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An integrative review of innovations in the agricultural sector: The roles of agency, structure, and their dynamic interplay

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ABSTRACT

The aim of this paper is to improve our understanding of the roles of individuals and the importance of their social contexts in shaping the dynamics of technological diffusion in the agricultural sector. When justifying the different rates of innovation adoption, existing literature reviews overemphasize either the drivers of technological changes enacted by farmers' agentic behaviour or the cognitive processes of individual farmers and their social contexts (structures). However, they continue to have a fragmented view of how local social systems and the agentic behaviour of individual actors influence the evolution of technological regimes, and they lack the ability to describe a purposeful interplay between agency and structures. We present an integrative review of the most relevant papers published in the last 20 years and discuss the impact of structures and agency emerging from local social systems on the local innovation process and, as a result, the evolution of technological regimes. The identified macro categories describe the main processes affecting individuals' abilities to mobilize and manage local resources for innovation, allowing us to critically assess the stock of previous developments from a new perspective and identify novel research avenues.

1. Introduction

The 2030 Agenda for Sustainable Development explicitly states that scaling up agricultural innovation requires more than new technology. Governments, in collaboration with academia, civil society, farming organizations, and the private sector, must create the conditions for the innovation process to thrive by connecting these various actors, strengthening the capacity of farmers and other stakeholders, and providing incentives for innovation. Indeed, institutions can be viewed as a prerequisite for a strategic agency to act, while institutionalized structures shaping individuals' social embeddedness in the social network, informal rules, and taken-for-granted scripts can be interpreted as conditions of pressures on strategic agents who, identifying constraints in the achievement of efficient outcomes, may violate institutionalized rules, structures, and strategies. Therefore, institutions can play a dual role by providing both a foundation for strategic agency to act in a complex system and a groundwork for emergent and better options to flourish while violating established institutions. In the same vein, we contend that the processes of democratization of innovation, in which people are encouraged to mobilize and manage their own resources with institutions acting as enablers, pass through a dynamic interplay between institutional pressures, strategic agency, and the organizational change that farmers embrace or may drive through the "embedded process of social engagement" facilitating people interactions (Emirbayer and Mische, 1998a, 1998b: 962–963). Its analysis necessitates an integrative approach in which both structures and agency are presented as drivers of the evolution of an innovation regime, as they destabilize each other while remaining interdependent and controlled by a political-strategic process in which institutions, elites, and structure collaborate (Collier, 1999).

Previous literature reviews on agricultural innovation have placed a strong emphasis on the drivers of technological changes enacted by farmers' agentic behaviour. When justifying the different rates and frequencies of innovation adoption in the agricultural sector, some other literature reviews have begun to pay attention to the cognitive processes of individual farmers and their social contexts (structures) (see for instance Molina-Maturano et al., 2019, El Bilali, 2018, Devaux et al., 2018). However, they continue to have a fragmented view of how local social systems and the agentic behaviour of individual actors influence the evolution of technological regimes, and they lack the ability to

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describe a purposeful interplay between agency and structures. We present an integrative review of the most relevant papers published in the last 20 years and discuss the impact of structures and agency, as well as their interaction, on the evolution of technological regimes.

Accordingly, we first examine papers that emphasize the locus of action towards the adoption of a new practice at the individual level, while also considering structures as the contexts in which situated actions occur (structure vs agency). Second, we investigate the extent to which differences in individual behaviours aimed at mobilizing resources and changing rules in the individuals' interests are caused by differences in the structure of network configuration individuals are in as well as their individual characteristics (agency vs structure). Third, we investigate how the level of individuals' embeddedness in social contexts (network agency) can explain individuals' personal decisions about actions to take for a practice to adopt and/or change, and how the social network can be viewed as favouring and constraining "social behaviour and social change" (Wellman, 1983: 157).

Thus, our research questions are as follows: What are the primary processes and mechanisms that promote farmers' strategic adoption? How is it possible for farmers to play a role in breaking established rules? The second research question seeks to observe the conditions of existence as well as the peculiarities of farmers who exhibit agentic behaviour. As a third aspect, we address the research question: What are the resource management reconfiguration approaches that promote local innovation in the agricultural sector? In doing so, we hope to provide an integrative view of the relationship between strategic agency and structures in an institutional change model, demonstrating how new technological regimes can propagate by overcoming farmers' interest-driven behaviour, inducing and maintaining proper institutional changes, and thus realizing the democratization of innovation.

These issues have not yet been raised, managed, or addressed. They reflect the current state of research in the agricultural sector's literature on innovation, which has provided only a fragmented picture of the complicated and paradoxical interplay between structural and agential factors and how they favour or hinder democratization of local innovation development.

In the following sections, we will first explain the methodological steps we will take to identify the core sample of papers and describe the established conceptual categories. We also make maps to show the reader the collaborative dynamics of the scientific community around the topic under investigation. Then, we provide a detailed description of the three emerging categories, including key takeaways and unresolved issues. The final section is important for proposing to the scientific community a research agenda for future studies.

2. Methodology

Our approach is grounded on an integrative review of the existing literature (Elsbach and Knippenberg, 2020). Integrative reviews provide new insights (theoretical and conceptual) derived from synthesising and/or critiquing existing research. According to Post et al. (2020, p. 354), "articles that review a body of work contribute to theory when they do not merely report on previous literature but, rather, analyse and synthesize the research to generate new ways of conceiving of a given field or phenomenon."

The outcome contributes to research by, first, offering a holistic perspective on the topic at hand, and second, organizing the existing body of knowledge in a meaningful way. To keep track of and clarify the integrative process, we use Tranfield et al.'s (2003) generic principles to (1) frame the objective, (2) execute the process, and (3) present the results.

2.1. Framing the objective

Because so much emphasis is placed on the implications of democratizing innovative processes (Von Hippel, 2005), giving people who operate in the agricultural sector a central role and shedding light on how they can mobilize and take advantage of their resources in order to innovate, we frame the paper's overall objective by recalling the main research questions:

RQ1: What are the main processes and mechanisms that favour farmers' strategic adoption?
RQ2: How is it possible for farmers to play a role in breaking established rules?
RQ3: What are the resource management reconfiguration approaches that promote local innovation in the agricultural sector?

2.2. Execution

We develop our literature search strategy in the second step by performing four actions: (a) identification, (b) screening, (c) assessment, and (d) selection. The literature search strategy is depicted in Fig. 1.

Because of their extensive coverage of relevant literature and advanced bibliometric features, we rely on two major bibliographical databases, Web of Science and Scopus (Gavel and Iselid, 2008; Falagas et al., 2008).

In terms of 'identification' (action a), we wanted to learn more about the agricultural innovation process. Relying solely on documents containing the word "agriculture" would provide a misleading view due to numerous overlaps. As a result, we chose some highly related terms, such as 'rural,' in order to collect relevant articles that may have been overlooked. Furthermore, we adopted the definition of 'innovation' proposed by West and Farr (1990: 9) who define it as "the intentional introduction and application within a role, group or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, organization or wider society."

As a result, we first searched Web of Science for all documents that contained the Boolean queries "innovat* AND agri*" and "innovat* AND rural*" in the topic search. Articles or reviews published in English and in peer-reviewed journals ranked in both agriculture and business economics domains and published between 2000 and 2020 met our inclusion criteria. This resulted in a total of 2783 contributions.

A second search for the aforementioned two strings was conducted using the Scopus search engine's 'title, abstract, keywords' field, with the following inclusion criteria: articles or reviews published in English and in peer-reviewed journals ranked in agricultural & biological sciences, business, management & accounting, and econometrics, economics, & finance subject areas published between 2000 and 2020. This second search yielded 2848 results. A total of 5631 contributions were found.

We got 5440 contributions after removing duplicates (n = 191). The 5440 documents were then screened (action b) by checking titles and abstracts and comparing them to the exclusion criteria. Contributions that were not ranked in Q1/Q2 journals in the Journal Citation Reports were excluded. This choice, while having some limitations, allowed us to focus on the most influential journals in the field (Appio et al., 2014; Appio et al., 2016) by keeping the literature review concise and relevant. We retained 202 contributions.

Finally, the selected contributions were evaluated (action c). We read the contributions and determined whether they could be related to the research objective, excluding those that: 1) were not clearly innovation-oriented; 2) did not place emphasis on the social-cognitive processes that sustain individuals in the adoption and utilization of innovations and thus did not represent the people-centered approach; 3) used industries and enterprises as the primary unit of analysis; and 4) demonstrated primarily methodological contributions. We also excluded (n = 114) book reviews, interviews, case studies, and summaries of previously published articles.

Accordingly, 88 contributions were retained.

From 2000 to 2020, the number of publications gradually increased. According to Table 1, the topic has been covered by 22 different journals

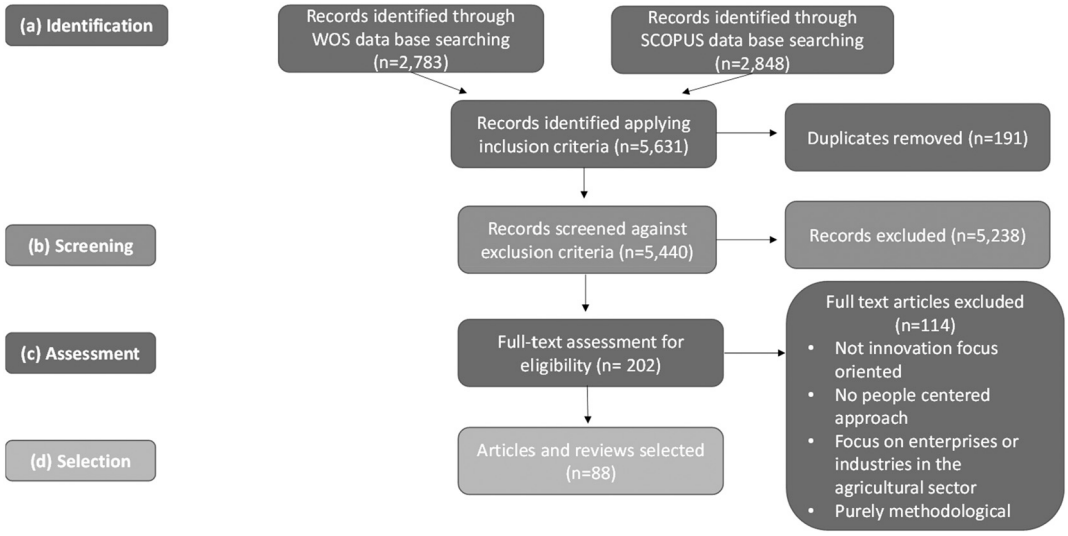

Fig. 1. Literature search strategy.

(18 classified as 'Q1' and 4 classified as 'Q2' in the Journal Citation Reports[1]). The majority of publications were ranked in the multidisciplinary agriculture research area.

The most important journals, according to the number of publications selected, are as follows: *Agricultural Systems*, *Agricultural and Human Values*, and *Agricultural Economics*. Only one paper is conceptual while the vast majority of contributions are empirical. Out of the empirical documents, 45 (i.e. 51.1 %) are quantitative whereas 43 (i.e. 48.9 %) are qualitative.

In terms of geographical distribution, 35 % originated in Africa, while 15 % were carried out in America, 13 % in Europe, and 11 % in Asia. For country-specific patterns, Ghana represented the highest number (n = 10) of studies, while Ethiopia, Kenya, and Uganda each represented 9 studies; finally, 25 studies covered more than one country.

The following map[2] shows the collaborative patterns between scholars researching this topic at country level (Fig. 2):

Scholars from the Netherlands dominate the sample and heavily interact with other countries such as Germany, United Kingdom, United States and quite a number of countries from the African continent.

The most influential scholars in the field as well as their collaborative network are shown in Fig. 3:

Klerkx Laurens[3] and Leeuwis Cees,[4] both at Wageningen University & Research Institute, are the most prolific authors and act as bridges between different research communities.

Finally, Fig. 4 shows the most influential institution researching the field:

The Wageningen University & Research Institute remains the reference point when it comes to this topic, with more than 18 publications associated published by its scholars.

2.3. Presenting the results

In order to present the findings, an inductive qualitative content analysis was carried out in accordance with the recommendations of, Creswell (2017), and Post et al. (2020).

Keeping in mind our main research questions, we discussed the following key questions for each of the selected articles: What is the article's purpose? What exactly is the research question? What is the significance of this research, and what gaps does it fill? Which key definitions were employed? What are the fundamental units of analysis? What is the theory that is being used and tested? What is the nature of the data collected and analyzed? What are the most important findings and implications?

These questions were crucial in determining the main emerging themes. Following our responses, we created a table of summarized information organized by theme, followed by a list of references related to each theme. A second round of in-depth reading was carried out to identify the common themes that linked the sources. This second step was completed by answering the following questions: what do the examined contributions have in common? What distinguishes them from one another? Which key themes stand out? These questions were helpful in avoiding thematic overlap and consolidating the tables of summarized data that we report in the Appendices.

Selected papers were carefully read, and their content was inductively analyzed based on key emerging concepts and keywords. To organize the data for each paper, an extensive excel file was created. The emerging topics were noted, along with their relationships, and the key messages for each paper were reported. Proper topic headings emerged iteratively, and the classification of papers into relevant categories became clear. Based on methodological indications (Miller, 1956), the number of categories was deductively reduced to three, each of which corresponded to one of the three research questions that guided the study. The entire process was discussed by all of the authors. Insightful comments gathered during the review process aided in the finalization of the results presentation, with a more refined selection of papers based on their relevance to the scope of the categories. The categories established were based on the problems defined by the three research questions, and thus they include papers: 1) reporting on the main processes and mechanisms favouring farmers' strategic adoption (structures vs agency); 2) describing how farmers can play a role in breaking established rules (agency vs structures); and 3) identifying reconfiguration approaches to resource management (such as the constellation of external (to the field) actors) (network agency).

Without claiming that these are the only research streams, we believe that they are the major avenues through which a people-centered approach to agricultural innovation processes can be understood. We can gain insights into how to address institutional and social processes that assist individuals in mobilizing and managing local resources for agricultural innovation by analyzing these processes.

[1] https://clarivate.com/webofsciencegroup/solutions/journal-citation-reports/.

[2] Maps generated by means of VOSviewer v1.6.16, https://www.vosviewer.com/ (Normalization method: Association Strength).

[3] https://www.vcard.wur.nl/Views/Profile/View.aspx?id=5100&ln=eng.

[4] https://www.vcard.wur.nl/Views/Profile/View.aspx?id=3943&ln=eng.

Table 1
Summary and classification of the core 88 contributions.

Journal	Ranking JCR	Type of study	Type of approach	Type of analysis	Analyzed countries
(22) Agricultural Systems	Q1	(22) Article	(22) Empirical	(10) Quantitative	Ghana, Malawi (2), United Kingdom, Australia, Mexico, China, Nigeria, Niger, Rwanda, Uganda, DR Congo, Zimbabwe, Mozambique, Chile, Ethiopia, Ireland
				(11) Qualitative	China, Morocco, Kenya (2), Bolivia, Ethiopia, Peru, Uganda, Benin, Ghana (2), Burkina Faso (2), Cameroon, Senegal (2), Ethiopia, France (2), Algeria, Madagascar, Dominican Republic, Vietnam, Mali, Indonesia, Brazil, Italy, Canada
				(1) Conceptual	N/A
(10) Agriculture and Human Values	Q1	(10) Article	(10) Empirical	(7) Quantitative	Ethiopia (2), Kenya, Ghana, Lao, Nicaragua, El Salvador, Thailand, Honduras
				(3) Qualitative	Vietnam, Togo, China
(9) Agricultural Economics	Q1	(9) Article	(9) Empirical	(9) Quantitative	Ethiopia (2), Benin, Turkey, Australia, Sri Lanka, Kenya, India, Thailand
(8) Outlook on Agriculture	Q2	(8) Article	(8) Empirical	(2) Quantitative	Malawi, Tanzania
				(6) Qualitative	New Zealand, Ghana (2), Benin (2), Mali, United Kingdom, Belgium (2), Malawi, Nigeria, Zimbabwe, India, The Netherlands
(6) International Journal of Agricultural Sustainability	Q1	(6) Article	(6) Empirical	(2) Quantitative	Bangladesh, Japan
				(4) Qualitative	Burkina Faso, Benin, Uganda (2), Ghana, Kenya (2), Bolivia, Peru, Ecuador, Nepal
(6) Renewable Agriculture and Food Systems	Q1	(6) Article	(6) Empirical	(3) Quantitative	Ghana, Nigeria, United States of America
				(3) Qualitative	Cuba (2), Australia
(5) Journal of Sustainable Agriculture	Q1	(5) Article	(5) Empirical	(3) Quantitative	Malawi, Brazil, Spain
				(2) Qualitative	Kenya, United States of America
(4) NJAS-Wageningen Journal of Life Sciences	Q1	(4) Article	(4) Empirical	(1) Quantitative	Ghana
				(3) Qualitative	Ghana, Myanmar, Benin
(3) Experimental Agriculture	Q1	(3) Article	(3) Empirical	(3) Qualitative	Nicaragua, Uganda, Ethiopia, India, Burkina Faso, Kenya, Nicaragua, Uganda, Burundi, Rwanda, DR Congo,
(2) Australian Journal of Agricultural and Resource Economics	Q2	(2) Article	(2) Empirical	(2) Quantitative	New Zealand, United Kingdom
(2) Precision Agriculture	Q1	(2) Article	(2) Empirical	(2) Quantitative	Germany (2), Greece (2), Spain, United Kingdom, Spain, The Netherland, Serbia, France, Czech Republic, Denmark
(1) Agroforestry Systems	Q2	Article	Empirical	Quantitative	Malawi
(1) Agronomy	Q1	Article	Empirical	Quantitative	Uganda
(1) American Journal of Agricultural Economics	Q1	Article	Empirical	Quantitative	Greece
(1) American Journal of Alternative Agriculture	Q1	Article	Empirical	Quantitative	Canada
(1) Applied Economic Perspectives and Policy	Q1	Article	Conceptual	Qualitative	California
(1) Crop Protection	Q1	Article	Empirical	Quantitative	Tanzania, Kenya, Uganda, Ethiopia, Benin
(1) Entrepreneurship & Regional Development	Q1	Article	Empirical	Qualitative	Colombia
(1) European Review of Agricultural Economics	Q2	Article	Empirical	Quantitative	DR Congo, Rwanda and Uganda
(1) Journal of Agricultural Education and Extension	Q1	Article	Empirical	Qualitative	The Netherlands
(1) Land Use Policy	Q1	Article	Empirical	Qualitative	New Zealand
(1) Livestock Science	Q1	Article	Empirical	Quantitative	Mexico

3. Results

This section synthesizes and organizes the data gathered in this current review into a multidimensional framework describing the interplay between structures, human agency, and network agency as enacted through socio-political systems. The established link between the individual agency, structure, and network agency will inform about the mechanisms governing the spread and evolution of new technology, organization, and/or related practices in the agricultural sector, as well as the process of democratization of innovation. Each sub-section discusses the key findings emerging from the papers collected in each identified category, provides insights into current research gaps, and proposes new research questions.

3.1. Structure vs agency

We intend to report on a structural perspective of human decision to adopt a new practice/technology/organization in this section. We summarized empirical evidence to explain the relationships between farmer decisions to adopt a technology or a new related practice and the cognitive-social-political processes that result in structures that influence human action. Based on this theoretical focus, we present the final list of research articles, all of which are summarized and referenced in Appendix 1 in relation to their implications for the structures relevant to

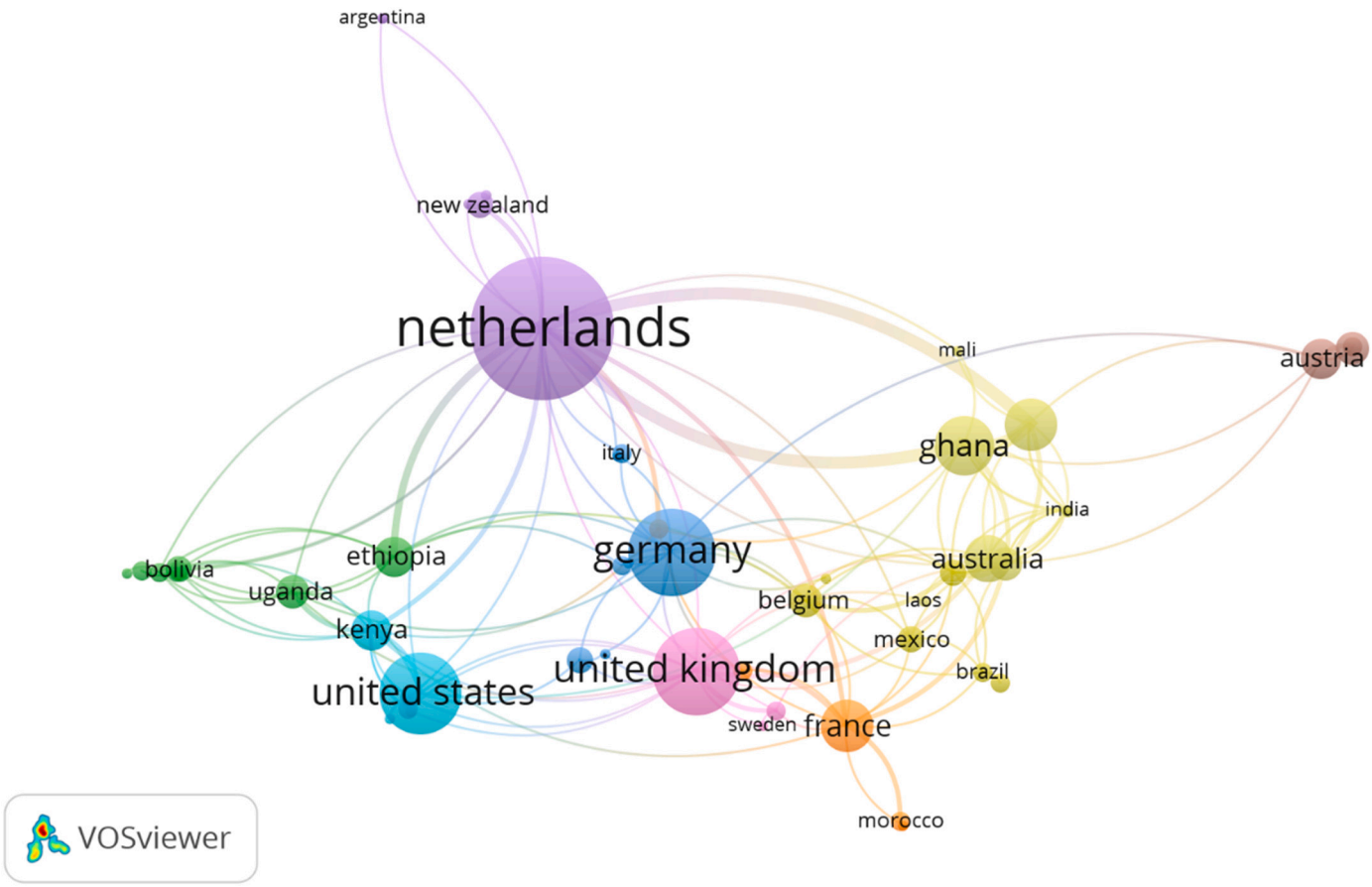

Fig. 2. Collaborative patterns (country level).

influencing farmers' decisions to adopt a new technology. In particular, in this category, we look at papers that demonstrate how farmers, as human agents, are influenced by the surrounding institutional settings and draw on their stocks of knowledge (tacit and explicit) of previous actions and the situation at hand, available resources and facilities, norms to operate, and make a decision about adoption (see Giddens, 1979).

More specifically, some papers in this category show how farmers use their unequally distributed assets (see social structure in Table 2) as the foundation for their engagement in social activity that leads to the adoption of a technology or a new related practice. In this case, the conditioning effect of structure on agency is not one of mechanical determinisms; rather, it provides the reason for different courses of action.

Together with social structure, individual types and attitudes have emerged (see types and attitudes in Table 2) as "coins that do not readily melt. Once they are formed they persist [...] and compel individuals and groups to behave in certain ways whatever they may wish to do- not indeed by destroying their freedom of choice but by shaping the choosing mentalities and by narrowing the possibilities from which to choose" Schumpeter (1974, pp 12/130).

Other papers in this category emphasize the importance of social contexts as spaces where subjectivities and identities are constantly formed through regular social interactions and where some constraints may be enacted shaping individual decisions to adopt a technology or a new related practice (see social context in Table 2).

Structures, on the other hand, are not just an external aspect on which individuals rely to guide their conduct and choices; they also become a part of the activity in the form of individuals' reason and motivations (Layder, 1993). According to Tsoukas (1989), these mechanisms (motivations, perceptions, and reasons) cause individuals to act in a certain way. Other papers in this category report on various types of perceptions and beliefs that help or hinder farmers' adoption (see perceptions, motivations and beliefs in Table 2).

According to research studies in this category, the extent to which farmers become change agents is also dependent on the power environment affords them, which in turn is related to the amount of information transmitted to them and that they master (see Information transmission and knowledge provision in Table 2). As a result, these studies link adoption to actors' knowledgeability because it gives them more control and leads to an underemphasis of the idea that institutions may work against them.

To summarize, the structural properties of the environment in which farmers operate contribute to the adoption of a technology or new related practices (agency), and their resources and uses also provide rules of signification. However, as some studies show, the perceived significance varies between men and women (see gender in Table 2). Table 2 reports on the specific structural elements referred to as affecting agency in the selected research studies in this category for each type of environmental structural property described in the selected research studies in this category, as well as the related studies discussing them.

3.1.1. Farmers' decision to adopt new practices as induced by institutional context

This section examines the theoretical contributions of the selected research studies in this category and discusses relevant future research directions.

3.1.1.1. A missed view on the institutionalization process leading farmers to adopt new practices. Famers are constantly exposed to opportunities to innovate in practices related to the use of new technologies, and in some cases, they even seek solutions in new technological products that

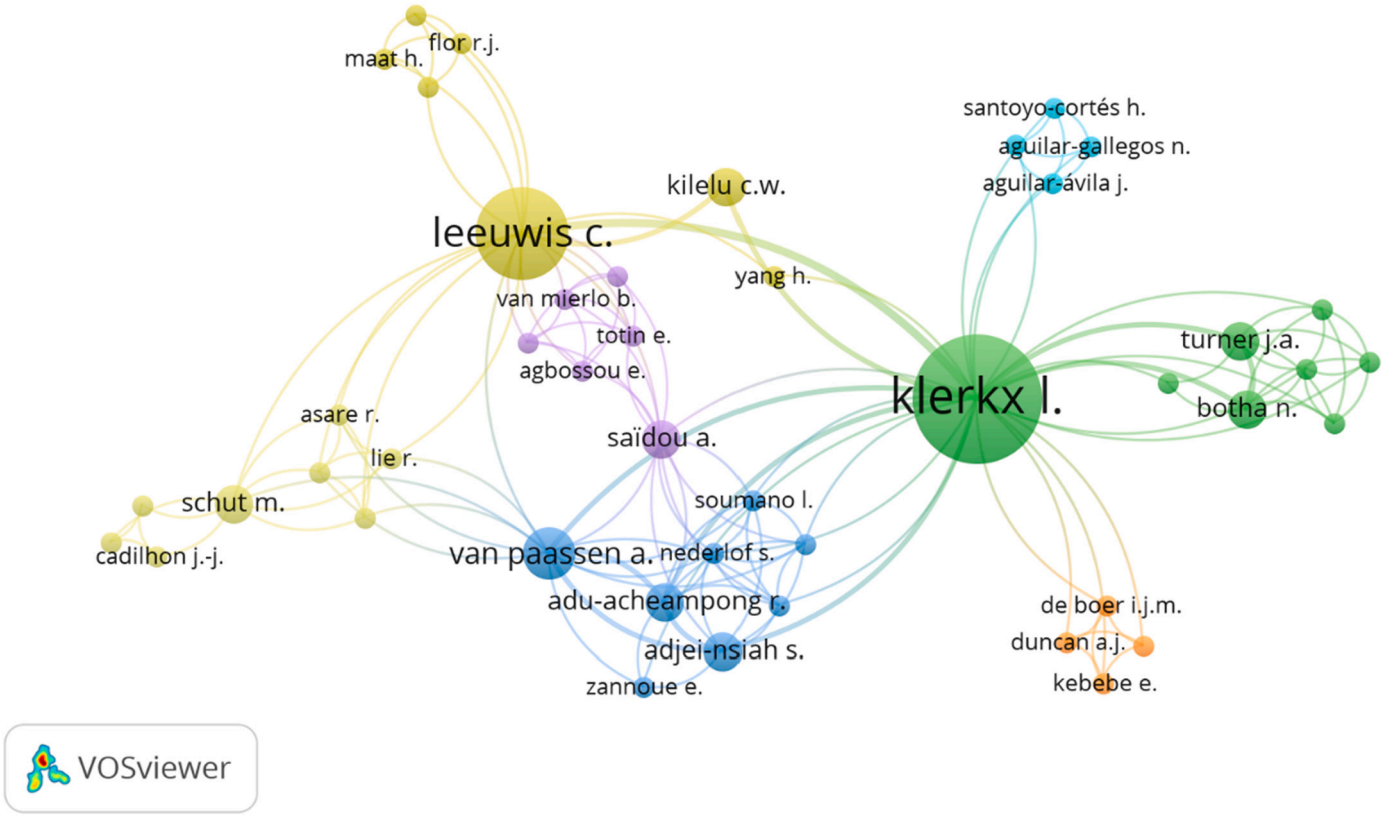

Fig. 3. Collaborative patterns (author level).

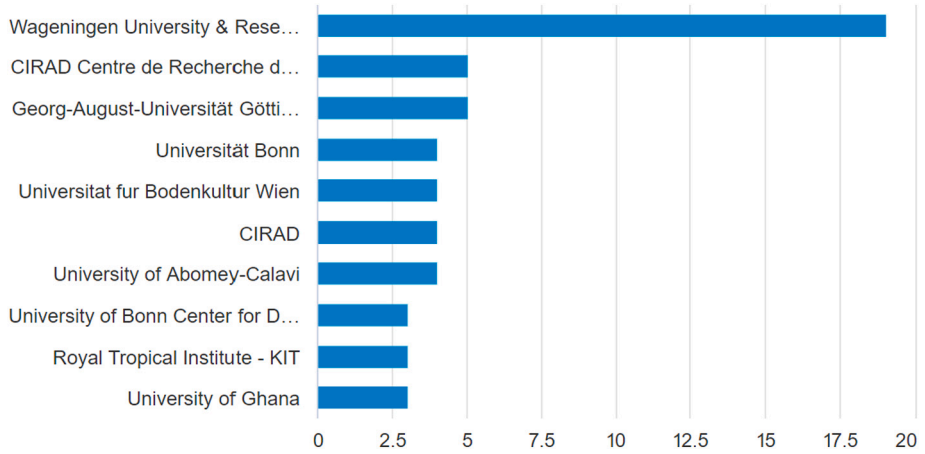

Fig. 4. Most prolific institutions.

circulate in their environment (see for instance Kernecker et al., 2020). With the majority of quantitative studies and theoretical approaches devoted to testing previous theories of technology diffusion (see Rogers, 2003) in specific and diverse geographical areas, current literature on farmers' adoption of new technologies or related practices appears to have overlooked the process by which social activity and newly introduced practices become institutionalized, and it eventually considers this process to be more or less taken-for-granted. Similarly, scholars did not pay attention to the activities and mechanisms that led to the field's institutionalization, despite the fact that they recognize the need for a more in-depth, context-specific analysis of the conditions that led to adoption (e.g. Mwaseba et al., 2006). This is also true of Burton et al. (2003)'s work, which recognizes the limitations of Roger's theory of technology diffusion (2003). The authors' theory could not explain the failure in the diffusion of organic farming techniques among traditional farmers, despite the fact that these were displaced in the community of organic farmers who were asked to disseminate information about organic farming practices to traditional farmers. The authors acknowledge that traditional farmers with more experience in traditional farming techniques have developed a lock-in with previous practices and have found it more difficult to adopt new ones. The same lock-in effect resulting from farmers' intensive involvement in old farming techniques, as well as the subsequent experienced barriers of farmers to change and embrace new systems, has been reported by Herath and Takeya (2003), implicitly pointing to the need for a de-institutionalization intervention.

Table 2
Types of structures affecting agentic choices to adopt a technology or new related practice.

Social structure	Types and attitudes	Social context as space to renovate identities and subjectivities	Perceptions, motivations, beliefs	Information transmission and knowledge provision	Gender
Land shortage (Masangano and Miles, 2004)	Farmers'attitude (Martinez-Garcia et al., 2013; Mbosso et al., 2015)	Contact with extension services (Thangata and Alavalapati, 2003; Boz and Akbay, 2005; Adegbola and Gardebroek, 2007; Aguilar-Gallegos et al., 2015; Schipmann and Qaim, 2010; Ogunlana, 2004; Herath and Takeya, 2003)	Perception of risk (Ghadim et al., 2005; Koundouri et al., 2006)	Field demonstrations resulted in a useful mean for them to overcome their limited absorptive capacity (Wandel and Smithers, 2000; Kutter et al., 2011; Tsinigo and Behrman, 2017)	Women better than men in adopting technologies (Murage et al., 2015)
Income of farmers (Boz and Akbay, 2005; Mbosso et al., 2015)	Different users' profiles towards innovation (Cavallo et al., 2014)	Social networks with other farmers (Freeman and Qin, 2020; Alexander et al., 2020; Kernecker et al., 2020)	Motivation (Greiner et al., 2009; Hammond et al., 2017)	Level of education (Herath and Takeya, 2003; Tsinigo and Behrman, 2017; Brown and Roper, 2017)	
Firm size (Tsinigo and Behrman, 2017; Ogunlana, 2004; Kutter et al., 2011)	Attitude towards risk (Ghadim et al., 2005; Greiner et al., 2009)	Larger networks to discuss farm finance (Brown and Roper, 2017)	Perceived practical value and relevance of the technology (Martinez-Garcia et al., 2013)	Farmers' exposure to information (see also Kabunga et al., 2012), literacy level and level of education (Masangano and Miles, 2004).	
Resource constraints (Hyland et al., 2018)		Structural social capital (Hunecke et al., 2017; Micheels and Nolan, 2016), especially the relationships beyond the village (Van Rijn et al., 2012), or through communities, technical and credit associations (Wossen, and Di Falco, 2015)	Positive opinion about institutions (Hunecke et al., 2017)	The ability of farmers to access to others' knowledge (Asfaw and Admassie, 2004; Goldberger et al., 2015)	
Local cooperation between public and private institutions (Taylor et al., 2017)		Engagement with AKIS (Abebe et al., 2013)	Perceived advantage (Wandel and Smithers, 2000), compatibility with farmers' work (Ogunlana, 2004).	Relevance of vocational learning activities (Boz and Akbay, 2005)	
Lack of government support (Wheeler, 2008)		Working context, specially related to the management of firms (Mwaseba et al., 2006) Social pressure from the belonging to a group (Martinez-Garcia et al., 2013)	Belief in the relevance of the environment (Wandel and Smithers, 2000)	Lack of information as the most relevant barriers to adoption (Wheeler, 2008; Matuschke and Qaim, 2009). Farmers' quality engagement in on-farm trials (Alomia-Hinojosa et al., 2018) absorptive capacity (Micheels and Nolan, 2016)	

3.1.1.2. A missed process view on the phenomenon of new practices' adoption. Other scholars have begun to challenge the application of the dominant technology diffusion perspective (Rogers, 2003) in the agricultural sector, which is consistent with the growing emphasis on how new technological solutions circulating within farmers contribute to shaping their productions. A series of studies have indicated that the decision to adopt a new technology may depend on: 1) some farmers' personal traits (i.e. see Murage et al., 2015 for the relevance of gender); 2) farmers' attitude and behaviours (i.e. Greiner et al., 2009 and Cavallo et al., 2014 for the emphasis on farmers' risk attitudes); 3) farmers' cognitive capabilities (see for instance Hounsome et al., 2006 for the effect of farmers' mental health and Micheels and Nolan, 2016, for the relevance of absorptive capacity); 4) farmers' possibility to access to relevant knowledge or through some training activities or through their informal network of suppliers and partners (Asfaw and Admassie, 2004; Micheels and Nolan, 2016); 5) farmers' perception of the intrinsic risks connected to the adoption of new technology (see for instance, Burton et al., 2003; Ghadim et al., 2005; Pannell et al., 2006); 6) the structure of support established around farmers (i.e. Adegbola and Gardebroek, 2007) during the technological transition, including the role of intermediaries (see the role of agricultural contractors in Kutter et al., 2011); 7) the level of exposure farmers have with informal or formal communities of peers (Matuschke and Qaim, 2009), 8) firms' characteristics such as firm size or economic conditions (i.e. Wandel and Smithers, 2000); 9) a complex mix of socio-economic, political and technical factors (i.e. Nederlof and Dangbégnon, 2007). However, we still know very little about how farmers' perceptions and associated practices may unfold and coevolve as a result of a new technology intervention, because most studies do not provide a process view of the phenomenon of technological adoption, but instead focus on the analysis of correlation links between different farmer-related factors and the likelihood they embrace the specific change.

3.1.1.3. A missed investigation of the effect of the farmers' emergent social context on the adoption of new practices. Furthermore, the majority of studies examine how formal institutions influence organizational (farmer's) decisions to adopt technologies, leaving out descriptions of how emergent and induced social interactions between farmers and relevant agents in the environment can act as a source of institutional change. Furthermore, while many papers recognize technology adoption as a phenomenon that necessitates a context-specific analysis of farmers' socio-cultural conditions (see, for example, Kernecker et al., 2020), the papers we collected did not report or describe the institutionalization process, which, as a non-linear process, occurs not only within the farmers' organization using the technology but also within the larger organizational field (King et al., 1994; Orlikowski and Barley, 2001). Scholars could examine in greater depth the interconnected processes by which discourses on technological adoption are generated, translated, and made concrete with farmers, as has already been suggested in other application fields (e.g., Wang and Ramiller, 2009).

3.1.1.4. Lack of deep insights on the multi-criteria decision process of farmers. Despite not being explicitly and clearly developed, some papers have begun to present a novel conceptualization of technology institutionalization as anchored in the metaphor of "traveling of ideas" (see Czarniawska and Joerges, 1996), in which extension agents are

described as assisting farmers in translating ideas into practical use for farmers (see Adegbola and Gardebroek, 2007). Some papers even distinguish the effectiveness of input received from these agents from input received from their peers or other supply chain actors such as buyers or traditional traders who are less able to convey relevant messages (see, for example, Adegbola and Gardebroek, 2007; Abebe et al., 2013), and thus they see the circulation of opinions about new technology taking different routes and facilitated by different carriers. Along the same lines of reasoning, Hunecke et al. (2017) only show that farmers make decisions independently of their informal relationships with their peers, instead relying on the benefits provided by formal networks comprised of technical advisors and trainers.

The preceding studies appear to point to the idea that the institutionalization process may be weak (Hining et al., 2004) in the presence of "contradictory patterns of human activity" (Morill, 2007, 5–6 pp), as they tend to view farmers' adoption decisions as being based on multiple criteria that involve trade-offs (e.g. Abebe et al., 2013). However, despite providing quantitative models in the majority of cases, these papers do not describe the processes by which the process of institutionalism may occur. Nonetheless, this may explain the varying rates of diffusion as well as changes in the ways practices are disseminated. This gap necessitates a more in-depth understanding of the mechanisms by which diverse logics persist within a field and favour the implementation of some institutional practices that emerge as a result of institutional complexity. As a result, future research should concentrate on how emerging fields emerge and the mechanisms that contribute to the spread of certain practices.

3.1.1.5. Preliminary usage of social network analysis to explain new practices' adoption. Another, but related, aspect of literature studies is inspired by social network theory, which proposes that farmers, when confronted with a technological innovation or new practices associated with an innovation, begin engaging in the new practices through interaction with neighboring organizational fields, thereby initiating the learning process that catalyzes institutional change (Haunschild and Chandler, 2008). Matuschke and M. Qaim's work, for example, is a relevant example (Matuschke and Qaim, 2009). According to some scholars, farmers adopt the norms and vision for how to use technology from the community in which they live (see Brown and Roper, 2017).

Recognizing that this body of literature has provided a solid foundation for understanding and analyzing forms of institutionalism, some research articles were designed to integrate this approach with an examination of how existing institutions influence and affect emerging processes and discourse between farmers and their local network of peers (Van Rijn et al., 2012). Indeed, Van Rijn et al. (2012) investigated the effect of intra-community norms expressed through cognitive social capital in conjunction with structural social capital on farmers' access to knowledge and resources outside their villages.

Similarly, in Martinez-Garcia et al. (2013), the perception of relevance of new practices in combination with the normative constraints identified in the social pressure from salient referents have been reported as main factors exerting a strong influence on farmers' intention to use improved practices. In accordance with the conceptualization of various types of isomorphic pressure on organizations, some papers address the relevance of mimetic pressure as a source of institutional change, in addition to the emphasis on normative pressure emphasized in the work above. For example, the work of Boz and Akbay (2005) demonstrates the sociological effect of imitation on late adopters when they recognize others who have already incorporated the new farming technique.

3.1.1.6. Limited understanding of how farmers reduce uncertainties through learning and exposure to credit institutions. Many other papers, particularly in the early years of the 2000s, emphasized the way farmers processed knowledge about new technology, as well as their level of awareness of it, as processes used to catalyze institutional change (Haunschild and Chandler, 2008). For example, consider the following papers: Wandel and Smithers (2000); Burton et al., 2003; Ghadim et al., 2005; Pannell et al., 2006, Goldberger et al. (2015), and Hyland et al. (2018). They examine the routines adopted by farmers as well as the materials used to form the micromotor that drives their decision to adopt new practices (e.g. Boz and Akbay, 2005). Some papers appear to suggest that the conceptualization of adoption is the result of learning bridges created by structure/agency (see extension agents in Aguilar-Gallegos et al., 2015) to influence farmers' decisions. In some successful cases, they rely on the middle stage process of "objectification," which includes field demonstration practices (e.g., Burton et al., 2003; Ghadim et al., 2005; Pannell et al., 2006; Tsinigo and Behrman, 2017) aimed at demonstrating the impact of famer adoption on their production. Other papers contend that an appropriate level of analysis can be found in farmers who learn through an induced level of experience embedded in "supra-individual repositories" of institutional agents such as extension agents (see Adegbola and Gardebroek, 2007). Many papers see the relationship with structure/agency as functional to farmers' need to improve their economic conditions through the adoption of new practices. As a result, extension farmers and innovation systems with the inclusion of credit institutions become a means for farmers to become aware of more profitable alternative solutions, which explains the tested correlations between the effort of reducing uncertainty through institutional designs added to innovation systems and the increase in adoption rates (see for example the work of Wandel and Smithers, 2000; Koundouri et al., 2006). Thus, as the uncertainty of the environment in terms of the economic impact of new technology decreases, value manipulation can follow the path towards the legitimization of practices. Given the quantitative approach, current papers do not provide the richness of information required to develop an understanding of the subsequent development of institutionalization practices following the reduction of uncertainties.

3.1.1.7. Temporality is an under-researched aspects of technological diffusion. Despite the fact that knowledge and experience have grown over time, as has diffusion, thanks to the persistence of local support or emerging institutions (Colyvas and Jonsson, 2011), temporality remains a relatively under-researched aspect of diffusion. This is a critical consideration because institutions emerge from the cumulative processes that give rise to them (Chandler and Hwang, 2015). These processes are strongly influenced by path-dependent interactions between structure, agent, and innovation decision (Cooper et al., 1996; Crouch, 2005; Schneiberg, 2007). However, previous literature studies failed to model this complexity, erroneously assuming temporal homogeneity in both decision diffusion and adoption. In addition, there was a lack of effort in generating more data (e.g., pandel data) to conduct follow-up studies and cover the evolution. In terms of adoption dynamics, papers presenting duration models have only tended to identify the factors that have a significant effect on the time it takes an individual to adopt a new practice (see Boz and Akbay, 2005; Schipmann and Qaim, 2010; Brown and Roper, 2017).

3.1.1.8. A missed investigation of the connections between communication and cognition of individuals and macrolevel institutions. Finally, as a result of the work of Freeman and Qin (2020), diffusion has been viewed as a field level process in which higher-level institutional effects emerge through lower-level organizational decisions. The authors proposed that analyzing technology diffusion with micro-adoption decisions necessitates an integrated and comprehensive approach that includes a multilayered perspective. Indeed, the authors examined the microfoundation perspective of technology adoption while accounting for the complex interactions between institutional forces and farmers, yielding a set of behavioural strategies to explain the heterogeneity of behaviour. In their specific case, they considered cell phone benefits, as

well as social networks and community interactions in which farmers participate, to be the most efficient strategies for disseminating information and encouraging innovation adoption. Despite the relevant approach of Freeman and Qin's (2020) work, the quantitative nature of the empirical evidence did not allow for the collection of a description of institutionalization processes, not fully responding to the need for more research to connect individuals' communication and cognition at the micro level and without exploration of interactions between individuals and macrolevel institutions.

3.2. Agency vs structure

The second category includes the processes and mechanisms that enable human action to sustain the mobilization of a set of resources. We report the final list of research articles based on this theoretical focus, all of which are summarized and referenced in Appendix 2 in relation to their implications for the structures relevant for farmers' agentic action to innovate.

The processes and mechanisms that enable human action to sustain the mobilization of a set of resources are included in the second category. We present the final list of research articles based on this theoretical focus, which are all summarized and referenced in Appendix 2 in terms of their implications for the structures relevant to farmers' agentic action to innovate.

The following section discusses the main theoretical contribution of the research articles included in this category, as well as the main future research directions.

3.2.1. How farmers bring change to the social practices related to the usage of a new technology

Papers in this category have conceptualized the relationship between agency and structure, linking the possibility of farmers bringing about technological changes to a broader economic and political structure that creates conditions for them to overcome the constraints of farmers' roles. This is the case with Leitgeb et al. (2011)'s work, which assumes that change cannot occur without cost and without causing conflicts with the larger structure. The results show that providing resources to farmers, such as land to use or government support for farmers' decisional autonomy, encouraged the flourishing of local experience and technology adaptation. Other scholars have emphasized the role of concrete situation needs (such as poverty, economic crisis, etc.) as elements to consider, as they reveal contradictions to individual agents (i.e. farmers) that current structures create within or between themselves, triggering social and individual actions that open up space for change. Similarly, bodies of ideas and social institutions can provide complementarities that strengthen individual positions and lead to the replication of adapted technologies. This is the case in the works of Sherwood and Larrea (2001) and Leitgeb et al. (2014), which also include years of living in a community and interaction with external institutions as complementary factors.

A wide range of papers credit individual social interactions, and the resulting formation of dyads, with contributing to the emergence of individual agency. When discussing the relevance of the innovation circle for farmers, farmer communication network (comprising kinship and neighbourhoods within villages and close relatives and friendship) (see Wu and Pretty, 2004), farmer field fora (Tambo and Wunscher, 2018), and farmers' trajectories, some papers indirectly refer to basic network level measures such as centralization as determinants of individual innovation capacity (see Deffontaines et al., 2020) In terms of agency, the density of established ties is frequently viewed as a prerequisite for the individual's ease of knowledge transfer and task mastery.

Another pathway for the emergence of agency in the farmer population has been reported by current literature as being related to the presence of a type of socialized agency on the field, which is represented by intermediaries bridging two distinct fields: technology manufacturers and farmers (see the work of Naouri et al., 2020). Intermediaries start the process of developing new farming practices by facilitating the combination of farmers' operational knowledge with the seed of intermediaries' knowledge-based innovation through the translation action of their knowledge. The same study by Naouri et al. (2020) demonstrates the importance of politics and power struggles in ensuring the emergence of new practices. Farmers who belong to multiple communities of practice (directly with manufacturers and through intermediaries) transform themselves into arenas of competition and contention, and the emerging dominant community may inhibit or delay innovation driven by the other communities (in line with Ferlie et al., 2005).

According to Giddens (1979), "structures are shaped by" knowledgeable "human agents (i.e., people who know what they are doing and how to do it), and agents act by putting into practice their necessarily structured knowledge," and numerous literature studies have highlighted the importance of education (e.g., Tambo and Wunscher, 2018), individual knowledge (e.g., Sherwood and Larrea, 2001; Oliveira et al., 2012). They have also been conceptualized as acting with others (their peers) through emerging structures that make them aware of the norms (schema) that govern social life. As a consequence, farmers' agency has been demonstrated as a result of their knowledge of norms and other people's practices, which has given them the ability to extend them to their own context (see Chowdhury et al., 2015). Farmers' agency is often increased when they gain control of resources (often cognitive in nature), which allow them to interpret or mobilize a sequence of resources using the schema that their peers or others have used to build their practices (Deffontaines et al., 2020).

Sumberg et al. (2003), on the other hand, propose that technologies and their embodied structure influence the rise of human agency. Depending on the technology and whether it is reconfigurable, different human behaviours are observed, ranging from a situation in which farmers know the technologies and apply the technologies in the execution of what they do to a new scenario in which farmers enact changes in the intended execution and outcome of related farmers' work practices, and/or in technological properties available to users proposing relevant change in the scope of the technology. Whether and how human agency emerges is also determined by social practices, intentions, and interpretation, as well as the institutional context affecting farmers.

3.2.1.1. Main research avenues. Analyzing agency and its connections to structure entails looking into the source of action—the impetus behind patterns of social action and interaction. As can be seen, some studies in this category have placed a premium on individuals who are committed to adopting new practices (see e.g., the work of Sumberg et al., 2003). In contrast, papers focusing on the social structure as enabling or constraining agency have been discussed. These approaches complement one another and provide perspectives on what and whether farmers drive action. This tension between agency and structure, however, should be enriched with more studies focusing on the effect of time on human agency, which will contribute to our understanding of agency relationships. Farmers, for example, can act agentically in the present by releasing ties that constrained action in the past. Other studies could add to our understanding of other individual characteristics that influence the ability to engage in agentic behaviour. Past experiences and self-confidence, for example, may be important determinants of individual actions. Previous research studies have also emphasized farmers' behaviour without including or detailing farmers' positions in the network of farmers' contacts as another possible determinant to understand perceived individual advantage and, thus, farmers' agentic behaviour.

An emphasis on behaviour rather than position necessitates taking into account the contingencies that reduce individual advantage (e.g., Soda et al., 2019). Women and men, for example, have different

perspectives on brokerage in friendship networks, which helps to explain gender differences in network broker performance (Brands and Mehra, 2019). Future research can build on the growing interest in the negative consequences of brokers' actions (e.g., Xiao and Tsui, 2007) to investigate whether brokerage causes collateral damage to exploited colleagues and how open and closed networks function to control such deviations from expected brokerage behaviour (Burt et al., 2019).

3.3. Network agency

The third category is concerned with reconfigurable approaches to field resource management. They, which are composed of a constellation of external (to the field) entities, provide schema for recurring action and resources for human agents to operate in the field, stabilizing and making predictable the use of technology (see also Sewell, 1992). In this section, we will discuss how each specific configuration of external entities linked through social networks and organized in various types of innovation systems creates a recursive interaction between farmers, technology, and collective action, as well as the premises for maintaining stability by avoiding the emergence and change in technology and its application. Therefore, we provide a social network microfoundational view of the source of individual action in developing or adapting technological solutions, and it is from this perspective that we present the findings of current studies on how people take actions in social networks such as agricultural innovation systems to develop technological solutions. Based on this theoretical focus, we present only articles that are centred on the interpersonal network of farmers and other actors belonging to the innovation systems. More specifically, papers in this section embrace a networked (e.g., Corsaro et al., 2012) and systemic (e.g., Sundbo and Gallouj, 2000; Geels, 2004) view of innovation, providing a more dynamic picture of it by highlighting the interaction among different actors and, thus, aiding in the development of a perspective on the various components required to induce innovation (seen here as farmers' adaptation or adoption). While the papers in the first category maintain the distinction between the actors developing innovation and the users (e.g. farmers) adopting it, the papers in the second category emphasize the fact that users (farmers) have the capacity to guide innovative efforts, implying a more unidirectional view of innovation processes, this group of papers presents a more interactive and systemic view of innovation. They report on network agency because the locus of action in these papers is at the level of macrostructures. Actions in this context are carried out through a "embedded process of social engagement" that individuals use to act and interact in the field (Emirbayer and Mische, 1998a, 1998b: 962–963). This perspective examines how people (farmers) and networks interact as mutually evolving systems, despite the fact that they exist in ontologically distinct realms. Table 4 clarifies and conceptualizes the processes and mechanisms by which social structures of networks or communication patterns are generated, how the former sustains the latter, and how they mutually interact to maintain or change the other, thus explaining the articulation between the development of farmers' actions and the generation of social interaction by farmers in the network. In the following section, we highlight the main theoretical contribution of the research articles in this category and illustrate the main future research directions.

3.3.1. Reconfiguration approaches to resource management of a field aiming to stabilize the embraced changes

Farmers have been represented as existing entities in a constantly changing network of relationships and with their system of interdependencies through the macro structures responsible for the transformation in the papers in this category.

3.3.1.1. Lack of a detailed analysis of interactions between networks and individuals, as well as understanding of how they mutually affect each other's identities and meaning. Current papers do not depict in detail the interaction between networks and individuals, nor do they describe how they mutually affect each other's identities and meaning (see, for example, White, 2008), nor do they describe how this can serve as elements for future research studies. Indeed, future research can examine how individuals' social network activities contribute to macro-level network change, which in turn affects individuals' outcomes (e.g., Lomi and Stadtfeld, 2014). Papers in this category also represent a shift towards a more dynamic approach to the study of innovation, and they implicitly challenge previous innovation models that focused on unidirectional processes, such as the linear model of innovation. This approach broadens the scope of innovation by shifting the emphasis from technology to market relationships, which primarily develop around innovation platforms (IPs), agricultural innovation knowledge systems (AKIS), and agricultural innovation systems (AIS). The study of innovation in this selected set of papers, in particular, goes beyond farmer-centric development activities and provides an opportunity to learn about the various participants in innovation. This alternative perspective focuses on the interconnected social processes and interconnected relationships among actors that are thought to trigger farmer agentic behaviour. Benefits stem from social connections and include the amount of relevant information about the technology to be used obtained through the related network of actors, as well as the level of support received from them in the implementation of new practices. Broadening the scope of innovation beyond the capability of farmers in charge of the decision to adopt or adapt new technology to their needs is consistent with Freeman's (1991) discussion of networks of innovations as sources of external scientific and technical information and advice assisting firms in developing the application of new technologies to a new field. In some papers, the dynamic perspective on innovation relies on the concept of social structures or *institutions* as a critical aspect to consider because they allow and induce the enactment of practices and interactions among multiple actors and, thus, constitute forces in the creation and determination of value. Poncet et al. (2010), Kebebe et al. (2015), Pamuk et al. (2015), and Munthali et al. (2018) are examples of this. The importance of institutions in innovation implies that current institutions must be in place in order for new practices to be developed and adopted (i.e., for innovation to occur).

Other papers in this category emphasize networks as dimensions capable of favouring or impeding "social behaviour and social change" (Wellman, 1983). They report on how network structures (e.g., Spielman et al., 2011; Flor et al., 2017; Lambrecht et al., 2018) and the nature of the ties influence farmers' actions (Adolwa et al., 2017).

Other papers describe how some roles take advantage of networking opportunities that are structurally provided by the social context, such as the ability to build and extract value from social connections (Burt, 1992: 34). This is the case of Isaac (2012)'s work, which demonstrated how producers with ties to organizations were more likely to be positioned in more efficient information networks, as indicated by a low level of redundant ties, and how this efficiency was positively correlated with higher reported on-farm agro-diversity. Accordingly, Chindime et al. (2016) emphasize that farmers' network positions and embeddedness in their social context make them central in their network and more susceptible to the influence of other stakeholders, making them more vulnerable. Similarly, Adolwa et al. (2017) claim that resources and new opportunities become available not through close-knit, local relationships, but through ties that connect distant groups. In terms of agency, Flor et al. (2017) demonstrated that the density of ties within an ego network influences an individual's ability to facilitate knowledge transfer, engage, and have a greater chance of producing initiative in farmers.

3.3.1.2. Lack of understanding about how farmers perceive their position in the network and how this awareness can affect their choices. What is still unknown is how farmers perceive their position in the network and how

this awareness influences their decisions, which can be investigated further in future studies. Current studies are limited to demonstrating how the use of social network analysis creates a sense of awareness about how different network configurations affect information diffusion differently (see the work of Friederichsen et al., 2013).

In this ecosystem and dynamic view of innovation, two broad categories of resources are considered and seen as constantly combining to generate value by creating conditions for the diffusion of innovation: intermediaries and innovation platforms. They interpret the roles of operant resources (those who can act on others to create values and others) and operand resources (those that require action to be valuable) (see Vargo and Lusch, 2004; Vargo and Lusch, 2008). According to Lusch and Nambisan (2015), innovation platforms in the agricultural sector serve a dual purpose in complementing extension services by acting as both an operand and an operant resource. Indeed, the selected studies report that innovation platforms require an organizing structure for the network of actors to coordinate (see for instance the relevance of innovation champions described in Klerkx et al., 2013 or the work of Botha et al. (2014) indicating the need to spend extra effort to build a team and to establish a proper level of communication around innovation platform and to integrate management, planning and policy practices) while they serve as venue for innovation triggering activities of value creation, process activities leading to resource integration and to incorporate roles of ecosystem actors. On purpose see the work of Thiele et al. (2011), Kilelu et al. (2013), Davies et al. (2018), and Schut et al. (2018).

3.3.1.3. A very limited view of intermediation as a process and its analysis seems tangential to the field of inquiry such as innovation diffusion or innovation systems. Papers in this category report on the function of intermediation as performed by various actors and represent the primary operand resources identified in current literature studies. Papers in this category highlight the intermediary roles of various actors, such as the Shiga Prefectural Government (see Kishioka et al., 2017), hub coordination in Kenya (see Kilelu et al., 2017), and academic-related research and advisory centers in Columbia (see Theodorakopoulos et al., 2014), primarily engaging farmers in innovation-supporting activities ranging from the provision of experiential and tacit knowledge collected by a dispersed set of actors (see the case of Kilelu et al., 2017). Indeed, the main concrete interests in intermediaries in relation to innovation are in the area of technology diffusion, where brokers or intermediaries have been conceived as change agents with the ability to influence the speed of diffusion and the updating of new practices. However, Klerkx and Leeuwis (2008) highlight other roles such as third parties played in the diffusion process, such as peer network brokers, who enact the role of support in inducing entrepreneurship development, enabling integrative learning, and broadening perspectives, whereas Ortiz et al. (2013) identify the International Potato Center in Peru as being in all systems, playing a role of innovation brokerage but lacking in enacting interaction among components or stakeholders, and, therefore, reducing the chances of learning from each other among farmer, government, non-governmental and private companies in the potato system. There is a very limited view of intermediation as a process in the collected studies that have intermediaries more in focus, and despite the fact that the related papers acknowledge the role of intermediaries, the analysis contained appears tangential to the field of inquiry such as innovation diffusion or innovation systems, as there is low emphasis on the interaction by the intermediary between different actors. The studies that outline the role of intermediaries in technology transfer do not emphasize or detail the interactions that the intermediary has with the various parties.

3.3.1.4. Lack of empirical evidence on the integration of various cultural elements such as discourse and languages in the analysis of social networks. In keeping with earlier recognitions that "a social network is a network of meanings" (White, 1992: 67) and that discursive "narratives" and "stories" are key elements of social life (Emirbayer and Goodwin, 1994: 1437), an emerging but limited stream of studies (e.g. Lambrecht et al., 2018) have dealt with the processes by which individuals shape their meaning with farmers, including discourse created by independent actors. Thus, according to Lambrecht et al. (2018), the goal of the network is to achieve effective face-to-face or direct communication as a way to better convey meanings and, thus, to better link research to practice, allowing for higher level exploitation of technology potential. In line with this approach, Crivits et al. (2014) highlight the importance of different interpretations of innovation and appropriations, pointing out that they co-evolve in networks of actors and must be collected in order to aim for a more inclusive approach to innovation that is based on a proper understanding of farmers' needs. Using a case study of pig farming in Flanders, the authors show how farmers' discursive framings reflect an ongoing tension between the linear and participatory innovation discourses. In a similar vein, Botha et al. (2014) discuss the importance of developing a shared language, perceptions of innovation, and understanding of different world views in order to reduce cultural differences and promote cross-institutional cooperation among participants in innovation programs. However, current papers do not report on empirical evidence related to the integration of different cultural elements, such as discourse and languages, in social network analysis, despite the fact that this investigation can improve our understanding of coordination and cultural alignment across organizations (Basov, 2020). More research studies can be conducted to demonstrate how the incorporation of various cultural elements can contribute to a better understanding of the mechanisms that work on the inclusion of innovation programs.

4. Concluding remarks and future research agenda

This paper proposes a new theoretical perspective for analyzing the dynamics of technological diffusion in the agricultural sector by positing that technological regimes evolve through two main coordination mechanisms, agency and structures (e.g. institutional rules). Despite their interdependence, these mechanisms destabilize each other (Beckert, 1999) through institutions that serve a dual purpose: to provide a mandatory basis for agency as well as a basis for better options to emerge with agents (e.g., farmers) in a position to partially violate current institutional rules. We have provided a holistic explanation of how the process of institutional change occurs as a result of technological changes by collecting separate views on the role of agency (individual and network) in relation to current structures and illustrating in each view the dynamic interplay with institutions and the specific mechanisms involved.

Previous literature reviews have failed to report on the systemic nature of technological innovation as a process that transforms the world of the inventor and invention alike and whose diffusion is dependent on the interaction between the system, seen as a 'whole,' and its elements, such as the people contained in that 'whole' (see also Spies, 2014). Despite the fact that this expanded view has become the subject of several studies, there is still a tendency in the field as a whole to consider new developments — such as tractors, fertilizer, and hybrid seeds — as technology per se, avoiding explicitly connecting the design and management of such innovations to the development of social-cognitive processes that allow or disallow the acceptance and usage of new technology by individuals and local conditions, practices, and cultures.

We intended to emphasize the role of institutional and social capacity in supporting greater local control, accountability, initiative, and resilience by emphasizing the interplay between agency and structure. We also place a high value on analyzing the social processes that underpin the democratization of the innovation process, in which people are encouraged to mobilize and manage their own resources, with institutions acting as enablers.

Indeed, when such decentralized, self-organizing approaches to resource management are taken seriously, they generally result in more efficient and productive resource management, less reliance on external resources, increased equity, increased local initiative and accountability, and strengthened economic discipline.

However, the dynamic model of interactions between agency and structures raises the question of which mechanisms should be considered for achieving the stability of institutionalized structures in order to secure the long-term use of new practices or a constant effort of adaptation to changing contextual conditions. This point of view or dilemma appears to be unaddressed in current research, leaving the question of which mechanisms to employ to stabilize a specific institutional order unanswered. Despite the fact that both habits and imitations have been considered important elements for the stability of institutionalized rules (Beckert, 1999), they have not been explored or mentioned in such a role in the empirical studies that have been collected. Imitation mechanisms, on the other hand, have emerged as a means of extending the diffusion of practices among peers. In this regard, we discovered that previous studies emphasized the endemic innovativeness of communities and other different social systems surrounding farmers while ignoring the processes by which farmers' agentic behaviour could have gained legitimacy through them. The process of conferring legitimacy is especially important in the presence of numerous social groups with disparate interests (e.g. Lounsbury and Glynn, 2001).

Indeed, the dimension of legitimacy, which scholars consider to be another relevant factor for stabilizing institution rules (Beckert, 1999), did not appear as the main discourse, while the concept of power and/or power struggles, based on the actors' position within a network, has been touched in some papers, such as the work of Chindime et al. (2016), with an indication for policy to intervene in the protection of weaker actors in the network, and in Klerkx et al. (2013). However, the papers examined do not describe the process by which a 'generalized perception or assumption that an entity's actions are desirable, proper, or appropriate' is formed (Suchman, 1995: 574).

The distinction between agency and network agency has also allowed us to understand two levels of institutionalization: the market of relationships, which as a meta institution must maintain a higher level of stability, and low ranking institutional rules that create conditions for forces acting against farmers, which are made up of an array of practices carrying out diverse regulations, cognitive models, and norms (Scott, 1995) and may promote a divergent c From that vantage point, we can see how, in the face of uncertainty, farmers mimic the behaviour of other organizations, in accordance with neoinstitutionalist theorists (see for instance the work of Boz and Akbay, 2005). At the micro-level of analysis, the state of uncertainty, as reported in Tables 2 and 3, is a relevant variable for explaining the process of institutional change. Analyzed research studies show that agency violates existing structures when there is a high level of risk attitude (see Table 3), whereas farmers are more likely to adopt new practices when they can build expectations on what third parties will do (see Table 2) (see, for example, Hunecke et al., 2017; Taylor et al., 2017; Wheeler, 2008). According to research, in complex situations where the elaboration of strategic decisions is difficult due to a lack of competence or trust in third parties, the decision to adopt new practices is not made. Other studies that have been examined show the influence of macro-level institutions in reducing uncertainty by creating positive expectations. Along similar lines of reasoning, many of the structural arrangements indicated as positively affecting agency, as shown in Table 2, aimed to reduce uncertainty (for example, the possibility of having filed level demonstration, Wandel and Smithers, 2000; Kutter et al., 2011; Tsinigo and Behrman, 2017) and to mitigate the transactional behaviour of some actors, such as with extension services (e.g., Thangata and Alavalapati, 2003). These structural arrangements tended to realize the stability of social orders in these cases, reproducing rather than changing practices.

At the same time, other empirical studies have highlighted the role of cognitive elements (farmers' level of education and experiences) as a condition that triggers change at the micro-level of analysis. According to this viewpoint, current literature depicts farmers as knowledgeable actors capable of contrasting taken-for-granted social rules and technological artefacts and adapting them to their local reality. In line with this viewpoint, our selected studies tend to report that farmers who are able to envision changes are those who are skilled or engaged in some learning activities to present and theorize the change in a way that allows them to collaborate with existing social groups in the field. Surprisingly, the concept of power relevant to creating relevant meaning around change (see Pettigrew, 1979) and also to secure some stability, as well as the analysis of the conditions farmers might satisfy to create specific meaning, are not present in current literature studies. However, some papers emphasize the importance of communication with others as a prerequisite for resource remobilization and schema transportations (see, for example, Leitgeb et al., 2014; Wu and Pretty, 2004). As a result, they highlight farmers' ability to coordinate other people's actions, as well as persuade as an important factor in bringing about change. There are also a couple of papers that emphasize that the extent of the agency's

Table 3
Examples of structural conditions affecting agentic behaviour towards change.

Social structure	Technology properties	Social context as space to renovate identities and subjectivities	Perceptions, motivations, beliefs	Information transmission and knowledge provision
Land size (Tambo and Wunscher, 2018)	Defensive type of technology vs commercial type (Sumberg et al., 2003)	Farmers' innovation circle and communication network (Wu and Pretty, 2004)	Perception of risk and climate shock perception (Tambo and Wunscher, 2018)	Education (Tambo and Wunscher, 2018; Sherwood and Larrea, 2001)
Land to use and government support (Leitgeb et al., 2011)		Experimental practices (Leitgeb et al., 2011)		Farmers' tacit knowledge (Oliveira et al., 2012)
Resource scarcity (Leitgeb et al., 2014)		Communication network and formal and informal collaboration (Leitgeb et al., 2014)		Learning from mistake during experiments (Leitgeb et al., 2014)
Firm size (Sherwood and Larrea, 2001)		Interactions with institutions and community life experience (Sherwood and Larrea, 2001)		Documentation about experiments (Bentley, 2006)
Resource shortage (Sherwood and Larrea, 2001)		Social interactions between farmers (Deffontaines et al., 2020)		Farming experience (Sherwood and Larrea, 2001)
Resource pooling only in the absence of competition for the resource (Deffontaines et al., 2020)				Watching others (their peers) who are trying new things also inspires people to try (Chowdhury and Hauser, 2015)
				Translation function operated by intermediaries (Naouri et al., 2020)
				Different intervention models (Faure et al., 2018)

Table 4
Examples of social structures, processes, and mechanisms affecting agentic behaviour towards change.

Social structure	Processes Mechanisms enabling farmers' action	Related paper
Learning alliances	Involvement of farmers in adaptive research with Researcher	Flor et al. (2017)
Network workshop with researchers	Reflections on the farmer's position within its network and on how to improve it	Lamb et al. (2016)
Extension service	Collection of farmers' needs and mediation of brokers social	Friederichsen et al. (2013)
Digital platform	Role of facilitators that should rely on a huge personal network of contacts	Dabire et al. (2017)
	Platform innovation intermediation function entered in conflict with the intermediation function of intermediaries.	Kilelu et al. (2013)
	Collective action are fostered by gathering multiple stakeholders.	Thiele et al. (2011)
	Innovation champions play different crucial roles in innovation platforms. Barriers were cognitive, administrative and relational and were addressed performing various activities.	Klerkx et al. (2013)
	Establishment of solid networks over time and more careful coordination of multi-actors through individuals and organizations	Davies et al. (2018)
	Effective innovation platform are created when enabling or hindering institution factors are locally identified, and the design of the platform is flexible to keep motivated multiple stakeholders.	van Paassen et al. (2014)
	Identified variables leading to the maintenance of innovation platforms members.	Schut et al. (2018)
	New-ICTs' innovation intermediation capacity is far from realised	Munthali et al. (2018)
	Integrating innovation platform within the AIS programme is challenging, as it demands significant effort to form a team and to interact with and mentor participants	Botha et al. (2014)
Farm cooperatives	Farm cooperatives as mediation entities between multiple stakeholders	Yang, Klerkx, and Leeuwis (2014)
Organic farmer network	Identification of elements of networks that help farmers to introduce innovations.	Kroma (2006)
Advisory centres can play to support farmers in a rural area of	Different functions of intermediaries helpful to the diffusion and adaptation of technology	Theodorakopoulos et al. (2014)
Liberalized market in Marocco	The role of formal and informal intermediaries in a large-scale irrigation scheme in innovation diffusion	Poncet et al. (2010)
Social network around farmers	Marketing network should be better integrated with the production network to affect positively t	Spielman et al. (2011)
	Weak ties with both homogeneous and heterogeneous actors give access to knowledge while the strong ties are means through which they can instil the acquired knowledge with different agricultural stakeholders.	Adolwa et al. (2017)
	Farmers in network with lower density have a more efficient access to information.	Isaac (2012)
	Relying on numerous contacts, fostering an integration of knowledge within the members of the network structure, close communication, and a self-initiated alliance are indicated as fundamental for innovation	Lambrecht et al. (2018)
	Power relations mediate interactions, and the smallholder farmers are the least influential ones, as they are the weakest group. As a matter of fact, their role is usually that of receiving technologies rather than determining them	Chindime et al. (2016)
	Benefit from connections with migrants since they can transfer translocal innovation	Rockenbauch, Sakdapolrak, and Sterly (2019)
	Typology of innovation brokers and their function for establishing different innovation arrangements	Klerkx and Leeuwis (2009)
Tuber innovation system in Bolivia, Ethiopia, Peru and Uganda.	Active participation of multi-stakeholder reduces local elites traditional power, generating spill-over effects for poor-resource farmers	Pamuk et al. (2015)
Dairy hubs in Kenya	Farmer organizations, participation increases collaboration at horizontal levels in the value chain; however, it is still limited at the vertical level.	Kilelu et al. (2017)
Dairy innovation systems in Ethiopia.	The main structural barriers are: lack of power of key actors, lack of skills, bureaucracy, lack of strong social relationships and scarce infrastructure. The main functional enablers are the learning process, market creation and legitimacy establishment.	Kebebe et al. (2015)
Japan agricultural innovation system	Results reveal that effective government intermediation function based on spreading a coherent technical and economic vision about innovations motivate farmers in adopting innovation	Kishioka et al. (2017)
Agricultural innovation systems in New Zealand	Successful factors securing innovation are: enabling role play by key actors, adaptive management and dynamic practices at multiple levels	Turner et al. (2017)
Innovation network in Belgium	Proposed framework to take into account the most relevant views when it comes to decision-making process to promote innovations.	Crivits et al. (2014)

control over others is determined by their positions in the collective organization (Isaac, 2012; Chindime et al., 2016). In general, Table 3 provides pertinent information about the strategies used to bring about change in the fields inhabited by farmers, given their commitment and the existing arrangements in place. However, the related studies do not explain how farmers are able to design and propose new practices while their motives and interests are influenced by the structures. Furthermore, the significance of other cognitive farmer characteristics such as skills, knowledge, foresight, wisdom, and understanding of farmers' purposeful actions towards the adoption of new technologies is unknown.

Although some papers have discussed aspects of social learning and social clustering, they do not examine in depth how farmers understand and assimilate new ideas brought about by new technologies while maintaining the stability of the established institutional order.

The studies we looked at did not look at the synergies between motivation and competence, social learning mechanisms, and ecosystems that could support the endemic diffusion of a local innovation.

Farmers' struggles within their fields, viewed as political arenas where power relations were transformed as a result of some difficulties such as a lack of resources (Leitgeb et al., 2014) or resource pooling in a competitive environment, are described as additional sources of change that explain the different nature of the institutional work farmers do in the direction of maintaining institutional orders (Deffontaines et al., 2020).

In this case, papers provide a more advanced understanding of institutional change in situations where actors face a collective action challenge. These papers, however, do not discuss how the new institutional arrangement evolved in the face of the difficulties associated with it.

At the macro level of analysis, the way market forces of relationships affect change appears to act through the following main mechanisms: intermediation functions or similar roles connecting actors and translating messages across the network of relationships; reconfiguration of the network of actors establishing different levels of power among actors (e.g. Ortiz et al., 2013); and the creation of a central place for actors to interact through the use of digital platforms (Thiele et al., 2011) and the norms regarding governances and property rights (Poncet et al., 2010).

Indeed, the concept of agency being distributed within structures and other institutional arrangements (see papers in Table 4) highlighted in the category network agency provided insights on the role of embedding structures, which do not represent constraints but rather provide a context for farmers to unfold their agentic behaviour. Within the relevant selected papers, the strategies for developing actions and bringing about changes in the fields take into account other actors with diverse commitments and being favoured by structural positions, presenting the process of institutional changes as a political process. Despite challenging the notion that new practices can be smoothly transferred, the act of negotiation between different parties and how the transmitted object is reshaped as a result of negotiation is not addressed. The complex process of combining collaborative and competitive actions is not examined. Papers in this network agency category also fail to consider how new practices spread through dispersed activities that are spatially distributed and enacted by diverse actors with varying backgrounds and resource levels.

CRediT authorship contribution statement

Maria Carmela Annosi: Supervision, Conceptualization, Formal analysis, Writing – review & editing. **Rosa María Oliva Ráez:** Conceptualization, Methodology, Formal analysis, Writing – original draft. **Francesco Paolo Appio:** Supervision, Conceptualization, Formal analysis, Writing – review & editing. **Teresa Del Giudice:** Supervision, Conceptualization, Formal analysis, Writing – review & editing.

Uncited references

Adelman and Verkuyten, 2020
Akullo et al., 2018
Agency, 1999
Czarniawska and Sevón, 2011
Damanpour, 1991
Figueroa, 2015
Gharajedaghi, 1999
Agency, 1979
Hinings et al., 2003
Holmes and Potvin, 2014
Hounkonnou et al., 2012
King et al., 2019
Klerkx et al., 2010
Korten, 1987
Lamprinopoulou et al., 2014
Marchezini, 2020
Mayring, 2000
Meyer et al., 2013
Culture and Theory, 2008
Mutenje et al., 2016
Orlikowski and Gash, 1994
Pant, 2016
Prost et al., 2018
Roberts and Geels, 2019
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Schumacher, 1973
Schumpeter, 1942
Spielman et al., 2008
Touzard et al., 2015
Turner et al., 2016
Wright, 2012

Appendix 1. Structure vs agency, an overview

Paper	Implication for structure vs agency
Wandel, J., & Smithers, J. (2000). Factors affecting the adoption of conservation tillage on clay soils in southwestern Ontario, Canada. American Journal of Alternative Agriculture, 181–188.	Farmers' ability to derive costs savings from their pre-existing farming systems has been judged as one of the most favourable conditions for them to adopt and risk. The possibility to have economic advantages has been found among the relevant triggers for their adoption. On the other hand, their ability to perceive the benefits was boosted by field demonstrations. Field demonstrations resulted in a useful mean for them to overcome their limited absorptive capacity. The main barriers to adoption were farmers aversion to change and the risk to have yield reduction.
Burton, M., Rigby, D., & Young, T. (2003). Modelling the adoption of organic horticultural technology in the UK using duration analysis. Australian Journal of Agricultural and Resource Economics, 47(1), 29–54.	The diffusion of organic farming techniques seems to require a different approach than the one suggested by Roger (1995). Besides the economic logic, the transition to a new system of practices seems to be justified by an underlining belief in the relevance of the environment and the accumulation of experience. It seems that farmers with more experience in the traditional farming techniques reach a situation of lock-in with more difficulty to adopt the completely new practices . Additionally, also the gender seems to justify a variant in the sample.
Herath, P. H. M. U., & Takeya, H. (2003). Factors determining intercropping by rubber smallholders in Sri Lanka: a logit analysis. Agricultural Economics, 29(2), 159–168.	Results indicate two relevant sets of variables affecting the adoption. The level of education, the possibility for the farmers to be assisted by extension services and the awareness about the potentialities of the intercropping are positively related to the adoption. The ownership of the land by a sole farmer seem having a negative impact on adoption
Thangata, P. H., & Alavalapati, J. R. (2003). Agroforestry adoption in southern Malawi: the case of mixed intercropping of *Gliricidia sepium* and maize. Agricultural systems, 78 (1), 57–71.	Two main relevant results derive from the survey. One seems to confirm the need for farmers to be assisted by extension agents to adopt the new practices. The second relevant result is the suitability and usefulness of the new farming technique in relation to the farmers' requirements.
Masangano, C. M., & Miles, C. A. (2004). Factors influencing farmers' adoption of Kalima bean (*Phaseolus vulgaris* L.) variety in Malawi. Journal of sustainable Agriculture, 24 (2), 117–129.	The study shows that cognitive barriers are the main limit for farmers to adopt. Therefore variables such as farmers' exposure to information, literacy level and level of education show to have an impact on the willingness or reluctance to adopt. Another important aspect of the study is the relevance of fit between farmers' setting conditions and the innovation. The work reveals that the adoption of a new variety of beans was impacted by the land shortage of some farmers who therefore were obliged to decline the invitation to adopt.
Asfaw, A., & Admassie, A. (2004). The role of education on the adoption of chemical fertiliser under different socioeconomic environments in Ethiopia. Agricultural economics, 30(3), 215–228.	Differently from other studies this paper relates the likelihood to adopt new technologies such as new fertilizers to the ability of farmers to access to others' knowledge in order to be helped in their decision. This results in two interesting scenarios. In the environment where farmers are exposed to media and traders, they constitute their primary source of knowledge to rely on to take the decision to adopt. But in a situation of deep isolation,

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Paper	Implication for structure vs agency
	where the exposure to others is quite limited, then other adults' education in the network of farmers' family will exert significant influence on the decision for adoption.
Boz, I., & Akbay, C. (2005). Factors influencing the adoption of maize in Kahramanmaras province of Turkey. Agricultural Economics, 33, 431–440.	In line with other studies, the relevance of extension service for the farmers' decision adoption was confirmed. However, the effect of age, contrary to the work of Rogers, was not found relevant to justify the adoption since its effect was eroded by the presence of farmers within the groups being supported by extension service. Additionally, the sociological effect of imitation seems to have an effect on late adopters once they recognize others having already adopted the new farming technique. Additionally, the relevance of vocational learning activities seems relevant against the missed effects of printed material, radio or television. Furthermore, in line with other studies, the effect of larger firms on the adoption showed its effect as proxy for higher income firms
Ghadim, A. K. A., Pannell, D. J., & Burton, M. P. (2005). Risk, uncertainty, and learning in adoption of a crop innovation. Agricultural economics, 33(1), 1–9.	A favourable or disapproving view of adoption is greatly affected by the farmers' perception of and attitude towards risk. The central role risk has was seen when the farmers were considering the possibility to adopt chickpeas and when they reflected upon the different variables to take into account in adoption, among which risk seemed to be of great importance.
Hounsome, B., Edwards, R. T., & Edwards-Jones, G. (2006). A note on the effect of farmer mental health on adoption: The case of agri-environment schemes. Agricultural Systems, 91(3), 229–241.	The findings reveal contradictory information. While healthier general conditions appear to favour the non-adoption of agri-environmental schemes, a healthier mental state seems to favour exactly the opposite, that is, the adoption of such schemes.
Adegbola, P., & Gardebroek, C. (2007). The effect of information sources on technology adoption and modification decisions. Agricultural Economics, 37(1), 55–65.	The findings of the study show that both, extension services and belonging to a cooperative, are crucial as sources of information for farmers who want to gain knowledge on innovations. Extension services play a fundamental role given their capacity to convince farmers.
Nederlof, E. S., & Dangbégnon, C. (2007). Lessons for farmer-oriented research: experiences from a West African soil fertility management project. Agriculture and human values, 24(3), 369–387.	A number of socio-economic, political, cultural and technical factors determine the farmers' decision to adopt innovations as well as the farmers' perception of agriculture. This is why it is vital to consider their socio-cultural context in farmer-oriented research.
Parra-Lopez, C., De-Haro-Giménez, T., & Calatrava-Requena, J. (2007). Diffusion and adoption of organic farming in the southern Spanish olive groves. Journal of Sustainable Agriculture, 30(1), 105–151.	Structural factors such as economic, social and institutional, affect farmers' decisions on organic farming adoption. Further influential factors include both farms and farmers characteristics.
Goldberger, J. R. (2008). Diffusion and adoption of non-certified organic agriculture: a case study from semi-arid Makueni District, Kenya. Journal of Sustainable Agriculture, 32(4), 531–564.	The diffusion is centralized with NGO training interested farmers who share information with their friends and fellow farmers. The NGO failed in translating knowledge into farmers' action for different reasons: unsuccessful workshops, no follow-up training after workshops and presence on the fields of actors with different interests creating a sort of competition.
Wheeler, S. A. (2008). The barriers to further adoption of organic farming and genetic engineering in Australia: Views of agricultural professionals and their information sources. Renewable agriculture and food systems, 161–170.	Market and farm-related problems are mentioned as the principal issues by the general sample. The most knowledgeable respondents had the same view of the adopters of organic farming and were claiming that the lack of government support and of information were the most relevant barriers to the development of organic farming.
Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. Agricultural Systems, 99(2–3), 86–104.	The paper demonstrates that farmers motivations and risk attitudes are two key factors to explain the extent to which innovative practices are adopted.
Matuschke, I., & Qaim, M. (2009). The impact of social networks on hybrid seed adoption in India. Agricultural Economics, 40(5), 493–505.	The findings of the study reveal that the behaviour of members within their farmer's individual network influence the adoption decision more than the members' own characteristics. Regarding the institutional barriers, it was concluded that limited information hindrance adoption.
Kutter, T., Tiemann, S., Siebert, R., & Fountas, S. (2011). The role of communication and co-operation in the adoption of precision farming. Precision Agriculture, 12(1), 2–17.	Results showed that farm size is an important factor that will account for differences in the effectiveness of farms' communication strategies on the adoption
	Professional literature, demonstrations and field days have proved to be of considerable help.
Kabunga, N. S., Dubois, T., & Qaim, M. (2012). Heterogeneous information exposure and technology adoption: the case of tissue culture bananas in Kenya. Agricultural Economics, 43(5), 473–486.	Different from other studies, this study differentiates between awareness of technology and knowledge about it. The paper shows that adoption rates of innovations may be significantly lower in the case of lower knowledge exposure.
Probst, L., Adoukonou, A., Amankwah, A., Diarra, A., Vogl, C. R., & Hauser, M. (2012). Understanding change at farm level to facilitate innovation towards sustainable plant protection: a case study at cabbage production sites in urban West Africa. International Journal of Agricultural Sustainability, 10(1), 40–60.	This work highlights the relevance of establishing partnerships to produce an interface which enables and encourages change.
	This collaborative approach should be considered as a precondition necessary to change and not as the driver per se.
Goldberger, J. R., Jones, R. E., Miles, C. A., Wallace, R. W., & Inglis, D. A. (2015). Barriers and bridges to the adoption of biodegradable plastic mulches for US specialty crop production. Renewable Agriculture and Food Systems, 30(2), 143–153.	A factor that impacts on farmers' decision-making ability is how accessible knowledge is. The study concluded that what hindered adoption of biodegradable mulches was mainly related to lack of knowledge and high cost. Increasing the participation of stakeholders, performing additional economic research and improving mulch products could reduce barriers to adoption
Martínez-García, C. G., Dorward, P., & Rehman, T. (2013). Factors influencing adoption of improved grassland management by small-scale dairy farmers in central Mexico and the implications for future research on smallholder adoption in developing countries. Livestock Science, 152(2–3), 228–238.	The paper confirms the strong relevance of farmers' attitude as well as of social pressure from others in the decision to adopt.
	Other relevant factors are related to the perceived practical value and relevance of the technology from the farmers' point of view
Cavallo, E., Ferrari, E., Bollani, L., & Coccia, M. (2014). Attitudes and behaviour of adopters of technological innovations in agricultural tractors: A case study in Italian agricultural system. Agricultural Systems, 130, 44–54.	From the findings of this study it can be concluded that there are different behaviours and attitudes towards innovations. The study found three different users' groups: 'unwilling', 'willing-cultural' and 'innovative-owner'. This type of information should be highly valuable for innovation producers so as to identify the behavioural patterns of users and to produce innovations that meet their needs
Aguilar-Gallegos, N., Muñoz-Rodríguez, M., Santoyo-Cortés, H., Aguilar-Ávila, J., & Klerkx, L. (2015). Information networks that generate economic value: A study on clusters of adopters of new or improved technologies and practices among oil palm growers in Mexico. Agricultural Systems, 135, 122–132.	The results of the study shows three level of adoption: basic, intermediate and advance. Contact with extension services was identified as the main factor for innovation adoption.
Mbosso, C., Degrande, A., Villamor, G. B., Van Damme, P., Tchoundjeu, Z., & Tsafack, S. (2015). Factors affecting the adoption of agricultural innovation: the case of a	The study reveals that, when it comes to how the machine is perceived, there are two main factors which are highly important: age, young are more inclined to adopt, and the rise of income seem to favour adoption.

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Paper	Implication for structure vs agency
Ricinodendron heudelotii kernel extraction machine in southern Cameroon. Agroforestry Systems, 89(5), 799–811.	Income is, once again, an important factor that impacts on the willingness to continue using the machine. The higher it is, the more eager farmers are to carry on using the machine.
Murage, A. W., Pittchar, J. O., Midega, C. A. O., Onyango, C. O., & Khan, Z. R. (2015). Gender specific perceptions and adoption of the climate-smart push–pull technology in eastern Africa. Crop Protection, 76, 83–91.	It was observed that a higher number of women see technology as very effective in comparison to men. Such findings seem to be a result of the technology characteristics, which appear to favour women. Along the same lines, a larger number of women showed to be eager to both continue using technology and expand on it. This is to be taken as a positive attitude, since would help reduce the main obstacles in cereal production, and, as a result, it would help to increase food security.
Hammond, J., van Wijk, M. T., Smajgl, A., Ward, J., Pagella, T., Xu, J., … & Harrison, R. D. (2017). Farm types and farmer motivations to adapt: Implications for design of sustainable agricultural interventions in the rubber plantations of South West China. Agricultural Systems, 154, 1–12.	The study identified six motivation types, which included farmers favouring innovation, farmers motivated mostly by profit or by social networks and environmental benefit, as well as farmers unwilling to introduce innovations under any circumstance.
Tsinigo, E., & Behrman, J. R. (2017). Technological priorities in rice production among smallholder farmers in Ghana. NJAS-Wageningen Journal of Life Sciences, 83, 47–56.	Farmers' adoption decisions show interdependencies and simultaneities that call for an accurate modelling in order to reach a better understanding of their adoption behaviour. Four decision-making patterns can be drawn: rejection, adoption of a specific technology, adoption of two of the technologies or adoption of all technologies. Factors such as size, use of extension services, education level, demonstration of the different technologies, complementary input disposal, and commercialization make the adoptions of these technologies consistently predictable.
Alomia-Hinojosa, V., Speelman, E. N., Thapa, A., Wei, H. E., McDonald, A. J., Tittonell, P., & Groot, J. C. (2018). Exploring farmer perceptions of agricultural innovations for maize-legume intensification in the mid-hills region of Nepal. International journal of agricultural sustainability, 16(1), 74–93.	The findings of the participatory research project asserted that: Intensification methods can help improve the productivity significantly; the farmers' quality engagement in on-farm trials allowed for a more accurate understanding of the underlying factors that favour or hinder the adoption of innovations and the farmers' involvement had a positive influence on their perceptions towards the adoption.
Orr, A. (2018). Markets, institutions and policies: a perspective on the adoption of agricultural innovations. Outlook on Agriculture, 47(2), 81–86.	Markets, institutions and policies con create valuable preconditions for innovations. As a matter of fact, high adoption can only occur as a result of a blending of some or all of these social elements.
Cafer, A. M., & Rikoon, J. S. (2018). Adoption of new technologies by smallholder farmers: the contributions of extension, research institutes, cooperatives, and access to cash for improving tef production in Ethiopia. Agriculture and human values, 35(3), 685–699.	The current research supports the view held by Jack (2013), which sees the access to resources that reduce the market negative externalities as the most reliable source to predict adoption. One such example would be the access to cash, which would enable farmers to afford the purchase of inputs. This view opposes the mainstream assumptions according to which the probability of adoption will only depend on the interactions with AIS.
Freeman, K., & Qin, H. (2020). The role of information and interaction processes in the adoption of agriculture inputs in Uganda. Agronomy, 10(2), 202.	Based on the results of this research, a multi-layered approach is crucial to comprehensively understand innovation diffusion. Cell phones, social networks and other interactions between farmers could encourage the distribution of information and innovation adoption
Alexander, K. S., Greenhalgh, G., Moglia, M., Thephavanh, M., Sinavong, P., Larson, S., … & Case, P. (2020). What is technology adoption? Exploring the agricultural research value chain for smallholder farmers in Lao PDR. Agriculture and Human Values, 37(1), 17–32.	The results are as follows: Farmers find motivation in technical incentives, compensation, decrease in input costs, agricultural productivity, and usefulness of technology use. As well, farmers show to be influenced by other peers' advice and need support. New technologies also allow to increase access to buyers and facilities. Farmers prioritize gaining off-farm income.
Brown, P., & Roper, S. (2017). Innovation and networks in New Zealand farming. Australian Journal of Agricultural and Resource Economics, 61(3), 422–442.	Results report that: Higher educational levels and the strong concern with the environment accelerates adoption timing. Innovators and early adopters rely on larger networks to discuss farm finances and environmental performance.
Kernecker, M., Knierim, A., Wurbs, A., Kraus, T., & Borges, F. (2020). Experience versus expectation: Farmers' perceptions of smart farming technologies for cropping systems across Europe. Precision Agriculture, 21(1), 34–50.	Farmers revealed to harbour doubts about the potential benefits of SFT that would enhance agricultural sustainability. Perceptions of SFT in this respect varied in relation to the farm context. Adopters, or SFT-experienced farmers were partly disappointed about the SFT adopted or experienced with, while non-adopters showed to have high expectations of such innovations. A crucial conclusion seems to be that for socio-technical change to take place, it is necessary to count with a kind of socially sensitive dialogue that puts farmers within the processes of agricultural technology development and information design.
Totin, E., Van Mierlo, B., Saïdou, A., Mongbo, R., Agbossou, E., Stroosnijder, L., & Leeuwis, C. (2012). Barriers and opportunities for innovation in rice production in the inland valleys of Benin. NJAS-Wageningen Journal of Life Sciences, 60, 57–66.	Results show that micro-level factors such as unclear division of responsibilities between local farmer groups and the government for the maintenance of infrastructure, a lack of effective local rules for the distribution and maintenance of the irrigation infrastructure and distrust among farmers, related to privileges of the farmer leaders, as well as macro level institutional barriers such as formal and informal credit systems and uncertain market outlets negatively affect the development of rice value chain in Benin
Van Rijn, F., Bulte, E., & Adekunle, A. (2012). Social capital and agricultural innovation in Sub-Saharan Africa. Agricultural Systems, 108, 112–122.	Structural social capital, especially the relationships beyond the village, increase the adoption of innovations. However, cognitive social capital (the norms and level of trust within the local community), reduce the adoption of innovations
Wossen, T., Berger, T., & Di Falco, S. (2015). Social capital, risk preference and adoption of improved farm land management practices in Ethiopia. Agricultural Economics, 46 (1), 81–97.	Results confirm that social capital is an essential determinant of innovation adoption. An essential driver for innovation adoption that reduces risk aversion is to be a member of different technical and credit associations. Barriers to innovation adoption are to have a very extended family and membership in funeral insurance arrangements.
Hunecke, C., Engler, A., Jara-Rojas, R., & Poortvliet, P. M. (2017). Understanding the role of social capital in adoption decisions: An application to irrigation technology. Agricultural systems, 153, 221–231.	The adoption of both technologies was favoured by two factors: networks and a positive opinion of institutions, which were considered reliable. General trust and social capital have a strong relationship with networks, being the major

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Paper	Implication for structure vs agency
	catalysts of social capital. As foreseen, both physical and human capital have a positive impact on innovation adoption.
Schipmann, C., & Qaim, M. (2010). Spillovers from modern supply chains to traditional markets: product innovation and adoption by smallholders. Agricultural Economics, 41(3–4), 361–371.	Results show that during early adoption, extension agents positively (and traditional traders negatively) influence the adoption of new practices but they harm the income. The adoption of new practices revealed an increase of performance, which is higher in the early adopters. At the level of early adopters, the following are the factors constraining the adoption: land tenure, lack of infrastructure and information
Abebe, G. K., Bijman, J., Pascucci, S., & Omta, O. (2013). Adoption of improved potato varieties in Ethiopia: The role of agricultural knowledge and innovation system and smallholder farmers' quality assessment. Agricultural Systems, 122, 22–32.	The paper shows that engagement with AKIS and access to credit positively influence preference and adoption of innovations. However, obtaining information from a primary buyer affect innovation adoption negatively.
Mwaseba, D. L., Kaarhus, R., Johnsen, F. H., Mvena, Z. S. K., & Mattee, A. Z. (2006). Beyond adoption/rejection of agricultural innovations: empirical evidence from smallholder rice farmers in Tanzania. Outlook on Agriculture, 35(4), 263–272.	The study concluded that the attitude towards adoption depended on the context, specially related to the management practices. Age and higher level of education affect adoption positively.
Koundouri, P., Nauges, C., & Tzouvelekas, V. (2006). Technology adoption under production uncertainty: theory and application to irrigation technology. American Journal of Agricultural Economics, 88(3), 657–670.	The findings reveal that risk perception and information access are highly important in the farmers' decision-making process that could lead up to adoption.
Micheels, E. T., & Nolan, J. F. (2016). Examining the effects of absorptive capacity and social capital on the adoption of agricultural innovations: A Canadian Prairie case study. Agricultural Systems, 145, 127–138.	The findings prove that social capital and the absorptive capacity are more relevant than farm size when it comes to the adoption of innovations.
Taylor, R., & Zilberman, D. (2017). Diffusion of drip irrigation: the case of California. Applied economic perspectives and policy, 39(1), 16–40.	The possibility of meeting success when adopting drip irrigation for different crops and locations depends on 2 main factors: coevolution of the innovation processes and local cooperation between public and private institutions.
Ogunlana, E. A. (2004). The technology adoption behavior of women farmers: The case of alley farming in Nigeria. Renewable Agriculture and Food Systems, 57–65.	The findings show for the women famers similar relationship as for the man farmers, linking their decision to adopt to the perceived advantage, compatibility with their work, the size of the farm, their linkages with extension contact and membership in some communities.
Hyland, J. J., Heanue, K., McKillop, J., & Micha, E. (2018). Factors underlying farmers' intentions to adopt best practices: The case of paddock based grazing systems. Agricultural Systems, 162, 97–106.	The studies identified three different clusters of farmers according to their view of resource constraints to adopt innovations: engage farmers don't see any issue in resource constraints, partially engaged farmers see resource constraints as problematic and restricted farmers see lack of resources as a barrier for innovation.

Appendix 2. Agency vs structure, an overview

Paper	Implication for agency vs structure
Tambo, J. A., & Wünscher, T. (2018). Building farmers' capacity for innovation generation: insights from rural Ghana. Renewable Agriculture and Food Systems, 33(2), 116–130.	The results indicate that beside Farmer Field Fora participation, the main factors that determine an innovation-generating capacity are education, land size, risk preferences and climate shock perception. The findings reveal that the higher the education level the household head shows to have, the more likely it is that innovation-generating practices will be favoured.
Wu, B., & Pretty, J. (2004). Social connectedness in marginal rural China: The case of farmer innovation circles in Zhidan, north Shaanxi. Agriculture and Human values, 21 (1), 81–92.	The physical environment is a determinant of innovation capacity but it is not the only one. Apart from the extension system, there are different kinds of farmer innovation circles functioning in unprivileged areas thanks to which farmers exchange learning experiences and knowledge. Despite the great variation in in terms of organizational forms, the paper found that the communication networks used by farmers (including kinship and neighbourhoods located in villages as well as close relatives and friendship) provide a fundamental rationale for farmer innovation
das Chagas Oliveira, F., Calle Collado, A., & Carvalho Leite, L. F. (2012). Peasant innovations and the search for sustainability: the case of Carnaubais territory in Piauí State, Brazil. Journal of Sustainable Agriculture, 36(5), 523–544.	Farmers' knowledge, referred to as tacit knowledge, shows to be the basis for the development of agroecological innovations.
Leitgeb, F., Funes-Monzote, F. R., Kummer, S., & Vogl, C. R. (2011). Contribution of farmers' experiments and innovations to Cuba's agricultural innovation system. Renewable Agriculture and Food Systems, 354–367.	Results show that the provision of resources to farmers such as the land to use, the government support experimental practices and encourage to participate in AIS and of farmers' decisional autonomy encouraged the flourish of local experience and adoption of technology.
Leitgeb, F., Kummer, S., Funes-Monzote, F. R., & Vogl, C. R. (2014). Farmers' experiments in Cuba. Renewable Agriculture and Food Systems, 29(1), 48–64.	Resources scarcity, learning from mistake during the experiments, communication networks and therefore formal and informal collaborations results affecting the innovation capacity of farmers
Bentley, J. W. (2006). Folk experiments. Agriculture and Human values, 23(4), 451–462.	The author argues that the aim of many experiments, also the smallest, regard the possibility to make technology more appropriate to the setting and they tend to combine new ideas creatively. Experiments tend not to be documented and this lack of documents also inhibits the diffusion
Sherwood, S., & Larrea, S. (2001). Looking back to see ahead: Farmer lessons and recommendations after 15 years of innovation and leadership in Güinope, Honduras. Agriculture and Human Values, 18(2), 195–208.	The results found that farms of highly innovative ideas were smaller than others. As individual factors, education, farming experience, community-life experience and interaction with external institutions look as the most relevant ones. The condition of poverty and the motivation to succeed seems the triggering criteria.
Deffontaines, L., Mottes, C., Della Rossa, P., Lesueur-Jannoyer, M., Cattan, P., & Le Bail, M. (2020). How farmers learn to change their weed management practices: Simple changes lead to system redesign in the French West Indies. Agricultural Systems, 179, 102,769.	Results show that trajectories, places where changes are learnt are key for innovation. Social interactions between farmers have been of great relevance. Resource pooling is able to favour innovation only in the absence of competition for the resources. Changes are incremental and rely on each other.

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Paper	Implication for agency vs structure
Chowdhury, A., Odame, H. H., Thompson, S., & Hauser, M. (2015). Enhancing farmers' capacity for botanical pesticide innovation through video-mediated learning in Bangladesh. International Journal of Agricultural Sustainability, 13(4), 326–349.	Results show that videos resulted to be an effective means to transmit new practices among peers since they use a shared language and common skills. Watching others (their peers) who are trying new things also inspires people to try new ideas.
Sumberg, J., Okali, C., & Reece, D. (2003). Agricultural research in the face of diversity, local knowledge and the participation imperative: theoretical considerations. Agricultural systems, 76(2), 739–753.	This paper classifies farmers' intervention in the participatory process of technology implementation depending on the specific type and characteristics of technology. Farmers see to have an important role in systems and defensive type of technology while for high technological and commercial types they do not have any role other than the decision to adopt them
Naouri, M., Kuper, M., & Hartani, T. (2020). The power of translation: Innovation dialogues in the context of farmer-led innovation in the Algerian Sahara. Agricultural Systems, 180, 102,793.	Results reveal the relevant role of translation operated by intermediaries placed on field to maintain dialogues between manufacturers and farmers. The increased ration from 1/500 to 1/100 secured high level of adaptation and usage of technology compared to the regions where these local actors were not present. Together with the translation service, the establishment of a support network also played a relevant role.
Faure, G., Barret, D., Blundo-Canto, G., Dabat, M. H., Devaux-Spatarakis, A., Le Guerroué, J. L., & Hainzelin, E. (2018). How different agricultural research models contribute to impacts: Evidence from 13 case studies in developing countries. Agricultural Systems, 165, 128–136.	The study reveals the existence of a variety of intervention models which researchers could exploit so as to make further contributions.

Appendix 3. Network agency, an overview

Paper	Main implications for network agency
Flor, R. J., Maat, H., Leeuwis, C., Singleton, G., & Gummert, M. (2017). Adaptive Research with and without a Learning Alliance in Myanmar: Differences in learning process and agenda for participatory research. NJAS-Wageningen Journal of Life Sciences, 81, 33–42.	The findings show that farmers and researchers could be involved in Adaptive Research and, thus, could learn about on-farm agronomic solutions. Learning alliances could contribute giving more insights about concerns about innovation and support solutions.
Lamb, J. N., Moore, K. M., Norton, J., Omondi, E. C., Laker-Ojok, R., Sikuku, D. N., … & Odera, J. (2016). A social networks approach for strengthening participation in technology innovation: lessons learnt from the Mount Elgon region of Kenya and Uganda. *International journal of agricultural sustainability*, *14*(1), 65–81.	Having network workshops to reflect on how to improve the network by helping researchers in interpreting data and applying suggestion, improved the communication among all the parties as they were called to reflect on their role on the network.
Friederichsen, R., Minh, T. T., Neef, A., & Hoffmann, V. (2013). Adapting the innovation systems approach to agricultural development in Vietnam: challenges to the public extension service. *Agriculture and Human Values*, *30*(4), 555–568.	Results showed the changing direction of extension staff who are now devoted to collect farmers' needs, but that should extend more the role of broker connecting and facilitating the mediation between farmers and local authority.
Dabire, D., Andrieu, N., Djamen, P., Coulibaly, K., Posthumus, H., Diallo, A. M., … & Triomphe, B. (2017). Operationalizing an innovation platform approach for community-based participatory research on conservation agriculture in Burkina Faso. *Experimental Agriculture*, *53*(3), 460.	Results show the following factors for a successful implementation of digital platform: the emerging local need to change the current system, the presentation of innovation platforms as a possible solution to diffuse relevant practices; the role of facilitators that must have a huge personal network of contacts.
Yang, H., Klerkx, L., & Leeuwis, C. (2014). Functions and limitations of farmer cooperatives as innovation intermediaries: Findings from China. *Agricultural Systems*, *127*, 115–125.	The results show that farm cooperatives (FC) do knowledge intermediation and innovation intermediation functions. Additionally, farm cooperatives link 3 important spheres of farming practice, namely the technical, social and economic ones. Furthermore, the FCs enable the communication between multiple stakeholders.
Kroma, M. M. (2006). Organic farmer networks: facilitating learning and innovation for sustainable agriculture. *Journal of Sustainable Agriculture*, *28*(4), 5–28.	The study shows how the organic networks support both the diffusion and the adoption of organic innovations. Furthermore, it explores the appearance of organic networks regarded as institutional innovations encouraging a knowledge system. Moreover, it examines the constituting elements of networks that help define them as social learning processes that improve farmers' skills to introduce innovations.
Theodorakopoulos, N., Bennett, D., & Sánchez Preciado, D. J. (2014). Intermediation for technology diffusion and user innovation in a developing rural economy: A social learning perspective. *Entrepreneurship & Regional Development*, *26*(7–8), 645–662.	Results identify different functions of intermediaries helpful to the diffusion and adaptation of technology: brokering in the sense of building membership with stakeholder, brokering in the sense of taking action, deciding the pursuit agenda, facilitating and configurating roles which help in striving for the collecting adaptation through workshop and other events, and finding other intermediaries with a good reputation.
Poncet, J., Kuper, M., & Chiche, J. (2010). Wandering off the paths of planned innovation: The role of formal and informal intermediaries in a large-scale irrigation scheme in Morocco. *Agricultural systems*, *103*(4), 171–179.	Results show that starting from changes in the socio-economical context leading to market liberalization process, different dynamics with new stakeholders were observed. Besides extension service, farmers could mobilize a wide range of intermediaries. In this new ecosystem farmers could innovate themselves adopting technology not designed for them.
Spielman, D. J., Davis, K., Negash, M., & Ayele, G. (2011). Rural innovation systems and networks: findings from a study of Ethiopian smallholders. Agriculture and human values, 28(2), 195–212.	By providing examples of analysis of the social network formed around farmers, this study concludes that: the marketing network should be better integrated with the production network to affect positively the ability to innovate; the heterogeneous network helps improving information access and different actors can play different roles.
Adolwa, I. S., Schwarze, S., Bellwood-Howard, I., Schareika, N., & Buerkert, A. (2017). A comparative analysis of agricultural knowledge and innovation systems in Kenya and Ghana: sustainable agricultural intensification in the rural–urban interface. *Agriculture and human values*, *34*(2), 453–472.	This study shows the relevance of having a combination of weak and strong ties connecting farmers with the environment in order for them to formulate the most innovative solutions Results show that weak ties with both homogeneous and heterogeneous actors give access to knowledge while the strong ties are means through which they can instill the acquired knowledge with different agricultural stakeholders.
Isaac, M. E. (2012). Agricultural information exchange and organizational ties: The effect of network topology on managing agrodiversity. *Agricultural systems*, *109*, 9–15.	The results show that producers which have networks with lower density has a more efficient access to information. In that sense, adoption of innovation is more likely.
Lambrecht, E., Crivits, M., Lauwers, L., & Gellynck, X. (2018). Identifying key network characteristics for agricultural innovation: a multi-sectoral case study approach. *Outlook on Agriculture*, *47*(1), 19–26.	Factors crucial for successful agricultural innovation are as follows: relying on numerous contacts, fostering an integration of knowledge within the members of the network structure, close communication, and a self-initiated alliance.

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Paper	Main implications for network agency
Chindime, S., Kibwika, P., & Chagunda, M. (2016). Positioning smallholder farmers in the dairy innovation system in Malawi: A perspective of actors and their roles. *Outlook on Agriculture*, *45*(3), 143–150.	The current scenario shows a diversity of interests embodied by the different actors. Power relations mediate interactions, and the smallholder farmers are the least influential ones, as they are the weakest group. As a matter of fact, their role is usually that of receiving technologies rather than determining them. Thus, they could easily become subjects of exploitation by more powerful actors (e.g. business entrepreneurs) whose aim is to increase their profits.
Rockenbauch, T., Sakdapolrak, P., & Sterly, H. (2019). Do translocal networks matter for agricultural innovation? A case study on advice sharing in small-scale farming communities in Northeast Thailand. *Agriculture and Human Values*, *36*(4), 685–702.	Local sharing networks could benefit from connections with migrants since they can transfer translocal innovation. Thus, top-down innovations, promoted by markets and policies, could be better adopted through translocal networks characterized by few ties and centralized brokerage. Additionally, a single boundary-spanning individuals interest in introducing changes can facilitate bottom-up innovations within these networks.
Kilelu, C. W., Klerkx, L., & Leeuwis, C. (2013). Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme. *Agricultural systems*, *118*, 65–77.	Results show that the usage of platforms helped in improving marketing capacity but not farmer level innovation. Platform innovation intermediation function entered in conflict with the intermediation function of intermediaries. The platform was not sufficient to secure an adaptive and responsive reaction.
Thiele, G., Devaux, A., Reinoso, I., Pico, H., Montesdeoca, F., Pumisacho, M., … & Horton, D. (2011). Multi-stakeholder platforms for linking small farmers to value chains: evidence from the Andes. *International Journal of Agricultural Sustainability*, *9*(3), 423–433.	The findings of the study support the view that platforms can improve collective action by gathering multiple stakeholders. Platforms are suitable spaces to boost changes in value chains such as novel innovations, practices and attitudes
Klerkx, L., Adjei-Nsiah, S., Adu-Acheampong, R., Saïdou, A., Zannou, E., Soumano, L., … & Nederlof, S. (2013). Looking at agricultural innovation platforms through an innovation champion lens: an analysis of three cases in West Africa. *Outlook on agriculture*, *42*(3), 185–192.	Innovation champions play different crucial roles in innovation platforms. Identifying their barriers are essential to promote changes. Barriers were cognitive, administrative and relational and were addressed performing various activities.
Ortiz, O., Orrego, R., Pradel, W., Gildemacher, P., Castillo, R., Otiniano, R., … & Kahiu, I. (2013). Insights into potato innovation systems in Bolivia, Ethiopia, Peru and Uganda. *Agricultural Systems*, *114*, 73–83.	The study results show that the tuber innovation systems had similar stakeholders shaping the systems and which are the main driver and barriers for innovation in each case. The International Potato Center played the role of innovation brokerage in all systems.
Pamuk, H., Bulte, E., Adekunle, A., & Diagne, A. (2015). Decentralised innovation systems and poverty reduction: experimental evidence from Central Africa. *European Review of Agricultural Economics*, *42*(1), 99–127.	The study reveals that innovation platforms help bring down the poverty level more effectively than traditional extension approaches. Active participation of multi-stakeholder reduces local elites traditional power, generating spill-over effects for poor-resource farmers.
Davies, J., Maru, Y., Hall, A., Abdourhamane, I. K., Adegbidi, A., Carberry, P., … & Watson, I. (2018). Understanding innovation platform effectiveness through experiences from west and central Africa. *Agricultural Systems*, *165*, 321–334.	Innovation platform effectiveness is achieved by the establishment of solid networks over time. In that sense, trust increases among members, which facilitates information diffusion and collective action. Maintaining effectiveness requires more careful coordination of multi-actors through individuals and organisations, enabling inter-organisational networks to promote further innovation.
Kilelu, C. W., Klerkx, L., & Leeuwis, C. (2017). Supporting smallholder commercialisation by enhancing integrated coordination in agrifood value chains: Experiences with dairy hubs in Kenya. *Experimental Agriculture*, *53*(2), 269–287.	The results show that hubs can create appropriate collaborative spaces between multiple stakeholders. In the case of smallholder farmers, thanks to farmer organization, their participation increases collaboration at horizontal levels in the value chain; however, it is still limited at the vertical level.
Kebebe, E., Duncan, A. J., Klerkx, L., de Boer, I. J., & Oosting, S. J. (2015). Understanding socio-economic and policy constraints to dairy development in Ethiopia: A coupled functional-structural innovation systems analysis. *Agricultural Systems*, *141*, 69–78.	The findings have made it evident that the main structural barriers for the dairy innovation system are: lack of power of key actors, lack of skills, bureaucracy, lack of strong social relationships and scarce infrastructure. The main functional enablers are the learning process, market creation and legitimacy establishment.
Kishioka, T., Hashimoto, S., Nishi, M., Saito, O., & Kohsaka, R. (2017). Fostering cooperation between farmers and public and private actors to expand environmentally friendly rice cultivation: intermediary functions and farmers' perspectives. *International Journal of Agricultural Sustainability*, *15*(5), 593–612.	Results reveal that effective government intermediation function based on spreading a coherent technical and economic vision about innovations motivate farmers to adopt them.
Klerkx, L., & Leeuwis, C. (2009). Shaping collective functions in privatized agricultural knowledge and information systems: the positioning and embedding of a network broker in the Dutch dairy sector. *Journal of Agricultural Education and Extension*, *15*(1), 81–105.	Results show seven different categories of innovation brokers in Dutch agriculture and reveal the difficulties encountered to establish coherent innovation arrangements. In some brokers types, scarce embeddedness, lack of neutrality or funding constraints are the main factors that hamper innovation.
van Paassen, A., Klerkx, L., Adu-Acheampong, R., Adjei-Nsiah, S., & Zannoue, E. (2014). Agricultural innovation platforms in West Africa: how does strategic institutional entrepreneurship unfold in different value chain contexts? *Outlook on agriculture*, *43*(3), 193–200.	The results reveal that an effective innovation platform can only be created when enabling or hindering institution factors are locally identified, and the design of the platform is flexible to keep motivated multiple stakeholders.
Schut, M., Cadilhon, J. J., Misiko, M., & Dror, I. (2018). Do mature innovation platforms make a difference in agricultural research for development? A meta-analysis of case studies. *Experimental Agriculture*, *54*(1), 96–119.	Results show that the main factors leading to mature innovation platforms are: effective knowledge diffusion, adaptive management and common interests among the members.
Munthali, N., Leeuwis, C., van Paassen, A., Lie, R., Asare, R., van Lammeren, R., & Schut, M. (2018). Innovation intermediation in a digital age: Comparing public and private new-ICT platforms for agricultural extension in Ghana. *NJAS-Wageningen Journal of Life Sciences*, *86*, 64–76.	The results of the study show that new-ICTs' innovation intermediation capacity is far from realised. Even though ICTs platforms can connect people and provide easy access to new information, broader social, organisational and institutional factors hinder their potential to promote innovation.
Botha, N., Klerkx, L., Small, B., & Turner, J. A. (2014). Lessons on transdisciplinary research in a co-innovation programme in the New Zealand agricultural sector. *Outlook on AGRICULTURE*, *43*(3), 219–223.	Integrating IP within the AIS programme is challenging, as it demands significant effort to form a team and to interact with and mentor participants Furthermore, it requires an integration of management, planning, policy and practice in conducting the integrative research that is related to IP.
Turner, J. A., Klerkx, L., White, T., Nelson, T., Everett-Hincks, J., Mackay, A., & Botha, N. (2017). Unpacking systemic innovation capacity as strategic ambidexterity: How projects dynamically configure capabilities for agricultural innovation. *Land use policy*, *68*, 503–523.	The results show that three are the main important elements regarding successful innovation capability: the enabling role play by key actors, adaptive management and dynamic practices at multiple levels.
Crivits, M., de Krom, M. P., Dessein, J., & Block, T. (2014). Why innovation is not always good: innovation discourses and political accountability. Outlook on AGRICULTURE, 43 (3), 147–155.	The study proposed a framework based on 'discursive accountability', to take into account the most relevant views when it comes to decision-making process to promote innovations.

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