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Bibliometric Analysis of Papers Published by Faculty of Life Science Departments of Savitribai Phule Pune University during 1999-2013

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ABSTRACT

The aim of this work is to analyse research productivity of life sciences faculty members at the Savitribai Phule Pune University (SPPU), Maharashtra, India. The research is conducted with the intention to know the research productivity over 15 years (1999-2013), the citations received, collaborations, and authorship patterns. Web of Science (WoS) database was used for the bibliographic and citation data. Data were analysed by using bibliometric techniques and software such as HistCite, Intcoll, and Pajek. Results show that the research productivity of faculty members is increasing, their publications are getting good citations and thereby their journals have better Impact Factor. The faculty members have collaborated with prominent international researchers and have extended interdisciplinary research. The paper is based on empirical data exclusively gathered for this research.

Keywords: Bibliometric analysis, citation analysis, life sciences departments, Savitribai Phule Pune University

1. INTRODUCTION

Citation analysis is being used as a tool for evaluation of research contributions made by scientific community. It is used for counting of citations of particular research institute or scientists. Citation analysis is a method that interlink a document with another on a specific subject. This performance measure assumes that influential scientists and important works were cited more often than others[1]. Researcher working in this field have used various parameters, viz., number of papers, citations received, h-index, impact factor of journals, etc., to measure the research output of researchers and organisations. Hirsch[2] calculated the h-indices that correlate positively with citation counts, publication counts and peer evaluation of research impact and quality.

In the present study, the research contributions by faculty members of seven Life sciences departments of Savitribai Phule Pune University (formerly, University of Pune, the name was modified to the current name in 2014) (http://unipune.ac.in), India was measured on the basis of various bibliometric parameters. Among its seven departments, the oldest department is Zoology department established in 1950. It has received recognition as Centre for Advanced Studies (CAS) by the University Grants Commission (UGC) since 2005. The department has also received funds from DST (Department of Science and Technology), Government of India under the Fund for Improvement of S&T Infrastructure in Higher Educational Institutions (FIST) programme. The second oldest department within life science is Botany Department established in 1952. It is one of the leading departments in the field of teaching and research in plant sciences. The Department of Microbiology was established in 1977 and well recognised due to the number of projects funded by agencies, viz., Board of Research in Nuclear Sciences (BRNS) of Department of Atomic Energy (DAE), UGC, Council of Scientific and Industrial Research (CSIR), DBT, DST, Indian Space Research Organisation (ISRO), Indian Council of Agricultural Research (ICAR), etc. The Bioinformatics Centre was established in 1987. Department of Health Science has received a seed grant from UGC in 1989 to initiate interdisciplinary teaching in the field of health sciences. The Department of Biotechnology was established in 1994. It offers a 2 year MSc Biotechnology course supported by the Department of

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Biotechnology (DBT), Government of India. In 2002, the Institute of Bioinformatics and Biotechnology (IBB) was established. The focus of IBB is to promote high-quality research and develop technically skilled human resource in the area of Bioinformatics and Biotechnology. Most of research projects of this department are funded by Indian Council of Medical Research (ICMR), DST, DST-Biocare, UGC, and CSIR. All seven departments conduct MSc and PhD programmes. Conducting seminars, workshops and other educational activities are regular features of all these departments. Table 1 gives a consolidated view of the Life sciences departments covered in this study.

Table 1. Life sciences departments with year of establishment

S. No.	Department name	Year of establishment
1.	Department of Zoology	1950
2.	Department of Botany	1952
3.	Department of Microbiology	1977
4.	Department of Bioinformatics	1987
5.	Department of Health Science	1989
6.	Department of Biotechnology	1994
7.	Institute of Bioinformatics and Biotechnology	2002

2. LITERATURE REVIEW

Number of quantitative studies have been conducted and reported based on bibliometric parameters to measure the research output of individual scientists, universities, research institutes, and research areas. Bibliometric parameters, viz., authorship pattern, citations received per paper, highly cited journals, international collaborations, h-index, etc., were used in these studies. Many of the studies have used Web of Science (WoS) and Scopus databases as the source of data. Various software tools are used for data analysis and visualisation, viz., VOSViewer, HistCite, Pajek, etc.

Among the Indian studies, Siwach & Kumar analysed the research contributions made by researchers of Maharshi Dayanand University (Rohtak)[3]. They found that chemistry department is at the first rank in publishing papers during 2000-2013 whereas highest numbers of citations were received for the papers published in the field of biotechnology. Hanumappa[4] *et.al.*, assessed research in Gujarat University, Ahmedabad in which they analysed 760 papers extracted from Scopus database published during 2004-2013. The results indicated that the publications trend is good but needs to be improved as compared to other universities. Pal & Ahmed[5] studied contributions from 8 NE-Indian Universities and analysed the publications published during 1994-2013. They found that average growth rate (AGR) has increased over the period. The growth rate is tremendous during 2004-2013 due to easy accessibility of electronic papers and databases for research. Kumbar[6] studied research contributions (1518 papers) by University of Mysore during the period 1996-2006 indexed in Scopus database. Results show that science and technology is on growing path. International research activities are small (14 %) but the chemistry, physics, astronomy, biochemistry are dominating research areas. Sambalpur University's research was analysed by Maharana[7],*et.al.* Gopikuttan & Awasthy[8] measured research productivity of Kerala University & Sudhier[9] studied research output of Physicists of the same university. In these studies the data set was downloaded from Web of Science database. The results of these studies indicated that chemistry, physics, astronomy and astrophysics are the leading areas of research. The highest numbers of international collaborations are with scientists from USA.

Research output of scientists for different Indian Institutes of Technology (IITs) was measured by Chavan & Chaurasia[10] for IIT Delhi for the period 2001-2010; Singh[11] *et.al.,* for IIT, Rurkela for the period 1993-2001 and Jeevan & Gupta[12] for IIT Kharakpur for the period 1994-1997. All three studies measured quantitatively the impact of research produced. All these studies have used Web of Science database (WoS) for data set. These studies measured individual scientist's research productivity as well as institutional level. Science, engineering and technology, physics, chemistry and earth sciences are the prominent research areas. Collaborative papers are more and USA ranks first in case of international collaborations. Mishra & Sarangi[13] conducted bibliometrics studies of IITs as well as National Institutes of Technologies (NITs) which have national importance. They ranked these technology institutes as per the citations received for papers and faculty h-index. The data were collected from Scopus database for the period 2012-2014.

Some studies measured research output of individual departments of different universities. Nandi & Bandopadhaya[14] analysed 719 articles from 216 PhD thesis submitted to department of zoology, University of Burdwan during 1960-2000. Results indicated that highest numbers of theses are submitted in the subject entomology. Indian journals were highly cited whereas multi-authored papers are cited more than single and double authored papers. Scientometric analysis of Indian research output using SCI for 1997 was undertaken by Garg[15] *et.al.* Authors found that universities/colleges are the major contributors of research papers, whereas IITS, medical colleges and CSIR institutes are followed the further ranks. Physical, chemical and

medical sciences are the dominant research areas. Mahrana[16] conducted bibliometric analysis of Orissa University of Agricultural Technology's research output as indexed in Scopus in 2008-2012. It was noticed that most of the papers are published in Indian journals and in collaborations. Collaborations are at national and international levels. The growth rate of publications is slow and steady.

All above mentioned studies analysed the author productivity, areas of specialisation, publication pattern, authorship patterns, most prolific authors and list of preferred journals by authors for publishing. Majority of the studies used quantitative methods for measuring the research. Web of Science and Scopus databases were used for data sets. The results of these studies indicate that there is a steady growth in publications and citations received. The studies also identified strong and weak areas of research as well as national and international collaborations of researchers. USA is the first choice of researchers for international collaborations.

3. OBJECTIVES

The objectives of the study are to:

- Find out the types of documents used for communicating research and areas of research;
- Know publication productivity of faculty members of life sciences departments;
- Understand collaboration and authorship patterns; and
- Know journals preferred for publication by life sciences faculty members.

4. METHODOLOGY, SCOPE AND LIMITATIONS

Data required for the present study were collected from WoS database for the period 1999-2013. Initially the address field was used to get the papers published by researches of SPPU. But it was noticed that retrieved data set has papers published by researchers from affiliated colleges of SPPU. Therefore, Life science department names within the University with variations in full form and short form were searched in Address (AD) field. Later all possible variations in the name of SPPU were searched in the field 'Organisation Enhanced (OG). AD and OG fields were then combined with AND operator to get the exact data set. Biochemistry and Biophysics papers were excluded from the study as these papers were already included in Chemistry and Physics department studies[17]. With the above-mentioned logic, following search strategy was used with necessary refinements:

OG=(university of pune OR university of poona OR univ pune OR pune univ OR univ poona OR poona univ) AND AD=(biotechnol OR biotechnology OR bioinformatics center OR bioinformat ctr OR IBB OR institute of biotechnology bioinformatics OR inst bioinformat and biotechnol OR zoology OR zool OR health science OR hlth OR botany OR bot OR microbiology OR microbiol) NOT AD=(Pune Univ Campus)Timespan:1999-2013

The final data set has 690 research papers written by Life sciences faculties of SPPU during 1999 to 2013. The retrieved bibliographic and citation data were analysed by using the traditional bibliometric techniques. HistCite, Intcoll, Pajek as well as VoSViewer software tools were also used.

In the present study the data set is small to measure the degree of collaborations and therefore not included. Moreover, in the present study individual author's research productivity is not considered and therefore prolific author is not listed. The present study focused on the research productivity of 7 Life science departments of the SPPU.

5. DATA ANALYSIS

5.1 Types of Documents

Total 690 records which had affiliation to SPPU were published during 1999-2013. Of these, 590 publications were published as journal articles, 38 as reviews and 20 as letters. These three categories of document types constituted about 94 % of all records and rest 6 % records were published as proceeding papers(16), meeting abstracts(14), editorials(8), book chapters(3), and corrections(1). All publications (690) were considered for further analysis.

5.2 Subject Areas

Table 2 indicates that apart from various facets of Life sciences, the faculty members have researched with diverse subject fields including physics, chemistry, environmental science and engineering.

5.3 Yearly Contributions

Table 3 presents chronologically, the number of papers contributed by the seven departments during 1999-2013. It also presents average citations received per paper (ACPP).

Table 3 also reveals that almost every year faculty members have contributed more papers than the previous year. The growth range is steady which is certainly considerable. However, there are exceptions to this. The exception is that either the same number of papers were published in two consecutive years (e.g., in 1999 & 2000 as well as in 2009 & 2010) or less number of papers were published in the subsequent year (e.g., 2001 & 2002 as well as in 2005 & 2006).

Table 3 also indicates that 60 % of the total publications are contributed during the last 5 years

Table 2. Subject areas of research

S. No.	Subject	Number of papers
1.	Biology	356
2.	Biotechnology	116
3.	Physics & Biophysics	102
4.	Chemistry	84
5.	Science and Technology	74
6.	Biomedical & Medical Sciences	55
7.	Pharmacology	55
8.	Agriculture	37
9.	Medicine	33
10.	Environmental Science	32
11.	Engineering	16
	Total	**960**

Table 3. Number of paper in chronological order and citations per paper

S. No.	Publication year	No. of papers	Citations	Average citations per paper (ACCP)
1.	1999	11	163	14.81
2.	2000	11	23	2.09
3.	2001	21	140	6.66
4.	2002	11	206	18.72
5.	2003	18	221	12.27
6.	2004	28	556	19.85
7.	2005	37	786	21.24
8.	2006	35	606	17.31
9.	2007	48	607	12.64
10.	2008	55	530	9.63
11.	2009	78	1077	13.80
12.	2010	78	629	8.06
13.	2011	80	381	4.76
14.	2012	88	237	2.69
15.	2013	91	48	0.52
	Total	**690**	**6210**	

i.e., during 2009-2013. Considerable number of new recruitments could be one of the reasons for this noticeable growth in publications. Higher number and amounts of research grants were received during this period on account of the University being recognised as 'University of Potential, Excellence' and Major and Minor Research projects'. In the year 2009 the UGC brought in the new scheme for career advancement for the faculties. The Academic performance indicators of this scheme necessitated every faculty to publish research papers. This could be the third major reason for the considerable growth in the publications during 2009-2013. Increase in number of journals along with the origin and growth of open access journals could also be a reason for increase in publications of Life sciences faculties of the SPPU.

Study of the citations in Table 3 indicates that there is no definite pattern in the citations received by the studied Life sciences papers. For example in the year 2009 papers received 1077 (13.80 CPP) out of total 6210 citations. As against this in the current year, i.e., 2013 only 48 (0.52 CPP) citations were received. Publication of papers on new topic, application of new research method could be some of the reasons for getting extraordinary high citations. Contrary to this publication of papers on a known theme could be a reason for not receiving better number of citations.

5.4 National Collaboration

Faculty members of SPPU have research collaborations with other experts in India from other institutions in the field of Life sciences. It is noticed that faculty members have collaborations with total 201 National Institutes including Universities, colleges and Research laboratories. Table 4 lists collaborations with top ten Indian institutions along with no. of papers published.

Table 4 indicates that most National collaborations are however, from Pune itself. Easy accessibility to laboratories can be one of the reasons for this. Data indicates that the highest number of collaborations is with the Bhabha Atomic Research Centre (BARC), Mumbai. This indicates that the research conducted is truly interdisciplinary. The trend also indicates that there are collaboration between the academics and scientists (those working is laboratories). This interdisciplinary and multidisciplinary approach is reflected through the areas of research as shown in Table 2 by faculty members.

Further, it is noticed the pattern of collaborations at National level are changed over the period and

Table 4. National collaborations

S. No.	Name of Institution	Papers
1.	Bhabha Atomic Research Centre, Mumbai	68
2.	National Chemical Laboratory (NCL), Pune	38
3.	Agharkar Research Institute (ARI), Pune	28
4.	Institute of Genomics and Integrative Biology (IGIB), New Delhi	27
5.	National Centre for Cell Science (NCCS), Pune	25
6.	Bharati Vidyapeeth Pune (BVP), Pune	21
7.	Council of Scientific and Industrial Research	16
8.	University of Delhi (UD), Delhi	19
9.	Centre for Rheumatic Diseases (CRD), Pune	17
10.	Indian Institute of Science Education & Research (IISER), Pune	11
	Total	**287**

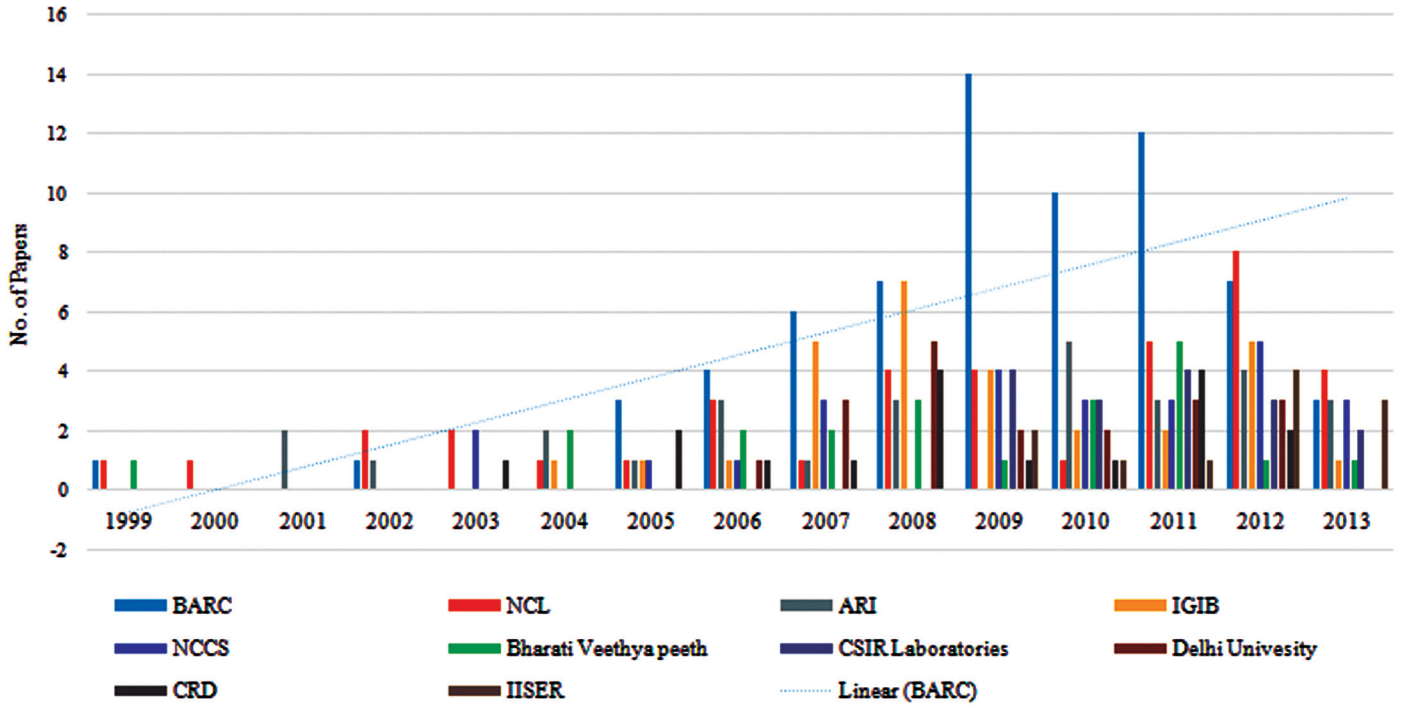

Figure 1. Pattern of collaborations at national level.

more number of papers are published with BARC, NCL, and other institutes. Figure 1 shows it clearly that number of collaborative publications are increased after 2006 and the trend is continued.

5.5 International Collaborations

Collaborations in the scientific research are seen essential and useful for universalisation and validation of the research. In collaborative research numbers of experts contribute to the given research. Multiplicity of contributing brains help increase quality of research. This is the reason International collaborations are considered more valuable in the research field. Study of international collaborations of faculty members of 7 Life sciences departments at SPPU reveals that they have collaborated with total 32 countries and have received 2016 citations. Country-wise collaborations are given in figure 1. The top ten countries are listed in Table 5.

Table 5. Top ten countries

S. No.	Country	No. of papers	Citations	Average citations
1.	USA	41	590	14
2.	UK	21	363	17
3.	Germany	16	235	15
4.	Iran	16	63	2
5.	Australia	7	51	7
6.	Italy	7	43	6
7.	Canada	6	18	3
8.	Denmark	4	104	26
9.	China	4	40	10
10.	France	3	81	27
	Total	**125**	**1588**	

Total 125 (18 %) papers are written with International collaborations. This percentage is quite encouraging. What is further noticeable that the highest number collaborations (41 papers) are with USA. Along with USA, European countries too are the major contributors in scientific and technological research. Considering this value of European countries it is noteworthy to observe that there are five European countries in the top ten countries with which the studied life science's faculties have collaborated. Total 51 (41 %) of the 125 international collaborations are with European countries. The collaborated five European countries are leading contributors to scientific research. It is also worth noting that Iran is emerging as preferred Asian collaborator (ranked fourth) of the life science faculties of SPPU.

Study of the citations received by the 125 papers written with International collaborations reveals that they have received 26 % (i.e., 1588 of 6210) citations. This is a considerable percentage. Analysis of average citations received reveals that papers written in collaboration with European countries have received much higher citations. For example, papers written in collaboration with France have received highest average citations (i.e., 27) followed by Denmark 26, UK 17 and Germany 15. By the criteria of average citations received per paper,

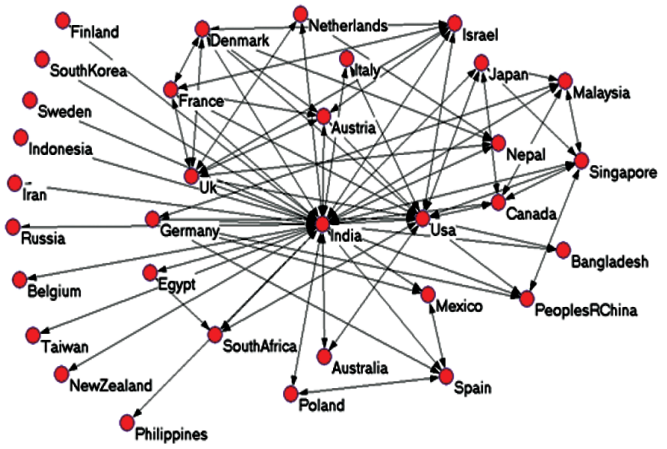

Figure 2. International collaborations.

USA ranks fifth after the four European countries mentioned above.

Fig. 2, red circles represent individual countries. Arrows show collaborations among the various countries. Figure do not indicate the number of papers but red circle with single line and arrow indicates the collaboration between the two countries, viz., India and Iran, India and Sweden, India and Taiwan, etc. Multiple lines and multiple arrows indicate the collaboration between more than two countries, viz., India, USA and Canada, etc.

5.6 Authorship pattern

Author and collaborative trends is towards multi-authored papers as there are 665 papers (97 %) are collaborative publications. There are only 24 single (3 %) authored publications, two-authored 93 (14 %) publications, multi-authored (3-4 authors) 294 (43 %) publications and mega-authored (5 and above authors) 278 (40 %) publications. This data indicates that science researchers including life science researchers mostly prefer to research and write in collaboration.

5.7 Journals Preferred

Faculty members have written in total 362 Journals including Indian and foreign journals. Out of 362 journals 17 journals were selected in which more than five papers are published. Among 17 journals (Table 6) faculty members have preferred four Indian journals, viz., *Current Science* (35 papers) and *Journal of Biosciences* (10 papers), *Indian Journal of Biotechnology* (7 papers) and *Indian Journal of Experimental Biology* (7 papers). The average impact factor of these four journals is 0.98. *Current Science* is one of the most prominent journals published in India in the field of science. It is worth noting that out of 17 most preferred journals, 13 are International journals. Among these journals, seven journals are published from USA among which five are published by Elsevier Science publisher. The average impact factor of these seven journals is 3.16. Journals from UK the Netherlands and ranks third and fourth in the top 17 list having 3.47 and 2.32 average impact factor respectively. This indicates that the research

Table 6. Ten most preferred journals

S. No.	Country name	Publisher	Country	Publications	Impact factor
1.	*Current Science*	Association and Indian Academy of Science	India	35	0.91
2.	*Evidence-Based Complementary and Alternative Medicine*	Hindawai Publishing Corporation	USA	15	1.72
3.	*PLOS*	PLOS	USA	14	3.73
4.	*Bioresource Technology*	Elsevier	USA	10	4.75
5.	*Journal of Biosciences*	Indian Academy of Sciences	India	10	1.76
6.	*Biochemical and Biophysical Research Communications*	Elsevier	USA	8	2.41
7.	*Bioorganic &Medicinal Chemistry Letters*	Elsevier	USA	8	2.34
8.	*Haemophilia*	Blackwell	UK	8	4.75
9.	*Journal of Applied Microbiology*	Blackwell	UK	8	2.20
10.	*Plant Cell Tissue and Organ Culture*	Springer	Netherland	8	3.63
11.	*Applied Microbiology and Biotechnology*	Springer	Netherland	7	3.811
12.	*Indian Journal of Biotechnology*	NISCAIR	India	7	0.510
13.	*Indian Journal of Experimental Biology*	NISCAIR	India	7	0.753
14.	*Journal of Ethnopharmacology*	Elsevier	USA	7	2.939
15.	*Colloids and Surfaces B-Biointerfaces*	Elsevier	USA	6	4.287
16.	*Genetic Resources and Crop Evolution*	Springer	Netherlands	6	1.482
17.	*Proceedings of the National Academy of Sciences India Section B-Biological Sciences*	Springer	Netherlands	6	0.396

by Life sciences faculty members of the SPPU is of international recognition. Further, the international journals selected have very good Impact Factor.

6. CONCLUSIONS

This attempt of quantitative analysis of papers published by faculty members of Life Science Departments of SPPU shows that the faculty members are very active in research in areas not only Life sciences but in interdisciplinary areas like biophysics, biochemistry, environmental sciences, engineering and medical sciences. The contributions of these departments are well recognised at National and International levels. This conclusion is based on the following findings:

- Year of establishments of each seven departments are different and new interdisciplinary departments are established by the university in the areas like biotechnology, bioinformatics and health sciences. The aim is to create expertise and to conduct research in these interdisciplinary areas. Most of these departments received research grants from various national and international funding agencies for research during last ten years. New recruitments have led to publishing more research papers than earlier.
- Faculty members have published total 690 papers in 362 journals and have received 6210 citations. When cumulated in five years the highest numbers of papers, i.e., 415 were published during 2009-2013 in various interdisciplinary areas.
- In case of National level collaborations by faculty members Bhaha Atomic Research Centre, Mumbai dominates. As far as international collaboration is concerned the, faculty members have collaborated with researchers from 5 continents and 30 countries among which Europe and Asia are at the top in case numbers of publications. As far as the citations received, Europe ranks 1st and America at 2nd position.
- Considering the countries publishing journals which are preferred by the life scientists of SPPU, USA, the Netherlands and UK are predominant.
- *Current Science* published in India is the first choice of faculty members.
- Most of the papers are published in journals having an Impact Factor of one or more. USA ranks first in case of average impact factor of the journals.
- More than 300 papers are published in the field of biology but it is also noticed that half of the papers in the collection are interdisciplinary and biotechnology is the dominant one.
- The authorship pattern varies from 2 to 53 authors and there are very few papers by a single author. Three and four-author papers have received more citations.

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