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Research

Small-scale fisheries and agricultural trade networks are socially embedded: emerging hypotheses about responses to environmental changes

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ABSTRACT. Global change is threatening the production and livelihoods of millions of smallholders. The capacity of smallholders to deal with such changes is influenced by the increasingly complex trade networks that connect them to local and global markets. Moreover, the social relationships (e.g., trust, reciprocity) in which these trade networks are embedded likely influence smallholders' capacity to respond to change. However, the prevalence and influence of such "social embeddedness" of trading across different fisheries and agricultural small-scale food systems is still largely unknown. Here, we characterize the social embeddedness of trade networks in small-scale food systems across different production and institutional contexts. We then explore how actors in small-scale food systems could respond to environmental changes in relation to their existing trade networks. We used a methodology based on the qualitative comparison of three different case studies of small-scale fisheries and agriculture in Mexico and South Africa. We analyzed and compared expert interviews among case studies and against the backdrop of embeddedness theory and a previous empirical study. We found key similarities in the level of social embeddedness of trade networks across cases. For example, business relationships characterized by stability and trust prevailed, whereby smallholders are often interdependent through networks of connected traders. There were also differences across cases, such as the higher formalization of business relationships in the agricultural cases, and the influence of institutional and country-specific factors on trade structures. Actors mostly responded to environmental change based on their existing trade networks, although these networks were also subject to change. The findings allowed us to propose more detailed hypotheses outlining how social embeddedness in trade networks play different roles in responding to environmental changes. These hypotheses aim to inspire future research toward the improved understanding of trade networks' influence on small-scale food systems' resilience.

Key Words: *agriculture; embeddedness; fisheries; food security; networks; resilience*

INTRODUCTION

Small-scale fisheries and agricultural systems are essential for food security and the livelihoods of millions of people globally (Meyfroidt 2017, Short et al. 2021). The importance of formal and informal institutional arrangements connecting producers to consumers has been widely recognized across fisheries and agricultural systems (Johnson 2010, Hall et al. 2017, Liverpool-Tasie et al. 2020). In small-scale food systems (SSFS), these arrangements often go beyond trading food products in that they comprise multiple types of exchange such as the provision of services, production inputs, and loans (Basurto et al. 2020, Liverpool-Tasie et al. 2020). In addition, multiple studies suggest that trading in food systems can be embedded in multiple types of social relationships such as trust and reciprocity (e.g., Hinrichs 2000, Penker 2006, Dulsrud and Grønhaug 2007, Turgo 2016). Thus, previous findings suggest that socially embedded trade networks reach across spatial scales and connect smallholders to diverse commercial actors and markets. However, little is known about what characteristics of socially embedded trade networks are a common feature across SSFS (if they are), and how they affect the way actors in the value chain deal with environmental change.

Knowledge about embeddedness of trading in social relationships is particularly important because it could play an important role for actors' capacity to deal with changes (see, e.g., Cinner et al. 2018). In an era of global change, food producers face the challenge of adapting and responding to environmental changes that arise across land and sea (Godfray et al. 2010, Milestad et al. 2012, Van Putten et al. 2018, Tigchelaar et al. 2021). There is a need to understand how the embeddedness of smallholders' trade networks influence how they adapt their practices and relationships to changing conditions. In fact, social relationships and networks have been shown to play an important role in influencing actors' responses to changes because they constrain or enable different adaptation strategies (Pelling and High 2005, Darnhofer et al. 2016, Barnes et al. 2017, Cinner et al. 2018). Research suggests that the embedding of trade networks in social relationships affects access to resources, social support, knowledge exchange, learning, and innovation (Uzzi 1997, 1999, Charterina et al. 2016, Garner 2017). Through these and other processes, it can increase actors' capacities to deal with changes and problems. However, there is a gap in understanding how the embeddedness of trading in SSFS influences value chain actors' responses to environmental changes and their capacities to deal with environmental change.

We view SSFS as social-ecological systems and use a social-ecological resilience perspective to understand the role of relationships and networks in the context of environmental changes (Bodin et al. 2019, West et al. 2020). Thus, we use the social-ecological resilience concepts of coping (i.e., persisting), adapting, and transforming to examine responses to environmental changes (Folke 2016, Reyers et al. 2022). We specifically apply these concepts to responses to changes in the context of SSFS trade as follows. "Coping" responses imply continuing with the same type of production practices and trade networks. "Adaptive" responses imply changing some production activities or trade relationships while generally maintaining the existing trade network structures and production systems.

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Table 1. Relational concepts used to characterize relational embeddedness.

Relationship	Definition
Embedded trade relationship	A trade relationship that consists of multiple components or types of trade and social relationships[1]. "Embedded" implies that economic actions take place within social relationships and structures[2]; includes both relational and structural embeddedness.
Trade relationship	General term used to describe the aspects of an embedded trade relationship that are solely or mostly based on the actual exchange of goods and services between any two actors. These exchanges could be exclusively related to the produced food, but they could also comprise other goods and services such as loans and production inputs.
Market relationship	Spot market relationship or arms-length relationship based on short-term economic interactions (low durability, high volatility) that imply the opposite from an embedded trade relationship, given the social relational part is missing[3].
Formalized business relationship	A business relationship based on contracts between two entities, which emphasizes the existence of written contract arrangements. Associated with a business relationship (see below), but it can diminish the role of social relationships because agreements are formalized (e.g., breaches can be brought to courts) and thus less based on social commitments of various sorts[4]. However, it can coexist with different social relationships[4,5,6].
Social relationship	General term used to describe the (mostly) social nature of relationally embedded trade relationships. Different components or types of social relationships (e.g., business, personal) lead to different types of embeddedness[1].
Business relationship	An embedded trade relationship in which the social aspect is strongly pronounced based on the history of economic exchange relations between two entities, which includes aspects related to the quality (e.g., loyalty), extent (e.g., reciprocity), effort (e.g., problem-solving), and ease (e.g., convenience) of the interaction[1]. It can also include obligations or commitments related to the economic exchange that have been associated with dyadic components of social capital[1].
Personal relationship	A social relationship based on personal knowledge, affect, or sociality[1], which can include friendship and kinship. It is therefore not contingent upon any exchange of goods and services, but can be embedded with such types of relationships.

[†]Hite (2003), [†]Granovetter (1985), [†]Uzzi (1997), [†]Ryu et al. (2013), [†]Uzzi (1999), [†]Fafchamps and Minten (1999).

"Transformative" responses imply a significant change in trade network structures or production systems. In this way, some transformative responses imply changes in trading networks within the same type of production activities. These changes in trade would imply a change in the associated social relationships. Transformative responses can also imply changes in both trade networks and production activities (and the associated social-ecological relationships), thus contributing to system-level transformative responses that change the structures and functions of these SSFS. Here, we use "transforming" or "transformative response" to describe a change in social and/or social-ecological relationships and structures, which does not imply a desirable change toward system-level transformation to sustainability (compare Reyers et al. 2018).

Here, we aim to develop hypotheses to advance a future research agenda investigating the role of embedded trade networks for dealing with environmental changes in SSFS through the comparison of different case studies in agriculture and fisheries. In doing so, we answer two overarching research questions: (1) What characterizes the social embeddedness of SSFS' trade networks across different food production systems and institutional contexts? (2) How do SSFS' actors at different scales respond to environmental changes, and how do these responses affect (or are affected by) their embedded trade networks?

To address these questions, we propose a methodology based on the qualitative comparison (see, e.g., Caggiano and Weber 2023) of different case studies of small-scale agriculture and fisheries in Mexico and South Africa. This comparison follows an abductive approach (see *Methods: Methodological approach*) that allows both an analysis of whether characteristics of embeddedness hold across case studies and systems, and the development of hypotheses regarding how such characteristics may affect smallholders' capacity to deal with change (Timmermans and Tavory 2012, Zittoun 2017). Following the abductive approach, we build on the concept of embeddedness from economic sociology (Granovetter and Swedberg 2011) and a previous case study of small-scale fisheries in Mexico (González-Mon et al. 2019, 2021) to characterize the embeddedness of trade networks in SSFS (following the types of relationships explained in Table 1). This previous case study led to the formulation of two working hypotheses: (1) Trade networks in SSFS are socially embedded, and (2) this embeddedness is important for the responses of SSFS' actors to environmental change. We next summarize these working hypotheses based on previous theory and research. These working hypotheses are then used to design and investigate three case studies of SSFS: coffee systems in Veracruz, Mexico; deciduous fruit systems in Western Cape, South Africa (SA); and multispecies fisheries in Western Cape, SA (see Table 2). These cases represent different production systems and countries, allowing us to explore the working hypotheses through the abductive comparative process and to tease out which insights potentially hold across different contexts vs. those that are more specific to a given setting. Finally, we explore responses to changes in these case studies and how they relate to the embedded trade networks, and discuss the findings by proposing four refined hypotheses for future research.

THE SOCIAL EMBEDDEDNESS PERSPECTIVE: WORKING HYPOTHESES

Theoretical framework

The theory of social embeddedness has its origins in economic sociology (Granovetter and Swedberg 2011). The theory implies that understanding social networks is essential for understanding and analyzing economic exchange in situations outside the ideal market because the economy is embedded in social relationships (Granovetter 1985). This assumption allows an analysis that goes beyond actors as individuals that follow "generalized moralities" or as atomized rational economic actors (Granovetter 1985), to study a diversity of actors based on their diverse relationships

Table 2. Key characteristics of the case studies. Local end market refers to markets within a community, a city, or the region of study.

Characteristic	Case study		
	Coffee in Veracruz, Mexico (Coffee-MX)	Deciduous fruit in Western Cape, South Africa (Fruit-SA)	Fisheries in Western Cape, South Africa (Fish-SA)
Social-ecological context of small-scale production	Coffee plantations in shade forests, where coffee trees coexist with other trees and shrubs. Coffee quality depends on the altitude of the plantation. Producers are mostly smallholders with parcels < 1 ha on average. Medium producers have < 5 ha.† Producers can occasionally be organized in cooperatives.	Deciduous fruits, including apples, pears, and stone fruits. Producers include emerging farmers (i.e., Black small-scale farmers) who operate parcels of 10 ha on average in a system strongly influenced by land tenure arrangements resulting from land redistribution policies that aim to integrate them into high-value markets. These actors represent the minority of farmers.	Multispecies finfish fishery in which some of the most important species are migratory. Fished usually with lines in small motorboats. Boat characteristics and permit arrangements depend on the type of fisher (broadly two types): interim relief fishing permits or commercial permits. Fishers hold diverse roles such as boat owners, rights holders, skippers, and crew; one actor can have multiple roles.
End markets	International (main), national, and local	International (main), national, and local	International, national, and local
Key trade characteristics	Fresh coffee berries are processed into "green/gold coffee" that enables storage, which, after roasting, becomes coffee to be consumed. Production is based on two species (*Coffea robusta* or *C. arabica*). Coffee is an export crop, but national value chains and specialty coffee have increased in importance.	Fruit production can be graded into first, second, or third class (highest to lowest value, respectively), depending on the market to which they are sold. Third-class fruit is processed in the food industry (e.g., to make juice). Most trade relationships in this case work on consignment (through a commission, instead of buying and selling relationships).	The availability of different species varies strongly among communities along the coast and by season. Snoek and other lower value finfish are the most common species for local and regional consumption. Yellowtail reaches international markets. Traders may specialize in local or international value chains.
Changes and shocks mentioned in interviews	Fungal pest (*la roya*), drops in prices, climate change, COVID-19	Drought, COVID-19	Seasonality, interannual changes in species availability, stock declines, COVID-19
Interviews	5 experts (4 researchers, 1 nongovernmental organization)	6 experts (4 researchers, 2 consultants)	6 experts (4 researchers, 2 consultants)

†For an extensive classification of coffee producers in Mexico, see Hernández-Martínez et al. (2009).

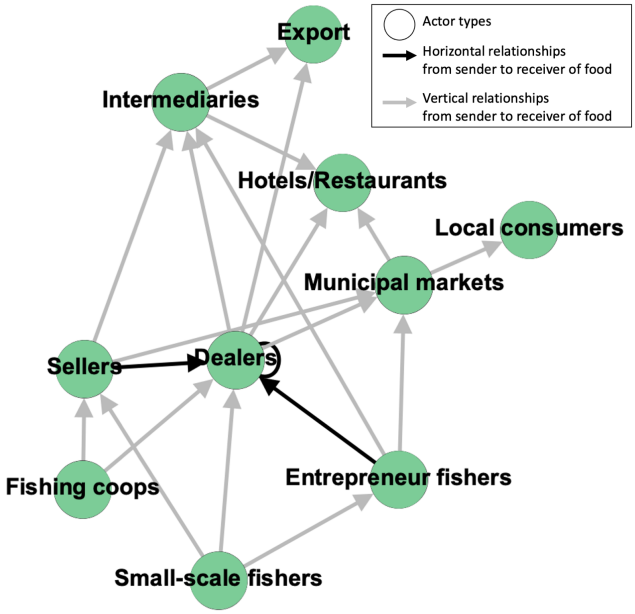
with each other. In this context, the embeddedness concept can help to account for the interdependencies between economic exchange relationships (e.g., trade of food) and other social processes that can be interlinked with the exchange such as trust and reciprocity (compare Uzzi 1997, Hite 2005). However, a common criticism of embeddedness theory is that it can appear highly abstract and lack specificity on what exactly social embeddedness comprises (Penker 2006, Turgo 2016). Several studies have highlighted the importance of investigating different dimensions or types of embeddedness, as well as the dynamics of embedded relationships, to provide a more nuanced understanding of embeddedness to refine, build, and extend the theory of embeddedness (e.g., Hite 2003, 2005, Charterina et al. 2016).

We differentiate between two types of social embeddedness: relational and structural embeddedness (Hite 2003, van Burg et al. 2022). Relational embeddedness relates to the nature of the relations between two actors, firms, or organizations. Within relational embeddedness, previous studies have identified different types of embedded relationships (Table 1). For example, embeddedness can be characterized as a continuum between strongly embedded and weaker (i.e., market-based) relationships that do not necessarily persist over time (Uzzi 1996). Other studies characterize different dimensions of embedded relationships, which can be defined by different types of social relationships (Table 1).

Structural embeddedness moves beyond the relationships between two actors to account for the structural characteristics of networks. This extension assumes that the behavior of actors is shaped by their pattern of relationships with others defined by the network structure (Granovetter 1985, Uzzi 1996). Structural embeddedness focuses on the influence of the pattern of both direct and indirect relationships in a trade network (Podolny 2001, Choi and Kim 2008). Such structural embeddedness has two implications. First, the trading relationships between different actors are interdependent (as in Hite 2003). For example, a fisher can be affected by selling to two traders who in turn are trading with each other (Fig. 1), thereby forming a closed triangular structure (González-Mon et al. 2019). Second, actors are affected by indirect relationships (Choi and Kim 2008, van Burg et al. 2022) through which fishers or traders can be influenced by actors not directly trading with them. Here, we apply this concept by focusing on the structural embeddedness of smallholders and its potential implications beyond the conceptualizations of trade relationships as interactions between two actors (e.g., between the smallholder and the trader). To operationalize structural

embeddedness, we define trade relationships between actors that buy from smallholders as **horizontal trade relationships** (Fig. 1), as opposed to vertical relationships along the value chain that describe flows from production to primary processing and trading, and then to consumption (Bolwig et al. 2010, González-Mon et al. 2021). In this context, structural embeddedness implies that smallholders are affected not only by their direct relationships with a given trader but also by that trader's relationships with others.

Fig. 1. Trade network of the finfish fishery in Baja California Sur, Mexico. Arrows indicate frequent trade relationships from a seller to a buyer. Sellers and dealers are two types of traders or fish buyers, as described by González-Mon et al. (2019, 2021). A loop back to the same actor (here, Dealers) indicates relationships among that type of actor. Modified from González-Mon et al. (2019).



Embeddedness of trading in small-scale food systems: two working hypotheses from a small-scale fishery in Mexico

Based on our previous empirical and modeling work on the multispecies, small-scale finfish fishery in Baja California Sur, Mexico (hereafter Fish-MX case), we developed two working hypotheses regarding social embeddedness in SSFS (González-Mon et al. 2019, 2021; see also Appendix 2 for an extensive description based on data collected by González-Mon et al. 2021). Hypothesis 1 suggests that trading in SSFS is socially embedded. That is, trading goes beyond purely market relationships and economic motivations by building on reciprocal commitments that are reinforced through norms. These relationships were described by interviewees as "moral commitments", which ensures a certain stability in trade relationships. Such embedded trade relationships generally consist of business relationships that sometimes coexist with personal relationships such as being family or friends (see definitions in Table 1). However, indications of more personal relationships between traders are highly variable among traders (Appendix 2). Fishers in the Fish-MX case are also structurally embedded in networks of what we refer as "horizontal relationships" between traders (Fig. 1). Hypothesis 2 suggests that this embeddedness is important for the ability of fishery actors to deal with change. Our work in the Fish-MX case suggests that the existence of horizontal and stable relationships can influence the capacity of traders to deal with changes such as fish catch fluctuations (González-Mon et al. 2019, 2021).

These working hypotheses were developed through a fieldwork experience, which presented us with initial observations about trading that we made sense of and further investigated through the concept of social embeddedness and additional fieldwork and modeling. Here, we further explore these working hypotheses in different food production systems and institutional contexts to enhance the understanding of social embeddedness in SSFS and its relevance for responding to change, and ultimately, to assess its generality across different contexts.

METHODS

Methodological approach

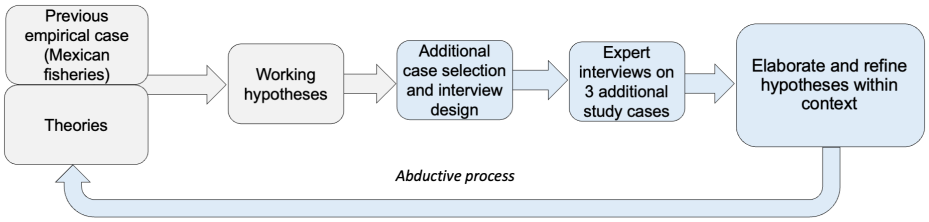
This research is based on an abductive approach, which is a form of reasoning that iteratively uses theories, previous experiences, and empirical cases to generate hypotheses about an observed phenomenon (Timmermans and Tavory 2012, Zittoun 2017). We used a methodology based on a process of abduction from different case studies (Fig. 2). In particular, we first developed working hypotheses based on our analysis of the Fish-MX case that were then questioned and revisited in three additional cases of SSFS. We selected these three additional cases because they represent cases of SSFS connected to diverse markets across diverse production and institutional contexts. The data from these case studies were collected and analyzed simultaneously and against our initial working hypotheses (Zittoun 2017). Explorations in individual cases and comparison across all cases allowed us to refine and further specify the hypotheses and also to investigate which aspects are generic across cases and which not.

Case studies

We selected three case studies representing different types of small-scale food production (Table 2): coffee systems in Veracruz, Mexico (hereafter Coffee-MX); deciduous fruit in Western Cape, South Africa (hereafter Fruit-SA); and finfish fisheries in Western Cape, South Africa (hereafter Fish-SA). The selection of cases aimed to include cases of SSFS in which trade is linked to both national and international markets, representing both fisheries and agriculture in different countries. The main common characteristic across cases is their "small-scale" nature, as defined in the different contexts, as well as their connection to markets (i.e., they are commercially oriented and not only based on subsistence). We chose cases from two different countries and continents to represent diverse contexts. This approach aimed to bring together new elements that could challenge the ideas generated in the Fish-MX case (Zittoun 2017, Candea 2018).

All cases selected are well-researched SSFS with publications available regarding their value chains, which facilitated the selection of interviewees and validation of some of the information obtained. The Coffee-MX case was selected to represent a case of a small-scale agricultural system in Mexico. This case allowed us to explore a different type of production system in Mexico (vs. the

Fig. 2. Methodological approach based on the process of abductive reasoning from several case studies. Blue boxes refer to the three small-scale food systems' case studies: Coffee-MX, Fruit-SA, and Fish-SA. Grey boxes refer to previous research and theory, which informed analysis of the case studies.



Fish-MX case) while being aware of potential country-specific factors that could affect the embeddedness of trade networks. The Fruit-SA case represents an agricultural system from a different country and continent, which allowed us to investigate a significantly different context. The lead author was able to triangulate the findings emerging from this study through direct engagement and collaboration within an ongoing research project concerning the deciduous fruit supply chains, which motivated the selection of this case. Finally, the Fish-SA case was selected to ensure the representation of both production systems in each country. This inclusion enabled a better understanding of country-specific factors that could potentially emerge in the South African context (i.e., not necessarily associated with the type of production system). See Appendix 2 for detailed narratives and findings of each case study.

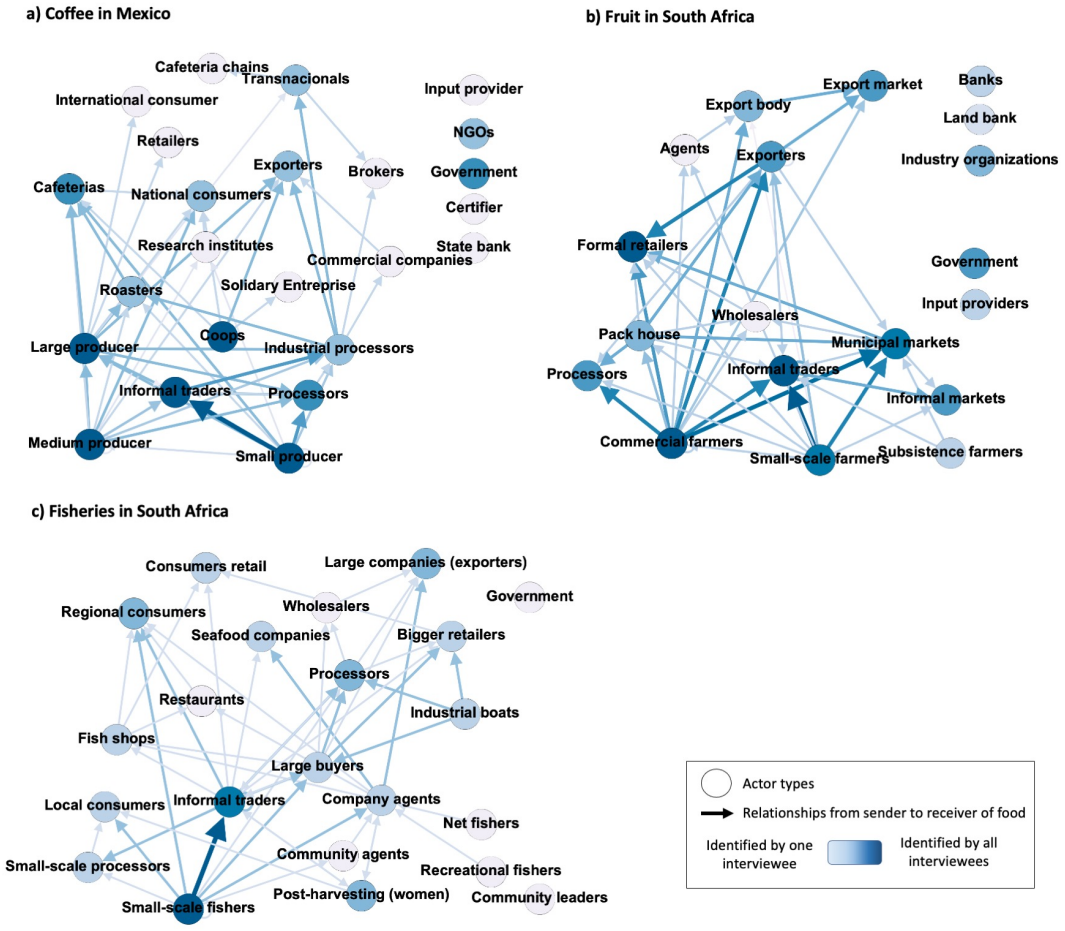
We define smallholders according to the specific context of each case study (Table 2), as opposed to defining a single metric of farm or boat extension. In all cases, smallholders refer to producers that are commercially oriented toward selling their produce (as opposed to subsistence oriented). In SA, the definition of smallholders is influenced by the post-Apartheid policy reforms. In the Fruit-SA case, smallholders are also called "emerging farmers", related to the government aim of increasing the commercial orientation of black smallholders, although the term is contested (Cousins 2010, Bitzer and Bijman 2014). In the Fish-SA case, some small-scale fishers hold traditional fishing permits and some previously excluded fishers hold "interim relief" permits after the 2012 small-scale fisheries policy reform, which has not been fully implemented in the Western Cape to date (Government of South Africa 2012, Isaacs 2013, Sowman and Sunde 2021). For this study, and given the context-specific diversity of actor groups and arrangements, we refer to all of these actors as smallholders while acknowledging the differences where they become relevant. Similarly, we use the term "informal traders" generally to refer to small-scale buyers who may not be integrated into the formal economy. This type of actor is relevant in all cases, although they have different names in each case study: *"acaparadores"* or "hoarders" in the Coffee-MX case, *"langanas"* or "hawkers" in the Fish-SA case, and "hawkers" or "bakkie traders" in the Fruit-SA case. It should be noted that although the case studies were focused on relationships involving smallholders, larger producers are also included because they emerged during the interviews.

Data collection

Data collection consisted of five to six online expert interviews in each of the three case studies. We selected experts based on opportunistic sampling given their experience with the respective case studies and identification through personal contacts and published literature. Interviewees were researchers or practitioners that had been working in each of the case studies for at least five years and live in the regions under study (Table 2). The online interviews were conducted via Zoom V5.8.4 (Zoom Video Communications, San Jose, California, USA) and lasted approximately 1.5 h on average. Interviews consisted of a mapping exercise adapted from the Net-map method to identify actors and different types of relationships between them (Schiffer and Hauck 2010, Hauck et al. 2015), fitting it to an online context aiming to map trade networks. This approach allowed us to identify and characterize the social structures and relationships between important types of actors in the trade systems. We used Network Canvas interviewer (Birkett et al. 2021) as a visualization interface. This interface enabled interviewees to interact with the screen, allowing for "participatory mapping" of the types of actors involved in each case study and their relationships with each other (including relationships of trading and assistance). Visualizations of the resulting network brought about discussions about the types and nature of relationships (see Appendix 1 for details on the data collection instrument).

To answer the second research question, we used a vignette method (Hughes 2008) in the online interviews for each case study to explore narratives of the existing and potential responses to a situation of resource scarcity, including the role of trade networks in such responses. The vignette method is often used in social science and medical research to explore perceptions and behaviors (Hughes 2008, Evans et al. 2015). Here, it relates to the use of explorative scenarios in social-ecological systems research as a method to identify dynamics of change and system trajectories accounting for the complexity of SSFS (Börjeson et al. 2006, Spijkers et al. 2021, Caggiano and Weber 2023). Following this approach, interviewees were exposed to the same vignette that could hypothetically be generalized to each case study based on previous experiences and literature. The vignette consisted of a fictional story in English or Spanish describing potential responses of smallholders and traders to a situation of resource scarcity, informed by the previous empirical evidence and key concepts following the embeddedness theory (see Appendix 1).

Fig. 3. (a–c) Summary of each trade network mapped by experts. The vertical position in the network indicates the spatial scale of the operation, from local communities (bottom) to international (top). Important relationships between actors of the same type are highlighted in Fig. 4. Isolated actors (without links) do not directly participate in food trade networks, but were identified as important in the case studies and may have other types of relationships not illustrated here.



Interviewees were then asked to reflect on what would happen in a similar situation based on their experience with the case in focus. Most interviewees indicated that such a situation was familiar and had happened before in each of the case studies, providing narratives of changes that have happened in the production systems. Therefore, the responses mentioned were most often related to a specific situation in which they took place, as observed or hypothesized by the experts. This observation supports the external validity of the vignette used (Hughes 2008, Evans et al. 2015).

Data analysis

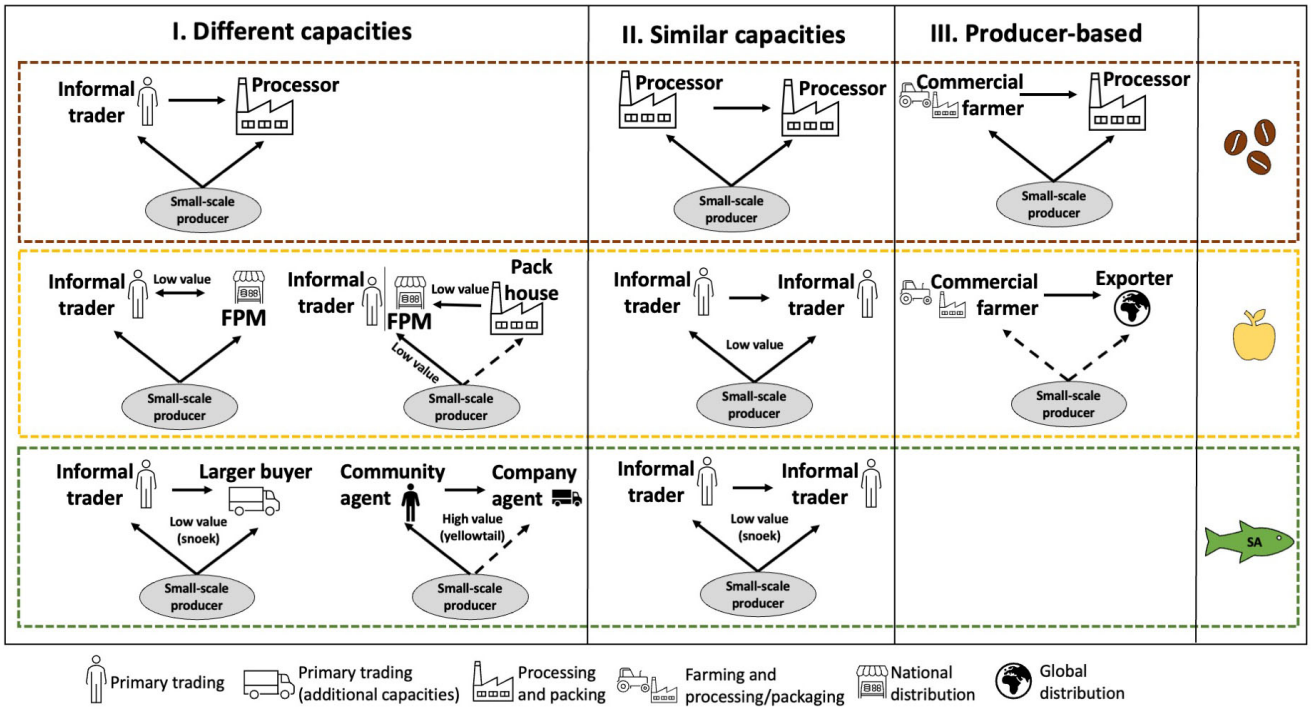
We used qualitative methods to analyze all interview data. We conducted thematic coding of data from the online expert interviews to understand the structural and relational embeddedness. We also used thematic coding to identify the responses to changes that were mentioned triggered by the vignette exercise. The themes were informed by existing literature, but the analysis also allowed for the emergence of new themes from the data collected (following an abductive approach). Although no quantitative network analyses were performed for this study, we aggregated the data from the network mapping into a single network per case study that was visualized using Gephi (Bastian et al. 2009) to facilitative the visualization and interpretation of horizontal relationships.

RESULTS

Comparing the embeddedness of trade networks across cases

Smallholders across all cases participate in trade network structures through which diverse end-markets are connected (Fig. 3). In all cases, smallholders have direct trade relationships with informal traders and other small-scale actors (Fig. 3). Smallholders are also connected with other types of traders who are closely related to higher value national markets or are larger actors operating at regional and national scales that are directly linked to higher value and international markets (although the characteristics of these traders differed among the cases). Experts

Fig. 4. Examples of the three types of horizontal relationship identified in the three case studies. Actor types are associated with icons to facilitate visualization of their similar or different capacities. Dotted lines indicate relationships that directly depend on institutional arrangements. When the relationship or structure is specific for one type of produce (species or value), it is indicated in text. FPM = fresh produce market. Examples are based on Figs. 1 and 3.



also mentioned actors who were identified as important in the case studies but do not directly participate in food trade networks, such as government, banks, or input providers (isolated actors in Fig. 3). We next describe the results regarding the structural and relational embeddedness characterizing these networks.

Structural embeddedness: horizontal relationships are ubiquitous and strongly shaped by local contexts, often connecting actors with different capacities

Horizontal relationships are present in all cases (Fig. 4). We identify three different types of horizontal relationships depending on the type of actors involved: horizontal relationships based on traders with different or similar capacities (Types I and II, respectively; Fig. 4) or organized around producers (Type III; Fig. 4). Overall, horizontal relationships create a type of structural embeddedness in which the relationship between a smallholder and the "buyer" of their produce is affected by the horizontal connectivity of buyers in the larger networks. However, the specific horizontal structures that exist in these networks may depend on the localities and institutional context within a case study, as reflected by the reduced overlap among informants on some of the horizontal relations that they have observed (lighter blue links, Fig. 3). In addition, the existing horizontal relationships can vary between cases.

First, horizontal structures can connect different types of actors, with some actors having additional functions or capacities (Fig. 4, Different capacities). In the Coffee-MX case, processors, locally called *"beneficios"*, who process the fresh coffee berries to dried coffee beans, buy directly from small-scale farmers, providing transport or establishing collection points. They can also buy from informal traders whose main function is to collect from producers and transport without any further value-adding activity. In SA, similar types of relationships can be found in the local fish and fruit markets. For example, in the farming context, informal traders can buy fruit from packhouses or fresh produce markets, which are large places receiving fruits directly from several farmers. Informal fish traders can also sell to other informal traders who transport larger volumes and establish connections with processors or other larger scale actors.

The second type of horizontal structure occurs between the same type of traders, defined as those similar to one another in terms of their role and position in the trade networks (Fig. 4, Similar capacities). In the Coffee-MX case, experts pointed to possible relationships between processing facilities located in different regions that produce different qualities of coffee (interview 5). In SA, informal fish and fruit traders could sell to each other, often in times of need, or between traders that sell in different locations (interviews 11, 14, 15, 24). However, we must note that the interviewees in all case studies were not certain about these relationships or indicated that they were only occasional, and they did not know whether they could be reciprocal.

The third type of horizontal structure highlights that vertically integrated producers who source produce from other smallholders create the horizontal trade relations (Fig. 4, Producer-based). Vertical integration refers to one actor owning different capacities or value chain functions or processes that would otherwise occur in different actors (e.g., being both a producer and a primary processor or trader). In the agricultural cases, there are larger commercial farmers with some level of vertical integration who have trade relationships with small-scale farmers. In the Coffee-MX case, large farmers often have processing facilities and can also buy coffee from informal traders. In the Fruit-SA case, large commercial farmers (who can own a packhouse) or exporters can have arrangements with small-scale farmers influenced by formal institutions. Exporters can also have arrangements with large and small commercial farmers to market the produce. We do not find the same type of vertically integrated large-scale producers linked to smallholders in the Fish-SA case. However, some small-scale producers could fulfill a similar role, as some South African small-scale fishers have opened retail shops (interviews 10, 14). In addition, South African industrial fishing companies could own large export companies and processors (interview 13), suggesting the existence of such vertical integration in the industrial fisheries as well. However, we found no evidence that industrial fisheries actors would trade fish directly from smallholders, as occurs in the agricultural cases (Fig. 3a).

Relational embeddedness: stable business relationships dominate, influenced by reciprocity and only sometimes coexisting with personal relationships

Generally, we found stable trade relationships across case studies. Common motivations for such stability were people knowing each other and the ease of transactions in dealing with people they already know (interviews 1, 3, 4, 10, 11, 13, 23, 24). For instance, stability can be linked to a higher sense of security, such as traders' need to secure the quality of coffee and fruit delivered (interviews 4, 24). The lack of alternative options for marketing was also mentioned as a reason for stable relationships. For instance, some communities have limited access to informal traders or processors in the Fish-SA and Coffee-MX cases (interviews 1, 2, 4, 13–15). Coffee certification systems and alternative market systems could increase the stability of relationships due to the required investments and logic of mutual benefit, respectively (interviews 2–4). Despite the prevalence of stability, some interviewees highlighted conflicts that would lead to changes in the relationships, such as disagreements about the prices paid (interviews 12, 15). For instance, in the Fish-SA and Coffee-MX cases, the importance of loyalty was mentioned, but interviewees believed that informal commitments could be broken when more profitable opportunities arose (interviews 4, 5, 12, 15). However, there is also the potential for socially derived enforcement, as highlighted in the Fish-SA case (interviews 12, 15). Breaking an agreement might still be associated with social costs in terms of tensions, dislike, and perhaps even social sanctioning. For instance, two interviewees described the relationships between fishers or coffee farmers and informal traders as "love-hate relationships", indicating the existence of both dependence and reliance on each other as well as a belief that traders would drive down prices and favor their economic profitability (interviews 3, 11).

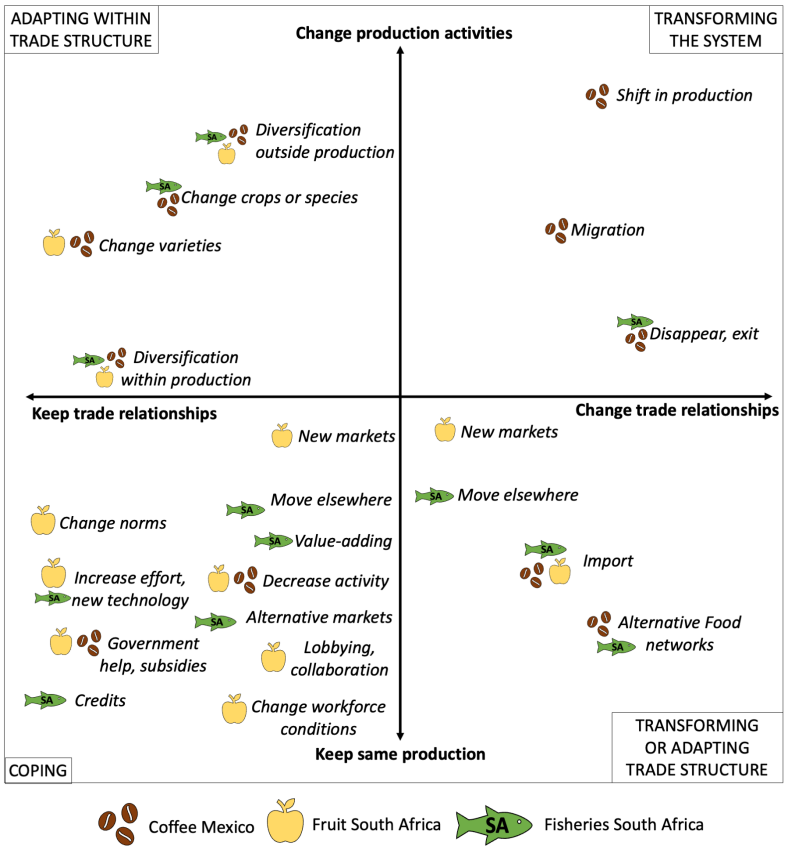
We can describe stable relationships as business relationships in which stability and certain types of commitment and reciprocity coexist with economic motivations. In general, interviewees highlighted the prevalence of economic motivations and rationale vs. the existence of deeper bonds or personal relationships. Several interviewees highlighted the existence of reciprocity linked to the mutual benefit and dependence between actors, indicating that trust between actors maybe exists in connection with such mutual interests and dependence on each other for trading (interviews 14, 15, 23, 25, 24). Actors in the Fruit-SA case build trust and commitment between each other because of the dependence between producers, packhouses, and exporters, because the trading system works on consignment (whereby the ownership of the fruit rests with the producer who trusts other actors for packing and marketing on a commission basis; interview 25). In essence, although the rationale for actors to engage in stable business relations is primarily economical, the stability of these relationships is partly, and to a varying extent, dependent on social factors such as reciprocity and joint commitment, which characterize business relationships.

The business relationships described are often informal, although formalized business relationships (based on written contracts) are described among some actors in the two agricultural case studies. In the Fruit-SA case, trade relationships between large commercial farmers, packhouses, exporters, and supermarkets (Fig. 3) can be based on written contracts as part of business relationships (interviews 20, 23). In this case, some small-scale farmers could have formalized arrangements with packhouses, commercial farmers, or exporters (mediated by county-specific institutions), which can involve arrangements for the commercialization of their produce (interviews 20, 25). In the Coffee-MX case, formalized business relationships are restricted to actors directly connected to international markets (interview 2). However, some transnational corporations can establish contracts mediated by the processors with small-scale farmers (interviews 2, 20). In both cases, written contracts with smallholders are not generally common, and informal traders would not engage in formal arrangements.

The coexistence of personal relationships with such informal business relationships (as part of an embedded trade relationship) seems to be specific to individual actors and contexts, whereby the different motivations and identities of actors (neighbors, belonging to the same community) can play a role in how prevalent personal relationships are. For example, when explaining the nature of the stable relationships that can exist between actors in the Coffee-MX case, interviewees mentioned the lack of friendship, kinship, or empathy, although there can be commitments or obligations between people who "know each other" regarding their business relationship (interviews 1, 2, 4). Overall, informants did not converge on the existence of such personal relationships between producers and traders or between specific actor types across scales. This result indicates the limited prevalence of personal relationships in these case studies, their potential diversity and specificity to different localities and people, or the lack of knowledge about such types of relationships among the interviewees selected for expert interviews.

Finally, it is worth highlighting that trade relationships were not always mentioned to be linked to other financial arrangements.

Fig. 5. Main strategies in response to change, identified for the three case studies (indicated by icons). Responses are grouped into four types based on two axes representing changing trade relationships (horizontal axis) and changing the production practices (vertical axis). Strategies were elicited as a response to a fictional narrative for the three cases based on expert interviews. See Appendix 2 for further details.



Financial assistance interlinked in the trade relationships was seldom mentioned or known by interviewees regarding the agricultural cases. Only in some cases, interviewees mentioned credit exchanges or assistance within the agricultural trade networks, such as credits between exporters or packhouses and commercial farmers in SA, or between processors or coffee shops (*"cafeterias"*) and small-scale coffee farmers in MX (see Fig. A2 in Appendix 2). Instead, experts in the agricultural cases highlighted several avenues for financial assistance mediated by external actors not directly involved in the trade of produce (Fig. A2 in Appendix 2), such as government subsidies or credit provided by private or state-dependent banks. Small-scale farmers in SA and Mexico can receive subsidies or grants from government-dependent authorities, although there are concerns about the reach of that finance (interviews 1–3, 5, 21, 24, 25). Banks were also mentioned as a source of credit to larger actors (interviews 1, 21–23), although smallholders were reported to have difficulty getting such credits from banks (interviews 2, 21). On the contrary, in the Fish-SA case, informal trade relationships also involve the existence of financial arrangements. Credits to fishers are often provided by informal traders with interest or by market agents (for high-value fish), although they can also be provided by boat owners or skippers, creditors, or other community members (interviews 10–15).

Responses to environmental change: most responses take place within existing trade structures, but relationships can break

After our analysis of the embeddedness of trade networks, we addressed our second research question to identify potential responses to changes in the three case studies in relation to whether and how these responses would imply changes in the existing trade networks. The responses mentioned mostly included changes in production practices and marketing strategies, but also financial assistance and other types of responses (Fig. 5; see also Table A3 in Appendix 2 for a detailed description of the responses with examples and interviews that mentioned them). We identified four types of responses that can be organized along two gradients representing the relative change in trade relationships and production activities (Fig. 5), and they are named after the social-ecological resilience concepts of coping, adapting, and transforming. Here, transforming can refer to changes in trade networks or to broader changes in both the trade networks and the production system (i.e., "transforming the system").

Most responses identified take place within existing trade networks (Fig. 5, left). In fact, most refer to coping responses within existing trade networks, as in the case of actors asking for credit or changing their production intensity (Fig. 5). Responses that contribute to adapting production practices include, for example, the development of new varieties or targeting and commercializing new species. These responses at the production level could be mediated by exporters, traders, or industry organizations through their existing trade networks, as exemplified by exporting companies contributing to the development of new varieties in the Coffee-MX case.

Comparatively fewer responses imply a change in existing trade networks (Fig. 5, right). Some of these responses can imply significant changes in trade structures (i.e., "transforming trade structure"), such as actively developing alternative food networks and short supply chains that are emerging in the Fish-SA and Coffee-MX cases (Fig. 5). However, other responses (e.g., importing food) imply changing a trade relationship without necessarily changing the overarching trade network structure (i.e., "adapting trade structure"). In some cases, responses in this category could keep existing trading relationships depending on the abilities or motivations of different actors. For example, fishers moving elsewhere to fish, or actors looking for new markets, can imply adding trade partners while maintaining existing trade relationships as a coping response. Finally, a few responses imply a more drastic change in the SSFS (in both the trade and production systems) and the potential disappearance of some trade networks, such as actors shifting production activities (e.g., coffee farmers transforming their coffee forest into sugar cane or chayote production) or migrating (Fig. 5, "transforming the system").

DISCUSSION

In our comparative study of SSFS, our first question allowed us to understand the embeddedness of trade networks across diverse food production systems and institutional contexts. We found that trade relationships in SSFS can be stable and socially embedded in business relationships, although there were key differences across cases (see below). Our second question allowed us to provide initial insights on the role of embeddedness in dealing with changes, which we summarize and discuss as four refined emerging hypotheses for future research.

The qualitative approach we used relies on qualitative abductive reasoning, which enabled us to refine hypotheses derived from a single case study and deepen them to further the understanding of embeddedness across cases of SSFS. This method offers opportunities to move beyond both the separation of fisheries and agricultural systems (Blanchard et al. 2017) and the reliance on single case studies that often occurs in social-ecological research (Meyfroidt et al. 2018). However, although the expert interviews served the intended purpose of describing and comparing across cases broadly, the approach is limited in that it obscures much of the diversity found within case studies. The case study descriptions rely on second-hand expert-based knowledge, which differs from approaches based on primary data collection and engagement with local stakeholders. Thus, our results reflect broad patterns within the cases as interpreted by the experts, and do not account for stakeholders' direct experiences.

Trading is socially embedded in all food systems, but the characteristics of this embeddedness vary with context

We found that trade can be described as socially embedded across case studies, whereby relational embeddedness often relies on stable business relationships that imply reciprocal commitments. This result highlights the importance of considering the social factors that influence food trade beyond economic motivations alone (Dulsrud and Grønhaug 2007, Stoll et al. 2020). However, we also found that different types of social relationships can coexist within such complex trade networks that span spatial scales, connecting small-scale producers to local and global markets. Thus, despite the similarities found across cases, context-specific factors shape how different trade networks are embedded. The comparison across different production systems and countries allowed us to reflect on the contextual characteristics that could influence the social embeddedness of trade networks.

For instance, the degree of formalization of trade relationships differs across fisheries and agricultural systems. Formalized business relationships (based on written contracts) are almost exclusively described in the two agricultural case studies, and are highlighted as absent from the Fish-SA case and in our earlier research in Mexican fisheries. In addition, informal financial arrangements involving producers and traders were often described in the fisheries case and are well known in small-scale fisheries across the world (e.g., Fabinyi et al. 2018), whereas external actors (e.g., banks, government authorities) seemed to have a more important role in the agricultural cases, providing credit and finance. Although the causes underlying these differences between production systems cannot be determined from this study, we can speculate that factors that differ across fisheries and agricultural systems play a role. For example, the uncertainty and shorter time frames of fisheries systems may increase the importance of informal financial arrangements while also challenging the establishment of formal contracts that require planning food supplies and deliveries.

We found that some horizontal relationships are driven by different types of traders with different capacities and roles in the trade network. In the agricultural cases, vertically integrated larger farmers can function as traders for smallholders and also create horizontal trade structures (Fig. 4). This relationship between large and small producers was not described in the fisheries cases under investigation, although relationships between large- and small-scale fisheries are suggested to be highly context specific, comprising both conflict and cooperation (Pollnac 2007). Thus, the potential role of vertical integration and trade relationships between large- and small-scale producers should be further investigated across different production systems.

Country-specific factors can also mediate differences in relational and structural embeddedness. For instance, in SA, horizontal relationships (Fig. 4) are strongly mediated by local institutions (i.e., formal or informal norms and rules, as in North 1990). These arrangements are often named strategic partnerships mediated by Black economic empowerment and land reform projects (Bitzer and Bijman 2014). For example, formal contracts that can involve the provision of credit or inputs to small-scale farmers can be facilitated between commercial farmers or exporters and small-scale farmers linked to strategic partnerships and land

reform projects (Bitzer and Bijman 2014). In the Fish-SA case, an interviewee explained that export company agents buy from small-scale fishers often operating larger boats. However, other small-scale fishers operating smaller fishing boats (and generally with interim relief fishing permits) do not have access to company agents, and instead sell to community agents who transport and sell the fish to company agents. In this case, the horizontal relationship between company and community agents could be shaped by the unequal access and capacities of different types of fishers.

Embeddedness to deal with changes in small-scale production systems

Across all case studies, relationships were generally characterized as stable business relationships, whereby most responses to change occur within existing trade relationships, such as the development of new varieties or marketing of new species. This result is in line with literature highlighting the role of embeddedness for innovation, learning, or problem-solving (e.g., Uzzi 1996, Charterina et al. 2016). However, the maintenance of certain embedded relationships and dense social structures, often linked to the concept of over-embeddedness (Uzzi 1996), can also be associated with negative outcomes (Fafchamps and Minten 2002, Dulsrud and Grønhaug 2007, Turgo 2016). For instance, they could promote coping strategies that enable short-term responses but could threaten the long-term capacity to deal with changes, such as credits used as a response to changes in relationships between small-scale fishers and traders (Ferse et al. 2014, Drury O'Neill et al. 2019). For example, as mentioned for the Fish-SA case, some smallholders might not have the capacity to engage in alternative markets given their dependence on more powerful actors at larger scales. Thus, we hypothesize that **the types of relationship that constitute embedded trade networks influence how relationships can be used to respond to environmental changes (through coping, adapting, and/or transforming).**

We found that embedded trade relationships are subject to change and, in fact, some responses implied changes to existing trade structures (Fig. 5, right). Such changes in trade structures and their relational embeddedness could have different system-level implications, depending on how and which relationships change. First, certain changes imply the disappearance of the existing SSFS (e.g., as mentioned in Fig. 5, "transforming the system"), which link to processes of land-use change (Malek and Verburg 2020), migration (Adger et al. 2020), or exiting fisheries (Daw et al. 2012) described globally. Second, alternative food networks that change existing trade structures are emerging across food systems (Goodman et al. 2012). However, the way in which these networks are embedded can have different implications (Hinrichs 2000). For instance, they could have negative effects on local food security and small-scale post-harvesting actors in some contexts (Haysom 2016). Therefore, we hypothesize that **trade networks and their embeddedness can change through time, influencing the capacity of smallholders to deal with changes and transform their trade structures and production systems.**

We found different types of actors and types of horizontal relationships through which smallholders can be structurally embedded. As existing literature suggests, structural embeddedness allows accounting for the indirect interdependencies of multiple trade relationships (Choi and Kim 2008) and can complement value chain and supply chain approaches to investigating the influence of horizontal relationships and structural patterns on actors' capacities to deal with changes (Borgatti and Li 2009, Bolwig et al. 2010, González-Mon et al. 2021). For example, a focus on horizontal relationships could allow the investigation of interdependencies between different producers and the network-level implications of actors' vertical integration across the value chain. In addition, the development of alternative food networks or other changes in trade networks that arise as a response to change may have different implications for the diverse actors in existing trade networks, given smallholders' structural embeddedness. Thus, we hypothesize that **the importance of structural embeddedness for smallholders' capacity to deal with changes depends on the capacities of the "buyer" they are connected to and on the buyer's patterns of horizontal and vertical relationships with other actors.**

We showed that the specific types of relational and structural embeddedness can be affected by personal and institutional factors. Factors such as personal motivations, tradition, and culture are also likely to affect responses to change (e.g., Daw et al. 2012, Talanow et al. 2021). As literature in economic sociology suggests, embeddedness in social relationships can influence responses to change, but the type of embeddedness and responses play out in combination with other structural, contextual, and personal motivations (Dobbin 2005). Such interactions could be understood by adopting broader conceptualizations of embeddedness that have been promoted in economic sociology, emphasizing cognitive, cultural, political, or institutional types of embeddedness (Zelizer 1988, Zukin and DiMaggio 1990, Dacin et al. 1999, Fligstein 2015) and literature discussing the interplay between networks and institutions (Owen-Smith and Powell 2008). Overall, we hypothesize that **feedback interactions between contextual factors such as institutions and social embeddedness influence the types of embeddedness and their potential effects on responses to changes.**

CONCLUSION

In a context in which SSFS are increasingly interconnected across scales and space while facing unprecedented global changes, understanding the role of trade networks for their capacity to deal with change is increasingly acute. Our study yields insights regarding the nature of trade networks within diverse SSFS, highlighting key features of their social embeddedness. The role of such different types of social relationships for enabling or constraining different responses to change remains a question for future research. The four refined hypotheses suggested above (bold font) provide avenues that should be investigated further to understand under which conditions embedded trade networks can lead to positive or negative outcomes in SSFS. For example, future research should investigate how diverse types of social relationships could enable or constrain the longer term adaptation of SSFS (adapting vs. coping), and investigate embeddedness from a dynamic perspective to understand transformation processes in SSFS' trade networks and their implications. In this context, the concept of structural embeddedness and associated analytical tools based on network analysis could help in understanding the indirect interactions and dependencies between actors connected through complex trade networks (Bodin et al. 2019). Furthermore, comparative approaches across different case studies, as we showcase here, could offer

opportunities to improve the understanding of how trade networks and contextual factors such as formal and informal institutions interact and influence responses to change, and the different motivations and mechanisms that coexist within embedded trade networks. Overall, we hope that the proposed emerging hypotheses inspire future research to advance our understanding of the role of socially embedded trade in the resilience of SSFS.

Author Contributions:

B. G.: conceptualization, data collection, formal analysis, investigation, methodology, visualization, writing - original draft. Ö. B.: conceptualization, methodology, supervision, writing - review and editing. M. S.: conceptualization, methodology, supervision, writing - review and editing, funding acquisition.

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Data Availability:

The data that support the findings of this study are available on request from the corresponding author, B. G. None of the data are publicly available because they contain information that could compromise the privacy of research participants given confidentiality agreements established when obtaining informed consent for the interview material. Ethical approval for this research study was granted by the Stockholm Resilience Center's research ethics subcommittee.

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APPENDIX 1: ONLINE EXPERT INTERVIEWS

We designed an interview protocol for a semi-structured interview lasting a maximum of 1.5h. Any of the questions could be skipped or adapted to the interviewee's expertise, since the main purpose of the questions was to trigger a discussion and a conversation between the interviewee and the interviewer concerning trade relations and responses to changes in the case study. The questions were explained by the interviewer as needed, who also facilitated the interaction with a visualization tool (Network Canvas) that was used to answer some questions, map relationships, and facilitate the discussion (using the sharing screen and remote-control functions of zoom). The interview protocol was implemented in the software Network Canvas 6.1.0, using Architect for the implementation and Interviewer for the application during the interview (all files containing the protocol can be requested by email).

The interview had two distinct parts, where the first part focused on mapping the trade network and understanding its embeddedness and the second part included the vignette method. Experts in the case of fisheries in Mexico were only given the second part of the interview. Below we detail the structure of the interview.

Part 1: Mapping trade networks and discussing their embeddedness

Section 1: Actor mapping

Interviewees were asked to name all types of actors that participate in your case study, starting from different types of producers and traders.

Section 2: Relationships and network mapping

Interviewees were asked to engage with the visualization interface to place the actors mentioned in the screen and connect them through links according to their trade relationships, material or financial assistance and technical assistance consecutively. Interviewees were encouraged to explain and discuss the relationships and respond to probes regarding the stability of the relationships.

Section 3: Embeddedness discussion

Interviewees were asked to discuss in more detail the relationships that can exist between the actors mapped, while observing the map resulting from section 2. Before the discussion, they were introduced to a description of different types of relationships that could exist (box 1), which were based on the conceptualization of embedded ties by Uzzi (1996), the typology of embedded ties described by Hite (2003, 2005), and contextualized based on the case study of González-Mon et al. (2019) following the theoretical framing of the manuscript. However, interviewees were not restricted to agree about the existence of these types of relationships in their case study and they were encouraged to discuss similar or other relationships in the case study previously mapped (whether they were present or absent).

Table 1. Concepts presented during the interview.

Concept	Definition
Family	Defined in the broad sense, for example relationships between parents and their children, between cousins, between in-laws.
Empathy, affect, friendship	Relationships where one person would care about the other one, for example being emotionally affected if the other person falls sick or gets bankrupt.
Commitment, moral obligation, trust	The existence of informal norms about an agreement or arrangement, where there is confidence that the other person would comply with that agreement. For example, a trader would not cheat and go to sell to someone else.
Help, problem solving, responsiveness	Relationships where one person would help the other one in times of need, for example lending equipment or finding solutions together.
Reciprocity	Linked to help, but specifically when there is an expectation that if one helps the other one in times of need, the other one would help in return when needed.

Part 2: Vignette method

Interviewees were asked to listen and/or read a short narrative, and then reflect and discuss how this narrative could relate to the case study they had been discussing in part one of this interview (figure 1). The narrative includes concepts (highlighted in bold below) related to the embeddedness of trade relationships contextualized based on the case study of González-Mon et al. (2019) following the theoretical framing of the manuscript. The narrative can be found below.

Narrative

The year is 2030. The day started as any other day in Tapias, a small village in a Peruvian valley. Pedro woke up before the sunrise to continue buying, transporting and selling fresh produce from the region as he had always done. However, his daily activities were changing. For some time now, the region had been facing a severe scarcity: the producers were no longer harvesting as much as they used to. Now, he was facing an important dilemma; he needed to feed his family. He wanted to keep practicing trading activities; and he wanted to maintain all the ***commitments*** *he had with producers and other traders; they depended on each other since they were* ***part of the same rural community.***

But this year there was absolutely no harvest available, and things were more difficult than ever. That day, he was going to talk to Lucas, his main buyer, to request for a ***credit*** *extension. He had some extra expenses at home and their current income was just not enough. Lucas and Pedro had been trading with each other* ***since he started this business****. They tried to* ***help*** *each other in times of need. They* ***trusted*** *each other and Pedro knew that Lucas would not deny the credit extension. That credit would be enough to cope for a while, but what if the harvest did not return back to normal as soon as expected? Or even if it would not come back at all?*

Pedro had been talking to some traders in the neighboring community. They were using credit from a bigger buyer to invest in new technology that would enable changes in the production practices. The relationship between Pedro and his producers was ***tight****. He knew that some of them would be open to* ***try new production practices*** *to increase the harvest, and they just required him to provide the* ***necessary inputs and knowledge****. But what if those new practices would not work? There were no guarantees, some of the new practices consisted even in harvesting new species. He thought about his relationships with Lucas, his lifelong buyer. They* ***trusted*** *each other but he knew how Lucas was* ***concerned with meeting the demands*** *of the*

exporting company he was selling to. If things went wrong with the new production strategy, Lucas would not necessarily be there for him. Maintaining the current production and trading practices seemed like the safest option for Pedro at that time.

However, just before the sunset he met his cousin Elena. Elena was also a trader. She had been ***helping her producers*** *to change their production practices for the last years. That same day Elena had also taken a very important decision. Now she was going to stop selling to her* ***lifelong trading partners*** *and start dealing with some new traders that had just established in the community providing an* ***alternative market****. She could not cope with this lack of harvest, so it was time to start in a new direction.*

That night, while drinking a cup of tea, Pedro imagined the uncertain future of his community. What could they do to face these drastic periods of scarcity?

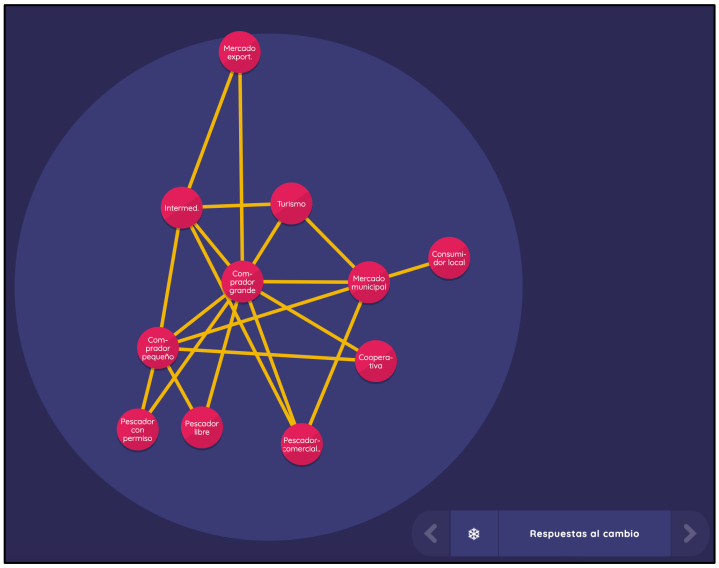

Figure 1 Example of the interface shown for the discussion of section or part 2 summarizing the relationships mapped in section 2 for an interview in Spanish. Interface shown after presenting the narrative.

APPENDIX 2: DETAILED RESULTS FOR THE FOUR CASE STUDIES

DESCRIPTION OF THE FIRST CASE STUDY: FISHERIES IN MEXICO

Small-Scale Fisheries in Baja California Sur, Mexico

This section presents an extended description of the case study from small-scale fisheries in Mexico, which constitutes the starting point of the comparative approach presented in the manuscript. Here we compile findings from published research based on this case study led by the main author of this manuscript (González-Mon et al., 2021, 2019), as well as extended results and exemplifying quotes from the interviews with traders conducted in González-Mon et al., (2021). González-Mon et al., (2021) used these results regarding the embeddedness of trade relationships in an aggregated form to inform an agent-based model using a multi-method approach and did not include a detailed description of the embeddedness types. Such detailed description is key for a deeper understanding of the embeddedness of trade relationships in this case study and, therefore, we report them below.

Embeddedness based on business relationships with "moral commitments"

Relationships amongst traders in the fish-MX case are rarely based on written contracts (table 1). Instead, they often rely on what was referred as "moral commitments" (González-Mon et al. 2019), even if a given trader may only have such type of commitments with some of their trading partners (table 1). These commitments can be influenced by different factors, such as the dependence on one another or the need to secure trading in a competitive market as highlighted by some traders (table 1). These commitments between traders can also be related to the easiness of the trade activities, since some traders prefer to not struggle and sell everything quickly instead of having to look for several traders to buy their fish before it gets bad, or to "go around and around" requesting payments. In this context, traders often described the need to have relationships with "good traders", or those that are reliable. For instance, traders' value that their partners keep their commitments even if others offer higher prices. In addition, such trade relationships often imply that traders rely on others to provide help when buying and selling fish, giving priority to one another when there are situations of special need to sell or buy fish (table 2). The following quote represents the type of relationship and assistance that characterize many of the trade relationships: "If they ask me for more [fish] than what I have, I divide [the traders/clients]. There is where I divide between the good and the bad [traders]. […] Which client was with me the whole year, how much did I sell them, and, in addition, who paid me immediately. [And to these clients] I say: hey, how much do you need?" (Seller 19 in González-Mon et al., 2021).

As the previous quote highlights, most traders mentioned the importance of commitments for securing payments, since their commitments often imply fish lending or delayed payments. Traders prefer to trade with those that can be trusted to pay back and deliver fish of the required quality. This is also one of the conditions that they consider when engaging in new trade relationships, where they may test progressively whether a trader can be trusted. Some traders even described situations of conflicts, and ways of sanctioning traders that do not stand by their commitment, for example "not selling to them ever again" (Seller 9 in González-Mon et al.

2021). Failing with the payments is indeed the most common reason to quit a trading relationship (González-Mon et al. 2021).

We found that most of the traders would define their relationship as being based on business or the convenience of the economic arrangement (table 1). However, we also observe that such interactions do not need to be opposed with the existence of moral commitments (Seller 18, table 1), which can be more important than short-term economic returns alone. In fact, traders may not always decide to trade based on the price, as a trader started: "Instead of selling to the highest bidder, it is important to know that he/she will buy from you securely, even if they pay a few pesos less. To know for example that they will buy when there is a lot, that they will be there." (Seller 10 in González-Mon et al., 2021).

Table 1. Characteristics of trade relationships described by traders in La Paz. *Closed question asked with how many of their trading partners they had a relationship of a given type, as a proportion of their total number of relationships (in brackets the number and % of respondents). Qualitative examples were descriptions that respondents gave while answering the closed questions and during other steps in the interview. based on 13 interviewees conducted for González-Mon et al., (2021).*

Characteristics of relationship	**Closed questions**	**Qualitative examples**
Written contracts	All Most Half Less half (2, 15%) None (11, 85%)	"It is moral, there is nothing written" (15, dealer)
Moral commitment	All (3, 23%) Most (4, 31%) Half (1, 8%) Less half (4, 31%) None (1, 8%)	"Moral commitment would be to hold on in the market and, for example, don't fail to them so that we don't have to struggle to sell later. Because there is so much competition, we need to have a commitment with them." (9, seller) "Because the person trusts me. They say: if so and so is going to bring me [fish] that day, they stop buying from someone else because I am going to bring them [fish]. And if I don't bring them [fish], I will make them *fail.*" (18, seller)
Reputation, reliability	All (2, 15%) Most (4, 31%) Half Less half (6, 46%) None (1, 8%)	"A good client is the one that consumes enough product and pays you timely." (16, dealer)
Help, reciprocity	All (1, 8%) Most (4, 31%) Half (2, 15%) Less half (5, 38%) None (1, 8%)	"One can count them, within my folder of clients it will be one or two. […] For example, when my car broke delivering I talked to him and told him: man lend me a car because it broke. Yes of course he said. Or for example [….] I tell him: man I need tare weights to deliver… and he says: of course take them. They lend them then." (19, seller). "The help could be financial, lending fish, paying later." (11, dealer)
Family or friends	All (2, 15%) Most (4, 31%) Half (2, 15%) Less half (3, 23%) None (2, 15%)	"There is not really friendship. We know each other from the same relationship that we have been having, and there is some trust from my side, from their side." (18, seller). "I knew them being friends before I knew them as traders, so I am very attached to them and the trading relationship, to not fail them." (11, dealer).
Empathy, caring	All (1, 8%) Most (2, 15%) Half (2, 15%) Less half (6, 46%) None (2, 15%)	"It is more about traders and the trust between each other. Those that would worry if you need at a given time are few" (18, seller). "I have seen it in other people that have died, and they don't go to pay their respects […], it is mainly interest" (19, seller).
Convenience, business	All (8, 62%) Most (2, 15%) Half Less half (2, 15%) None	"If I like them that is something else, but it is business." (7, dealer) "To be honest, it is merely for convenience. Because there is a bit more money. But stability in one, with him always. You arrive and he doesn't say no. There is like a commitment, like a relationship." (18, seller)

Table 2. Use of trade relationships in times of need, as described by traders in La Paz. *Number and % of respondents answering how often they receive a specific type of assistance from their trading partners. Based on 9-10 interviews conducted for González-Mon et al., (2021).*

Type of assistance	Always	Often	Sometimes	Hardly ever	Never
Help selling/buying in times of need	**4 (31%)**	**4 (31%)**	1 (8%)		1 (8%)
Help establishing trade relationships		1 (8%)	2 (15%)	2 (15%)	**4 (31%)**
Help with trading operations	2 (15%)	1 (8%)	2 (15%)	1 (8%)	**3 (23%)**
Help outside trade	**3 (23%)**			2 (15%)	**4 (31%)**

Embeddedness based on personal relationships

Our results show that there is also diversity in the ways different traders may choose to interact with others. The definition of trade relationships as an economic interaction does not exclude the existence of additional personal relationships. Friendship and family relationships can exist, even if they are not the most common for everyone (table 1). Empathy may also be present in some cases, but it is less common, and it may characterize only a few traders with strong personal connections with their trading partners (table 1). How much traders can rely on other traders for help, and expect reciprocity, can also be highly variable amongst traders: some may only expect help from few of their trading partners whereas others may expect to receive help from most of their relationships (table 1). In relation to this, we find that trade relationships are only sometimes used to help in trading operations, either lending equipment or providing financial assistance (lending fish and/or money), or to help with issues outside the trading activities (e.g., providing credit do deal with personal issues) (table 2). In addition, these relationships rarely have a function to help others create new relationships (table 2), since traders are considered "jealous" of revealing such type of information.

We should also note that the embeddedness of trade relationships may be different amongst traders than between fishers and traders. As some traders highlighted, there can be more commitment, and even personal relationships, with the fishers they buy from in the fishing camps or at the beach (first point of commercialization). In these cases, traders often describe detailed arrangements with fishers and the stability of that relationship. Such fisher-trader relations often imply the provision of credits or financial services, as it has also been described elsewhere for this case study (Basurto et al., 2013; Frawley et al., 2019; González-Mon et al., 2019).

RESULTS OF THE THREE CASE STUDIES BASED ON EXPERT INTERVIEWS

Below we present a detailed description of the results emerging from a thematic coding of the expert interviews per case study. Descriptions are structured as follows: first, we provide a general description of the trade networks; then we describe the structural embeddedness and the relational embeddedness (including business and personal relationships and financial arrangements).

Small-scale coffee systems in Veracruz, Mexico

The coffee trade system is highly diverse, where multiple vertical and horizontal relationships can exist (figure 1). We can describe this trade network according to three components. The

first one (blue, figure 1) comprises the smaller scale actors: processors, producers, and informal traders. The second one (pink, figure 1) comprises larger producers and other actors that are important for the national trade system of coffee, mainly based in Veracruz and other regions of Mexico. Finally, the third component (yellow, figure 1) comprises actors that directly participate in the higher value markets that mainly focus on the export of coffee.

Structural embeddedness

Horizontal relationships can exist between informal traders and processors and between different types of processors that may have different sizes or operate in different locations. In this case, informal traders and processors buy from farmers, but processors can also buy from the informal traders or other processors. An interesting case is also the vertical integration of large producers that can have processing functions. These large producers have coffee production activities but can also buy coffee from smaller producers or from informal traders creating horizontal relationships. Large producers with high trading capacities can sometimes sell to exporters or transactional corporations, but they can also sell to national-level actors or big processors (especially if they don't have all processing capacities themselves). The specific horizontal relationships that exist in this network may depend on the localities and communities of Veracruz, as reflected by the reduced convergence (orange links, figure 1) amongst informants on the specific relations that they have observed. For example, the degree of functional upgrading or vertical integration of some actors vary, given that not all large producers have processing capacities and buy form others as reported by the experts.

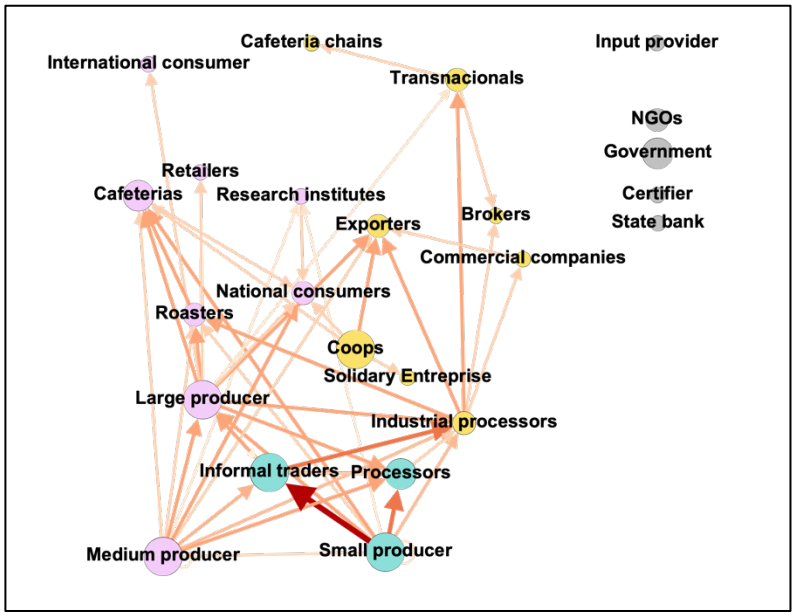

Figure 1. Results of mapping the coffee trade network in Veracruz. *Summary of trade network mapped by 5 actors working in the coffee systems in Veracruz. Arrows: trade relationships from seller to buyer; nodes: actor types identified as important in the value chain; colour of node: network components; size of arrow and colour intensity: number of people that identified the relationship (the biggest and most intense -red- were identified by the 5 interviewers); position: spatial scale of their main operations, from local communities (bottom) to international (top).*

Relational embeddedness

Generally, trading relationships in the coffee trade are described as stable, more than as one-time market transactions, even if the stability of the relationship can depend on the type of actors. For instance, informants described the existence of written arrangements or partnerships between some actors that would tend to last over the years. This type of arrangements would be specific to some transnational corporations or exporters that have written contracts with industrial processors (big processors), and to some specialty coffee value chains that rely on certifications and are characteristic of producer cooperatives. However, for other types of actors, relationships would be mostly informal. Interviewees described how bigger corporations or companies rarely establish direct relationships with producers, and instead rely on relationships mediated by the processors. Processors (and informal traders) in turn can have stable relationships with producers, but those are mostly informal and not binding. This implies that producers can decide who to sell to based highest bidder or other economic motivations, and in fact informants highlighted that producers would often sell to the most profitable alternative regardless of the existence of some stability in their relationships with their buyers. In this way, trade relationships are described as business or commercial relationships, and not always as stable.

However, when explaining the nature of these business relationships, interviewees did mention the existence of certain commitment (i.e., reciprocity) or obligations between actors. This type of commitment would not be associated to friendship, kinship, or empathy. For example, there can be commitment between and amongst small or medium producers, informal traders, and processors because they know each other from several years, so that producers know their usual prices, and buyers know the quality of the product offered. Commitment can also exist because producers or traders prefer to continue operating as they are used to, since they can always sell to the same people. For example, informal traders may have their specific locations where they buy coffee from, and always buy from the same producers. Sometimes there may also be a lack of options available for producers to decide who to sell to (e.g., only a few buyers or processors in the area).

In other instances, the commitment described for business relations can also be related to being friends or neighbors, and some informants highlighted that there can be a sense of obligation for small producers to sell to someone that has contributed to the community or helped them, but this was not highlighted by most interviewees. However, most informants highlighted that there are relationships based on family, friendship, trust, empathy and helping each other that operate amongst small and medium producers that are neighbors. These more personal relationships are also present inside of producer cooperatives and in alternative value chains that are associated with specific values where there is solidarity and trust. In the cases where social relationships are described as being neighbors, friends or trusting each other, informants highlighted instances of independent producers or producers in a cooperative helping each other in times of need (e.g., to repair the crop after rainfall, etc.). This help may be commercial in some cases, when for example producers can buy agricultural inputs or trees to another producer that is facing a sudden need for cash. Some highlighted some reciprocal practices of helping each other as a characteristic of indigenous communities.

Credit arrangements or delayed payments can be interlinked in these trade relationships (figure 2a), guaranteeing higher stability. For example, big processors, large producers, or informal

traders giving small credits to small producers (figure 2a) that would be repaid with coffee or money. It could also happen between (smaller) processors that may receive the coffee and pay later to the producers. In these cases, there would be trust and stability/security between the actors knowing that they will pay back and sell/buy to them. A somehow similar type of relationship could exist between informal traders and processors, where informal traders work for a processor and obtain a commission (such commission was considered a "payment" and not financial assistance and therefore not indicated in figure 2a). However, most informants did not agree on the existence of such informal credit arrangements between specific actor types (thinner lines in figure 2), indicating that these arrangements may be diverse and highly specific to different localities and people, or the lack of knowledge about such types of relationships amongst the interviewees selected. Most informants highlighted that the main source financing actors in the coffee trade is through government funding, state banks, or private banks (figure 2a), and that the existence of informal credits is rare.

Finally, we must highlight that the coffee trade system is characterized by the recent emergence of alternative and differentiated value chains that operate nationally. In this way, cafeterias (coffee shops) have taken an important new role in establishing direct relationships with producers. This relationship can even involve the existence of credit and trust, and even technical assistance to the producers to improve the quality of the coffee. This is also related to the increased of value addition activities amongst medium producers, that are starting to process their own coffee to develop differentiated coffee brands that are mostly consumed locally or within Veracruz (a coffee production region in Mexico). In addition, some research institutions and NGOs are helping small producers with processing activities to source such differentiated markets. These newly emerging value chains can also show certain types of embeddedness, often also based on social relationships. They are often also based on the quality of the product and the loyalty of some consumers to specific brands.

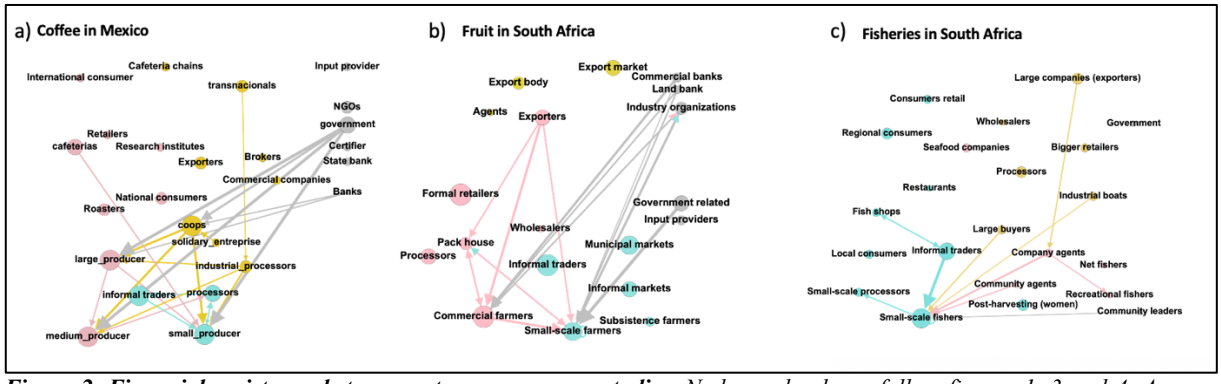

Figure 2. Financial assistance between actors across case studies. *Nodes and colours follow figures 1, 3 and 4. Arrows indicate the provision of financial assistance, from giver to receiver, coloured according to the node where the assistance originates form. Size of arrows: number of interviewees highlighting the relationship*

Small-Scale deciduous fruit production in Western Cape, South Africa

The Western Cape deciduous fruit trade network comprises two different types of actors. We can differentiate between those that are mostly formal related to the fruit export market (most yellow and pink actors in figure 3) and those that are characteristic of the local or lower-value markets (blue actors in figure 3). Amongst the actors mainly oriented to export markets we also find supermarkets or formal retailers (pink, figure 3) that are considered national higher-value markets for fruit, mostly consisting of formal actors and relationships; and processors (pink, figure 3), that buy the lower quality and lower value fruit for the processed food market such as the juice industry. An important characteristic of this trade network described by interviewees is that the relationships amongst formal actors are rarely buying-selling relationships, instead they work on consignment where the ownership of the product rests in the producer until it is sold to final selling point (e.g., supermarkets in Europe) and the intermediaries (e.g., pack houses, exporter) get a commission based on the selling price. We should note that for this manuscript and in the Western Cape deciduous fruit context, small-scale farmers can be defined as emerging farmers, as mentioned in the manuscript. Other smallholders and subsistence farmers would only sell to local markets.

Structural embeddedness

The deciduous fruit trade system in the Western Cape shows some horizontal relationships. The horizontal relationship between commercial farmers and small-holder farmers is often mediated by government policies (in the context of Black Economic Empowerment policies and land reform projects). Here commercial farmers mostly provide different types of assistance to small-scale farmers, and some can also buy produce from them or help them market their produce through established pack houses. Some commercial farmers are also vertically integrated and own pack houses (either individually or amongst several commercial farmers that are shareholders of the pack houses), and therefore commercial farmers could both store and sort their produce in those facilities and arrange the packing of produce form small-scale farmers. Small-scale farmers can also have a similar relationship with exporting companies, mediated by the similar institutional arrangements. Therefore, both commercial farmers and exporting companies can engage in arrangements with small-scale farmers that involve marketing their produce. At the same time, commercial farmers often sell to exporting companies (figure 3), since they do not often establish direct relationships with external markets abroad. However, note that some commercial farmers can reach a higher level of vertical integration and have exporting functions as well.

Regarding horizontal relationships in the local and lower-value trade systems, we can highlight the role of informal traders, Fresh Produce Markets (FPM) and pack houses. All these types of actors can buy or get produce directly from producers (figure 3). Informal traders can also buy produce from the pack houses or from the FPM, and they can also buy and sell to each other. Thus, informal traders could buy from different types of actors, probably depending on the strategy of each informal trader as well as their selling locality and the distance between farms and towns. In addition, pack houses can also sell the fruit that is not of enough quality to be exported to the FPM.

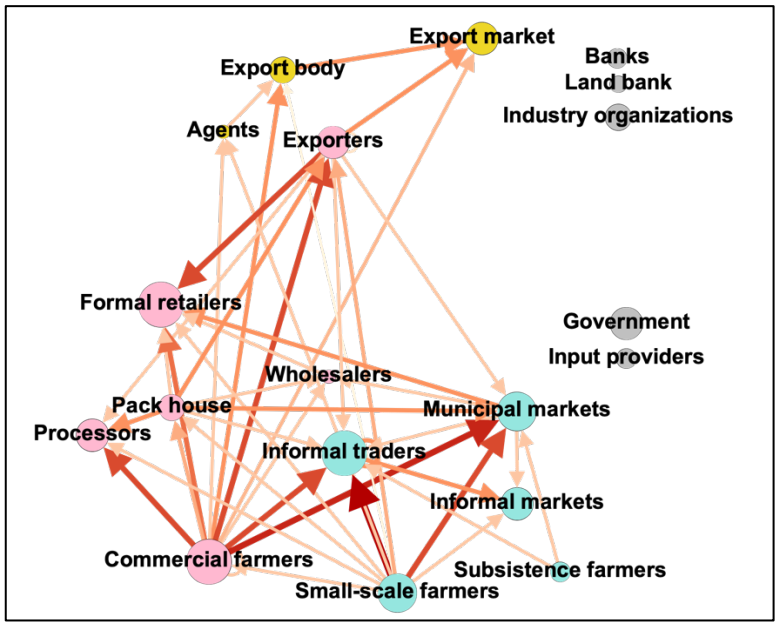

Figure 3. Results of mapping the Western Cape deciduous fruit trade network. *Summary of trade networks mapped by 6 interviewees, where: arrows: trade relationships from seller to buyer; nodes: actor types identified as important in the value chain; colour of node: network components; size of arrow and colour intensity: number of people that identified the relationship (the biggest and most intense -red- were identified by the 6 interviewers); position: spatial scale of their main operations, from local communities to international.*

Relational embeddedness

Interviewees described the relationships between the export-oriented value chain actors as stable. Relationships between farmers and exporters are often based on written contracts and highly formalized. Some informants noted that this level of formalization guaranteed that stability, as compared to the more informal relationships that can exist with informal traders and local markets. In addition, other factors were mentioned as important reasons for maintaining stable relationships, such as the need to guarantee a stable provision of fruit with the right quality standards for exporting and selling to high-value national supermarkets, or the importance for producers to get high consistent prices for all their produce. Interviewees described that these are trusting business relationships. However, there is also active testing of the quality of the produce at the level of exports and supermarkets to guarantee compliance with quality standards.

Other relationships would be highly informal or based on verbal agreements. Those relationships were described as more inconsistent, even though they could also be stable. For instance, situations were described where farmers and informal traders can have arrangements to trade every year. For example, arrangements where the farmer can call the informal traders requesting him/her to come to pick up the produce before it rots, which would favor that the farmer sells to him/her when there is extra fruit. It was also mentioned that a farmer may only sell to a few informal traders. This indicates certain stability and reciprocity or loyalty between informal traders and farmers that builds over time. However, others described situations where farmers can be waiting for the informal traders to come, and they would not show up causing the harvest to fall and rot; or the fact that farmers would prioritize the export-oriented markets and sell to informal traders depending on what produce is available at a given time and the quality of that produce.

In all these cases the stable relationships can be defined as commercial relationships, where the agreements benefit each other´s operations, and they may be driven by economic motivations such as establishing a profitable arrangement. For instance, interviewees suggest that farmers aim to maintain relationships with higher-value markets with that aim.

Actors involved in the export fruit value chain know each other and often participate jointly in the same forums, events, and producer's association. Therefore, there can be some friendship linked to moral obligations associated successful business arrangements between actors such as exporters, pack houses and commercial farmers. Still, most of the relationships are defined as commercially oriented where economic incentives prevail. We can highlight the case of some supermarkets (formal retailers) that may even disincentivize practices that may build friendship or tight relationships with producers to obtain produce at the best prices, as described by one interviewee. Producers can complain on such deliberative strategies to change partners on a regular basis (Interview 24). These practices were highlighted as characteristic of supermarket chains but not of other actors in the trade system that may value stability in the relationships. Despite the dominance of commercial relationships, other situations were described where there may be friendship and actors may help each other, mainly refereeing to neighbors or members of a farming community such as small-holder farmers helping each other, for example lending equipment or inputs in times of need. Commercial farmers may also cooperate to influence the industry towards beneficial conditions through producer associations, events, and sometimes engaging in joint ventures with each other such as sharing ownership of pack houses.

The relationships between commercial farmers and small-scale farmers may also imply technical assistance and credit provision. Commercial farmers could also help small-scale farmers in times of need with machinery, inputs, or credits (figure 2b). These relationships are criticized by some stating that they may trap small-scale farmers into relationships with commercial farmers, but others highlight that they are necessary to promote smallholder´s integration in the highly formalized export value chain and help them meet the required quality standards. Informants also noted that agents or export companies could also have the role of providing technical assistance and helping small-scale farmers with logistics and meeting quality standards for export markets. Agents and export companies can also help commercial farmers in a similar way, and export companies could also provide loans or advance payments to commercial farmers (figure 2b).

Despite this assistance between actors directly participating in the value chain, informants also highlighted the important role of the government, commercial and state-dependent banks, and different associations, in providing financial assistance (figure 2b). Commercial farmers would be able to obtain finance through banks, and the state may provide certain finance aid to small-scale farmers through different programs. Small-scale farmers and subsistence smallholders would often face problems to request loans from commercial banks according to one interviewee.

Small-Scale Fisheries in Western Cape, South Africa

The trade network for finfish in the Western Cape, South Africa (figure 4) can be described in 3 different components. The first one (blue, figure 4) comprises the informal trade networks and actors, whose most important traded species is snoek. In this context, some fish shops (e.g., fish and ships shops, smaller retail shops) can be associated to the informal trade and be sourced by informal traders (i.e., langanas) providing fish to poorer households. The second one (yellow, figure 4) comprises the larger actors associated to the formal value chains for the South African national markets, including industrial fisheries, processors, which are often factories, supermarkets, and retail shops. Retail shops such as supermarket chains are rarely sourced by informal traders directly, they are mostly sourced by other producers and traders (e.g., processors) that guarantee higher "quality standards" and often provide fish to richer households. Finally, the third component (pink, figure 4) includes actors associated to some fishing communities where yellowtail is an important target species which is mainly targeted for international markets. Note that as one interviewee explained, the dominance of the snoek vs. the yellowtail trade may depend on the fishing community and its location within Western Cape, which can be related to the presence of different species. Interviewees also highlighted that even if these two are the most important species, small-scale fishers also catch other species such as cape bream, but that they are of less economic importance. Note that industrial boats refer to trawlers that target species such as hake offshore, but that may also land other species such as snoek.

Structural embeddedness

We find some horizontal relationships, mostly involving the informal traders. Interviewees highlighted how langanas can trade with each other at times, and there can also be relationships between langanas and large hawkers or aggregators, who are other informal traders that deal bigger volumes. We must also note that the relationships identified were not identified by all researchers, and interviewees highlighted the need for further research in those relationships, since they were not the focus of previous research in the area. In addition, a horizontal relationship exists between community agents and company agents for the export of yellowtail (figure 4). Both are traders, but community agents live in the fishing communities and were described as "resource-poor", whereas company agents work closer with the companies and operate at regional scales. Therefore, they can be considered as different types of traders where the community agents sell to the company agents. Both have relationships with fishers, but they buy from different types of fishers depending on their technological capabilities (which can be associated to their ethnicity as described by one interviewee).

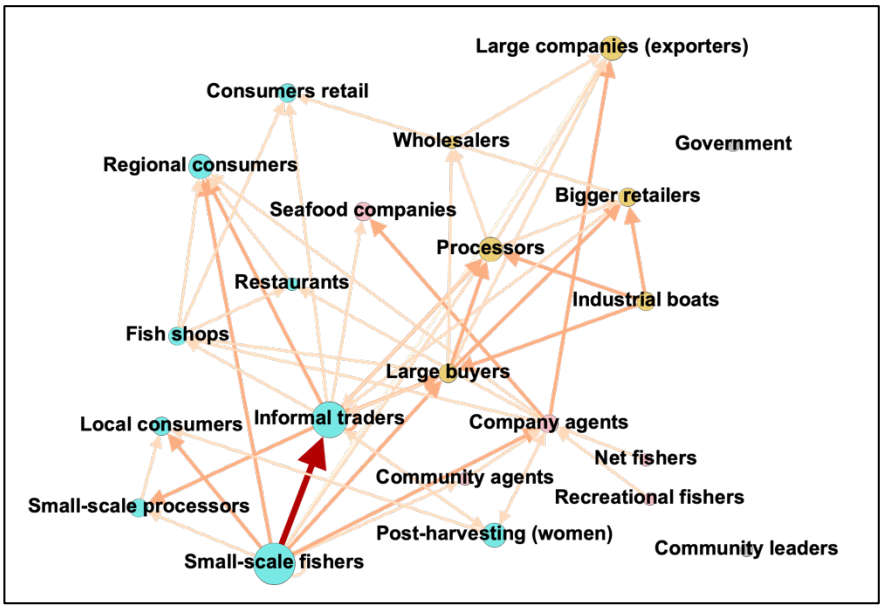

Figure 4. Results of mapping the Western Cape finfish trade network. *Summary of trade networks mapped by 6 interviewees, where: arrows: trade relationships from seller to buyer; nodes: actor types identified as important in the value chain; colour of node: network components; size of arrow and colour intensity: number of people that identified the relationship (the biggest and most intense -red- were identified by the 6 interviewers); position: spatial scale of their main operations, from local communities to international. Note: large buyers can also be named aggregators or larger hawkers that can be or not informal traders. Small-scale fishers aggregate different types of actors: skippers, crew, boat owners and right holders, where these roles can be held by the same actor or by different individuals. Small-scale fishers also aggregate fishers fishing under different types of access rights: commercial fishers and interim relief permit fishers, although they have significant differences discussed elsewhere.*

Relational embeddedness

The relationships between small-scale fishers (boat owners) and traders, being langanas, large hawkers, or community agents, was described as mostly stable. This stability is associated to commercial relationships where they always trade with the same person they already know and have certain understanding that they would buy/sell fish in times of need. This guarantees some security in the trade relationships. Informants highlighted that this relationship is not binding and there are auctions in the landing sites where informal traders would bid and fish is sold to the highest bidder; however, they also highlighted that this system coexist with some *de facto* relationships that can be maintained over time. This stability was also associated with the existence or loans or advance payments between traders and fishers or the provision of fishing inputs (e.g., ice, bait, fuel) by agents. However, not all interviewees agreed that the relationships between langanas or other traders and small-scale fishers involved credit arrangements (figure 2c).

Interviewees stated that long-term relationships between fishers and their traders often imply the existence of certain loyalty or trust in the relationship and reciprocity regarding the commercial arrangement, but mostly based on business motivations. Sanctions and conflicts were mentioned as mechanisms to guarantee that such relationships are maintained, especially when credits were linked to the trading relationships. In addition, we must also note that such type of relationships can also exist between skippers or boat owners and their crew, and not only between the boat owner and the informal traders. In this case study, crew fishers often have informal arrangements with the boat owners, where they may receive inputs necessary for

fishing (e.g., to cover fuel cost, bait) and sometimes loans in exchange of a percentage of the catch that should be given to the owner. This can happen in small-scale fishing boats but also in bigger commercial boats. Informants also highlighted the practice amongst some crew fishers to switch boats when they cannot face debts.

The nature of the horizontal relationships amongst traders was less known amongst interviewees. The relationships between langanas with each other and with large hawkers could be less stable and based on trading with each other in times of need. The relationships between community agents and company agents could be more stable and even imply the provision of some material assistance to community agents, who are resource-poor and may not be able to provide such assistance to fishers otherwise (although the interviewee stated not being sure about the existence of financial assistance in this specific relationship). In addition, informants highlighted the possibility that agents from different communities have relationships with each other. They also highlighted trade relationships between langanas that sell in different locations, noting that the selling location is often well defined through informal norms. However, such relationships have not been verified or investigated in depth by the interviewees. In other respects, company agents can have long term relationships working on a commission basis for the companies, but they are independent and could sell outside that arrangement at times.

Friendship or empathy would rarely exist between fishers and traders and amongst traders, according to the interviewees. Langanas, large hawkers and company agents were said to not generally be part of the local communities. Such personal relationships could exist between fishers at sea, and between members of the same fishing community, such as fishers, women, and community leaders. In such cases, fishers would try to help each other at sea or feel for each other in cases of accidents or formal sanctions by the fisheries department. In some cases, there may also a sense of caring about fishers being employed as crew, and women having work during pre and post harvesting activities.

Community members that work outside fisheries, either family members or having other relationships with fishers, can also provide informal credits or loans to fishers. Boat owners could also try to provide help in times of need to the fishers that work for them and are their neighbors, if they have a strong relationship, which has been found in some cases.

RESPONSES TO CHANGE ACROSS CASE STUDIES

We present a description of the subthemes identified from the responses to the fictional narratives as part of the vignette method (table 3). Table 4 shows the documents in which each sub-theme was identified per case study, corresponding to the icons in figure 5 in the manuscript.

TABLE 3. Responses to change. Sub-themes emerging from the analysis of responses triggered by the narrative of change for all case studies.

Response	Description	Example
Decrease activity	Decrease volumes or activities of production and commercialization.	Less volumes to informal traders in SA; coffee processors or fruit packs houses operating at lower intensities.
Increase effort / New technology	Increasing effort or productivity which may be associated with acquiring new technology.	Push to get bigger boats in South African fisheries, technology that increases productivity in South African fruit production, increase effort in Mexican fisheries.
Move elsewhere	Movement to other locations to engage in the same activities within the sector.	Movement of fishers to fish in other locations.
Migration	Movement to other locations outside the production sector. Related to new entrants in the Mexican fisheries case.	Coffee farmers migrating to Mexican cities or to the US; climate-related migration moving to the fisheries sector in Mexico.
Diversification outside production	The combination of other activities with food production, although the difficulties of doing that were mentioned by many (lack of assets and capacities, lack of options, and cultural identity to fishing).	Tourism activities in fisheries; fishers in SA and farmers in Mexico working on construction or other income-generating activities; informal traders in Mexico engaging in other occupations. In some cases, this can include illegal activities.
Shift in production	Diversification or transformation other coastal livelihoods in fisheries or land-use change in coffee production systems.	Shift to urban development, new crops (sugar cane, chayote) or pastures in Mexican coffee. In Mexican fisheries, tourism or aquaculture can also become an alternative occupation.
Diversification within production	Diversification between species or crops.	Fishers targeting multiple species, coffee farmers planting other tree species, fruit farmers engaging in livestock production. Also applied to informal traders trading multiple resources in SA.
Change crops or species	The start of harvesting a new species that was not in production before. It could be similar or combined with on-farm diversification. In the coffee-MX case, it can be related to the shift in production.	In fisheries, they start harvesting or commercializing new species that were not available or not commercialized before. In the Mexican coffee, start gradually changing the coffee forest for other crops eventually leading to a shift in production; or using another species of coffee (i.e. robusta) or traders changing to other crops.
Change varieties	Development and change of crop varieties.	Coffee varieties more resistant to pests, or fruit varieties more resistant to droughts.
Import	Importing (nationally or internationally) to supply the scarce resource. It can imply species substitution.	Imports of coffee or fish form other countries, imports of fruit from other regions or production areas.
Alternative food networks	Push to engage in alternative markets linked to sustainable and/or fair production or short value chains. Many highlighting the aim to cut the middleman. Also includes upgrading or vertical integration of actors where they develop new functions or add value to products.	Information technology connecting producers and consumers or producers integrating activities in South African fisheries; short value chains of specialty coffee or certified coffee systems in Mexico.
Value-adding	Increase processing of products or new processing to add value	In South African fisheries, new uses of fish skin, or the potential increase of locally processed fish and its consumption.
New markets	Searching for new markets to sell the product.	South African fruit exporters looking for new markets for different fruit quality or varieties; searching for new markets in Mexican fisheries, which can occur maintaining the same relationships with producers or not.
Disappear / exit	Abandoning the production or going out of business.	Younger generations not wanting to fish anymore; lack of profitability that leads to abandon the activities.
Government help / subsidies	Relying on government-mediated aid.	Fishers receiving subsidies in Mexico; small-scale (emerging) farmers relying on government support in SA; government facilitating access to new coffee varieties.
Credits	Asking or relying of credits as a response to the change.	Consumers relying on credit with interest form the informal fish traders or fishers in SA.
Lobbying / Collaboration	The use of collaboration, cooperatives or industry organizations to influence change.	South African fruit industry bodies mediating with the government to address challenges.
Change workforce conditions	Changes in the farm workers conditions.	Increase seasonal workers in South African farms.
Change norms and regulations	Changes in formal regulations or informal norms.	Changes in norms regarding fruit quality in SA.

Table 4. Frequency of interviews mentioning each sub-code*. Note that one interview in the Fruit-SA case did not include this section of the interview.*

Responses	**Number of documents**	**Coffee-MX case**	**Fruit-SA case**	**Fish-SA case**	**Cases**
Diversification outside production	9	3	2	4	3
Diversification within production	8	2	3	3	3
Change varieties	7	4	3		2
Alternative markets	7	2		5	2
Disappear / exit	6	4		2	2
Decrease activity	5	3	2		2
Import	5	1	1	3	3
Change crop or species	4	3		1	2
Migration	4	4			1
Move elsewhere	3			3	1
Shift in production	3	3			1
Credits	3			3	1
New markets	2		2		1
Government help / subsidies	2	1	1		2
Increase effort / New technology	2		1	1	2
Value-adding	2			2	1
Lobbying / collaboration	1		1		1
Change workforce conditions	1		1		1
Change norms/laws	1		1		1
TOTAL	**16**	**5**	**5**	**6**	

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