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What are the ingredients for food systems change towards sustainability?—Insights from the literature

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Abstract

Many detrimental effects on the environment, economy, and society are associated with the structure and practices of food systems around the world. While there is increasing agreement on the need for substantive change in food systems towards sustainability, divergent perspectives exist on what the appropriate points of intervention and strategies to achieve such change are. Change in diets and nutrition, the importance of social food movements, and sustainable farming practices are all disparately featured in the literature; yet, there is little effort to compare and integrate these perspectives. This review offers a comprehensive overview of perspectives on food systems change towards sustainability. We discern where there is convergence and assess how the literature reflects emergent theory on sustainability transformation. We analyzed more than 200 peer-reviewed articles employing an approach that combines quantitative and qualitative analysis. First, we performed a semantic hierarchical cluster analysis of the full texts to identify thematic clusters representing different perspectives on sustainability transformations and transitions of food systems. Second, we conducted a qualitative text analysis for representative articles of each cluster to examine how deep changes in the food system are conceptualized. We identified five distinct approaches to food systems change that are currently discussed, i.e. *Alternative food movements*, *Sustainable diets*, *Sustainable agriculture*, *Healthy and diverse societies*, and *Food as commons*. Each approach provides a nuanced perspective on identified sustainability problems, envisioned sustainable food systems, and proposed actions to change food systems towards sustainability. The findings offer guidance for researchers and practitioners working on food systems change towards sustainability.

1. Introduction

Contemporary food systems, responsible for feeding the world's population, face major challenges that require profound structural changes to become sustainable. The global food system can be characterized as complex and heterogeneous, integrating social, environmental, economic, and technological processes from production to consumption and waste disposal (Ericksen 2008, Eakin *et al* 2017a). Over a century of intensification and industrialization of activities in the global food system have resulted in pollution of land, soil and water (Ericksen 2008), an increase of diet-related chronic diseases and obesity

(Guyomard *et al* 2012), as well as economic disparities and injustices across the value chain (Lebel *et al* 2008, Clapp 2015). Simultaneously, with global population growth and urbanization, dietary patterns are changing, and the demand for resource-intensive food is growing (Garnett 2014). 'Deep' or structural changes are needed to address these challenges and achieve food system sustainability (IASSTD 2009, Foley *et al* 2011, WBGU 2011, Eakin *et al* 2017b). According to Eakin *et al* (2017a p 759), a sustainable food system 'achieves and maintains food security under uncertain and dynamic social-ecological conditions, through respecting and supporting the context-specific cultural values and decision-processes that

give food social meaning, and the integrity of the social-ecological processes necessary for food provisioning today and for future generations.' While the need for deep changes in social values, resource use, production and consumption practices, as well as socio-economic relations is widely recognized, there is less agreement among scientists and practitioners on *how* such changes should be achieved.

We refer to deep or structural change as 'systemic societal change' (Meadows 1999, Abson *et al* 2017, Hölscher *et al* 2018) in social norms and values, institutions and behaviours, practices and technologies that together produce the functions (parameters and feedbacks), structure (design), and identity (intent) of food systems. Deep change is often coined as 'transformation' or 'transition', yet in many cases without a specific theory of change (Feola 2015, Rau *et al* 2018). In recent years, more pronounced conceptualizations have evolved (Hölscher *et al* 2018), relevant to deep change in food systems (Stirling 2011, Hinrichs 2014, Eakin *et al* 2017b). We use deep change as an umbrella term for transition/transformation.

Transitions are defined as long-term, significant changes of essential social-technical systems. They are often conceptualized from the multi-level perspective (Geels and Kemp 2000) and describe change as a process traversing governance levels, namely, niche (micro), regime (meso), and landscape (macro). Transitions start from niche innovations of products, technologies, infrastructures, or practices that, if successful, reach the regime level and replace or successfully compete with mainstream products, technologies, infrastructures, or practices (Geels and Schot 2007). Transition processes are often managed or governed according to a specific goal (Rotmans *et al* 2001). Transformations, on the other hand, describe significant changes of essential social-technical systems that disrupt the current state. Transformations to sustainability include substantive change in personal (beliefs, attitudes, values), practical (behaviours, technologies, institutional reforms) and political (system-level dynamics and structures) spheres of human interaction with the environment (O'Brien and Sygna 2013). Transformations are often based on social and technological innovation, consider different types of knowledge (Scoones *et al* 2018) and see a strong role for social movements (e.g. Slow Food) and civil society (e.g. food policy councils). Transformations are less *managed*, rather emerge and involve grassroots action or exogenous forcing (Stirling 2015). Both conceptualizations of deep change are relevant in advancing food systems sustainability.

This study draws on research on deep sustainability change processes (transitions or transformations) of e.g. energy and mobility systems (Markard *et al* 2012, El Bilali 2018) with research on sustainable food systems and practices, e.g. organic farming (Delonge *et al* 2016), agroecology (de Molina 2013), or local food systems (Connelly *et al* 2011).

The goal is to identify convergence in approaches towards food systems change, and to assess how the literature reflects emergent theory on sustainability transformation. We offer food systems researchers and practitioners a comprehensive view of perspectives on food systems change towards sustainability by analyzing, mapping, and synthesizing these diverse bodies of literature. The study addresses the following research questions:

- *What are distinct clusters of research on deep change processes (transitions/transformations) towards sustainability in food systems?*
- *How do the identified clusters conceptualize deep change processes towards sustainability in food systems?*

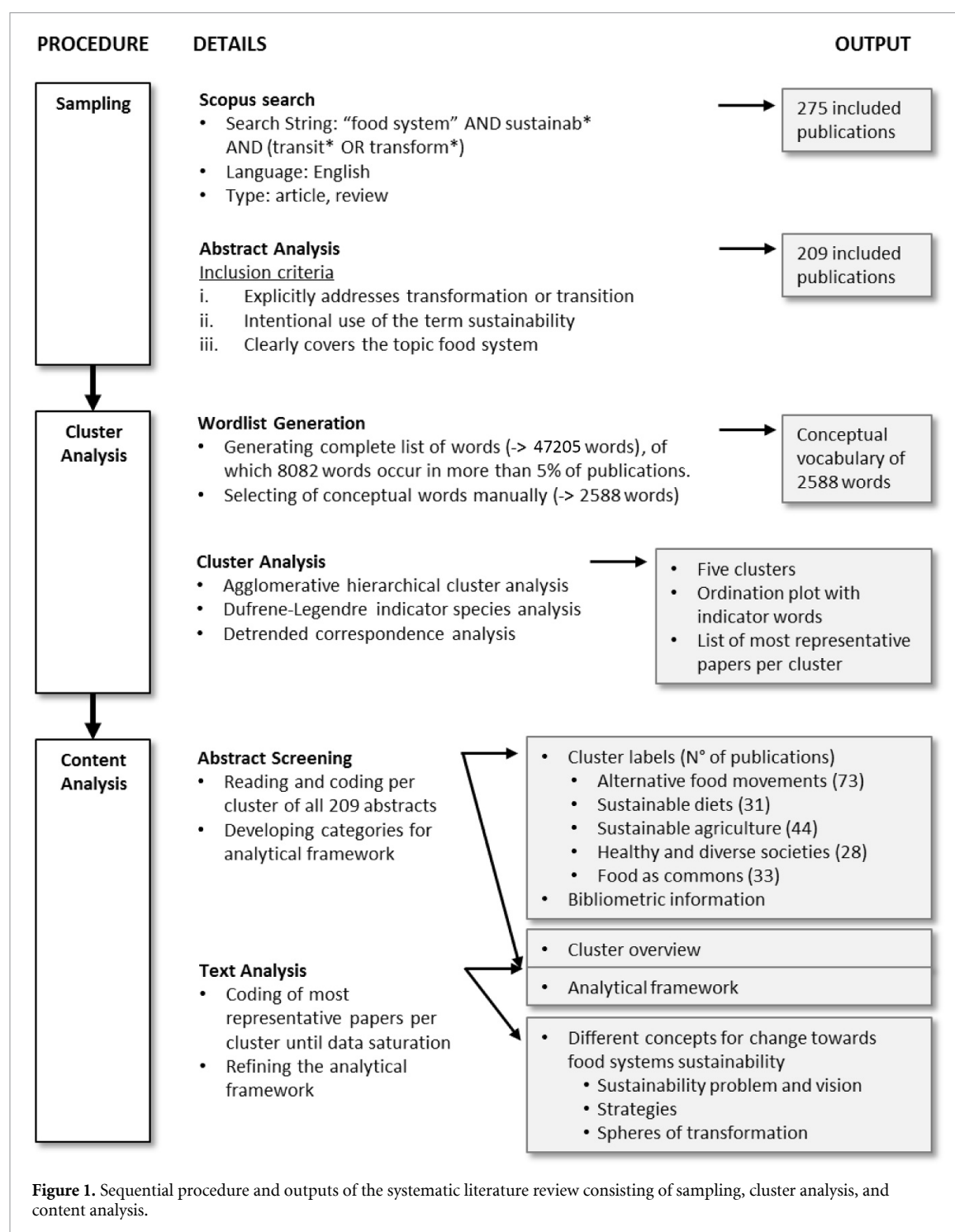
We analyzed 209 peer-reviewed articles using a two-step approach starting with a statistical semantic full-text analysis to group the literature into clusters. In a next step, we conducted a qualitative text analysis for representative articles of each cluster to examine how change processes towards sustainability in food systems are conceptualized. For this purpose, we developed an analytical framework (see section 3). Our findings offer an initial map to systematically navigate a vibrant interdisciplinary field, supporting researchers and practitioners in changing the current food systems towards sustainability and enable discussion, reflection and learning across different perspectives.

2. Research design

This study combines cluster analysis and content analysis of the existing literature (figure 1). We adopt procedures of systematic literature reviews (Luederitz *et al* 2016, Fischer *et al* 2017) and semantic full-text analyses to cluster the body of literature (Abson *et al* 2014, Ives *et al* 2017, Rathgens *et al* 2019).

2.1. Sampling

In a first step, we used the SCOPUS database to identify peer-reviewed articles on transformation or transition of food systems towards sustainability, including the nutrition transition as deep change process in the past (Popkin 2003). We applied the search string: 'food system' AND sustainab* AND (transit* OR transform*) including all articles with the search terms appearing in title, abstract, or keywords. The concept of a 'food system' is relatively new in the academic literature (Sobal *et al* 1998, Ericksen 2008); nevertheless, given our focus on system-wide and deep change, we concentrate on literature that explicitly adopts a system perspective rather than focusing narrowly on system components or disciplinary domains. We searched for articles in English, resulting in a sample of 275, published between 1981 and 2018. In the second step, we assessed each article for



relevance (based on the abstract) and only included articles that met all of the following criteria: (1) the article explicitly addresses ‘transformation’ or ‘transition’ as deep change in the context of food systems, or addresses the nutrition transition; (2) the article does not just mention sustainability but provides details, e.g. climate adaptation/mitigation, organic production, or agroecology; (3) the article focuses on food systems or its distinct features (Ericksen 2008) such as food system activities (production, consumption) and outcomes (food security, social welfare, environmental integrity), or diets.

2.2. Cluster analysis

With the reduced set of 209 publications (see supplementary material A1, available online at stacks.iop.org/ERL/15/113001/mmedia), we conducted a semantic full-text cluster analysis (Abson *et al* 2014), which groups publications into different clusters based on co-abundance of words. The rationale is that publications addressing a topic in similar ways would use similar vocabulary. Our analysis first lists the occurrence of all words in a publication (a). It then groups these publications into clusters based on co-abundance of conceptual

vocabulary (b, c). Finally, it identifies representative words (indicator words) for each cluster (d) and locates these words in a two-dimensional space (e). This yields our final word cloud (figure 4). Statistical analyses were carried out using R 3.5.2.

- (a) **Digitizing PDFs and metadata:** To digitize the publications, R imports the 209 PDF files to the working directory and creates a matrix (packages: 'snowballC', 'tm', function: 'readPDF') for further processing. The matrix consists of 209 rows that correspond to the number of articles and 20 columns. One column corresponds to the full text of the publication, the others are filled in a next step with general and bibliometric metadata of each publication (e.g. Title, Year, Journal, Citation per Year, DOI, etc) obtained from the SCOPUS database (code: 'scopus.R', available in SI).
- (b) **Wordlist generation:** To identify the list of conceptual vocabulary, we first generated a complete list of abundant words within the 209 analyzed publications (47 205 words), of which 8082 words appeared in more than 5% of the publications. Of these, we manually removed all abstract nouns, e.g. pronouns, articles, numbers, authors' and geographical names, compass directions, units for time, lengths, and mass, as well as individual words with no association to food systems or change processes, or words from which no clear meaning could be inferred. For example, 'collect' was retained for its description of a harvesting technique. In this way we retained a list of 'conceptual vocabulary' of 2588 words (see supplementary material A3(a)).
- (c) **Building clusters:** Based on the co-abundance of these words, we performed an agglomerative hierarchical cluster analysis using Ward's method (function: 'hclust', package: 'mclust'). This method clusters 'single elements (i.e. publications) into aggregates of two elements based on the minimum variance criterion. [in order to] minimize within-group variance and maximize dissimilarities between groups' (Abson *et al* 2014, p 31). In our case, within-group variance was low if a similar set of words was used in the articles. Similarly, the dissimilarities between groups were high when each community had a distinct set of vocabulary. Our analysis identified five distinct clusters, with an agglomerative coefficient of 0.83.
- (d) **Finding representative words for each cluster:** To identify words that characterize the differences between the clusters, we used a Dufrene Legend Indicator Species Analysis, which is commonly used in biology to determine habitats and compare them through representative species. The analysis yielded

representative words (indicator words), for each cluster (Abson *et al* 2014). The five most significant indicator words per cluster are shown in figure 4 and an extended list of 25 indicator words per cluster can be found in the supplementary material (A4). Based on the indicator words, we were able to identify a hierarchy of publications according to their representativeness of the cluster. The most representative articles most frequently include the most significant indicator words.

- (e) **Identifying the thematic landscape:** We used a detrended correspondence analysis to locate the indicator words according to their relative distance to each other (figure 4). Relative distances were calculated by R. In a final step, we inductively identified gradients' labels in the thematic landscape of publications. They derived from indicator words and were refined in the content analysis (table 2).

2.3. Content analysis

To establish a meaningful label and yield a general topical overview of each cluster, we first screened the abstracts of the 209 publications and composed headings for clusters. While screening the abstracts, we coded general information of each publication to provide an overview of the field (sections 4.1.1 and 4.1.2). General information included discipline, country of first author's affiliation, country of study, type of article (conceptual, empirical, review) and methods applied. We also coded which term was used to describe deep change (transition or transformation) and the underlying theory of change. The results of abstract screening informed the development of categories for our analytical framework (see section 3), in particular the three change characteristics. The framework was developed in an iterative process, starting from theoretical concepts and refining categories during data analysis.

We conducted qualitative analyses of full texts according to Kuckartz (2014) to gain a thorough understanding of the five obtained clusters (sections 4.1.2 and 4.2). We used the analytical framework as a coding scheme, which was further refined throughout the analysis. According to the hierarchy of publications identified with the Indicator Species Analysis (section 2.2, step d), we coded the full texts of the *representative* articles of each cluster (see supplementary material A2). We used data saturation as a criterion for determining the number of articles to be reviewed in full text (Fusch and Ness 2015, Saunders *et al* 2018). Data saturation is reached when no additional new information has been attained. Studying the representative articles until data saturation reduced the number of articles for in-depth review while providing sufficient information for thorough understanding. Two coders independently coded the selected article according to thematic categories and guiding

questions. The results were discussed to create a consensually coded (Schmidt 2004) overview of each cluster.

3. Analytical framework

We developed categories for the analytical framework both inductively and deductively in an iterative process (table 1). Inductive categories emerged from the cluster analysis (figure 4) and an initial familiarization with the literature through abstract screening. These categories include three characteristics of change: (1) the geographical scale where change happens; (2) the organizational level where change happens; (3) the adopted theory of change (El Bilali 2018). Change characteristics were also informed by other studies (Cash *et al* 2006, Eakin *et al* 2017a). Deductive categories were derived from theoretical concepts by Wiek and Lang (2016) and O'Brien and Sygna (2013), which were subsequently refined during the full-text analysis.

Wiek & Lang's (2016) theoretical framework served to answer the research question, *how do the identified clusters conceptualize deep change processes towards sustainability of food systems?* The framework offers analytical categories for all key elements of the change process. This allows for a systematic and transparent analysis of the respective article: what sustainability problem(s) in the current food system it addresses; what sustainable food system it envisions; and what actions it proposes to realize the change from the current problematic situation to the envisioned sustainable system (figure 2).

In order to categorize identified actions and explore the transformative potential of the approaches, we added the theoretical concept of three spheres of transformation by O'Brien and Sygna (2013). The three spheres of transformation are: the *practical* sphere includes changes of behavior, in policies, and technological solutions; the *political* sphere focuses on creating new institutional structures, which are in turn needed to support transformations in the practical sphere; and the *personal* sphere refers to changes of individual and collective beliefs, values, worldviews, and paradigms that shape society and its structures. According to O'Brien and Sygna (2013), the greatest potential for generating deep change lies in the interactions across the spheres. Therefore, we highlight such interactions.

4. Results

4.1. Clusters of research on food systems change towards sustainability

4.1.1. Bibliometric information.

The sample indicates that research on food system sustainability change is a relatively young field. The first articles are a critical analysis of the role of organic farms by David Vail in 1981 and a system analysis of

the world food system by Donella Meadows in 1985. Most articles have been published in the last four years (figure 3). This is due to the overall increase in research publications, the relatively recent conceptualization of 'food systems' as a unit of analysis (Sobal *et al* 1998, Ericksen 2008), and the fact that the concept of sustainability/sustainable development became more prominent in academia after the Brundtland report in 1987.

The abstract screening has shown that studies of our sample originate in diverse research fields, i.e. Geography, Sociology, Ecological Economics, Environmental Studies, Nutrition and Health, Agriculture, Law and Politics. Most research was conducted in North America and Europe. Of the few studies carried out in the Global South, researchers mostly came from the Global North. This is partly related to the selection of English language publications and international journals. Older articles revolve around classical sustainability concepts, such as the three pillars concept, while recent publications mostly use the Sustainable Development Goals.

4.1.2. Cluster overview

Within the research field of food systems change towards sustainability, we identified five clusters, which are represented by indicator words displayed in the thematic landscape of the sample (figure 4). We inductively identified the two labels 'local-global' and 'institutional-individual', which represent gradients within the thematic landscape of the sample. How clusters link to the gradients is described in table 2.

The cluster *Alternative food movements* includes a diversity of alternative food initiatives (indicator word: *movement*) and networks creating new *spaces* for consumers and producers and their communities (*citizen*) to *learn* together and for political action. The *Sustainable diets* cluster engages with the nutrition transition (*diseases, cancer, kcal*) aiming at sustainable diets and individuals' health. The *Sustainable agriculture* cluster focuses on sustainable farming practices (*input*), and food sovereignty via agroecology as practice and movement (*paradigm*). The cluster *Healthy and diverse societies* engages with healthy populations and rural developments globally in the context of the economy (*market, trend, work*), with an emphasis on the Global South. The cluster *Food as commons* focuses on North American food systems arguing for a shift in mindsets to acknowledge food as a collective good. Indicator words in this cluster especially underline the individual level of food system organization (*worker, owner, garden*). The distribution of clusters in figure 4 shows that *Sustainable diets* is detached from the others whereas the remaining four clusters overlap with each other, with the cluster *Alternative food movements* showing most overlaps.

From a methods perspective, in the cluster *Alternative food movements*, researchers mostly conducted case studies to understand different initiatives around

Table 1. Final analytical framework (category with guiding questions, examples, and respective theoretical concept) for content analysis.

Theoretical concept	Thematic category with guiding question	Examples	Results in
Change characteristics	Geographical Scale: Which geographical scale(s) of food systems are addressed? How do these scales interact with/effect each other?	<i>local, regional, national, global, urban, rural</i>	Cluster overview (section 4.1.2)
	Organizational Level: Which organizational level of food systems is addressed? How do these levels interact with/effect each other?	<i>institutional, community, individual</i>	
	Theory of Change: How do authors approach change? What theory of change do they refer to?	<i>jargon used, explicit understanding of transformation, multi-level-perspective, practice theory, technological innovation</i>	
	(P) Sustainability Problems: What major overall sustainability challenges are mentioned beyond the food system?	<i>pollution, climate change, social injustice, biodiversity loss, deforestation, overpopulation, urbanization</i>	
	(P) Food System Sustainability Problems: What challenges related to food systems are mentioned?	<i>health problems, degraded soils, power imbalance along food supply chains, waste, malnutrition, hunger</i>	
	(P,V) Sustainability Concept: What concept of sustainability do the authors adopt?	<i>three pillars concept, SDGs/MDGs, planetary boundaries, resilience</i>	
	(V) Sustainability Vision Outcomes: What are envisioned outcomes of sustainable food systems?	<i>community well-being, local and resilient food systems, healthy and diverse diets, food citizenship, food security, food sovereignty, empowered small-scale farmers</i>	
	(V) Sustainability Vision Activities What are the envisioned activities of a sustainable food systems?	<i>localization, alternative production and consumption practices, participatory decision making, collaboration, agroecology, organic farming</i>	
	(S) Subject of Change: What is being changed?	<i>policy, diets, consumption and production practices, power structures</i>	
	(S) Change Agent(s): Who transforms the food system?	<i>policy makers, farmers, consumers, researchers, educators, social movements</i>	
Wiek and Lang (2016) (P) = Problem, (V) = Vision, (S) = Strategy	(S) Proposed Actions and Expected Results: What are the actions proposed to realize the change? What are the expected results from these actions?	<i>local practices shape global policies, global diet shift, policy and governance measures, creation of diverse networks, grassroots mobilization</i>	In-depth study of clusters (section 4.2.)
O'Brien and Sygna (2013)	Spheres of Transformation: In which sphere(s) does change happen?	<i>practical, political, personal sphere</i>	

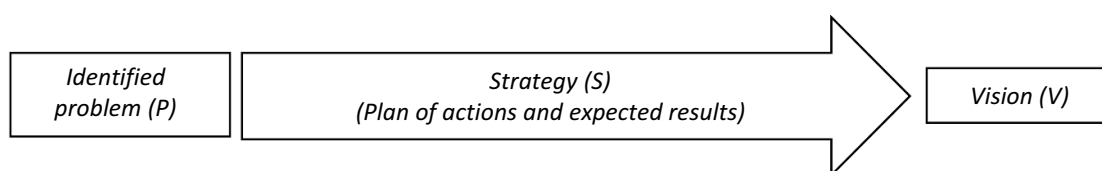


Figure 2. Theoretical framework for sustainability transformations (Wiek and Lang 2016).

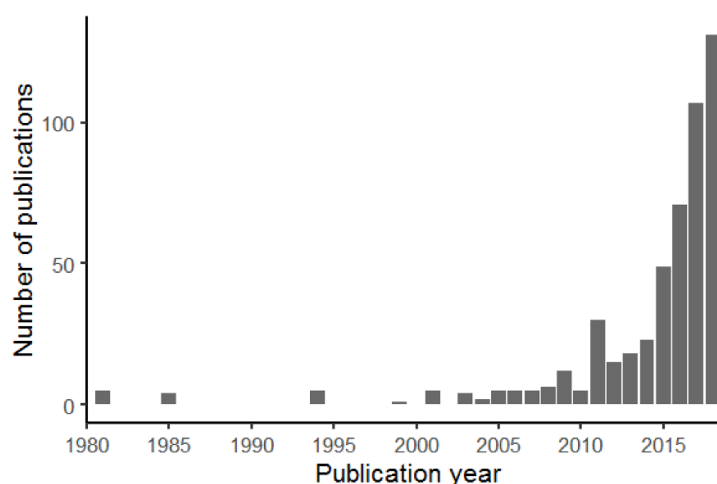


Figure 3. Number of SCOPUS registered publications on food systems, sustainability, and transformation/transition ($n = 209$) per cluster per year from 1980 to 2018.

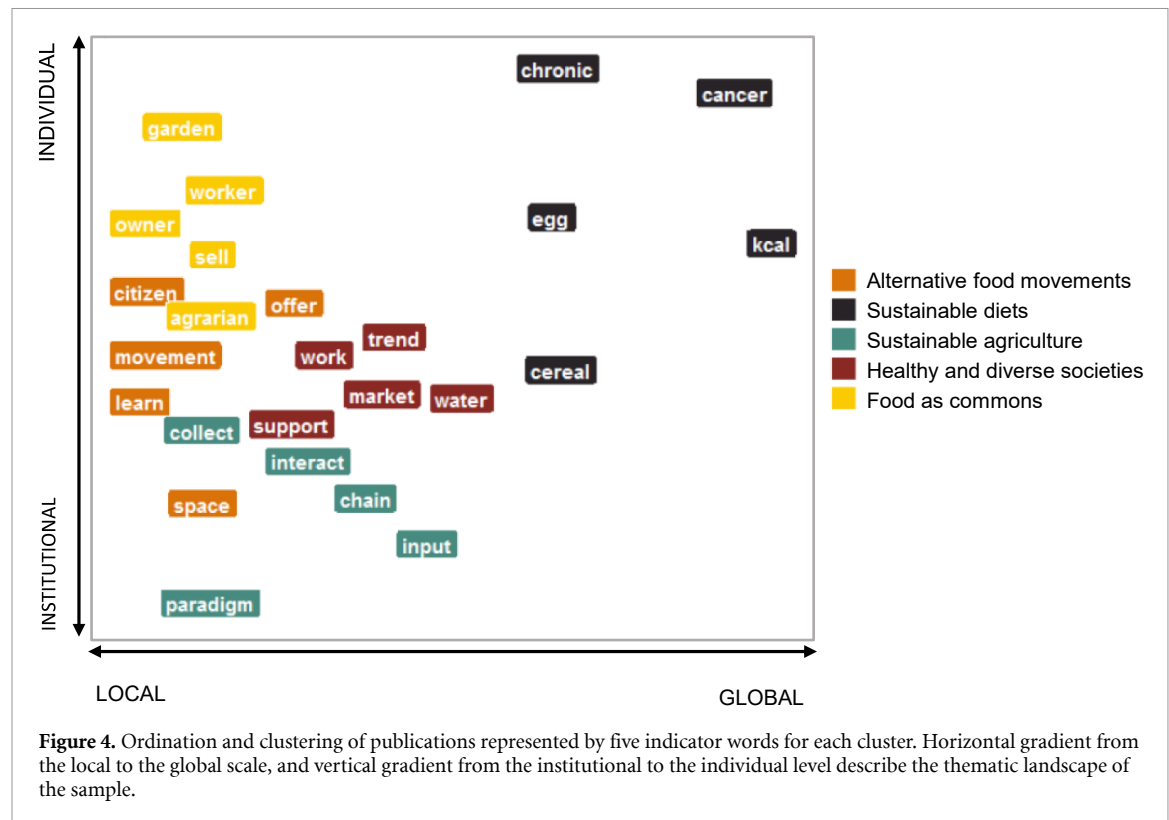
Table 2. Descriptions of each cluster according to the identified gradients.

Cluster	Local—Global	Individual—Institutional
Alternative food movements	Local: Global networks of local or regional initiatives to change the food system.	Community: Changing community initiatives and networks
Sustainable diets	Global: Transformational activities at global level to mainstream sustainable diets and integrate into policy.	Individual: Changing consumption patterns of individuals to achieve positive public health outcomes.
Sustainable agriculture	Local—Global: Locally developed sustainable practices that support agroecology movement and global application.	Institutional: Changing public education and policy programs
Healthy and diverse societies	Local (rural)—Global: Focusing on local and rural activities in the Global South in collaboration with international organizations to engage against negative effects of globalized food markets.	Community: Changing rural communities
Food as commons	Local: Mostly locally directed activities that increase democratic understanding of food.	Individual: Changing the meaning of food from a commodity to a common good, requiring a shift in mind-sets of individuals.

sustainable food systems. *Sustainable diets* primarily uses population level analyses, i.e. life cycle assessments (LCA) and modelling of future (diet) scenarios, whereas in *Sustainable agriculture*, researchers concentrate on framework development and transdisciplinary research, in particular at the farm and community level. *Healthy and diverse societies* includes both LCAs and conceptual works. Authors in *Food as commons* utilize reviews and case studies.

For all clusters, we found that researchers use the terms ‘transformation’ and ‘transition’ often

interchangeably to describe any kind of change process in food systems. We could identify patterns when the terms were used intentionally. When authors apply a theory of change for ‘transition’, they likely apply the multi-level perspective. This is the case for clusters *Alternative food movements* and *Sustainable agriculture*. In *Alternative food movements*, change is framed equally often as ‘transition’ or ‘transformation’. Authors in *Sustainable diets* refer more often to nutrition transition and tend to focus on technical innovations primarily using the term ‘transition’. In



the cluster *Healthy and diverse societies*, most authors provide no definition of change when they use both terms interchangeably. Authors in the cluster *Food as commons* tend to make more use of the term ‘transformation’ without referring to a specific theory. Beyond these observed tendencies, we could not identify a clear pattern regarding a specific application of transformation/transition.

4.2. Different concepts for deep change towards food systems sustainability

4.2.1. Alternative food movements

4.2.1.1. Sustainability problem and vision

The cluster *Alternative food movements* addresses unequal concentration of wealth and power in the dominant (global corporate) food regime and associated externalities, such as environmental problems and food insecurity as well as marginalized local food practices. The vision for sustainability highlights local, self-reliant and small-scale community food systems that enable community well-being, healthy diets, and social justice as forms of food security and food sovereignty. Equally important for sustainability are environmentally friendly practices, e.g. organic farming, and consumption practices that are environmentally conscious and collective, e.g. food co-ops.

4.2.1.2. Strategies

Grassroots organizations promote and engage consumers and small-scale producers in adopting non-conventional practices of producing and consuming food (e.g. Community Supported

Agriculture—CSAs, farmer markets, community gardens). Together with educational institutions, these organizations actively create networks, knowledge platforms, and educational offerings on alternative food practices and its critical reflection, as well as social exchange beyond food. They collaborate with primarily local public sector authorities to advocate and lobby for policy changes that support and foster local, self-reliant and small-scale community food systems. Strategies of this cluster are explicated as actions and expected results (table 3).

4.2.1.3. Spheres of transformation

- **Practical:** alternative consumption patterns, new food practices, and formation of networks
- **Political:** scale-appropriate and food-informed policies that empower citizen-consumers
- **Personal:** values of connection to nature, food, community, and solidarity
- **Interactions:** educational programs, collaboration between consumers and governments, food networks and platforms for knowledge sharing

4.2.2. Sustainable diets

4.2.2.1. Sustainability problem and vision

Nutrition transitions are the focus of this cluster. The authors problematize the global shift towards Westernized ways of eating, and the severe effects for public health and the environment, such as malnutrition and hunger, GHG emissions, land and air pollution and biodiversity loss. The general vision is to achieve sustainable diets, characterized by adequate nutrient

Table 3. Actions and expected results of cluster *Alternative food movements*.

Actions	Expected Results
Local communities and grassroots initiatives create niches and challenge the status quo (Brunori <i>et al</i> 2012, Blay-Palmer <i>et al</i> 2016) via e.g. pushing the boundaries of ‘grey areas’ of regulations (Laforge <i>et al</i> 2017)	Reflexivity and changed attitudes; lived alternative values and changed behaviors of consumers (Levkoe 2011, Brunori <i>et al</i> 2012, Blay-Palmer <i>et al</i> 2016, Laforge <i>et al</i> 2017)
Local communities and grassroots initiatives create alternative and diverse food networks and platforms for sharing knowledge and developing skills for alternative food practices (Brunori <i>et al</i> 2012, Blay-Palmer <i>et al</i> 2016, Laforge <i>et al</i> 2017)	Shared knowledge; consumer education; empowered consumers; strengthened communities (Brunori <i>et al</i> 2012, Blay-Palmer <i>et al</i> 2016) and collective subjectivities (Levkoe 2011)
Educational institutions enable students to reconnect to food (Rojas <i>et al</i> 2011), alternative food initiatives critically analyze their own practices (Levkoe 2011)	Reflexive, critical, and practical consumerism, food literacy; and food citizenship (Rojas <i>et al</i> 2011)
Citizen (consumers) collaborate with governments in new political spaces (Levkoe 2011, Brunori <i>et al</i> 2012, Laforge <i>et al</i> 2017)	New forms of governance with participatory decision-making processes (Levkoe 2011, Brunori <i>et al</i> 2012, Laforge <i>et al</i> 2017); scale-appropriate and food-informed policies, as well as funding opportunities (Blay-Palmer <i>et al</i> 2016)

intake, less resource consumption, and low waste; leading to food security, healthy individuals, and low environmental impacts of food systems (Food and Agriculture Organization 2012).

4.2.2.2. Strategies

In order to ensure food security, research identifies consumption patterns towards healthy, increasingly plant-based diets (Guyomard *et al* 2012). Research facilitates technological innovation, e.g. novel foods and practices for sustainable intensification, to advance sustainable food systems. Policy makers, consumers, researchers, and the food industry collaborate to create consistent policies addressing change in consumption for healthy diets. Policy makers develop a global agenda, such as the Sustainable Development Goals (SDGs), influencing national policies that address the universal problem of malnutrition, food insecurity and environmental externalities. Strategies in this cluster are explicated as actions and expected results (table 4).

4.2.2.3. Spheres of transformation

- **Practical:** emphasizing technological innovation and individual consumption choices; as well as creating policies to change consumption behavior

4.2.3. Sustainable agriculture

4.2.3.1. Sustainability problem and vision

The sustainability challenges addressed in this cluster are high-input farming and locked-in farming systems leading to food insecurity, malnutrition and environmental degradation. To address these socio-ecological externalities, this cluster envisions long-term food sovereignty through resilient and

diverse farming systems, e.g. agroecological practices, diversified farming, conservation agriculture, and smart agricultural technologies, as well as social mobilization addressing socio-political aspects of the food system. This approach results in an increase in (agro-)biodiversity, achieving socio-economic benefits for farmers and sustainable diets for consumers.

4.2.3.2. Strategies

Central actors are policy makers and institutions that create regulations to support the adoption of low-input agricultural practices drawing on local knowledge such as agroecology, biodiversity-based farming, smart agricultural technologies, crop diversification, and conservation agriculture. Researchers and farmers collaborate to provide evidence for agroecological practices, including the preservation of traditional knowledge, and to facilitate the institutionalization of agroecology. Social movements advocate for shifting power from the agro-industry to farmers, social movements and small-scale actors to facilitate more independent collaboration. Strategies of this cluster are explicated as actions and expected results (table 5).

4.2.3.3. Spheres of transformation

- **Practical:** creating networks for communication and collaborations; policies supporting agroecological and organic and diversified farming practices
- **Political:** mainstreaming such alternative farming practices, especially agroecology, in political programs, research agendas, and higher education through establishing new institutions
- **Interactions:** intensive collaboration between political actors, farmers, researchers and grassroots initiatives

Table 4. Actions and expected results of cluster *Sustainable diets*.

Actions	Expected Results
Researchers conduct (quantitative) studies on nutrition, dietary externalities, health and environmental effects, and potential of alternative diet scenarios, e.g. via LCA assessments (Guyomard <i>et al</i> 2012, Rööß <i>et al</i> 2017, Chaudhary <i>et al</i> 2018, Lindgren <i>et al</i> 2018)	Evidence for policy-makers as a condition/base to change policies (Guyomard <i>et al</i> 2012, Rööß <i>et al</i> 2017, Chaudhary <i>et al</i> 2018)
Researchers, farmers, and industry invest resources in new technologies and innovations around novel food and sustainable intensification (Rööß <i>et al</i> 2017, Lindgren <i>et al</i> 2018)	Improved farming techniques and more efficient infrastructures, as well as more sustainable food items (Lindgren <i>et al</i> 2018)
Policy makers engage the food industry, retailers and producers in policy development (Rööß <i>et al</i> 2017, Lindgren <i>et al</i> 2018)	Consistent policies along the entire supply chain, e.g. economic and fiscal incentives, subsidies, eco taxes, and eco-labelling facilitating sustainable diets (Guyomard <i>et al</i> 2012, Rööß <i>et al</i> 2017, Lindgren <i>et al</i> 2018)
Transnational food collaborations develop guidelines for promoting sustainable diets (Lindgren <i>et al</i> 2018)	Adapted national/local policies and programs (Lindgren <i>et al</i> 2018); consumer awareness for healthy and sustainable diet patterns, consumption choices and waste management (Guyomard <i>et al</i> 2012, Lindgren <i>et al</i> 2018)

Table 5. Actions and expected results of cluster *Sustainable agriculture*.

Actions	Expected Results
Networking and collaborating of all actors (NGOs, civil society, farmers, researchers, policy makers, etc) as social movement (Sanderson Bellamy and Ioris 2017, Migliorini <i>et al</i> 2018)	Changed power and governance structures in and infrastructure of food systems to overcome human-nature disconnectedness (Sanderson Bellamy and Ioris 2017, El Bilali 2018), preserved traditional knowledge.
Farmers experiment with agroecology and alternative agricultural practices based on traditional knowledge and technological innovations and share knowledge (Voisin <i>et al</i> 2014, Sanderson Bellamy and Ioris 2017, Therond <i>et al</i> 2017)	Actionable knowledge (Voisin <i>et al</i> 2014, Therond <i>et al</i> 2017) and evidence for the success of agroecological farming practices (El Bilali 2018)
Researching and teaching in close collaboration with farmers (Voisin <i>et al</i> 2014, Miles <i>et al</i> 2017, Migliorini <i>et al</i> 2018)	Improved understanding of agroecological and organic farming practices (Migliorini <i>et al</i> 2018); preserved traditional knowledge, mobilizing and training of actors (Voisin <i>et al</i> 2014) and technical innovation (Therond <i>et al</i> 2017)
Political institutions collaborate with researchers, farmers, and grassroots initiatives to create policy frameworks and new institutions based on evidence provided by researchers and others (Voisin <i>et al</i> 2014, Miles <i>et al</i> 2017, Sanderson Bellamy and Ioris 2017, Migliorini <i>et al</i> 2018)	Institutionalization of agroecology and diversified organic, efficient farming practices (Therond <i>et al</i> 2017), environmental regulations, adapted academic funding systems and research agendas (Miles <i>et al</i> 2017, Therond <i>et al</i> 2017)

4.2.4. Healthy and diverse societies

4.2.4.1. Sustainability problem and vision

Counteracting economic growth paradigms and the resulting nutrition transition, this cluster envisions a regenerative natural and socially just system, as well as reliable and nutritious food supplies leading to healthy population with diversified diets, especially acknowledging rural areas and socio-economic development in the Global South. Central in this cluster is the acknowledgement of cultural diversity as ‘a globe of villages’ (Dahlberg 1994, p 172) and achieving food sovereignty that is not solely based on a

Western perspective of sustainable food production. This would support and empower small- to medium-sized farms to define their own futures and to produce nutritious, biodiverse, and traditional food.

4.2.4.2. Strategies

Potential actions include the acknowledgement and sharing of indigenous knowledge and traditional farming practices, as well as innovation and the active involvement of peasants. Authors advocate for international negotiations to strengthen the influence of local and rural producers and authorities in

Table 6. Actions and expected results of cluster *Healthy and diverse societies*.

Actions	Expected Results
Policy makers acknowledge and promote traditional, indigenous, and local knowledge, as well as sustainable innovation in food systems (Ambalam 2014, van Vliet <i>et al</i> 2015, Rijsberman 2017)	Diversified farming practices as well as diverse and healthy diets (Ambalam 2014, van Vliet <i>et al</i> 2015, Hammond Wagner <i>et al</i> 2016), conserved indigenous and traditional food systems (Rijsberman 2017)
International trade negotiations include diverse stakeholder groups in policy making and prioritize local and rural agricultural practices (Ambalam 2014, Anderson 2015)	Empowered small-scale and mid-scale farmers including improved access to markets and democratic participation; rural livelihood opportunities and decentralized food systems (Ambalam 2014, Anderson 2015)
International policy makers prioritize health and diversity criteria and food sovereignty principles instead of criteria of economic growth (Dahlberg 1994, Ambalam 2014, Rijsberman 2017)	Regenerative and healthy food systems (Dahlberg 1994, van Vliet <i>et al</i> 2015, Rijsberman 2017)

Table 7. Actions and expected results of cluster *Food as commons*.

Actions	Expected Results
Different niche actors exemplarily live alternative food values and connect as social movements (Tai 2011, Lengnick <i>et al</i> 2015, Vivero-Pol 2017)	Organic, local and slow food; change of food meaning from commodity to commons, reconnection and well-being (Tai 2011, Vivero-Pol 2017)
(Local) authorities create (local) policy frames supporting the consumers and private sector to actively participate, e.g. in urban gardening (Shannon <i>et al</i> 2015, Ilieva 2017)	Direct democracy, collective, open and transparent decision-making and participatory and reflexive food governance, e.g. food policy councils (Ilieva 2017, Vivero-Pol 2017)
Public interventions/public institutions create targeted programs, such as incentives and taxes and employ staff (Shannon <i>et al</i> 2015, Ilieva 2017, Vivero-Pol 2017)	Sustainable diets, resilient urban food infrastructure and diversified and just food practices (Lengnick <i>et al</i> 2015, Shannon <i>et al</i> 2015, Ilieva 2017)
NGOs advocate for food literacy via communication and knowledge sharing (Jaffe and Gertler 2006, Tai 2011)	Awareness and informed consumers with respect to externalities of food and reskilled consumers to create food citizenship (Tai 2011, Shannon <i>et al</i> 2015)
Academia and strong democratic institutions vote/engage/communicate a new narrative of food as collective good (Ilieva 2017, Vivero-Pol 2017)	Wider awareness of food being a collective good and the importance of community (Vivero-Pol 2017)

face of increased urbanization and the concentration of power. Strategies of this cluster are explicated as actions and expected results (table 6).

4.2.4.3. Spheres of transformation

• **Personal:** focusing on a shift in worldviews creating systems that are not oriented on productivity but on health criteria

4.2.5. Food as commons

4.2.5.1. Sustainability problem and vision

Starting from the problem of commodification of food and industrialization of food systems, this cluster aims to change the underlying guiding market principles and policies. The goal is to steer food systems towards respecting food and health as basic human rights. It envisions food as a collective good embodying culture, human factors, sociality and health—instead of a being a commodity.

4.2.5.2. Strategies.

Actors in food niches and social movements advocate for alternative meaning of food with the potential to change the economic and market-based orientation in society. Local authorities, niche actors, and consumers collaborate in collective, reflexive and participatory decision-making for democratic governance of food systems. NGOs sue for legal measures (litigation) and promote education for food citizenship. Local authorities pass bills to change food programs and nutrition policies, with a potential for wider policy change. Academia, NGOs, and the media support the change process by creating the narrative of food as collective good. Strategies of this cluster are explicated as actions and expected results (table 7).

4.2.5.3. Spheres of transformation

• **Practical:** creating policies and targeted programs to support diversified and just food practices

- **Political:** enabling a power shift from industry and state to collective and participatory decision-making processes.
- **Personal:** aiming at a new value system in which food is acknowledged in its diversity of meanings rather than as commodity.
- **Interactions:** active participation in governance, democratic institution communicating and acting according to paradigm shift.

4.2.6. Synthesis

In summary, the five research clusters present distinct, yet complementary, concepts for transforming food systems towards sustainability with differences regarding identified sustainability problems, envisioned sustainable food systems, and proposed actions to transform food systems towards sustainability (table 8).

5. Discussion

We identified five research clusters that provide insights on how to change food systems towards sustainability. Our results are in line with the work of other scholars (Eakin *et al* 2017a, Béné *et al* 2019). While Eakin and colleagues (2017a) provide a deeper understanding of food systems and sustainability attributes, our work adds a transformation/transition perspective presenting a suite of actions and their expected results to advance change. The outlined approaches suggest key components for change:

- *Political action* to support inclusive and participatory governance structures that enable citizen-consumers, empower (small-scale) farmers and allow for an active role of grassroots movements.
- *Close collaboration* of stakeholders in food systems (consumers, farmers, politics, industry, NGOs, researchers) in new networks and platforms.
- *Education* to support consumers in adopting sustainable consumption behavior, to help farmers in adopting diversified farming practices, and to inform policy makers how to advance healthy diets.
- *A deep value shift* with regard to food and food systems informing actions.

The cluster *Food as commons* represents a North-American perspective emphasizing a paradigm shift in the personal sphere to value food instead of commodifying it, which might change the economic and market-based orientation in society. Many authors in the *Alternative food movements* cluster stem from European countries and seem to aim for a shift towards alternative networks and policies. These tendencies reflect Goodman's (2003) distinction between proposals from European food systems research (incremental improvements/policies)

vs. proposals from North American food systems research (opposition/grassroots movements).

The distinction of spheres by O'Brien and Sygna (2013) demarcates the focus of the transformation approach. According to these authors, a comprehensive approach to transformation emphasizes the interconnectedness of spheres represented here as interactions. *Alternative food movements* and *Food as commons* are the only clusters that comprehensively acknowledge change in all three spheres of transformation. They suggest actions intervening in values and knowledge, policies, and practices, and include elements that facilitate interconnection between these spheres. For example, in *Alternative food movements*, network building and dissemination of knowledge aims at empowering citizen-consumers to engage in participatory decision making (political sphere) and shape scale-appropriate and food-informed policies. This can in turn influence consumption patterns and farming practices (practical sphere). Educational actions enable students to reconnect to food (personal sphere) which may influence individual food practices and policies (practical sphere). In addition, this cluster overlaps with three other clusters (figure 4) indicating that alternative grassroots mobilization and network building are broadly seen as a relevant approach for deep change. At the same time, alternative mobilization alone might not comprehensively change food systems. For example 'thoughtful practice of pragmatic politics and the development of a strong food democracy will be key to transformation in the long run' (Hassanein 2003, p 78). In summary, all clusters offer promising strategies; thus, it might be meaningful to combine different approaches to systems change. We argue that interconnected spheres and their related actions could create synergies and accelerate progress towards sustainability.

Despite the identified tendencies regarding the use of the terms 'transformation' and 'transition' described in the end of section 4.1.2, authors do not use the terms consistently. A clear attribution of change process to the respective term is missing. This finding corresponds with the fact that the food systems literature has not consolidated on one theory of change or theoretical perspective (Foran *et al* 2014, van Bers *et al* 2019). Even though authors apply both terms, the described change processes in four of the five clusters show a strong consistency with our definition of transformation as encompassing both social and technological innovation and seeing a strong role for social movements and civil society (Stirling 2015, Scoones *et al* 2018). The term 'transition', describing a rather controlled change process with less emphasis on human agency, contestation, and deliberation (Stirling 2011), has been used in the *Sustainable diets*, the *Sustainable agriculture* and the *Alternative food movements* clusters (Hinrichs 2014). As these clusters address aspects of justice and power,

Table 8. Key components of the five concepts for changing food systems towards sustainability.

	Cluster 1: Alternative food movements	Cluster 2: Sustainable diets	Cluster 3: Sustainable agriculture	Cluster 4: Healthy and diverse societies	Cluster 5: Food as commons
<i>Food System Sustainability Problems</i>	Food insecurity, power imbalances, environmental problems	Nutrition transition, environmental and public health problems	Food insecurity, high-input oriented farming, socio-ecological problems, human nature disconnect	Detrimental effects of economic growth (and underlying paradigms), power concentration, nutrition transition, health problems	Commodification and industrialization of food, McDonaldization, health problems, alienation
<i>Sustainability Concept</i>	Social justice, community well-being, empowerment, environmental and social health	Millennium and Sustainable Development Goals (M/SDGs), planetary boundaries, human health	Resilience, community-based economic development, SDGs	SDGs, regeneration, health and diversity, social justice	Resilience, respecting human rights, SDGs
<i>Sustainability Vision Outcomes</i>	Empowered consumers, community well-being, adequate diets, and social justice (food security and food sovereignty)	Food security, healthy individuals, low environmental impact	Food sovereignty, food security, (agro-)biodiversity	Paradigms based on health and diversity, food sovereignty, food security, healthy populations, empowered farmers, socio-ecological well-being	Food sovereignty, food democracy, food security, human well-being, food as a collective good, food citizenship
<i>Sustainability Vision Activities</i>	Local, self-reliant, and small-scale community food systems: environmentally friendly, conscious, and collective food production and consumption practices (CSAs, farmer markets, community gardens), participatory decision making	Sustainable diets (adequate nutrient intake, low resource consumption, low waste)	Low-input and environmentally friendly farming systems: agroecologically practices, smart agricultural technologies; institutionalization of agroecology; community-based economic development	Small-scale diverse farming systems acknowledging traditional practices (focus on Global South)	Local participatory food governance: food policy councils, civic agriculture, just food practices, healthy diets, support mechanisms
<i>Subject of Change</i>	Values, knowledge, skills, decision making structures, policies, consumption and production practices	Diets, consumption patterns, policies	Power relations, research agenda, agricultural practices, policies	Paradigms, power relations, policies	Underlying guiding market principles, meaning of food, governance structures, practices
<i>Change Agents</i>	Grassroots organizations, local food initiatives, educational institutions, (government agencies)	Policy makers, consumers, researchers	Farmers, grassroots initiatives, researchers, policy makers	Global policy makers	Alternative food initiatives, NGOs, food policy councils, local authorities
<i>Proposed Actions</i>	Building awareness, networking, promoting, educating, advocating, lobbying	Researching, investing, engaging, developing	Sharing, collaborating, creating, experimenting, researching	Shifting paradigms, acknowledging, including, prioritizing	Voting, communicating, creating, connecting, participating, advocating

resistance and agency, transition as theory of change seems not entirely sufficient, which is also reflected in a ‘thin record of sustainability transitions research focused on food systems’ (Hinrichs 2014, p 147), (Markard et al 2012).

We think the reviewed literature articulates a fundamental critique of the status quo. The critique includes social aspects, e.g. human health (*Sustainable diets*), and social movements (*Alternative food movements*, *Sustainable agriculture*, and *Food as commons*) (Hinrichs 2014, El Bilali 2018) engaging questions of power and justice in food systems, and rejecting the current system driven by neo-liberal market economy and growth paradigms. Additionally, most clusters have different modes to engage with politics: either political frameworks need to be created (*Sustainable agriculture* and *Healthy and diverse societies*), policy makers are addressed as change agents (*Alternative food systems* and *Healthy and diverse societies*), or the acquired information is intended to serve as evidence for political decisions (*Sustainable diets* and *Sustainable agriculture*). Change towards sustainability in food systems deals with moral and political questions, such as, ‘What is a good life?’ (Garnett 2014). Therefore, the literature calls on policy makers to allow emerging processes of social mobilization (Hospes and Brons 2016, Eakin et al 2017b) and to recognize cultural aspects of food and its meaning for people’s identity (Stajic 2013, Bauermeister 2015, Béné et al 2019, Dyen and Sirieix 2016). Moreover, food is inherently embodied (Sarmiento 2017), showing a strong biological connection to the consumer and the nature surrounding it (Hinrichs 2014). Therefore, actions towards sustainability seem to be motivated rather by moral and value-based reasons, even if accompanied by technological innovation as described in the *Sustainable agriculture* cluster. Consequently, change processes in food systems are conceptualized differently from sustainability transitions in other systems, e.g. the energy or mobility system (Garnett 2014, Hinrichs 2014, El Bilali 2018).

Despite the critique of current food systems and embedded economies, which are dominated by exploitative, growth-oriented and profit-maximizing practices, the analyzed literature is not connected to emergent sustainability innovations of food businesses around the world (Nabhan 2018, Antoni-Komar et al 2019, Weber et al in press). Consequently, none of the five clusters integrates insights from the fact that sustainability-oriented organizations (universities, clinics, etc), social enterprises, cooperative businesses, benefit corporations, local living economy advocates, and other economic actors are advancing change in food economies around the world beyond the conventional models of CSAs, farmers markets, and community gardens (Friedmann 2007, Lutz and Schachinger 2013, Lutz et al 2017, Antoni-Komar et al 2019). It would be beneficial to link this broader

spectrum of *food economies* with the perspective on sustainability transformations of *food systems*.

Our literature review displays several limitations. It only represents academic perspectives on food systems change and even more specifically only literature using the terms ‘transition’ or ‘transformation’ to conceptualize change. Including further literature and especially experiential knowledge from practitioners and the broader public might enrich the understanding of change processes towards sustainability. In addition, cluster analysis does not allow for detailed investigation of concepts, such as food systems or sustainability but has its strength in portraying the lowest common denominator of these concepts. In addition, analyzing a set of the most representative publications per clusters led to a representative summary of clusters (section 4.2). This implies that it is rather more likely that a publication of a determined cluster addresses the discussed issues, e.g. seeing only policy makers as change agents and less likely that there is a publication included in that clusters that addresses other aspects, e.g. farmers as change agents, too. However, that publication would have been listed at the end of the ‘hierarchy’ of represented publications identified by the statistical indicator Species Analysis (see section 2.2). Overall, our results are based on the assumption that scholars articulate similar concepts through similar terms. Although the approach has been applied successfully (Abson et al 2014), exceptions of this supposition are not considered. As we included publications of English language only, the study is strongly shaped by a Western research perspective.

6. Conclusions

This systematic literature review focuses on the emerging research field on deep change towards sustainable food systems and identifies five research perspectives, namely, *Alternative food movements*, *Sustainable diets*, *Sustainable agriculture*, *Healthy and diverse societies*, and *Food as commons*. For each approach, our analysis indicates actions and actors to advance sustainable food systems. We also identify four key crosscutting components for change relevant to all clusters: political action, close collaboration between stakeholders, education, and a deep value shift.

Our analysis reveals that the concepts of transformation vs transition are used differently and inconsistently when theorizing change in food systems. Further, the analyzed literature reflects a call for deep change in values, consumption and production practices, as well as politics allowing for deliberation and grassroots mobilization. This resonates with transformation literature but does not exclude transition approaches.

We identify departure points for researchers from developing countries to recognize traditional and indigenous knowledge, and overcome the Western bias. In addition, future studies ought to address emergent sustainability business innovations and its potential role in contributing to change of food systems, as well as the socio-cultural dimension for food systems transformation. Future research should also conduct empirical evaluative studies in all five clusters in order to create actionable knowledge and allow for evidence-informed interventions. Deep change of food systems towards sustainability is an ongoing learning process drawing on a broad spectrum of expertise and wisdom. Thus, studies and projects to advance interconnectedness of actions and strategies of food systems transformations can facilitate change processes. Work on different change approaches and conceptualizations to further consolidate and refine the field's engagement with change will be meaningful.

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Data availability statement

The data that support the findings of this study are openly available at <https://doi.org/10.5281/zenodo.3859418>.

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