



A research framework to investigate food systems at a national scale

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ARTICLE INFO

Keywords:

Food systems transformation
National scale
Food regimes
Social metabolism
Social reproduction
Food systems governance
Food degrowth

ABSTRACT

This article aims to advance understandings of food systems functioning at a national level and explore ways for its transformation towards sustainability and social justice. Integrating food regime theory from political economy with social metabolism from ecological economics, and surplus/reproduction from feminist economics, we develop a novel research framework which combines six dimensions—food systems governance, monetary agrifood chain, socio-metabolic agrifood chain, surplus/reproduction, socioecological impacts, and conflicts & levers of change—encompassing 34 elements linked through six key connections. The research framework highlights the role of cheap food for the social reproduction of the labouring population in capitalism. Since national states play important roles in maintaining food regimes, we conducted a critical literature review through which we identified the main contributions and limitations of studies of food regimes at the national level aimed at foreseeing exit ways beyond the current corporate food regime. This regime is one of the main drivers of the overcoming of planetary boundaries. An agroecological transition and food system change is needed to address this socio-ecological crisis, and this requires new food polices at a national level as well. This is why we consider it essential to integrate social metabolism with the approaches of food regimes and surplus/reproduction.

1. Introduction

Food systems play a critical role in addressing the socio-ecological crises of our era. Current food systems are responsible of one third of Green House Gas (GHG) emissions and the surpassing of at least other five planetary boundaries—including biodiversity loss, cropland and fresh water use, and phosphorus and nitrogen loss—[Intergovernmental Panel on Climate Change (IPCC), 2019; Rockström et al., 2020]. In addition, while one third of all produced food is wasted (FAO, 2011), around 800 million people suffer from hunger and diet-related diseases are on the rise (WFP, FAO, IFAD, UNICED, and WHO, 2022). This explains why there is broad scientific consensus on the urgency to transform food systems to be more sustainable and fair (Crippa et al., 2021; IPCC, 2019; Rockström et al., 2020). Examples of this can be seen in the call and actions put forward by institutions like the United Nations Committee on World Food Security (CFS) and the Food and Agriculture Organization (FAO) as well as the European Commission to promote food system changes towards agroecology [European Commission, 2024; High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security and (HLPE), 2019]. The research on

food systems transformations has importantly bloomed (Gliessman, 2016; Hubeau et al., 2017; IPES-Food and ETC Group, 2021; Orozco-Meléndez and Paneque-Gálvez, 2022; Schmidt-Traub et al., 2019). However, the paths to follow in order to accomplish such transformations remain contested (Canfield et al., 2021; Davies, 2020; Duncan et al., 2020; Moragues-Faus et al., 2017; Rivera-Ferre, 2020).

Food systems encompass “the entire range of actors and their inter-linked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded” (Food and Agricultural Organization of the United Nations, 2018). Late Modern and Contemporary food systems are embedded in the functioning of capitalist system in which they develop a key role, as we explain in the following section. Therefore, addressing the relation between food systems and capitalism is essential to understand food systems functioning.

The aim of this article is to advance the understanding of food systems at the national level, and particularly of their role in the reproduction mechanisms of the capitalism system within the web of life in

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which they are embedded (Moore, 2015a). To make our approach comprehensive and to include the interactions between society and nature, we build on the food regimes concept (Friedmann, 2005; Friedmann and McMichael, 1989; McMichael, 2005), and combine it with the social metabolism (Gerber and Scheidel, 2018; Haberl et al., 2019; Keen et al., 2019) and surplus/reproduction approaches (Marco et al., 2020a; Mincyte, 2023; Picchio, 1992).

We make use of food regime theory because it provides an approach to study the relations of agriculture, food and the reproduction dynamics of global capitalism, and is also widely used in agrarian change (Bernstein, 2016; Buttel, 2001) and agrifood studies (Magnan, 2012). However, a move towards problematizing the spatiality of food regimes approach has been recently identified among food regimes scholars due to the insufficient attention paid to the national and regional variability in their paths (Jakobsen, 2021; Moran et al., 1996; Mukahhal et al., 2022; G. Otero, 2016; Rioux, 2018; Schermer, 2015). As Moran et al. (1996) put forward “some of the characteristics of the production and distribution systems that are assumed in the food regimes literature remain quite differentiated and important national and local political-economic processes are not incorporated into international processes” (p. 245: Moran et al., 1996).

Given that we aim for a research framework useful to address the current crisis of the corporate food regime and explore the opportunities and barriers to advance towards fairer and more sustainable food systems, we take the nation-state as the scope of our analysis, being the unit of the global (food regime). The national scale is important because nation-states are a critical agents in determining the extent to which global food regimes dynamic materialises in space and time within national boundaries (Moran et al., 1996; Pechlaner and Otero, 2010; Tilzey, 2018, 2019), while also being considered essential in building national models that can enhance food systems transformations (Schmidt-Traub et al., 2019).

Building on this, McMichael has recently made a distinction between identifying food regime moments—that is, periods of accumulation and associated transitions—and using ‘food regime analysis’ to identify significant relationships and contradictions in the political history of capital across space and time. In this regard, McMichael contends that, as a method of analysis, food regimes “can be deployed in a variety of ways to illuminate local, national, regional and global processes” (McMichael, 2013). An emerging body of studies that link food regimes to regional (Andrew et al., 2022; Corrado, 2016; Otero, 2012; Otero and Lapegna, 2016; Wang, 2018), national (Camarero, 2017; Corrado, 2016; Dixon, 2014; Mikle and Randelli, 2022; Moran et al., 1996; Ríos-Núñez and Coq-Huelva, 2015; Schiller et al., 2020; Scott and L., 2021, 2022; Soldevila Lafon et al., 2015; Torrado, 2016) and local (Jakobsen, 2019; Vicol and Pritchard, 2020) scenarios highlights the utility of this approach. Yet, what remains less clear is “how, theoretically and methodologically, can we approach the interrelations between multiple special loci and scales” (Jakobsen, 2021). In this article, we address this question and propose a research framework to investigate food systems dynamics and transformation at the national level.

To that aim, our research framework is grounded on a critical review (Grant and Booth, 2009) of research linking food regimes to national case studies to systematically identify the main aspects addressed so far in the literature. We discuss their contributions and limitations, and combine them with the approaches of social metabolism and of surplus/reproduction, which consider the role of energy and materials as well as social reproduction respectively for the dynamics of capital and labour in capitalist accumulation. This helps to better understand and articulate the aspects identified throughout the review, and aligns with the call to expand the political economy of food systems to be more interdisciplinary and transdisciplinary (Duncan et al., 2019). It also responds to the request to integrate social and natural sciences from scholars in the field of social metabolism (Haberl et al., 2019) and food policy and agroecological transitions (Gaitán-Cremaschi et al., 2019; Moragues-Faus et al., 2020). In all cases, these calls have emerged because it is

precisely this way of exploiting the land, livestock and labour—the living self-reproductive fund elements that provide for food delivered as a commodity—that originates the unsustainable socioecological impacts of the current corporate food regime, undermining the possibilities for providing a good life for all within the planetary boundaries. The resulting research framework consists of six main dimension—food systems governance, monetary agri-food chain, socio-metabolic agri-food chain, surplus/reproduction, socioecological impacts, and levers of change—further differentiated into 34 specific elements and identifies six cross-cutting connections within and between dimensions.

The article is structured as follows. After this introduction, we briefly address the theoretical and conceptual framework of this proposal in section two. In section three we explain the methods followed for the critical review and summarize and discuss the results. Section four presents the research framework and explains how to use it as a guide for studying national food systems and exploring ways to transform them. Finally, section five includes some concluding remarks.

2. Theoretical and conceptual framework: food regimes, social metabolism and surplus/reproduction

In this section, we succinctly explain the three approaches on which the research framework we develop is based—food regimes, social metabolism and surplus/reproduction. We also discuss how bringing them together is crucial to comprehensively address food system functioning.

2.1. Food regimes: conceptualization and periodization

In 1989, Friedmann and McMichael published the seminal work in which they “explored the role of agriculture in the development of the capitalist world economy and in the trajectory of the state system” (Friedmann and McMichael, 1989). They organized their argument around the concept of food regime: linking international relations of food production and consumption to forms of capital accumulation. In so doing, they distinguished different historical periods since 1879. The two theoretical approaches underpinning the initial food regime formulation were regulation theory and the world system theory.

Since then, the concept of food regime has significantly evolved, particularly from the 2000s onwards (Campbell and Dixon, 2009). Friedmann’s more recent definition of food regime is “a specific constellation of governments, corporations, collective organizations, and individuals that allow for renewed accumulation of capital based on shared definition of social purpose by key actors while marginalizing others” (p. 228: Friedmann, 2005). From her side, there has been a movement of focus on the change from periods of food regime stability to periods of transition and change, giving particular attention to the role of social movements as engines of transformation. Taking another direction, (McMichael, 2009) has emphasised the distinction between identifying food regime moments and using the ‘food regime analysis’ to identify significant relationships and contradictions in capital accumulation processes across time and space. Recently, (Bernstein, 2016) further advanced understandings and framing of the purpose and scope of food regimes encapsulating the questions it addresses as well as identifying eight key dimensions or analytical elements to address such questions.

For the purpose of this article, we are particularly interested in the recent contributions made by Potter and Tilzey (2005) and Tilzey (2018, 2019) in regard to the nature of the state and its relation to capitalism in food regimes. Building upon the ‘capitalist type of state’ of Jessop (2016), Tilzey develops the concept of ‘state-capital nexus’ which encapsulates two key ideas: the understanding of the state as a ‘social relation’ and its function in performing legitimacy to sustain capital accumulation. Capitalism, in intimate conjunction with the state, generates food regimes as integral parts of its growth and power dynamic.

This has a threefold logic: first, to supply food to its labour force; second, to supply this food as cheaply as possible to diminish the socially average wage and thus maximize surplus value in the production of commodities; and third, to afford opportunities for profit-making by the various class fractions of agrarian capital.

The historical application of the concept of food regimes has led to identify different periods of stability in food systems since 1879: the first food regime (Friedmann and McMichael, 1989) or ‘diasporic-colonial food regime’ (Friedmann, 2005) between 1870 and 1914/1930s, and the second food regime (Friedmann and McMichael, 1989), also termed as the ‘mercantile-industrial food regime’ (Friedmann, 2005) and ‘US-centered intensive food regime’ (McMichael, 2013), between 1947 and 1973. A succinct summary of the characteristics of these regimes can be found in Magnan (2012) and Bernstein (2016).

The period after the crises of the second food regime has remained a disputed arena among food regimes scholars, without a consensus on whether a new third food regime has completely unfolded since the 1980s to the present day (Jakobsen, 2021). Friedmann (2005) has suggested the emergence of a ‘corporate-environmental food regime’ that would result from a larger restructuring of capitalism in response to ‘green’ issues. Yet, she has concluded that the regime has not been completely unfolded, since the set of more lasting relations on which regimes rests is not yet visible (Campbell, 2009). McMichael (2005, 2009) has identified a third ‘corporate food regime’ which is characterized as a vector of the ‘globalization project’, which refers to “a politically-instituted process of economic liberalisation privileging corporate entities and rights in the food system, with respect to crop development and the management of ‘food security’ as a service performed not by nation-states, but by transnational corporations through the world market” (p. 150: McMichael, 2009).

Other authors have added other features to the debate of this contested third food regime. Burch (2007) and Burch and Lawrence (2005, 2009) have elaborated on the relevance acquired by the financial side in this period. Pritchard (2009) has centred on the WTO and presented the collapse of the Doha Round as an argument against a third food regime. Campbell (2009) has brought the discussion between ‘food from somewhere’ and ‘food from nowhere’ into focus. More recently, a new strand of the debate has been focused on the re-emergence of China’s power and its impact in the reordering of the food regime through agri-food production, trade and finance (Belesky and Lawrence, 2019; Green, 2021; McMichael, 2019). Despite the lack of agreement on the consolidation and crisis of this third food regime, these contributions have provided significant and complementary insights on the role of food and agriculture in the financialized corporate capitalism unleashed since the 1980.

2.2. Social metabolism

The concept of ‘social metabolism’ (or ‘economic’, ‘socioeconomic’ or ‘societal’ metabolism) arose from the acknowledgment that biological system—e.g. organisms and ecosystems—and socioeconomic systems—e.g. households and firms—depend on a continuous throughput of energy and materials in order to maintain their internal structure and functioning (Giampetro et al., 2012; González de Molina and Toledo, 2014; Haberl et al., 2019; Krausmann, 2017). Specifically, the social metabolism “refers to all energy and material transformations that are taking place, within an open social system such as an economy, and between this system and its environment” (Gerber and Scheidel, 2018). The social metabolism encompasses biophysical flows exchanged between society and their natural environments as well as the flows within and between social systems. These sociometabolic flows operate and maintain biophysical structures of society, such as buildings, infrastructures or machinery (Haberl et al., 2019) as well as the reproduction of key living and non-living fund-components of agroecosystems with which farmers coproduce food, fertile soils, aquifers, crops, livestock, pastures and forests (Guzmán and de Molina, 2017; Tello et al.,

2016).

Sociometabolic research builds on the following assumptions: (1) the functioning of social systems, including the economy, rests on successfully organizing energy and material flows to expand, maintain and operate its biophysical basis: human population, livestock, landscape and artefacts such as buildings, infrastructures or durable commodities; (2) the composition, magnitude and patterns of social metabolism determine societal environmental pressures and impacts; and (3) first principles of the natural sciences—e.g. the laws of thermodynamics—apply to the metabolism of socioeconomic systems and are fundamental to their understandings (Fischer-Kowalski and Weisz, 1999; Haberl et al., 2019; Pauliuk and Hertwich, 2015).

In these biophysical society-nature interactions, energy resources play a particularly relevant role. Production is impossible without energy provision since energy is an input to labour and capital that enables them to produce output—as Keen et al. (2019) say, “labour without energy is a corpse, while capital without energy is a sculpture” (p. 41: Keen et al., 2019). Key concepts in this realm are ‘exosomatic metabolism’, which refers to the external energy flows that support human societies, encompassing all the energy and material inputs extracted from the environment that are necessary for societal functioning, and ‘endosomatic metabolism’, which refers to the internal energy flows within individual organisms supporting individual life and enabling social reproduction (Georgescu-Roegen, 1975).

2.3. Surplus/reproduction

The surplus/reproduction approach refers to the key role that the interlinked dynamics of capitalist firms and social reproduction of labouring population play in capital accumulation. The capitalist system depends on the supply of labour that requires ensuring its social reproduction—the processes of meeting the material and social needs of human communities (Polanyi and Pearson, 1977). Surplus value equals the value of commodity production sold to household consumers minus the costs of producing them. A relevant share of these cost is the subsistence wage of labour that allows its reproduction, according to a prevailing norm of consumption socioeconomically and culturally set as acceptable, including the food basket that meets the endosomatic needs of labouring people (Picchio, 1992).

At the same time, this same wage labour provides most of the effective demand that allows capitalist firms to sell their product. Thus, the lower the subsistence wage of labour, the higher the surplus and capital accumulation provided that the commodity production can be bought and consumed. The shares are determined by the social conflict between labouring people, farmers, and capital owners (Marco et al., 2020b). As Georgescu-Roegen (1977) pointed out “differences between individuals or between groups of individuals are not only normal but also unavoidable phenomena in the biological world. But only within the human species do we find, from the dawn of history on, inequalities of a different nature—social inequalities which have little, if anything, to do with the biological differences” (p. 361: Georgescu-Roegen, 1977).

2.4. Bringing together food regimes, social metabolism, and surplus/reproduction approaches

Below, we present the rationale for the integration of the former approaches in food systems research.

Firstly, the role of food in the capitalist system can be more comprehensively understood when food regimes, social metabolism and surplus/reproduction are brought together to highlight how cheap exosomatic raw materials and energy make cheap food production and endosomatic human consumption possible. The low cost of food for the social reproduction of the labouring population becomes the key nexus between food regimes, social metabolism and surplus/reproduction. Cheap endosomatic food intake enables both production and workforce reproduction inexpensive for the entire economic system, thus reducing

the wage bill for all production-consumption chains (Tilzey, 2019). This is the core assumption of food regimes theory that explains why food regimes exist and which make food production so dissimilar to the rest of economic sectors—the much-debated agrarian question, asymmetric differentiation and market power exerted along the agri-food chain, and state intervention through subsidies, public infrastructures and specific rules.

Yet, the social reproduction of labouring population not only depends on energy, materials and food, but also on unpaid domestic and care work (Marco et al., 2020a; Mies, 1984). This essential work for social reproduction has been historically carried out principally by women that have thus become subordinated to ensure the creation of surplus value for capital accumulation (Mellor, 1997; Picchio, 1992). In other words, food regimes are based on Moore's 'Four Cheaps'—energy, raw materials, food and labour (Moore, 2012)—on which capital accumulation relies (Moore, 2015b).

Second, many studies in ecological economics and political ecology provide clear evidence that counteracting the current overshoot of planetary boundaries while providing a safe and just space for a good life for all requires material and energy degrowth to at least the level of per capita consumption that prevailed in the Global North in the 1970s, precisely when the Second Globalization unleashed by the neoliberal turn began, along with the corporate food regime (Dietz and O'Neill, 2013; Fanning et al., 2020; Hinkel, 2019; Hinkel et al., 2022b; Hinkel et al., 2022a; Hinkel and Kallis, 2020; O'Neill, 2020; O'Neill et al., 2018; Vogel et al., 2021). Such reflections remain limited in food regime literature, with scholars writing about capitalist prospects without explicitly acknowledging that being so unsustainable also means that the prevailing corporate food regime cannot be sustained and is leading humanity towards a societal collapse (Steffen et al., 2018; Weis, 2010). The integration of food regimes with social metabolism is crucial to address socioeconomic and political processes along with their biophysical processes, and to understand how specific compositions, magnitudes and patterns of social metabolisms determine societal environmental pressures and impacts. In a nutshell, the integration of the aforementioned approaches plays a pivotal role in the understanding of society-nature interactions within food systems.

Furthermore, scholars working on the political economy of food systems have recently called for bringing society and nature into the field by expanding it with socioecological and feminist perspectives among others, thus reinforcing the importance of interdisciplinary and transdisciplinary research (Duncan et al., 2019; Moragues-Faus and Marsden, 2017). At the same time, scholars from sociometabolic research have also called for systemic interdisciplinary research frameworks that help integrate scientific knowledge from different disciplines, stressing the need of bringing together natural and social sciences (Haberl et al., 2019). Additionally, other researchers have called for more systemic approaches to agri-food sustainability transitions that consider power relations and governance change (Gaitán-Cremaschi et al., 2019; Hebinck et al., 2021; Marsden et al., 2018; Moragues-Faus et al., 2020; Rossi et al., 2019; Sievers-Glotzbach and Tschersich, 2019; Weigelt et al., 2020). Our framework proposal responds to all the former calls, and brings together the political economy and the political ecology of food systems.

3. Critical review

3.1. Methods

We followed the guidelines of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA)¹ (Page et al., 2021) for a concise way of reporting the steps followed in the critical review. We adapted this method due to the very great heterogeneity of the studies

reviewed in terms of issues addressed and approaches used. Additional information of this review process can be found in Supplementary Materials (Annex I).

We set the following inclusion criteria: (i) studies must use food regimes approaches, and only studies that clearly identified the subject as the main topic were included; (ii) the scale of analysis must be national; (iii) studies must be written in English or Spanish; (iv) only peer-reviewed scientific literature is included. Studies were identified from direct search in SCOPUS² on the 25/07/2022 using 'food regimes' as search term (including titles, abstracts, and keywords). 511 records were identified from the SCOPUS searching. To these, we added the work by (Soldevila Lafon et al., 2015), leading to 512 records in total (Fig. 1). 478 were excluded after a first fast reading. From them, 404 (84.5 % of total exclusions) were removed because of not meeting criterion one (approach); 73 studies (15.3 %) because of not meeting criterion two (scale); and one study (0.2 %) because of not meeting criterion three (language). The studies by Jakobsen (Jakobsen, 2018, 2019) and (Brown, 2020) were excluded after particular consideration because their main point is expanding the food regime analysis from a Gramscian standpoint rather than applying it at the national scale. After a deeper reading of the 34 studies assessed for eligibility, 24 of them were finally included in the review and ten excluded (see Fig. 1, and Table 2 in Annex I in Supplementary Materials for the full list of studies included and a detailed explanation for those excluded).

Then we created an Excel document with the following items for each of the reviewed studies: year of publication; author(s); title; journal; key words; country; period of study; food regime(s) addressed; main focus; sources; terminology used to identify the approach; summary of food regimes aspects at which authors looked at, including a synthetic description of the variables entailed, and key remarks for a better interpretation of the such aspects when necessary. For each of the studies reviewed, we created a Word document in which we included detailed information regarding the aspects identified.

The results of this first round of examination, and particularly the aspects identified, which are the target of the critical review, were discussed by the authors of this article and other researchers involved in this study. We made use of 14 main categories and 32 sub-categories covering all the aspects identified so far and re-examined all the studies reviewed to check whether they addressed them or not, and how, using key words (see Table 3 in Annex I in Supplementary Materials). We created another Excel document to quantify the number of studies addressing each aspect and sub-aspect (see Annex II in Supplementary Materials) and took further notes regarding the way such categories were addressed. We summarize the results in the following section.

3.2. Results and discussion

Fig. 2 shows the aspects of food regimes identified through the critical review of 24 national scale food regime studies including 14 aspects (shown in capital letters), some of them further divided into sub-aspects (32 in total; shown in small letters). The size of circles accounts for the number of studies that addressed them. While some aspects have the same weight in terms of number of studies including them, the depth in which such aspects are tackled significantly varies within a same study or between studies. In some cases, detailed data is provided whereas in others only a general trend is mentioned (see Annex III in Supplementary Materials for a detailed description of the results of the review).

The review points to the centrality of state regulations as a key aspect to understand how food regimes unfold at the national level, being

² <https://www.scopus.com/>; We decided to use SCOPUS as search engine because we found similar results when using other search engines (Web of Science, Google Scholar), while SCOPUS offers more nested results regarding the meaning of food regimes used in this study.

¹ <http://www.prisma-statement.org/>

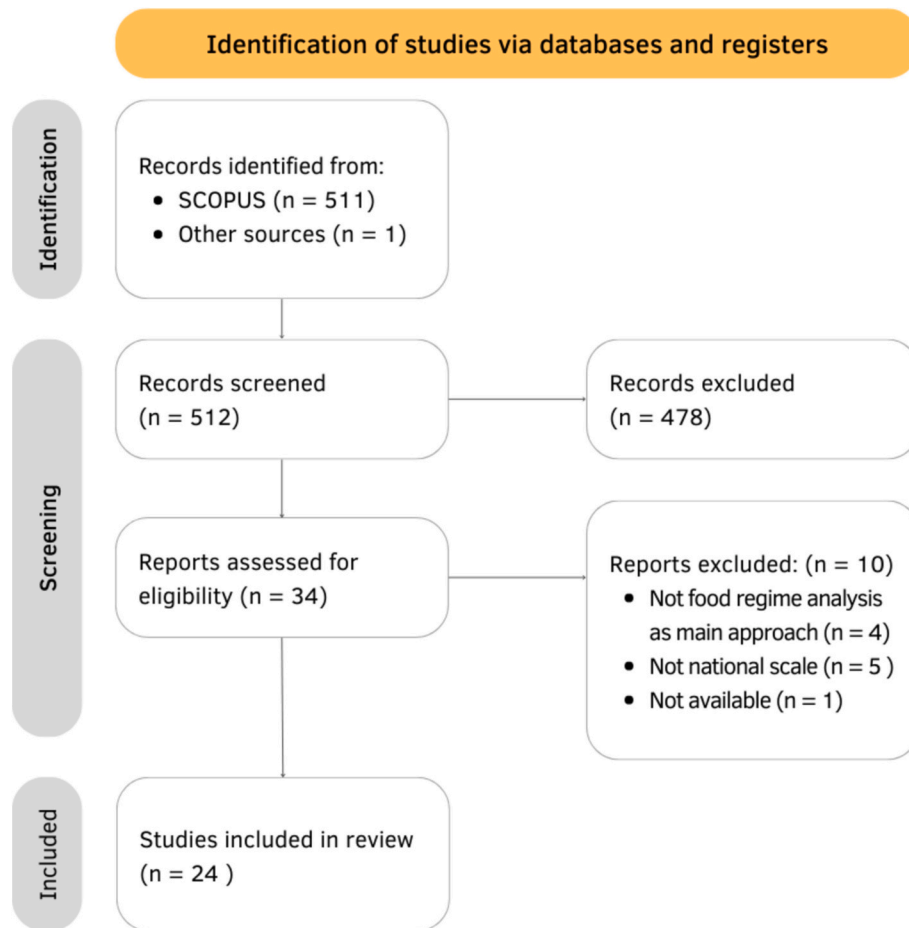


Fig. 1. Reporting of the review selection process.

Source: Own elaboration based on Page et al. (2021). PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. DOI:<https://doi.org/10.1136/bmj.n71>

addressed in all of the studies reviewed (24 out of 24). This finding is consistent with other studies (Jakobsen, 2021; Moran et al., 1996; Tilzey, 2018, 2019). However, the focus is put mostly on regulations related to international trade and to primary agricultural production, while little attention is given to regulations over the remaining areas of the food system (see Fig. 2).

With regards to production aspects, the results also show an emphasis on agriculture, tackled in 21 out of the 24 of the studies reviewed (Fig. 2), and particularly on its outcomes, while modest consideration is given to labour. Similarly, when tackling markets, the focus is put on the primary agricultural market, and notably on international trade, addressed in 18 out of the 24 studies reviewed (Fig. 2). Less attention is given to the market of agro-industrial inputs, wholesale markets, and retail markets, as well as to their articulation within agrifood chains.

Prices are included in 15 out of the 24 studies reviewed (Fig. 2). However, it is important to stress that the way they are tackled is very vague. As prices are a key component of food expenses of consumers and farmer's incomes, examining prices in more depth seems to us essential. Another outcome of the limited scrutiny of prices is reflected in the insufficient attention given to food expenses within the total expenditure of household budgets. Only three of the studies reviewed address this issue (Fig. 2).

Power is a recurrent aspect, included in 19 out of the 24 studies reviewed. Corporate power is the type of power most frequently addressed (Fig. 2). Social and farmer movements are considered in 18 studies and socio-economic and environmental impacts in 14 studies,

most of them merely acknowledging their existence. To a lesser extent, the studies reviewed address the ideological paradigm, the historical context, the roles of global powerful nations, finances and food self-sufficiency (Fig. 2).

The review also brings out a set of connections between the aspects identified. A thorough explanation of these connections, including the studies which hold them as well as how they did it can be found in Annex III in Supplementary Materials. These connections are: (i) state regulations result from contestation and influence from dominant forms of capital, social & farmer movements, and global hegemonic-powerful nations; (ii) state regulations are a central element framing food production, consumption and trade; (iii) dominant forms of capital exert power on the food system—including their price setting mechanisms—; (iv) social and environmental impacts result from the food system functioning; and, (v) social and environmental impacts produce social and environmental movements in response.

The results of the critical review make visible the great complexity of food regimes at a national scale, in which numerous aspects and connections interplay at different levels, including many nation-wide or even regional and local features that come from site-specific historical trajectories and heritages (Bernstein, 2016; Jakobsen, 2021).

4. Our proposal of a research framework to investigate food systems at a national level

Our proposal of a research framework to investigate national food systems draws on the results from the critical literature review presented

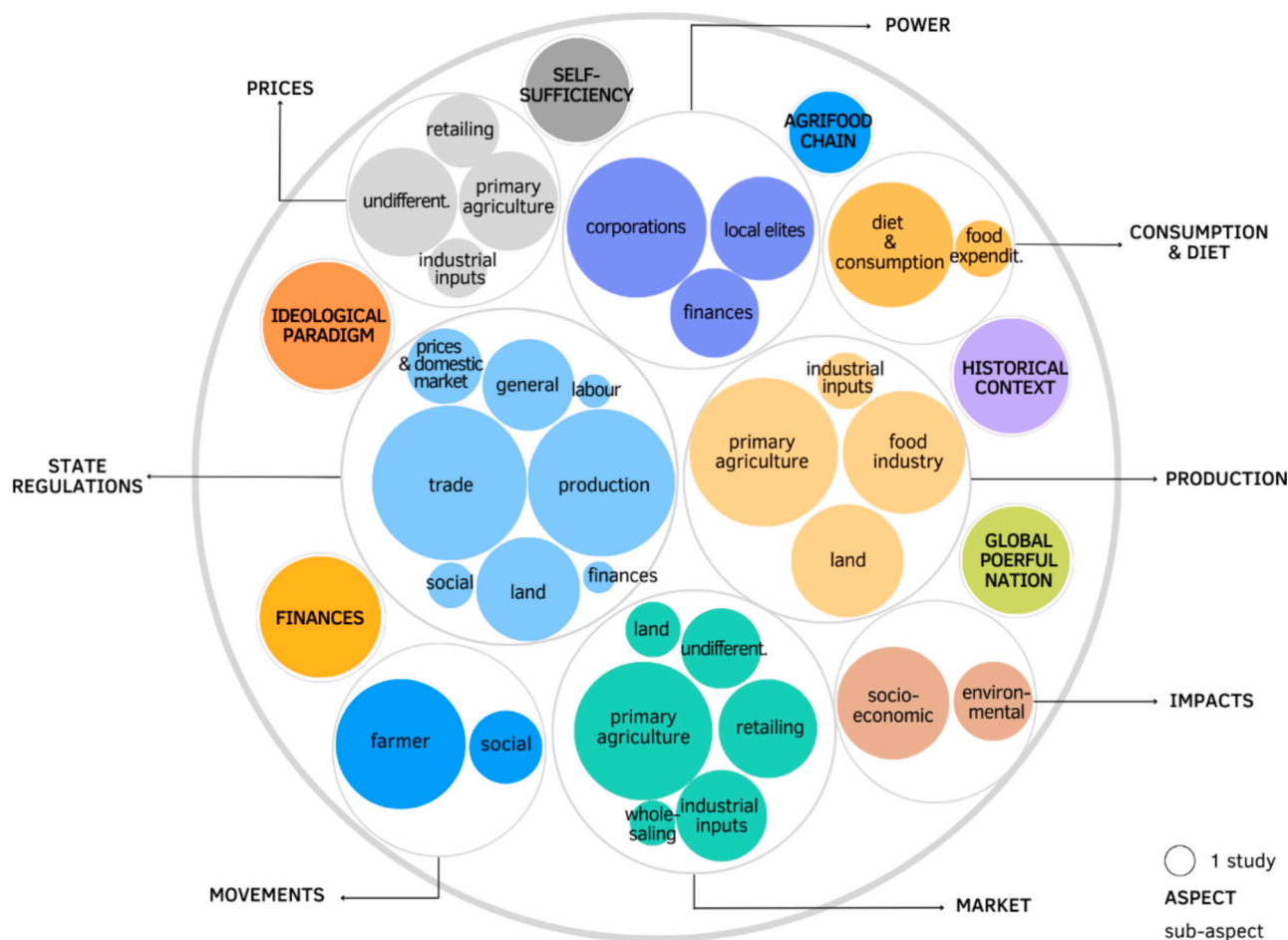


Fig. 2. Aspects and sub-aspects of food regimes identified in 24 national scale food regime studies and number of studies addressing them. Source: Our own, with the dataset explained in the text.

in section 3 and its discussion, considering both the contributions and shortcomings of the 24 national scale food regime studies reviewed. To address these shortcomings, and also gain a deeper insight on the systemic dynamics of food regimes functioning, we also draw on the approaches of the social metabolism from ecological economics (Gerber and Scheidel, 2018; Keen et al., 2019) and of surplus/reproduction from feminist economics (Marco et al., 2020a; Picchio, 1992). As explained in section 2, the latter approaches are critical to make more explicit some key nexuses between monetary value-added flows and matter-energy flows, as well as how the social conflicts arising from their unsustainability in unjust settings become the levers of change involved in food systems trends and transformation at a national level. In short, these socioeconomic and sociometabolic nexuses are key to better understand how food systems shape capitalism and are shaped by it.

The resulting research framework organizes the functioning of food system at a national level into six main dimensions, each one encompassing a set of elements. In addition, we include six connections between some of these aspects. Some connections are of cross-cutting character as they connect aspects of different dimensions. Table 1 summarize the dimensions, the elements they encompass, and the conceptual frames they belong to. Fig. 3 illustrates them, and we offer a more detailed description below in this section. By integrating all of them, our research framework follows a food system approach (Caron et al., 2018; Rivera-Ferre, 2020).

The first dimension of Table 1 and Fig. 3 concerns food systems governance, understood as “institutions, actors, rules, and norms that shape how food is produced, distributed, and accessed across borders” (p. 128: Canfield et al., 2021). The state, along with regional and local

governments and large cities, are central agents (Moran et al., 1996; Vignola et al., 2021). We understand the state as a social relation (Jessop, 2016; Tilzey, 2018, 2019) which shows the features of the ‘capitalist type of state’ (Jessop, 2016) and functions as the ‘capital-state nexus’ (Tilzey, 2018, 2019). Through food policy (Hawkes and Parsons, 2019) and also rural policy (Bollman and Reimer, 2019), they frame the space in which agrifood production, distribution and consumption take place by setting the playground and its working rules. This conforms connection one (see Table 1, Fig. 3), which entails the mechanism through which such policies translate into practice and the impacts they unfold in the actual functioning of food systems.

The ruling agency of the state, regional and local governments, and large cities results from contestation and influences between three other key agents: ruling capital owners, social, farmer and indigenous movements, and global powerful nations, the latter working hand in hand with international institutions over which they influence—World Bank, International Monetary Fund, World Trade Organization—(see Table 1, Fig. 3). These influences conform connection two (see Fig. 3). Ruling capital owners might be of national or international nature. As long as they influence the national food system, they are to be included. In addition, global powerful nations and their linked international institutions work and promote certain ideological paradigms—i.e. the implicit rules as named by (Friedmann, 2005)—which legitimise the modus operandi of each regime. To it, the particular historical and geopolitical trajectory of each country needs to be added to explain to some extent the differences between one nation and other. We include both of them as elements of the food systems governance dimension.

Finally, we added state borders to this dimension, too. Food and rural

Table 1

Organization of national food systems in dimensions, elements encompassed, and connections between them, as well as the conceptual frames they belong to.

DIMENSION	ELEMENTS	CONCEPTUAL FRAMES
Food systems governance	<ul style="list-style-type: none"> - State - Regional & local governments - Large cities - Ruling capital owners - Social & farmer movements - International institutions - Global powerful nation(s) - Ideological paradigm - Historical & geopolitical context - State borders 	Food Regimes Home Rule of nation-states in the Postcolonial New World Order
Monetary agrifood chain	<ul style="list-style-type: none"> - Agro-industrial inputs - Agriculture or Primary agricultural production 	Food Regimes Political Economy
Socio-metabolic agrifood chain	<ul style="list-style-type: none"> - Land - Food industry - Food consumption - Market (distribution & trade) - Technological packages 	Ecological Economics Planetary Boundaries
Surplus/reproduction	<ul style="list-style-type: none"> - Capital goods & financial assets - Labouring population - Surplus/Reproduction divide of value added & Capital accumulation process - Social reproduction of labouring population 	Feminist Economics Political Economy
Socioecological impacts	<ul style="list-style-type: none"> - Expansion of export-led agricultural frontiers and land grabbing - Small farm abandonment - Ecological unequal exchange - Environmental (un)justice - Food poverty & deserts - Nutrition related diseases - Land degradation & desertification - Extension of agricultural frontiers of cash-crops exports - Biodiversity loss - Pollution of water, soils & atmosphere - Water scarcity and deprivation - GHGs & climate change - Other 	Food Regimes Social Metabolism Planetary Boundaries
Conflicts & levers of change	<ul style="list-style-type: none"> a) the state, as a site of contestation between ruling and protesting agents, and with a critical power in shaping the food system at the national level and integrating nations into a global one. b) disputes over land property, land grabbing, as well as on land and commons reclamation. c) struggles on the distribution of surplus value between capital owners and labourers. d) struggle over the unpaid appropriation of women's domestic and care work. e) any other societal and environmental impact that led to social mobilisation, as well as the ecologically harmful impacts that endanger the food system functioning. 	Food Regimes
CONNECTIONS WITHIN AND BETWEEN DIMENTIONS		
1. The state, regional and local governments, and large cities frame through food and rural policies the space in which agrifood production, distribution and consumption take place.		
2. Ruling capital owners, social and farmer movements, global powerful nations and international institutions influence and contest food and rural policies.		
3. Capital goods & financial assets are a mechanism trough which ruling capital owners exert their power on the agrifood chain functioning.		
4. The price of food determines the food cost of households, and thus, the cost of labour reproduction.		Food Regimes Social Metabolism Political Economy
5. Food system functioning causes socio-ecological impacts.		
6. Socio-ecological impacts prompt social and farmers mobilisations.		

Source: Our own.

policies also interact with other state policies over state borders. States enforce and watch over their territorial borders to open and close to different flows of people and commodities, creating their “Home Rule” (Sharma, 2020). For example, until World War I the borders of Old Colonial Empires were crossed by massive migrations of European settlers to colonize the agricultural frontiers open, as well as by forced migrations of slaves and indentured workers coming from the Global South. After World War II, in what Nandita Sharma (Sharma, 2020) calls the ‘Postcolonial New World’, nation-states watch over their borders to prevent illegal migrants to come in, only opening the door either to qualified workers from other countries of the Global North or to the entry of cheap precarious labour of casual workers from the Global South seasonally needed for harvesting or picking specific crops (Werner, 2019).

Another of the key aspects of national food systems corresponds with the agrifood chain, that is, the group of activities and products involved

in the production, distribution and consumption of food which articulated in specific fashions conform agrifood chains. In our research framework, we consider the monetary and biophysical spheres of the agrifood chain and represent them into two different but related dimensions: the monetary agrifood chain (see Table 1, Fig. 3), addressing the monetary flows, and the socio-metabolic agrifood chain (see Table 1, Fig. 3), addressing the flows of materials and energy. Both dimensions represent two sides of a single coin, so that production, consumption, saving and investment decisions made by socially different social classes of agents according to market prices and values assign, distribute and drive the biophysical flows of social metabolism that, in turn, allow social reproduction to occur both in material and monetary terms. Keeping in mind this intertwined character of agrifood value chains, monetary and biophysical at the same time, both dimensions move across them from the production of agri-industrial inputs to primary agricultural products, and then to industrial processed food or directly to

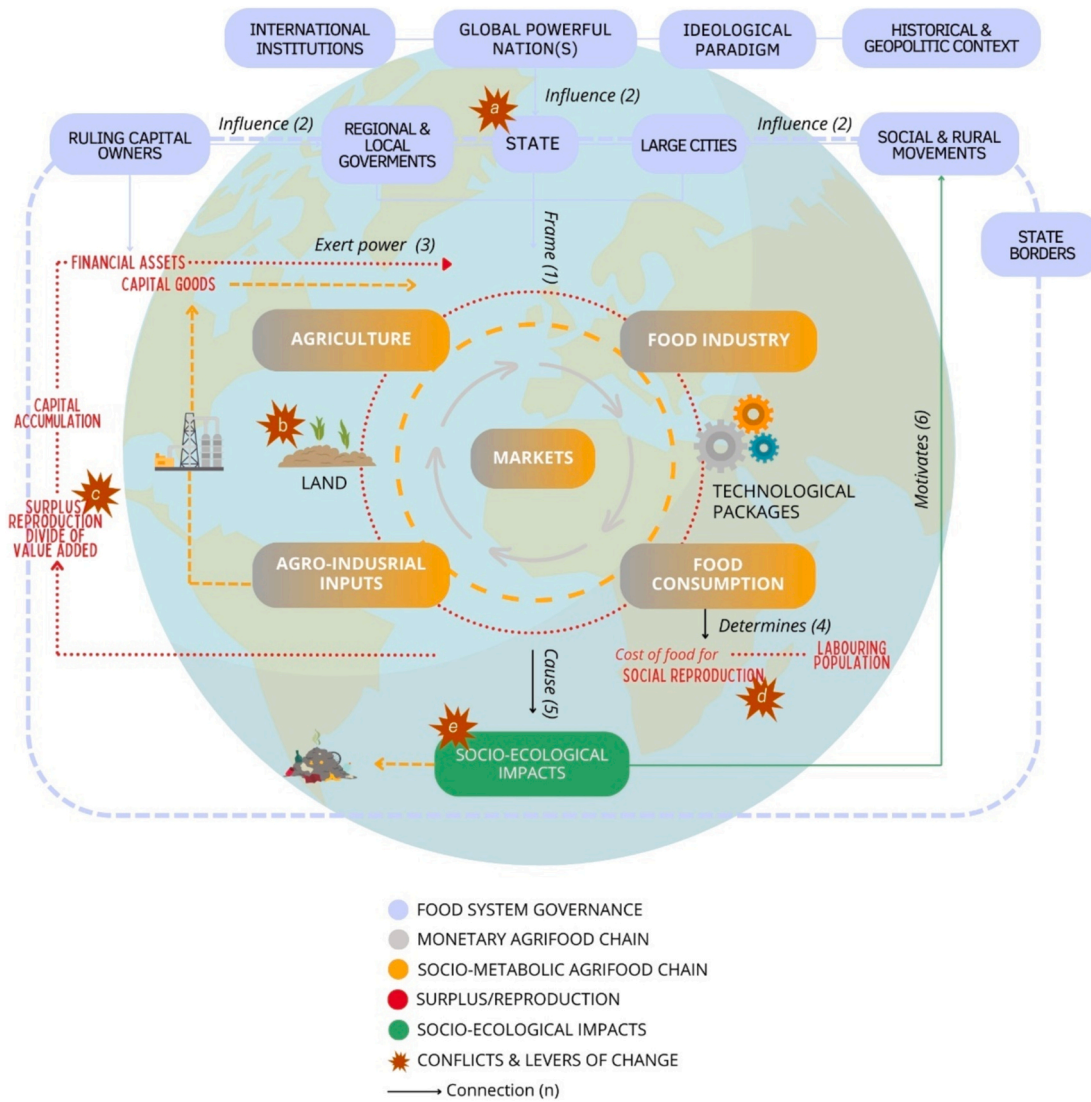


Fig. 3. Functioning of national food systems considering their key dimensions, elements, and connections between them. Source: Our own. Note that mixed-degraded grey and brown colour elements indicate that agrifood value chains are of money and biophysical character.

sales markets when eaten fresh. For all of them, it should be also considered *what* products are produced and by *whom*. In addition, in order to assess *how* production is carried out, and also because of its critical role in the transformation of biophysical flows along the agrifood chain—for example, in terms of energy spending and efficiency and derived emissions—, we included the element of technological package as another element. We understand technological packages as a set of technologies and managements that are designed to work together to achieve specific goals. The land, being an essential element for agricultural production, is also included in these two-sided dimensions.

The sales markets, encompassing distribution and trade, are other of the element included in the double monetary and socio-metabolic agrifood chain dimensions of our framework (Table 1, Fig. 3). We consider that at least four main markets need to be taken into consideration: the market of agro-industrial inputs—which in turn includes oil, gas and electricity markets, synthetic fertilizers and agrochemicals, machinery, mining raw materials, etc.—, the market of primary agricultural products, the wholesale market, the retail market, and the land market. Understanding the functioning of these markets involves looking at *what* is traded in monetary and biophysical terms and by *whom*, both nationally and internationally.

Finally, we included food consumption as another element in the

monetary and socio-metabolic agrifood chain dimensions (Table 1, Fig. 3). Food consumption encompasses *what* food is eaten and by *whom*. Addressing this aspect implies looking at least at diets and consumption patterns, both in monetary and biophysical terms, and also the time spent on buying, preparing and eating food. It should be also addressed the role of food services, such as restaurants, meal houses, street stalls and canteens, hotels, and resorts. We know that different social classes, communities and nations buy different types of food in different food environments leading to different diets and healthy impacts (HLPE, 2019).

A fourth dimension included in the research framework corresponds to surplus/reproduction. This dimension includes the dynamics of capital and labour in capitalist accumulation, and encompasses as elements capital good & financial assets, labouring population, the processes of surplus/reproduction divide of value added linked to capital accumulation, and social reproduction of labouring population (Table 1, Fig. 3). In addition, capital goods & financial assets are mechanisms through which ruling capital owners exert their power on the agrifood chain functioning, conforming connection three (Fig. 3).

The former three dimensions—the monetary agrifood chain, the socio-metabolic agri-food chain and the surplus/reproduction cycle—are linked through food consumption, which determines the cost of

food for the social reproduction of the labouring population (connection four) (Table 1, Fig. 3). Here appears a central issue of our research framework. As shown in food regimes theory and explained in section 2, cheap food is a prerequisite for capital accumulation, being a central goal of food systems in capitalism. Production is impossible without energy provision since energy is an input to labour and capital that enables them to produce food. The operation and renewal of all sorts of capital goods require a constant provision of exosomatic material-energy flows to compensate for their inevitable entropy and provide for their expanded reproduction. Food is also a form of endosomatic energy intake—while also providing other essential nutrients for humans—whose metabolization allow our bodies and minds to perform work, and reproduce and expand the population. Both the exosomatic and endosomatic energy inputs are thus essential to carry out human labour and the physical work of capital goods in the production processes, as well as to reproduce and expand them over time.

Here appears an interesting contrast resulting from the dual material and monetary values of these flows and funds; capital goods are subject to constant entropic corrosion that leads to the need for repair and maintenance costs, and inevitably shortens their useful life until replacement. As Joan Robinson and the group of economists at the University of Cambridge (United Kingdom) pointed out in the 1970s debate on capital theory (Cohen and Harcourt, 2003) physical capital goods are primary contributors to increasing labour productivity and the wealth of society. Their monetary valuation as assets, used by the Harvard economists—in the other Cambridge of Massachusetts—to account for capital stocks in their theory of economic growth is a social construction that determines who owns those capital goods. That is, who is entitled to appropriate the surplus resulting from subtracting the cost of reproduction of the labour force and the payment of other material and energy inputs—which must always be ‘cheap’—from the monetary value added flow of production.

Interestingly, instead of the entropic decay of physical capital goods, monetary financial assets endure over time demanding an interest rate for its mere existence as debt-based ‘virtual wealth’ even before any real production, consumption and excretion cycle begins, and whatever its outcome—unless they become burst, also virtually, in the panic of a financial bubble—. Financialization has become a salient feature of the economic trends during the third food regime. Yet, financial assets can only grow ultimately relying on biophysical turnover of the real economic life driven by human labour, capital goods, natural resources, and ecosystem services coproducing together— analogously to how viruses can only reproduce and spread through infection of living bodies—. Land grabbing, and the corporate advance at the expense of family farms, small food stores, cooperatives, and public food markets and facilities are clear examples of that in today’s food system.

It is no coincidence that the productive capacity that mainstream economists ascribe to capital goods and their owners is actually carried out, and sustained, by all the other ‘factors of production’ that the prevailing commodification of capitalism underestimates as ‘cheap’ to foster capital accumulation. They include the undervalued human labour, raw materials, energy, and food, together with the unpaid provision of care and reproductive domestic work, as well as of nature-based ecosystem services, which are taken for granted and ignored (Moore, 2015b; Otero et al., 2024). As this means that market-driven decisions are blind to the real reproduction, maintenance and reposition needs of all those who actually sustain the economic life of our societies, the prevailing economic rules and functioning inevitably entail a series of unsustainable societal and ecological impacts that lead to conflicts.

Here comes a fifth dimension that we label as socioecological impacts (Table 1, Fig. 3), and through which we try to encapsulate impacts of the food system functioning which arise from the previous dimensions. This conforms connection five (Fig. 3). We consider the following impacts of high relevance: expansion of export-led agricultural frontiers and land grabbing, small farm abandonment, ecological unequal exchange, environmental (un)justice, food poverty & deserts,

food swamps and nutrition related diseases, land degradation & desertification, biodiversity loss, pollution of water, soils & atmosphere, water scarcity and deprivation, and GHGs & climate change (Crippa et al., 2021; IPCC, 2019; Rockström et al., 2020). However, this is not a closed list, and any other impact could be added.

These socioecological impacts further cause discontent among those affected, and eventually lead to their mobilisation aiming at pushing governments to act in the opposite direction. This conforms connection six (Fig. 3) and links this dimension with the dimension of food systems governance. Such mobilisations arise within the national boundaries but may be connected with other places also becoming international ones.

Finally, we include in our research framework six key conflicts and levers of change, which are highly linked to the socioecological impacts (Table 1, Fig. 3). We understand key systemic conflicts and levers of change as a single twofold issue, which refers to relations—both within a same dimension or in the intersection of them—that currently push towards a direction that cannot be sustained over time without undermining a healthy reproduction of key components of the life system, either societal, natural, or both. Precisely because of that, they are being contested from social forces or natural environmental changes thus creating contexts, conditions, and opportunities for new societal relations between humans and with nature to be established (Martínez Alier, 2023). Levers of change are, thus, closely linked to the ‘contradictions’ of the food regimes as named by Friedmann (Friedmann, 2005) and McMichael (2009).

This research framework provides a guide for studying food systems at the national level and better addresses their complexity by identifying key dimensions, elements and connections between them at play, as well as the main conceptual frames needed to combine when exploring different feasible, viable, and desirable pathways to overcome the current unsustainable corporate food regime. There can be many different ways to use it according to different research questions and approaches focused on different aspects, with the advantage of keeping a holistic and systemic view of food systems. One of its goals is to facilitate comparison with empirical evidence—some inspiring studies are those by Friedmann (2018), Krausmann and Langthaler (2019), González de Molina et al. (2020), Dorninger et al., 2021 and Roux et al. (2022) on the biophysical sphere, and Parajuá (2022) on the monetary sphere—.

Furthermore, we consider that one of the main utilities of this research framework is to consider under it how to advance through the incremental and transformative levels of the agroecological transition towards re-localized, circular and fairer food systems at the local and city-regional scales, and how to scale them up to a new global food regime based on food sovereignty and social and solidarity economies (Gliessman, 2016; Gliessman et al., 2022; HLPE, 2019). Addressing this agroecological transition from a national-scale food regime framework—also connected to the global, regional and local levels in a multi-scalar and multi-dimensional way—helps to identify the main barriers as well as the levers of change for the transformation of food systems.

Just to give an example, our research framework helps to pose and address research questions such as the following: Would the agroecology transition, as formulated and being fostered by Via Campesina and other international movements fighting for it, mean the end of cheap food ‘from nowhere’ (Moore, 2015b)? If so, how can the provisioning of healthy food ‘from somewhere’ provide a decent income for farmers and be affordable for all at the same time? Which societal, cultural and political barriers must be overcome, and which corporate powers must be overthrown (IPES-Food and ETC Group, 2021)? Is such a food systemic change compatible or incompatible with continuing the economic growth that brought us here (Dietz and O’Neill, 2013; Hickel and Kallis, 2020)? Is such a systemic change compatible or incompatible with capitalist rule over social production and reproduction in general, and over the agrifood chains in particular (Friedmann, 2005; McMichael, 2005)? Which alliances of social and political actors must be built to put in action a subject of change capable of facing and overthrowing the corporate rule of the current unsustainable food regime (Anderson et al.,

2021; González de Molina et al., 2019)? Which public food and agricultural policies are needed to enable these transformative, agroecology-based food systems to be implemented and integrated at different scales (Gaitán-Cremaschi et al., 2019; Moragues-Faus et al., 2020; Moragues-Faus and Marsden, 2017)? Depending on the research questions addressed and the methods used, researchers will focus on the elements, dimensions and connections that are most relevant to them, but without ever forgetting that they are also interrelated with the rest of them. Hence the usefulness of the research framework presented here.

5. Conclusions

In this article, we put forward a research framework to investigate food systems functioning at a national scale and explore possible ways for their transformation towards sustainability and social justice based on the integration of the approaches of food regimes, social metabolism and surplus/reproduction. We first conducted a critical review of studies of food regimes at the national level through which we identified a set of key aspects and connections, which we further combined with the approaches of food regimes and surplus/reproduction. The resulting research framework consists of six main dimensions—food systems governance, monetary agrifood chain, socio-metabolic agrifood chain, surplus/reproduction, socioecological impacts, and conflicts & levers of change—that encompass 34 elements, and six cross-cutting connections between elements within or between different dimensions. The goal of this framework is to provide a guide for studying food systems and their functioning at the national level, as well as to explore barriers and facilitators for an agroecological transition taking a systemic and holistic perspective.

The rationale behind the integration of food regimes, social metabolism and surplus/reproduction is to address society-nature interactions of food systems and link them with the accumulation dynamics of capitalism to facilitate a deeper understanding of how it shapes them and how capitalism is shaped by them. More specifically, firstly, the integration of the aforementioned approaches facilitates a more thorough grasp of the interaction between monetary value-added and matter-energy flows and stocks for the essential provision of ‘cheap food’ for the social reproduction of the labouring population in capitalism. Secondly, it highlights the need to acknowledge the biophysical processes associated with the socioeconomic processes already considered in food regimes, and particularly, the fact that the sociometabolic patterns associated with the third food regime are undermining the possibilities for providing a good life for all within the planetary boundaries and leading to its environmental collapse.

This work contributes to food regimes literature by addressing the problematization of its scale—by proposing a research framework for the national scope—as well as its level of abstraction—by identifying a set of key dimensions, elements and connections involved in food regimes and explicitly addressing their biophysical dimension—. Furthermore, we link food regimes with a food system approach. By doing so, we expand the political economy of food systems making it more transdisciplinary, responding to the call from scholars in this field. Additionally, we contribute to the integration of social and natural sciences, and bring together political ecology and political economy, as scholars from social metabolism and food systems transformations have also called for.

Nevertheless, we also recognize that our proposal presents some limitations and that further research is needed to address them. First of all, we consider that it is essential to advance in the incorporation of feminist and gender perspectives for a sound understanding of the actual working of food systems (Marco et al., 2020a, 2020b; Mincyte, 2023; Ortega López and Cabana Iglesia, 2021) and beyond (Carrasco and Rodríguez, 2000; Picchio, 2003). Secondly, further research is needed in terms of deepening the understandings of the articulation between national, local, and global scales. Thirdly, we identify a set of critical questions in regard to the connections already included in the research

framework: How do ruling capital owners and social and rural movements influence state, regional, and local governments, as well as large cities? How do ruling capital owners exert power over the agri-food chain? How can these be accounted for? And how can existing conflicts become levers of change beyond the corporate food regime towards a fairer one for all within planetary boundaries? Finally, on top of this, we believe that new connections and dimensions may be envisioned and incorporated to the research framework.

CRedit authorship contribution statement

Noelia Parajuá: Writing – original draft, Investigation, Conceptualization. **Enric Tello:** Writing – review & editing, Supervision, Conceptualization. **Jessica Duncan:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Acknowledgements

We would like to thank Ana Moragues-Faus for her valuable comments and suggestions that greatly contributed to the development of the first version of this work, as well as to the three peer-reviewers of this article whose comments greatly improved the current version of this work. This article is framed in the project AGRO-ECOLAND—*Agroecological Landscapes and Food Systems in Catalonia and the Balearic Islands: Past, Present and Future Transitions* (PID2021-123129NB-C41), which is funded by the Spanish Ministry of Science and Innovation.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ecolecon.2024.108428>.

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