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Crop science literature and Bradford law

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An attempt has been made to test whether crop science literature follows Bradford law. The dataset comprised 10,100 papers indexed in *Indian Science Abstracts* and *CAB Abstracts* during the period 1965-2010. A ranked list of journals has been prepared and Leimkuhler test was conducted. The list of core journals is provided. The dataset does not follow Bradford law even with Leimkuhler formulation. The crops covered are rice, wheat, barley, maize, sorghum and millets. Possibly combining of data for six crops together and cumulating of data of every fifth year deviated the dataset from Bradford law of scattering.

Keywords: Crop science; Bradford law of scattering; Crop science literature; Bibliometric study

Introduction

Highly cited journals are called core journals that always contain a higher concentration of articles belonging to a particular specialty. The concept of core journals was derived by Bradford in 1934. Journal articles belonging to a particular subject often follow the Bradford law - which states that, ‘‘If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus, when the number of periodicals in the nucleus and succeeding zones will be as 1: n: n^2, where ‘n’ is a multiplier[1].

Bradford termed the first zone as the nuclear zone, which is highly productive; the second zone as moderately productive; and the third zone as low productive. Sen named these three zones as nuclear zone, allied zone and alien zone[2]. The periodicals which figure in the nuclear zone are usually called core periodicals.

In the present study, Bradford's law was applied to a dataset comprising of 10,100 papers published in 738 journals originating from different parts of the globe, pertaining to six cereal crops (rice, wheat, barley, maize, sorghum and millets) as abstracted in *Indian Science Abstracts* and *CAB Abstracts* for the period 1965-2010 in gaps of five years.

Review of literature

A number of studies have been conducted to test the applicability of Bradford’s law of scattering. Bandopadhyay studied the application of Bradford law in the field of mathematics, physics, mechanical engineering, philosophy and political science based in the theses submitted to University of Burdwan during 1981-90 and found that the data for all subjects follow Bradford’s law, except political science[3].

Sudhier attempted to test the Bradford law with doctoral theses submitted at the Indian Institute of Science, Bangalore[4]. The dataset did not follow Bradford’s law. The author extended the law and calculated constant k for first two zones only, but the modification was logically not correct since it did not follow the Bradford formulation. Therefore, Leikuhler formulation was applied to distributed papers.

Shahabuddin experimented with the data pertaining to neuroscience research in India for the period 1992-2005 using *Neuroscience Citation Index* and *Pubmed*

and found the data to be a perfect fit for the Bradford law of scattering[5].

Wardikar and Gudadhe applied Bradford law to the data generated using doctoral theses in the field of library and information science submitted to universities of Maharashtra during 1982-2010[6]. They found that the dataset does not fit into Bradford's law. However, the dataset followed the law according to Leimkuhler formulation.

A study conducted by Ram and Paliwal with psoriasis literature published during 1960-2009 found that the dataset does not fit into the Bradford law. However, here also the data were found compatible with Leimkuhler formulation[7].

Singh and Bebi applied Bradford's law to find out the core journals in the field of social sciences based on social science theses. They found the collected data fit into the Bradford's law[8].

As can be seen, in many studies the datasets do not fit into Bradford's law. However, the datasets fitted well into Leimkuhler formulation. In the present study, both Leimkuhler formulation and Bradford's law were tested.

Objectives of the study

- To prepare a list of most productive journals in the field of crop science research; and
- To test whether or not the dataset follows Bradford's law, as well as Liemkuhler formulation.

Methodology

Data from *CAB Abstracts* and *Indian Science Abstracts* pertaining to six crops, i.e. rice, wheat, barley, maize, sorghum and millets were downloaded for the period 1965-2010 with 5-year gaps essentially to limit the size of data. As two databases were used to collect data, a number of duplicate records were found. After removing duplicates, 10,100 unique records were used for the analysis. The records pertained to 738 journals (Table 1).

To test the applicability of Bradford's law to the dataset, the articles were roughly divided in three

Table 1—Journals productivity in descending order

Rank	No. of journals	No. of papers	Cumulative no. of papers
1	1	435	435
2	1	432	867
3	1	368	1235
4	1	313	1548
5	1	265	1813
6	1	249	2062
8	2	248	2558
9	1	230	2788
10	1	200	2988
11	1	161	3149
12	1	160	3309
13	1	148	3457
14	1	143	3600
15	1	141	3741
16	1	132	3873
17	1	112	3985
18	1	111	4096
19	1	109	4205
20	1	99	4304

Contd—

Table 1—Journals productivity in descending order

—Contd

Rank	No. of journals	No. of papers	Cumulative no. of papers
21	1	95	4399
22	1	93	4492
23	1	85	4577
24	1	82	4659
25	1	80	4739
26	1	75	4814
27	1	71	4885
28	1	69	4954
29	1	68	5022
30	1	67	5089
31	1	66	5155
32	1	63	5218
33	1	61	5279
35	2	60	5399
36	1	59	5458
37	1	57	5515
40	3	56	5683
41	1	55	5738
42	1	53	5791
43	1	52	5843
44	1	50	5893
45	1	49	5942
46	1	48	5990
48	2	45	6080
49	1	44	6124
51	2	43	6210
53	2	41	6292
55	2	40	6372
56	1	39	6411
59	3	38	6525
61	2	37	6599
64	3	36	6707
67	3	35	6812
70	3	33	6911
74	4	32	7039
77	3	30	7129
80	3	29	7216
82	2	28	7272
84	2	27	7326
87	3	26	7404
89	2	25	7454

Contd—

Table 1—Journals productivity in descending order

—Contd

Rank	No. of journals	No. of papers	Cumulative no. of papers
92	3	24	7526
95	3	23	7595
98	3	22	7661
100	2	21	7703
104	4	20	7783
109	5	19	7878
111	2	18	7914
117	6	17	8016
119	2	16	8048
122	3	15	8093
132	10	14	8233
139	7	13	8324
148	9	12	8432
157	9	11	8531
166	9	10	8621
173	7	9	8684
194	21	8	8852
213	19	7	8985
237	24	6	9129
258	21	5	9234
308	50	4	9434
373	65	3	9629
479	106	2	9841
738	259	1	10100

Table 2—Distribution of data in Bradford zones

	No. of journals	No. of papers	Percentage	Bradford multiplier
1	12	3309	32.76	1
2	54	3434	34.00	4.50
3	672	3357	33.24	12.45
Total	738	10100	100	

equal parts. In this case, each zone accounts for about 3366 articles. Table 2 depicts the data in three Bradford zones.

It may be seen that the Bradford multiplier in the second zone is 4.50 and the third zone is 12.45. The difference in the value of the multiplier is too high, almost three times. Hence, it is concluded that the dataset does not fit into Bradford's law.

Probably two factors are responsible for this anomaly. First the data is not comprehensive as they do not pertain to the entire period 1965 to 2010, but of the years 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005 and 2010. Secondly, the data of six different crops were merged. If a comprehensive bibliography is compiled on any one of the crops for the whole period without any gap, possibly

Bradford's law will fit into the dataset. The core journals identified are given in Table 3.

An attempt has also been made to see whether the dataset follows Leimkuhler's formulation.

Leimkuhler[9] developed a model based on Bradford's verbal formulation as:

$R(r)= a \log(1+br)$ … (Eq. 1)

Egghe (1986) considered $R(r) = y_0$ and $1+br = K$

Using these values Eq. 1 would be:

$y_0 = a \log K$ … (Eq. 2)

Thus $a = y_0/\log K$ … (Eq. 3)

And $b= (K-1)/r_0$ … (Eq. 4)

r_0 is the number of sources in the first Bradford's group, y_0 is the number of items in every Bradford group (all these groups of items being of equal sizes) and K is the Bradford multiplier.

R(r) is the cumulative number items produced by the sources of rank 1,2,3…r, and a and b are constants appearing in the law of Leimkuhler. In forming Bradford groups, it is shown that the number of groups p is a parameter that can be chosen freely.

Egghe[10] has given a mathematical formula for calculating the Bradford multiplier as

$K= (e^y y_m)^{1/p}$ ... (Eq. 5)

where e^y is the Euler's number (value 1.781)

Putting the value of e^y in Eq. 5, we get

$K= (1.781\ y_m)^{1/p}$ … (Eq. 6)

Let us denote the total number of journals in Bradford group as T, and $T = r_0k^{i-1}$, where (i=1,2,3,4,...,p)

$T= r_0k^0+r_0k^1+r_0k^2+r_0k^3+.....+r_0k^{p-1}$ [p^{th} term of the sequence =0+(p-1)1=p-1]

So, $r_0= T/[(1-k^p)/(1-k)]$ [the sum of numbers in geometric progression ie $k^0+k^1+k^2+.....+k^{p-1}$]

$r_0= T(k-1)/(K^P-1)$

A and T are known from data set, r_0 and y_0 are calculated. P is calculated by the formula

Maximum number of papers $y_m= 435$

Total number of journals T=738

p = number of zones, i.e. 3

$y_0=A/p= 10100/3= 3367$, where A= total number of papers and

$K= (1.781x\ 435)^{1/3} = (774.735)^{1/3}$

Taking log both sides

$Logk= (1/3)\log (774.735) = (1/3) (2.89) = 0.96$

Table 3—List of core journals

Sl. no.	Journal	Number of papers	Impact Factor
1	*Indian Journal of Agricultural Sciences*	435	0.177
2	*Indian Journal of Agronomy*	432	NA*
3	*Madras Agricultural Journal*	368	NA*
4	*Journal of Maharashtra Agricultural University*	313	NA*
5	*Oryza*	265	NA*
6	*Environment and Ecology*	249	NA*
7	*Crop Research*	248	NA*
8	*International Rice Research Newsletter*	248	NA*
9	*Journals of Indian Society of Soil Science*	230	NA*
10	*Indian Journal of Genetics & Plant Breeding*	200	0.198
11	*Indian Journal of Weed Science*	161	NA*
12	*Annals of Agricultural Research*	160	NA*

NA = Not available in JCR 2013*

Table 4—Distribution of papers according to zones

Zone	Number of journals	No. of papers	Percentage
1	8	2558	25.3
2	69	4353	43.1
3	661	3189	31.6
Total	738	10100	100

K= antilog of 0.96 = 9.12

r_0= T(k-1)/K^p-1= 738(9.12-1)/(9.12^3-1)
= 738 x 8.12/ 757.55 = 7.91

a = y_0/logk = 3367/0.96= 3507.29;
b= (k-1)/r_0 = (9.12-1)/7.91 = 1.026

7.91: 7.91 x 9.12: 7.91 x $(9.12)^2$
= 7.91 : 72.14 : 657.91

Table 4 indicates that the number of periodicals in the first zone is eight with 2558 papers, which falls short by 809 papers with a deviation of 24%. In the second zone, the number of papers crosses the limit by 986 papers indicating a deviation of 29%. Only the third zone comes close to the expected number. With such a great deviation ranging from 24% to 29% we cannot say the dataset follows Bradford's law even with Leimkuhler formulation. Bradford law straightforwardly underlines the fact that each zone should have the same number of articles. A slight variation in the number of articles, say up to four or five per cent may be acceptable. The law never emphasizes Bradford multiplier for its verification. Since the equal multiplier is not a guarantee that the dataset follows Bradford law.

Conclusion

Scattering of crop science literature as reflected through *Indian Science Abstracts* and *CAB Abstracts* does not fit into the Bradford's distribution pattern. The method developed by Leimkuhler and expanded by Egghe was also applied for the study in order to test the application of Bradford's Law of Scattering to the crop science data which also failed. There is no guarantee that every dataset will follow Bradford's law.

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