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Scientometric assessment of research publications from fisheries institutes under Indian Council of Agricultural Research (ICAR) during 2009-2018

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ABSTRACT

The national fisheries research in India is spearheaded by domain-specific fisheries research institutions under the aegis of the Indian Council of Agricultural Research (ICAR), New Delhi. The current study was undertaken to assess the temporal trends in research publications during the period 2009-2018, from eight fisheries research institutes under ICAR using 'SciVal', a web-based scientometric tool of Elsevier for measuring research performance. The data on various research metrics, such as the number of publications, their citations, field-weighted research impacts, number of publications in top journals, subject area categories and key phrases used in research outputs were extracted from the application. The assessment revealed that a total of 3263 papers were published by the fisheries research institutes under ICAR during the study period, which received 24,253 citations in total. The number of publications from the ICAR fisheries research institutes and their quality showed a steady increase over the years. The foremost journal for publishing Indian fisheries research outputs during the assessment period was the Indian Journal of Fisheries (408 papers; 12.5%) published by ICAR, New Delhi. The research focus of these institutes was found to be more towards the widely cultivated species, *i.e*., *Penaeus* (*=Litopenaeus) vannamei* and *Pangasionodon hypophthalmus.* The present study highlights the research areas with significant momentum and scope for future funding; provides insights on the research trends and necessary leads to prioritise research among the national fisheries research institutes under ICAR.

Keywords: Citations, Fisheries research, ICAR, India, SciVal, Scientometrics

Introduction

Fisheries and aquaculture form a subset of life sciences and research covering various aspects of these domains have been underway in different national and state; public and private; research and academic organisations. State agricultural universities with fisheries faculty and traditional universities have also contributed to the advancement of knowledge in fisheries as reported by Jayashree and Arunachalam (2000). The systematic fisheries research in India started in the 1940s through the Union Government initiative to establish the country's first dedicated fisheries research centre of Central Marine Fisheries Research Station (now known as the ICAR-Central Marine Fisheries Research Institute) on 03 February 1947 (Silas, 2003). Since then, the country had seen a progressive transformation in fisheries research with the establishment of more fisheries institutes, under the Indian Council of Agricultural Research (ICAR), New Delhi, each specifically focusing on a particular research and development (R&D) domain related to freshwater, brackishwater and marine capture and culture fisheries, which included aspects on fish harvest and post-harvest technology, genetic resources documentation and management, cold-water fisheries and human resource development (Ayyappan and Diwan, 2006). As of now, eight fisheries research institutes with specific subject focus and pan-India scope, are operating under the aegis of ICAR. Apart from these institutes, location-specific fisheries research is also underway in the ICAR research complexes based in Andamans (ICAR-Central Island Agricultural Research Institute, Port Blair); Goa (ICAR-Central Coastal Agricultural Research Institute, Goa); Meghalaya (ICAR Research Complex for the North-east Hill Region, Umium) and Bihar (ICAR Research Complex for Eastern Region, Patna). A few fisheries scientists also serve in ICAR crop/animal science institutes and undertake research on fisheries as a component of integrated farming system.

Periodical assessment of the trend in research focus and performance of any organisation is necessary to evaluate the continued relevance to the present-day requirements and the nature of scope in meeting the future needs both nationally and globally. Further, in recent times, the need for evaluation of the research programmes of different organisations is growing because of demands for greater accountability and effectiveness (OECD, n.d.). Scientometrics is considered a reliable tool for the research performance evaluation and plays a crucial role in decision making for periodical refinement and reorientation of national research policies in tune with the global standards and also for appropriate funding for infrastructure and manpower requirement. It analyses the data which are relevant to the essence of scientific work of individual researcher, research group, organisation and at country levels (Bornmann and Leydesdorff, 2014). Several tools are used for the scientometric assessment like Web of Science (WoS), InCites, Scopus, SciVal, Google Scholar and Publish or Perish (Smith, 2017; Brennan, 2018).

SciVal, which uses advanced citation data analyses, is a potential tool to assess the productivity of faculties/ institutes and their existing collaborations through analyses of publications (Dresbeck, 2015; Waltman, 2016). It enables us to evaluate the research performance relating to a variety of perspectives based on reliable evidence gleaned from over 50 million publication records from more than 22,000 journals of 5,000+ publishers worldwide (SciVal, 2020). Many scientometric studies have used the SciVal tool to assess the research performance of universities and other organisations (Khor and Yu, 2016; Rajan *et al.,* 2018). Earlier scientometric studies, applied in the Indian fisheries science field covering the overall subjects, selected research topics *viz.,* fish stock assessment, seaweeds and white spot syndrome virus (WSSV) and significantly from the journal *Aquaculture* and the *Journal of Marine Biological Association of India* (Jayashree and Arunachalam, 2000; Arunachalam and Jeyashree, 2001; Vivekanandan *et al.,* 2009; Kumaresan *et al.,* 2013, 2014, 2015; Chaman *et al.,* 2016; Singh *et al.,* 2019; Bhoomaiah *et al.,* 2020). Analysis of research outputs of the Indian fisheries sector during 1992-2016, using the WoS database, showed the significant contribution of ICAR fisheries institutes (Vinitha *et al.,* 2018) in advancing knowledge in various facets of the field.

In the present study, an effort has been made to undertake a scientometric overview of eight ICAR fisheries research institutes, which have significant role in spearheading the national fisheries development, based on the research papers published by them during the period from 2009 to 2018, using SciVal. This bibliometric tool helps to assess the research performance, its quality and the impact of research outputs, especially in social and economic domains by analysing the publication data at institutional and collaborative levels. The results would aid in understanding the research focus and contribution of ICAR fisheries institutes and would help to provide insights and direct the way forward to sustainable fisheries development in India.

Materials and methods

Publication and citation metrics, journal metrics and collaboration metrics are used for assessing research performance. The present study used Elsevier's bibliometric tool, SciVal (representing Science Value) (https://www.scival.com) as the main data source to assess the research performance of Indian fisheries research institutes *viz.,* ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi; ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore; ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), Kochi; ICAR-Central Institute of Fisheries Education (ICAR-CIFE), Mumbai; ICAR-National Bureau of Fish Genetic Resources (NBFGR), Lucknow; ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA), Bhubaneshwar; ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA), Chennai and ICAR-Directorate of Coldwater Fisheries Research (ICAR-DCFR), Bhimtal functioning under the ICAR, New Delhi. All the above fisheries institutes have a specialised research focus *viz.,* Marine fisheries, Marculture, Inland fisheries, Cold water fisheries, Freshwater aquaculture, Brackishwater aquaculture, Fish genetic resources or Harvest and post-harvest technology, except ICAR-CIFE which, being a Deemed University under ICAR, undertakes research on all aspects of fisheries, cutting across disciplines. The present study does not include fisheries research publications from research complexes under ICAR and different academic institutes across the country. The scientific and technical manpower status of these institutes were extracted from their respective Annual Reports of the year 2014 (Fig. 1). In case of ICAR-CIFE, the masters and Ph. D. students also contribute to the research publications of the institute, but their number is not included as part of the scientific manpower to estimate research productivity.

The SciVal offers quick and easy access to the details of the research performance of more than 19,100 research institutions and their associated researchers worldwide. Initially, the ICAR fisheries institutes were selected one by one in the entity panel and grouped as ICAR-Indian fisheries institutes in the SciVal tool. The scholarly research outputs published by the scientists of the respective institutes during 2009 to 2018 were extracted from SciVal in May 2020. The data on various research metrics, such as Scholarly Output, Citation Count, Citations per

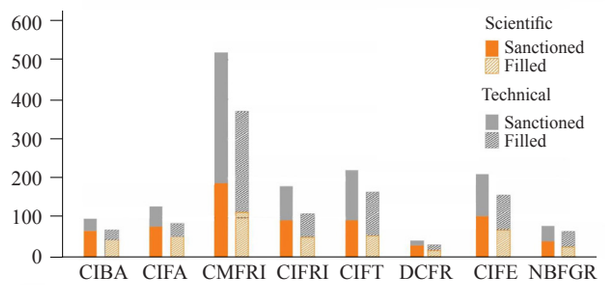

Fig. 1. Scientific and technical manpower status (2014) of Fisheries Research Institutes under ICAR

Publication (CPP), Field-Weighted Citation Impact (FWCI), papers in Top Citation and Journal Percentiles were extracted for ICAR fisheries institutes as an entity. FWCI compares the article citation count of a particular institute to the average citation count of similar articles published elsewhere in the same field and time frame.

Besides, details on the top subject area category, top journals and most widely used key-phrases in publications were also extracted from the database. The SciVal based 'Topic Prominence (TP) analysis' of research papers, which is based on its (1) citation count and (2) Scopus views count in year 'n' to papers published in n and n-1 and (3) average cite score for the year 'n', were performed for ICAR fisheries institutes. A 'topic' is a collection of articles focused on a common intellectual research problem, clustered together based upon a direct citation analysis. TP analyses aid in finding topics in which the research momentum of an institute is high and the areas which are likely to be well-funded in the future (Elsevier, 2020b).

In key phrase-based assessment, the 'relevance value' of each key phrase range from 0 to 1, where the highest value, *i.e.* 1 is assigned to the most frequently occurring keyword. The remaining key phrases were given a value based on their relative frequency, which is also projected by the size of the key phrases in the word cloud figure (SciVal, 2020).

Results and discussion

Pattern of publications and citations from ICAR Fisheries Research Institutes

The summary results of the 'SciVal' based scientometric assessment on publications from national fisheries research laboratories under ICAR are provided in Table 1. The study revealed that a total of 3263 papers were published by ICAR fisheries institutes during 2009-18, which received 24,253 citations. A steady increase in the publication count was observed from 2009 (197 papers) to 2018 (462 papers). Scientometric study on Indian fisheries research using 6 different databases (Jayashree and Arunachalam, 2000) reported a total of 2454 publications from all Indian research and academic institutes during 1994-1999. A recent scientometric assessment based on 'Scopus' database using search keywords 'Fisheries', 'Fishery' and 'Aquaculture' reported 10,999 papers published during 2006-2017 (Singh *et al.,* 2019). The significant increase in the number of publications may be attributed to the evolving Human Resource (HR) policies, the introduction of objective and quantitative performance metrics for career advancement of scientists (effective from 2009), enhanced sensitisation on research publications and improved inter-institutional collaboration due to information technology advancements (ASRB, 2009; Bhoomaiah *et al.,* 2020).

In contradiction to this, Vinitha *et al.* (2018) reported only 2639 publications having been included in the 'Web of Science' database for the search term 'Fisheries' in 'India (n)' geographical range during 1992-2016. The observed difference in the number of publications could be attributed to the journal coverage between the databases and variation in the search terms selected for the analysis. The present study has used the Scopus-based tool *i.e.* SciVal for the analysis. The highest number of citations per publication (12.3 CPP in 2013) reported during the initial period of assessment was mainly due to the extended record of time under consideration for those publications, which accounted for more citations over such a period. The research performance evaluation of organisations based on the citations of recent years' publications provides little

Table 1. Temporal trends in the cumulative research publications and pattern of citations from Fisheries Research Institutes under ICAR during 2009-2018

Metrics	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Overall
No. of papers	197	206	247	336	314	354	304	383	460	462	3263
Citations	2424	2893	2617	3030	2866	3057	2017	2270	1860	1219	24253
Citations per publication	12.30	14.00	10.60	9.00	9.10	8.60	6.60	5.90	4.00	2.60	7.40
Field-weighted citation impact	0.39	0.53	0.49	0.46	0.49	0.54	0.53	0.64	0.62	0.67	0.56
Outputs in top citation percentiles (Top 10%)	4.10	6.30	6.90	5.10	5.40	5.90	4.60	6.30	3.90	5.60	5.40
Publications in top journal percentiles (Top 10% by Cite score percentile)	11.30	9.40	7.80	8.40	8.70	7.80	9.10	13.50	14.90	20.40	11.9

information and hence a window period of at least 3 years need to be considered for the citation-based assessments (Bornmann and Leydesdorff, 2014)

The lowest Field Weighted Citation Impact (FWCI) value (0.39) was derived for the publications during 2009 and the highest value of 0.67 was obtained for publications made in the year 2018. The SciVal based FWCI compares the number of citations received by the publications of a particular institute/year along with the average number of citations received by all the other similar publications indexed in the Scopus database. For instance, FWCI value 1 indicates that the publication's citation impact is the same as the other similar publications indexed in the Scopus database (Elsevier, 2020a; Purkayastha *et al.,* 2019). The results lead us to infer that the citation impact of ICAR fisheries institutes has improved over the period (0.39 in 2009 to 0.67 in 2018) and there is a need to sustain this research focus to stand on par (*i.e.* FWCI $\geq$ 1) with other similar papers published at the global arena.

Though the extent of research outputs of ICAR fisheries institutes published in the Top Citation Percentiles (top 10%) group during the study period was observed to be low (5.4%), the number of papers published in the top journal percentiles (top 10% by CiteScore Percentile) group was found to be on the increase, especially after 2016, indicating an improvement in the quality of the research publications (Table 1).

ICAR-Fisheries Institute-wise research output

Among the fisheries institutes, the highest number of publications was made by ICAR-CMFRI (847 papers), followed by ICAR-CIFE (825 papers), ICAR-NBFGR (487 papers) and ICAR-CIFA (483 papers) (Table S1). The temporal trend in the number of publications from all the fisheries institutes showed a steady increase over the years (Fig. 2). While ICAR-CMFRI and ICAR-CIFE recorded a consistently increasing trend in the total number of publications since 2015, the rate of increase was much sharper in the former. The consistent increase in the number of scholarly outputs temporally in specific organisations could be attributed to the measures implemented to promote ease of doing research, in general and to facilitate development of knowledge products, in particular. ICAR-DCFR showed a gradually declining trend of publications in the corresponding period.

The ICAR fisheries research institutes were plotted in a decision matrix (Fig. 3) based on their cumulative scholarly output and citations during 2009-18 in order to understand their relative research output and influence, notwithstanding the differences among them in terms of their size (number of human resources and budget) and age. ICAR-CMFRI and ICAR-CIFE recorded higher publications and citations (>500 publications and 3500 citations) compared to the other organisations. Previous scientometric studies performed on Indian fisheries research since 1992 also reported ICAR-CMFRI as the top institute in terms of scholarly output, which reflects its prominent contribution to the marine fisheries research, over the period (Jayashree and Arunachalam, 2000; Vivekanandan *et al.,* 2009; Vinitha *et al.,* 2018).

The Average Citations per Publication (ACPP) value was found to be higher for the publications of ICAR-CIFA, followed by ICAR-CIFT and ICAR-NBFGR (Fig. 3), which suggest that the research interest among the scientists in the areas of freshwater aquaculture, fishing technology and fish genetic resource assessment, which are the focus areas of the above institutes, respectively, are higher than that of natural resource management. In the present study, total citations include self-citations which ranged between 9.12% (DCFR) and 14.48% (NBFGR) of the total citations, with a mean value of 10.52±2.27%. There are documented views for and against self-citations (Soares *et al.,* 2015), which vary with the field of study (Neuroscience - 18%; Psychology - 21%; Biology - 12%) (Aksnes, 2003; Hyland, 2003). While self-citations in zoological studies in general and taxonomic studies in particular can not necessarily be considered as fraudulent (Pinto *et al.,* preprint), instances of researchers citing their earlier papers under irrelevant circumstances to establish their own scientific authority or to enhance their visibility have also been recognized (Lawani, 1982; Esfe *et al.,* 2015).

The publications of ICAR-CIBA had the highest FWCI (0.73) (Fig. 3; Table S1), which indicates that these publications attracted 73% of average citations, of similar articles published in the same field and time frame globally (Purkayastha *et al.,* 2019). The FWCI considers the differences in research behaviour across disciplines, hence it is considered as a better indicator than the raw citation count of an institute (UC, 2020; Elsevier, 2020a).

The research productivity (average publications per scientist) was found to be the highest for ICAR-NBFGR (17.39), followed by ICAR-CIFE (11.79) and ICAR-DCFR (10.47) (Fig. 4). Higher research productivity in these institutes could be attributed to measures taken to facilitate implementation of research projects and to develop knowledge products. It could also be related to the field of research of the respective institutes. ICAR-CIFE, being a deemed university, undertakes research under diverse areas and its research outputs also include publications made as part of students' research.

The SciVal-based data on the publications in top 10 percentile is widely used as an indicator to assess the quality of the research (Rajan *et al.,* 2018). Publications in top journal, citation or views percentiles represent the number of publications of a selected entity that have

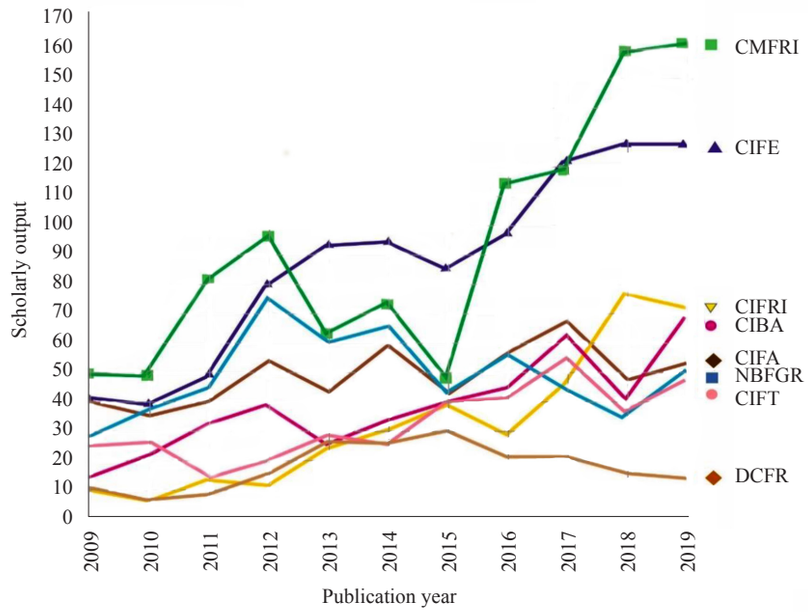

Fig. 2. Temporal trend in the number of research papers from Fisheries Research Institutes under ICAR during 2000-2019

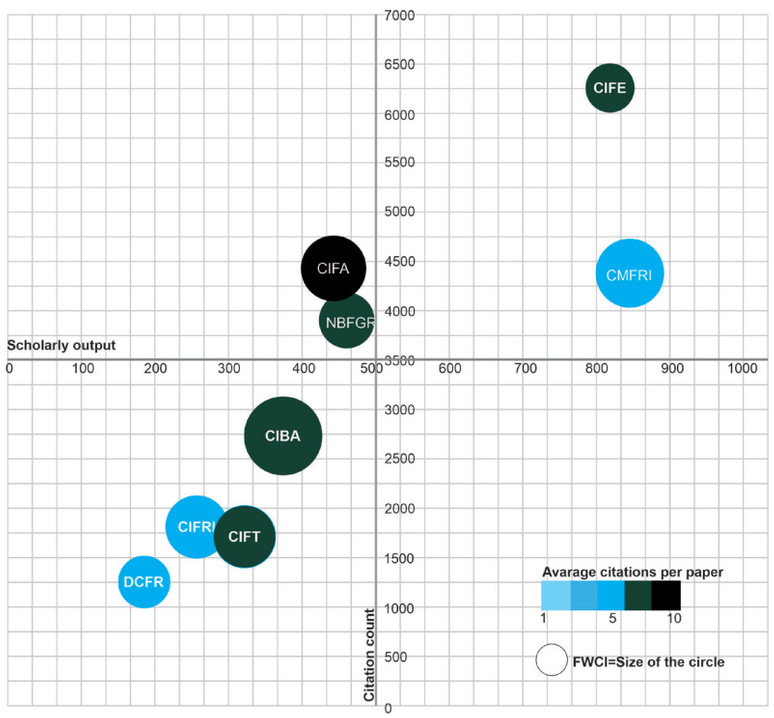

Fig. 3. Decision matrix showing the scholarly output of Fisheries Research Institutes under ICAR against their respective citations during 2009-2018

been published in the world's top journals or those which are highly cited or viewed, having reached a threshold, respectively. The proportion of publications in top journal and citation percentiles was the highest for ICAR-CIBA, while the outputs from ICAR-CIFT had the highest visibility as it topped among the institutes in terms of maximum outputs in top views percentiles (Fig. 5).

Subject area-wise publications

The subject area-wise scholarly output assessment was undertaken by adopting the Scopus journal

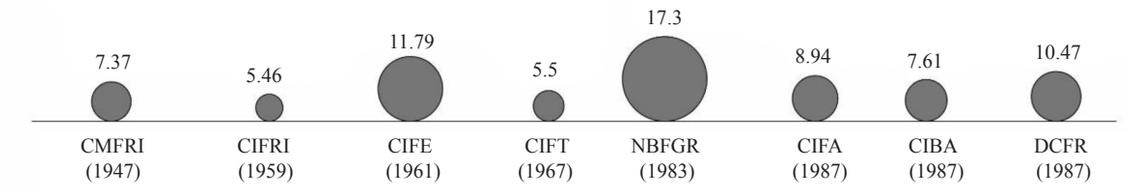

Fig. 4. Research productivity (research papers per scientist) of Fisheries Research Institutes under ICAR during 2009-2018. Year of establishment of the institute is provided in parenthesis

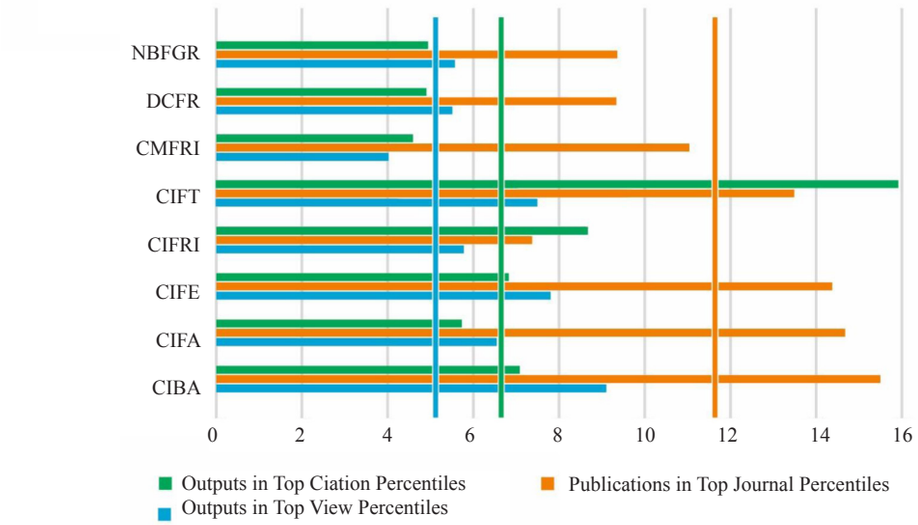

Fig. 5. Quality characteristics of research publications from individual ICAR Fisheries Research Institutes during 2009-2018 (vertical lines represent average value of IFRIs for respective parameters)

classification system *i.e.,* All Science Journal Classification (ASJC), which indicated that the top 3 subject areas focused by ICAR fisheries institutes were 'Agricultural and Biological Sciences' (2024 papers; ICAR-CMFRI topping the list with 599 papers); 'Biochemistry, Genetics and Molecular Biology' (699 papers; ICAR-NBFGR accounting for 205 papers) and 'Environmental Science' (636 papers; with ICAR-CMFRI accounting for 125). The subject area, 'Earth and Planetary Sciences' (271 papers; ICAR-CMFRI - 154 papers) covering Oceanography, General Earth and Planetary Sciences, Atmospheric Sciences and Geology, showed very high percentage growth in the number of publications and authors (Table 2; Fig. 6) between 2009 and 2018. Detailed information on subject area-wise research publications (2009-18) showed that ICAR fisheries institutes undertake research on diverse fields and publish them in journals dedicated to different subject areas, *viz.,* 'Chemical engineering', 'Earth sciences', 'Pharmacology, toxicology and pharmaceutics', 'Medicine' and 'Psychology'. The FWCI values for publications of the top 10 subject areas were found to range between 0.33 (Earth and Planetary Sciences) and 1.01 (Chemistry), indicating the reach of these publications compared to other subject areas. In the light of the diversification in research that is underway in the national fisheries research institutes and their increasing influence and visibility, it is pertinent to institutionalise capacity building programmes in inter-disciplinary areas.

The 'Topic Prominence analysis' depicted in a wheel (Fig. 7), as obtained from the SciVal platform, provides a measure of visibility, momentum and demand of a particular 'Topic' in a research subject area (Elsevier, 2020b; Klavans and Boyack, 2017). While 'topic prominence' can aid in recognising the research areas with potential to attract more funds, it does not necessarily represent the importance of research (Klavens and Boyack, 2017), which are driven by strategic goals and societal values of the organisations, as in case of national fisheries research institutes. The present study on ICAR fisheries institutes suggests that the topics under the subject area clusters 'Agricultural and Biological Science'; 'Biochemistry, Genetics and Molecular Biology'; "Environmental Sciences'; 'Immunology and Microbiology'; 'Social Sciences' and 'Chemistry/Chemical Engineering' could attract more funds in the upcoming years. The prominent topic clusters which have the highest percentile value (>95%) are listed in Table S2. In particular, the topic clusters such as 'Photocatalysis, Photocatalysts, Solar Cells';

Table 2. Subject area-wise* research publications from different Fisheries Research Institutions under ICAR during 2009-18

Broad subject area (Number of sub-categories)	Research publications		Authors		Citations		Field-weighted Citation Impact (FWCI)
	No. of papers	% Growth**	No. of Authors	% Growth**	Total	Citations per publication	
Agricultural and Biological Sciences (12)	2024	100.0	2155	132.5	15361	7.6	0.61
Biochemistry, Genetics and Molecular Biology (16)	699	169.7	805	218.7	6840	9.8	0.61
Environmental Science (13)	636	79.6	952	169.9	5311	8.4	0.59
Immunology and Microbiology (6)	273	100.0	420	124.4	2684	9.8	0.64
Earth and Planetary Sciences (7)	271	800.0	440	1153.8	1148	4.2	0.33
Veterinary (5)	206	71.4	410	153.5	1083	5.3	0.58
Medicine (23)	187	73.3	378	100.0	1960	10.5	0.67
Pharmacology, Toxicology and Pharmaceutics (5)	129	42.9	235	46.2	1231	9.5	0.68
Chemical Engineering (9)	121	140.0	277	92.9	1310	10.8	0.62
Engineering (11)	120	157.1	251	369.2	718	6.0	0.66
Chemistry (7)	116	300.0	199	238.5	1633	14.1	1.01

*Subject categories as per SciVal (Scopus)
**between 2009 and 2018

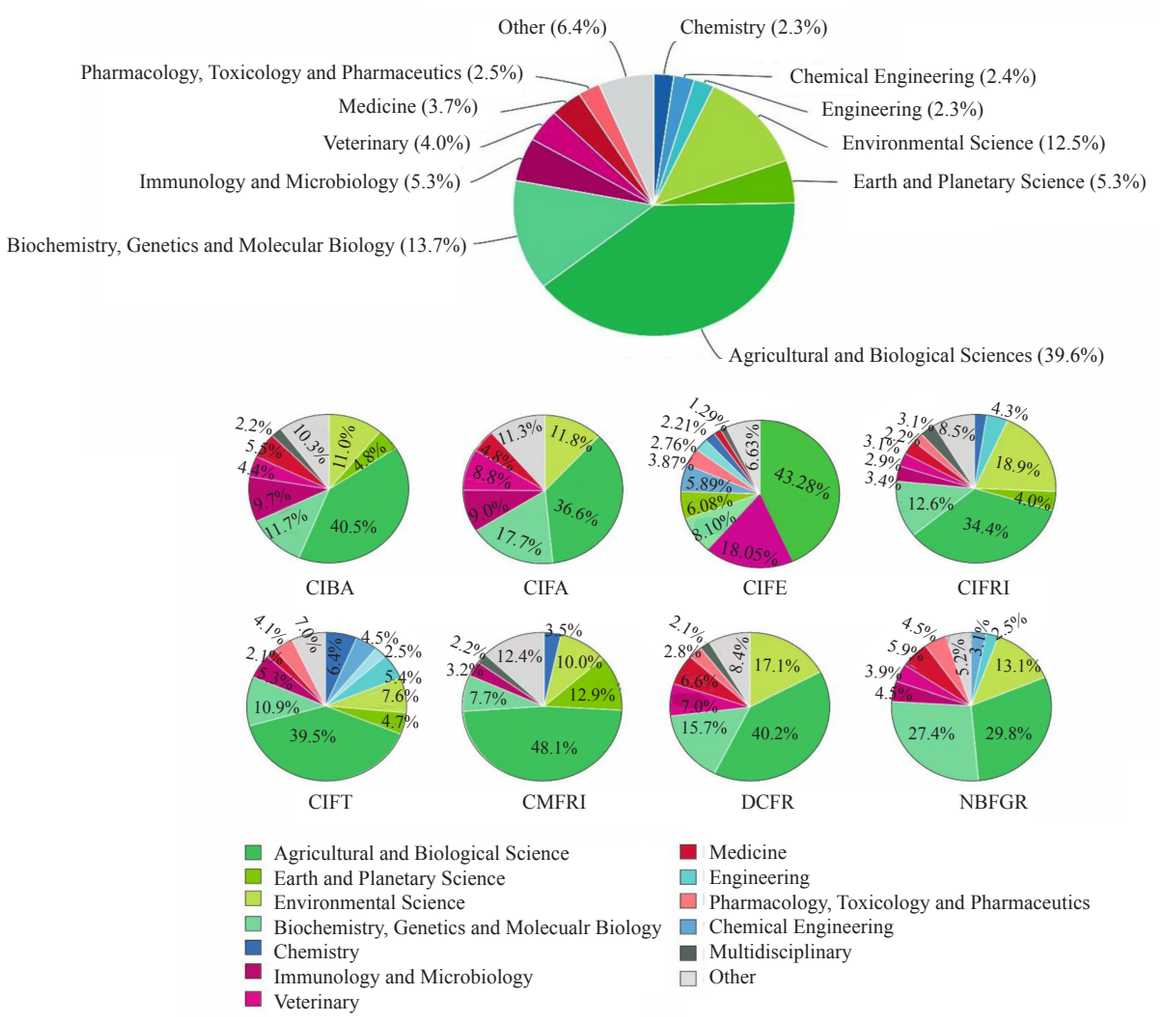

Fig. 6. Subject area-wise publication details of Fisheries Research Institutes under ICAR during 2009-2018

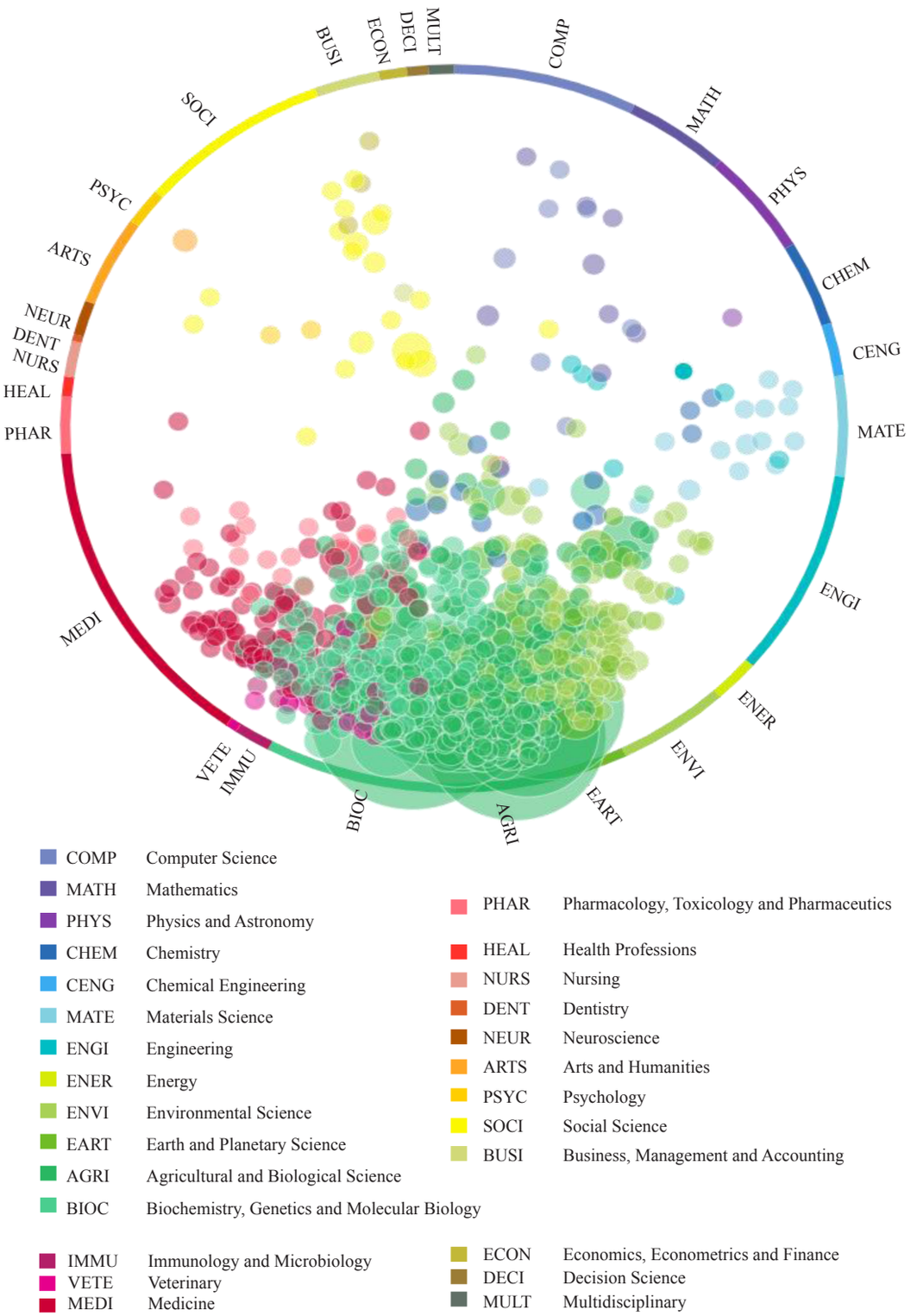

Fig. 7. 'Topic prominence analysis' based on scholarly output (top 500 topic clusters) of ICAR Fisheries Research Institutes

'Graphene, Carbon Nanotubes, Nanotubes'; 'Catalysis, Synthesis (Chemical), Catalysts'; 'Catalysts, Zeolites, Hydrogenation' and 'T-Lymphocytes, Neoplasms, Immunotherapy' were the top five clusters with research momentum, high visibility and scope for future funding. The ranking of these topics based on prominence in science is helpful for the research managers to identify those topics that reveal supply and demand in the science systems (Klavens and Boyack *et al.,* 2017; Munoz-Ecija *et al.,* 2019).

Top key-phrases of scholarly outputs

The key-phrase based assessment of publications indicates the current focus of a particular research domain (Rehn *et al.,* 2014). The 'SciVal' extracts top key-phrases through text mining by 'Elsevier Fingerprint Engine' in titles and abstracts of the documents (SciVal, 2020). The 'key-phrase' cloud shown in Fig. 8 indicates that the predominant key-phrase appeared in the research papers of ICAR fisheries institutes during 2009-18 was 'India' (reference value: 1), followed by '*Labeo rohita*', 'fish', 'shrimp', 'coast' and 'fishery'. The key-phrase denoted in green colour indicates the increase of key phrase occurrence in publications, while the key-phrase in blue colour indicates the decrease in occurrence frequency during the assessment years (2009-18). The decrease in frequency of key-phrases such as '*Penaeus monodon*', '*Clarias batrachus*', 'catfishes', '*Cirrhinus cirrohosa*' and '*Macrobrachium rosenbergii*' and increase in the frequency of key-phrases *viz*., '*Pangasionodon hypophthalmus'* and '*Litopenaeus vannamei'* clearly indicated the increasing research focus from indigenous species to exotic farmed species in India. This could be attributed to the fact that the latter two species are widely cultivated commercially and constitute a significant portion of the cultivated area and thus driving the research focus towards them. The production of *P. monodon* has reduced drastically since 2009, especially after the introduction of *P. (=L.) vannamei,* which explains the shift in the research focus of ICAR fisheries laboratories on the latter (Srinivas *et al.,* 2016). It is noteworthy that the cultivation of *P. (=L.) vannamei* has been perceived to be more advantageous due to the fact that they can be grown in the widely varying environment in freshwater to brackishwater and the production and export economics are much higher. Likewise, annual production of up to 1 million t has been predicted by the year 2025 for *P. hypophthalmus* (Mohan *et al.,* 2019), a status attained only by Indian major carps, so far.

Top journals in Indian fisheries research

The journal which published most (408 papers; 12.5%) of the research papers from the ICAR fisheries institutes during the assessment period was the *Indian Journal of Fisheries* (IJF), which is published by ICAR, New Delhi. A recent scientometric study report on South Asian fisheries and aquaculture concluded IJF as the top journal with a high article count (Bandara and Wijewardene, 2018). The diagrammatic representation of bibliometrics of the top 10 journals which account for 31.84% (1039 papers) of the total papers is depicted in Fig. 9. There were 4 international journals listed under the top 10 journals, which published about 320 papers during the study period. It is also worth mentioning here that the citation impact of the publications of those journals, *i.e., Aquaculture*, *Aquaculture Research* and *Fish and Shellfish Immunology* was observed to be significantly higher than the other journals. These results are in accordance with other scientometric research performed during the contemporary period on Indian fisheries research (Chaman *et al.,* 2016; Vinitha *et al.,* 2018; Bhoomaiah

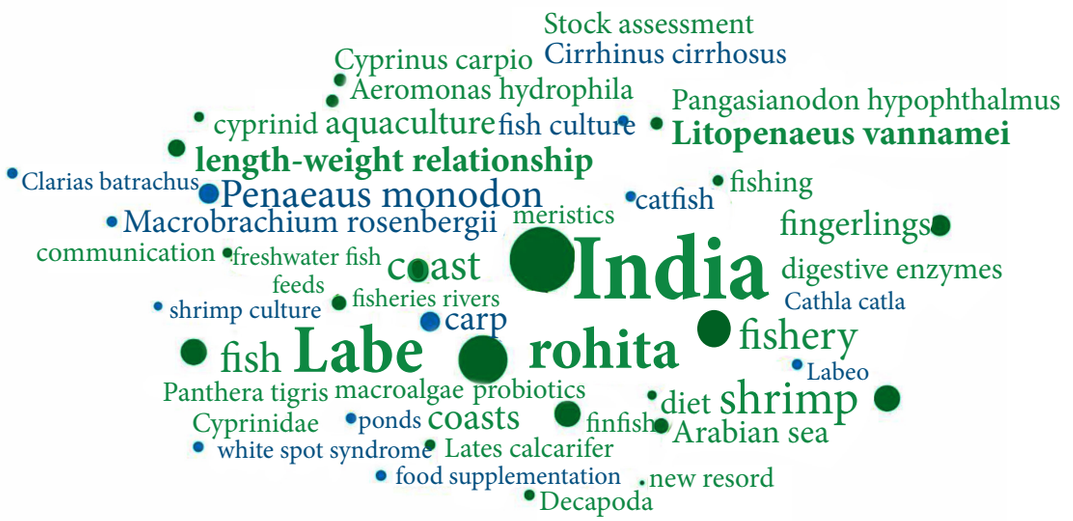

Fig. 8. A cloud view of 'Key-phrases' used in ICAR fisheries research publications during 2009-18

et al., 2020). The shift in the choice of impactful international journals by the researchers in national fisheries research institutions in comparison to the earlier study (Jayashree and Arunachalam, 2000), wherein the top 10 journals comprised only of Indian journals, indicates the improvement in the research quality of ICAR fisheries institutes over the years.

The SciVal-based scientometric assessment of research outputs of ICAR fisheries research institutes shows a steady growth in scientific publications during 2009-18. The high FWCI value for publications and the increase in the proportion of publications in top journals and citation percentiles in recent years indicate improvement in the quality of research over the study period. However, this study suggests the need and scope for further improvement in research publications, productivity *i.e.,* publications per scientist, especially in the case of larger institutes. The topic prominence analysis suggest the areas that have high research momentum and scope for future funding in national fisheries laboratories, though they do not necessarily represent the importance of research, which are driven by strategic goals and societal values of the respective national fisheries research institutes. While significant research focus towards potential commercially cultivable species, *i.e., P. (=L.) vannamei* and *P. hypophthalmus* could well be justified based on their extent of cultivation and commercial significance, there is a need to undertake strategic research on indigenous fish genetic resources to ensure sustainable growth and development of the Indian fisheries sector. Detailed analysis on variations in the subject area-wise productivity between domain-specific research institutes and academic as well as research institutes and various drivers like budgetary allocations and demographic attributes of the researchers, would provide a deeper understanding of the research productivity of the institutions and would aid in identification of parameters which could be addressed to improve the research output.

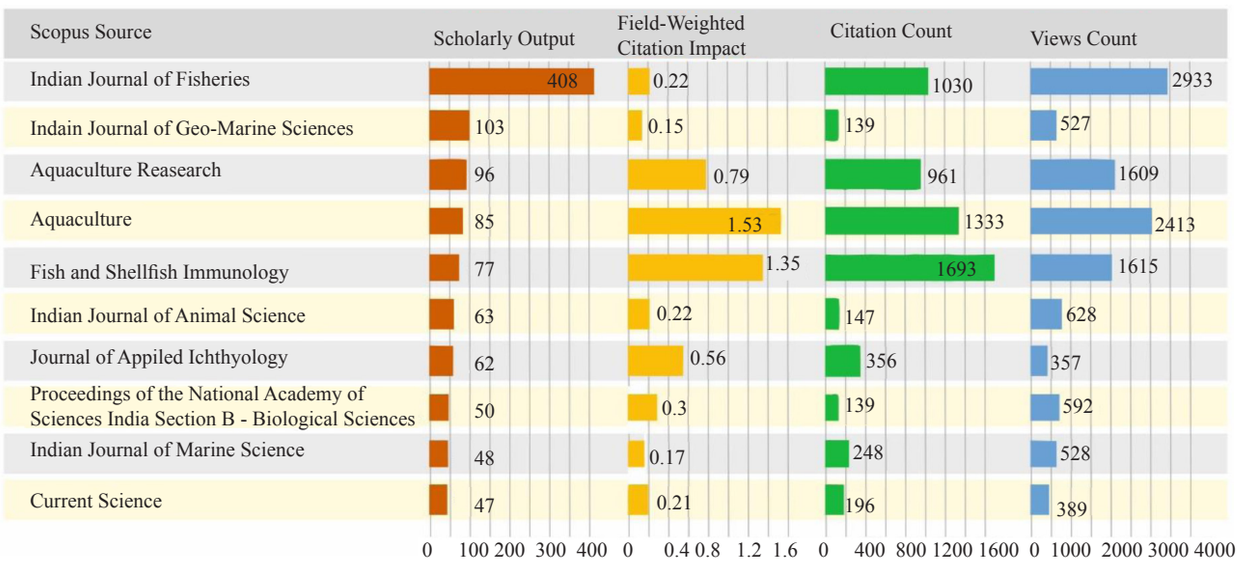

Fig. 9. Top 10 journals for ICAR Indian Fisheries Research Institutes during 2009-18.
[Note: 'Indian Journal of Marine Sciences' is renamed as 'Indian Journal of Geo-Marine Sciences']

Supplementary Information

Table S1. Institute-wise research output from different fisheries research institutions under ICAR during 2009-18

Name of the Institute	No. of research publications	Citation Count	Field-Weighted Citation Impact (FWCI)
ICAR-Central Marine Fisheries Research Institute, Kochi	847	4500	0.46
ICAR-Central Institute of Fisheries Education, Mumbai	825	6716	0.64
ICAR-National Bureau of Fish Genetic Resources, Lucknow	487	4047	0.52
ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar	483	4696	0.61
ICAR-Central Institute Brackishwater Aquaculture, Chennai	350	2786	0.73
ICAR-Central Institute of Fisheries Technology, Kochi	308	2602	0.57
ICAR-Central Inland Fisheries Research Institute, Barrackpore	284	1957	0.58
ICAR-Directorate of Coldwater Fisheries Research, Bhimtal	178	1121	0.47

Table S2. Prominent topic clusters (>95 Percentile value) identified in SciVal based on ICAR-Fisheries Institutes scholarly output (top 500 topic cluster)

Topic Cluster	Prominence Percentile
Photocatalysis; Photocatalysts; Solar Cells	99.933
Graphene; Carbon Nanotubes; Nanotubes	99.866
Catalysis; Synthesis (Chemical); Catalysts	99.799
Catalysts; Zeolites; Hydrogenation	99.732
T-Lymphocytes; Neoplasms; Immunotherapy	99.665
Plasmons; Metamaterials; Surface Plasmon Resonance	99.531
MicroRNAs; Long Untranslated RNA; Neoplasms	99.398
Microbial Fuel Cells; Anaerobic Digestion; Bioreactors	99.063
Climate Models; Model; Rainfall	98.929
Arabidopsis; Plants; Genes	98.862
Ozonization; Degradation; Wastewater Treatment	98.728
Metagenome; Probiotics; Bacteria	98.661
Electricity; Energy; Economics	98.594
Dengue; Viruses; Dengue Virus	98.327
Anti-Bacterial Agents; Infection; Methicillin-Resistant *Staphylococcus aureus*	98.26
Cellulose; Lignin; Cellulases	98.126
Soil; Biochar; Soil Organic Carbon	98.059
Mesenchymal Stromal Cells; Stem Cells; Induced Pluripotent Stem Cells	97.657
Aerosols; Air Quality; Atmospheric Aerosols	97.59
Pharmaceutical Preparations; Nanoparticles; Tablets	97.39
Industry; Innovation; Entrepreneurship	97.256
Adsorption; Adsorbents; Activated Carbon	97.189
Chromatin; Histones; Epigenomics	96.653
Oceans; Lakes; Dissolved Organic Matter	95.984
Microfluidics; Fluidic Devices; Microchannels	95.917
Polypropylenes; Lactic Acid; Blending	95.649
Supply Chains; Supply Chain Management; Industry	95.382
RNA; Ribosomes; Proteins	95.315
Remote Sensing; Image Classification; Satellite Imagery	95.114

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