

AMERICAN UNIVERSITY OF BEIRUT

A SYSTEMATIZED REVIEW OF THE CONTRIBUTION OF
SOCIAL NETWORKS TO AGROECOLOGICAL
INFORMATION TRANSFER IN FARMING COMMUNITIES

by
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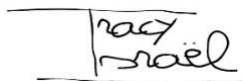
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ABSTRACT OF THE PROJECT OF

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The impact of human actions on the environment is enormous, it reached a planetary scale. One of the solutions proposed for solving the unsustainability of global agriculture and food systems is agroecology. Human behavior is a driving force for environmental change. Since social networks are primary channels of information flow between humans and profoundly affect human behavior; it is important to explore their impact and linkages to agroecology and knowledge transfer. Therefore, this study aims to assess the contribution of social networks in agroecological information transfer in farming communities using a systematized review that explored three different databases. Results showed that social networks are vehicles that transmit knowledge, nonetheless it is important to recognize what type of knowledge is transmitted and who are the powerful actors that initiate this process. Moreover, the farmers' characteristics, motivation and vision could also affect knowledge acquisition. Finally, it is important to highlight a theme that appeared throughout this paper: asymmetric power relation and inequality. This was present in different levels, whether between different actors (individuals and institutions) in the networks or between countries. In order to transmit agroecological knowledge different engagement level should be present: individual, community, national and international.

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CHAPTER I

INTRODUCTION

The impact of human actions on the environment is enormous, it reached a planetary scale. Humanity is profoundly dependent on the processes of the Earth system, in order to proceed with its social and economic development. Therefore, natural resources depletion will not only affect Earth systems and the environment, but also, societal and economic development, as humans rely on the ecological services offered by the ecosystems (Bansard & Schröder, 2021). Knowledge concerning these two areas and their complex relationship is increasing; nonetheless, the ability to predict future outcomes and human activities is still limited. This challenge can be faced by getting a better understanding on how to alter the way humans govern natural resources, on how institutions work and their governance structures and of course on how to enhance the sustainability of ecosystems in order to generate ecosystem services and natural resources. This requires different disciplines and research that engulf both social and environmental sciences (Bodin & Prell, 2011).

Environmental governance faces different range of social issues; starting from designing adequate institutions that can mitigate uncertainties, facilitating the stakeholder's cooperation, going to more complex issues such as power, conflicts, class and consensus and how these aspects play a role in shaping the way the resources are governed (Bodin & Prell, 2011). For example, one of the main challenges of natural resources are the ineffective institutional arrangements that carry a wide range of actors that compete, this led to overexploitation of those resources and distribution of the ecosystem's dynamics and processes (Bodin & Prell, 2011; UNEP, 2012). On the other hand, natural resources are crucial assets that food systems rely on; whether to produce

and harvest food or even for packaging, processing, cooking and transport. Therefore, in order to keep the food system going, sustainable usage of natural resources is crucial (UNEP, 2016). It is important to highlight that food systems are accountable for 26% of the global greenhouse gases and 60% of biodiversity loss. Moreover, agriculture uses 70% of freshwater and half of the habitable lands worldwide (Ritchie & Roser, 2020). Since food systems rely on natural resources and are main contributors for natural resources exploitation and degradation, people behind these systems are key agents in changing unsustainable practices and properly managing natural resources (UNEP, 2016). One of the solutions proposed for solving the unsustainability of global agriculture and food systems is agroecology (HLPE, 2019).

Agroecology developed as an approach to limit the environmental impact of farming systems by applying ecological principles. It is based on developing an in-depth understanding of the ecology of farming systems. It came as a response to the rising problems resulting from the industrialization and globalization of agro-food system (Méndez et al., 2013). It is characterized by its multidisciplinary character and its ability to evolve over time. Agroecology is not only seen as a scientific approach, but also, as a movement and a series of practices. It is a holistic approach that applies ecological and social principles and concepts in order to design and manage sustainable agriculture (Sarandon & Marasas, 2017). Agroecology helps to provide contextual solutions to local problems while putting the people at the center. “It seeks to optimize the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced” (FAO, 2022).

Agroecology is based on knowledge intensive agricultural practices; it is based on different knowledge systems. At the farm level, it is presented by re-skilling farmers and combining local knowledge with scientific knowledge, in order to create a knowledge system that suits the context (Altieri & Nicholls, 2012). It not only conserves productivity and natural resources, but also, it is culturally sensitive, economically viable and socially just (Coolsaet, 2016). Agroecology pushes the integration of social, ecological and economic principles to help farming system become more resilient. It includes social movements that seek behavioral change, sustainable agriculture practices and transdisciplinary science (Sinclair et al., 2019). A key element of agroecology is the co-creation and sharing of knowledge. Moreover, human behavior is a driving force for environmental change (Barnes et al., 2016). Since social networks are primary channels of information flow between humans and profoundly affect human behavior; it is important to explore their impact and linkages to agroecology and knowledge transfer (Barnes et al., 2016).

Social networks are social structures constituted of several social actors, ties and other forms of social interactions between individuals and organizations (Snijders, 2011). By analyzing and examining those networks, the network dynamics will be interpreted. Social network analysis is a useful tool to study the diffusion of agroecological knowledge (Cadger et al., 2016). Social networks enable farmers to transmit technical information using those social relations. Thus, farmers practices are dynamic learning processes (Wang et al., 2020). At the farm level, the three development factors (entrepreneurial skills, resources and labor) are properly combined by ensuring adequate technical knowledge and skills. Agricultural knowledge helps farmers to be part of a system that allows them to participate in idea and knowledge exchange and in decision

making with different farmers. This has a positive impact on rural development; however, knowledge acquisition and transfer aren't an easy process (Mkenda et al., 2017). Therefore, this study aims to assess the contribution of social networks in agroecological information transfer in farming communities.

CHAPTER II

RESEARCH QUESTION

In order to assess the contribution of social networks in agroecological information transfer in farming communities, the following research question is tackled: How is agroecological knowledge produced and transferred through social networks in farming communities?

In order to tackle the research question; the following sub questions are answered:

- Is agroecological information passed through social networks?
- Which form of agroecology is passed through social networks?
- Does the type/characteristics of social networks affect knowledge transfer?
- Does the type of knowledge system (formal or informal) affect knowledge transfer?

CHAPTER III

LITERATURE REVIEW

A. Agroecology

There are different definitions for agroecology; institutions and countries choose to adopt the one that represent their concerns and priorities (HLPE, 2019). Some of the traditional agricultural systems could be labeled as agroecological; for example, mixed cropping systems, traditional agroforestry, some pest management techniques (Oteros-Rozas et al., 2013). Therefore, modern agroecological science rely on local practices and techniques to face the negative social, economic and ecological impacts of the “industrial agriculture model”. However, agroecology complements these efforts with scientific research and new innovative practices (Migliorini et al., 2018; Montalba et al., 2017). As mentioned in the introduction, agroecology is not only seen as a scientific approach, but also, as a movement and a series of practices (HLPE, 2019). As a scientific approach, agroecology is the application of ecological principles in farming systems in order to maximize the interactions between humans, animals and the environment for better nutrition and food security. Some of those principles are diversification, soil health, recycling... (FAO, 2022). Furthermore, the transdisciplinary aspect of agroecological science pushed this concept to a more holistic approach. The scope of agroecology widened and engulfed the whole agri-food system (Wezel & David, 2012; Côte et al., 2019). When it comes to agroecology as a set of practices, it is defined as the practices that aim to turn away from the “industrial agriculture model” to a more sustainable model (Wezel & Silva, 2017). Different researchers tried to specifically define what is an agroecological practice. For example, for Shiming and Gliessman (2016) “agroecological

practices are those ecologically sound methods which can balance and enhance all ecosystem services provided by agroecosystems and hence benefit to the sustainable development of agriculture” (HLPE, 2019, p. 36; Shiming & Gliessman, 2016). However, there isn't a definitive list for what is considered as an agroecological practices and what is not (Wezel & Silva, 2017). Nonetheless, there are few criteria that can highlight if a certain agricultural practice is on the agroecological spectrum: “(i) they rely on ecological processes as opposed to the use of synthetic agrochemical inputs; (ii) they are equitable, environmentally friendly, locally adapted and controlled; and (iii) they adopt a systemic approach, rather than focusing only on specific technical measures” (HLPE, 2019, p.36). Some examples of agroecological practices include: organic fertilization, drip irrigation, integrated pest management... (Leakey, 2014). As for agroecology as a social movement; “agroecosystems cannot be separated from the human communities living in them: social and political dynamics are at the heart of agroecology” (HLPE, 2019, p.38). In order to face agrarian crisis, agroecological approaches are intertwined with social movements to induce change (Mier y Terán et al., 2018). Moreover, social movements (for example, La Via Campesina), try to advocate for food sovereignty and the right to food. They considered agroecology an important pillar of food sovereignty and not only a set of practices and technologies. It became an ideology that will help people to fight power imbalances in order to “generate local knowledge, promote social justice, nurture identity and culture, and strengthen the economic viability of rural areas” (HLPE, 2019, p.38). Moreover, it will help build sustainable local food systems (Nyéléni, 2015; Anderson et al., 2015).

Adopting sustainable and agroecological practices can face several challenges. They can be divided into four categories: “perspective of individual landholders, the

characteristics of desirable management practices, the socioeconomic structure of adopters' communities and the broader institutional settings" (Kheiri, 2014, p.160). These practices necessitate constant learning commitment. Farmers can be hesitant into adopting such practices as they lack information concerning the management techniques and economic and technical issues. Also, farmers' personal characteristics and perceptions tend to play a role in this transition. On the other hand, economic factors present another barrier; farmers are burdened and worried about the economic cost of these practices (Kheiri, 2014).

B. Knowledge System

1. Definitions

In order to move forward towards agroecological practices, one of the main pillars is to understand farmers' learning processes and knowledge. This not only includes how farmers understand their farms and its environment, but also, knowledge transfer and conflicts that arise when they are in contact with others (the focus is more towards farmer-to-farmer knowledge relations) (Thomas et al., 2020). "Farmers' knowledge is defined as the capability of a farmer to co-ordinate and to (re-) mould a wide range of socio-technical growth factors within specific localities and networks towards desired outcomes (e.g. sustainable levels of production)" (Stuiver et al., 2004, p.100). Farmers' social relations are vital to their knowledge acquisition and sharing (Pe'er et al., 2020). Moreover, farmers' knowledge is shaped by complex processes and factors; it is mostly linked to "place". This local knowledge is developed by and within a context or place and shaped by features that are specific for this area. They come from different sources such as the culture and the economy of this area (Riley et al., 2018). As for knowledge systems, they

present how people and institutions join together to generate, share, and exchange knowledge and information (Tengö et al., 2017).

2. Type of knowledge systems

There are two types of farmers' knowledge system; the formal knowledge system that generate knowledge from practitioners, while the informal knowledge system is the one gained outside the formal one (Curry & Kirwan, 2014; Sumane et al., 2018). Informal knowledge is the first channel of knowledge transfer between farmers. They “operate in fuzzier networks, relying on community ties, family and personal relations, neighborhood associations, peer groups, territorial communication structures and traditions” (Sumane et al., 2018, p.6). Informal knowledge produced in the local context is more holistic as it takes into consideration the different dimensions that affect farmers (social, economic, environmental technical) and the complexity of their realities. On the other hand, these networks help diffuse knowledge as farmers are more prone to adopt practices implemented by their peers (Aidoo & Freeman, 2016; Rivera et al., 2018).

3. Factors affecting knowledge systems

It started to be acknowledged that farmers' knowledge has a crucial role in agriculture and innovations that are sustainable (Chambers & Thrupp, 1994). Of course farmers' knowledge can integrate elements from formal knowledge systems (for example, formal education, the government, scientific knowledge...), however it is not enough. It should be complemented by local/ informal knowledge systems specific to the local context and specific farm (this knowledge comes from other types of social networks such as family, neighbor coworker...). Debates emerged concerning the role of the informal knowledge

systems and the role of farmers in agroecological knowledge dissemination (HLPE, 2019).

Several studies show that sustainable agriculture is best acquired and transferred by multiple actors' knowledge networks. These networks turn farmers from passive receivers to active participants, which valorize interactive and participatory knowledge creation and transfer (Moschitz et al.,2015; Beckford & Barker, 2007). In order to understand how those informal networks promote sustainability, the factors that reinforce farmers' decisions should be listed. There are different social and personal factors that affect farmers' knowledge acquisition and learning decisions. Social factors can be linked to the expectations of the community they live in (food quality, environmental protection, new services and products). As for the personal factors they are more related to the farmers' values, ethics and emotional considerations. These factors guide farmers and impact their choices of which sources and form of knowledge to acquire (Rivera et al.,2018). Other studies noted that the way farmers perceive the meaning of farming also impact their behavior and choices. If they perceive it as business; they will seek information that can enhance their performances (reduce costs, increase growth and income). On the other hand, if they perceive it as something ethical and social; their passion is what drives knowledge seeking behaviors. This is also linked to family pride and the responsibility to keep it flourishing from generation to another. This latter perspective pushes farmers to care not only for their production and efficiency, but also, for the environment (even if it will affect their production). Another incentive that pushes farmers towards knowledge is the community itself: the local village, cooperative and neighboring farmers (Hurwitz et al., 2015; Rivera et al.,2018).

Farmers seek knowledge from different sources. First, they rely on their own knowledge for their daily operations (Buckley & Shortle, 2015). Also, farmers can seek their knowledge from family members; this information is accumulated over the years and passed to different generations. Moreover, farmers can seek knowledge from their successful colleagues, especially when they work in similar condition or type of farms. Small farmers seek knowledge from each other not only for better production but also as source of inspiration (De Roest & Ferrari, 2015). It is also important to mention that farmers also seek knowledge from formal networks (institution, governments, NGOs). In some studies, it was also mentioned that market actors also bring valuable knowledge for farmers. They stimulate farmers to rethink their practices (marketing, selling, products...) (Darnhofer & Starss, 2015; Bourdin et al.,2015).

C. Social Network

1. Definition

Farmers can rely on information from their social network to acquire agricultural knowledge and transfer it through social interactions. These interpersonal relationships and interactions facilitate learning processes between farmers; this will lead to knowledge formulation. However, not all social networks are built the same way and lead to similar outcomes. There are bonding ties that are more related to families and neighbors, and on the other hand there are bridging ties that are more related to extended relationships that reach different sources of information (Pratiwi & Surzuki, 2017).

Farmers' social networks are systems that connect farmers with social identities and international patterns. There are different types of social networks, for example, horizontal social networks that are characterized by interaction between some people that

know each other and have similar power and status. When the network is constituted from people that have different asymmetric relationship and power, it is a vertical social network (Liu et al., 2017; Alemu et al., 2018).

Social networks are social capitals; they are a community level resource that helps coordinating actions and an individual level resource that can complement other forms of capital such as natural, financial and even physical. These different types of capital are valuable assets for humans and enable them to achieve better livelihood outcomes. Social networks are considered as the structural elements of the social capital whereas norms and trust as the cognitive element (Claasen & Lemke, 2019).

2. Characteristics of social networks

Social networks help addressing environmental problems of agriculture by transferring knowledge; this will expand the number of farmers adopting adequate management practices. In order to understand social networks, the drivers that influence the formation of those ties should be understood: nodal attributes, network structure and external factors (Alexander et al., 2018; Palacios & Villalobos, 2016). Nodal attributes are the characteristics of the farmer; they can give a clear insight on the farmer's socio-economic situation. For example, age, perceptions, gender and more. As for the network structure: "Network structure refers to endogenous network processes, like reciprocity (you sharing knowledge with me, makes me more likely to also share knowledge with you), transitivity (I ask those for advice that my advisors also ask for advice), or centralization (most people ask you for advice)" (Albisua et al., 2021). As for the external contextual factors, they are concerned with the characteristics of the farm and land of the

farmer, its location and the distance between it and other plots (Alexander et al., 2018; Palacios & Villalobos, 2016).

Another way to measure social networks is its size and density. The former is concerned with the number and direction of ties, actors and connections. The latter, constitute the percentage of actual ties; this feature is important as it affect information flow and transfer. For example, a network with high density can lead to higher communication between actors, however, this do not guarantee new information. On the other hand, low dense networks may acquire new information; nonetheless, the information flow is low. It is important to note that the density is not the same throughout of the network, it can alter. For example, at the core of the network usually there is a denser connection and the information flow is high; unlike at the peripheries, where the density is lower and communication and exchange are minimal. A core-periphery relationship might help enhancing the information flow even in low density areas (Isaac & Dawoe, 2011).

In a social network the ties between the actors can be weak or strong. Strong ties are descried by tightly-knit networks between the individuals and groups, along with higher levels of bonding and trust. The members of those networks mainly have similar characteristics (socio-economic and demographic). On the other hand, weak ties are defined by having different characteristics between actors (such as power or status); it is a hierarchical relationship. However, these ties are also important in certain context, they might help bridging between the less advantaged groups with more socially advantaged groups; in this case they might gain access to knowledge or resources from them (Claasen & Lemke, 2019).

There are constant changing dynamics in agricultural systems; farmers need access to different types of information in order to better manage the system or farm. In some cases, specialized scientific knowledge is not enough to reach the desired outcomes, due to its irregular transfer of agrarian information. Therefore, informal information is needed to counteract such gaps between farmers and institutions. Informal social networks are important for resource management. Adopting new techniques in agriculture is partially dependent on links within social systems, on the other hand, when the focus is channeled towards understanding the relationships and structures of those ties, it becomes a social network. The structure of social informal networks has a role in advancing or weakening sustainable agrarian management. Communication patterns can grow into different forms of social networks. These networks also have several structural characteristics that can either obstruct or enhance information transfer (Bodin & Prell, 2011).

A study conducted on farmers in Spain showed that, farmers' awareness regarding land management was associated with the structure of the social network among them. For example, intensive farmers were engaging in the network and exchange knowledge, whereas traditional farmers were more isolated and refraining from sharing their knowledge. However, in this case knowledge transfer was not for positive outcomes. The farmers that are adopting agriculture intensification were aware of their negative impacts and traditional farmers were also aware that their traditional knowledge had positive impacts. Nonetheless, since the "modern farmers" were at the core of the social network they were in control of the flow of information and its transfer (Albizua et al., 2021). Different studies have noted that informal networks should complement formal networks and not replace them. Different features and different locations of social networks have different implications on practices. In a study conducted in Tanzania and Ghana, social

networks played a major role in information transfer in specific parts of practices. Moreover, farmers were willing to exchange information with peers that had similar characteristics (education level, same farm type and same village); it was noted that the strong kinship ties that are present in these community helped in enhancing the effects of social networks (Wossen et al.,2013; Muange et al., 2014).

CHAPTER IV

METHODOLOGY

This study aims to explore how is agroecological knowledge produced and transferred through social networks in farming communities. Moreover, it will answer the following sub-questions:

- Is agroecological information passed through social networks?
- Which form of agroecology is passed through social networks?
- Does the type/characteristics of social networks affect knowledge transfer?
- Does the type of knowledge system (formal or informal) affect knowledge transfer?

To be able to tackle these questions the following methodology will be used.

A systematic review is “a review of the evidence on a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant primary research, and to extract and analyze data from the studies that are included in the review” (Temple University Libraries, 2022). It is often used when the research has a defined research question, a team working together, time, access to databases and data availability (Grant & Booth, 2009). When it comes to a systematized review, it includes characteristics similar to the characteristics of a systematic review. However, it doesn’t present the same results as a systematic review. Nonetheless, systematized reviews are reliable and provide adequate data to rely on for further studies (Paz et al., 2020; Mahvar et al., 2018; Sawka et al., 2013). Some of those characteristics

are: a defined research question, inclusion and exclusion criteria, protocols, comprehensive evaluation of study quality, a rigorous search of literature that will allow other researchers to replicate the work (a transparent methodology) (Duke University, 2022). Systematized reviews include rigorous elements of a systematic review; however, it only explores a limited number of databases. In other words, they commit to the process of selecting and analyzing literature using a well-defined methodology; however, their scope will be limited to what an emerging scholar may complete within a certain time frame (Yamane & Helm, 2022). The main aim of a systematized review is to provide an indicative review on a certain topic without complete comprehensiveness and analysis of everything that has been written in the literature (Clarke & Crane, 2018).

In order to answer the research question and its sub questions, a systematized review was conducted. Scopus, Web of Science and Google Scholar were the databases used to collect the articles. These databases were chosen because the researcher has full access to their content and they cover rural community development and social sciences subjects. Based on different inclusion and exclusion criteria, the articles were chosen using the following keywords: social networks, farmers, agroecology, social network analysis, knowledge system and knowledge transfer.

The inclusion criteria:

This review considered qualitative or quantitative research studies conducted worldwide on farmers, their social networks and agroecological knowledge transfer.

The exclusion criteria:

- Studies that tackle aspects other than agricultural practices.

- Studies that don't include farmers participants
- Studies that are more than 10 years old.

First, each database was searched using the strategies shown in Table 1. Second, articles were filtered using the inclusion and exclusion criteria mentioned above. The researcher went over the abstract of each article in order to choose the article that fit the criteria and to eliminate duplicates; it is presented in Table 2. Finally, each article is a unit of analysis, they are critically read and the content is analyzed based on different aspects: the form of agroecology discussed, the characteristics of the social network, the type of knowledge system and whether knowledge transfer is reached or not.

Database	Search Strategy	Total number of articles
Google Scholar	“social network” AND farmers AND agroecology AND “social network analysis” AND “knowledge system” AND “knowledge transfer”	63
Scopus	farmer AND “social network” AND agroecology	13
Scopus	farmer AND social network AND social network analysis AND knowledge transfer	24
Scopus	farmer AND “social network” AND “knowledge transfer”	10
Web of Science	“social network” AND farmer AND “knowledge transfer AND “social network analysis”	20

Table 1 Search Strategy

Database	Final number of articles
Google Scholar	15
Scopus	7
Scopus	8
Scopus	7
Web of Science	2
	Total = 39

Table 2 Final Articles

CHAPTER V

RESULTS AND DISCUSSION

It was clear throughout all the articles included in this systematized review that social networks are essential pathways for knowledge transfer. However, there are factors that hinder or empower this process. This section will elaborate these factors.

A. Social Network

1. Formal and informal knowledge systems

It was shown in different studies that knowledge transfer is best acquired when both the formal and informal knowledge systems are intertwined. Nonetheless, farmers do not always have access to both or they don't reach out for both (Musacchio et al., 2020; Prastyo et al., 2020; Rockenbauch et al., 2019). Both formal and informal systems/institutions were needed in order to reach knowledge transfer. The informal system operates in a bottom-up manner, it was characterized by trust between the members and unity (members held similar characteristics). On the other hand, the formal system was a state-led medium that has legal and financial resources that will reinforce knowledge transfer (Prastyo et al., 2020).

Farmers perceive two knowledge systems: the formal one that comes from scientists and authorities, and the informal one that comes from neighbors. Farmers use each knowledge system to collect a different type of knowledge and information. The former to collect technical information and the latter for advice that can help them change their farm strategies (Musacchio et al., 2020). For example, in different stages in the adoption of agroecological practices, different actors were reached by farmers. Farmers that are in the first stages, rely mainly on informal networks (their peers); on the other hand, farmers

that are already practicing agroecological practices were more relying on the formal network (the government, NGOs or private sector) for support and knowledge transfer (Garbach & Morgan, 2017). It is also important to mention that scientist don't perceive a difference between formal knowledge and advice (informal knowledge). However, it does differ for the farmer: "In farmers' opinion, frequency, informality and consistency with their production goals makes the relationships that occur on a local scale (i.e. with retailers and other farmers) stronger and relevant compared to those with the actors of other governance scales" (Musacchio et al., 2020, p. 511).

"Direct knowledge sharing and exchange not only helps to develop and disseminate practices, but also strengthens the social structures of the network particularly when joint learning creates collective benefits, such as an improved local environment, an eradicated pest or a boosted local economy" (Malusà et al., 2022). This was fueled by the bottom-up approach that was used by the organic farmers in the European union; they diversified their networks and sources to be able to sustain. The good intentions and efforts of the farmers are not enough, it should be coupled by the availability of the adequate diversified support networks. This study highlighted the importance of the formal network and connections at a higher territorial level to face different challenges and to strengthen the network development. However, this isn't possible in all regions. In some cases, formal agriculture knowledge still empowers conventional, production-oriented model of agriculture (Malusà et al., 2022). In some countries, formal institutions were absent or poorly developed, this pushed farmers to rely on informal knowledge systems (Tuna et al., 2020; Koutsouris & Zarokosta, 2021).

The presence of formal and informal knowledge systems is important because it allows farmers to diversify the source and type of knowledge acquired, but also, to

strengthen the formal lines of communication. Some of the informal network members share the knowledge they acquire from the formal network with their peers (Sandoval & Blazquez, 2019). A study conducted in Ethiopia showed that there are few formal networks that disseminate knowledge through trainings. However, only the farmers that have central positions in the social network are involved in these trainings. Nonetheless, this community was also characterized by strong informal networks between different farmers. This had a positive impact on knowledge transfer; as farmers who didn't attend trainings, acquired the knowledge from their peers that attended the trainings (Alemu et al., 2018).

2. Social network structure

The interpretation of the farmer network structure facilitates agricultural development interventions, this will improve knowledge exchange and will yield sustainable agricultural practices (Cadger et al., 2016). There is no one type of structure or characteristic that insures knowledge transfer or the adoption of agroecological practices. "Different types of social network effects are effective for producers with different traits, which refers to the importance of visual inspection versus verbal contact for illiterate and literate producers, respectively. Social learning thus comes in different forms, requiring 'tailormade' interventions when working with heterogeneous pools of producers" (Alemu et al., 2018, P.313).

In a study conducted in New Zealand, the farmers' network is characterized by being densely tied, having homogenous members and decentralized. These characteristics facilitates the transmission of new and complex knowledge and enhance collective problem solving. When it comes to the relationship between farmers and scientists, it was

based on interpersonal trust as they had many people in common. Due to this structure, communication concerning new agricultural knowledge became an everyday conversation and interaction rather than being a formal meeting or activity (Wood et al., 2014). Other studies have showed that having a core-periphery structure can also help in transmitting knowledge between members. In the absence of agricultural extension support due to lack of public budgets, members of farmers groups form ties that will facilitate knowledge exchange. Farmers that are mostly reached for advice are considered leaders and are in the center/core of the network. Other farmers are more isolated and are present in the peripheries of the network. Between these two, there are farmers that play the role of brokers, they play an important role to transmit knowledge to the farmers that are at the periphery, linking them to the farmers present at the core. This shows the importance of peer advice network in the diffusion of agricultural knowledge (Lin et al., 2021). Farmers that play the role of brokers and disseminate knowledge are very important actors in networks, because sometimes the central actors won't be able to reach all members of the network (Polge & Pagès, 2022; Adolwa et al., 2017; Seitova & Stankulova, 2017). However, it is not always the case. A study conducted on farmers in Spain showed that, farmers' awareness regarding land management was associated with the structure of the social network among them. For example, intensive farmers were engaging in the network and exchange knowledge, whereas traditional farmers were more isolated and restraining from sharing their knowledge. However, in this case knowledge transfer was not for positive outcomes. The farmers that are adopting agriculture intensification were aware of their negative impacts and traditional farmers were also aware that their traditional knowledge that had positive impacts. Nonetheless, since the "modern farmers" were at the core of the social network they were in control of the flow

of information and its transfer. This is an example of how key network members can inhibit transformational change. This asymmetric knowledge sharing occurred not only due to the close connections between intensive farmers but also, due to the formal intuitions that favors intensification (Albizua et al., 2020).

“Innovation depends on the equilibrium between the closeness (bonding) and openness (bridging and linking) of the network ensured by the figure of the broker that connects different groups of people” (Polge & Pagès, 2022). Social networks include bridging ties (with institutions) and bonding ties (generational, kinship, friendship, peer to peer). The former type focus on infusing novel information and intervention, whereas the latter focus on shaping the adoption of the practices via interactions. The balance between these two types fuels knowledge transfer and the adoption of practices. The structural pattern of the social network are the members and the links between them (information flow) is also important in these processes. These patterns could be assessed by centrality and density measures (Hauck et al., 2016). “The challenge is not to theorize and professionally legitimize new forms of specialist facilitation that link the knowing with the unknowing. Rather, it is to take stock of the farmer-facilitated networking already in practice and to learn more about the complexity it introduces into the systems that sustain agricultural innovation” (Wood et al.,2014).

3. Weak vs strong ties

“Weak ties are linkages between actors characterized by infrequent contact, communication or interaction in terms of knowledge exchange. Conversely, strong ties are characterized by dense networks of mutually interconnected and often homophilous actors that interact frequently” (Seitova & Stamkulova, 2017). Homophilous actors are

members that have similar characteristics. Therefore, having a combination of both ties enhances knowledge transfer. Since the weak ties will allow the farmer to acquire new knowledge and the strong ties will let him disseminate them to other peers (Seitova & Stamkulova, 2017). Although strong bonding ties can have positive implications on farmers, in some cases they might hinder the farmers progress and innovation as they block him from reaching or engaging in new knowledge. “When this is the case, the so-called ‘dark’ bonding social capital takes ‘the form of lock-in, path-dependency, or entrenchment of incumbent power, all of which can depress opportunities for sharing knowledge or other resources’” (Koutsouris & Zarokosta, 2021). For example, in a study conducted in Greece, strong bonding ties and the lack of bridging ties resulted in isolating farmers from important resources and stopped them from being part of the innovation process. An important aspect to consider is temporality, networks should change during the innovation journey (Koutsouris & Zarokosta, 2021). “Informal knowledge generated in local contexts tends to be holistic as it considers the complexity of the realities in which farms operate and integrates the many or at least several of the environmental, economic, social, financial, technical and other dimensions into a single whole” (Šūmane et al., 2018). Moreover, practical and experimental knowledge motivate farmers to learn more and boost his confidence and resilience (Šūmane et al., 2018). However, the importance of strong formal ties should not be underestimated (Adolwa et al., 2017). Being aware of the key sources of information in a network can help us identify potential entry points for further information dissemination. Moreover, each type of information has a different network (Simon et al., 2021).

B. Type of Crop

Even in the same community farmers can have different patterns for knowledge acquisition, especially when they harvest different type of crops. In Thailand, researchers found that each crop has its own network that has its own characteristics; therefore, it has its own knowledge transfer pathway. Initiating decisions to adopt certain practices are driven by local ties (trusted peers); however, implementation advice is driven by translocal ties (ties that connect people from different locations). For example, in the sugarcane network, a top-down oriented knowledge system was more effective. The central actors (large scale farmers) were in control of the type of information shared and impact local sugarcane farming. Those farmers were bridging between formal and informal knowledge systems. On the other hand, when it comes to the rice farming, the structure of the network is different and the central actors are not large-scale farmers. The network follows a bottom-up approach; they retrieve their innovative knowledge in other ways (Rockenbauch et al, 2019). Low engagement with social institutions leads to weak structures of formal networks. In a study conducted in Western Balkan countries, farmers had low engagement with social institutions yet they acknowledge their benefits. These farmers were more oriented towards informal networks. This was due to their common historical, political and economic background that fractured their trust with formal institutions. Nonetheless, researchers found that the trust of farmers can be regained through positive experiences with those institutions (Tuna et al., 2020).

Also, some formal networks are more interested in certain crops, therefore they focus their benefits on the farmers that harvest it (Rockenbauch et al, 2019). For example, in France the organic farming network is more supported by formal institutions; whereas in

the conservation agriculture network, farmers rely on their peers to seek knowledge and resources (Polge & Pagès, 2022).

C. Farmers' Characteristics

In Malishow, although the farmer's network structure was good and can facilitate knowledge transfer, it wasn't the case. This was due to the characteristics of the farmers; they were young farmers that are overwhelmed with off farm employment. Information acquisition is an important step for the actual adoption of new practices or new technologies.

The farmer's motivation and positive experiences are key factors that will allow the success of social networks (Tuna et al., 2020). Farmers are sometimes reluctant to share information due to competition (especially when it is a cash crop) (Rockenbauch et al, 2019). Formal and informal actors sometimes discriminate between members. The religious affiliation of the farmer affected knowledge acquisition and transfer in both the formal and informal knowledge systems (Alemu et al.,2018). "Geographical and social distance presents an obstacle for social learning just as it does for extension operations" (Matouš et al., 2013). In other words, farmers that live closer to villages centers, have larger farms and personal networks, and belong to the same ethnic or religious group as the extension worker are more likely to be included in formal networks and services (Matouš et al., 2013).

Moreover, farmers began to expand their knowledge acquisition sources for example, magazines, websites, mobile application... (Musacchio et al., 2020). Social media became a promising communication media that will allow learning and knowledge sharing. However, this is mostly popular in developed countries like United States,

Canada, Australia and UK. For example, twitter is one of the social media tools that could be used for knowledge sharing within the agriculture sector. A study was conducted on knowledge sharing between farmers concerning sustainable soil management. They found that this platform has potential especially that it also delivers visual content and brief messages. Nonetheless, it is considered as an informal peer network; farmers will be inspired by trusted peers to implement new practices. They noticed that younger farmers are more interactive on such platforms; but since the conversations (for example, problem-solving discussion) are publicly available, everyone will benefit from the information. It is important to mention that one of the challenges is the geographical inequalities between and within countries; not all areas are equipped with the right technology infrastructure and literacy. Moreover, farmers expressed that although this platform offer them wider networks and various resources, it can't diminish the importance of face-to-face interactions in the field. Researchers highlighted the importance of "blended learning" which is an approach that intertwine online and face to face knowledge exchanges. Also, they encouraged scientists and advisors to join in these discussions to enrich the outcomes (Mills et al., 2019). Several factors predicted a farmer's choice to use information and communications technology for agroecological knowledge: accessibility, cost and his level of education (Achora et al., 2019).

The literature also showed that those networks are not only build of male local farmers even though most studies have them as the main focus. In Italy, researchers found that innovation support systems (advisory services, training, information) and the female farmers' entrepreneurial characteristics impacts the innovation behavior. Both formal and informal networks were important for female farmers to collect adequate information to run their farms sustainably (De Rosa et al., 2020). Migrant farmers tend to have larger

social network compared to local farmers. Moreover, in this study they have a central position in the network therefore, they play an important role in knowledge dissemination. However, there are two main challenges, first, local farmers tend to only seek knowledge exchange from local peers. Second, the transfer of agroecological information could occur, if those migrant farmers have or already implement such environmental practices. In Ghana, external information is needed. Migrant farmers allow bridging between geographically and socially distant groups (Isaac et al., 2014).

D. Agroecology: A Top-Down or A Bottom- Up approach?

In most studies agroecology is mainly referred as a practice. This aspect of agroecology is mostly linked to top-down approaches. However, agroecological knowledge and innovation is not only originated from sciences; different actors should work together (Mills et al., 2019). However, even if the actors were heterogeneous, a horizontal hierarchy is needed to keep the farmers engaged. This is possible by implementing a bottom-up approach that brings together farmers that have indigenous knowledge with experts that have scientific knowledge; through a two-way communication network (Dessie et al., 2013). Social networks that are strongly bonded might resist foreign people, especially when those foreigners' knowledge is not similar to the knowledge that the farmer is seeking. This problem is usually faced when using top-down approaches in agroecological knowledge transfer (Prastyo et al., 2020). In order to achieve an agroecological transition, resilience and adaptation in rural communities is required. When it comes to the farmers, they should be aware of the farming system in order to achieve a successful transition. Therefore, they need social relationships, clear policies, institutional support and interactions with diverse actors. Nonetheless, this

process is turbulent and requires structural changes, different stages and a shift in the relationships between the actors. The participation of different actors that share knowledge with farmers is needed (Polge & Pagès, 2022).

The presence of different type of stakeholders is important (private, public and NGOs), they facilitate knowledge transfer in the community. It is also important that these actors interact in the network in order to deliver better outcomes. Moreover, each actor has different intensity and role, therefore their impact is different (Pali et al., 2013).

Knowledge generation is often driven and funded by international donor organizations and international agendas. The poor engagement of national organization in developing countries to fund knowledge generation activities is a great concern. It is important that governments and local organization prioritize local/national concerns. This will help local actors to better assimilate and implement practices on the long term. “Inter-organizational collaboration has the potential to increase the legitimacy and credibility of knowledge generation and dissemination activities” (Ofoegbu et al., 2018). The core-periphery structure of social networks is also present between organizations. Moreover, having a two-way flow of information between them is essential for knowledge dissemination. For example, in Kenya, having no collaboration between organizations is hindering the knowledge transmission to pastoralists (Ofoegbu et al., 2018).

A study conducted in Senegal, analyzed a different level of networks: the transnational level. The researchers found that the agroecological community form a niche network that is mainly dependent on international NGOs and international cooperation programs. After studying the structures of network, it turns out that NGO have a central role in the network whereas farmers unions are in the peripheries. This leads to the empowerment of the NGO instead of farmers and their unions. Moreover,

knowledge and resources will be control by the NGO. Most literature link agroecology to a bottom-up social movement in order to alter the agrarian system and empower farmers. However, in Senegal the case was different, farmers and their organizations still consider agroecology as a foreign concept that they don't actually understand and implement. This is enhanced by the fact that organizations that are responsible of disseminating this concept, dissociate agroecology and social movements. This will make the farmer a passive actor. This structure and dependency on NGO are due to the political history of Senegal (colonization). Knowledge transfer is therefore based on external donors and NGOs. What is interesting about this article is that it highlights the effect of the power relation in knowledge exchange (NGO- farmers, North-South). The agroecological transition is still relying on international aid; this favors NGOs, donors and research organizations which are pro top-down approaches and focus more on agroecology as a practice rather than ideology and movement (Boillat et al., 2022). On the contrary, the case in Colombia was different. Researchers found that agroecology is being implemented by a bottom up/ horizontal approach (farmer to farmer and "learning by doing") and consider agroecology as a social movement. Farmers' schools are farmer-led formative initiatives that aim to develop and transfer agroecological knowledge and new leaning systems. This horizontal knowledge exchange between farmers "generate a dialog between socio-technical, traditional, and scientific agroecological knowledge" (Chaver-Miguel et al., 2022). This also encouraged collective actions in which social learning occurs. Moreover, these schools give farmers shared identities and push them to work together. The presence of such schools in the community creates networks between farmers that allows them to transfer knowledge. Nonetheless, the role of the state and the

environment in which these schools are built in are important as they are the ones that infuse the knowledge and adequate resources (Chaver-Miguel et al., 2022).

Agroecological practices are often unevenly adopted; this is influenced by “macro- and micro-forces linked to institutions, the state, agricultural cooperatives, markets, and farmer-to-farmer knowledge sharing” (Isaac et al., 2021). Those social transactions and interactions can empower or weaken the adoption of such practices. The transmission of new information via social networks is a key factor in this process. After studying different cocoa farmers community in Ghana that have been exposed to agroforestry interventions, researchers found that farmers that are part of larger network, have direct ties to organizations (local or external) and have connections with distant farmers (external actors) implement more agroecological practices. It is important to mention that farmers that were part of developmental projects sought information for informal networks and not formal ones. In other words, the first wave of information and adoption of agroecological practices is through formal networks, however, the expansion of this process is more based on informal networks between farmers. Although the findings came from three different regions in Ghana (different history, cultural and environment), the results were similar. However, what these community have in common was the type of crop produced. In this study, agroecology was also coming from a top-down approach that does not take account of the socio-political factors of the community. They noticed that they were fewer collective actions and unity. For example, farmers benefited from the knowledge exchange on a personal level and not collective level. They also highlight the importance of intertwining both type of network and not only focusing on farmer to former knowledge acquisition (Isaac et al., 2021). The participatory method is more effective in the in the innovation dissemination process rather than the usual

hierarchical mechanisms. Especially that the implementation the agroecology is not only possible when adequate information is present. Farmers are not always able to apply what they know due to lack of adequate resources and infrastructure (Aguirre-López et al., 2019). Farmers are more comfortable and cooperative when they are included and play active roles. Moreover, they tend to learn more when they are in the field and seeing the methods and the benefits of the practices discussed (Dessie et al., 2013).

CHAPTER VI

CONCLUSION

This systematized review aimed to explore the contribution of social networks in agroecological information transfer in farming communities. Agroecological knowledge could be transferred through social networks, however different aspects should be taken into consideration. First, farmers' characteristics, motivation and vision affect knowledge acquisition. Also, it is crucial to understand the structure of the social network (the roles and the responsibilities of the actors); researchers should answer the question who is involved in the process and not only which agriculture practice to implement (how). Social networks are vehicles that transmit knowledge, nonetheless it is important to recognize what type of knowledge is transmitted and who are the powerful actors that initiate this process. There is no one rule that defines the best structure or characteristics of a social network that could transmit agroecological knowledge; it is context specific, especially that each country and community have its own political, historical social and economic background. Therefore, it is important to engage the community and be aware of the asymmetric power relations. Agroecology is mostly considered as a practice in the literature and is coupled with top-down approaches. Nonetheless, the results showed that farmers engage more when they are involved. Limiting agroecology to specific practices weakens its outcomes. Especially when it is imposed by outsiders that don't take into account the context of the farming community. Interpersonal relationships and formal relationships are essential in the agroecological transitions. However, actors and their roles can differ in each stage; especially that knowledge generation, dissemination and implementation are different processes tailored by different actors. Finally, it is important

to highlight a theme that appeared throughout this paper: asymmetric power relation and inequality. This was present in different levels, whether between different actors (individuals and institutions) in the networks or between countries. In order to transmit agroecological knowledge different engagement level should be present: individual, community, national and international.

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