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Scientometric study of the research performed on Agronomy: The Indian perspective

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Abstract;

The present study was conducted with an aim to provide a summary of research activity in Agronomy research and characterize its most important aspects. The data downloaded from the Scopus database during the period from 1956 to 2017. The analysis covers mainly the year wise distribution of articles, category wise classification of papers, authorship patterns of papers, growth rate study, most prolific contributions of papers, institutions-wise distribution of contributions, geographical distribution of papers of the area of Agronomy research. The analysis showed that 1206 papers were published in Agronomy research for the period from 1956 to 2017. The maximum number of publication was recorded with 195 (16.17%) in the year of 2014 and the least number publications were found to be 1956 with 1 (0.08%) publications. Articles were found the most used document type with 1057 (87.65%). It is found that 67 papers are published by single author and 1132 papers are published by multi author during the study period. The period the mean doubling time from 1956 to 1986 is 2.446 years. The period the mean doubling time from 1987 to 1998 is 6.992 years. The period the mean doubling time from 1999 to 2008 is 5.172 years. The mean doubling time from 2009 to 2017 is 3.483 years. The subject wise distribution of publications retrieved for the years considered for the study. There were 1017 (84.33%) publications in Agricultural and biological science subject occupying the highest position. The Indian journal of agronomy gets the maximum number documents to be published with 435 (36.07). The author Shivay, Y.S., occupied first rank followed by Rana, D.S., occupied the second rank in the list. Rana, K.S., occupied third position among the productivity.

Keywords;
Bibliometrics, Scientometrics, Agriculture, Agronomy, Relative growth rate, Doubling Time

Introduction;

"A man without food for three days will quarrel, for a week will fight and for a month or so will die." Agriculture is a branch of applied science. The term agriculture has been derived from the Latin word 'ager' meaning land or field and 'cultura' meaning cultivation. Agriculture is the most important enterprise in the world. In a true sense it is a productive unit where the free gift of nature namely, land, light, air, temperature, rain water, humidity etc., are integrated into a single primary unit indispensable for human beings. Agriculture provide us food, feed, fiber, fuel, furniture, raw materials and feedback materials for and form factories, funds, flood control, a free, fair and fresh environment, abundant food driving out famine friendship eliminating fights. It also considers employment generation, economics, education, ecology, energy consumption use of equipment and earning for production, protection, processing consumption preservation and war against waste, transport and trade. Even though agricultural commodities are mostly seasonal, bulky and perishable in nature, they help the nation to earn and conserve a greater amount of foreign exchange and to build up the national economy. Satisfactory agriculture production brings peace, prosperity, hormone, health and wealth to individuals of a nation by driving away distrust, discord and anarchy. It helps to elevate the community consisting of different castes and communities to better social, cultural political and economic life. Agriculture consists of growing plants and rearing animals in order to yield produce and, thus it helps to maintain a biological equilibrium in nature. It congregates the integration of all environmental factors namely, water, heat, light, air and soil distributed in the different spheres such as the lithosphere, pedosphere, atmosphere, hydrosphere and photosphere. Agriculture helps to meet the basic needs of humans and their civilization by providing food, clothing, shelter medicine and recreation. In a wide sense agriculture implies the effective use of land, water, light and other resources of environment through the production of field crops, forage crops, arm animals, fisheries and forestry.

Basic Concepts of Agronomy;

The word agronomy has been derived from two Greek words 'agros' meaning field and 'nomos' meaning manage literally it means the science and economics of crop production by management of form land. In other words it is the art underlying science in production and improvement of

field crops with the efficient use of soil fertility, water, labour and other factors related to crop production. Agronomy is the field of study and practice ways and means of production of food, feed and fiber crops. Thus agronomy as a branch of agricultural science deals with principles and practices of the field management for the production of field crops. Among all the branches of agriculture, agronomy occupies a pivotal position and is regarded as the mother or primary branch. Like agriculture, it is nothing but an integrated and applied aspect of different disciplines of pure science. It has three clear branches

1. Crop science
2. Soil science
3. Environmental sciences

The central theme of agronomy is of soil crop environment relationships. Field crops without soil cannot be considered and soil without crop is barren. The core of agronomy is the field of crop plants with the theme of controlling the environment and the nature of agronomy is based on soil plant environment relationships. The study of the magnitude of variation in yield, cause and effect relationships, techniques of increasing use efficiency of inputs, evolving techniques for better management practices of soil, water plant nutrients, weeds and crop plants are the major aspects of agronomy to boost production and its usable products per unit land, time and input. Scientific crop production includes crop improvement improved agro-techniques, the ameliorating agro-climate of the locality and other aspects of the surrounding area for the entire field duration of the crop concerned.

Basic principles of Agronomy;

Science deals with five w's? they are what, when, where, and how? As an applied science agronomy deals a little more in detail in most cases, ie., which, whether, who, whom, and how many, how much, and how long. A principles means a scientific law that explains natural action and agronomic principles are the ways and means for the better management of soil, plants and environment for economically maximum returns per unit area of years. Some of the factors of crop production are controlled by the environment and the rest are man made factors. The environmentally controlling factors are modifiable to a limited extent, for instance drought is mitigable by irrigation or gales are retrievable with shelterbelts. Principles of crop management depend largely on the type of forming namely, specialized, diversified, mixed and integrated and also on the physical and technological facilities available irrigated forming and rain fed forming.

Scientometrics;

Scientometrics is the study of measuring and analysing science, technology and innovation. Major research issues include the measurement of impact, reference sets of articles to investigate the impact of journals and institutes, understanding of scientific citations, mapping scientific fields and the production of indicators for use in policy and management contexts.[1] In practice there is a significant overlap between scientometrics and other scientific fields such as bibliometrics, information systems, information science and science of science policy.

Review of literature

This paper to examine the review of works relating to various aspects of Scientometric studies. It could be observed that there are various research studies highlighting the importance of Scientometric analysis and their applications to library management and administration. This type of analysis enables the researcher to identify the research gap in the previous studies.

Divic, J. (1994)[1]. This paper analyzed scientometric investigation described assessment of these entities require an objective, accurate method of evaluation. Scientometrics has been employed to analyze Croatian science. All data shown here were retrieved from Science Citation Index and are available on compact disc (CD-ROM) from 1985 to 1992. Croatian science is seemingly not productive (only 0.5 papers published per scientist or technician over an eight years period), poorly cited and underfinanced. Yet, if we divide the total number of some European countries' papers published over the same period by the number of US dollars invested in research and development in one year, Croatia stands second only to Denmark. Croatian scientists have reached out internationally and data reveal more cooperative research with international scientists (54%) than with colleagues in former Yuqoslavia (7%). Croatian science is centralized in scientific institutions and faculties, while relatively neglected in major industry (7.2% of papers). Croatian science is also centralized in one center, 91% of all papers published come out of Zagreb. Furthermore, despite the usual suppressive effect of war on the scientific production, armed aggression against Croatia has not shown that effect thus far. Most of the papers published in 1991 and 1992 are the result of works done in previous years, but still in 1993, three years after the war broke, Croatian scientific output rose from 657 papers in 1991 to 682 papers in 1992 and 765 papers in 1993 (11). This is possibly because many scientists have left Croatia due to the war and found temporary jobs abroad, where they still publish papers using Croatian addresses. Changes in economic policy such as Markovic's financial program in 1990, have had positive effects (increases of more than 20%) on scientific performance, as well as

announncement of Croatian and Slovenian independency. This suggests that more specific changes in scientific policy could even further improve scientific performance.

Pouris, A.(1996)[2]. This paper an investigation of the health of academic science in South Africa in terms of papers published over the period 1981- 1994. It is suggested that national scientific performance should be assessed as interim results of 'marathon races' and that mapping in tire matrix Publication Ratio-Relative Citation Index can provide useful insights into disciplinary priorities and their trends, particularly for countries with pluralistic scientific systems. We argue that it is an unfortunate irony that South Africa was relatively strong in science at a time when this activity, was less crucial than it is today in determining economic performance and international competitiveness. In the 1990s, South African science is losing ground when the winning economies and industries are becoming increasingly science intensive. The disciplinary mapping of South African science confirms our previous findings that the country's natural wealth still determines national research priorities. We further suggest that national funding policies have strengthened the traditionally most active disciplines and that the country would need innovative new mechanisms in order to redirect the scientific system.

Modak, J.M., Madras, G. (2008)[3]. The objective of this work was to analyze the scientometric parameters for chemical engineering publications. They have compared the number of journal publications and citations by various countries and institutions. The publication record in terms of quantitative aspects of the number of publications from China has increased exponentially over the last decade and has overtaken USA. However, the citation analysis indicates that there is ample scope for improvement. Thus, USA continues to maintain its leadership position with regard to impact in the field. Analysis of the output of selected Indian universities/organizations against that of the top universities in the world, indicated that the records of top institutions from India are not comparable to the best universities in USA, but are comparable to the best in Asia and are significantly better than the best universities in China.

Carneiro, F.M., Nabout, J.C., Bini, L.M. (2008)[4]. The use of scientometric techniques can assist in evaluating the importance of a subject, author or article, and also emphasize the trends and contributions of a discipline, scientist or research group, institution or country regarding world-wide scientific and technological advances. We applied scientometric analysis to papers in the Thomson ISI database, in order to understand temporal trends in phytoplankton research.

From the years 1991 through 2005, the number of articles on this topic increased. We found 19,681 articles containing the word "phytoplankton" in the title, keyword and/or abstract. Principal components analysis (PCA) was used to summarize changes in the focus of papers published from 1991 to 2005. The keywords gradually changed, in the earliest years indicating descriptive study, whereas in recent years (2000 and after), the keywords became more diversified and related to aspects of technology, genetics, evolution and public health. © The Japanese Society of Limnology 2008.

Raja, S., & Balasubramani, R. (2011)[5]. Their study analyzes plasmodium falciparum research publication in India measured from Histcite software and other tools. The results show that the growth of Indian literature in plasmodium falciparum deposition and make the quantitative assessment of the research in terms of year-wise research output, geographical distribution, nature of collaboration, characteristics of highly productive institutions and the channel of communication used by the scientists. © EuroJournals Publishing, Inc. 2011.

Dias, J.D., Simões, N.R., Bonecker, C.C. (2012)[6]. This study presents a scientometric analysis of studies on net cages in order to determine whether these studies are considering environmental issues or only seeking an increase in food production.they selected 238 articles that were published between 1990 and 2009; Results: There was a temporal increase in the number of articles published. These articles focused mainly on fish production and environmental impacts; Conclusion: The studies of net cages in fish farming mainly investigated fish production, although environmental issues relating to this recent human activity were also important. Policy makers should consider both sides of the coin (i.e., both the benefits and environmental impacts of fish production) in regulation of this activity.

Gunasekaran, M., Balasubramani, R. (2012)[7]. This study analyses the artificial intelligence research output carried out during the year 1973 - 2011 the different parameters including authorship pattern, growth, rank with global publication, institutions contribution, most productivity journals were analysed. Scoups citation database has been used to retrieve the data for 39 years (1973-2011) by using the keywords (Artificial, Intelligence, Neural networks). The profile of India research output was compared with other countries help of scientometrics technique. During the study period a total of 228 papers were published by authors. Analysis report shows that India ranks at 1st position among the top 17 countries with 219 (96.05%)

papers. The Indian research output delivered very slightly decreases in the year 1973 and gradually increased every year. The journal of Expert Systems with Applications was the topesest among 147 journals published in the articles. The Indian authors Kulkarni BD, Patnaik PR have been published 7,6 respectively with 1st & 2nd rank among the authors contribution.

Pouris, A. (2012)[8]. This article reports the findings of a scientometric analysis of South Africa's research performance during the period 2000-2010. A multitude of government incentives were introduced during the period and their effects have appeared in the country's research outputs. In contrast to earlier investigations, it was found that South Africa's world share of publications is on the verge of reaching the highest contribution ever. South Africa improved its international ranking by two positions during 2000-2010 and was ranked 33rd in the world during 2010. It is argued that, provided the plan of the Minister of Science and Technology to increase the research and development expenditure in the country materialises, South Africa may be on the verge of a scientific renaissance.

Sooryamoorthy, R. (2013)[9] . The bibliometric study was undertaken of the publication trends and patterns of South African researchers in the natural sciences from 1975 to 2005 (choosing selected sample years), using the Thomson Reuters' Web of Knowledge database of selected indexed natural science journals. Characteristics of natural science publications, such as the trends over the years, were revealed as well as the collaborative dimensions involved in the production of scientific papers in these disciplines in South Africa. The connection between collaboration and publication, as well as between collaboration and sectors of authors was evident. The key findings of this study were that authors were based mostly in universities and were collaborative in their research endeavours. In addition, the participation of international collaborators has increased.

Garnett, A., Lee, G., Illes, J. (2013)[10]. They used existing and customized bibliometric and scientometric methods to analyze publication trends in neuroimaging research of minimally conscious states and describe the domain in terms of its geographic, contributor, and content features.We considered publication rates for the years 2002-2011, author interconnections, the rate at which new authors are added, and the domains that informthe work of author contributors. We also provided a content analysis of clinical and ethical themes within the relevant literature.We found a 27% growth in the number of papers over the period of study, professional

diversity among a wide range of peripheral author contributors but only few authors who dominate the field, and few new technical paradigms and clinical themes that would fundamentally expand the landscape. The results inform both the science of consciousness as well as parallel ethics and policy studies of the potential for translational challenges of neuroimaging in research and health care of people with disordered states of consciousness.

Elango, B., Rajendran, P., Bornmann, L. (2013)[11]. The SCOPUS database was used to retrieve records related to the nanotribology research for the period 1996-2010. Publications were counted on a fractional basis. The level of collaboration and its citation impact were examined. The performance of the most productive countries, institutes and most preferred journals is assessed. Various visualization tools such as the Sci2 tool and Ucinet were employed. The USA ranked top in terms of number of publications, citations per paper and h-index, while Switzerland published a higher percentage of international collaborative papers. The most productive institution was Tsinghua University followed by Ohio State University and Lanzhou Institute of Chemical Physics, CAS. The most preferred journals were Tribology Letters, Wear and Journal of Japanese Society of Tribologists. The result of author keywords analysis reveals that Molecular Dynamics, MEMS, Hard Disk and Diamond like Carbon are major research topics.

Siebrits, R., Winter, K., Jacobs, I. (2014)[12]. They performed a scientometric analysis of water research publications extracted from four decades of South African related papers to identify paradigms and paradigm shifts within water research in South Africa. Between 1977 and 1991, research publications are dominated by research into technical and engineering solutions, as well as designs and plans to secure water supply. From 1992 to 2001, publications on water pollution, water quality, water resource management and planning are prominent. The second major paradigm is observed from 2001 to 2011 in which the emphasis is on planning, modelling, catchment-scale studies and a multidisciplinary approach to research. Another transition period, towards the end of 2011, is characterised by uncertainty, although it also shows the prominence of key concepts such as participation, governance and politics in water management. The second aim of this study was to identify and prioritise current and future water research questions through the participation of a wide range of researchers from across the country, and to relate these questions to research paradigms, issues and concerns in water in South Africa. Over 1600 questions were collected, reduced in number and then prioritised by specialists in the water sector. The majority (78%) of questions offered by respondents in the South African case study

dealt with relatively short - to medium-term research requirements with 47% of questions focused on medium-term issues such as supplying water, service delivery and technical solutions.

Pautasso, M. (2015)[13]. Scientometric and bibliometric methods are increasingly applied to study temporal trends in scientific outputs, but there has been little application in plant and forest health. This research note uses the Google Books N-Grams search engine to explore temporal trends in the use of terms related to forest pathology in published books. The search was performed for books in American and British English, French, German and Italian. There is evidence for a relative decline in the use of the term 'forest pathology', since the 1950s in books in American English and since the 1990s in books in British English. This decline was counterbalanced by a relative increase in the use of the term 'forest health' between the 1980s and the end of the 1990s, whereas the term 'tree diseases' roughly followed the same trend as 'forest pathology'. A declining trend was observed for 'pathologie forestière' (since the 1980s), both 'Waldschutz' and 'Forstschutz' (since the 1990s), as well as 'patologia forestale' (since the 1950s). The use of the terms 'dendrology', 'forest entomology', 'forest genetics', 'mycology', 'plant pathology' appears to have followed the trend observed for 'forest pathology' in all studied languages. Conversely, there has been an increase in books mentioning topics such as 'ecosystem health' and 'old-growth forests.' The trends observed here call for increased efforts to make the public aware of trees, their diseases and the health of forests.

Objectives;

1. To study and analyze the overall representation of publications of Agronomy.
2. To sketch the year wise allocation of the publications.
3. To depict the subject wise production of publications.
4. To identify the document types of the publications.
5. To find out the most prolific authors of the publications.
6. To find the relative growth rate and doubling time for publications.
7. To identify the preferences of source titles for communication of these publications.
8. To trace out the geographic distribution of publications.

Methodology;

Scientometric analysis of publications on Agronomy research during the years 1956-2017 was done which formed the basic data for this study. The data was collected by searching the online database Scopus[13]. The world largest abstract and citation database of peer reviewed literature encompassing almost all subjects of science and technology. Scopus indexes documents of different source types like journals, conference proceedings, book series, trade publications etc., were included the study. The analysis data was done to figure out first top results of prolific authors, subjects and source titles which are considered for publication. The data thus obtained were analyzed and interpreted as distribution of publication individual institutes, subject wise distribution, document type, year wise, language wise, prolific authors, source title, etc.

Significance / Purpose of this study;

The study was carried out to analyse the growth and development of research contribution of the field Agronomy and the research publications output as indexed by Scopus database. The aim was to highlight the research output of the Agronomy research, trends in yearly increase and progress of the documents, subject mapping, identifying the medium of publication, and finding the most used document type and most prolific authors in the field in terms of publications count. It will be of enormous use for the scientometticans in general.

Results and Analysis;

Year wise distribution of publications;

The table -1 illustrates the yearly allocation of publications of the agronomy research. It provides the year wise output of publications. It found that the most product year in the terms of publications count is 195 (16.17%) with the highest number of publications in the year of 2014. The least number of publications are found to be of 1956 with 1 (0.08%) publication.

Table - 1 Year-wise distribution of publications;

S. No	Year	Number of Publications	% of 1206
1	1956	1	0.08
2	1968	1	0.08
3	1973	1	0.08
4	1974	2	0.17
5	1976	1	0.08
6	1981	1	0.08
7	1982	1	0.08
8	1984	2	0.17
9	1985	2	0.17

10	1986	1	0.08
11	1987	3	0.25
12	1988	2	0.17
13	1989	6	0.50
14	1990	4	0.33
15	1992	3	0.25
16	1993	1	0.08
17	1995	4	0.33
18	1996	4	0.33
19	1997	4	0.33
20	1998	6	0.50
21	1999	6	0.50
22	2000	11	0.91
23	2001	8	0.66
24	2002	6	0.50
25	2003	12	1.00
26	2004	17	1.41
27	2005	15	1.24
28	2006	24	1.99
29	2007	27	2.24
30	2008	34	2.82
31	2009	36	2.99
32	2010	35	2.90
33	2011	41	3.40
34	2012	57	4.73
35	2013	99	8.21
36	2014	195	16.17
37	2015	172	14.26
38	2016	179	14.84
39	2017	182	15.09

Document type distributions;

The Table -2 demonstrate the distribution of publications in terms of document types. The articles were found the most used document type with 1057 (87.65%), Review with 64 (5.31%), Book chapter with 35 (2.90%), Conference paper with 26 (2.16%), and so on. The least used document type was Erratum with only 1(0.08) document.

Table .2 Document type distributions;

S. No	Types of Documents	No of Documents	% of 1206
1	Article	1057	87.65
2	Review	64	5.31
3	Book Chapter	35	2.90
4	Conference Paper	26	2.16
5	Book	21	1.74
6	Short Survey	2	0.17
7	Erratum	1	0.08

Year wise Authorship pattern and their percentage;

Table- 3 indicates the year wise authorship pattern in the source topic. 67 single authors contributed all over the publication output. 207 double authors paper contributed for the source title. 252 three authors contributed for publishing. 673 multi authors contributed for paper publishing.

Table-3.Year wise Authorship pattern and their percentage.

S. No	Year	Single Author	Two Authors	Three Authors	More than Three authors	Total	Percentage
1	1956	1	0	0	0	1	0.08
2	1968	0	1	0	0	1	0.08
3	1973	0	1	0	0	1	0.08
4	1974	0	0	2	0	2	0.17
5	1976	0	1	0	0	1	0.08
6	1981	1	0	0	0	1	0.08
7	1982	1	0	0	0	1	0.08
8	1984	1	0	1	0	2	0.17
9	1985	1	1	0	0	2	0.17
10	1986	0	1	0	0	1	0.08
11	1987	1	2	0	0	3	0.25
12	1988	2	0	0	0	2	0.17
13	1989	1	3	0	2	6	0.50
14	1990	0	2	2	0	4	0.33
15	1992	1	0	1	1	3	0.25
16	1993	0	0	0	1	1	0.08
17	1995	1	0	1	2	4	0.33
18	1996	0	4	0	0	4	0.33
19	1997	0	3	1	0	4	0.33
20	1998	0	2	2	2	6	0.50
21	1999	1	1	0	4	6	0.50
22	2000	1	2	5	3	11	0.92
23	2001	2	2	2	2	8	0.67
24	2002	1	0	1	4	6	0.50
25	2003	0	4	1	8	13	1.08
26	2004	1	6	4	5	16	1.33
27	2005	1	4	2	8	15	1.25
28	2006	5	4	6	9	24	2.00
29	2007	1	4	8	14	27	2.25

30	2008	1	4	14	14	33	2.75
31	2009	3	7	7	18	35	2.92
32	2010	3	9	8	15	35	2.92
33	2011	1	7	10	22	40	3.34
34	2012	1	12	8	36	57	4.75
35	2013	3	16	16	63	98	8.17
36	2014	5	43	42	103	193	16.10
37	2015	13	21	34	104	172	14.35
38	2016	5	21	48	105	179	14.93
39	2017	8	19	26	128	181	15.10
Total		67	207	252	673	1199	100.00

Year wise Single author VS Multi author contributions;

Table 4 shows that Single author and multi author contribution in the source topic. It is found that 67 papers are published by single author and 1132 papers are published by multi author during the study period

Table - 4 Year wise Single author VS Multi author contribution.

S.No	Year	Single Author	Multi Authors	Total
1	1956	1	0	1
2	1968	0	1	1
3	1973	0	1	1
4	1974	0	2	2
5	1976	0	1	1
6	1981	1	0	1
7	1982	1	0	1
8	1984	1	1	2
9	1985	1	1	2
10	1986	0	1	1
11	1987	1	2	3
12	1988	2	0	2
13	1989	1	5	6
14	1990	0	4	4
15	1992	1	2	3
16	1993	0	1	1
17	1995	1	3	4
18	1996	0	4	4
19	1997	0	4	4
20	1998	0	6	6
21	1999	1	5	6
22	2000	1	10	11

23	2001	2	6	8
24	2002	1	5	6
25	2003	0	13	13
26	2004	1	15	16
27	2005	1	14	15
28	2006	5	19	24
29	2007	1	26	27
30	2008	1	32	33
31	2009	3	32	35
32	2010	3	32	35
33	2011	1	39	40
34	2012	1	56	57
35	2013	3	95	98
36	2014	5	188	193
37	2015	13	159	172
38	2016	5	174	179
39	2017	8	173	181
Total		67	1132	1199

DEGREE OF COLLABORATION;

The degree of collaboration is defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period of time. The formula suggested by Subramanyam is used in this study.

$$C = \frac{N_m}{N_{m+} N_s}$$

C = Degree of Collaboration

N_m = Number of Multiple authors

Ns = Number of single authors

Degree of collaboration;

Table -5 shows that degree of collaboration in the source topic. The degree of collaboration (0.00) occurred in the year of 2008 to 1988. The degree of collaboration (0.33) occurred in the year of 1989 and 1993. The degree of collaboration 0.67 occurred in the year of 1999. The degree of collaboration (0.43) occurred in the year of 2010. The degree of collaboration (0.71) occurred in the year of 2017 so on.

Table – 5 Degree of collaborations

S.No	Year	Degree of Collaboration
1	1956	0.00
2	1968	0.00
3	1973	0.00
4	1974	0.00
5	1976	0.00
6	1981	0.00
7	1982	0.00
8	1984	0.00
9	1985	0.00
10	1986	0.00
11	1987	0.00
12	1988	0.00
13	1989	0.33
14	1990	0.00
15	1992	0.33
16	1993	1.00
17	1995	0.50
18	1996	0.00
19	1997	0.00
20	1998	0.33
21	1999	0.67
22	2000	0.27
23	2001	0.25
24	2002	0.67
25	2003	0.62
26	2004	0.31
27	2005	0.53
28	2006	0.38
29	2007	0.52
30	2008	0.42
31	2009	0.51
32	2010	0.43
33	2011	0.55
34	2012	0.63
35	2013	0.64
36	2014	0.53
37	2015	0.60
38	2016	0.59
39	2017	0.71

Relative Growth Rate;

The relative growth rate and doubling time model developed by Mahapatra was applied to examine the growth rate of research publications of Agronomy research. The relative growth rate

is increased in the number of publications or pages per unit of time. A specified period of interval can be calculated from the following equations.

$$\bar{R}(1\text{-}2) = \frac{W_1 - W_2}{T_2 - T_1}$$

Where, $\bar{R}(1\text{-}2)$ is mean relative growth rate over the specified period interval

W_1 = Log W_1 : (Natural Log of initial number of publications / pages)

W_2 = Log W_2 : (Natural Log of final number of publications / pages)

$T_2 - T_1$ = The unit difference between the initial time and final time

The relative growth rate for both publications and pages can be calculated separately. Therefore,

$\bar{R}$ (a) = Relative growth rate per unit of time (year)

$\bar{R}$ (p) = Relative growth rate per unit of pages, per unit of time (year)

Doubling Time;

From the calculation, it is found that there is a direct equivalence existing between the relative growth rates and doubling time. If the number of publications/pages of a subject doubles during a given period, then the difference between the logarithm of the numbers at the beginning and at the end of the period must be the logarithms of the number 2. If one uses a natural logarithm, this difference has a value of 0.693. The corresponding doubling time for publications and pages can be calculated by using the following formula:

$$\text{Doubling time (Dt)} = \frac{0.693}{\bar{R}}$$

Therefore, Doubling time for publications Data $Dt(a) = \frac{0.693}{\bar{R}(a)}$

$$\text{Doubling time for pages } Dt(p) = \frac{0.693}{\bar{R}\,(p)}$$

Relative growth rate and doubling time for publications;

The study of data in table - 6 indicates the relative growth rate and doubling time for publications of agronomy research. It is clear that relative growth rate of total research output decreased

gradually. The growth rate is 0.69 in 1956 which decreased up to 0.16 in 2017. The mean relative growth rate for the study period from 1956 to 1986 is 0.256. The mean relative growth rate for the study period from 1987 to 1998 is 0.135. The mean relative growth rate for the study period from 1999 to 2008 is 0.144. The mean relative growth rate for the study period from 2009 to 2017 is 0.175. The period the mean doubling time from 1956 to 1986 is 2.446 years. The period the mean doubling time from 1987 to 1998 is 6.992 years. The period the mean doubling time from 1999 to 2008 is 5.172 years. The period the mean doubling time from 2009 to 2017 is 3.483 years.

Table-6 Relative growth rate and doubling time for publications;

Year	R.O	Cumulative O/P	W1	W2	R(a) W2-W1	Mean R (a) (1-2)	Doubling time Dt(a)	Mean Dt(a) (1-2)
1	1956	1	-	0.00	-			
2	1968	2	0.00	0.69	0.69		1.00	
3	1973	3	0.69	1.10	0.41		1.71	
4	1974	5	1.10	1.61	0.51		1.36	
5	1976	6	1.61	1.79	0.18		3.80	
6	1981	7	1.79	1.95	0.15	0.256	4.50	2.446
7	1982	8	1.95	2.08	0.13		5.19	
8	1984	10	2.08	2.30	0.22		3.11	
9	1985	12	2.30	2.48	0.18		3.80	
10	1986	13	2.48	2.56	0.08		8.66	
11	1987	16	2.56	2.77	0.21		3.34	
12	1988	18	2.77	2.89	0.12		5.88	
13	1989	24	2.89	3.18	0.29		2.41	
14	1990	28	3.18	3.33	0.15	0.135	4.50	6.992
15	1992	31	3.33	3.43	0.10		6.81	
16	1993	32	3.43	3.47	0.03		21.83	
17	1995	36	3.47	3.58	0.12		5.88	
18	1996	40	3.58	3.69	0.11		6.58	
19	1997	44	3.69	3.78	0.10		7.27	
20	1998	50	3.78	3.91	0.13		5.42	
21	1999	56	3.91	4.03	0.11		6.11	
22	2000	67	4.03	4.20	0.18		3.86	
23	2001	75	4.20	4.32	0.11		6.14	
24	2002	81	4.32	4.39	0.08	0.144	9.00	5.172
25	2003	93	4.39	4.53	0.14		5.02	
26	2004	110	4.53	4.70	0.17		4.13	
27	2005	125	4.70	4.83	0.13		5.42	
28	2006	149	4.83	5.00	0.18		3.95	
29	2007	176	5.00	5.17	0.17		4.16	
30	2008	210	5.17	5.35	0.18		3.92	

31	2009	246	5.35	5.51	0.16	0.175	4.38	3.483
32	2010	281	5.51	5.64	0.13		5.21	
33	2011	322	5.64	5.77	0.14		5.09	
34	2012	379	5.77	5.94	0.16		4.25	
35	2013	478	5.94	6.17	0.23		2.99	
36	2014	673	6.17	6.51	0.34		2.03	
37	2015	845	6.51	6.74	0.23		3.04	
38	2016	1024	6.74	6.93	0.19		3.61	
39	2017	1206	6.93	7.10	0.16		4.24	

Subject wise distribution of publications;

Table – 7 depicts the analysis of the data, subject wise distribution of publications retrieved for the years considered for the study. There were 1017 (84.33%) publications in Agricultural and biological science subject occupying the highest position. This is followed by Environmental science with 200 (16.18%), Biochemistry, genetics and molecular biology with 116 (9.62%) and Immunology and microbiology with 54 (4.48%) publications and so on. The weakest subject area found to Neuroscience with only 1 (0.08%) publication.

Table – 7 Subject wise distribution of publications;

S. No	Subject wise distribution	No of publications	% of 1206
1	Agricultural and biological sciences	1017	84.33
2	Environmental science	200	16.58
3	Biochemistry, genetics and molecular biology	116	9.62
4	Immunology and microbiology	54	4.48
5	Engineering	52	4.31
6	Earth and planetary sciences	35	2.90
7	Chemistry	29	2.40
8	Energy	28	2.32
9	Chemical engineering	27	2.24
10	Social sciences	26	2.16
11	Medicine	19	1.58
12	Computer science	17	1.41
13	Pharmacology, toxicology and	15	1.24
14	Business, management and accounting	10	0.83
15	Multidisciplinary	7	0.58
16	Materials science	6	0.50
17	Mathematics	5	0.41
18	Economics, econometrics and finance	4	0.33
19	Physics and astronomy	4	0.33
20	Arts and humanities	3	0.25
21	Decision sciences	2	0.17
22	Health professions	2	0.17
23	Neuroscience	1	0.08

Top 25 source titles in terms of number of productivity;

Table -8 shows source titles with their total number of publications. The list shows the source titles up to 25 ranks which established in this analysis. It is found that the Indian journal of agronomy gets the maximum number documents to be published with 435 (36.07%) titles in its share followed Ecology environment and conservation with 44 (3.65%) titles and Agronomy Journal with 38 (3.15%) and so on.

Table -8 top 25 source titles in terms of number of productivity;

S.No	Source titles wise distribution	No of Productivity	% of 1206
1	Indian journal of agronomy	435	36.07
2	Ecology environment and conservation	44	3.65
3	Agronomy Journal	38	3.15
4	Research on crops	31	2.57
5	Annals of biology	28	2.32
6	Field crops research	28	2.32
7	Industrial crops and products	23	1.91
8	Pestology	20	1.66
9	Indian journal of agricultural sciences	19	1.58
10	Theoretical and applied genetics	18	1.49
11	Annals of agri bio research	14	1.16
12	Plant archives	14	1.16
13	Journal of pure and applied	13	1.08
14	Communications In soil science and	12	1.00
15	Journal of environmental quality	10	0.83
16	Scientia horticulturae	9	0.75
17	Agricultural research	8	0.66
18	Biomass and bioenergy	7	0.58
19	Water stress and crop plants a	7	0.58
20	Environmental monitoring and	6	0.50
21	European journal of agronomy	6	0.50
22	Genetic resources and crop evolution	6	0.50
23	Irrigation science	6	0.50
24	Legume research	6	0.50
25	Advances In agronomy	5	0.41

Top 25 prolific authors in terms of productivity count;

Table – 9 represents the list of top 25 prolific authors in terms of productivity count and their affiliations thereof. The list is ranked the list is ranked in the order of decreasing productivity. It is found that the Shivay, Y.S., occupied first rank followed by Rana, D.S., occupied the second rank in the list. Rana, K.S., occupied third position among the productivity.

Table -9 top 25 prolific authors in terms of productivity count;

S.No	Prolific authors	No of Productivity	% of 1206
1	Shivay, Y.S.	20	1.66

2	Rana, D.S.	19	1.58
3	Rana, K.S.	14	1.16
4	Kaur, R.	13	1.08
5	Kumar, A.	13	1.08
6	Upadhyaya, H.D.	13	1.08
7	Dass, A.	12	1.00
8	Lal, R.K.	12	1.00
9	Kumar, D.	11	0.91
10	Prasad, R.	11	0.91
11	Singh, A.K.	11	0.91
12	Singh, R.K.	11	0.91
13	Pooniya, V.	10	0.83
14	Choudhary, A.K.	9	0.75
15	Das, A.	9	0.75
16	Das, T.K.	9	0.75
17	Dhar, S.	9	0.75
18	Jat, S.L.	9	0.75
19	Kumar, R.	9	0.75
20	Patel, H.K.	9	0.75
21	Singh, D.	9	0.75
22	Babu, S.	8	0.66
23	Mishra, J.S.	8	0.66
24	Ram, H.	8	0.66
25	Vyas, A.K.	8	0.66

Conclusions;

- The study was observed the maximum number of publication was recorded with 195 (16.17%) in the year of 2014 and the least number publications were found to be 1956 with 1 (0.08%) publications.
- It is observed from the study demonstrate the distribution of publications in terms of document types. Articles were found the most used document type with 1057 (87.65%). The least used document type was Erratum with only 1(0.08) document.
- 67 single authors contributed all over the publication output. 207 double authors paper contributed for the source title. 252 three authors contributed for publishing. 673 multi authors contributed for paper publishing.
- It is found that 67 papers are published by single author and 1132 papers are published by multi author during the study period.
- The study exposes is clear that relative growth rate of total research output decreased gradually. The growth rate is 0.69 in 1956 which decreased up to 0.16 in 2017. The mean relative growth rate for the study period from 1956 to 1986 is 0.256. The mean relative

growth rate for the study period from 1987 to 1998 is 0.135. The mean relative growth rate for the study period from 1999 to 2008 is 0.144. The mean relative growth rate for the study period from 2009 to 2017 is 0.175.

- The period the mean doubling time from 1956 to 1986 is 2.446 years. The period the mean doubling time from 1987 to 1998 is 6.992 years. The period the mean doubling time from 1999 to 2008 is 5.172 years. The period the mean doubling time from 2009 to 2017 is 3.483 years.
- It is observed from the study the subject wise distribution of publications retrieved for the years considered for the study. There were 1017 (84.33%) publications in Agricultural and biological science subject occupying the highest position. This is followed by Environmental science with 200 (16.18%), Biochemistry, genetics and molecular biology with 116 (9.62%) and Immunology and microbiology with 54 (4.48%) publications and so on. The weakest subject area found to Neuroscience with only 1 (0.08%) publication.
- It is observed from the study the Indian journal of agronomy gets the maximum number documents to be published with 435 (36.07%) titles in its share followed Ecology environment and conservation with 44 (3.65%) titles and Agronomy Journal with 38 (3.15%) and so on.
- It is observed from the study that the Shivay, Y.S., occupied first rank followed by Rana, D.S., occupied the second rank in the list. Rana, K.S., occupied third position among the productivity.

It should be highlighted that the articles are the key method of communication by researchers, supplying a primary indication on the quantum associated with work carried out in different. Scientometric method is used for various purposes such as identification of different scientific indicators, analysis of scientific results and predicting the potential of a field. This work presents an analysis of Agronomy over a period (1956-2016). In future we plan investigate the influence of the collaboration degree, the number of co-authors and the forms of documents to the citations and therefore, on the impact factor of the field Agronomy. These studies can help researchers to comprehend the magnitude of Plant pathology research in India and establish future research directions.

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