

## Research Productivity of Indira Gandhi Kirishi Vishwavidhyalaya (IGKV), Raipur: A Bibliometric study

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### ABSTRACT

*This paper is the analysis of the research contribution of Indira Gandhi Kirishi Vishwavidhyalaya, Raipur in the field of Agricultural during 1988-2018 and indexed by CAB Direct database. This study focused on relative growth rates, doubling time, authorship pattern and measure of collaboration, application of Bradford's law of scattering. Out of 2177 articles, 2097 articles belongs to Journal and rest of articles belongs to Books, books chapters, Conference-proceedings and newsletters. Under this study total 2177 article published by total 6831 authors and mean value of degree of collaboration is 0.88 which indicates the prevalence of team research and solo research is quite substantial. By Bradford's theory found relationship of each zone is 10:39:236. Trends in Biosciences (114 articles) and Plant Archives (101 articles) were found most productive journals.*

**KEYWORDS:** Bibliometric, CAB Direct database, Authorship Collaboration, Degree of Collaboration, Bradford's Law, Chi-square.

### INTRODUCTION

After green revaluation agricultural production, food security and reducing poverty increased in India with an impressive growth. The vast majority of the population in India depends on the agricultural sector for their livelihood. The Indian public agricultural research system has divided into two levels. The first levels include a network of close to 100 institutions coordinated by the Indian Council for Agricultural Research (ICAR). ICAR is playing vital role to promote agriculture research system and promoting excellence in higher agricultural education and funding to agricultural R&D. The second level is at the regional level and consists of a system of state agricultural universities (SAUs) funded by the state governments.<sup>1</sup> IGKV, Raipur is one of the State University in Chhattisgarh established on 20th January 1987 promoting education, Research in the field of agriculture i.e. veterinary, dairy and agricultural engineering and conducting various major extension activities.<sup>2</sup>

Contribution of such kind of organisation is published in the form of various types of resources i.e. books, books chapters, reviews, journal articles, conference papers etc. and it should be stored and arranged in proper manner in form of databases, so that information can be retrieved by research scholars, scientists, specialists and others. But due to the era of Information technology, huge amount of information is available in on internet, so research scholars, scientists and faculty members are facing the problem to select the document to retrieve and disseminate information for their interest. To solve these problems, librarians have to use quantitative techniques i. e scientometrics, bibliometrics and webometrics etc. to measure scientific activities, mainly by producing statistics on scientific publications indexed in databases.<sup>3</sup>

### POPULAR WORKS

**Maheswarappa & Rao (1982)**<sup>4</sup> conducted a bibliometric study on Journals of Food Technology. They analysed total 270 citing article covered with their 4570 cited articles. About 74.46% (3403) of all the citations were found as journal articles followed by 14.55% (665) books and rest of 10.98% citations belongs to other forms like proceedings, reports, thesis, patents etc. A rank list of 366 most cited journals indicated that Journal of Food Science contains (U.S.A.) Most of the citations are from the journals being published in USA followed by India, UK and Japan. **Vaishnav & Deo (1993)**<sup>5</sup> carried a bibliometric study on computerised information storage and retrieval articles indexed by LISA database. They analysed data in term of growth of literature of computerised library and information services, subject wise growth, authorship trend, authors publishing outlets, journal literature, its distribution and application of Bradford's law. **Gupta (1993)**<sup>6</sup> covered the publications on Geophysics based on database of Geophysics for the period 1936-1985. A total of 3417 publications in the field of Geophysics and 1318 publications in the field of Geophysical Prospecting have been calculated. The study reveal that authors collaboration has been increasing in Geophysics research over the period of time. Investigated 100 volumes of the Journal of Hydrology to analysed the contribution of Indian hydrologists and experts in

the field of water resources analysed by Ullah (1994)<sup>7</sup> for the period 1981 to 1993. The Indian hydrologists are principally concerned with groundwater related issues.

### **RESEARCH METHODOLOGY**

Out of 64 state agricultural universities “Indira Gandhi Krishivishwa Vidhayalaya, Raipur” has chosen for the analysis of its contribution in the field of agriculture research as a random sample. Data has been collected form CAB Direct database for the 30 Year time span from 1988 to 2018. “CAB Direct is the most thorough and extensive source of reference in the applied life sciences, incorporating the leading bibliographic databases CAB Abstracts and Global Health. This database includes over 12.5 million bibliographic records, over 465,000 full text articles hosted by CABI, many other authoritative reviews, news articles and reports”.<sup>8</sup> Total no. 2177 records has been extract (March, 2019) form CAB Direct based on author affiliation and analysed in MS excel with bibliographic details in terms of authorship pattern, year-wise growth, Relative Growth Rate, Doubling Time, types of source, Name of Journal and its publication country and Bradford’s Law of scattering applied to identify the core journals. In addition, the Chi-square test of goodness-of-fit was applied for confirmation of the Bradford’s Law.

### **OBJECTIVES OF THE STUDY**

- To determine year-wise growth, relative growth rate and doubling time of the literature in the field of agricultural research.
- To observe the pattern of authorship collaboration and most productive author who have significantly contributed to the field.
- To identify core journals and their Geographical Distribution.
- To identify the distribution of articles by types of documents.
- To check the applicability of Bradford’s Law and Leimkhuler’s Model on Agricultural research articles.

### **ANALYSIS & INTERPRETATION:**

In this study, total 2177 articles has been analysed and their results tabulated according to year wise growth, relative growth rate, doubling time, authorship pattern, ranking of authors, ranking of Journals, Geographical scattering of Journal, application of Bradford’s Law and Chi Squire test.

#### **1. YEAR WISE GROWTH OF ARTICLES**

Fig.1 shows no of articles listed in CAB direct database belongs to IGKV, Raipur during 1988-2018. Total 2177 articles have been published during the study period. After 1999, growth of literature is fluctuate and its decline from 2000 to 2003 and 2007 to 2013, where the growth of literature increase gradually in the previous year from 1988-1999. Table-1 depict highest number of articles was 231 (10.61%) in 2015 and lowest number of articles 03 (0.14%) in 1988.

TABLE-1: YEAR WISE GROWTH OF ARTICLES				
Year	No. of Articles	Percentage	Cumulative No. of Articles	Cumulative %
1988	3	0.14	3	0.14
1989	5	0.23	8	0.37
1990	4	0.18	12	0.55
1991	4	0.18	16	0.73
1992	17	0.78	33	1.52
1993	19	0.87	52	2.39
1994	19	0.87	71	3.26
1995	26	1.19	97	4.46
1996	42	1.93	139	6.38
1997	72	3.31	211	9.69
1998	101	4.64	312	14.33
1999	114	5.24	426	19.57
2000	94	4.32	520	23.89
2001	68	3.12	588	27.01
2002	59	2.71	647	29.72
2003	67	3.08	714	32.8
2004	100	4.59	814	37.39
2005	101	4.64	915	42.03
2006	103	4.73	1018	46.76
2007	85	3.9	1103	50.67
2008	82	3.77	1185	54.43
2009	64	2.94	1249	57.37
2010	72	3.31	1321	60.68
2011	72	3.31	1393	63.99
2012	82	3.77	1475	67.75
2013	73	3.35	1548	71.11
2014	136	6.25	1684	77.35
2015	231	10.61	1915	87.97
2016	83	3.81	1998	91.78
2017	136	6.25	2134	98.02
2018	43	1.98	2177	100
<b>Total</b>	<b>2177</b>	<b>100</b>		



FIG.1: YEAR WISE ARTICLES GROWTH

**2. RELATIVE GROWTH RATE (RGR) AND DOUBLING TIME (Dt)**

Table-2 presents the relative growth rate and doubling time of total research outputs. It is observed that the relative growth rates of research output have decreased from 0.477 to 0.09 during whole study period. The mean relative growth rates for the period of 1988-2002 is 0.187 and for 2003-2018 is 0.033 whereas the mean relative growth rate for the whole study period is 0.01.

TABLE -2: RELATIVE GROWTH RATE (RGR) AND DOUBLING TIME (Dt)						
Year	No of Articles (A)	Cumulative No of Articles (CA)	W1 log C	W2 (log CA)	RGR	Dt
1988	3	3	0.000	0.477	0.477	1.45
1989	5	8	0.477	0.903	0.426	1.63
1990	4	12	0.903	1.079	0.176	3.94
1991	4	16	1.079	1.204	0.125	5.55
1992	17	33	1.204	1.519	0.314	2.20
1993	19	52	1.519	1.716	0.197	3.51
1994	19	71	1.716	1.851	0.135	5.12
1995	26	97	1.851	1.987	0.136	5.11
1996	42	139	1.987	2.143	0.156	4.44
1997	72	211	2.143	2.324	0.181	3.82
1998	101	312	2.324	2.494	0.170	4.08
1999	114	426	2.494	2.629	0.135	5.12
2000	94	520	2.629	2.716	0.087	8.00
2001	68	588	2.716	2.769	0.053	12.98
2002	59	647	2.769	2.811	0.042	16.69
2003	67	714	2.811	2.854	0.043	16.19
2004	100	814	2.854	2.911	0.057	12.17
2005	101	915	2.911	2.961	0.051	13.64
2006	103	1018	2.961	3.008	0.046	14.96
2007	85	1103	3.008	3.043	0.035	19.90
2008	82	1185	3.043	3.074	0.031	22.25
2009	64	1249	3.074	3.097	0.023	30.34
2010	72	1321	3.097	3.121	0.024	28.47
2011	72	1393	3.121	3.144	0.023	30.07
2012	82	1475	3.144	3.169	0.025	27.90
2013	73	1548	3.169	3.190	0.021	33.03
2014	136	1684	3.190	3.226	0.037	18.95
2015	231	1915	3.226	3.282	0.056	12.41
2016	83	1998	3.282	3.301	0.018	37.61
2017	136	2134	3.301	3.329	0.029	24.23
2018	43	2177	3.329	3.338	0.009	79.99
<b>Total</b>	<b>2177</b>				<b>3.338</b>	<b>505.76</b>

On the other hand, the mean doubling times for above two periods are 5.577 and 26.382 respectively, whereas the mean doubling time for the whole study period is 16.3. Fig.2 and Fig.3 is showing decline trend of relative growth rate of research output and increasing trend of doubling time.

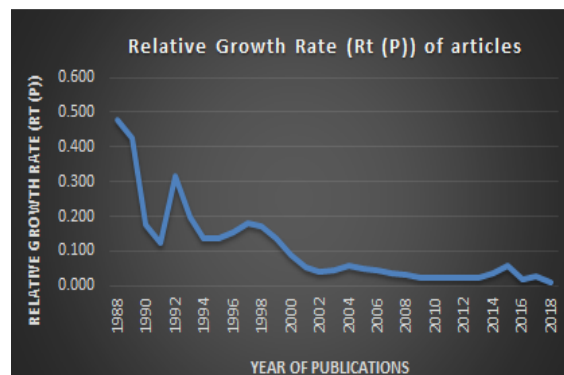


FIG.2: RELATIVE GROWTH RATE (RGR) OF ARTICLES

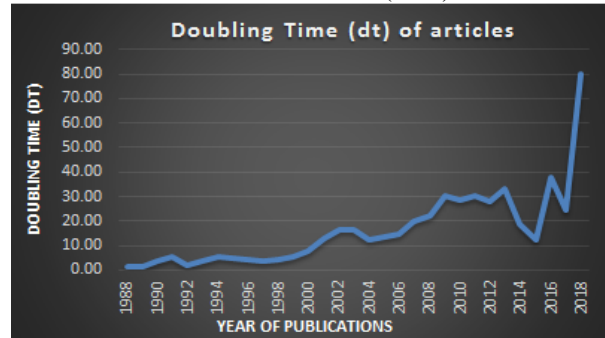


FIG.3: DOUBLING TIME (Dt) OF ARTICLES

### 3. AUTHORSHIP PATTERN AND MEASURE OF COLLABORATION

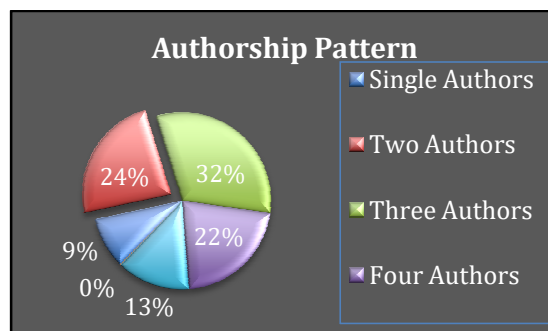
#### ➤ AUTHORSHIP PATTERN

Table 3 depict authorship pattern of 2177 articles of IGKV, Raipur. Fig 4 shows that highest articles 690 (%) written by the collaboration of three authors out of 2177 articles. 204 articles are single-authored this

indicated that solo research is quite substantial in this field. 516 (12.81%) articles are by two authors and 466 articles (16.25%) contributed by four authors. Similarly, Five; Six, Seven and more authored articles count as 199 (14.39%), 73 (17.30%), 15 (12.17%) respectively. There are 2 article having incomplete bibliographical details and have no authors. In all, nearly 90% articles is the result of team research and 10% solo research. (Fig. 4)

**TABLE 3- YEAR WISE DISTRIBUTION OF AUTHORSHIPS DURING 1988-2018**

No. of Authors	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	%	
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.09	
1	1	1	1	0	4	2	4	5	4	12	15	30	18	18	6	6	8	6	4	4	7	3	2	3	7	9	6	10	3	4	1	204	9.37	
2	1	3	2	1	8	9	6	6	12	19	30	29	31	18	12	19	21	33	24	17	14	15	18	12	20	20	29	45	15	18	9	516	23.70	
3	1	0	1	0	4	4	6	13	17	29	37	33	30	19	19	26	30	25	44	32	31	20	19	26	26	14	35	75	24	40	10	690	31.69	
4	0	1	0	2	1	4	3	2	7	10	12	15	11	9	15	9	27	24	18	18	20	14	24	19	17	19	46	50	21	39	9	466	21.41	
5	0	0	0	1	0	0	0	0	2	2	4	5	2	2	4	5	9	10	8	7	6	8	6	11	8	6	16	35	14	21	7	199	9.14	
6	0	0	0	0	0	0	0	0	0	0	2	1	1	2	1	2	5	2	4	6	2	1	2	1	4	4	3	12	2	12	4	73	3.35	
7	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	3	1	1	2	15	0.69	
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	5	0.23	
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0.09
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	3	0.14	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.05	
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.05	
Total	3	5	4	4	17	19	19	26	42	72	101	114	94	68	59	67	100	101	103	85	82	64	72	72	82	73	136	231	83	136	43	2177	100.00	



**FIG. 4: AUTHORSHIP PATTERN OF ARTICLES**

**MEASURE OF COLLABORATION**

Table 4 depicts that 2177 articles written by 6831 authors. Average number of authors in each article (CI) is 2.96. The number of authors has fluctuated during the 10 years, so that in 2018 the largest number of authors (3.86) and in 1988, the lowest number of authors (2.00) counted per papers. Table 4 shows the degrees of collaboration from 0.67 to 0.98 during 1988-2018. Mean value of degree of collaboration is 0.88 which indicates the prevalence of team research in the field of Agriculture Research. Collaborative coefficient is 0.57.

**TABLE-4: MEASURES OF COLLABORATION OF AUTHORS**

Year	No of Articles	No. of Authors	Collaborative Index (CI)	Degree of Collaboration (DC)	Collaborative coefficient (CC)	Mean Collaborative coefficient (MCC)
1988	3	6	2	0.67	0.39	0.58
1989	5	11	2.2	0.8	0.45	0.56
1990	4	8	2	0.75	0.42	0.56
1991	4	15	3.75	1	0.7	0.93
1992	17	36	2.12	0.76	0.44	0.46
1993	19	48	2.53	0.89	0.54	0.56
1994	19	46	2.42	0.79	0.49	0.51
1995	26	64	2.46	0.81	0.51	0.53
1996	42	117	2.79	0.9	0.58	0.59
1997	72	187	2.6	0.83	0.53	0.53
1998	101	266	2.63	0.85	0.54	0.55
1999	114	285	2.5	0.74	0.47	0.47
2000	94	237	2.52	0.81	0.5	0.51
2001	68	169	2.49	0.72	0.47	0.47
2002	59	180	3.05	0.9	0.61	0.62
2003	67	195	2.91	0.91	0.59	0.59
2004	100	323	3.23	0.92	0.62	0.63
2005	101	312	3.09	0.93	0.61	0.62
2006	103	327	3.17	0.96	0.64	0.64
2007	85	284	3.34	0.95	0.64	0.65
2008	82	267	3.26	0.91	0.62	0.63
2009	64	220	3.44	0.95	0.64	0.65
2010	72	256	3.56	0.97	0.65	0.66
2011	72	242	3.36	0.96	0.66	0.67
2012	82	257	3.13	0.91	0.61	0.62
2013	73	230	3.15	0.88	0.58	0.59
2014	136	459	3.38	0.96	0.65	0.66
2015	231	801	3.47	0.96	0.66	0.66
2016	83	309	3.72	0.96	0.67	0.68
2017	136	508	3.74	0.97	0.69	0.69
2018	43	166	3.86	0.98	0.68	0.7
<b>Total</b>	<b>2177</b>	<b>6831</b>	<b>91.86</b> (Mean of CI)	<b>27.32</b> (Mean of DC)	<b>17.82</b> (Mean of CC)	<b>18.78</b> (Mean of MCC)

**5. CONTRIBUTION OF AUTHORS**

The most prolific authors with their number of articles are given in Table 5. The most productive authors found in the study in order of the number of articles are Oudhia, P. who tops the list with 77 articles followed by Singh, A. K. with 21 articles.

**TABLE 5: RANKING LIST OF AUTHORS**

Sl.No.	Name of Author	Total No. of Articles	%	Rank
1	Oudhia, P.	77	3.54	1
2	Singh, A. K.	21	0.96	2
3	Yadav, R. K.	19	0.87	3
4	Lakpale, N.	16	0.73	4
5	Sunil Puri	16	0.73	4
6	Thakur, M. P.	16	0.73	4
7	Tiwari, R. K. S.	16	0.73	4
8	Marothia, D.	13	0.60	5
9	Rao, S. S.	13	0.60	5
10	Swamy, S. L.	13	0.60	5
11	Verma, A. K.	13	0.60	5
12	Gupta, S. B.	12	0.55	6
13	Pandey, C. B.	12	0.55	6
14	Rai, N.	12	0.55	6
15	Sarawgi, S. K.	12	0.55	6
16	Tiwari, S. P.	12	0.55	6
17	Chandrakar, H. K.	11	0.51	7
18	Dwivedi, R. K.	11	0.51	7
19	Sarawgi, A. K.	11	0.51	7
20	Tripathi, A. K.	11	0.51	7
21	Anuj Bhatnagar	10	0.46	7
22	Arvind Kumar	10	0.46	8
23	Chaudhary, J. L.	10	0.46	8
24	Choudhary, V. K.	10	0.46	8
25	Jayalaxmi Ganguli	10	0.46	8
26	Khare, N.	10	0.46	8
27	Patel, S. R.	10	0.46	8
28	Sharma, D.	10	0.46	8
29	Singh, A. P.	10	0.46	8
30	6 authros with 9 papers	54	2.48	9
36	6 authros with 8 papers	48	2.20	10
42	10 authros with 7 papers	70	3.22	11
52	12 authros with 6 papers	72	3.31	12
94	31 authros with 5 papers	155	7.12	13
95	49 authros with 4 papers	196	9.00	14
96	86 authors with 3 papers	258	11.85	15
97	193 authors with 2 papers	386	17.73	16
98	509 authors with 1 paper	509	23.38	17
99	No authors	2	0.09	18
<b>Total</b>		<b>2177</b>	<b>100.00</b>	

Third position got by Yadav, R. K. with 19 articles. Lakpale, N., Sunil Puri , Thakur, M. P. And Tiwari, R. K. S. Published 16 articles where as Marothia, D., Rao, S. S., Swamy, S. L. Verma, A. K. Published 13 articles and got 5<sup>th</sup> position. 18 authors contributed 194 articles having rang of 12-10 articles individually. Rest of the authors contributed 1748 papers having less than Ten papers individually. There are 2 articles found without any authors' name.

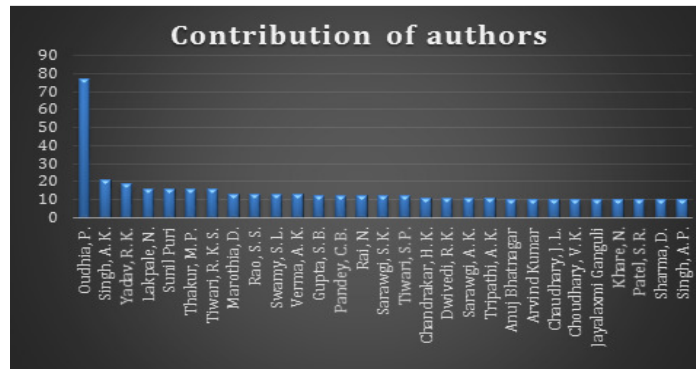


FIG. 5: CONTRIBUTION OF AUTHORS

**6. LIST OF CORE JOURNALS AND THEIR GEOGRAPHICAL SCATTERING**

A Core journal list (Table 6) contain 55 journals those are published more than 10 articles. It was found that out of 2177 publication, 2097 articles belongs to 285 journals. A rank list of the journal shows that 29 journals account for 50% of the total articles. Top ten journals accounting 32.98% of the publications. Trends in Biosciences (114 articles) and Plant Archives (101 articles) are most productive journals followed by Environment and Ecology (95), Advances in Plant Sciences (87), Journal of Soils and Crops (69). It was further found that all these top 5 Journals published by India.

Sl. No.	Name of Journal	No. of Articles	Cumulative Articles	% of Articles	% of cumulative Articles	Rank
1	Trends in Biosciences	114	114	5.44	5.44	1
2	Plant Archives	101	215	4.82	10.25	2
3	Environment and Ecology	95	310	4.53	14.78	3
4	Advances in Plant Sciences	87	397	4.15	18.93	4
5	Journal of Soils and Crops	69	466	3.29	22.22	5
6	Annals of Agricultural Research	54	520	2.58	24.80	6
7	Journal of Plant Development Sciences	50	570	2.38	27.18	7
8	Journal of Interacademia	44	614	2.10	29.28	8
9	Insect Environment	40	654	1.91	31.19	9
10	Indian Journal of Agronomy	38	692	1.81	33.00	10
11	Agricultural Science Digest (Karnal)	37	729	1.76	34.76	11
12	Journal of Applied Zoological Researches	33	762	1.57	36.34	12
13	Oryza	30	792	1.43	37.77	13
14	Orissa Journal of Horticulture	29	821	1.38	39.15	14
15	International Journal of Plant Sciences (Muzaffarnagar)	28	849	1.34	40.49	15
16	Indian Journal of Animal Sciences	27	876	1.29	41.77	16
17	Journal of Mycology and Plant Pathology	25	901	1.19	42.97	17
18	International Journal of Agricultural Sciences	24	925	1.14	44.11	18
19	Current Advances in Agricultural Sciences	22	947	1.05	45.16	19
20	International Journal of Plant Protection	21	968	1.00	46.16	20
21	Annals of Plant Protection Sciences	20	988	0.95	47.11	21
22	International Journal of Tropical Agriculture	20	1008	0.95	48.07	21
23	Agricultural Marketing	19	1027	0.91	48.97	22
24	Electronic Journal of Plant Breeding	19	1046	0.91	49.88	22

Sl. No.	Name of Journal	No. of Articles	Cumulative Articles	% of Articles	% of cumulative Articles	Rank
25	International Journal of Bio-resource and Stress Management	19	1065	0.91	50.79	22
26	International Rice Research Notes	19	1084	0.91	51.69	22
27	Indian Journal of Agricultural Sciences	18	1102	0.86	52.55	23
28	Indian Journal of Agroforestry	17	1119	0.81	53.36	24
29	Journal of Veterinary Parasitology	17	1136	0.81	54.17	24
30	Bhartiya Krishi Anusandhan Patrika	16	1152	0.76	54.94	25
31	Indian Phytopathology	16	1168	0.76	55.70	25
32	Crop Research (Hisar)	15	1183	0.72	56.41	26
33	Indian Journal of Genetics and Plant Breeding	15	1198	0.72	57.13	26
34	International Journal of Agricultural Engineering	15	1213	0.72	57.84	26
35	Journal of Oilseeds Research	14	1227	0.67	58.51	27
36	Current Research - University of Agricultural Sciences (Bangalore)	13	1240	0.62	59.13	28
37	Indian Journal of Agricultural Research	13	1253	0.62	59.75	28
38	Indian Journal of Weed Science	13	1266	0.62	60.37	28
39	Journal of Agrometeorology	13	1279	0.62	60.99	28
40	Progressive Horticulture	12	1291	0.57	61.56	29
41	The Bioscan	12	1303	0.57	62.14	29
42	Advance Research Journal of Crop Improvement	11	1314	0.52	62.66	30
43	Asian Journal of Soil Science	11	1325	0.52	63.19	30
44	Indian Forester	11	1336	0.52	63.71	30
45	Indian Journal of Tropical Biodiversity	11	1347	0.52	64.23	30
46	Journal of Pure and Applied Microbiology	11	1358	0.52	64.76	30
47	Journal of Spices and Aromatic Crops	11	1369	0.52	65.28	30
48	Madras Agricultural Journal	11	1380	0.52	65.81	30
49	Mysore Journal of Agricultural Sciences	11	1391	0.52	66.33	30
50	Asian Journal of Horticulture	10	1401	0.48	66.81	31
51	Haryana Journal of Horticultural Sciences	10	1411	0.48	67.29	31
52	Indian Journal of Ecology	10	1421	0.48	67.76	31
53	Journal of Maharashtra Agricultural Universities	10	1431	0.48	68.24	31
54	Range Management and Agroforestry	10	1441	0.48	68.72	31
55	Vegetable Science	10	1451	0.48	69.19	31
56	6 Journals Having 9 Publications each	54	1505	2.58	71.77	32
57	6 Journals Having 8 Publications each	48	1553	2.29	74.06	33
58	10 Journals Having 7 Publications each	70	1623	3.34	77.40	34
59	6 Journals Having 6 Publications each	36	1659	1.72	79.11	35
60	19 Journals Having 5 Publications each	95	1754	4.53	83.64	36
61	21 Journals Having 4 Publications each	84	1838	4.01	87.65	37
62	26 Journals Having 3 Publications each	78	1916	3.72	91.37	38
63	45 Journals Having 2 Publications each	90	2006	4.29	95.66	39
64	91 Journals Having 1 Publications each	91	2097	4.34	100.00	40
	<b>Total</b>	<b>2097</b>				

In any subject fields, scientific research has international characteristics. Most of the countries in the world are giving their contribution in Research and Development and publishing the results in form of research articles. Table 7 listed all core journals according to their country of origin and showing most productive countries in the field of Agriculture (Fig 6) and shows that India ranks first by producing 72.63% of the total listed journals. Netherlands got second rank with 3.86% of total no of Journals, followed by United Kingdom, United States and Pakistan with 2.81% got third position. The above five countries produced nearly 80% of total journals. The renaming 20% of journals are form 27 countries i.e International organization, Germany, Nigeria, Switzerland, and Bangladesh etc. This result shows that most of Indian authors chose Indian journals for their publications.



**TABLE-7: COUNTRIES OF PUBLICATIONS**

Sl. No.	Name of Country	No of Publications	%
1	India	207	72.63
2	Netherlands	11	3.86
3	United Kingdom	8	2.81
4	United States	8	2.81
5	Pakistan	8	2.81
6	Nigeria	5	1.75
7	International organization	4	1.40
8	Germany	4	1.40
9	Switzerland	4	1.40
10	Bangladesh	3	1.05
11	Australia	2	0.70
12	China	2	0.70
13	Japan	2	0.70
14	United Arab Emirates	2	0.70
15	Thailand	1	0.35
16	Italy	1	0.35
17	New York	1	0.35
18	Bangkok	1	0.35
19	Canada	1	0.35
20	Colombia	1	0.35
21	Egypt	1	0.35
22	Hungary	1	0.35
23	Iran, Islamic Republic of	1	0.35
24	Jordan	1	0.35
25	Lincolnshire	1	0.35
26	Lithuania	1	0.35
27	New Zealand	1	0.35
28	Sri Lanka	1	0.35
29	Turkey	1	0.35
	<b>Total</b>	<b>285</b>	<b>100.00</b>

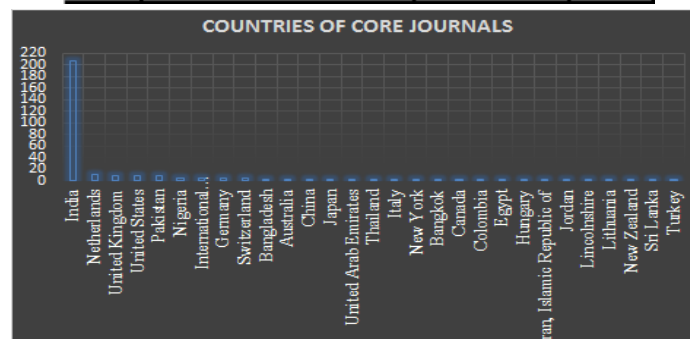


FIG.6: COUNTRIES OF CORE JOURNALS

**7. APPLICATION OF BRADFORD’S LAW AND CHI- SQUARE TEST**

**TABLE-8: BRADFORD ZONES OF SCATTERING**

Zone	No of Articles in each zone	%	No of Journals (Observed)	%	Bradford Multiplier (bm)	No of Journals (Expected)	%
Zone I	692	32.99	10	3.5		<b>10</b>	3.26
zone II	699	33.33	39	13.68	3.9	49.70≈ <b>50</b>	16.20
zone III	706	33.66	236	82.8	6.05	247.009≈ <b>247</b>	80.54
<b>Total</b>	<b>2097</b>	<b>100</b>	<b>285</b>	<b>100</b>	<b>9.95</b>	<b>306.709≈307</b>	<b>100.00</b>

**Geometric mean of bm = 4.97**

In Table 8, data set of agricultural research (2097 articles) was divided into three zones for the testing the verbal interpretation of the Bradford’s Law and it is found that 10 journals published 692 articles, next 39

journals published 699 articles and next 236 journals published 706 articles. So here, the relationship of each zone is 10:39:236.

According to Bradford’s Law of Scattering successive zones followed a common pattern for the ratio of the journals and identifies form an approximately geometric series 1: n: n<sup>2</sup>. Bradford’s Law of scattering shows that each zone should be produces 1/3 of total relevant papers. Here, “n represent Bradford’s multiplier which was arrived at by dividing journals of a zone by its preceding zone”.<sup>9</sup> Here the number of journals in the nucleus are 10 and the mean value of Multiplier (n) is 4.98, so the ratio of zone is:

$$1 \times 10: 10 \times 4.97: 10 \times (4.97)^2$$

$$10: 49.7: 247.009 = 306.709$$

$$\text{Percentage of error} = \frac{306.709 - 285}{285} \times 100 = 7.61$$

Here the percentage error is not much higher and it was found that the number of journals contributing references each zone increase by a multiplier of 4.97. So it can be said that this result fit into the Bradford’s distribution.

**APPLICATION OF LEIMKUHLE MODEL:**

In this study, the mathematical formula of Leimkuhler’s model<sup>10</sup> is applied here to verify the Bradford’s law of scattering. Here articles were divided in three zones (p=3 where p shows the Number of Zones),

$$R(r) = a \log(1+br) \dots \dots \dots (1)$$

Where R (r) is the cumulative number articles produced by the source of rank 1,2,3.....r, a and b are constant

$$a = \frac{y_0}{\log k} \dots \dots \dots (2)$$

$$b = \frac{k-1}{r_0} \dots \dots \dots (3)$$

where r<sub>0</sub> is the number of source in the frist Bradford’s group, y<sub>0</sub> is the number of articles in every Bradford group and k is Bradford multiplier.

Now we calculate of the value of Bradford’s multiplier k:

$$k = (e^y y_m)^{1/p} \text{ where } e^y = (1.781)$$

In this study y<sub>m</sub>= number of articles in the most productive source = 114 and hence

$$k = (1.781 \times 114)^{1/3} = 5.877$$

$$y_0 = A/P$$

where, A is the total number of articles = 2098 and p is the number of zones = 3

$$y_0 = \frac{2097}{3} = 699$$

and r<sub>0</sub>= number of journals in the nucleus of Bradford is calculated as

$$r_0 = \frac{T(k-1)}{(k^p-1)} \text{ where T is total no. of journals}$$

$$r_0 = \frac{285(5.877-1)}{(5.877^3-1)} = 6.88$$

$$a = \frac{y_0}{\log k} = \frac{699}{\log(5.877)} = 908.788$$

$$b = \frac{k-1}{r_0} = \frac{5.877-1}{6.88} = \frac{4.877}{6.88} = 0.708$$

Here, calculations shows that the number of journals in first zone is 6.88 and the mean value of the Bradford multiplier is 5.877 (Table No.9). Therefore, the Bradford’s distribution is written as:

TABLE-9: LEIMKUHLE MODEL FOR BRADFORD'S LAW						
Zone	No. of Journals (Observed)	%	No. of Journals (Expected) (formula r <sub>0</sub> , r <sub>0</sub> k, r <sub>0</sub> k <sup>2</sup> )	%	No. of Cumulative Articles in each zone (Observed)	No. of Cumulative Articles in each zone (Expected) [R (r) = a log (1+br)]
Zone I	10	3.51	6.88	2.41	692	698.599
Zone II	39	13.68	40.434	14.19	1391	1397.53
Zone III	236	82.81	237.629	83.4	2097	2086.92
<b>Total</b>	<b>285</b>	<b>100</b>	<b>285.98</b>	<b>100</b>		

$$6.88: 6.88 \times 5.87: 6.92 \times (5.87)^2$$

$$6.88: 40.433: 237.629 = 285.98$$

$$\text{Percentage error of Journals} = \frac{284.94 - 285}{285} \times 100 = -0.020$$

$$\text{Percentage error of Articles} = \frac{2086.920 - 2097}{2097} \times 100 = -0.480$$

As a result, it may say that in this data set Bradford's Law fits very well because value of multiplier (5.877) increased the no. of articles in each zone and percentage error is negligible in both the cases. Table 9 shows that the first zone containing 7 journals contributed 699 citations, second zone with 40 journals produced 699 articles and the 238 journals of third zone produced 689 articles. Here the mean value of the Bradford Multiplier (BM) is large and larger the Bradford Multiplier, presumably, the higher is the scatter.

> **Graphical Formulation:**

Fig.7 presents Bradford's Bibliograph, according to Bradford "a bibliograph is plotted with cumulative number of articles (r) against logarithm of cumulative number of journals (log n)".<sup>11</sup> On a Bradford Bibliograph, the core journals are those whose points lay on the initial curved part of the graph until tangentially becomes a straight line.

TABLE-10: GRAPHICAL PRESENTATION AND CHI-SQUARE TEST FOR CORE JOURNALS										
S. No.	No of Journals	Cum of JI. (r)	Log of Cum of JI. (r)	No of Articles	Total No. of Articles	Cum. No of articles observed (O)	Cum. No. of articles expected (E) [R (r) = a log (1+b r)]	Difference (O-E)	Squared Difference (O-E) <sup>2</sup>	(O-E) <sup>2</sup> / (E)
1	1	1	0	114	114	114	211.282	-97.282	9463.82	44.79
2	1	2	0.30	101	101	215	348.154	-133.154	17729.96	50.93
3	1	3	0.48	95	95	310	449.587	-139.587	19484.65	43.34
4	1	4	0.60	87	87	397	530.210	-133.210	17744.93	33.47
5	1	5	0.70	69	69	466	597.124	-131.124	17193.63	28.79
6	1	6	0.78	54	54	520	654.322	-134.322	18042.33	27.57
7	1	7	0.85	50	50	570	704.270	-134.270	18028.30	25.60
8	1	8	0.90	44	44	614	748.600	-134.600	18117.29	24.20
9	1	9	0.95	40	40	654	788.451	-134.451	18077.11	22.93
10	1	10	1.00	38	38	692	824.645	-132.645	17594.58	21.34
11	1	11	1.04	37	37	729	857.796	-128.796	16588.40	19.34
12	1	12	1.08	33	33	762	888.377	-126.377	15971.21	17.98
13	1	13	1.11	30	30	792	916.758	-124.758	15564.68	16.98
14	1	14	1.15	29	29	821	943.235	-122.235	14941.40	15.84
15	1	15	1.18	28	28	849	968.047	-119.047	14172.08	14.64
16	1	16	1.20	27	27	876	991.390	-115.390	13314.88	13.43
17	1	17	1.23	25	25	901	1013.430	-112.430	12640.46	12.47
18	1	18	1.26	24	24	925	1034.304	-109.304	11947.27	11.55
19	1	19	1.28	22	22	947	1054.129	-107.129	11476.54	10.89
20	1	20	1.30	21	21	968	1073.005	-105.005	11026.11	10.28
21	2	22	1.34	20	40	1008	1108.249	-100.249	10049.77	9.07
22	4	26	1.41	19	76	1084	1170.501	-86.501	7482.51	6.39
23	1	27	1.43	18	18	1102	1184.643	-82.643	6829.86	5.77
24	2	29	1.46	17	34	1136	1211.491	-75.491	5698.90	4.70
25	2	31	1.49	16	32	1168	1236.629	-68.629	4709.88	3.81
26	3	34	1.53	15	45	1213	1271.566	-58.566	3429.99	2.70
27	1	35	1.54	14	14	1227	1282.557	-55.557	3086.58	2.41
28	4	39	1.59	13	52	1279	1323.694	-44.694	1997.51	1.51
29	2	41	1.61	12	24	1303	1342.758	-39.758	1580.72	1.18
30	8	49	1.69	11	88	1391	1410.958	-19.958	398.31	0.28
31	6	55	1.74	10	60	1451	1455.340	-4.340	18.84	0.01
32	6	61	1.79	9	54	1505	1495.233	9.767	95.40	0.06
33	6	67	1.83	8	48	1553	1531.461	21.539	463.94	0.30
34	10	77	1.89	7	70	1623	1585.306	37.694	1420.82	0.90
35	6	83	1.92	6	36	1659	1614.407	44.593	1988.53	1.23
36	19	102	2.01	5	95	1754	1694.532	59.468	3536.50	2.09
37	21	123	2.09	4	84	1838	1767.499	70.501	4970.38	2.81
38	26	149	2.17	3	78	1916	1842.401	73.599	5416.76	2.94
39	45	194	2.29	2	90	2006	1945.702	60.298	3635.86	1.87
40	91	285	2.45	1	91	2097	2096.597	0.403	0.16	0.00
Total	285				2097			Chi-Square Value	546.20	

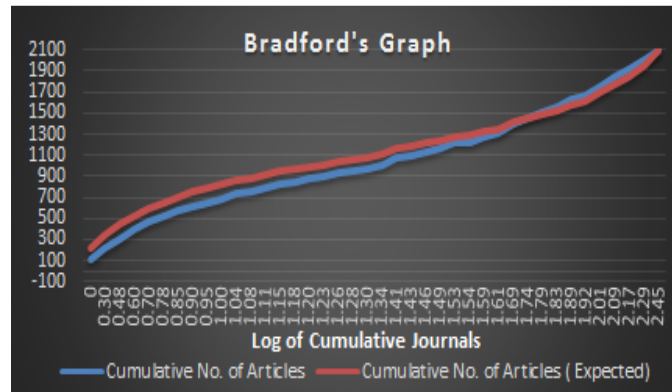


FIG. 7: BRADFORD'S BIBLIOGRAPH

### CHI SQUARE TEST

Chi-Square value is calculated by taking the summation of last column (Table 8):=  $\sum(O-E)^2/E = 516.38$

Therefore, Degree of Freedom = (c-1) (r-1) = (2-1)(40-1) = 39

The results of Chi-square test of goodness-of-fit indicated that the Chi-square value ( $\chi^2 = 516.38$ ) is much higher than the critical Chi-square value of 54.57 for 39 degrees of freedom at 0.05 level of significance.

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