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Synthesising the diversity of European agri-food networks: A meta-study of actors and power-laden interactions



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ABSTRACT

Farmers are at the centre of scientific and political debates about sustainability in European agriculture, but rarely do we discuss the roles of other actors who shape their behaviour. Understanding the interactions and balance of power in agri-food systems is critical to effectively govern sustainability transitions. Here, we conduct a meta-study of 71 case studies in European agri-food systems to synthesise evidence on the diversity of actors and network configurations. We characterise the reported power-laden relationships to generate an agri-food network for each case study and then create a typology of archetypical network configurations. Our study provides three major insights. First, we find a diverse range of actors and complex network configurations. This indicates that the predominant focus on farmers in sustainability policy overlooks the other actors in their agrifood networks – agro-industrial control, multifunctional value chains, and civic food networks – associated with diverging levels of farmer autonomy. Agricultural governance should therefore consider the context-specific agency of farmers; policies that target farmer decision-making can only have impact if farmers have the capacity to change. Third, the typology demonstrates the potentially complementary roles of conventional and alternative value chains, as well as top-down state support and bottom-up civil society mobilisation. Agri-food networks hence provide diverse leverage points for sustainability transformation.

1. Introduction

It is increasingly clear that industrialised agricultural systems will need to transform to support healthy and sustainable diets (Willett et al., 2019). Regardless of the paradigms that guide this transformation, it will necessarily require profound changes in farming practices (Frison and Clément, 2020). Policy and research accordingly often focus on farmers as key agents of change (Coderoni et al., 2021). However, farmers are not autonomous actors operating in a vacuum, but are embedded in wider agri-food systems (AFS), comprising networks of actors upstream and downstream in the value chain (VC), state actors at multiple scales, and a diverse range of third sector and civil society organisations (CSOs) (Debonne et al., 2021; Fischer and Newig, 2016). The interactions in these networks can enable or constrain farmers' capacity for action (Gaitán-Cremaschi et al., 2019), which limits the effectiveness of interventions that focus solely on farmers (Fresco and Poppe, 2016). Effective governance strategies therefore need to engage with the full diversity of agri-food actors and the power relations embedded in their interactions. Unfortunately, the characteristics of such agri-food networks are poorly understood, especially across larger spatial scales, which hinders our capacity to steer transformative changes towards sustainability.

There exists a rich body of empirical research on the relations between AFS actors. This research can be separated into three overarching categories. First, many systems have been found to have institutional and socio-technical structures that are resistant to change (Conti et al.,

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2021; Oliver et al., 2018). For instance, state subsidies and industry R&D can create lock-ins that reinforce norms and practices centred around input intensification (Turner et al., 2016; Vanloqueren and Baret, 2008). A second category of research problematises the increasing power consolidation in AFS (Folke et al., 2019; Howard, 2021). In particular, VC actors, such as retailers and distributors, are found to increasingly control market relations, shape discourses, and set rules to govern food commodities (Clapp and Fuchs, 2009; IPES-Food, 2017; Konefal et al., 2005). Farmers are frequently disempowered by these processes (Hendrickson, 2015). Yet, a third category of evidence demonstrates that AFS both can and have transformed against these trends (El Bilali, 2019; Melchior and Newig, 2021), for instance through novel actors facilitating alternative VCs and more balanced governance arrangements (Rossi et al., 2019).

However, this rich and diverse research is fragmented into conceptual silos that each emphasise different actors and visions of change (Weber et al., 2020). Additionally, within these silos, case studies typically relate to only one or a few locations. This makes it difficult to directly analyse or compare the dispersed evidence, due to the large diversity of farming systems, scales, research questions, and approaches applied in the original studies. The failure to connect this knowledge may lead policy-makers to make decisions that are not attuned to the diversity of network constellations, potentially hindering progress towards achieving sustainability targets. There is thus a need for synthesis to distil broader, recurrent patterns from local observations of actor relations.

In this article, we conduct a meta-study to characterise the diversity of documented agri-food networks in European AFS. Our approach combines qualitative and quantitative techniques drawn from social network analysis and theories of power in transitions. We focus on Europe because it is a highly industrialised and globally important context with a considerable diversity of landscapes, food cultures, production systems, and histories (IPES-Food, 2019; Jepsen et al., 2015; Levers et al., 2018). Synthesising knowledge from Europe thus may also provide insights relevant to industrialised systems in other global regions. Our meta-study addresses the questions: 1) What kinds of actors are identified in the literature on European AFS, and in which ways do they exercise power in their networks? 2) What is the diversity and complexity of network configurations? And 3) Are there distinct and recurrent network configurations?

2. Methods

2.1. Collecting case study literature

Our meta-study aimed to synthesise the diversity of documented network configurations in European AFS. As opposed to a formal metaanalysis, we did not aim to collect an exhaustive sample of evidence or to draw statistical inferences about the relationships between drivers and outcomes (Rudel, 2008). Instead, we collected a body of case studies from the academic literature that encompasses a range of countries, agricultural systems, spatial scales, and power dynamics (i.e., lock-in, concentration, and re-distribution). The sample was designed to permit an exploratory overview of European agri-food networks to a greater degree than is currently available. This approach is commonly used in interdisciplinary research fields to generalise archetypical patterns and identify knowledge gaps across case studies (Lambin et al., 2014; Magliocca et al., 2018, 2015; Oberlack et al., 2019; Rudel, 2008).

We selected studies that: (1) present primary empirical information; (2) relate to a specific European context (European Union plus United Kingdom, Switzerland, and Norway); (3) mention farmers and at least one other actor in the empirical narrative; and (4) are published since 2000 (but not excluding those that describe conditions before 2000). We included this final criterion to prioritise studies that provide descriptions relevant to current AFS. We excluded case studies on urban agriculture, as they typically do not involve farmers in a traditional sense. We used snowballing to build our sample (Wohlin, 2014) (see Supplementary Material A). Through this process, we identified a set of 140 potentially relevant articles. We then scored the articles, based on their abstracts, on the degree to which they focus on the relations between actors and thus are likely to provide relevant and rich information. We iteratively increased the sample size (i.e., progressively added studies that appeared decreasingly relevant to our aims) until we reached a level of saturation in the diversity and depth of information extracted from the case study narratives.

The final sample includes 57 articles, describing 71 cases across a diverse range of AFS (Table 1). Most studies in our sample were conducted in Western Europe, and all used qualitative methodologies such as interviews, focus group discussions, or document analysis. The sample is dominated by studies describing sustainability transitions, due to the high attention that such processes have received in the literature (Darnhofer, 2015). As these articles often describe transitions between radically different system states, our unit of analysis is a case-time period. Our final sample includes 82 case-time periods, each hereafter referred to as a case study for simplicity. These case studies contain a total of 149 unique kinds of actors, which we aggregated into 13 groups for the analysis (Table A4). We hereafter refer to these groups as actors.

2.2. Characterising agri-food networks

We adopt "agri-food networks" as units of analysis. Agri-food networks are based on the premise that farmers are embedded in socialmaterial networks, and the power-laden interactions within these networks are intertwined with agricultural management and sustainability (Gaitán-Cremaschi et al., 2019; Hambloch et al., 2023). The notion that social environments are instrumental in explaining behaviours aligns with theories in social sciences (Bourdieu and Nice, 1977; Giddens, 1984), applications using social network analysis (Borgatti et al., 2009; Mitchell, 1969), and evidence in AFS (Revoyron et al., 2022; Thompson et al., 2022). Through the focus on actors and their interactions, agrifood networks allow investigating the agency side of agri-food systems (in reference to Giddens' (1984) agency-structure duality). The

Table 1

Descriptive statistics of the case studies included in the final sample. Sample sizes are in parentheses.

Unit	Characteristic	Statistics
Article (N = 57)	Journal	Journal of Rural Studies (12); Sustainability (5); Agriculture and Human Values (4); Sociologia Ruralis (4); Agricultural Systems (3); Ecological Economics (3): Other (26)
	Publication date	2000–2004 (3); 2005–2009 (7); 2010–2014 (8); 2015–2019 (25); 2020–2022 (14)
Case (N = 71)	Country of focus a	United Kingdom (15); France (13); Netherlands (11); Belgium (7); Italy (5); Norway (4); Sweden (3); Finland (3); Poland (3); Switzerland (2); Denmark (1); Romania (1); Czechia (1); Spain (1); Portugal (1); Austria (1)
	Scale of narrative	Country (32); Region/territory (26); Local (12): EU (1)
	Farming system type ^b	Mixed (production-focus) (14); Mixed (consumption-focus) (13); Fieldcrops (9); Other grazing livestock (7); Horticulture (6); Granivores (6); Dairy (5); Other permanent crops (2); Wine (2); Unclear (7)
Case-time period (case study) (N = 82)	Focus	Transition (52); Industrialisation/ corporatisation (14); Lock-in (8); Other (8)

^a Some case studies span multiple countries.

^b Using the eight types of farming adopted in the European Commission's Farm Accountancy Data Network (FADN) surveys.

networks also allow examining structure to the extent that it is reflected in relationships between actors, and either enables or constrains actors' capacity to exercise their will (Hayward and Lukes, 2008).

Our approach for constructing an agri-food network from a case study description involved three steps (Fig. 1). These steps are based on established content analysis methodologies (Stemler, 2001; White and Marsh, 2006), employ a structured coding scheme that was established *a priori* based on several conceptual approaches to power (Avelino, 2017; Clapp and Fuchs, 2009), and utilise a complementary mix of quantitative and qualitative techniques (Crossley, 2010).

We first extracted quotes from the empirical narrative of each case study, excluding background information, the authors' discussion, and empirical information outside the context of the specific case study. Quotes needed to identify at least one actor and a process operating within or between actors. This approach assumes that the actors and relationships mentioned by the original authors are the most important in describing their empirical context. The actor mentioned in a quote can represent an individual, an organisation, or a collective of individuals and organisations (Avelino and Wittmayer, 2016). The resulting networks characterise relationships between aggregate entities such as farmers and media, rather than specific individuals (c.f. Brinkley (2017)).

In the second step, we characterised the described interactions using a multidimensional coding scheme. The coding scheme classifies the nature of the relationship and the different ways that power can manifest therein. Due to the highly heterogeneous dynamics that are described across the case studies, we do not adopt a single interpretation of power, but recognise different interpretations as overlapping and draw from a range of concepts developed in social and political theory (Avelino, 2021). The first dimension in our classification concerns the nature of the relation, which we assume can take three general forms: asymmetric, mutual, or cooperative (c.f. Kriesi et al. (2006)). Asymmetric relations correspond most closely to situations in which one actor has *power over* another (Partzsch, 2017), principally when there is an extant power imbalance and actors have opposing values or objectives, such as competition in economic market structures (Yamagishi et al., 1988). Asymmetric relations can also materialise through dependence (Emerson, 1962), whereby one actor is disempowered through their dependence on another. But a relationship need not be a zero-sum game: actors with similar goals can work together to create resources (Avelino, 2017), such as new knowledge or infrastructure. In these cases, we consider power to be cooperative, corresponding more closely with conceptions of power as enabling and possible to exercise as a collective (Arendt, 1970; Mann, 2012). Between these two extremes lies a third category, mutual dependence, which represents give-and-take situations wherein both actors have similar levels of influence. Here, both actors effectively have *power over* each other (Avelino, 2017), but neither can leverage their position to coerce or manipulate the other. This typology leads to notions of "active" and "passive" roles in a relationship (Grimble and Wellard, 1997), defined by whether an actor exercises resources (active) or has resources exercised on them (passive).

The other dimension in our classification describes the qualities of a relationship (Table 2). Drawing from Avelino, (2017), we identify several resources that can be mobilised by actors and flow through the networks. The resources are not necessarily exhaustive and represent, to some extent, the capital bases from which actors' actions draw (Scoones, 1998). We also distinguish three principal types of influence whereby an actor can: (a) directly affect the actions of another actor (instrumental influence), (b) affect another actor's values or beliefs (discursive influence), or (c) change the rules or network structure itself (structural influence) (Clapp and Fuchs, 2009; Lukes, 1974). These types of influence respectively relate to visible, invisible, and hidden forms of power (Gaventa, 2006). Actors can exercise these resources and types of influence to either maintain the status quo, create new resources, or disrupt dominant regimes (Avelino 2017), Supplementary Material A). Finally, we complement these qualitative characterisations with an open-ended code for the activity that the relationship describes.

For consistency, all papers were coded by the first author. To mitigate interpretation bias, a collective validation of the coding exercise was performed (see <u>Supplementary Material B</u>), and the research team held periodic discussions to collectively refine the definitions and approach. A level of subjectivity is however inevitable.

In the final step, we aggregated all individual relationships within the case study to create a representation of the agri-food network. The



Fig. 1. Summary of our approach for characterising an agri-food network from a case study. (A) Identify quotes that describe relationships between or within actor groups. (B) Characterise the balance of power and the qualitative features in each relationship (see also Table 2). (C) Aggregate all relationships within the case study. The arrow thickness represents the strength of each interaction, and colours represent each actor's net power.

Table 2

Definitions used to characterise qualitative components of relationships. Each relationship was assigned to a category within each feature (or multiple categories, if relevant).

Feature	Category	Definition and examples
Resource mobilised ^a	Ideology	Values, preferences, and normative evaluations (e.g., framing, discourse, prestige)
	Information	Knowledge (e.g., learning, research, advising)
	Monetary	Money (e.g., subsidies, trade, price-setting)
	Artifactual	Physical infrastructure, brands, products,
		technology, or organisational capacity (e.g.,
		fertiliser, processing facilities)
	Human	Human labour, collective action, or social
		capital (e.g., personnel, members, voters)
	Natural	Raw materials and natural factors of
		production (e.g., land, crop or livestock
		production)
	Legal-	Accepted rules that have legitimacy within a
	institutional	particular domain (e.g., regulations within a
		country, production conditions within a contract)
Type of	Instrumental	Directly determine the actions of another actor
influence		by affecting their likelihood of making a
		decision or their capacity to mobilise resources
	Structural	Affect the network structure or the option space
		of other actors
	Discursive	Create and spread cultural values, norms, and
		ideas
Activity	(Open-ended)	A verb that describes the action or process
		operating in the interaction (e.g., advise,
		permit, educate, fund, compete)

^a The original presentation included mental resources (Avelino, 2017), which we split into information and ideology to distinguish the level of subjectivity (Mann, 2012). We also added the legal-institutional category to represent the development or enforcement of rules (Crawford and Ostrom, 1995) (c.f. rational-legal authority (Weber, 2019)).

agri-food network contains information about the actors that are present and the ways in which they interact (comprising both quantitative and qualitative aspects). An actor's position in a social network has long been acknowledged in social network analysis as critical to describing their power (Brass, 1984). To summarise each actor's overall position in a network, we constructed an indicator that represents their net power, which was, here, calculated as the difference between the total strength of the relationships in which they play active and passive roles (i.e., the weighted difference between their out-degree and in-degree centrality (Pinheiro, 2011)). Actors play a net-passive role if they more frequently have resources exercised on them, a net-active role if they more frequently exercise resources on others, and a neutral role if the active and passive components balance.

Given the motivation for understanding agri-food networks to steer transitions towards sustainability, we also coded the conditions that triggered network re-configuration as well as the sustainability outcomes associated with each network configuration. The triggers represent processes or events that instigated change within the networks, such as new policy contexts or climate shocks. We classified the sustainability outcomes into four broad categories—environmental, social, economic, and food and nutrition (Béné et al., 2019)—as well as either desirable or undesirable, based on how the outcome was presented in the empirical narrative. As most articles did not explicitly analyse these triggers and outcomes, we interpret this coding only in an exploratory manner.

2.3. Network analysis and typology

We calculated three simple metrics to examine the complexity and diversity of the case study networks: the number of actors, the average number of actors that each actor is connected to (i.e., the "mean degree"), and the Gini coefficient. Here, the Gini coefficient represents the inequality in the distribution of power between the actors; it is zero if all actors exercise the same amount of resources and one if a single actor exercises all resources.

We conducted a clustering analysis to identify a typology of distinct and recurrent network configurations. We used the k-means clustering algorithm and a set of indicators that we inductively developed to encompass the most important dimensions of difference between the case studies, based on the in-depth reading of the articles (Table 3). Supplementary Material C further describes and justifies the k-means clustering. For each resulting cluster, we created a representative network configuration by aggregating all constituent case study networks and filtering to the strongest and most prevalent relationships. The representative networks are therefore ideal-typical configurations, rather than selected, exemplary case study networks. To facilitate the network visualisation, we restrict our focus to the (eight) actors that play dominant roles in *multiple* network configurations. To re-integrate the qualitative features that are abstracted by the quantification and visualisation, we also provide a narrative interpretation of each ideal-typical network by examining the recurrent processes (e.g., state actors subsidising farmers) and the qualitative nature of what these interactions represent.

3. Results

3.1. Actor presence and power

Across the case studies, each actor exercises a range of resources and types of influence (Fig. 2), and some actors are mentioned more frequently than others (Fig. 3). In this section, we focus on the actors that exercise the most power across all case studies.

By design of the research, farmers are central actors in the majority of case studies. They play net-passive roles more frequently than any other actor (in 28 case studies), but the articles collectively describe a large range of situations, with farmers playing net-active roles in 43 case studies. Farmers regularly mobilise all categories of resources except monetary and legal-institutional, and exercise a larger amount of discursive influence than the other studied actors. Their discursive influence frequently takes the form of knowledge-sharing between farmers as well as with consumers. Most narratives do not distinguish between different types of farmers and implicitly focus on family farmers (n = 523 unique interactions) as opposed to corporate farms (n = 6). Some case studies discuss small-scale cooperatives or sustainability labels that are managed exclusively by a small group of farmers (n = 80).

State actors are arguably the most powerful in our results; they are the second-most prevalent (Fig. 3A), almost always play a net-active role in the network (Fig. 3B), and across all case studies they exercise the largest proportion of the total power (Fig. 2). Their actions most frequently influence the network structure or rules and often leverage monetary resources through subsidies and funding mechanisms, as well as legal-institutional resources through legislation and regulations. The most frequently mentioned state actors are national-level institutions (e. g., agricultural ministries) (n = 200 interactions), followed by regional (n = 72) and local/municipal (n = 68) bodies, and then the EU (n = 42). Several studies also focus on the role of state actors playing important roles as food purchasers in AFS transitions (n = 40).

Consumers are the third-most studied actor and play diverging roles across the case studies. Many studies mention the dependence of other actors on consumers and the consequent capacity for consumers to influence others' practices (Milestad et al., 2010). However, consumers cannot always leverage this position and other actors frequently influence consumer knowledge and perceptions, giving consumers a more passive role in some case studies. Given their role in the food system, consumers most frequently exercise monetary and ideological resources, respectively through their purchasing power and their desire for food quality attributes. Most narratives discuss consumers as individuals (n = 172 interactions), but they occasionally organise into collectives, such as cooperatives or purchasing groups (n = 47).

Table 3

Ouantitative variables used to characterise	the networks for t	the clustering analy	vsis. Each case stud	lv was thus modelled	by four continuo	us variables
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Variable	Calculation details	Range	Interpretation
Farmer autonomy	The farmers' net power divided by the total amount of resources exercised in the case study.	[-1,1]	 -1: all power is exercised on farmers 0: farmers' active and passive components balance 1: farmers exercise all power
cVC-aVC balance	The fraction of the total power exercised by conventional VC (cVC) actors minus the fraction of power exercised by alternative VC (aVC) actors.	[-1,1]	 -1: aVC actors exercise all power 0: balanced aVC and cVC power, or these actors are both not mentioned 1: cVC actors exercise all power
state-society balance	The fraction of the total power exercised by state actors minus the fraction of power exercised by actors in civil society and the third sector ("society", comprising consumers, citizens, education, research, CSOs, labourers, and media).	[-1,1]	 -1: societal actors exercise all power 0: balanced societal and state power, or these actors are both not mentioned 1: state actors exercise all power
Scale of power	The fraction of the total power that is exercised by organisations.	[0,1]	0: individuals exercise all power 1: organisations exercise all power



Fig. 2. The resources and types of influence exercised by each actor, aggregated across all case studies. See Table 2 for definitions.

Conventional VC (cVC) actors are the fourth-most prevalent in the literature and primarily play net-active roles, albeit less consistently than state actors. Given their economic and logistical roles, cVC actors most frequently exercise artifactual and monetary resources and build significant power through innovation and capacity-building. However, cVC actors also often develop quality labels and standards, which are used as legal-institutional resources to exert structural influence within their supply chains. Retailers are the most frequently mentioned cVC actor (n = 155 mentions), followed by processors (n = 58), conventional farmer cooperatives (n = 40), and wholesalers (n = 39).

Despite being the seventh-most prevalent actor, alternative VC (aVC) actors exercise the fourth largest amount of power overall. aVCs are market-based actors with values or practices that work in opposition to the "conventional" industrialised paradigm, for instance through shorter supply chains or distinctive ecological or social characteristics (Renting et al., 2003). The prominent role of aVC actors in the results is due to the focus of many articles on documenting the emergence and development of aVCs, exemplified by their large proportion of structural influence (i. e., aVCs' role in creating new network configurations) and artifactual resources (e.g., creating novel food processing facilities). The most frequently mentioned actors within the aVC group are novel cooperatives (n = 72 mentions), marketing schemes (e.g., food hub, box

scheme, farmers' market) (n = 65), small-scale or artisanal VC actors (n = 62), and local VCs (n = 55).

3.2. Network characteristics

The case study networks are both complex and diverse (Fig. 4). The average case study narrative contains between 5 and 6 actors, each of whom is connected to approximately two other actors. The networks are therefore not fully connected, i.e., each actor generally interacts with only a subset of the others. In no instance does a single actor exercise all power, and the low to moderate levels of power inequality imply that the networks cannot generally be described by a single, dominant actor or exclusively one-sided influence. Yet the distributions also demonstrate the diversity of the case study networks, implying that the AFS exhibit qualitatively different structures.

3.3. A typology of agri-food network configurations

Choosing seven clusters led to an appropriate combination of interpretability and statistical performance (Supplementary Material C). The resulting clusters demonstrate that there are recurring network configurations associated with distinct levels of farmer autonomy (i.e., net



Fig. 3. Actor presence and balances of power across the case studies. For panel B, an actor's net power represents the difference between the amounts of resources they exercise and the resources exercised on them.



Fig. 4. Distribution of network characteristics across the case studies. (A) Number of unique actors. (B) Actor connectedness, measured as the average number of actors that each actor is connected to, i.e., the mean degree. (C) Inequality in the distribution of power among the actors.

power), market structures, state involvement, and scales of power (Fig. 5). Each cluster includes case studies from diverse farming systems and countries (Fig. C5), and we categorise them into three main groups along a gradient of farmer autonomy (Fig. 6). Supplemental analysis demonstrates that the three chosen *meta*-groups compare favourably to the k-means clustering results with k = 3 (Table C2), thereby providing

statistical support for the grouping. Exemplary quotes for each network configuration are shown in Table 4.

3.3.1. Agro-industrial control with power over farmers

The first group contains two network configurations in which farmers play net-passive roles. The *Farmer dependence* configuration (n



Fig. 5. Distribution of characteristics within each network configuration in the typology. Variables are described in Table 3.



Fig. 6. Typology of network configurations, organised into three groups along a gradient of farmer autonomy. The nodes represent the eight actors that play central roles in multiple network configurations, which we display along the sides of an octagon to facilitate visual comparison between the networks. The arrows depict the dominant relationships across all case studies in each cluster, and the text describes each configuration's defining features. Circles to the top-right of a node represent relationships within an actor group. Abbreviations: aVC = alternative value chain, cVC = conventional value chain, CSO = civil society organisation.

= 10 case studies), is characterised by powerful state actors, primarily at national- and EU-levels, that regulate environmental impacts and provide subsidies and advice to farmers (Kuokkanen et al., 2017; Vanloqueren and Baret, 2008). Input companies, cVC actors, and research organisations play similar, advisory roles (Belmin et al., 2018; Magrini

et al., 2018). In these narratives, farmers are described as being highly dependent on other actors and subject to strong instrumental and discursive influence (Bui, 2021; Vermunt et al., 2022). The case studies exhibiting this network configuration frequently comprise analyses of socio-technical lock-in into trajectories of agricultural modernisation

Table 4

Exemplary quotes for each network configuration. A larger set of exemplary quotes is shown in Supplementary Material D.

Network configuration	Exemplary quote
Farmer dependence	"For some time, farmers have received agricultural subsidies based on their output level. As these payments were a major part of farm revenue [] it pushed farmers towards the quest for the highest achievable yield, and influenced both breeding objectives and the evaluation criteria in extension services" (Vanloqueren and Baret, 2008, p. 442)
cVC control	"the [] wholesaler moves from mainly buying on the spot market or from a list of customary suppliers, to starting outgrower schemes where it contracts production that meets the specific grades and standards of the retail chain" (Dries et al., 2004, p. 547)
Innovative cVCs	"Two new cooperative models [] present a mixed membership of farmers, milk processors, and consumers. The presence of other actors, beyond farmers, in the new cooperative models, offers structural opportunities of dialogue across the value chain [] and complementarity in strength and resources between actors" (De Herde et al., 2020, p. 10)
State-supported aVCs	"This alliance [between a novel farmer cooperative and a municipality] is critical as it allows benefiting from the support of departmental authorities [] that have direct connection with EU agents and manage to get a special envelope from the European Union. These credits act as a driving force: the cooperatives receive funds that national and regional institutions would not have granted otherwise, and the high rates of funding incite them to develop a more ambitious program" (Bui 2021 p. 8)
Consumer-centric aVCs	"Meeting farmers during the feasibility study allowed these parents to develop a more complex understanding of agri- food sustainability issues, and they consequently chose to structure the food hub as a community association with a board equally composed of consumers and producers" (Rossi et al., 2019, p. 151)
Civil society mobilisation	"Civil society organisations (CSOs) committed on practical and political levels to sustainability and biodiversity have played another pivotal role in this process of re- empowerment. While supporting on-farm experimentation and fostering interactions, they have created occasions to bridge different worlds – scientists/practitioners, micro/ macro levels of action, production/consumption, production systems/movements. Overall, they have created the common framework (sharing meanings, approaches, goals and narratives) which underlies the activities of all stakeholders" (Rossi et al., 2019, p. 150)
Farmer-consumer relations	"The ability to talk to the actual producer at FMs [farmers' markets] was frequently mentioned by consumers as an important means of assessing the produce quality. In some cases this was to ask specifically about the production methods employed [], but more usually it was to develop a relationship of trust with the producers, which gave consumers greater confidence in the food they were buying" (Kirwan, 2004, p. 402)

(Fig. C5) (Meynard et al., 2018).

The second configuration in this group, *cVC control* (n = 11), is characterised by powerful cVC actors, and particularly retailers. The cVC actors innovate and interact with each other, as well as exert control over farmers. They develop private quality standards and sustainability labels (Dewick and Foster, 2018), and frequently engage with farmers through contracts that require specific farming and marketing practices (Dries et al., 2004). These contracts can be exploitative, though contracting with producer organisations can offer farmers more collective voice (Bonnaud and Anzalone, 2021; Richards et al., 2013). The case studies in this cluster frequently sit within a body of literature on corporate consolidation (Fig. C5).

3.3.2. Multifunctional value chains that support farmer autonomy

The second group contains three network configurations, each describing different VC arrangements in which farmers have a greater

degree of autonomy. These networks are all "multifunctional", as they embed values beyond economics into formal VCs, but they each achieve this through distinct mechanisms and actors. In the first configuration, *Innovative cVCs* (n = 16), conventional VC actors remain as farmers' primary market outlet, but actors unite around shared visions. Collaborative decision-making arrangements facilitate innovation in farming practices (Moschitz and Oehen, 2020), the co-creation of sustainability labels (Forney, 2021), and novel VC relations and pricing mechanisms (De Herde et al., 2020). The innovations can be co-developed with researchers (Klerkx et al., 2010), and cooperatives and CSOs also frequently play supportive roles in these networks (Elzen et al., 2011; Gertel and Sippel, 2014).

The second configuration, *State-supported aVCs* (n = 10), contains networks with novel VC actors. State funding and organisational support, most commonly at regional and local scales, frequently assists the emergence of aVC actors (Rossi et al., 2019). Within these networks, the priorities of state actors begin to reorient towards promoting local food networks and sustainable forms of production (Bui, 2021), occasionally resulting in changes to research funding and agendas (Hermans et al., 2013). One common mechanism involves institutional consumers (e.g., schools, universities, hospitals) as market outlets for local and sustainable produce that can also integrate educational objectives to improve citizens' knowledge and health outcomes (Sonnino, 2009; Stahlbrand, 2016). CSOs also occasionally feature in these networks, for instance by attempting to influence state and farmer priorities (Juntti and Potter, 2002).

In the third configuration, *Consumer-centric aVCs* (n = 12), consumers collectively organise to create novel food systems, for instance through purchasing groups (Poças Ribeiro et al., 2021), farmers' markets (Chiffoleau et al., 2016), food box schemes (von Oelreich and Milestad, 2017), farm shops (Syrovátková, 2016), and food hubs (Rossi et al., 2019). These networks frequently include farmers in the governance of the aVC, as well as receive financial support from state actors, e. g., through national or regional grants (von Oelreich and Milestad, 2017). In some cases, aVC actors rely on existing cVC capacities (Ilbery and Maye, 2005), leading to coexistence or hybrid arrangements. In other cases, however, competition with incumbent cVC actors can pose a barrier to the emergence or establishment of the aVCs (Ajates Gonzalez, 2017; De Herde et al., 2019; Milestad et al., 2010).

3.3.3. Civic food networks with net-active farmers

The third group comprises two configurations in which farmers are comparatively empowered. Here, VC and state actors play less prominent roles and most power is exercised by civil society and third sector actors (Fig. 5). In the first configuration, *Civil society mobilisation* (n = 12), CSOs play a central role in connecting actors (Bui et al., 2016; Rossi et al., 2019), providing education (Skrzypczyński et al., 2021), developing sustainable food labels (Immink et al., 2013), and lobbying state actors for policy change (Pitt and Jones, 2016; van Gameren et al., 2015; Zollet and Maharjan, 2021). This empowers farmers by providing space to innovate and share knowledge (Maye, 2018). Despite the prevailing bottom-up mobilisation in these networks, state actors frequently provide some degree of monetary and/or organisational support (de Olde et al., 2017; Pitt and Jones, 2016).

The second configuration, *Farmer-consumer relations* (n = 7), represents direct sale of farm products to consumers. As fewer organisational actors mediate such interactions, most power in these networks is exercised by individuals. This can take the form of knowledge-sharing between farmers (e.g., using social media) (Drottberger et al., 2021; Hvitsand, 2016), as well as consumers influencing farmer behaviour (Smeds, 2015) and farmers influencing consumer behaviour (Holloway et al., 2006). Although state actors occasionally provide forms of support (Drottberger et al., 2021; Lamine, 2011), the narratives in these case studies are almost exclusively about the provision of local (and often organic) food through direct farmer-consumer relations. Due to the highly localised scales, local cultures and histories can influence the

development of the initiatives (Goszczyński et al., 2019; Hvitsand, 2016).

4. Discussion

4.1. Engaging diverse actors in agri-food research and governance

Our results call into question the efficacy of agricultural policy and research that conceptualises farmers as autonomous decision-makers who respond to policy incentives. Even if the network configurations found in this study do not represent all European contexts, they show that many actors exercise power in European AFS and, through their interactions, collectively shape behaviours and norms surrounding farming systems. For instance, farmers' decisions about agricultural input application (e.g., fertilisers, pesticides) are highly influenced by advice from input companies in Agro-industrial control networks, whereas farmers in Civic food networks respond more directly to consumer preferences. A central message emerging from our results is that efforts to build agricultural sustainability should take a multi-actor perspective to consider the diversity of actors impacting land management. The typology suggests that such efforts should be particularly sensitive to the level of farmer autonomy in their target systems, as interventions that target farmer decision-making can only be effective if farmers have the resources and agency to change their practices.

Europe's Common Agricultural Policy (CAP), which heavily focuses on direct payments to farmers and agri-environmental schemes (Pe'er et al., 2020), may be ineffective at changing farming practices if not attentive to the power relations within the wider AFS that influence farmers' values, option space, and decisions (Benoit and Patsias, 2017; Fresco and Poppe, 2016). Research frequently focuses on disentangling the individual-level determinants of farmer decision-making to more effectively target policy (Bartkowski et al., 2022; Brown et al., 2021; Coderoni et al., 2021; Hoek et al., 2021), but may miss potentially impactful leverage points through other actors who influence farmers' decisions. Policy and research could therefore be more effective by moving beyond the farmer-policymaker nexus, i.e., considering actors other than the farmers and targeting interactions beyond those between the state and the farmer.

The argument for considering multiple actors is not new (Lemos and Agrawal, 2006; Newell et al., 2012), even in the context of European agricultural policy (Leventon et al., 2017; Moschitz et al., 2021; Soriano et al., 2023), but our synthesis helps to integrate fragmented knowledge and thereby improve its applicability. The 57 academic articles in our analysis demonstrate a considerable base of knowledge on the relationships between AFS actors, and our empirical typology brings new insights, complementing other efforts to characterise the diversity of AFS institutional contexts and governance modes (Gaitán-Cremaschi et al., 2019; Hoek et al., 2021; Marshall et al., 2021; Pahl-Wostl, 2015; Therond et al., 2017). Food systems approaches also already encourage considering multi-stakeholder mechanisms (Herens et al., 2022; UNEP, 2019) and are gaining traction in global policy and governance discussions (IPES-Food, 2019). Europe's new Farm to Fork Strategy takes a much more holistic approach than the CAP and, with effective governance, could help to engage multiple actors and bridge policy domains (Schebesta and Candel, 2020). The 2021 UN Food Systems Summit also marked a broadening of global discourse beyond farmer-centric narratives of agricultural productivity (Montenegro de Wit et al., 2021).

However, these approaches have been criticised for inadequately considering and even reinforcing prevailing power imbalances, such as by remaining silent on issues of corporate power (Clapp, 2021). Slater et al. (2022) find that while many actors are involved in producing reports on food system transformation, these reports rarely consider power asymmetries. Such efforts could therefore benefit from integrating insights on the political economy of AFS, which aims to critically examine the interplay of political, economic, and social forces and how power shapes pathways of development (Baker and Demaio, 2019; De Schutter,

2019). Our study contributes to this discourse in two ways. First, our typology illustrates the large diversity of agri-food networks across Europe, thereby strengthening the argument for context-sensitive governance that considers the multiple actors impacting agri-food sustainability. Second, our approach for characterising interactions helps to make the often fuzzy concept of power more tangible and therefore amenable to inclusion in public action. The approach integrates different manifestations of power, making it relevant across a wide array of contexts, ranging from interactions wherein one actor exercises power over another to situations in which actors exercise power with others through cooperation or leadership (Partzsch, 2017). The approach therefore could inform discussions about which network configurations foster lock-in versus facilitate transitions, and which actors correspondingly have the capacity to lead transformation. These contributions are globally relevant; our novel approach could be applied in different regions of the world and our typology could be used as a reference against which to evaluate distinct AFS.

Despite the documented diversity of actors in the case studies, some actor groups are mentioned less frequently than might be expected. For instance, although large-scale farming is common in European agriculture and relies heavily on external labour (Van der Ploeg, 2012), most case study narratives focused on family farmers employing their own labour, with only one study mentioning hired (migrant) labourers (Gertel and Sippel, 2014). Additionally, banks were mentioned in only four case studies (grouped in the "market (other)" category in Fig. 3), despite the important roles of credit and indebtedness in European agriculture (Gerber, 2014) as well as the rising financialisation in the agri-food sector (Clapp and Isakson, 2018). Other actors, such as input companies and farmer lobbies, are frequently discussed in the media and known to exercise large amounts of power, but are poorly studied in the literature. Finally, no case studies discussed actors associated with food waste or disposal, which are important components in the life cycle of food (Notarnicola et al., 2017). This reinforces the call for food system debates to better incorporate food waste issues (Conti et al., 2021). These biases together underscore that our results should be interpreted as a current state of our understanding of Europe's AFS, and suggest opportunities for future research to investigate these under-represented actors and integrate knowledge about other food system components.

4.2. Steering sustainability transitions in agri-food systems

Our results highlight the power structures behind different paradigms guiding AFS development, as well as shed light on the network configurations that allow farmers more autonomy. The networks each foreground distinct agents of change and therefore present complementary entry points for policy and public action. Farmer empowerment is a normative goal in much of the agri-food literature (Sodano and Gorgitano, 2022; Weber et al., 2020), including many of the studies in our sample. However, farmer autonomy is not the only relevant objective, so pursuing sustainability through network re-configuration inevitably requires navigating trade-offs between outcomes.

The first group of configurations (*Agro-industrial control*) corresponds most closely to an "ecological modernisation" approach to improving sustainability (Mol and Spaargaren, 2000). This approach aligns with many existing agri-environmental schemes that rely on state subsidies, as well as VC-driven initiatives to create sustainability standards for particular commodities (Folke et al., 2019; Sikor et al., 2013). Here, change aligns with the regime actors who maintain their dominance by reorienting their activities in response to societal pressures (Geels and Schot, 2007). We find that the most common trigger for transitions towards agro-industrial control was novel policy conditions (Fig. C6), such as countries entering the EU and the devolution of communism, which exposed agricultural systems to international markets and facilitated privatisation (Dries et al., 2004). These globalisation processes have shaped many European (and global) agricultural systems since the 1950s (Clapp and Fuchs, 2009; Jepsen et al., 2015), providing evidence for considering *Agro-industrial control* as the baseline against which other network configurations emerge.

Our study demonstrates the passive role that farmers play in *Agro-industrial control* networks (Fig. 5), for instance through their dependence on other actors' capital, infrastructure, and knowledge. Particularly in networks of *Farmer dependence*, our exploratory results show that these narratives overwhelmingly mention negative sustainability outcomes (Fig. 7), such as nutrient pollution and losses to farmer income, profitability, and autonomy. This corroborates other research asserting that it may be fundamentally difficult to reconcile corporate objectives with the goals of sustainable food systems (Béné, 2022; Zwart and Wertheim-Heck, 2021). Nevertheless, the case studies suggest that while corporatisation has led to declining autonomy and resource quality (Table C3), it can confer benefits to food access such as improved food safety and supply consistency (Dries et al., 2004). Navigating sustainability trade-offs is therefore necessary within such a development paradigm.

The five subsequent configurations within *Multifunctional value chains* and *Civic food networks* all demonstrate a re-configuration of actor relations from this dominant paradigm, primarily leveraging organisational and social innovations (as opposed to technical, agricultural innovations). This institutional restructuring represents a deeper, and potentially more transformative, leverage point (Abson et al., 2017).

Additional analysis reveals that these innovations were most frequently triggered by actors' dissatisfaction with their positions in the network, such as perceived lack of autonomy or economic marginalisation (Fig. C6), as well as health and economic shocks. Such network reconfigurations have emerged in a diverse range of regions and production systems (across Northern, Southern, Eastern, and Western Europe, and in livestock, arable, and mixed farming systems; Fig. C5), demonstrating both the cross-cutting challenges confronting farmers in Europe and the potential generalisability of our typology to contexts beyond these particular case studies.

In the *innovative cVCs* configuration, the main changes occur through establishing more collaborative relationships between farmers and existing VC actors, with concomitant increases in farmer autonomy. The articles within our sample demonstrate that these social innovations, such as food labelling schemes and collaborative governance, can facilitate access to local and/or organic food (Bui et al., 2016; von Oelreich and Milestad, 2017), improve farmers' feelings of belongingness (Forney, 2021), and preserve cultural landscapes (Moschitz and Oehen, 2020). These outcomes indicate the potential of organisational innovations within cVCs as a pathway towards more sustainable AFS. However, we also observed trade-offs with economic outcomes such as farmer income (Fig. 7), so re-configuration may require external support or incentives (Farstad et al., 2021). There are also risks that innovations



Fig. 7. Exploratory associations between the network typology and sustainability outcomes. The data were constructed by compiling instances where the case study narratives mentioned positive or negative outcomes associated with the described network configurations. The labels represent themes that were mentioned multiple times for a given network configuration (i.e., themes with a single mention are not displayed); the complete results for all themes are shown in Table C3.

are "conventionalised" due to vested interests of cVC actors, causing a dilution of their original principles (De Wit and Verhoog, 2007). How to foster sustainable private governance is an ongoing debate and must go hand-in-hand with appropriate public policies to shape the playing field for corporations (Österblom et al., 2022).

The final four configurations include new actors-aVCs, CSOs, and consumer-citizens-as agents of change who create different kinds of alternative agri-food networks. Our results show that these configurations are generally more beneficial to farmer autonomy and also correspond with a reduction in the power of the cVC and input companies. Discursive influence plays an important role in these networks (Fig. C3) through processes such as education, peer-influence, and close personal relationships, underscoring the role of values as a leverage point for agri-food transitions. The values guiding aVCs and civic food networks stand in opposition to the agro-industrial norm and often emerge due to actors' dissatisfaction with the current status (Fig. C6), but are quite diverse and are not always radical or counter-cultural (Clarke et al., 2008). Alternative agri-food networks are often described to improve access to quality food (Fig. 7), with actors gaining deeper socio-cultural connections to their food systems (Hvitsand, 2016; Rossi et al., 2019). These networks therefore embody notions of embeddedness and focus on the delivery of multiple cultural and ecosystem services (hence the term "multifunctional"), which others argue is crucial to making progress on sustainability (Chaplin-Kramer et al., 2023). Arrangements such as community-supported agriculture construct a more radical alternative to the market through solidarity between producers and consumers (Urgenci, 2016), moving towards a decommodification and democratisation of food (Renting et al., 2012).

However, network re-configuration means disrupting incumbent structures (Rutting et al., 2022) and can create winners and losers, both between and within actor groups. For instance, case studies frequently documented conflicts between producers' and other actors' expectations and values (de Olde et al., 2017; Ponte, 2021; Smeds, 2015). Farmers in reality are also not a monolithic actor group and often have vested interests in current agro-industrial paradigms (van der Ploeg, 2020). Thus, while our results suggest that network re-configuration can be facilitated by value alignment and collaborative learning (cf. Weber et al. (2020) and Béné (2022)), managing conflicting relationships is an important governance challenge (Andrée et al., 2020; Díaz-Méndez and Lozano-Cabedo, 2020). In alternative agri-food networks, this often materialises as a tension between idealism and pragmatism (Poças Ribeiro et al., 2021).

Despite the bottom-up nature of innovations in the *Multifunctional value chains* and *Civic food networks* groups, state actors play important roles in all network configurations. Many cases of transition involved state actors reorienting their priorities and providing financial and organisational space for other actors to innovate (Bui, 2021; Bui et al., 2019). State actors also facilitated the development of alternative VCs through public procurement (Pitt and Jones, 2016; Sonnino, 2009). Network transitions were often instigated by a single, well-connected "champion" taking interest in and responsibility for the innovation (Klerkx et al., 2010; Stahlbrand, 2016). The consistent importance of state actors in our results illustrates a need for top-down policy to create an enabling environment that empowers actors to innovate (Fischer and Newig, 2016; IPES-Food, 2019; Jackson et al., 2020), while monitoring progress towards larger-scale sustainability and development goals (e.g., as laid out in the European Green Deal).

4.3. Methodological considerations

Our study provides an overview of the diversity of agri-food networks in Europe. However, we cannot claim to provide a complete description of European AFS, as the case studies do not represent all European contexts. As the networks were built from the articles' narratives, they reflect the actors and relationships perceived as most important by the original authors and are possibly biased by the research objectives of the original studies. For instance, farmers play net-active roles in most networks in our typology, reflecting the large number of studies documenting agri-food transitions. The network types are therefore not equally prevalent and it is likely that additional configurations exist in reality. We attempted to mitigate our own biases by forming a research team comprising diverse academic identities, regularly re-evaluating our coding protocol during its development, and by seeking to maintain a neutral stance when interpreting the results.

We made several analytical simplifications to facilitate comparison across the diverse case studies. Most significantly, our grouping of actors obscures the heterogeneity within each category. To further improve policy design and targeting, our analysis and typology could be integrated with other typologies that characterise farmer heterogeneity (Bartkowski et al., 2022) and distinguish between the roles of the EU, national, and local governments. Our calculations of net power as an indicator of autonomy also abstract the heterogeneity in an individual actor's relations (Ribot and Peluso, 2009) and in specific contexts should be tied to concrete aspects of decision-making (e.g., farming and/or marketing practices), i.e., autonomy *over what*.

Our novel, semi-quantitative approach for characterising powerladen relationships helps to operationalise concepts frequently discussed only in qualitative social science research. Power is an inherently political and highly contested topic (Lukes, 1974), and while our characterisation encompasses many conceptions of power (Avelino, 2021), alternative categorisations inevitably exist. For instance, we do not consider features such as the political spaces and levels in which change takes place (Gaventa, 2006), and the resource typology misses structural forces such as the power of traditions (Weber, 2019). To facilitate the synthesis, we sacrifice nuance for cross-compatibility. Similar approaches have previously proven useful in comparing empirical case studies (Poças Ribeiro et al., 2021; Turner et al., 2020) and our approach presents opportunities for further synthesis research in social and socialecological systems.

5. Conclusions

Given the diverse actors and ubiquity of power-laden relationships in AFS, re-configuring agri-food networks will be a key component of any agricultural sustainability transition. Network structures should therefore feature prominently in both policy design and academia. By synthesising the evidence on European agri-food networks, our study contributes to both of these domains.

For stakeholders effecting or affected by decisions in specific AFS, our results provide support to arguments for involving diverse actors in context-sensitive agri-food governance. This would signify a move away from top-down policy and one-size-fits-all approaches. Instead, our results reveal that many actors have the power to re-configure network structures, but that their resources and ability to do so vary. Different actors, network configurations, and governance modes may therefore play complementary roles in sustainability transitions. State actors have an important role to play in creating enabling environments that foster social and organisational innovations, whereas other actors (e.g., farmers, CSOs, and citizens) can build collective power by sharing knowledge, aligning visions, and enrolling other actors. Although our typology cannot be used to predict sustainability outcomes of agri-food networks, our results demonstrate the potential benefits of reducing Agro-industrial control while navigating trade-offs in sustainability transitions.

For scientists, our approach for characterising power-laden relationships in networks of actors can facilitate knowledge-sharing between disparate disciplines. We found that some kinds of actors (e.g., banks and investors, migrant labourers) were under-studied in the analysed research, and therefore could feature more prominently in future case studies. Some questions remain about the conditions under which the network configurations emerge, how they impact farmers' decisions, and how they influence sustainability outcomes. More research is therefore necessary to embed agri-food networks in middlerange theories and frameworks of sustainable governance. Further, even within the frontrunner regions included in our study, the case studies provide limited evidence of truly transformational change that transcends system scales. Advancing understanding of sustainability transitions will therefore require integrating empirical knowledge with prospective visioning and modelling, as well as leveraging collaboration between social and natural scientists.

CRediT authorship contribution statement

Tim G. Williams: Conceptualization, Methodology, Validation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. Sibylle Bui: Conceptualization, Methodology, Writing – review & editing. Costanza Conti: Conceptualization, Methodology, Writing – review & editing. Niels Debonne: Conceptualization, Methodology, Writing – review & editing, Validation. Christian Levers: Conceptualization, Methodology, Writing – review & editing. Rebecca Swart: Conceptualization, Methodology, Writing – review & editing, Validation, Visualization. Peter H. Verburg: Conceptualization, Methodology, Writing – review & editing, Funding acquisition.

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

Data will be made available on request.

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Appendix A. Supplementary data

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