Scholarly Literature from Selected Universities of Delhi and Uttar Pradesh: A Pilot Study

Bhaskar Mukherjee,
Lecturer, Department of Library and Information Science,
Banaras Hindu University, Varanasi, U.P. INDIA.
Email: mukherjee.bhaskar@gmail.com

Abstract

This study presents the publications output of the four most productive Indian academic institutions in the mainstream scientific literature for the eight-year-period 2000-2007. This paper discusses the distribution of publications by institution, type of publication, pattern of co-authorship, and citations. The results show that among the four universities, the authors of Delhi University contributed the highest number of articles, followed by Banaras Hindu University. There is also an increasing trend of collaborative research among Indian authors as well as more frequent collaboration with international authors. Biochemistry and molecular biology is one of the most prolific research areas in these four Indian universities. The average rate of references per item is 28 and the citations received per item are 3.56.

Keywords: Scientific Research-India; University Productivity-India; Scholarly Literature-India.

Introduction

Historically, India has been one of the most prominent South Asian countries, owing to its global reputation for academic and research excellence. India has a large scientific establishment and publishes on average thirteen thousand research papers a year according to the *Science Citation Index*. The last few decades have witnessed a restructuring in scientific research in India. Modern information and communication technology (ICT) has acted as a catalyst in a paradigm shift in terms of quality and quantity of research. Now researchers in national institutions and universities in India have greater access to research literature due to subscriptions to many e-journals and scholarly databases in most subject areas. Government research agencies have introduced research fellowship opportunities for pursuing research degrees in order to attract talented students into research and teaching professions in India and to reverse the brain-drain to developed countries. At the same time, however, there continues to be extensive discussion regarding the perceived deficit in quantity, and possibly in quality, of research at the university level. One optimistic view explains the reason as lack of funds while others blame the lack of infrastructure. It is, therefore, important that a study be undertaken with the sole purpose of identifying the quality and quantity of research activity of well-funded Indian universities.

Objective and Scope of the Study

The purpose of this pilot study is to explore the main scientific output in order to measure the extent of scientific development in India. Specific objectives of the paper include:

- to track the growth of publications from prominent Indian universities during 2000-2007.
- To explore the type of publications in which authors have preferred to publish their work.
- To determine the nature of collaborative research and the amount of international collaboration.
- To know the amount of inter-university collaborative research.
- To document the highly preferred journals and research subjects of published authors.
- To discover the countries and institutions most involved in research collaboration with Indian scholars and researchers; and

- to compare the quality of research output in terms of the number of citations given and received

Methodology

The data presented in this paper have been accessed from *Web of Science*, published by the Institute for Scientific Information (ISI). Since the level of interest in this study was institutional rather than departmental or individual, a different approach than per full time equivalent (FTE) publication rate was developed. All papers contributed by the authors (either individually or in collaboration with authors from other organizations) from four central universities in India have been considered for the present study. The four Indian institutions studied are Aligarh Muslim University (AMU), Aligarh, U.P.; Banaras Hindu University (BHU), Varanasi, U.P.; Delhi University (DU), Delhi; and Jawaharlal Nehru University (JNU), New Delhi. It was possible to determine institutional counts for each of these universities by counting the times that faculty members' publications from each university were listed in the *Science Citation Index, Social Science Citation Index* (2001 to present), and *Arts & Humanities Index* (2001 to present) during 2000 to 2007. All these universities have a long history, and all offer a wide range of academic programs and subjects, which is not characteristic of other Indian universities.

The bibliographic details of the published literature were collected using the general search option of *Web of Science.* In the address field of the general search option, the name of the university or popular abbreviated name of the university (AMU or Aligarh Muslim Univ., BHU or Banaras Hindu Univ., DU or Delhi Univ. and JNU or Jawaharlal Nehru Univ.) were used. Additionally, in the publication year field, 2000-2007 was used in order to search literature published only during those years in the scholarly journals. After careful verification, only those records were selected that were contributed by the authors of these four universities either individually or in collaboration with others. All the searched results were then saved in a text file and imported into Microsoft Excel for analysis.

The performance of these four institutions were judged and compared on the basis of various quantitative indicators: (a) size of scientific activity measured by volume of production in various types of publications during the period of study, (b) authorship pattern and collaboration of scientific activity measured by co-authorship and the amount of national and international collaboration, and (c) impact of scientific activity measured by the numbers of citations given and citations received during the period of study. These bibliometric techniques constitute a relatively objective indicator for measuring discourse popularity (Ponzi & Michael, 2003). According to the work of Abrahamson (1991, 1996) and Abrahamson & Fairchild (1999), the bibliometric technique of article counting is a reliable approach to beginning an analysis of published literature in order to illuminate and trace the development of a concept.

Basic information about these four universities was collected from their official Web sites. Table 1 below presents this material.

Table 1: Basic Information about the Universities

Name of the Institution	Year of Establishment	Schools/ Faculty	Departments	Faulty Members* (approx)
AMU	1,866	12 Faculties	71	1,111
BHU	1,916	14 Faculties, 3 Institutes	138	2,820
DU	1,922	16 Faculties	76	849
JNU	1,969	10 Schools 04 Centers	-	526

* Excluding faculty members at the college level

Results

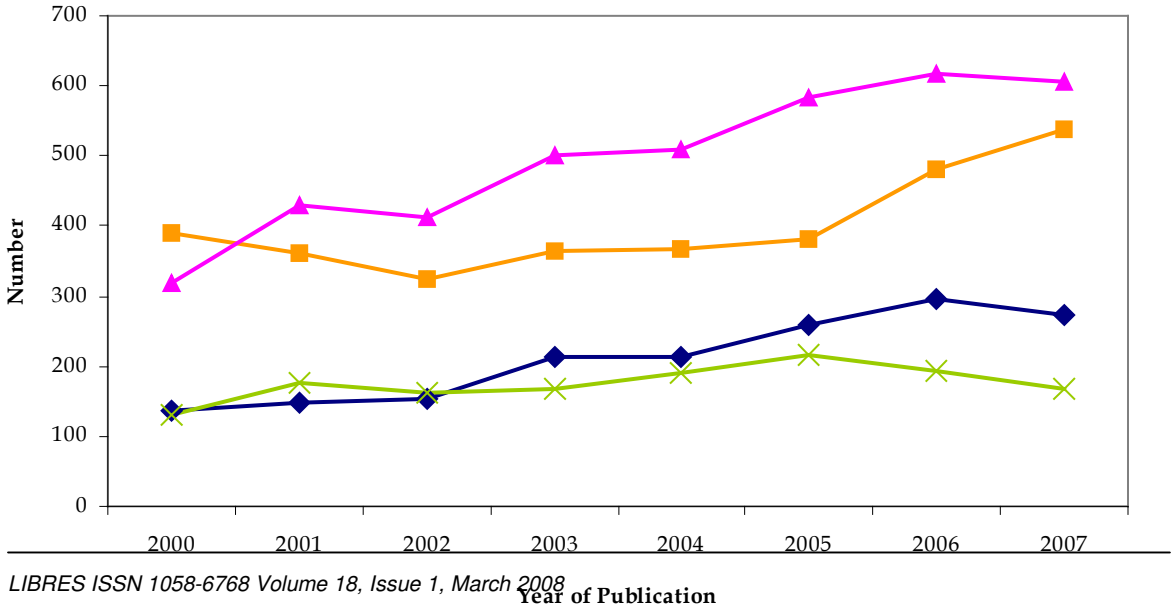
Growth of Literature

As indicated in Table 2, authors from these four universities have contributed as many as 10,281 publications during 2000 to 2007 in different scholarly journals. A steady growth in the number of total publications has been observed from 2000 to 2007. In 2000 (the starting year of the study), 979 articles were published. This number rose to 1,587 in 2006, falling by one (1,586) in 2007. From 2000 to 2006, the number of published articles increased by an average of 86 per year.

Table 2: Distribution of Articles by Year

Year	AMU	BHU	DU	JNU	Total
2000	137	391	320	131	979
2001	147	360	429	177	1,113
2002	153	323	412	163	1,051
2003	212	365	500	168	1,245
2004	213	368	508	192	1,281
2005	259	381	583	216	1,439
2006	296	481	617	193	1,587
2007	274	538	607	167	1,586
Total	**1,691**	**3,207**	**3,976**	**1,407**	**10,281**

Figure 1: Growth of Literature during 2000 to 2007



As evident from Figure 1, at the individual universities there is a gradual increase in publications from 2000-2006 with a nominal drop between 2001-2002 in the case of BHU, DU and JNU and between 2006-2007 in the case of AMU, DU, and JNU. The reasons for the slow growth rate between 2001/2002 and 2006/2007 are not known. Of the total 10,281 publications, the highest number of publications were contributed by authors from Delhi University (3,976) followed by Banaras Hindu University (3,207), Aligarh Muslim University (1,691), and Jawaharlal Nehru University (1,407). The number of publications in the case of BHU and DU is very much higher than that of the other two universities. A possible explanation for this phenomenon is that BHU and DU have more faculty members (including faculty members from affiliated colleges) than AMU and JNU.

Types of Publication

Table 3 presents the distribution of published literature according to type. Of the 10,281 published papers, 9,180 (89.29%) were periodical articles, followed by 264 (2.56%) reviews and 238 (2.31%) abstracts. That the highest number of publications was scholarly periodical articles indicates that the authors from these universities were involved enough in various meaningful research activities to be able to disseminate their research findings through scholarly journals.

Table 3: Type of Publications

Year	AMU	BHU	DU	JNU	Total
Articles	1,598	2,933	3,482	1,167	9,180
Biographical items	0	8	10	2	20
Book Reviews	3	5	140	80	228
Corrections	9	12	15	7	43
Editorials	15	47	38	31	131
Letters	17	65	56	16	154
Meetings/Abstracts	21	47	120	50	238
News Items	0	6	2	13	21
Reviews	28	84	111	41	264
Reprints	0	0	1	0	1
Poetry	0	0	1	0	1
Total	**1,691**	**3,207**	**3,976**	**1,407**	**10,281**

Authorship Pattern

As Harsanyi (1993) has shown, different disciplines interpret the order of authorship differently. Some list co-authors alphabetically; some list co-authors by the order of contribution to the article. There is at least one book for which the order of authorship was decided by a coin toss (Nye & Keohane, 1972). There is also a reference to a practice in which the order of authorship was rotated within a group of researchers who published many articles and reports.

The last few decades have witnessed a growth in collaborative endeavors (Subramanyam, 1983). According to Qiu (1992), there is also a strong trend towards borrowing from and interpenetration across disciplines. The collaboration pattern of scientists working in these four Indian universities has been presented in Table 4.

Table 4: Authorship Pattern

Authors per Article	Number of Articles				Total
	AMU	BHU	DU	JNU	
Single author	103	197	472	242	1,014
2 authors	529	998	897	348	2,772
3 authors	612	901	913	244	2,670
4 authors	244	498	592	219	1,553
5 authors	87	253	329	127	796
6 authors	39	129	185	66	419
7 authors	25	74	148	36	283
8 authors	14	27	75	19	135
9 authors	8	18	48	14	88
10 authors	4	8	30	6	48
> 10 authors	26	104	287	86	503
Total	**1,691**	**3,207**	**3,976**	**1,407**	**10,281**

Although the trend is toward multi-authorship, the majority of items published by these universities have two authors. The number of authors per item ranges mostly from one to twelve. In some cases, however, there are more than 500 authors in a single work. Most of these works were originated from corporate bodies. There were 169 items (105 from DU and 64 from BHU) published by corporate bodies. PHENIX Collaboration and DO Collaboration are two of the most prolific corporate bodies. Of the 10,281 items designated in this study, 1,014 articles (9.82%) were by single authors. The number of articles written by two authors, three authors, and four authors were 2,772 (26.96%), 2,670 (25.97) and 1,553 (15.10%) respectively. The collaborative coefficient 0.90 indicates the trend of present research in these universities. At the individual university level, the highest number of the items from AMU and DU was contributed by three authors with two authors in the case of BHU and JNU.

If one considers the average publication rate by faculty members from these four universities, the present study indicates that the faculty members of DU have contributed the highest (4.68) number of articles followed by JNU (2.67), AMU (1.52), and BHU (1.13). It is essential to mention that the total number of faculty members in the present study (Table 1) includes only faculty members from university teaching departments. The total articles of an individual university as indexed in *Web of Science*, however, may include those authored by faculty members from affiliated colleges as well. For the purposes of this study, only publications listed under university headings were counted. Publications by faculty members from affiliated organizations of the same university or any other units at off-campus locations were studied separately.

There is a common perception that the first author is indeed *primus inter pares*. Either the first author has made the more significant contribution to the article or is the more senior member of the team. The minority view is that the order of authorship has little significance. From a practical point of view, it is true that most indexes list at least the first three authors of an article, but some reduce all but the first author to the status of et al. *Web of Science*, however, lists the names of all authors in the author's field. During investigation, it was found that at least one

article in the dataset contained a list of 588 authors. The total number of authors in various positions (up to the fifth author) in an article is provided in Table 5.

Table 5: Authors' Position in an Article

Universities	Authors' Position					
	Single Author	1st Author	2nd Author	3rd Author	4th Author	5th Author
AMU	103 (6.09)	1,302	307	62	18	10
BHU	208 (6.48)	2,168	744	211	45	24
DU	479 (12.04)	2,242	1,038	282	82	29
JNU	248 (17.62)	786	311	104	31	9

Note: Position of all authors of an article measured. If both authors were from the same university, different position is mentioned for different authors.

From the data in Table 5 it is evident that most of the authors from these universities preferred to contribute their work either as first or second author rather than any other position. Only 17.62 percent of the items from JNU, 12.04 percent of the items from DU, 6.48 percent of the items from BHU, and 6.09 percent of the items from AMU were reported as by a single author. This is a clear indication that team research is the most prevalent research process within these four universities of India. It is important to note, however, that most of these research teams consist of members of different national and international research organizations rather than faculty only from these four universities. It may be that inter-university research is not common among these universities. As indicated in Table 6, there are only 52 items reported that have been jointly contributed by authors from JNU and DU, 13 from DU and BHU, 7 from JNU and BHU, four from BHU and AMU, two from DU and AMU, and one from AMU and JNU.

Table 6: Inter-university Research Activity among the Four Indian Universities

	AMU	BHU	DU	JNU
AMU	89	4	2	1
BHU	4	316	13	7
DU	2	13	387	52
JNU	1	7	52	103

Geographic Location of Collaborative Authors

International scientific collaboration has been of increasing interest in recent years. This is due to the higher quality of collaborative papers as shown by higher average impacts when compared to solely national publications (Van Raan, 1998) and to the benefits gained by peripheral countries in being able to integrate their national publications into the international scientific network (Russell, 1995). The prolific countries' (top ten) authors who mostly contribute articles jointly with the authors from these four Indian universities are indicated in Table 7. Table 7 shows a fairly wide geographical distribution. It is interesting to see that, next to India, the United States ranks highest in collaboration with the authors from these four Indian universities. After that, the collaboration is more variable. For example, it is Germany for BHU and JNU, Saudi Arabia for AMU, and England for DU. Other prominent countries are Japan, the People's Republic of China, Canada, etc. The worldwide collaboration with authors from all these universities may be dependent upon the quality of research conducted in these universities and the authors' standing in the scholarly world.

Table 7: Geographic Location of Collaborative Authors *(Top Ten)*

Uttar Pradesh			
AMU	**Number of Articles**	**BHU**	**Number of Articles**
India	1,691	India	3,206
USA	45	USA	220
Saudi Arabia	41	Germany	198
Germany	34	Japan	123
Taiwan	33	France	108
Canada	20	People's Rep. China	86
England	17	South Korea	84
Japan	15	Sweden	80
Ethiopia	11	Brazil	78
Malaysia	11	Hungary	78
Italy	9	Taiwan	76
Delhi			
DU	**Number of Articles**	**JNU**	**Number of Articles**
India	3,972	India	1,407
USA	463	USA	151
England	223	Germany	53
Germany	195	Japan	19
People's Rep. China	156	England	14
France	148	Canada	12
Russia	146	France	10
South Korea	141	Australia/Sweden	8
Brazil	140	Israel	6
Mexico	134	Netherlands	6
Colombia	127	Scotland	6

Institutes Prolific in Collaborative Research

The top ten institutes whose authors collaborate on articles with the authors from these four universities are mentioned in Table 8. It is interesting to note that each Indian university collaborates with totally different institutes. Exceptions are the Indian Institute of Technology, Jamia Millia Islamia University, SUNY Stony Brook, and the Centre for Nuclear Science, all of which have authors who have collaborated with authors from each of the Indian universities targeted in this study.

Table 8: Top Institutes

Uttar Pradesh			
AMU	**No.**	**BHU**	**No.**
Jamia Millia Islamia, India	68	Indian Institute of Technology	85
Indian Institute of Technology, India	44	Bhabha Atomic Research Centre	80
National Sun Yat-sen University, Taiwan	23	University of Tokyo	79
Nuclear Science Centre, New Delhi	18	Tokyo Institute Technology	76
King Fahd University Petroleum & Minerals, Saudi Arabia	18	University of Munster, Germany	75
University of Hannover, Germany	16	Vanderbilt University, USA	74
University of Jammu, India	16	Waseda University, Japan	73
Central Drug Research Institute, India	11	Brookhaven National Laboratory, USA	72
DSN College, Unnao, India	9	Oak Ridge National Laboratory, USA	72
St Francis Xavier University, Canada	8	SUNY Stony Brook University, NY	72
Delhi			
DU	**No.**	**JNU**	**No.**
Tata Institute of Fundamental Research	146	University of Delhi	52
National Physical Laboratory	142	International Centre for Genetic Engineering & Biotechnology	34
Panjab University	137	Indian Institute of Technology	31
Brookhaven National Laboratory, USA	135	Jamia Millia Islamia	24
Michigan State University	135	National Control Plant Genome Research	18
University of Rochester, USA	132	National Institute of Immunology	17
Columbia University	131	Gobind Ballav Pant Institute of Himalayan Environment & Development	17
SUNY Stony Brook University, NY	131	All India Institute of Medical Science	15
University of California Riverside, USA	131	Annamalai University	14
University of Maryland, USA	131	Nuclear Science Centre, New Delhi	14

Distribution to Periodicals

Table 9 includes the list of the top ten periodicals that published most of the articles contributed by the authors from these universities. The periodicals are arranged in decreasing order by the number of articles published. The table shows that *Current Science* is one of the most preferred periodicals of Indian origin among the authors of three of the four universities. Other journals preferred by authors from at least two of the universities have also been noted. They are *Contributions to Indian Sociology, Indian Journal of Chemistry Section A-Inorganic Bio-Inorganic Physical Theoretical & Analytical Chemistry, Indian Journal of Chemistry Section B-Organic Chemistry Including Medicinal Chemistry, Journal of the Geological Society of India, Journal of the Indian Chemical Society, Microwave and Optical Technology Letters, Physical Review Letters, Spectrochimica Acta Part A-Molecular and Biomolecular Spectroscopy*, and *Synthesis and Reactivity in Inorganic and Metal-Organic Chemistry*. It is interesting to observe that out of the top ten most preferred periodicals, authors from AMU mostly prefer to contribute their articles to journals of Indian origin whereas authors from JNU prefer periodicals of foreign origin.

Table 9: Top Sources to which Authors Contributed Articles

Uttar Pradesh			
AMU	**No. of articles**	**BHU**	**No. of articles**
Indian Journal of Chemistry Section A-Inorganic Bio-Inorganic Physical Theoretical & Analytical Chemistry	32	*Current Science*	116
Transition Metal Chemistry	24	*Materials Science and Engineering A-Structural Materials Properties Microstructure and Processing*	50
Journal of the Geological Society of India	23	*Physical Review Letters*	47
Colloids and Surfaces A-Physicochemical and Engineering Aspects	22	*Microwave and Optical Technology Letters*	44
Synthesis and Reactivity In Inorganic and Metal-Organic Chemistry	22	*Spectrochimica Acta Part A-Molecular and Biomolecular Spectroscopy*	43
Indian Journal of Chemical Technology	21	*Journal of the Geological Society of India*	39
Indian Journal of Chemistry Section B-Organic Chemistry Including Medicinal Chemistry	19	*Indian Journal of Chemistry Section A-Inorganic Bio-Inorganic Physical Theoretical & Analytical Chemistry*	35
Journal of the Indian Chemical Society	19	*Journal of Materials Science*	35
Bulletin of Electrochemistry	18	*Pramana-Journal of Physics*	32
Journal of Mathematical Analysis and Applications	18	*Synthesis and Reactivity in Inorganic and Metal-Organic Chemistry*	28
Delhi			
DU	**No. of articles**	**JNU**	**No. of articles**
Current Science	107	*Current Science*	59
Physical Review D	84	*Biochemical and Biophysical Research Communications*	55
Physical Review Letters	66	*Physical Review E*	52
Spectrochimica Acta Part A-Molecular and Biomolecular Spectroscopy	59	*Contributions to Indian Sociology*	28
Contributions to Indian Sociology	53	*Journal of Biosciences*	20
Indian Journal of Chemistry Section A-Inorganic Bio-Inorganic Physical Theoretical & Analytical Chemistry	51	*Molecular and Cellular Biochemistry*	19
Microwave and Optical Technology Letters	49	*Physical Review B*	18
Physics Letters B	49	*Journal of Biological Chemistry*	13
Indian Journal of Chemistry Section B-Organic Chemistry Including Medicinal Chemistry	48	*Journal of Chemical Physics*	12
Journal of the Indian Chemical Society	43	*Journal of Physics-Condensed Matter*	12

Distribution of Papers According to Broad Subjects

The departmental affiliations of the authors indicate the prominent research areas of these universities. The distribution of papers according to broad subject is presented in table 10. Table 10 principally lists the top ten broad subjects regarding which authors of these universities

mostly contribute articles. From the data in Table 10 one can clearly infer that biochemistry and molecular biology are one of the most prolific research areas among these four universities. Other prolific fields of research are pharmacology and pharmacy, physics, plant science, biotechnology and applied microbiology, chemistry, electrical and electronic engineering and material science.

Table 10: Distribution of Papers According to Broad Subjects

AMU		**BHU**	
Biochemistry & Molecular Biology	186	Materials Science, Multidisciplinary	313
Chemistry, Multidisciplinary	137	Biochemistry & Molecular Biology	194
Chemistry, Physical	118	Engineering, Electrical & Electronic	169
Mathematics, Applied	111	Multidisciplinary Sciences	154
Engineering, Chemical	77	Physics, Applied	154
Pharmacology & Pharmacy	70	Chemistry, Physical	148
Chemistry, Analytical	67	Physics, Multidisciplinary	146
Chemistry, Inorganic & Nuclear	66	Plant Sciences	145
Biotechnology & Applied Microbiology	65	Physics, Condensed Matter	143
Mathematics/ Environmental Science	62	Pharmacology & Pharmacy	137
DU		**JNU**	
Biochemistry & Molecular Biology	314	Biochemistry & Molecular Biology	239
Physics, Multidisciplinary	252	Biophysics	101
Chemistry, Multidisciplinary	250	Physics, Mathematical	77
Biotechnology & Applied Microbiology	235	Multidisciplinary Sciences	72
Plant Sciences	228	Cell Biology	69
Physics, Applied	222	Physics, Condensed Matter	68
Chemistry, Organic	212	Environmental Sciences	66
Materials Science, Multidisciplinary	191	Plant Sciences	65
Engineering, Electrical & Electronic	189	Pharmacology & Pharmacy	55
Physics, Condensed Matter	187	Physics, Fluids & Plasmas	53

Prolific Authors

Table 11 documents the top fifteen most published authors during 2000-2007 from these four universities as indexed in *Web of Science*. The credit for the most productive author goes to R.K. Shivpuri, Department of Physics, Delhi University, followed by Virinder S. Parmar, Department of Biochemistry, Delhi University, and O.N. Srivastava, Department of Physics, Banaras Hindu University. Interestingly, however, the author with the highest number of citations received is N.N. Ajitanand, Department of Physics, Banaras Hindu University, followed by Vivek Singh, Department of Physics, Banaras Hindu University. These counts are, of course, limited to pieces published in archival journals covered by the indexes; books, monographs, technical reports, and other non-archival products are not included in these counts. It is equally essential to note that almost all the publications of these authors were reported with joint rather than single authorship.

Table 11: Prolific Authors

Author	Number of Articles	No. of References Given	No. of Citations Received
Shivpuri, R.K., Dept. Physics, Delhi University	142	4,663	1,264
Parmar, Virinder S, Dept. Biochemistry, Delhi University	127	3,554	544
Srivastava, O.N., Dept. Physics, Banaras Hindu University	104	2,303	350
Kabir-Ud-Din, Dept. Chemistry, Aligarh Muslim University	95	3,506	293
Sundar, S., Dept. of Medicine, Institute of Medical Science, Banaras Hindu University	88	2,877	1,246
Quraishi, Mumtaz Ahmad, Faculty of Engineering & Technology, Dept. Applied Chemistry, Aligarh Muslim University	73	1,333	234
Singh, Vivek, Dept. Physics , Banaras Hindu University	64	2,496	3,196
Ajitanand, N.N, Dept. Phys, Banaras Hindu University	63	2,534	3,315
Khan, Rizwan Hasan, Interdisciplinary Biotechnology Unit, Aligarh Muslim University	57	2,332	272
Khan, Mukhtar A, Dept. Zoology, Fish Nutrition Research Laboratory, Aligarh Muslim University	56	1,951	145
Prasad, Rajendra School of Life Science, Jawaharlal Nehru University	47	2,024	333
Ramaswamy, R., School of Physical Science, Jawaharlal Nehru University	45	1,405	168
Ghosh, Subhasis, School of Physical Science, Jawaharlal Nehru University	42	1,143	181
Puri, Sanjay, School of Physical Science, Jawaharlal Nehru University	41	1,676	182
Bhattacharya, Alok, School of Life Science, Jawaharlal Nehru University	40	1,213	356

Citations Given Versus Citations Received

Table 12 shows the data for the 10,281 items published by authors of these four universities contained 288,029 references and received 34,282 citations during 2000-2007. The average number of references per item was 28, and the average number of citations received per item was 3.56. The growth rate of references per items has tended to increase over the period 2000-2007, whereas the number of citations received has decreased during the same period. The average rate of references per item during 2000-2007 varied from a minimum of 23.71 (AMU), 24.48 (BHU), 22.68 (DU) and 27.69 (JNU) to a maximum of 31.63 (AMU), 31.51 (BHU), 33.44 (DU) and 35.49 (JNU). The rate of citations received per item during 2000-2007 varied from a minimum of 0.18 (AMU), 0.28 (BHU), 0.23 (DU) and 0.26 (JNU) to a maximum of 6.69 (AMU), 7.81 (BHU), 5.98 (DU) and 7.15 (JNU). The highest number of references per item was noted in 2007 for all these universities. However, articles for 2000 from AMU (6.69) and DU (5.98), for

2002 from BHU (7.81), and 2001 from JNU (7.15) received the highest number of citations per item. Overall, articles from DU contained the highest number of references (109,311) during 2000-2007, and articles from BHU received the highest percentage of citations (i.e., 4.21 citations per item).

Table 12: Distribution of Citations Given and Citations Received

Year	AMU				BHU				DU				JNU			
	CG	RA	CR	CA	CG	RA	CR	CA	CG	RA	CR	CA	CG	RA	CR	CA
2007	8,669	31.63	30	0.10	16,956	31.51	151	0.28	20,299	33.44	141	0.23	5,927	35.49	44	0.26
2006	8,737	29.62	172	0.58	13,559	28.19	633	1.32	17,144	27.83	763	1.24	5,900	30.57	159	0.82
2005	7,358	28.41	381	1.47	11,504	30.19	1,214	3.19	16,005	27.45	1,723	2.96	6,518	30.18	561	2.60
2004	5,980	28.08	566	2.66	10,133	27.54	1,437	3.90	13,068	25.72	1,644	3.24	6,844	35.46	618	3.20
2003	5,362	25.29	748	3.53	8,937	24.48	1,902	5.21	14,653	29.31	2,290	4.58	4,812	28.64	589	3.51
2002	3,867	25.27	535	3.50	8,321	25.84	2,514	7.81	10,575	25.67	2,359	5.73	4,514	27.69	675	4.14
2001	3,693	25.12	712	4.84	9,220	25.61	2,257	6.27	10,308	24.03	2,399	5.59	4,901	27.69	1,265	7.15
2000	3,248	23.71	917	6.69	10,116	25.87	2,215	5.66	7,259	22.68	1,914	5.98	3,642	27.80	754	5.76
	46,914	27.14	4061	2.92	88,746	27.4	12,323	4.21	109,311	27.02	13,233	3.69	43,058	30.44	4,665	3.43

CG: Citations Given, CR: Citations Received, RA: Average References per article, CA: Average Citation Received per article.

Conclusion

Kaushik Basu, professor of economics, Cornell University, in his article posted on BBC Online (2006), pointed out India's faltering higher education system. According to Basu:

> India's production of professionals is phenomenal. With over 300 universities and 15,600 colleges spewing out 2.5 million graduates each year, in terms of the volume of production India trails behind only the US and recently China . . . . In terms of research and the purely academic disciplines, such as mathematics, physics and literature, India is beginning to trail in comparison not just to other countries but its own past performance. (2006, np).

In fact, after independence, India had to respond to many problems, and funding for science and research was not a high priority until the recent period of economic boom. Still, in India, no standard evaluation method exists for measuring the quality of scientific productivity in universities. The newly developed National Assessment & Accreditation Council (NAAC) recently measured the performance of some Indian universities, grading them on a five-point scale. With the exception of BHU, none of the universities in this study is currently accredited by NAAC. The results of the present study, however, suggest that the quantity of research output from these central government universities is quite satisfactory. Although the number of faculty at each institution has influenced publication rates, these four universities with similar missions can be cautiously compared to each other regarding faculty publication productivity.

The data in the present study suggest that the science faculties (mostly applied science) of these four universities are quite productive in publications (most appearing in peer-reviewed Indian journals) as compared to social sciences and arts and humanities faculty. The present pilot study includes only four prestigious universities of India. The picture, however, may be more vivid if one can compare the research productivity of Indian Institutes of Management and Indian Institutes of Technology with that of academic institutions.

It is quite evident that the library facilities, technological infrastructure, and research funds that are basic prerequisites for conducting quality research are uneven in Indian universities. Although budget allocations are quite healthy in central universities as compared to state-owned universities, the attitude of the researcher is also essential for better research. In addition, to attract some of the best minds to fundamental research, we have to award research funding to match a scholar's productivity.

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