MAPPING LIFE SCIENCES RESEARCH OF INDIA

*Tariq Ahmad Shah

ABSTRACT

Life Sciences research in India is mapped from journal literature indexed for four years in BIOSIS Biological Abstracts (2000-2003).Reveals India with 37202 papers, roughly 2.5% of the global output, occupying 10th rank among 179 contributing countries. Researchers over 2400 institutions located in 32 states/union territories have authored papers in 1960 journals published across 61 countries. About 51% of research papers have appeared in 85 Indian journals. Less than 55% of papers are published in journals indexed in Journal Citation Report. Uttar Pradesh, Maharashtra & Delhi based scientists have published highest number of papers from India. About 90% of papers are co-authored with highest share of 2 and 3-authored papers. In all, Indian research shows an overall growth rate of 4.4% during the period with an annual average increment of 1.46%.

KEYWORDS

Indian Contribution, *Life sciences research, Bibliometrics.*

INTRODUCTION

Incessant research has been encouraged in all fields of life whether in the Science, Social Science, or Humanities, ever since the instigation of industrial era. The escalating activity is obvious from the number of research journals published in world, disseminating reports of research carried out in all fields of endeavour. These ever growing research activities have their insinuations for libraries. An information officer and a policy maker should be well aware about the latest nascent ideas, inventions & techniques, generated in the particular field all around the world.

Librarian, Popular College of Education HMT, Srinagar (J&K) e-mail: tariqahmadshah@gmail.com

From the last six decades or so research in the field of sciences has seen many fold increase due to its accurate, reliable, result oriented methodology and usefulness to human life. It is due to science we see today man is able to unfold centuries old mysteries with accuracy and precision. The development and progress of any nation depends upon how much advanced it is in the field of science. Thus keeping the value of science in view the study was carried out to quantify the Life Sciences research in India.

OBJECTIVES

The study is carried out to assess in the field of life sciences

a) The volume of research output published in India
b) The journals choice of Indian researchers vis- a- vis their impact factors,
c) The institutional research output in the field, and
d) Collaboration degree among researchers.

SCOPE

The current study aims to map the life science research in India as reflected by journal literature. The study is a deep analysis of Indian research work. The data is taken from the *'Biological Abstracts'*, a publication of BIOSIS confined to the disc years 2000-2003. The work outlines a glimpse of the global contribution while the main emphasis is given to the Indian research output.

LITERATURE REVIEW

The study of **Arunachalam (1998)**, using data indexed in *BIOSIS Biological Abstracts 1992-1994*, reveals the existence of two groups of Indian institutions: a large number of institutions devoted to agriculture and classical biology, publishing mostly in low-impact journals, often in Indian journals, and a smaller group of institutions publishing some papers in new biology and some areas of medicine in quality international journals of medium impact. The larger cluster includes the agricultural universities and many general universities, while the smaller cluster includes the Indian Institute of Science, AIIMS, Centre for Cellular and Molecular Biology, National Institute of Immunology, and Indian Institute of Chemical Biology. **Arunachalam (2001)** again conducted a study,

consulting papers published in 1998 and indexed in *BIOSIS Biological Abstracts 1998* and concluded that there has been tendency over the years to publish papers in journals of higher impact factors. However, the output of academic institutions has declined by 9.2%, against the output in 1992-1994.

An analysis of 11067 papers published by Indian scientists and indexed by *Science Citation Index (SCI)* CD-ROM for the year 1997 indicates that academic institutions (universities and colleges) are the major contributors to the scientific publications output. Fifty seven percent of the output is concentrated in physical sciences, chemical and medical sciences. Indian scientists widely publish their findings in journals published from the scientifically advanced countries of the West **(Garg, Dutt and Kumar, 2006)**.

Arunachalam & Umarani (2001) mapped agricultural research in India by analysing journal literature published in 1998 and indexed in *Chemical Abstracts*. The study covered 11,855 publications which include 10,412 *journal* articles. The Authors found that more than 1280 institutions situated in 531 locations are active in agricultural *research*. Academic institutions accounted over 59% of the papers while scientific agencies of the central government contributed 22% of the papers. About 0.68% of papers were published in non-SCI journals (Science Citation Index) and 0.16% in journals of impact factor less than 1.0. The study highlighted that in no other field except Agricultural science, a large percentage of papers were published in endogenous journals. **Jayashree & Arunachalam** (2000) quantified fish research in India using data from *CAB Abstracts, Science Citation Index (SCI), BIOSIS Biological Abstracts, BBCI (Biophysics and Biochemistry Citation Index), BTCI (Biotechnology Citation Index and ASFA (Aquatic Science and Fishereis Abstracts)*. The authors reported that roughly 5.5% of the world output comes from India every year, of which 82% are journal articles. Close to 70% of journal articles have appeared in 113 Indian journals. Less than a third of the journals articles are published in SCI-indexed journals. About 61% of publications are contributed by government laboratories and over 25% by academic institutions. Kochi, Chennai, Mumbai and Mangalore are the cities and Tamil Nadu and Kerala are the states contributing large number of papers. **Arunachalam & Balaji (2001)** compared fish research in China and India by scrutinizing papers published over the six years (1994 – 1999) and

indexed by *CAB Abstracts, BIOSIS Biological Abstracts, SCI (Science Citation Index), BBCI (Biophysics and Biochemistry Citation Index), BTCI (Biotechnology Citation Index) and ASFA (Aquatic Science and Fisheries Abstracts)*. The authors observe that in China fish research institutes and fishery colleges are the major contributors, while the leading contributors in India are academic institutions followed by central government institutions. Less than one-eighth of the journal articles published by Chinese researchers are published in journals indexed in SCI, compared to 30% of journal articles by Indian researchers. Despite the fact that China's research output and its citation impact are less than those of India, China's fish production and export earnings are far higher than those of India. Probably China is better at bridging the gap between know-how (research) and do-how (technology and creation of employment and wealth).

The work by **Arunachalam & Gunasekaran (2002)** highlights that India and China lead the world in the rate of tuberculosis (TB), accounting for 23% and 17% respectively, of the global burden of the disease and hold the 15th and the 18th positions in terms of incidence per 100,000 population. But India accounts for only about 5–6% of the world's research output in this area and China a paltry 1% as seen from papers indexed in three international databases, viz. *PubMed, Science Citation Index and Biochemistry and Biophysics Citation Index* over the ten-year period 1990–1999. The authors found that though China performs much less research than India and its work is quoted much less often, it seems to have done far better than India in health-care delivery in TB. **Arunachalam & Gunasekaran (2002)** gauge diabetes research in India and China, based on papers published during 1990–1999 and indexed in *PubMed, Science Citation Index and Biochemistry and Biophysics Citation Index* and citations to each one of these papers up to 2000. The authors notice that though these two countries account for 26% of the prevalence of diabetes, they contribute less than 2% of the world's research.

An investigation by *Arunachalam* and *Rino* concerned the Mathematics research in India, as reflected by papers indexed in *Mathsci* 1998, and compared with the papers indexed in *Mathsci* 1994. It shows that there is considerable decrease in the number of papers published in low impact journals. Besides, it reveals that every third paper from India results from inter-institutional

collaboration and about 23% from international collaboration (**Arunachalam and Rino, 2001).**

METHODOLOGY

The bibliographic information on all papers indexed in BIOSIS Biological Abstracts 2000 – 2003 was downloaded by using Windows based Silver Platter retrieving software *SPIRS 5.0.* For multi-authored papers, BIOSIS provides the address of only one author and as such the papers get attributed to the country to which that author belongs, and therefore all the jointly-authored papers where the Indian authors' addresses have not appeared were missed. Unlike many databases (*Pubmed), Biological Abstracts* provided the name of the country in the address field, avoiding the hectic procedure of adding the names of cities, towns, districts & states in the search expression. Since *free-text* searching feature of WINSPIRS was employed to attribute the papers to their respective countries, which at times retrieved irrelevant records, e.g., for the search expression "India-in-AD" (AD = Author Address Field), the retrieved results also included papers having INDIANA in the Address field. To avoid this, author address field of papers belonging to a particular country was first downloaded (using country-name as keyword), checked in Microsoft Excel (using 'RIGHT' function), name(s) of any other country, if spotted, were then added in the final search expression through Boolean operator 'NOT' [e.g., (India in AD) NOT (Indiana in AD)] thereby arriving at the exact figure. The procedure was repeated for all countries & their contributions were noted down. Also, a search was carried out where names of known countries were used as keywords and connect via 'NOT' (e.g, ".... NOT *India* in AD NOT *Pakistan* in AD NOT *China* in AD...."), in order to highlight the contribution of those countries which remained unnoticed. By this practice, it was also found that some of the papers lack author address field thus making it impossible to ascertain their origin. Finally, fields were downloaded from Indian papers which include: Author's address (AD), Authors (AU), Source (SO) and International Standard Serial Number (ISSN).

The Biological Abstract represents the information given in the indexed journals, which sometimes slack in giving the accurate bibliographic information. For example, *Panjab University* (which is in Chandigarh) may be printed as

Punjab University (which is in Lahore, Pakistan). Another problem which surfaced was the non-standard rendering of names of institutions. Often agricultural universities were named as '*Krishi Vishwavidyaliaya*' or '*Krishi Vidapeth*' (the Hindi equivalent). The different variants of names of institutions were standardized, e.g., *Sagar University* was merged with *Dr H S Gaur Vishwavidyaliaya, Haryana Agricultural University* was merged with *CCS Haryana Agricultural University, and Andhra Pradesh Agricultural University with Acharya N.G. Ranga Agricultural University.*

For each journal publishing Indian papers, the country of origin was found by consulting *Thomson Scientifics'* Master list of journal & *PubMed's* journal list, web sources of information on serials. The impact factor values from *Journal Citation Reports 2003* were also added to them. The status of institutions (whether it is university, college, research centre etc.) were checked from their respective websites. The different centres of the same institution were not clubbed. For example, *Botanical Survey of India*, Kolkata, has centres at Itanagar, Port Blair, Allahabad, Shillong, Jodhpur, Dehradun, Gangtok, Coimbatore, and Pune, and each was counted as separate unit. Similarly *Sugarcane Breeding Institute*, Coimbatore, has centers at Kannur (Kerala), Karnal (Haryana) and Samalispur (Bihar), which were counted separately. Institutions serving both as College & Hospital or College & Research Centre were categorized under "*Colleges*", and those acting both as University & Research Centre were classified under "Universities". The state-wise categorization of papers is based according to the present (2007) political demarcation of Indian states. The data thus collected was converted into a database using Microsoft Excel for analysis.

DISCUSSION

The study is carried out by analysing the journal literature indexed in the CD-ROM edition of BIOSIS Biological Abstracts 2000-2003. Here the years indicate the disc years and not the years of publication of the individual papers. In the four years considered, 14,72,770 papers were contributed by nearly 179 countries, out of which 37,202 papers are of India origin, accounting merely 2.5% of the total global output. 29,425 of papers (2%) do not include author addresses making it impossible to ascertain their origin.

Indian vs. Global output

It is clear that 14 countries (out of 179 contributing countries) are active in Life Sciences research. USA leads with 429941 papers (29.19%), followed by Japan and UK with each 134401 (9.13%) and 102981 (6.99%) papers respectively. India ranks 10th in its contribution. However, while comparing it with USA, its output accounts merely 8.65% of it. (Table 1)

Table 1: Indian Contribution vs Global Output

Rank	Country	Year wise distribution of output				TOTAL
		2000	2001	2002	2003	
1	USA	103920	110211	107344	108466	429941 (29.19)
2	Japan	35254	34715	31942	32490	134401 (9.13)
3	UK	25799	27105	25086	24991	102981 (6.99)
4	Germany	22084	22976	22008	21685	88753 (6.03)
5	France	16219	17521	15943	16061	65744 (4.46)
6	Italy	12890	13749	13020	13180	52839 (3.59)
7	Canada	12637	13403	12481	13271	51792 (3.52)
8	China	9158	10329	11038	13124	43649 (2.96)
9	Spain	9305	9716	9475	9531	38027 (2.58)
10	**India**	**8983**	**9301**	**9126**	**9792**	**37202 (2.53)**
11	Australia	8958	9236	8777	8745	35716 (2.43)
12	Netherlands	7550	7710	7402	7460	30122 (2.05)
13	Sweden	6258	6346	5998	6086	24688 (1.68)
14	Brazil	5186	6007	5911	6853	23957 (1.63)
11 Countries publishing 10,000-20,000 papers						157806 (10.71)
27 Countries publishing 1000-10,000 papers						106289 (7.22)
49 Countries publishing 100-1000 papers						17418 (1.18)
78 Countries Publishing 1-100 papers						2020 (0.14)
Unascertainable						29425 (2.00)
TOTAL		**359700**	**376365**	**361232**	**375473**	**1472770 (100)**

* *Figures in parenthesis indicate percentage*

Journal Distribution

Biological Abstracts has indexed papers from 4363 journals during the study period. Among these, Indian researchers used 1960 journals (44.92%) to publish their work. *Indian Veterinary Journal* (1367 papers), *Indian Journal of Animal Sciences* (1175) and *Current Science* (1065) are the only journals that have published more than 1000 papers each. Ten journals contain 500 or more papers but less than 1000, and 50 journals have published 100 or more papers but less than 500. At the other extreme, 473 journals have published just one paper each and 293 journals two paper each.(Table2).

However, in the top 50 journals in which Indians have published 140 or more papers, only 7 are foreign journals: *Tetrahedron-Letters,* UK, 17th rank(358 papers); *Journal of Ethnopharmacology*, Ireland, 37th rank(179 papers); *World-Journal-of-Microbiology-and-Biotechnology*, USA, 39th rank(172 papers); *Biochemical-and-Biophysical-Research-Communications*, USA, 41st rank(166 papers); *Asian-Australasian-Journal-of-Animal-Sciences,* South Korea, 46th rank(153 papers); *Bulletin-of-Environmental-Contamination-and-Toxicology*, USA, 48th rank(147 papers); and *Bioresource-Technology*, UK, 50th rank(50 papers).

Of the 1960 journals, only 34 are letters journals[1] which have published 1194 papers from India (3.21% of journal articles). *Tetrahedron Letters* (358 papers) and *Biochemical-and Biophysical Research Communications* (166) are the only letter journals that have published more than 100 papers each. Besides, all are foreign publications making evident that there is no urgency among Indian scientists in using rapid communication channels to report one's findings. Fig. 1 shows the distribution of papers among journals is very nearly *Bradfordian curve*

1 Only journals with the words 'letter(s)' or 'communication(s)' in their title are taken into consideration.

Table 2: Volume of papers in Indian journals

Rank	Journal Title	Journal Country	No. of Papers
1	Indian Veterinary Journal	India	1367
2	Indian Journal of Animal Sciences	India	1175
3	Current Science (Bangalore)	India	1065
4	Crop Research (Hisar)	India	725
5	Indian Journal of Experimental Biology	India	718
6	Indian Forester	India	708
7	Indian Journal of Pediatrics	India	665
8	Journal of Economic and Taxonomic Botany	India	600
9	Indian Journal of Agricultural Sciences	India	591
10	Journal of the Bombay Natural History Society	India	566
11	Advances in Plant Sciences	India	564
12	Indian Journal of Agronomy	India	560
	5 Journals publishing 350-550 papers		2047
	30 Journals publishing 150 – 350 papers		6466
	74 Journals publishing 50 –150 papers		6004
	415 Journals publishing 10–50 papers		8874
	658 Journals publishing 3–10 papers		3448
	293 Journals publishing 2 papers each		586
	473 Journals publishing 1 paper each		473
Total			**37202**

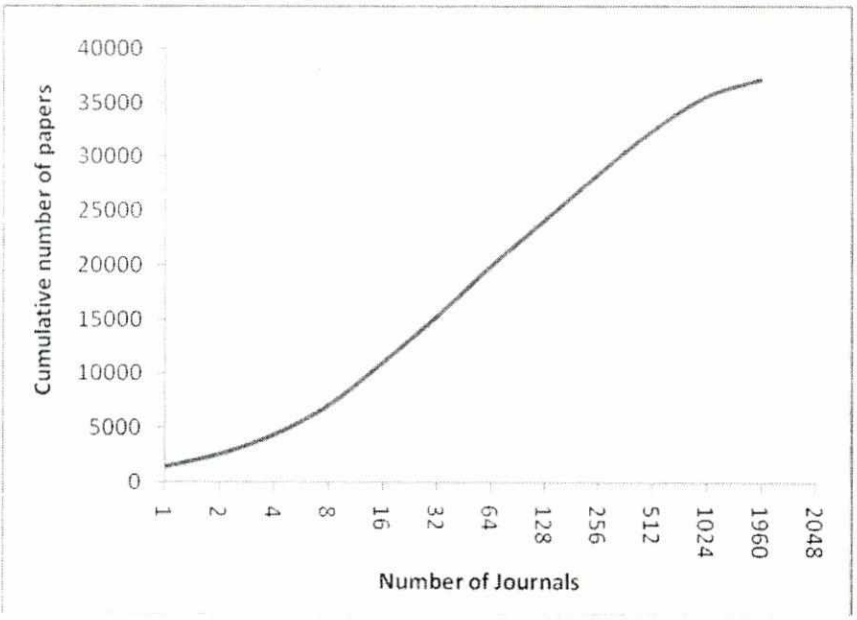

Fig 1: Graph depicting Number of journals vs. cumulative number of Indian papers.

Country wise Contribution

Indian researchers have authored papers in journals published in 61 different countries. It is evident that 51.43% of papers (19134) are published in 85 Indian journals. Indian authors have used 588 USA journals to publish 8491 papers (14.76%), 486 UK journals to publish 5221 papers (14.03%), and 193 journals published in the Netherlands to publish 2749 papers (7.39%). The least preferred countries are Qatar, Guinea, Finland (2 papers in a journal), Estonia and Colombia (1 paper in a journal). (Table3)

Table 3: Country of publication of the journals preferred by Indian researchers

Rank	Name of country	No. of Journals	No. of papers
1	India	85	19134 (51.43)
2	USA	588	5491 (14.76)
3	UK	486	5221 (14.03)
4	Netherlands	193	2749 (7.39)
5	Germany	121	933 (2.51)
6	Ireland	28	497 (1.34)
7	Japan	67	405 (1.09)
8	Switzerland	50	358 (0.96)
9	South Korea	11	218 (0.59)
10	Poland	23	198 (0.53)
11	Australia	20	185 (0.50)
50 other countries		288	1813 (48.87)
Total		**1960**	**37202 (100)**

* *Figures in parenthesis indicate percentage*

Impact factor

It is clear from the study , papers published in journals of different impact factor ranges (as given in Journal Citation Reports 2003), that 44.71% papers (16633) have published in 510 journals not indexed in JCR 2003. Besides, 30.43% of papers (10320) stand published in journals having impact factor less than or equal to 1.0. Only 1682 papers (4.53%) have published in journals with impact factor greater than or equal to 3.(Table 4) The distribution of papers over journals in different impact factor ranges and the distribution of journals used by Indian researchers over impact factors are shown in Fig. 2.

Table 4: Distribution of Indian papers by impact factor range of journals (based on impact factor data from JCR 2003)

Impact Factor [JCR 2003]	No. of Journals	No. of Papers
0.0	510	16633 (44.71)
0.0 - 0.5	148	5336 (14.34)
0.5 - 1.0	331	5984 (16.09)
1.0 - 1.5	262	2792 (7.50)
1.5 - 2.0	200	2042 (5.49)
2.0 - 2.5	160	1831 (4.92)
2.5 - 3.0	102	902 (2.42)
3.0 - 3.5	70	482 (1.30)
3.5 - 4.0	46	371 (1.00)
> 4.0	131	829 (2.23)
Total	**1960**	**37202 (100)**

* *Figures in parenthesis indicate percentage*

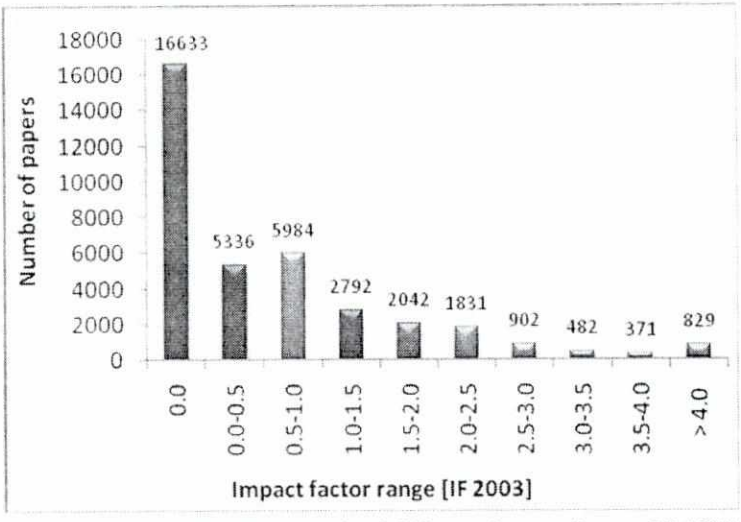

Fig 2: No. of papers published in journals of different Impact factor (IF 2003) range

Institutional Contribution

More than 2400 Institutions are active in India and have published at least one paper during the study period . The most prolific institutions are *All India Institute of Medical Sciences (AIIMS)*, Ansari Nagar (986 papers) and CCS *Haryana Agricultural University*, Hisar (695), followed by *Indian Institute of Science*, Bangalore (634) and *Postgraduate Institute of Medical Education and Research (PGIMER)*, Chandigarh (534). Only 80 institutions have published over 100 papers. At the other extreme, 979 institutions have published one paper and 327 institutions have published two papers each. Besides, researchers not affiliated with any institution and captioned under "Home Addresses" have contributed 1387 papers. It is also evident that among top 10 institutions, 4 are universities. (Table 5).The proportion of contributions from Universities, Colleges, Research Institutions, etc, is portrayed in figure 4 while figure 3 is a curve of the number of institutions vs the cumulative number of papers.

Table 5: papers from various institutions

Rank	Institution	No. of papers
1	All India Institute of Medical Sciences (AIIMS), Ansari Nagar	986
2	CCS Haryana Agricultural University, Hisar	695
3	Indian Institute of Science, Malleswarum, Bangalore	634
4	Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh	534
5	Indian Agricultural Research Institute, New Delhi	531
6	Punjab Agricultural University, Ludhiana	508
7	Indian Veterinary Research Institute, Izatnagar, Bareilly	467
8	Banaras Hindu University, Varanasi	463
9	University of Delhi, Delhi, DEL	394
10	Central Food Technological Research Institute, Mysore	384
11	Central Institute of Medicinal and Aromatic Plants (CIMAP), CSIR, Lucknow	360
12	Panjab University, Chandigarh	323
13	Tamil Nadu Agricultural University, Coimbatore	322
14	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar	274
15	Indian Institute of Chemical Technology, Hyderabad	273
16	Bhabha Atomic Research Centre, Mumbai	270
17	Central Drug Research Institute, Lucknow	252
18	Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow	241
	2400 other institutions	27626
	Home Addresses	1387
	Unascertainable	278
	TOTAL	**37202**

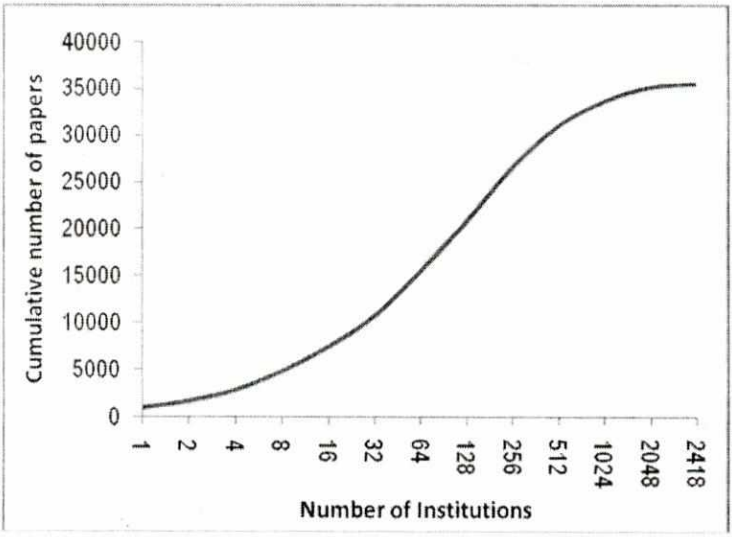

Fig 3: **No. of institutions vs cumulative no. of papers**

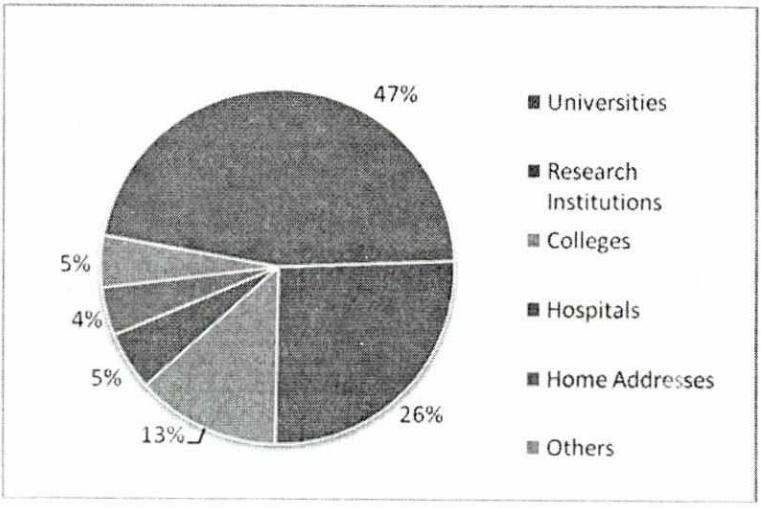

Fig 4: Contribution of different Indian institutions

State wise Distribution

Uttar Pradesh based scientists account for the largest number of papers (4135), followed by Maharashtra (4105), Delhi (4097) and Tamil Nadu (3572) . The least number of papers are contributed from institutions of Tripura (46), Nagaland (39) and Mizoram (23). From the comparative assessment of contributions made in 2000-02 & 2003, it is evident that Delhi, Uttaranchal, Madhya Pradesh & Assam (contribution > 100) are the states that have slid from their respective ranks in 2003.(Table 6) However, this distribution should be attributed to higher density of research institutions in the capital cities and other towns and not to any inherent or biological factor present in that particular region of the country.

Table 6: Contribution from Indian states

Rank	State/Union Territory	No. of papers		
		2000-02	2003	TOTAL
1	Uttar Pradesh	3072	1063	4135
2	Maharashtra	3053	1052	4105
3	Delhi	2660	912	3572
4	Tamil Nadu	2539	988	3527
5	Karnataka	2494	953	3447
6	Andhra Pradesh	1843	796	2639
7	West Bengal	1705	659	2364
8	Kerala	998	358	1356
9	Haryana	983	331	1314
10	Uttaranchal	882	315	1197
11	Punjab	838	299	1137
12	Rajasthan	815	307	1122
13	Chandigarh (UT)	831	277	1108
14	Madhya Pradesh	872	232	1104
15	Gujarat	623	233	856
16	Himachal Pradesh	558	168	726
17	Assam	528	144	672

Contd---

18	Orissa	461	177	638
19	Pondicherry (UT)	240	80	320
20	Jammu & Kashmir	211	88	299
21	Chattisgarh	225	42	267
22	Bihar	211	49	260
23	Jharkhand	176	33	209
24	Goa	139	53	192
25	Meghalaya	95	55	150
26	Andaman & Nicobar Islands (UT)	80	24	104
27	Manipur	69	18	87
28	Arunachal Pradesh	64	20	84
29	Sikkim	40	29	69
30	Tripura	41	5	46
31	Nagaland	24	15	39
32	Mizoram	15	8	23
	Unknown	25	9	34
	TOTAL	**27410**	**9792**	**37202**

Collaboration

It is clear from the analysis that 90.2% of papers are co-authored. The highest alliance has taken place between 2 and 3 authors, which constitute 29.82% and 27.55% papers respectively. The least coalition is observed in a team greater than 5 (7.59%).(Table 7)

Table 7: Collaboration among authors
N = 37202

No. of Authors	No. of Papers
1	3421 (9.2)
2	11092 (29.82)
3	10251 (27.55)
4	6401 (17.21)
5	3215 (8.64)
More than 5	2822 (7.59)
Total	**37202 (100)**

** Figures in parenthesis indicate percentage*

Growth Trend

The four year study makes it evident that Indian research shows an overall growth rate of 4.4%. However, while comparing the Indian contribution made in two successive years the growth rate shows following trends : from 2000 to 2001, -1.2%[2] (negative sign indicates decline); 2001 to 2002, 2.43% and 2002 to 2003, 3.16%. However, despite a dip of 1.2% during 2000-01, Indian research expands annually at the rate of 1.46% .(Table 8).Besides, figure 5 depicts the growth trend by plotting a percentage e graph for four consecutive years which can be further projected to reveal a positive growth story of Indian contribution.

2 $\frac{\text{Current year Output - Previous year Output}}{\text{Current year Output}} \times 100$

Table 8: Year wise Indian contribution

Year	Global Output	Indian Output	Growth Rate
2000	359700	8983 (2.50)	–
2001	376365	9301 (2.47)	-1.20%
2002	361232	9126 (2.53)	2.43%
2003	375473	9792 (2.61)	3.16%

* *Figures in parenthesis indicate percentage*

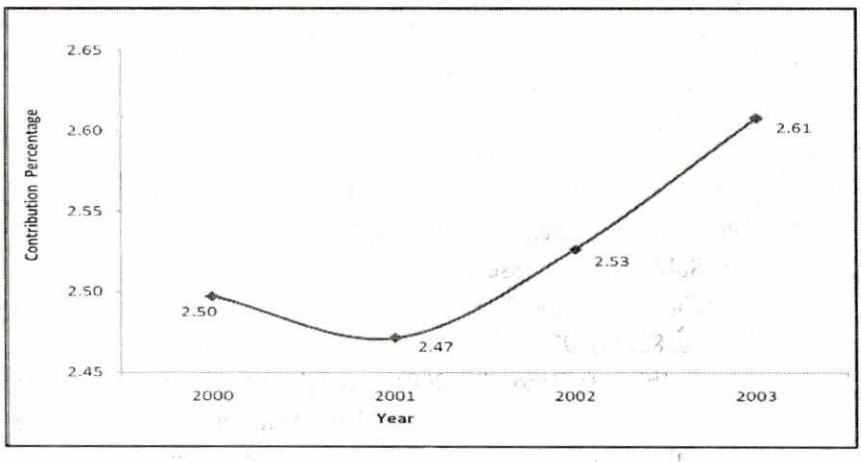

Fig 5: Indian contribution graph

CONCLUSION

Life Sciences research in India appears to be mediocre in general. Although Indian researchers accounted for about 2.43% of the world publications on Life Sciences and ranked 10th among 179 contributing countries, a large majority of their papers get published either in non-JCR journals or low-impact journals of poor visibility.

The study has had the limitation of being unable to comment on international collaboration in Life sciences research in India, as the database does not list the address of all authors. Also, it is restricted to analyzing the research output over a four year period in the form of published literature and that too from a single database. One could extend this study by consulting more databases, looking at actual citations to papers (instead of impact factor of journals), and by looking at the performance of different institutions, in conjugation with manpower and budgetary data. Such studies carried out at a comprehensive size and period may prove helpful to take timely measures for the development of Life Sciences research in India.

REFERENCES

Arunachalam, Subbiah & Balaji, Jayashree. (2001). Fish science research in China: How does it compare with fish research in India?. *Scientometrics*, 52 (1). 13-28

Arunachalam, Subbiah & Gunasekaran, Subbiah. (2002). Diabetes research in India and China today: From literature-based mapping to health-care policy, *Current Science*, 82 (9). 1086-1097

Arunachalam, Subbiah & Gunasekaran, Subbiah. (2002). Tuberculosis research in India and China: From bibliometrics to research policy. *Current Science*, 82, (8). 933-947

Arunachalam, Subbiah & Rino SI. (2001). Mapping Mathematics Research in India in 1998: An Analysis Based on Mathsci. Report submitted to National Information systems for Science & Technology. Oct 2001. Retrieved April 6, 2007 from http://dlist.sir.arizona.edu/860

Arunachalam, Subbiah & Umarani, K. (2001). Mapping Agricultural Research in India: A profile based on CAB Abstracts 1998. *Current Science*, 81(8). 896 - 906

Arunachalam, Subbiah. (1998). Mapping Life Sciences Research in India: A Profile Based on Biosis 1992-1994. Report submitted to National Information systems for Science & Technology, Nov 1998

Arunachalam, Subbiah. (2001). Life Sciences Research in India: A Profile Based on Biosis 1998. Report submitted to National Information systems for Science & Technology, Nov 2001.

Garg K. C, Dutt, B & Kumar, Suresh. (2006). Scientometric profile of Indian science as seen through Science Citation Index. *Annals of library and information studies*, 53 (3). 114-125

Jayashree, B. & Arunachalam, Subbiah. (2000). Mapping fish research in India. *Current Science*, 79 (5). 613-620