

Technology transfer in the agricultural sector: a bibliometric analysis

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Abstract

Technology transfer is a process that involves modifying production processes through the conversion, adaptation, or application of innovative ideas, which should generate a benefit for the small producer. This article aims to understand the existing trend of technology transfer in the agricultural sector in the period 2021-2024, through a bibliometric analysis that was divided into two moments: 1) search for information on the Scopus and Web of Science platforms, to later carry it out and 2) construction of the bibliometric map of technology transfer. The findings identified indicate a downward trend in the subject of analysis in 2024 compared to 2023; mixed and quantitative methodologies are the most used to write scientific articles on technology transfer. With the documents analyzed, three thematic groups were identified using the VOSviewer program, where innovation in the agricultural sector accounted for 52% of the analyzed documents and the trend focused on the digitization of the agricultural sector.

Keywords:

bibliometric map, innovation, production process, thematic groups, trend.



Introduction

Technology transfer is a process that involves the conversion, application, or adaptation of innovative ideas with the intention of generating a benefit (Velásquez, 2010). According to Navarro *et al.* (2006), this process involves: 1) perception; 2) acquisition; 3) adaptation; 4) advances and 5) abandonment of such technology. It is important to emphasize that technology transfer involves understanding from its creation, the manufacturing methods, the flow of know-how between organizations, the exchange of skills, knowledge, and the management or administration of industrial property rights between a technology supplier and a concessionaire (Escorsa and Valls, 2003; Castro *et al.*, 2008; González, 2011; Odremán, 2014; Chiş and Crişan, 2020; Bermeo *et al.*, 2021).

It is essential to mention that technology transfer is not the same as developing skills, and these concepts are often confusing in the agricultural sector. In a globalized world, innovation and technology transfer are crucial issues for the development of a nation, since they promote productivity and competitiveness in regions (Briceño and Conti Montero, 2015; Monge *et al.*, 2023). This makes technology transfer a rapidly changing element in the agricultural sector (Dalampira *et al.*, 2023).

A tool that enables us to understand the trend in research in rapidly evolving fields (Sornoza-Parrales *et al.*, 2025), such as technology transfer, is bibliometric analysis. It has its own dynamic conceptual body that implies the integration of creative and specific methods to measure the production and dissemination of scientific knowledge through variables such as the articles published in a specific period, the frequency of keywords, the number of citations, and bibliographic associations (Archambault and Vignola, 2004).

The purpose of this article is to understand the existing trends of the topic 'technology transfer in the agricultural sector' through bibliometric analysis, which allow us to identify the behavior of publications in the period 2021-2024 through the analysis of the authors and their reference in citations with respect to the year of publication, the methodology used, as well as to build a bibliometric map where the thematic groups where the topic of technology transfer is most relevant are identified. This article consists of the definition of the topic of technology transfer and its importance in the agricultural sector. The methodology section explained in detail how the bibliometric analysis was carried out to achieve the proposed objective. The results and discussion sections present the findings on the behavior of the publications of the analyzed topic during the period 2021-2024, and finally, the conclusion of the bibliometric analysis and the areas of opportunity with respect to the topic under study are presented.

Materials and methods

For the bibliometric analysis, part of the methodology used by Cortés-Rodríguez *et al.* (2022) was taken as a reference. This author divides bibliometric analysis into two phases: 1) search for information in bibliographic repositories and 2) the construction of the bibliometric map (Table 1).

Table 1. Methodology used for bibliometric analysis.

Step	Description	Articles Scopus	WoS	Total
Phase 1: search for information				
1	"Technology transfer" and "agricultural sector"	30	7	37
2	Type of document: article and review	16	6	22
3	Language: English	16	6	22
4	Period: 2021-2024	16	6	22

Step	Description	Articles Scopus	WoS	Total
5	Records after deleting repeated entries	13	2	15
Phase 2: building of the bibliometric map in VOS viewer				
6	Counting method: full	552		
7	Minimum number of occurrences: 5	22		
8	% of most relevant terms: 60%	13		
9	Refining the most relevant terms	8		
Based on the methodology by Cortés-Rodríguez <i>et al.</i> (2022).				

The period of analysis was from 2021 to 2024; this period was considered important due to the global pandemic caused by Covid-19 in 2019, which generated a process of awareness in the revaluation of food at the local level. Understanding what is being published during the aforementioned period helps identify areas of opportunity with respect to technology transfer in Mexico.

Phase 1. Search for information

The search for information was carried out in two bibliographic repositories [Scopus and Web of Science (WoS)]. The analysis focused on scientific documents in English (2021-2024) due to their greater dissemination (Cortés-Rodríguez *et al.*, 2022; Días *et al.*, 2019). The search using the keywords 'technology transfer' and 'agricultural sector' identified 37 documents. By filtering by articles and removing duplicates, 15 documents focused on technology transfer in the agricultural sector remained. Based on these documents, the analysis was carried out to understand the trends in the topic of technology transfer.

Phase 2. Construction of a bibliometric map in VOS viewer

The 15 documents found in the information search phase were the raw material for constructing the bibliometric map in the VOSviewer program. This program is an optimal tool that allows the construction and visualization of information in a graphic scheme (Eck and Waltman, 2010; Cortés-Rodríguez *et al.*, 2022). Three bibliometric methods were used in the program: 1) analysis was that of co-occurrence, which allows us to analyze the strength of association and coincidence between the terms, this strength was 552 terms, which was later elementary for the construction of the three thematic groups; 2) the full counting method, which was assigned a value of five concurrences, resulting in 22 terms. These terms were subjected to this method and 3). The method of % of most relevant terms, which represented 60% according to the system. Subsequently, FDI, GAP, value chain, role and paper were eliminated because they were not related to the topic, resulting in a final sample of eight terms.

Results and discussion

It was identified that the study of technology transfer began in 1919 with an article on automotive mechanics. For the agricultural sector (2021-2024), 14 documents were identified, with 2022 being the most productive year (7 articles) and 2023 with the lowest record (1 article). In 2024, the number of publications is below average (Figure 1). This indicates the existing lag in publications with respect to technology transfer in the agricultural sector.

Figure 1. Record of published documents from 2021 to 2024.

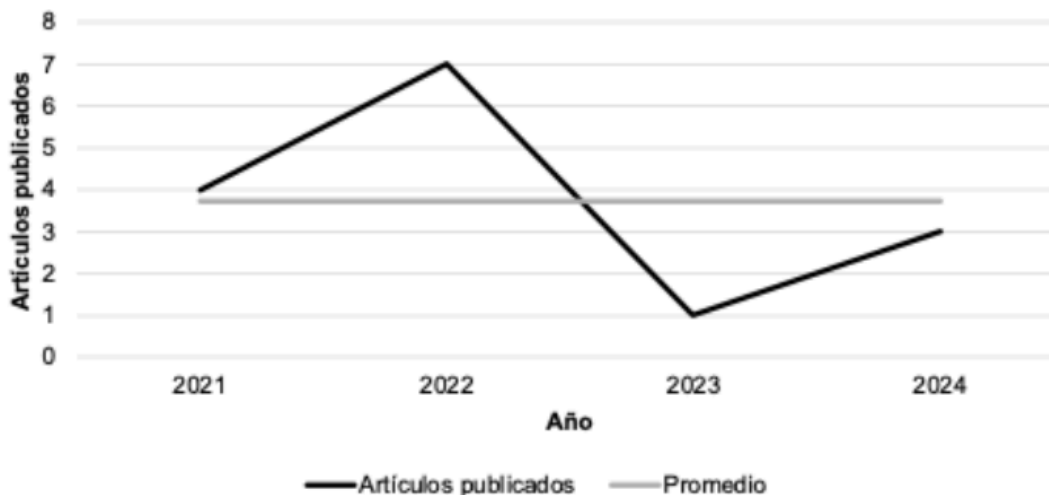


Table 2 showed the most cited documents (43 citations). These documents are focused on the following topics: foreign investment, climate change, digitalization, field schools, value chains, digital divides, higher education and university-industry-government interaction for technology transfer in agriculture (Aggarwal *et al.*, 2021; Marques and Vorontsova, 2022; Yongabo, 2022; Djokoto *et al.*, 2022; Dalampira *et al.*, 2023; Izuogu *et al.*, 2023; Fazaalloh, 2024; Bampasidou *et al.*, 2024). The topic of digitalization is the most cited (13), setting the trend for future research.

Table 2. Most cited documents.

N	Author-Title	Citation	Year
1	"Biró, K.; Csete, M. S.; Németh, B. Climate-smart agriculture: sleeping beauty of the Hungarian agribusiness."	13	2021
2	"Fazaalloh, A. M. FDI and economic growth in Indonesia: a provincial and sectoral analysis"	6	2024
3	"Djokoto, J. G.; Agyei Henaku, K. A. A. O.; Badu-Prah, C. Welfare effects of agricultural foreign direct investment in developing countries"	6	2022
4	"Izuogu, C. U.; Olaolu, M. O.; Azuamairo, G. C.; Kadurumba, P. C.; Agou, G. D. A. Review of the digitalization of agriculture in Nigeria"	5	2022
5	"Dalampira, E.-S.; Tsoukalidis, I.; Lazaridou, D.; Livadiotis, A.; Michailidis, A. Investigating technology transfer gaps through farmers field school"	3	2022

N	Author-Title	Citation	Year
6	"Yongabo, P. Technology and innovation trajectories in the Rwandan agriculture sector: are value chains an option?"	3	2022
7	"Aggarwal. Chakraborty, S.; Bhattacharyya, D. R. Determinants of domestic value added in exports: empirical evidence from India's manufacturing sectors"	2	2021
8	"Bampasidou, M.; Goldgaber, D.; Gentimis, T.; Mandalika, A. Overcoming 'digital divides': leveraging higher education to develop next generation digital agriculture professionals"	2	2024
9	"Marques, J. P. C.; Vorontsova, N. Triple helix interactions in a rural context: the case study of a regional business incubator."	1	2022
10	"Ondrasek, G. and Rengel, Z. Centers for optimizing water management in agroecosystems & global food security"	1	2024
11	"Toledo, L.; Salmoral, G. and Viteri-Salazar, O. Rethinking agricultural policy in Ecuador (1960-2020): analysis based on the water-energy-food security nexus/ sustainability"	1	2024

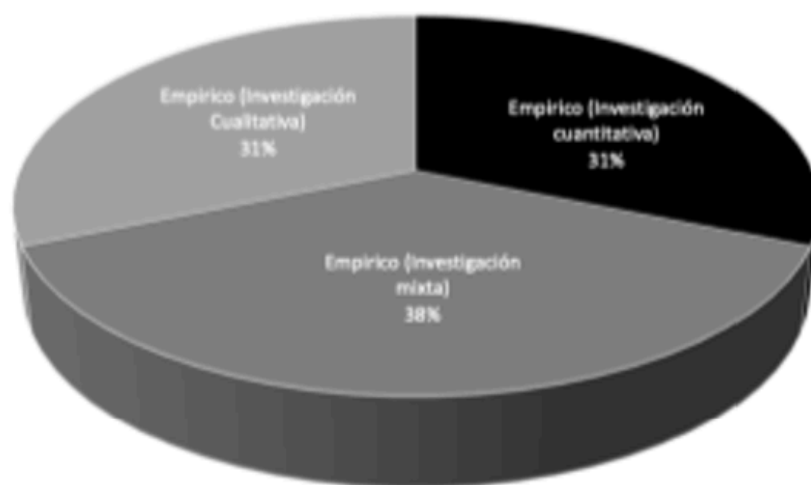
with data from the Scopus and WoS databases.

Methodologies used

In the 15 articles analyzed, quantitative research predominates (34%), followed by mixed (33%) and qualitative research (33%). Within the quantitative research, 40% are case studies and 20% are patent analyses (Figure 2). In citations, the trend of articles published on technology transfer presents a mixture of mixed methodology, which represented 37%, and quantitative methodology (35%), reflecting a predominance of numerical analysis (72%) to achieve the research objectives.

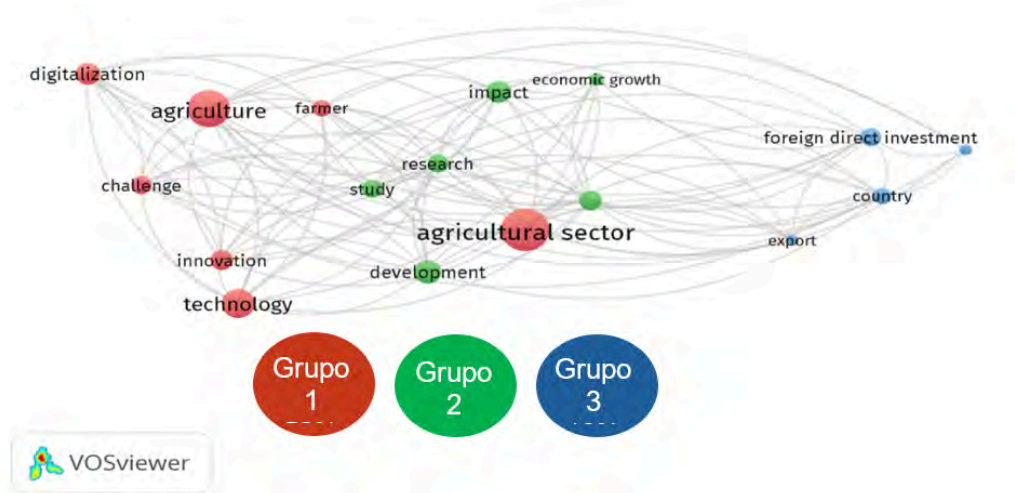


Figure 2. Methodologies used in the 15 articles analyzed.



The cluster generated in VOSviewer presented 1 207 links and 552 terms, of which only 22 exceeded the threshold of five occurrences (Figure 3). Three groups and their percentage of importance were identified: innovation in the agricultural sector (52%), technology transfer, development and economic growth (32%) and exports, foreign investment and well-being (16%).

Figure 3. Bibliometric map of technology transfer in agriculture.



Group 1. Innovation in the agricultural sector. Agro-innovations, such as digitalization -Biró *et al.* (2021) related digitalization to climate smart agriculture (CSA), where they integrated some climate change adaptation and mitigation measures, including robotization, bioinnovation, smart monitoring system, Big data, precision agriculture, and IoT (Internet of Things)- offer small farmers opportunities to increase their production, adopt sustainable practices, and improve their position in the market (Biró *et al.*, 2021). Digitalization has strengthened ties between research centers and

small producers, improving their productivity. Nevertheless, challenges, such as technical training and infrastructure, remain, which could be addressed through government programs (Izuogu *et al.*, 2023).

Digitalization is a shared responsibility between the government and academia, which must update their educational programs to prepare the future workforce in AI, with an ethical approach. This made it possible to leverage digital agriculture to develop skills that benefit the agricultural sector (Bampasidou *et al.*, 2024). However, for this to happen, there must be connectivity and digital literacy, that is, digital ecosystems built through public works that potentiate technology transfer and allow the inclusive development of rural territories (Beduschi *et al.*, 2022).

Group 2. Technology transfer, development and economic growth. According to Marques and Vorontsova (2022), the interaction between academia, industry and government (the triple helix) can promote the creation of innovative companies and products, but it requires an active dynamic among its actors. An example is Incubadora Penela, which facilitated technology transfer and regional development. For this to be possible, state public universities must have four capacities: 1) institutional; 2) innovative development; 3) entrepreneurship and 4) academic; without neglecting academic competitiveness; these factors guarantee the technology transfer process (Calderón-Altamirano *et al.*, 2023).

Nonetheless, technology transfer in the agricultural sector is evolving rapidly and requires more strategies, such as farm field schools, which encourage hands-on learning and cooperation (Dalampira *et al.*, 2023). In addition, the adoption of technological innovations by small producers depends on an organized structure in the value chain, linking innovation systems with the market. To achieve this, it is key to generating synergies between actors, where field schools can play a fundamental role (Marques and Vorontsova, 2022; Yongabo, 2022; Dalampira *et al.*, 2023).

Group 3. Exports, foreign investment, and well-being. While foreign investment boosted economic growth in secondary and tertiary sectors, its impact on the agricultural sector is significantly negative (Fazaalloh, 2024). Some developing countries have promoted this investment to transfer technology, but in agriculture, it can affect the well-being of indigenous populations due to land grabbing and unfair competition with imported products (Djokoto *et al.*, 2022). In India, Aggarwal *et al.* (2021) highlighted that export policies require strengthening job training and technology transfer, since the lack of skilled workers and organized micro-industries limits value added in the agricultural sector.

Conclusions

In the last four years, the trend of technology transfer in the agricultural sector has been downward. In 2024, only three documents were published, none of which are by Mexican authors, according to the two revised databases. The theme of technology transfer has a tendency towards digitalization; however, there are limitations for it to develop in rural communities in Mexico, due to the scarce or non-existent internet infrastructure and digital illiteracy on the part of small producers.

The trend of the three thematic groups that make up the bibliometric map illustrated the trend of technology transfer in the agricultural sector. Digitalization is seen as a necessity in innovation in the agricultural sector, the relationship between academia, government, and society as an alliance to prepare future professionals in AI, field schools as a mechanism for technology transfer as long as they have links to the market and finally, the importance and benefits of foreign investment in technology transfer issues, without neglecting the risk involved in exposing the lands of small producers to the interests of foreign investors for production.

The limitation of this research lies in its bibliographic origin; nevertheless, it can be taken up as a point of reference for future research on technology transfer through quantitative or qualitative methodologies for the agricultural sector.

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