Dynamics and structure of research in swine health in Mexico: A methodological approach

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ABSTRACT

Objective: To characterize the socio-structural dynamics in the field of swine health research in Mexico.

Design/methodology/approach: The data used were obtained from proceedings of IPVS international conferences from 2010-2018. The study unit was the result of co-authorships. The Social Networks Analysis (SNA) was used to understand the working dynamics of the research groups through the UCINET 6 software for Windows.

Results: In the area of swine health and veterinary science, 63% of the research has depended on higher education institutions and research centers and the rest on the private sector. The most active universities with research are Universidad Nacional Autónoma de México (34%), Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias (9%), Universidad Autónoma del Estado de México, and Universidad Autónoma de Yucatán. The main research areas in swine diseases were PRRS, Circovirus, Influenza, Porcine Epidemic Diarrhea, among others.

Limitations on study/implications: This study was done considering only scientific information about swine health contained in proceedings of IPVS Conferences from 2010-2018. To visualize these working networks allows detecting spaces for possibility in terms of creation of research policies.

Findings/conclusions: The research about swine health in Mexico is concentrated in five working groups, which is why understanding these key stakeholders will allow greater dissemination of the information.

Keywords: Social networks analysis, universities, laboratories.

INTRODUCTION

Pork meat production in Mexico represented a volume of 1,652,362 TM in 2020, 41% more than in 2010 and 60% more than in 2000, with a value of $2.20, 2.84 and 3.50 trillion dollars and an inventory of 15.39, 15.43 and 18.79 million heads, respectively (SIACON-NG, 2020).

To produce and feed this number of animals, large amounts of natural resources, inputs and farming lands are required, involving diverse processes and procedures for their transformation into food for human beings (Samán *et al.*, 2020).

One of the most important characteristics in the Mexican swine farming system has been its tendency towards the concentration of animals in few farms (Callejas-Juárez *et al.*, 2020) partly due to the intent to increase productivity and as a response to an economic concentration model with huge pressures for agrifood systems (Ploeg, 2010; Delgado, 2010).

This structural weight of swine farming in Mexico, in terms of volume of kg, heads produced and its economic value, means broad technological and scientific subsystems implicated in trying to solve the contradictions that are inherent to the sector's growth, primarily the contradictions of health in such massive herds, which are susceptible to epidemics and zoonosis, something that reflects in the concerns of research systems in the sector.

In relation to this, the agroindustrial systems of swine farming in Mexico, as well as the homogenization they have developed in their levels of modernization and biosafety, and local and international transport systems for loads of swine products and byproducts resulting from globalization processes, have presented an issue of urgent analysis: the risk factors over the increasingly common presence of pathogens and diseases that circulate in such porcine systems (Pradal-Roa *et al.*, 2010; Vial-Rigo *et al.*, 2018). Some of the most prominent diseases in the production system are: Porcine Reproductive and Respiratory Syndrome (PRRS); Circovirus-PCV2; Swine flu; Porcine Rubulavirus; Parvovirosis and Porcine Epidemic Diarrhea.

This allows us to consider wide gaps in research and social intervention about the health-market pairing, primarily due to some of these zoonotic and epizoonotic scenarios. In face of this, the presence of broad social structures made up by people and legal stakeholders that have built a communication ecosystem that underpins, one way or another, the technological process of animal production and health systems in Mexico in the swine sector; although, at the same time, they generate structural omissions in these animal research and production systems. This makes it possible to attempt to categorize the organization patterns that predominate in the scientific-technological and swine health sector, as well as the social dynamics in the regional and national structures responsible for it.

In this order of ideas, swine farming faces challenges specific to its area such as safety, low productivity, nutrition, etc., and they are inclined towards a structural framework of different specialty and scientific areas that must be addressed by different experts, private, government and academic institutions, which safeguard the functioning of this productive aggregate (Núñez-Espinoza *et al.*, 2022). Therefore, the objective of this study was to characterize the socio-structural dynamics in the research field of the swine health sector in Mexico. Although the dimensions of this task could be immeasurable for the limits of this study, a condensed and partial exercise on such structures is proposed, in order to achieve the aforementioned.

MATERIALS AND METHODS

The data used that allowed this analysis were obtained directly from the proceedings of international conferences of the International Pig Veterinary Society (IPVS) from the year 2010 to 2018 (IPVS 2010, 2012, 2014, 2016 and 2018).

The social unit used for this study came from two elements: a) social dyads and b) ordered pairs contained in co-authorships of conference presentations, which allowed defining and typifying the relationships of collaboration in the research subsystem involved in this analysis. According to prior analyses (Nuñez-Espinoza *et al.*, 2022), this set of scientific collaborations makes it possible to gain access to a measurable and topological structural expression allowing to distinguish different qualities: exploring possible access to research funds, opportunities of scientific intellectual capital management, and access to subsystems of trust between research teams.

To access these agglomeration patterns and the social dynamics present within the scientific and research structures in the area of swine health, the Social Networks Analysis (SNA) was used, which considers the complexity and topological dimensionality of the social structures, allowing for establishing a variety of measures and delimitations, under specific circumstances, to conceptualize and measure the diameter of the social network structure.

The analysis of the resulting social structure was conducted through the mathematical equalities of centrality and grouping: degree of centrality, intermediation, social density and cliques.

The data were analyzed with the UCINET 6 software for Windows.

RESULTS AND DISCUSSION

Mexico occupied the sixth place of the total of scientific contributions in the IPVS with 5.82% (Núñez-Espinoza *et al.*, 2022). A total of 283 studies were presented with participation from 642 researchers.

Swine farming has increased in practically the entire world (OCDE-FAO, 2021) and the demand for pork meat is increasing. Mexico, according to SADER (2022), was among the main consumers and producers in Latin America, with an estimated production of 1.73 million tons at the end of the year 2022. Because of this, the production of pork meat is strategic in the country (Sosa-Urrutia *et al.*, 2017), although currently this sector presents various challenges such as safety, low productivity, nutrition, profitability, sustainability, design, and development of intervention strategies, among others.

Table 1 summarizes the concentration of studies by institution and laboratory. The participation of UNAM stands out, which concentrates a fifth of the Mexican production.

Presently, in Mexico, 51 institutions teach undergraduate studies in Veterinary Medicine and Zootechnics, each with its objectives, missions and visions; however, all of them have contributed to the improvement of productive sectors through research, technical training with producers, expositions and attendance to debates, both nationally and internationally.

In the area of swine health and veterinary science, the study has depended primarily on higher education institutions and agencies from the public and the private sectors participate actively, to a lesser degree. During the conferences analyzed in this study, 283 studies were

Table 1. Main institutions in swine farming research in Mexico.

Source	Studies	%
Universidad Nacional Autónoma de México	72	25
Laboratorio Avi-mex	26	9
INIFAP	17	6
Universidad Autónoma del Estado de México	16	6
Universidad Autónoma de Yucatán	13	5
Boehringer-Ingelheim Vetmedica, Inc.	11	4
Others	128	45
Total	283	100

presented, of which 178 (63%) by universities or public research centers and the remainder by the private sector. Of the studies, 68.55% were generated by 8 institutions: 5 public and 3 private; 96 studies were generated by the scientific cluster of Universidad Nacional Autónoma de México (33.92% of the total), 26 (9%) by a laboratory, 17 by INIFAP (public research institution), 16 by Universidad Autónoma del Estado de México, and 13 by the Universidad Autónoma de Yucatán.

The main research areas in swine diseases in Mexico were PRRS, Circovirus, Influenza, Rubulavirus, Porcine Epidemic Diarrhea and to a lesser extent actinobacillocis, provovirosis and almonelosis, among others.

According to the units analyzed in the period covered (2010-2018), these populations of researchers were clustered in a structure of scientific collaboration, with particular dynamics and areas: a) a significantly condensed central area; b) areas of dispersion or social expansion; and c) peripheral areas independent from the central component. These particularities showed a variety of groups and social connections through the collaboration process analyzed, as well as a social hierarchy, in function of intellectual and economic resources handled by each group, expressing a concrete symbolic and political differential: some have greater power than others to make and/or change the information that circulates within the network (Núñez-Espinoza and Martínez-Castañeda, 2020). In the case of this general structure, the mean values of centrality and intermediation were 3.85 and 96.75. The degree of centrality of the network was 1.12% which indicated certain paths through which the information is distributed, but also a structure fed with circumstantial connections. A socio-centric behavior was seen (Figure 1), although with areas directed at centralization processes.

The importance of the working groups observed in the graphs of the period analyzed (2010-2018) has concentrated the information in a few stakeholders, and two positions emerge from this: a) they are stakeholders that have prominence in the information flow, centralizing it, which places them in a strategic situation as intermediary stakeholders between institutions, producers, and public policy designers for the swine farming sector; and b) this behavior indicates a centralized structure in a scientific and technological sector that develops immersed in a complex agrifood concept: that of health; so this centralization, instead of generating diverse solutions to the complex epizootic and zoonotic schemes at
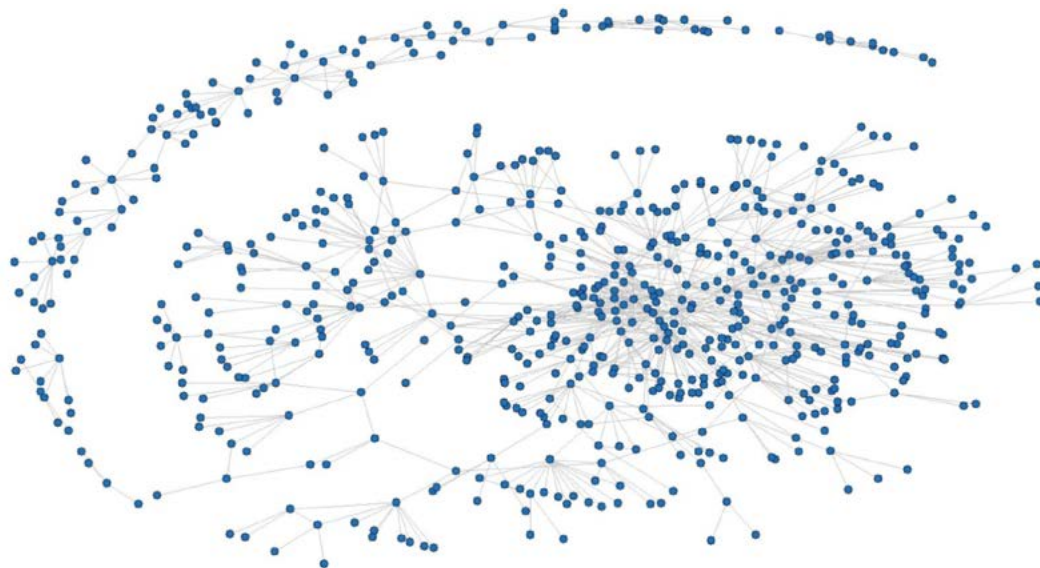
Figure 1. General structure of the Mexican research network on swine health.
Source: IPVS (2010-2018).

the level of large livestock production systems, generates solutions that are unavoidably and problematically partial.

Mexico Network 2010

Considering the analysis of such a structure for each of the periods analyzed, it was seen that the structure expressed in 2010 (Vancouver, Canada), presented an average degree of centrality of 3.23, a maximum of 53 and a standard deviation of 5.42. This behavior suggests variation in the number of direct connections and a distribution of the moderately uniform social prominence (Figure 2). For its part, the average degree of intermediation was 3.88 although with deviation of 16.66.

Mexico Network 2012

This research structure suffered changes by the year 2012 (Jeju, South Korea), showing a degree of centrality of 2.31, with a maximum of 13 (40 less than in 2010) and a deviation of
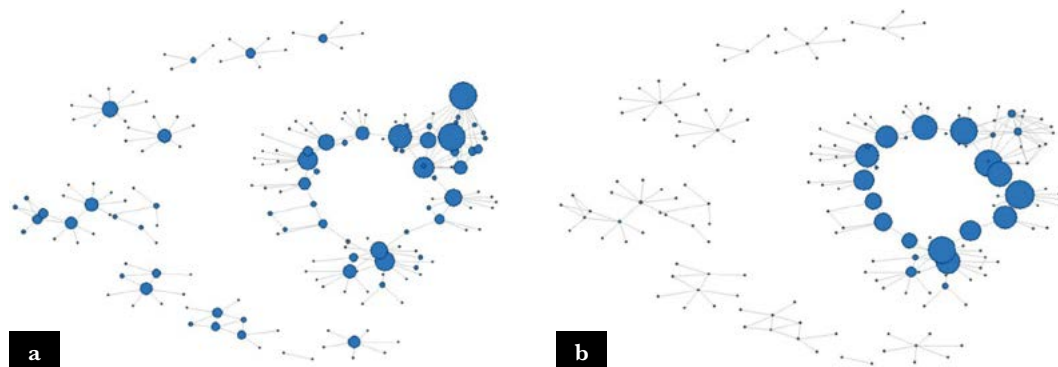

Figure 2. Degree of centrality (a) and intermediation (b) of Mexican collaborators in IPVS 2010.

2.57. In addition, a disconnect was evidenced of the structure for research and collaboration, presenting ego networks with a reduced number of components and one main component (which could suggest a differential in terms of economic resources to present studies in a conference of this type, although evidence about it is still lacking) (Figure 4). Compared to the 3.88 of intermediation from 2010, and due to the low connection between areas and/ or research groups, in 2012 it was only possible to record a value of 0.611 with a deviation of 3.21 (Figure 3).

Mexico Network 2014

The structural behavior found in 2014 (Cancún, Mexico) was characterized by a more socio-centric behavior. The degree of centrality reported was 3.08, with a maximum of 43 and a deviation of 4.10, and these values were higher than those reported for 2012, although lower than those of year 2010. The number of observations was the highest, with a total of 383, 270 more than in 2012 and more than in 2010. Despite this, it is possible to identify a higher number of nodes and relationships, and two integration areas were observed: one main component and an area of peripheral groups disconnected between each other (Figure 4). The intermediation was 5.10, but it was still concentrated in central groups.

Mexico Network 2016

The behavior observed for the social structure of the year 2016 (Dublin, Ireland) was very similar to that of year 2012. A central component and a periphery made up of ego networks, perhaps evidencing groups with better resource management to participate in this type of international events. The degree of centrality was 2.21 with a deviation of 2.29 (Figure 5). This conference was where the least observations by the Mexican delegation were recorded, with only 103. The degree of intermediation was 0.21, suggesting a concentration of the power of information in few stakeholders.

Mexico Network 2018

The structural behavior of the year 2018 (Chongqing, China) was similar to that observed in 2012 and 2016, although with some slight variations: a more articulate central
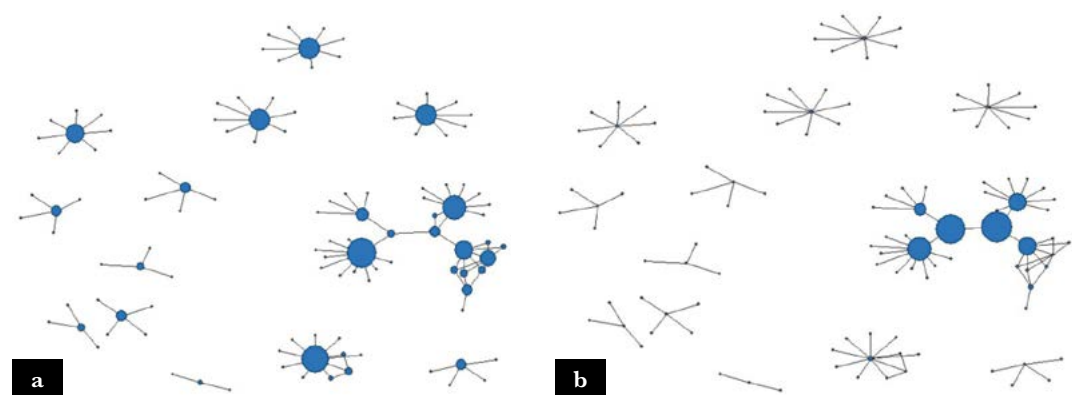

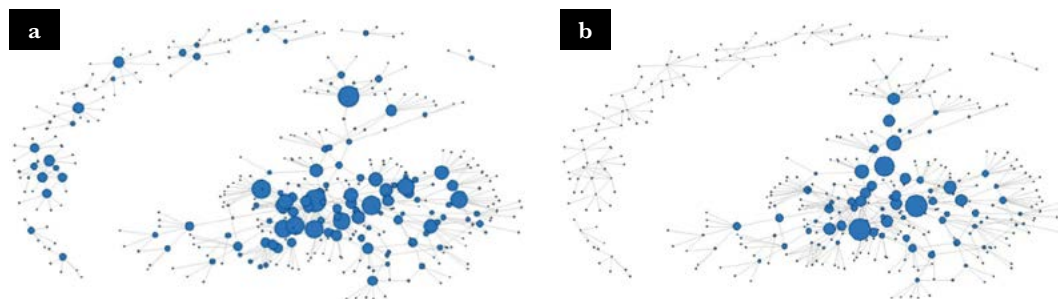**Figure 3**. Degree of centrality (a) and intermediation (b) of Mexican collaborators in IPVS 2012.

Figure 4. Degree of centrality (a) and intermediation (b) of Mexican collaborators in IPVS 2014.
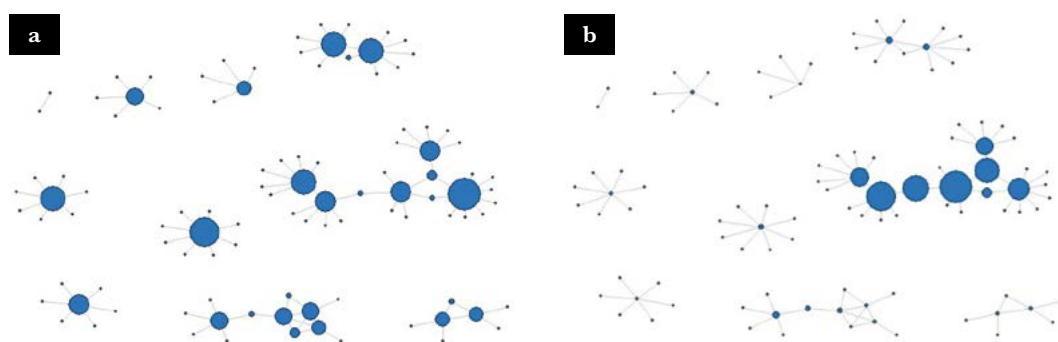

Figure 5. Degree of centrality (a) and intermediation (b) of Mexican collaborators in IPVS 2016.

component and with egos in the process of connecting between each other. The values of centrality and intermediation were 2.85 and 0.88, and the deviations 3.53 and 5.56. The information flow was concentrated in the central component (Figure 6).

Network by gender

When this research structure in swine health was addressed, dividing the values by gender (Figure 7), it was observed that its composition was determined by 53.58% men, 30.37% women, and 16.04% whose gender it was not possible to determine.
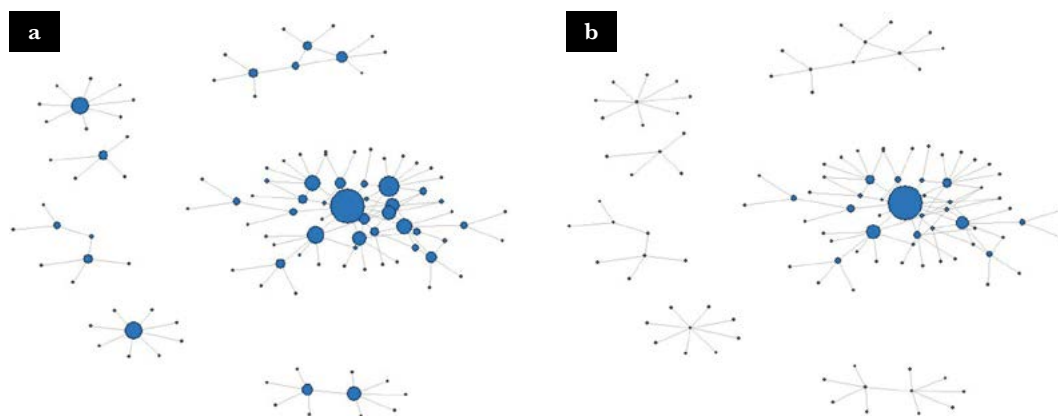

Figure 6. Degree of centrality (a) and intermediation (b) of Mexican collaborators in IPVS 2018.
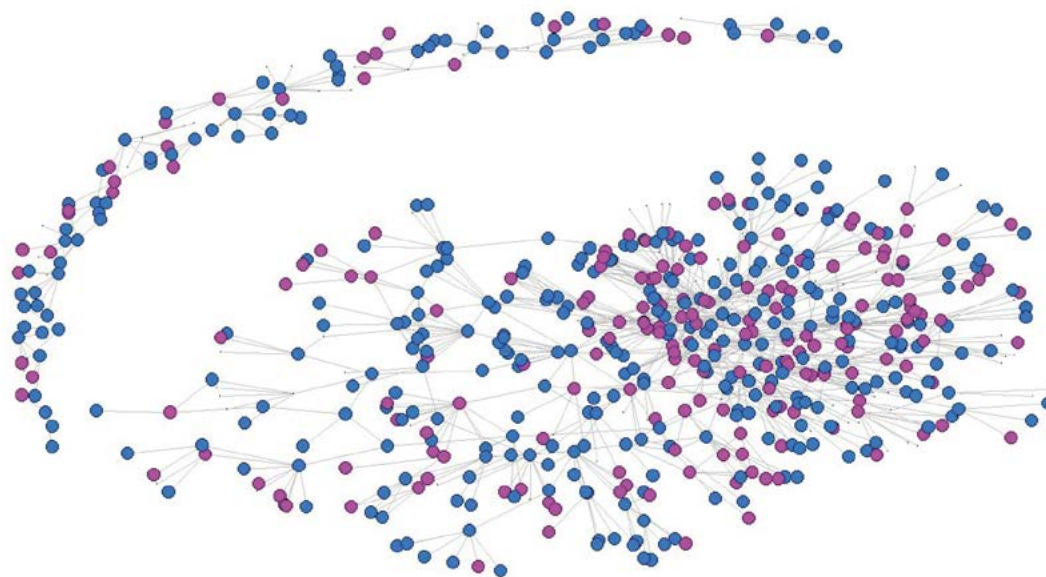
Figure 7. General structure of the Mexican research network in swine health divided by gender.

When analyzing the centrality of the structure, it was seen that both the nodal degrees and the intermediation degrees were managed and centralized primarily by women, indicating a strategic position to gain access to the information circulating in the network, as well as to connect nodes and areas that are not directly connected between each other. This indicates a prominence in the determination of research themes in the area analyzed (Figure 8). The means of centrality and intermediation by gender were 2.51 and 45.45.

With a more introverted analysis of the information flow in this structure and gender network, focusing on the central component, informed by recurrences, strengths, continuity and reciprocity in the information flow between stakeholders, the decision was made to discriminate the circumstantial values of correlation, with a nodal value=1. Therefore, it was possible to gain access to a more condensed social structure, with a more horizontal distribution of social prominence. In this case, both the values of degree and intermediation were managed by feminine stakeholders (Figure 9).

The asymmetrical relationship that traditionally exists between men and women who do research on swine in Mexico is notable, given that as Lechuga Montenegro *et al.*, (2018) mentions, education in Mexico is influenced by the customs and traditions of the place where it develops, and for the case of livestock production, because of how heavy animals are and the maneuvers necessary, it has been regarded as an area of masculine action. However, the analysis presented here detected that although there are less women participating, they are the ones who have highest degree of intermediation, which indicates that they are key stakeholders to connect with the network. There is still much to do to achieve a real education with gender perspective; however, it is worth highlighting that currently there is an important feminine representation in the sector of research on swine health and veterinary science.
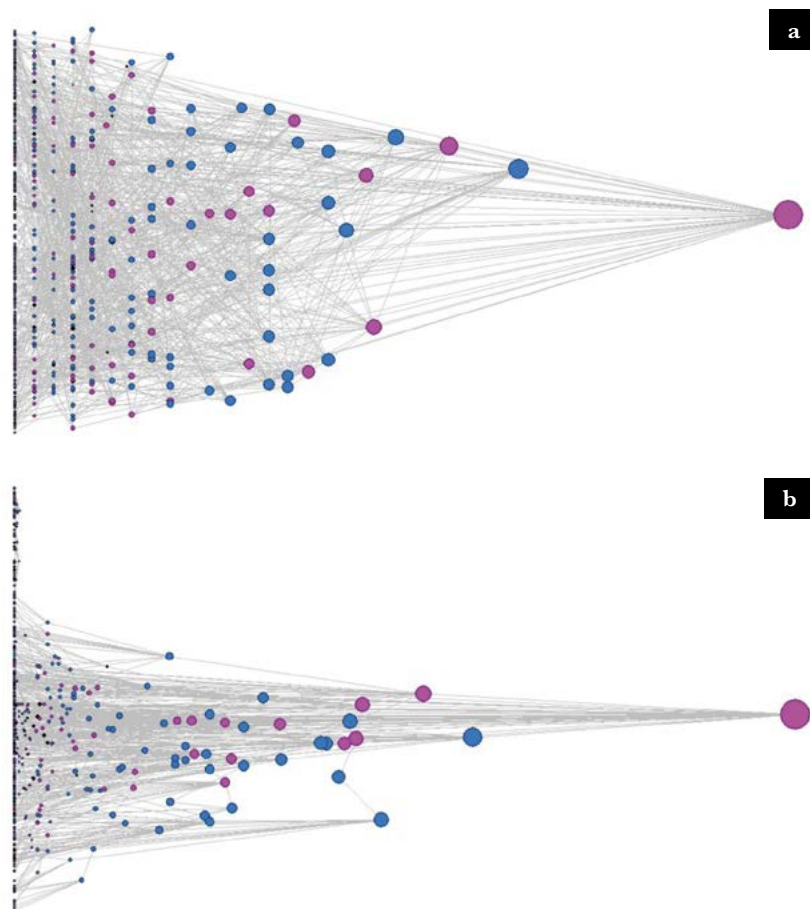
Figure 8. Degree of centrality (a) and intermediation (b) by gender. Pink (women), blue (men).
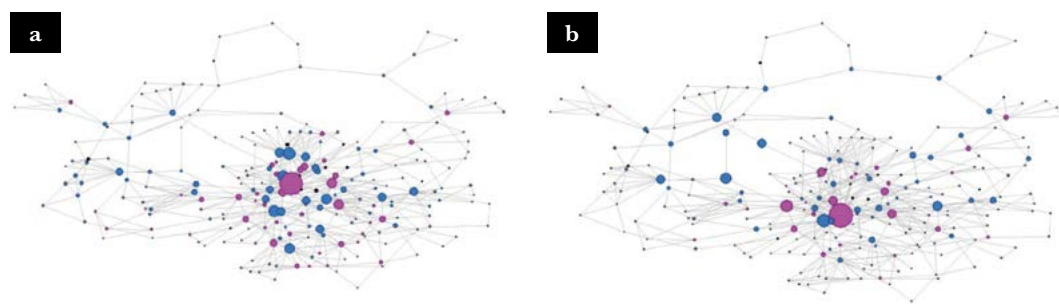

Figure 9. Degree of centrality (a) and intermediation (b) in the structure of the Mexican research network on swine health, divided by gender, excluding the nodal value=1.

CONCLUSIONS

Public universities are integrated into the current quandary that affects swine farming in Mexico and they have some connection with the swine-producing industry and some private sectors.

The degree of centrality shows that throughout the IPVS events, the nuclei of researchers became centralized from more to less, ending up with less than five research groups in

the country that disseminate through these means the scientific results that support swine farming in the country, which without a doubt contribute to the resolution of problems present in swine farms, since without a doubt the porcine livestock inventory has increased, as well as the productive efficiency and per capita consumption.

Mexican women researchers are leaders in the research sector in the country, through the generation and intermediation of research projects connecting to a certain degree between each other and in lower proportion with the private sector. Understanding who the key stakeholders are in these working networks between universities will allow an adequate dissemination of information.

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