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Publications Productivity of Odisha in S&T: A Quantitative Study

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ABSTRACT

In this study, the publications of Odisha are collected from ISI *Web of Science* and quantitatively analysed. Total 14,899 items were retrieved for the period 1967-2011, and there was no publications available from 1945-1966. From 1972, the publications grow steadily up to 1982 but after that the growth is irregular, then rapidly growth is notices from 2006 onwards. Authors of State have collaborated with most of the developed countries of the world. It is a good sign that the publications of new institutes are increasing but publications of old colleges have decreased. The authors have published some of their publications in high impact journals. Some areas which are priority to State such as clinical sciences, geology, environmental sciences, marine sciences, and computer sciences are neglected.

Keywords: ISI *Web of Science*, Odisha, high impact journals, impact factor, international collaboration, Bradford's function

1. INTRODUCTION

There is a remarkable growth in science & technology (S&T) in India during last sixty years. For sustainable growth, there must be research in basic sciences and engineering, which improves the conditions capabilities and opportunities for trained scientists and engineers to pursue innovative research and educate the next generation[1]. In India, due to its diverse environment, the research should focus the problems of different regions. The state Odisha (formerly Orissa) is the ninth largest state by area in India, and 11th largest by population. The study conducted by Gupta[2] has recognised that Odisha is a medium productivity state having 15th rank in S&T. It is rich in natural resources but under-developed. A large portion of state comes under tropical climate where diseases like malaria, filaria, and diarrohea are highly prevalent. The primary source of income is agriculture but farmers face challenges of uncertain climate. So there is a need for region-based continuous research in S&T.

2. OBJECTIVES

The objectives of this study are to:

(i) Analyse Odisha's publications growth between 1945-2011

(ii) Analyse its research priorities as reflected in its subject areas of publications

(iii) Identify Odisha's share in international collaborative papers with leading countries

(iv) Analyse the publications growth of major state universities of Odisha, and

(v) Identify highly preferred journals for publications of the authors of the state.

3. METHODOLOGY AND DATA SOURCE

In this study, publication data of the State indexed in *Web of Science*[3] (*WOS*) is used. The *WOS* published by the company Thomson Reuters, USA, is the online version of Science Citation Index (SCI)-Expanded of Institute for Scientific Information (ISI), Philadelphia. It covers over 12,000 world-wide high impact journals. It also includes open access journals and more than 150,000 conference proceedings. It has a standard journal selection policy for inclusion in the database. If a journal does

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not follow the standard then it gets excluded from the list of source journals for the database. Most of the study relating to quality of S&T considers the literature covered by *WOS* as 'mainstream international' due to its coverage of high impact journals from all disciplines[4,5].

For retrieval of publications from Odisha, keywords 'ODISHA' OR 'ORISSA' were used. It is noticed that some records do not carry the name of state in the address field. So to get most of the records, besides above two keywords, the name of some city or towns where an institute/research centre is situated was taken as keywords (for example Cuttack, Rourkela, Sambalpur, Mayurbhanj, Rayagada, etc). All these selected keywords entered in the search box and address field is selected for the period 1945-2011 to get the published items.

4. ANALYSIS

4.1 Number of Publications

Total 14,899 items retrieved from the database. As per *WOS*, they are categorised as articles (12,703), notes (1,387), proceedings paper (403), letters (273), reviews (237), meeting abstracts (183), and editorial (78). The records are quantitatively analysed. In Table 1, articles are presented year wise as per their year of publication in source titles. First article found in the database is of the year 1967. No record is found for 1945-1966. It is found that number is steadily increasing up to 1981 but after that there is negative growth rate up to 1994. Its growth again increased 2006 onwards (Fig. 1). The 10 years of time between 1995-2005, the trend sustained more or less steady. In Table 2, the list of institutions having more than 40 publications are given. Maximum papers are published by Institute of Physics (IOP), Bhubaneswar. Out of 36 institutes listed in Table 2, serial no.1, 3, 5, 9, 10, 12, 14, 16, 17, 20 and 25 are funded by Govt. of India (GOI). Among state institutes, Utkal University has

Table 1. Number of papers published year wise from 1967-2011 by Odisha

Year	No. of papers
1967	1
1970	1
1972	19
1973	145
1974	141
1975	198
1976	164
1977	223
1978	261
1979	324
1980	326
1981	345
1982	321
1983	334
1984	299
1985	225
1986	250
1987	265
1988	279
1989	282
1990	249
1991	281
1992	290
1993	297
1994	326
1995	394
1996	427
1997	412
1998	429
1999	416
2000	375
2001	400
2002	436
2003	432
2004	470
2005	406
2006	476
2007	554
2008	675
2009	842
2010	935
2011	974

Note. No record found in 1968, 1969, and 1971

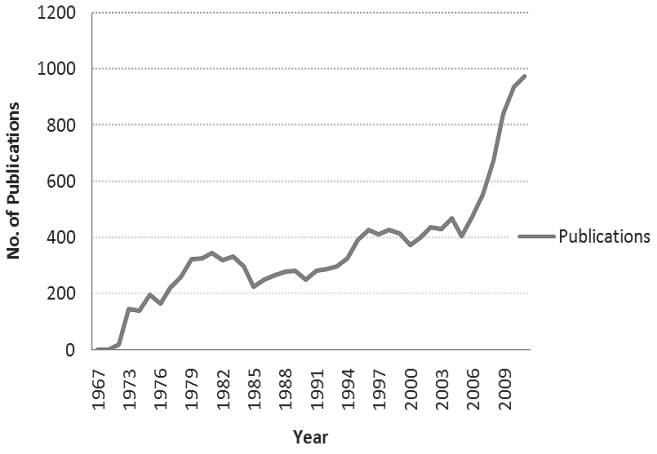

Figure 1. Publications of State Odisha from 1967-2011.

Table 3. Institutions having publications more than 40 from 1967-2011

S. No.	Name of institutions	No. of papers
1.	Institute of Physics, Bhubaneswar	2038
2.	Utkal University, Bhubaneswar	1865
3.	Inst Min Mat Tech, Bhubaneswar	1354
4.	Berhampur University, Berhampur	1058
5.	Central Rice Research Institute, Cuttack	912
6.	Sambalpur University, Sambalpur	894
7.	Ravenshaw University, Cuttack	876
8.	Orissa University of Agriculture & Technology, Bhubanswar	683
9.	National Institute of Technology, Rourkela	634
10.	Central Institute of Freshwater Aquaculture, Bhubaneswar	299
11.	Gangadhar Meher College, Sambalpur	256
12.	Regional Medical Research Centre, Bhubaneswar	234
13.	Regional Plant Resource Centre, Bhubaneswar	200
14.	Institute of Life Sciences, Bhubaneswar	175
15.	SCB Medical College, Cuttack	138
16.	Cent Inst Plastic Engineering Technology, Bhubaneswar	131
17.	Regional College of Education, Bhubaneswar	119
18.	North Orissa University, Baripada	111
19.	Orissa Vet. College, Bhubaneswar	102
20.	Water Technology Centre Eastern Reg., Bhubaneswar	101
21.	BJB Autonomous College, Bhubaneswar	86
22.	KIIT University, Bhubaneswar	78
23.	Siksha O Anusandhan University, Bhubaneswar	76
24.	NISER, Bhubaneswar	69
25.	Ispat General Hospital, Rourkela	68
26.	LV Prasad Eye Institute, Bhubaneswar	62
27.	MKCG Medical College, Berhampur	61
28.	Government Science College, Chatrapur	52
29.	Inst. Material Sci., Bhubaneswar	49
30.	College of Pharmaceutical Science, Berhampur	47
31.	VSS Medical College, Sambalpur	47
32.	National Inst. Sci. Techn., Berhampur	46
33.	Indira Gandhi Institute of Technology, Saranga	45
34.	Fakir Mohan University, Balasore	43
35.	Central Tuber Crops Research Institute, Bhubaneswar	42
36.	Khalikote College, Berhampur	42

highest number of publications. There are around 300 institutes/research stations who have published at least one paper.

4.2 Subject Areas of Research

The papers are categorised as per *WOS* subject category. In Table 3, the number of publications in major subjects is presented. Physics, Chemistry, Biology, and Engineering are considered as the high priority S&T research areas in Odisha. Next priority areas are Agriculture Sciences, Medical Sciences, and Material Sciences. Comparatively less publication are found in subjects like Mathematics and Earth Sciences.

Table 3. Number of publications in major subjects

S. No.	Subject	No. of publications
1.	Physics	4500
2.	Chemistry	3478
3.	Biology	2513
4.	Engineering	2125
5.	Material Sciences	1471
6.	Agriculture	1446
7.	Medical Sciences	1349
8.	Environmental Sciences	845
9.	Mathematical Sciences	401
10.	Earth Science	344
11.	Veterinary Sciences	336
12.	Pharmacology	258
13.	Computer Science	245

4.3 Status of Odisha's International Collaboration

There are approximately 12 % of papers having collaboration with one or more foreign authors, whereas India's overall collaboration rate is 15 %[6]. Maximum collaborated papers are published with USA. Table 4 contains the first 20 countries where maximum authors of Odisha have collaborated. Most of the such countries (Table 4) in S&T have collaboration with authors of the State.

Ten subjects were selected to find the degree of international collaboration. In Table 5, the number of internationally collaborated papers and number of countries are presented. It is found that the maximum countries have collaborated in physics discipline. Less international collaboration is found in the areas of Geology, Agriculture, and Mathematics. Presently research is getting more and more interdisciplinary. Due to this interdisciplinary research and inter-institutional collaborations are necessary to increase productivity and quality of research. Higher international collaboration rate is found for articles of IOP, Bhubaneshwar. It is one of the reasons for high productivity of IOP.

Table 4. First 20 countries for international collaboration

S. No.	Country	No. of papers
1.	USA	730
2.	Germany	420
3.	Japan	335
4.	Poland	259
5.	South Korea	259
6.	England	256
7.	Russia	254
8.	China	247
9.	France	230
10.	Netherlands	182
11.	Switzerland	172
12.	Australia	165
13.	Brazil	162
14.	Czech Republic	156
15.	Canada	128
16.	Croatia	128
17.	Taiwan	119
18.	Italy	117
19.	Austria	90
20.	Sweden	77

Table 5. Number of collaborated countries with number of papers in different subjects

Subjects	No. of countries	No. of papers	No. of papers per country
Physics	90	926	10.288
Chemistry	39	149	3.82
Engineering	16	165	10.31
Biology	41	134	3.26
Agriculture	14	51	3.64
Material Science	26	151	3.8
Metallurgy	11	57	5.18
Mathematics	9	64	7.11
Geology and Mineralogy	14	141	10.07
Medical Sciences	23	55	2.39

The number of international collaborated papers and number of collaborated countries from different continents with the authors of Odisha is presented in Table 6. Around 90 % of European countries have collaboration with the authors of the state and contributing the highest number of collaborated papers for Europe. Next is Asia also contributing second highest number of collaborated papers. As USA has the highest number of collaborated papers so the number of papers per countries for North America is the highest. International collaboration also increases the visibility of research, and citation impact. It is found that both the degree of collaboration and citation impact rate are high for physics papers.

4.4 Publications of Universities of Odisha

In this study we have taken five universities of Odisha which were started before 1970. They have a long history of research activity. Utkal University (UU), Bhubaneswar started in 1943. Orissa University of Agriculture Technology (OUAT), Bhubaneswar (1962) is the second oldest agriculture university in the country. Sambalpur University (SU), Berhampur University (BU) both were in existance since 1967. Ravenshaw University (RU), Cuttack started as college in 1868. Its post graduate department began in 1922. In 2006, it was declared as a deemed university. In Table 7, the number of publications for these five universities are represented year-wise from 1970-2011. For OUAT, the publications of its constituent colleges are also included with the total publications of the university. Figure 2 shows that for all cases the number of publications increases for initial years (1971-79). The productivity for Ravenshaw University (RU) was high for the period 1972-82, also it had attained the highest number among all the universities; however it declines then onwards. For other universities the rate of publication falls for the period 2002-2005. For three universities (UU, SU, BU) increasing trend started since 2005 but for the rest two universities (OUAT, RU) increasing trend started frm 2006. However, the trend is by and large same.

Table 6. Number of collaborated countries from different continents with the number of publications

Name of continent (No. of countries)	No. of collaborated countries	No. of collaborated publications	No. of papers per country
Africa (54)	14	93	6.64
Asia (48)	24	1051	73.79
Europe (50)	44	2582	58.68
N. America (23)	8	917	114.62
S. America (15)	8	215	26.87
Oceania/Australia (14)	2	166	83

Note- USSR is included both in Asia & Europe

Table 7. Publications of five Universities of Odisha from 1970-2011

Publication Year	Utkal University	Sambalpur University	Berhampur University	Orissa Univ. of Agri. Technology	Ravenshaw University
1970	1	0	0	0	0
1971	0	0	0	0	0
1972	3	1	0	0	2
1973	30	11	12	5	36
1974	34	5	16	7	30
1975	35	15	14	5	31
1976	25	5	16	6	18
1977	34	11	28	11	32
1978	24	7	41	14	44
1979	36	30	47	12	45
1980	34	34	48	7	45
1981	42	31	57	10	62
1982	32	26	49	11	61
1983	26	33	45	17	56
1984	40	25	36	18	30
1985	33	21	27	9	30
1986	41	16	30	14	25
1987	48	14	28	22	19
1988	38	30	23	18	9
1989	47	32	29	17	13
1990	40	31	27	19	13
1991	40	20	28	24	12
1992	36	18	32	22	8
1993	48	13	31	27	14
1994	54	13	26	36	16
1995	69	24	24	44	19
1996	75	28	23	40	22
1997	78	23	21	36	23
1998	64	24	20	25	23
1999	61	22	20	33	18
2000	49	13	21	28	18
2001	52	20	20	22	18
2002	76	22	27	23	11
2003	69	28	25	22	8
2004	62	22	21	22	7
2005	38	18	9	15	7
2006	42	28	17	7	3
2007	50	22	18	20	6
2008	63	36	18	34	4
2009	58	42	32	30	10
2010	72	28	23	35	9
2011	63	52	29	35	19
Total	**1862**	**894**	**1058**	**802**	**876**

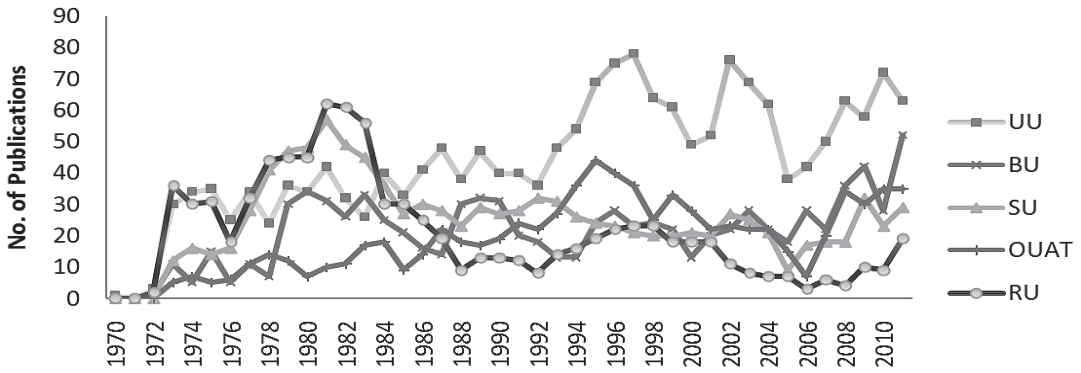

Figure 2. Publications of five universities of Odisha from 1970-2011.

4.5 Publications of New Institutions

From study it is found that there are many new S&T institutes who have started publications. Some of these institutions are government funded and others are private institutions. Eleven institutions have been selected to study the rate of research output in term of publications. The publications of those institutions for the year 2007-2011 are presented in Table 8. It shows the publications of new institutions are continuously increasing. It is a good sign that many GOI-funded projects are sanctioned to these institutions. That may be a one of the reasons for rapid increase of papers from 2006 for Odisha.

4.6 Publications of Colleges in Odisha

In this study it is found that most of the colleges in Odisha have contributed articles in journals. A few of them are selected with their publications and the results are presented in Table 9 (decade-wise). It is found that out of seven, only one college (Fakir Mohan Auto. College) has high publication record for the period 2001-2011. Other colleges have good initial research output but in the last decade publication have decreased.

4.7 Preferred Journals for Publishing

It is a good indicator that the authors in Odisha have published their research outputs in high impact journals like *Nature, Nature Materials, New England*

Table 8. Publications of new institutions from 2007-2011

S. No.	Name of institution	2007	2008	2009	2010	2011
1.	KIIT University, Bhubaneswar	2	3	13	18	28
2.	Fakir Mohan University, Balasore	7	5	10	10	10
3	SOA University, Bhubaneswar	3	3	9	14	47
4.	Roland Inst. Pharmaceut. Sci., Berhampur	1	1	8	3	11
5.	Seemanta Inst. Pharmaceut Sci, Mayurbhanj	6	4	4	7	6
6.	Silcon Inst. Technol., Bhubaneswar	1	0	9	5	4
7.	NISER, Bhubaneswar	0	8	16	23	22
8.	IIT, Bhubaneswar	0	0	2	10	12
9.	Royal College of Pharmacy and Health Sciences, Berhampur	0	3	8	3	2
10.	National Inst. Sci. Technol., Berhampur	2	3	6	6	13
11.	North Orissa University, Baripada	5	23	23	24	25

Table 9. Publications of selected colleges from 1970-2011 (decade-wise)

S. No.	Name of institute	1970-80	1981-90	1991-2000	2001-11
1.	Bhadrak College, Bhadrak	5	20	0	4
2.	BJB College, Bhubaneswar	12	33	23	17
3.	Fakir Mohan Auto. College, Balasore	2	5	2	16
4.	Gangadhar Meher College, Sambalpur	110	82	39	25
5.	Khalikote College, Berhampur	0	14	2	26
6.	MPC College, Baripada	1	2	12	11
7.	SKCG College, Paralakhemundi	0	1	7	5

Journal of Medicine, Blood, Physical Reviews, Physical Review Letters, Soil Biology Biochemistry, Tetrahedron, British Journal of Surgery, Gut, Chest etc. total of 2,134 journals are used to publish their papers. Some of the high preferred publishing journals with number of times published in the selected time period of study with their impact factor (IF) are presented in Table 10. For IF of journals, ISI Journal Citation Reports for 2010 is used. In all disciplines the maximum preferred journals for publication are Indian journals except for physics where more foreign journals are preferred over Indian journals. It is general that the subjects like Agriculture is more region specific so an article has good use if that is published in a highly circulated journals of the country, but in other way science is an international activity without internationalisation it cannot progress[6]. Thus, the research work must be visible worldwide otherwise the researchers will be isolated from mainstream. Also publishing in a high impact factor journals helps in getting funding from national and international agencies.

Table 10. List of highly preferred journals (22) with number of publications and impact factor

S. No.	Source titles	No. of publications	Impact factor
1.	*Journal of the Indian Chemical Society*	479	0.301
2.	*Indian Journal of Chemistry Sec. A*	468	0.92
3.	*Current Science*	358	0.897
4.	*Indian Journal of Agricultural Sciences*	344	0.156
5.	*Indian Veterinary Journal*	252	NA
6.	*Physical Review D*	237	4.964
7.	*Trans. of the Indian Institute of Metals*	220	NA
8.	*Physical Review C*	211	3.416
9.	*Physical Letters B*	195	5.255
10.	*Journal of Applied Polymer Science*	162	1.24
11.	*Indian Journal of Agronomy*	159	NA
12.	*Indian Journal of Animal Sciences*	146	0.147
13.	*Pramana Journal of Physics*	240	0.561
14.	*Physical Review Letters*	129	7.621
15.	*Nuclear Instrumentation Methods in Physics Research Sec. B*	126	1.042
16.	*Physical Review B*	117	3.772
17.	*Hydrometallurgy*	110	1.917
18.	*Thermochimica Acta*	107	1.899
19.	*Physical Letters A*	101	1.963
20.	*Journal of Physics G*	96	1.77
21.	*Indian Journal of Pure and Applied Physics*	95	0.511
22.	*Indian Journal of Chemistry Sec. B*	95	0.562

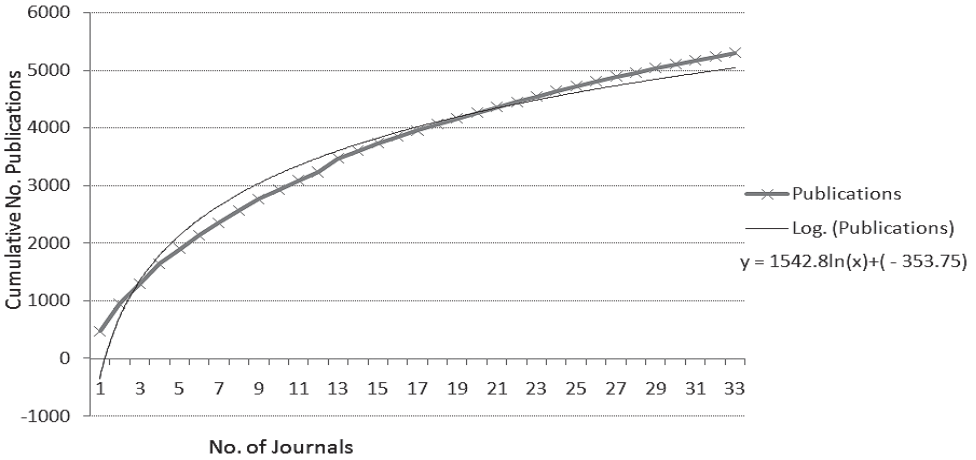

Figure 3. Scattering of publications in different journals.

To study the scattering phenomenon of papers in different journals, a graph (Fig. 3) was drawn with cumulative number of publications and number of journals, it is found that the curve mostly fits to the logarithmic growth of Bradford's function

$F(x) = a + b \log x$.

$F(x)$ = the cumulative number of papers contained in the first x most productive journal, a and b are constants.

Here, function for trend line is Y or

$F(x) = 1542.8\ln(x) + (- 353.75)$,

Value of 'a' is -353.75 and 'b' is 1542.8.

5. CONCLUSIONS

It is good indicator that publication output of Odisha is increasing continuously in the last six years. Researchers of the state have been collaborating with the authors of different institutions within the country and across the globe. But still some priority areas are neglected, like Clinical Sciences, Geology, Environmental Sciences, Marine Sciences, and Computer Sciences. There is rise and fall of research publications in state universities, which shows there is no regular continuous research. It shows that there are some pitfalls which hinder the research work. Also, in old reputed colleges of state publications output have decreased. The main factors contributing to research is highly experienced researchers and resources. There are shortage of experienced faculties in universities and colleges of the state[7]. As S&T creates new resources so it should not be neglected. State government should create more funds for this sector. New institutes may be created where the experienced scientific community working outside of the country can be attracted.

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