Mapping Research Contributions on Agricultural Extension in India: A Bibliometric Analysis

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ABSTRACT

Agricultural Extension is vital for sustainable farming development and food systems. During the past decades, several agricultural extension modelshave been implemented in India. The present study emphasises on the scientific contribution of agricultural extension researchduring the last decade (2011-2020). Bibliometric techniques have been employed to the secondary data for analysing 145 articles to identify relevant themes, collaboration patterns, topics under study and major journals for publication. It was observed that the research on agricultural extension has been increasing in recent years. The journals that have published the articles have highlighted multi-disciplinary research to address the challenges of the discipline. The central thematic area of research in the domain was new extension methodologies for technology transfer,applying information and communication technologies (ICTs) in farming and climate-change based research in extension. Probably, this might be the first bibliometric study to offer exhaustive information on extension research in India. The findings of the study will aid academics and decision-makers in formulating plans and strategies for better extension approaches for agricultural development. Agricultural extension practitioners may also use those findings for reorienting advisory services at the grassroots level.

Keywords: Extension research; Bibliometrics; Agricultural extension research; Scopus database; Research mapping

1. INTRODUCTION

Most developing countries rely heavily on agriculture for income and employment. Economic development in such a scenario is impossible without a growing agricultural sector. Agricultural extension plays a pivotal role in sustaining rural development by linking farmers with research systems, improving farm production and profitability, etc.[1] In recent years, there has been an increase in debates about the contribution of extension services in agriculture. The role of extension service is more perceived at the initial stage of technology dissemination when information disequilibrium (difference between 'have' and 'have not') is the greatest.[2] Extension enables farmers to assess their goals and aspirations, helps make better decisions, and enables knowledge-sharing between researchers and farmers, thus contributing towards desirable agricultural developments.[3] Extension activates communication channels between researchers and farmers, facilitating the development of tailor-made technology suitable for farmers' local situations. Kareemulla, *et al.*[4] reported that the average landholding size is only 0.3 hectares in India. India's diverse agro-climatic situation

and the rural population's varying socio-economic status call for specialised extension interventions customised and targeted to the intended clientele.[5] The extension structure for reaching the farmers was devised long ago, which needs a rapid transformation to meet the challenges of the 21st century.[6]

Research in any subject is a prerequisite for avoiding stagnancy and accelerating the growth and development of the discipline. The research in extension systems is experiencing a shift from a single-discipline approach to an interdisciplinary area approach.[7] In the current context, the role of extension and delivery systems is rapidly changing with the harnessing of potential advances in the extension sector.[8] Extension research is a prerequisite to strengthening extension systems' role and efficiencies by developing strategy, concepts, processes, and methodologies.[9] The significant bulk of agricultural extension research is carried out by the Indian Council of Agricultural Research (ICAR), New Delhi and Agricultural Universities located in different states (SAUs), most of them being a part of student research.[10] Survey-based extension research by deploying ex post facto methodology is the predominant approach followed in India.[11] A bibliometric analysis of research during a specific period helps document the significant themes of study during the period, along with

studying the publication output, collaborating partners, preferred journals for publication, etc. An understanding of research themes is crucial to set a research agenda for the country.[12] Thus, the paper performs a bibliometric study of publications in the Agricultural extension discipline in the last decade to understand the research status and development of the discipline during the last decade. The outcome of the present study could be helpful not only for the academicians but also for the policymakers to foster better research.

2. LITERATURE REVIEW

The literature on agricultural extension highlights the importance of identifying thrust areas in the discipline. Ponnusamy and Padaria,[13] in their analysis, opined about initiating the All India Coordinated Research Project in Extension in order to facilitate meta-analysed data and derive useful policy guidelines. The study also recommends formulating new approaches and methodologies so that professionals in the discipline can inculcate expertise in various areas.

Bharadwaj[14] studied that several institutions in India have set up Research Data Repositories (RDRs), but it is difficult for researchers, publishers, and academic institutions to locate the appropriate RDR and understand their specific features. Therefore, a bibliometric analysis of research in the discipline during the specific period may be helpful in this case to document the major area of study in the specific period of the study.

Ponnusamy & Pachaiyappan[15] investigated the current status of extension research in India and found that research in the discipline is a prerequisite to strengthening extension system's role and efficiencies by developing strategy, concepts, processes, and methodologies. Further, Ogundari[16] conducted an impact study on agricultural extension services and recommended that research in the area must be updated from time to time to revitalise extension education and research.

Rasheed[17] explored the way forward for agricultural extension in the country and opined that research in the discipline had experienced many transformations over the last two decades, enabling private extension services, public-private partnerships in agriculture, consultancy services, and so on. However, Singh, *et al.*[18] opined that little contribution to basic research in the discipline is madeand suggested that extension should play a crucial role in enabling nodes to create opportunities for accessing and sharing knowledge among various entities within the innovation system.

Malanski[19], *et al.* conducted a bibliometric analysis of scientific articles published in agriculture over the past ten years from the Scopus database. The study's major findings were that four key scientific communities (agricultural economics, ergonomics, rural sociology and livestock farming systems) had conducted the most important research in the past decade. Upon analysis of the community, it was found that research in the field is organised into five main domains: social issues in the labour market, household labour allocation strategies, work organisation in livestock systems and occupational health in farms. A bibliometric analysis was carried out by Paul Mansingh[20], *et al.* to examine the global literature on a specific branch of agricultural extension related to information and communication technologies. The analysis aimed to track publication patterns, citation rates, notable authors, keywords, and institutions. Using Scopus data, 280 articles from the years 2004 to 2020 were identified and analysed. The authors found out that the United States was leading India in terms of the number of citations, while the Netherlands achieved more citations per document.

Similarly, Ribeiro[21], *et al.* identified a group of research topics in relation to ICT in agriculture using the Scopus database from 2010 to 2020. The authors analysed 91 peer-reviewed publications to find two major themes. The first theme emphasised the importance of knowledge and skill acquisition among farmers, while the second theme was related to the Internet of Things.

The ideal sample size for a bibliometric study in decadal research depends on various factors, including the research question, the source and nature of data, and the statistical methods used. Glanzel[22] found that a sample size of at least 50-100 documents is recommended for bibliometric studies. Similarly, Borgman & Furner[23] recommended a minimum sample size of 50 papers per decade for bibliometric studies of scientific productivity. Li[24] also reported that the sample size for bibliometric analysis was between 50-100. In our study, the final sample size was 145, which is large enough to cover a representative population under study (i.e., publications in Agricultural Extension during the decade under investigation in India). This has enabled us to draw meaningful comparisons and analyses for the study.

On reviewing previous research, a knowledge gap is identified regarding the systematic review of agricultural extension research in Indian context, so there is a need to conduct specialised research using different approaches to identify the thrust areas of the discipline, which will help in strengthening the agricultural extension system in the country. Also, the Scopus database was found to be one of the most used databases for bibliometric data analysis by the authors. Hence, the study is relevant to bridge the research gap by systematically studying the extension research carried out in the past decade to get insights into the advances and future directions.

3. OBJECTIVES OF THE STUDY

The objective of the study is to evaluate research on agricultural extension over ten years from 2011-2020. Bibliometric analysis was used to examine the literature published in Scopus-listed journals. With the use of these techniques, the analysis of articles and associated metadatawas performed with the following objectives:
- To study the publication output and growth trend over the years
- To identify the major collaborating countries for research

- To find out major productive institutions
- To reveal the preferred journals of publication
- To find out the most prolific authors
- To visualize thematic clusters using keyword analysis

4. METHODOLOGY

4.1 Data Source and Method of Retrieval

The online database from which the publications were searched and retrieved was Scopus (last access date: May 24, 2022). Scopus is one of the most used databases for bibliometric data retrieval which is owned by Elsevier group.[25] When it comes to obtaining international scientific literature from a variety of study area, Scopus has a more standardised record than other databases like PubMed, Web of Science, and Google Scholar.[26]

4.2 Search Strategy

The retrieval and export of articles were finished in a single day to reduce the bias brought on by changes during different periods (May 24, 2022). In order to find pertinent search terms, a thorough analysis of the literature on extension research was conducted first. The study's objectives were met by identifying and entering the phrases "extension education," "agricultural extension," "extension systems," and "community extension" into the Scopus research engine. Second, all selected "terms" were restricted to the "Article Title/Abstract/Keywords" section. The year was defined as 2011 to 2020, and the source was limited to journal articles and conference proceeding. In addition, the country was limited to India. The period from 2011 to 2020 was only chosen for the study since it was identified from the literature review that a significant contribution of work was conducted in the last decade. Since a decade is a long span, the last decade was only chosen to accommodate relevant research in the current context, which has not grown obsolete. Moreover, in the last decade few important observations about agricultural extension research in India also came from the highest policy-making body in Indian Agricultural research and education, the National Academy of Agricultural Sciences (NAAS). Thus, the present paper considers only the current decade to be more relevant in policy discourse by exploring the present status of extension research.The source was limited to journal articles and conference papers to include only relevant research for the study. Other forms of literature,like book chapters, popular articles, etc., is more concerned with generalised topics and approaches so that it could dilute the quality of the article selected for the study. Finally, the study is based on the Indian context, as India is an agriculture-based country with a large number of people directly or indirectly dependent on agriculture. Also, the farmer-extension ratio in the country is very wide, i.e., 1:1000, and has remained low as against the recommended ratio of 1:750.[27] Therefore, India was selected for the study, and articles only from India were chosen. Subsequently, all the papers retrieved
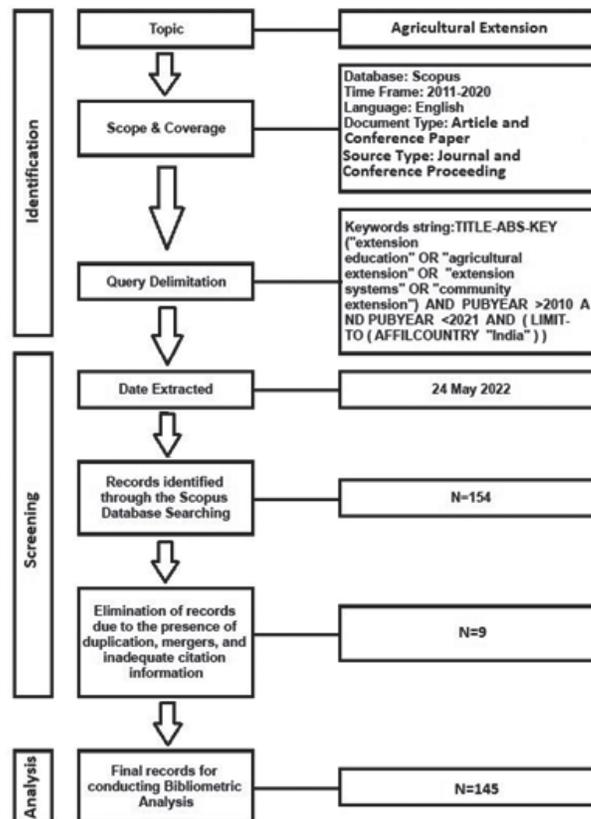

Figure 1. Methodology adopted for the study.

from the database were downloaded. The methodology is further depicted in Fig 1.

4.3 Data Analysis and Visualisation

The articles with the selected keywords were retrieved from the Scopus database published from 2011-2020. Each publication was considered a potential addition to this field of study. From the database, 154 articles in total were extracted. Out of which, nine articles were discarded due to incomplete citation information and associated metadata. Thus, the analysis was performed on the 145 articles. To manage the obtained bibliometric data, we used the BibExcel programme[28] to analyse the data, find indicators, categorise different components, etc. In addition, we performed analyses based on the networks using the VOSviewer programme as a tool to establish and graphically depict linkages.[29]

5. ANALYSIS AND DISCUSSION

5.1 Publication Output and Growth Trend

The volume of publications is a crucial determinant of research development patterns. The record of how often other authors cite the article is a measure of the quality of the publication.[30] As seen in the accompanying Table 1, there have been citations throughout the time period. The number of publications has been steady from 2011 to 2017, with less than 18 publications per year. However, from 2018, the publications have seen a rise from 16 publications in 2018 to 23 in 2020. An increasing number of published articles implies that the subject is moving into a developmental phase. The 145 publications during the selected timeframe have received a total of 1266 citations, with an average of 9.05 citations per year.

Table 1. Year-wise publications and citations

Year	Articles	Cumulative	Citation	Average citation per year
2011	13	13	33	2.54
2012	7	20	94	13.43
2013	12	32	244	16.27
2014	10	42	83	8.30
2015	17	59	144	8.47
2016	18	77	188	10.44
2017	9	86	76	8.44
2018	16	102	212	13.25
2019	20	122	149	7.45
2020	23	145	43	1.87
2011-20	148		1,266	9.05

5.2 Major Collaborating Countries

The inter-country collaboration is an important aspect of understanding the major countries focusing on the area of research. It can be observed from Table 2 that

scientists from India collaborated with researchers from the United States in the publication of 11 documents. The other countries in which Indian scientists looked for collaboration in this area were the United Kingdom with 11 articles, Canada, Ethiopia and Nepal with three articles and Bangladesh, Brazil, China and Germany with two articles (Fig. 2). From the researcher's standpoint, enhanced collaborations provide a better perspective on the research and open a window of opportunity for engaging more partners and institutions in collaborative research. Total link strength refers to the overall intensity of the collaboration between Indian researchers and researchers from other countries.

Table 2. Collaborating countries and publications

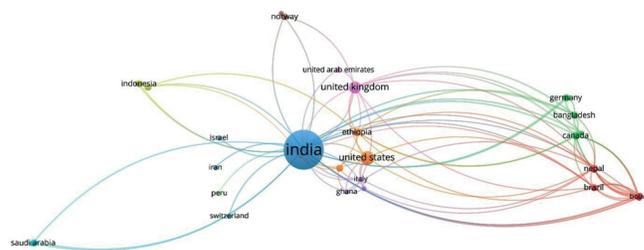| Country	Documents	Citations	Total link strength
United States	11	116	1160
United Kingdom	8	74	971
Canada	3	57	448
Ethiopia	3	30	181
Nepal	3	40	752
Bangladesh	2	178	511
Brazil	2	21	506
China	2	36	255
Germany	2	166	163

Figure 2. Collaboration with major countries in the publication of research.

5.3 Major Productive Institutions

Researchers in social science from various institutes in the country have contributed to theliterature on extension research. The institutions from India and international institutions based on research productivity are depicted in Tables 3 and 4, respectively. The major institutions releasing the documents are the "Division of Agricultural Extension, Indian Council of Agricultural Research, New Delhi, India", with six documents and 53 citations,followed by the "ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India", (14 citations) and "Division of Socio-Economic and Extension, ICAR Research Complex for Eastern Region, Patna, Bihar, India", with four documents and six citations. The rest of the institutions has released only two documents in the last decade. The number of co-authorship relationships between researchers from that specific university and

researchers from other universities is represented by the total link strength. With this parameter, the total link strength of "University College London, Institute for Global Health, London, United Kingdom", was found to be the maximum with 1009 links, followed by the "Division of Agricultural Extension, Indian Council of Agricultural Research, New Delhi, India", with 626 links. "ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India", was next with 437 links and the "Division of Dairy Extension, ICAR-National Dairy Research Institute, Karnal, Haryana, India", with 367 links.

nodes' size (journals) shows the relative number of publications from the journal. The total link strength of the Indian Journal of Animal Sciences was found to be a maximum of 86 links, followed by the Indian Journal of Agricultural Sciences with 36 links. Current Science followed it with 25 links, and Journal of Rural Studies with 23 links.

The preferred journal for publication of research in the extension domain from India was the Indian Journal of Agricultural Sciences, with 12 documents and 26 citations. Indian Journal of Agricultural Economics

Table 3. Institutions in India based on productivity of research

S. No.	Name of institution/organization	No. of documents	No. of citations	Total link strength
1.	Division of Agricultural Extension, Indian Council of Agricultural Research, New Delhi, India	6	53	626
2.	ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India	4	14	437
3.	Division of Socio-Economic and Extension, ICAR Research Complex for Eastern Region, Patna, Bihar, India	4	6	220
4.	ICAR-National Dairy Research Institute (NDRI), Karnal, Haryana, India	2	9	367
5.	ICAR-National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi, India	2	8	186

Table 4. International Institutions based on productivity of research

S. No.	Name of institution/organization	No. of documents	No. of citations	Total link strength
1.	University College London, Institute for Global Health, 30 Guilford Street, London, United Kingdom	2	13	1009
2.	Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh	1	164	144
3.	Department of Agricultural Economics, Ghent University, Belgium	1	164	144
4.	Institute of Agricultural Policy and Market Research, Justus Liebig University, Germany	1	164	144
5.	International Maize and Wheat Improvement Center (CIMMYT), India	1	53	149

5.4 Preferred Journals of Publication

Although the articles were published in 68 journals and three conferences, just 28 of them represented more than 65 % of the total publications. Table 5 lists the top ten preferred journals in the selected field. Additionally, Figure 3 offers a visualisation map of the journals to visually represent the most popular journals. As seen in Figure 3, the space or gapamong the pair of journals is indicative of the similarity in terms of co-citation links. The closeness of the two journals indicates a more substantial relatedness. Lines also represent the strongest co-citation links between different journals. Alternatively, the distance between the nodes (journals) emphasises the association's relative strength, and the

and Plant Archives published seven articles from each, having 24 and 2 citations, respectively. Indian Journal of Animal Sciences released five articles receiving 12 citations, while the Journal of Rural Development and Indian Journal of Agricultural Research produced four articles each.

5.5 Most Prolific Authors

There were 16 single authors in the sample of articles analysed for the study. Table 6 shows the most productive authors for the study. The classification was performed based on the number of documents released during 2011-2020. Kumar S from the "ICAR-National Institute of Economics and Policy Research, New Delhi,
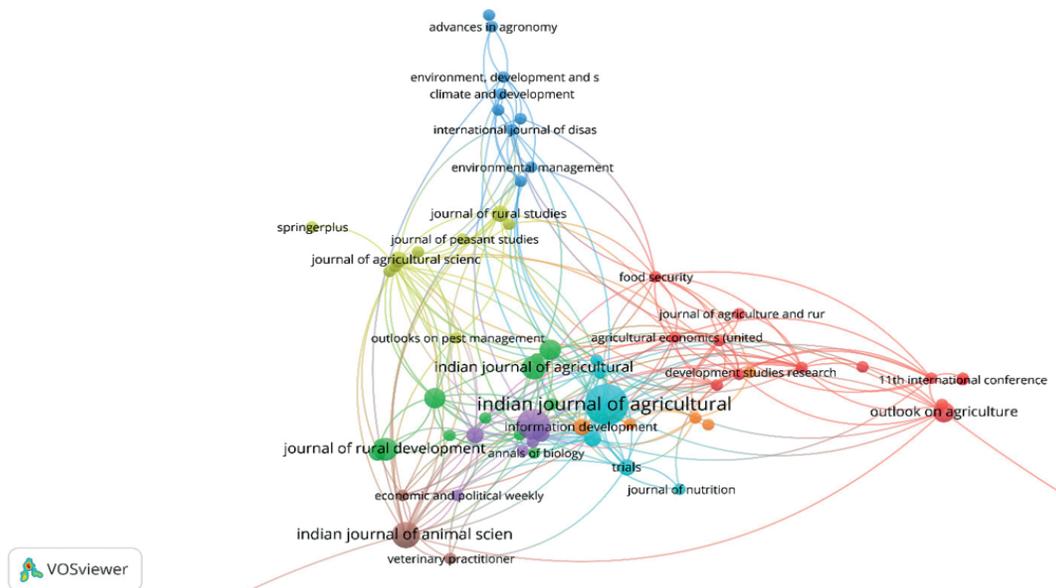
Figure 3. Network visualisation map of preferred journals for publication.

Table 5. Preferred journals for publication

S. No.	Source	Documents	Citations	Total link strength
1.	Indian Journal of Agricultural Sciences	12	26	36
2.	Indian Journal of Agricultural Economics	7	24	18
3.	Plant Archives	7	2	2
4.	Indian Journal of Animal Sciences	5	12	86
5.	Journal of Rural Development	4	10	5
6.	Indian Journal of Agricultural Research	4	5	8
7.	Current Science	3	20	25
8.	Outlook on Agriculture	3	11	16
9.	Indian Journal of Fisheries	3	4	13
10.	Journal of Rural Studies	2	89	23

Table 6. Productivity of authors

S. No.	Author	Documents	Citations	Total link strength
1.	Kumar, S.	6	9	1215
2.	Chander, M.	5	8	1054
3.	Pal ,S.	4	92	452
4.	Sinha, N.	3	66	348
5.	Verma, P.	3	66	348
6.	Kadiyala, S.	3	28	3036
7.	Gupta, J.	3	9	412
8.	Chahal ,V.P.	3	7	250
9.	Singh, A.	3	7	837
10.	Singh, P.	3	5	192
11.	Meena, M.S.	3	4	107
12.	Singh, A.K.	3	4	377
13.	Mehar, M.	2	110	280
14.	Mittal, S.	2	110	280
15.	Chatterjee, S.	2	51	539
16.	Goswami, R.	2	51	539
17.	Talukdar, S.	2	41	236
18.	Bahinipati, C.S.	2	37	333
19.	Subash, S.P.	2	28	336
20.	Sharma, A.	2	27	474

India", published a total of six articles. His articles mainly focused on climate variability and the economics of production in extension research. Chander M produced five articles from "ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar, Uttar Pradesh, India". His articles mainly focus on livestock extension systems and innovation systems. Pal S from "ICAR-National Rice Research Institute, India" produced four articles.His article focuses on the farming system analysis and rural development. The overall robustness of a researcher's co-authorship ties with other researchers is shown by the total link strength.

this cluster. The second cluster provides knowledge on impact assessment strategies supported by previous research by Ragasa.[33] A total of 29 articles contributed to this cluster.The papers under this cluster focused on randomised control trials, cluster analysis, economic evaluation, social networks etc. In contrast, the last cluster deals with the impacts of climate change in extension research with interrelated words such as vulnerability, adaptation, mitigation strategies, etc., consistent with previous findings by Sajesh & Suresh.[34] Under this domain, a total of 10 articles were placed.
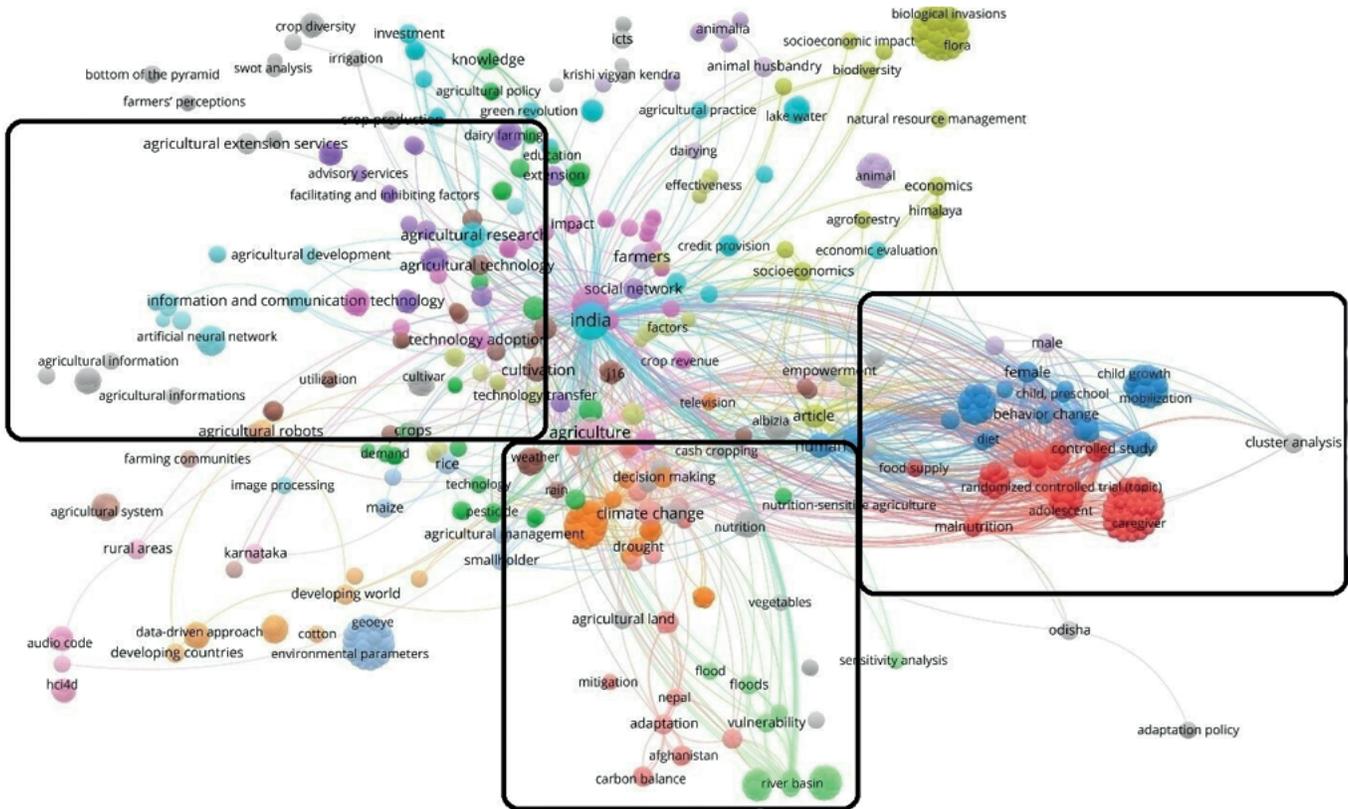

Figure 4. Keyword network analysis.

The total link strength of Kadiyala S was found to be maximum with 3036 links, followed by Kumar S and Chander M with 1215 and 1054 links, respectively.

5.6 Keyword Analysis

The study sample consists of a total of 1071 keywords. Fig. 4 displays the 186 keywords that were mentioned at least six times. Each word's weight on the map is represented by the size of the nodes. Words and lines that are close together show how closely related they are.[31] Three clusters of interrelated keywords are visible in the study. The first cluster shows new approaches to technology transfer, such as ICTs, Artificial Neural Networks (ANN), and Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. The findings correspond to earlier studies by Simpson & Burpee.[32] A total of 35 published articles come under

6. FINDINGS AND CONCLUSION

Over the last decade, the agricultural extension discipline has received significant research attention, particularly on new methodologies for technology transfer and the use of information and communication technologies. Based on the co-keyword analysis, the main research areas could be distinguished as: (a) Climate change research, (b) Information and communication technologies for technology transfer and (c) Impact assessment strategies. This article made new contributions to the existing body of literature. First, this article is believed to be the first attempt to review present agricultural extension research in India systematically and draws outlines of the structure of research. Secondly, common themes of research, collaboration pattern, forerunner research institutions, and prominent researcher identified by the study may be helpful for policymakers and researchers to find future

trajectories for development. Thirdly, researchers may position themselves in the present research domain and identify future research directions. Our study found that significant institutions publishing agricultural extension research were directly functional under the ICAR. The research is essential to provide sufficient grounding for developing new studies in the extension domain or exploring relationships between topics and different frameworks.[35] This study adds to the existing literature by providing a national perspective of ongoing agricultural extension research in India.The importance of this research cannot be overstated as it lays a strong groundwork for future studies in the extension field, allowing for deeper investigation into the relationships between topics and frameworks. Additionally, identifying key themes of extension research will serve as a valuable resource for stakeholders and policymakers, providing them with the necessary information to further advance this discipline.

6.1 Limitations of the Research

Journals which are not included in the Scopus database, were excluded from the study sample, so all the published literature may not come under the study sample. The search criteria based on the few keywords may also reduce the chance of getting the exact number of articles published during the period on other related themes in agricultural extension.Since this study focuses on the extension research scenario, broader terms were preferred for assessment.

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