
Analysing Soil Science Research Productivity using Bradford's Law of Scattering: 2020-2024: A Bibliometric Study

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Abstract

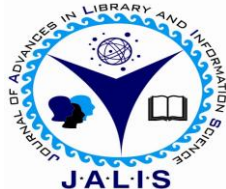
The present paper explores the scientific output of 'Soil Science Research' from 2020 to 2024. The information was gathered from the Web of Science database and analyzed using the Bibexcel Software. The study examines the Year-wise distribution of the publication research output, author-wise pattern, country-wise distribution of the publication, language-wise distribution, etc. The study revealed that most of the publications were found in 2024 (25.48%). The maximum number of publications was found in the Peoples R China (955). 2,402 records were retrieved and analysed by Bibexcel and VOSviewer Software.

Keywords

Bibliometric Study; Degradation; Management;
Nitrogen, Soil.

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1. Introduction

The science of bibliometrics is multidisciplinary and interdisciplinary. The science of bibliometrics is an interdisciplinary study that assesses several aspects of library and information science. "Information processes and information handling in libraries and information centers by quantitatively analyzing the characteristics and behavior of documents, library staff, and library users" is the focus of the field of bibliometrics. Metrics is derived from the Latin/Greek word "Metricus" or "Metrikos," which means measurement, whereas biblio is derived from the Latin/Greek word "biblio," which means books. The application of mathematical and statistical techniques to books and other communication mediums is the focus of bibliometrics, according to Alan Pritchard (1969). Fairthorne (1969) defined it as a quantitative analysis of the characteristics of recorded conversation and behaviour as they appear in it. The study of soil as a natural resource on Earth's surface, including its formation, classification, and mapping, as well as its physical, chemical, biological, and fertility characteristics and how they relate to soil use and management, is known as soil science. In terms of analytical concepts and operational methods, which are generated by disciplines like physics and physical chemistry, the future development of these specialised fields within soil science will be heavily reliant on other sciences. Soil science is the study of soil as a natural resource on the Earth's surface, including soil formation, classification, and mapping, and the physical, chemical, biological, and fertility properties of soils and these properties about the use and management of soils. As a discipline, soil science is relatively new compared to other sciences like mathematics or astronomy, which have been around for more than 2000 years.

2. Review of Literature

This paper presents a bibliometric analysis of research trends in soil nutrients using data from the Web of Science core collection and software tools like Vosviewer, HistCite, and Citespace. The results show an exponential increase in publication outputs between 1992 and 2020, with the overall contribution of journals, authors, institutions, and countries ranked using the synthetic parameter of the sum of normalized data (SND). The number of Russian journals publishing papers on soil science has expanded by over six times in just 14 years (2005-2018), with the fastest rate of growth between 2016

and 2018. Citation research shows that the Web of Science Core Collection (WoS CC) and Scopus databases have a higher citation rate. Brazil ranks fifth globally in soil science research between 1989 and 2018, with Empresa Brasileira de Pesquisa Agropecuária making the largest contribution to the collection of soil science publications.

Objectives

The main objectives of the study are as follows:

1. To analyze the year-wise distribution of the publications.
2. To identify the document type of the publications.
3. To know the country-wise distribution of the publications in Soil Science Research.
4. To determine the Authorship pattern of the publications.
5. To apply Bradford's law of scattering and Zipf's law of words of occurrence.

3. Methodology

The present study aims to analyze the research publications on "Soil Science Research". The study required data collected from the Web of Science Core Collection published by Clarivate Analytics. The basic search strategy has been used for collecting data about the publication "Soil Science Research" and the period was 2020-2024. 2,402 publications have been taken up for the study. Year-wise distribution of the publications, language-wise distribution of the publication, author-wise distribution of the publications and types of document type of the publications, etc., were recorded and analyzed by using the Bibexcel and VOSviewer Software.

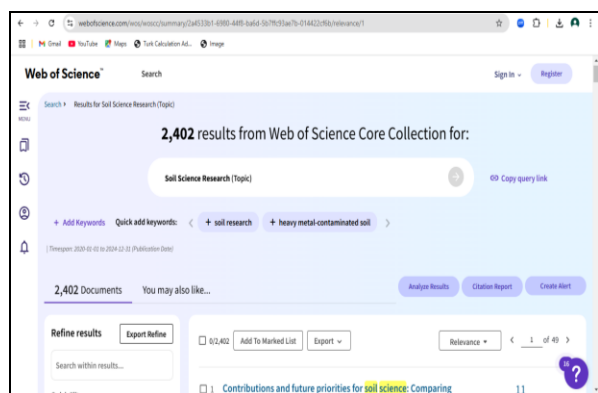


Figure 1. Web of Science Research Output

4. Data Analysis and Discussion

Table: 1 Year-wise Distribution of the Publications

S.No	Years	Record	Percentage
1.	2020	376	15.78
2.	2021	398	16.57
3.	2022	523	21.77
4.	2023	490	20.40
5.	2024	612	25.48
Total		2,402	100

Table 1 shows the year-wise distribution of Soil Science Research during 2020-2024 (five years). The total number of articles published was 2,402. Out of 2,402 articles, the top most number of articles published was in the year 2024 with 612 (25.48%) records, followed by 523 (21.77%) records in the year 2022, 490 (20.40%) records published in the year 2023 and 398 (16.57%) records were published in the year 2021. The lowest number of articles published was 376 (15.78%) in the year 2020.

Table: 2 Language-wise distribution of the publication

S.No	Language	Records	% of 2,402
1.	English	2,389	99.46
2.	Chinese	4	0.18
3.	French	2	0.08
4.	German	2	0.08
5.	Polish	2	0.08
6.	Korean	1	0.04
7.	Russian	1	0.04
8.	Turkish	1	0.04

Table 2 reveals that a maximum of 2,389 records (99.46%) were published in English, and 4 (0.18%) were published in the Chinese Language. 2 were published in French, German, and Polish. Each record was published in Korean, Russian and Turkish Language on Soil Science Research.

Table 3 Citation Analysis of Soil Science Research

Year	Records	Citing Article		Time Cited		H – Index
		Without Self- Citation	Total	Without Self- Citation	Total	
2020	379	11,043	11,061	11,456	11,482	52
2021	398	10,281	10,305	10,597	10,624	50
2022	523	6,785	6,808	7,015	7,040	36
2023	490	3,354	3,367	3,479	3,498	25
2024	612	1,064	1,084	1,115	1,137	12
	2,402		32,625		33,781	

Table 3 shows records were published between 2020 and 2024, the data shows a decreasing trend in overall citations. While 612 records received only about 1,100 citations in 2024, 379 records received over 11,000 citations in 2020. This implies that although the amount of research produced has grown, its overall influence has decreased over time. This decrease is also reflected in the H-index, which fell from 52 in 2020 to just 12 in 2024. Newer articles are not being mentioned as regularly or often when the H-index is lower. After 2021, there is the biggest decline in citations, going from over 10,000 in 2021 to over 6,800 in 2022 and then to roughly 3,300 in 2023.

Table: 4 Document-wise distribution of the publication

S. No	Document Types	Records	Percentage
1.	Article	1,647	68.57
2.	Review Article	709	29.52
3.	Editorial Material	41	1.71
4.	Early Access	40	1.66
5.	Data Paper	8	0.33
6.	Book Chapters	7	0.29
7.	Proceeding Paper	4	0.17
8.	Letter	3	0.12
9.	Biographical Item	2	0.08
10.	Retracted Publication	1	0.04

Table 4 The analysis of the distribution of Soil Science Research by document type of publication was done. There are about 10 types of documents published. The study is classified into broader groups: Article, Review Article, Editorial Material, Early Access, Data Paper, Book Chapter, etc. The

majority of the contribution 1,647 (68.57%) are Articles, followed by Review Articles 709 (29.52%). By large, it is found that the academic literature and scholarly communication of Soil Science Research output is found through Articles and Review Articles.

Table: 5 Country Wise distribution of the publication

S.No	Country	Records	Percentage
1.	Peoples R China	955	39.01
2.	USA	476	19.44
3.	England	153	6.25
4.	Australia	150	6.13
5.	India	150	6.13
6.	Germany	135	5.52
7.	Canada	119	4.86
8.	Brazil	114	4.66
9.	France	98	4.00
10.	Italy	98	4.00

Table 4.5 reveals the country-wise distribution of the publications in Soil Science Research, Peoples R China topped the list with the highest share of 955 (39.01%) publications. The USA ranked second position with a share of 476 (19.44%) publications followed by England with a share of 153 (6.25%) records. Australia and India ranked fourth position with a share of 150 (6.13%) publications, Germany with 135 (5.52%) publications, Canada with a share of 119 (4.86) publications, and so on. France and Italy ranked in the eighth position with a share of 98 (4%) publications.

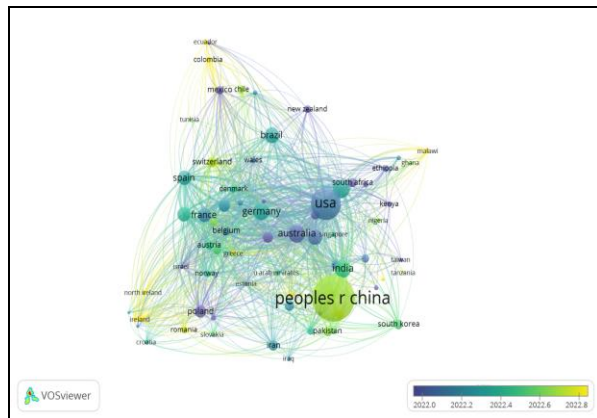


Figure 2 Visualization of the country-wise distribution

Table: 6 Authors-wise distribution of the publication

Authors	2020	2021	2022	2023	2024	Total
One Author	28	20	24	22	24	118
Two Authors	49	36	48	44	52	229
Three Authors	55	75	66	67	66	329

Table 7 Single Author Vs Joint Authors Vs Collaborative Author

Year	Single Author		Joint Authors		Collaborative Authors		Total	Percentage
	Records	%	Records	%	Records	%		
2020	28	23.73%	49	21.40%	302	14.70%	379	15.78%
2021	20	16.95%	36	15.72%	342	16.64%	398	16.57%
2022	24	20.34%	48	20.96%	451	21.95%	523	21.77%
2023	22	18.64%	44	19.21%	424	20.63%	490	20.40%
2024	24	20.34%	52	22.71%	536	26.08%	612	25.48%
Total	118	100%	229	100%	2,055	100%	2,402	100%

Table 4.7 shows the percentage of collaborative authors rising from 14.7% in 2020 to 26.08% in 2024, the data shows a growing trend in collaborative authorship over time. This points to a move toward interdisciplinary research and teamwork. Conversely, the percentage of single-author publications has fluctuated but stays very low, peaking at 23.73% in 2020 and stabilizing at 20.34% in 2022 and 2024. Joint authorship also indicates a rising tendency, climbing from 21.40% in 2020 to 22.71% in 2024. Nonetheless, joint authorship has seen the biggest increase, suggesting that research is increasingly being done across fields and organisations. The total number of documents increased from 379 in 2020 to 612 in 2024, indicating a growing output of research.

Four Authors	58	55	75	75	68	331
Five Authors	59	57	66	73	90	345
Six Authors	36	52	62	48	69	267
Seven Authors	24	21	44	48	61	198
Eight Authors	16	15	42	28	58	159
Nine Authors	21	15	31	27	49	143
Ten Authors	3	13	15	12	14	57
Above Ten Authors	30	39	50	46	61	226
Total	379	398	523	490	612	2,402

In Soil Science Research the Authorship Pattern – Year Wise has been analyzed as shown in Table 4.6. The table reveals that in the year-wise authorship pattern of article publications in the research areas of the total 5 years, the five authors scored in first place have contributed 345. The second and third place scores for four authors and three authors in each 331 and 329 Counts. The six and two authors scored fourth and fifth place in each 267 and 229 Counts.

Table: 8 Single Author Vs Multiple Authors

Year	Single Author		Multiple Authors		Total
	No.of. Output	Percentage	No.of. Output	Percentage	
2020	28	23.73	351	15.37	379
2021	20	16.95	378	16.55	398
2022	24	20.34	499	21.85	523
2023	22	18.64	468	20.49	490
2024	24	20.34	588	25.74	612
Total	118	100	2,284	100	2,402

Table 4.8 shows the Research Output of Single Versus Multiple Authors. The highest number of publications by a Single Author is 28 records in the year 2020, followed by 24 records in the year 2022 and 2024, 22 records in the year 2023, and 20 records in the year 2021. It is also known that as many as 588

records were published by Multiple Authors in the year 2024, followed by 499 records in the year 2022, 468 records in the year 2023, 378 records in the year 2021, and 351 records in the year 2020.

Table:9 Author wise Vs Paper wise distribution of the publication

S. No	Year	No of Author	No. of Paper	AAPP	APPA
1.	2020	379	345	1.10	0.91
2.	2021	398	391	1.00	0.98
3.	2022	523	458	1.14	0.87
4.	2023	490	503	0.97	1.03
5.	2024	612	650	0.94	1.06
Total		2,402	2,347	1.03	0.97

$$\text{AAPP (Average Authors Per Paper)} = \frac{\text{No. of Authors}}{\text{No. of Papers}}$$

$$\text{APPA (Average Productivity Per Author)} = \frac{\text{No. of Papers}}{\text{No. of Authors}}$$

Table 9 shows that the author's average frequency per paper was 1.03 for 2,347 publications published between 2020 to 2024. The year 2024 had the leading publications per author (1.06). The analysis determined that 2,402 authors contributed to 2,347 papers with an average output of 0.97 for each author.

Table: 10: Keyword-wise distribution of the publication

S.No	Words	Records	Percentage
1.	Soil	292	17.38
2.	Water	143	8.51
3.	Science	134	7.98
4.	Management	129	7.68
5.	Climate-Change	119	7.08
6.	Carbon	108	6.43
7.	Heavy-Metals	100	5.95
8.	Growth	94	5.60
9.	Model	91	5.42
10.	Impact	90	5.36
11.	Diversity	87	5.18
12.	Organic-Matter	77	4.58
13.	Quality	74	4.40
14.	Nitrogen	72	4.29
15.	Degradation	70	4.16
Total		1,680	100

Table 4.10 A total of 1,680 words are in the Publications that are considered for the study of Soil Science Research. Among the words "Soil" occurs in 292 records of the publications, taking up the first position in frequency, followed by the word "Water" which occurs in 143 records occupying the second position in frequency, the word "Science" which occurs in 134 records occupying the third position in frequency, the word "Management" which occurs in 129 records with the fourth position in frequency.

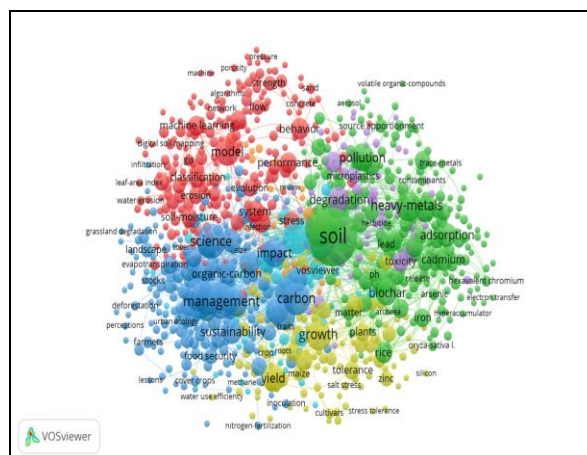


Figure 3 Visualization Map of Keyword Occurrence

4.1.1 Zipf's Law of Word Occurrence

George Kingsley Zipf developed his law in 1935 to forecast how frequently words appear in a book. The law states that the rank of a word on a list multiplied by its frequency will be equal to a constant if the words that appear in a fairly long text are listed in decreasing order of frequency.

$$r \times f = C \text{ (where C is Constant)}$$

Taking log on both sides, $\text{Log } r \times \text{Log } f = \text{Log } C$

To apply this law, the terms gathered from the article titles are arranged in decreasing order of word occurrence frequency.

Table: 11 Ranking of Word Occurrence

S.No	Words	Frequency	Rank	Log R	Log F	Log C
1.	Soil	292	1	0	2.47	0
2.	Water	143	2	0.31	2.16	0.67
3.	Science	134	3	0.48	2.13	1.02
4.	Management	129	4	0.60	2.11	1.27
5.	Climate-Change	119	5	0.70	2.08	1.46

6.	Carbon	108	6	0.78	2.03	1.58
7.	Heavy-Metals	100	7	0.85	2.00	1.70
8.	Growth	94	8	0.91	1.97	1.79
9.	Model	91	9	0.96	1.96	1.88
10.	Impact	90	10	1.00	1.95	1.95
11.	Diversity	87	11	1.04	1.94	1.08
12.	Organic-Matter	77	12	1.08	1.89	2.04
13.	Quality	74	13	1.11	1.87	2.07
14.	Nitrogen	72	14	1.15	1.86	2.14
15.	Degradation	70	15	1.18	1.85	2.18

Table 4.11 only includes terms that have a frequency of up to 1,680. After this law was applied, the log of the frequency of occurring terms was discovered. The findings are nearly identical for each term when added to the log of their rank. On applying Zipf's law, it is found that the frequency of occurrence of words when added to the log of their rank is almost the same for each word. The log of the frequency of the words in the title, "Soil" and "Impact", is given below.

1. Words: SOIL

Frequency: 292

Rank: 1

Log of Frequency \times Log of Rank

Log 292 \times Log 1

$= 2.47 \times 0$

$= 0$

2. Words: IMPACT

Frequency: 90

Rank: 10

Log of Frequency \times Log of Rank

Log 90 \times Log 10

$= 1.95 \times 1.00$

$= 1.95$

Thus, it is proved that Zipf's law is valid.

4.1.2 Bradford Law of Scattering

Bradford (1934) reviewed two bibliographies on Applied Geophysics (1928–31) and Lubrication (1931–32) that were generated in the Science Library. He also created a list of journals listed in decreasing order of the source materials that the journals gave to the bibliographies. Periodicals in the list are arranged according to declining productivity. Bradford Law identified three groups of periodicals in the list of periodicals listed by decreasing productivity. These groups produced almost the same number of articles

on the subject, but the number of periodicals in these three zones increased constantly.

Table 12 Bradford Law of Scattering

S. No	No. of Journals	Cumulative No. of Journals	No. of Article	Cumulative No. of Journals	Log (n)	Zones
1.	1	1	317	317	0	
2.	1	2	168	485	0.3	
3.	1	3	64	549	0.48	
4.	1	4	42	591	0.6	
5.	1	5	39	630	0.7	
6.	1	6	37	667	0.78	
7.	1	7	33	700	0.84	
8.	1	8	32	732	0.9	
9.	1	9	29	761	0.95	Zone 1
10.	3	12	81	842	1.08	
11.	2	14	50	892	1.15	
12.	2	16	42	934	1.2	
13.	1	17	20	954	1.23	
14.	1	18	19	973	1.25	
15.	1	19	18	991	1.28	
16.	1	20	17	1008	1.3	
17.	3	23	45	1053	1.36	
18.	2	25	28	1081	1.4	
19.	3	28	39	1120	1.45	
20.	1	29	12	1132	1.46	
21.	4	33	44	1176	1.52	
22.	6	39	60	1236	1.59	
23.	3	42	27	1263	1.62	
24.	8	50	64	1327	1.7	
25.	12	62	84	1411	1.79	
26.	14	76	84	1495	1.88	
27.	17	93	85	1580	1.97	Zone 2
28.	23	116	92	1672	2.06	
29.	36	152	108	1780	2.18	
30.	105	257	210	1990	2.41	
31.	452	709	452	2442	2.85	Zone 3
	709		2442			

We are applying the Bradford's Law,

1	N	n ²
814	1628	2442

According to Bradford's law, the zones thus identified will form an approximately geometric series in the form 1:n:n². However it is found that the relationship of each zone in the present study is 9:84:616. This fit into Bradford's distribution. Here, 9 represents the number of periodicals in the nucleus and

$$n = 8.33, 9 : 9 \times 8.33 : 9 \times 8.33^2$$

9:

$$74.97: 9 \times 69.39$$

$$9: 74.97: 624.51 = 708.48$$

The percentage error = 100, = - 0.0010 ×
 The percentage error = $\frac{708.48-709}{709} \times 100$ = - 0.1%
 100 Here the percentage of error is low and the present data will confirm Bradford's Law.

$$= \frac{-0.52}{709} \times 100$$

Table 13 The Bradford's Distribution of Journals

Scatter of Journals and Articles over Bradford's Zone					
Zones	No. Of. Journals	% of Journals	No. Of. Articles	% of Articles	Bradford Multiplier
1	9	1.27	761	31.16	0
2	84	11.85	819	33.54	9.33
3	616	86.88	862	35.30	7.33
	709	100	2,442	100	16.66
Mean Value of Bradford Multiplier					8.33

Table 13 indicates that the first nine journals covered the first one-third of the total articles published. The next eighty-four journals covered another one-third of the articles. The remaining 616 journals covered the last one-third of the published articles. According to Bradford's distribution, the relationship between the three zones is 1:n:n², the relationship in each zone of

the present study. The easy and interesting observation from the table is the number of journals in each zone. Bradford's formulation when applied to the present study gives the observed number of journals in the three zones as 9:84:616. According to Bradford, the relationship between the zones is 1:n:n². The mean value of the multiplier is **8.33**.

6. Findings

- A total of 2,402 Publications were published at a global level. Among them, the highest Publication of 612 records was found in the year 2024, followed by 523 records in the year 2022, 490 records in the year 2023, 398 records in the year 2021, and 376 records in the year 2020.
- 68.57% (1,647 records) of the overall publications on Soil Science Research were find and followed by Review articles with 29.52% (709 records), Editorial Materials with 1.71% (41 records) and the document types like Early Access, Data Paper, and Proceeding, etc.
- A year-wise authorship pattern of article publications in the research areas of the total 5 years, the five authors scored in first place have contributed 345. The second and third place scores for four authors and three authors in each 331 and 329 Counts. The six and two authors scored fourth and fifth place in each 267 and 229 Counts.
- Peoples R China topped with 955 records (39.01%), followed by the USA with 476 records (19.44%), England with 153 records (6.25%),

Australia and India with 150 records (6.13%), Germany with 135 records (5.52%), Canada with 119 records (4.86%) and Brazil with 114 records (4.66%) research publication respectively.

6. Conclusion

This study has highlighted Bibliometric analysis such as measuring various reviews such as Year-wise distribution of the publications, Language-wise distribution of the publications, Authorship pattern of the publications, and Country-wise distribution of the publications which can be used for observations analysis of this article. The most commonly used keywords in publications on Soil Science Research during this period were "Soil", "Nitrogen", and "Degradation". It has been identified that Soil Science Research has a significant scope for research.

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