

Trust networks and innovation dynamics of small farmers in Colombia: An approach from territorial system of agricultural innovation

Redes de confianza y dinámica de innovación de pequeños agricultores en Colombia: Un enfoque desde el sistema territorial de innovación agrícola

Carlos Julián Ramírez-Gómez ¹, Jorge Robledo Velasquez ², Jorge Aguilar-Avila ³

Originales: *Recepción*: 17/04/2019 - *Aceptación*: 03/03/2020

ABSTRACT

This study addresses the concepts of territorial systems of agricultural innovation and social network analysis. The general purpose of this research was analyzing a relationship between trust networks (technical, strategic and normative) and the dynamics of technological diffusion and adoption by Hass avocado farmers in each territory. To this end, two rural municipalities were compared as case studies; where 94 farmers were interviewed. A database was obtained and analyzed using a social network approach by calculating network indicators, as well as the technology adoption index (TAI) for farmers. Correlation tests were also used to determine the effect of the farmers' trust networks on their own technology diffusion-adoption dynamics. Case studies showed that there are no significant differences in terms of technology adoption when comparing municipalities. However, the farmers' diffusion networks show different public-private actors, as well as different degrees of input centrality and intermediation in each municipality, where correlation was found only with normative trust networks in a municipality. The capture of specific information from a geographical space is steered by the approach of territorial systems of agricultural innovation, allowing for the development of increasingly accurate strategies and interventions.

Keywords

territorial innovation systems • trust networks • diffusion • agricultural adoption

-
- 1 Universidad Nacional de Colombia. Grupo de investigación en innovación y gestión tecnológica. * cajramirezgo@unal.edu.co
 - 2 Universidad Nacional de Colombia. Departamento de Ingeniería de la Organización. Calle 59^a N. 63-20. Medellín. Antioquia.
 - 3 Universidad Autónoma Chapingo. Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y la Agricultura Mundial (CIESTAAM). Km 38.5 Carretera México-Texcoco. C. P. 56230. Estado de México. México.

RESUMEN

Se abordó un estudio sobre el concepto de sistema territorial de innovación agrícola y análisis de redes sociales. La presente investigación se desarrolló con el objetivo general de analizar una relación entre las redes de confianza (técnica, estratégica y normativa) y la dinámica de difusión y adopción tecnológica de los agricultores de aguacate Hass en cada territorio. Para ello se compararon dos municipios rurales como estudios de caso, donde se entrevistaron 94 agricultores. Se obtuvo una base de datos y se analizó mediante enfoque de redes sociales, calculando indicadores de red, así como el índice de adopción de tecnología (INAT) para los agricultores. También se usaron pruebas de correlación para determinar la incidencia de las redes de confianza de los agricultores en sus propias dinámicas de difusión-adopción de tecnología. Los estudios de caso mostraron que no existen diferencias significativas en la adopción de tecnología comparando municipios. Sin embargo, las redes de difusión de los agricultores evidencian diferentes actores público-privados, así como diferentes grados de centralidad de entrada y de intermediación en cada municipio, donde se halló correlación solo con las redes de confianza normativa en un municipio. El enfoque de sistemas territoriales de innovación agrícola orienta la captura de información específica de un espacio geográfico, permitiendo desarrollar estrategias e intervenciones más precisas.

Palabras clave

sistema territorial de innovación • redes de confianza • difusión • adopción agrícola

INTRODUCTION

Latin America's agricultural sector faces new challenges related to the increase in productivity, reduction of poverty and a greater agricultural development. In this sense, innovation is recognized as an important source of improvement in terms of productivity, competitiveness, growth and modernization of rural economies and regions (23). The concept of agricultural innovation systems is particularly relevant for fostering agricultural innovation, from heterogeneous actors that create networks and that can influence and support technology diffusion and adoption dynamics of farmers (38).

The agricultural innovation system has been approached from a geographical perspective of analysis of the country (26),

as well as from a regional perspective (7). Other approaches propose the territorial innovation system approach, as a framework that allows interpreting the performance of innovation according to the specific characteristics of a rural region (24). Although more integrative approaches of the agricultural innovation system have been proposed (10), there are still no approaches that incorporate the rural region as a geographical level of innovation analysis (37), based on rural territory components, population and public and private actors (25), and where territorial spatial scale analysis stands out.

It is important to incorporate spatial scales of analysis from rural territories, as there is evidence showing a heterogeneous performance of agricultural

innovation systems in local territories, both in adoption rates by farmers and diffusion processes (37). In fact, the dynamics of technological diffusion to farmers, and its learning, can also be developed from a set of actors located in specific territorial contexts (1, 4). The analysis of different territorial links highlights the existence of several types of links in networks (11), between farmers and diverse actors of the innovation system, that influence both technology adoption and information exchanges, as well as dynamics that can vary when comparing rural territories (13).

These approaches highlight the importance of understanding the innovation system from a localized geographical perspective. However, even though there has been some interest in relating territorial aspects to technological diffusion and adoption dynamics, there is still little literature accounting for these approaches, in particular, around a discussion that is not addressed from the perspective of the agricultural innovation system, which relates to the effects of trust in farmers' innovation dynamics.

In this sense, it has been demonstrated that the process of technology adoption by farmers can also be mediated by trust relationships and their intersection in diverse networks (3). Likewise, it has been shown that the process in which farmers acquire information and learn can be placed in specific geographical contexts where trust also plays a part (31). Although the territorial relationship between trust and technological diffusion-adoption by farmers is not a thoroughly explored approach, some studies provide approximations in this regard. Such is the case of

farmers' trust towards entities and within the same rural community, in relation to technology adoption (12), the relationship of trust between farmers and local and non-local institutions and its effects on adoption (22), as well as the perception of trust and solidarity, and its effects on diffusion in innovation systems (33).

These approaches usually associate the idea of trust with the concept of share capital, based on network structures of links and relationships between actors (29). However, some authors have suggested a different approach, from the perspective of trust networks (technical, strategic and normative), seen as a set of positive expectations about others, regarding their actions and the role of interactions (16). Technical trust relates to the perception one has towards an actor, mainly in terms of its capacities; strategic trust implies a relationship based around self-interest or convenience, and normative trust relates to the values and norms shared within individuals (15). Considering the general hypothesis that the dynamics of innovation is different at a spatial scale, where the bonds of trust can influence in a differentiated way, this work is based on the territorial vision of trust from geographical contexts that allow understanding the innovation dynamics in specific places (8). The objective of this study is to analyze the existence of a relationship between trust networks (technical, strategic and normative) and the technological diffusion and adoption dynamics of Hass avocado farmers, from the perspective of territorial systems of agricultural innovation.

MATERIALS AND METHODS

This study analyzes the territorial system of agricultural innovation by sector (Hass avocado), and by rural municipal territory, approached as a political administrative division with clear limits, based on a set of geographically continuous rural municipalities articulated around one or more productive nuclei (6). From an empirical approach, two rural municipalities with increasing productive dynamics, different geographical distances, as well as contrasting social contexts were selected (figure 1).

Collecting, sampling and analysis methods

The research design was based on the case study approach and involved interviews with actors to explore the innovation dynamics and networks. Initially, five in-depth interviews were conducted with

key informants; this provided specific information on the sector and helped to create a list of public and private actors of the avocado innovation system for each municipality. In addition, it was possible to find the most representative locations to approach the farmers. This information was complemented by farmers participating in training events in each municipality. Additionally, data collection was carried out between June and August of 2017; 94 interviews to farmers were conducted, 45 of them in the municipality of San Vicente and 49 in the municipality of Sonsón.

For the selection of farmers, snowball sampling was used, as it is a technique that helps to construct networks, through random sampling (36), in the most representative localities regarding Hass avocado production in each municipality.

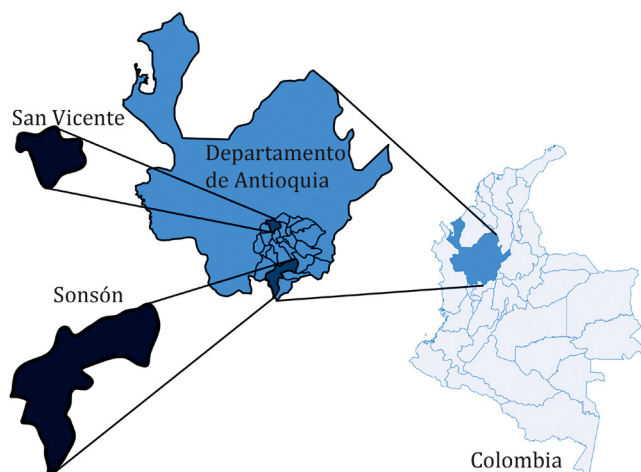


Figure 1. Map of the study area (eastern rural region and the municipal territories of San Vicente and Sonsón).

Figure 1. Mapa del área de estudio (región rural de oriente y los territorios municipales de San Vicente y Sonsón).

In the context of social network analysis (SNA), this type of sampling is better for capturing the properties of the network, and it also saves resources (17). In the survey, producers were asked about three types of information: (i) links of trust networks according to the list of actors for each municipality, (ii) adoption of agricultural technology associated with the crop, (iii) mapping of the diffusion network from the learning sources (table 1). For the networks, the farmers mentioned the link with each actor of the innovation system in each municipality, thus generating a bivariate answer option (yes or no) in the questions. In the diffusion networks, the farmer could point out the specific actors of the innovation system from which they learned different technologies and practices in each territory.

In the technology adoption section, farmers were consulted with regard to a list of 37 technologies and technological practices, which were identified and validated with expert professionals in the crop. These technologies were grouped into 7 categories: crop fertilization, phyto-sanitary management, conservation practices, crop management cultural

practices, administration, organization, harvesting and post-harvesting (21). In this case, farmers were also given a bivariate answer option (yes or no), regarding each technology. The technology adoption index (TAI) was calculated based on the farmer's innovative capacity; TAI_k corresponds to the technology adoption rate in the "k" category, which is made up of a determined number of technologies and practices. In addition, "K" corresponds to the number of categories, which are seven (21).

$$TAI = \frac{\sum_{k=1}^K TAI_k}{K} * 100$$

For the analysis of trust networks and diffusion networks approached from the perspective of farmers, centrality and intermediation indicators were calculated (2). For trust networks, the farmer's degree of output centrality (number of links that farmers sends to other actors) was calculated. Likewise, for diffusion networks, the degree of input centrality regarding the system's actors (those from whom the farmers state having learned) was calculated. This indicator relates to the number of links an actor receives from others, in this case farmers (9).

Table 1. Data collection mechanisms based on guiding questions.

Tabla 1. Mecanismos de recolección de datos a partir de preguntas orientadoras.

Analysis variables	Types of questions
Technical trust network	In which of these entities or organizations do you trust for your knowledge and technical skills?
Strategic trust network	Which of the following entities or organizations do you generate trust from some type of benefit obtained?
Normative trust network	With which of the following entities do you maintain good interpersonal relationships and consider that you share your values, beliefs and norms?
Adoption of technology	Which of the following 37 technologies and technological practices do you currently incorporate at the cultivation level?
Diffusion network	From whom did you learn these technologies and technological practices?

Finally, the degree of intermediation centrality of the same actors was calculated. This indicator enables finding actors that act as bridges or links of information (14). The influence of trust networks in farmer's diffusion-adoption dynamics was analyzed and compared between rural municipal territories, using Spearman's statistical correlation tests.

RESULTS

Innovation dynamics of farmers shows different behaviors in each rural municipal territory. Additionally, trust networks have a different influence in the results regarding diffusion-adoption by farmers in each municipality. Figure 2 shows results obtained in the technology adoption index (TAI) for each rural municipality; in certain categories,

results between municipalities differ. The lowest adoption levels are found in the categories of organization, with similar averages of 5% and 4%, and management, with averages of 29% and 32% in each municipality. The low adoption rates by farmers of both municipalities in the category of organization was also proven in the field work; low participation in meetings, low organizational capacity of some producers to act collectively and lack of associative business approach. Likewise, in the management category, several practices are not being incorporated by the producers: management of records and information about the farms, productivity, costs, prices, etc. This low level adoption in administrative practices is disadvantageous in terms of adjusting the production to the requirements of the exporting traders.

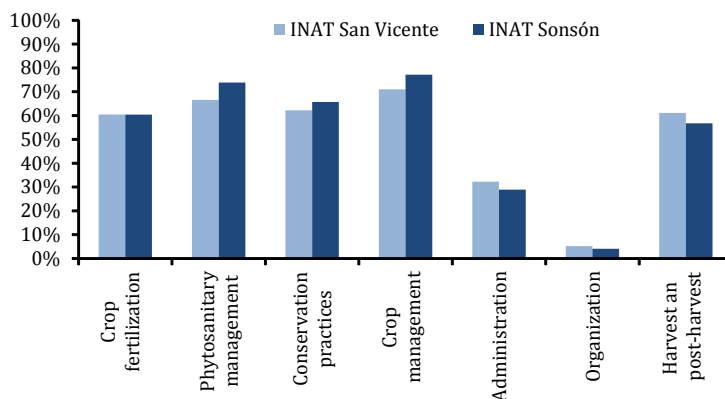


Figure 2. Technology adoption index (TAI) of producers in the rural municipal territories sorted by category.

Figura 2. Índice de adopción de tecnología (INAT) de los productores ordenados por categoría en los territorios municipales rurales.

Then, the category of sanitary management shows differences in the averages between territories, reaching a 73.8% adoption rate in the municipality of Sonsón. In this case, there is a greater adoption rate of diverse technological practices related to the crop's sanitary management for quality improvement purposes. However, a homogeneous adoption rate is observed in the category of crop fertilization as both municipal territories reach 60%. The categories of conservation practices and agronomic management have different adoption averages, and the technology adoption rate is higher in the municipality of Sonsón; 65% and 77.1% respectively. In this case, these are technologies and practices related to a sustainable and specific management of the crop to improve production, stimulate flowering, pruning of trees, etc. However, with regard to harvesting and post-harvesting practices, the municipality of San Vicente reaches the highest technology adoption percentage with 61%. In this case, avocado harvesting, classification, selection and preservation practices are incorporated for exporting purposes.

Although technology adoption depends on a wide range of factors

related to the personal characteristics of farmers, social, cultural, economic factors, the characteristics of the technologies and farm-related aspects (28), this study has demonstrated the role played by trust networks (technical, strategic, normative) in this process. In fact, there is an association relationship between trust networks and technology adoption in the municipality of Sonsón (table 2). This demonstrates that, in each territory, farmers have different ways to capitalize the links of the different types of trust into their own technology adoption results. Based on the field research, it was possible to establish that there is some degree of technical trust in the municipality of Sonsón, as farmers believe in the capacities and recommendations of certain actors of the innovation system. On the contrary, the municipality of San Vicente shows an environment of distrust as a result of unfulfilled promises by actors such as marketing companies. With regard to strategic trust, farmers are interested in resources such as the delivery of materials, access to credits, personalized farm-related technical assistance, gathering and transport of avocado directly from the farms, and export certification for farms.

Table 2. Relationship between trust networks and technology adoption index in the municipal territories.

Tabla 2. Relación entre las redes de confianza y el índice de adopción de tecnología en los territorios municipales.

Trust networks	Municipal Territories	
	Municipality of San Vicente	Municipality of Sonsón
	TAI	TAI
Technical trust	0.103	0.409**
Strategic trust	0.064	0.531**
Normative trust	0.055	0.382**

* Correlation is significant at 0.05. / ** Correlation is significant at 0.01.

* Correlación es significativa al 0,05. / ** Correlación es significativa al 0,01.

The fieldwork evidenced that, within the municipality of Sonsón, farmers feel they have more access to additional incentives and guidance, which motivates them to incorporate better technological practices in their avocado crops.

The field research showed some degree of normative trust within the municipality of Sonsón in terms of values such as honesty, and credibility towards various marketing companies from the territory. Therefore, issues such as compliance with verbal and informal purchase agreements, other fulfilled promises by other actors, as well as the outstanding role of farmers in rural extension strategies such as field days, have strengthened the ties that facilitate information exchange and favor technology adoption. Finally, in addition to the background of non-compliance and an environment of territorial distrust in the municipality of San Vicente, after observing the development of rural extension strategies from field schools, a very linear and not very interactive training process among farmers was observed, which can ultimately affect both the technical and regulatory trust of producers.

Technology diffusion dynamics in rural municipal territories

Farmers' diffusion networks showed that actors are different between municipalities; both in number and in several network indicators such as input centrality and intermediation. Regarding the number of actors, the most relevant differences relate to the business component which contributes to a greater flow of information and knowledge from a greater number of actors in the municipality of Sonsón (table 3, page 261). The opposite happens in the intermediary component, such as in the municipality

of San Vicente, where there is a greater number of network-diffusion actors.

It is also important to highlight how the local association of farmers has a greater role in the municipality of San Vicente, both for its input centrality and for its intermediation in the diffusion of knowledge to producers. This contrasts with the municipality of Sonsón, where other local producers and the Secretariat of local agriculture have greater input centrality and intermediation indicators in this territory. In both municipalities, the actors who are able to generate links in relation to the flow of information and knowledge are different, which demonstrates the variation of the role of actors according to geographical space. Of course, the approach of territorial innovation system allows us to determine that, within the various components, the role of the actors is different in relation to network indicators, and in relation to the diffusion they generate towards farmers in both territories. Therefore, they are also important actors of the intermediary, support, education and research components, which must be linked to an innovation management and territorial diffusion strategy.

It is also important to consider that the actors of the intermediary and education components have better skills in the process of training and technology transfer. However, there are several universities, both public and private, and research centers in the region, which do not contribute to the diffusion networks of avocado producers in the territorial municipalities, as they are not mentioned as sources of learning. On the other hand, trust networks (technical, strategic and normative) showed little relation of association with diffusion networks in both territories (table 4, page 262).

Table 3. Relation of actors of the farmers' diffusion network in rural municipalities.**Tabla 3.** Relación de actores de las redes de difusión de los productores en los territorios municipales

Municipality of San Vicente				Municipality of Sonsón			
System Components	Actors	Network centrality measures		System Components	Actors	Network centrality measures	
		In-degree (%)	Betweenness (%)			In-degree (%)	Betweenness (%)
Company	CI Green West	4.91	0.69	Company	Hass Colombia	1.53	0
	Local farmers association	21.31	17.33		CI Green West	3.07	0.10
					CI. WestSole	7.69	4.36
Suppliers of inputs	1.63	0	Cartama		9.23	1.28	
			Local farmers association		3.07	0.19	
Suppliers of inputs	15.38	7.93					
Support	Agriculture Ministry	1.63	0	Support	Governation	1.53	0
	Secretariat of Local Agriculture	13.11	15.57		Secretariat of Local Agriculture	36.92	33.32
Intermediary	Ceam	3.27	0.04	Intermediary			
	Corpohass	1.63	0		Campo Limpio	12.30	5.29
	Campo Limpio	19.67	15.11		Corpoaguacate	3.07	0.10
	Asohofrucol	27.86	12.92		Asohofrucol	3.07	0.22
	Coredi	4.91	1.27		ICA	27.69	22.04
	ICA	8.19	3.99				
Education	Sena	37.70	30.57	Education	Corpoica	6.15	0.65
					Sena	12.30	4.61
Referred	Technical assistant	16.39	17.23	Referred	Technical assistant	10.76	4.77
	Other local producers	3.27	6		Other local producers	36.92	32.72
	Referred entities	3.27	0.05				

Table 4. Relationship between trust networks and diffusion networks in rural municipal territories.

Table 4. Relación entre las redes de confianza y las redes de difusión en los territorios municipales rurales.

Municipal Territories		
Trust networks	Municipality of San Vicente	Municipality of Sonsón
	Diffusion networks	Diffusion networks
Technical trust	0.29	0.18
Strategic trust	0.279	0.279
Normative trust	0.361*	0.061

* Correlation is significant at 0.05./ ** Correlation is significant at 0.01.

* Correlación es significativa al 0,05. / ** Correlación es significativa al 0,01.

By comparatively analyzing farmer's trust networks (degree of output), with diffusion networks (degree of input of the system's actor), a significant correlation can only be found in the municipal territory of San Vicente.

In other words, the farmer's perception of certain shared norms, beliefs and values towards other actors of the system is positively influencing information and knowledge flow channels, although farmers can't capitalize this into their own technology adoption results in the same territory. The field research showed that in the municipality of San Vicente, farmers have better rapport, interpersonal and respectful relationships with various actors and feel better understood in aspects of their culture. This generates a reliable knowledge diffusion channel for farmers by several actors; nevertheless, normative trust networks fail to influence technology adoption by farmers in this municipality. The field research made it possible to understand that farmers in this

municipality also generate other types of more informal, indirect and localized diffusion channels which they are more likely to trust for their technology adoption process.

The existence of certain neighborly relationships (also determined by similar attitudes of farmers regarding crop management) where there is a greater degree of understanding and identities has been demonstrated in these more informal channels; this implies very localized social learning processes (20). Although trust networks are associated with technology adoption in the municipality of Sonsón, there are no reliable diffusion channels for farmers. Although they can recognize and accept an innovation that is disseminated by the actors, they can also adopt it through other channels. In this territory, farmers seek greater technological validation by participating in training events and by socializing with their peers.

For this reason, several producers are cited as the main source of learning and technology promotion, with greater degree of input and intermediation in the diffusion networks. In fact, various forms of interaction and informal communication were observed in rural extension events; this facilitates exchanges between farmers and other actors of the system.

DISCUSSION

The approach of the territorial system of agricultural innovation constitutes an important framework of analysis, as it allows understanding specific innovation dynamics of farmers through geographical spaces. This research provides an approach on the rural region composed of the territories and the actors, and takes rural municipalities as a clearly defined unit of analysis, unlike other works proposed in the literature (7, 24, 27). Likewise, and acknowledging that trust is considered as a basic prerequisite for the acceptance of innovations promoted by various actors (19), this research (unlike other approaches) proposes an analysis on trust networks and their relationship with the technology diffusion-adoption dynamics of farmers from the territory.

In fact, from the perspective of technical trust, there are studies that associate the degree of professional reputation, credibility and skills of extension agents with the degree of trust producers can develop towards them, which influences the adoption of agricultural technology (32). This aspect is important in territorial systems of agricultural innovation because of the role that multiple public and private actors have in advising and technology diffusion (6). Likewise, it is important to consider strategic trust within the

approach of territorial systems of agricultural innovation, as it has been proven to increase technology adoption capacities of different producers and accelerate agricultural diffusion, based on a variety of incentives such as subsidies, provision of goods and services, among others, in which producers are certainly interested (18, 30). Finally, normative trust networks are important because the process through which farmers learn is mainly social and requires mutual communication as well as communication with other actors, which is favored by an assertive interpersonal communication that allows information flows (34), based on links that allow to strengthen certain territorial relationships, where certain shared values are achieved, even if there is no real friendship involved (35).

CONCLUSIONS

This study empirically demonstrated how both technology adoption by farmers and diffusion networks have different trends across geographical spaces. This implies that, in certain categories such as agronomic management, good practices and sanitary management of the crop, there were differences between territories in terms of technology adoption by farmers. Likewise, diffusion networks of farmers from each rural municipality were built upon different actors, several of which were different and had different input centrality indicators. These actors are quite important as they are cited as intermediation indicators and sources of learning, which means they are fundamental actors in promoting greater diffusion in each territory. Likewise, trust networks (technical, strategic and normative) were found to have a different

influence in each rural municipality in relation to farmers' diffusion networks and the technology adoption index. This illustrates the importance of understanding farmers' innovation dynamics

across the geographical space, as they obey to logics and network links that materialize in a particular way in each rural municipality, creating territorial systems of agricultural innovation.

REFERENCES

1. Blandi, M. L.; Rigotto, R. M.; Sarandón, S. J. 2018. Influencia de factores contextuales en la adopción de modelos de agricultura insustentables. La incorporación del invernáculo en agricultores platenses. *Revista de la Facultad de Ciencias Agrarias. Universidad Nacional de Cuyo. Mendoza. Argentina.* 50(1): 203-216.
2. Borgatti, S. P.; Everett, M. G.; Freeman, L. C. 2002. *Ucinet 6 for Windows: Software for Social Network Analysis. User's guide.* Harvard. Analytic Technologies Inc. Massachusetts. USA. 47 p.
3. Carolan, M. S. 2006. Social change and the adoption and adaptation of knowledge claims: Whose truth do you trust in regard to sustainable agriculture? *Agriculture and Human Values.* 23(3): 325-339. doi:10.1007/s10460-006-9006-4
4. Díaz-José, J.; Rendón-Medel, R.; Govaerts, B.; Aguilar-Ávila, J.; Muñoz-Rodríguez, M. 2015. Innovation diffusion in conservation agriculture: A Network Approach. *European Journal of Development Research, (Cc).* 1-16. Doi:10.1057/ejdr.2015.9
5. Eastwood, C.; Klerkx, L.; Nettle, R. 2017. Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *Journal of Rural Studies.* 49: 1-12. doi:10.1016/j.jrurstud.2016.11.008
6. Echeverri, R.; Sotomayor, O. 2010. Estrategias de gestión territorial rural en las políticas públicas en Iberoamérica. In documentos de proyectos. N° 376 (LC/W.376. Santiago de Chile. Comisión Económica para América Latina y el Caribe (CEPAL). p. 93.
7. Espejel-García, A.; Cuevas-Reyes, V.; Muñoz-Rodríguez, M.; Barrera-Rodríguez, A.; Cervantes-Escoto, F.; Sosa-Montes, M. 2014. Sistema Regional de Innovación y Desarrollo Rural Territorial. *Spanish Journal of Rural Development,* 5(3): 1-14. doi: 10.5261/2014.GEN2.01
8. Foronda-Robles, C.; Galindo-Pérez de Azpillaga, L. 2012. Argumentación relativa a la confianza territorial. *Claves sobre capital social. Cuadernos de Desarrollo Rural.* 9(68): 41-63.
9. Freeman, L. 1979. A set of measures of centrality: I. Conceptual clarification. *Soc. Networks.* 1: 215-239.
10. García-Sánchez, E. I.; Vargas-Canales, J. M.; Aguilar-Ávila, J. 2018. Sistema de innovación como marco analítico de la agricultura protegida en la región centro de México. *Cuadernos de Desarrollo Rural.* 15(81): 1-24.
11. Hernández Hernández, M. L.; Gallardo Cobos, R.; Dios-Palomares, R.; Martínez Pellégrini, S. E. 2018. An application of network theory to territorial analysis: The case of Yaqui Valley networks (2006 and 2016). *Revista de la Facultad de Ciencias Agrarias. Universidad Nacional de Cuyo. Mendoza. Argentina.* 50(2): 311-329.
12. 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. doi: 10.1016/j.agsy.2017.02.002
13. Isaac, M. E. 2012. Agricultural information exchange and organizational ties: The effect of network topology on managing agrodiversity. *Agricultural Systems.* 109: 9-15. doi:10.1016/j.agsy.2012.01.011
14. Joyce, K. E.; Laurienti, P. J.; Burdette, J. H.; Hayasaka, S. 2010. A new measure of centrality for brain networks. *PLoS ONE.* 5(8): 1-13. doi:10.1371/journal.pone.0012200

15. Luhmann, N. 1988. Familiarity, confidence, trust: Problems and alternatives. In *Making and Breaking Cooperative Relations*. Oxford: Basil Blackwell. p. 62-92.
16. Luna, M.; Velasco, J. L. 2005. Confianza y desempeño en las redes sociales. *Revista Mexicana de Sociología*. 67(1): 127-162.
17. Maertens, A.; Barrett, C. B. 2013. Measuring social networks' effects on agricultural technology adoption. *American Journal of Agricultural Economics*. 95(2): 353-359.
18. Monge, M.; Hartwich, F.; Halgin, D. 2008a. How change agents and social capital influence the adoption of innovations among small farmers: Evidence from social networks in rural Bolivia. *Intl Food Policy Res Inst*.
19. Monge, M.; Hartwich, F. 2008b. Análisis de redes sociales aplicado al estudio de los procesos de innovación agrícola. *Revista Hispana de Redes Sociales*. 14: 31.
20. Morgan, S. L. 2011. Social learning among organic farmers and the application of the communities of practice framework. *The Journal of Agricultural Education and Extension*. 17(1): 99-112. doi:10.1080/1389224X.2011.536362
21. Muñoz Rodríguez, M.; Aguilar-Vila, J.; Rendón Medel, R.; Reyes Altamirano Cárdenas, J. 2007. Análisis de la dinámica de innovación en cadenas agroalimentarias. Universidad Autónoma Chapingo-CIESTAAM/PIIAI. Chapingo, México.
22. Nato, G. N.; Shauri, H. S.; Kadere, T. T.; Lecturer, A.; Lecturer, S.; Box, P. O. 2016. Influence of social capital on adoption of agricultural production technologies among beneficiaries of African institute for capacity development Training programmes in Kenya. *International Journal of Social Science and Technology*. 1(1): 1-21.
23. OECD. 2014. *Innovation and Modernising the Rural Economy*. OECD Publishing. doi: 10.1787/9789264205390
24. Oliveira, P. M.; Natário, M. M. 2016. Territorial innovation systems and strategies of collective efficiency: the case of Tagus Valley agro-food complex. *European Journal of Innovation Management*. 19(3): 362-382. doi: 10.1108/09564230910978511
25. Ortiz-Guerrero, C. E. 2013. The new regionalism. Policy implications for rural regions. *Cuadernos de Desarrollo Rural*. 10(70): 47-67.
26. 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. doi: 10.1016/j.agsy.2012.08.007
27. Ozier-Lafontaine, H.; Chave, M.; Noël, Y. 2012. Towards agricultural innovation systems: designing an operational interface. *Outlook on Agriculture*. 41(2): 81-86. doi: 10.5367/oa.2012.0090
28. Pannell, D. J.; Marshall, G. R.; Barr, N.; Curtis, A.; Vanclay, F.; Wilkinson, R. 2006. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*. 46(11): 1407-1424. doi: 10.1071/EA05037
29. Putnam, R. D. 1993. *Making Democracy work. Civic traditions in Modern Italy*. Princeton: Princeton University Press.
30. Robalino, D. A. 2000. Social capital, technology diffusion and sustainable growth in the developing world. *RGSD-151. RAND*. 286 p.
31. Sligo, F. X.; Massey, C. 2007. Risk, trust and knowledge networks in farmers' learning. *Journal of Rural Studies*. 23(2): 170-182. doi:10.1016/j.jrurstud.2006.06.001
32. Takahashi, R.; Todo, Y.; Degefa, T. 2015. The effects of a participatory approach on the adoption of agricultural technology: Focusing on the social network structure in rural Ethiopia. *Studies in Agricultural Economics*. 117(1): 50-56.
33. Tumbo, S. D.; Mutabazi, K. D.; Masuki, K. F. G.; Rwehumbiza, F. B.; Mahoo, H. F.; Nindi, S. J.; Mowo, J. G. 2013. Social capital and diffusion of water system innovations in the Makanya watershed, Tanzania. *Journal of Socio-Economics*. 43: 24-36. doi: 10.1016/j.socec.2013.01.001
34. Unay Gailhard, Í.; Bavorová, M.; Pirscher, F. 2015. Adoption of agri-environmental measures by organic farmers: The role of interpersonal communication. *The Journal of Agricultural Education and Extension*. 21(2): 127-148. doi: 10.1080/1389224X.2014.913985

35. Vázquez-Valencia, R. A.; Aguilar-Benítez, I. 2010. Organizaciones lecheras en los Altos Sur de Jalisco: un análisis de las interacciones productivas. *Región y Sociedad*. 22(48): 113-144.
36. Wasserman, S.; Faust, K. 1994. *Social network analysis, Methods and applications*. New York: Cambridge University Press. p. 857.
37. Wellbrock, W.; Roep, D. 2015. The learning rural area framework: A heuristic tool to investigate institutional arrangements which support collaboration in rural areas. *Sociologia Ruralis*. 55(1): 106-124. doi: 10.1111/soru.12049
38. World Bank. 2006. *Enhancing agricultural innovation: How to go beyond the strengthening of research systems*. Washington. DC. USA: The World Bank.