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## Research Performance of Indian Council of Agricultural Research (ICAR): A Scientometric Study

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**P. N. Sindhu**

Research Scholar,  
Dept. of Library & Information Science  
Alagappa University, Karaikudi, Tamil Nadu, India  
[sindhugauthu@gmail.com](mailto:sindhugauthu@gmail.com)

**S. Kishore Kumar**

Deputy Librarian, University Library  
Alagappa University, Karaikudi, Tamil Nadu, India  
[libkishore@yahoo.com](mailto:libkishore@yahoo.com)

### Abstract

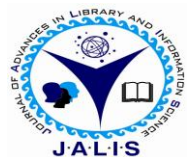
*The study examined scholarly research trends in agriculture from 2001 to 2023 using the Web of Science database. The total number of publications across all institutions was 1451; the highest number of records (146) was published in 2023, followed by 132 in 2022. Pearson's Correlation Coefficient value for TLCS and TGCS is identified (0.9663). The EGR value has not been in a standard position from 2012 to 2023. The mean EGR value is 0.87. The time series values are identified as negative and positive. The average degree of collaboration is impressive at 0.956581. The most prolific author is Kumar A (74 records), and the Centre for Environment Science and Climate Resilient Agriculture, ICAR-Indian Agricultural Research Institute, New Delhi, has produced more articles (86). Agriculture, Ecosystems & Environment claimed the top spot with 5.65 % of articles, followed by the Indian Journal of Agricultural Sciences (5.61%). The study found a positive trend across all ICAR institutes.*

### Keywords

Scientometrics, Agriculture Research, Exponential Growth, Bradford's law, ICAR

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## 1. Introduction

Scientometrics is defined as the 'quantitative study of science, communication in science, and science policy' (Hess, 1997: p. 75). What started as Eugene Garfield's idea of an index to improve information retrieval in the 1960s and resulted in the creation of the *Science Citation Index* (SCI) (Garfield, 1979; Wouters, 1999) was soon recognized as a novel instrument in the empirical study of the sciences (e.g., de Solla Price, 1965; Cole & Cole, 1973). The extent of scientometrics in this sense encompasses a few subjects, such as quantitative aspects of science, science strategy, science organisation, and so forth. In reality, the branch of knowledge, scientometrics, conducts quantitative investigations of the impact of all controls on science (BidyartiDutta). Scientometrics concerns the quantitative features and characteristics of science and logical analysis. Accentuation is set on examinations in which the events and system of science are concentrated by factual numerical strategies. Scientometrics is currently considered as a piece of the humanism of science and is applied to science strategy making. Along these lines, scientometrics includes concentrations in a) Sociology of Science, b) History of Science, c) Growth of Literature, d) Behaviour of Scientists, e) Science markers, and so on. The present study examines agricultural research in the Indian Council of Agricultural Research (ICAR) during the period from 2001 to 2023 and the required data for the study were downloaded from the Web of Science database.

The Indian Council of Agricultural Research (ICAR) functions as an autonomous body under the Department of Agricultural Research and Education (DARE), falling under the purview of the Ministry of Agriculture and Farmers Welfare, Government of India. Originally established as the Imperial Council of Agricultural Research, it was formally instituted on 16 July 1929 and operates as a registered society under the Societies Registration Act, 1860. Its inception followed recommendations outlined in the Royal Commission on Agriculture's report. As the apex body, ICAR is entrusted with coordinating, supervising, and facilitating agricultural research, education, and exploration across agriculture, fisheries, and animal sciences nationwide. CAR oversees four esteemed Deemed Universities, including the Indian Agricultural Research Institute, the National Dairy Research Institute, the Indian Veterinary Research Institute, and the Central Institute of Fisheries Education.

## 2. Review of Literature

Several studies have conducted bibliometric and scientometric assessments of research across ICAR institutes.

Hazarika and Sudhier (2025) in their study explored the research impact and collaboration of Central Agricultural University (CAU) and Manipur University (MU), India, between 2013 and 2022. A bibliometric analysis of 1,932 publications and 23,519 citations extracted from the Scopus database reveals a significant increase in publications. The analysis of co-authorship patterns indicates a decline in single and two-authored papers, while multi-authored papers have increased significantly. These findings indicate that both CAU and MU have significantly expanded their research networks, resulting in improved research output and citation impact. Akbar, Arif and Rafiq (2024) have analysed 2,868 research publications from 16 communication channels spanning the period from 2001 to 2020. The growth rate varied during the study period and the year 2020 was the most productive year of the organization. Most of the research was produced in multi-authorship and five authors were dominant. Pakistan Journal of Botany was the most preferred and cited source. Moreover, PARC research collaboration with Pakistani researchers was more than their international counterparts. Schneider et al (2024) investigated Hybrid breeding of wheat (*Triticum aestivum* L.) is limited by its self-pollinating nature. Past cross-pollination improvements mostly focused on optimising male traits. They tested the hybrid seed yield of 100 diverse elite lines treated with a chemical hybridisation agent (CHA) and pollinated by non-sterilised male plants in multi-environmental field trials. Plant height and phenological traits of female plants were also assessed.

Mitrović et al. (2023) examined research publications on the topic 'organic plant breeding' from the Web of Science database using bibliometric science-mapping and visualisation tools. The number of analysed documents in the bibliographic dataset was 204 from the 53 sources. The overall trend in the organic plant breeding literature showed that the number of publications increased during the observed time-span. We found that, in total, 65 countries and 337 institutions are active in organic plant breeding, with a high degree of international collaboration. The top five countries by number of publications were the

United States, Italy, Germany, France, and Canada, while the most active institutions were Wageningen University, Iowa State University, the University of Alberta, the University of Copenhagen, and the University of Hohenheim. Li et al. (2022) found that many reviews of agricultural research were conducted from different perspectives, but there is a lack of work analysing the research trend from large volumes of publications in the field of agricultural pollution. In the present work, a scientometric analysis of agricultural pollution was conducted to fill the gap using the software VoSviewer and HistCite. The datasets were collected from the Web of Science core database from 1991 to 2019, totalling 1338 records on agricultural pollution. In most years (1996, 1999, 2002, 2006, 2009, 2011, and 2013), the total local citation score (TLCS) and total global citation score (TGCS) have coincident peaks. Zhang, Ju, and Zhu have the highest TLCS and TGCS.

Nidhisha and Sarangapani (2021) depicted the co-authorship and collaboration patterns among 19990 publications of ICAR Deemed Universities during the 32-year period from 1989 to 2020, based on the Web of Science database. According to citation metrics, Singh A K emerged as the author with the most significant impact. The USA emerged as the most collaborative country, while the Indian Journal of Animal Sciences stood out as the most productive journal. Garg, Kumar, and Lal (2006) examined 16,891 publications by Indian scientists from 1993-2002, indexed in the Science Citation Index Expanded (Web of Science). Their findings suggested a decline in publication output in agricultural sciences since 1998, with agricultural universities and ICAR-affiliated institutes being the primary producers of research output. Most notably, highly productive institutions tended to be agricultural universities or ICAR-affiliated institutes.

## 3. Objectives

- To identify the year-wise research papers on agricultural research from 2001 to 2023
- To know the most prolific journals on agricultural research
- To test the Bradford law of journal distribution in agricultural research publications
- To measure the Exponential Growth Rate on agricultural research
- To apply Lotka's law for the author's productivity on agricultural research

- To test the Price Square Root law and Pareto Principle for the author's Productivity on agricultural research

#### 4. Methodology

Data were downloaded from Web of Science for 'Agricultural Research with all the terms for '23 years' from 2001 to 2023. A total of 1451 records were obtained from Web of Science database for this study. This study covers the most prolific authors, most prolific journals, and the degree of Collaboration for authors has also been discussed. An aggregate of 1451 records were downloaded and analyzed by using HistCite. To discover the nature of the examination, yield a portion of the scientometric methods and tools are utilized. The American Psychological Association (APA) way of referring to technique has been utilized in this investigation. The data gathered has been compiled into an MS Excel spreadsheet and dissected according to the investigation's outlined targets.

#### 5. Data Analysis

The present study aims to conduct a scientometric analysis of Agricultural research over 23 years, i.e., from 2001 to 2023. The examination aims to investigate the scrutiny profile of world researchers, the publication-based research output, publication types, exponential growth rates, most prolific authors, most prolific institutions, and so on.

##### 5.1 Year-wise growth of Publications

**Table 1:** Year-wise Publication on Agricultural Research

Sl. No.	Year	No. of Records	Percentage	TLCS	TGCS	Mean	Median	Mode	Range
1	2001	14	0.96	2	18	63.09	61	61	132
2	2002	23	1.59	2	108				
3	2003	32	2.21	3	240				
4	2004	37	2.55	0	1026				
5	2005	28	1.93	3	1260				
6	2006	44	3.03	1	342				
7	2007	39	2.68	8	334				
8	2008	47	3.24	10	1320				
9	2009	52	3.58	3	661				
10	2010	48	3.31	4	541				
11	2011	43	2.97	7	1463				
12	2012	61	4.20	10	1077				
13	2013	53	3.66	24	2510				
14	2014	65	4.48	72	1840				
15	2015	61	4.20	58	3388				
16	2016	63	4.34	23	3500				
17	2017	74	5.10	42	5276				
18	2018	82	5.65	60	4734				
19	2019	94	6.48	118	8675				
20	2020	103	7.10	326	12320				
21	2021	110	7.58	310	15611				
22	2022	132	9.10	440	20639				
23	2023	146	10.06	246	15872				
<b>Total</b>		<b>1451</b>	<b>100</b>	<b>1772</b>	<b>102755</b>				

*TLCS- Total Local Citation Score and TGCS- Total Global Citation Score*

The table 1 describes that during the period of study from 2001 to 2023, agricultural scientists published 1451 articles on agricultural Research. Analysis of the data indicates that the annual research output in the Agricultural Research was increased throughout the period of study, with highest number of 146

publications in the year 2023, 132 papers are published in 2022 with second place, 110 papers are produced in 2021 with third rank and the least number of publications was in the year 2001 with 14 records. Mean value is 63.09, median is 61, mode is 61 and range value is 132. Total TLCS is 1772 and TGCS is 102755.

**Table 2:** Application of Pearson's Correlation Coefficient for TLCS and TGCS

X - Mx	Y - My	(X - Mx) <sup>2</sup>	(Y - My) <sup>2</sup>	(X - Mx)(Y - My)
-75.043	-4449.609	5631.524	19799017.544	333914.113
-75.043	-4359.609	5631.524	19006187.979	327160.200
-74.043	-4227.609	5482.437	17872675.284	313026.853
-77.043	-3441.609	5935.698	11844670.414	265153.505
-74.043	-3207.609	5482.437	10288753.544	237502.505
-76.043	-4125.609	5782.611	17020647.110	313725.635
-69.043	-4133.609	4767.002	17086720.849	285398.722
-67.043	-3147.60	4494.828	9907440.501	211026.635
-74.043	-3806.609	5482.437	14490269.762	281854.548
-73.043	-3926.609	5335.350	15418255.849	286813.157
-70.043	-3004.609	4906.089	9027673.414	210453.244
-67.043	-3390.609	4494.828	11496227.327	227318.200
-53.043	-1957.609	2813.611	3832231.805	103838.374
-5.043	-2627.609	25.437	6904327.457	13252.287
-19.043	-1079.609	362.654	1165554.936	20559.505
-54.043	-967.609	2920.698	936266.588	52292.940
-35.043	808.391	1228.045	653496.501	-28328.843
-17.043	266.391	290.480	70964.327	-4540.234
40.957	4207.391	1677.437	17702141.588	172320.113
248.957	7852.391	61979.350	61660049.197	1954904.026
232.957	11143.391	54268.741	124175169.762	2595925.679
362.957	16171.391	131737.437	261513896.718	5869511.940
168.957	11404.391	28546.306	130060141.023	1926846.287
<b>Mx: 77.043</b>	<b>My: 4467.609</b>	<b>Sum: 349276.957</b>	<b>Sum: 781932779.478</b>	<b>Sum: 15969929.391</b>

Where,

X: X Values

Y: Y Values

Mx: Mean of X Values

My: Mean of Y Values

X - Mx & Y - My: Deviation scores

(X - Mx)<sup>2</sup> & (Y - My)<sup>2</sup>: Deviation Squared

(X - Mx)(Y - My): Product of Deviation Scores

**Result Details & Calculation**

X Values

$\sum = 1772$

Mean = 77.043

$\sum(X - Mx)^2 = SSx = 349276.957$

Y Values

$\sum = 102755$

Mean = 4467.609

$\sum(Y - My)^2 = SSy = 781932779.478$

X and Y Combined

N = 23

$\sum(X - Mx)(Y - My) = 15969929.391$

R Calculation

$r = \frac{\sum((X - Mx)(Y - My))}{\sqrt{(SSx)(SSy)}}$

$r = \frac{15969929.391}{\sqrt{(349276.957)(781932779.478)}}$

= 0.9663

Meta Numeric (cross-check)

r = 0.9663

The value of R is 0.9663.

This is a strong positive correlation, which means that high X variable scores go with high Y variable scores (and vice versa).

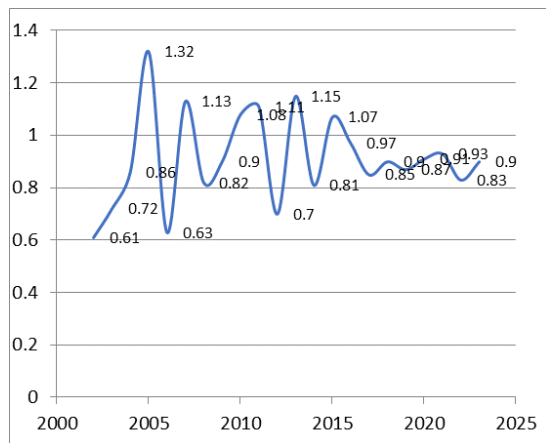
The value of R<sup>2</sup>, the coefficient of determination, is 0.9337.

**5.2 Exponential Growth Rate**

**Table 3:** Exponential Growth Rate

Sl. No.	Year	No. of Records	EGR
1	2001	14	-
2	2002	23	0.61
3	2003	32	0.72
4	2004	37	0.86
5	2005	28	1.32
6	2006	44	0.63
7	2007	39	1.13
8	2008	47	0.82
9	2009	52	0.90
10	2010	48	1.08
11	2011	43	1.11
12	2012	61	0.70
13	2013	53	1.15
14	2014	65	0.81
15	2015	61	1.07
16	2016	63	0.97
17	2017	74	0.85
18	2018	82	0.90
19	2019	94	0.87
20	2020	103	0.91
21	2021	110	0.93
22	2022	132	0.83
23	2023	146	0.90
Total		1451	20.07

*\*Mean value for ECR is 0.87*



**Figure 1:** Exponential Growth Rate

Table 3 discovers that the exponential growth value has been increased from 2001 to 2005 (0-1.32). The EGR value is decreased in 2006 (0.63). Further, the value has been increased in 2007 (1.13). The EGR values being decreased in 2008 (0.82). From the year 2009 to 2011, the EGR value has been increased (0.90-1.11). The EGR value has not been in standard position from 2012 to 2023. The mean value of EGR is 0.87.

**5.3 Time series analysis on Agricultural Research**

**Table 4:** Time series analysis on Agricultural Research

Year	No. of Records (Y)	X	X <sup>2</sup>	XY
2001	14	-9.5	90.25	-133
2002	23	-8.5	72.25	-1955
2003	32	-7.5	56.25	-240
2004	37	-6.5	42.25	-2405
2005	28	-5.5	30.25	-154
2006	44	-4.5	20.25	-198
2007	39	-3.5	12.25	-1365
2008	47	-2.5	6.25	-1175
2009	52	-1.5	2.25	-78
2010	48	-0.5	0.25	-24
2011	43	0.5	0.25	21.5
2012	61	1.5	2.25	91.5
2013	53	2.5	6.25	132.5
2014	65	3.5	12.25	227.5
2015	61	4.5	20.25	274.5
2016	63	5.5	30.25	346.5
2017	74	6.5	42.25	481
2018	82	7.5	56.25	615
2019	94	8.5	72.25	799
2020	103	9.5	90.25	978.5
2021	110	10.5	110.25	1155
2022	132	11.5	132.25	1518
2023	146	12.5	156.25	1825

Table 4 exposes that the time series analysis on Agricultural Research during the study period from 2001 to 2023. It is confirmed that the time series analysis value (XY) on productivity of agricultural research has been in negative values (-133)-(-24) from 2001 to 2010. It is explored that the time series analysis value (XY) in field of agricultural research

has been in positive values (21.5-1825) from 2011 to 2023. It is focused that the time series value was in negative position for first ten years and the next thirteen years was in positive values on agricultural research during the twenty-three years period of study.

**5.4 Authorship Pattern**

**Table 5: Authorship Pattern**

Sl. No	Authors	No of Records	Cumulative	Percentage
1	Single	63	63	4.34
2	Two	87	150	6.00
3	Three	95	245	6.55
4	Four	110	355	7.59
5	Five	119	474	8.20
6	Six	131	605	9.02
7	Seven	140	745	9.65
8	Eight	154	899	10.61
9	Nine	163	1062	11.23
10	Ten	182	1244	12.54
11	More than Ten	207	1451	14.27
<b>Total</b>		<b>1451</b>	<b>-</b>	<b>100.00</b>

Table 5 focused that more than ten authored contribution (14.27%) is found to be most prime, followed by ten authored communications (12.54%), nine authored publications (11.23%), eight authored records (10.61%), seven authored contributions (9.65%), six authored papers (9.02%), five authored communications (8.20%), four authored publications (7.59%), three authored contributions (6.55%), two authored publication is 6.00% and single authored contributions were occupied as the least position (4.34%).

**5.5 Degree of collaboration**

**Table 6: Degree of collaboration**

Sl. No.	Authors	Contributions
1	Single authors	63
2	Multi- authors	1388
Degree of Collaboration		0.956581

Degree Collaboration (DC), a proxy measure for research collaboration among the contributors was

conceived by using Subramaniam formula, as the ratio of the number of collaborative contributions to the total number of research contributors published in the discipline during the certain period of time. Mathematically it can be referred to as, DC = Nm/Nm+Ns or,

$$DC = 1388/1388+63 = 0.956581 \text{ or}$$

$$1388/1451 = 0.956581$$

Where Nm refers to collaborative communications

Ns indicates the number of single-authored communications

Table No. 4.6 revealed that collaboration scenario of the contributors of the agricultural research output 2001 to 2023. Out of a total of 1451 publications, about 95.65% collaborated by multiple – authors ranging from two to ten plus co-authored contributions and rests were non – collaborative. The table also indicates that the degree of collaboration of the agricultural research output from 2001 to 2023. The average degree of collaboration is impressive 0.956581.

**5.6 Prolific Authors**

**Table 7: Prolific Authors**

Sl. No.	Name of the Authors	No. of Records	Percentage
1	Kumar, A	74	5.1
2	Kumar, SN	66	4.5
3	Yadav, A. N	59	4.1
4	Singh, S. D	53	3.7
5	Srivastava, A.	47	3.2
6	Majumdar, D	45	3.1
7	Bhatia, A	39	2.7
8	Guptnath Trivedi	32	2.2
9	Suneha Goswami	31	2.1
10	Joshi, S	28	1.9
11	Aggarwal, PK	26	1.8
12	Dibyajit Varghes	22	1.5
13	Verma, N	18	1.2
14	Bandyopadhyay, SK	17	1.2
15	Reddy, MG	14	0.9
16	Mishra, RK	13	0.8
17	Shukla, AK	12	0.8
18	Behera, SK	12	0.8
19	Sangwan, S	11	0.7

20	Sehgal, VK	9	0.6
21	Datta, SC	8	0.5
22	Choudhary, AK	8	0.5
23	Umamaheswari, T	7	0.4
24	Gupta, MK	6	0.4
25	Parihar, CM	5	0.3
<b>Total</b>		<b>662</b>	<b>45.0</b>

Table 7 explains that the most productive author is Kumar, A, with 74 (5.1%) records dealing with Agricultural research in first position. Kumar SN is published 66 (4.5%) research articles is appeared as second rank. Yadav, A. N has produced 59 (4.1%) records in the area of agricultural research with third place. Singh, S. D is contributed 53 (3.7%) research papers with fourth rank. Srivastava, A. has published 47 (3.2%) articles in agricultural research with fifth place out of top twenty five authors i during the study period. Remaining authors have produced below five papers in the field of agricultural research. It is noted that the above twenty five authors have produced 45% of publications during the period of study.

### 5.7 Applicability of Lotka's law

**Table 8:** Lotka's Law on Agricultural Research Publications

Authors hip Pattern	No. of Contributions	Total No. of Contributions	Percent age	Cumulative No. of Total Contributions	Cumulative %
1	63	63	4.34	63	4.34
2	26	52	3.58	115	7.92
3	40	120	8.28	235	16.20
4	43	172	11.86	407	28.06
5	21	105	7.25	512	35.31
6	14	84	5.79	596	41.10
7	8	56	3.86	652	44.96
8	6	48	3.32	700	48.28
9	5	45	3.10	745	51.38
10	3	30	2.05	775	53.43
11	2	22	1.53	797	54.96
12	1	12	0.85	809	55.81
13	3	39	2.70	848	58.51
15	2	30	2.07	878	60.58
16	5	90	6.20	968	66.78
18	5	120	8.27	1088	75.05
20	4	80	5.51	1168	80.56
25	5	125	8.61	1293	89.17
26	5	130	8.90	1423	98.07

28	1	28	1.93	1451	100.00
Total	262	1451	100	-	-

The stressed value in the above table identifies that single authorship pattern contributed i.e. 63 (4.34%) articles followed by the two author's contribution i.e. 26 (3.58%), three authors who have contributed 40 (8.28%), four authors who have contributed 43 (11.86%), five authors contributed 21 (7.25%) publications from the total publications and so on.

The table 8 also focuses the author productivity data for Lotka's law. Of the 1451 total contributions 63 (4.34%) publications was contributed by single authors. Based on the Lotka's law 4.34% of the contribution must contributed by single authors. So the dataset did not match the generalized form of Lotka's law. Hence, it is confirmed that hypothesis 2 "Lotka's law fit to the observed frequency of author productivity which distributed on agricultural research publications" has not statistically proved.

### 5.7 Price's Square Root Law

**Table 9:** Price's Square Root Law

S. No	No. of Contributions A	No. of Contributors B	% of 262	A * B	Cum ulated A*B	Cum ulated % of A*B
1	30	1	0.38	30	30	1.36
2	29	1	0.38	29	59	1.31
3	28	1	0.38	28	87	1.27
4	27	1	0.38	27	114	1.22
5	26	2	0.76	52	166	2.35
6	25	2	0.76	50	216	2.26
7	24	1	0.38	24	240	1.08
8	23	2	0.76	69	309	3.12
9	22	2	0.76	44	353	1.98
10	21	3	1.15	63	416	2.85
11	20	4	1.53	80	496	3.62
12	19	5	1.91	95	591	4.29
13	18	7	2.67	126	717	5.70
14	17	5	1.91	85	802	3.84
<b>15</b>	<b>16</b>	<b>4(41)</b>	<b>1.53</b>	<b>64</b>	<b>866</b>	<b>2.89(39.14)</b>
16	15	5	1.91	75	941	3.39
17	14	4	1.54	56	997	2.54
18	13	8	3.05	104	1101	4.70
19	12	9	3.43	108	1209	4.88
20	11	10	3.82	110	1319	4.97
21	10	12	4.58	120	1439	5.43
22	9	14	5.35	126	1565	5.70
23	8	15	5.72	120	1685	5.42
24	7	16	6.11	112	1797	5.06

25	6	17	6.48	102	1899	4.62
26	5	19	7.25	95	1994	4.29
27	4	20	7.63	80	2074	3.62
28	3	21	8.02	63	2137	2.85
29	2	24	9.16	48	2185	2.17
30	1	27	10.31	27	2212	1.22
		<b>262</b>	<b>100</b>	<b>2212</b>	<b>-</b>	<b>100</b>

Total number of authors in Agricultural Research, N=2212

Total number of publications = 1451

According to this law,  $\sqrt{N}$  authors contributed half of the total number of publications, Therefore,  $\sqrt{2212} = 47.0319 = 41$  Authors

Half of the total publications =  $\frac{1451}{2} = 725.5$

From table 3, it can be observed that 41 authors contributed only 39.14% of total publications.

That is  $1451 \times \frac{39.14}{100} = 567.631$  publications.

The Price square root of total authors (262 authors) contributed only = 567.631 numbers of total (1451) publications. Half of the publications (567 publications) have not come from the square root of all authors (41 authors). Therefore, the price square root law does not apply to the publication of Agricultural Research.

### 5.9 Pareto Principle

According to the Pareto Principle, 80% of total publications in a subject field come from 20% of the field's authors.

Total number of articles in Agricultural Research publications from 2001 to 2023 = 1451

Total number of authors in the same period of study = 2212

80% of total publications =  $80 \times 1451 / 100 = 1160.8$  publications

20% of total authors =  $20 \times 2212 / 100 = 442.4$  authors

### 5.10 Top-ranked Journals

**Table 10:** Top-ranked Journals

Sl. No.	Name of the Journal	No. of Records	Perc entage
1	Agriculture, Ecosystems & Environment	82	5.65
2	Indian Journal of Agricultural Sciences	75	5.16
3	Agriculture Basel	62	4.27

4	Bioresource Technology	58	3.99
5	International Journal of Genomics	55	3.79
6	Annals of microbiology	51	3.51
7	Environmental Science and Pollution Research	46	3.17
8	Sustainability	39	2.69
9	Current Science	36	2.48
10	Legume Research	30	2.07
11	Biocontrol Science and Technology	27	1.85
12	Waste and Biomass Valorization	22	1.52
13	Theoretical and Applied Genomics	20	1.37
14	International Journal of Tropical Agriculture	17	1.17
15	Land Degradation & Development	15	1.03
16	Frontiers in Plant Science	14	0.96
17	Microbial Ecology	13	0.89
18	Physics and Chemistry of the Earth	12	0.82
19	Archives of Agronomy and Soil Science	9	0.62
20	Plant Genome	9	2.47
21	Others	35	2.47
<b>Total</b>		<b>727</b>	<b>50.03</b>

Table 10 analysed that the most productive journal is Agriculture, Ecosystems & Environment with 82 (5.65%) papers dealing with Agricultural Research in first place. Indian Journal of Agricultural Sciences appeared as second rank with 75 (5.16%) articles, Agriculture Basel has produced 62 (4.27%) communications with third positions, Bioresource Technology is contributed in fourth place with 58 (3.99%) papers, International Journal of Genomics has produced 55 (3.79%) articles in Agricultural research and its appearing as fifth place out of top 25 most contributed journals in agricultural research field during the period of study from 2001 to 2023. It is identified that the above twenty five journals are produced about 50% of articles in overall research publications in agricultural research during the period of study.

### 5.11 Applicability of Bradford's Law of Scattering

**Table 11:** Applicability of Bradford’s Law of Scattering

Rank	No. of Journals	Cumulative No. of Journals	No. of Papers	Total Papers	Cumulative Papers	Log N of Cum. Jl.	Zone
1	1	1	25	25	25	0	Zone 1
2	1	2	24	24	49	0.69	Zone 1
3	2	4	23	46	95	1.38	Zone 1
4	2	6	22	44	139	1.79	Zone 1
5	1	7	21	21	160	1.94	Zone 1
6	1	8	20	20	180	2.07	Zone 1
7	3	11	19	57	237	2.39	Zone 1
8	2	13	18	36	273	2.56	Zone 1
9	3	16	17	51	324	2.77	Zone 1
<b>10</b>	<b>1(17)</b>	<b>17</b>	<b>16</b>	<b>16</b>	<b>340</b>	<b>2.83</b>	<b>Zone 1</b>
11	4	21	15	60	400	3.04	Zone 1
12	3	24	14	42	442	3.17	Zone 1
13	5	29	13	65	507	3.36	Zone 1
14	1	30	12	12	519	3.40	Zone 1
15	1	31	<b>11</b>	11	569	3.43	Zone 1
16	5	36	10	50	619	3.58	Zone 1
17	7	43	9	63	682	3.76	Zone 2
18	8	51	8	64	746	3.93	Zone 2
19	9	60	7	63	809	4.09	Zone 2
<b>20</b>	<b>11(54)</b>	<b>71</b>	<b>6</b>	<b>66</b>	<b>875</b>	<b>4.26</b>	<b>Zone 2</b>
21	12	83	<b>5</b>	60	935	4.39	Zone 2
22	15	98	4	60	995	4.58	Zone 2
23	22	120	3	66	1061	4.78	Zone 3
24	26	146	2	52	1113	4.98	Zone 3
<b>25</b>	<b>33(108)</b>	<b>179</b>	<b>1</b>	<b>33</b>	<b>1146</b>	<b>5.18</b>	<b>Zone 3</b>

Table 11 demonstrated that the highest number of paper communicated to journals in agricultural research. This analysis information 179 journals to have published 1451 articles. The bold letters states the values of three zones based on Bradford’s law of

scattering. It is completed from the analysis that first twenty five journals are nuclear or core journals.

### 5.12 Top-ranked Institutions

**Table 12:** Productive Institutions

Sl. No.	Name of the Institution	No. of Records	Percentage
1	Center for Environment Science and Climate Resilient Agriculture, ICAR-Indian Agricultural Research Institute, New Delhi	86	5.93
2	Division of Microbiology, Indian Agricultural Research Institute (IARI), New Delhi	83	5.72
3	Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi	79	5.44
4	Division of Soil Science and Agricultural Chemistry, Indian Agricultural Research Institute, New Delhi	66	4.54
5	Water Technology Centre, Indian Agricultural Research Institute, New Delhi 110012, India	64	4.41
6	Division of Environmental Sciences, Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi	61	4.20
7	Centre for Environment Science and Climate Resilient Agriculture, ICAR-Indian Agricultural Research Institute, New Delhi, 110 012, India	57	3.93
8	Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar	53	3.65
9	Key Laboratory of Agricultural Soil and Water Engineering in Arid and Semiarid Areas,	50	3.45

	Ministry of Education, Northwest A&F University, Yangling 712100, China.		
10	Department of Humanities and Social Sciences, Indian Institute of Technology-Kanpur, Kanpur, Uttar Pradesh	45	3.10
11	ICAR-Indian Agricultural Statistics Research Institute, New Delhi, India 2 ICAR-Indian Agricultural Research Institute, New Delhi, India	42	2.89
12	Division of Biotechnology, CSIR-Institute of Himalayan Bioresource Technology, Palampur 176061, India.	38	2.62
13	Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi 110012, India	35	2.41
14	Agronomy-Soil Division, CSIR-Central Institute of Medicinal and Aromatic Plants, P.O. -CIMAP, Near Kukrail Picnic Spot, Lucknow	31	2.14
15	IARI Regional Station, Karnal, India	27	1.86
16	Division of Agricultural Extension and Water Technology Centre, IARI, New Delhi	23	1.58
17	Division of Crop Protection, ICAR-Indian Institute of Spices Research, Kozhikode, India and Division of Plant Pathology, ICAR-Indian Agricultural Research Institute, New Delhi, India	22	1.52
18	Indian Agr Res Inst, Div Microbiol, New Delhi 110012, India. ICAR Cent Inst Cotton Res, Nagpur 440010, Maharashtra, India.	20	1.37
19	ICAR Indian Inst Farming Syst Res, Meerut 250110, Uttar Pradesh, India	19	1.31
20	Tamil Nadu AgrUniv, CtrAgr, Dept Agr Econ & Rural Dev Studies, Coimbatore	16	1.10
<b>Total</b>		<b>917</b>	<b>63.17</b>

Table 12 shows the Institution-wise productivity of Agricultural research output. A total of 74 institutions have been contributed their research articles for this study. It is identified that Center for Environment Science and Climate Resilient Agriculture, ICAR-Indian Agricultural Research Institute, New Delhi is produced more research articles. The second most productive institution is the Division of Microbiology, Indian Agricultural Research Institute (IARI), New Delhi, with 83 publications (5.72%). Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi appeared as third rank with 79 (5.44%). Division of Soil Science and Agricultural Chemistry, Indian Agricultural Research Institute, New Delhi has produced 66 (4.54%) articles with fourth rank. Water Technology Centre, Indian Agricultural Research Institute, New Delhi 110012, India has contributed 64 (14.41%) contributions with fifth place and Tamil Nadu AgrUniv, CtrAgr, Dept Agr Econ & Rural Dev Studies, Coimbatore has produced 16 (1.10%) with least place out of top 20 research institutions in the field of agricultural research during the period of study from 2001 to 2023. It is highlighted that the above twenty institution has produced more than 63% of research output out of 1451 publications during the study period. Bradford's law is applied for the distributions of journals in present research work.

## 6. Conclusion

Indian Agricultural Research Institute (ICAR) is the prominent institution in the field of agriculture in

India. The study investigated the research trend of ICAR publications indexed in the Web of Science database. During the study period 2001-2023 the ICAR institutions contributed 1451 research works. The findings of the study show some interesting results. The highest number of 146 (10.06%) publications in the year 2023. Pearson's Correlation Coefficient value for TLCS and TGCS is identified (0.9663). The EGR value is decreased in 2006 (0.63). Further, the value has been increased in 2007 (1.13). The EGR values being decreased in 2008 (0.82). From the year 2009 to 2011, the mean value of EGR is 0.87. It is confirmed that ten authored contribution (14.27%) is found to be most prime, The average degree of collaboration is impressive 0.956581. It is confirmed that hypothesis 2 "Lotka's law fit to the observed frequency of author productivity which distributed on agricultural research publications" has not statistically proved. The price square root law does not apply to the publication of Agricultural Research. Pareto principle is tested for author's productivity on agricultural research. The study finds that Kumar, A, with 74 (5.1%) records on agricultural research, is in first place. Kumar SN has published 66 (4.5%) research articles, ranking second. Yadav, A. N has produced 59 (4.1%) records in the area of agricultural research with third place. The study found that Agriculture, Ecosystems & Environment, with 82 (5.65%) papers on Agricultural Research, ranked first. Indian Journal of Agricultural Sciences appeared as second rank with 75 (5.16%) articles, Agriculture Basel has produced 62 (4.27%) communications with third positions. It is noted that the above twenty institutions have produced more

than 63% of the research output out of 1451 publications during the study period. Brod Ford's law is applied to the distributions of journals in the present research study during the period from 2001 to 2023.

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