Approximation to the social structure of swine health and production research in Colombia

Nuñez-Espinoza, Juan F.[1]; Martínez-Castañeda, F. E.[2*]; Rendón-Rendón, C.[3]

[1] Colegio de Postgraduados. Montecillo, Texcoco, Estado de México, México, 56264.
[2] Universidad Autónoma del Estado de México. Campus El Cerrillo Piedras Blancas UAEM, Toluca, México, 50090.
[3] Universidad de Antioquía, Medellín, Dirección: calle 67 No. 53 – 108, Medellín, Colombia. Universidad Autónoma Metropolitana, Xochimilco, Calzada del Hueso 1100, Coapa, Villa Quietud, Coyoacán, 04960 Ciudad de México, CDMX.
* Correspondence: femartinezc@uaemex.mx.

ABSTRACT

Objectives: To characterize the organizational patterns in the swine health and production research systems in Colombia.

Design/methodology/approach: The social networks approach was used to analyze the associative pairing of a prominent community of researchers in the field of swine health and production in Colombia, considering scientific studies generated between 2010 and 2018.

Results: The swine research network in Colombia has a circumstantial growth, incipient behavior, and is highly centralized, delimiting the research narrative and generating a normal distribution in the transitivity of the network.

Limitations on study/implications: The sample analyzed was by convenience and determined to a number of scientific studies, so it would be necessary to broaden considerably the population and the period analyzed. Visualizing and measuring this social structure could allow managing risks and opportunities for the local swine farming sector.

Findings/conclusions: The social density and the values of structural centrality obtained reflect an organizational model that replicates the global production model: limited information flows and partially connected structures, highly centralized and with low variability in their information channels and knowledge exchange in a highly strategic sector.

Keywords: Social networks analysis, swine farming research systems, agrifood sector.

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INTRODUCTION

The high nutritional and protein value of pork meat has made it the second most consumed globally, after chicken meat [1, 2, 3]. In 2020, nearly 110 million tons of pork meat were produced in the world [4], and this will increase 13% by 2030 [5]. In 2019, swine farming in Latin America and the Caribbean was the one that increased most in the

world, with a weighted average of 4.6%; in 2020, it was 8.9 million tons: Brazil contributed 50%; Mexico, 18.4%; Argentina, 7.3%; Chile, 6.4%; and Colombia, 4.9%. The latter increased its pork meat production the most [6], which means an exponential increase in size, yield, productivity and specialization of the farms [5], as well as the consolidation of a globalized agroindustrial production model based on the intensification and concentration of the activity, expulsion of animals from the farmlands, establishment of industrial farms with mechanized productive methods, and genetically improved animal breeding, in confinement under specific dietary and pharmacological requirements [7]. According to Shahbandeh [8], the global herd is composed of 784.2 million pigs and to feed them, the following is required: intensive use of industrial inputs and biotechnology for large-scale monocrop production, hoarding and concentration of land, as well as entrepreneurial expansion and financial capital [9].

This also depicts swine farming systems linked to ecological problems of public health and food security, since massive confinements have been built under homogeneous conditions, reduced spaces, and constrained genetic diversity, accelerating the rotation of animals and amplifying the risk of various diseases [10, 11, 12]. This is worsened since the globalized swine farming model promotes the interregional transport of inputs for production and consumption (pig carcass, cold meats, etc.); therefore, complex social networks are articulated of commercial branches and international supply chains with high interconnectivity, which makes them more vulnerable to systemic interruptions: wars, economic and environmental crises, epidemics; pandemics; epizootics, etc. [13, 14].

In this sense, the propensity of the global swine farming system to the transmission and dissemination of trans-border diseases of the animals is logical: African swine fever (ASF), classical swine fever (CSF), Aujeszky disease, foot and mouth disease, or porcine reproductive and respiratory syndrome, among other pathologies [15]. On the other hand, the global and annual emission of greenhouse gases associated to swine farming has been estimated to be in the order of 700 million tons of CO_2, where the production of concentrated feed for animals is the main contributor, with nearly 60% of the emissions of the supply chain, while manure management, post-farming processing, transport, use of energy in production and enteric fermentation add the remaining 40% [16]. These potentialities and vulnerabilities have been accentuated regionally.

In Colombia, the swine agribusiness grew during the decade of the 1980s, as a result of globalization and trade liberalization processes in Latin America [9]. The participation of the World Trade Organization promoted the liberalization and a greater privatization of the agrifood sector [17].

In 1983, the Colombian Pig Producers' Association was created with the aim of modernizing and strengthening the production of pork meat. In 1996, the creation of the National Swine Farming Fund (*Fondo Nacional de la Porcicultura*, FNP), promoted a greater investment in technical, sanitary, economic, commercial, research and technological transference programs for the development of the swine farming activity in Colombia [18, 19]. These organizational dynamics implied a clear expansion of productive processes, greater integration of the chain, innocuousness, formalization of the activity, improvement of the perception of quality, etc. [20], allowing the significant increase in the production and

consumption of pork meat [21], which made Colombia a competitive regional producer [22]: from 2010 to 2019, the activity grew on average 8.7%; by 2021, 491,233 tons of pork meat were produced, which corresponded to an additional offer of 22,805 tons compared to 2020 [23].

The Colombian swine farming system went from slightly over 2 million heads in 1961, to reaching 6 million heads in 2019 (Figure 1). However, this also meant high degrees of productive homogenization and contradictions in animal health.

According to Rincón [25], in 2006-2009 there was an epizootic outbreak in Colombia of the porcine post-weaning multi-systemic wasting syndrome (PMWS) caused by type 2 porcine circovirus (PCV2n), in the herds of industrial swine farms, causing important economic losses. The presence of classical swine fever (CSF) [26], respiratory syndrome (PRRS), porcine parvovirus (PPV) [27], virus of porcine epidemic diarrhea (PED) [28] has also been detected; high presence of toxoplasmosis [29]; in addition to a large variety of parasites in swine [30]. These problems are derived from deficient practices in herd management, causing significant mortality rates [31]. On the other hand, the Colombian swine farming system is a globalized consumer of livestock inputs, so some of their problems come from the interregional swine transport system (disseminator of PED among various regions of Colombia [32]), and from inputs imported for the production. According to Rincón [33], the prevalence of the porcine reproductive and respiratory syndrome virus (PRRSV) in intensive swine farms (agroindustrial) is associated to the import of live animals and seed from Canada and the United States.

All of this suggests transversal organizational processes in the animal market-production-health trinomial. In face of the development of massive swine farming systems, the institutional systems of scientific-technical research have broadened their capacities to measure, prevent, analyze, stop and mitigate these scenarios in local productive chains. These systems involve community dynamics whether as societies, trade unions, communities,

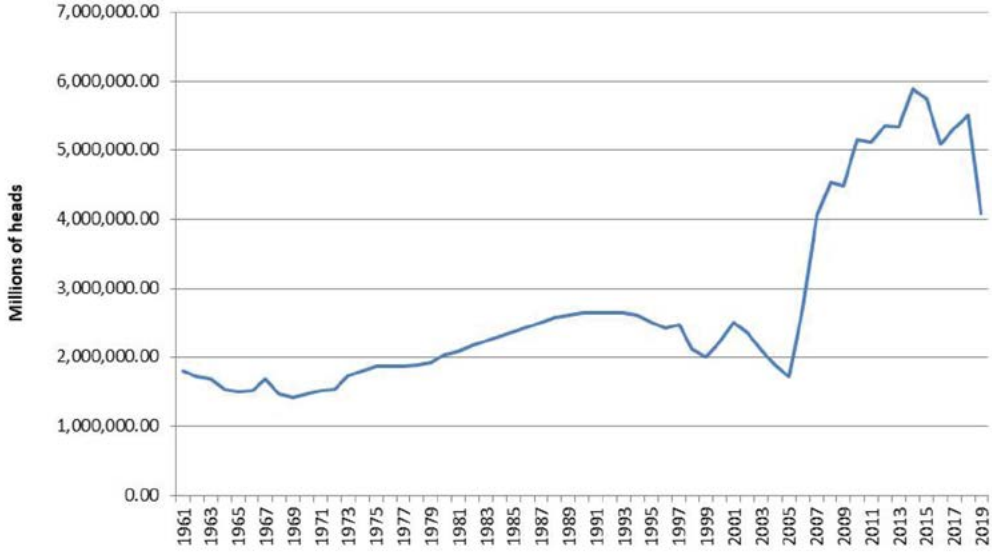

Figure 1. Evolution of swine farming in Colombia, 1961-2019. Source: [24].

etc., generating flows and exchanges of specialized information and knowledge [34], which beg the following question: What are the organizational patterns that predominate in the technical-scientific structures responsible for the animal health and production of the Colombian swine farming system? Concerning this, the objective established was to recognize and characterize the organizational patterns in the field of swine health and production research in Colombia, considering the processes of social agglomeration generated in the technological and scientific research structures of that productive chain. As a result, a partial approach to an otherwise complex system is proposed, with the aim of starting to generate strategic information about the organizational patterns that prevail in these social systems.

MATERIALS AND METHODS

The analysis of the social structures of swine health and production research allows gaining access to the dynamics of correlation and management of specialized knowledge between diverse academic and agribusiness sectors. This analysis was made based on a mixed methodological approach using two instruments of analysis:

1. The proceedings from international conferences carried out by the International Pig Veterinary Society (IPVS) conducted in 2010 to 2018 [35-39], and selecting the studies that refer to Colombia (67 researchers). The IPVS was founded in 1969 with the objective of "…sharing knowledge related to swine health and production… and fostering the potential cooperation between swine veterinary societies, scientists, swine veterinarians, and pork meat producers…" [40]. Thus, IPVS represents a historical model for the integration of porcine veterinary research globally. This has generated a growing participation of specialists in the subject matter. For example, in 1969 there were 500 participants; in 2010 there were 2716 and in 2018, 5599. The IPVS is not the sole scientific information exchange forum about swine farming, but it has generated, globally, spaces for the exchange and generation of specialized knowledge, through dialogue and discussion of scientific information and ideas [41]; and it allows having the certainty that whatever is proposed has been measured and justified methodologically, making its experimental replication possible [42], and fostering the construction of collaboration networks [34] as well as the possibilities of analyzing these connections.
2. Social networks analysis (SNA). This is a structuralism approach centered on the relationships established by social stakeholders [43, 44], exposing structures of correlation generated by the diversity of relationships found between these stakeholders (individuals, institutions, organizations, etc.). In the case of this study, the connections between various scientific stakeholders in Colombian swine farming were analyzed, involving the co-authorship in scientific works circumscribed to Colombia. This analysis used measures of centrality (nodal degree and intermediation) and cohesion (social density), which belong to the SNA. The first refer to the position that each stakeholder occupies in the network [45], and

they are a way of measuring the dominance and influence of the stakeholders [44]. The second describes the structural efficacy to manage information [45].

- Nodal degree: It is the number of direct connections (co-authorships) that each author has [44, 46]. Its calculation [47]:

$$C_g(n_i) = \sum {}^{A}L(n_i, n_j) / (A-1)$$

Where: $Cg(n_i)$: number of nodes with which n_i is connected; $(A-1)$: Amplitude of the network.

- Degree of intermediation: It is the number of times that a stakeholder connects to a pair of stakeholders not connected directly [48]:

$$C_I(n_i) = \sum g_{jk}(n_i) / g_{jk} \forall j < k$$

Where: $C_I(n_i)$: degree of intermediation; $g_{jk}(n_i)$: number of geodesics between nodes j and k that pass by node i; g_{jk}: number of geodesics that connect nodes j and k [47].

- Density: Percentage of existing relationships between the possible relationships [49]:

$$\Delta = \frac{L}{g(g-1)}$$

Where: L: number of existing arches; $g(g-1)$: possible number of arches [46].

These measurements allowed characterizing topological qualities of the set of connections between Colombian researchers, and therefore potentialities and vulnerabilities. The software used was UCINET 6 [50].

RESULTS AND DISCUSSION

The network of swine production and health research in Colombia has an incipient behavior between 2010 and 2018, although with a clear growth: some disconnected areas are observed and two sub-groups stand out that expose a socio-centric and hierarchical behavior, although one is broader, with a higher number of connections, inputs of trust (thickness of arches) and defined reciprocity (arch in red), although centralized; this evidences a more cohesive group and with more operation time (Figure 2). The social density of the structural set is 2.46%. In turn, the average in nodal degree is 3.06, with a standard deviation of 4.13, pointing to a circumstantially communicated structure. This pattern of centralization is replicated at the level of intermediation: the average values

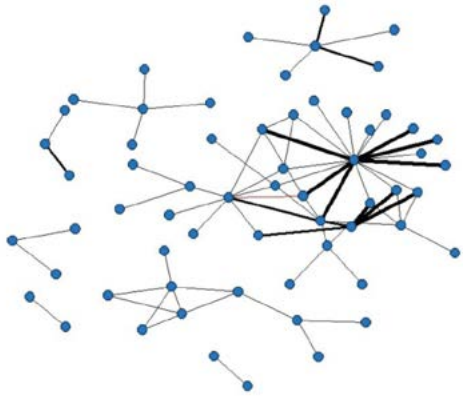

Figure 2. Swine research network in Colombia 2010-2018. IPVS 2010-2018.
Source: [35-39].

were 0.953, with a deviation of 4.58, indicating communication channels and limited information exchange.

This centralization has influenced the temporary dynamics of the social structure itself, which has gone from limited patterns of communication, correlation and transitivity (2010), to intermediate stages of greater transitivity (2012-2014), although evolving towards structures that are clearly more centralized (2016), more limited and reduced (2018) than those found in the first year of the period reviewed (Figure 3).

In general terms, the agglomeration trends in this research network have moved towards decreasing their information and correlation exchange channels. Although in 2018 there was a limited recovery at the level of intermediation, compared to 2016 and 2010, it is still a

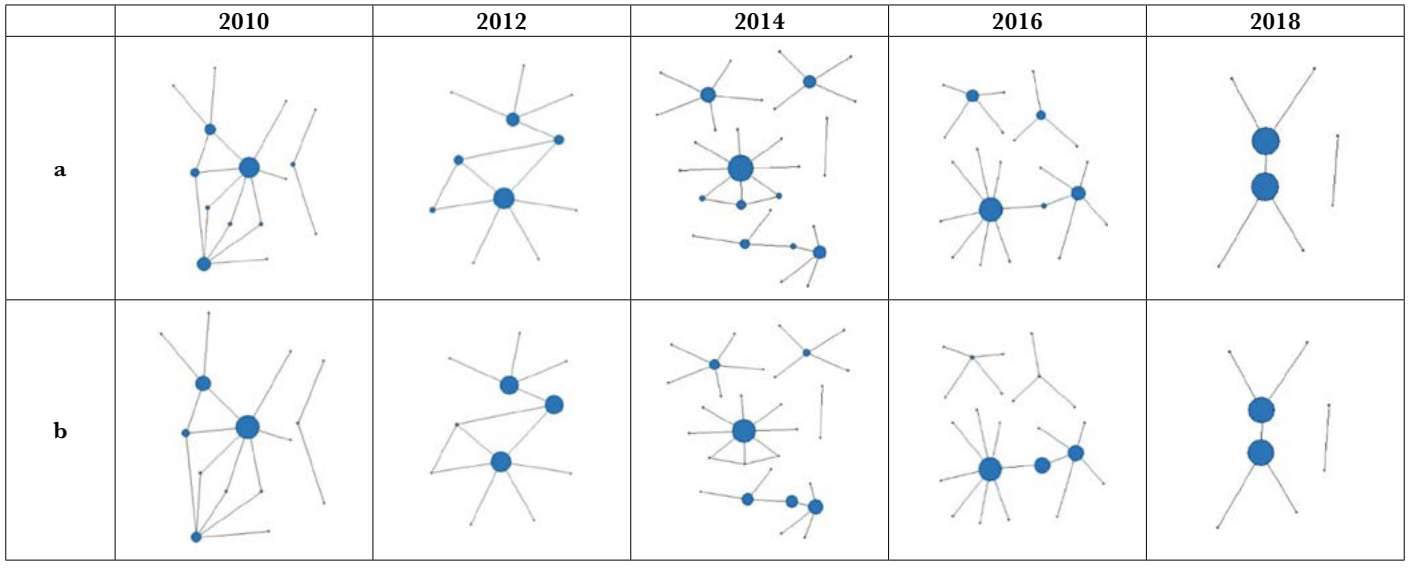

Figure 3. Evolution in Degree (a) and Betweenness (b) in the swine farming research network in Colombia, 2010-2018
Source: [35-39]

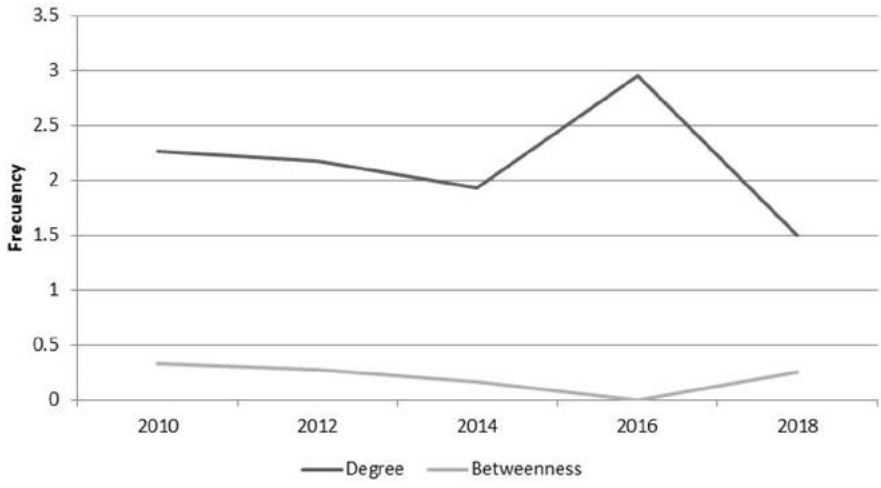

Figure 4. Structural trends in the swine farming research network in Colombia. Source: [35-39]

lower value (Figure 4). For its part, the capacity for communication increased significantly in 2016 although it fell by 2018.

It should be mentioned that the patterns of social prominence observed in time are the expression of the information management itself (and the power of correlation) inside the structure analyzed, and the flow of this information allows observing a structure connected from the first year analyzed (2010) to the last (2018), confirming a continuum of correlation/communication between research groups in swine health and production. In this case, defining the capacity for intermediation in the graph, it is evident that this capacity is managed by a limited group of stakeholders, primarily since the first year (Figure 5).

For its part, the gender composition of the research structure is mainly masculine (56.45%), although the feminine factor is highly significant (43.55%) and holds the main values of communication and correlation of this research structure (Figure 6).

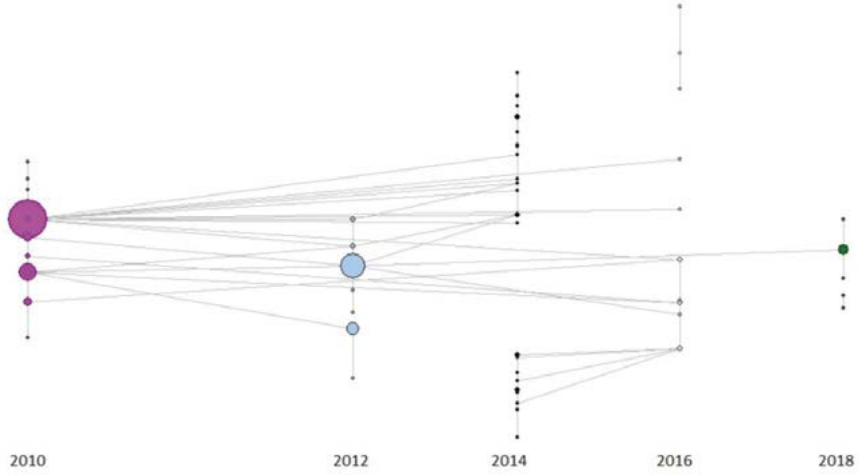

Figure 5. Swine farming research network in Colombia from a five-year period (2010-2018). Source: [35-39]

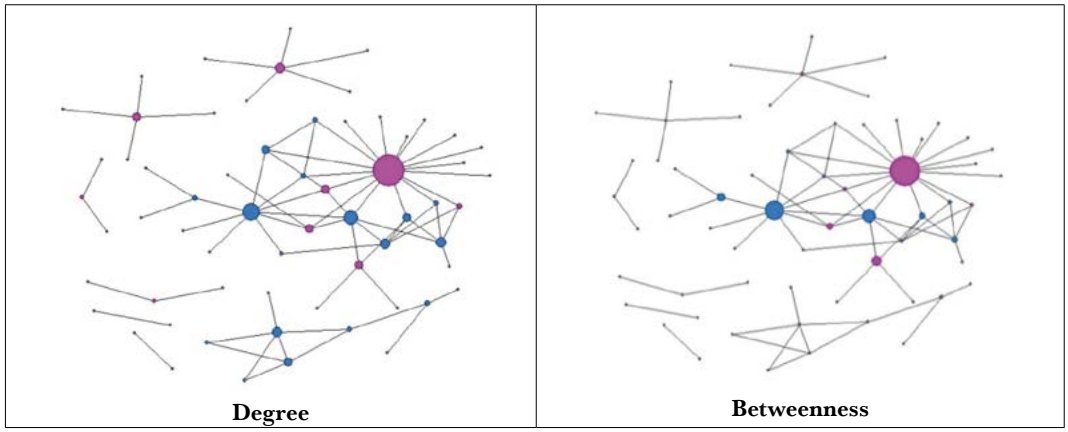

Figure 6. Gender in the swine farming research network in Colombia (2010-2018). Source: [35-39]

CONCLUSIONS

The scientific and technological system involved in swine farming in Colombia presents an incipient and circumstantial organizational behavior. The social density and values of structural centrality found reflect a partially-connected organizational model, highly centralized and with low variability in the information/exchange channels of knowledge in the branch. However, the size of the network itself presents a specific potential to reformulate the information flows in animal health and production with the aim of strengthening the structural value of the network; the latter, primarily, because the complexity of the contradictions inherent to swine farming tend to spill over to the local systems of research and safety control. The zoonotic scenarios, increasingly present in our societies, indicate the need for research networks in agrifood and livestock sectors that are capable of innovation in their organization models.

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