A Scientometric Analysis of Aquaculture Research Productivity: Study Based on Web of Knowledge Database

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Abstract

An analysis of 13,679 publications published by scientists during the time span of 1999 to 2013 and indexed by Web of Science online Database indicates that the publication output in the Aquaculture Research Publication. Chinese Academy of sciences, University of Stirling and fisheries & Oceans Canada institutions were the most producers of research output in aquaculture. Most prolific authors were found from productive institutions, Sorgeloos and Bossier were identified the active authors. This work is to provide a profile of research in Aquaculture research publication in global level. This includes tracking the number of papers, scatter of papers over journals, and its effect on publication output, authors' institutional affiliations and authorship patterns

Keywords

Scientometrics, aquaculture, Marine science, oceanology, Science Citation Index

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INTRODUCTION

Aquaculture - also known as fish or shellfish farming -- refers to the breeding, rearing, and harvesting of plants and animals in all types of water environments including ponds, rivers, lakes, and the ocean. Researchers and aquaculture producers are "farming" all kinds of freshwater and marine species of fish, shellfish, and plants. Aquaculture produces food fish, sport fish, bait fish, ornamental fish, crustaceans, mollusks, algae, sea vegetables, and fish eggs. Aquaculture includes the production of seafood from hatchery fish and shellfish which are grown to market size in ponds, tanks, cages, or raceways. Stock restoration or "enhancement" is a form of aquaculture in which hatchery fish and shellfish are released into the wild to rebuild wild populations or coastal habitats such as oyster reefs. Aquaculture also includes the production of ornamental fish for the aquarium trade, and growing plant species used in a range of food, pharmaceutical, nutritional, and biotechnology products. Marine aquaculture refers to the culturing of species that live in the ocean. U.S. marine aquaculture primarily produces oysters, clams, mussels, shrimp, and salmon as well as lesser amounts of cod, moi, yellowtail, barramundi, seabass, and seabream. Marine aquaculture can take place in the ocean (that is, in cages, on the seafloor, or suspended in the water column) or in on-land, manmade systems such as ponds or tanks. Recirculating aquaculture systems that reduce, reuse, and recycle water and waste can support some marine species.

Freshwater aquaculture produces species that are native to rivers, lakes, and streams. U.S. freshwater aquaculture is dominated by catfish but also produces trout, tilapia, and bass. Freshwater aquaculture takes place primarily in ponds and in on-land, manmade systems such as recirculating aquaculture systems. Scientometrics is concerned with the quantitative features and characteristics of science and scientific research. Emphasis is placed on investigations in which the development and mechanism of science are studied by statistical mathematical methods.

OBJECTIVES

The main objective of this study was to use Scientometric mapping and analyze the key features of Food Science and Technology research activities at India level:

To identify and analysis the rate of growth of research productivity on aquaculture;

- To analysis the authorship pattern and examine the extent of research collaboration;
- To identify the ranking of authors based on publications;
- To identify journal wise distribution of publications;
- To assess the Institution wise research concentration;

METHODOLOGY

"Aquaculture" is the search string for receiving data from the database, 13679 records were downloaded. This analytical study encompassing records output on Science from Science Citation Index (SCI) available on online (Web of Science). The present study aims at analyzing the research output of Researchers in the field of aquaculture. The growth rate of output in terms of research productivity is analyzed from 1999 to 2013. Further, an attempt is made to measure the performance of researchers and their research concentration in the field aquaculture and it is also analytical in nature in strengthening the empirical strength due to application of suitable statistical tools.

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Relative Growth Rate of Publications

The research output on aquaculture publication is taken as a tool to evaluate the performance at various levels. The study also reveals all these 1060 publications have 587373 cited references it shows that there is a healthy trend in citing reference is found in aquaculture. To analyze the year wise publication of research on Aquaculture research productivity, the data has been presented in below pictorial table. It also shows that chronological histogram of citations, demonstrating that citation frequency propagated steadily from 1999 to 2013

Table1: Year Wise Distribution of Aquaculture Research Output During 1999 - 2013

Year	Output	W1	W2	R (a)	Dt	TLCS	TGCS	CR	NA	H index
1999	367 (2.7)	-	5.905	-	-	2394	9764	12803	1228	47
2000	362 (2.6)	5.905	5.892	0.01	69.30	3246	11168	12139	1109	51
2001	414 (3.0)	5.892	6.026	0.13	5.33	2926	11988	16494	1380	51
2002	478 (3.5)	6.026	6.169	0.14	4.95	2631	12124	17376	1600	50
2003	569 (4.2)	6.169	6.344	0.18	3.85	3801	12899	21592	2036	53
2004	620 (4.5)	6.344	6.429	0.09	7.70	3651	14561	23280	2338	**55**
2005	683(5.0)	6.429	6.526	0.10	6.93	3584	13259	26280	2545	53
2006	936 (6.8)	6.526	6.842	0.32	2.17	**4617**	**16085**	36377	3570	51
2007	973 (7.1)	6.842	6.880	0.04	17.33	3827	13945	38599	3891	45
2008	1090 (8.0)	6.880	6.993	0.11	6.30	3160	12960	46327	4546	43
2009	1179 (8.6)	6.993	7.072	0.08	8.66	3197	10712	51279	4782	37
2010	1317 (9.6)	7.072	7.183	0.11	6.30	2377	9294	61018	5763	33
2011	1542 (11.3)	7.183	7.340	0.16	4.33	1606	6047	70634	7096	21
2012	**1651 (12.1)**	7.340	7.409	0.07	9.90	672	2768	**79135**	**7658**	13
2013	1498 (11.0)	7.409	7.312	0.10	6.93	155	534	74040	7511	6
	13679			**0.11**	**10.66**	**41844**	**158108**	**587373**	**57053**	

Table 1 reveals that during the period 1999 to 2013 a total of 13679 publications were published at global level. The highest publication is 1651 (12.1 %) in 2012 with 672 TLCS and 2768 TGCS scaled and stood in first rank position of its published articles in the aquaculture field; followed by 1542 (11.3 %) papers in 2011 with 1606 TLCS and 6047 TGCS scaled and in second rank position; 1498 (11 %) of papers in 2013 with 155 TLCS and 534 TGCS scaled in third rank position; 1317 (9.6 %) of articles in 2010 with 2377 TLCS and 9294 TGCS scaled and being fourth rank position of its publication level; 1179 (8.6 %) of articles in 2009 with 3197 TLCS and 10712 TGCS were scaled and it stood at fifth rank position; and 1090 (8.0 %) of articles in 2008 with 3160 TLCS and 12960 TGCS were scaled and it stood in sixth rank position. The lowest publication is 362 (2.6 %) in 2000 with 3246 TLCS and 11168 TGCS scaled. It shows that even minimum numbers of records were scored higher global citations. It also has the highest number of cited references 79135 in 2012; the highest number of H index 55 in 2004 respectively.

It is observed that its relative growth rates have decreased gradually from 0.01 in 1999 to 0.10 in 2013. The whole study period records the mean relative growth rate of 0.11. Contrarily, the doubling time for publication of all sources of output has increased from 69.3 in 1999 to 6.93 in 2013. The doubling time for publications at the aggregate level has been computed as 10.66 years.

Table 2: Document wise Distribution of Publications in aquaculture

S.No.	Document Type	Records	%	TLCS	TGCS
1	Article	11416	83.5	29379	107953
2	Article; Proceedings Paper	911	6.7	5018	17735
3	Review	853	6.2	6778	29932
4	Meeting Abstract	199	1.5	13	22
5	Editorial Material	174	1.3	421	1322
6	News Item	45	0.3	1	5
7	Letter	28	0.2	27	66
8	Review; Book Chapter	16	0.1	162	787
9	Correction	15	0.1	3	12
10	Article; Book Chapter	10	0.1	22	230
11	Book Review	5	0.0	0	0
12	Biographical-Item	3	0.0	0	0
13	Reprint	2	0.0	1	1
14	Bibliography	1	0.0	19	42
15	Software Review	1	0.0	0	1
	Total	**13679**	**100**	**41844**	**158108**

Table 2 discloses that the major source of publications covered by web of science on Aquaculture research productivity. Article has 11416 (83.5 %) of total records, it has 29379 TLCS and 107953 TGCS. Article, Proceedings paper has 911 records with 6.7 Percentage. Review has 853 records with 6778 TLCS and 29932 TGCS scaled. Meeting Abstract had 199 with 1.5 percentage of publication and Editorial material has 11.3 percent of records were produced. Remaining formats were produced below 100 records in the field of aquaculture.

Single Vs. Multiple Authors

The below table 3 reveals that the status of authorship contribution. The single authored contribution is just 8.79 percent, i.e., 1202 records among 13679. Remaining 12477 (91.21 %) of records were produced by multiple authored articles. Among the multiple authors, three authored team has contributed more articles 2674 (19.55 %); followed by four authored team has in second rank; two authored team has in third position; five authored team has in fourth rank and single authored contribution in sixth rank position respectively. It is found from the study that multiple authors' research is confirmed between the authors in Aquaculture research as of publications made by multiple authors. Degree of collaboration is 0.91, i.e., 91 percent of articles were produced by the collaborative method.

Table 3: Authorship Pattern in Aquaculture Research Output

Authors	Publica-tions	%	Rank
Single authored	1202	8.79	6
Double authored	2174	15.89	3
Triple authored	**2674**	**19.55**	**1**
Four authored	2553	18.66	2
Five authored	1970	14.40	4
Six authored	1272	9.30	5
Seven authored	789	5.77	7
Eight authors	432	3.16	8
Nine authored	226	1.65	10
Ten and above authored	387	2.83	9
Total	**13679**	**100**	

Prolific authors

There are 57053 authors were contributed in the field of Aquaculture research. The following results were founded by the researcher; the Anonymous gets the 80 records and 0.6 percentage without any citation scores. At author wise 'Sorgeloos p' gets the second place of 59 records with 0.4 percentage and 634 local citation scores, 1466 global citation scores with first rank position. 'Bossier P' having 54 records with 0.4 percentage with local citation scores 393, Total global citation scores having 843 and gets the third place. Remaining authors were contributed below 50 articles in this field. It could be found from this analysis, 'Sorgeloos p', 'Bossier P', 'Karunasagar I' and ' Wahab MA' were identified the most prolific authors in the area of Aquaculture research.

Table 4: Shows prolific authors in aquaculture research output (top 10 authors)

S.No	Author	Records	TLCS	TGCS
1	Sorgeloos P	59 (0.4)	634	1466
2	Bossier P	54 (0.4)	393	843
3	Karunasagar I	44 (0.3)	235	612
4	Wahab MA	41 (0.3)	329	482
5	Tocher DR	40 (0.3)	231	1235
6	Verdegem MCJ	39 (0.3)	384	609
7	Dempster T	36 (0.3)	390	619
8	Liu Y	35 (0.3)	91	326

9	Boyd CE	34 (0.2)	215	356
10	Sanchez-Jerez P	33 (0.2)	267	519

Prolific journals

There are 1521 journals were produced in the field of Aquaculture research during 1999 - 2013. The following results were founded by the researcher; the journal of 'Aquaculture' has produced more number of records 1823 (13.3 %) with 10118 TLCS; 29034 TGCS and 7058 TLCR with first rank position in producing articles if aquaculture research. the journal of 'Aquaculture Research' has produced 630 (4.6 %) of records with 1878 TLCS; 5837 TGCS and 1893 TLCR with second rank position in producing articles if aquaculture research. Remaining journals were produced below 500 articles in the area of aquaculture research. The below table showed the journals were identified the most prolific journals in aquaculture research output. It could be found from this analysis, 'aquaculture', 'Aquaculture research', 'Aquacultural engineering' and ' Journal of shellfish research' were identified the most prolific journals in the area of aquaculture research.

Table 5: Shows prolific journals in Aquaculture research output (top 10 journals)

S.No	Journals	Records	TLCS	TGCS	TLCR
1	Aquaculture	1823 (13.3)	10118	29034	7058
2	Aquaculture Research	630 (4.6)	1878	5837	1893
3	Aquacultural Engineering	372 (2.7)	2599	4408	1785
4	Journal of Shellfish Research	313 (2.3)	436	1717	333
5	Aquaculture International	250 (1.8)	601	1581	919
6	Journal of the World Aquaculture Society	224 (1.6)	444	1237	670
7	Fish & Shellfish Immunology	211 (1.5)	590	2866	721
8	North American Journal of Aquaculture	191 (1.4)	357	942	406
9	Diseases of Aquatic Organisms	174 (1.3)	545	2038	315
10	Journal of Fish Diseases	156 (1.1)	799	2453	507

Institution wise Publication output in the field of Aquaculture

There are 7113 institutions were participate the research output in the field of Aquaculture. 'Chinese Academy of Sciences' gets the first place to produce the research productivity in the field of aquaculture having 345 records with 745 total local citation scores and 3280 Global citation scores scaled. 'University of Stirling' has 249 records with 1911 local citation scores and 5503 global citation scores. 'Fisheries & Oceans Canada' has 227 articles with 1123 TLCS and 3016 TGCS measured. IFREMER having the fourth place with 224 records with 1137 global citation scores and 3273 scaled. CSIC having 159 records with situated sixth place. The table mentioned institutions were identified the most productive institutions in the area of aquaculture research output.

Table 6: Shows prolific institutions in aquaculture research output (top 10 institutions)

S.No	Institutions	Records	TLCS	TGCS
1	Chinese Acad Sci	345	745	3280
2	University Stirling	249	1911	5503
3	Fisheries & Oceans Canada	227	1123	3016
4	IFREMER	224	1137	3273
5	Unknown	192	124	234
6	CSIC	159	568	3480
7	Inst Marine Res	153	770	2398
8	Univ Tasmania	150	627	2262
9	Ocean Univ China	132	153	711
10	INRA	128	374	1381

Country wise analysis

The below table reveals that the country wise analysis of Aquaculture research, 141 countries were participating, among those, USA having the 2543 records and highest percentage with 9915 total local citation scores and having 36447 global citation scores measured. The country of Peoples of Republic Chine has the second place with 1181 records, 1988 TLGS and 9151 TGCS. United Kingdom has getting 1031 documents contributed. In India 529 records with 1059 local citation scores and 4054 Global Citation Scores gets the eleventh place in the field of Aquaculture research productivity.

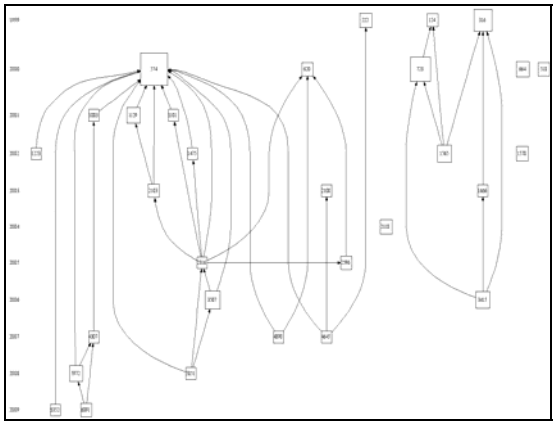
Table 7: Distribution of country wise in Aquaculture research output (top 15 countries)

S.No	Countries	Records	TLCS	TGCS
1	USA	2543	9915	36447
2	Peoples R China	1181	1988	9151
3	UK	1031	5384	20191
4	Canada	1027	4922	16886
5	Australia	981	3584	14273
6	Spain	930	2913	13421
7	Norway	680	2735	9096
8	Japan	639	1703	7443
9	France	620	2140	9497

10	Italy	540	1933	6623
11	India	529	1059	4054
12	Brazil	524	513	3072
13	Mexico	393	348	3190
14	Germany	364	894	4456
15	Chile	307	1252	272

HISTRIOGRAPHIC ANALYSIS OF CITED JOURNALS

The researcher has effort to trace the development of aquaculture research by creating historiographs using HistCite software (developed by Garfield and colleagues) in aggregation with *Web of Science*. Here for this analysis the sample data has taken 13679 Aquaculture research papers. All the papers have cited these papers as well as all the references quoted in the cited papers. A histriographical map has been drawn based on two separate levels by using HistCite, such that; Local Citations Score (LCS) and Global Citations Score (GCS). For the citation score map, the data sample was based on 13679 documents (nodes). For the LCS map, due to the top publication (top 30) number (38) of links, and to have a clear graph a, minimum of 64 local citation scores to maximum 484 local citation scores was derived.



Nodes: 30, Links: 38, LCS, Top 30; Min: 64, Max: 484 (LCS scaled)

574th article has written by the authors of "Naylor RL, Goldburg RJ, Primavera JH, Kautsky N, Beveridge MCM, et al." published journal in "Nature" at 2000, this articles earned 94 Cited references, 484 LCS and 878 GCS with 13 cited links, this article having highest links among the selected top thirty articles and this article having maximum number of GCS scores among the selected thirty nodes from the historiography mapping. 2316th article has written by "Naylor R, Burke M" published in the journal of "Annual Review of Environment and resources" at 2005, and its earned 149 CR, 67 LCS and 85 GCS scored measured with six quoted and two cited links. 1223rd articles has written by the authors of "Dempster T, Sanchez-Jerez P, Bayle-Sempere JT, Gimenez-Casalduero F, Valle C" published in the journal of "Marine Ecology Progress Series" at 2002 and it earned 46 CR value, 64 LCS and 94 GCS values with only one quoted link and this article having minimum LCS scored among the selected thirty nodes. 12 articles were published on the journal of "Food Science And Technology "from the selected 30 nodes, it shows this journal is most productive of aquaculture research of selected nodes.

CONCLUSION

The present study describes the scientometric analysis of the Aquaculture research output. The sample data has drawn global research interest documented by articles from 141 countries. Most articles came from countries with traditional high research output in USA, China and UK, but also countries like India, Netherlands, Sweden and Brazil have embarked on important research activity in this area. In the field of aquaculture research found an even louder growth in publication during the sample time span. With the number of publications the numbers of authors/publication also have increased over time. This phenomenon was also described by the above mentioned author [De Sola Price D, 1974]. The worldwide increase in publication might partly be attributed to the advance in computer-based communication and association with the rapid development of the world-wide-net after 2000. This expansion also facilitated the cooperation between workgroups from different countries. The majority of publications are published in English and it is difficult for non-English journals to be included in the data bases. This is a major bias. The central hub of research cooperation is the USA.

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