

Endogeneidad y autoorganización como propiedades dinámicas de los clústeres productivos

Endogeneity and Self-Organization as Dynamic Properties of Productive Clusters

*Endogeneidade e auto-organização como propriedades dinâmicas de clusters
produtivos*

Carlos Alejandro Custodio González

Universidad Nacional Autónoma de México, México

karlos_097@hotmail.com

<https://orcid.org/0000-0001-9683-3864>

Resumen

El desarrollo es un fenómeno colectivo territorial que sintetiza la expresión espaciotemporal de la interacción de tres estructuras sistémicas: social, productiva y organizacional. La dinámica de las interacciones es regulada por la endogeneidad y la autoorganización. El objetivo del presente artículo fue determinar qué componentes estructurales de la endogeneidad y la autoorganización aseguran la reproducción socioterritorial en el tiempo de los clústeres productivos.

La base metodológica de esta investigación estuvo integrada por tres fases: 1) la identificación de las variables empleadas en estudios empíricos de los clústeres; 2) el análisis de las interacciones entre las variables a partir del análisis de redes sociales, y 3) la caracterización de los atributos de los elementos que estructuran la dinámica de un clúster de base agrícola.

Los resultados muestran que los componentes que definen la dinámica de los clústeres son los siguientes: empresas, centros de formación y red de comunicaciones. Se concluye que la sinergia entre el componente endógeno y de autoorganización constituye la base funcional del sistema territorial para configurar estados temporales de bienestar colectivo.

Palabras clave: análisis de redes sociales, clúster agrícola, desarrollo, estructuras sistémicas.

Abstract

Development is a collective phenomenon of a territorial system, which synthesizes the spatio-temporal expression of the interaction of three systemic structures: social, productive and organizational. The dynamics of interactions are regulated by endogeneity and self-organization. The objective of this article was to determine what structural components of endogeneity and self-organization ensure socio-territorial reproduction over time of productive clusters.

The methodological base is integrated by three phases: 1) identification of variables used in empirical studies of the clusters; 2) analysis of the interactions between the variables from the analysis of social networks; and 3) characterization of the attributes of the elements that structure the dynamics of an agricultural-based cluster.

The results show that the components that define the dynamics of the clusters are companies, training centers and communications network. It is concluded that the synergy between the endogenous component and self-organization constitutes the functional basis of the territorial system to configure temporal states of collective well-being.

Keywords: analysis of social networks, agricultural cluster, development, systemic structures.

Resumo

O desenvolvimento é um fenômeno coletivo territorial que sintetiza a expressão espaço-temporal da interação de três estruturas sistêmicas: social, produtiva e organizacional. A dinâmica das interações é regulada pela endogeneidade e auto-organização. O objetivo deste artigo foi determinar quais componentes estruturais de endogeneidade e auto-organização garantem a reprodução sócio-territorial ao longo do tempo de clusters produtivos.

A base metodológica desta pesquisa foi composta por três fases: 1) a identificação das variáveis utilizadas nos estudos empíricos dos clusters; 2) a análise das interações entre as variáveis a partir da análise das redes sociais, e 3) a caracterização dos atributos dos elementos que estruturam a dinâmica de um cluster agrícola.

Os resultados mostram que os componentes que definem a dinâmica dos clusters são os seguintes: empresas, centros de treinamento e rede de comunicação. Conclui-se que a sinergia entre o componente endógeno e a auto-organização constitui a base funcional do sistema territorial para configurar estados assistenciais coletivos temporários.

Palabras-chave: análise de redes sociais, cluster agrícola, desenvolvimento, estruturas sistêmicas.

Fecha Recepción: Mayo 2018

Fecha Aceptación: Octubre 2018

Introduction

The approach to development as an emergent property of a complex, dynamic and highly synergized territorial system (Boisier, 2003, p.8) assumes this as the result of the interaction between tangible and intangible components that are organized from three systemic structures: productive, social and organizational. These structures are modified over time depending on the functional relationships between endogeneity and self-organization of the territorial system.

Endogeneity is a capacity that arises from the interaction of systemic structures that gives particularities to the territorial system and defines its internal dynamics. Self-organization, on the other hand, is the potential that allows developing adaptation and transformation strategies of systemic structures in the face of disturbances introduced by exoterritorial contexts, such as the market, public policies and competitiveness. The synergy between the endogenous component and the self-organization component constitute the dynamics of the territorial system.

The objective of this article was to determine the structural components of endogeneity and self-organization that ensure socio-territorial reproduction over time of productive clusters. For which a methodology was developed consisting of three phases: 1) the identification of variables in empirical studies that have been used to characterize the dynamics of the clusters; 2) the organization and evaluation of the network of variables to determine the elements that structure the dynamics of the clusters from the analysis of social networks, and 3) the characterization of the attributes of the elements that structure the dynamics of a core cluster agricultural.

Development: an emerging property

The emergency refers to a temporary state of organization of a system that results from the interaction of components based on simple relationship rules (Vivanco, 2014, p.33). From the bond, functional qualities that are not found in the components acting individually appear in the system. According to Boisier (2003, pp. 8-13), development is an emergent property of a complex, dynamic

and highly synergized territorial system because it imbricates the material element of economic growth -with- the intangible element of well-being. And as already mentioned, the material and intangible of development is based on three structures: the productive, the social and the organizational. The productive structure is made up of economic activities that transform natural resources into goods and services based on the organization of productive factors. The social structure integrates relationships between people that allow the transfer of tangible and intangible information. The organizational structure, finally, is made up of institutions that define the patterns of social, economic and political interactions.

The interaction between these structures encourages the appearance of regularities in the territorial system. The regularities, in turn, constitute the basis on which development emerges as a temporary state of systemic organization. Consequently, to assume development as an emergent property of a system implies incorporating the temporal dimension into its understanding. Therefore, development is assumed to be relative and dynamic. The relative refers to the property of the territorial system to generate regularities based on the particularities of the structures; while the dynamic is a quality present in the relationships established by the systemic structures that support the evolutionary change of the territorial system.

Complexity as an episteme provides two explanatory categories to incorporate the temporal dimension in the understanding of development as an emergent phenomenon: endogeneity and self-organization. That is the capacity of the system for the construction of internal operating rules (Lara, 2008, p.86). This is a process by means of which the system can modify and innovate structures (Velázquez, 2012, p.204) against modifications coming from the environment.

In addition to the temporary character, development is a collective phenomenon that takes place in a given space. The space contains actors -productive, social, institutional- and local resources -natural, infrastructure, financial, technological-, as well as the network of relationships that are configured around local resources. The space evolves in function of the transformation in the relations that maintain the systemic structures of the development. Therefore, space is the empirical synthesis of development as emergent property, which reflects the regularities and particularities that arise from the interaction of systemic structures, which constitutes it at the starting point to reach the understanding of development as a relative phenomenon and dynamic.

An approach to the cluster as a complex territorial system

The cluster is a structure of spatial agglomeration around a productive activity (González and Figueroa, 2011, p.53). The agglomeration is the key element of the structure and operation of the cluster because it facilitates the interaction between companies, which promotes the exchange of goods, services, information and dissemination of knowledge (Lara, 2008, p 86, Mendoza, 2014, p. 85). In the cluster the distribution of companies does not follow a random logic; There is a localization pattern influenced by the proximity to material resources and commercial and labor markets. Productive links between companies are anchored to the territorial context of which they are part, that is, the history of the place where they are located, as well as the relationships and rules that arise from social, economic and institutional actors.

Consequently, it is not just a spatial structure of a productive nature, but can be considered as a territorial system made up of a set of socio-economic interactions resulting from three structural components: companies, social actors and institutional network (Ávila and Canizalez, 2015, pp 188-189; Morales, Velasco and Pérez, 2015, p.15). The companies constitute the material base of the cluster to contain productive relations for the transformation and use of local resources. Social actors are structured as a collective subject around an identity, values, symbolism and knowledge that form the intangible base on which the productive transformation processes of the cluster are based. The institutional network is integrated by the formal institutions of government at its various levels; its purpose is to regulate the relations between the material component (companies) and immaterial (social actors) through public policies, programs and management processes for the potentialization of local resources of the territorial system.

The socio-economic interactions of the structural components of the cluster generate flows of different types: of materials such as inputs and products; of money for the transactions that take place; of information for decision making, and knowledge for improvement and innovation (Mendoza, 2014, p.87). These flows mobilize the internal capacities of the cluster from dynamizing local resources, constituting the endogenous base of development. Endogeneity defines the specific resources available to the cluster to respond to changes arising from changes in the socioeconomic interactions of its internal components. Therefore, endogeneity is a key element for the understanding of development as emergent property, given that clusters generate differentiated internal dynamics as a result of territorial particularities.

Likewise, the cluster assumes itself as an open territorial system when it is immersed in diverse exoterritorial contexts: markets, public policies and competitiveness, which introduce material, information and knowledge flows that trigger random fluctuations (Carrasco and Vivanco, 2011, p.70).), which generate momentary states of disturbance -disorder- in the internal structures of the territorial system. The cluster, based on its endogenous capacity, develops the property to build new regularities, and adapt or transform itself in the face of disturbances from the environment (Bonil, Sanmartí, Tomás and Pujol, 2004, p.12). This property is called self-organization and describes the external dynamics resulting from the cluster relationship -system structures- and the environment-exoterritorial contexts.

Hypothetically, it is postulated that endogeneity and self-organization constitute analytical properties to understand development as an emergent property - a temporary state - of a complex territorial system. While endogeneity refers to the internal capacity of the system to establish regularities based on the relationships between the structure: social, productive and organizational, self-organization defines the potential of the territorial system to adapt to disturbances from exoterritorial contexts starting from endogenous qualities. Both make it possible to explain the temporal dimension of development -relativity and dynamics. Therefore, the objective was to determine which are the structural components of endogeneity and self-organization that ensure the socio-territorial reproduction of the productive cluster over time.

Methodology

The methodology base considered three sentences. The first consisted in the review of scientific articles that analyze the empirical aspect in order to identify variables used for the characterization of the cluster and its dynamics. Once the variables were identified, they were organized taking as a reference the structural components of the cluster they described (see Table 1).

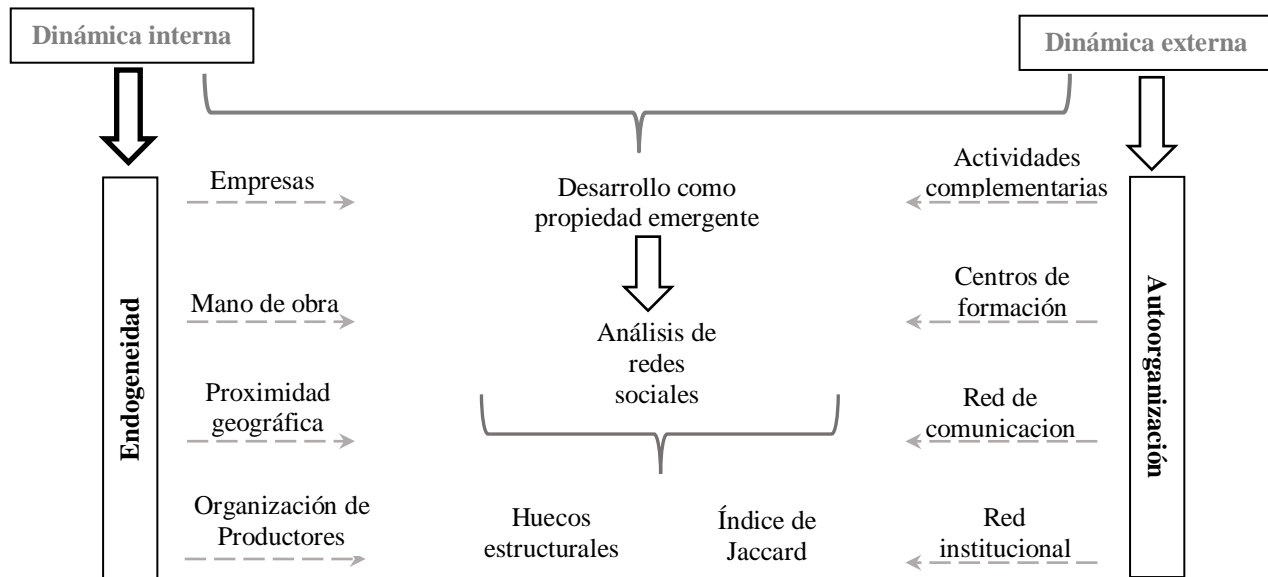
Tabla 1. Variables empleadas en la caracterización de los componentes estructurales del clúster productivo

Componente estructural	Variable	Autor o autores
Empresas	Actividades complementarias	Capó y Capó (2013); González y Figueroa (2011).
	Número de empresas	Avilés y Canizalez (2015); Tapia, Hermes, Pacheco y Alba (2015).
	Proximidad geográfica	Mendoza (2014); Montero y Morris (1999).
	Infraestructura o red de comunicaciones	Esqueda y Trejo (2014); Tapia <i>et al.</i> (2015).
Actores sociales	Centros de formación	Cincunegui y Brunet (2012); Diez y Urtizberea (2015); Coque, González, López y Vázquez (2015).
	Mano de obra	Avilés y Canizalez (2015); Esqueda y Trejo (2014); Fernández, Alfaro y Davies (2009); Tapia <i>et al.</i> (2015); Yu, Calzadilla, López y Villa (2013).
Organizacional	Centros de investigación	Cincunegui y Brunet (2012); Coque <i>et al.</i> (2015); Diez y Urtizberea (2015).
	Organización de empresarios	Capó y Capó (2013); Mendoza (2014).
	Red institucional	Esqueda y Tapia (2014); González y Figueroa (2011); Mendoza (2014).

Fuente: Elaboración propia

The second phase of the work evaluated the relationships that emerge between the structural components of the cluster, through the analysis of the links between the variables identified in the first phase, in order to determine the variables that define the overall dynamics of the cluster and that, in addition, they explain the temporality of development as an emergent property of a territorial system (see figure 1). The following variables have been used in empirical studies to describe the endogenous potential of the cluster, that is, the internal dynamics: companies -number and size-, labor, geographical proximity and organization of entrepreneurs. While the complementary activities, namely, Training centers, communications networks and institutional networks have been used to describe the relationship of the cluster with its environment, that is, external dynamics (see Figure 1)

Figura 1. La dinámica del desarrollo en el sistema territorial



Fuente: Elaboración propia

The analysis of the relationships between the variables of internal and external dynamics was made through the social networks approach. This approach studies the patterns that emerge from the interactions between actors (Aguirre, 2011, p.5). Therefore, by focusing your analysis on relationships rather than on the attributes of the elements, it is a systematic approach. The central idea of the analysis of social networks is that over time the interactions between actors give rise to structures that synthesize collective actions and decisions and define the behavior dynamics of complex systems (López, 2008, p.96, Lozares, 1996, p.101). Of the multiple analysis techniques that the social network approach has, the work employed only two, namely, the structural gaps and the Jaccard index.

Structural hollows is a concept used by Ronald Burt in his 1992 work *The Social Structure of Competition* to describe the formation of gaps or gaps in information between groups of actors, given that these, the actors, focus on the activities within their own set. The actors of a network that establish bridging relationships between structural gaps have advantages in being able to access diverse information. Hence their importance, since they link structurally distant groups (Burt, 2004, pp. 353-354). As a technique, structural gaps discard the importance of quantity to

focus rather on the quality of interactions, which is measured from the effective size of the network and non-redundancy.

For its part, the Jaccard index or Jaccard coefficient is a measure of similarity used in ecological studies to analyze the similarity between two communities. This index is based on the presence-absence between the number of common species in two areas in relation to the total number of species (Badii, Landeros and Cerna, 2007, page 635). It has also been incorporated into the analysis of social networks to determine the number of actors shared by two different networks of actors from a measure of similarity. The Jaccard index shows a coefficient of similarity between the communities compared, where a value close to zero indicates that there is no similarity; while a value close to one indicates the presence of the actor in the two different social networks. The coefficient is expressed as follows:

$$ISj = \frac{c}{a+b+c}$$

As ISj = Jaccard's similarity index; a = Number of species exclusive to the community A; b = Number of species exclusive to the community B; c = Number of species shared by both communities.

As can be seen, the techniques of structural gaps and Jaccard index are complementary in the analysis of the actors that are present in two different social networks. This allows to visualize which or which actors establish bridging relationships between the networks. While the Jaccard index gives a value to the actors based on their presence in both groups. In the present work both techniques were incorporated to determine the variables that define the general dynamics of the cluster, and explain the relationships that emerge between the internal and external dynamics of the cluster.

The first group or network was made up of the variables that describe the endogenous dynamics of the cluster: companies, labor, geographical proximity and organization of actors. While the second group was made up of the variables that describe the dynamics of self-organization of the cluster: complementary activities, training centers, infrastructure and institutional networks. The variables were systematized in matrices to be evaluated through the software UCINET for Windows, version 6 (Borgatti, Everett and Freeman, 2002).

The third and last methodological phase consisted in the characterization of a particular cluster using the attributes of the variables identified as determinants of the general dynamics. For the characterization, official information was used from the National Statistical Directory of Economic Units [Denue] and the Agrifood and Fisheries Information Service [SIAP]. The chosen cluster was composed of the municipalities of Coatepec Harinas, Tenancingo and Villa Guerrero, belonging to the State of Mexico.

Results and Discussion

The results presented below specify what is specified in the methodology: 1) the evaluation of the network of variables that determine the overall dynamics of the cluster and 2) the characterization of the attributes of the overall dynamics of the floriculture cluster.

The synergy of the endogenous dynamics and self-organization of the productive cluster

According to the analysis of structural gaps in the variable network, the factors that explain the general dynamics of productive clusters are the following: companies, training center and communications network (see figure 2). Companies are one of the elements that structure the endogenous dynamics of the cluster according to the size and type of relationships between them; the relationships are classified in vertical and horizontal. Vertical relationships refer to the productive chains of the cluster. Horizontal relationships, on the other hand, are those that arise from the linkage between companies and are classified into relations of competence, complementarity and collaboration (Mendoza, 2014, p.87). Horizontal interactions give rise to "repetitive games" that raise confidence (Vera and Ganga, 2007, p.312) and favor processes of technical innovation and knowledge.

A cluster whose productive base is characterized by a large and diverse number of companies has greater complexity in the number of interactions. In addition, non-linear or horizontal relationships potentiate the benefits that arise from the geographical proximity of companies (Mendoza, 2014, p.88). Therefore, the heterogeneity, in terms of the size and type of horizontal relationships of the companies, determines the capacity of the cluster to generate collective strategies against changes coming from the environment. However, the asymmetries in

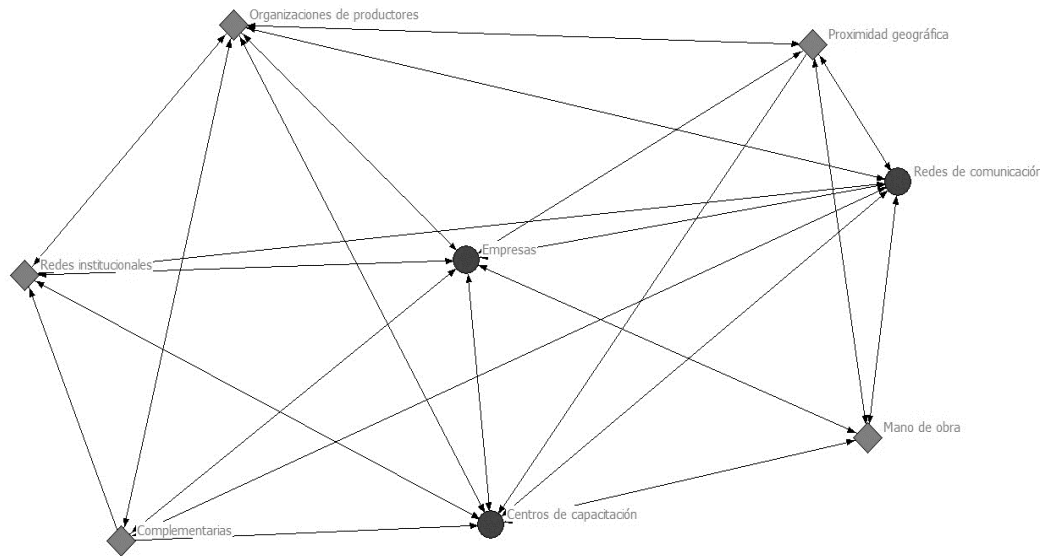
the access to benefits, namely, materials, technology and training, limit the systemic cohesion of companies and, thereby, reduce the dissemination of knowledge and the use of new technologies.

On the other hand, the training centers and the communications network are structural elements that belong to the external dynamics of the territorial system. The training centers or education centers are spaces for the transmission and generation of codified knowledge. For the cluster they fulfill two qualitative and intangible functions: the formation of human resources at the different educational levels and the accumulation of knowledge resulting from research and development (Lochmüller, 2008, p.147).

The training centers are responsible for the development of the cognitive, work, procedural and communication capacities of the people that constitute the social base of the cluster. A cluster whose productive activity is developed in a dense context of training centers can access qualified human resources, which affects the diffusion of technological and knowledge innovations between companies; all of which favors the flexibility of the cluster as a territorial system.

The communication network, meanwhile, is made up of the road infrastructure that connects companies with urban centers, localities and markets (commercial, labor and supplies). It also integrates the infrastructure for the use of information and communication technologies (ICT) involved in the production process. In short, communication networks allow the mobility of material, technological and human resources within the cluster. And they facilitate the access of companies to professional and governmental services, which fosters synergy between the primary, secondary and tertiary sectors, as well as favors the diversification of economic activities and the multiplication of the forms of integration of the cluster with its environment (Vázquez, 2007, p.196) (see Figure 2).

Figura 2. Análisis de huecos estructurales de la red de variables utilizadas para explicar la dinámica de los clústeres productivos



Fuente: Elaboración propia

The Jaccard index confirmed the results obtained in the analysis of structural gaps, where companies, training centers and communications networks are the elements that determine the overall dynamics of the cluster. Added to this, it allowed to identify the links that these elements establish with the rest of the variables that make up the network. The variables that explain the synergy between the endogenous component and the self-organization of the cluster are the following: companies-complementary activities (0.94); business-institutional network (0.87); training centers-labor (0.94), and communications-labor network (0.85) (see Table 2).

Tabla 2. Valores otorgados por el índice de Jaccard a los vínculos entre las variables que describen la dinámica del clúster

		Autoorganización			
		Actividades complementarias	Centros de formación	Red de comunicaciones	Red institucional
Endogeneidad	Empresas	0.94	0.71	0.71	0.87
	Mano de obra	0.79	0.94	0.85	0.50
	Proximidad geográfica	0.79	0.71	0.71	0.77
	Organización de empresarios	0.71	0.76	0.76	0.82

Fuente: Elaboración propia

The links established by the companies with the rest of the actors in the network are built around the access of inputs and knowledge; from the activities that complement the main productive activity and from the institutional environment that regulates socio-productive relationships in the territorial system. The complementary activities integrate the services that are used by the companies for the development of the main productive process. These include raw materials, machinery, equipment, facilities, transportation and professional services. The interactions between companies and complementary activities make up a network or business chain (González and Figueroa, 2011, p.53) that generates financial, technological, institutional and knowledge information flows in the cluster. The understanding of the characteristics of the linkages of the business network of the cluster allows identifying the type of endogenous advantages of the territorial system, as well as the knowledge transmission flows (Lagunas, 2010, p.121).

The institutional network and companies structure relationships that underpin collective innovation processes within the cluster. Innovation within this type of structure requires the synergy of four agents: the company, the public research and development system, the innovation support organizations and the public administration (Coque et al, 2014, pp. 209-210). Regarding public institutions, these regulate knowledge transfer processes in the territorial system based on the creation of the environment for access and dissemination of innovation via the transmission of information. This environment facilitates or limits the interactions for the generation and

dissemination of innovation at the cluster level; This is based on providing a set of rules and public entities that favor the creation of agreements between social, productive and public actors for collective learning.

Regarding the links of the training centers with the rest of the analyzed network, the Jaccard index identified that these establish a direct relationship with the workforce, since its main function is the transmission of codified knowledge through the training and training of human capital for the management of the information used in the development of the main productive process in its different stages. Undoubtedly the formation of human capital favors access to technical improvements in the production process. In addition, it facilitates the assimilation of new technologies, since the mere acquisition of technology does not ensure the appearance of innovative processes within the company; they require a capacity to absorb new knowledge. The absorption capacity refers to the quality of the workforce to recognize, assimilate and apply the value of the novel external information (Páez, 2012, p. 83).

The main function of the communications network is the mobility of human capital inside and outside the cluster. Internal mobility is possible through road infrastructure and transportation services; The synergy of these elements allows the displacement of labor towards companies for the development of the main activity. It also allows access to complementary activities that are regularly located in urban centers, which facilitates the linkage between the productive sectors of the cluster, namely the primary-tertiary, secondary-tertiary or primary-secondary-tertiary; all of which promotes the emergence of innovation processes based on productive diversification.

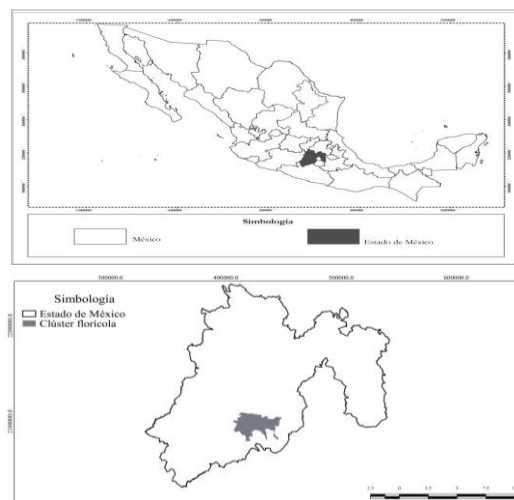
External mobility refers to the mobility of raw materials, technology, products and human capital outside the productive cluster. Therefore, the synergy of road infrastructure-transport services acquires relevance, in addition to the information technologies available in the cluster, since they facilitate access to external information from markets and public policies.

The dynamics of development in a productive agricultural-based cluster

For the State of Mexico, the floricultural activity represents one of the most productive agricultural activities: 5657.78 ha of surface are destined to this type of sowing; and concentrates 53.44% of the total production (SIAP, 2015). This activity also generates 70,000 direct jobs and 4500 million pesos annually (Secretary of Agriculture, Livestock, Rural Development, Fisheries and Food [Sagarpa], 2013), which positions the entity as the main producer of cut flower from the country.

The floricultural production of the State of Mexico is concentrated mainly in three municipalities: Coatepec Harinas, Tenancingo and Villa Guerrero: These provide 63.47% of the total production of the entity and allocate 3765.08 hectares planted (SIAP, 2015). The activity has determined for 67 years the productive base of the three municipalities from the development of technification processes, as well as distribution channels at different market scales and value chains throughout the production process. In this way, the development of the floricultural activity has been consolidated as the basis of the productive structure of this Mexican municipal triad. In addition to all the above, the development of the production process has also had an impact on social and institutional relations, which have developed around the floricultural activity. These conditions have led to the emergence of a productive agricultural-based cluster in the southwest of the State of Mexico (see Figure 3).

Figura 3. Localización del clúster florícola del sur del Estado de México



Fuente: Elaboración propia

The structure of the endogenous dynamics of the floricultural cluster

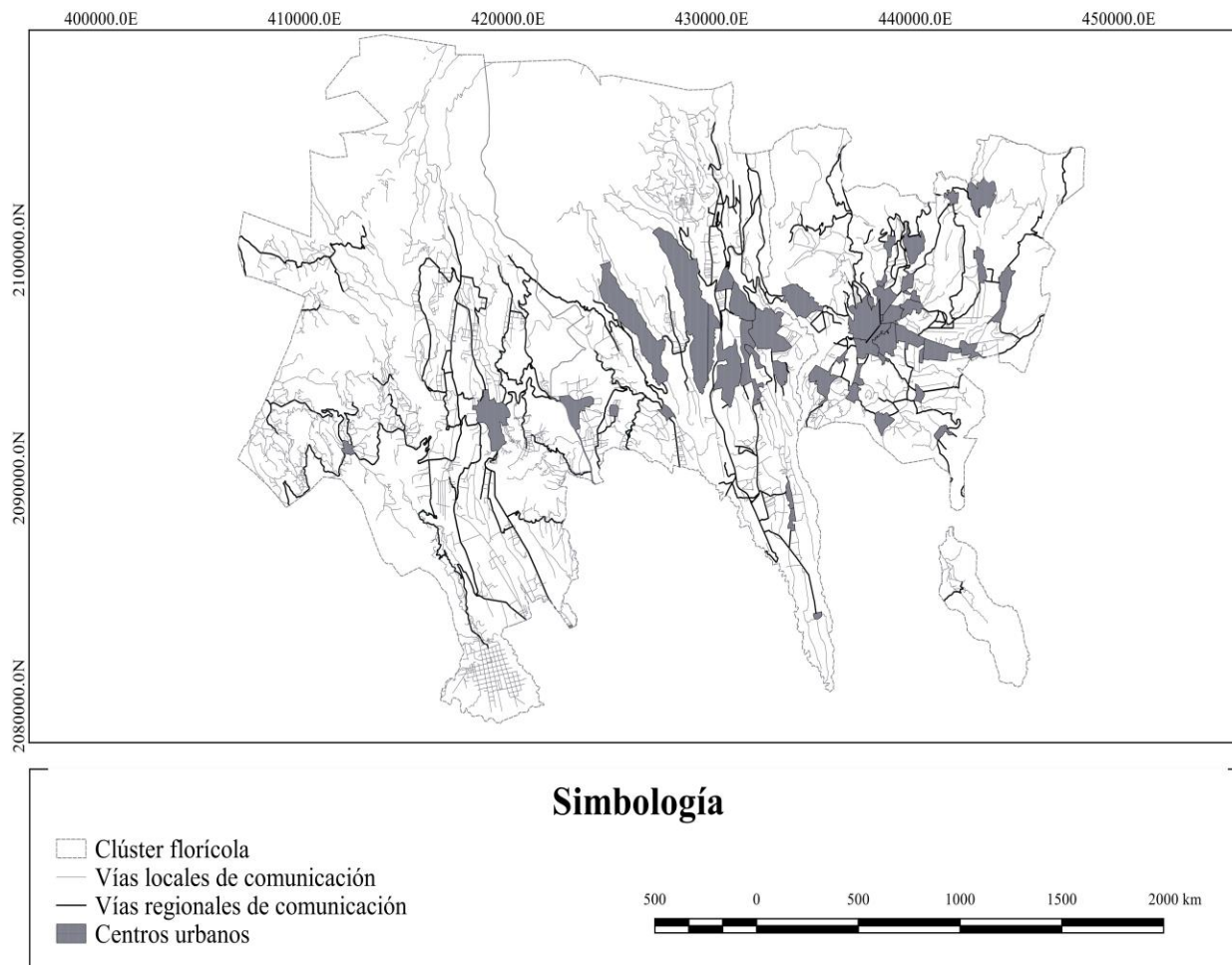
The endogenous capacity of the floriculture cluster is based on the interactions of companies with labor, complementary activities and the communications network. The production base is composed of 2587 productive units. And its productive structure is formed mostly by micro and small family businesses, which represent 81.8%; while the remaining percentage is made up of medium-sized companies (18.2%) (Iglesias, Carreño and Castillo, 2015, p 255). This characteristic determines the type of labor that these two groups of companies can access.

The micro and small companies have family labor; consequently, the knowledge of the productive process comes from the development of the floricultural activity. While innovation is the result of contact between production units and experimentation in the incorporation of new techniques and technologies. The flow of knowledge in this type of units derives, therefore, from tacit knowledge, that is, from knowledge generated in practice and transmitted by contact between people (Stiglitz and Greenwald, 2014, p.96). Undoubtedly, in this context, the proximity of the productive units and the trust of the people for the transmission of knowledge becomes relevant. On the other hand, medium-sized companies have a wider range of possibilities in the access to labor, since tacit knowledge is added to the ability to approach training centers and links with complementary activities, in specific with the technical advisory services.

The floriculture cluster has 175 economic units (Denué, 2016), which constitute the productive base associated with the complementary activities. In this regard, 53.14% are integrated economic units that provide productive inputs such as fertilizers, vegetative material, packaging for the marketing of products and equipment for the installation of irrigation systems. The economic units providing professional services represent, for their part, 32% of the complementary activities. These professional services include technicians who provide advice for crop management and disease control, legal advice for the acquisition of vegetative material that has a patent and accounting services. The government services contribute, in turn, 8% of the complementary activities. These services are integrated by the offices of delegations of secretariats of the different levels of government in charge of operating the public policies of the agricultural sector. Finally, financial services represent 5% and the remaining 1% is made up of companies responsible for the construction of greenhouse infrastructure.

As for the structure of the communications network of the floriculture cluster, it is integrated by 185 km in length. Of these, 149.54 km correspond to local communication routes and 35.46 km to regional roads. Together, the communications network covers 59.68% of the total area of the floriculture cluster (see figure 4). This is a determining factor to explain the mobility of information within the cluster since, although there is a pattern of association in the concentration of the productive units, these are not located close to the urban centers where the complementary activities are found, factor that promotes synergy between the primary sector and the service sector. Likewise, the presence of regional communication channels determines the connectivity of the floriculture cluster with external markets of consumption and input of products (see Figure 4).

Figura 4. Estructura de la red de comunicaciones del clúster florícola del Estado de México



Fuente: Elaboración propia

The structure of the dynamics of self-organization of the floricultural cluster

The potential for self-organization of the territorial system is the result of the interaction that companies have with the training centers and the institutional network. In relation to training centers, the floriculture cluster has two higher education institutions and a research center. The first institution of higher education to emerge in the cluster was the Technological Superior Studies of Villa Guerrero in 1999; However, it was not until 2011 that the career of Engineer in Sustainable Agricultural Innovation was created to link the training center with the main activity of the territorial system; a fact that resulted in the incorporation of students to the development of the floricultural activity, mainly in medium-sized enterprises, through the provision of social service and professional practices.

For its part, the Tenancingo University Center of the Autonomous University of the State of Mexico (UAEM) was created in 2003 with the objective of strengthening the development of the floricultural activity through the training of human resources for the production and marketing phase. Said center has two careers related to the activity: Agronomist in Floriculture and International Economic Relations. However, the generation of scientific and technological knowledge of the Tenancingo University Center was enhanced by the incorporation of postgraduate students in 2012. At present, it develops research lines focused on the understanding and solution of technical, social problems, economic and institutional related to flower production.

However, the research center was created in 1991 under the name of Salvador Sánchez Colín-Cictamex Foundation. It was an initiative of its founder, Salvador Sánchez Colín, and the Government of the State of Mexico for the generation and transfer of scientific and technical knowledge in the southern region, mainly in the municipality of Coatepec Harinas. Although the research center has focused its research projects on fruit and horticultural production, the floriculture activity has benefited from the development of research projects in the area of plant breeding and parasitology.

In Mexico, the institutional network of agricultural-based clusters is structured on the basis of the Law of Sustainable Rural Development (LDRS), through the Regional Councils for Sustainable Rural Development (CRDRS), which, it should be noted, are intended to specify the decentralization in the rural area for strategic planning, social participation and implementation of public policies. The councils are integrated by federal, state and municipal agencies; complemented

by the participation of producer organizations and training centers in order to be spaces of concurrence between productive, social and institutional actors for the consensual decision making in relation to the operation of public rural development policies.

The institutional network of the floriculture cluster is configured in the Regional Council of Sustainable Rural Development Ixtapan de la Sal. In this regard, González, García, Ramírez and Castañeda (2013) evidenced the existence of coordination barriers of the Ixtapan de la Sal CRDRS, a result of an information asymmetry between actors, which limits the mechanisms to generate own resources and the creation of strategies to integrate local demands due to the parallelism and duplicity of functions of the entities. The communication between productive and institutional actors for coordination in decision making is limited by the network of contacts built by producers with government officials.

Therefore, the competition finds its limitation in the dissimilar behavior of the actors due to the specificity of assets, uncertainty, opportunism and limited rationality, as well as in the bureaucracy of the levels of government (González et al, 2013, p 255) . This condition reflects the centrality in decision-making by federal and state agencies in the way in which the resources of public policies and the productive actors that are benefited are used.

Conclusions

The analysis through the technique of structural gaps identified three key elements in the overall dynamics of the cluster: companies, training centers and communications network. While Jaccard's index established that the synergy between the endogenous component and self-organization of the clusters is the result of the links established between companies, labor, complementary activities, training centers and institutional network. Consequently, the dynamics and relativity of development is explained by the information flows of a tangible and intangible type that arise from the relationship between the key components of the territorial system, which involves the three systemic structures that define it: the social, the productive and the organizational.

The synergy between the endogenous component and self-organization is the basis for the emergence of regularities of the territorial system. The regularities are patterns of behavior that define the characteristics and functionalities of the systemic structures of the cluster. From the

systemic structures, the territorial system develops its capacity of transformation and adaptation in front of the modifications coming from the exoterritorial contexts. This explains the emergence of development.

The endogeneity in the clusters is defined by the relationships that the companies maintain with the workforce, the complementary activities and the communications network. The interaction between companies and labor allows the flow of intangible information in the cluster, which is defined by the ability of employees to apply, adapt and incorporate knowledge in the different stages of productive development of the main activity.

Likewise, the relationship between companies and complementary activities generates tangible information flows in the cluster, translated into raw materials, technologies, equipment and professional services that are incorporated by companies for innovation in the main production process. The communications network brings to the cluster tangible and intangible interactions based on the mobility of labor and material resources from complementary activities. Likewise, it allows access to market scales.

The self-organization in the clusters, on the other hand, arises from the relationships established by the company with the training centers and the institutional network. The incorporation and generation of new knowledge for the productive process depends on the training centers, specifically on the higher levels of education. Universities are responsible for the creation of knowledge and the dissemination of learning from the formation of human capital capable of assimilating new techniques and technologies that empower the capabilities of cluster companies. The development of these functions is determined by the support of public policies aimed at creating the conditions for the development of science and technology, from fostering research and consolidating research groups that incorporate the problems that limit the synergy between the endogenous component and self-organization of the territorial system.

The institutional network provides intangible information flows that link companies with the institutions in charge of regulating the social and productive relationships that emerge as a result of the development of the main activity. Local government entities are a key element in the definition and operation of intervention strategies and programs, since they are the closest to the problems generated by the interaction between the systemic structures of the cluster and the relationship it maintains with the exoterritorial contexts. Hence the importance in the transition

from sectoral public policies to territorial public policies that consider the particularities of territorial system functioning and that incorporate the notion that fragility and robustness are explanatory factors of the cluster and its permanence over time. Fragility and robustness are the result of the synergy between the endogenous capacity and self-organization of the territorial system.

The development as emergent property in the floriculture cluster of the south of the State of Mexico is determined by the action of three structural elements: companies, training centers and communications network. These three elements establish functional interactions with the workforce, complementary activities and the institutional network. These interactions are possible due to the flows of material and immaterial information. The characteristics of the flows explain the dynamics of the floriculture cluster and its capacity to generate temporary states of organization of the systemic structures.

This dynamic can be explained after organizing the structural elements and the functional interactions of the cluster around the analytical qualities of endogeneity and self-organization. Endogeneity makes it possible to identify the internal capacities of the floricultural territorial system based on the attributes of the companies, the workforce, complementary activities and communication networks; Self-organization allows describing the potential of the cluster to manage disturbances from exoterritorial contexts. The potential depends on the construction of functional interactions between the endogeneity of the cluster, training centers and institutional network.

The endogeneity of the floriculture cluster is characterized by the asymmetry of the companies to access labor and complementary activities, as a result of the productive characteristics of the companies. On the one hand, there are small companies whose productive base and the introduction of innovation in the productive process depends on family labor and tacit knowledge. On the other hand, medium-sized companies have access to employed labor and to coded knowledge based on access to professional services, which facilitates knowledge management generated by the development of productive activity for the introduction of innovations.

The self-organization of the floriculture cluster is also characterized by asymmetries in terms of access and allocation of resources from public policies focused on rural development. The access depends on the social capital management that the producers who own the medium-sized

companies build with the institutional actors; while the training centers have not been able to draw up schemes for the transfer of information and human resources to small businesses.

Therefore, the general dynamics of the floriculture cluster is subordinated by the material and immaterial flows generated by medium-sized companies. In this sense, the floricultural territorial system is characterized by fragility in the face of external disturbances as a result of the absence of diversity in the functional interactions established above all in the productive and institutional structure. In this context, it becomes fundamental to create a socio-institutional environment that overrides the limitations of the institutional network. The environment should prioritize the synergy between the training centers and small producers to enhance their productive capacities, as well as to know and systematize the tacit knowledge that emerges from the development of the floricultural activity in the small production units.

Acknowledgment

The author thanks the Masters and Doctorate programs in Agricultural Sciences and Natural Resources of the University Center Tenancingo of the UAEM.

References

- Aguirre, J. (2011). *Introducción al análisis de redes sociales*. Buenos Aires, Argentina: Centro Interdisciplinario para el Estudio de Políticas Públicas.
- Avilés, E. y Canizalez, P. (2015). Industrias culturales y crecimiento económico. Un modelo para el estudio del surgimiento de clusters creativos. *Economía, Sociedad y Territorio*, (47), 185-216.
- Badii, M., Landeros, J. y Cerna, E. (2008). Patrones de asociación de especies y sustentabilidad. *International Journal of Good Conscience*, 3(1), 632-660.
- Boisier, S. (2003). ¿Y si el desarrollo fuese una emergencia sistémica? *Reforma y Democracia*, (27), 1-24.
- Boisier, S. (2010). Descodificando el desarrollo del siglo XXI: subjetividad, complejidad, sinapsis, sinergia, recursividad, liderazgo, y anclaje territorial. *Semestre económico*, (27), 11-37.
- Borgatti, S. Everett, M. and Freeman, L. (2002). Ucinet for Windows: Software for Social Network Analysis (Versión 6). Harvard, United States: Analytic Technologies.
- Bonil, J., Sanmartí, N., Tomás, C. y Pujol, R. (2004). Un nuevo marco para orientar respuestas a las dinámicas sociales: el paradigma de la complejidad. *Investigación en la escuela*, (53), 5-19.
- Burt, R. (2004). Structural Holes and Good Ideas. *American Journal of Sociology*, (2), 349-399.
- Capó, J. y Capó, J. (2013). Adaptación de los distritos industriales a un entorno competitivo globalizado. *Revista Venezolana de Gerencia*, (62), 179-199.
- Carrasco, I. y Vivanco, M. (2011). ¿Sistemas dinámicos en ciencias sociales? *Revista de Sociología*, (26), 169-191.
- Cincunegui, C. y Brunet, I. (2012). Innovación y desarrollo territorial en aglomeraciones industriales periféricas: el caso del polo petroquímico de Bahía Blanca (Argentina). *ARBO Ciencia, Pensamiento y Cultura*, 188(753), 97-111.
- Coque, J., González, P., López, N. y Vázquez, D. (2014). Análisis de un sistema local de innovación. Agentes y red de relaciones. *Dyna*, (184), 209-2013.
- Diez, J. y Urtizbera, N. (2015). Redes institucionales y desarrollo económico en ciudades pequeñas el caso de la localidad de Pigué (Argentina). *EURE*, (123), 26-287.

- Directorio Estadístico Nacional de Unidades Económicas [Denué]. (2016). Directorio Estadístico Nacional de Unidades Económicas del Instituto Nacional de Estadística y Geografía (Inegi). México: Inegi.
- Esqueda, R. y Trejo, A. (2014). Desarrollo local, competitividad y apertura económica en Tamaulipas. *Región y Sociedad*, (59), 113-150.
- Fernández, V., Alfaro, M. y Davies, C. (2009). Aglomeraciones productivas y territorio: en busca de una manera más holística de entender sus contribuciones al desarrollo. *Economía, Sociedad y Territorio*, (31), 629-680.
- Iglesias, D., Carreño, F. y Castillo, J. (2015). Posibilidades de integrar un sistema productivo sustentable en I región VI, sur del Estado de México. *Revista Mexicana de Ciencias Agrícolas*, (1), 251-256.
- González, M. y Figueroa, P. (2011). Sobre clusters, intangibles y competitividad: reflexiones conceptuales y retos. *Revista de la Escuela Jacobea de Posgrado*, (1), 41-74.
- González, J., García, R., Ramírez, J. y Castañeda, T. (2013). La territorialización de la política pública en el proceso de gestión territorial como praxis para el desarrollo. *Cuadernos de Desarrollo Rural*, (72), 243-265.
- Lagunas, C. (2010). Cadenas productivas, columna vertebral de los clusters industriales mexicanos. *Economía mexicana*, (1), 119-170.
- Lara, A. (2008). Sistemas complejos adaptables y teoría de la empresa: el programa de investigación. *Economía informada*, (352), 65-92.
- Lochmüller, C. (2008). Información, conocimiento y desarrollo económico. *Revista EIA*, (9), 143-155.
- López, M (2008). El análisis de redes sociales. Una herramienta explicativa para la comprensión de las relaciones internacionales. *Revista de Relaciones Internacionales de la UNAM*, (101-102), 73-98.
- Lozares, C. (1996). La teoría de redes sociales. *Papers*, (48), 103-126.
- Mendoza, J. (2014). La dinámica de los clusters. *Revista Dimensión empresarial*, (1), 84-97.
- Montero, C. y Morris, P. (1999). Territorio, competitividad sistémica y desarrollo endógeno: metodología para el estudio de los Sistemas Regionales de Innovación. En Comisión Económica para América Latina y el Caribe (Cepal), *Instituciones y actores del desarrollo*

territorial en el marco de la globalización. Santiago de Chile, Chile: Ediciones Universidad del Bío-Bío.

Morales, L., Velasco, L. y Pérez, S. (2014). Estrategias para la formación de clúster agrícolas en zonas rurales. *Revista Mexicana de Agronegocios*, (35), 1004-1011.

Páez, I. (2012). Capital Humano, redes externas e innovación en la industria colombiana. *Revista Estudios Gerenciales*, (28), 81-107.

Secretaría de Agricultura, Ganadería, Desarrollo rural, Pesca y Alimentación [Sagarpa]. (2013). Boletín de Prensa de la Delegación Federal en el Estado de México. México: Sagarpa.

Servicio de Información Agroalimentaria y Pesquera [SIAP]. (2015). Sistema de Información Agroalimentaria de consulta. México: SIAP.

Stiglitz, J. y Greenwald, B. (2014). *La creación de una sociedad del aprendizaje. Un enfoque hacia el crecimiento, desarrollo y progreso social*. Ciudad de México, México: Editorial Paidós.

Tapia, B., Hermes, T., Pacheco, Q. y Alba, P. (2015). Clusters agrícolas: un estado del arte para los estudios de competitividad en el campo. *Revista de Ciencias Agrícolas*, (2), 13-124.

Velázquez, H. (2012). Autoorganización, complejidad y naturaleza: hacia una revaloración de la forma aristotélica. *Revista Eikasia*, 197-205.

Vázquez, A. (2007). Desarrollo endógeno. Teorías y políticas de desarrollo territorial. *Investigaciones Regionales*, (11), 183-210.

Vera, J. y Ganga, F (2007). Los clúster industriales: precisión conceptual y desarrollo teórico. *Cuadernos de Administración*, (33), 303-322.

Vivanco, M. (2014). Emergencia. Concepto y método. *Cinta de Moebio*, (49), 31-38.

Yu, M., Calzadilla, J., López, J. and Villa, A. (2013). Engineering agro-food development: The cluster model in China. *Agricultural Sciences*, (9), 33-39.