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Indian S&T During Fifteen Years (1996-2010): A Quantitative Assessment using Publications Data

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ABSTRACT

This study examines India's performance in S&T on several quantitative measures including India's global publication share, rank and growth rate, its publication share in various subjects in terms of national and global context using 15 years publications data (1996-2010) from the Scopus database. It also determines share of its international collaborative papers at the national level as well as across subjects and analyses the geographical distribution of its research output. In addition, it analyses the highly productive institutions and characteristics of high-cited papers.

Keywords: Scopus, quantitative measures, publication data, scientometrics, research analysis

1. INTRODUCTION

Science and technology (S&T) has been central to India's development efforts since the time of Independence. Even though there have been shortfalls, limitations, and missed opportunities, India has made substantial progress in a number of areas-reasonably high rates of economic growth, considerable food security, substantially high average life expectancy, growing literacy rates, success in higher education, etc. In bringing about these socio-economic changes, the S&T policy and approach which have been formulated in various five year plans by taking guidance from the Scientific Policy Resolution of the year 1958, the Technology Policy Statement of 1983 and Science and Technology Policy of 2003 have played a considerable important role.

At the time of independence, the S&T base of the country was very small. But, today it consists of a wide spectrum of infrastructure in terms of higher education institutions, research laboratories and institutions, in-house R&D establishments, etc., covering several disciplines. Indian investments in S&T have also grown many-fold, from Rs 163.6 billion (US $3.8 billion) in 2005-06[1] to Rs 284 billion (US $5.8 billion) in 2009-10. India's R&D intensity increased only slightly from 0.80 per cent in 2003 to 0.88 per cent in 2007 of GDP, the share of the business enterprise sector in gross domestic expenditure on research and development (GERD) leapt from 18 per cent to an estimated 28 per cent during the same period[2].Several bibliometric studies have so far attempted to look at indicators as require for understanding the status of S&T in India[3-9]. They had focused on developing indicators on institutional productivity, national productivity, scattering of research across Indian and foreign journals, quality of research, and nature of collaboration, etc.

Another important study[10] had reported several important indicators to understand the progress in Indian science and technology, covering the period 1985-1986, 1995-2006 and 2001-2002. Raghuraman[11], *et al.* compared research performance of Indian institutions with foreign institutions on selected bibliometric parameters. A more recent study[12] compared overall S&T publications output of India, China, and South Korea across 20 broad subjects as defined by Scopus bibliographical database. The present study seeks to build Indian S&T indicators by examining and analysing 15-years continuous S&T publications data from India for the purpose.

2. OBJECTIVES

The objectives of this study are: (i) to analyse India's publications growth and global share in comparison with

select leading countries; (ii) to analyse its research priorities as reflected in its subject areas distribution; (iii) to identify its share of international collaborative papers, leading countries collaborating with India and as well as its international collaborative publications share across subjects; (iv) to determine its productive and weak geographical regions; and (v) to understand the characteristics of its highly productive institutions and cited papers.

3. METHODOLOGY AND DATA SOURCE

The publications data (derived from Scopus database from 1996 to 2010) on India and select countries forms the basis of this study. Scopus has a world wide coverage, of which more than half of the Scopus contents originate from Europe, Latin America and the Asia and the Pacific Region. Scopus coverage of Indian journals is much higher, compared to *Web of Science* database. The study used larger data set covering 15 publication years in order to ensure that the study reflects a more accurate and reliable results. The study has used a number of absolute publications, citation and collaborative measures for depicting India's status in science and technology from 1996 to 2010.

4. ANALYSIS

4.1 India's Publication Share and Rank in the World

India ranks 10th among the top 20 productive countries in science and technology, with its global publications share of 2.32 per cent as computed from cumulative world publications data for 1996-2010 (Table 1). The other countries in the top 20 list that contributed world share similar to that of India are Spain, Australia and Russia (in the range 2.15 per cent to 2.53 per cent). In overall, the global publication shares of the top 20 productive countries in S&T from 1996-2010 ranged from 1.03 per cent to 22.77 per cent. The United States tops the list with its global publication share of 22.77 per cent during 1996-2010, followed far behind are China, United Kingdom, Japan, and Germany (their global publication share ranging 6.07 per cent to 8.32 per cent). Other countries rank between 6th and 20th positions, with their publications share between 1.02 per cent to 4.45 per cent. The publications share of most developed countries (except Spain, Canada, and Australia) has declined over the last 15 years. In contrast, all developing countries included in top 20 productive countries have shown significant rise in their publications share, rising from 3.20 per cent to 6.39 per cent and to 12.75 per cent during 1996-2000, 2001-05 and 2006-10, respectively. China, in particular, improved its world ranking from 8th position during 1996-2000 to 4th during 2001-05 and to 2nd during 2006-10. South Korea has also improved its world share (from 1.16 per cent to 1.25 per cent and to 2.38 per cent), Taiwan (from 1.02 per cent to 1.22 per cent and to 1.65 per cent), and Brazil (from 0.97 per cent to 1.25 per cent and to 1.84 per cent) during the corresponding block years.

The world ranking of these three developing countries also improved-South Korea (from 16th to 14th and to 12th), Taiwan (from 18th to 18th and to 16th), and Brazil (from 20th to 17th and to 14th) during corresponding block years. India also witnessed rise in its world publications share. The shift in its global share was from 1.89 per cent to 2.03 per cent and to 2.78 per cent during 1996-2000, 2001-05 and 2006-10, respectively. Correspondingly, it improved its world ranking from 13th position during 1996-2000 to 12th during 2001-05 and to 10th during 2006-10 (Table 1).

4.2 India's Publication Growth Rate in the World Context

The developed and developing countries differ significantly in their annual average publication growth rate as seen from their annual publications output data during 1996-2000 to 2006-10 in S&T. It was 2.24 per cent to 7.08 per cent for developed countries and 9.59 per cent to 11.35 per cent for developing world. Whereas the developed countries maintained slow pace of growth in their publications output, the developing countries on the other hand have shown significantly faster growth rate (Table 2).

India achieved annual average growth rate in publications output at 9.32 per cent as seen from its publications output data for 1996-2010. China showed growth rate of 19.45 per cent per annum, the highest amongst top 20 countries, followed by South Korea (13.12 per cent), Brazil (12.64 per cent), and Taiwan (9.50 per cent) (Table 3).All countries from the developing world (among top 20 productive countries) have shown growth rate of their annual publications output higher than the average (7.10 per cent) during 1996-2010 are shown in Table 2. The countries from the developed world (among top 20 productive countries) that have shown growth rate lower than the average (7.10 per cent) during 1996-2010 (Table 3). Growth rate of publications output by developing countries has also changed over the period of time. Based on publications output data for 1996-2000 to 2006-2010, it was found that China improved its growth rate from 13.43 per cent to 28.69 per cent, India from 3.05 per cent to 13.70 per cent and Taiwan from 4.54 per cent to 8.39 per cent, as against decrease in South Korea from 14.65 per cent to 8.04 per cent and Brazil from 12.29 per cent to 12.08 per cent (Table 2).

4.3 Subject Profile of India in Science and Technology

As per publications output data for 1996-2010, India's research profile by broad disciplines emerges as follows:

Table 1. Publication productivity, world share and world rank of top 20 most productivity countries, 1996-2010

Country	Top productive courntries				Rank (world share in %)			
	1996-2000	2001-2005	2006-2010	1996-2010	1996-2000	2001-2005	2006-2010	1996-2010
USA	1586567	1643852	2061016	5291435	1(27.2)	1(22.07)	1(20.7)	1(22.77)
China	186904	476201	1269537	1932642	8(3.2)	4(6.39)	2(12.75)	2(8.32)
UK	426473	480863	633839	1541175	3(7.31)	3(6.46)	3(6.37)	3(6.63)
Japan	449878	497122	555016	1502016	2(7.71)	2(6.68)	5(5.58)	4(6.46)
Germany	388720	453554	569562	1411386	4(6.66)	5(6.09)	4(5.72)	5(6.07)
France	286552	322309	424322	1033183	5(4.91)	6(4.33)	6(4.26)	6(4.45)
Canada	201621	246783	359833	807237	6(3.46)	7(3.31)	7(3.61)	7(3.47)
Italy	192668	242015	296198	775881	7(3.3)	8(3.25)	8(2.98)	8(3.34)
Spain	130561	177995	280038	588504	10(2.24)	9(2.39)	9(2.81)	9(2.53)
India	110454	151475	276680	538609	13(1.89)	12(2.03)	10(2.78)	10(2.32)
Australia	120553	160505	251609	532667	11(2.07)	11(2.16)	11(2.53)	11(2.29)
Russia	159958	169295	169818	499071	9(2.74)	10(2.27)	15(1.71)	12(2.15)
Netherlands	112835	136629	192684	442148	12(1.93)	13(1.83)	13(1.94)	13(1.90)
South Korea	67665	130635	237011	435311	16(1.16)	14(1.75)	12(2.38)	14(1.87)
Brazil	56563	93286	182887	332736	20(0.97)	17(1.25)	14(1.84)	15(1.43)
Taiwan	59509	91076	163826	314411	18(1.02)	18(1.22)	16(1.65)	16(1.35)
Switzerland	80083	96347	137152	313582	15(1.37)	16(1.29)	17(1.38)	17(1.35)
Sweden	87446	98372	123591	309409	14 (1.5)	15(1.32)	18(1.24)	18(1.33)
Poland	60694	88469	118738	267901	17(1.04)	13(1.19)	19(1.19)	19(1.15)
Belgium	59283	74814	106146	240243	19(1.02)	20(1.0)	20(1.07)	20(1.03)

Physical science subjects together contributed the highest publication share (41.06 per cent), followed by engineering sciences (32.69 per cent), life sciences (30.05 per cent), and health sciences (22.17 per cent) in cumulative national publication output of India during 1996-2010.

India's subject profile is quite different from that of China, South Korea, Taiwan and Brazil. For example, compared to India, China, South Korea, and Taiwan each contributed the highest publication share (56.15 per cent, 50.69 per cent, and 49.95 per cent) in engineering, followed by 37.05 per cent, 38.24 per cent and 34.06 per cent in physical sciences, 15.39 per cent, 23.66 per cent and 18.28 per cent in life sciences, and 12.525 per cent, 16.51 per cent and 21.78 per cent in health sciences during similar period.

In contrast, Brazil emphasis equally (36.70 per cent, 30.62 per cent and 33.75 per cent) in life sciences, physical sciences and health sciences, and 22.59 per cent in engineering sciences (Table 3).

4.3.1 Subject Areas of Research in India

Medicine, chemistry, engineering, physics, materials science, biochemistry, genetics and molecular biology and agricultural and biological sciences are considered the seven high priority areas of India in S&T, each contributing publication share between 12.04 per cent and19.40 per cent in the cumulative national publication output of the country during 1996-2010. Pharmacology, toxicology and pharmaceutics, computer science, environmental sciences, chemical engineering, mathematics, earth and planetary sciences, and immunology and microbiology are the seven medium productive subjective areas of Indian research, each contributing between 3.70 per cent to 7.33 per cent share in the cumulative publication output by India during 1996-2010. Energy, veterinary science, and neurosciences are the three low productive subject areas contributing publications share between 1.28 per cent and 2.37 per cent in cumulative publication output by India during 1996-2010. Public health nursing and dentistry are the three least productive Indian subject area contributing each < 1 per cent publication share in cumulative publication output during 1996-2010. The largest increase of 6.39 per cent (from 3.15 per cent to 9.54 per cent) in national publications share from 1996-2000 to 2006-2010 has been observed in computer science, followed by 4.16 per cent in medicine, 3.58 per cent in engineering, 2.69 per cent in pharmacology, toxicology and pharmaceutics, 1.53 per cent in materials science, 1.42 per cent in biochemistry, genetics and molecular biology and from 0.21 per cent to 0.75 per cent in mathematics, energy, chemical engineering, dentistry, environmental science, nursing, immunology and microbiology, chemistry,

neurosciences and public health. Compared to these subjects, there was a decrease in national publication share of 3.93 per cent (from 14.43 per cent to 10.50 per cent) in agricultural and biological sciences, followed by 1.83 per cent in earth and planetary sciences, 0.91 per cent in veterinary sciences and 0.21 per cent in physics from 1996-2000 to 2006-2010. In terms of global publication share in 20 broad subjects during 1996-2010, the largest publication share (5.49 per cent) in India is accounted by veterinary science, followed by chemistry, pharmacology, toxicology and pharmaceutics (4.56 per cent) and agricultural and biological sciences (from 4.05 per cent to 4.93 per cent), materials science, environmental science, chemical engineering (3.24 per cent) and physics (from 3.04 per cent to 3.68 per cent), energy, immunology and microbiology, earth and planetary sciences, mathematics, biochemistry, genetics .and molecular biology, computer science (2.09 per cent) and engineering (from 2.00 per cent to 2.61 per cent), dentistry, medicine, public health, neurosciences and nursing (from 0.52 per cent to 1.93 per cent).

Table 2. Annual average publications growth rate of top 20 countries during 1996-2010

Country	Annual average publications growth rate, 1996-2010			
	1996-2000	2001-05	2006-10	1996-10
USA	-0.25	2.78	7.15	3.12
China	13.43	28.69	14.55	19.45
UK	2.48	6.77	3.92	3.87
Japan	2.5	4.68	0.39	2.1
Germany	3.37	6.09	6.02	4.52
France	2.44	6.37	5.96	4.24
Canada	-0.42	11.33	4.93	4.82
Italy	1.8	8.42	31.85	12.74
Spain	4.76	11.06	7.85	7.71
India	3.05	10.79	13.7	9.32
Australia	3.69	9.39	8.43	7.27
Russia	0.22	2.34	2.88	0.9
Netherlands	1.25	9.69	6.45	5.22
South Korea	14.65	16.35	8.04	13.12
Brazil	12.29	13.03	12.08	12.64
Taiwan	4.54	14.48	8.39	9.5
Switzerland	2.77	10.33	5.98	5.58
Sweden	2.37	6.42	4.52	3.87
Poland	3.82	11.06	3.63	6.25
Belgium	2.79	10.37	6.31	5.8

Table 3. National cumulative publication share of select developing countries by broad disciplines, 1996-2010

Country (%)	Health sciences	Life sciences	Physical sciences	Engineering sciences
India	22.17	30.05	41.06	32.69
China	12.52	15.39	37.05	56.15
South Korea	16.51	23.66	38.24	50.69
Brazil	33.75	36.70	30.62	22.59
Taiwan	21.78	18.28	34.06	49.95
World	29.68	24.93	28.35	30.59

India has improved its global publication share in 19 out of 20 broad subjects varying from 0.11 per cent to 2.48 per cent from 1996-2000 to 2006-2010, with largest increase of 2.8 per cent (from 0.7 per cent to 3.18 per cent) in dentistry, followed 1.91 per cent in chemistry, 1.75 per cent in immunology and microbiology, 1.64 per cent in environmental science, 1.35 per cent in biochemistry, genetics and molecular biology, 1.31 per cent in chemical engineering, 1.18 per cent in materials science, 1.14 per cent in physics, 1.03 per cent computer science and from 0.11 per cent to 0.91 per cent in engineering, neurosciences, energy, public health, agricultural, and biological sciences, nursing, earth and planetary sciences, veterinary science and mathematics. In contrast, India's global publication share of 0.32 per cent (from 2.61 per cent to 2.29 per cent) decreased in pharmacology, toxicology and pharmaceutics from 1996-2000 to 2006-2010.

4.3.2 Status of India's International Collaboration

India's average annual share of international collaborative papers in its total cumulative publications output during 1996-2010 has been 15.98 per cent, compared with 12.19 per cent for China, 21.05 per cent for South Korea and 25.35 per cent for Brazil. India and South Korea witnessed increase in its share of international collaborative papers from 14.49 per cent and 20.85 per cent during 1996-00 to 16.90 per cent and 22.75 per cent during 2006-2010, as against decrease in China and Brazil from 15.08 per cent and 29.02 per cent during 1996-00 to 11.73 per cent and 24.12 per cent during 2006-10 (Table 4).

Among 25 leading countries collaborating with India, the major ones from the developed world are: USA with

Table 4. India, China, South Korea, and Brazil overall International collaboration with different countries, 1996-2010

	Number of international collaborative papers				Share of international collaborative papers			
	1996-00	2001-05	2006-10	1996-2010	1996-00	2001-05	2006-10	1996-2010
India	16002	23333	46478	85813	14.49	15.40	16.90	15.98
China	187172	476008	1364604	2027784	15.08	12.36	11.73	12.19
South Korea	13901	27449	52813	94163	20.85	18.50	22.75	21.05
Brazil	16412	23822	43984	84218	29.02	25.54	24.12	25.35

36.58 per cent publications share during 1996-2010, followed by Germany, UK, Japan and France (with publications share from 9.65 per cent to 13.00 per cent), Canada, Italy, Australia, Netherlands, Switzerland, Spain, Russia, and Sweden (with publications share from 2.10 per cent to 5.83 per cent) and Poland (1.62 per cent share), Belgium (with publications share from 1.55 per cent to 1.62 per cent). Similarly, the leading countries from the developing countries collaborating with India during 1996-2010 are South Korea with 5.22 per cent publications share, followed by China (3.52 per cent share), Taiwan (2.69 per cent share), Malaysia (2.39 per cent share), Brazil (2.15 per cent share), Singapore (1.92 per cent), Colombia (1.79 per cent share), Mexico (1.69 per cent) and Israel (1.33 per cent share) (Table 5).

India witnessed a shift in its share of collaborative papers with different developed and developing countries from 1996-00 to 2006-10. With some developed countries it had witnessed decline in its share of internationally collaborative papers by 5.92 per cent with United States,, followed by 1.35 per cent with Germany, 1.13 per cent with UK and from 0.02 per cent to 0.37 per cent with Canada, Belgium, UK, Netherlands and Italy, as against increase of 1.42 per cent with Australia, followed by 0.67 per cent with Sweden and from 0.08 per cent to 0.62 per cent with Poland, Australia, Switzerland, and Russia. With developing countries, except Brazil and Colombia, India witnessed increase in its share of international collaborative papers from 1996-00 to 2006-10: 5.55 per cent with South Korea, followed by 1.50 per cent with Malaysia, 1.29 per cent with China, 0.82 per cent with Singapore, 0.69 per cent with South Africa, 0.26 per cent with Mexico and 0.24 per cent.

Among the S&T fields, the largest share (27.60 per cent) of international collaborative papers was in physics during 1996-2010, followed by mathematics (26.25 per cent), earth and planetary sciences (22.99 per cent), nursing (20.91 per cent), biochemistry, genetics and molecular biology (19.18 per cent), materials science (19.01 per cent), immunology and microbiology (18.88 per cent), computer science (18.24 per cent), neurosciences (17.03 per cent), chemistry (15.02 per cent), engineering (14.95 per cent), energy (14.93 per cent), chemical engineering (14.45 per cent), agricultural and biological sciences (12.67 per cent), medicine (12.21 per cent), environmental sciences (12.11 per cent), public health (11.56 per cent), pharmacology, toxicology and pharmaceutics (8.75 per cent), dentistry (6.29 per cent) and veterinary science (4.33 per cent).

India has improved its international collaborative publication share in 16 out of 20 broad subjects varying from 1.12 per cent to 12.73 per cent from 1996-2000 to 2006-2010, with largest increase of 12.73 per cent (from 3.09 per cent to 15.82 per cent) in computer science, followed by 10.00 per cent in nursing, from 4.16 per cent to 7.03 per cent in materials science, earth and planetary sciences, medicine, neurosciences and chemistry, from 3.05 per cent to 3.85 per cent in agricultural and biological sciences, environmental sciences and public health, 2.61 per cent in chemical engineering and from 1.12 per cent to 1.66 per cent in veterinary science, pharmacology, toxicology, and pharmaceutics, engineering, biochemistry, genetics and molecular biology and physics. In contrast, the India's international collaborative publications share decreased by 4.05 per cent (from 10.05 per cent to 6.00 per cent) in dentistry, followed by

Table 5. Number and share of india's international collaborative papers with leading countries, 1996-2010

Collaborating country	Number of international collaborative papers				Share of international collaborative papers			
	1996-2000	2001-2005	2006-2010	1996-2010	1996-2000	2001-2005	2006-2010	1996-2010
USA	6550	8569	16272	31391	40.93	36.72	35.01	36.58
Germany	2151	3390	5618	11159	13.44	14.53	12.09	13.00
UK	1948	2743	5578	10269	12.17	11.76	12.00	11.97
Japan	1481	2553	3777	7811	9.26	10.94	8.13	9.10
France	1199	1684	3683	6566	7.49	7.22	7.92	7.65
Canada	1004	1254	2742	5000	6.27	5.37	5.90	5.83
South Korea	250	919	3307	4476	1.56	3.94	7.12	5.22
Italy	721	1027	2087	3835	4.51	4.40	4.49	4.47
Australia	550	909	2259	3718	3.44	3.90	4.86	4.33
China	443	693	1888	3024	2.77	2.97	4.06	3.52
Netherlands	480	696	1373	2549	3.00	2.98	2.95	2.97
Switzerland	396	648	1402	2446	2.47	2.78	3.02	2.85
Spain	374	577	1369	2320	2.34	2.47	2.95	2.70
Taiwan	243	697	1368	2308	1.52	2.99	2.94	2.69
Russia	392	543	1174	2109	2.45	2.33	2.53	2.46
Malaysia	252	371	1429	2052	1.57	1.59	3.07	2.39
Brazil	399	466	978	1843	2.49	2.00	2.10	2.15
Sweden	274	426	1105	1805	1.71	1.83	2.38	2.10
Singapore	219	414	1016	1649	1.37	1.77	2.19	1.92
Colombia	302	385	853	1540	1.89	1.65	1.84	1.79
Mexico	253	347	854	1454	1.58	1.49	1.84	1.69
Poland	196	334	857	1387	1.22	1.43	1.84	1.62
Belgium	321	233	772	1326	2.01	1.00	1.66	1.55
Israel	184	312	645	1141	1.15	1.34	1.39	1.33

3.72 per cent in energy, 1.38 per cent in immunology and microbiology and 1.34 per cent in mathematics from 1996-2000 to 2006-2010.

4.4 INDIA'S RESEARCH OUTPUT BY GEOGRAPHICAL REGIONS

4.4.1 High Productivity States

Maharashtra, Delhi, Karnataka, Tamil Nadu, West Bengal, and Uttar Pradesh are the top six high productivity states in order of ranking, with their cumulated publications share ranging from 10.07 per cent to 14.16 per cent in India's total cumulative publication output during 1996-2010. Tamil Nadu witnessed the largest increase of 2.41 per cent (from 10.96 per cent to 13.37 per cent), followed by Karnataka of 1.89 per cent (from 11.26 per cent to 13.15 per cent) from 1996-2000 to 2006-2010. In contrast, Maharashtra witnessed the largest decrease of 1.59 per cent (from 15.08 per cent to 13.48 per cent), followed by Delhi of 0.83 per cent, West Bengal of 0.21 per cent and Uttar Pradesh of 0.14 per cent from 1996-2000 to 2006-2010 (Table 6).

Table 6. Geographical distribution of indian research output, 1997-2007

State Name	Publications outputs				Publications outputs (%)			
	1996-00	2001-05	2006-10	1996-2010	1996-00	2001-05	2006-10	1996-2010
High productivity states in science and technology								
Maharashtra	16652	22312	37309	76273	15.08	14.73	13.48	14.16
Delhi	14532	20879	34103	69514	13.16	13.78	12.33	12.91
Karnataka	12438	18506	36379	67323	11.26	12.22	13.15	12.50
Tamil Nadu	12101	17177	36983	66261	10.96	11.34	13.37	12.30
West Bengal	11823	15565	29042	56430	10.70	10.28	10.50	10.48
Medium productivity states in science and technology								
Andhra Pradesh	7367	9442	10489	27298	6.67	6.23	3.79	5.07
Gujarat	3642	4843	9554	18039	3.30	3.20	3.45	3.35
Kerala	3415	4906	9604	17925	3.09	3.24	3.47	3.33
Chandigarh	2879	4652	7079	14610	2.61	3.07	2.56	2.71
Madhya Pradesh	2707	3398	7284	13389	2.45	2.24	2.63	2.49
Uttaranchal	2388	3253	6948	12589	2.16	2.15	2.51	2.34
Rajasthan	2479	3509	6412	12400	2.24	2.32	2.32	2.30
Haryana	2476	3353	6133	11962	2.24	2.21	2.22	2.22
Punjab	1683	2911	5895	10489	1.52	1.92	2.13	1.95
Orissa	2523	2574	4853	9950	2.28	1.70	1.75	1.85
Jharkhand	1072	1504	3065	5641	0.97	0.99	1.11	1.05
Low productivity states in science and technology								
Assam	891	1227	3104	5222	0.81	0.81	1.12	0.97
Himachal Pradesh	1020	1236	2464	4720	0.92	0.82	0.89	0.88
Pondicherry	715	1278	1937	3930	0.65	0.84	0.70	0.73
Goa	556	688	1520	2764	0.50	0.45	0.55	0.51
Chattisgarh	498	563	1283	2344	0.45	0.37	0.46	0.44
Bihar	717	506	746	1969	0.65	0.33	0.27	0.37
Meghalaya	476	543	801	1820	0.43	0.36	0.29	0.34
Manipur	155	289	588	1032	0.14	0.19	0.21	0.19
Arunachal Pradesh	149	233	440	822	0.13	0.15	0.16	0.15
Tripura	83	98	264	445	0.08	0.06	0.10	0.08
Mizoram	18	66	239	323	0.02	0.04	0.09	0.06
Nagaland	16	104	180	300	0.01	0.07	0.07	0.06
Andaman & Nicobar	96	145	176	417	0.09	0.10	0.06	0.08
Sikkam	34	45	157	236	0.03	0.03	0.06	0.04
Least productivity states in science and technology								
Dadar & Nagar Havelli	2	0	9	11	0.00	0.00	0.00	0.00
Lakshadeep	2	1	4	7	0.00	0.00	0.00	0.00
Daman & Diu	0	0	4	4	0.00	0.00	0.00	0.00
Total	**110454**	**151475**	**276680**	**538609**				

4.4.2 Medium Productivity States

Andhra Pradesh, Gujarat, Chandigarh, Madhya Pradesh, Uttaranchal, Rajasthan, Haryana, Punjab, Orissa, Jharkhand, and J&K are the eleven medium productivity states in order of ranking, with their cumulated publications share ranging from 1.03 per cent to 5.07 per cent in India's total cumulative publication output during 1996-2010. Punjab witnessed the largest increase of 0.61 per cent (from 1.52 per cent to 2.13 per cent), followed by Kerala (0.38 per cent), Uttarakhand (0.35 per cent), J&K (0.24 per cent), Madhya Pradesh (0.18 per cent), Gujarat (0.16 per cent), Jharkhand (0.14 per cent) and Rajasthan (0.07 per cent) from 1996-2000 to 2006-2010. In contrast, Andhra Pradesh witnessed the largest decrease of 2.88 per cent (from 6.67 per cent to 3.79 per cent), followed by Orissa (0.53 per cent), Chandigarh (0.05 per cent) and Haryana (0.03 per cent) from 1996-2000 to 2006-2010 (Table 6).

4.4.3 Low Productivity States

Assam, Himachal Pradesh, Pondicherry, Goa, Chattisgarh, Bihar, Meghalaya, Manipur, Arunachal Pradesh, Tripura, Mizoram, Nagaland, Andaman and Nicobar and Sikkan are the fourteen low productivity states in order of ranking, with their cumulated publications share ranging from 0.04 per cent to 0.97 per cent in India's total cumulative publication output during 1996-2010. Of these 14 geographical places, Assam witnessed the largest increase of 0.32 per cent (from 0.81 per cent to 1.12 per cent), followed by Manipur (0.07 per cent), Mizoram (0.07 per cent), Nagaland (0.06 per cent), Pondicherry (0.05 per cent), Goa (0.05 per cent), Sikkam (0.03 per cent), Arunachal Pradesh (0.03 per cent), Tripura (0.02 per cent) and Chattisgarh (0.01 per cent) from 1996-2000 to 2006-2010. In contrast, Bihar witnessed the largest decrease of 0.38 per cent followed by Meghalaya (0.14 per cent), Himachal Pradesh (0.03 per cent) and Andaman & Nicobar (0.03 per cent) from 1996-000 to 2006-2010

4.4.4 Least Productivity States

Dadar and Nagar Haveli, Lakshdeep and Daman and Diu are the three least productivity states in order of ranking, with their cumulated publications share almost negligible in the overall India's total cumulative publication output during 1996-2010.

4.5 HIGH PRODUCTIVE S&T ORGANISATIONS IN INDIA

A total of 100 Indian organisations were identified as high productive one publishing 1278 and above papers during 1996 to 2010. These 100 organisations include: (i) 14 institutes of national importance, (ii) 27 research institutes, (iii) 44 universities, (iv) 9 medical colleges and hospitals, and (v) 6 other institutes of higher education. These 100 organisations together contributed 54.92 per cent share (295827 papers) in the cumulative publications output of India during 1996-2010. Their individual contribution varied from 1278 to 17019 papers in 15 years (1996-2010), with an average output of 2958 papers per organisation. The publications output of these 100 organisations to the total cumulative publications output of India declined from 59.40 per cent (65606 papers) during 1996-00 to 52.25 per cent (144564 papers) during 2006-10.These 100 organisations together have registered *h*-index of 220 and contributed 70.08 per cent share (1169 papers) in cumulative high cited papers of India during 1996 to 2010.

The 14 institutes of national importance together contributed 18.71 per cent share (100773 papers) to the total publications output in science and technology in

Table 7. Profile of top 14 most productive institutes of national importance (INI) in S&T in India, 1996-2010

INI	TP	*h*-index	HCP	ICP	INI	TP	*h*-index	HCP	ICP
Indian Institute of Science, Bengaluru	17032	112	137	3796	Postgraduate Institute of Medical Education & Research, Chandigarh	6879	51	4	370
Indian Institute of Technology, Kharagpur	11746	80	44	2124	Indian Institute of Technology, Roorkee	5350	66	28	875
All India Institute of Medical Sciences, New Delhi	11214	74	36	1218	Indian Statistical Institute, Kolkata	3444	60	21	717
Indian Institute of Technology, New Delhi	10710	79	45	1940	Indian Institute of Technology, Guwahati	2545	42	2	325
Indian Institute of Technology, Chennai	9630	70	37	1834	National Institute of Mental Health & Neurosciences, Bengaluru	1720	44	9	287
Indian Institute of Technology, Kanpur	8944	85	66	2208	Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruv*	1542	34	6	119
Indian Institute of Technology, Mumbai	8666	75	46	3237	Jawaharlal Institute of Postgraduate Medical Education & Research, Pondicherry	1351	23	0	64

India during 1996 to 2010. Their individual contribution varied from 1351 to 17032 papers in 15 years (1996-2010), with an average output of 7198 papers per organisation. The publications output of these 14 institutes of national importance to the total cumulative publications output of India declined from 19.11 per cent (21112 papers) during 1996-00 to 17.81 per cent (49271 papers) during 2006-10. These 14 institutes of national importance together have registered *h*-index of 165 and contributed 26.92 per cent share (449 papers) in cumulative high cited papers of India during 1996 to 2010. The international collaborative papers share of these 14 institutes of national importance constitute 20.01 per cent share (20952 papers) of its total output. The international collaborative papers share of these 14 institutes of national importance has decreased from 20.82 per cent (4784 papers) during 1996-00 to 20.01 per cent (10362 papers) during 2006-10 (Table 7).

The 27 research institutes together contributed 14.78 per cent share (79600 papers) to the total publications output in science and technology in India during 1996 to 2010. Their individual contribution varied from 1306 to 10666 papers in 15 years (1996-2010), with an average output of 2848 papers per organisation. The publications output of these 27 research institutes to the total cumulative publications output of India declined from 17.41 per cent (19234 papers) during 1996-00 to 12.10 per cent (33490 papers) during 2006-10. These 27 research institutes together have registered *h*-index of 166 and contributed 26.98 per cent share (450 papers) in cumulative high cited papers of India during 1996 to 2010. These 44 universities together have registered *h*-index of 142 and contributed 19.18 per cent share (320 papers) in cumulative high cited papers of India during 1996 to 2010. The international collaborative papers share of these 27 research institutes constitute 20.60 per cent share (15746 papers) of its total output. The international collaborative papers share of these 27 research institutes has increased from 18.97 per cent (3645 papers) during 1996-00 to 21.47 per cent (7198 papers) during 2006-10 (Table 8). The 44 universities together contributed 20.80 per cent share (118238 papers) to the total publications output in science and technology in India during 1996 to 2010. Their individual contribution varied from 1280 to 7821 papers in 15 years (1996-2010), with an average output of 2687 papers per organisation. The publications output of these 44 universities to the total cumulative publications output of India declined from 21.91 per cent (24200 papers) during 1996-00 to 20.42 per cent (56487 papers) during 2006-10. These 44 universities together have registered *h*-index of 142 and contributed 19.18 per cent share (320 papers) in cumulative high cited papers of India during 1996 to 2010. The international collaborative papers share of these 44 universities constitute 17.33 per cent share (19418 papers) of its total output. The international collaborative papers share of these 44 universities has increased from 14.89 per cent (3604

Table 8. Profile of top 27 most productive research institutes in S&T in India, 1996-2010

Name of research institutes	TP	*h*-Index	HCP	ICP
Bhabha Atomic Research Centre, Mumbai	10666	72	44	1887
Tata Institute of Fundamental Research, Mumbai	6744	90	71	3237
Indian Institute of Chemical Technology, Hyderabad	5752	71	31	540
National Chemical Laboratory, Pune	5419	85	58	814
Indian Association for the Cultivation of Science, Kolkata	4661	61	25	1010
Indian Space Research Organisation, Bangalore	3270	40	2	241
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru	3007	83	56	408
Saha Institute of Nuclear Physics, Kolkata	2995	50	9	700
Indira Gandhi Centre for Atomic Research, Kalpakkam	2984	39	3	370
Indian Veterinary Research Institute, Izatnagar	2966	29	3	137
Indian Agricultural Research Institute, New Delhi	2890	45	12	337
National Physical Laboratory, New Delhi	2731	43	9	381
Central Drug Research Institute, Lucknow	2675	46	9	221
Central Food Technology Research Institute, Mysore	2117	50	13	213
Physical Research Laboratory, Ahmedabad	1997	51	10	639
Central Leather Research Institute, Chennai	1831	50	9	149
Central Electrochemical Research Institute, Karaikudi	1808	40	3	220
National Institute of Oceanography, Goa	1711	38	4	335
Indian Institute Chemical Biology, Kolkata	1705	46	11	309
PR Centre Advanced Technology, Indore	1554	32	1	270
Regional Research Laboratory -Thiruvan	1547	68	32	296
Centre for Cellular & Molecular Biology, Hyderabad	1533	57	17	287
Bose Institute, Kolkata	1515	52	17	262
National Geophysical Research Institute, Hyderabad	1479	34	0	225
Institute of Physics, Bhubaneswar	1371	44	14	287
SN Bose National Centre for Basic Sciences, Kolkata	1366	35	4	335
Institute of Mathematical Sciences, Chennai	1306	41	7	401

papers) during 1996-00 to 19.02 per cent (10742 papers) during 2006-10 (Table 9). The 9 medical colleges and hospitals together contributed 3.42 per cent share (18452 papers) to the total publications output in science and technology in India during 1996 to 2010. Their individual contribution varied from 732 to 2133 papers in 15 years (1996-2010), with an average output of 2050 papers per organisation. The publications output of these 9 medical colleges and hospitals to the total cumulative publications output of India declined from 3.40 per cent (3754 papers) during 1996-00 to 3.25 per cent (8992 papers) during 2006-10. These 9 medical colleges and hospitals together have registered *h*-index of 82 and contributed 3.18 per cent share (53 papers) in cumulative high cited papers of India during 1996 to 2010. The international collaborative papers share of these 9 medical colleges and hospitals constitute 11.23 per cent share (2036 papers) of its total output. The international collaborative papers share of these 9 medical colleges and hospitals has increased from 8.82 per cent (331 papers) during 1996-00 to 12.81 per cent (1152 papers) during 2006-10 (Table 10).

The 6 other institutes of higher education together contributed 1.76 per cent share (9461 papers) to the total publications output in science and technology in India during 1996 to 2010. Their individual contribution varied from 1278 to 2124 papers in 15 years (1996-2010), with an average output of 1359 papers per organisation. The publications output of these 6 other institutes of higher education to the total cumulative publications output of India increased from 0.89 per cent (990 papers) during 1996-00 to 1.94 per cent (5386 papers) during 2006-10. These 6 other institutes of higher education together have registered *h*-index of 53 and contributed 0.66 share (11 papers) in cumulative high cited papers of India during 1996 to 2010. The international collaborative papers share of these 6 other institutes of higher education constitute 15.17 per cent share (1237 papers) of its total output. The international collaborative papers share of these 6 other institutes of higher education have decreased from 18.48 per cent (183 papers) during 1996-00 to 13.98 per cent (223 papers) during 2006-10 (Table 11).

4.6 High Cited Papers

India published a total of 1668 high-cited papers in science and technology in last 15 years as seen from the publications output data for 1996 to 2010. Since their publication, these select high cited papers received between 100 and 3429 citations per paper.

Of these 1668 papers, 875 were international collaborative. In overall, Indian participation in these 1668 papers was confined to very large number of Indian institutions, which includes 137 papers from Indian Institute of Science, Bangalore, followed by 71 from Tata Institute of Fundamental Research, Mumbai, 66 from Indian Institute of Technology, Kanpur, 58 papers from

Table 9. Profile of top 44 most productive universities in S&T in India, 1996-2010

Name of university	TP	*h*-index	HCP	ICP
Jadavpur University, Kolkata	7821	63	26	1389
University of Delhi	7322	67.5	28	1743
Banaras Hindu University, Varanasi	5614	56.5	22	886
Anna University, Chennai	5576	50	17	1003
University of Calcutta	4567	47	7	731
University of Madras	4508	53	14	818
Aligarh Muslim University	4315	50	8	648
Panjab Universitiy, Chandigarh	3977	73	37	690
University of Hyderabad	3688	74	41	888
Annamalai University	3658	44	4	335
Jawaharlal Nehru University, Delhi	3100	47	11	561
University of Mysore	2960	35	1	412
University of Rajasthan, Jaipur	2909	43	15	289
University of Pune	2886	54	13	552
Andhra University	2668	37	6	349
University of Mumbai	2596	47	8	204
Punjab Agricultural University, Ludhiana	2577	32	1	259
Osmania University, Hyderabad	2554	38	4	246
Cochin University of Science	2506	39	3	258
Guru Nanak Dev University, Amritsar	2372	40	3	391
CCS Haryana Agriculture University, Hissar	2299	37	6	257
Sri Venkateswar University, Tirupati	2276	40	4	437
M.S. University of Baroda, Vadodara	2175	38	1	156
University of Allahabad	1961	27	1	132
Madurai Kamraj University	1848	37	10	345
Mangalore Universities	1830	36	3	910
University of Lucknow	1817	32	2	221
Karnatak University, Dharwad	1815	41	2	206
Bharathidasan University	1785	43	7	489
GB Pant University of Agriculture & Technology, Pantnagar	1781	22.5	1	139
Bharathiar University, Coimbatore	1697	42	17	437
Shivaji University, Kolhapur	1657	36	2	206
Bangalore University	1634	35	5	161
University of Kalyani	1631	35	4	137
University of Burdwan	1553	41	3	201
Dr HG University, Sagar	1506	37	4	
IU Acellerator Centre, Delhi	1483	28	0	184
Tamil Nadu Agriculture University, Coimbatore	1436	31	3	212
University of Kerala	1362	38	4	38
Kurukshetra Universities	1361	27	0	107
Punjabi University, Patiala	1292	28	0	86
North-East Hill University, Shillong	1295	32	4	286
Tamil Nadu Veterinary & Animal Science University, Chennai	1290	19.5	0	55
Jawaharlal Nehru Technological University, Hyderabad	1280	21	3	133

Table 10. Profile of top 9 most productive medical colleges and hospitals in S&T in India, 1996-2010

INI	TP	*h*-index	HCP	ICP
Christian Medical College & Hospital, Vellore	3307	49	11	554
SGPGIMS, Lucknow	3119	49	6	259
KEM Hospital, Mumbai	2120	37	9	212
Tata Memorial Hospital, Mumbai	1975	41	5	282
Kasturba Medical College, Manipal	1808	32	1	148
Banaras Hindu University-Institute of Medical Sciences	1781	46	14	144
Maulana Azad Medical College, Delhi	1555	28	2	84
University College of Medical Sciences, Delhi	1448	32.5	2	60
CSM Medical Universities, Lucknow	1339	36	3	132

Table 11. Profile of top 6 most productive other institutes of higher education in S&T in India, 1996-2010

INI	TP	*h*-index	HCP	ICP
Institute of Technology, Banaras Hindu University, Varanasi	2124	40	3	199
Bengal Engineering & Science Universities, Howrah	1558	25	1	159
National Institute of Technology, Thiruchrapalli	1554	26	0	195
NIT, Jamshedpur	1545	22	0	110
Birla Institute of Technology & Science, Pilani	1402	40.5	7	252
PSG College of Technology, Coimbatore	1278	23.5	1	56

Indian Institute of Technology, Kanpur, 58 papers from National Chemical Laboratory, Pune, 56 papers from Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore, 46 from Indian Institute of Technology, Mumbai, 45 papers from Indian Institute of Technology, Kharagpur, 44 papers from Bhabha Atomic Research Center, Mumbai, 41 papers from University of Hyderabad, 37 papers each from Indian Institute of Technology, Chennai and Panjab University, Chandigarh, 36 papers from All India Institute of Medical Sciences, New Delhi, 32 papers from Regional Research Laboratory, Thiruvanathapuram, 31 papers from Indian Institute of Chemical Technology, Hyderabad, 28 papers from University of Delhi, 26 papers from Jadavpur University, 25 papers from Indian Association for the Cultivation of Science, Kolkata, etc.

Some of the most prominent and productive scientists associated with these comparatively high cited papers in order of ranking are C.N.R Rao (JNCASR, Bangalore) (33 papers), G.R. Desiraju (University of Hyderabad) (19 papers), D. Das (Jadavpur University, Kolkata) (17 papers), S. Kumar (CDRI, Lucknow) (16 papers), A. Sen (HCRI, Allahabad) (14 papers), Satishkumar, B.C. (JNCASR, Bangalore) (14 papers), M.M. Aggarwal (Panjab University., Chandigarh) (12 papers), S.K. Das (IIT, Madras) (12 papers), C. Namasivayam (Bharathiar University, Coimbatore) (12 papers), S. Sundar (IMS-BHU, Varanasi) (12 papers), V.K. Gupta (University of Delhi) (11 papers), T. Padmanabhan (IUCAA, Pune)(10 papers), C.S.Yajnik (KEM Hospital) (9 papers), K. Kadirvlu (Bharathiar University, Coimbatore) (8 papers), V.Sahni (IUCAA, Pune) (8 papers), B.C. Ranu (IACS, Kolkata) (7 papers), A. Ramachandran (Diabetes Research Centre, Chennai), S.K. Ghosh (IIT, Kanpur) (7 papers) and A. Pandey (RRL, Thiruvanathapuram).

These 1668 high cited papers were published in 557 journals, including 94 papers from *Physical Review Letters*, 47 from *Journal of the American Chemical Society*, 47 from *Physical Review B*, 42 from *Nature*, 35 from *Journal of Physical Chemistry B*, 32 from *Science*, 30 from *Chemical Reviews*, 26 from *Accounts of Chemical Research*, 24 from *Lancet*, 22 from *Tetrahedron Letters*, 21 each from *Applied Physics Letters, Chemical Physics Letters, Current Science and Longmuir,* 20 each from *Bioresource Technology, Chemistry of Materials and Water Research*, etc.

5. CONCLUSIONS AND SUMMARY

India had contributed 538609 papers in science and technology during the last fifteen years from 1996 to 2010 as reflected in Scopus international database. The cumulative Indian research output in science and technology increased from 110454 papers during 1996-2000 to 276680 during 2006-2010, showing a growth rate of 150.49 per cent. The total Indian research output during 1996 to 2010 has grown at an annual average growth rate of 9.32 per cent. The annual average growth rate of Indian publications in science and technology has increased from 3.05 per cent during 1996-2000 to 13.70 per cent during 2006-2010. India's global publications share and rank in science and technology is still very small (2.32 per cent share and 10th rank) during 1996-2010. However, its global publications share has increased from 1.89 per cent during 1996-2000 to 2.78 per cent during 2006-2010 and its global publication rank from 13th to 10th during the same period. In India's research profile, physical science subjects together contributed the highest publication share (41.06 per cent), followed by engineering sciences (32.69 per cent), life sciences (30.05 per cent), and health sciences (22.17 per cent) in cumulative national publication output of India during 1996-2010. Among the

cumulative national contribution of 20 broad subject areas in Indian S&T during the last 15 years from 1996 to 2010: (i) medicine, chemistry, engineering, physics, materials science, biochemistry, genetics and molecular biology and agricultural and biological sciences are considered the seven high priority areas of Indian S&T (each subject contributing publication share between 12.04 per cent and 19.40 per cent), (ii) pharmacology, toxicology and pharmaceutics, computer science, environmental sciences, chemical engineering, mathematics, earth and planetary sciences and immunology & microbiology are the seven medium productive subjective areas of Indian research (each subject contributing publications share between 3.70 per cent to 7.33 per cent), (iii) energy, veterinary science and neurosciences are the three low productive subject areas (each subject contributing publications share between 1.28 per cent and 2.37 per cent) and (iv) public health nursing and dentistry are the three least productive Indian subject areas (each subject contributing publications share less than 1 per cent). Among these 20 broad subjects, computer science had showed the largest increase of 6.39 per cent in national publications share of India, followed by 4.16 per cent in medicine, 3.58 per cent in engineering, 2.69 per cent in pharmacology, toxicology and pharmaceutics, 1.53 per cent in materials science and 1.42 per cent in biochemistry, genetics and molecular biology from 1996-2000 to 2006-2010.

Among the India's contribution to global research output in broad 20 subjects during 1996-2010, the largest publications share (5.49 per cent) comes from veterinary science, followed by chemistry, pharmacology, toxicology and pharmaceutics and agricultural and biological sciences (from 4.05 per cent to 4.93 per cent share), materials science, environmental science, chemical engineering and physics (from 3.04 per cent to 3.68 per cent share), energy, immunology and microbiology, earth and planetary sciences, mathematics, biochemistry, genetics .and molecular biology, computer science and engineering (share from 2.00 per cent to 2.61 per cent share) and dentistry, medicine, public health, neurosciences and nursing (from 0.52 per cent to 1.93 per cent share). India has improved its global publication share in 19 out of 20 broad subjects varying from 0.11 per cent to 2.48 per cent from 1996-2000 to 2006-2010, with largest increase of 2.80 per cent in dentistry, followed by 1.91 per cent in chemistry, 1.75 per cent in immunology and microbiology, 1.64 per cent in environmental science, 1.35 per cent in biochemistry, genetics and molecular biology, 1.31 per cent in chemical engineering, 1.18 per cent in materials science, 1.14 per cent in physics and 1.03 per cent in computer science.

India still lacks equitable distribution of resources as its 9 geographical states/union territories still continue to contribute very little cumulative publications share (< 1 per cent) in science and technology during 1996-2010. In contrast, only six geographical states/union territories, namely, Maharashtra Delhi, Karnataka, Tamil Nadu, West Bengal and Uttar Pradesh contribute publications share ranging from 10.07 per cent to 14.16 per cent in India's total cumulative publication output during 1996-2010.

The top 100 most productive Indian organisations, publishing 1278 and above papers together contributed 54.92 per cent share (295827 papers) in the cumulative publications output of India during 1996-2010.They include: (i) 14 institutes of national importance, (ii) 27 research institutes, (iii) 44 universities, (iv) 9 medical colleges and hospitals and (v) 6 other institutes of higher education. Among these four type of Indian organisations: (i) the universities contributed the highest publications share of 20.80 per cent, followed by by institutes of national importance (18.71 per cent), research institutes (14.78 per cent), medical colleges and hospitals (3.42 per cent) and other institutes of higher education (1.76 per cent), (ii) the highest average productivity per institution of 7198 was achieved by institute of national importance, followed by research institutes (2848 papers), universities (2687 papers). Medical colleges and hospitals (2050) and other institutes of higher education (1359 papers); (iii) the highest *h*-index of 166 was achieved by research institutes, followed by institutes of national importance (165), universities (142), medical colleges and hospitals (82) and other institutes of higher education (53); (iv) the highest share (26.98 per cent) of high cited papers in India's total output of high cited papers was achieved by research institutes, followed by institutes of national importance (26.92 per cent), universities (19.18 per cent), medical colleges and hospitals (3.18 per cent) and other institutes of higher education (0.66 per cent) and (v) the highest share (20.60 per cent) of international collaborative papers was achieved by research institutes, followed by institutes of national importance (20.01 per cent), universities (17.33 per cent), other institutes of higher education (15.17 per cent) and medical colleges and hospitals (11.23 per cent).

From the above, it is clear that research institutes and institutes of national importance have shown comparative better performance in terms of average output and quality measured in terms of *h*-index, share of high cited papers and share of international collaborative papers, compared to universities, medical colleges and hospitals and other institutes of higher education. India's share of international collaborative papers in the cumulative publications output was 15.98 per cent during 1996 to 2010, compared with 12.19 per cent for China, 21.05 per cent for South Korea and 25.35 per cent for Brazil during the same period. Its international collaboration was highest (36.58 per cent) during 1996-2010, followed by Germany (13.00 per cent), United Kingdom (11.97 per cent), Japan (9.10 per cent), France (7.65 per cent),

etc. India had published 1668 high-cited papers in SandTin last 15 years, with citations varying from 100 to 3429 citations per paper. Of these 1668 papers, 875 were international collaborative. In overall, Indian participation in these 1668 papers was confined to large number of Indian institutions: Indian Institute of Science, Bangalore (with 137 papers), followed by Tata Institute of Fundamental Research, Mumbai (71 papers), Indian Institute of Technology, Kanpur (66 papers), National Chemical Laboratory, Pune (58 papers), Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore (56 papers), Indian Institute of Technology, Mumbai (46 papers), Indian Institute of Technology,Kharagpur (45 papers) and Bhabha Atomic Research Center, Mumbai (44 papers). Some of the most prominent and productive scientists associated with these comparatively high cited papers in order of ranking are C.N.R Rao (33 papers), followed by G.R. Desiraju (19 papers), D. Das (17 papers), S. Kumar (16 papers), A. Sen (14 papers), Satishkumar, B.C. (14 papers), M.M. Aggarwal (12 papers), S.K. Das (12 papers), C. Namasivayam (12 papers), S. Sundar (12 papers), V.K. Gupta (11 papers), T. Padmanabhan (10 papers), etc.

REFERENCES

1. Jayaraman, K. India hikes science budget despite slowdown, 2009. http://www.nature.com/news/2009/090708/full/news/2009/09-708/full/news.2009652.html (accessed on 1 May 2011).

2. Mani, Sunil. India. *In* Current Status of Science Around the World. UNESCO, Paris. pp. 365. http://unesco.org/new/Fileadmin/MULTIMEDIA/HQ/Sc/pdf/sc_us r10_India_EN.pdf/S&T/F

3. Garg, K.C. & Dutt, B. Bibliometrics of Indian science as reflected through *Science Citation Index*. *J. Sci. Indus.Res.,* 1992, **51**, 329-40.

4. Arunachalam, S.; Srinivasan, S. & Raman, V. Science in India: A profile based on India's publications as covered by *Sci. Citation Index*, 1989-1992. *Current Science,* 1998, **74**(5), 433-41.

5. Basu, Aparna & Nagpaul, P.S National Mapping of Science. NISTADS, New Delhi. Report No.248/98.

6. Garfield, Eugene. Mapping science in the third world. Part 1. *Science & Public Policy,* 1983, **10**(3), 112-27.

7. Raghuram, N. & Madhavi, Y. India's declining ranking. *Nature,* 1996, **383**(6601), 572.

8. Arunachalam, S. Is science in India on decline? *Current Science,* 2002, **83**(2), 107-08.

9. King, David. The scientific impact of nations. *Nature,* 2004, **430**, 311-16.

10. Gupta, B.M. & Dhawan, S.M. Measures of Progress of Science in India: An Analysis of the Publication Output in Science and Technology. Office of the Principal Scientific Adviser to the Government of India, New Delhi. 3 May 2011. http://psa.gov.in/writereaddata/11913286541_MPSI.pdf

11. Raghuraman, K.P.; Chander, Romesh & Madras, Giridhar. Scientometric analysis of some disciplines: Comparison of Indian institutions with international institutions. *Current Science*, 2010, **99**(5), 577-87.

12. Gupta, B.M. A comparative study of India, China, and South Korea S&T publication output during 1999-2008. *Ann. Lib.Infor. Stu.,* 2010, **57**, 207-21.

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