

Characteristics and trends of scientific-technical publications on plantations and agroforestry systems

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Abstract— Forest plantations management demands generating knowledge and developing innovative technologies that make their production process more efficient. The objective of this research was to analyze the characteristics and trends of scientific publications from the Centro Nacional de Investigación Disciplinaria en Conservación y Mejoramiento de Ecosistemas Forestales (National Center for Disciplinary Research in Conservation and Improvement of Forest Ecosystems) from Mexico produced from 1994 to 2021, by the Plantations and Agroforestry Systems research program. A documentary review was performed in scientific journals and documents with an editorial committee; the compiled information was systematized and analyzed through graphs prepared in Microsoft Excel®. A total of 36 documents were found for three periods: 18 documents from 2019-2021 (52.78%), 14 documents from 2008-2018 (38.89%), and three (8.33%) from 1994-2007. Specifically, 30 scientific articles, five technical guidelines, and one book chapter were published from 1994 to 2021. The main research topic from 1994 to date was conservation. Their keywords analysis indicates that the main study subject was the *Pinus* genus. Regarding their geographical scope, 40 works were carried out at five levels: one international, twelve national, seven regional, fourteen states level, five municipal, and one local. Most of the studies (77.78%) were published in Mexican journals and publishers. The number of reported species in these documents amounted to 90. To increase its impact in the coming years, it is advisable to strengthen the research carried out with other institutions and researchers.

Keywords— Cenid Comef, conservation, INIFAP, *Pinus*, scientific and technological knowledge.

I. INTRODUCTION

In Latin America, forest development has focused on the management of the forests and non-timber resources, as well as the establishment of commercial plantations (Soler *et al.*, 2021); however, efforts for biodiversity conservation are moderate (Chaudhary *et al.*, 2016). Because forest resources play an important role in the populations of different countries —because they promote their economy and improve quality of life and their environment (FAO and UNEP, 2020)— establishing strategies that guarantee their permanence and stability through time for a country's improvement is a priority.

The knowledge about forest resources, based on scientific research, is important for decision-makers during the implementation of effective policies, *i. e.*, the reduction of

carbon emissions from forestry activities (Houghton *et al.*, 2015), the effect of land reconversion policies on national scales (Liu *et al.*, 2020). In this regard, studies on the state of the art are a tool that provides ranking criteria. On the contrary, the lack of knowledge about the response and behavior of the species when erroneously managed can have a negative effect. Generally, three sociopolitical factors are reported that directly influence forest area reduction: i) political failures, ii) institutional failures, and iii) policies favoring social growth (Scullion *et al.*, 2019).

In that respect, in Mexico, activities that reduce the forest area are supported by political instruments for agricultural development —like the “Procampo” and “Alianza para el Campo” programs (Schmook and Vance, 2009) —, which are not connected to any conservation policy that reduces

the high percentage of illegal lumbering extraction (70%) (García-Jiménez and Vargas-Rodríguez, 2021), or reduces the impact of human activities.

Faced with this scenario, government institutions like the Comisión Nacional Forestal (National Forestry Commission), the Secretaría del Medio Ambiente y Recursos Naturales (Environment and Natural Resources Secretariat), the Procuraduría Federal de Protección al Ambiente (Federal Attorney for Environmental Protection) and the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (National Commission for the Knowledge and Use of Biodiversity) have been articulated to favor forestry development that support the management, regulation and conservation of this resource. These dependencies in turn seek the support of universities like the Universidad Nacional Autónoma de México (National Autonomous University of Mexico), Universidad Autónoma Chapingo, Colegio de Postgraduados, Universidad Autónoma Agraria Antonio Narro or research centers like the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (National Institute of Forestry, Agricultural and Livestock Research), the Instituto Nacional de Ecología (National Institute of Ecology), or the Colegio de la Frontera Sur to address specific actions or solve particular problems that lead to the main agents that deteriorate forest masses: changes in land use, illegal logging, fires, pests and diseases (Goldstein *et al.*, 2011).

Regarding forest plantations (FP), Mexico has 11.3 million ha with agroecological potential for development, their annual wood production is estimated to be 702 thousand m³ (Conafor, 2020). For 2020, the operation of 237,139 ha of FP for commercial production stands out, out of which 74% were concentrated in seven states: Tabasco (49 362 ha), Veracruz (35 969 ha), Campeche (27 800 ha), Chiapas (17 840 ha), Michoacán (16 367 ha), Puebla (14 347 ha) and Oaxaca (13 290 ha) (Conafor, 2020). At the same time, it has been established that FPs actively participate in the restoration of degraded areas, carbon sequestration, and the preservation of ecosystems and biodiversity (Flores *et al.*, 2021). Forest plantations management demand generating new knowledge and developing innovative technologies that promote an efficient production process and increase its potential.

In 1985, the Instituto Nacional de Investigaciones Forestales (National Forestry Research Institute), the Instituto Nacional de Investigaciones Agrícolas (National Agricultural Research Institute) and the Instituto Nacional de Investigaciones Pecuarias (National Livestock Research Institute) were merged to create the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (National Forestry, Agricultural and Livestock Research

Institute, INIFAP) (Urbina, 2017). In FP the context, the INIFAP has developed research—for more than 35 years— related to problem solving and developing technological packages. A decade later, within the structure of INIFAP, the Centro Nacional de Investigación Disciplinaria en Conservación y Mejoramiento de Ecosistemas Forestales (National Center for Disciplinary Research in Conservation and Improvement of Forest Ecosystems, Cenid Comef) was created, with the objective to generate scientific and technological knowledge for timber and non-timber forest resources sustainable management of Mexico (Zamora and Romero, 2019). The results of their research have been mainly disseminated through the publication of technical guidelines, manuals, books, articles and research notes (Urbina, 2017), and their presentation at national and international scientific events.

The objective of this research was to analyze the characteristics and trends of the scientific publications of the Cenid Comef from Mexico generated by the Plantations and Agroforestry Systems research program during the 1994-2021 period. These results could support and guide subsequent research of the analyzed research program.

II. BIBLIOGRAPHIC REVIEW

To determine the number of publications of research results from Cenid Comef (Mexico), an exhaustive documentary review was carried out in printed and digital scientific journals (scientific articles, research notes) and documents with an editorial committee (technical guidelines, books, and book chapters). The search was carried out in Google Scholar (Google), Scientific Electronic Library Online (SCiELO), SCOPUS, in the Network of Scientific Journals of Latin America and the Caribbean, Spain, and Portugal (Redalyc–Universidad Autónoma del Estado de México)—to identify documents in Spanish and English—, and on INIFAP's Integral Management Institutional System (SIGI) platform and Cenid Comef's Forestry Library.

The search was based on the authors who were or are assigned to the Cenid Comef in the Plantations and Agroforestry Systems program. The researchers referred to as the first author or co-author of the manuscript were considered when the predecessor was not assigned to the Cenid Comef, and as the author for correspondence. The search period comprised 28 years (1994-2021), which corresponded to three stages of study during the operation of the Cenid Comef: establishment, growth, and consolidation.

The compiled information was systematized through bibliographic reference files—which determined the year

of publication, research topic, geographical area, journal or publisher, species studied, keywords, number of bibliographic references reviewed, and number of times cited—, the data was analyzed through graphs elaborated in Microsoft Excel®.

III. RESULTS AND DISCUSSION

Based on the defined search criteria, 36 documents were found. The period with the highest number of publications was 2019-2021—with 18 documents—, which represented 52.78% of the total publications (Figure 1). Fourteen documents were produced from 2008 to 2018

(38.89%) and three (8.33%) from 1994 to 2007, the latter, being the period with the lowest production (Figure 1). In this regard, it is possible that the establishment stage (start of operations) of the Cenid Comef (1994-2007) directly influenced the production of documents, which were obtained from research projects developed in collaboration with other institutions; while during the growth stage of the Cenid Comef (2008-2018), the number of publications increased. Finally, it is during the consolidation phase of Cenid Comef (2019 onwards), that the Plantations and Agroforestry Systems program achieved the highest number of publications.

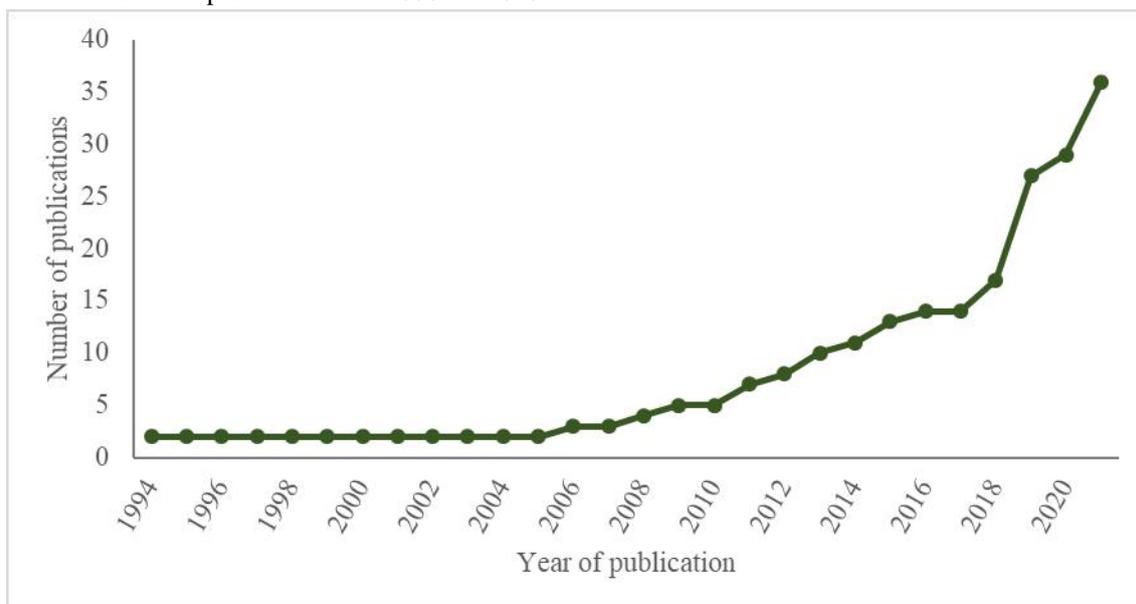


Fig. 1: Number of accumulated scientific publications from the Cenid Comef generated by the Plantations and Agroforestry Systems program between 1994 and 2021.

Specifically, 30 scientific articles, five technical guidelines, and a book chapter from 1994 to 2021 were published (Table 1). The publication of articles increased from 2019 to 2021 compared to technical guidelines and book chapters, which have decreased (Figure 2). The average number of references reviewed per article/year has been higher in 2019-2021 and 2008-2018 compared to the 1994-2007 period (Table 1); while it was not possible to compare the averages of references per technical guideline/year and chapter/year between periods, due to the lack of these publications.

The average number of citations per article/year was higher from 2008 to 2018 compared to the other periods, which is probably due to the lack of publications from 1994 to 2007 and the short period of publication from

2019 to 2021 (Table 1, Figure 2). Due to the low number of publications between periods, it was not possible to compare the average number of citations per technical guidelines/year and book chapter/year. Overall, despite the small number of manuscripts, some documents stand out as widely cited and, consequently, of relevance for other research, such as Garibay-Orijel *et al.* (2013), Angeles-Argáiz *et al.* (2016) and Flores *et al.* (2008) (cited 36, 18, and 16 times, respectively). Three documents have a lower number of citations (7, 6, and 5, respectively), probably due to the short publication time (2015-2019): Flores *et al.* (2018a), Arriola *et al.* (2015) and Flores (2019a).

Table 1: Characteristics of the Cenid Comef publications generated by the Plantations and Agroforestry Systems program from 1994 to 2021.

Years	A [†]	G	C	RA	RG	RC	RA/A	RG/G	RC/C	CA	CG	CC	CA/A	CG/G	CC/C	AA	AG	AC	AA/A	AG/G	AC/C
1994-2007	3	0	0	50	0	0	16.67	0.00	0.00	2	0	0	0.67	0.00	0.00	11	0	0	3.67	0.00	0.00
2008-2018	8	5	1	318	244	85	39.75	48.80	85.00	78	6	1	9.75	1.20	1.00	36	27	4	4.50	5.40	4.00
2019-2021	19	0	0	779	0	0	41.00	0.00	0.00	18	5	0	0.95	0.00	0.00	69	0	0	3.63	0.00	0.00
Total	30	5	1	1147	244	85	-	-	-	98	11	1	-	-	-	116	27	4	-	-	-

†A: Total number of articles, G: Total number of technical guidelines, C: Total number of book chapters, RA: Total number of reviewed references for articles, RG: Total number of reviewed references for technical guidelines, RC: Total number of reviewed references for book chapters, RA/A: Average references reviewed per article/year, RG/G: Average references reviewed per technical guidelines/year, RC/C: Average references reviewed per chapter/year, CA: Total number of citations to articles, CG: Total number of citations to technical guidelines, CC: Total number of citations to book chapters, CA/A: Average citations per article/year, CG/G: Average citations per technical guidelines/year, CC/ C: Average number of citations per book chapter/year, AA: Total number of article authors, AG: Total number of technical guidelines authors, AC: Total number of book chapter authors, AA/A: Average number of authors per article /year, AG/G: Average number of authors per technical guidelines/year, AC/C: Average number of authors per book chapter/year.

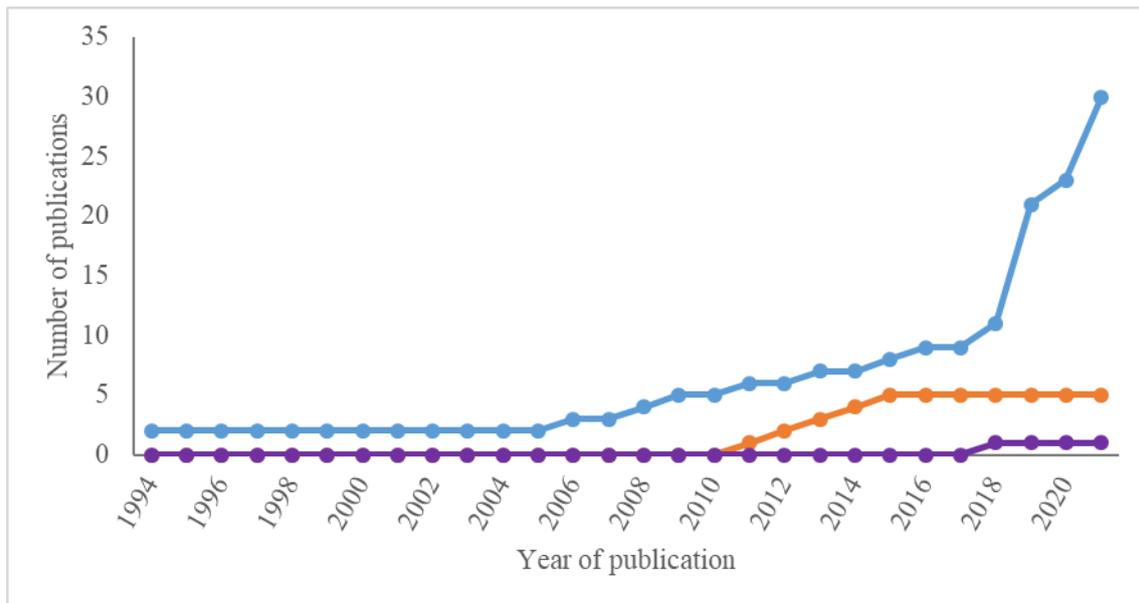


Fig. 2: Number of accumulated scientific articles (blue line), technical guidelines (orange line), and book chapters (purple line) from the Cenid Comef by the Plantations and Agroforestry Systems program from 1994 to 2021.

Most of the documents with fewer citations (4–1), are considered to have this potential in the coming years, since they are recently published: Flores *et al.* (2018b), Flores *et al.* (2019b), Flores *et al.* (2019c), Flores *et al.* (2019d), Hernández-Hernández *et al.* (2019), Méndez-Espinoza and Vallejo (2019), Muñoz-Gutiérrez *et al.* (2019a), Muñoz-Gutiérrez *et al.* (2019b) and Flores *et al.* (2021). In relation to the average number of authors per article/year, the value is slightly higher from 2008-2018 compared to the 1994-2007 and 2019-2021 periods, which are similar (Table 1). The average number of authors per technical guidelines/year and per book chapter/year was not compared between periods due to the lack of publications.

The main research topic from 1994 to the present was conservation ($n = 11$); while genetic tests, plant production and timber production had 18 publications (Figure 3). The least studied topics were four: reforestation, mycorrhizae, phenotypic characterization, and development and perspectives ($n = 7$) (Figure 3). Keyword analysis ($n = 335$) indicated twelve main study topics: *Pinus* (3.88%), forestry (3.58%), conservation and genetics (2.99% each),

production (2.39%), plant and seed (1.79% each), variation and nursery (1.49% each), and *Abies*, management and pine (1.19% each) (Figure 4).

Regarding the geographical scope of the studies, one was international (Jiaozuo, Henan province, China), twelve national, and seven at the regional level (Trans-Mexican Volcanic Belt, Oaxaca Coast, Pacific Coast, Southeast Mexico), fourteen at the state level (Estado de México, Puebla, Mexico City, Oaxaca, Chihuahua, Michoacán and Veracruz), five at the municipal level (Ajusco, CDMX; Apizaco, Tlax.; Metepec, Edo. Méx.; San Pedro Tultepec, Edo. Méx., and Tlaquilpa, Ver.) and one locally (Parque Desierto de Los Leones) (Figure 5).

Most of the studies have been published in Mexican journals and national publishers ($n = 28$, 77.78%) compared to international ones ($n = 8$, 22.22%) (Figure 6). The main species studied and reported in the documents were 90 (list not included), but only six predominated: *Pinus pseudostrobus* (5.95%), *P. greggii*, *P. hartwegii*, *P. montezumae* and *P. patula* (4.17% each), and *Abies religiosa* (3.57%).

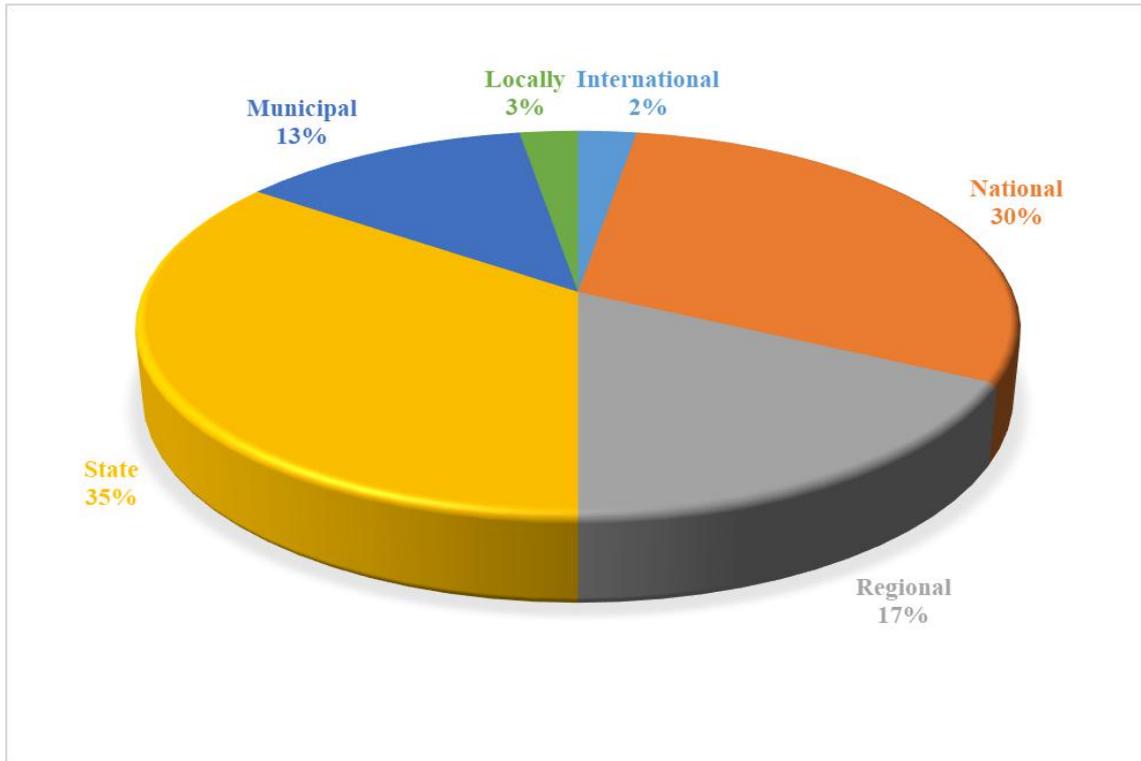


Fig. 5: Coverage of research carried out at the Cenid Comef by the Plantations and Agroforestry Systems program from 1994 to 2021.

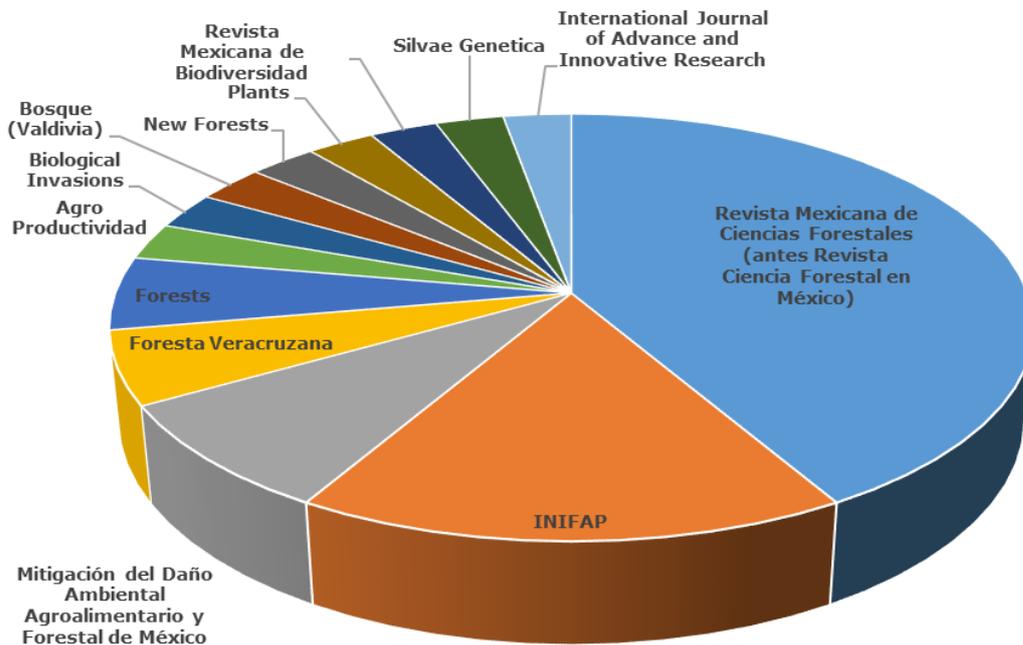


Fig. 6: Journals and editorials that have published Cenid Comef research generated by the Plantations and Agroforestry Systems program from 1994 to 2021.

IV. CONCLUSION

This research analyzed the trends of the publications that

the Cenid Comef from Mexico has generated by the Plantations and Agroforestry Systems program; likewise, it

shows the main characteristics that they have had and the research topics that have been addressed for almost three decades. The growth in the production of scientific articles is highlighted, but also a decrease in technical guidelines and book chapters. The periods with a higher and intermediate production have been 2019-2021 (consolidation stage) and 2008-2019 (growth stage), respectively. The main subject of study has been conservation and dominated the research carried out at the national level. Most of the research has been published in national journals, most of which has been in the *Revista Mexicana de Ciencias Forestales* (formerly *Revista Ciencia Forestal en México*). It is suggested to strengthen the research work carried out in this Center with other institutions and researchers to increase its impact in the coming years.

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