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A Scientometric Study of Authorship Collaboration in Agricultural Research from 1970 - 2012

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Abstract – **The study analyses agriculture research publication output for the period of 1970-2012. It is determined to observe the performance of a continent and country in a particular discipline of scientific research. This study deals from the web of science, applying the analytical tools part; Specialization Index (SI), Author Productivity, Authorship Pattern, Collaborative Index, Lotka's Law, and Pareto Principle (80 X 20 Rule) have also been taken up to identify the research output of agriculture in the selected continents and special identification of Indian research.**

Keywords: **Agricultural Research, Scientometric Study**

I. Introduction

In identifying the research performance in any area of science, it is essential to analyze the author's productivity. The author's productivity is determined by the scientists in a field. Generally, research activity is carried out by a scientist or a group of scientists, depending on the nature and aim of the research. It also depends on the ability and efficiency of the involved scientists. This is based on their skills and talents. The analysis of the author's productivity examines the prevailing trend in understanding the research process in any discipline of science.

II. Review of Literature

Davarpanah (2010) describes a model for measuring the strength and weakness of individual disciplines. The model is developed based on the balanced approach. The model is tested on Iranian and Malaysian social sciences publications between 1991-2008 as a case study. The result indicates that the differences in rankings for measures of publication output, citation distribution, and mean observed citation rate are large, which justifies the use of the scientific power index. Raghuraman, Chander and Madras (2010) describes the three-part study comparing the research performance of Indian institutions with that of other international institutions. They found that the institutions of national importance contributed the highest in terms of publications and citations per institution. Voracek and Loibl (2009) reveals that a scientometric analysis of modern research on the second-to-fourth digit ratio (2D:4D), a widely studied putative marker for prenatal androgen action, is presented. Key findings included evidence of publication bias and citation bias, incomplete coverage and out datedness of existing reviews, and a dearth of meta-analyses in this field.

LaRowe, *et al.,* (2009) studies that the Scholarly Database aims to serve researchers and practitioners interested in the analysis, modelling, and visualization of large-scale data sets. A specific focus of this database is to support macro-evolutionary studies of science and to communicate findings via knowledge-domain visualizations. Lewis, Templeton and Luo (2007) investigates the measurement validity of the findings in the IS journal quality stream over the past ten years. The results of our tests for content, convergent, and discriminant validity, as well as those for parallel-form, test-retest, and item-to-total reliability, were highly supportive. Bharvi, Garg and Bali (2003) analysis 1317 papers published in first fifty volumes during 1978 to 2001 of the international journal scientometrics indicates the heterogeneity of the field with emphasis on scientometric assessment. The study indicates that the US share of papers is constantly on the decline while that of the Netherlands, India, France and Japan is on the rise. R. Revathi and S. Ravi examined India's performance based on its publication output in Biodiversity during 1992-2009, based on several parameters, including the country annual average growth rate, global publicationshare, rank among ten countries of the world, national publication output, authorship pattern, high productive Indian Institutes etc.

III. Objectives of The Study

The major objectives are framed with the unique principle of the present study as mentioned below:

1. To identify the source and year wise distribution of Comprehensive and national Agriculture research output Scientists.

2. To compare and to measure the analysis of continent with country-wise of agriculture research output performance.
3. To assess the institution-wise research concentration on agriculture of global and India level.
4. To test the applicability of Lotka's law of author productivity in the field of Agriculture.

IV. Methodology

There are various sources contributing to the research output in the field of Agriculture by global and Indian Scientists. In this study the secondary sources are taken for analysis from the Web of Science online data base. The Web of knowledge is the search platform provided by Thomson Reuters (the former Thomson Scientific emerged from the Institute for Scientific Information (ISI) in Philadelphia). The study period 1970 to 2012 is selected as the database is available. The search string is "Agriculture" field web of science was used for the year's from 1970 to 2012 download the records based the string.

V. Analysis And Interpretation

The Table I describes the analysis of agriculture research output at Indian visual aid the following facts: It is observed that its relative growth rates have shrunk gradually from 1.09 at 1973 to 4.43 in the year of 2012. The whole study period sample mean relative growth rate of 0.45. Contrary to this, the Doubling Time for Indian publication of all sources of agriculture research output has decreased from 0.64 in 1973 to 0.16 in 2012. The doubling time for publications at the aggregate level has been computed as 3.47 years.

The Table II describes that the researcher concludes from the overall percentage analysis that the year group of 2007 to 2012 produced highest publications in the field of Agriculture. The first year group of 1970 to 1976 has very low number of publications. The European continent establishes the highest publication among other continents.

Table III indicates forty six (23.96 %) Asian countries (totally 192 countries) with 9766 (17.66 %) Agriculture research output compared to other continents. It is noted that in the year group of 1970 to 1976 just five articles were articles appeared and it rose to 6498 at the year group of 2007 to 2012. It indicates an increase in the level of the total research output in the selected area of the Asian continent with 85341 TCS.

Table I Relative Growth Rate of Agriculture in Global and National Research Output

Year	R. o/p	India	$log_e 1^p$		$log_e 2^p$		Rt(P)		Dt(P)	
			G	*I*	*G*	*I*	*G*	*I*	*G*	*I*
1970	178	1	-	-	5.18	0	-	-	-	-
1971	119	-	5.18	0	4.77	0	0.41	0	1.69	0
1972	138	-	4.77	0	4.93	0	-0.16	0	-4.33	0
1973	108	3	4.93	0	4.68	1.09	0.25	1.09	2.77	0.64
1974	156	2	4.68	1.09	5.05	0.69	-0.37	0	-1.87	0
1975	120	-	5.05	0.69	4.78	0	0.27	0.69	2.57	1.0
1976	127	-	4.78	0	4.84	0	-0.06	0	-11.55	0
1977	208	3	4.84	0	5.33	1.09	-0.49	1.09	-1.41	0.64
1978	251	4	5.33	1.09	5.53	1.38	-0.2	0.29	-3.47	2.34
1979	270	3	5.53	1.38	5.59	1.09	-0.06	0.29	-11.55	2.34
1980	270	4	5.59	1.09	5.59	1.38	0	0.29	0	2.34
1980	221	3	5.59	1.38	5.39	1.09	0.2	0.29	3.47	2.34
1981	273	5	5.39	1.09	5.60	1.60	-0.21	0.51	-3.30	1.34
1982	243	15	5.60	1.60	5.49	2.70	0.11	1.1	6.30	0.63
1983	252	8	5.49	2.70	5.53	2.07	-0.04	0.63	-17.33	1.1
1984	242	7	5.53	2.07	5.48	1.94	0.05	0.13	13.86	5.33
1985	257	3	5.48	1.94	5.55	1.09	-0.07	0.85	-9.90	0.82
1986	250	6	5.55	1.09	5.52	1.79	0.03	0.7	23.1	0.99
1987	217	7	5.52	1.79	5.37	1.94	0.15	0.15	4.62	4.62
1988	221	17	5.37	1.94	5.39	2.83	-0.02	0.89	-34.65	0.78
1989	319	15	5.39	2.83	5.76	2.70	-0.37	0.13	-1.87	5.33
1990	729	31	5.76	2.70	6.59	3.43	-0.83	0.73	-0.83	0.95
1991	749	25	6.59	3.43	6.62	3.22	-0.03	0.21	-23.10	3.3
1992	806	26	6.62	3.22	6.69	3.25	-0.07	0.03	-9.9	23.1
1993	952	34	6.69	3.25	6.85	3.52	-0.16	0.27	-4.33	2.57
1994	1050	28	6.85	3.52	6.95	3.33	-0.1	0.19	-6.93	3.65
1995	1041	33	6.95	3.33	6.94	3.49	0.01	0.16	69.3	4.33
1996	1193	45	6.94	3.49	7.08	3.80	-0.14	0.31	-4.95	2.24
1997	1207	32	7.08	3.80	7.09	3.46	-0.01	0.34	-69.3	2.04
1998	1679	54	7.09	3.46	7.42	3.98	-0.33	0.52	-2.10	1.33
1999	1905	62	7.42	3.98	7.55	4.13	-0.13	0.15	-5.33	4.62
2000	1879	68	7.55	4.13	7.54	4.22	0.01	0.09	69.30	7.7
2001	2062	65	7.54	4.22	7.63	4.17	0.09	0.05	-7.70	13.86
2002	2219	65	7.63	4.17	7.70	4.17	-0.07	0	-9.90	0
2003	2198	79	7.70	4.17	7.69	4.36	0.01	0.19	69.30	3.65
2004	2643	99	7.69	4.36	7.87	4.59	-0.18	0.23	-3.85	3.01
2005	2941	114	7.87	4.59	7.98	4.73	-0.11	0.14	-6.30	4.95
2006	3534	155	7.98	4.73	8.17	5.04	-0.19	0.31	-3.65	2.24
2007	4064	199	8.17	5.04	8.30	5.29	-0.13	0.25	-5.33	2.77
2008	4449	189	8.30	5.29	8.40	5.24	-0.1	0.05	-6.93	13.86
2009	4835	219	8.40	5.24	8.48	5.38	-0.08	0.14	-8.66	4.95
2010	5434	276	8.48	5.38	8.60	5.62	-0.12	0.24	-5.78	2.89
2011	3287	169	8.60	5.62	8.09	5.12	0.51	0.5	1.36	1.39
2012	160	2	8.09	5.12	5.08	0.69	3.02	4.43	0.23	0.16
	55296	2173					0.007	0.45	-	3.47

Table II Distribution of Year Wise vs. Continents Wise Research Output of Agriculture

Rank	Continents	Recs	TCS	70 -76	77 - 82	83 - 88	89 - 94	95 -00	01 -06	07 - 12
1	Europe	19177	86476	51	237	298	824	2159	4117	11491
2	North America	16745	445150	118	369	422	1543	2114	4354	7825
3	Asia	9766	85341	5	49	89	322	779	2024	6498
4	Africa	2234	24036	3	9	16	79	164	352	1611
5	Australia	2946	54034	13	82	64	167	393	618	1609
6	South America	2148	25343	4	7	11	59	208	399	1460
	Total	53016	720380	194	753	900	2994	5817	11864	30494

Table IV Priority and Specialization Index of Asian Countries

Year	N_{ij} (X_α)	N_{io} = A ($P_{x\alpha}$)	N_{oj} (Y_α)	N_{oo} = B ($P_{y\alpha}$)	PI Value	SI value
1970 - 1976	5	0.05	946	1.71	0.03	0.55
1977 - 1982	49	0.50	1493	2.70	0.19	
1983 - 1988	89	0.91	1461	2.64	0.34	
1989 - 1994	322	3.30	3776	6.83	0.48	
1995 - 2000	779	7.98	8075	14.60	0.55	
2001 - 2006	2024	20.72	13942	25.21	0.82	
2007 - 2012	6498	66.54	25603	46.30	1.44	
	9766	100	55296	100	3.85	

The year group of 1970 to 1976 (0.03); 1977 to 1982 (0.19); 1983 to 1988 (0.34); 1989 to 1994 (0.48); 1995 to 2000 (0.55) and 2001 to 2006 (0.82) were showed lower priority among the selected period to the given time span. There is seen no average priority during the selected periods. The year group of 2007 to 2012 (1.44) were indicates higher priority.

The Table V indicates the continents specialized index value and showed how they are related with their publication with world level. All continent were don't have specialized relation with the world output. Specialized index values are European continent (0.68); North American continent (0.92); Asian continent (0.55); African continents (0.53); Australian continent has (0.83) and South America has (0.53) SI value is below 1. North American continent (0.92) has showed their publications levels have average specialized relation to the world research output because their SI value is nearly equal to 1.

The Table VI reveals the first 25 prolific authors of Agriculture research belongs to their highest productivity. It shows the total local citation scores; total global citation scores; total citation ranks; first author's contribution and single author contribution among these seventy five authors. In the present study, the authors are ranked on the basis of their maximum number of papers published.

Table V Specialization Index of Selected Continents Research Output on Agriculture

S.No.	Continent	SI
1	Europe	0.68
2	North America	0.92
3	Asia	0.55
4	Africa	0.53
5	Australia	0.83
6	South America	0.53
	Total	4.04

Table III Research Performance of Agriculture Output by Asian Countries

S. No.	Countries	Recs	TCS	70-76	77- 2	83-88	89-94	95-00	01-06	07-12
1	Peoples R China	2306	20929	0	2	1	22	107	504	1670
2	India	2068	21007	4	20	45	141	230	443	1185
3	Japan	1031	9744	1	9	21	50	118	279	553
4	Turkey	792	5671	0	0	0	2	26	163	601
5	Iran	503	2919	0	0	1	2	6	46	448
6	Israel	446	6368	0	7	12	35	78	121	193
7	Pakistan	406	1637	0	0	0	6	9	48	343
8	South Korea	305	2356	0	0	0	1	15	64	225
9	Thailand	251	2423	0	0	0	11	19	63	158
10	Taiwan	238	1757	0	1	0	6	19	54	158
11	Malaysia	181	1143	0	2	0	3	10	20	146
12	Philippines	168	1727	0	0	6	8	19	34	101
13	Sri Lanka	131	972	0	4	0	3	11	14	99
14	Indonesia	114	903	0	0	0	2	13	23	76
15	Saudi Arabia	104	352	0	1	0	9	8	17	69
16	Vietnam	97	706	0	0	0	1	4	18	74
17	Syria	87	866	0	0	1	6	5	9	66
18	Bangladesh	81	391	0	0	1	3	12	13	52
19	Jordan	69	430	0	0	0	0	11	19	39
20	Singapore	67	1260	0	0	0	1	7	14	45
21	Nepal	50	239	0	0	0	3	3	10	34
22	Laos	38	321	0	0	0	0	1	8	29
23	Uzbekistan	35	184	0	0	0	0	1	5	29
24	U Arab Emirates	30	185	0	0	0	0	6	5	19
25	Oman	27	163	0	0	0	1	8	5	13
26	Lebanon	25	97	0	2	0	3	2	5	13
27	Kuwait	21	97	0	0	0	0	6	9	6
28	Kazakhstan	16	115	0	0	0	0	3	3	10
29	Hong Kong	12	140	0	0	0	1	11	0	0
30	Iraq	8	64	0	1	0	1	0	3	3
31	Azerbaijan	7	3	0	0	0	0	0	0	7
32	Afghanistan	6	13	0	0	0	0	0	1	5
33	Cambodia	6	6	0	0	0	0	1	0	5
34	Mongol Peo Rep	5	10	0	0	0	0	1	0	4
35	Bahrain	5	32	0	0	0	0	3	1	1
36	Yemen	5	28	0	0	0	0	1	1	3
37	Qatar	5	19	0	0	1	0	2	0	2
38	Bhutan	4	26	0	0	0	0	1	0	3
39	Kyrgyzstan	3	10	0	0	0	0	0	1	2
40	Myanmar	3	5	0	0	0	0	0	0	3
41	Turkmenistan	3	1	0	0	0	0	1	0	2
42	Micronesia	2	10	0	0	0	1	1	0	0
43	North Korea	2	0	0	0	0	0	0	0	2
44	Kiribati	1	11	0	0	0	0	0	0	1
45	Maldives	1	1	0	0	0	0	0	1	0
46	Tajikistan	1	0	0	0	0	0	0	0	1
		9766	85341	5	49	89	322	779	2024	6498

Table VI Prolific Authors According to Highest Research Productivity (109547 Authors And 5132 Indian)

S. No.	Author name	Global	Indian	TLCS	TGCS	TLCR
1	Anonymous	500	-	1	0	25
2	Lal R	69	-	378	1541	376
3	Smith P	58	-	589	1632	459
4	Kumar A	51	43	18	347	63
5	Pimentel D	51	-	631	2187	290
6	Uri ND	48	-	65	194	59
7	Li Y	44	-	36	188	123
8	Rozelle S	43	-	157	453	146
9	Kumar S	41	35	14	111	67
10	McCarl BA	41	-	435	1234	131
11	Blair A	37	-	221	1326	124
12	Buerkert A	36	-	79	207	148
13	Ramakrishnan PS	36	36	230	524	95
14	Schnug E	36	-	43	181	67
15	Wang Y	35	-	21	470	74
16	Rockstrom J	34	-	308	667	171
17	Zhang L	34	-	44	497	75
18	McSorley R	33	-	123	559	118
19	Giller KE	32	-	180	558	168
20	Hoppin JA	32	-	52	478	123
21	Six J	32	-	229	1262	220
22	Sudduth KA	32	-	320	719	141
23	Deckers J	31	-	112	423	107
24	Hoogenboom G	30	-	68	244	129
25	Huang JK	30	-	112	413	65

The Table VII indicates authorship pattern in the field of agriculture research. Here the authors are classified according to the number of research contribution. In this aspect single author 15325 (8.83 %) contributed papers are 15325 (27.71%) taken into the purview of this study. It is noted that out of 55296 research papers envisaged in the study, two authors 23246 (13.4%) team were contributed 11623 (21.02%) of articles and it is occupying first rank. 29749 (17.14 %) of three authors were contributing 9914 (17.93%) of article in the field of agriculture research occupies the third rank. Followed by 28704 (16.54%) of four authors team were contributed the articles 7176 (12.9 %); 22970 (13.24 %) of five authored team were contributed the articles of 4594 (8.31%); 16542 (9.54 %) of six authored team were 2757 (4.99 %) of publications produced in the area of agriculture respectively. 10388 (5.99 %) of seven authored team has produced 1484 (2.68 %) of research output; 6544 (3.78 %) of eight authors' team were contributed 818 (1.48 %) of articles in agriculture; 4725 (2.72 %) of nine authored team were contributed 525 (0.95 %) of articles and 15283 (8.81%) of ten and more than ten authors team were produced the 1080 (1.95 %) of related field articles.

Table VIII Single vs Multi-Author and Degree of Collaboration of Agriculture Research Output

Year	Single Authors		Multi Authored		Total	Degrees of Collaboration
	No. of Output	%	No. of Output	%		
1970	154	1.0	24	0.06	178	0.13
1971	103	0.67	16	0.04	119	0.13
1972	116	0.76	22	0.06	138	0.16
1973	85	0.55	23	0.06	108	0.21
1974	122	0.80	34	0.09	156	0.22
1975	96	0.63	24	0.06	120	0.20
1976	95	0.62	32	0.08	127	0.25
1977	158	1.03	50	0.13	208	0.24
1978	195	1.27	56	0.14	251	0.22
1979	205	1.34	65	0.16	270	0.24
1980	207	1.35	63	0.16	270	0.23
1981	159	1.04	62	0.16	221	0.28
1982	192	1.25	81	0.20	273	0.30
1983	165	1.08	78	0.20	243	0.32
1984	173	1.13	79	0.20	252	0.31
1985	168	1.10	74	0.19	242	0.31
1986	182	1.19	134	0.34	257	0.52
1987	168	1.10	82	0.21	250	0.33
1988	146	0.95	71	0.18	217	0.33
1989	133	0.87	88	0.22	221	0.40
1990	178	1.16	141	0.35	319	0.44
1991	336	2.19	393	0.98	729	0.54
1992	319	2.08	430	1.08	749	0.57
1993	317	2.07	489	1.22	806	0.61
1994	371	2.42	581	1.45	952	0.61
1995	363	2.37	687	1.72	1050	0.65
1996	361	2.36	680	1.70	1041	0.65
1997	327	2.13	866	2.17	1193	0.73
1998	373	2.43	834	2.09	1207	0.69
1999	629	4.10	1050	2.63	1680	0.63
2000	685	4.47	1220	3.05	1906	0.64
2001	598	3.90	1281	3.20	1880	0.68
2002	649	4.23	1413	3.54	2063	0.68
2003	575	3.75	1644	4.11	2219	0.74
2004	564	3.68	1634	4.09	2198	0.74
2005	666	4.35	1977	4.95	2643	0.75
2006	628	4.10	2313	5.79	2941	0.79
2007	689	4.50	2845	7.12	3534	0.81
2008	814	5.31	3250	8.13	4064	0.80
2009	814	5.31	3635	9.09	4449	0.82
2010	805	5.25	4026	10.07	4831	0.83
2011	787	5.14	4592	11.49	5379	0.85
2012	455	2.97	2832	7.09	3287	0.86
	15325	27.71	39971	72.28	55296	0.72

Table VII Authorship Patterns in The Area of Agriculture Research Output

Authorship Pattern	1	2	3	4	5	6	7	8	9	10 & >	Total
1970	154	17	6	1	-	-	-	-	-	-	178
1971	103	10	5	1	-	-	-	-	-	-	119
1972	116	17	3	2	-	-	-	-	-	-	138
1973	85	21	1	1	-	-	-	-	-	-	108
1974	122	26	6	1	-	-	-	-	-	1	156
1975	96	15	6	2	-	1	-	-	-	-	120
1976	95	24	5	2	-	1	-	-	-	-	127
1977	158	29	15	4	1	1	-	-	-	-	208
1978	195	39	11	6	-	-	-	-	-	-	251
1979	205	45	15	1	3	1	-	-	-	-	270
1980	207	41	15	3	2	1	-	-	-	1	270
1981	159	42	14	5	1	-	-	-	-	-	221
1982	192	49	14	10	5	3	-	-	-	-	273
1983	165	50	14	8	2	2	1	1	-	-	243
1984	173	51	18	6	1	2	1	-	-	-	252
1985	168	40	22	7	2	1	1	-	-	1	242
1986	182	101	21	3	4	4	1	-	-	-	257
1987	168	41	28	4	5	1	1	-	1	1	250
1988	146	48	12	8	3	-	-	-	-	-	217
1989	133	50	24	7	3	1	2	1	-	-	221
1990	178	71	44	9	7	2	4	1	1	2	319
1991	336	183	113	51	24	9	1	6	3	3	729
1992	319	171	115	74	34	12	9	4	6	5	749
1993	317	194	141	71	32	28	8	3	2	10	806
1994	371	279	136	88	35	16	9	7	3	8	952
1995	363	292	182	101	58	26	14	4	3	7	1050
1996	361	271	198	93	64	32	9	5	3	5	1041
1997	327	329	228	152	80	28	23	7	4	15	1193
1998	373	294	229	139	78	39	27	14	5	9	1207
1999	629	385	287	166	92	48	31	14	9	18	1680
2000	685	481	303	213	97	51	27	18	12	18	1906
2001	598	448	326	220	115	64	45	21	11	31	1880
2002	649	470	369	253	142	79	42	20	14	24	2063
2003	575	527	439	280	181	88	56	21	19	33	2219
2004	564	489	421	311	167	113	50	25	23	35	2198
2005	666	565	498	363	236	139	72	33	23	48	2643
2006	628	606	612	416	269	159	97	57	26	71	2941
2007	689	745	690	578	355	211	88	63	39	76	3534
2008	814	830	812	584	412	256	129	70	48	109	4064
2009	814	856	862	684	514	291	149	91	67	121	4449
2010	805	869	952	775	560	367	182	105	66	150	4831
2011	787	957	1044	942	622	409	240	145	82	151	5379
2012	455	555	658	531	388	271	165	82	55	127	3287
Total No. of articles	15325 (27.71)	11623 (21.02)	9914 (17.93)	7176 (12.9)	4594 (8.31)	2757 (4.99)	1484 (2.68)	818 (1.48)	525 (0.95)	1080 (1.95)	55296
Total No. of authors	15325 (8.83)	23246 (13.4)	29742 (17.14)	28704 (16.54)	22970 (13.24)	16542 (9.54)	10388 (5.99)	6544 (3.78)	4725 (2.72)	15283 (8.81)	173469
CI	0.32	0.64	0.95	1.28	1.59	1.91	2.24	2.55	2.86	4.52	3.14

Table IX Lotka's Law of Author Productivity

No. of Contribution	No. of Contributor's	Y	∑X = log x	∑Y = log y	∑X*Y	∑X*X
1	500	500	0	6.214	0	0
1	69	69	0	4.234	0	0
1	58	58	0	4.060	0	0
2	51	102	0.693	4.624	3.20	0.48
1	48	48	0	3.871	0	0
1	44	44	0	3.784	0	0
1	43	43	0	3.761	0	0
2	41	82	0.693	4.406	3.05	1.48
1	37	37	0	3.610	0	0
3	36	216	1.098	5.375	5.90	1.21
1	35	35	0	3.555	0	0
2	34	68	0.693	4.219	2.92	0.48
1	33	33	0	3.496	0	0
4	32	128	1.386	4.852	6.72	1.92
1	31	31	0	3.433	0	0
6	30	180	1.791	5.192	9.29	3.21
3	29	87	1.098	4.465	4.90	1.21
6	28	168	1.791	5.123	9.17	3.21
7	27	189	1.945	5.241	10.19	3.78
6	26	156	1.791	5.049	9.04	3.21
5	25	125	1.609	4.828	7.77	2.59
2	24	48	0.693	3.871	2.68	0.48
5	23	115	1.609	4.744	7.63	2.59
10	22	220	2.302	5.393	12.41	5.30
17	21	357	2.833	5.877	16.64	8.03
16	20	320	2.772	5.768	15.98	7.68
23	19	437	3.135	6.079	19.05	9.83
21	18	378	3.044	5.934	18.06	9.27
21	17	357	3.044	5.877	17.88	9.27
33	16	528	3.496	6.269	21.91	12.22
43	15	645	3.761	6.469	24.32	14.15
75	14	1050	4.317	6.956	30.03	18.64
87	13	1131	4.465	7.030	31.39	19.94
98	12	1176	4.584	7.069	31.40	21.01
141	11	1551	4.948	7.346	36.34	24.48
192	10	1920	5.257	7.560	39.74	27.64
250	9	2250	5.521	7.718	42.61	30.48
359	8	2872	5.883	7.962	46.84	34.61
528	7	3696	6.269	8.215	51.49	39.30
836	6	5016	6.728	8.520	57.32	45.27
1443	5	7215	7.274	8.883	64.61	52.91
2642	4	10568	7.879	9.265	72.99	62.08
5615	3	16845	8.633	9.731	84.0	74.53
15448	2	30896	9.645	10.338	99.71	93.03
81585	1	81479	11.309	11.308	127.88	127.89
109443	1557	173469	133.989	267.574	1046.22	772.37

The Table VIII indicates the degree of collaboration in the research output on Agriculture. The degree of collaboration is 0.72 during the study period 1970 to 2012. i.e., out of the total 55296 literature published, 72% of them are published under combined undertaking. During the year 1970 to 2012 the degree of collaboration was not a constant value, it shows differs of 0.13 and 0.86. It is seen clearly from the above that the degree of collaboration in producing research output on Agriculture research has shown an increasing trend during the study period since it is a new discipline. Based on this study, the result of the degree of collaboration C = 0.72. i.e, 72% of collaborative authors' articles published during the study periods.

The Table IX indicates the application of Lotka's Law with respect to author productivity of agriculture research output. It is seen clearly from the table among the proportion of all contributions made single contribution 81585 (47.03 %) supremacy high. Further, Lotka's Chi square model confirms the source trend. It explains the fact that the tabulated value shows that observed authors' value is higher than the expected value. Thus the present analysis clearly invalidates Lotka's findings. In the present analysis, productivity is attributed to several factors. If a complete publication detail of an author is taken, Lotka's Law testing may present a different picture. This analysis proves the eighth (The scientific productivity of authors in the discipline of Agriculture research conforms to Lotka's (n-value) inverse square law of scientific productivity) hypothesis.

Table X Showing Institution wise Growth Rate of Agriculture Indian Research Output

S.No.	Institution	No. of Output	Rank	Percent of 1753	TLCS	TGCS
1	Indian Institution Technology	117	1	6.67	32	1131
2	Indian Agr Res Inst, New Delhi	104	2	5.93	43	966
3	Int Crops Res Inst Semi Arid Trop, Lucknow	71	3	4.05	36	672
4	Banaras Hindu Univ,	65	4	3.71	48	725
5	Govind Ballabh Pant Inst Himalayan Environm & Development, Uttaranchal	45	5	2.57	63	450
6	Jawaharlal Nehru Univ, New Delhi	45	5	2.57	44	481
7	Punjab Agr Univ, Punjab	40	6	2.28	18	211
8	University of Delhi, New Delhi	34	7	1.94	8	238
9	NE Hill Univ, Himachal Pradesh	30	8	1.71	97	334
10	Univ Calcutta, West Bengal	26	9	1.48	7	167
11	Cent Arid Zone Res Inst, Jodhpur	25	10	1.43	18	176
12	Indian Inst soil Science, Bhopal	25	10	1.43	9	295
13	Aligarh Muslim Univ,	24	11	1.37	8	203
14	Cent Res Inst Dryland Agr, Hyderabad	24	11	1.37	22	194
15	ISRO, Kerala	23	12	1.31	14	131
16	Univ Agr Sci, Bangalore, Karnatak	23	12	1.31	10	139
17	Cent Soil Salin Res Inst, Karnal	22	13	1.25	15	185
18	Annamalai University, Tamilnadu	21	14	1.20	4	125
19	CSIR, Tamilnadu	20	15	1.14	5	273
20	Indian Vet Res Inst, Izatnagar	20	15	1.14	3	69

The Table X describes that among the 1753 Indian institutions, the top 20 (1.14 %) familiar institutions are contributing 36.99% research outputs, and the researcher has taken for analysis. Remaining 98.86% of institutions were having 63.01% of articles were published in the selected field of agriculture. From "IIT's" contributed more number of publications 117 (6.67%) and stood in first rank among 1753 various institutions with 32 TLCS and 1131 TGCS. "Indian Agr Res Inst, New Delhi" has brought out the publications of 104 (5.93 %) and been second rank with 43 TLCS and 966 TGCS in the selected field. "Int Crops Res Inst Semi Arid Trop, Lucknow" has stood the ranks third in order at the 71 (3.71 %) in reflecting output performance of agriculture research along with 36 TLCS and 672 TGCS measured from this mentioned institution. Remaining institutions were contributing below 70 articles in this subject of agriculture.

VI. Conclusion

The analysis of authorship pattern explains the extent of research contribution by the researchers. Generally, nowadays, research is carried out by a group of researchers rather than by a single individual. It indicates the growing popularity of collaborative research endeavor among scientists. The authorship pattern analysis explains the performance of Scientists contributing to the number of papers in given time span. Many studies have analyzed the characteristics of the subject literature and have focused their attention on the quality and rate at which authors published in their respective fields. It has received adequate attention in the present research.

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