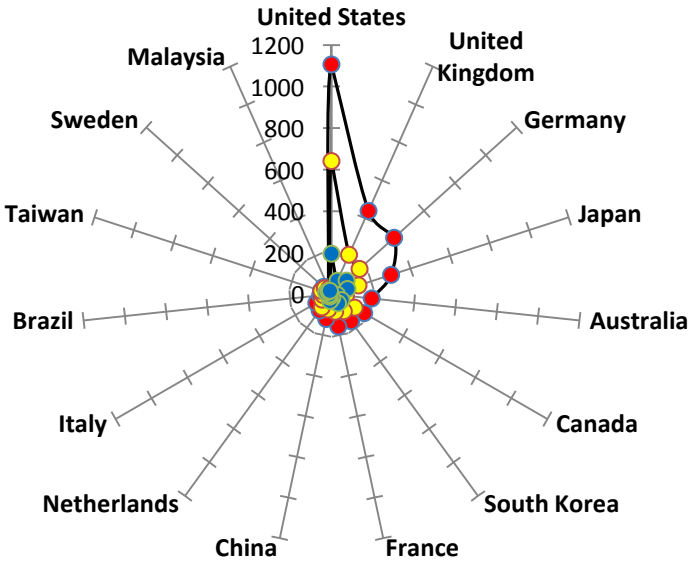
Measures of Performance of Universities in India: An Analysis of the Publication Output in Science and Technology

(Study period 1998-2008)



Department of Science and Technology
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CSIR-National Institute of Science Technology & Development Studies
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Report Submitted to:

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Project Team

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Preface

CSIR-National Institute of Science, Technology and Development Studies (CSIR-NISTADS) is one of the leading institutions under CSIR exploring interface between science, technology, and society. The institute as a knowledge-generating organization carries out studies in several areas of national importance, for example, S&T policy, innovation & national competitiveness in global context, CSIR & public funded knowledge & technology, mapping knowledge trends and outcomes in S&T. It also undertakes studies on history & philosophy of science and technology (S&T), and S&T for weaker sections.

The institute has built core competence in studies on various scientific indicators, measurement of S&T, based on publications and patents output from India and other countries. The institute has made significant contributions in this field and published number of studies and results in national and international peer reviewed journals, research reports, books and presented at national and international conferences. The expertise of its scientists has also been referred by major funding agencies and policy-making bodies through sponsored and consultancy projects.

The studies undertaken by the institute has enabled to develop national indicators on Indian S&T, based on the peer reviewed publications output as covered in international databases, such as Scopus and Web of Science. The present report is based on SCOPUS an international database and presents the performance status of Indian universities in science and technology area as reflected in its publication output covered in the Scopus international database from 1998 to 2008.

The study provides a comprehensive analysis of publication output of Indian universities to map the Indian universities in terms of comparative performance in different science and technology disciplines, inter-university collaboration & collaboration with research organization at national and international level as well. The analysis may be helpful to understand the dynamics of Indian universities. The report will provide wider perspective on university performance and the results will be helpful for scientists, R&D managers, S&T policy-makers and scholars in the field.

Dr. Partahasarathi Banerjee
Director,
CSIR-NISADS

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The organizational support was instrumental in preparation of the report. We are grateful to Dr. P. Banerjee, Director, CSIR-NISTADS for providing valuable suggestions, guidance and help in the formulation and completion of the project that helped in preparing the report more focused and comprehensive. We are grateful to Sh. P. R. Bose & Sh. S. A. Nabi for their help in formulation of the project. We also thank CSIR-NISTADS' administrative and accounts personnel for their administrative support for executing the project smoothly.

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Executive Summary

The report provides the performance status of Indian universities based on the quantitative analysis in the area of S&T, as reflected in its publications output reported in mainstream national and international journals. The main objective of the present report was to provide the research output of Indian universities across geographical regions and subjects. The study may be useful for Indian science planners & policy-makers for gaining macro insights into the university performance for improving the current status of the universities. This study is based on universities' publication in S&T indexed in SCOPUS international database. The subject classification is adopted from SCOPUS. The study reference period is considered for 11 years i.e. 1998-2008, and cumulative publications and citations output data of Indian universities covered in the emerging Science & Technology (S&T) disciplines, namely Physics, Chemistry, Mathematics, Biology, Chemical Engineering, Material Science, Environment Science, Energy, Engineering and Agriculture is used for performance comparison. From the computational analysis it was found that all the disciplines show increasing trends and also expected to rise in the future.

General performance

It was found that University of Delhi, Banaras Hindu University and Jadavpur University were the top productive universities during 1998-2008. The share of, to the total Indian S&T publication, University of Delhi, Banaras Hindu University and Jadavpur University was 1.84%, 1.67% and 1.49% respectively. The top 50 university counted nearly 26% publication of the total Indian S&T publication. The central universities performed better because among the top 10 universities 4 central universities, namely University of Delhi, Banaras Hindu University, Aligarh Muslim University and University of Hyderabad, registered their presence. Alagappa University, Guru Nanak Dev University, Mahatma Gandhi University and University of Hyderabad were the top cited universities. The percentage of citation of papers of these universities was 85.23%, 81.91%, 81.61% and 80.80% respectively. Physics, Chemistry and Biology were the most productive subjects with a share of 7.41%, 7.28% and 5.66% respectively of the total output. Among the basic sciences Biology was the most cited discipline with decadal average CPP of 10.82 followed by Chemistry (average CPP 9.09), Physics (average CPP 8.91) and Mathematics (average CPP 6.91). Among engineering disciplines papers from Chemical Engineering received the most citation with decadal average CPP 10.50. Chemical Engineering was followed by Energy ((average CPP 8.54), material Science ((average CPP 8.54), Environment science (average CPP 6.77), Engineering ((average CPP 5.88) and Agriculture ((average CPP 5.41). University of Hyderabad, University of Delhi, Panjab University, Banaras Hindu University and Jadavpur University were the top 5 universities based on h-index. Their respective h-index was 62, 61, 59, 58 and 55. Some state universities performed comparable as central universities.

Subject-wise and university-wise performance

Physics

The decadal average publication of universities was about 50.87% to the total Indian publication. University of Delhi (1360), Jadavpur University (6629) and Panjab University (988) were the top productive universities in Physics. The decadal average CPP of Physics was 8.91 for the period 1998-2008.

Chemistry
The universities published about 46.64% of the total publication in Chemistry. Jadavpur University (1095), University of Delhi (877) and University of Rajasthan (789) were the top publishing universities in Chemistry. The publication of Indian universities' in chemistry was about 2.12% to global publication in chemistry and share of Indian publication to the global chemistry publication was about 4.59%. The decadal average CPP of Chemistry was 12.69 during 1998-2008.

Mathematics
The decadal average publication by universities was about 53.55% of the total publication in mathematics. University of Delhi, Jadavpur University and University of Calcutta were the top publishing universities in Mathematics. The publication of Indian universities' was about 2.28% to global publication in Mathematics and share of Indian universities publication share was about 1.22% to the global publication in Mathematics during the period 1998-2008.
The decadal average CPP of Mathematics was 6.83 in 1998-2008.

Biology
The decadal average publication by universities was about 43.25% of the total publication in Biology. Madras University, University of Delhi and, Banaras Hindu University were the top publishing universities in Biology. The share of Indian publication was about 2.13% to global publication in Biology and share of Indian universities' publication was about 0.93% to the global publication in Biology during the period 1998-2008. The decadal average CPP of Biology was 10.82 during the period 1998-2008.

Agriculture
The decadal average publication by universities was about 42.70% of the total publication in Agriculture. Punjab Agricultural University (6.06%), CCS Haryana Agricultural University (5.19%) and University of Delhi (3.79%) were the top productive universities in Agriculture to the total publication in Agriculture. The decadal average national publication was about 4.04% to global publication in Agriculture and the share of Indian universities' publication was about 1.71% to the global publication in Agriculture. The decadal average CPP of Agriculture publication was 5.41 during 1998-2008.

Energy
The decadal average publication by universities was about 30.46% of the total publication in Energy whereas average contribution of publication output of universities was about 0.63% of total S&T Indian publication. Jadavpur University with 8.46%, Anna University with 7.96% and Banaras Hindu University with 5.21% were the top publishing universities in Energy. The decadal average national publication was about 2.10% to global publication in Energy and share of Indian universities' publication was about 0.64% to the global publication in Energy during the period 1998-2008. The decadal average CPP in Energy was 8.54 for 1998 to 2008.

Environment Science:
The decadal average publication by universities was about 42.31% of the total publication in Environment whereas average contribution of publication output of universities in Environmental science was about 2.74% of total S&T Indian publication. Anna University, Annamalai University and Mumbai University were the top publishing universities in Environmental science. The decadal average Indian publication in Environment science was 3.34% to global publication in Environmental science and the share of Indian universities'

publication in Environment science was 1.42% to the global publication in Environment science.
The decadal average CPP of Environment science was 6.77 for the period 1998-2008.

Chemical Engineering
The decadal average publication by universities was 41.53% of the total publication in Chemical engineering. Mumbai University, Anna University and Jadavpur University were the top productive universities in Chemical engineering. The decadal average publication was 2.82% to global publication in Chemical engineering and the share of Indian universities' publication was about 1.16% to the global publication in Chemical engineering. The decadal average CPP of chemical engineering was 10.50 during 1998-2008.

Engineering
The decadal average publication by universities was 29.45% of the total publication in Engineering whereas average contribution of publication output of universities was 4.22% of total S&T Indian publication. Anna University (8.42%), Jadavpur University (7.93%) and University of Delhi 5.09%) of the total publication in Engineering were the top productive universities. The decadal average publication of India in Engineering was 1.75% to global publication in Engineering and the share of Indian universities' publication was 0.51% to the global publication in Engineering. The decadal average CPP of chemical engineering was 5.88 during 1998-2008.

Material Science
The decadal average publication by universities was 41.01% of the total publication in Material science whereas average contribution of publication output of universities was 4.99% of total S&T Indian publication. Anna University, Banaras Hindu University and Jadavpur University were the top publishing universities in Material science. Their publication share was 5.76%, 4.07% and 3.81% respectively in Material science. The average decadal publication of India was 3.39% to global publication in material science and the share of Indian universities' publication was 1.39% to the global publication in Material science. The decadal average CPP of Chemical engineering was 6.83 during 1998-2008.

Pattern of Collaboration
United States, Germany, Japan, United Kingdom and France were the leading collaborative countries having joint papers in all disciplines. In general, most of the joint papers came from the United States universities/institutions. Considerable international joint papers were found in Physics, Chemistry and Biology while least collaboration was observed in Mathematics. It was found that inter-university collaboration was less as compared to university and other research institutes/autonomous agency.

The research institutions associated with Council of Scientific & Industrial Research (CSIR) were major collaborators with universities in Physics, Chemistry and Biological disciplines.

Recommendations for enhancing Universities' research potential

- Analysis indicates that there is a little variation in the performance of central and state universities, except University of Delhi & Banaras Hindu University, despite lack of adequate and good infrastructure in the state universities. The central universities are well funded and most of the state universities have no sufficient resources to expand infrastructure. This requires strengthening state universities & Colleges.

- Special grants should be given to the better performing universities to develop infrastructure and set up laboratory facilities.

- Strengthen low and medium productivity universities by offering special packages to low and medium productive state universities.

- Upgrade science laboratories, improve internet connectivity, improve information access, course contents and quality of teaching, with a view to improve the quality and quantity of research in Universities & Colleges.

- There should be provision of support to selected universities & colleges on long-term basis in selected areas to make them competitive.

- Improve research environment in universities by introducing better award system, encouragement of creative work and goal-oriented research.

- Increase accessibility to electronic resources in all universities particularly in faculty of science and engineering to access international journals and material.

Measures of Performance of Universities in India: An Analysis of the Publication Output in Science and Technology

1. Abstract

Quality human resource is a critical determinant of technological competency and economic growth of a country. Universities are the source of skilled manpower however the quality of Indian manpower is suspected by several studies which requires a comprehensive analysis of performance indicators. Analysis of performance indicators enables planners in S&T to measure and evaluate the country's progress in research. The report seeks to provide performance of Indian universities by means of publication output and its related indicators such as H-index and citation of Indian universities vis-a-vis international comparison. The study uses 11 years publications data (1998-2008) pertaining to Indian universities The publications data was computed from Scopus international database covering the period 1998 to 2008. The study examines the performance of Indian universities on several measures including the country's publication share in world research output and country publication share in various subjects in the national context and in the global context. It also determines patterns of research communication in core Indian and foreign journals, geographical distribution, share of international collaborative papers at the national level as well as across subjects. In addition it profiles high productivity universities are also discussed. The study compares similarities of Indian universities research profile with other top productive universities of the world. The findings of the study will be helpful and significant to the policy-makers and planners in the area of higher education system.

2. Introduction

India has a long and great convention in science and technology, from the ancient times to great achievements during this century. The latter half prior to independence was related largely to pure research and at the time of independence Indian scientific and technological infrastructure was neither strong nor organised as compared to the developed world. This had resulted in Indian technologically dependent on the skills and expertise available with other countries due to lack of sufficient educational institutions in the country. However, in the past five decades, infrastructure and capability largely corresponds with meeting national needs, and has created minimal dependence on other countries. The higher education system in India has grown in a remarkable way, particularly in the post-independence period, to become one of the largest systems of its kind in the world. However, the system has many issues of concern at present, like financing and management including access, equity and relevance, reorientation of programmes by laying emphasis on health consciousness, values and ethics and quality of higher education together with the assessment of institutions and their accreditation. This is hampering research output in Indian universities. These issues are important for the country, as it is now engaged in the use of higher education as a powerful tool to build a knowledge-based information society of the 21st Century.

Institutions of higher education, whether public or private, and regardless of national structures of finance and governance, are facing a number of challenges related to strategies for and management of human resources. The changing and competitive environment of higher education demands for accountability of universities and institutions to produce quality manpower. Consequently, universities and their authorities who provide funding and overall regulation are also affected by these winds of change are facing variety of new issues and problems such as:

- increasing dynamics in recruitment, and systemizing staff development
- attracting a new generation of staff in years of ageing population
- bridging the gender gaps in senior management
- developing competences in a long term perspective
- meeting short term demands on productivity and societal relevance
- coping with new features in remuneration systems and performance evaluation
- solving conflicts of interest in academic employment and dealing with ethical aspects
- considering internationalisation of competency in a global perspective

The major emphasis on to improve the status of higher education and university system to produce the quality manpower to cater the need of increasing demand of skilled human capital particularly Science and Technology (S&T) human resource. So, S&T pursuit has been a major objective of the country, identified on purpose to initiate, advance and accelerate national development in all sectors of the economy. Consequent upon this policy initiative, India has been able to usher significant growth in its capacity and capability in basic, applied, and developmental research in science and technology. Its S&T infrastructure

has grown large, comprising of more than 475 universities, 400 research laboratories, 21 institutes of national importance (15 IITs, 01 IISc, 05 IISER) and 1361 in-house industrial R&D units (2009), besides several other government departments, private, international and non-profitable institutions. Correspondingly, investments in S&T have also grown many-fold between 1980 2006. The total annual expenditure on science and technology is nearly 0.8% of the Gross National Product (GNP). Government of India is committed to expand education sector XII Five-Year Plan. Accordingly, the higher education sector, S&T infrastructure in India is expected to witness significant expansion too in the near future.

Keeping in view the overall size of the S&T infrastructure in the country and its steady growth in S&T investments, it is desirable that India comes out with a program to measure and monitor its performance in S&T on a regular basis. This task inevitably requires building appropriate indicators of S&T performance, designed to understand the dynamics of research at institutional, sectoral, geographic and at subject level. Besides, indicators are required for depicting how Indian science is performing vis-à-vis select similarly placed countries and against countries from the developed world. S&T indicators are also required for understanding how collaborative research at national and international level is used to improve the quality and capability building in the country.

3. Need of the study

Several bibliometric studies have so far attempted to look at indicators as required for understanding the status of science and technology in India [1-7]. They had focused on developing indicators on institutional productivity, national productivity, scattering of research across Indian & foreign journals, quality of research, and nature of collaboration, etc. Another important study [8] by the authors to this paper, conducted recently under the sponsorship of the Office of the Principle Scientific Advisor (PSA) to the Government of India, had reported several important indicators to understand the progress in Indian science and technology. The data on these S&T indicators, developed mainly on publications output for select and short periods is old and outdated. Therefore, for understanding the current status of India's S&T, there is a need to produce latest S&T indicators, based on publications data for comparatively longer duration, and hence this study. The present study attempts to provide performance of Indian universities S&T indicators by analyzing 11-years continuous S&T publications data for the purpose.

4. Objectives & Methodology

4.1 Objectives

The main objective of the study was to provide current status of Indian universities by measuring progress of research in India using publications output data. Such indicators are of special significance to the planners & policy-makers in the country. The objective of the study was to provide basic performance statistics of Indian universities on the following points:

- Performance of Indian universities across all subject areas of knowledge;
- Geographical distribution and performance
- Pattern of collaboration

4.2 Methodology and Data Source

There are number of methods to assess the institutional performance but bibliometric analysis is considered a reliable method to access performance of any research or academic institution. In this study to analyse the performance of Indian universities we have used bibliometric method. The Scopus database was used for drawing publications data on Indian universities. Scopus database is an international multidisciplinary database indexing over 18000 international peer reviewed journals in science and technology (S&T), besides more than 500 international conference/seminar proceedings. So far Scopus is the single largest international multidisciplinary database in the world. Given its wider coverage of journals and conference/seminar proceedings from developed and developing countries (including from India and China) compared to another international multidisciplinary database such as Web of Science database, the use of Scopus is expected to generate a better picture of Indian S&T indicators.

The study uses 11 years publications data from 1998 to 2008 on Indian universities. The span of 11 years provides a larger data set covering major disciplines in order to ensure more reliable results as possible. In addition, it used citations data for measuring quality and visibility of Indian universities research output.

Computation and analysis was made for 10 emerging subjects comprising basic science e.g. Physics, Chemistry, Mathematics and Biology and major engineering subjects namely Agriculture, Energy, Environment science, Material Science, Chemical engineering and engineering. The SCOPUS classification was adopted for all the mentioned subjects. The required data was searched from all types of documents e.g. papers, review, notes, conference proceedings etc. for the period 1998-2008.

4.3 Limitation of the study

Efforts have been made to provide consistent results but these may vary due to different search methods and techniques.

5. Analysis

5.1 India's Publication share and rank in World (1998-2008)

India ranks 12th in terms of publications in science and technology, with its global publications share of 2.10% as computed from cumulative world publications data for 1998-2008. India is next to China (6.47%) in the BRIC region in publication output. The share of Russia and Brazil was 2.15% and 1.28% respectively. The global publication share of the top productive countries in S&T from 1998-2008 ranged from 1.04% to 22.77%. The United States tops the list with its global publication share of 22.77%, followed far behind are United Kingdom, Japan, China, Germany, and France (their global publication share ranging 4.5% to 7.4%). The countries that rank between 13th and 20th positions are Netherlands, South Korea, Sweden, Switzerland, Taiwan, Brazil, Poland and Belgium with their global publication share ranging 1% to 1.9%.

The detailed publication output of BRIC vis-a-vis the United States is given in Table-1&2.

Table-1: Pattern of publication output in emerging countries (1998-2008)

Year	India	Brazil	China	Russia	USA	World
1998	21652	11349	36512	31310	316014	1159674
1999	22767	12271	38218	29945	312133	1160252
2000	23173	13322	44591	30453	316407	1222300
2001	24230	13714	57770	31029	311781	1324704
2002	26055	15903	57189	30638	318493	1367832
2003	30083	17967	69633	31530	338636	1422903
2004	31670	19966	102340	31343	321536	1576811
2005	36104	22423	152545	34986	345298	1742246
2006	42033	28008	179762	30997	367573	1826053
2007	46836	30825	203110	31981	381902	1915694
2008	52126	35150	236014	32808	384892	1971339

Table-2: Share of publication in emerging countries (1998-2008)

Year	India	Brazil	China	Russia	USA
1998	1.87	0.98	3.15	2.70	27.25
1999	1.96	1.06	3.29	2.58	26.90
2000	1.90	1.09	3.65	2.49	25.89
2001	1.83	1.04	4.36	2.34	23.54
2002	1.90	1.16	4.18	2.24	23.28
2003	2.11	1.26	4.89	2.22	23.80
2004	2.01	1.27	6.49	1.99	20.39
2005	2.07	1.29	8.76	2.01	19.82
2006	2.30	1.53	9.84	1.70	20.13
2007	2.44	1.61	10.60	1.67	19.94
2008	2.64	1.78	11.97	1.66	19.52

5.2 Publication pattern of Indian universities

India has a large system of higher education and over the last decade a phenomenon growth in infrastructure was registered. But despite government efforts to promote quality of Indian higher education the quality of Indian universities is suspected. It is obvious that no Indian university could place in top 200 universities in the World University Rankings 2010, while China has 6 universities in the list. This indicates that India is lagging behind in higher education which is affecting the research output of Indian universities. Moreover, there is a significant variation in the publication out among the universities particularly between central and state universities. It was found that 4 central universities were figured among the top 10 universities indicates that central universities are performing better. University of Delhi (1.84%) is the most productive university followed by Banaras Hindu University (1.67%), Jadavpur University (1.49%), Anna University (1.19%), University of Madras (0.94%), University of Calcutta (0.89%), Aligarh Muslim University (0.81%), Panjab University (0.79%), Annamalai University (0.73%) and University of Hyderabad (0.70%). The top 10 universities published about 11% plus of the total S&T publications. However, the top 50 universities published about 26% papers of the total national S&T publications.

On the other hand percentage of cited papers of the top 50 universities lies in the range 52%-86%. It is significant to note that papers from some state universities are being cited more than the central universities. The percentage of cited papers of Alagappa University (85.23%) is the highest though University of Delhi is at top in respect of research publication. The Alagappa University is followed by University of Hyderabad (80.80%), Guru Nanak Dev University (81.91%), Mahatma Gandhi University (81.61%), University of Hyderabad (80.80%), University of Burdwan (79.92%), Shivaji University (79.91%) and University of Pune (78.90%). The least percentage of cited papers among top 50 universities is the Tamilnadu Agricultural University (52.44%). This signifies that some state universities are comparable or even more in producing qualitative research publications.

Percentage share of University of Delhi was (1.84%) to the total India S&T publication. University of Delhi is followed by Banaras Hindu University (1.67%), Jadavpur

University (1.49%), Anna University (1.19%), University of Madras (0.94%), University of Calcutta (0.89%), Aligarh Muslim University (0.81%), Panjab University (0.79%), Annamalai University (0.73%) and University of Hyderabad (0.70%).

However, Delhi University 5.38%, Jadavpur University published 4.75% papers to the total universities papers followed by Panjab University 3.91%, Anna University 3.70% and Banaras Hindu University 3.48%.

The publication out of top 50 universities is given in Table-3 and their respective h-index in Table-4 for the period 1998-2008.

Table-3: Top 50 University based on Publication (1998-2008)*

Sl. No.	Name of University	Total Papers	Cited Papers	% Cited Papers
1	University of Delhi	6572 (1.84)	4884	74.32
2	Banaras Hindu University	5951 (1.67)	4506	75.72
3	Jadavpur University	5328 (1.49)	3749	70.36
4	Anna University	4250 (1.19)	2747	64.64
5	University of Madras	3338 (0.94)	2629	78.76
6	University of Calcutta	3160 (0.89)	2259	71.49
7	Aligarh Muslim University	2880 (0.81)	2066	71.74
8	Panjab University	2829 (0.79)	2189	77.38
9	Annamalai University	2617 (0.73)	1863	71.19
10	University of Hyderabad	2511 (0.70)	2029	80.80
11	Jawaharlal Nehru University	2296 (0.64)	1717	74.78
12	University of Rajasthan	2096 (0.59)	1532	73.09
13	University of Mysore	2087 (0.59)	1503	72.02
14	University of Mumbai	2020 (0.57)	1504	74.46
15	Punjab Agricultural University India	1970 (0.55)	1097	55.69
16	University of Pune	1910 (0.54)	1507	78.90
17	Andhra University	1901 (0.53)	1204	63.34
18	Cochin University of Science and Technology	1784 (0.50)	1266	70.96
19	CCS Haryana Agricultural University	1746 (0.49)	935	53.55
20	Osmania University	1741 (0.49)	1119	64.27
21	Guru Nanak Dev University India	1664 (0.47)	1363	81.91
22	Sri Venkateswara University	1609 (0.45)	1247	77.50
23	The Maharaja Sayajirao University of Baroda	1520 (0.43)	1122	73.82
24	Madurai Kamaraj University	1360 (0.38)	1051	77.28
25	G B Pant University of Agriculture & Technology	1350 (0.38)	735	54.44
26	Karnatak University India	1311 (0.37)	1015	77.42
27	Mangalore University India	1255 (0.35)	939	74.82
28	University of Allahabad	1217 (0.34)	881	72.39
29	University of Lucknow	1209 (0.34)	867	71.71
30	Bharathidasan University	1201 (0.34)	946	78.77
31	Bharathiar University	1150 (0.32)	903	78.52
32	Bangalore University	1138 (0.32)	799	70.21

33	University of Kalyani	1097 (0.31)	862	78.58
34	University of Burdwan	1066 (0.30)	852	79.92
35	Shivaji University	1065 (0.30)	851	79.91
36	University of Kerala	1050 (0.29)	748	71.24
37	Tamilnadu Agricultural University	1047 (0.29)	549	52.44
38	Dr. Harisingh Gour University Sagar	983 (0.28)	719	73.14
39	Alagappa University	982 (0.28)	837	85.23
40	North-Eastern Hill University India	901 (0.25)	690	76.58
41	Sardar Patel University	864 (0.24)	639	73.96
42	Kurukshetra University	864 (0.24)	635	73.50
43	Punjabi University Patiala	831 (0.23)	544	65.46
44	Mahatma Gandhi University	821 (0.23)	670	81.61
45	University of Agricultural Sciences Bangalore	787 (0.22)	502	63.79
46	Pondicherry University	781 (0.22)	601	76.95
47	Jai Narain Vyas University Jodhpur	755 0.21)	515	68.21
48	Kakatiya University	740 (0.21)	500	67.57
49	University of Jammu	696 (0.20)	499	71.70
50	Utkal University	685 (0.19)	501	73.14

As on November 2, 2010; Figure in brackets indicates %age share to total national publication

H-Index Definition and Calculation

H-index is another significant marker of scientific activities which attempts to measure both the productivity and impact of the published work of a scientist or scholar which can be applied to an institution. The h-index is based on the set of the most cited papers and the number of citations that they have received in other people's publications (Figure-1).

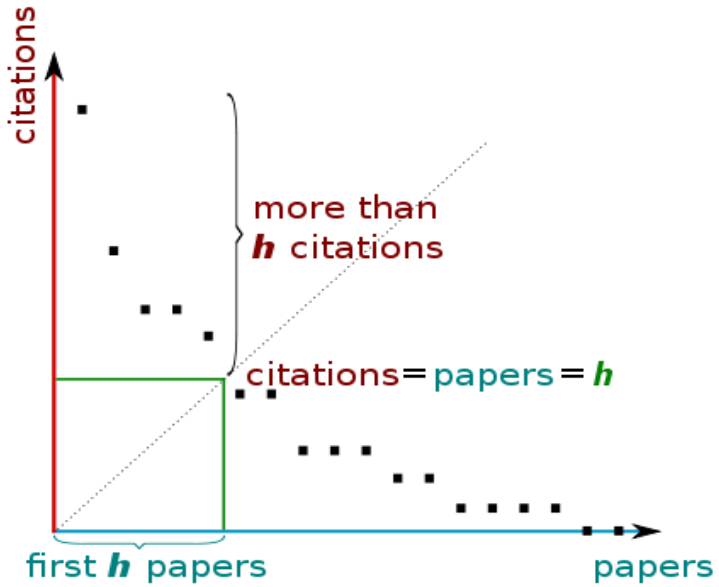

Figure-1: Computation of h-index

Source: http://en.wikipedia.org/wiki/H-index

In terms of h-index Hyderabad University (62) is at the top followed by University of Delhi (61), Panjab University (59), Banaras Hindu University (58), Jadavpur University (55), University of Pune (47), Anna University (46), University of Madras (44), Jawaharlal Nehru University (43) and Aligarh Muslim University (43). Analysis indicates that state universities like Panjab University, Jadavpur University and University of Pune have higher H-index as compared to Jawaharlal Nehru University (43) and Aligarh Muslim University (43). Table-4, provides h-index of the top 50 Indian universities.

Table-4: Top 50 University based on h-Index (1998-2008)*

Sl. No.	Name of University	h-Index
1	University of Hyderabad	62
2	University of Delhi	61
3	Panjab University	59
4	Banaras Hindu University	58
5	Jadavpur University	55
6	University of Pune	47
7	Anna University	46
8	University of Madras	44
9	Jawaharlal Nehru University	43
10	Aligarh Muslim University	43
11	University of Calcutta	42
12	University of Mumbai	42
13	Annamalai University	41
14	University of Rajasthan	39
15	Karnatak University India	38
16	Bharathidasan University	37
17	Bharathiar University	37
18	University of Burdwan	36
19	Guru Nanak Dev University India	36
20	Sri Venkateswara University	35
21	Mahatma Gandhi University	35
22	University of Jammu	34
23	Cochin University of Science and Technology	34
24	The Maharaja Sayajirao University of Baroda	33
25	Shivaji University	33
26	University of Kerala	33
27	Utkal University	33
28	Madurai Kamaraj University	32
29	Osmania University	32
30	Dr. Harisingh Gour University, Sagar	32
31	Mangalore University India	31
32	Andhra University	31
33	University of Kalyani	31
34	University of Mysore	30
35	University of Lucknow	30
36	CCS Haryana Agricultural University	30
37	Bangalore University	30
38	Pondicherry University	30

39	Punjab Agricultural University India	29
40	University of Agricultural Sciences, Bangalore	28
41	Tamilnadu Agricultural University	27
42	Alagappa University	27
43	Sardar Patel University	26
44	North-Eastern Hill University India	26
45	Kakatiya University	25
46	University of Allahabad	25
47	Punjabi University Patiala	24
48	Himachal Pradesh University	23
49	Jai Narain Vyas University, Jodhpur	22
50	Kurukshetra University	22

*As on November 2, 2010

6. Subject profile of universities

The computed data shows that Physics is a leading discipline in which maximum numbers of papers were published. The universities' share of Physics was 7.41% of total published papers while Chemistry's share was 7.28% of the total published papers. Biology was the third largest discipline in which 5.66% papers were published. In the area of energy only 0.63% papers were published. The comparative share of subject-wise profile of basic sciences i.e. Physics, Chemistry, biology, Mathematics and engineering sciences namely Chemical engineering, Environmental Science, Material Science, Energy, Engineering and Agriculture are presented in Figure-2..

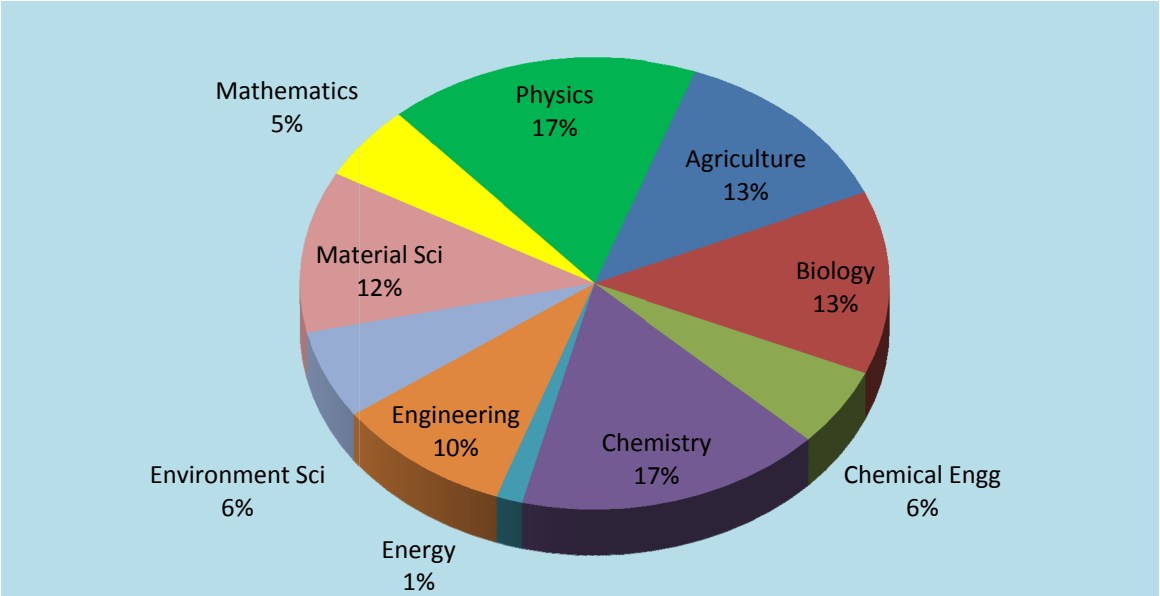

Figure-2: Percentage share of publication in different disciplines from Indian Universities

The year wise publications, citation per paper (CPP) and zone wise distribution and comparison of publication performance in different disciplines along with top 20 leading universities is presented below.

6.1 Basic Sciences

The following sub-section provides an analysis of performance in basic sciences at national level with global comparison. The analysis may give a feed back to the policy makers and researchers. The detailed research output in terms of publications in Physics, Chemistry, biology, Mathematics is discussed.

(i) Physics

The decadal average publication of universities was about 50.87% to the total Indian publication. University of Delhi (1360), Jadavpur University (6629) and Panjab University (988) were the top publishing universities in Physics. The percentage share of University of Delhi was 5.38%, Jadavpur University 4.75% and Panjab University 3.91% respectively to the total universities' publication in Physics for the period 1998-2008.

The decadal average contribution of publication output of universities in Physics was 7.41% of total S&T Indian publication. The share of Indian physics was about 2.74% to global publication during the period 1998-2008 and the universities' share was about 1.40% to the global Physics publication for the period 1998-2008.

The decadal average CPP of Physics was 8.91 for the period 1998-2008.

The detailed analysis of Indian universities is presented below.

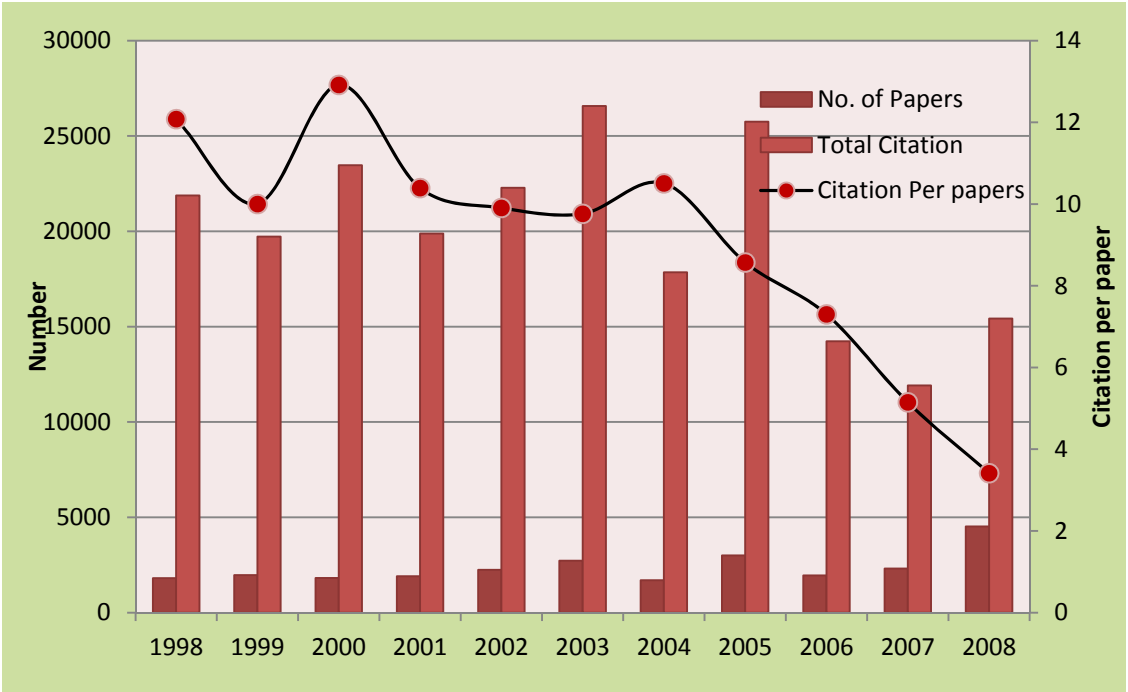

Figure-3-: Publication and Citation pattern in Physics

Table-5: Top 20 universities and their publication profile in Physics

Sl. No.	Institute Name	No. of Papers	Citation
1	University of Delhi	1383	9201
2	Jadavpur University	1214	6769
3	Panjab University	1006	12746
4	Anna University	940	5416
5	Banaras Hindu University	897	5654
6	Madras University	819	3206
7	University of Calcutta	818	4518
8	Hyderabad University	761	6286
9	Pune University	645	6953
10	Mangalore University	601	2639
11	Cochin University of Science and Technology	495	2747
12	Bharathidasan University	482	2700
13	Mysore University	465	1681
14	University of Allahabad	447	4630
15	Inter University Accelerator Centre	422	1819
16	University of Rajasthan	404	5566
17	Aligarh Muslim University	392	2223
18	Sri Venkateswara University	391	2509
19	Madurai Kamraj University	353	1421
20	Guru Nanak Dev University	340	2103

Table-6: Top 20 University from "North Zone" based on publication output in Physics

Sl. No.	Institute Name	No. of Papers	Citation
1	Delhi University	1383	9201
2	Panjab University	1006	12746
3	Banaras Hindu University	897	5654
4	University of Allahabad	447	4630
5	Inter University Accelerator Centre	422	1819
6	Aligarh Muslim University	392	2223
7	Guru Nanak Dev University	340	2103
8	Jawaharal Nehru University	333	2200
9	University of Jammu	235	4763
10	Kurukshetra University	166	711
11	University of Lucknow	159	805
12	Himachal Pradesh University	141	568
13	Punjabi University	140	634
14	Jamia Millia Islamia University	113	1904
15	GB Pant University of Agriculture & Technology	95	225
16	Kumaun University	91	238
17	Roorkee University	85	469
18	Chaudhary Charan Singh University	84	413
19	Deen Dayal Upadhyay Gorakhpur University	84	386
20	Maharshi Dayanand University	74	329

Table-7: Top 20 University from "South Zone" based on publication output in Physics

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	940	5416
2	Madras University	819	3206
3	Hyderabad University	761	6286
4	Mangalore University	601	2639
5	Cochin University of Science and Technology	495	2747
6	Bharathidasan University	482	2700
7	Mysore University	465	1681
8	Sri Venkateswara University	391	2509
9	Madurai Kamraj University	353	1421
10	Annamalai University	249	1332
11	Bharathiar University	242	1337
12	Osmania University	235	1378
13	Bangalore University	231	924
14	Andhra University	196	876
15	Alagappa University	184	1488
16	Kerala University	165	720
17	Karnataka University	126	511
18	Mahatma Gandhi University	116	478
19	Acharya Nagarjuna University	108	922
20	PA College of Engineering	105	435

Table-8: Top 20 University from "East Zone" based on publication output in Physics

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	1214	6769
2	University of Calcutta	818	4551
3	University of Burdwan	238	1562
4	North Eastern Hill University	203	1348
5	University of North Bengal	196	1000
6	University of Kalyani	189	943
7	Utkal University	183	2147
8	The Bengal Engineering & Science University	163	632
9	Visva Bharati University	160	848
10	Gauhati University	156	568
11	Tezpur University	108	466
12	Vidyasagar University	108	434
13	Sambalpur University	81	366
14	West Bengal University of Technology	66	186
15	Berhampur University	65	256
16	Manipur University	63	203
17	Dibrugarh University	55	89
18	TM Bhagalpur University	50	163
19	Inter University Consortium for DAEF	39	270
20	St. Xavier`s College	30	67

Table-9: Top 20 University from "West Zone" based on publication output in Physics

Sl. No.	Institute Name	No. of Papers	Citation
1	Pune University	645	6953
2	University of Rajasthan	404	5566
3	Inter University Center for Astronomy and Astrophysics	335	5795
4	Shivaji University	281	2189
5	Maharaja Sayajirao University of Baroda	247	837
6	Mumbai University	236	1344
7	Sardar Patel University	160	798
8	The Rashtrasant Tukadoji Maharaj Nagpur University	135	554
9	Saurashtra University	127	380
10	Mohan Lal Sukhadia University	101	380
11	Jai Narain Vyas University	82	473
12	Gujarat University	79	258
13	Goa University	61	362
14	Dr. Babasaheb Ambedkar Marathwada University	57	265
15	North Maharashtra University	48	264
16	South Gujarat University	43	295
17	Bhavnagar University	43	207
18	Sant Gagde Baba Amravati University	39	137
19	Inter University Consortium for DAE Facilities	27	275
20	Swami Ramanand Teerth Marathwada University	23	69

Table-10: Top University from "Central Zone" based on publication output in Physics

Sl. No.	Institute Name	No. of Papers	Citation
1	Devi Ahilya University	202	740
2	Inter University Consortium for DAE Facilities	168	1530
3	Barkatullah University	121	452
4	Pt. Ravi Shankar Shukla University	90	336
5	Vikram University	72	188
6	Rani Durgavati University	48	135
7	Dr Hari Singh Gour University	47	142
8	Guru Ghasidas University	46	210
9	Inter University Consortium for DAEF	44	427
10	Awadhesh Pratap Singh University	42	100
11	Jiwaji University	34	225
12	Madhya Pradesh Bhoj Open University	25	124
13	Rajiv Gandhi Proudyogiki University	8	1

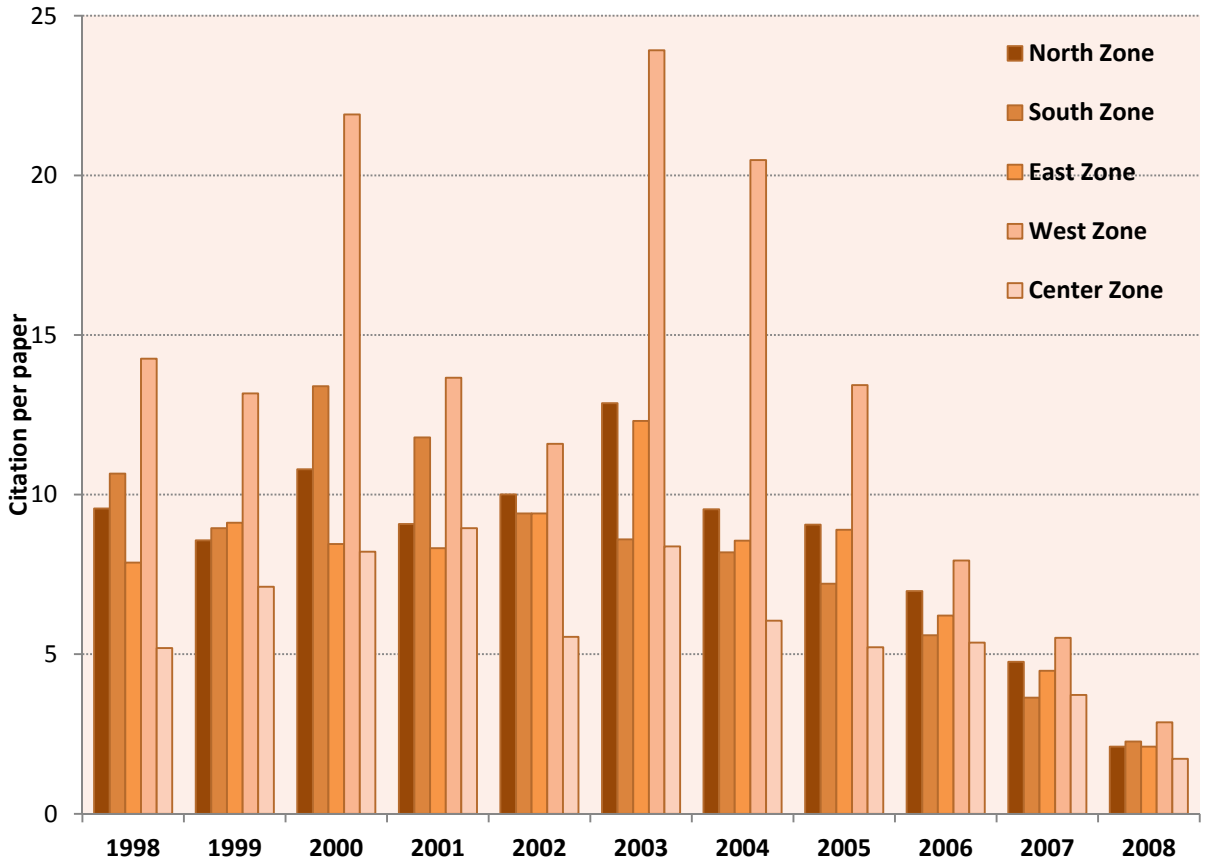

Figure 4 : Zone wise citation per paper in Physics

(ii) Chemistry

The universities published about 46.64% of the total publication in Chemistry whereas the decadal average contribution of publication output of universities in Chemistry was about 7.28% of total S&T Indian publication (1998-2008).

Jadavpur University (1095), University of Delhi (877) and University of Rajasthan (789) were the top publishing universities in Chemistry. The percentage share of Jadavpur University was 4.27%, University of Delhi 3.42% and University of Rajasthan 3.08% respectively to the total univerities' publication in chemistry during the period 1998-2008.

The publication of Indian universities' in chemistry was about 2.12% to global publication in chemistry and share of Indian publication to the global chemistry publication was about 4.59% during the period 1998-2008.

The decadal average CPP of Chemistry was 12.69 during 1998-2008.

The detailed analysis of Indian universities is presented below.

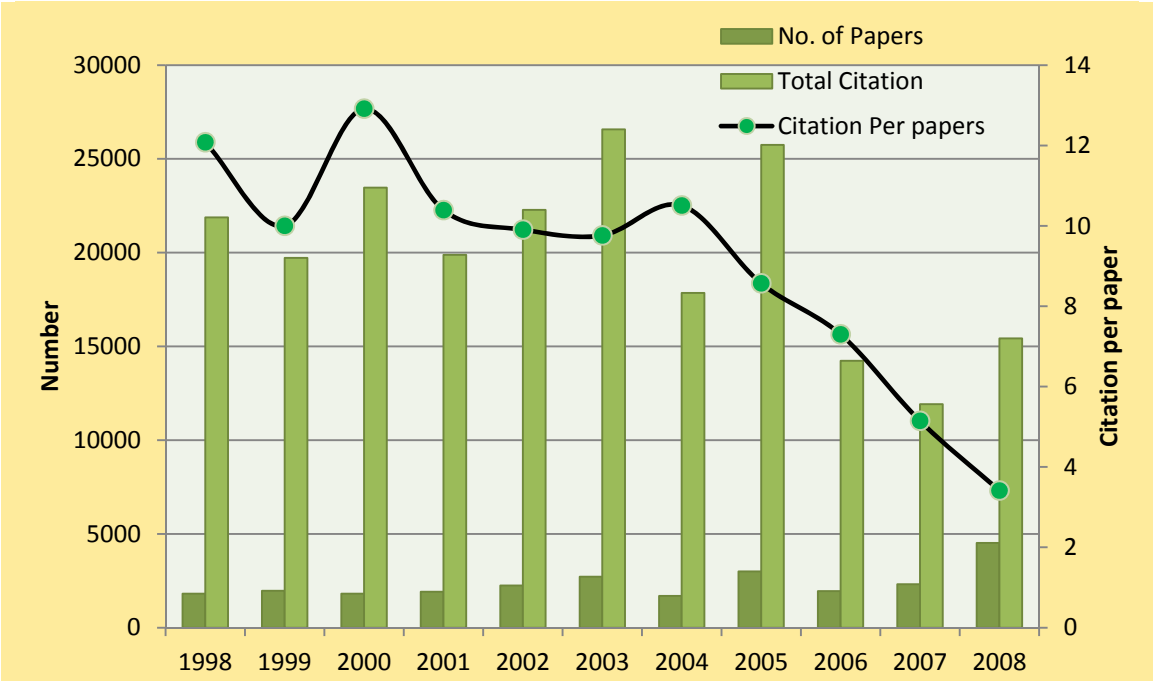

Figure-5: Publication and Citation pattern in Chemistry

Table-11: Top 25 University in Chemistry based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	1099	11136
2	Delhi University	879	8734
3	University of Rajasthan	792	3862
4	Hyderabad University	742	17653
5	Banaras Hindu University	728	6632
6	Mumbai University	712	6021
7	Sri Venkateswara University	624	3764
8	Aligarh Muslim University	603	3792
9	Madras University	591	4280
10	Mysore University	561	3320
11	University of Calcutta	560	4397
12	Annamalai University	532	3164
13	Guru Nanak Dev University	522	4937
14	Panjab University	458	3716
15	Karnataka University	451	3503
16	Anna University	450	3317
17	Pune University	426	4433
18	University of Burdwan	401	3862
19	University of Kalyani	376	3032
20	Osmania University	371	1320
21	Andhra University	359	1581
22	Madurai Kamraj University	343	2888
23	Mangalore University	335	2029
24	Bharathiar University	329	2183
25	University of Allahabad	307	1673

Table-12: Top 20 University based on publication output in Chemistry (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Delhi University	879	8734
2	Banaras Hindu University	728	6632
3	Aligarh Muslim University	603	3792
4	Guru Nanak Dev University	522	4937
5	Panjab University	458	3716
6	University of Allahabad	307	1673
7	Kurukshetra University	260	1913
8	Maharshi Dayanand University	241	902
9	University of Lucknow	225	1107
10	Deen Dayal Upadhyay Gorakhpur University	223	1162
11	Jamia Hamdard University	202	1337
12	Punjabi University	170	817
13	Roorkee University	168	2989
14	University of Jammu	154	872
15	Jamia Millia Islamia University	137	1095
16	Punjab Agricultural University	116	455
17	Himachal Pradesh University	115	528

18	Jawaharal Nehru University	98	934
19	Kumaun University	90	342
20	Chaudhary Charan Singh University	74	579

Table-13: Top 20 University based on publication output in Chemistry (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Hyderabad University	742	17653
2	Sri Venkateswara University	624	3764
3	Madras University	591	4280
4	Mysore University	561	3320
5	Annamalai University	532	3164
6	Karnataka University	451	3503
7	Anna University	450	3317
8	Osmania University	371	1320
9	Andhra University	359	1581
10	Madurai Kamraj University	343	2888
11	Mangalore University	335	2029
12	Bharathiar University	329	2183
13	Kakatiya University	307	1826
14	Bangalore University	303	1840
15	Bharathidasan University	273	2647
16	Cochin University of Science and Technology	229	1362
17	Mahatma Gandhi University	195	1956
18	Kerala University	187	1226
19	Alagappa University	166	1290
20	Jawaharlal Nehru Technological University	157	550

Table-14: Top 20 University based on publication output in Chemistry (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	1099	11136
2	University of Calcutta	560	4397
3	University of Burdwan	401	3862
4	University of Kalyani	376	3032
5	North Eastern Hill University	255	1996
6	University of North Bengal	131	1026
7	Utkal University	120	527
8	The Bengal Engineering & Science University	100	660
9	Gauhati University	88	473
10	Visva Bharati University	81	400
11	Sambalpur University	80	1137
12	Vidyasagar University	67	474
13	Tezpur University	58	466
14	Manipur University	42	139
15	Dibrugarh University	40	227
16	Patna University	35	69
17	Magadh University	34	49

18	Berhampur University	25	130
19	BR Ambedkar Bihar University	20	31
20	Ranchi University	17	21

Table-15: Top 20 University based on publication output in Chemistry (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	University of Rajasthan	792	3862
2	Mumbai University	712	6021
3	Pune University	426	4433
4	Jai Narain Vyas University	262	1105
5	Shivaji University	261	1730
6	Maharaja Sayajirao University of Baroda	242	1398
7	Sardar Patel University	199	1402
8	South Gujarat University	199	1502
9	Dr. Babasaheb Ambedkar Marathwada University	193	1189
10	Saurashtra University	188	859
11	Mohan Lal Sukhadia University	157	394
12	The Rashtrasant Tukadoji Maharaj Nagpur University	125	550
13	Gujarat University	111	826
14	Swami Ramanand Teerth Marathwada University	80	455
15	Sant Gagde Baba Amravati University	76	281
16	Goa University	66	626
17	Maharshi Dayanand Saraswati University	59	257
18	University Institute of Chemical Technology	51	285
19	North Maharashtra University	41	213
20	Bharati Vidyapeeth University	29	220

Table-16: Top University based on publication output in Chemistry (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Dr Hari Singh Gour University	304	1582
2	Pt. Ravi Shankar Shukla University	162	544
3	Awadhesh Pratap Singh University	147	1445
4	Devi Ahilya University	145	1066
5	Vikram University	101	352
6	Jiwaji University	94	362
7	Rani Durgavati University	83	654
8	Inter University Consortium for DAE Facilities	21	321
9	Barkatullah University	19	72
10	Rajiv Gandhi Proudyogiki University	10	22
11	Guru Ghasidas University	9	22
12	Chhattisgarh Swami Vivekanand Technical University	3	7
13	Indira Gandhi Agricultural University	2	4

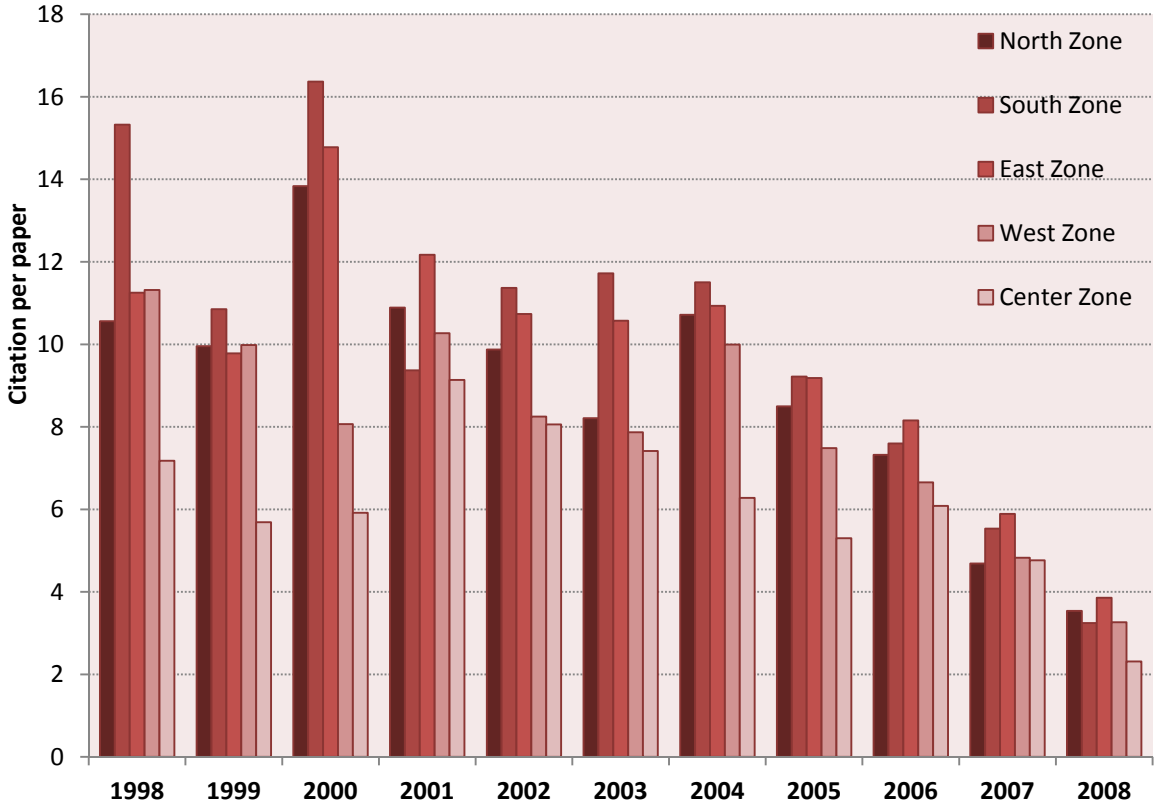

Figure-6: Zone-wise citation pattern in Chemistry

(iii) Mathematics

The decadal average publication by universities was about 53.55% of the total publication in mathematics whereas average contribution of publication output of universities in Mathematics was about 2.33% of total S&T Indian publication for the period 1998-2008.

University of Delhi, Jadavpur University and University of Calcutta were the top publishing universities in Mathematics. Their percentage share to the total universities' publication in Mathematics was 8.28%, 5.89% and 4.88% respectively during 1998-2008.

The publication of Indian universities' was about 2.28% to global publication in Mathematics and share of Indian universities publication share was about 1.22% to the global publication in Mathematics during the period 1998-2008.

The decadal average CPP of Mathematics was 6.83 in 1998-2011.
The detailed publication distribution of Indian universities is presented below.

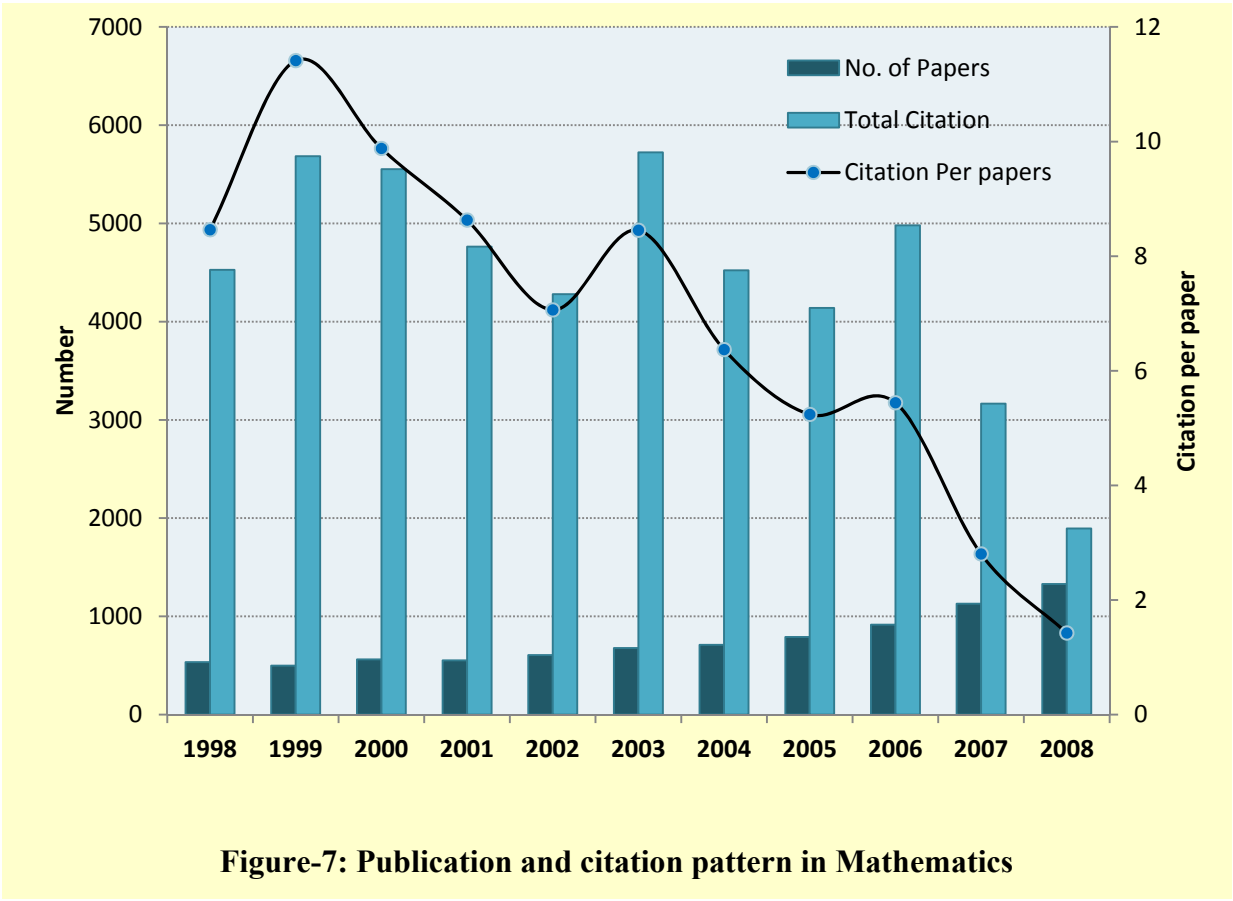

Figure-7: Publication and citation pattern in Mathematics

Table-17: Top 25 University in Mathematics based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Delhi University	578	2610
2	Jadavpur University	406	2365
3	University of Calcutta	337	1755
4	Panjab University	308	1669
5	Aligarh Muslim University	241	1196
6	Anna University	234	697
7	Hyderabad University	175	663
8	Banaras Hindu University	157	671
9	Pune University	155	948
10	Jawaharal Nehru University	143	823
11	University of Allahabad	141	1592
12	Madras University	137	423
13	Inter University Center for Astronomy and Astrochemistry	134	3291
14	Bharathidasan University	122	902
15	Cochin University of Science and Technology	119	326
16	Bharathiar University	103	335
17	The Bengal Engineering & Science University	95	265
18	University of Kalyani	94	417
19	Vidyasagar University	76	535
20	University of Rajasthan	75	119

Table-18: Top 20 University based on publication output in Mathematics (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Delhi University	578	2610
2	Panjab University	308	1609
3	Aligarh Muslim University	241	1196
4	Banaras Hindu University	157	671
5	Jawaharal Nehru University	143	823
6	University of Allahabad	141	1592
7	Himachal Pradesh University	72	226
8	University of Lucknow	71	223
9	Kurukshetra University	58	122
10	University of Kashmir	39	45
11	University of Jammu	37	97
12	Jamia Millia Islamia University	35	1277
13	Roorkee University	31	125
14	Punjabi University	30	158
15	GB Pant University of Agriculture & Technology	30	104
16	Maharshi Dayanand University	29	144
17	Guru Nanak Dev University	26	40
18	Kumaun University	23	106
19	Guru Gobind Singh Indraprashta University	22	114
20	Chaudhary Charan Singh University	22	38

Table-19: Top 20 University based on publication output in Mathematics (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	234	697
2	Hyderabad University	175	663
3	Madras University	137	423
4	Bharathidasan University	122	902
5	Cochin University of Science and Technology	119	326
6	Bharathiar University	103	335
7	Annamalai University	76	154
8	Mysore University	70	61
9	Madurai Kamraj University	68	175
10	Osmania University	59	119
11	Andhra University	58	166
12	Bangalore University	50	80
13	Kerala University	49	87
14	Manonmaniam Sundaranar University	37	45
15	Karnataka University	36	80
16	Periyar University	33	68
17	Mangalore University	24	66
18	Acharya Nagarjuna University	24	30
19	Gulbarga University	24	78
20	Vellore Institute of Technology University	23	52

Table-20: Top 20 University based on publication output in Mathematics (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	406	2365
2	University of Calcutta	337	1755
3	The Bengal Engineering & Science University	95	265
4	University of Kalyani	94	417
5	Vidyasagar University	76	535
6	University of North Bengal	70	403
7	Utkal University	67	287
8	University of Burdwan	67	205
9	North Eastern Hill University	50	279
10	Visva Bharati University	50	294
11	Berhampur University	47	209
12	Tezpur University	39	128
13	West Bengal University of Technology	36	82
14	Gauhati University	33	100
15	Sambalpur University	16	24
16	Veer Surendra Sai University of Technology	14	2
17	Indian School of Mines University	14	12
18	Manipur University	12	17
19	St. Xavier`s College	12	12
20	TM Bhagalpur University	10	2

Table-21: Top 20 University based on publication output in Mathematics (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Pune University	155	948
2	Inter University Center for Astronomy and Astrochemistry	134	3291
3	University of Rajasthan	75	119
4	Mumbai University	52	113
5	Sardar Patel University	42	153
6	Jai Narain Vyas University	29	112
7	Shivaji University	29	78
8	Maharaja Sayajirao University of Baroda	27	70
9	Gujarat University	21	57
10	Dr. Babasaheb Ambedkar Marathwada University	17	71
11	The Rashtrasant Tukadoji Maharaj Nagpur University	17	27
12	Maharana Pratap University of Agriculture and Technology	13	31
13	Mohan Lal Sukhadia University	12	5
14	Saurashtra University	12	10
15	North Maharashtra University	10	20
16	Bhavnagar University	9	13
17	Rajasthan Technical University	8	7
18	Banasthali Vidyapith University	6	12
19	Goa University	5	18
20	Maharshi Dayanand Saraswati University	5	5

Table-22: Top University based on publication output in Mathematics (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Vikram University	37	91
2	Rani Durgavati University	30	63
3	Devi Ahilya University	21	129
4	Pt. Ravi Shankar Shukla University	20	23
5	Awadhesh Pratap Singh University	9	148
6	Guru Ghasidas University	8	88
7	Jiwaji University	7	12
8	Dr Hari Singh Gour University	7	6
9	Kalyan Mahavidyalaya	4	26
10	Rajiv Gandhi Proudyogiki University	4	4

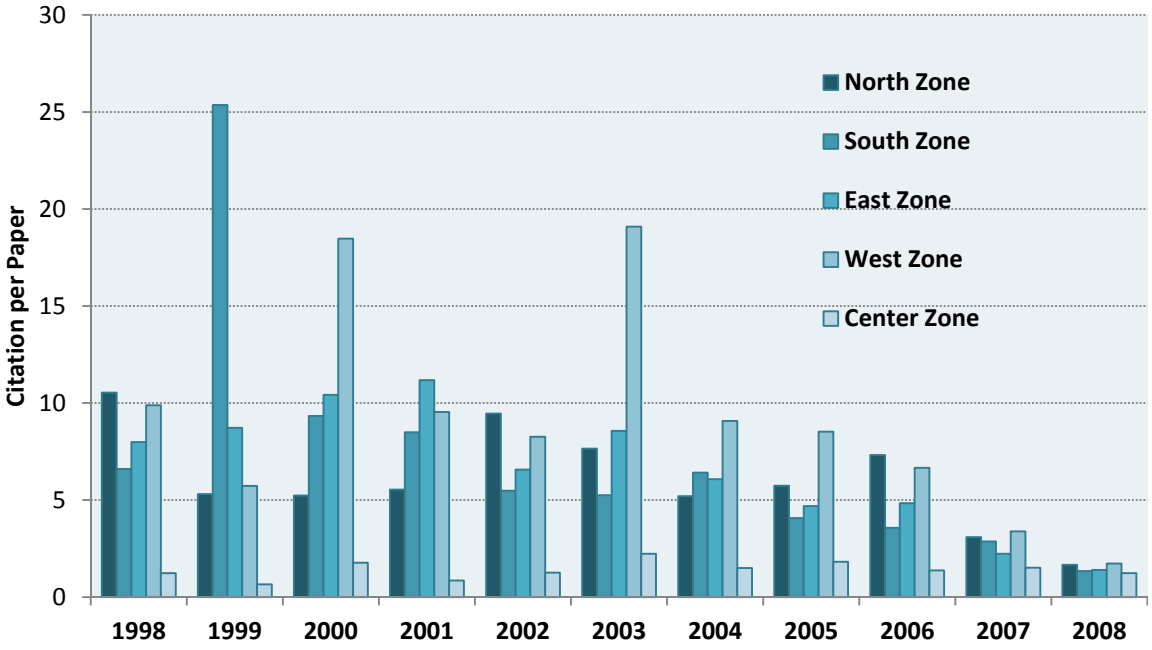

Figure-8: Zone-wise citation pattern in Mathematics

(iv) Biology

The decadal average publication by universities was about 43.25% of the total publication in Biology whereas average contribution of publication output of universities in Biology was about 5.66% of total S&T Indian publication for the period 1998-2008.

Madras University, University of Delhi and, Banaras Hindu University were the top publishing universities in Biology. Their percentage share to the universities publication in Biology was 6.40%, 4.92% and 4.05 % respectively in the period 1998-2008.

The share of Indian publication was about 2.13% to global publication in Biology and share of Indian universities' publication was about 0.93% to the global publication in Biology during the period 1998-2008.

The decadal average CPP of Biology was 10.82 during the period 1998-2008.

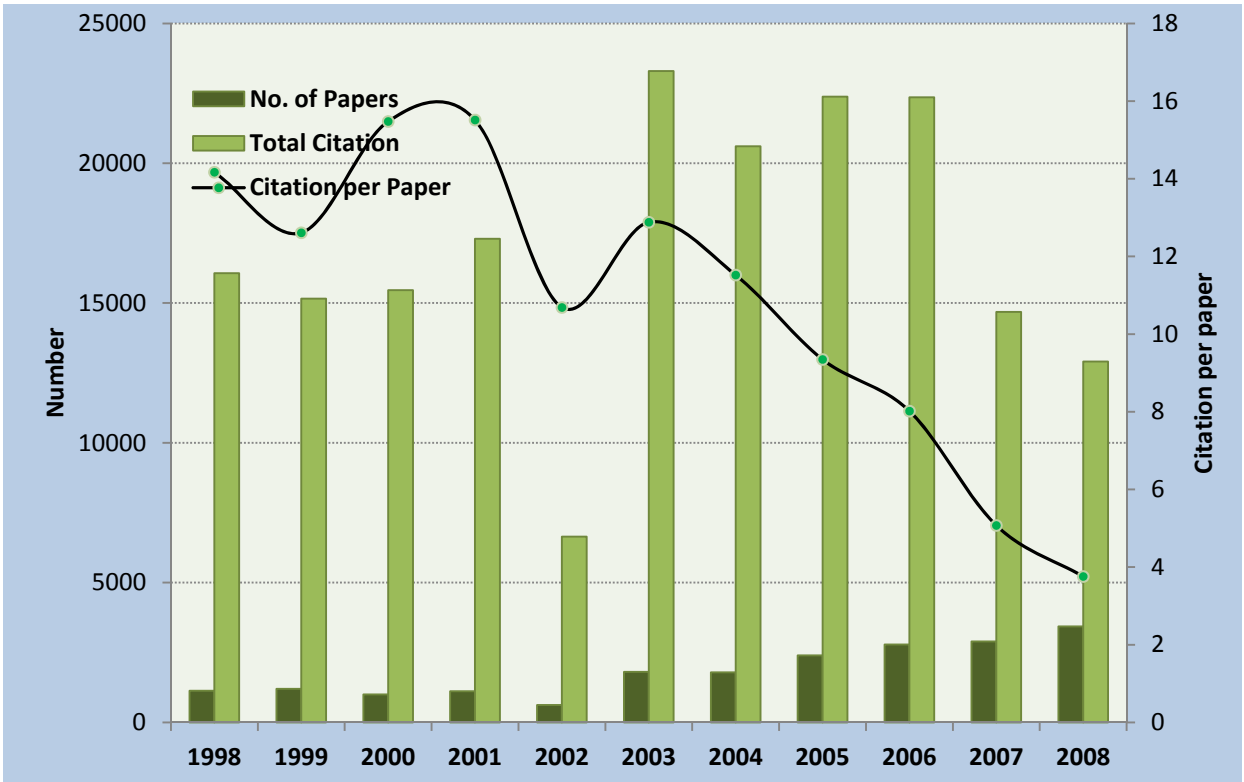

Figure-9: Publication and Citation pattern in Biology

Table-23: Top 25 University in Biology based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Madras University	1243	8526
2	Delhi University	964	12115
3	Banaras Hindu University	789	6161
4	Jadavpur University	635	5891
5	Panjab University	569	4699
6	Mysore University	554	2494
7	Hyderabad University	552	6946
8	Annamalai University	544	4471
9	Jawaharal Nehru University	521	5161
10	University of Calcutta	493	3799
11	Bharathidasan University	477	3179
12	Aligarh Muslim University	454	3290
13	Mangalore University	450	2265
14	Anna University	441	1956
15	Madurai Kamraj University	390	2629
16	Mumbai University	322	3397
17	Pune University	306	2576
18	Andhra University	300	2226
19	Osmania University	285	2054
20	Guru Nanak Dev University	283	2909
21	Jamia Hamdard University	262	2588
22	Punjab Agricultural University	234	1873
23	Sri Venkateswara University	219	2146
24	University of Kalyani	211	2609
25	Maharaja Sayajirao University of Baroda	201	1498

Table-24: Top 20 University based on publication output in Biology (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Delhi University	964	12115
2	Banaras Hindu University	789	6161
3	Panjab University	569	4699
4	Jawaharal Nehru University	521	5161
5	Aligarh Muslim University	454	3290
6	Guru Nanak Dev University	283	2909
7	Jamia Hamdard University	262	2588
8	Punjab Agricultural University	234	1873
9	University of Lucknow	150	1314
10	Punjabi University	131	982
11	University of Allahabad	130	1083
12	Chaudhary Charan Singh University	113	2132
13	CCS Haryana Agricultural University	107	1245
14	GB Pant University of Agriculture & Technology	98	690
15	Chhatrapati Shahuji Maharaj Medical University	91	514
16	Maharshi Dayanand University	83	577
17	University of Jammu	79	472

18	Kurukshetra University	78	702
19	Jamia Millia Islamia University	70	667
20	Himachal Pradesh University	58	526

Table-25: Top 20 University based on publication output in Biology (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Madras University	1243	8526
2	Mysore University	554	2494
3	Hyderabad University	552	6946
4	Annamalai University	544	4471
5	Bharathidasan University	477	3179
6	Mangalore University	450	2265
7	Anna University	441	1956
8	Madurai Kamraj University	390	2629
9	Andhra University	300	2226
10	Osmania University	285	2054
11	Sri Venkateswara University	219	2146
12	Karnataka University	177	1543
13	Kerala University	177	1143
14	Bangalore University	175	825
15	Bharathiar University	165	910
16	Tamil Nadu Agricultural University	131	831
17	Kakatiya University	129	835
18	University of Agricultural Sciences	119	1140
19	Cochin University of Science and Technology	115	1283
20	Gulbarga University	110	605

Table-26: Top 20 University based on publication output in Biology (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	635	5891
2	University of Calcutta	493	3799
3	University of Kalyani	211	2609
4	North Eastern Hill University	196	1566
5	University of Burdwan	136	1878
6	The Bengal Engineering & Science University	68	511
7	Vidyasagar University	58	629
8	Utkal University	58	567
9	Visva Bharati University	53	399
10	Gauhati University	51	241
11	University of North Bengal	51	443
12	West Bengal University of Health Sciences	49	335
13	Tezpur University	27	196
14	Manipal University	26	109
15	Manipur University	26	184
16	West Bengal University of Technology	22	40
17	Nagaland University	21	98
18	Sambalpur University	20	135

19	Berhampur University	19	62
20	Assam Agricultural University	18	104

Table-27: Top 20 University based on publication output in Biology (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Mumbai University	322	3397
2	Pune University	306	2576
3	Maharaja Sayajirao University of Baroda	201	1498
4	University of Rajasthan	167	1151
5	The Rashtrasant Tukadoji Maharaj Nagpur University	110	638
6	Sardar Patel University	89	868
7	Gujarat University	66	473
8	Dr. Babasaheb Ambedkar Marathwada University	61	291
9	Saurashtra University	58	347
10	Bharati Vidyapeeth University	55	236
11	Jai Narain Vyas University	54	178
12	Goa University	52	459
13	Mohan Lal Sukhadia University	50	184
14	Shivaji University	45	288
15	Swami Ramanand Teerth Marathwada University	39	365
16	Sant Gagde Baba Amravati University	35	142
17	North Maharashtra University	28	47
18	Maharshi Dayanand Saraswati University	26	143
19	University Institute of Chemical Technology	26	177
20	Rajasthan Agricultural University	25	129

Table-28: Top University based on publication output in Biology (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Devi Ahilya University	149	1359
2	Dr Hari Singh Gour University	120	908
3	Pt. Ravi Shankar Shukla University	70	453
4	Awadhesh Pratap Singh University	58	736
5	Jiwaji University	56	254
6	Barkatullah University	47	95
7	Rani Durgavati University	35	200
8	Jawaharlal Nehru Krishi University	12	8
9	Vikram University	12	109
10	Rajiv Gandhi Proudyogiki University	11	21

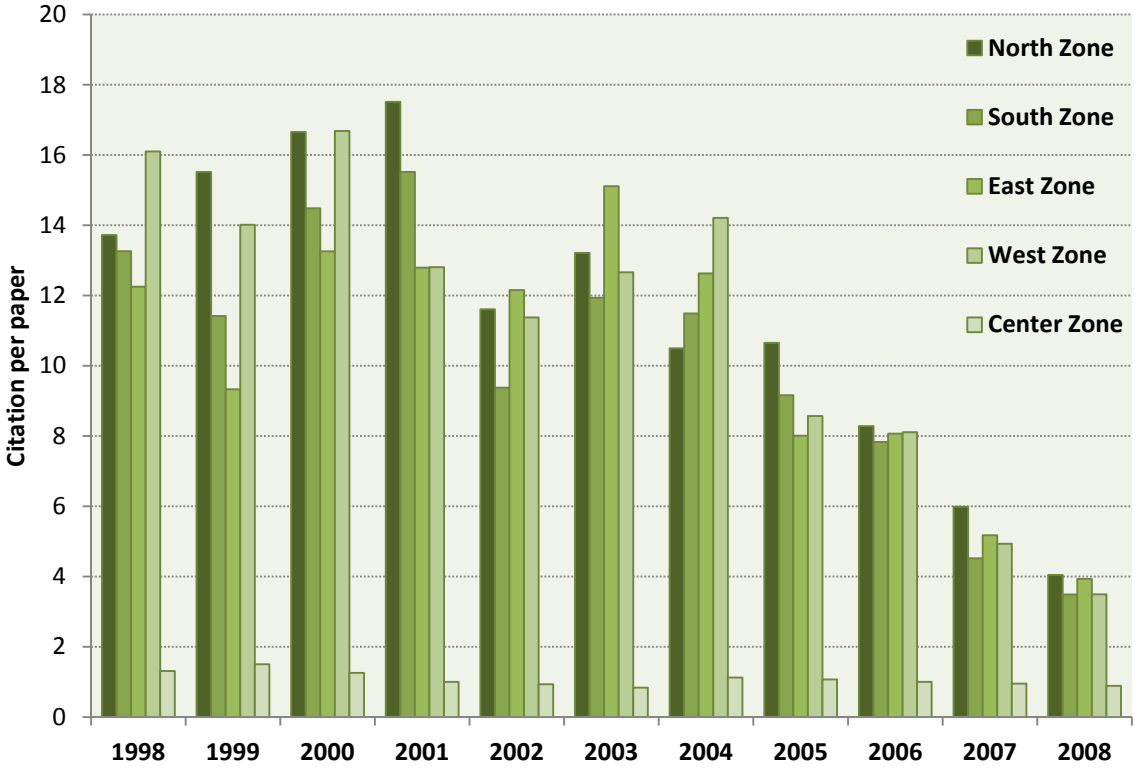

Figure-10: Zone-wise citation pattern in Biology

6.2 Applied Science:

In this sub-section performance of some traditional engineering stream with different indicators is presented.

(i) Agriculture

The decadal average publication by universities was about 42.70% of the total publication in Agriculture whereas average contribution of Agriculture publication output of universities was about 5.56% of the total S&T Indian publication.

Punjab Agricultural University (6.06%), CCS Haryana Agricultural University (5.19%) and University of Delhi (3.79%) were the top publishing universities in Agriculture to the total publication in Agriculture for the period 1998-2008.

The decadal average national publication was about 4.04% to global publication in Agriculture and the share of Indian universities' publication was about 1.71% to the global publication in Agriculture during the period 1998-2008.

The decadal average CPP of Agriculture publication was 5.41 during 1998-2008.

The detailed performance with different indicators is given below.

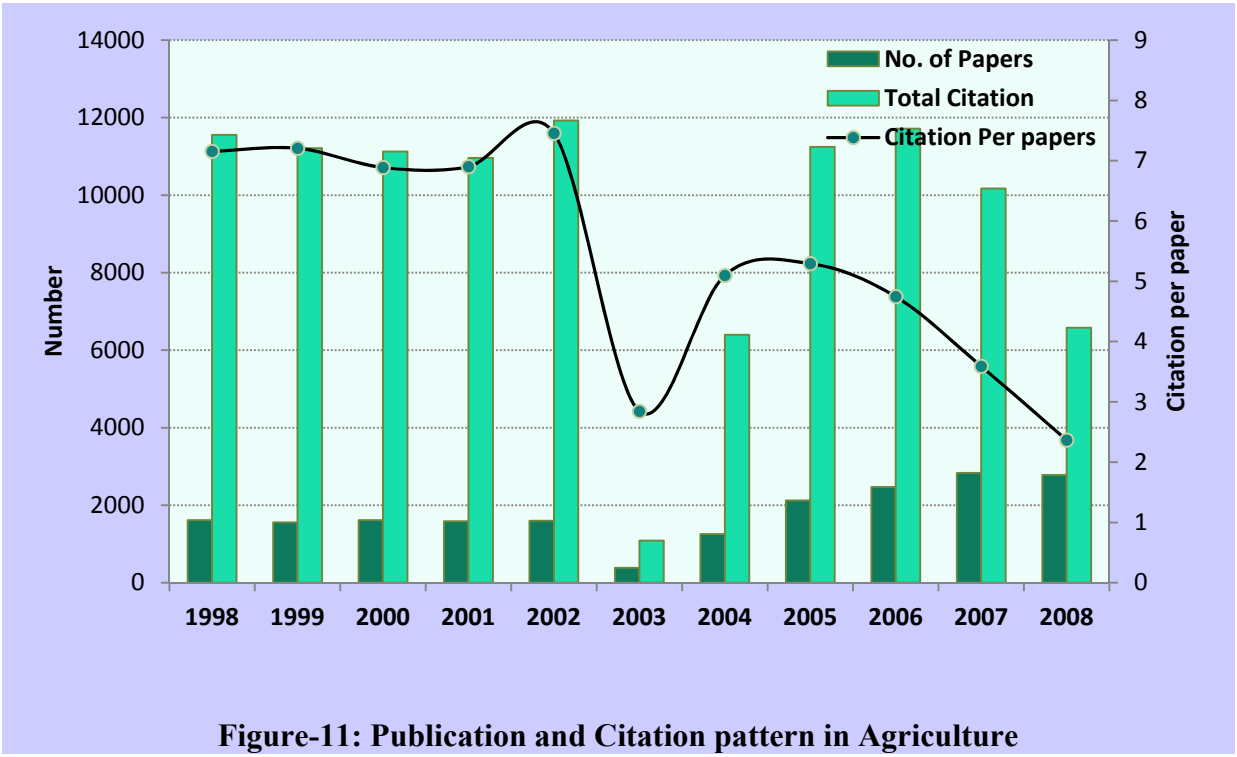

Figure-11: Publication and Citation pattern in Agriculture

Table-29: Top 20 University in Agriculture based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Punjab Agricultural University	1300	5167
2	CCS Haryana Agricultural University	1042	3670
3	University of Agricultural Sciences	734	3139
4	Delhi University	730	6063
5	GB Pant University of Agriculture & Technology	717	1998
6	Tamil Nadu Agricultural University	694	2561
7	Banaras Hindu University	684	5431
8	Aligarh Muslim University	456	2109
9	University of Calcutta	318	1967
10	Madras University	315	1781
11	Annamalai University	291	1972
12	Jawaharal Nehru University	288	2857
13	Panjab University	282	2192
14	Mysore University	278	1349
15	Tamil Nadu Veterinary & Animal Sciences University	277	497
16	Assam Agricultural University	269	385
17	Guru Nanak Dev University	265	2037
18	Acharya N G Ranga Agricultural University	265	561
19	Rajasthan Agricultural University	264	484
20	University of Lucknow	243	1301

Table-30: Top 20 University based on publication output in Agriculture (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Punjab Agricultural University	1300	5167
2	CCS Haryana Agricultural University	1042	3670
3	Delhi University	730	6063
4	GB Pant University of Agriculture & Technology	717	1998
5	Banaras Hindu University	684	5431
6	Aligarh Muslim University	456	2109
7	Jawaharal Nehru University	288	2857
8	Panjab University	282	2192
9	Guru Nanak Dev University	265	2037
10	University of Lucknow	243	1301
11	Dr. YS Parmar University of Horticulture & Forestry	202	358
12	Chaudhary Charan Singh University	127	1289
13	Sher-e-Kashmir University of Agricultural Science and Technology	123	312
14	Jamia Hamdard University	122	901
15	Hemwati Nandan Bahuguna Garhwal University	121	414
16	Kumaun University	118	314
17	Narendra Dev University of Agriculture and Technology	117	411
18	Deen Dayal Upadhyay Gorakhpur University	115	506
19	CSK Himachal Pradesh Krishi University	112	325
20	Guru Angad Dev Veterinary and Animal Sciences University	110	67

Table-31: Top 20 University based on publication output in Agriculture (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	University of Agricultural Sciences	734	3129
2	Tamil Nadu Agricultural University	694	2561
3	Madras University	315	1781
4	Annamalai University	291	1972
5	Mysore University	287	1349
6	Tamil Nadu Veterinary & Animal Sciences University	277	497
7	Acharya N G Ranga Agricultural University	265	561
8	Madurai Kamraj University	230	1711
9	Andhra University	215	1088
10	Osmania University	210	1694
11	Hyderabad University	202	1664
12	Kerala Agricultural University	195	484
13	Bharathidasan University	180	1154
14	Calicut University	167	442
15	Karnataka University	161	823
16	Bharathiar University	153	1856
17	Kerala University	128	576
18	Anna University	119	1110
19	Bangalore University	92	304
20	Mangalore University	88	489

Table-32: Top 20 University based on publication output in Agriculture (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	University of Calcutta	318	1967
2	Assam Agricultural University	269	385
3	Jadavpur University	154	1182
4	North Eastern Hill University	142	758
5	University of Kalyani	140	403
6	Rajendra Agricultural University	123	239
7	Orissa University of Agriculture and Technology	119	114
8	West Bengal University of Animal & Fisheries Science University	115	241
9	Visva Bharati University	114	499
10	Birsa Agricultural University	103	192
11	University of Burdwan	95	486
12	Manipur University	72	198
13	Utkal University	62	490
14	Gauhati University	61	131
15	University of North Bengal	47	255
16	Assam University	46	257
17	Sambalpur University	44	258
18	Bidhan Chandra Krishi University	41	218
19	Vidyasagar University	38	100
20	Tezpur University	37	232

Table-33: Top 20 University based on publication output in Agriculture (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Rajasthan Agricultural University	264	484
2	Pune University	202	999
3	Mumbai University	171	1281
4	Maharaja Sayajirao University of Baroda	138	756
5	Gujarat Agricultural University	137	319
6	University of Rajasthan	135	627
7	Jai Narain Vyas University	90	384
8	Sardar Patel University	85	615
9	Saurashtra University	81	398
10	Maharana Pratap University of Agriculture and Technology	74	181
11	Marathwada Agricultural University	65	142
12	Goa University	62	210
13	Mohan Lal Sukhadia University	58	203
14	Anand Agricultural University	55	49
15	Gujarat University	50	293
16	The Rashtrasant Tukadoji Maharaj Nagpur University	45	67
17	Shivaji University	36	311
18	North Maharashtra University	29	114
19	Maharashtra Animal and Fishery Sciences University	24	18
20	Junagadh Agricultural University	23	9

Table-34: Top University based on publication output in Agriculture (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jawaharlal Nehru Krishi University	172	171
2	Pt. Ravi Shankar Shukla University	73	304
3	Indira Gandhi Krishi University	69	245
4	Devi Ahilya University	58	578
5	Dr Hari Singh Gour University	45	139
6	Barkatullah University	42	118
7	Indira Gandhi Agricultural University	42	153
8	Rani Durgavati University	41	158
9	Vikram University	28	73
10	Jiwaji University	28	84

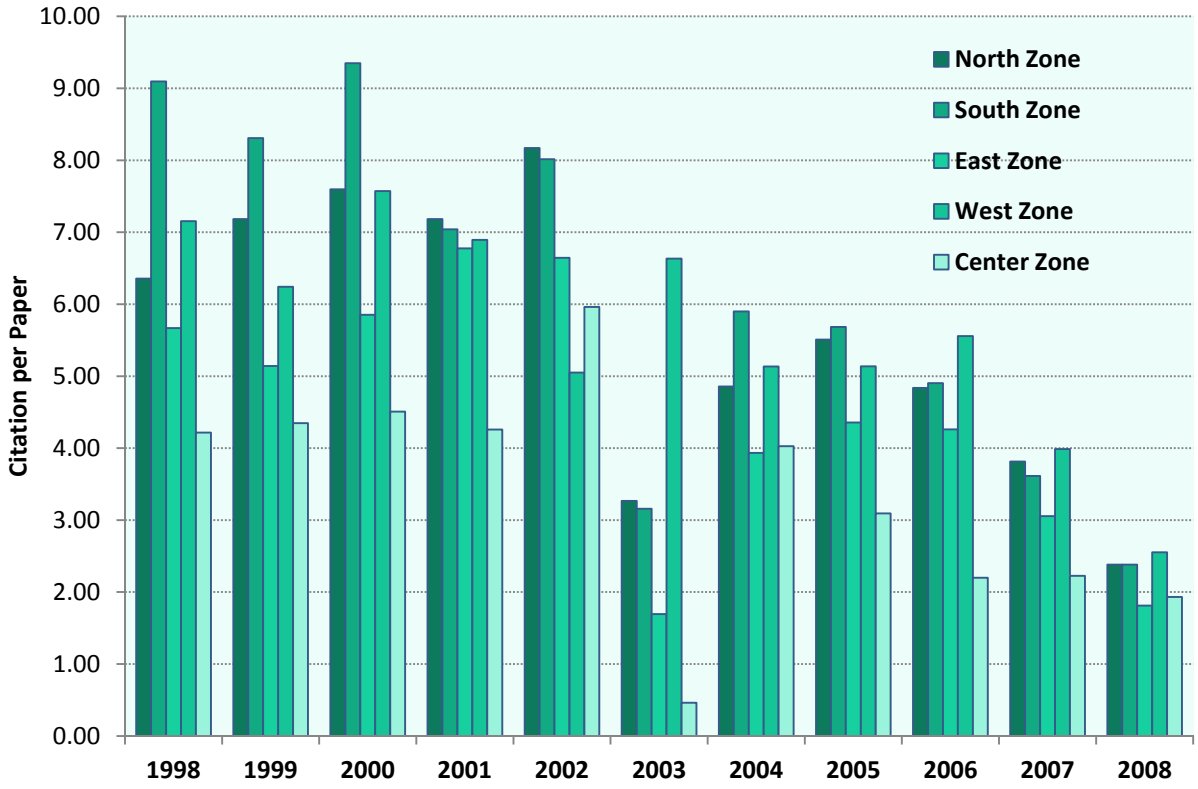

Figure-12: Zone-wise citation pattern in Agriculture

(ii) Energy

The decadal average publication by universities was about 30.46% of the total publication in Energy whereas average contribution of publication output of universities was about 0.63% of total S&T Indian publication for 1998-2008.

Jadavpur University with 8.46%, Anna University with 7.96% and Banaras Hindu University with 5.21% were the top publishing universities in Energy in the period 1998-2008.

The decadal Average national publication was about 2.10% to global publication in Energy and share of Indian universities' publication was about 0.64% to the global publication in Energy during the period 1998-2008.

The decadal average CPP in Energy was 8.54 for 1998 to 2008.

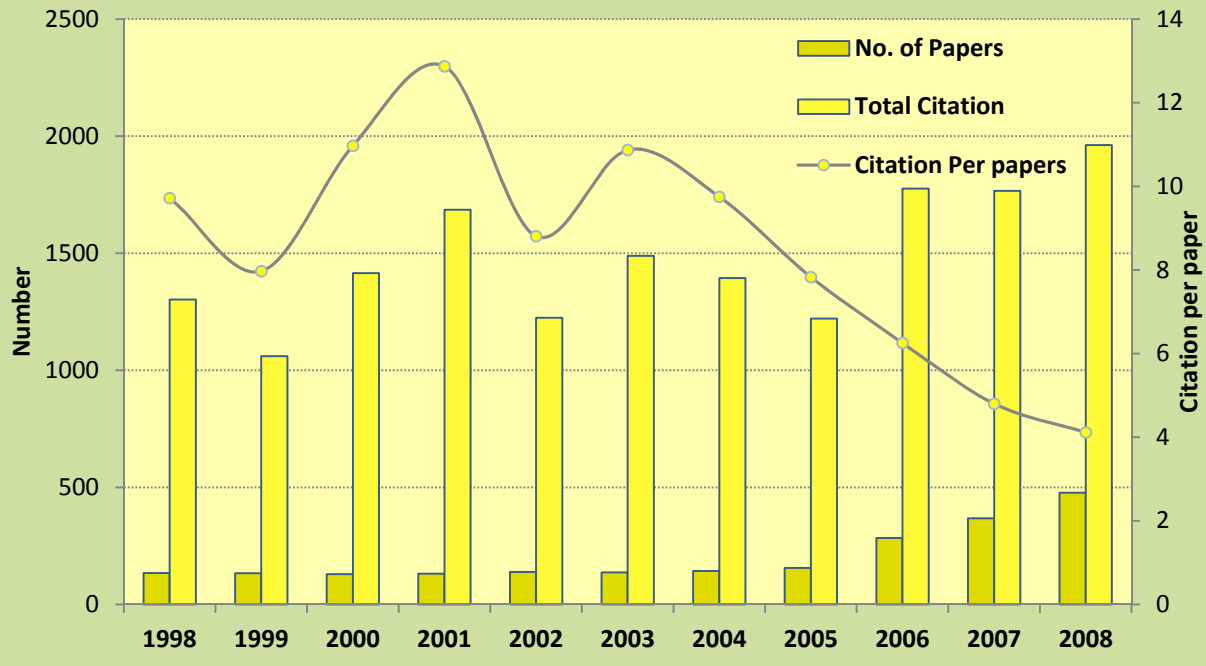

Figure-13: Publication and Citation pattern in Energy

Table-35: Top 20 University in Energy based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	177	877
2	Anna University	159	1013
3	Banaras Hindu University	106	870
4	Annamalai University	72	756
5	Delhi University	54	367
6	Aligarh Muslim University	49	129
7	Guru Nanak Dev University	42	273
8	Roorkee University	42	273
9	Bharathiar University	40	335
10	University of Rajasthan	40	201
11	Alagappa University	40	542
12	Shivaji University	38	393
13	Mumbai University	37	207
14	University of Burdwan	36	142
15	Jai Narain Vyas University	35	242
16	Pune University	32	204
17	Devi Ahilya University	30	246
18	Jawaharlal Nehru Technological University	30	102
19	Osmania University	30	175
20	Pondicherry University	30	186

Table-36: Top 20 University based on publication output in Energy (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Banaras Hindu University	106	870
2	Delhi University	54	367
3	Roorkee University	45	359
4	Guru Nanak Dev University	42	273
5	Aligarh Muslim University	39	129
6	Punjab Agricultural University	27	191
7	Punjabi University	23	95
8	Panjab University	23	132
9	Inter University Accelerator Centre	19	56
10	GB Pant University of Agriculture & Technology	14	145
11	Jawaharal Nehru University	11	74
12	Thapar University	10	43
13	Jamia Millia Islamia University	9	37
14	Deen Dayal Upadhyay Gorakhpur University	8	86
15	Uttar Pradesh Technical University	5	39
16	Maharshi Dayanand University	5	17
17	Deenbandhu Chhotu Ram University of Science and Technology	5	25
18	University of Allahabad	4	25
19	Hemwati Nandan Bahuguna Garhwal University	4	14
20	Himachal Pradesh University	4	14

Table-37: Top 20 University based on publication output in Energy (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	159	1013
2	Annamalai University	72	756
3	Alagappa University	40	542
4	Bharathiar University	40	335
5	Osmania University	30	175
6	Jawaharlal Nehru Technological University	30	102
7	Pondicherry University	30	186
8	Madras University	27	262
9	Bangalore University	26	234
10	Madurai Kamraj University	23	133
11	Sri Venkateswara University	21	71
12	Cochin University of Science and Technology	17	176
13	Andhra University	16	98
14	Mangalore University	14	109
15	Kerala University	13	61
16	Hyderabad University	12	38
17	Vellore Institute of Technology University	10	17
18	Karnataka University	10	129
19	Calicut University	9	80
20	Mysore University	8	96

Table-38: Top 20 University based on publication output in Energy (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	177	877
2	University of Burdwan	36	142
3	Tezpur University	28	154
4	West Bengal University of Technology	27	14
5	North Eastern Hill University	22	84
6	University of Calcutta	22	93
7	Utkal University	18	77
8	The Bengal Engineering & Science University	15	82
9	Rajiv Gandhi University	9	49
10	Visva Bharati University	9	46
11	Dibrugarh University	8	67
12	Gauhati University	8	16
13	Nagaland University	7	38
14	University of Kalyani	6	66
15	Indian School of Mines University	4	2
16	Inter University Consortium for DAEF	3	25
17	LN Mithila University	3	5
18	Berhampur University	2	6
19	Sambalpur University	2	4
20	Vinoba Bhave University	2	0

Table-39: Top 20 University based on publication output in Energy (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	University of Rajasthan	40	201
2	Shivaji University	38	393
3	Mumbai University	37	207
4	Jai Narain Vyas University	35	242
5	Pune University	32	204
6	Maharaja Sayajirao University of Baroda	16	32
7	The Rashtrasant Tukadoji Maharaj Nagpur University	12	42
8	Mohan Lal Sukhadia University	8	19
9	North Maharashtra University	8	23
10	Sardar Patel University	7	82
11	Goa University	7	127
12	Nirma University of Science & Technology	7	38
13	Dr. Babasaheb Ambedkar Technological University	6	25
14	Maharana Pratap University of Agriculture and Technology	5	2
15	University Institute of Chemical Technology	4	6
16	Sant Gagde Baba Amravati University	4	32
17	Dr. Babasaheb Ambedkar Marathwada University	2	5
18	Gujarat Technical University	2	83
19	Gujarat University	2	13
20	Inter University Consortium for DAE Facilities	2	5

Table-40: Top University based on publication output in Energy (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Devi Ahilya University	30	246
2	Pt. Ravi Shankar Shukla University	10	67
3	Jiwaji University	4	10
4	Guru Ghasidas University	4	7
5	Dr Hari Singh Gour University	4	20

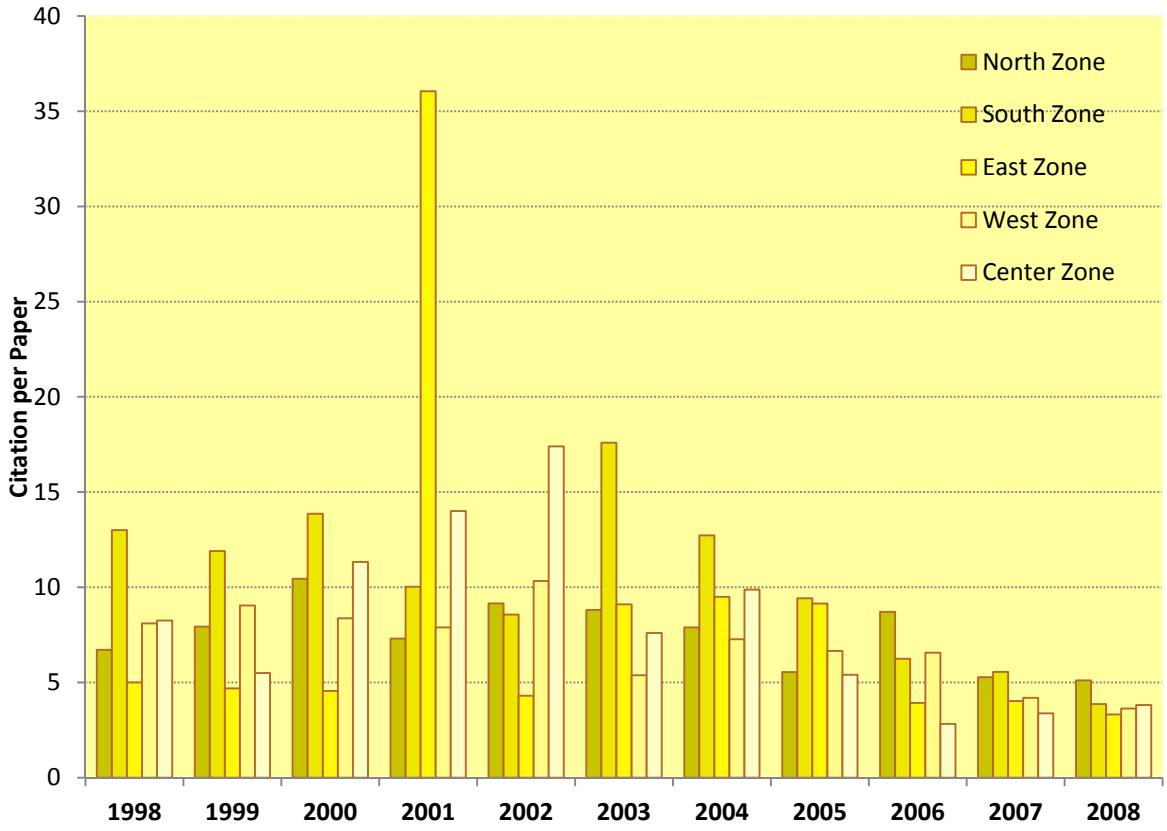

Figure-14: Zone-wise citation pattern in Energy

(iii) Environment Science:

The decadal average publication by universities was about 42.31% of the total publication in Environment whereas average contribution of publication output of universities in Environmental science was about 2.74% of total S&T Indian publication.

Anna University, Annamalai University and Mumbai University were the top publishing universities in Environmental science. Their percentage share was 3.92%, 3.85% and 2.90% respectively to the total publication in Environment science in the period 1998-2008.

The decadal average Indian publication in Environment science was 3.34% to global publication in Environmental science and the share of Indian universities' publication in Environment science was 1.42% to the global publication in Environment science during the period 1998-2008.

The decadal average CPP of Environment science was 6.77 for the period 1998-2008.

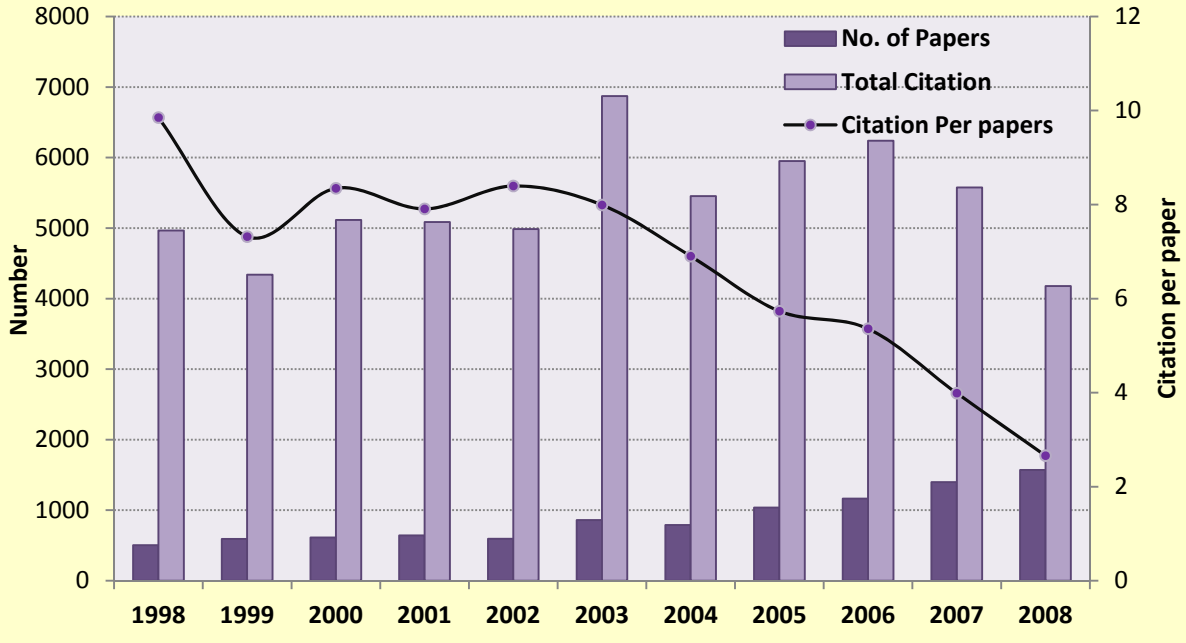

Figure-15: Publication and Citation pattern in Environmental Science

Table-41: Top 20 University in Environmental Science based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	370	2968
2	Annamalai University	366	1752
3	Mumbai University	273	2004
4	Banaras Hindu University	268	2328
5	Aligarh Muslim University	234	1611
6	Jadavpur University	219	2331
7	University of Calcutta	218	1667
8	Sri Venkateswara University	209	1407
9	Madras University	202	1354
10	Punjab Agricultural University	197	872
11	Jawaharal Nehru University	186	2042
12	Delhi University	179	1478
13	GB Pant University of Agriculture & Technology	171	602
14	Andhra University	170	597
15	Tamil Nadu Agricultural University	154	560
16	Panjab University	151	993
17	Bharathiar University	139	1229
18	University of Rajasthan	136	643
19	Osmania University	134	562
20	Pune University	111	401

Table-42: Top 20 University based on publication output in Environmental Science (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Banaras Hindu University	268	2328
2	Aligarh Muslim University	234	1611
3	Punjab Agricultural University	197	872
4	Jawaharal Nehru University	186	2042
5	Delhi University	179	1478
6	GB Pant University of Agriculture & Technology	171	602
7	Panjab University	151	993
8	University of Lucknow	99	893
9	CCS Haryana Agricultural University	96	307
10	Roorkee University	89	1011
11	Punjabi University	88	247
12	Guru Jambeshwar University	87	756
13	Guru Nanak Dev University	80	417
14	Hemwati Nandan Bahuguna Garhwal University	71	238
15	Jamia Hamdard University	70	943
16	Kumaun University	60	219
17	Deen Dayal Upadhyay Gorakhpur University	57	288
18	Dr Ram Manohar Lohia Awadh University	52	256
19	Babasaheb Bhimrao Ambedkar University	51	167
20	Maharshi Dayanand University	42	199

Table-43: Top 20 University based on publication output in Environmental Science (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	370	2968
2	Annamalai University	366	1752
3	Sri Venkateswara University	209	1407
4	Madras University	202	1354
5	Andhra University	170	597
6	Tamil Nadu Agricultural University	154	560
7	Bharathiar University	139	1229
8	Osmania University	134	562
9	Mysore University	96	300
10	University of Agricultural Sciences	94	516
11	Kerala University	94	686
12	Bangalore University	88	227
13	Cochin University of Science and Technology	88	241
14	Madurai Kamraj University	80	261
15	Mangalore University	68	413
16	Acharya Nagarjuna University	65	105
17	Bharathidasan University	62	234
18	Karnataka University	60	234
19	Calicut University	48	47
20	Gulbarga University	46	121

Table-44: Top 20 University based on publication output in Environmental Science (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	219	2331
2	University of Calcutta	218	1667
3	Gauhati University	99	383
4	University of Kalyani	87	486
5	North Eastern Hill University	70	419
6	Berhampur University	55	213
7	Visva Bharati University	45	170
8	University of Burdwan	42	272
9	Utkal University	42	175
10	Manipur University	41	94
11	Assam Agricultural University	41	47
12	Bidhan Chandra Krishi University	38	161
13	The Bengal Engineering & Science University	37	73
14	Sambalpur University	28	95
15	West Bengal University of Health Sciences	27	569
16	Assam University	24	162
17	Orissa University of Agriculture and Technology	22	30
18	Patna University	21	90
19	University of North Bengal	20	100
20	Vidyasagar University	18	115

Table-45: Top 20 University based on publication output in Environmental Science (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Mumbai University	273	2004
2	University of Rajasthan	136	643
3	Pune University	111	401
4	Maharaja Sayajirao University of Baroda	72	301
5	Gujarat University	60	366
6	Jai Narain Vyas University	58	208
7	Mohan Lal Sukhadia University	56	154
8	The Rashtrasant Tukadoji Maharaj Nagpur University	55	134
9	Dr. Babasaheb Ambedkar Marathwada University	45	49
10	North Maharashtra University	44	175
11	Shivaji University	40	113
12	Gujarat Agricultural University	37	50
13	Goa University	36	90
14	Sardar Patel University	33	99
15	Maharana Pratap University of Agriculture and Technology	29	27
16	University Institute of Chemical Technology	27	220
17	Maharshi Dayanand Saraswati University	26	66
18	Swami Ramanand Teerth Marathwada University	24	29
19	Saurashtra University	23	120
20	South Gujarat University	23	67

Table-46: Top University based on publication output in Environmental Science (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Devi Ahilya University	61	400
2	Jiwaji University	47	245
3	Barkatullah University	43	73
4	Pt. Ravi Shankar Shukla University	38	209
5	Dr Hari Singh Gour University	27	35
6	Vikram University	18	268
7	Awadhesh Pratap Singh University	18	20
8	Indira Gandhi Krishi University	17	35
9	Rani Durgavati University	15	94
10	Indira Gandhi Agricultural University	15	37
11	Devi Ahilya University	61	400
12	Jiwaji University	47	245
13	Barkatullah University	43	73

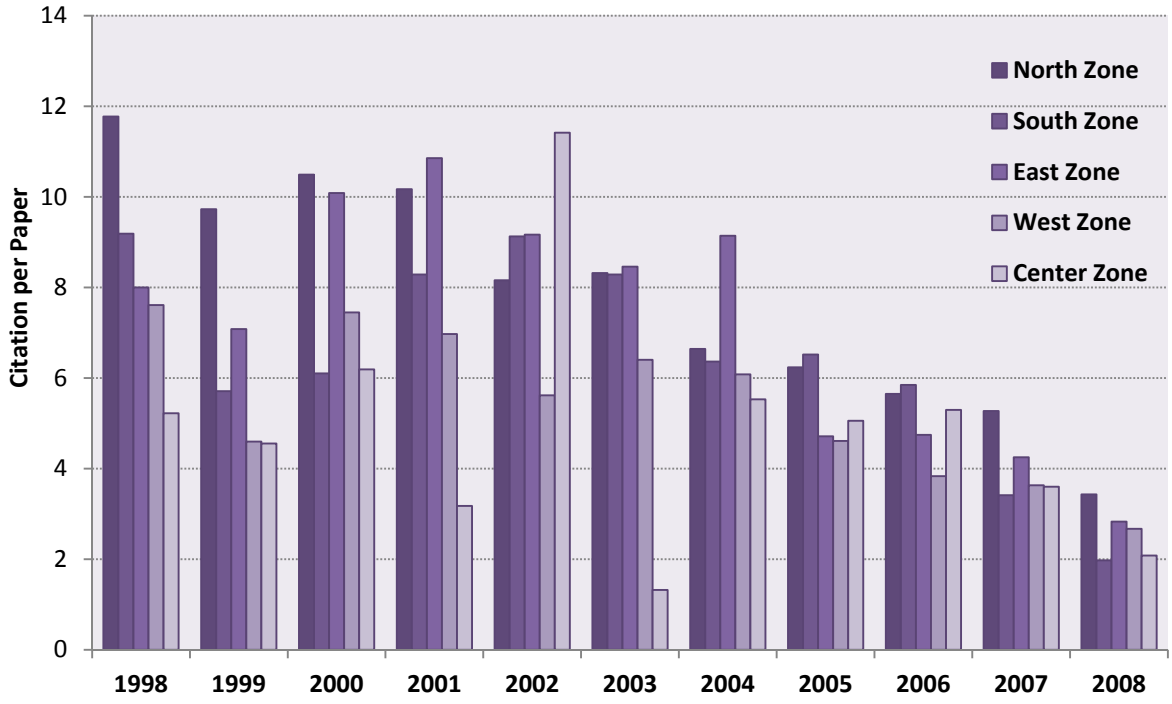

Figure-16: Zone-wise citation pattern in Environmental Science

(iv) Chemical Engineering

The decadal average publication by universities was 41.53% of the total publication in Chemical engineering whereas average contribution of publication output of universities was about 2.43% of total S&T Indian publication in the period 1998-2008.

Mumbai University, Anna University and Jadavpur University were the top publishing universities in Chemical engineering. Their percentage share to the total publication in Chemical engineering was 7.12%, 6.82% and 4.59 % respectively in the period 1998-2008.

The decadal Average publication was 2.82% to global publication in Chemical engineering and the share of Indian universities' publication was about 1.16% to the global publication in Chemical engineering during the period 1998-2008. The decadal average CPP of chemical engineering was 10.50 during 1998-2008.

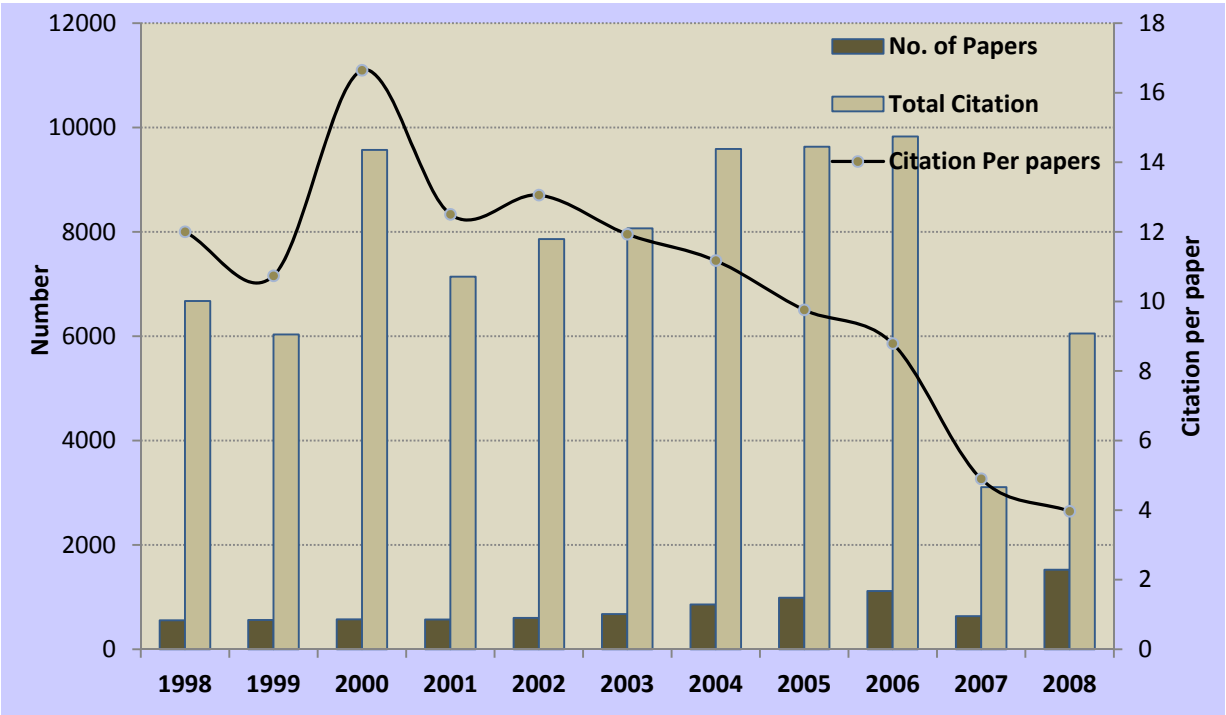

Figure-17: Publication and citation pattern in Chemical engineering

Table-47: Top 25 University in Chemical Engineering based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Mumbai University	577	6829
2	Anna University	550	5595
3	Jadavpur University	376	3996
4	Banaras Hindu University	275	2497
5	Aligarh Muslim University	259	2999
6	Delhi University	238	3309
7	Panjab University	198	1583
8	Cochin University of Science and Technology	194	941
9	Annamalai University	187	1699
10	University of Calcutta	179	1154
11	Karnataka University	169	1837
12	Maharaja Sayajirao University of Baroda	157	1208
13	Sardar Patel University	155	822
14	Madras University	151	1219
15	Guru Nanak Dev University	149	1270
16	Bharathiar University	127	2259
17	Sri Venkateswara University	122	973
18	Madurai Kamraj University	116	1097
19	Andhra University	114	436
20	Osmania University	94	642

Table-48: Top 20 University based on publication output in Chemical Engineering (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Banaras Hindu University	275	2497
2	Aligarh Muslim University	259	2999
3	Delhi University	238	3309
4	Panjab University	198	1583
5	Guru Nanak Dev University	149	1270
6	Roorkee University	83	1256
7	Jawaharal Nehru University	63	604
8	Deen Dayal Upadhyay Gorakhpur University	61	372
9	Kurukshetra University	59	464
10	CCS Haryana Agricultural University	55	619
11	Himachal Pradesh University	55	337
12	Punjab Agricultural University	55	204
13	Jamia Millia Islamia University	52	408
14	Guru Jambeshwar University	51	1148
15	University of Allahabad	44	218
16	GB Pant University of Agriculture & Technology	42	251
17	Punjabi University	40	230
18	Maharshi Dayanand University	35	97
19	University of Lucknow	26	127
20	Punjab Technical University	19	159

Table-49: Top 20 University based on publication output in Chemical Engineering (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	550	5595
2	Cochin University of Science and Technology	194	941
3	Annamalai University	187	1699
4	Karnataka University	169	1837
5	Madras University	151	1219
6	Bharathiar University	127	2259
7	Sri Venkateswara University	122	973
8	Madurai Kamraj University	116	1097
9	Andhra University	114	436
10	Osmania University	94	642
11	Mahatma Gandhi University	82	685
12	Kerala University	81	858
13	Mysore University	81	500
14	Bangalore University	77	430
15	Gulbarga University	77	616
16	Alagappa University	71	375
17	Bharathidasan University	60	274
18	Hyderabad University	46	339
19	Tamil Nadu Agricultural University	36	141
20	Jawaharlal Nehru Technological University	31	208

Table-50: Top 20 University based on publication output in Chemical Engineering (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	376	3996
2	University of Calcutta	179	1154
3	North Eastern Hill University	63	521
4	Gauhati University	60	808
5	University of Burdwan	44	202
6	University of Kalyani	44	482
7	Tezpur University	37	306
8	Utkal University	34	134
9	University of North Bengal	34	353
10	Dibrugarh University	31	151
11	Sambalpur University	22	211
12	Visva Bharati University	19	138
13	Vidyasagar University	17	109
14	Assam Agricultural University	11	47
15	The Bengal Engineering & Science University	9	79
16	Ranchi University	8	15
17	Berhampur University	7	13
18	West Bengal University of Technology	7	10
19	Indian School of Mines University	6	8
20	Manipur University	6	29

Table-51: Top 20 University based on publication output in Chemical Engineering (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Mumbai University	577	6829
2	Maharaja Sayajirao University of Baroda	157	1208
3	Sardar Patel University	155	822
4	Pune University	85	759
5	South Gujarat University	65	732
6	North Maharashtra University	59	285
7	Shivaji University	56	418
8	University of Rajasthan	56	346
9	The Rashtrasant Tukadoji Maharaj Nagpur University	48	172
10	Jai Narain Vyas University	47	408
11	University Institute of Chemical Technology	42	333
12	Gujarat University	38	239
13	Goa University	37	322
14	Mohan Lal Sukhadia University	32	112
15	Dr. Babasaheb Ambedkar Marathwada University	28	128
16	Saurashtra University	27	179
17	Bhavnagar University	18	126
18	Sant Gagde Baba Amravati University	14	70
19	Dr. Babasaheb Ambedkar Technological University	11	40
20	Swami Ramanand Teerth Marathwada University	10	59

Table-52: Top University based on publication output in Chemical Engineering (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Devi Ahilya University	44	424
2	Pt. Ravi Shankar Shukla University	35	127
3	Jiwaji University	33	235
4	Dr Hari Singh Gour University	23	177
5	Barkatullah University	19	35
6	Rani Durgavati University	16	98
7	Vikram University	10	229
8	Jawaharlal Nehru Krishi University	8	2
9	Awadhesh Pratap Singh University	6	44
10	Inter University Consortium for DAE Facilities	4	36

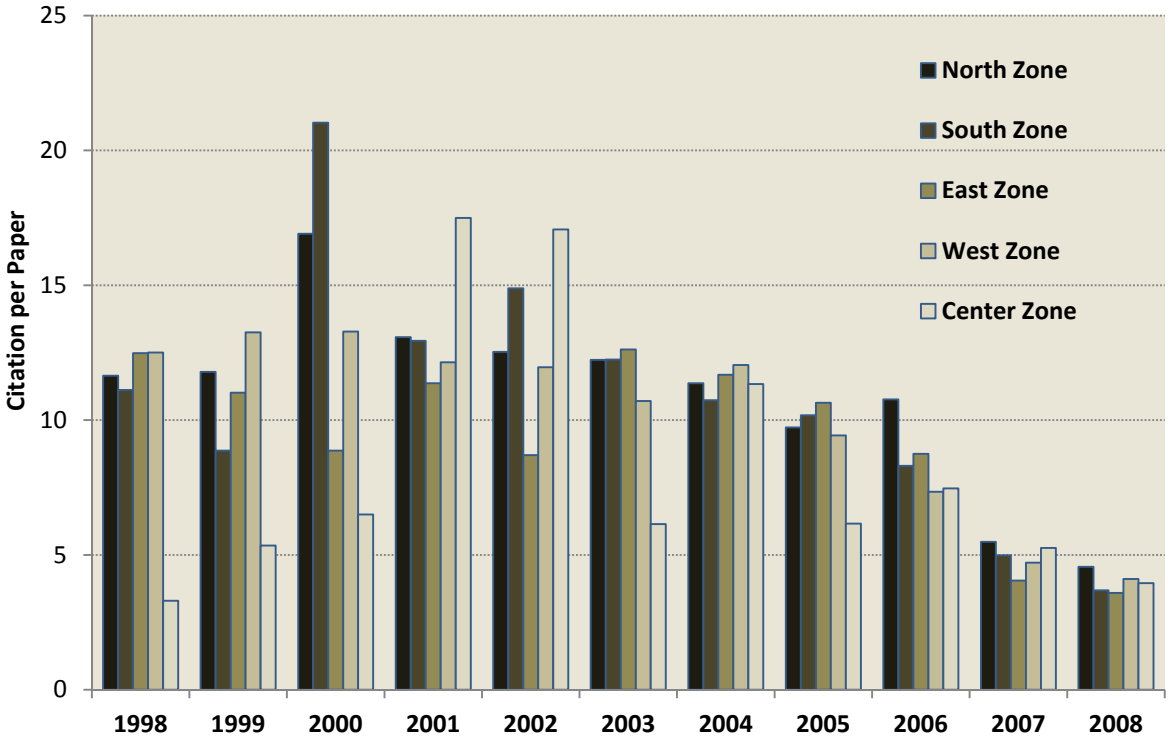

Figure-18: Zone-wise citation pattern in Environment science

(v) Engineering

The decadal average publication by universities was 29.45% of the total publication in Engineering whereas average contribution of publication output of universities was 4.22% of total S&T Indian publication in the period 1998-2008.

Anna University (8.42%), Jadavpur University (7.93%) and University of Delhi 5.09%) of the total publication in Engineering were the top publishing universities in the period 1998-2008.

The decadal average publication of India in Engineering was 1.75% to global publication in Engineering and the share of Indian universities' publication was 0.51% to the global publication in Engineering during the period 1998-2008. The decadal average CPP of chemical engineering was 5.88 during 1998-2008.

The detailed analysis in Engineering is given below for the period 1998-2008.

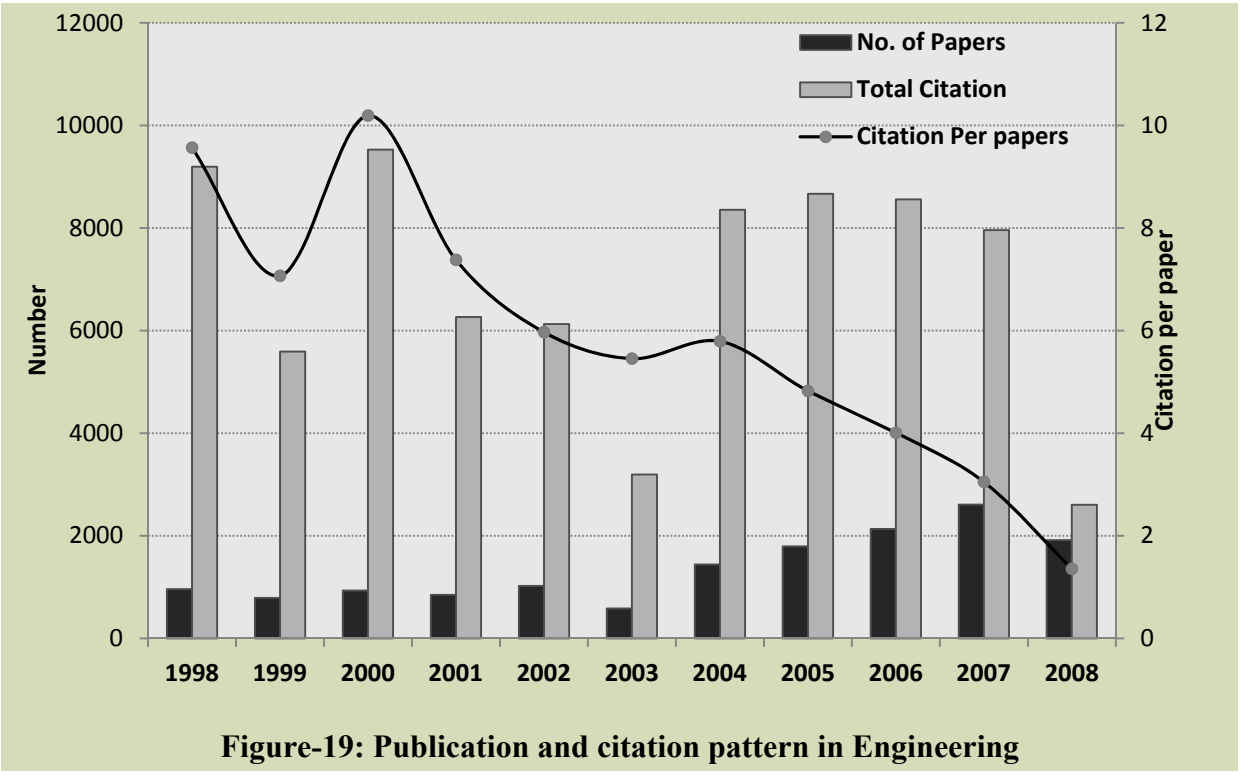

Figure-19: Publication and citation pattern in Engineering

Table-53: Top 25 University in Engineering based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	1065	3852
2	Jadavpur University	1034	4347
3	Delhi University	665	2212
4	Banaras Hindu University	575	2577
5	Annamalai University	379	1293
6	University of Calcutta	376	1052
7	Cochin University of Science and Technology	343	1057
8	Aligarh Muslim University	292	1674
9	Mumbai University	270	1716
10	The Bengal Engineering & Science University	260	847
11	Osmania University	258	342
12	Roorkee University	253	1740
13	Pune University	216	1456
14	Andhra University	162	336
15	Jawaharlal Nehru Technological University	161	286
16	West Bengal University of Technology	157	346
17	Bharathiar University	156	709
18	Hyderabad University	147	479
19	Kurukshetra University	142	439
20	Sri Venkateswara University	136	773

Table-54: Top 20 University based on publication output in Engineering (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Delhi University	665	2212
2	Banaras Hindu University	575	2577
3	Aligarh Muslim University	292	1674
4	Roorkee University	253	1740
5	Kurukshetra University	142	439
6	GB Pant University of Agriculture & Technology	124	215
7	University of Allahabad	117	312
8	Panjab University	115	483
9	Guru Nanak Dev University	101	238
10	Jawaharal Nehru University	84	319
11	Maharshi Dayanand University	74	220
12	Punjabi University	60	193
13	Guru Gobind Singh Indraprashta University	57	116
14	Himachal Pradesh University	56	356
15	Jaypee University of Information Technology	54	126
16	Deen Dayal Upadhyay Gorakhpur University	54	266
17	Punjab Technical University	53	216
18	Uttar Pradesh Technical University	51	191
19	Punjab Agricultural University	49	117
20	Jamia Millia Islamia University	47	431

Table-55: Top 20 University based on publication output in Engineering (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	1065	3852
2	Annamalai University	379	1293
3	Cochin University of Science and Technology	343	1065
4	Osmania University	258	342
5	Andhra University	162	336
6	Jawaharlal Nehru Technological University	161	286
7	Bharathiar University	156	709
8	Hyderabad University	147	479
9	Sri Venkateswara University	136	773
10	Bangalore University	132	674
11	Gulbarga University	115	713
12	Madras University	114	387
13	Kerala University	112	383
14	Madurai Kamraj University	96	261
15	Mysore University	95	548
16	Alagappa University	91	336
17	Mahatma Gandhi University	63	860
18	Vesveswaraiah Technological University	54	163
19	Vellore Institute of Technology University	48	50
20	University of Agricultural Sciences	42	35

Table-56: Top 20 University based on publication output in Engineering (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	1034	4347
2	University of Calcutta	376	1052
3	The Bengal Engineering & Science University	260	847
4	West Bengal University of Technology	157	346
5	University of Burdwan	103	373
6	University of Kalyani	70	309
7	Gauhati University	64	236
8	Visva Bharati University	61	240
9	Vidyasagar University	61	273
10	Tezpur University	58	212
11	Berhampur University	36	103
12	Veer Surendra Sai University of Technology	35	139
13	Utkal University	29	205
14	Sambalpur University	22	35
15	Biju Patnaik University of Technology	22	115
16	Dibrugarh University	21	95
17	University of North Bengal	17	83
18	TM Bhagalpur University	17	79
19	Indian School of Mines University	13	9
20	Manipal University	12	45

Table-57: Top 20 University based on publication output in Engineering (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Mumbai University	270	1716
2	Pune University	216	1456
3	Maharaja Sayajirao University of Baroda	133	185
4	Shivaji University	115	564
5	Jai Narain Vyas University	73	271
6	North Maharashtra University	68	280
7	University of Rajasthan	66	218
8	Sardar Patel University	66	397
9	The Rashtrasant Tukadoji Maharaj Nagpur University	59	133
10	Gujarat University	47	174
11	Nirma University of Science & Technology	42	66
12	University Institute of Chemical Technology	37	297
13	Dr. Babasaheb Ambedkar Technological University	35	34
14	Goa University	34	82
15	Dr. Babasaheb Ambedkar Marathwada University	33	45
16	Bhavnagar University	27	51
17	Sant Gagde Baba Amravati University	26	82
18	Bharati Vidyapeeth University	19	39
19	Inter University Center for Astronomy and Astrochemistry	18	9
20	Mohan Lal Sukhadia University	18	144

Table-58: Top University based on publication output in Engineering (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Devi Ahilya University	49	176
2	Dr Hari Singh Gour University	34	124
3	Barkatullah University	26	66
4	Pt. Ravi Shankar Shukla University	24	40
5	Jiwaji University	19	97
6	Rani Durgavati University	15	28
7	Rajiv Gandhi Proudyogiki University	15	27
8	Vikram University	13	214
9	Inter University Consortium for DAE Facilities	9	22
10	Guru Ghasidas University	8	0

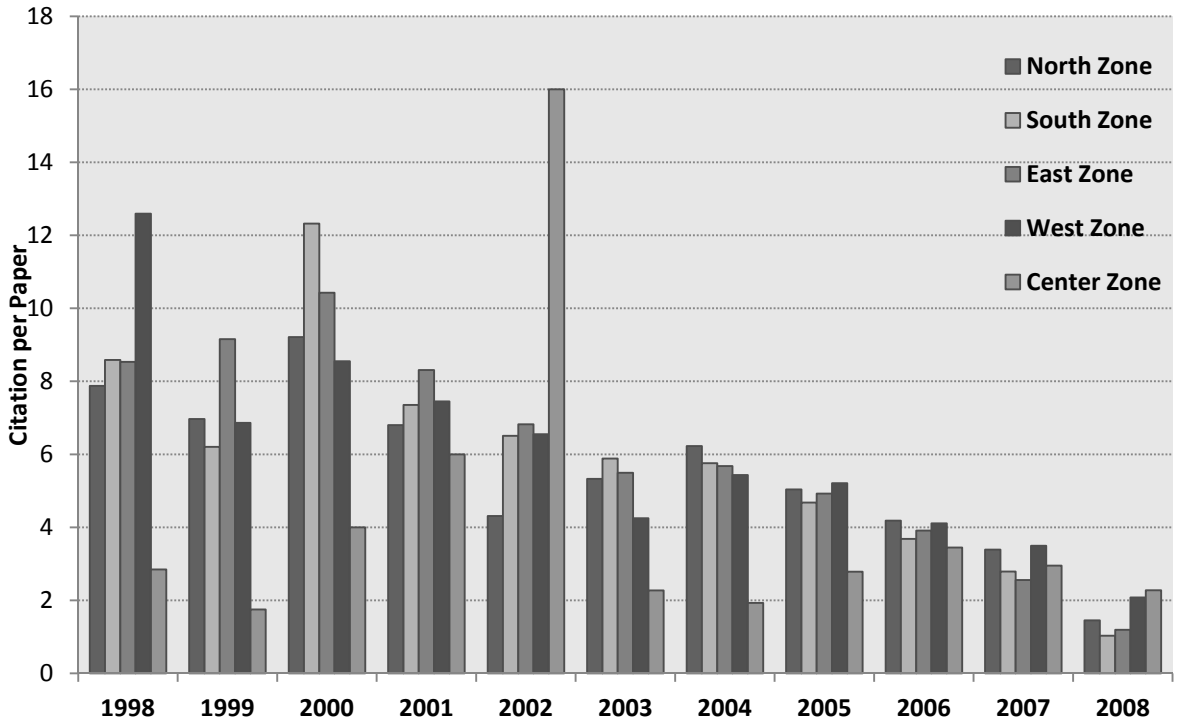

Figure-20: Zone-wise citation pattern in Engineering

(vi) Material Science

The decadal average publication by universities was 41.01% of the total publication in Material science whereas average contribution of publication output of universities was 4.99% of total S&T Indian publication in the period 1998-2008.

Anna University, Banaras Hindu University and Jadavpur University were the top publishing universities in Material science. Their publication share was 5.76%, 4.07% and 3.81% respectively in Material science in the period 1998-2008.

The decadal average publication of India was 3.39% to global publication in material science and the share of Indian universities' publication was 1.39% to the global publication in Material science during the period 1998-2008.

The decadal average CPP of Chemical engineering was 6.83 during 1998-2008. The detailed analysis of Chemical engineering for the period 1998-2008 is given below.

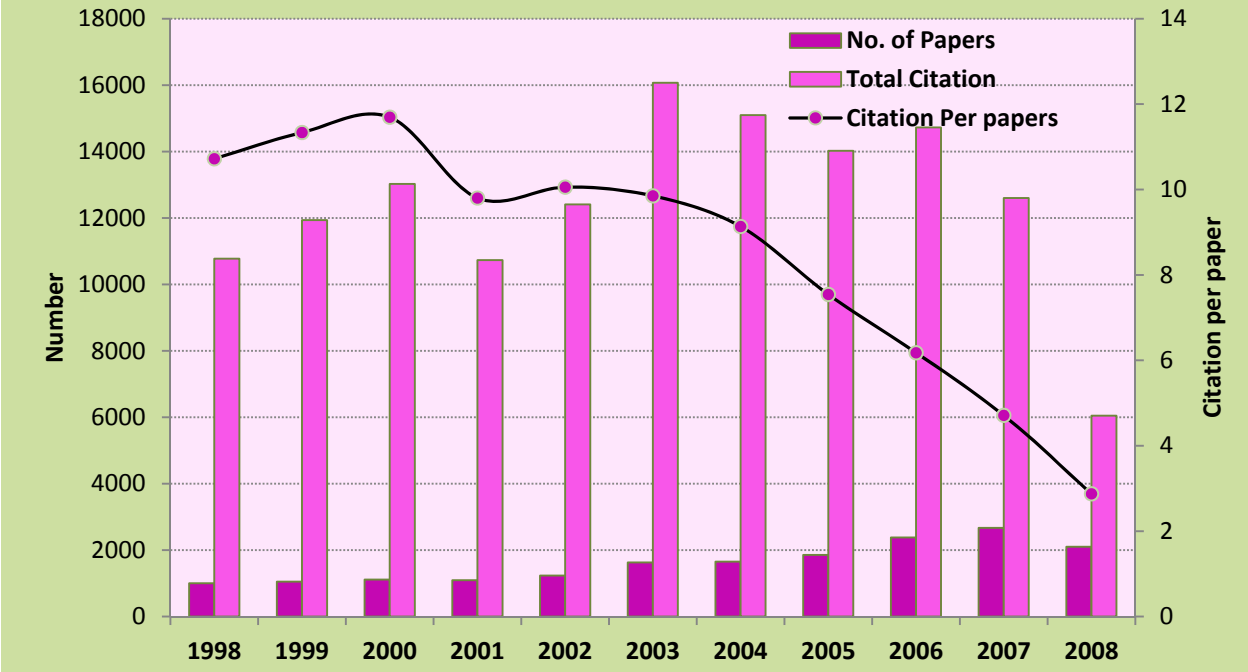

Figure-21: Publication and citation pattern in Material Science

Table-59: Top 25 University in Material Science based on publication output

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	984	6314
2	Banaras Hindu University	702	4161
3	Jadavpur University	655	5346
4	Delhi University	572	3289
5	Cochin University of Science and Technology	503	3511
6	Sri Venkateswara University	493	4015
7	Mumbai University	487	3758
8	Shivaji University	473	5333
9	Mahatma Gandhi University	440	5014
10	Madras University	405	2710
11	University of Calcutta	402	2969
12	Hyderabad University	389	3876
13	Pune University	379	3702
14	Alagappa University	352	2842
15	Osmania University	314	1861
16	Mysore University	284	1493
17	Sardar Patel University	270	1257
18	Maharaja Sayajirao University of Baroda	270	1176
19	Bharathiar University	246	1848
20	Karnataka University	238	1945

Table-60: Top 20 University based on publication output in Material Science (North Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Banaras Hindu University	702	4161
2	Delhi University	572	3289
3	Guru Nanak Dev University	235	1883
4	Panjab University	220	1285
5	Inter University Accelerator Centre	216	707
6	Aligarh Muslim University	195	1408
7	University of Allahabad	182	956
8	Himachal Pradesh University	128	851
9	Jawaharal Nehru University	103	588
10	GB Pant University of Agriculture & Technology	100	217
11	University of Lucknow	90	428
12	University of Jammu	89	379
13	Kurukshetra University	85	398
14	Roorkee University	75	1588
15	Jamia Millia Islamia University	71	458
16	Deen Dayal Upadhyay Gorakhpur University	68	340
17	Punjabi University	54	327
18	Chaudhary Charan Singh University	53	440
19	Maharshi Dayanand University	52	253
20	Chhatrapati Shahuji Maharaj Kanpur University	44	200

Table-61: Top 20 University based on publication output in Material Science (South Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Anna University	984	6314
2	Cochin University of Science and Technology	503	3511
3	Sri Venkateswara University	493	4015
4	Mahatma Gandhi University	440	5014
5	Madras University	405	2710
6	Hyderabad University	389	3876
7	Alagappa University	352	2842
8	Osmania University	314	1861
9	Mysore University	284	1493
10	Bharathiar University	246	1848
11	Annamalai University	238	1494
12	Karnataka University	238	1945
13	Sri Venkateswara University	204	1604
14	Kerala University	199	1683
15	Madurai Kamraj University	197	1220
16	Bangalore University	196	1660
17	Mangalore University	171	901
18	Bharathidasan University	109	1043
19	Acharya Nagarjuna University	85	1083
20	Andhra University	84	443

Table-62: Top 20 University based on publication output in Material Science (East Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Jadavpur University	655	5346
2	University of Calcutta	402	2969
3	The Bengal Engineering & Science University	184	1265
4	University of Burdwan	128	1833
5	Utkal University	85	724
6	North Eastern Hill University	81	762
7	TM Bhagalpur University	72	378
8	Tezpur University	71	419
9	University of Kalyani	63	426
10	Vidyasagar University	53	208
11	Visva Bharati University	51	175
12	Gauhati University	38	198
13	Dibrugarh University	32	165
14	West Bengal University Of Technology	30	71
15	University of North Bengal	29	208
16	Sambalpur University	29	105
17	Manipur University	29	145
18	Ravenshaw University	28	489
19	Berhampur University	22	160
20	Inter University Consortium for DAEF	16	92

Table-63: Top 20 University based on publication output in Material Science (West Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Mumbai University	487	3758
2	Shivaji University	473	5333
3	Pune University	379	3702
4	Sardar Patel University	270	1257
5	Maharaja Sayajirao University of Baroda	270	1176
6	University of Rajasthan	236	1300
7	North Maharashtra University	159	1281
8	Saurashtra University	133	516
9	The Rashtrasant Tukadoji Maharaj Nagpur University	121	633
10	Jai Narain Vyas University	85	651
11	Dr. Babasaheb Ambedkar Marathwada University	66	375
12	University Institute of Chemical Technology	57	429
13	Goa University	51	578
14	South Gujarat University	46	226
15	Gujarat University	38	371
16	Mohan Lal Sukhadia University	34	140
17	Sant Gagde Baba Amravati University	24	134
18	Maharshi Dayanand Saraswati University	24	169
19	Inter University Consortium for DAE Facilities	23	177
20	Bhavnagar University	17	111

Table-64: Top University based on publication output in Material Science (Central Zone)

Sl. No.	Institute Name	No. of Papers	Citation
1	Inter University Consortium for DAE Facilities	132	925
2	Devi Ahilya University	104	649
3	Rani Durgavati University	73	277
4	Barkatullah University	71	400
5	Dr Hari Singh Gour University	36	230
6	Inter University Consortium for DAEF	32	260
7	Pt. Ravi Shankar Shukla University	32	223
8	Guru Ghasidas University	31	107
9	Jiwaji University	27	169
10	Awadhesh Pratap Singh University	27	336

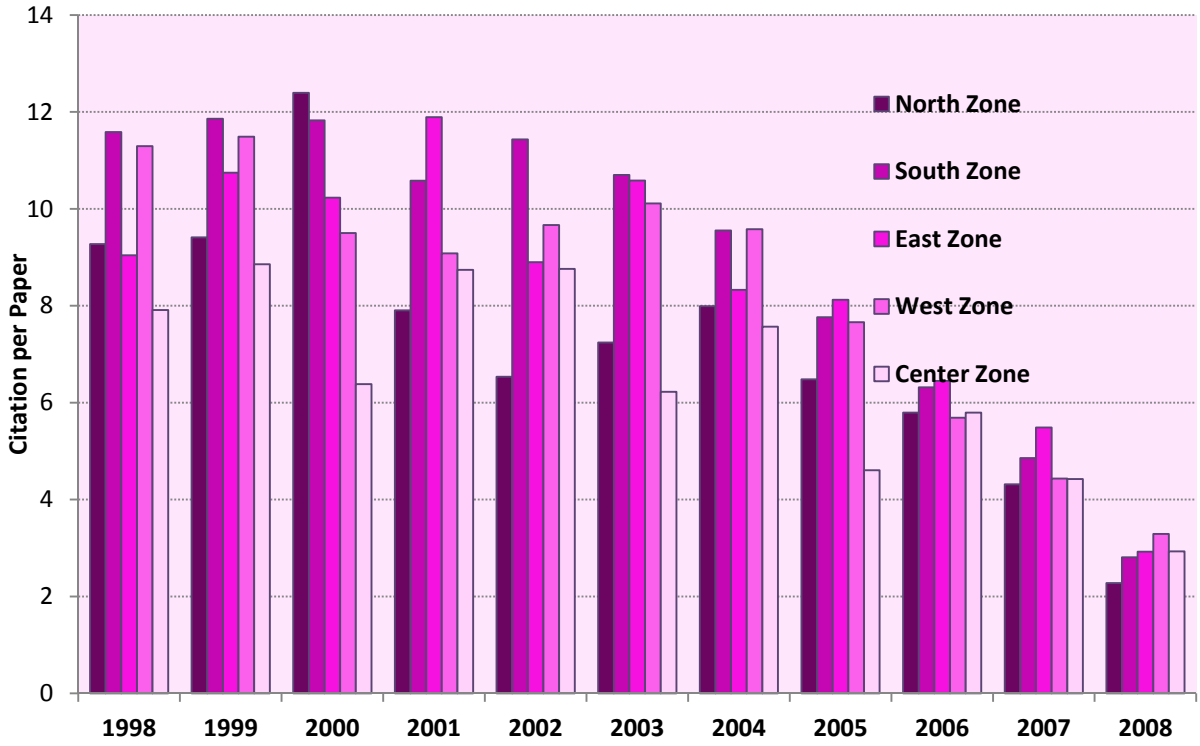

Figure-22: Zone-wise citation paper in Material Science

7. Publication performance of Central & State Universities (1998-2008)

A significant variation was observed between central and state universities however, productivity of some state universities were comparable during 1998-2008.
The top five productive central universities were Delhi University, Banaras Hindu University, Aligarh Muslim University, Hyderabad University and Jawaharlal Nehru University respectively. The University of Allahabad secured position 5 though earlier it was a state university (Figure-23).

The top five leading state universities namely Jadavpur University, Anna University, University of Madras, University of Calcutta and Panjab University (Figure24).

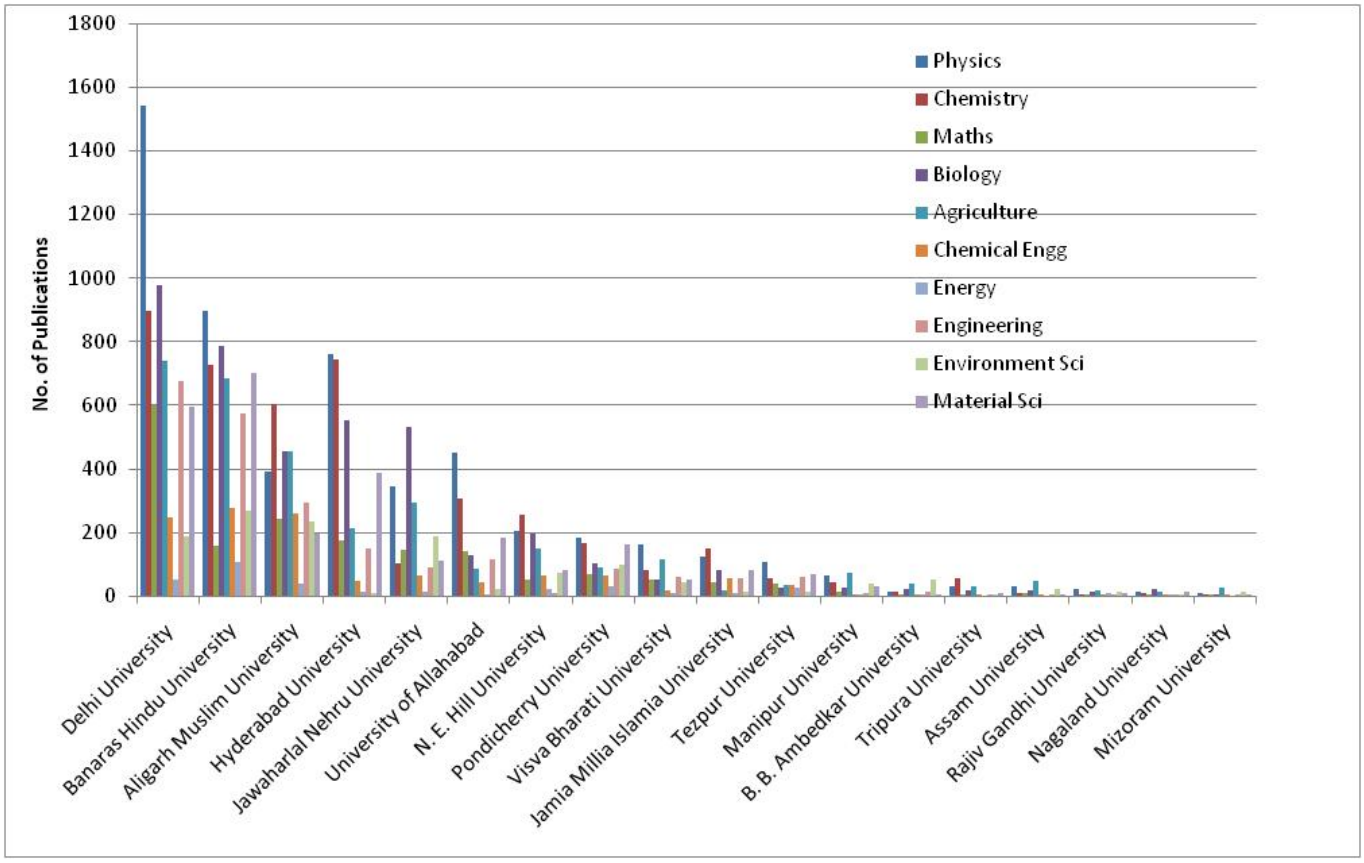

Figure-23: Publication profile of Central Universities

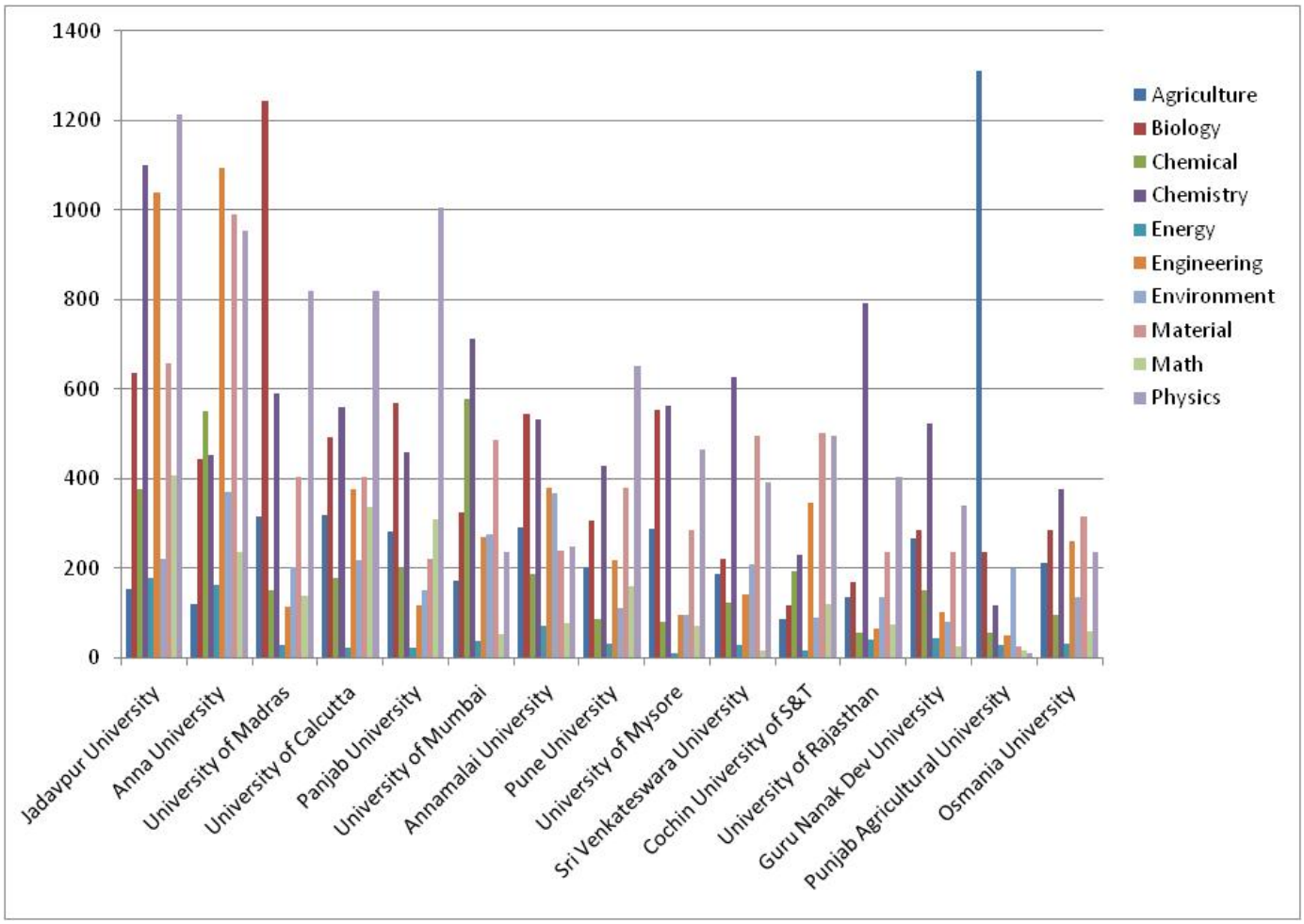

Figure-24: Publication profile top 20 state Universities

8. Collaboration pattern in publication

8.1 International collaboration

It is assumed that professional network and scientific collaboration have positive association with publication activities. Consequently, scientific collaboration and Co-authored publications are increasing. Therefore, in terms of its meaning for policy-makers and funding agencies collaboration has become considerable important. The following section provide collaboration pattern at national and international as well which may be useful for further growth of scientific productivity.

The analysis indicates that the most international collaborative papers came from Physics, Engineering and Agriculture whereas minimum collaborations were found in Mathematics, Energy and Engineering field.

United States (3662), Germany (2305), Japan (1522), United Kingdom (1293) and France (1258) were the most collaborative countries in Physics. China collaborated in 750 joint papers in Physics

United States (1540), Germany (831), Japan (582), United Kingdom (582) and South Korea (299) were the leading collaborator in publishing joint papers in Chemistry. China collaborated in 97 papers in the area of Chemistry.

United States (2427), Germany (868), United Kingdom (813) Japan (480) and Malaysia (390) published maximum numbers of joint papers in Biology while China's numbers were 143 only.

United States (1310), Germany (385), Canada (336), United Kingdom (316) and France (260) were the leading countries to publish joint papers in Mathematics whereas China's contribution was 198 joint papers.

The leading collaborative countries to publish joint papers in Physics, Chemistry, Biology and Mathematics are presented in Figure 25-27.

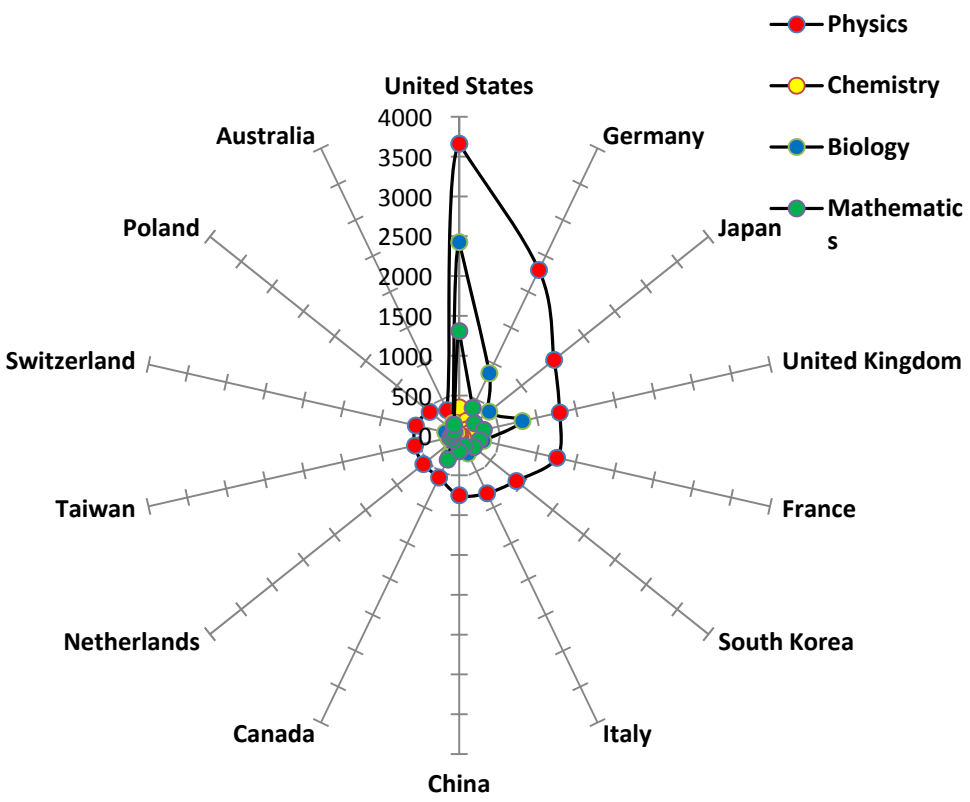

Figure-25: International collaboration pattern in Physics, Chemistry, Mathematics & Biology

United States (1106), United Kingdom (439), Germany (406), Japan (302) and Australia (195) were the top 5 countries to publish joint papers in Agriculture. China published jointly 122 papers with university professionals.

Similarly, United States (641) was the leading country for publishing joint papers in Environment science followed by United Kingdom (208), Germany (182), Japan (137) and Canada (129) while China published were 75 joint papers with university.

United States (195), Germany (98), Japan (81), United Kingdom (71) and Canada (56) published considerable good number of papers in Energy. China's contribution in joint papers was only 33.

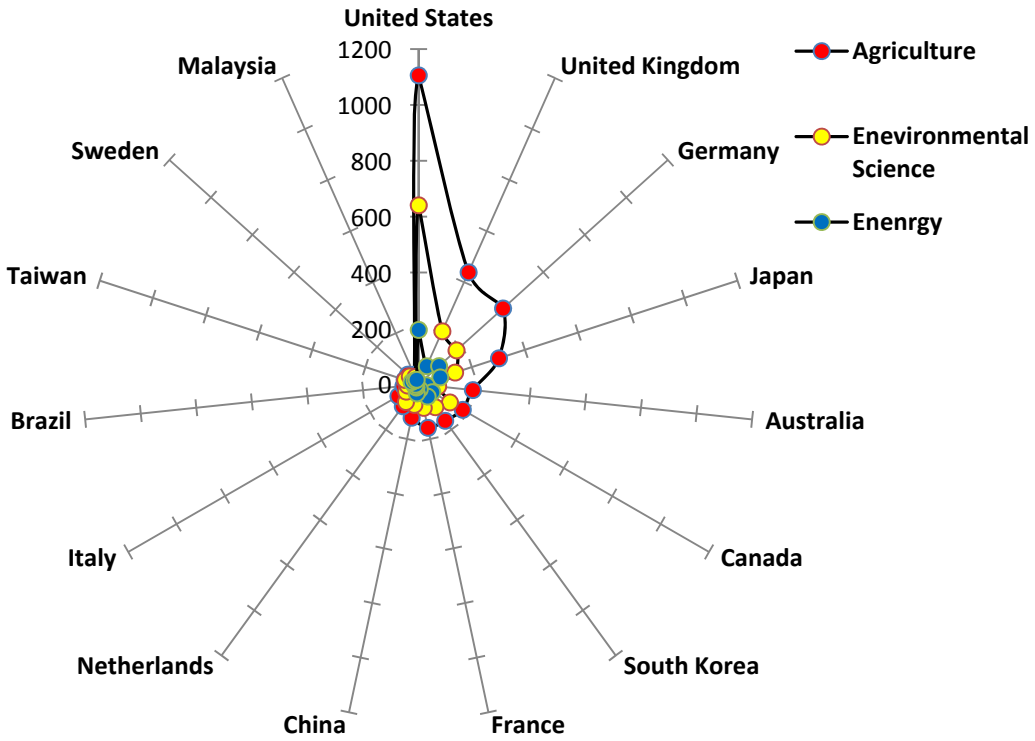

Figure-26: International collaboration pattern in Agriculture, Environment Science & Energy

In the case of Engineering United States (1853), United Kingdom (460), Germany (375), Japan (364) and Canada (346) were the top 5 country in publishing joint papers. China's contribution was 77 joint papers in Engineering.

United States (471), Germany (254), Japan (201), South Korea (164), and United Kingdom (147) were the top contributors of joint papers in Chemical Engineering. China published 31 joint papers in this field with university researchers.

United States (1380), Germany (824), Japan (723), United Kingdom (535) and South Korea (490) were the leading collaborator in material Science. China published 118 joint papers with universities researchers.

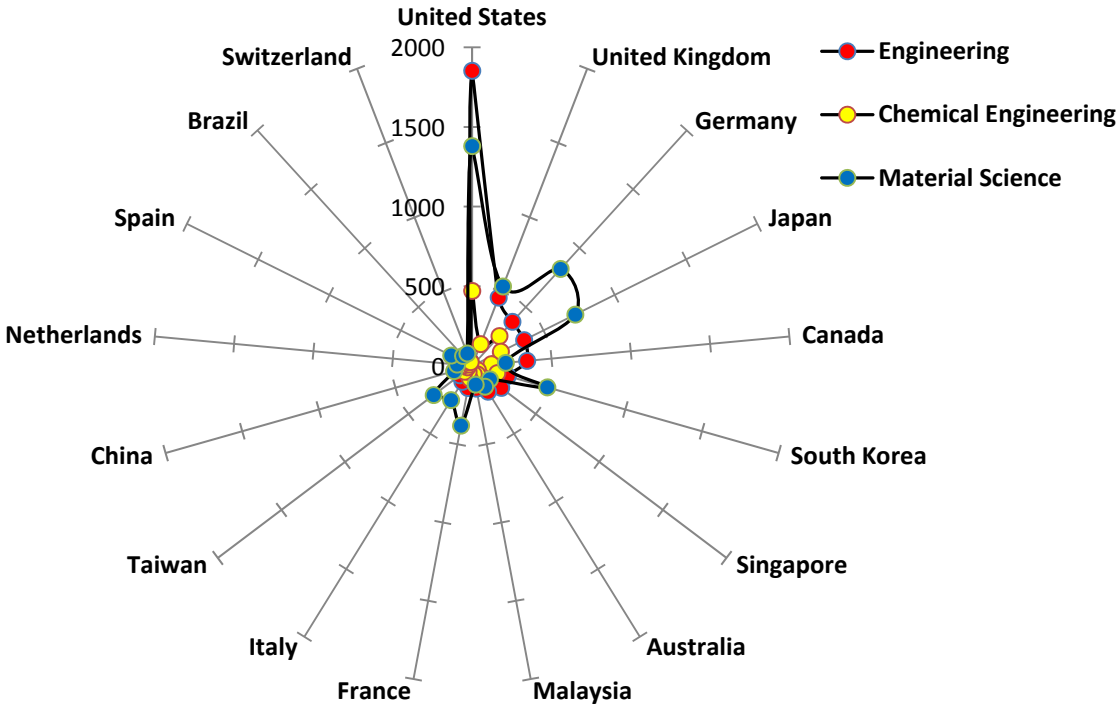

Figure-27: International collaboration pattern in Engineering, Chemical Engg. & Material Sci

8.2 International collaboration with International University-Subject wise collaboration

University of Delhi

Physics

Researchers from about 80 countries were found having joint papers with University of Delhi. The United States was the top collaborator with 226 joint papers in Physics. Next to the United States were United Kingdom (175), France (174), Russian Federation (173), South Korea (168), Brazil (164) Germany (160), Mexico (156), Colombia (146), Argentina (140), and China (139). Country such as Yemen (4), Saudi Arabia (3), Bangladesh (2), Iran (2), Algeria (1), Oman (1) and Pakistan (1) were also published joint papers with University of Delhi.

Chemistry

Authors from about 30 countries wrote co-authored papers with University of Delhi. The most of the joint papers were written with the United States' researchers (59), followed by Denmark (38), Belgium (13), United Kingdom (13), Japan (10), Germany (5), Italy (5), Egypt (4), Canada (3) and the Russian Federation (3).

Mathematics

Total collaborative country having joint papers: 60

Leading collaborative country:

United States (86), United Kingdom (60), France (49), Russian Federation (47), Germany (45), South Korea (45), Brazil (43), Mexico (41), China (38) and Colombia (38).

Biology

Total collaborative country having joint papers: 40

Leading collaborative country

United States (88), Denmark (32), United Kingdom (30), Japan (17), Belgium (13), Germany (13), Canada (11), Netherlands (10), France (5), Israel (5) and Switzerland (5).

Banaras Hindu University

Physics

The most co-authored papers in physics were with Germany (79), United States (73) and Japan (46). The other leading collaborators were France (47), China (45), South Korea (44), Sweden (41), Russian Federation (41), Brazil (39) and Israel (38). Bangladesh, Oman, Malaysia and Turkey published 2 joint papers each while country like South Africa, Ethiopia and Finland published 1 paper each.

Chemistry

25 countries were found to have joint papers and most of the joint papers were with Germany (33). Germany, was followed by the United States (22), Japan 16), United Kingdom (11) and France (7). Few joint papers were with countries such as Jordan, Oman, Singapore, Sweden and Ukraine.

Mathematics

Total collaborative country having joint papers: 28

Leading collaborative country:

United States (18), Germany (15), Japan (7), Brazil (6), China (6), France (6), South Korea (6), Hungary (5), Israel (5), and Russian Federation (5)

Biology

Total collaborative country having joint papers: 25

Leading collaborative country

United States (52), Germany (23), Japan (19), Canada (6), United Kingdom (6), Italy (5), Belgium (4) and France (4)

Jadavpur University

Physics

Jadavpur University comparatively have less international co-authored papers. The main collaborators were United Kingdom (27), United States (21), Germany (17), Japan (16), Hong Kong (15), Canada (9), Italy (9), China (98), Spain (7) and France (6).

Chemistry

35 countries produced joint papers with Jadavpur University and the top collaborators were United Kingdom (71), Taiwan (37), United States (33), Spain (32), Switzerland (24), Germany (22), France (21), Canada (19), Japan (18) and Australia (11). 10 Joint papers were recorded with China. Country like Nigeria, Russian Federation, South Africa, Sweden, Ukraine and Zimbabwe were also the academic collaborator in terms of research publication.

Mathematics

Total collaborative country having joint papers: 25

Leading collaborative country:

United States (13), Germany (7), Norway (5), Canada (4), China (4), and United Kingdom (3)

Biology

Total collaborative country having joint papers: 25

Leading collaborative country:

United Kingdom (58), United States (34), Spain (30), France (27), Taiwan (23), Germany (20), Switzerland (17), Australia (14), Japan (12), Italy (7), and Malaysia (7)

Anna University

Physics

Top collaborators in Physics were Malaysia (136), Japan (46), Germany (31), United States (26), China (20), Italy (14), South Korea (12), Taiwan (10) United Kingdom (9) and Thailand (7).

Chemistry

Leading collaborators countries to publish joint papers in chemistry include Germany (18), Japan (14), South Korea (14), Malaysia (13), Canada (9), United States (6), Italy (5) and Taiwan (3). There were about 15 collaborators countries.

Mathematics

Total collaborative country having joint papers: 17
Leading collaborative country:

United States (8), Canada (7), Germany (2), Iran (2) and Malaysia (2)

Biology

Total collaborative country having joint papers: 17
Leading collaborative country:

Malaysia (135), United States (21), China (17), Germany (12), Netherlands (6), Thailand (6), United Kingdom (5), Taiwan (4)

University of Madras

Physics

Total Collaborative country having joint papers: 25
Leading collaborative country:

Malaysia (139), United States (48), Japan (35), Netherlands (12), South Korea (12), Germany (8), Taiwan (8), France (5), Israel (5), Canada (4), and Mexico (4)

Chemistry

Total Collaborative country having joint papers: 17
Leading collaborative country:

Japan (11), United States (8), Germany (7), Malaysia (7), and Israel (4)

Mathematics

Total collaborative country having joint papers: 20
Leading collaborative country:

Canada (9), Japan (7), United States (6), South Africa (5), Malaysia (3), and Netherlands (3).

Biology

Total collaborative country having joint papers: 45
Leading collaborative country:
Malaysia (136), United States (67), Japan (27), South Korea (16), Netherlands (9), Germany (8), Israel (7), Canada (6), Taiwan (6) and Belgium (5)

University of Calcutta

Physics

Total collaborative country having joint papers: 25
Leading collaborative country:

Belgium (24), United States (22), Italy (20), Germany (17), United Kingdom (17), Sweden (12), France (10), Canada (9), Brazil (7), Denmark (6), and Taiwan (6)

Chemistry
Total collaborative country having joint papers: 20
Leading collaborative country:

United Kingdom (42), United States (25), Spain (20), Italy (17), France (15), Taiwan (14), Japan (7), Canada (5), China (5), and Sweden (5)

Mathematics
Total collaborative country having joint papers: 55
Leading collaborative country:

United States (1212), Germany (342), Canada (328), United Kingdom (308), Japan (237), France (216), South Korea (212), China (169), Russian Federation (152), and Australia (139)

Biology
Total collaborative country having joint papers: 25
Leading collaborative country:

United States (47), United Kingdom (34), Italy (15), Spain (12), Taiwan (10), China (7), Germany (7), Sweden (7), France (6), Bangladesh (4) and Japan (4)

Aligarh Muslim University

Physics
Total collaborative country having joint papers: 70
Leading collaborative country:

Canada (19), South Korea (18), United States (16), Spain (15), France (14), United Kingdom (14), Taiwan (13), Ireland (10), China (9), and Japan (9)

Chemistry
Total collaborative country having joint papers: 20
Leading collaborative country:

Saudi Arabia (6), Germany (5, Japan (5), United Kingdom (5), and United States (4)

Mathematics
Total collaborative country having joint papers: 60
Leading collaborative country:

Taiwan (19), Saudi Arabia (12), France (10), Italy (8), United States (8), United Kingdom (5), Australia (4), Romania (4), Spain (4), Canada (3), Germany (3), Japan (3), and South Korea (3).

Biology
Total collaborative country having joint papers: 34
Leading collaborative country:

United States (32), Germany (12), United Kingdom (9), China (7), France (4), Italy (4), and Japan (4)

Punjab University

Physics
Most co-authored papers in physics came out from United States (434), Russian Federation (417), Germany (349), South Korea (334), France (331), China (325), Netherlands (268),

United Kingdom (266), Switzerland (265), Brazil (258), Czech Republic (203), Poland (203), Mexico (201), Colombia (183), Argentina (142), Sweden (138), Ecuador (131), Canada (128), Japan (122), Taiwan (120), and Australia (100).

Chemistry

About 20 collaborative countries were found having joint papers in chemistry. The leading countries include Germany (15), United States (14), United Kingdom (12), Spain (11), Australia (10), Italy (8), Japan (5), and Poland (5).

Mathematics

Total collaborative country having joint papers: 75
Leading collaborative country:

United States (100), Russian Federation (91), South Korea (83), China (73), Switzerland (61), France (55), Brazil (53), Mexico (52), Poland (50), Colombia (46), Germany (46), and United Kingdom (46)

Mathematics

Total collaborative country having joint papers: 20
Leading collaborative country

Biology

United States (22), Switzerland (17), United Kingdom (16), Germany (12), Italy (12), Spain (11), and Denmark (5)

Annamalai University

Physics

Annamalai University comparatively has marginal co-authored papers in Physics. United States was the chief collaborator United States (14), followed by Germany (6), Switzerland (6), Israel (5) and Japan (5). However, about 25 countries were found having academic joint papers in Physics.

Chemistry

Total collaborative country having joint papers: 24
Leading collaborative country:

Italy (16), Germany (6), Israel (6), Malaysia (6), United States (6) and South Korea (5)

China, Finland, Greece, Hong Kong, Saudi Arabia and Spain having 1 joint paper each respectively.

Mathematics

Total collaborative country having joint papers: 07
Leading collaborative country

Canada, China, France, New Zealand, South Korea and United States with a few joint papers

Biology

Total collaborative country having joint papers: 23
Leading collaborative country:

United States (28), Japan (13), Italy (10), Germany (7), Israel (6), Malaysia (5), Switzerland (4), Hungary (3), Netherlands (3), South Korea (3), and United Kingdom (3)

University of Hyderabad

Physics

Total collaborative country having joint papers:
Leading collaborative country:

Chemistry

Total collaborative country having joint papers: 30
Leading collaborative country:

Germany (36), United States (33), United Kingdom (15), France (10), Japan (6), Hong Kong (5), Mexico (4), Spain (4) and Switzerland (4)

Mathematics

Total collaborative country having joint papers: 15
Leading collaborative country:

United States (5), Italy (4), Japan (4), United Kingdom (4), Australia (2), Brazil (2) and Israel (2)

Biology

Total collaborative country having joint papers: 30
Leading collaborative country:

United States (35), Germany (34), United Kingdom (19), Japan (12), France (7), Poland (6), Singapore (4), Sweden (4), Italy (3), Netherlands (3), Portugal (3), and Switzerland (3)

8.3 Inter university and Institution collaboration

University of Delhi

Physics

Academic association with was found about 60 universities & colleges and 60 research institution and subsidiaries.

Panjab University (177), Inter University Accelerator Centre (34), University of Allahabad (22), Jawaharal Nehru University (20), Jamia Millia Islamia University (16), Banaras Hindu University (11) and Inter University Center for Astronomy and Astrophysics (10).

Tata Institute of Fundamental Research (172), National Physical Laboratory (94), IIT Delhi (34), Nuclear Science Centre (19), Solid State Physics Laboratory (18), Saha Institute of Nuclear Physics (13) Consortium for Scientific Research (12), Indian Institute of Science (11), Bhabha Atomic Research Centre (10) and IIT Roorkee (7).

Chemistry

Leading universities and affiliated school & college having joint papers: 40

Jamia Millia Islamia University (9), Chaudhary Charan Singh University (8), Punjab Agricultural University (8), Guru Nanak Dev University (6), Guru Gobind Singh Indraprashta University (5), Deen Dayal Upadhyay Gorakhpur University (4), Guru Jambeshwar University (4), Panjab University (4), Sri Aurobindo College (4), Jamia Hamdard University (3) and Jawaharal Nehru University (3)

Leading institution & autonomous body having joint papers: 35

National Physical Labo

ratory (43), Institute of Genomics and Integrative Biology (14), Institute of Nuclear Medicine and Allied Sciences (13), IIT Delhi (10), Bhabha Atomic Research Centre (6), Solid State Physics Laboratory (4), Centre for Fire Explosives and Environmental Safety (3), Fluorosis Research and Rural Development Foundation (3), Indian Agricultural Research Institute (3) and Institute of Pesticide Formulation Technology (3)

Mathematics

Leading universities and affiliated school & college having joint papers: 25

Panjab University (44), Jawaharal Nehru University (13), Jamia Millia Islamia University (8), University of Allahabad (8), Inter University Center for Astronomy and Astrophysics (6), Chaudhary Charan Singh University (5), Guru Gobind Singh Indraprashta University (5)

Leading institution & autonomous body having joint papers: 27

Tata Institute of Fundamental Research (42), IIT Delhi (10), IIT Kanpur (5), Indian Institute of Science (5), National Physical Laboratory (5)

Biology

Leading universities and affiliated school & college having joint papers: 50

Jawaharal Nehru University (15), Jamia Millia Islamia University (8), Hyderabad University (7), Jamia Hamdard University (7), Chaudhary Charan Singh University

(6), Kurukshetra University (6), Punjab Agricultural University (6), Guru Gobind Singh Indraprashta University (5)

Leading institution & autonomous body having joint papers: 110

Institute of Genomics and Integrative Biology (47), All India Institute of Medical Sciences (26), Institute of Nuclear Medicine and Allied Sciences (25), National Physical Laboratory (13), Centre for Biochemical Technology (11), Indian Institute of Science (9), National Institute of Immunology (9), National Research Centre on Plant Biotechnology (9), Center for DNA Fingerprinting and Diagnostics (8), IIT Delhi (8) and Indian Agricultural Research Institute (8)

Banaras Hindu University

Physics

Association was found about 70 universities & associated colleges and 60 research and autonomous agencies.

Uttar Pradesh Technical University (22), Inter University Accelerator Centre (15), Panjab University (12), Delhi University (11), University of Allahabad (10), Veer Kunwar Singh University (10), Inter University Consortium for DAEF (9), Guru Nanak Dev University (8), Udai Pratap Autonomous College (7), and Chaudhary Charan Singh University (6).

Bhabha Atomic Research Centre (30), National Physical Laboratory (25), Tata Institute of Fundamental Research (14), Consortium for Scientific Research (13), IIT Roorkee (13), Nuclear Science Centre (9), Indian Institute of Science (7) Institute of Physics (7), Saha Institute of Nuclear Physics (7) and IIT Kharagpur (5).

Chemistry

Leading universities and affiliated school & college having joint papers:

VBS Purvanchal University (9), Udai Pratap Autonomous College (5), University of Lucknow (5), Jagatpur P.G. College (4), North Eastern Hill University (4), Rajendra College (4), Guru Nanak Dev University (2), Manipur University (2) and Panjab University (2)

Leading other institution & autonomous body having joint papers:

IIT Kanpur (6), IIT Kharagpur (6), Indian Institute of Science (6), Bhabha Atomic Research Centre (5), Central Drug Research Institute (5), Drug Research and Development Centre (5), Indian Institute of Chemical Technology (5), Indian Institute of Toxicology Research (5) and Tata Institute of Fundamental Research (5)

Mathematics

Leading universities and affiliated school & college having joint papers: 14

Uttar Pradesh Technical University (6) and Rani Durgavati University (4)

Leading institution & autonomous body having joint papers: 21

IIT Kharagpur (5) and Bhabha Atomic Research Centre (4)

Biology

Leading universities and affiliated school & college having joint papers: 51

Jiwaji University (5), Jawaharal Nehru University (3), Madras University (3), Madurai Kamraj University (3), Udai Pratap Autonomous College (3), Uttar Pradesh Technical University (3), and VBS Purvanchal University (3)

Leading institution & autonomous body having joint papers: 67

Indian Institute of Science (9), Indian Institute of Technology Gauhati (7), Indian Institute of Chemical Biology (6), Central Drug Research Institute (5), IIT Kharagpur (4) and Regional Cancer Centre (4)

Jadavpur University

Physics

Total association were found about 70 with universities & associated colleges and 75 research institution and autonomous agencies.

University of Calcutta (107), West Bengal University of Technology (37), The Bengal Engineering & Science University (28), St. Xavier`s College (17), Visva Bharati University (17), University of Allahabad (15), Inter University Center for Astronomy and Astrophysics (10), University of Kalyani (10), Vidyasagar University (8) and West Bengal State University (8).

Indian Association for the Cultivation of Science (61), IIT Kharagpur (42), SN Bose National Centre For Basic Sciences (17), Variable Energy Cyclotron Centre (16), Saha Institute of Nuclear Physics (14), Indian Statistical Institute 12), Bhabha Atomic Research Centre (10), Tata Institute of Fundamental Research (9), Manipal Institute of Technology (8), and Central Glass and Ceramic Research Institute (7).

Chemistry

Leading universities and affiliated school & college having joint papers: 58

University of Calcutta (51), University of Burdwan (17), Tamil Nadu Dr MGR Medical University (8), Vidyasagar University (8), The Bengal Engineering & Science University (7), Berhampur University (5), Chandidas Mahavidyalaya (5), Nagaland University (5), University of Kalyani (5), West Bengal University of Health Sciences (5) and West Bengal University Of Technology (5)

Leading institution & autonomous body having joint papers: 55

Indian Association for the Cultivation of Science (50), IIT Kharagpur (17), Indian Institute of Chemical Biology (15), Indian Institute of Science (15), Bose Institute (8), IIT Kanpur (6), Indian Institute of Chemical Technology (6), BITS Pilani (5), Central Drug Research Institute (4) and Saha Institute of Nuclear Physics (4)

Mathematics

Leading universities and affiliated school & college having joint papers: 39

University of Calcutta (23), The Bengal Engineering & Science University (14), West Bengal University of Technology (14), St. Xavier`s College (9), Inter University Center for Astronomy and Astrophysics (7), University of Allahabad (7), University of Kalyani (6) and University of Burdwan (5)

Leading institution & autonomous body having joint papers: 35

Indian Statistical Institute (36), IIT Kharagpur (7), SN Bose National Centre For Basic Sciences (7), Ramakrishna Mission Vivekananda Educational & Research Institute (6), IIM Calcutta (5), Indian Institute of Science (5), and Tata Institute of Fundamental Research (4)

Biology

Leading universities and affiliated school & college having joint papers: 41

University of Calcutta (25), University of Burdwan (18), West Bengal University of Technology (9), University of Kalyani (8), College of Pharmacy (5), West Bengal University of Health Sciences (5), Chandidas Mahavidyalaya (4), Nagaland University (4), Panjab University (4)

Leading institution & autonomous body having joint papers: 50

Indian Association for the Cultivation of Science (40), Indian Institute of Chemical Biology (1), Bose Institute (11), Indian Statistical Institute (11), Saha Institute of Nuclear Physics (10), IIT Kharagpur (9), Indian Institute of Science (8), National Institute of Cholera and Enteric Diseases (7), Central Drug Research Institute (5) and IIM Calcutta (5)

Anna University

Physics

About 65 associations were found with universities & affiliated college and 50 other institution and autonomous bodies.

Madras University (187), Alagappa University (31), SRM University (26), Pondicherry University (20), Inter University Accelerator Centre (19), Bharathidasan University (14), Madurai Kamraj University (11), SSN College (11), SRM Engineering College (9), and Vellore Institute of Technology University (9).

Indira Gandhi Center for Atomic Research (46), National Physical Laboratory (26), IIT Madras (24), IIT Kharagpur (18), Karunya Institute of Technology & Sciences (11), Nuclear Science Centre (11), Central Electrochemical Research Institute (8), Gandhigram Rural Institute (8), Institute of Mathematical Sciences (6) and Raja Raman Center for Advance Technology (6).

Chemistry

Leading universities and affiliated school & college having joint papers: 35

Madras University (36), SRM University (13), Annamalai University (7), Bharathiar University (7), Aligarh Muslim University (5), Madurai Kamraj University (5) and Alagappa University (4)

Leading institution & autonomous body having joint papers: 40

Central Leather Research Institute (9), Central Electrochemical Research Institute (7), IIT Madras (6), Indian Institute of Science (5), Karunya Institute of Technology & Sciences (5), Gandhigram Rural Institute (4) and National Institute of Technology (4)

Mathematics

Leading universities and affiliated school & college having joint papers: 23

Madras University(15), Annamalai University (5), Pondicherry University (5), Bharathiar University (4), Jerusalem College (3), Madurai Kamraj University (3), Manonmaniam Sundaranar University (3)

Leading institution & autonomous body having joint papers: 22

Institute of Mathematical Sciences (9), IIT Madras (8), Gandhigram Rural Institute (3), Central Leather Research Institute (2), IIT, Delhi (2), IIT Roorkee (2) and Indira Gandhi Center for Atomic Research (2)

Biology

Leading universities and affiliated school & college having joint papers: 32

Madras University (133), SRM University (14), Annamalai University (9), Bharathidasan University (9), SRM Engineering College (8), The Bengal Engineering & Science University (8), Bharathiar University (5), Pondicherry University (5) and Madurai Kamraj University (4)

Leading institution & autonomous body having joint papers: 51

IIT Kharagpur (18), IIT Madras (11), Karunya Institute of Technology & Sciences (5), Central Leather Research Institute (4), Central Electrochemical Research Institute (3), Indian Institute of Science (3), and Nicholas Piramal India Limited (3)

University of Madras

Physics

Leading universities and affiliated school & college having joint papers: 54

Anna University (187), SRM University (26), Madurai Kamraj University (23), Bharathidasan University (15), Annamalai University (12), Mysore University (11), Bharathiar University (10), Pondicherry University (10), Vellore Institute of Technology University (7), Government College of Engineering (5), Inter University Accelerator Centre (5), SRM Engineering College (5)

Leading institution & autonomous body having joint papers: 42

Indian Institute of Chemical Technology (134), Indian Institute of Science (61), Central Leather Research Institute (29), Indira Gandhi Center for Atomic Research (25), Chennai Petroleum Corporation Limited (18), IIT Madras (17), Chennai Mathematical Institute (7), Asthagiri Herbal Research Foundation (4), Bioinformatics Research Institute (4), Central Drug Research Institute (4), Central Electrochemical Research Institute (4), Institute of Mathematical Sciences (4), National Metallurgical Laboratory (4) and Nuclear Science Centre (4)

Chemistry

Leading universities and affiliated school & college having joint papers: 38

Anna University (36), SRM University (16), Annamalai University (13), Madurai Kamraj University (8), Bharathiar University (6), Mangalore University (4), Periyar University (4), Pondicherry University (3), Sri Venkateswara University (3) and Vellore Institute of Technology University (3)

Leading institution & autonomous body having joint papers: 38

Indian Institute of Chemical Technology (37), Central Leather Research Institute (13), IIT Madras (10), Indian Institute of Science (7), Central Electrochemical Research

Institute (5), Central Ground Water Board (5), Indira Gandhi Center for Atomic Research (5), Asthagiri Herbal Research Foundation (4), and Centre for Natural Products (4)

Mathematics

Leading universities and affiliated school & college having joint papers: 13

Anna University (15) and Vellore Institute of Technology University (3)

Leading institution & autonomous body having joint papers: 07

IIT Madras (4) and Indian Statistical Institute (3)

Biology

Leading universities and affiliated school & college having joint papers: 51

Anna University (133), Madurai Kamraj University (17), SRM University (17), Tamil Nadu Dr MGR Medical University (17), Annamalai University (15), Bharathidasan University (15), Bharathiar University (8), Mysore University (7), Pondicherry University (6), Government College of Engineering (5), and SRM Engineering College (5)

Leading institution & autonomous body having joint papers: 69

Indian Institute of Chemical Technology (115), Indian Institute of Science (45), Central Leather Research Institute (39), Chennai Petroleum Corporation Limited (15), IIT Madras (10), Chennai Mathematical Institute (9), Central Research Institute for Siddha (7) and Indira Gandhi Centre for Atomic Research (5)

University of Calcutta

Physics

Leading universities and affiliated school & college having joint papers: 77

Jadavpur University (107), The Bengal Engineering & Science University (15), University of Burdwan (15), West Bengal University of Technology (15), University of Allahabad (14), Inter University Accelerator Centre (11), University of Kalyani (11), St. Xavier`s College (9), Andhra University (7), Inter University Center for Astronomy and Astrophysics (7)

Leading institution & autonomous body having joint papers: 54

Saha Institute of Nuclear Physics (58), Indian Association for the Cultivation of Science (32), Indian Statistical Institute (22), Tata Institute of Fundamental Research (22), IIT Kharagpur (21), Nuclear Science Centre (19), Variable Energy Cyclotron Centre (17), Bose Institute (11), SN Bose National Centre For Basic Sciences (11), Indian Institute of Science (9), Manipal Institute of Technology (9)

Chemistry

Leading universities and affiliated school & college having joint papers: 49

Jadavpur University (51), University of Kalyani (12), University of Burdwan (10), Vidyasagar University (5), Visva Bharati University (4), West Bengal State University (4), West Bengal University of Technology (4)

Leading institution & autonomous body having joint papers: 44

Indian Association for the Cultivation of Science (33), Bose Institute (21), Saha Institute of Nuclear Physics (12), Indian Institute of Chemical Biology (9), IIT Kharagpur (8), Indian Institute of Science (6), Central Salt and Marine Chemical Research Institute (4)

Mathematics

Leading universities and affiliated school & college having joint papers: 27

Jadavpur University (23), The Bengal Engineering & Science University (9), West Bengal University Of Technology (9), University of Burdwan (6), University of Allahabad (5)

Leading institution & autonomous body having joint papers: 28

Indian Statistical Institute (37), Saha Institute of Nuclear Physics (17), SN Bose National Centre For Basic Sciences (4)

Biology

Leading universities and affiliated school & college having joint papers: 36

Jadavpur University (25), West Bengal University of Health Sciences (17), University of Kalyani (12), West Bengal State University (6)

Leading institution & autonomous body having joint papers: 48

Bose Institute (33), Indian Institute of Chemical Biology (25), Indian Association for the Cultivation of Science (15), Saha Institute of Nuclear Physics (11), National Institute of Cholera and Enteric Diseases (10), Ramakrishna Mission Vivekananda Educational & Research Institute (10), Indian Statistical Institute (9), Indian Institute of Science (6), Institute of Haematology and Transfusion Medicine (6)

Aligarh Muslim University

Physics

Leading universities and affiliated school & college having joint papers: 63

Inter University Accelerator Centre (41), Bharathidasan University (20), University of Jammu (12), SN College (8), University of Rajasthan (8), Jamia Millia Islamia University (7), Pune University (7), Anna University (6), Calicut University (6), Panjab University (6), and Pondicherry University (6)

Leading institution & autonomous body having joint papers: 27

Variable Energy Cyclotron Centre (12), Nuclear Science Centre (11), Consortium for Scientific Research (10), Bhabha Atomic Research Centre (8), IIT Kharagpur 6), IIT Mumbai (6), Tata Institute of Fundamental Research (5), and IIT Delhi (4)

Chemistry

Leading universities and affiliated school & college having joint papers: 36

Jamia Millia Islamia University (56), Anna University (5), Jadavpur University (4), Kurukshetra University (4), Maharashtra Udayagiri Mahavidyalaya (4), Dr. Babasaheb Ambedkar Marathwada University (3), Kakatiya University (3) and Maharaja Sayajirao University of Baroda (3)

Leading institution & autonomous body having joint papers: 22

Bhabha Atomic Research Centre (5), Indian Institute of Chemical Technology (5), IIT Roorkee (2), Indian Institute of Science (2), National Chemical Laboratory (2), NEERI (2) and Regional Research Laboratory (CSIR) (2)

Mathematics

Leading universities and affiliated school & college having joint papers: 18

Jamia Millia Islamia University (4), University of Kashmir (4), Pondicherry University (3), Roorkee University (3), University of Calcutta (3) and University of Jammu (3)

Leading institution & autonomous body having joint papers: 18

IIT Roorkee (6), IIT Madras (3), NIT Srinagar (3)

Biology

Leading universities and affiliated school & college having joint papers: 36

Bharathidasan University (22), Jamia Hamdard University (15), Chhatrapati Shahuji Maharaj Medical University (5), Urumu Dhanalakshmi College (4), Bharathiar University (3), Jamia Millia Islamia University (3), and Punjab Agricultural University (3)

Leading institution & autonomous body having joint papers: 40

International Centre for Genetic Engineering and Biotechnology (6), All India Institute of Medical Sciences (5), Indian Institute of Integrative Medicine (4), Indian Institute of Toxicology Research (3) and National Institute of Immunology (3)

Panjab University

Physics

Leading universities and affiliated school & college having joint papers: 51

Delhi University (177), University of Jammu (105), University of Rajasthan (99), Bharathidasan University (26), Inter University Accelerator Centre (25), Utkal University (20), Punjabi University (13), Banaras Hindu University (12), Hyderabad University (11), Guru Nanak Dev University (9)

Leading institution & autonomous body having joint papers: 35

Tata Institute of Fundamental Research (301), Institute of Physics (114), Variable Energy Cyclotron Centre (98), IIT Mumbai (43), Nuclear Science Centre (23), SLIET (15), Bhabha Atomic Research Centre (10), Central Scientific Instruments Organisation (8), IIT Roorkee (7) and Indian Institute of Chemical Technology (7)

Chemistry

Leading universities and affiliated school & college having joint papers: 27

Guru Nanak Dev University (11), Delhi University (4), North Eastern Hill University (4), Punjab Agricultural University (4), Thapar University (4)

Leading institution & autonomous body having joint papers: 33

IIT Kanpur (10), IIT Delhi (6), Indian Institute of Chemical Technology (4), Bhabha Atomic Research Centre (3), Central Scientific Instruments Organisation (3), Institute of Microbial Technology (CSIR) (3), Panacea Biotec Limited (3), Postgraduate Institute of Medical Education and Research (3), SLIET (3)

Mathematics

Leading universities and affiliated school & college having joint papers: 23

Delhi University (44), Guru Nanak Dev University (5) and Kurukshetra University (4)

Leading institution & autonomous body having joint papers: 19

Tata Institute of Fundamental Research (77), IIT Kanpur (4), IIT Mumbai (3), NIT Jalandhar (3)

Biology

Leading universities and affiliated school & college having joint papers: 32

Bharathidasan University (29), Guru Nanak Dev University (12), Baba Farid University of Health Sciences (4), Chaudhary Charan Singh University (4), Jadavpur University (4)

Leading institution & autonomous body having joint papers: 43

Postgraduate Institute of Medical Education and Research (60), Institute of Microbial Technology (CSIR) (21), Indian Institute of Chemical Technology (6), All India Institute of Medical Sciences (5), Indian Agricultural Research Institute (5), Indian Institute of Integrative Medicine (4), National Bureau of Animal Genetic Resources (4)

Annamalai University

Physics

Leading universities and affiliated school & college having joint papers: 30

Bharathidasan University (39), Madras University (12), Anna University (8), Dr. Babasaheb Ambedkar Marathwada University (5), Pondicherry University (4)

Leading institution & autonomous body having joint papers: 21

IIT Madras (13), Indira Gandhi Center for Atomic Research (9), Indian Institute of Chemical Technology (8), National Physical Laboratory (4)

Chemistry

Leading universities and affiliated school & college having joint papers: 37

Bharathidasan University (19), Madras University (13), Anna University (7), Pondicherry University (7), Periyar University (6), Government Arts College (4), National College (4) and Sri Aravindar Arts and Science College (4)

Leading institution & autonomous body having joint papers: 27

Central Electrochemical Research Institute (30 and Indian Institute of Science (3)

Mathematics

Leading universities and affiliated school & college having joint papers: 09

Bharathiar University (6) and Anna University (5)

Leading institution & autonomous body having joint papers: 11

IIT Madras (5)

Biology

Leading universities and affiliated school & college having joint papers: 30

Bharathidasan University (30), Madras University (15), Anna University(9), Kerala University (5), Punjab Agricultural University (5)

Leading institution & autonomous body having joint papers: 34

Indian Institute of Chemical Technology (10), Central Leather Research Institute (4), IIT Madras (4), and Indian Institute of Science (4)

University of Hyderabad

Physics

Leading universities and affiliated school & college having joint papers:

Leading institution & autonomous body having joint papers:

Chemistry

Leading universities and affiliated school & college having joint papers: 18

Jawaharlal Nehru Technological University (4), Pune University (4) and Sri Venkateswara University (4)

Leading institution & autonomous body having joint papers: 37

Indian Institute of Chemical Technology (27), Indian Institute of Science (17), Bhabha Atomic Research Centre (7), National Chemical Laboratory (6), CES (4), IIT Mumbai (4)

Mathematics

Leading universities and affiliated school & college having joint papers: 09

Punjabi University (6) and Panjab University (3)

Leading institution & autonomous body having joint papers: 27

Institute of Mathematical Sciences (12), Indian Institute of Science (7), Physical Research Laboratory (7), Indian Statistical Institute (6) and IIT Kanpur (5)

Biology

Leading universities and affiliated school & college having joint papers: 22

Delhi University (7), Jawaharlal Nehru Technological University (7) and Sri Venkateswara University (3)

Leading institution & autonomous body having joint papers: 54

Center for Cellular and Molecular Biology (14), Center for DNA Fingerprinting and Diagnostics (12), Indian Institute of Science (12), Indian Institute of Chemical Technology (11), National Research Centre on Plant Biotechnology (7), National Institute of Nutrition (6) and National Institute of Immunology (5)

9. Findings

The analysis provides a broad picture of performance of Indian universities. The computed statistics indicates that publication output has increased over the last couple of years and it is expected to increase in future.

General performance

- It was found that University of Delhi, Banaras Hindu University and Jadavpur University were the top productive universities during 1998-2008. The share of, to the total Indian S&T publication, University of Delhi, Banaras Hindu University and Jadavpur University was 1.84%, 1.67% and 1.49% respectively.

- The top 50 university counted nearly 26% publication of the total Indian S&T publication.

- The central universities performed better because among the top 10 universities 4 central universities, namely University of Delhi, Banaras Hindu University, Aligarh Muslim University and University of Hyderabad, registered their presence.

- Alagappa University, Guru Nanak Dev University, Mahatma Gandhi University and University of Hyderabad were the top cited universities. The percentage of citation of papers of these universities was 85.23%, 81.91%, 81.61% and 80.80% respectively.

- Physics, Chemistry and Biology were the most productive subjects with a share of 7.41%, 7.28% and 5.66% respectively of the total output.

- Among the basic sciences Biology was the most cited discipline with a decadal average CPP of 10.82 followed by Chemistry (average CPP 9.09), Physics (average CPP 8.91) and Mathematics (average CPP 6.91).

- Among engineering disciplines papers from Chemical Engineering received the most citation with a decadal average CPP 10.50.

- Chemical Engineering was followed by Energy ((average CPP 8.54), material Science ((average CPP 8.54), Environment science (average CPP 6.77), Engineering (average CPP 5.88) and Agriculture (average CPP 5.41).

- University of Hyderabad, University of Delhi, Panjab University, Banaras Hindu University and Jadavpur University were the top 5 universities based on h-index. Their respective h-index was 62, 61, 59, 58 and 55.

- Some state universities performed comparable as central universities.

Subject-wise and university-wise performance

Physics

- Decadal average publication of universities was about 50.87% to the total Indian publication.
- University of Delhi (1360), Jadavpur University (6629) and Panjab University (988) were the top productive universities in Physics.
- The decadal average CPP of Physics was 8.91 for the period 1998-2008.

Chemistry

- The universities published about 46.64% of the total publication in Chemistry.
- Jadavpur University (1095), University of Delhi (877) and University of Rajasthan (789) were the top publishing universities in Chemistry.
- The publication of Indian universities' in chemistry was about 2.12% to global publication in chemistry and share of Indian publication to the global chemistry publication was about 4.59%.
- The decadal average CPP of Chemistry was 12.69 during 1998-2008.

Mathematics

- The decadal average publication by universities was about 53.55% of the total publication in mathematics.
- University of Delhi, Jadavpur University and University of Calcutta were the top publishing universities in Mathematics.
- The publication of Indian universities' was about 2.28% to global publication in Mathematics and share of Indian universities publication share was about 1.22% to the global publication in Mathematics during the period 1998-2008.
- The decadal average CPP of Mathematics was 6.83 in 1998-2008.

Biology

- The decadal average publication by universities was about 43.25% of the total publication in Biology.
- Madras University, University of Delhi and, Banaras Hindu University were the top publishing universities in Biology.
- The share of Indian publication was about 2.13% to global publication in Biology and share of Indian universities' publication was about 0.93% to the global publication in Biology during the period 1998-2008.
- The decadal average CPP of Biology was 10.82 during the period 1998-2008.

Agriculture

- The decadal average publication by universities was about 42.70% of the total publication in Agriculture.
- Punjab Agricultural University (6.06%), CCS Haryana Agricultural University (5.19%) and University of Delhi (3.79%) were the top productive universities in Agriculture to the total publication in Agriculture.
- The decadal average national publication was about 4.04% to global publication in Agriculture and the share of Indian universities' publication was about 1.71% to the global publication in Agriculture.
- The decadal average CPP of Agriculture publication was 5.41 during 1998-2008.

Energy

- The decadal average publication by universities was about 30.46% of the total publication in Energy whereas average contribution of publication output of universities was about 0.63% of total S&T Indian publication.
- Jadavpur University with 8.46%, Anna University with 7.96% and Banaras Hindu University with 5.21% were the top publishing universities in Energy.
- The decadal average national publication was about 2.10% to global publication in Energy and share of Indian universities' publication was about 0.64% to the global publication in Energy during the period 1998-2008.
- The decadal average CPP in Energy was 8.54 for 1998 to 2008.

Environment Science

- The decadal average publication by universities was about 42.31% of the total publication in Environment whereas average contribution of publication output of universities in Environmental science was about 2.74% of total S&T Indian publication.
- Anna University, Annamalai University and Mumbai University were the top publishing universities in Environmental science.
- The decadal average Indian publication in Environment science was 3.34% to global publication in Environmental science and the share of Indian universities' publication in Environment science was 1.42% to the global publication in Environment science.
- The decadal average CPP of Environment science was 6.77 for the period 1998-2008.

Chemical Engineering

- The decadal average publication by universities was 41.53% of the total publication in Chemical engineering..
- Mumbai University, Anna University and Jadavpur University were the top productive universities in Chemical engineering.
- The decadal average publication was 2.82% to global publication in Chemical engineering and the share of Indian universities' publication was about 1.16% to the global publication in Chemical engineering.
- The decadal average CPP of chemical engineering was 10.50 during 1998-2008.

Engineering

- The decadal average publication by universities was 29.45% of the total publication in Engineering whereas average contribution of publication output of universities was 4.22% of total S&T Indian publication.
- Anna University (8.42%), Jadavpur University (7.93%) and University of Delhi 5.09%) of the total publication in Engineering were the top productive universities.
- The decadal average publication of India in Engineering was 1.75% to global publication in Engineering and the share of Indian universities' publication was 0.51% to the global publication in Engineering.
- The decadal average CPP of chemical engineering was 5.88 during 1998-2008.

Material Science

- The decadal average publication by universities was 41.01% of the total publication in Material science whereas average contribution of publication output of universities was 4.99% of total S&T Indian publication.
- Anna University, Banaras Hindu University and Jadavpur University were the top publishing universities in Material science. Their publication share was 5.76%, 4.07% and 3.81% respectively in Material science.
- The decadal average publication of India was 3.39% to global publication in material science and the share of Indian universities' publication was 1.39% to the global publication in Material science.
- The decadal average CPP of Chemical engineering was 6.83 during 1998-2008.

Pattern of Collaboration

United States, Germany, Japan, United Kingdom and France were the leading collaborative countries having joint papers in all disciplines.

- In general, most of the joint papers came from the United States universities/institutions.
- Considerable international joint papers were found in Physics, Chemistry and Biology while least collaboration was observed in Mathematics.
- It was found that inter-university collaboration was less as compared to university and other research institutes/autonomous agency.
- The research institutions associated with Council of Scientific & Industrial Research (CSIR) were major collaborators with universities in Physics, Chemistry and Biological disciplines.

10.Recommendations

Attract fresh graduate and post graduate into science by giving them teaching opportunity and set up modern facility for S&T education and research in the country.

Focus should be given to the medium productive universities and colleges to enhance their quantity and quality of research output. This is possible by providing opportunities to the fresh faculty to participate in the national and international good conferences and training programmes.

For catalyzing S&T activities in universities, new interdisciplinary programmes need to be initiated to encourage greater participation, greater collaboration in research at national and international level.

Improvement in the Universities & Colleges sector is required in terms of the technical and computing infrastructure, course-content, teaching methods, faculty development in new and interdisciplinary fields, creating better linkages with research organisations. Fresh faculty should be encouraged to develop research paper for enhancing the growth of universities research output.

Strengthening low and medium productivity universities is required to strengthen linkages between other universities and institutions within their own geographical regions because results shows that major co-authored papers are form the near organisations and regional proximity. This will facilitate the low and medium productivity universities to benefit from the high productivity institutions and universities.

Strengthen the monitoring and evaluation system in the universities and colleges to ensure that their research output is reported in good quality journals. Measures should be taken to evolved for ensuring good quality output from Ph.D. work and from the sponsored projects.

Distribution of resources should be uniform among all the universities to give equal opportunities to universities. This will reduce regional and institutional disparity in terms of funding support for creating infrastructure, so that even low productivity states are able to contribute higher.

Chalk out strategy to encourage faculty to publish their research papers in good journals and the quality of Indian journals should be improved by strengthening their peer-reviewing system and making them more specialized. This will help to improve the quantity of research output of India.

Universities should strengthen collaboration with developed and emerging economies.

11. Bibliography

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Annexure-1

Zone distribution

West Zone –
Rajasthan, Gujarat, Maharashtra, Goa, Dadra & Nagar Haveli (UT), Daman & Diu (UT)

Central Zone –
Madhya Pradesh, Chhattisgarh

South Zone –
Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Lakshadweep (UT), Andaman & Nicobar Islands (UT), Pondicherry (UT)

East Zone –
Bihar, Jharkhand, West Bengal, Orissa, Meghalaya, Mizoram, Manipur, Sikkim, Tripura, Assam, Nagaland, Arunachal Pradesh

North Zone –
Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Haryana, Punjab, Delhi (UT), Chandigarh (UT)

Source: Maps of India

Catalysis

Table-1: Total publication of India in catalysis (1999-2008)

Year	Papers	Citation
1999	379	4473
2000	417	9132
2001	462	8388
2002	579	10837
2003	711	13701
2004	708	10022
2005	638	10775
2006	770	9817
2007	894	9177
2008	1,009	7276

Table-2: Top 20 institutes in Catalysis based on publications (1999-2008)

SL. No.	Institute Name	No. of Papers	Citation	H index
1	Indian Institute of Chemical Technology	987	17862	53
2	National Chemical Laboratory India	522	7906	39
3	Indian Institute of Science	196	4518	33
4	Indian Institute of Technology, Kanpur	174	4256	34
5	Indian Association for the Cultivation of Science	149	3502	33
6	University of Delhi	146	2130	24
7	Indian Institute of Technology, Bombay	144	3725	30
8	Indian Institute of Technology, Madras	139	4469	26
9	Indian Institute of Technology, Kharagpur	127	2349	26
10	University of Mumbai	127	1376	21
11	Central Drug Research Institute India	114	1313	20
12	Indian Institute of Technology, Guwahati	101	2039	26
13	Jadavpur University	95	1235	20
14	University of Madras	91	911	17
15	Central Salt and Marine Chemicals Research Institute India	85	1299	20
16	Indian Institute of Technology, Delhi	82	1526	18
17	University of Kalyani	80	880	18
18	Regional Research Laboratory Jorhat	78	1344	21
19	Anna University	75	646	14
20	Kakatiya University	75	674	15
21	University of Mysore	74	457	12

Table-3: Top 20 institutes in Catalysis based on h-index (1999-2008)

Sl. No.	Institute Name	No. of Papers	Citation	H index
1	Indian Institute of Chemical Technology	987	17862	53
2	National Chemical Laboratory India	522	7906	39
3	Indian Institute of Technology, Kanpur	174	4256	34
4	Indian Institute of Science	196	4518	33
5	Indian Association for the Cultivation of Science	149	3502	33
6	Indian Institute of Technology, Bombay	144	3725	30
7	Indian Institute of Technology, Madras	139	4469	26
8	Indian Institute of Technology, Kharagpur	127	2349	26
9	Indian Institute of Technology, Guwahati	101	2039	26
10	National Institute of Pharmaceutical Education and Research India	68	1651	25
11	University of Delhi	146	2130	24
12	University of Mumbai	127	1376	21
13	Regional Research Laboratory Jorhat	78	1344	21
14	Regional Research Laboratory Thiruvananthapuram	66	1610	21
15	Central Drug Research Institute India	114	1313	20
16	Jadavpur University	95	1235	20
17	Central Salt and Marine Chemicals Research Institute India	85	1299	20
18	University of Hyderabad	66	1994	19
19	Central Leather Research Institute India	65	1180	19
20	Indian Institute of Technology, Delhi	82	1526	18
21	University of Kalyani	80	880	18
22	Mumbai University Institute of Chemical Technology	69	930	18

Search methodology

Key words based search for catalysis into Title, keywords, abstract from SCOPUS in chemistry discipline for all types of documents e.g. papers, review, notes, conference proceedings etc. for the period 1999-2008

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Nidhi Tyagi is a graduate engineer in computer science, she has programming, analytical skills and capability to manage large scale database.

About the Book

The report provides the performance status of Indian universities based on the quantitative analysis in the area of S&T, as reflected in its publications output reported in mainstream national and international journals. The main objective of the present report was to provide the research output of Indian universities across geographical regions and subjects. The study may be useful for Indian science planners & policy-makers for gaining macro insights into the university performance for improving the current status of the universities. This study is based on universities' publication in S&T indexed in SCOPUS international database. The subject classification is adopted from SCOPUS. The study reference period is considered for 11 years i.e. 1998-2008, and cumulative publications and citations output data of Indian universities covered in the emerging Science & Technology (S&T) disciplines, namely Physics, Chemistry, Mathematics, Biology, Chemical Engineering, Material Science, Environment Science, Energy, Engineering and Agriculture is used for performance comparison. From the computational analysis it was found that all the disciplines show increasing trends and also expected to rise in the future.

CSIR-NISTADS

CSIR-National Institute of Science, Technology and Development Studies (CSIR-NISTADS) is one of the leading institutions under CSIR exploring interface between science, technology, and society. The institute as a knowledge-generating organization carries out studies in several areas of national importance, for example, S&T policy, innovation & national competitiveness in global context, CSIR & public funded knowledge & technology, mapping knowledge trends and outcomes in S&T. It also undertakes studies on history & philosophy of science and technology (S&T), and S&T for weaker sections.

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