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Analysis of trends in research on internationalization and production chains in the pork sector

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Abstract

The pig sector has shown sustained growth in the last thirteen years in Latin America, which is why it is of special importance for these economies. This article explores trends in research on internationalization and production chains in the pig sector. For this purpose, a network analysis of keyword co-occurrences was developed, which allowed visualizing the state of development of research in the field. Four clusters or thematic groups were identified that summarize the areas addressed in the research on internationalization and production chains in the pig sector: pig industry market, supply chain management and animal welfare, sustainable development in the pig industry and human welfare in the pig industry.

Keywords: trends in internationalization research; production chains; pork sector.

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Análisis de las tendencias de la investigación sobre internacionalización y cadenas de producción en el sector porcino

Resumen

El sector porcino ha mostrado un crecimiento sostenido en los últimos trece años en América Latina, por lo que es de especial importancia para estas economías. Este artículo explora las tendencias en la investigación sobre internacionalización y cadenas productivas en el sector porcino. Para ello, se desarrolló un análisis de redes de co-ocurrencias de palabras clave, que permitió visualizar el estado de desarrollo de la investigación en el campo. Se identificaron cuatro clusters o grupos temáticos que resumen las áreas abordadas en la investigación sobre internacionalización y cadenas de producción en el sector porcino: mercado de la industria porcina, gestión de la cadena de suministro y bienestar animal, desarrollo sostenible en la industria porcina y bienestar humano en la industria porcina.

Palabras clave: tendencias en la investigación sobre internacionalización; cadenas productivas; sector porcino.

1. Introduction

Pork sector has a special importance for world economies due to their contributions to employment, the production of quality meat, as well as the satisfaction of consumer demands at a global level (Iglesias et al, 2017). According to the data bases of Food and Agriculture Organization of the United Nations, the worldwide pork production meat IN 2019 was 102 million of tons, being China the leading in production (41.7%), followed by the European Union (23.4%) and the United States in third place (12.3%). In Latin American region, the country with the highest pork production in 2019 was Brazil, with 3.9% of world production (FAO, 2020).

According to the world bank (2020) pork consumption meat in Latin American countries has increased steadily during the last thirteen years, in the same way, pork consumption in region households ranges between five and twenty kilograms per inhabitant annually.

The country with the highest consumption is Mexico, with a 19.4 kg followed by Chile with 18.7 kg and Uruguay with 17.7 kg per habitant; mean while Colombia ranks eighth (World Bank, 2020). Although pork consumption is determined by multiple variables Rebollar, Hernández and Rebollar, (2022) argue that real prices of the economy and per capita gross domestic product are two fundamental determinants.

In Colombia, pork meat full production in 2021 was 491.244 tons, 5% more than in 2020 (Porkolombia, 2022), pork meat production national statistics are shown a highest tendence of increase since 2010 until 2021. Another indicator that has grown in the country is pork consumption, going from 4.8kg per habitant in 2010 to 12.2 kg in 2021 (Porkolombia, 2022), which makes evident the growth of the sector.

These indicators show the need to undertake efforts in the sector in order to strengthen production chains and internationalization processes, also taking into account the global dynamics of the agri-food industry in recent years, influenced by profound changes, especially in transnational production networks, directly affecting the flows of goods (Klein, 2018).

By the other hand, Wognum et al, (2009) affirm that another aspect who has an impact on commercial relations within the pig industry are the political and administrative processes of each country, because these determine the quality of the product and the final consumer satisfaction. The standards, norms and technical elements in the pork industry also played a leading role in the international competition of countries to reach other markets, since they are conceived both as instruments for market regulation and on some occasions as geopolitical control tools (Agustín-Jean & Xie, 2016).

However, another concern in the pig sector is the consolidation of environmentally friendly practices (Cárdenas et al, 2019; Rodriguez et al, 2022; Xie et al, 2022), so key industry players are challenged to learn to articulate economic pressures with environmental demands (Dai, Zhanli & Muller, 2021).

A recent global event who has had a direct impact on food security and agricultural production chains was the Covid-19 pandemic, which required the implementation of strategies for the prompt recovery of supply channels, the stabilization of markets and improving the income of farm workers (Ni, Cheng, Ding & 2020); however, despite the disruptive dynamics caused by the pandemic, some authors maintain that the pork sector proved to be resilient in the face of the threats of Covid-19 (McEwan et al, 2020; Weersink, von Massow, & McDougall, 2020). .

The relevance of the sector in the world economy, this paper should identify the state of research on production chains and internationalization processes in the pig sector. This research is a precedent for future research because it systematizes research trends in the field of study, promoting the identification of theoretical gaps.

2. Research method

In order to achieve the research objective, this article proposes to develop a network analysis, which allows the researcher to obtain a global vision of scientific production in a field of study (Van Eck and Waltman, 2014), in this way, The construction of bibliometric networks makes it possible to simplify complex data, which favors communication in investigative processes (Vargas-Quesada & de Moya-Anegón, 2007), a fundamental aspect for the dissemination of knowledge, as well as for Identifying gaps in knowledge.

2.1. Information recovery

At first, as a methodological route for the development of this article, a

search was carried out in the Scopus database, with the purpose of identifying scientific articles that addressed the subject matter under study. To make the search more representative, the following structure was achieved, it was applied to keywords, titles and abstracts.

TITLE-ABS-KEY ("pork sector" OR "pig sector" OR "pork industry" OR "pig industry") AND (LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "DECI")) AND (LIMIT-TO (DOCTYPE , "ar"))

Then, the search was limited to the following four areas: business, administration and finance, economics and econometrics, decision-making, and social sciences. Finally, the scientific articles were focused, resulting in a total of 197 (table 1). The choice of the database was made since Scopus contains the largest number of scientific articles worldwide.

Table 1
Identification of publications

Stage	Number of publications found
First research in Scopus	2111
Documents from the area of business, administration and finance, economics and econometrics, decision making and social sciences.	236
Publication Type: Articles	197

For the analysis of the information, the methodology used by Gálvez (2018), developing in the first stage a description of the information collected, considering elements such as the source of the articles, the volume of production, the fields or areas of knowledge addressed, to name a few elements.

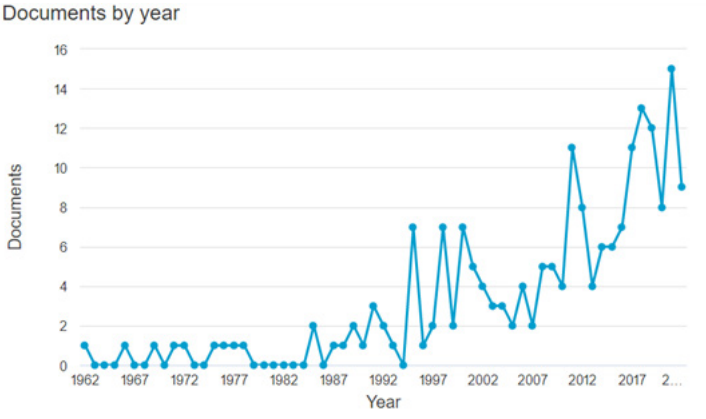
Secondly, the search was undertaken in the Scopus database, the retrieved information was processed by the VOSviewer software, through which the keyword co-occurrence map was constructed. Third, the analysis of the clusters identified through the co-occurrence map, presented below, was carried out.

The map or network of co-occurrences is configured through the keywords present in the identified academic production, the links or links emerge due to the recurrence of the keywords in the articles (Yoo et al, 2019).

3. Characteristics of scientific production

First, the scientific production per year was characterized. The period of analysis includes from the year 1962 to the year 2022 (with a cutoff to June). Graph 1 presents the evolution of scientific production in the years analyzed.

Graph 1
Production of scientific articles per year



Source: Scopus

Largest number of articles was registered for the year 2021 with 15 publications, which represent 8% of the total. Subsequently, in 2018, 13 articles were published and 12 for 2019. As can be seen in Graph 1, the trend in the production of scientific articles referring to internationalization and production chains in the pork sector is growing, for which reason can assert that it is a dynamic and developing field of study.

The characterization of the analyzed scientific production shows the areas in which the scientific articles have been published. Regarding this aspect, it is important to clarify that some scientific articles are not exclusively associated with one area, due to the interdisciplinarity and transdisciplinarity of the studies.

Table 2 shows the areas of knowledge on which this research has focused. The area with the largest number of published scientific articles is "Economics, econometrics and finance" which has 103 publications, representing 42% of the articles; followed by the area of social sciences with 70 articles, which represent 29%.

Table 2
Production by area

Area	Number of publications
Economics, Econometrics and Finance	103
Social Sciences	70
Business, Management and Accounting	58
Decision Sciences	13

Source: Scopus.

For its part, the area of "business, administration and accounting" participates with 58 articles, which represents 24%; the remaining 5% is made up of articles on decision sciences. The country with the highest number of articles in the field under study is the United States with 34 articles, followed by the Netherlands with 18 articles and the United Kingdom with 9 articles (Diagram 1).

Diagram 1
Country of origin of the articles

Source: Own elaboration with Scopus data and Bing Maps

On the other hand, the journal with the largest number of published articles is called the American Journal Of Agricultural Economics, participating with 12 articles, which is an academic space for the publication of research on agricultural and food economics, natural resources, the environment and rural and community development, worldwide, categorized in Q1 by Scimago (table 3).

Table 3
Journals with more publications

Magazine Name	Number of publications
American Journal Of Agricultural Economics	12
Canadian Journal Of Agricultural Economics	10
British Food Journal	8
Journal On Chain And Network Science	8
Agribusiness	7

Fuente: Scopus

In second place is the Canadian Journal of Agricultural Economics, in which 10 articles were published, which is in Q1 according to Scimago. This journal publishes research papers related to agri-food, agribusiness, policies for the use of resources and environmental impacts, agricultural resource, and environmental economics, among other related issues.

The British Food Journal has 8 published articles, and disseminates works related to consumer behavior, perceptions, attitudes and decision-making; business, administration and marketing; health, welfare and education and sustainability and environment. It is classified in Q2 by Scimago.

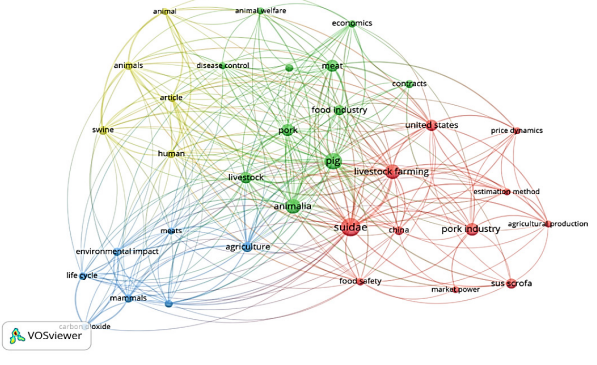
Next is the Journal On Chain and Network Science, which is a scientific research journal that aims to disseminate theory and practice in the field of innovation in business chains and networks, including issues related to organizational governance, management of innovation, logistics, quality management, marketing and strategic planning.

In fifth place is Agribusiness magazine, an international journal that publishes studies that contribute to the understanding of food systems, their evolution, and public or private actions that affect the performance of the global agro-industrial complex. Subject areas include supply and demand analysis, industry organization analysis, price and trade analysis, marketing, finance, and public policy analysis. It is classified in Q1 according to Scimago.

3.1. Network analysis

After having characterized the scientific production, the network analysis is developed. For this, the construction of a map of co-occurrences of keywords was essential, as can be seen in Diagram 2, from which four clusters made up of 32 keywords emerged. In accordance with the number of focused articles, keywords with a minimum of five occurrences were chosen, that is, they are found in at least five articles.

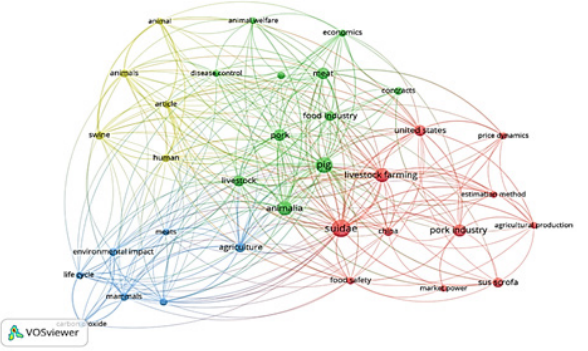
Diagram 2
Keyword co-occurrence map



Source: Own Elaboration with

The Graph 3 shows the keywords that make up each cluster in detail, as well as the occurrence of each word and the total strength of its links.

Graph 3
Occurrences of keywords



Source: Own Elaboration

4. Trends in research on internationalization and production chains in the swine sector. Discussion

The main contributions of the articles associated with each cluster are discussed and exposed. The clusters or global themes identified, considering the identified keywords, were the following:

- Cluster 1. The pig industry market.
- Cluster 2. Management of the supply chain in the pork industry.
- Cluster 3. Sustainable development in the pig industry.
- Cluster 4. Human well-being in the pig industry.

4.1. Cluster 1. The pig industry market

In this cluster there are keywords such as “livestock”, “pig industry”, “price dynamics”. “Agricultural production”, “market power”, among others, as shown in Graph 3.

In a first identified article, Ken and León (2022) expose how the pork industry in the United States has created three conditions that directly affect workers in the industry, these three conditions are: 1) high monopoly power and monopsony (monopoly of the buyer), 2) a hyper-efficient industry, but with harmful conditions for the worker and 3) destruction of unions.

This work constitutes a critique of predatory capitalism, against which the authors argue that normative regulations only favor the employer, leaving aside the interests of the worker, to support this the authors use as a theoretical model the theory of structural conditions, through which it is possible to demonstrate the way in which the state articulates with corporations, causing a detrimental effect on communities, workers, and others.

However, although in theory there are laws that are intended to protect

these vulnerable players in the industry, the pressures of the industrialists always emerge as winners. Finally, the authors reaffirm the need to redirect industry practices towards forms of capitalism that are friendlier to the environment, people, and animals.

Guo, & Tanaka, (2022) are authors of the article "Potential factors in determining cross-border price spillovers in the pork sector: Evidence from net pork-importing countries", with the purpose of analyzing the relationship between international and local pork prices. pork for the period from January 2001 to December 2018, in 10 countries that are net importers of pork. The results support that commercial self-sufficiency in the pork industry could have a direct impact on the transmission of price volatility in the global market. The relevance of this study is that through the analysis presented it can be concluded that protectionist regimes do not work to stabilize the national food supply, specifically those related to the pork industry.

For his part, Troncoso (2021) develops the work entitled "Market power and asymmetric price transmission in Chile: the case of beef and pork", whose purpose was to study the effect of market power on the transmission of prices between producer and wholesaler in the Chilean bovine and swine industries. As a methodology, the author uses conjectural elasticities to signify market power, and a threshold error correction model (TECM).

The main results suggest that market power directly affects the bovine sector exclusively when prices are in a declining stage, since in this phase wholesalers have greater market power to slow down price adjustment, while guaranteeing higher prices. profit percentages. Research of this type can serve as a background for the construction of public policy regarding issues such as barriers to entry, product quality, consumer benefit, price control, among other aspects related to the market.

Another relevant study is that of McEwan et al, (2020), which is entitled "Potential implications of COVID-19 on the Canadian pork industry", whose objective is to explore the effects of the COVID-19 pandemic. 19 in the Canadian pork industry in relation to three aspects: the ability of Canada to continue exporting hogs to the United States, the non-existence of pork throughout the value chain and world trade, especially due to the dependence on the Canadian economy of exporting pork to international markets.

As conclusions, the authors assert that in the short term there was a rise in pork prices, mainly due to panic buying due to COVID-19 and the weakness of the Canadian dollar, another associated factor is the change in consumer behavior. The aspects that most concern the industry are the lack of labor, the closure of processing plants, and the suspension of trade relations with the United States and other countries. In the long term, the response of the pork market to these challenges will determine the dynamics of this sector in Canada.

4.2. Clúster 2. Gestión de la cadena de suministro en la industria porcina

Associated with cluster 2, keywords such as "food industry", "supply chain management", "animal welfare", among others, were found.

Fousekis, & Tzaferi, (2022)

carried out the research "Tail price risk spillovers along the US beef and pork supply chains", whose objective was to analyze the intensity and pattern of the indirect effects of tail price risk in meat industries beef and pork in the United States. To carry out this analysis they made use of CoVar functions, between farms and wholesalers and wholesalers and retailers. Within the results, the beef industry seems to show a greater tail price risk than the pork industry, in the same way, in both industries the negative and positive effects of tail prices are transmitted with the same intensity.

The practical utility of the study lies in the fact that, according to Fousekis & Tzaferi, (2022), the strength and pattern of price transmission throughout the supply chain contains important information about market efficiency, strategies price and the distribution of wealth.

On the other hand, Herrera & Trujillo-Díaz, (2021) present a case study of the pig supply chain in Colombia, called "Towards a strategic innovation framework to support supply chain performance", whose purpose was to determine how to measure the performance of a supply chain through a strategic innovation model, which articulates concepts of dynamic performance management (DPM), innovation function and system dynamics modeling (SD).

Within the methodological design, three steps were considered to achieve the objective: a systemic intervention based on the innovation functions that affect the performance of the supply chain, an analysis of the system's operation, and the design of a SD simulation model. The results show that the identification of supply chain performance drivers through innovation functions contributes to inventory improvement.

The research is useful both for businessmen and for public policy makers, for the former because they can make use of the proposed model to measure the return on investment in innovation and understand its impact on the supply chain; For public policy makers, it functions as an element for decision-making and policy design, specifically related to research and development (R&D).

Another preponderant investigation is that of Barberis et al, (2020) with the title "Trade relationships in the European pork value chain: a network analysis", whose objective was to analyze the European pork sector and its transformations, especially considering aspects such as the vertical integration and its specialization by phases. For them, the authors resorted to network analysis, applied to data from Eurostat and FAO, on production and trade for the period 2000-2016.

As a result, the extensive transformations that the pork market in Europe has undergone are evident: the increase in connections and specializations in constant dynamics, as well as the various forms of market integration both at an interregional, territorial, and international. At the same time, the changes in position in the value chain of some countries during the period studied are identified. The conclusions highlight the importance of strengthening communication channels in the European pork value chain, as well as contracting strategies, which promote the elimination of asymmetries in the chain.

Another keyword associated with this cluster is "animal welfare". Uzea et al, (2011) are authors of the article "Activists and animal welfare:

Quality verifications in the Canadian pork sector", which analyzes the role of quality verification in a consumer market with heterogeneous preferences about animal welfare. As an instrument for collecting information, a survey was used directed at two different samples: the general population and members of animal welfare organizations. The results of the study confirm the heterogeneous preferences of Canadian consumers, one part is indifferent to animal welfare and another portion expresses concern that better standards of animal welfare are promoted.

4.3. Cluster 3. Sustainable development in the pig industry

In the third cluster there are keywords such as "sustainable development", "agriculture", "environmental impact", to name a few. In a first article by Chen et al, (2021) called "Investigating historical dynamics and mitigation scenarios of anthropogenic greenhouse gas emissions from pig production system in China" the greenhouse gas emissions originated by the pig production system were analyzed in China, through a carbon footprint method and the use of national statistics between the period 2000 - 2016.

The results show a downward trend in carbon emissions in the period analyzed, especially in relation to the average carbon emissions per unit mass of live pigs in specialized medium- and large-scale backyard farms in China. The authors argue that this decrease is due to the change in the style of pig production, going from being extensive to intensive, to the improvement of fodder crops and animal waste management systems. The research serves as a background for the generation of awareness about the importance of clean production processes in the pork sector.

In a second article called "Adopting environmentally friendly farming practices and the role of quality labels and producer organizations: a qualitative analysis based on two European case studies" by the authors Duvaleix et al, (2020), a qualitative study is carried out developed through interviews with producer organizations in the pig sector in Brittany, France and the olive oil sector in Crete, Greece.

In relation to the studied pig sector, it was evidenced that many quality labels used in the industry do not have the purpose of producing an environmental impact, even when the organizations that provide advisory services serve as motivating agents for the introduction of environmentally friendly practices. The authors suggest that quality labels be integrated into the financial instruments of the sector, in order to promote sustainable development.

In a third investigation, Nakamura, & Itsubo, (2019) study the impact of carbon and water footprints, of feeding pigs with cereal crops (Japanese model) and low-protein feed (French model), using the use of the ISO14067 standards to assess the carbon footprint and ISO14046 for the water footprint. It was found that when the use of low-protein foods was implemented, both the carbon footprint and water consumption were reduced. The study is relevant, since it responds to the latent social need to undertake actions so that companies reduce the environmental impact derived from their commercial activities.

For their part, Piot-Lepetit, & Moing, (2007) develop the work "Productivity and environmental regulation: the effect

of the nitrates directive in the French pig sector" in which changes in productivity in the French pig sector are evaluated after the introduction of regulations on water pollution by nitrates originating from agriculture. To do this, the authors used the Malmquist-Luenberger index, which makes it possible to show changes in productivity through the indices of technical progress and efficiency.

The results of the investigation reveal that in the first phase the increase in productivity was due to greater efficiency, rather than technical progress. Similarly, the authors estimated the costs and benefits resulting from the introduction of the environmental standard. Finally, it was estimated that there is a "win-win" effect as a result of the relationship between efficiency and environmental regulation.

4.4. Cluster 4. Human well-being in the pig industry

In the fourth cluster are keywords such as "animal", "human", "pig". One of the relevant articles identified is entitled "Securing participation in global pork production networks: biosecurity, multispecies entanglements, and the politics of domestication practices", in this work Wang (2022:200) argues that global agrifood production studies should emphasize the "dark sides" of the pig sector in Taiwan, due to the fact that there are failures in the process of domestication of pigs, caused by internal threats from the strategies of confinement of the animals, after the foot-and-mouth disease presented in 1997. A process in which on some occasions Western practices are articulated with local indigenous practices, which generates a great biosafety risk.

In conclusion, the author affirms that to conceive the pork market in Taiwan in a homogeneous way, is to ignore those markets that are built in a hybrid way and that have characteristics, which can represent a threat when guaranteeing the biosecurity in industry.

Huan et al, (2022) evaluate the effectiveness of the vaccine against the pseudorabies virus (PRV), which affects both animals in the pig industry in China and people, causing economic losses throughout the entire life supply chain. The study confirmed the effectiveness of the anti-PRV vaccine, through the reduction of oxidative stress induced by PRV infection. This research expresses the need to create synergies between the animal industry and scientific research, in such a way that these types of events that affect human health can be dealt with, as well as mitigating the derived economic risks.

Another study associated with this cluster is that of Ji et al, (2019) entitled "Estimating effects of cooperative membership on farmers' safe production behaviors: Evidence from pig sector in China", who investigate the determinants of the participation of breeders of pigs in farmer cooperatives in China, and the impact of such cooperatives on the adoption of safe production practices, for this, data from a household survey applied to 540 cooperative farmers and 270 non-associated farmers were used.

It was found that membership in farmers' cooperatives has a direct relationship with the adoption of safe production practices by pig farmers. However, aspects such as vaccination practices and the use of drugs for animal trafficking are questionable and heterogeneous. Additionally, a limitation of the study is that it focuses on analyzing the safe production behaviors of breeders, so the study does not It has direct data on the quality of pork.

For their part, Shang, & Tonsor, (2019) are authors of the article "Sanitary and phytosanitary regulations and international red meat trade", whose purpose was to carry out an ex post econometric evaluation of sanitary and phytosanitary measures related to human health and animal, and its impact on the red meat trade, to identify the determinants of the world red meat trade. To achieve the objective, the authors used a gravity model. The results show that the economic conditions of the destination countries and the production capacity of the suppliers are important determinants of the commercial values of beef and pork worldwide.

Additionally, the study has implications especially for international negotiators, as well as for trade policy makers, since this type of non-tariff measures can have direct positive or negative effects in other sectors, as is the case with sanitary and phytosanitary measures of the pig sector, which directly influence the trade of beef.

5. Conclusion

This article constitutes a work that contributes to the systematization and visualization of research trends in the pork sector, especially related to internationalization processes and their production chains, considering the complexities of this industry. The interdisciplinary and transdisciplinary way in which most of the investigations are addressed was evidenced, which expresses the need for the pork sector to articulate with external actors, to improve the processes of their productive chains, and the quality of the Final product.

The investigative processes in the pork sector are of special importance because they contribute to the understanding of the problems of the sector, and at the same time potentiate its transformation. The countries with the greatest academic production in the field are the United States, the Netherlands, the United Kingdom, China and Brazil, the latter being the only country in Latin America that appears in the top ten countries with the greatest amount of research, which denotes the need to generate greater investigative processes in the region.

Four general topics were identified that account for research trends in internationalization processes and production chains in the pork sector, these are:

1. Pork industry market
2. Management of the supply chain in the pork industry.
3. Sustainable development in the pig industry.
4. Human welfare in the pig industry.

These issues can be perceived as the main interests of researchers in the sector, from which the problems to intervene in the swine sector originate. Within the four clusters, supply chain management is the one that contains the largest number of associated keywords, which expresses the growing concern in relation to this aspect, because of the marked economic and social dynamics that affect it.

Vulnerable actors and actors in a position of power are identified in the sector, the investigation should serve as an instrument for the generation of greater equity in the pork industry. Additionally, it is evident that investigative processes are a fundamental element for decision-making and the best management of public policy in the pork industry.

The main limitation of the research is related to the choice of the database

it is suggested that future research broaden the focus of analysis.

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