 | https://doi.org/10.2903/j.efsa.2022.7257 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on bovine milk osteopontin as a novel food (NF 2020/1698) | 06/05/2022 | https://doi.org/10.2903/j.efsa.2022.7137 | Derived from animals or their parts |
| Request for a scientific opinion on defatted whole cricket (Acheta domesticus) powder as a novel food (NF 2019/1227)[a] | 13/05/2022 | https://doi.org/10.2903/j.efsa.2022.7258 | Derived from animals or their parts |
| Request for a scientific opinion on Lacto-N-tetraose (LNT) as a novel food (NF 2020/1809)[a] | 16/05/2022 | https://doi.org/10.2903/j.efsa.2022.7242 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on 3'-Sialyllactose (3'-SL) (NF 2020/1794) | 25/05/2022 | https://doi.org/10.2903/j.efsa.2022.7331 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on 3-Fucosyllactose (3-FL) as a novel food (NF 2020/1620) | 25/05/2022 | https://doi.org/10.2903/j.efsa.2022.7329 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Vitamin $D_2$ mushroom powder as a novel food (NF 2019/1471) | 10/06/2022 | https://doi.org/10.2903/j.efsa.2022.7326 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on Zinc L-carnosine as a novel food (NF 2019/1090) | 10/06/2022 | https://doi.org/10.2903/j.efsa.2022.7332 | - Modified molecular structure<br>- Vitamins, minerals and other substances |
| Request for a scientific opinion on Antrodia camphorata mycelia powder as a novel food (NF 2018/0329) | 29/06/2022 | https://doi.org/10.2903/j.efsa.2022.7380 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on frozen and freeze-dried formulations of the lesser mealworm (Alphitobius diaperinus larva) as a novel food (NF 2018/0125)[a] | 04/07/2022 | https://doi.org/10.2903/j.efsa.2022.7325 | Derived from animals or their parts |
| Request for a scientific opinion on Yarrowia lipolytica yeast biomass as a novel food (NF 2020/1950)[a] | 28/07/2022 | https://doi.org/10.2903/j.efsa.2022.7450 | Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on iron milk proteinate (IMP) as a novel food (NF 2020/1866) | 16/09/2022 | https://doi.org/10.2903/j.efsa.2022.7549 | Vitamins, minerals and other substances |

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| Request for a scientific opinion on β-Hydroxybutyrate salts (Sodium/ Magnesium/Calcium) as a novel food (NF 2018/0291) | 13/10/2022 | https://doi.org/10.2903/j.efsa.2022.7449 | Modified molecular structure |
| Request for a scientific opinion on an aqueous ethanolic extract of Labisia pumila as a novel food (NF 2019/1337) | 10/11/2022 | https://doi.org/10.2903/j.efsa.2022.7611 | Derived from plants or their parts |
| Request for a scientific opinion on Lemna minor (and Lemna gibba) whole plant material as a novel food (NF 2020/1757) | 30/11/2022 | https://doi.org/10.2903/j.efsa.2022.7598 | Derived from plants or their parts |
| Request for a scientific opinion on 6'-Sialyllactose (6'-SL) as a novel food (NF 2020/1801) | 07/12/2022 | https://doi.org/10.2903/j.efsa.2022.7645 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on 2'-Fucosyllactose (2'-FL) as a novel food (NF 2020/1825) | 14/12/2022 | https://doi.org/10.2903/j.efsa.2022.7647 | - Modified molecular structure<br>- Derived from microorganisms, fungi or algae |
| Request for a scientific opinion on whole seeds of oilseed rape as a novel food (NF 2018/0590)[a] | 12/01/2023 | https://doi.org/10.2903/j.efsa.2023.7706 | Derived from plants or their parts |
| Request for a scientific opinion on cellobiose as a novel food (NF 2020/1805) | 13/01/2023 | https://doi.org/10.2903/j.efsa.2022.7596 | Modified molecular structure |
| Application for modification of use of Xia Powder 435 as a novel food | 13/04/2023 | https://doi.org/10.2903/j.efsa.2023.7904 | Derived from plants or their parts |
| Request for a scientific opinion on water lentil protein concentrate from a mixture of Lemna gibba and Lemna minor as a novel food (NF 2018/0801) | 27/04/2023 | https://doi.org/10.2903/j.efsa.2023.7903 | Derived from plants or their parts |

[a] NF mandates meeting three criteria according to the EFSA checklist and selected for their "relatively" high social media prominence.

## Annex C

Results of the scientific literature search.

| NF assessed | Study (authors, year) | Method | Main findings |
|---|---|---|---|
| Insect-based food | Verbeke, 2015 | Experimental study in BE | Readiness to adopt insects stronger among younger consumers compared to older consumer; willingness to eat is low overall. |
| | Gmuer et al., 2016 | Experimental study in CH | The higher the degree of processing of the insect ingredient (flour or bits instead of whole crickets), the more positive consumers are. |
| | Hartmann and Siegrist, 2016 | Experimental study in CH | People who consumed a processed insect product report a higher willingness to eat unprocessed insects. |
| | Megido et al., 2016 | Experimental study in BE | Influence of experience: people who have already heard about entomophagy or eaten insects in the past rate insect burgers' taste higher. |
| | Tan, van der Berg, and Stieger, 2016 | Experimental study in NL | Food neophobia is the main factor determining consumers' readiness or not to adopt insects as a meat replacement. |
| | Ardoin and Prinyawiwatkul, 2021 | Literature review | Disgust is the most salient and immediate reaction to eating insects in the West and plays a major role in entomophagy avoidance. |
| | Wendin and Nyberg, 2021 | Literature review | Major barrier to edible insect consumption: lack of information available on alternative protein, cooking methods and preparation of dishes using insects. |
| | Marquis et al., 2023 | Experimental study in FR and CO | The use of cute visual elements on insect-based product packaging can positively affect young adult consumers' perception and acceptance. |

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| Cell culture-derived meat | Verbeke et al., 2015 | Experimental study in BE, PT, UK | Potential personal and societal risks outweigh the expected benefits, as benefits are believed to be situated at the global societal rather than at the personal or individual level. |
| | Verbeke, Sans and Van Loo, 2015 | Experimental study in BE | Possible repulsion or the so-called "yuck factor" is the typical initial reaction that consumers feel at the idea of eating cell culture-derived meat. |
| | Bryant and Barnett, 2018 | Literature review | Preference for cell culture-derived meat is higher amongst men, younger people, more educated people, those who consume meat substitutes, and those with high concern for the environment. |
| | Bryant and Barnett, 2019 | Experimental study in US | Test of different names. "Lab grown meat": most negative associations (artificiality/unnaturalness and disgust). "Cultured meat": associations with science, deviations from nature. "Clean meat": associations with healthiness / nutrition, tastiness, cleanness, and naturalness. |
| | Bryant and Dillard, 2019 | Experimental study in US | More technical descriptions of cell culture-derived meat led to lower acceptance compared to less technical descriptions, as they are associated with science and unnaturalness. |
| | Siegrist and Hartmann, 2020a | Literature review | Consumers' reactions: perception of unnaturalness and feeling of disgust, therefore low acceptance. Consumers consider factors like taste and price rather than animal welfare. |
| | Siegrist and Hartmann, 2020b | Experimental study in AU, CH, UK, FR, DE, MX, SA, ES, SE, US | Cultural differences identified: low levels of acceptance in France, high in Mexico, South Africa and England. |
| | Tomiyama et al., 2020 | Literature review | Consumers' concerns revolve around the adverse societal consequences associated with the loss of culinary traditions, rural livelihoods, and the preservation of livestock, open space and biodiversity. |
| | Wilks, Homsey and Bloom, 2021 | Experimental study in US | The thought of eating cell culture-derived meat, rather than the process of creating it, triggers the feeling that it is "unnatural". |
| Insect-based and cell culture-derived meat | Hartmann and Siegrist, 2017 | Literature review | Consumer's willingness to reduce their meat consumption is generally low. Health reasons are perceived as more convincing compared with environmental reasons to reduce meat consumption. |
| Plant- and insect-based proteins | De Koning et al., 2020 | Experimental study in BR, CN, DR, ES, FR, NL, NZ, UK, US | Food neophobia and food technology neophobia influence the behavioural intentions and decrease the willingness to try, buy, and pay more for meat-alternative proteins. |
| Plant- and insect-based meat, algae, and cell culture-derived meat | Tso, Lim and Forde, 2020 | Literature review | Consumers are motivated mostly by health concerns when opting for alternative proteins, and less by sustainability, environmental or animal welfare concerns. |
| Plant- and animal-based food | Faber et al., 2021 | Experimental study in DE, DK, ES | Consumers not in favour of products deviating substantially from what is perceived as "natural"; more interest in plant-based proteins. |
| Pulses, algae, insects, plant-based meat alternatives, and cell culture-derived meat | Onwezen et al., 2021 | Literature review | Plant-based meat alternatives and pulses are most accepted, insects are least accepted, and cell culture-derived meat is in-between. |
| Plant- and insect-based food, and cell culture-derived meat | Possidónio et al., 2021 | Experimental study in PT | Effect of framing: presenting meat alternatives in a meal has a more positive impact than presenting them as individual products. |

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| Plant- and insect-based food | Anusha Siddiqui et al., 2022 | Literature review | Acceptance of novel food technologies influenced by: 1) food technology aspects: voluntary exposure, perceived naturalness, perceived dread and perceived control; and 2) people's characteristics: disgust sensitivity, food technology neophobia, cultural values. |
| Plant-, insect-based meat, and cell culture-derived meat | Siegrist and Hartmann, 2023 | Literature review | Acceptance of insect-based and cell culture-derived meat is low, while for plant-based meat it is high. |
| Precision fermentation | Broad et al., 2022 | Experimental study in DE, UK, US, and SG | Concerns about the interference of human technology with nature and the potential health risks; animal welfare seen as the only benefit. |
| | Banovic and Grunert, 2023 | Experimental study in DE, DK and PL | Framing this technology as natural and similar to traditional fermentation increased acceptance, trust levels and perceived benefits. |
| Microalgae | Van der Stricht et al., 2023 | Experimental study in DE, ES, HU, IT and NL | Willingness to pay affected by the product label: highest for organic label, followed by "healthy and nutritious" label, and least for a vegan label. |

AU: Australia; BE: Belgium; BR: Brazil; CH: Switzerland; CN: China; CO: Colombia; DE: Germany; DK: Denmark; DR: Dominican Republic; ES: Spain; FR: France; HU: Hungary; IT: Italy; MX: Mexico; NL: The Netherlands; NZ: New Zealand; SG: Singapore; PL: Poland; PT: Portugal; SA: South Africa; SE; Sweden; UK; United Kingdom; US: United States

# Challenging high-tech solutionism in an era of polycrisis: A commentary on claims for novel foods and on building an alternative narrative[1]

Paper first received: 09 February 2024; Accepted: 15 July 2024; Published in final form: 31 December 2024
https://doi.org/10.48416/ijsaf.v30i2.625

Colin SAGE[1]

## Abstract

Considering the contemporary global landscape of interlocking environmental, economic and political challenges - labelled as a polycrisis - the paper takes issue with an influential narrative of technological solutionism. Both within the rapidly digitalizing agricultural sector that is reshaping industrial farming and across the novel foods category engaged in scaling protein production, there is a tendency to proclaim new technologies as providing singular remedies to existential problems. While conceding that new technologies may have an important role to play as we navigate uncertainty in striving for healthy, sustainable diets, this commentary argues that such efforts ought to be informed by a wider vision embracing complexity and scientific humility and capable of scrutinising the purpose of such innovations while ensuring the inclusion of valued social and cultural attributes of food. Ultimately, challenging dominant narratives of technological solutionism requires civil society to develop alternative discourses that speak to human and ecological wellbeing above purely technocratically defined objectives.

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**Bibliographical notes**

**Colin Sage** is an independent research scholar now based in Portugal. He is the author of Environment and Food (2012) and the editor or co-editor of six books including A Research Agenda for Food Systems (2022). He was founding Chair of the Cork Food Policy Council.

**ACKNOWLEDGEMENTS**

I wish to thank my fellow co-editors of this special section on novel foods for their helpful comments on earlier drafts of this paper, as well as the three anonymous peer reviewers whose critique sharpened the commentary. Naturally, none can be held responsible for what is written below.

[1] The conception of this paper was a Rapporteur's report closing the one-day conference, 'Novel Foods and Novel Food Production: A solution to food systems sustainability?' held at the American University of Rome on 10 March 2023.

## Introduction

We are living through a time of multiple and interlocking existential challenges – having recently emerged from a global pandemic – and confronted by a range of environmental problems that have been highlighted by scientists' warnings (Ripple et al. 2022; Albert et al. 2020; Garcia-Gonzalez et al. 2024; Wiedmann et al. 2020; Richardson et al. 2023). Yet these concerns have been further exacerbated by a variety of economic, social and political issues – financial system instability, cyber terrorism, choke-points in global supply chains, large-scale migration, and rising social and political discord including increased military conflict – that demonstrate our enmeshment in a global polycrisis marked by the 'amplification, acceleration, and synchronisation of systemic risks' (Homer-Dixon et al. 2022: 3; Lawrence et al. 2022). That these challenges are conceivably connected in ways that we may not fully understand is a consequence of a reductionist mindset not well placed to accommodate holistic thinking in an era of complex causation, nonlinearity and post-normal science that may be vulnerable to unexpected tipping points (Morin 2008; Montuori 2022; Byrne 2017). This is the predicament of the contemporary human condition where a global population of eight billion people is differentiated by enormous social and economic inequalities and where the basic material needs for existence – let alone those required for a dignified life free of hunger and preventable disease – are denied to so many. Yet there is an assumption that a series of 'techno-fixes' are in the pipeline that will deliver us from catastrophe and allow us to continue to maintain our existing levels of consumption despite evidence to suggest that we are in advanced ecological overshoot[1] (Merz et al. 2023; Rees 2023).

One of the key challenges facing the global community is the ways in which we produce and make available food for human consumption. The global food system has become an increasing focus of attention, given the ever-widening chorus of voices that argue it is no longer fit for purpose (Sachs, 2021; GLOPAN 2020; Sage 2022a). Its contribution to the global climate crisis – accounting for more than 30% of greenhouse gas emissions, biodiversity loss, and disturbance of global nutrient cycles (Sage 2022b, 2022c) – is most especially evident in regard to human consumption of animal products, which exerts a higher impact than any other major aspect of human ecology (Coimbra et al. 2020). Yet, at the same time, there is a growing realisation that the food system is also failing to feed people adequately. With numbers of chronically hungry and malnourished people remaining stubbornly high, while those suffering from diet-related diseases continue to rise, the food system is increasingly regarded as the cause of a global public health crisis (Swinburn et al. 2019; Scrinis 2020). It is in this context of overshoot, polycrisis and complexity that we have witnessed the inexorable rise of 'techno-solutionism' (Morozov 2013; Milan 2020; Sætra 2023). The term is used here not only to profess a *faith* in technology but also embodies how we frame social phenomena to make them more amenable to the technological solutions proposed by their advocates. Solutionism takes us beyond techno-optimism which presumes that technology will deliver beneficial outcomes, and where it is even demonstrated that the good outweighs the bad (Danaher 2022). Solutionism possesses a rhetorical dimension whereby it takes the pursuit of scientific idealism and genuine problem resolution into a realm that privileges its narrative and potentially hinders opportunities to examine alternatives. As Digital Rights Watch have pointed out, 'techno solutionism is problematic because its roots run deep and it's incredibly hard to weed from public discourse once it has been introduced' (DRW 2021).

Drawing on this notion of technological solutionism, the paper examines elements of the narrative surrounding the development of novel foods and of digitalisation processes in agriculture. While 'novel foods' has been used as an umbrella term for this special issue, within the EU it refers to any food that had not been consumed to a significant degree by humans in the EU before 15 May 1997. Novel foods is therefore a capacious, even ambiguous, category and extends well beyond the often synonymous 'alternative proteins' label. The latter term is better understood as comprising a new and diverse technology sector utilising

[1] Anthropogenic ecological overshoot is defined by Merz et al. as 'the human consumption of natural resources at rates faster than they can be replenished, and entropic waste production in excess of the Earth's assimilative and processing capacity' (Merz et al. 2023: 2-3).

advanced scientific techniques that are engineering plants, micro-organisms, fungi, algae, insects or animal cells to deliver products that will largely replicate the experience of eating meat, dairy or fish. Given the diversity of developments in this category, the paper focusses upon precision fermentation to illustrate aspects of the narrative surrounding novel foods.

In doing so, the paper seeks to sidestep description of the technology and its products, and rather to attend to the discourse of solutionism which has come to prevail both within this sector and in the wider agri-food system. For without under-valuing the *potential* contribution of new technologies, it would seem that some of our most treasured attributes around food – its cultural significance, the act of eating with others (commensality), the deeply-rooted territorial dimensions of food production (farming) systems, its life-giving and nutritional properties – are in danger of being swept aside in pursuit of novel products that appear to be designed more to solve professed singular problems (the need for more protein) than to improve global dietary health and human wellbeing.

The paper embarks from the position that underpinning contemporary food system vulnerabilities has been the pursuit of a reductionist, growth-driven, wealth accumulating paradigm now largely in the hands of powerful corporate interests (Clapp 2022; Howard 2016; Carolan 2018). If food systems are to recover greater resilience in the face of polycrisis, then it seems vitally important to make the case for a more holistic, transdisciplinary and socially equitable approach in addressing how we are to feed ourselves. Indeed, if we genuinely wish to improve global food security and dietary health, it might be more appropriate to strike out on a path that embodies greater public engagement and transparency, rather than the pursuit of a strategy of enclosure that enshrines intellectual property rights over seeds and other food organisms in the hands of private corporations. Thus, in contrast to much solutionist rhetoric that makes claims to 'feeding the world' (as will be outlined below), this paper makes the case for a different approach, one rooted in humility and a more expansive mode of thinking.

Following Jasanoff (2007), this paper argues that we need to look beyond science for possible solutions to our current predicament of polycrisis. As she argues, humility compels us to think harder on ways to reframe problems so that their ethical dimensions are better revealed, to focus on known causes of people's vulnerability, to pay attention to the distribution of risks and benefits, and to reflect on the factors that promote or discourage learning. Humility is about defending modes of knowing often pushed aside in the expansion of technological capacities and re-engaging with the moral foundations for acting in the face of scientific uncertainty (Jasanoff 2007). This means embracing complexity, contingency and continuous learning through feedback loops, where positive outcomes are measurable not only in financial terms but also in terms of human flourishing (Ehrenfeld 2024, Mullally et al. 2017). As Cilliers notes, "'In order to open up the possibility of a better future we need to resist the arrogance of certainty and self-sufficient knowledge' (Cilliers 2005: 265). That means having regard for the precautionary principle, for prudent action and, as concerns the topic here, for the need to engage on a deeper level with a wide range of issues surrounding the production and consumption of food.

Consequently, underpinning the paper is a belief that the extent of our planetary predicament and our capacity to address the polycrisis requires a profound change in our values and expectations that have been so significantly shaped by neoliberal capitalism. In this regard, the first objective of this paper in approaching the question of technological solutionism is to challenge the singular, often rather simplified, narrative that it promotes. This means not only asking questions about the technologies and their ownership but also about whether the products being promised are as necessary for our wellbeing as their proponents insist. It also means establishing the identity of those likely to carry a disproportionate share of these products' externalised costs and risks.

The second objective for the paper is to make a case for an alternative narrative. This may certainly appear both less coherent – comprising divergent themes and aggregating a discordant polyphony of voices engaged

in dialogic opposition (Gruber 2023) – and undoubtedly 'messier' to operationalise than the alternative promulgated by technological solutionism. Yet in challenging the latter's promised universality where all are proclaimed as 'beneficiaries', an alternative approach establishes the situational, contextual and ecological basis of narrative construction and, embracing complexity, works to recover greater individual and collective agency on food matters across society. This raises important questions about modes of governance capable of ensuring participation and the integration of different forms of knowledge into effective policymaking (Van Assche et al. 2024) while guarding against utilitarianism aimed at 'solving' market-defined problems or developing technologies that control rather than anticipate societal needs (Mullally et al. 2017).

Drawing upon a wide range of literature, this paper offers a commentary arguing that the pace and power of technological change not only poses a challenge to consumers by widening the knowledge deficit (what, precisely, are we eating, how was it produced and how are we to know?) but threatens to overwhelm many of the social and cultural attributes of food. Thus, the paper seeks to make the case that technological innovation should proceed in such a way that nutrition and wellbeing, taste and enjoyment, cultural meaning, conviviality and social identity are not driven from consideration as we chart a course toward a more sustainable, resilient and equitable food system.

## Technology as solution. But for whose benefit?

While innovation has been a feature of food production throughout human history (Mazoyer and Roudart 2006), there would surely be widespread agreement that the pace of technological change has accelerated with digitalisation (Bronson and Knezevic 2016; Guthman and Butler 2023). As the biosciences and chemistry meet new data gathering and management tools, most especially with the development of machine learning in complex data analysis, new processes executed through advanced engineering techniques have emerged to deliver novel food products. Such efforts are regarded by many as breathtaking in their scope and ambition, and demonstrate the capacity for human ingenuity (CATO Institute 2015). The claimed ambition of their proponents – in the 'move quickly, break things' language of Silicon Valley – is to disrupt the current model and design solutions for how we might eat in the future (Guthman and Biltekoff 2021). Indeed, it is argued that "'Disrupting the legacy food system is a global imperative if we are to have a thriving society… we are on the precipice of seismic shifts in how our food is produced and delivered' (Rethink Food 2024; see also Reboot Food). Yet the development of such radical innovations carries with it important cultural consequences, given that technologies are invariably embedded with human values, biases and privileges. That digital technologies have become central to a reimagination of the food system speaks to the materialist and cultural power of scientific innovation, particularly when backed by billions of dollars of new financial investments (Fasler 2024). As Guthman and Butler (2023) argue, claims to be solving the structural problems of the food system have however not been matched by their capacity to address the fundamental biophysical challenges of food and farming. Indeed, the promotion of solutions may precede problem definition where existing technologies are looking for new applications and many Silicon Valley 'solutionaries' lack a basic familiarity with the challenges facing food production.

The promise of delivering 'magic bullet' solutions, framed by promiscuous deployment of such concepts as 'sustainability', 'regenerative', and 'climate smart' production, has consequences, of course, not only in diminishing their meaning but in distracting policy and funding from engaging in the kinds of structural changes that are truly needed to effect a necessary food system transformation (IPES-Food 2022). Moreover, while moving at speed to ensure scientific breakthroughs are translated into proprietary patented technologies and achieve regulatory approval, powerful commercial interests work to exercise influence over policy processes and institutions.[2] This raises questions around how society can respond, given the privileged position

[2] At the time of writing there is considerable concern amongst non-governmental, civil society and environmental organisations about the pace of roll-back of proposed measures within the EU to protect nature. The 'great backtracking' includes diluting some of the provisions of the Nature Restoration Law, abandoning measures to reduce pesticide use, exempting cattle production from the EU's industrial emissions rules, and shelving a proposed strategy to improve Europe's freshwater resilience.

that scientific innovation enjoys in societies where governments are supportive in pursuit of competitive economic growth. Moreover, while recognising the legitimacy of claims to protect the rights of scientists over their technological innovations, this cannot extend to the wholesale exclusion of civil society when the precautionary principle demands an agreed level of transparency and accountability.

Before looking more closely at precision fermentation as one strand of novel foods, it is useful to consider the solutionist narrative that has established itself in the agricultural sector, hitherto the sole source of primary foods, where the digitalisation of farming has been proceeding at rapid pace, constituting what has been termed a 'Fourth Agricultural Revolution' (Rose et al. 2022, Klerkx et al. 2019). Leading technologies here include sensors and other data capture tools (wearable and implanted devices for animals, cameras using the visible, multispectral, and thermal imaging elements of the electro-magnetic spectrum on drones and satellites) providing a continuous stream of information that can be processed by Artificial Intelligence and other machine learning capabilities in order to deliver actionable outputs. Combining remotely sensed images of soil or crop conditions using Global Navigation Satellite Systems with enhanced granularity (i.e., sub-centimetre spatial resolution) provides precise coordinates capable of determining the application of chemicals and the performance of other field tasks using driverless and other robotic machinery.

Paying attention to such technological developments within the agricultural sector reveals the increasingly interconnected web of corporate interests where, 'Big Ag giants such as Bayer, Deere & Company, Corteva, Syngenta and Nutrien are restructuring their entire businesses around Big Data platforms. Bayer's "Field View" digital platform, for example, extracts billions of datapoints from farmland in 23 countries and funnels it into the cloud servers of Microsoft and Amazon'(ETC 2022: 10). Characterising them as the new Food Barons, the ETC Group[3] report alerts us to the ways that the assemblages of the new digital agri-technologies are enabling greater corporate control over the entire food system and, without vigilance, this might as easily unfold in the field of novel foods (Howard 2022). Being alert to – and challenging – the solutionist narrative that is used to justify path-dependent technologies is therefore critically important. For example, perhaps the most persistent trope that is used to justify and indeed to insist upon the imperative of rapid and far-reaching technological innovation is that of neo-Malthusianism. Most frequently amongst the promotional output of the agri-tech sector, one will find the rhetorical question posed, 'How will we feed a population of ten billion by 2050?'. This question is asked regularly throughout a video series available on the BBC World News platform funded by Corteva Agriscience,[4] the company formed by the merger of two already large seed and agrochemical companies, Dow and Dupont. What this series makes clear is how the 'chemicals plus seeds' model first developed under the Green Revolution is now an integral part of a deeper digitalisation of the entire food system all the way through processing and distribution to retail. It is as if digitalisation and the sophistication of the algorithms were designed to conceal what continues to be a chemically driven productivist model dominated by a handful of mega corporations that together exercise oligopolistic control of key sectors.[5]

This is believed to be a consequence of lobbying efforts by farming and agri-food interests www.euractiv.com/section/agriculture-food/news/ngos-unite-against-eus-rollback-of-green-policies-for-the-agrifood-sector/
See also 'The EU's great green retreat benefits the far right. For the rest of us, it's a looming disaster' https://www.theguardian.com/commentisfree/2024/apr/02/eu-green-deal-far-right-environment-agribusiness-extremists#comment-167097992 (accessed 13/05).
See also 'The global power of Big Agriculture's lobbying' Financial Times, 22 August 2024.
On the power of lobbying on behalf of biotech companies this piece on Jack Bobo makes for interesting reading: https://gmwatch.org/en/106-news/latest-news/20445-american-biotech-lobbyist-drives-gmo-deregulation-discussions-in-uk-eu

[3] The ETC Group is a think-tank that monitors the impact of emerging technologies and corporate strategies on biodiversity, agriculture and human rights. https://www.etcgroup.org/
[4] Follow the Food: https://www.bbc.com/future/bespoke/follow-the-food/
As James Wong pronounces in the first episode of Season Two, 'With our current global population growing at current rates, it's been estimated that we will have to produce more food in the next 30 years than we have in the entire history of humanity.'
[5] According to Clapp (2022) approximately 60% of the global seed market was held by the top four firms in 2018, while around 70% of the global agrochemical market was controlled by those same four firms. Corporate consolidation and concentration

Seizing control of the solutionist narrative appears to require claims for the highest stakes, that is, to establish the existential challenge which their technologies will resolve. Thus, in a digital newsletter on European food and agriculture which carries promoted content, the Regional Director of Syngenta Europe writes:

> *We are poised on the brink of a golden opportunity to redefine European agriculture. The questions we face are pivotal: How do we support agriculture within our planet's limits? How can we unlock the potential of knowledge and technological innovation? Our planet's health and our agricultural practices are intertwined, and the challenge, though immense, is within our grasp. (Hill 2024).*

The issue, of course, is that we do not all share the same vision for European agriculture. Syngenta, it might be noted, was created by the merger of the agricultural divisions of Novartis and AstraZeneca and was then bought by ChemChina, making it one of the world's largest pesticide manufacturers. So, if, as they suggest, our 'planet's health and agricultural practices are intertwined', it may be that their vision also includes the need to conceal from European regulators the results of brain toxicity studies arising from exposure to their chemicals (Carrington 2023a, b).

It is important to note how the language of 'precision', 'climate-smart' and 'sustainable' farming underpins the proposed solutions to our environmental predicament. Yet we might ask: what are the implications of such high-level technological developments for users? (Bronson and Knezevic 2016). If AI is to support farmer decision-making with algorithmic rationality, what are the implications for those who have previously enjoyed a high degree of autonomy drawing upon more empirical knowledge? Will we witness a new generation of cyborg farmers? This question has become increasingly prescient in light of the Right to Repair movement that has sought to challenge the capacity of companies such as John Deere to exert rights over machines purchased and owned by farmers (National Agricultural Law Center 2023, Farm Action 2024). In this respect, the deepening penetration of such technologies into agri-food production raises profound questions regarding the practice of surveillance capitalism and digital colonialism (Zuboff 2019), and demonstrates the urgent need to build a collective, democratic and open-source response (Maschewski and Nosthoff n.d). It also generates uncertainties about the future of rural areas where the likelihood of increasing farm size in order to meet the new economies of scale set by robotics may lead to a loss of population and changing cultural landscapes. Arguably, this is precisely an outcome desired by many supporters of precision fermentation as we see below, and it raises profound questions about how we are to navigate a socially just technological transition.

## Precision Fermentation

The Silicon Valley-led digitalisation of food, underpinned by biotechnology and utilising tissue engineering, precision fermentation, gene editing and other related technologies, is bringing to market a range of plant, cellular, insect and fermented proteins. The professed objective in developing these novel foods is to produce substitutes for animal protein since this is an area widely and correctly regarded as the principal source of biodiversity loss, climate disruption, and land utilisation by agricultural activities (Xu et al. 2021; Clark et al. 2020; Coimbra et al. 2020). Besides their putative environmental and animal welfare benefits, novel foods are also often represented as a way of extending consumer choice, developed to accommodate changing 'lifestyle' considerations and healthier bodies (Sexton et al. 2019).

Precision fermentation is one of the novel food technologies currently being developed. Given that the first keynote address at the 2023 Rome Conference on Novel Foods was given by George Monbiot[6] on the topic of precision fermentation, it seems appropriate to look more closely at the claims being made for this technology, and leave aside other novel food processes. Fermentation of foodstuffs is, of course, a long-

continues in other parts of the agri-food system, for example with four firms controlling around 70% of global grain trade.

[6] George Monbiot, for those who may not be familiar with this name, is a UK based, award-winning journalist, author, and environmental and political activist. He writes a regular column for The Guardian newspaper and was the first invited Keynote speaker at the Rome Conference on Novel Foods. Further details about him and his work can be found here: www.Monbiot.com.

established practice that provides a sense of familiarity given its use to process raw materials into stable products such cheese, yoghurt, kimchi, bread and beer. Biomass fermentation may utilise algae or fungi to yield high protein food products, such as Quorn, as well as biofuels such as ethanol. Precision fermentation, on the other hand, uses microbes as 'cell factories' in order to produce a wide range of functional ingredients such as protein, enzymes, flavouring agents, vitamins, natural pigments, and fats (GFI 2024). Precision fermentation can use a wide range of feedstocks including food waste, by-products from food processing industries (e.g. whey from cheese-making), while algae offer a particularly promising option (Augustin et al. 2024). The process takes place in brewery-style fermentation tanks, or bioreactors, which are very 'space-efficient', and when "scaled up, fermentation can produce many tons of biomass every hour' (GFI 2024).

Monbiot began his talk[7] by insisting that the use of land around the world ought to be one of our key environmental metrics, one matching the climate emergency, yet it receives too little consideration. Drawing on land use statistics (Ritchie and Roser 2019), he argued that livestock production worldwide was the major driver of biodiversity loss and agricultural sprawl, and that it was imperative to get out of animal farming. Fortunately, for Monbiot, single cell organisms offer an exit route while also supplying high levels of protein, and so for him represent 'the most important environmental technology ever developed'. Indeed, as he has written, 'It might be all that now stands between us and Earth systems collapse' (Monbiot 2022a).

Significantly, Monbiot is not alone in this view, given work underway on the development of single cell proteins that could be produced from hydrogen or other cheap and abundant feedstock. Such proteins could potentially support human survival in the event of a global catastrophe such as a super-volcanic eruption, asteroid impact, or nuclear winter causing global agricultural collapse due to reduced sunlight reaching the Earth's surface (Pham et al. 2022; Garcia Martínez et al. 2022). One might consequently assume that these new technologies are pitched at the highest level of existential solutionism yet are made more miraculous by their claim to dematerialise the production of nutritionally comparable protein. This inevitably raises more sceptical doubts around 'magical thinking' (Guthman and Biltekoff 2021). In his talk, for example, Monbiot extolled Solar Foods, a Finnish company, that produces a high protein powder using a hydrogen-oxidising bacterium and which the company states is 'a protein out of thin air' (Solar Foods 2024). Yet making such claims for precision fermentation is a high stakes game and necessarily invites scrutiny of the data, methods and assumptions that support the case, let alone evaluation of the implications arising from the technology's widespread implementation.

In his talk, Monbiot placed particular emphasis on the 'land sparing' possibilities of single cell organisms and microbial fermentation, not only in comparison to livestock rearing but also in relation to crop plant proteins such as soy. Producing all of the world's protein requirements in contained bioreactors could be achieved, he suggested, in an area the size of Greater London. This would then enable a Great Rewilding of previously farmed landscapes to take place, a notion in line with the 'Half Earth' strategy, a conservation initiative which advocates that protecting half of the Earth's land and sea areas would likely conserve at least 80% of preindustrial species richness (Crist et al. 2021). Precision fermentation would then appear to be an ideal solution in achieving these aims if Monbiot's calculations are correct:

> *…using methanol (as feedstock) needs 1,700 times less land than the most efficient agricultural means of producing protein: soy grown in the US. This suggests it might use, respectively, 138,000 and 157,000 times less land than the least efficient means: beef and lamb production (Monbiot 2022a).*

Logically, this technology would also bring about radical reductions in water use and greenhouse gas emissions and avoid the spillover of waste and chemicals typically caused by farming. It would thus appear then that the technology offers a self-evident win-win solution and perhaps explains Monbiot's rather exasperated tone when responding to more sceptical questions.

[7] Available at https://aur.edu/node/4713. Monbiot's talk begins at 09 min17 and finishes at 1hr 11.30.

Clearly, new technologies do offer possible pathways to reduce livestock's environmental burden, provide malnutrition mitigation pathways and enhance food system resilience (Tzachor et al. 2021). Yet cautiously evaluating such possibilities, while recognising the serious technical and institutional challenges that exist, requires a broadening of perspective as well as the need for reliable data drawn from methodologically sound and systematic analyses. For example, a recent review paper has suggested that single cell protein bioreactors may not necessarily exhibit environmental benefits, and that various conditions such as the cultivation system, location, season, scale, microbial species and source of nutrients would considerably influence environmental impact (Smetana et al. 2023). It goes on to argue that 'the environmental impact of single-cell proteins is dependent on the use of renewable energy' given that the production of hydrogen for cell growth is so energy intensive (Smetana et al. 2023: 7). This is why detailed and transparent life-cycle assessments are necessary in order to evaluate the legitimacy of solutionist claims.

In his book, *Regenesis* (2022c), Monbiot sets out a broader case for the subject of his Rome talk, that of microbial protein production, but also takes to task agriculture more generally, regarding it as little more than an outdated – and highly inefficient – way of producing food. In a book-length rebuttal, Smaje (2023) offers something of a forensic analysis of Monbiot's book and, in particular, subjects the latter to detailed scrutiny around its treatment of energy. Highlighting the paradox of substituting free solar energy to grow plants by the need to supply large amounts of electricity needed to drive bioreactors, Smaje calls into question the feasibility of this shift. In a peer-reviewed publication (Järviö et al. 2021) reporting on the LCA study they conducted at Solar Foods (the same company visited by Monbiot), the authors calculate an electricity requirement of 18 kWh per kilogram of product output. Without appropriate attribution, this is the figure that Monbiot uses to suggest that meeting the global population's protein needs would therefore require just 11% of the world's installed electricity capacity.[8] Here Monbiot displays his ecomodernist credentials, for he argues that this additional energy could easily be supplied through new nuclear technology as well as through a massive expansion of renewables. Given the urgency – yet financial and regulatory challenges – of decarbonising electricity generation to meet current needs, let alone the controversial role of nuclear in the energy mix, Monbiot's position seems, at best, ingenuous.

In this respect, the enthusiasm for the technology of precision fermentation – which, it has to be said, borders on zealous advocacy in Monbiot's case – appears to overwhelm all other considerations, while the building and installation of thousands of fermentation tanks – a brewery in every town according to Monbiot – underplays the embedded resource investments in concrete and steel, let alone their operating energy requirements. Precision fermentation also potentially threatens many farmers around the world, and not just those engaged in livestock rearing. For example, Planet A Foods uses precision fermentation to create ChoViva, 'an indulgent, cocoa-free chocolate'. This means 'we can utilise local crops, which are harvested in a much more sustainable and people-friendly way, than crops like cocoa' (Planet A Foods 2024). Cocoa farmers in West Africa are already under severe pressure because of climate disruption, the spread of a viral infection and the growth cycle of cocoa plants, and are now likely to face increasing competition from a manufactured substitute that might promise environmental benefits but will come at a cost to livelihoods.

Such developments reveal the highly complex, interconnected issues of technological, ecological and social change driven by the pursuit of financial returns by corporate interests. Yet this complexity is reduced to simplistic tropes by companies – such as by Planet A Foods – declaring 'A new era of sustainable food ingredients is here' without fully considering what this might mean for small farmers in West Africa. Likewise, Monbiot's enthusiasm to rewild land spared from livestock agriculture has simply enormous consequences for temperate upland farmers with limited options for arable crop cultivation. Perhaps Montenegro de Wit

[8] Smaje, drawing on studies from elsewhere, arrives at a figure nearly four times this – 65 kWh/ kg of product – and extrapolates that this would require around 43% of the world's electricity consumption or 89% of its low-carbon electricity supply. Smaje blogs on these and other issues. See 'The energetic implausibility of manufactured food revisited' at https://chrissmaje.com/2024/01/the-energetic-implausibility-of-manufactured-food-revisited/

(2022) poses this dilemma best when interrogating the assumptions about nature that distinguish the 'saving-land-from-people discourse' of gene editors and ecomodernists, as opposed to the 'saving-land-with-people' discourse of agroecology. Above all, the solutionist narratives emerging from the novel foods sector reveals the ways in which problems are framed to match the solutions they can provide, but appear to disregard the wider consequences, such as the livelihoods of livestock or cocoa farmers. Surely any claim to be feeding the world sustainably must embrace a more holistic and inclusive perspective as well as some degree of scientific humility about the technology's limitations and consequences.

## Technological solutionism and sustainable, healthy diets

It has been noted that a consequence of media interest in the novel foods sector is that it skews to the celebratory and thus overshadows a broader debate on what these developments might mean for food and agriculture more generally (Sexton and Goodman 2022). Indeed, maintaining a focus on the *technology* rather than the *outcomes* of that technology serves to deprive society of a voice, an opportunity to question the desirability of the products being developed (Nerlich 2021). A preoccupation with the 'heroic' efforts of laboratory scientist-entrepreneurs invariably circumscribes the opportunity for wider societal debate around the pursuit of alternative strategies that take social inequality, nutritional security and ecological integrity seriously (McGreevey et al. 2022). It therefore seeks to maintain a top-down approach seeking global solutions to ostensibly meet consumer *wants* (continued availability of cheap and convenient protein) rather than enabling more localised food systems that engage with helping citizens to achieve their nutritional *needs* while preserving the social, cultural and ecological importance of those systems. It certainly does not challenge consumerism nor provide any restriction on freedom of choice. Simply extending a range of options in the supermarket might assuage a moral dilemma for flexitarians but is unlikely to keep us within 1.5°C of global atmospheric heating (Clark et al. 2020).

This is, of course, not disconnected from the extraordinary economic power and influence exercised by those businesses emerging as leaders in the field. The consolidation of corporate power in the food system through merger and integration as well as through extending market reach and product diversification is well documented (Clapp 2022; Howard et al. 2021; ETC 2022; IPES-Food 2017). Some of the big investors in novel foods are also some of the largest meat and dairy processing firms, and reconciling their involvement in plant-based substitutes while their core business remains in slaughtering animals appears to be resolved by relabelling themselves as 'protein' companies (Howard et al. 2021). This positioning around a charismatic macro-nutrient regarded as indispensable to human health serves to obfuscate those companies' continued activities in meat. At the same time, spreading risks in the event of regulation- or climate-driven destocking rules enables the co-existence of novel foods with business-as-usual livestock operations and crowds out alternative solutions for just, equitable dietary solutions (Guthman et al. 2022).

It is clear how the discursive power of solutionism is underpinned by a wide portfolio of products and technologies capable of utilising a range of interchangeable materials (microbial enzymes, algae, plant biomass, animal cells, secretions and tissue) as feedstock to deliver a diverse set of building blocks for food, energy and other industrial applications. Given the urgency to transition from fossil fuels, biorefineries, in addition to meeting the demand for protein, are likely to be processing growing volumes of agricultural raw materials into biofuels and biopolymers.[9] The entanglement of novel food production with the energy, transport and chemical sectors is therefore bound to increase and, depending upon market conditions, greater volumes of commodity crops hitherto regarded as primary foods might yet find themselves being used as feedstock in bioprocessing operations rather than feeding people directly.

In this respect it is necessary to ask if novel foods will facilitate or hinder the encouragement of consumers to move toward more whole plant-based eating in the interests of sustainability and dietary health, as proposed

[9] Currently an estimated 40% of the US corn crop is converted into ethanol.

by the planetary health diet (Willett et al. 2019)? While these new products may achieve comparability in terms of protein and other essential nutrients, the use of ingredients to provide flavour, colour, edibility, digestibility and binding agents has raised concerns about levels of sodium and other markers characteristic of ultra-processed foods (Lumsden et al. 2024; Monteiro et al. 2019). Moreover, it is worth reminding ourselves that the majority of these novel food products are presented in the form of burgers, nuggets, meatballs, hot dogs and other processed, extruded and printed shapes symptomatic of fast-food eating. Invariably served with potato fries and within a white bread bun, the dish is not a testament to healthy eating. We might also ask how novel foods fit within existing culinary traditions and associated agri-food culture, given their tendency to mimic conventional fast-food analogues. What does the increasing prevalence of such products mean for more territorially specific and healthier foodways such as the Mediterranean Diet?

Ultimately, novel foods' preoccupation with protein should remind us that any nutrient is not consumed in isolation but rather ingested as an element within complex dietary patterns that, depending on their society and geography, can display significant daily, weekly, and seasonal variability (Lumsden et al. 2024). Moreover, the complementarity of different foods and the ways they work in combination has provided the basis for nutritionally adequate diets (rice and lentils, corn and beans) for hundreds of generations. Plants contribute almost two-thirds of global dietary protein compared to one-third for animal products, though this ratio is reversed amongst the richest countries where the incidence of diet-related non communicable diseases (NCD) is most marked. Consequently, while novel foods are likely to find space on future plates within a continuum of flexitarianism (Kanerva 2022), the role of whole-plant farmed foods surely remains central to dietary well-being.

Finally, while this paper has sought to critically evaluate the solutionist claims for novel foods, it is recognised that it faces challenges from the incumbent meat lobby. Reactions to the EAT-*Lancet* publication (Willett et al. 2019) – amongst a deluge of other scientific studies highlighting the problems of industrial meat production – are testament to the power of livestock interests not engaged in the protein transition to resist such initiatives, including building alliances with university academics in order to establish a science-based rebuttal (Morris and Jacquet 2024; Garcia et al. 2019).[10] Consequently, challenging technological solutionism and its promissory narratives should not distract us from remaining vigilant to incumbent interests anxious to protect the status quo centred upon productivism and consumerism. Creating an alternative narrative capable of supporting food system transformation in the interests of human and planetary health at a time of polycrisis thus requires an enormous collective, collaborative, and creative effort across civil society and beyond.

## Building an alternative narrative

The paper has argued that the food system has become particularly susceptible to narratives of solutionism in which neo-Malthusian, environmental or animal welfare tropes are deployed to demonstrate the critical – even existential – contribution that its technology plays in overcoming the issue. Here the multi-dimensional attributes of food as the basis for social cohesion, cultural meaning, nourishment for wellbeing throughout the life-course, and ecological equilibrium begin to disappear. This is why it is important to create new narratives of food system transformation that can address the diverse challenges highlighted at the beginning of this paper, and do so in a way that recognises complexity, contingency and the need for collective and continuous learning. Embarking on such a task requires the rejection of reductionist metaphors of food ('food as protein, fuel for the body as machine') and the creation of new metaphors that span food's cultural and social domains (Sage et al. 2022). It also requires the identification of key concepts around which to mobilise – ideally words that have not yet been completely (mis)appropriated by defenders of 'business-as-usual'.

[10] See also the Dublin Declaration of Scientists on the societal role of livestock (https://www.dublin-declaration.org/) as an example of this pushback where it is stated that livestock systems 'are too precious to society to become the victim of simplification, reductionism or zealotry'.

Agroecology is one such term that has gained real traction in offering a focus for an alternative paradigm for food systems. That it has largely emerged from subaltern usage, especially in Latin America (Altieri and Toledo 2011) and its association with La Via Campesina, provides it with a legitimacy denied to other more tainted concepts. Agroecology is however not simply a technical roadmap for low-external input agriculture; it comprises a more holistic, transdisciplinary, epistemological framework through which to understand the multiple shortcomings of the existing food system and the place of various actors within it. While encompassing a wide portfolio of farm and landscape-level 'best practices' that need to be evaluated and implemented as place-specific operations, it builds upon principles of stakeholder participation, the co-creation of knowledge and transformative efforts to establish a more resilient, equitable and socially just food system (Bezner Kerr et al. 2023).

Incrementally, then, an agroecological paradigm has taken shape and gained legitimacy in policy circles in recent years, not least as a consequence of the UN Committee on World Food Security (CFS) High Level Panel of Experts (HLPE) report (HLPE. 2019), the FAO's creation of an agroecological knowledge hub (Barrios et al. 2020), and a growing academic literature inspired by the work of Miguel Altieri, Steve Gliessmann and others.[11] Yet the agroecology movement has pushed back against attempts to co-opt the narrative by agri-food corporations (Bless et al. 2023) and has worked hard to maintain its tripartite definition as comprising science, practice and social movement. It is this pragmatic epistemological framework of agroecology that could provide the basis for promoting an alternative narrative that can also be taken up by other social actors engaged with food system transformation.

It is now clear that there exists a relatively well-organised and interconnected global social movement around food which, in contrast to first-generation alternative food networks (Goodman et al. 2012), is now demonstrating greater ecological and social justice awareness and capability for action. This 'second generation' food movement (Sage et al. 2021), while largely comprising civic food initiatives, is increasingly well-connected both within national jurisdictions and through international networks. These initiatives, thinking critically about the food system, recovering a territorial dimension to production systems, and finding ways to recover the materiality of endogenous foods and culinary traditions, present one opportunity through which to start a wider conversation around alternative 'food futures' (IPES-Food and ETC Group, 2021).

While many of these initiatives, seeking to co-design their urban spaces in collaboration with municipal government, reveal a wide variety of practices, one expression of this new civic collaboration has been the creation of food policy councils[12] (Schiff et al. 2022; Giambartolomei et al. 2021). These provide a platform for engaging citizens within a quasi-legitimate framework, not only to devise local strategies but potentially to enable a wider civic dialogue around food. At a time of polycrisis marked by growing polarisation, populism, and pessimism, the application of representative deliberative processes to improve public policy outcomes is being more widely considered. These include citizens' assemblies, citizens' juries and other consultative and consensus building models (OECD 2020). There is consequently an emerging epistemological framework involving civil society actors, local government, deliberative methodologies and a growing sense of urgency that could provide the basis for developing new narratives around the food system.

Yet challenging technological solutionism raises the issue of knowledge deficit: how can the public better understand – and trust – novel foods, recognising their societal usefulness, ethical acceptability and sustainability rather than accepting their existence under a barrage of solutionist marketing? Broad and Biltekoff argue that achieving such trust requires engaging the public through multi-stakeholder dialogue, enabling them to

[11] This paper cannot do justice to the range and scope of published work or to the efforts of activists working in the field of agroecology. However, useful entry points, besides the work of Altieri and Gliessman, are provided by Anderson and Anderson (2020) and Tomich (2011).

[12] Food policy councils may exist under a different nomenclature, such as food partnerships or food advocacy coalitions, but generally they hold in common an organisation that brings together diverse stakeholders sharing a common interest in advocating on local food issues.

explain what they want from the food system, the ethical principles to which industry should conform, and the questions they have about the new technologies (Broad and Biltekoff 2022). If this means upstream involvement of citizens able to examine the innovation process – and not simply to offer thoughts on near-to-market improvements – it will require the building of public capacity to ask the kinds of penetrating questions posed by Schweizer (2022). Armed with such knowledge, would that then permit a more generous openness to new tools and techniques that give rise to novel foods?

In an intriguing paper, Montenegro de Wit (2022) examines the contrasting ontologies of agroecology and the gene editing technology known as CRISPR which, for most of us familiar with the regulatory struggles over first-generation GMOs, would be regarded as entirely incompatible. Given her natural and social scientific education, as well as cultural background, the author offers an argument for complementarity – even synergy – for the two. Stripping away the economic and political advantages and protections that corporate biotechnology enjoys, she poses important questions about ownership and control, considering whether open-source and commoning arrangements could overcome the IP lock-in that CRISPR and other techniques enjoy. Here, she outlines six principles for technology sovereignty which ultimately come down to establishing people's right to make decisions about and co-create 'technologies that reflect, respond to, and mobilise communities' collective knowledge and power' (Montenegro de Wit 2022: 750).[13]

Building an alternative narrative, then, invites us to reconsider the role of technology but stripped of its solutionist hubris, freed from the chains of corporate hegemony, and carefully unrolled with due regard for precaution, the capacity for collective learning, and the sharing of benefits. However, at the heart of this narrative must lie a foundational objective that can mobilise communities and drive a strategy for transformation, particularly at a time of polycrisis. The concept of resilience, for example, might serve this purpose. Though long used as a desirable property of systems – the capacity to withstand shocks, stress and risks, underpinned by robustness, adaptive capacity and recovery (Folke 2006) – its application to food systems establishes the central importance of equitable access to food, nutritional security and social justice. Building adaptive capacity within food systems for producers means prioritising local diversity of culturally appropriate foods, using agroecological principles that reduce reliance on external inputs and exposure to their fluctuating market prices (Schipanski et al. 2016). Above all, however, food systems need reorientation, moving them gradually away from short-term and resource-intensive productivism delivering cheap food that increases vulnerability to a host of risks for producers and consumers alike. A just and lasting reduction in vulnerability will involve 'changing societal expectations and the demands of system outcomes in order to enhance food system resilience'[14] (Zurek et al. 2022: 521).

Reorientation of food systems involving changing societal expectations would therefore seem to be an inescapable part of strengthening resilience; it implies going beyond a gradualist reduction in levels of food waste, meat consumption, adoption of novel food products and other such 'nudged' behaviours in the hope that consumers make informed choices and that these lead to reduced environmental impacts. Building a more democratised and socially just food system could mean reorientation toward a broadly agroecological structure, involving a reimagination and re-creation of food production, processing, distribution, consumption and governance (McGreevey et al. 2022). As Montenegro de Wit (2022) observes, technology has an important role to play but it depends upon the social, political and economic ecosystem around it to guide it towards desirable, democratic and more equitable outcomes. Above all, this requires the engagement of citizens to reclaim agency and voice, challenging dominant narratives of technological solutionism in the service of profit accumulation and corporate control, and creating an alternative discourse that speaks to human and

[13] These six principles of technology sovereignty – closely following those of food sovereignty – focus on: technology for people; valuing food providers as tech providers; localising tech systems; putting control in local hands; building knowledge and skills; and working with nature (Montenegro de Wit 2022).

[14] It should be noted that the High-Level Panel of Experts on Food Security and Nutrition of the FAO's Committee on World Food Security (CFS) has been charged with producing a report on 'Building resilient food systems' to be presented at the 53rd plenary session of the CFS in October 2025.

ecological wellbeing, social justice, and planetary stability.

## Conclusions

This paper has sought to offer a critical commentary on technological solutionism especially as it is emerging in the realm of novel foods. Utilising the notion of polycrisis as representing a multidimensional and interconnected set of contemporary challenges, it argues that if we are to live within planetary boundaries and ensure nutritional security for all, we need to look beyond mainstream science and the invention of technical fixes, and develop a new mode of thinking that embraces complexity and greater scientific humility. Following a brief examination of precision fermentation, outlining George Monbiot's belief that single cell proteins represent 'the most important environmental technology ever developed' – though with enormous uncertainties around its energy demand – the paper considered how novel foods might contribute to the achievement of sustainable, healthy diets. Asking questions about the technology not only reveals a scarcity of uncontested scientific evidence able to establish its case for superior performance – whether environmental or nutritional – over existing products, but also raises concerns about possible impacts from scaling production on other groups of people far removed from the sites of bioreactors. The narrow framing of problems ('a future protein shortage') is therefore designed to match the solutions the technology can provide but critically at the cost of disregarding wider consequences.

This demonstrates the need to develop alternative narratives capable of drawing together – and energising – a much wider range of stakeholders than the corporate interests that lie behind technological solutionism. It was suggested that agroecology might provide a suitable framework given its holistic, transdisciplinary and knowledge co-creating epistemology, as well as the importance attached to participation in building a more resilient, equitable and socially just food system. The role of technology will be critical, and we have to closely consider how it can best support civil society to exercise greater agency, perhaps through pressing for more collective, open-source tools in resistance to digital colonialism. This will require challenging dominant narratives of technological solutionism in the service of profit accumulation and corporate control, and creating an alternative discourse that speaks to human and ecological wellbeing, social justice, and planetary stability.

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# Book Review. Loconto, A and Constance D (eds.) 2024. Agrifood Transitions in the Anthropocene: Challenges, Contested Knowledge, and the Need for Change London: SAGE Publications Ltd.

Paper first received: 31 July 2024; Accepted: 09 August 2024; Published in final form: 24 February 2025
https://doi.org/10.48416/ijsaf.v30i2.632

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## Abstract

In July 2024, an author meets critics session was organized at the Rural Sociological Society's Annual meeting that was held at the University of Wisconsin, Madison. In this session, the co-editors (Allison Loconto and Doug Constance) of the book *Agrifood Transitions in the Anthropocene: Challenges, Contested Knowledge, and the Need for Change* met co-authors Elizabeth Ransom and Claire Lamine to discuss the contents of the book. They also met two critics - one in person and one at a distance - in order to debate the pertinance, the interest and the contribution of the book to the epistemic community gathered in Madison. This article publishes these two critiques back-to-back as a means to stimulate further debate and discussion in the sociology of agriculture and food community.

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## Welcoming Agrofood Nanarchy: Transitioning Away from the Monstrous Problem

*Michael M. Bell*

To be honest, I didn't enjoy reading *Agrifood Transitions in the Anthropocene* as much as I expected to. I was delighted – in these challenging times of contested knowledge in much need of change – to be invited to have a look. We face a difficult and fiercely complicated situation as a planet. One often hears the phrase a "wicked problem" to describe the condition of food and agriculture, but that's not exactly apt. What is wrong with being alive and animate, the original meaning of "wick"? I'm OK with spirit. I think we need more, in fact. Maintaining the alive and animate is, after all, the whole point of food and agriculture – or, rather, should be. Really, what we face is a *monstrous problem*, monstrous in size and moral aspect. Indeed, it's a Frankenstein problem, being both human and non-human, birthed by us, and rampantly out of our control. But reading this book, I did not get a sense of how we might regain that control, despite what I took from the title was its intent.

Don't get me wrong! It's a very good book by some very good folks on a very important topic: the concern we should all have over the terrible state of what the authors often call – although I wish they wouldn't – our "food system." It's not a system, and we don't want it to be. I have often complained about the creeping crude of this term in our field, although people generally look at me blankly when I do, or whistle a tune, the same old tune, until the moment passes. The meaning of system, says the *Online Etymology Dictionary*, is an "organised whole" with sys- coming from *syn-*, meaning together, and -tem coming from *histanai*, meaning to "stand up" or "set up." Tell the starving it's an organized whole. Tell the impoverished farmer it's an organized whole. The problems stem from its disconnections and disorganization. Indeed, to the extent it is organized, it is even more a monstrous problem. Which is more in keeping with the etymology given by the *Oxford English Dictionary*, which reports that "sys-" comes from the Greek to "set up" or "stand up" something, but "-tem" comes from "-oma," as in carninoma. A system, by this derivation, is an organized cancer.

So why do we love this term so much? So why, when we intone it, do we raise our arms in supplication to this higher power?

Besides, the "agrifood system" is not much about food, nor agrifood – although, again, it should be. It is mainly about power, oppression, and accumulation. The co-authors of the book agree that this is the sad case. And they are right that, by whatever name, this organized whole has gone cancerous, and is in crisis. The co-authors are clearly quite depressed about this. So that did not make for enjoyable reading.

I also have some more minor irritations about this and that, concerning the book's framing and content. For one thing, I'm not sure the book is really about the troubles of the anthropocene, dating from whenever the geologists can first detect a layer of radioactive fallout from atom bombs, or whenever. The troubles of agriculture and food are not new, and we need to be cautious about implying that there was a golden age of agroecological harmony before the atom bomb. The same goes for related terms that some of the authors in the book favor, or toy with, such as capitalocene or the plantationocene. Capitalism and dominating relationships have long been a part of agriculture, from Mesopotamian times to now, if not from before that, if we take seriously what late lamented Jim Scott (2017) said in *Against the Grain*.

And if by anthropocene we mean the staggering impact of the human on the Earth, even at a geologic scale, such ecological power is not necessarily bad. Perhaps that power could be used to promote transition and transformation. Perhaps we now have the power to do food and agriculture right, in ways that are just and sustainable. The moral issues of power are its common inequality and how it is commonly used for unequal ends. But agroecological power could be used differently, and sometimes is. It could be a form of love, built from below, promoting regeneration, as I think Harriet Friedman in the book wants us to consider.

I also hoped to read more about concrete issues of labor in food and agriculture. The book seems framed more around the question of relationship of humans to the rest of the planet and the Latourian question of how different are we anyway then it is about human exploitation of humans in food and agriculture. Yay for relational ontologies! Still, framing of the book around the anthropocene made the focus more on overcoming binaries than on overcoming exploitation.

But these are not the main issues that made the book less enjoyable than I hoped. It is that, aside from Friedman's contribution and a few others, the book is about troubles, not solutions. Even the many case studies of transition and transformation that constitute the bulk of the book generally have the flavor of, well, somebody tried doing something but it wound up just being just the latest manifestation of the world system, albeit perhaps with a bit of a smiley face – which almost made matters worse by disguising and papering over what is really going on. The book feels reactive more than active. It does valuable work of critique and complaint. But the book analyses more than it proposes. The overall tone is one of despair. I didn't see a chapter here to inspire the undergraduates in the introduction to agroecology course I co-teach.

Solutions are hard! If they weren't they probably would have already been enacted! I get that. But I guess I read too much into the "need for change" ending of the book's subtitle. We got plenty on the need, but very little on the how.

The editors and many of the book's authors do address the how in some of their other work. There is Allison Loconto's wonderfully helpful "innovator's handbook" on *Enabling Sustainable Food Systems*, a beautifully produced 231-page book published by FAO and INRAE in 2020. There is the half million dollar 2016 USDA-AFRI grant that Doug Constance was part of on "Pathway to Organic: A Research, Extension, and Education Project in the Southcentral Texas on Transitioning Cropping Systems." But that was evidently not the mood that the contributors to this volume were in.

OK, so if I am going to complain about too much complaining, what have I got to say about solutions? What would I have contributed, if I had been one of the co-authors? Would I have had anything even modestly hopeful to suggest about solutions?

Maybe something. I want to conclude by sketching out a new thought that I think is also an old thought, a thought that I hear in the background of many of these papers and chapters. And I'll give this new old thought a new name: what I will term *nanarchy* – not anarchy, but nanarchy. I mean it in the sense of nano, the small. I'll offer this initial definition or description of nanarchy: sovereignty of the small, for the small, in the small – and in the large.

Like anarchy, and like many of the chapters of this book, nanarchy is suspicious of scale. It's not necessarily against scale but wary of it, as nanarchy is protective of autonomy and sovereignty. Nanarchy encourages what the philosopher Isaiah Berlin (1969 [1958]) called "freedom-to" – freedom to do, to act, to be as individuals and collectives. Clearly, we have little freedom-to in agrifood – in what I would prefer to call the *agrifood complex* rather than system. I gave a talk at the 2023 ESRS meeting in Rennes, and someone in the crowd suggested that term (a Dutch man, by look and accent) in the question period afterwards. I never got his name, but I think he was on to something. It gets at the complexity of the agrifood context, but without a sense that it is actually an organised whole – or that we would even want it to be, given the way organisation so commonly squelches freedom-to.

But not inherently. Indeed, freedom-to is only possible with what Berlin called freedom-from. Space needs to be created and held open for freedom-to, and to ensure that one freedom-to does not compromise another freedom-to – what John Rawls (1971) called the first principle of justice. As my colleague Michaela Hoffelmeyer (2023) points out in her work on meat packing, small is not necessarily beautiful. It can be the

site of much exploitation. We need to protect the small from the small, not only from the large. So nanarchism differs from anarchism – or at least differs from much anarchism – by recognizing the need for the protective role of the state or state-like entities.

This is what my colleague Loka Ashwood (Ashwood and Bell, forthcoming) calls the horizontal power of the state, creating space for the sovereignty of the small, while also ensuring that there is no infringement in the small of basic human rights and more-than-human rights. The trouble, says Loka, is that the state has become too vertical.

What does food and farming nanarchy look like in practice? It looks like an egg from my backyard chickens, which I am now allowed to have 8 of in my city, without troubling my neighbors very much. It looks like the bottle of wild-harvested blackberry jam that my wife and I made last summer. It looks like the incubator farm at Wisconsin's Farley Center, just outside my city of Madison, Wisconsin. It looks like hot sauce from my city's farmer's market, made by my friend Sandra Morris, based on a recipe from her native Togo. She makes it in my city's FEED (Food Enterprise and Economic Development) kitchen – a kind of incubator for food businesses in Madison. It looks like the IPM blueberries from a Latino growers coop in Michigan that my friend Margaret Krome brings to Madison as part of a buying club she organizes. It looks like the Wily St Food Coop in Madison. It looks like farmers organizations like Grassworks, the Practical Farmers of Iowa, Family Farm Defenders, and the Wisconsin Farmers Union, which have grown up in my region to create more space for freedom-to. It looks like OSHA rules that are enforced in the small meat packing plants that Michaela Hoffelmeyer studies, and that we may soon lament, as the Trump administration continues its efforts to make an organised whole that puts the billionaires even more firmly on top. It looks like the overturning of so-called right-to-farm laws, which are really right-to-exploit laws.

But I can't hope to solve the monstrous problem of agrifood in a few pages of fine words, and nor can these authors in 388 pages of fine words. Still, as I sat on a bench on my city's Capital Square this past summer, during the Rural Sociological Society's Annual Meeting, I was inspired by a Madison tradition: the solidarity sing-along, every Friday, noon to 1pm. Here's what they were singing as I sat there between sessions of the meeting:

> *We shall overcome*
>
> *We are not afraid*
>
> *We shall live in peace*

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## Urgent, immediate and ambitious action is needed to address the challenges of the Anthropocene and the transformation of our agrifood system for a sustainable future

*William Lacy*

Senior researchers and policy analysts Allison Loconto and Douglas Constance have produced a very timely and critically important edited volume which addresses perhaps the greatest challenges of the 21st century, the new Anthropocene epoch. This new geological age is viewed as the period during which human activity has been the dominant influence on climate and the environment. Loconto and Constance bring a much needed sociological insightful and compelling analysis of this new epoch and strategies for moving forward.

They summarise the increasing evidence of this evolution and the major role played by agriculture (recent estimates identify food systems as being responsible for a third of the global Anthropocene greenhouse emissions). They point out that the debates about the consequences of this transition can be characterized as (1) those who view these changes as global ecological, social and economic disaster and (2) those who believe this will enable humans to achieve total control over the planet. The debate is further complicated by the climate change deniers. These conflicting world views often at the intersection of knowledge, environment, and governance contribute to an inability to reach consensus of the problem itself. They argue that the challenges of the Anthropocene and human/nature relationships require a new way of thinking in both the natural and social sciences and a drastic rethinking of modernity's assumptions, neoliberal consumer capitalism, and the politics of unsustainability.

The Loconto and Douglas overview and sophisticated analysis is enhanced by the subsequent chapters by philosopher Paul Thompson, sociologist Harriett Friedmann, technical advisor and teacher Nora Mckeon, and independent scholar and researcher Wardah Alkatiri. These scholars provide much needed sociological, philosophical and historical insights, as well as compelling analysis of this new epoch and strategies for moving forward. Both Friedmann and McKeon critique the governance models that have contributed to the unequal development, exploitation and inequalities of the current agrifood system.

Friedmann further questions whether the Nation-State is an appropriate governing model for the needed transition and future societal sustainability. She persuasively argues that a liveable, sustainable future lies in decolonizing the Anthropocene and reaffirms a commitment to a communal relations with the earth. Alkatiri concludes that governance of societal and agrifood transitions require holistic, integrated, and coordinated actions among a wide range of stakeholders.

These theoretical and historical analyses are also complemented by several excellent chapters that explore the current societal struggles to transition towards a more sustainable agrifood system in several countries worldwide. These empirical stories of the challenges of transition in the Anthropocene include the analysis of the French efforts to reduce antibiotic use in intensive and industrial livestock farming, pasture restoration in Brazilian animal agriculture, ethical issues in the role of Indonesian fisheries, the corporate agribusiness diet in Argentina, Brazil's experiment with biodiesel for rural development policy, and food systems in Europe and Sub-Saharan Africa. Each of these stories illustrate that while some modest positive change may have resulted from these initiatives, little fundamental change has occurred and that these technological strategies enable the current system to remain unchanged. Moreover, the provisioning of an adequate diet has fallen far short with the number of people who did not have access to adequate food in 2020 rising to 2.4 billion, nearly a third of the world's population.

Loconto and Douglas conclude with a call for a relational, interactionist approach for agrifood transitions in the Anthropocene that incorporates responsibility for sustainability of the natural and human environments and rights-based food sovereignty. In contrast, in Loconto's chapter on corporate research at Nestles and

Unilever she observed that their main purpose for doing research and innovation is to create marketable products and not a concerted response to societal sustainability. Similarly, Loconto and Douglas' final chapter provides a strong critique of institutional scientific knowledge of the United States Department of Agriculture public research system and the international agricultural research system, which reinforce the dominance of the industrialized agrifood system. Several other chapter authors also emphasize the need for reflexive approaches to research that value qualitative, indigenous, and farmers knowledge and citizen science.

In the Ransom and Raymond chapter they further expand the notion of knowledge to include knowledge from the margins and peripheries and that way of knowing is tied to the emotions and produced through social relations. They conclude that concern for the future of the earth can be a source of new or more appropriate knowledge. Finally, Loconto and Douglass encourage sociologists of agriculture and food to engage more strongly in these critical debates and political agenda and embrace a more activist public sociology.

Finally, I would be remiss if I didn't acknowledge the appropriateness of dedicating this book to the memory of Professor Lawrence Busch. He was my colleague and friend for several decades and provided significant theoretical grounding for this scholarship while championing many of the themes in this book. Equally importantly, he was the first President of the International Sociological Association's Research Committee on the Sociology of Agriculture and Food which began in the 1980s to analyse issues of inequality, knowledge, power, and institutional change in a global agrifood system.

In conclusion, although I have engaged in several decades of knowledge generation, dissemination and application on agrifood systems, science, higher education, and democracy, this volume provides a myriad of timely, important, new insights, perceptions and analysis in both a local and broad global context.

I can only hope it is read widely and acted upon! Urgent, immediate and ambitious action is needed to address the challenges of the Anthropocene and the transformation of our agrifood system for a sustainable future.

Volume 30 | Issue 2 | October 2024



## NOVEL FOODS