

October 2013

Research publication trend of Utkal University's researchers indexed in Scopus during 2008 to 2012: a bibliometric analysis

Rabindra K. Maharana

National Institute of Science Education and Research (NISER), maharana.rabindra@gmail.com

Prangya Das

Siksha O Anusandhan University, Bhubaneswar, prangyadas1976@gmail.com

Follow this and additional works at: <http://digitalcommons.unl.edu/libphilprac>

 Part of the [Library and Information Science Commons](#)

Maharana, Rabindra K. and Das, Prangya, "Research publication trend of Utkal University's researchers indexed in Scopus during 2008 to 2012: a bibliometric analysis" (2013). *Library Philosophy and Practice (e-journal)*. 999.
<http://digitalcommons.unl.edu/libphilprac/999>

Research publication trend of Utkal University's researchers indexed in *Scopus* during 2008 to 2012: a bibliometric analysis

Rabindra K. Maharana

Technician (Library)

National Institute of Science Education & Research (NISER)

IOP Campus, Sachivalaya Marg, Sainik School,

Bhubaneswar-751005

E-mail: marahana.rabindra@gmail.com

Dr. Prangya Das

Librarian

Siksha O Anusandhan University

Bhubaneswar, Odisha

E-mail: prangyadas1976@gmail.com

Abstract

Purpose- The present study is a bibliometric analysis of research papers of Utkal University published in various research journals of repute which were indexed in *Scopus* (*officially known as Sciverse Scopus*) during 2008 to 2012. It also identifies the annual growth of university publication, authorship pattern, author productivity, degree of collaboration, length of paper published, most prolific contributor, prolific institution/ organization, geographical distribution etc.

Design/ methodology/ approach- For information retrieval “Utkal University” and “India” were the keywords used as affiliation and “2008” to “2012” selected as the time span of the study, further, the result was refined only to “articles”. Finally, 447 research papers in different disciplines of science and technology retrieved and matched with Utkal University as “author’s affiliation”. The papers were analyzed according to their year-wise publication, authorship pattern, length of paper published, geographical distribution of papers etc., statistical techniques such as Lotka’s Inverse Square Law was used to identify author’s productivity and Bradford’s law used to determine scattering of literature in the publication pattern of the university during the period under study.

Findings- International Journal of Earth Sciences and Engineering, Prof. P. K. Panda and Pharmacology, Toxicology and Pharmaceutics were the most favoured journal, contributor and research area respectively during the period under study. The study also revealed that, out of 1702 contributor only 680 were affiliated to Utkal University with 1.53 average authors per paper and 0.66 productivity per author.

Research limitations/ implication- The present study has limitation by geographical area i.e. it covers only Utkal University and by time i.e. it covers only the research papers which were indexed during 2008 to 2012.

Originality/ value- The paper is the result of an original bibliometric analysis of the research papers of Utkal University which were indexed in *Sciverse Scopus* during 2008 to 2012.

Keywords: Bibliometrics, *Scopus*, Utkal University, Lotka's Law, Bradford's Law, Degree of Collaboration.

Introduction

Bibliometrics involves the quantitative analysis of the literature of a subject domain, as represented by bibliographic entities such as keywords, classification codes, authors and citations (Willett, 2008). It has been used to measure scientific progress in many disciplines of science and technology, and is a common research instrument for systematic analysis (Van Raan, 2005). Furthermore, the Institute for Scientific Information (ISI) *Web of Science* and Elsevier's *Sciverse Scopus* are used to analyze research performance from an international perspective (Moed, 2002). Since Narin et al. (1976) first proposed the concept of "evaluative bibliometrics," many scientists have tried to evaluate the research trend in the publication outputs of countries, research institutes, journals, and subject category (Garcia-Rio et al., 2001; Zhou et al., 2007), the citation analysis (Cole, 1989), and the peak year citation per publication (Chuang et al., 2007; Li and Ho, 2008).

Bibliometric is an approach based on quantitative characteristics, attributes or objects of documentary flows. It is primarily based on the analysis of the bibliographic data on publications. A principal assumption underlying the use of bibliometric indicators is that scholars publish their research findings in the publicly available literatures and that one may obtain pictures of scholarly activities from a quantitative analysis of scholarly documents (Garfield, 1979).

Objectives

- To measure the research output of the university;
- To identify the most prolific authors during the period;
- To identify the authorship pattern the papers published;
- To identify the journals which were most preferred by the researchers of the university;
- Measure the most cited journals during the period under study;

Literature review

Oyedokun (2001) analyzed scientist's activities in the agricultural research institutes in Nigeria and reported that activities of scientists in agricultural research institutes span through technological development and delivery. Shaw (1999) in his study observed that co-authorship establishes a relation among authors which is a measure of the extent to which they communicate directly and that the strength of this relationship between any two authors may be computed by counting the number of papers they produce jointly. Bennell (1987) in a bibliometric analysis of publications output of sub-Saharan African Agriculture during 1973 to 1982 found that there has been a significant decrease in the number of crop science publications by the researchers affiliated to government institutions/ organizations.

Maharana and Sethi (2013) in a bibliometric analysis of the research output of Sambalpur University's publication in *ISI Web of Science* found that a total of 707 authors contributed 170 papers out of which only 317 contributors affiliated to Sambalpur University. Prof. B.K. Mishra from Department of Chemistry with 28 (16.47%) contributions was the most prolific contributor. Anilkumar (2013) in his study publication pattern of scientists of Physical Research Laboratory (PRL), Ahmedabad found that Physical Review A with 83 papers is the most preferred research journals among the scientists of PRL and among top 20 journals 4 were Indian journals. In a bibliometric analysis of research output of University of Mysore, Kumbhar, Gupta and Dhawan (2008) analyzed 1518 research paper and found that the university's research growing with an average rate of 23% per annum. USA is the most collaborative country with 51% contributions.

Analysis and discussion

Annual distribution of publication

During 2008 to 2012 Utkal University published a total of 447 research papers in different fields of science and technology, as listed in Table-1, which gives the annual distribution of papers. Maximum number of 109 (24.39%) papers published in 2012 followed by 2010 (23.04%); 2011 (22.82%); 2009 (15.21%) and 2008 (14.54%) respectively. Further, it shows that there is a positive growth except in 2011.

Table-1 Annual distribution of publication

Year	No. of publication	Percentage (%)	Annual average growth rate percent (%)
2008	65	14.54	--
2009	68	15.21	4.42
2010	103	23.04	33.99
2011	102	22.82	-0.99
2012	109	24.39	6.43
Grand Total	447	100	Average 8.77

Period-wise authorship pattern of publication

Table-2 gives a detailed overview of authorship pattern of papers published during the period under study. It is analyzed that out of 447 contributions, maximum of 133 (29.75) contributions have been contributed by three authors, followed by two authors (20.36%), four authors (19.02%) etc. respectively. Only 21 (4.7%) papers have been contributed by eight or more than eight authors.

Table-2 Authorship pattern of papers published during 2008-2012

Year	One	Two	Three	Four	Five	Six	Seven	≥Eight	Total
2008	3	8	20	12	5	6	5	6	65 (14.54)
2009	2	13	21	12	7	6	3	4	68 (15.21)
2010	8	19	31	15	16	3	4	7	103 (23.04)
2011	2	22	29	24	11	3	9	2	102 (22.82)
2012	4	29	32	22	11	8	1	2	109 (24.39)

Grand Total	19 (4.25)	91 (20.36)	133 (29.75)	85 (19.02)	50 (11.19)	26 (5.81)	22 (4.92)	21 (4.7)	447 (100)
-------------	--------------	---------------	----------------	---------------	---------------	--------------	--------------	-------------	-----------

Note: Figures in parentheses represented percentage.

Author productivity

Table-3 gives a detailed overview of productivity of authors, which shows a total of 1702 authors produced 447 papers with an average of 3.8 authors per paper and 0.26 paper per author. And out of 1702 total authors only 680 authors are affiliated to Utkal University, with an average of 1.53 authors per paper and 0.66 paper per author. It also shows that Total AAPP ranges from 2.64 to 5.72 and in Total PPA 0.17 to 0.37.

Table-3 Author productivity

Year	Total no. of papers	Total no. of authors	Total AAPP	Total PPA	Authors only affiliated to UU	AAPP (UU)	PPA (UU)
2008	65	372	5.72	0.17	99	1.53	0.66
2009	68	381	5.6	0.17	103	1.53	0.67
2010	103	387	3.75	0.26	155	1.51	0.67
2011	102	270	2.64	0.37	157	1.54	0.65
2012	109	292	2.67	0.37	166	1.53	0.66
Total	447	1702	3.8	0.26	680	1.53	0.66

Note: Average Authors Per Paper (AAPP) = Number of authors/ Number of papers.

Productivity per author (PPA)= Number of papers/ Number of authors.

Lotka's Law of Author's Productivity

In order to determine the author's productivity, Lotka's Inverse square law of Scientific Productivity has been widely used in bibliometric mapping of research output. Lotka's law describes the frequency of publications by the authors in a given field (Lotka, 1926). It states that the number of authors making 'n' contributions is about $1/n^2$ of those making one contribution. However, taking into account the number of observed authors per paper(s), the expected authors per paper(s) is calculated by Lotka's principle as stated in Table 4, and following formula is used to calculate lotka's law:

$$X^n Y=C \text{ or } Y= C/ X^n$$

Where, X=number of publications,

Y= relative frequency of authors with X publications and

C= Constants depending on the specified field.

Putting the value of X=1, and Y=19, (vide Table-4), the calculation obtained was;

$$1^n \cdot 19=C$$

$$\Rightarrow 19=C$$

Putting the value of X=2 and Y=91 and C=19, the calculation obtained was;

$2^n \cdot 91 = 19$
 $\Rightarrow 2^n = 19/91$
 $\Rightarrow n \log 2 = \log 0.208$
 $\Rightarrow n (0.301) = 0.681$
 $\Rightarrow n = 0.682/0.301$
 $\Rightarrow n = 2.27$

Table-4 Lotka's Inverse Square Law of Scientific Productivity

No. of papers	No. of authors (observed)	No. of authors (expected with n=2)	No. of authors (expected with n=3)	No. of authors (expected with n=2.27)
1	19	19	19	19
2	91	5	2	4
3	133	2	1	2
4	85	1	--	1
5	50	1	--	--
6	26	--	--	--
7	22	--	--	--
8	8	--	--	--
9	6	--	--	--
10	3	--	--	--
11	1	--	--	--
12	2	--	--	--
19	1	--	--	--

Degree of collaboration

In bibliometric studies degree of collaboration examines the prominent area of inquiry indicating the trend in patterns of single and joint authorship in the publication pattern of Utkal University. Table-5 shows the degree of collaboration “C” is 0.95 (nearly equals to 1) which means there is few/ negligible contributions by single authors during the period under study. Further it shows the degree of collaboration ranges from 0.92 to 0.98. The degree of collaboration “C” is calculated by using the following formula:

$$C = \frac{N_M}{N_M + N_S}$$

Where, C= Degree of Collaboration

N_M = Number of multiple authors

N_S = Number of single authors

Table-5 Degree of collaboration

Year	Single authored paper (N_S)	Multiple authored paper (N_M)	N_M+N_S	Degree of Collaboration (C)
2008	3	62	65	0.95
2009	2	66	68	0.97
2010	8	95	103	0.92

2011	2	100	102	0.98
2012	4	105	109	0.96
Total	19	428	447	0.95

Bradford's law and distribution of core journals

Bradford's law states that documents on a given "subject" is distributed (scattered) according to a certain mathematical function so that a growth in papers on a subject requires a growth in the number of journals/information sources (Hjorland; 1992). The numbers of the groups of journals to produce nearly equal numbers of articles is roughly in proportion to 1: n : n^2 ..., where n is called the Bradford multiplier¹. Bradford's law states that a small core of, for example, journals have as many papers on a given subject as a much larger number of journals, n , which again has as many papers on the subject as n^2 journals. Bradford himself provided both a graphical and a verbal formulation of his law that have later been found not to be mathematical equivalent (Bradford; 1948).

Table-6 Bradford's distribution of core journals

Rank	Most favored journal for publication	No. of paper	Percentage (%)	Cumulative	
				No. of papers	Percentage (%)
1	International Journal of Earth Sciences and Engineering	12	2.68	12	2.68
2	Asian Journal of Chemistry	11	2.46	23	5.14
3	Monthly Notices of the Royal Astronomical Society	8	1.79	31	6.93
3	Physical Review D - Particles, Fields, Gravitation and Cosmology	8	1.79	39	8.72
4	Journal of the Geological Society of India	7	1.58	46	10.3
4	Tropical Journal of Pharmaceutical Research	7	1.58	53	11.88
5	Indian Journal of Physics	6	1.34	59	13.22
5	Journal of the Indian Chemical Society	6	1.34	65	14.56
6	Indian Journal of Pharmaceutical Sciences	5	1.12	70	15.68
6	International Journal of Pharma and Bio Sciences	5	1.12	75	16.8
6	International Journal of Pharmaceutical Sciences Review and Research	5	1.12	80	17.92
6	Journal of Applied Physics	5	1.12	85	19.04
6	Journal of Applied Polymer Science	5	1.12	90	20.16
6	Journal of Environmental Biology	5	1.12	95	21.28
7	AIP Conference Proceedings	4	0.89	99	22.17
7	Applied Energy	4	0.89	103	23.06
7	Asian Journal of Pharmaceutical and	4	0.89	107	23.95

	Clinical Research				
7	Economic and Political Weekly	4	0.89	111	24.84
7	Indian Journal of Environmental Protection	4	0.89	115	25.73
7	International Journal of Agricultural and Statistical Sciences	4	0.89	119	26.62
7	Journal of Chemical and Pharmaceutical Research	4	0.89	123	27.51
7	Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms	4	0.89	127	28.4
7	Pharmacologyonline	4	0.89	131	29.29
8	18 journals with three papers	54	12.09	185	41.38
9	37 Journals with two papers	74	16.56	259	57.94
10	188 journals with single paper	188	42.06	447	100
Grand Total		447	100	--	--

Figure-1 provides a brief idea about Bradford's distribution of core journals on publication pattern of Utkal University during 2008 to 2012. A total of 266 journals presented by 447 papers, out of which, two journals published more than 10 papers, twelve journals published 5-8 papers; nine journals published 4 papers; eighteen journals published 3 papers; 37 journals published two papers and remaining 188 papers were scattered among 188 journals (Table-6). In Bradford's distribution, core journals are those that lay on the initial curved part of the "S" shaped plot until it tangentially becomes a straight line. Here, in figure-2, the slope of the curve also decreases slightly after the 13th journal, so these journals may be regarded as the core journals on the research publication of Utkal University during 2008 to 2012.

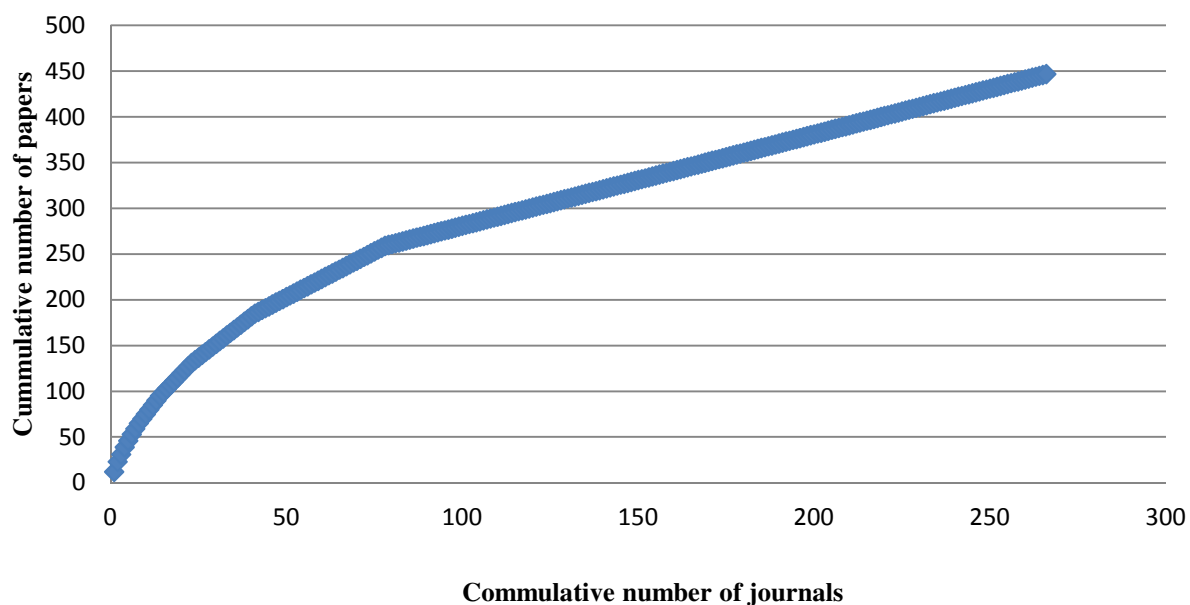


Fig.-1 Bradford's distribution of core journals during 2008 to 2012

Length of paper published

Table-7 gives a detailed overview of published paper's page length, which shows that half of the papers are in between 6-10 pages in length i.e. 225 (50.34%), followed by 106 (23.71%) papers in between 1-5 pages, 74 (16.55%) in between 11-15 pages etc. respectively.

Table-7 Length of paper published during 2007-2011

Page range	1-5	6-10	11-15	16-20	21-25	≥26	Total
2008	18	28	10	3	3	3	65 (14.54)
2009	18	34	8	4	3	1	68 (15.21)
2010	21	57	14	8	1	2	103 (23.04)
2011	30	49	17	5	1	0	102 (22.82)
2012	19	57	25	4	3	1	109 (24.39)
Grand Total	106 (23.71)	225 (50.34)	74 (16.55)	24 (5.37)	11 (2.46)	7 (1.57)	447 (100)

Most prolific institution/ organizations

With 447 (100%) publications the contributors affiliated to North Orissa University, Orissa are the most prolific contributor after Utkal University with having 34 (7.61%) contributions (Table-8), followed by the contributors of Siksha 'O' Anusandhan University with 5.15% contributions. Orissa University of Agriculture and Technology, Orissa; Inter University Accelerator Centre, India ; Institute of Physics, Bhubaneswar stood at 4th, 5th and 6th rank respectively.

Table-8 Most prolific institution/ organization

Rank	Most prolific Institution/ Organizations	No. of publication (N=447)	Percentage (%)
1	Utkal University, Odisha	447	100
2	North Orissa University, Odisha	34	7.61
3	Siksha 'O' Anusandhan University, Bhubaneswar	23	5.15
4	Orissa University of Agriculture and Technology, Odisha	16	3.58
5	Inter University Accelerator Centre, India	15	3.36
6	Institute of Physics, Bhubaneswar	14	3.14
6	Institute of Minerals and Materials Technology, India	14	3.14
7	Institute of Technology, Banaras Hindu University	11	2.47
8	University degli Studi di Napoli Federico II	9	2.02
9	Ravenshaw University	8	1.79
9	University of Chicago	8	1.79

10	KIIT University, Bhubaneswar	7	1.57
10	University of Louisville	7	1.57
10	Indian Institute of Technology, Delhi	7	1.57
10	Central Institute of Freshwater Aquaculture India	7	1.57
10	University of South Carolina	7	1.57

Prolific author during 2008-2012

Prof. P.K. Panda from P.G. Department of Pharmaceutical Sciences is the most prolific contributor during the period under study with having 26 (5.82%) contributions to a total of 447 contributions, followed by Prof. N.C. Mishra (4.7%); Dr. B.B. Barik and Dr. P.K. Sahoo with 4.48%; Dr. S.K. Mishra and Dr. R.C. Mohanty with 4.26% respectively.

Table-9 Top-10 most prolific contributor

Rank	Name of contributor	No. of contributions (N=447)	Percentage (%)	Affiliation department of UU
1	P.K. Panda	26	5.82	Pharmaceutical Sciences
2	N.C. Mishra	21	4.7	Physics
3	B.B. Barik	20	4.48	Pharmaceutical Sciences
3	P.K. Sahoo	20	4.48	Physics
4	S.K. Mishra	19	4.26	Pharmaceutical Sciences
4	R.C. Mohanty	19	4.26	Botany
5	P. Mohanty	17	3.81	Chemistry
5	S. Sahoo	17	3.81	Botany
6	S.K. Sahoo	15	3.36	Pharmaceutical Sciences
7	P.K. Chand	12	2.69	Botany
7	P. Dash	12	2.69	Physics
8	R.N. Hota	10	2.24	Geology
9	S. Behera	9	2.02	Botany
10	S.K. Sahu	8	1.79	Pharmaceutical Sciences

Subject-wise rank distribution of publication

The subject-wise distribution of publications is listed in Table-10, which shows Pharmacology, Toxicology and Pharmaceutics is the most favoured research area among the research community of Utkal University with 21.71%, followed by Physics and Astronomy (17.01%), Chemistry (14.99%), Biochemistry, Genetics and molecular Biology (14.1%). Environmental Science, Agricultural and biological Sciences, Earth and Planetary Sciences, Medicine and Engineering stood at the 5th, 6th, 7th, 8th, 9th and 10th position respectively.

Table- 10 Major research areas

Rank	Top 15 Research Areas	No. of publication (N=447)	Percentage (%)
------	-----------------------	----------------------------	----------------

1	Pharmacology, Toxicology and Pharmaceutics	97	21.71
2	Physics and Astronomy	76	17.01
3	Chemistry	67	14.99
4	Biochemistry, Genetics and Molecular Biology	63	14.1
5	Environmental Science	61	13.65
6	Agricultural and Biological Sciences	58	12.98
7	Earth and Planetary Sciences	55	12.31
8	Medicine	40	8.95
9	Materials Science	37	8.28
10	Engineering	36	8.06
11	Mathematics	33	7.39
12	Chemical Engineering	19	4.26
13	Social Sciences	16	3.58
14	Immunology and Microbiology	15	3.36
15	Energy	10	2.24

Geographical distribution of publication during 2008-2012

Table-11 represents the geographical distribution of the university's publications, on the whole a total of 447 contributions contributed by 1702 contributors belonging to India with 28 foreign countries. The contributors of India with 1141 (67.04%) contributions stood at the 1st position followed by United States (5.64%). The other collaborative countries are Italy (4.05%), France (2.76%), Saudi Arabia (2.59%) etc. Further it also shows that 12 countries with single contributions each stood at the 18th positions. The geographical distribution of the university shows the university researchers collaboration with foreign researchers.

Table-11 Geographical distribution of publication

Rank	Country	No. of contributions	Percentage (%)
1	India	1141	67.04
2	United States	96	5.64
3	Italy	69	4.05
4	France	47	2.76
5	Saudi Arabia	44	2.59
6	Germany	38	2.23
7	Japan	37	2.17
8	South Korea	34	2
9	United Kingdom	31	1.82
10	Canada	28	1.65
11	Netherlands	25	1.47
12	Taiwan	23	1.35
13	China	21	1.23
14	Hungary	19	1.12

15	South Africa	17	1
16	Spain	11	0.65
17	Thailand	9	0.53
18	12 Countries with single contribution	12	0.7
Grand Total		1702	100

Findings/ Conclusion

The followings are the key findings of the present study:

1. The University's annual distribution of paper ranges between 65 to 109 papers with an annual average growth rate percent of 8.77%.
2. Three authored paper (29.75%) dominated during the period under study followed by two authored papers (20.36%). Only 4.7% papers have been contributed by eight or more than eight authors.
3. Total 1702 authors contributed a total of 447 papers with 3.8 average authors per paper and 0.26 productivity per author. Out of 1702 authors only 680 authors were affiliated to Utkal University with 1.53 average authors per paper and 0.66 productivity per author.
4. Out of 447 papers only 19 papers have been contributed by single author which resulted in high degree of collaboration i.e. 0.95.
5. Bradford's distribution of journals shows that International Journal of Earth Sciences and Engineering is the most favoured journal for publication with 12 (2.68%) papers followed by Asian Journal of Chemistry with 11 (2.46%) papers. Further it shows that a total of 266 journals covered 447 papers and only 19 journals alone consists one third of papers published by the University.
6. Contributors affiliated to North Orissa University, Odisha with 34 (7.61%) contributions stood at the second position in most prolific institution/ organization followed by Siksha 'O' Anusandhan University, Bhubaneswar with 23 (5.15%) contributions.
7. Prof. P.K. Panda from P.G. Department of Pharmaceutical Sciences is the most prolific contributor with 26 (5.82%) contributions, followed by Prof. N.C. Mishra (4.7%). Further it has been seen that among top-10 most prolific contributor majority of contributors were affiliated to P.G. Department of Pharmaceutical Sciences.
8. Pharmacology, Toxicology and Pharmaceutics is the most preferred research area followed by Physics and Astronomy; Chemistry; Biochemistry, Genetics and Molecular Biology; Environmental Science etc.
9. All 1702 contributors were scattered among India with 28 foreign countries, which shows the collaboration of university's authors with foreign authors.

References

Anilkumar, N. (2013). Publication Pattern of scientists of Physical Research Laboratory (PRL), Ahmedabad, India. *Library Philosophy and Practice (e-journal)*. Paper 901. accessed June 15, 2013 available from <http://digitalcommons.unl.edu/libphilprac/901>

- Bennell, P. (1987). Crop science research in sub-Saharan Africa: a bibliometric overview. *Agricultural Administration and Extension*, 25 (2), 99- 103.
- Bradford, S.C. (1948). Documentation. Crosby Lockwood, London.
- Chuang, K.Y., Huang, Y.L. and Ho, Y.S. (2007). A bibliometric and citation analysis of stroke-related research in Taiwan. *Scientometrics*, 72 (2), 201-212.
- Cole, S. (1989). Citation and the evaluation of individual scientist. *Trends in Biochemical Sciences*, 14 (1), 9-13.
- Garcia-Rio, F., Serrano, S., Dorgham, A., Alvarez-Sala, R., Pena, A.R., Pino, J.M., Alvarez-Sala, J.L. and Villamor, J. (2001). A bibliometric evaluation of European Union research of the respiratory system from 1987 to 1998. *European Respiratory Journal*, 17 (6), 1175-1180.
- Garfield, E. Citation Indexing: Its Theory and Application in Science, Technology and Humanities. New York: Wiley, 1979.
- Hjorland, B. (1992). The concept of 'subject' in Information Science. *Journal of Documentation*, 48 (2), 172-200.
- Kumbhar, M., Gupta, B.M. and Dhawan, S.M. (2008). Growth and impact of research output of University of Mysore, 1996-2006: a case study. *Annals of Library and Information Studies*, 55 (3), 185- 195.
- Li, Z. and Ho, Y.S. (2008). Use of citation per publication as an indicator to evaluate contingent valuation research. *Scientometrics*, 75 (1), 97-110.
- Maharana, R. K. and Sethi, B. B. (2013). A bibliometric analysis of the research output of Sambalpur University's publication in ISI Web of Science during 2007-11. *Library Philosophy and Practice (e-journal)*. Paper 926, accessed June 15, 2013 available from <http://digitalcommons.unl.edu/libphilprac/926>
- Moed, H.F. (2002). Measuring China's research performance using the Science Citation Index. *Scientometrics*, 53 (3), 281-296.
- Narin, F. Pinski, G. and Gee, H.H. (1976). Structure of biomedical literature". *Journal of the American society for information science*, 27 (1), 24-45.
- Oyedokun, A.O. (2001). Scientists in agricultural research institutes of Nigeria: activities and performance. *Moor- Journal of Agriculture Research*, 2 (1), 75-82.
- Peter Willett. (2008). A bibliometric analysis of the literature of chemoinformatics. *Aslib Proceedings* 60 (1), 4-17, accessed May 27, 2013 available from <http://dx.doi.org/10.1108/00012530810847335>
- Shaw, W. (1999). Entropy, information and communication. *Proceedings of the 42nd ASTS Annual Meeting*, 16 (1979), 32-37.
- Van Raan, A.F.J. (2008). For your citations only? Hot topics in bibliometric analysis. *Measurement: Interdisciplinary Research and Perspectives*, 3 (1), 50-62.
- Zhou, F., Guo, H.C., Ho, Y.S. and Wu, C.Z. (2007). Scientometric analysis of geostatistics using multivariate methods. *Scientometrics*, 73(3), 265-279.