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Research Article

Bibliometric Analysis Of Scientific Articles On The Application Of The Value Network Methodology In The Agroforestry Sector

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ABSTRACT

The objective of this research was to analyze spatially and temporally the scientific articles that have used the Value Network technique in the agroforestry sector, using bibliometric techniques. It was found that researchers from countries in Europe, the United States of America and Canada have applied the value network methodology in agricultural production systems such as sugar cane, rice, and oil palm; in forestry it has been used for the timber market and the silviculture of pines, firs and teak. In the case of Mexico, a centralization of research was found that is spatially out of phase with the production areas of crops such as mango, corn, strawberry and chihua squash, which is presented as an area of opportunity for the development of research on topics associated with agricultural and forestry economics that generate new knowledge and alternatives to describe production systems and add value to their products.

KEYWORDS: scientific article, bibliometrics, value chain, Porter's diamond.

INTRODUCTION

The value network approach is a strategy for organizing productive systems that specialize in a common activity. This perspective is characterized by a territorial concentration of economic actors and other institutions. The links developed, whether economic or non-economic, contribute to the creation of wealth for their members and their territory (Barrera *et al.*, 2013). This approach also highlights the importance of territory and the interactions and cooperation between the actors in the network. In addition, it proposes that companies and sectors are understood as an integral part of the network, which in turn conditions its mode of operation and results.

In Mexico, this value network approach has found wide application in agricultural research to understand the complexities of production chains. It has been used in studies ranging from the rice food chain in Campeche (Flores and Muñoz, 2005), to the strategies adopted by the meat industry (López et al., 2010), to the analysis of the competitiveness of the rice value network in the states of Campeche, Michoacán and Morelos (Ireta-Paredes *et al.*, 2016), and the value network of the ataulfo mango (Ruíz-Díaz & Muñoz-Rodríguez, 2016).

However, the application of this value network methodology in forest production systems has been limited, especially with regard to a species as emblematic of southeastern Mexico as the Ramon tree, or *Brosimum alicastrum* Swartz. This tree, native to Mesoamerica and the Caribbean, has a wide distribution in southeastern Mexico, where it grows wild in evergreen and subdeciduous forests (Vega-López *et al.*, 2003). Despite its potential importance for the livestock feed agribusiness in the pork, bovine, sheep, poultry and aquaculture sectors, due to its nutritional characteristics (Martínez-Yáñez *et al.*, 2010), there is still a considerable

knowledge gap about the added value that its cultivation can generate in rural producers of the Yucatan Peninsula. To a large extent, this is due to the fact that the species is currently mainly distributed naturally, with little or no silvicultural management (Hernández-González *et al.*, 2014).

Bibliometric techniques are the most appropriate for detecting research gaps in a particular topic where new knowledge must be generated, since they allow the generation of indicators and mathematical models to characterize the development and evolution of texts published worldwide (Malesios & Arabatzis, 2012). The publication of a scientific text is the most effective way to transmit the knowledge acquired as a result of research, and its visibility is important for the researchers themselves, for the institutions where they work, and for the organizations that fund the research (Sanz-Valero & Wanden-Berghe, 2017).

In the forestry sector, bibliometric studies have been carried out for specific topics such as forestry (Polinko and Coupland, 2020), community forestry development (Bullock and Lawler, 2015), the use of drones in the determination of forest biomass (Raparelli and Bajocco, 2019), and even to evaluate national forest systems as in the case of India (Hazarika et al., 2003) and Bangladesh (Miah et al.,2008). In the agricultural sector, bibliometric studies have been developed to evaluate general topics of agronomy (Cañas-Guerrero *et al.,* 2013), specific topics such as organic farming (Aleixandre *et al.,* 2015), fruits and vegetables (Tatry *et al.,* 2014) and even for agronomists in particular (Nayak and Bankapur, 2017), agricultural journals (Bravo-Vinaja, 2015), national agricultural sectors (Bravo-Vinaja and Sanz-Casado, 2008) and specific crops such as wheat and barley (Giraldo *et al.,* 2019), and rice (Peng, 2017; Sun and Yuan, 2020).

However, despite the growth in the number of publications that have been presented in the agricultural and forestry sector, there is little research on the application of the value network methodology as an alternative to know the production system and add value to agroforestry products. In this context, the objective of this research was to analyze spatially and temporally the scientific articles that have used the Porter Value Network or Diamond technique in the agroforestry sector, using bibliometric techniques, to determine the scope of such research and its impact on the generation of value of the evaluated production systems.

1. MATERIALS AND METHODS

1. 1. Source of information

In this work, scientific articles from the agroforestry sector that used the value network methodology as an analysis tool, available in the Web of Science database (WoS, 2021), were considered. The keyword used in the search was *value network*, identifying it in the titles and keywords of the publications. Additionally, the "snowball" technique was used to obtain the missing articles, from the reference list of the articles initially found (Leipold, 2014). By means of a content analysis, those theoretical and conceptual works on the value network methodology were discarded, as well as those works whose object of study was different from agricultural or forest species.

1.2. Analysis of information

The variables analyzed for each of the scientific articles were: *Authors' names, year of publication, number of citations, title and abstract of the text, keywords, name of the journal, publishing institution, country of publication, and authors' institutions*. Based on a content analysis of the titles, abstract and keywords of each scientific article, the agricultural or forest species evaluated was determined using the value network methodology, and the text was classified as agricultural or forestry.

The variables were captured in a spreadsheet, in which they were systematized and classified into thematic areas according to their content; in addition, the original language of each of the texts was kept. During the capture of all the information, some records were standardized, because the information available in the articles was sometimes incomplete or presented with variants (Aguado-López *et al.*, 2009). In addition, special characters were eliminated or changed to facilitate the analysis, such as: ñ (for n), accents, superscripts, subscripts, ® , © among others.

Following the methodology of Santillán-Fernández *et al.* (2021), Espinosa-Grande *et al.* (2023), and Santillán-Fernández *et al.* (2023) graphs of the temporality of scientific production were constructed with the help of the year variable and a least squares regression model was estimated to estimate its trend (Gujarati, 2004). The countries with the highest number of publications in the ARGIS® geographic package (ESRI, 2015) were spatially located, and a graph of topics developed by country was generated. Co-authorship networks were built in the Gephi software (Bastian *et al.*, 2009); and bibliometric indicators were generated for the main journals that published the scientific texts, and the most relevant scientific articles measured by the number of citations. In the case of works developed by authors whose country of origin was Mexico, networks of authorship and keywords were built. In addition, the authors' institutions of affiliation were spatially located, and the species analyzed with the value network methodology were associated with the main producing states of these crops, for which information on agricultural and forestry productivity available in the Agricultural and Fisheries Information System (SIAP, 2023) was used.

2. RESULTS AND DISCUSSION

From 1999 to 2021, a total of 327 scientific texts were published in the bibliographic reference databases of the Web of Science (WoS, 2021), where the object of study is the application of the value network methodology in agroforestry crops. This scientific production gave rise to 29896 bibliographic citations (Figure 1). Of the 327 texts, 89.42% were scientific articles, and bibliographies were reviewed. The first recorded work dates back to 1999; however, from 2012 onwards there was a growing production for the topic.

The period of highest productivity was from 2012 to 2021 with 84.02% of the total texts, which contributed to an exponential trend in the growth of publications (R2 = 0.7303). The most cited works were those published in the period 2012-2020, which together accounted for 79.02% of the total bibliographic citations.

According to Altieri and Nicholls (2017), the exponential trend in publications denotes the relevance that the topic of value network is having in the scientific community, as an alternative to learn about the production system and add value to agroforestry products.

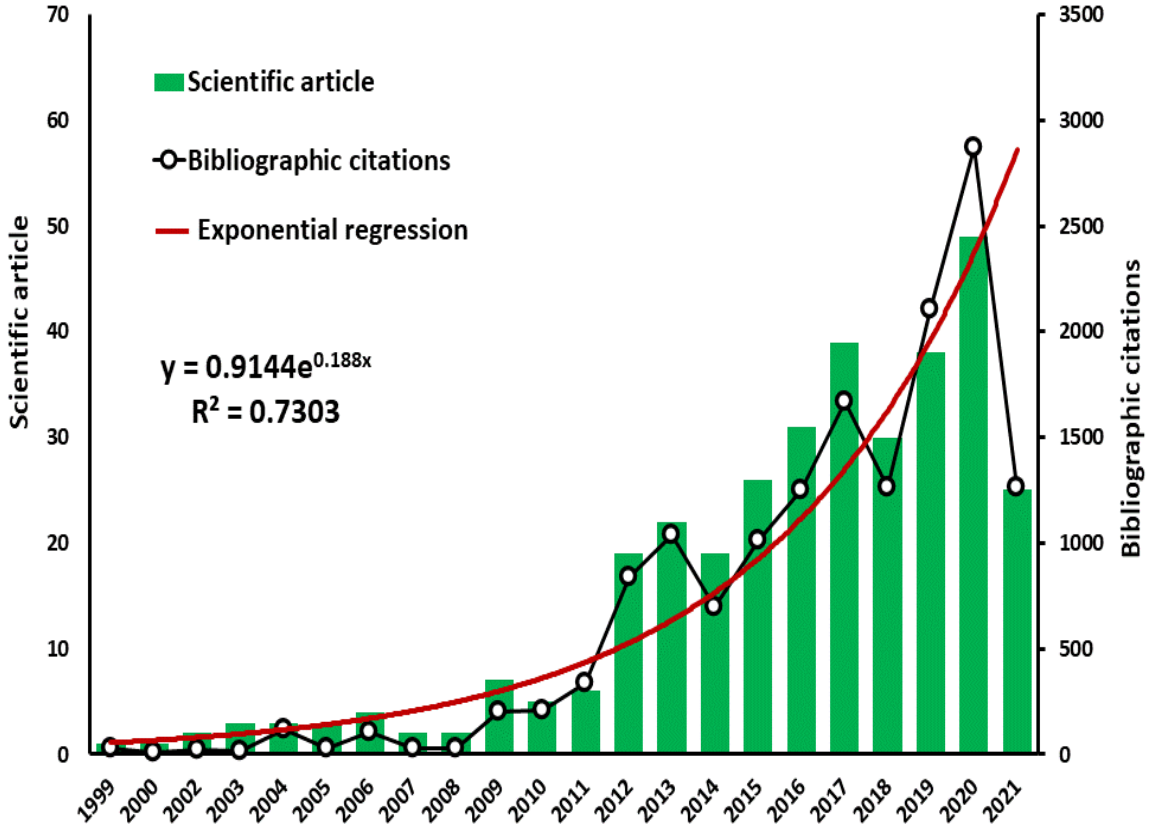

Figure 1. Temporal evolution of scientific production and bibliographic citations on the topic of application of the value network methodology in the agroforestry sector worldwide from 1999 to 2021.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

According to the country where the scientific texts were published, the 327 papers originated in 27 countries. 90.93% were concentrated in five countries: the Netherlands (64), the USA (United States of America, 41), France (39), Switzerland (37), and Canada (22). Figure 2 shows that most of the research that has been developed on the topic of value network has taken place in the USA and European countries with consolidated economies.

According to Gersbach and Schneider (2015), the economic development of a country is directly related to the quality of the research it conducts; countries with consolidated economies invest more in their research centers, which allows them greater technological development, unlike underdeveloped economies such as Latin America where investment in research is lower; in such a way that agricultural competitiveness in a country is directly related to the quality of the research carried out in that sector.

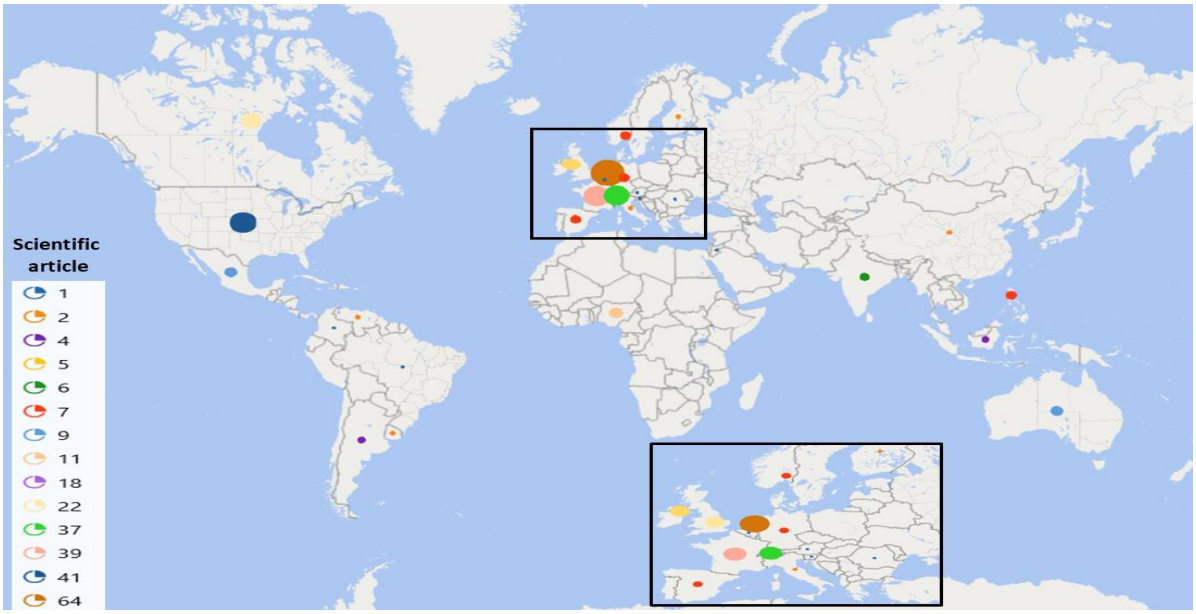

Figure 2. Spatial location of scientific production in the topic: application of the value network methodology in the agroforestry sector at a global level from 1999 to 2021.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

In the case of the main countries that registered scientific production on the application of the value network methodology in the agroforestry sector, the topics associated with agricultural crops such as sugarcane (11.38%), rice (3.81%) and oil palm (1.23%) presented the largest number of investigations and in the case of the forestry sector, the topics related to the timber market (21.56%), and forestry of pine (8.12%), fir (2.56%) and teak (1.52%). Figure 3 shows the Netherlands and the USA as the main countries where value network research has been carried out in agricultural crops, and England and Canada in the case of forest species. González-Merino and Ávila-Castañeda (2014) found that the policy adopted by the United States to encourage the development of technological innovations allowed it to become the world's leading agricultural producer. In the case of Canada, it is one of the main forestry leaders at the international level.

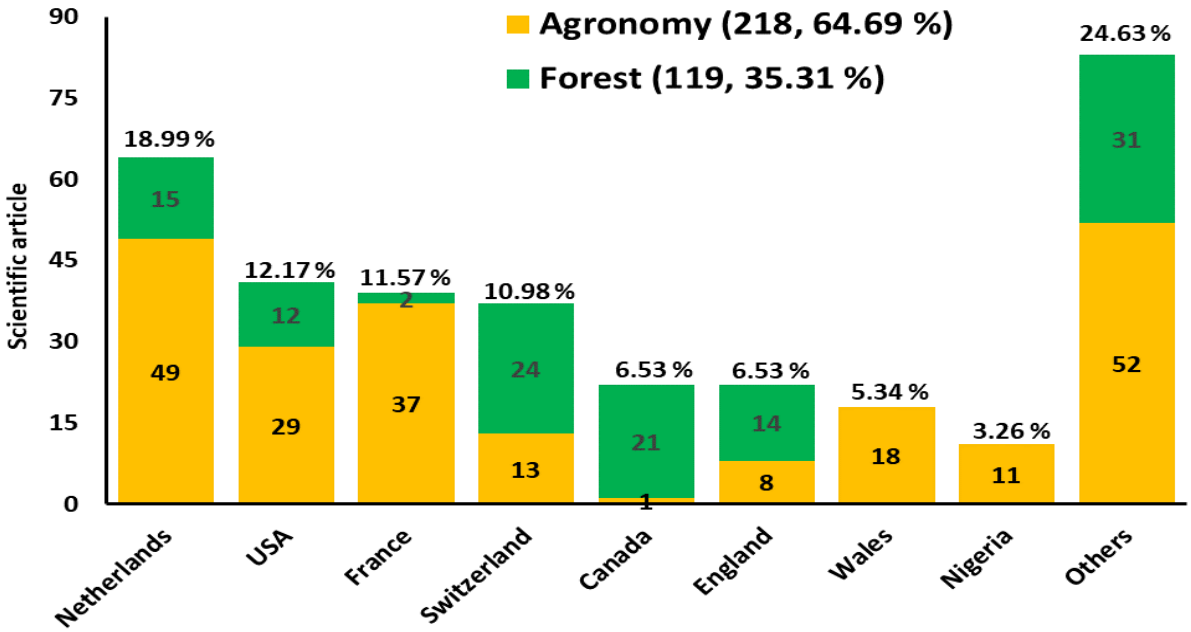

Figure 3. Leading nations and research they have developed on the topic application of the value network methodology in the agroforestry sector globally from 1999 to 2021.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

In the 327 articles analyzed, 283 first authors were found, between author and collaborators they totaled 1184 different individuals. The mean co-authorship was 2.57 and the mean (160) was 3 authors per article, with extreme values of a single author (29 articles) and 6 works with more than 12 authors. The network of authors and collaborators (Figure 4) was composed of 1184 nodes (authors) and 1002 edges (links). Links in an Social Network Analysis (SNA) are important because it is through them that an author can reach certain ideas, knowledge, and information that are socially distant to him (Granovetter, 1973).
The density of the network had a value of 0.001, which implies that for the topic of application of the value network methodology in the agroforestry sector there is not much collaboration between the authors in the international context. This is evident from the fact that 254 institutions (out of 327 works) are indicated as the first author's affiliation. Density is an indicator of SNA that implies that both nodes interact (link) with each other; mathematically it is a value within the interval [0 to 1], the closer to 1 the interaction in the network is greater (Aguilar-Gallegos et al., 2016).
The main authors were Pretzsch_J from the Forestry Faculty of the Technical University of Dresden (Germany) with 8 papers as first author, and 4 as collaborator; Pitt_DG from the Forest Service Institute of Canada with 5 articles as first author and 3 as co-author; Darr_D from the Rhine-Waal University of Applied Sciences in Germany (4 texts as first author, and 2 as collaborator); and Toppinen_A from the Faculty of Forestry Sciences of the University of Helsinki (Finland) with 3 texts as first author and 2 as co-author (Figure 4).

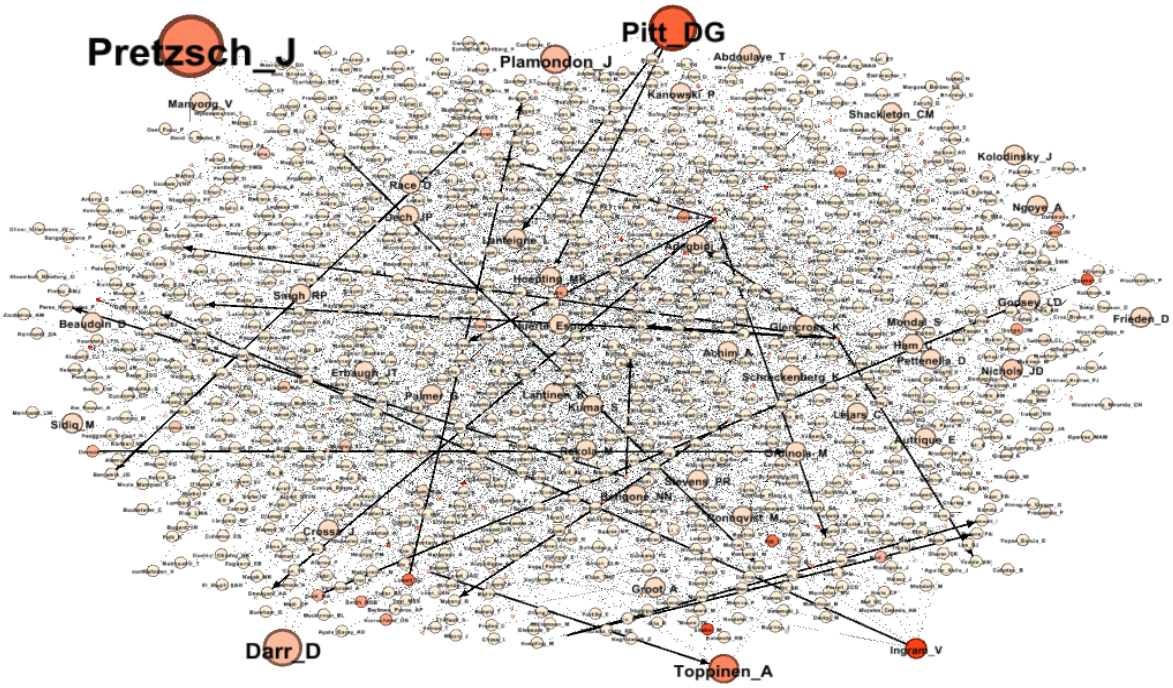

Figure 4. Network of authors and co-authors who have published scientific articles on the topic application of the value network methodology in the agroforestry sector globally from 1999 to 2021. The size of the node corresponds to its productivity.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

From 1999 to 2021, Mexican researchers published 9 scientific articles on the topic of application of the value network methodology in the agroforestry sector. Of the 9 scientific papers, 33 different authors were found (Figure 5). The most outstanding authors were Ireta_Paredes_AR who has worked on themes of chihua squash and mango; Mena_BML that has developed research on corn value network; and Zarazua_Escobar_JA in strawberry. The 9 works were developed in 14 institutions, with CIESTAAM_Chapingo (appears in 5 of the 9 works), ColPos_Ver (3), INIFAP_Tex (2) and ColPos_Cam (2) being the institutions that lead research on value network in the agroforestry sector in Mexico (Figure 6). Traditionally, in CHAPINGO (founded in 1854), COLPOS (1959) and INIFAP (1985) the published research originated from the initiatives for the development of agricultural research.

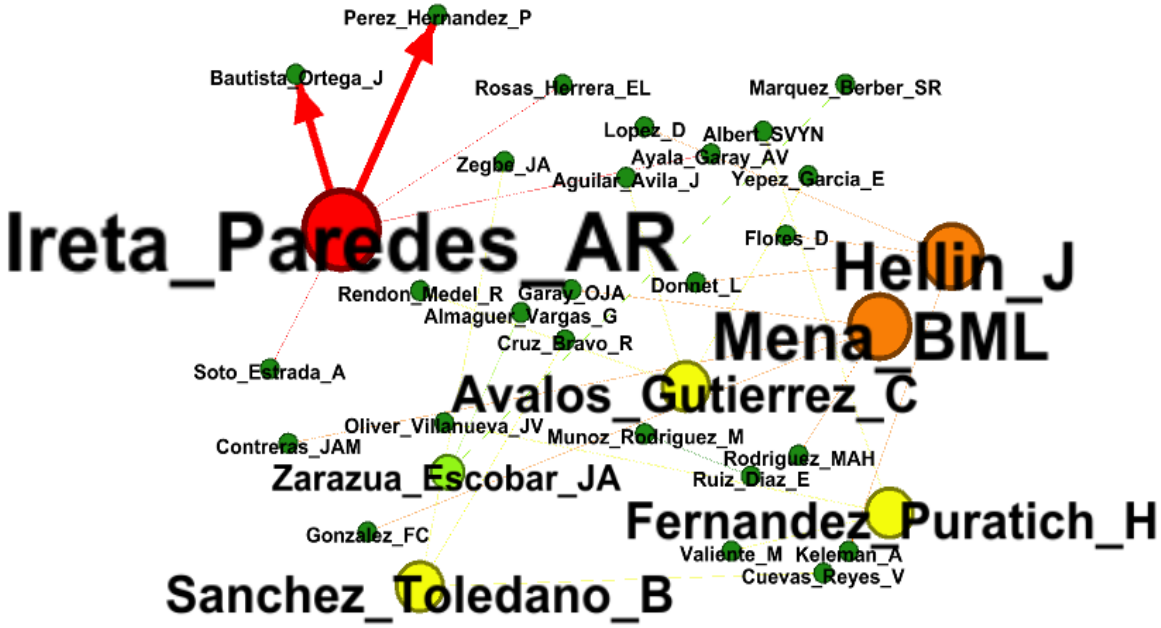

Figure 5. Network of authors and co-authors in Mexico who have published scientific articles on the topic application of the value network methodology in the agroforestry sector from 1999 to 2021. The size of the node corresponds to its productivity.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

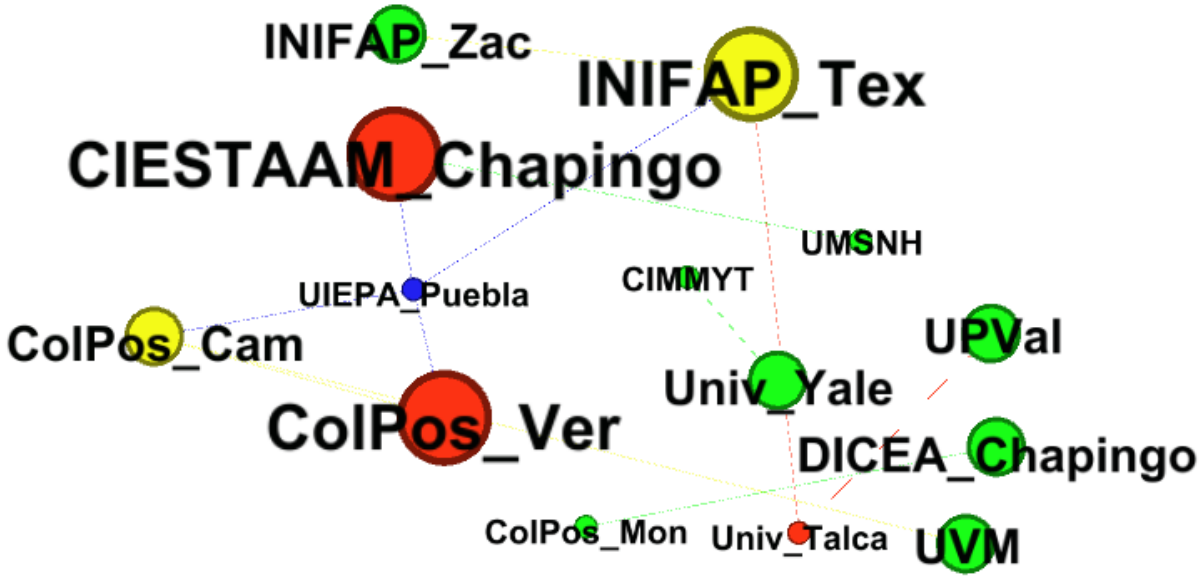

Figure 6. Network institutions in Mexico that have published scientific articles on the topic application of the value network methodology in the agroforestry sector from 1999 to 2021. The size of the node corresponds to its productivity.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

The network of keywords (Figure 7) highlighted that concept associated with the Value Network such as Supplier, Customer, Competitor and Complementor, and concepts such as competitiveness, profitability, adding value, and innovation, are unusual terms for researchers, which according to Santillán-Fernández *et al.* (2023) is due to the fact that in Mexico the area of agricultural and forestry economics has been underdeveloped. Finally, the spatial distribution of the institutions, associated with the main producing states of the crops analyzed with the value network methodology (Figure 8), allowed us to deduce that the research

on this topic is located in the center of the country. This aspect of research centralization has been addressed by Martínez-Santiago *et al.* (2017), who found that the gap between production areas and research centers hinders technology transfer.

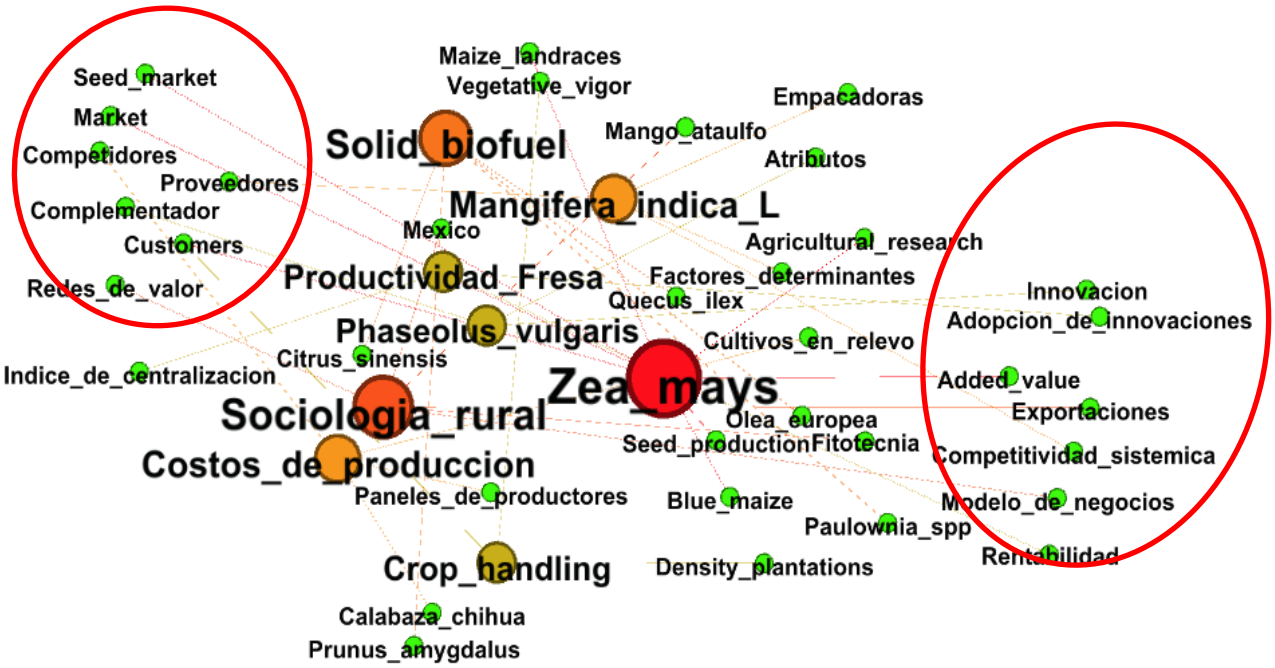

Figure 7. Network of keywords used in the publications of Mexican authors on the topic application of the value network methodology in the agroforestry sector from 1999 to 2021. The size of the node corresponds to its productivity.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

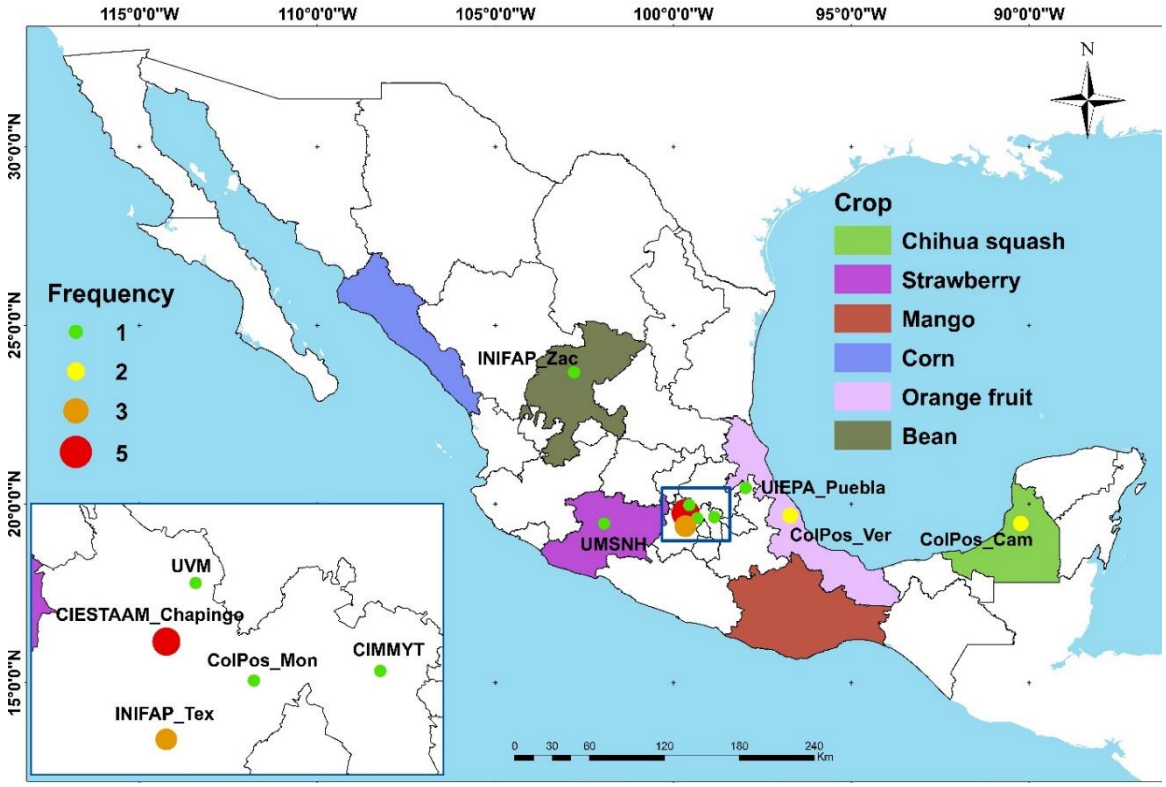

Figure 8. Spatial distribution of academic and research institutions in Mexico that published articles on the application of the value network methodology in the agroforestry sector from 1999 to 2021, and main production areas of the crops analyzed.

Source: Authors' elaboration with data collected from the WoS (2021) on the application of the value network methodology in the agroforestry sector at the global level

CONCLUSIONS

The exponential growth that has sustained the publication of scientific articles on topics of value network for the agroforestry system since 2010, is a reflection of the importance that the subject has acquired among the scientific community, as a way to generate knowledge and alternatives to know the productive system and add value to agroforestry products. However, in the case of Mexico, a centralization of research was found that is spatially out of phase with the production areas, as a result of a lack of development of topics associated with agricultural and forestry economics. Researchers from countries in Europe, the United States of America and Canada have applied the value network methodology in agricultural production systems such as sugar cane, rice, and oil palm, in the case of forestry issues it has been used for the timber market and the forestry of pines, firs and teak. Therefore, research on the Value Network methodology applied to agricultural and forest species in Latin America is a window of opportunity for the development of research, which can contribute to the agricultural and forestry competitiveness of each country.

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