April 2019

Seed Technology Research Output: A Scientometric Analysis on SCOPUS Database

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Abstract

. The study analyses the seed technology research publications during 2008-2017 based on the Scopus database. The objective of the study was to perform a scientometric analysis of all seed technology research publication. Data for a study is total of 8576 have been downloaded and analyzed according to objectives. The study reveals that the growth of literature follows the liner growth pattern, journal articles are the most published form of literature (73.83%), International Journal Of Food Science and Technology followed by Nongye Gongcheng Xuebao Transactions Of The Chinese Society Of Agricultural Engineering are top journals, China and Chinese Academy of Sciences are top research contributing country and institution. The highly productive subject areas are Agricultural and Biological Sciences .Collaborating authorship pattern analysis shows that degree of collaboration (92%) significantly high. Overall, the paper presents an informed account of seed technology research performance.

Keywords: Seed Technology , Agriculture, Engineering , Scientometrics , Bibliometrics , Growth pattern,

1. Introduction

Agriculture plays a very important role in providing employment and food production. Around the world large proportion of population depends on agriculture and agriculture related activities. Most of countries Economic growth largely depends on development of agriculture. Over a period of time extensive use of technology has led to growth in agriculture production all over the world and also benefited from technological infusion in agriculture. With this regard Seed Technology is essentially an interdisciplinary agricultural science which encompasses broad range of subjects and its plays an important role in the agricultural Practice.

Scientometrics analysis of literature provides clear picture of research trends in the field concerned. In this paper attempts to analyze quantitatively research output in seed technology in terms of research publication in SCOPUS database during 2008 to 2017 (10 Years) .

2. Review of Literature

Swain and Rautaray (2013) have analyzed 275 scholarly articles of Library Review from the year 2007 to 2011; single authored articles occupy the prominent position indicating the supremacy of solo research. The degree of collaboration in the publications of this journal is found to be 0.36. It is evident that LR has accommodated over 22 citations per article and regard to country productivity, the UK leads the table, followed by the USA and Nigeria. The findings of this study will serve as a model for future single journal bibliometric studies of journals of similar stature

Serenko (2013) has described the overall volume of scientometrics Knowledge Management works has been growing, reaching up to ten publications per year by 2012, but their key findings are somewhat inconsistent. The top six most productive countries are the USA, the UK, Canada, Germany, Australia, and Spain. Knowledge management exhibits attributes of a healthy academic domain with no apparent anomalies and is progressing towards academic maturity. This is the first documented attempt to conduct a meta-analysis of scientometrics research of the Knowledge management.

Bharadwaj and Ram (2013) have focused the Osteoporosis research output, one of the silent disease causes of fractures and disability in the aged. The data were obtained from Scopus from the year 1973 to 2012. USA is the most productive country with global share 27.21% publications. Indian researchers have contributed 1.02% with 921papers. AIIMS, Delhi is the most productive institution in India. India's highest research collaboration has been with USA within the period. Osteoporosis International (21 papers; IF 4.58) is the most productive journal in Indian research and N. Chattopadhyay (25 papers, 12.25%, and h-index 12) form Central Drug Institute; Lucknow is the most productive author in Osteoporosis research.

Dutt and Nikam (2013) have examined the Solar cell research for the period of 20 years from the Web of Science (WOS) database. The 90% contributions from top 22 Indian Institutions like IITs, IISc, CSIR, DAE and seven State Universities. CSIR-IICT, IISc, Shivaji University (AU) and Alagappa University (AU) had the highest citation rate and citation per paper. The International research trends as more than 90% originating from the USA, UK and other advanced countries in Europe. Among the all types of Solar cells Organic and Polymer solar cell, dye-sensitized solar cell, photoelectrochemical solar cell and quantum dot solar cell were the recent focus of research of Indian scientists.

According to Thanuskodi (2011), identified bibliometric analysis of articles and references provided at the end of each article contributed in *Indian Journal of Chemistry* from 2005-2009. The analysis cover mainly the number of articles, authorship pattern, forms of document cited, etc. All the studies point towards the merit and weakness of the journal which will be helpful for its further development. This study showed that most of the contributions are India. The authorship pattern of the articles published during the period of study. Maximum number of articles were contributed by two authors. This study also showed that majority of the contributors preferred journals as the source of information which occupied the top position. All the studies point towards the merits and weakness of the journal which will be helpful for its further development.

Gupta and Kaur (2013) have analyzed the global research output in glaucoma research during 2002 to 2011, 33098 papers were published. USA tops the list with a global publication share of 27.25% followed by China (8.60%), UK (8.09%) and India ranks 6th with 3.26% and an annual average publications growth rate 6.94%. University of Melbourne, Centre for Eye research registered the higher publications with 298 papers and Harvard Business School, Boston, 293 papers. Only seven Indian institutes have registered higher impact than the group average. In glaucoma, research witnessed an annual average growth rate of 6.94%.

Mukherjee (2013) has presented the research performance and contributions of Prof. Lalji Singh an eminent Indian Scientist in the field of genome analysis, DNA finger printing, etc., 222 articles were indexed in the WoS and Scopus database during 1968 to 2011. The highest number of articles appeared in 2006 (27). He wrote 05 articles under single-authorship, 13 in two-authorship, and 20 in four-authorship and so on, and he is serving as a leader of his research term and K. Thangaraj is the fellow scientist with whom he wrote most. Prof. Singh has cited 3978 (up to July 2012) times with an average of 17.83 citations per paper. The percent H-index of Prof. Singh has reached 30, which is rare among Indian Scientists.

Konur (2012) has evaluated the global research performed by the higher education institutions on the education for the period from 1980 to 2011. The total 179,832 references with 69.6% were articles followed by book reviews 16.7%, editorial materials 5.5%, proceedings papers 2.6%, note 2.3%, and reviews 2.1%. The other materials constituted 3.9% of the sample. Countries publishing the most are USA with 61.7% followed by England (9.6%), Canada (5.4%), Australia (4.9%), and Netherlands (2.2%). In addition, most prolific authors, as the universities, were from the most publishing countries such as the US.

Sinha and Joshi K (2012) have analyzed the status of solar photovoltaic (PV) research in India during the year 2000 to 2009. India solar PV comprises of 1375 journal papers, 381 conference papers, 52 reviews and 6 other type documents. India has increased almost steadily at the rate of 16% per year (global AAGR 19%) with slight dip in 2001and somewhat larger decline in 2005. This study concludes with comprehensive mapping of solar PV R&D capability of India should be taken out on a priority bases in order to make effective R&D strategies to make advantage of supportive policy initiatives like the National Mission 2010.

Suresh and Thanuskodi (2018) has analyses India's research in Seed technology during the period 1989–2017 based on WEB OF SCIENCE records, it found that Seed Technology research output has grown by 475% between 2006-2009 which shows that there is an increasing trend of research activities in Seed Technology research. India was 3rd among the top ten most productive countries of the world in Seed Technology research during 1989-2017.

3. Objectives of the study

The main objectives of this study is to analysis the research output of seed technology Research as reflected in the publication output during 2008 to 2017 the study focuses on the following aspects.

- To analyze the growth pattern of research publication output of seed technology during 2008 to 2017 and find out the Relative Growth Rate and Doubling Time of that publications.
- To predict research publication output of seed technology for the year 2020 to 2025 by using time series analysis
- To evaluate the document type of Publication
- To find out the most productive Journals in seed technology research
- To identify the most prolific Authors by using different quality Indicators such as H-index and CPP
- To examine the authorship patterns and degree of collaboration
- To find High Productive Subject areas
- To find out the application of Zipfs law

4. Data Collection and Research Methodology

Data for this study were retrieved from the SCOPUS international and multidisciplinary indexing database on 2nd December 2018. SCOPUS was chosen because it is a relatively large database with a more expanded variety of journals. The data collected for this purpose covers publications of the period 2008 to 2017. A search query was constructed and employed to retrieve data that contained the term seed technology. MS Excel worksheet using for statistical analysis.

5. Data analysis

5.1 Research Output and Growth Trend

Table 1 shows there are total 8576 publications in SCOPUS during the period 2008 to 2017 for seed technology research. An overall increasing trend was observed. The year 2016 has been identified as the most productive year with 13.50 % of cumulative output. It shows that the total publications (n = 8576) have been cited more than 10 times during the period 2008 – 2017. Even though the annual publication output is gradually increasing the average citation per paper has follows decreasing trend from 2014 to 2017.

Year	TP	Cum. TP	% output	Total Citation	Average Citation Per Paper
2008	575	**575**	6.70	15874	27.61
2009	583	**1158**	6.80	8994	15.43
2010	674	**1832**	7.86	10131	15.03
2011	777	**2609**	9.06	11123	14.32

2012	811	**3420**	9.46	10007	12.34
2013	929	**4349**	10.83	13477	14.51
2014	961	**5310**	11.21	10426	10.85
2015	1023	**6333**	11.93	6098	5.96
2016	1158	**7491**	13.50	4435	3.83
2017	1085	**8576**	12.65	2217	2.04
TOTAL	**8576**			**92782**	

Table No. 1: Year-Wise Distribution of Publications

The curve fitting methodology was used to fit the growth of research publication, Growth model has been tested by the P value method (Table 1(a). The P value for the linear growth model given in the table 1(b) is 0.057 which is equal to the σ (5% or 0.05). It has been confirmed by the statistical analysis that the growth of seed technology research publication output for the period 2008 – 2017 is linear.

	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***	***Lower 95.0%***	***Upper 95.0%***
Intercept	-133674.98	9293.04	-14.38	0.0533	-155104.76	-112245.19	-155104.76	-112245.19
X-Variable	66.85	4.62	14.48	**0.057**	56.20	77.50	56.20	77.50

Table No. 1 (a): Statistical analysis for Growth model

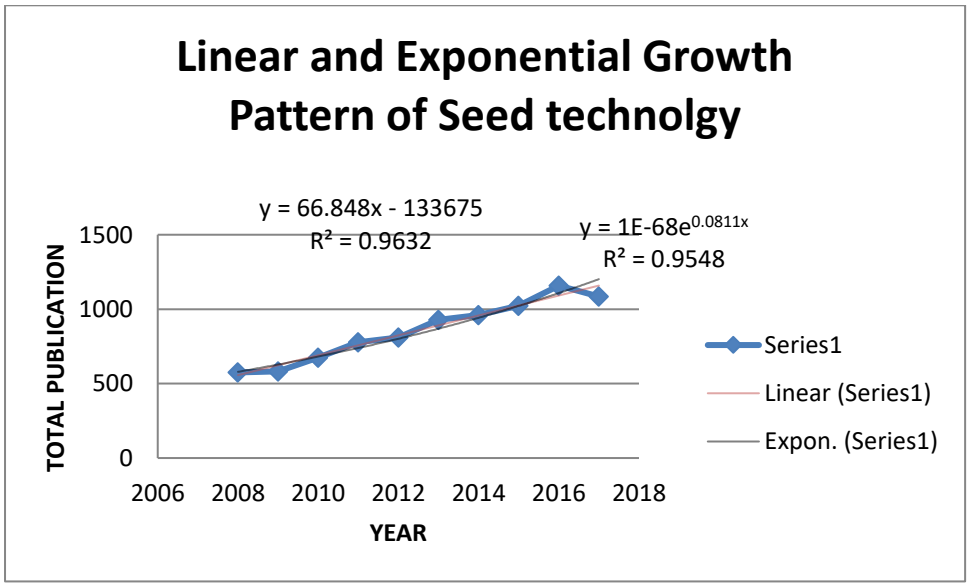

Fig.1 Growth Pattern

5.2. Relative Growth Rate (RGR) and Doubling Time (DT) of Publication

A study of data in table 2 indicates that the relative Growth rate and Doubling time for publications of seed technology research. The relative growth rate (RGR) and doubling time (DT). RGR is the increase in the number of publications per unit of time and it is calculated using the formula RGR = (lnN2 - lnN1)/ (t2 –t1), where N2 and N1 are the cumulative number of publications in the years t2 and t1. The parameter doubling time (DT) indicates the time required for publications to become double of the existing amount. DT is related to RGR in that if the number of articles doubles then the difference between the logarithms of numbers at the beginning and end of that period is 693 and it is calculated as DT = 0.693/RGR.

Table 2 that RGR has shown a gradually increasing trend from 2009 (0.69) to 2017 (2.07) whereas Doubling time had an increased trend from 1.01 to 4.70 in the same period. This means that although the number of publications increased since 1966, its rate of growth slightly decreased while the corresponding doubling time increased. The mean relative Growth rate for the periods of 2008 to 2017 is 1.33. This study period resulted that the mean doubling time for total output 0.94.

Year	***Papers***	***Cumulative of Papers***	***W1***	***W2***	***R(a) (1-2)***	***Mean R (a) (1-2)***	***Doubling Time Dt (a)***	***Mean Dt(a) (1-2)***
2008	575	575						
2009	583	1158	6.37	7.05	0.69		1.01	
2010	674	1832	6.51	7.51	1.00		0.69	
2011	777	2609	6.66	7.87	1.21		0.57	
2012	811	3420	6.70	8.14	1.44	**1.33**	0.48	**0.94**
2013	929	4349	6.83	8.38	1.54		0.45	
2014	961	5310	6.87	8.58	1.71		0.41	
2015	1023	6333	6.93	8.75	1.82		0.38	
2016	1158	7491	7.05	8.92	1.87		0.37	
2017	1085	8576	6.99	9.06	2.07		0.34	
					13.35		4.70	

Table:2 Relative Growth Rate (RGR) and Doubling Time (DT) of Publication

5.3 Time Series Analysis: The Future Growth of Publications:

Time Series Analysis (Table 3)is to predict the number of publications for the near future that is 2020 and 2025.

Year	*Count (Y)*	*X*	X^2	*XY*
2008	575	-4.5	20.25	-2587.5
2009	583	-3.5	12.25	-2040.5
2010	674	-2.5	6.25	-1685
2011	777	-1.5	2.25	-1165.5
2012	811	-0.5	0.25	-405.5
2013	929	0.5	0.25	464.5
2014	961	1.5	2.25	1441.5
2015	1023	2.5	6.25	2557.5
2016	1158	3.5	12.25	4053
2017	1085	4.5	20.25	4882.5
	8576	**0**	**82.5**	**5515**

Table.4 Time Series Analysis: The future growth of publications

Straight line equation Yc = a+bX
Since ∑X=0
a=∑Y/N
=8576/10
=857.6
b=∑XY/∑X2
=5515/82.5
=66.85

Estimated Literature in 2020 is when X =2020-2008 -12 years
*=857.6+66.85*12*
=857.6+808.12
=1665.72
Estimated Literature in 2025 is when X =2025-2008-17 years
*=857.6+66.85*17*
=857.6+1136.4
=1994

5.4 Document wise Distribution of Publications

Table.5 shows that the major source of publications covered by SCOPUS Database on research output of seed technology in journal articles with 6329 (73.8%) records, while the Conference Proceedings with 1091(12.72%) Books 551(6.42%), Book series 495 (5.77%), Trade Publication 107(1.25%) and Undefined document type 3 (0.03%) record found of this study.

Document Types	Publications	%

Journals	6329	73.80
Conference Proceedings	1091	12.72
Books	551	6.42
Book Series	495	5.77
Trade Publications	107	1.25
Undefined	3	0.03

Table .5 Document wise Distributions of publications

5.5. Most prolific authors

The top 10 prolific authors of seed technology research during the year 2008to 2017 along with their citation indicates. A quantitative analysis of research output published by the authors found the top most prolific authors were Wang ,D (17), Varshney, R.K (12), and Struik, P.C. (11). On the contrary a quality Indicators i.e H-index and CPP has revealing that Varshney, R.K (H –index 8,CPP 21.5) followed by Struik, P.C. (H –index 5,CPP 21.5) , Qaim, M. (H –index 5,CPP 13.5) and Baributsa, (H –index 5,CPP 13.5).

AUTHOR	No. of Publication	Total Publication (%)	Total Citations	Citation per publications	Max Citation Per Paper	H index
Wang, D.	17	0.20	27	1.6	9	3
Varshney, R.K.	12	0.14	258	21.5	69	8
Struik, P.C.	11	0.13	89	8.1	21	5
Holt, G.A.	10	0.12	21	2.1	4	3
Liu, Z.	10	0.12	48	4.8	15	5
Huang, M.	9	0.10	45	5.0	10	4
Qaim, M.	9	0.10	158	17.6	54	5
Shao, C.	9	0.10	21	2.3	9	2
Shiferaw, B.	9	0.10	9	1.0	1	2
Baributsa, D.	8	0.09	107	13.4	34	5

Table:6 Most prolific Authors

5.5. Authorship patterns and degree of collaboration

Table 7 described the authorship pattern of seed technology majority of articles(n=4034 ;47%) were produced by >5 followed by Four authors (1104 ;12.9%) , Three authors (993 ; 11.6%) finally the single authors were (627 ;7.3%) . The degree of collaboration (0.92) shows that collaborate in the research activities.

Authorship Pattern	Records	Percentage
Single Author	627	7.3
Two Authors	885	10.3
Three Authors	993	11.6
Four Authors	1104	12.9
Five Authors	933	10.9
>Five Authors	4034	47.0

Table: 7 Authorhip Patern

Author Pattern	Records	Percentage
Single Authored Paper	627	7.3
Multi Authored Paper	7949	92.7
Total	**8576**	**100**

Table: 7 (a) Degree of collaboration

The degree of collaboration has been measured with the help of K.Subrarmaniam formula

The formula where:

$$DC=\frac{Nm}{Nm+Ns}$$

DC= Degree of collaboration, Nm=Number of Multi Authors, Ns=Number of Single Authors

$$=\frac{7949}{7449+627}$$

$$=\frac{7949}{8576}$$

$$=0.92$$

5.6. Productive research areas

The subject-wise breakup of publications based on subject categories in SCOPUS shows that most publications were in Agricultural and Biological Sciences (45.95%), Engineering (26.36%) Biochemistry, Genetics and Molecular Biology (20.22%), Environmental Science (9.92%), Medicine (7.25%), Chemistry (6.75%), Chemical Engineering (6.54%), Immunology and Microbiology (4.59%).

Subject Area	Papers	Percentage
Agricultural and Biological Sciences	3941	45.95

Engineering	2261	26.36
Biochemistry, Genetics and Molecular Biology	1734	20.22
Environmental Science	851	9.92
Medicine	622	7.25
Chemistry	579	6.75
Chemical Engineering	561	6.54
Immunology and Microbiology	394	4.59
Energy	333	3.88
Mathematics	265	3.09
Earth and Planetary Sciences	216	2.52
Business, Management and Accounting	205	2.39
Economics, Econometrics and Finance	190	2.22
Arts and Humanities	103	1.20
Decision Sciences	66	0.77
Health Professions	27	0.31
Dentistry	4	0.05

Table: 8 Productive Subjects

5.7. Most productive journals

Of the total world output in research that seed technology as a quantitative tool, 73.8% (6329) publications appeared as articles in 166 peer reviewed journals These 166 journals had 8 or more research articles each. Illustrates the top 20 most productive journals, it indicates that 5 most common journals (Table 9) originated from United States. There other preferred journals are from China, UK and India. Top three Productive Journal were International Journal Of Food Science And Technology (2.79%) followed by Nongye Gongcheng Xuebao Transactions Of The Chinese Society Of Agricultural Engineering (2.46%) and Acta Horticulturae (2.38%) .

Rank	Journal	Total Publication	H Index	Country
1	International Journal Of Food Science And Technology	177	78	United Kingdom
2	Nongye Gongcheng Xuebao Transactions Of The Chinese Society Of Agricultural Engineering	156	38	China
3	Acta Horticulturae	151	49	Belgium
4	Food Science And Biotechnology	100	27	South Korea
5	Plos One	100	241	United States
6	Plant Archives	51	5	India
7	BMC Genomics	47	130	United

				Kingdom
8	Modern Food Science And Technology	47	6	China
9	Indian Journal Of Agricultural Sciences	39	21	India
10	Korean Journal Of Food Science And Technology	38	17	South Korea
11	Journal Of The Chinese Cereals And Oils Association	37	5	China
12	Methods In Molecular Biology	36	117	United States
13	Journal Of Agricultural And Food Chemistry	35	247	United States
14	Journal Of The Science Of Food And Agriculture	33	114	United States
15	Optics Express	32	225	United States
16	Frontiers In Plant Science	31	65	Switzerland
17	Industrial Crops And Products	31	94	Netherlands
18	International Journal Of Pharmacy And Technology	29	12	India
19	Guang Pu Xue Yu Guang Pu Fen Xi Spectroscopy And Spectral Analysis	28	26	China
20	Journal Of Clinical Rehabilitative Tissue Engineering Research	28	9	China

Table: 9 Most productive journal

5.8 Most productive countries and Institutions

Table.10 shows that research contributions in seed technology research among top 10 countries and Research institutions were analyzed. Out off 142 Countries were contributed and top 10 contributed countries were taken for analysis. The China was contributed 1906 (22.22 %) research publications out off 8576 publications and occupied the first position. United States contributed 1560 (18.19 %) research publications and occupied second position. India occupied the third position with 1042 (12.15 %). Out off 160 Research institution Contributed and top 10 institutions were taken for analysis, Chinese Academy of Sciences were top in list with 149 (1.74%) followed by China Agricultural University 132(1.54%) and Ministry of Education China 120 (1.40%).

Country	TP	TP (%)
China	1906	22.22
United States	1560	18.19
India	1042	12.15
Germany	351	4.09
Japan	339	3.95
Brazil	308	3.59
United Kingdom	308	3.59
South Korea	266	3.10
Canada	263	3.07
Australia	238	2.78

Table:10 Most Productive Countries

Institution	TP	TP (%)
Chinese Academy of Sciences	149	1.74
China Agricultural University	132	1.54
Ministry of Education China	120	1.40
USDA Agricultural Research Service, Washington DC	104	1.21
United States Department of Agriculture	83	0.97
Wageningen University and Research Centre	78	0.91
Ministry of Agriculture of the People's Republic of China	62	0.72
Chinese Academy of Agricultural Sciences	60	0.70
Zhejiang University	58	0.68
Cornell University	54	0.63

Table: 10 (a) Most Productive Institutions

5.9 Keywords wise distribution – Application of Zip Law

Zipf's Law states that in a relatively lengthy text, if the words occurring within that text are listed in order of decreasing frequency, the rank of a word on that list multiplied by its frequency will equal a constant. The equation for this relationship is: r x f = k where r is the rank of the word, f is the frequency, and k is the constant Kromer, V (2002). "Seed" is keyword used frequently of 980 3.72% in Seed technology research followed that "Nonhuman"(769;2.92%) and "Plant Seed" (752:2.85%)

Rank (r)	Word	Frequencies (f)	Multiplication of r & f r x f = k (expected constant)
1	Seed	980	980
2	Nonhuman	769	1538
3	Plant Seed	752	2256
4	Seeds	666	2664
5	Genetics	501	2505
6	Controlled Study	495	2970
7	Chemistry	477	3339
8	Human	476	3808
9	Metabolism	447	4023
10	Agriculture	409	4090
11	Priority Journal	380	4180
12	Humans	370	4440
13	Germination	299	3887
14	Zea Mays	292	4088

15	Cultivation	281	4215
16	Procedures	279	4464
17	Animals	277	4709
18	Unclassified Drug	276	4968
19	Technology	268	5092
20	Maize	252	5040

Table:11 Keyword Distribution

6. Findings

- During 10 years of study period 2016 is the most productive year with 1158 publication and 2007 are the least productive years with 575 publications.
- All the Publications were published in English language only
- It found that total citation received 2008 -2017 is 92782 and average citation per paper is 10.81,
- The Growth rate is 0.69 in 2009 and which increase up to 2.07 in 2017. The mean relative Growth rate 1.33. This study period resulted that the mean doubling time for total output 0.94.
- It predicted that research publication output for the year 2020 is computed as 1666.72 and for the year 2025 are 1994
- Journals (73.80%) have been observed as most preferred publication pattern and 1226 (19.37%) articles were published in Open access Journals.
- Wang, D. published the highest number of articles for the study period with 17 Publications, and research output measured in terms of citation counts Varshney, R.K.has received More H- Index 8 and CPP 21.5
- Agricultural and Biological Sciences 3941 (45.95%) has been identified as most productive research area followed by Engineering 2261 (26.36%).
- The average H-index of the top twenty preferred journals for seed technology research are 76.3% . Thus seed technology research output is published in most renowned journals with high H-index.
- The China was contributed 1906 (22.22 %) research publications occupied the first position. United States contributed 1560 (18.19 %) occupied second position and India in the third position with published 1042 (12.15%).
- Top three Contributing research institutions are from China ,Chinese Academy of Sciences 149 (1.74 %) publications ,China Agricultural University has 132 (1.54

%) next Ministry of Education China 120 (1.40 %) ; Indian Agricultural Research Institute in 12th place .

7. Conclusion

This study has highlighted quantitatively the research output during the years 2008-2017 as available in SCOPUS database. During this 10 years contribution in terms of number of publications is significant and more interdisciplinary nature. Databases such as Web of Science and CAB Direct Online Database would have been appropriate source of data for the future research to reveal the research output of seed technology.

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Acknowledgement

This article has been written with the financial support of RUSA – Phase 2.0 grant sanctioned vide Letter No. F.24-51 / 2014-U, Policy (TNMulti-Gen), Dept. of Edn. Govt. of India, Dt.09.10.2018