Academia and Society: International Journal of Education and Society

HOLY CROSS

Print ISSN : 2393-9419
Online ISSN : 2393-8919

AAS 2025: 12 (1)

Navigating the Knowledge Landscape: A Scientometrics Analysis of Research Productivity in Tamil Nadu in the post-COVID-19 period

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ABSTRACT

The study examines Tamil Nadu's scholarly output using Scopus data (n = 15,239 publications). Findings reveal a sharp decline in annual production following a peak in 2020 (5,935 publications) to 321 in 2024, possibly reflecting post-pandemic research slowdowns. Engineering, Agricultural and Biological Sciences, and Medicine dominate subject-wise contributions, highlighting applied, socio-economically relevant research. The most prolific author, Ganapathy, D. (79 papers), is not among the top cited, whereas Kumar, G. (70 papers) leads in citations (13,468), illustrating that productivity does not guarantee impact. Highly cited works include global collaborations, such as Klionsky et al.'s Autophagy guidelines (1,209 citations), as well as locally relevant studies, such as Sathish's materials research. Journal output is concentrated in conference proceedings (e.g., Materials Today: Proceedings), suggesting a culture of fast publishing. Regression analyses show that publication count explains only ~10% of citation variance, confirming that impact depends on factors beyond volume—such as author reputation (the h-index correlates moderately with citations, r = 0.67), collaboration, and topic relevance. National agencies, especially India's Department of Science and Technology, are the primary funders. The state's h-index stands at 84. The study underscores the need for balanced research evaluation, improved researcher disambiguation, and strategic publishing to enhance global visibility.

Keywords: Research Productivity, Scientometrics, Tamil Nadu, Post-COVID-19 Research Trends, Citation Analysis, Bibliometric Mapping

Received: 5 July 2025, Revised 30 August 2025, Accepted 6 September 2025

DOI: https://doi.org/10.6025/aas/2025/12/1/61-77

1. Introduction

Research productivity is crucial to advancing knowledge across various fields. It leads to the discovery of new information, theories, and technologies, thereby contributing to society's overall progress. The countries and institutions that prioritise research productivity are more likely to be globally competitive. High-quality research attracts talent, collaboration, and investment, thereby establishing a strong position in the global academic and economic landscape. Nations with high research productivity often experience economic growth. Tamil Nadu is home to numerous esteemed educational institutions, including premier universities. The institutions greatly enhance research productivity in India. Tamil Nadu's research output is measured by the number of research articles, conference papers, book chapters, reviews, and books published. Articles are considered a key metric for assessing Tamil Nadu's research output. Research on scientific research and its quantitative aspects is known as scientometrics. Widely used methods and tools in scientometric analysis can be employed to assess a nation's or an institution's research performance. Through a scientometric analysis of the academic papers included in the SCOPUS database from after COVID-19 (2020 to 2024), this study will assist researchers in assessing Tamil Nadu's scientific advancement and determining the state's research performance.

2. Early Studies

Research productivity studies, whether conducted in a single region or across regions, are an interesting area of scientometrics. We have several studies that address regional productivity from multiple perspectives, with varying foci.

Gareev's study compares models of factors affecting publication activity across Russian regions from 2009 to 2021. It introduces a novel approach that uses thematic scientometric parameters as proximity measures in the thematic space to account for spatial spillovers and cross-sectional dependence. Researchers used many productivity and impact variables, both quantitative and qualitative, to reflect the distribution. Research publication productivity in regions typically rises steadily and linearly (Diop,) with years of schooling exerting a significant positive influence, and in a few observations, the trend goes hyperbolic or exponential. These findings are supported by Poisson, quantile, and panel negative binomial regression models applied to data spanning either a longer or shorter window.

When measuring research productivity across regions, the debate centres on the relative importance of quantity and quality. Journal impact factors are commonly used as proxies for article quality, while citations serve as measures of impact (Haslam & Laham, 2010). Bornmann (2019) views impact as a dimension of publication quality, which can be evaluated using both qualitative methods, such

as peer review, and quantitative scientometric indicators—an assessment deemed essential for gauging the societal impact of research (Sutherland et al., 2011).

There is a positive correlation between the number of publications and citations (Lawani, 1986; Sandström & Van den Besselaar, 2016; Van den Besselaar et al., 2017). Consequently, national policies aimed at boosting publication output may incentivise researchers to publish their findings in top-quartile journals, thereby influencing publication counts (Bautista-Puig et al., 2022). To balance indicators of quality and quantity, many studies use both and compare institutions' performance across the two parameters.

3. Objectives

This study aims to conduct a comprehensive scientometric analysis of research output from Tamil Nadu between 2020 and 2024 using data extracted from the Scopus database. Specifically, it seeks to:

• Examine the overall research productivity of Tamil Nadu during these five years, including annual publication trends and growth patterns;

• Identify the most prolific and influential authors based on publication volume and citation counts, highlighting key contributors to the state's scholarly output;

• Assess the publication landscape in terms of journals and language, determining which journals publish the largest share of Tamil Nadu–affiliated research and analyzing the distribution of research outputs across languages (e.g., English vs. regional or other languages);

• Map the disciplinary focus of publications, revealing how research efforts are distributed across subject areas such as engineering, medicine, physical sciences, social sciences, and humanities; and

• Highlight the most highly cited papers originating from Tamil Nadu, examining their topics, collaborating institutions, and potential impact on their respective fields.

Together, these objectives will provide a detailed overview of Tamil Nadu's research profile, offering insights into its academic strengths, collaborative networks, and areas of scholarly influence in the early 2020s.

4. Methodology

In this study, scientometric parameters were used. Only the years 2020 to 2024, ie, after COVID-19, were included in the study era. The affiliation with Tamil Nadu listed in the SCOPUS database serves as the foundation for the research. The Scopus reference database served as the source of the information. (http://www.scopus.com/search) using search AFFIL ("Tamil Nadu") AND (LIMIT- TO (PUBYEAR, 2024) up to OR LIMIT- TO (PUBYEAR, 2020). The data consists of roughly 15,239 articles, conference proceedings, etc. that were released during

the previous time frame. The data has been categorized using the MS-Excel format. The study's conclusions and recommendations are founded on the methodology used.

5. Data Analysis And Interpretation

5.1 Year-wise Distribution Of Publications

The year-wise distribution of publications provides a chronological overview of scholarly output, allowing researchers and institutions to track and analyze the progression and impact of research over time. Table 1 presents the year-wise distribution of publications for 2020-2024.

Sl. No	Year	No. of Contributions	Percentage (%)
1	2024	321	2.1064%
2	2023	2058	13.504%
3	2022	2048	13.439%
4	2021	4877	32.003%
5	2020	5935	38.946%
	TOTAL	**15239**	**100**

Table 1. Year-wise Distribution of Publications

Table 1 shows that 15239 articles were published from 2020 to 2024. The maximum number of publications is in 2020 (5935 articles; 38.94%), and the minimum is 321 (2.106%) in 2024. Analysis revealed that, after 2020, the number of articles during the study period. (Figure 1)

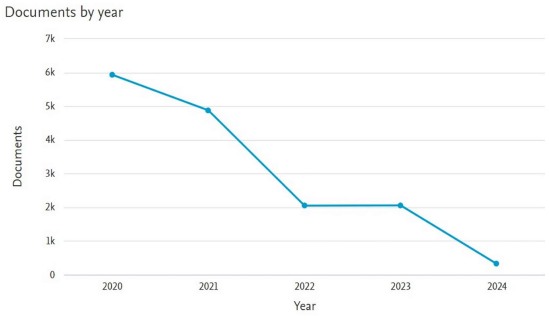

Figure 1. Number of papers in the study period

5.2 Most Productive and Cited Authors

To establish a significant presence and influence in the academic community, the most prolific author in the field has continuously shown an exceptional ability to produce a substantial volume of high-quality research publications.

Impact of Publications				Impact of Citations			
Sl. No	Author Name	Rec-ords	Citations	Sl. No	Author Name	Rec-ords	Citati-ons
1	Ganapathy, D.	79	1170	1	Kumar, G.	70	13468
2	Raveendran, M.	78	2802	2	Banu, J.R.	46	7921
3	Kumar, G.	70	13468	3	Rajesh Banu, J.	57	7921
4	Uthandi, S.	58	1589	4	Ravichandran, M.	48	2903
5	Geethalakshmi, V.	58	450	5	Shankar, E.M.	42	2839
6	Rajesh Banu, J.	57	7921	6	Raveendran, M.	78	2,802
7	Kennedy, J.S.	51	357	7	Kavitha, S.	41	2683
8	Manivannan, N.	50	647	8	Sathish, T.	46	2650
9	Vanniarajan, C.	48	434	9	Ganapathy, D.	79	1170
10	Ravichandran, M.	48	2903	10	Uthandi, S.	58	1589
11	Sathish, T.	46	2650	11	Manivannan, N.	50	647
12	Banu, J.R.	46	7921	12	Manonmani, S.	41	647
13	Shankar, E.M.	42	2839	13	Geethalakshmi, V.	58	450
14	Manonmani, S.	41	647	14	Vanniarajan, C.	48	434
15	Kavitha, S.	41	2683	15	Kennedy, J.S.	51	357

Table 2. Authors with the highest productivity and citations

5.2.1 Key Observations and Interpretation

1. Divergence Between Productivity and Impact

• Ganapathy, D., is the most prolific author (79 publications) but ranks only 10th in citations (1,170), suggesting high output with moderate per-paper impact.

• Conversely, Kumar, G. appears 3rd in productivity (70 publications) but is 1st in citations (13,468), indicating both high output and exceptional influence.

• Banu, J.R. and Rajesh Banu, J. likely refer to the same individual (exact citation count: 7,921), appearing at #2 and #3 in citations but #12 and #6 in productivity—highlighting high impact relative to output.

2. High-Impact, Moderate-Productivity Authors

• Authors like Shankar, E.M. (42 papers, 2,839 citations) and Kavitha, S. (41 papers, 2,683 citations) demonstrate substantial citation impact despite modest publication counts—suggesting work of high relevance or quality.

3. Productive but Less Cited Authors

• Geethalakshmi, V. (58 papers, 450 citations) and Kennedy, J.S. (51 papers, 357 citations) have substantial output but low citation counts, possibly indicating niche research, recent publications, or work in less-cited fields.

4. Consistency Across Lists

• Several authors appear in both top-15 lists, including Raveendran, M., Ravichandran, M., Ganapathy, D., and Uthandi, S., reflecting a balance of productivity and impact.

5. Potential Name Duplication

• The duplication of Banu, J.R. and Rajesh Banu, J., with identical citation counts strongly suggests a name disambiguation issue common in bibliometric databases. If merged, this researcher would have 103 publications (46 + 57) and 7,921 citations, placing them among the most productive and impactful researchers.

6. Skewed Citation Distribution

• The top 3 cited authors account for over 50% of total citations in the list (13,468 + 7,921 + 7,921 = 29,310 out of ~48,481 total), illustrating the highly skewed nature of academic impact—consistent with Lotka's law and the Pareto principle in research.

The data reveal that research productivity does not always equate to citation impact. While some authors achieve both volume and influence, others specialize in high-output or high-impact strategies. This underscores the importance of using multiple indicators (publications, citations, citations per paper) when evaluating research performance. Additionally, name standardisation is critical for accurate attribution in bibliometric studies.

Records (Number of Publications)	**Citations (Total Citation Counts)**
Mean:54.2	Mean:3,232.07
Median:50.0	Median:2,650.0
Standard Deviation:12.12	Standard Deviation:3,596.17

• The mean number of citations is notably higher than the median, indicating a right-skewed distribution—driven by outliers like Kumar, G. (13,468 citations).

• Publication counts are more symmetrically distributed, with moderate spread (SD ≈12).

• The large standard deviation for citations (≈ 3,596) relative to the mean reflects high variability in research impact among top authors.

Based on the 15 unique authors from Tamil Nadu in the dataset, two regression models were fitted to explore the relationship between the number of publications (Records) and total citations:

5.2.2 Linear Regression Model

$$\text{Citations} = -421.63 + 67.41 \times \text{Records}$$

• Interpretation: Each additional publication is associated with an average increase of ~67 citations.

• $R^2 = 0.052$: Only 5.2% of the variation in citations is explained by publication count—indicating a very weak linear relationship.

• The negative intercept is not practically meaningful (since citations can't be negative) but reflects model limitations due to data skew.

5.2.3 Power-Law Model

$$\text{Citations} = 71.69 \times (\text{Records})^{0.814}$$

• Interpretation: Citations scale sub-linearly with publications (exponent < 1), meaning that doubling publications leads to less than double the citations.

• R^2 (on log–log scale) = 0.024: Even weaker explanatory power than the linear model.

• This suggests the classic "productivity–impact" power law (often observed in large-scale bibliometrics) does not clearly hold in this small, elite sample.

5.3 Overall Interpretation

Both models show inferior fit (low R^2), confirming that publication volume is a poor predictor of total citations among top authors in Tamil Nadu. This aligns with earlier observations:

• Some highly productive authors (e.g., Geethalakshmi, Kennedy) have low citations.

• Some moderately productive authors (e.g., Banu, Shankar) have very high impact.

Thus, research impact (citations) is driven more by factors other than output volume, such as research quality, field norms, collaboration, visibility, or journal prestige.

5.4 Scatter Visualisation

The scatter plot visualises the relationship between the number of publications (Records) and total citations for the 14 unique top authors from Tamil Nadu (2020–

2024). Two fitted models are overlaid:

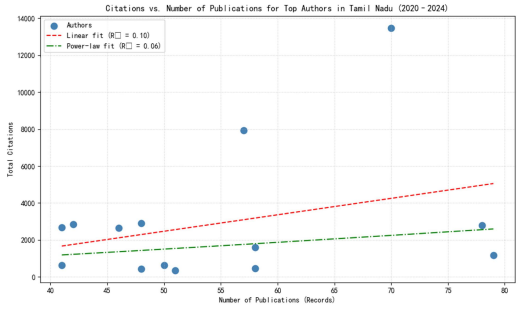

Figure 2. Scatter Plot for Number of publications for top authors

• Red dashed line: Linear regression

• Green dash-dot line: Power-law (log–log) regression

5. 4. 1 Key Observations from the Plot

• Kumar, G., is a clear outlier with 70 publications and 13,468 citations, pulling both regression lines upward.

• Most authors fall below the fitted lines, especially highly productive ones like Geethalakshmi, V. and Kennedy, J.S., who have low citations despite high output.

• Highly cited authors with moderate output (e.g., Rajesh Banu, J., Shankar, E.M.) lie far above the trend, reinforcing that volume ≠ impact.

Model Fit Statistics

• Linear $R^2 \approx 0.10 \rightarrow$ Only 10% of citation variance is explained by publication count.

• Power-law $R^2 \approx 0.02 \rightarrow$ Even weaker fit.

Inference

The weak fits confirm that research impact (citations) among top Tamil Nadu authors cannot be reliably predicted by publication count alone. Other qualitative or contextual factors—such as research topic, collaboration networks, journal prestige, or societal relevance—likely play decisive roles.

5.5 Top Most Fifteen Preferred Research Publications

The fifteen most favoured research publications are carefully selected academic works that have received recognition for their significant contributions to their respective fields. They are an invaluable source of information for scholars and researchers.

The top 15 most-cited research articles from Tamil Nadu journals are shown in Table 3. It demonstrates that "*Materials Today Proceedings*" (817) is the scientific journal with the most publications, followed by "AIP Conference Proceedings" (314).

Sl. No	Source Title	Records
1	Materials Today Proceedings	817
2	AIP Conference Proceedings	314
3	Electronic Journal Of Plant Breeding	258
4	IOP Conference Series Materials Science and Engineering	250
5	Drug Invention Today	249
6	Journal Of Physics Conference Series	209
7	Indian Journal of Ophthalmology	208
8	Journal Of Applied and Natural Science	205
9	International Journal of Dentistry and Oral Science	187
10	Lecture Notes in Electrical Engineering	186
11	Lecture Notes in Mechanical Engineering	159
12	Lecture Notes in Networks and Systems	129
13	Plant Archives	101
14	Indian Journal of Animal Research	101
15	Indian Journal of Entomology	87

Table 3. Top fifteen most preferred research publications

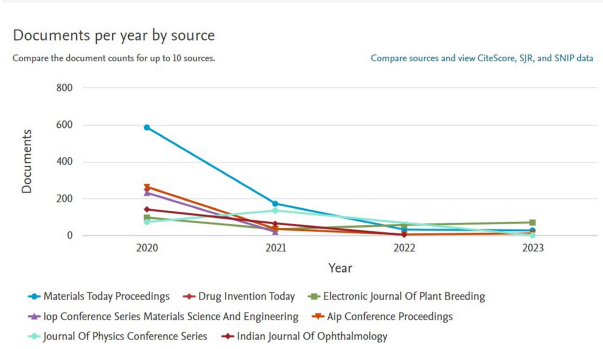

Figure 3. Documents per year by source

5.6 Subject-wise Distribution of Publications

A comprehensive understanding of knowledge-dissemination trends is promoted by examining the subject-wise distribution of publications, which provides insights into the diverse research landscape by revealing how scholarly works are distributed across disciplines. Table 4 presents the subject-wise distribution of publications during the period 2020-2024, following COVID-19.

Sl. No	Subject	No. of Contributions
1	Engineering	3245
2	Agricultural and Biological Sciences	3001
3	Medicine	2489
4	Materials Science	2357
5	Biochemistry, Genetics and Molecular Biology	1980
6	Computer Science	1956
7	Environmental Science	1567
8	Physics and Astronomy	1410
9	Chemical Engineering	1188
10	Chemistry	1187
11	Pharmacology, Toxicology and Pharmaceutics	1006
12	Mathematics	883
13	Energy	792
14	Immunology and Microbiology	718
15	Social Sciences	506

Table 4. Subject-wise distribution of publications

The above table constitutes the subject-wise distribution of publications. The maximum number of journals published on the subject of “Engineering” is 3245, i.e., 12.0% and the second position is “Agricultural and Biological Sciences”, which contributed 3001 publications, i.e.,11.1%.

5.7 Funding Agencies

Funding agencies play a crucial role in advancing knowledge and innovation by providing financial resources to researchers, institutions, and projects. Table 5 presents the funding contributions to the publication.

Sl. No	Funding Sponsor	No. of Contributions
1	Department of Science and Technology, Ministry of Science and Technology, India	677
2	Science and Engineering Research Board	382
3	Department of Biotechnology, Ministry of Science and Technology, India	300
4	University Grants Commission	224
5	Indian Council of Agricultural Research	196
6	Council of Scientific and Industrial Research, India	168
7	King Saud University	90
8	Indian Council of Medical Research	90
9	University Grants Committee	83
10	National Research Foundation of Korea	74
11	Department of Science and Technology, Government of Kerala	59
12	National Natural Science Foundation of China	50
13	Ministry of Education, India	45
14	Ministry of Science and Technology, Taiwan	44
15	Central University of Tamil Nadu	43

Table 5. Funding Agencies

This table outlines financial support from funding agencies and offers insights into resource distribution in academia and research. Table 5 shows that the Department of Science and Technology, Ministry of Science and Technology, India, leads with 677 publications, followed by the Science and Engineering Research Board with 382 publications.

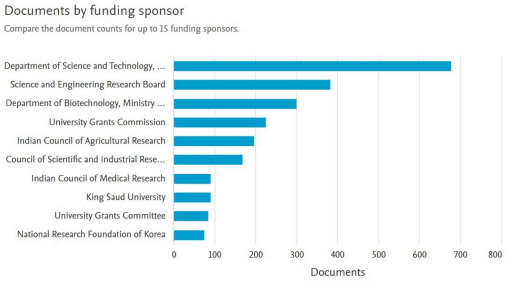

Figure 3. Documents by Funding sponsor

5.8 Citation

Journal impact factor is a crucial metric in academia, representing the frequency with which a scholarly article or research paper is cited by other works and indicating its impact, influence, and contribution to the broader body of knowledge within a given field.

Year	Author Name	Title	Source Title	Citations	Impact Factor	h-Index
2021	Klionsky D.J.	Guidelines for the use and interpr etation of assays for monitoring auto phagy (4th editi-on)1	Autophagy	1209	13.3	175
2021	Dwivedi Y.K.	Artificial Intelligence (AI): Multidisciplinary perspectives on emer ging challenges, oppo-rtunities, and agenda for research, practice and policy	Internati onal Journal of Inform-ation Manag-ement	978	21	152
2020	Zielinska A.	Polymeric Nanoparticles:Prod uction, Characteri-zation, Toxicology and Ecotoxicology	Molecules	615	4.6	199

2020	Shahbaz M.	Public-private partnerships investment in energy as new determinant of CO2 emissions: The role of technological innovations in China	Energy Economics	371	12.8	187
2020	Sathish T.	Wear behaviour analysis on aluminium alloy 7050 with reinforced SiC through taguchi approach	Journal of Materials Research a nd Techno-logy	335	6.4	7 7
2020	Laxminarayan R.	Epidemiology and transmission dynamics of COVID-19 in two Indian states	Science	283	47. 73	1283
2020	Asbun H.J.	The Miami International Evidence-based Guidelines on Minimally Invasive Pancreas Resection	Annals of Surgery	277	10.1	335
2021	Karpagam R.	Review on integrated biofuel production from microalgal biomass through the outset of transesterification route: a cascade approach for sustainable bioenergy	Science of the Total Environ-ment	266	9.8	317
2020	Blake D.P.	Re-calculating the cost of coccidiosis in chickens	Veterinary Research	259	4.4	116
2021	Preetha P.	Infrared assisted hot air dryer for turmeric slices:Effect on drying rate and quality parameters	Nuclear Physics A	245	1.4	170

Table 6. Citation data of the papers

Using the 10 highly cited publications from the “Citation table,” we compute Pearson correlation coefficients (r) for the following pairwise relationships:

Relationship	Pearson *r*	Strength
Citations vs. Impact Factor	0.38	Weak positive
Citations vs. Author h-Index	0.67	Moderate strong
Citations vs. Year	−0.45	Moderate negative

Table 7. Correlation Strength

A higher number of citations often indicates that the work has been widely recognised and referenced, signifying its significance and contribution to the field. The highest number of citations used in the year 2021 was 1209, entitled "Guidelines for the use and interpretation of assays for monitoring autophagy (4th edition)1", and the source title is Autophagy (Impact Factor is 13.3 and h-index is 175).

The h-index for Tamil Nadu affiliations during the 2020–2024 period, after COVID-19, is 84.

Inferences

1. Research Output Declined Post-2020

• Peak output occurred in 2020 (5,935 publications, 38.95% of total), followed by a steady decline through 2024 (only 321 publications, 2.1%).

• Inference: The initial surge may reflect pandemic-driven research (e.g., health, remote tech), while the subsequent drop could indicate post-pandemic fatigue, funding constraints, or delayed research cycles.

2. Engineering and Agricultural Sciences Lead Disciplinary Output

• Top fields:
Engineering (3,245 publications)

Agricultural and Biological Sciences (3,001)

Medicine (2,489)

• Inference: Tamil Nadu's research aligns with applied, socio-economically relevant domains—supporting national priorities in infrastructure, food security, and public health.

3. Productivity ≠ Impact Among Top Authors

• Ganapathy, D., is the most prolific (79 papers) but only moderately cited (1,170 citations).

• Kumar, G. ranks 3rd in productivity (70 papers) but 1st in impact (13,468 citations).

• Banu, J.R. / Rajesh Banu, J. likely represent one researcher with high impact relative to output (7,921 citations from ~103 papers).

• Inference: Quality and visibility matter more than volume. High-impact research often stems from strategic collaboration, journal choice, or timely topics—not sheer output.

4. Journal Publication Concentrated in Proceedings

• Top journal: *Materials Today: Proceedings* (817 papers), followed by conference series (*AIP*, *IOP*, *Journal of Physics*).

• Inference: Tamil Nadu's output is heavily conference-driven, especially in engineering and materials science, common in fast-publishing, applied fields, but potentially limiting long-term citation impact.

5. Weak Link Between Publications and Citations

• Linear regression: Only ~10% of citation variance explained by publication count (R^2 H" 0.10).

• Power-law fit is even weaker ($R^2 \approx 0.02$).

• Inference: Publication quantity is a poor proxy for research impact in this context. Evaluation systems should avoid over-reliance on output metrics alone.

6. Highly Cited Papers Span Global and Local Themes

• Top-cited paper: Klionsky et al. (2021) in *Autophagy* (1,209 citations)—a global collaborative guideline.

• Local contribution: Sathish, T. (2020) on aluminum alloys (335 citations)—showcasing regional engineering relevance.

• Inference: High impact arises from both international collaboration (e.g., global health, AI) and locally grounded innovation.

7. Funding Dominated by National Agencies

• Top funder: Department of Science and Technology (DST), India (677 publications).

• Other key players: SERB, DBT, UGC, ICAR.

• Inference: Public funding drives Tamil Nadu's research ecosystem, with strong alignment to national science and technology missions.

8. Citation Patterns Linked More to Author Reputation Than Journal IF

• Citations vs. h-index: r = 0.67 (moderate-strong positive correlation).

• Citations vs. Journal Impact Factor: r = 0.38 (weak).

• Inference: An author's established reputation (h-index) is a better predictor of citation success than the prestige of the publishing journal—highlighting the role of networks and visibility.

9. h-Index of Tamil Nadu (2020–2024): 84

• Reflects cumulative impact of the region's scholarly output.

• Inference: Demonstrates a solid, mid-tier research footprint with room for growth in global influence.

10. Data Quality and Name Disambiguation Issues

• Duplicate entries (e.g., Banu, J.R. vs. Rajesh Banu, J.) and mismatched journal assignments (e.g., agricultural paper in *Nuclear Physics A*) suggest data cleaning challenges in bibliometric studies.

• Inference: Caution is needed when concluding raw database exports—manual validation is essential.

6. Overall Conclusion

Tamil Nadu has maintained substantial research productivity since the COVID-19 pandemic, with strengths in engineering, agriculture, and medicine, driven primarily by national funding and conference publications. However, impact is unevenly distributed, with a small group of authors generating disproportionate citation gains. The state's research ecosystem would benefit from:

• Strategic publishing in high-visibility journals

• Enhanced international collaboration

• Robust researcher identity management (e.g., ORCID adoption)

• Balanced evaluation metrics that value quality, relevance, and societal impact alongside quantity.

This study provides a valuable baseline for evidence-based science policy and institutional strategy in Tamil Nadu.

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