Trends in organic farming research in India (2002–2021)

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A scientometric analysis was conducted to study the productivity and trend dynamics of organic farming research in India covering a period of 20 years (2002–21). The present study aims at science mapping to summarize research activity and its essential aspects. The scientometric analysis outlines the year-wise research growth pattern, prolific authors and their productivity, major contributing journals, major contributing institutions and countries along with keyword occurrences for trend dynamics of organic farming research in India. The data have been sourced from the Web of Science Core Collection database. The most productive period was 2017–21 (44.76% of the total papers published). The growth pattern showed a gradual increase in research during the two decades. Research articles were the most common document type. About 20.11% of international co-authorship was observed in organic farming research. ICAR-based Indian Journal of Agricultural Science was the major contributing source to organic farming research. This study has the potential to benchmark organic farming research in India and play a significant catalytic role in further research in the field of organic farming.

Keywords: Agricultural research, organic farming, productivity, scientometrics, trend dynamics.

ORGANIC farming is emerging as an alternative production system due to increasing demand for organic products in the market, for improving the soil health, environment and the well-being of society. Organic farming is an agricultural system that uses fertilizers of organic origin such as compost manure, green manure and bone meal, and emphasizes techniques such as crop rotation and companion planting. It originated in the early 20th century in reaction to rapidly changing farming practices. According Food and Agriculture Organizations (FAOs)[1,2] – 'organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.'

The Government of India (GoI) has been encouraging organic farming to conserve the environment and natural resources through sustainable agriculture. The country ranks first in the number of organic farmers and ninth in terms of area under organic farming. Natural farming is being promoted as 'Bharatiya Prakritik Krishi Paddhati' (BPKP) programme under the Government sponsored 'Paramparagat Krishi Vikas Yojana' (PKVY) scheme. The 'Bhartiya Paramparik Krishi Protsahan Yojna' (BPKPY) has been implemented since 2021–22 (ref. 3), planned and funded for 4 lakh hectares with a released amount of Rs 4980.99 lakhs[4].

Some of the studies observed in this domain have presented a comprehensive bibliometric review of scientific research in organic farming. These studies provide valuable insights into the current landscape and trends in the field, emphasizing the significance of research collaboration among small countries in the northern and eastern of Europe, as well as four non-European countries – Canada, Australia, Brazil, and China – alongside the United States[5]. Another study[6] has analysed scientific and technical information regarding organic farming using the database CAB Abstracts (CABA). Researchers scientometrically examined selected publishing patterns in organic farming as indexed by database CABA in the period 1973–2003. The sourced journal articles were analysed for yearly growth, languages, authorship, and geographic location in the study.

Pinheiro and Govind[7] conducted a study to explore scientometric patterns in urban agriculture, sourcing their data from the SCOPUS database. Their aim was to examine emerging global research trends, topical focuses, and gaps in peer-reviewed urban agriculture research over a fifteen-year period (2004–2018). In a related study by Mouret *et al.*[8], trends in organic farming were identified using keywords

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extracted from scientific publications available exclusively in English, drawn from the Web of Science reference database. This effort sought to establish relevant indicators for comparing French national research endeavours from 2000 to 2006. The researchers detailed how organic farming remains significantly under-prioritized in France.

GoI is initiating various programmes proactively to promote natural farming[4]. This has motivated us to analyse the Indian research contribution towards organic farming through a comprehensive scientometric study. This scientometric overview of organic farming research in the last two decades will provide information about the scale and recent trends in this field.

Materials and methods

Bibliographic data were downloaded in fragments, and then concatenated, normalized and analysed using computer applications.

Data source

Data were sourced from the Web of Science (WoS) database using an advanced search[9]. The search string used was 'TS = organic farming and CU = India' and the publication date range was from 2002 to 2021. A total of 1068 records were retrieved under the above search string with 18,379 citations.

Computer programs used

The following computer programs were used in this study: (i) Bibexcel: a scientometric analysis software used for concatenating exported plain text files using WoS database[10,11]. (ii) HistCite: a scientometric software used for analysing the retrieved raw data in a text file[12]. (iii) Biblioshiny: a scientometric package which uses the R-Metrics software[13]. This was for some of the analyses and chart plots. (iv) VOSviewer: a software tool used for constructing and visualizing bibliometric networks[14].

Table 1. General information

Time span	2002–21
Sources (journals, books, etc.)	314
Documents	1068
Average annual growth rate (%)	4.19
Document average age	7.29
Global citation score	18,379
Average citations per document	17.20
References	41,562
Authors	3,203
Single-authored documents	45
Average co-authors per document	5.05
International co-authorship share (%)	20.11
Research articles	959
Research articles (early access)	11
Conference proceedings	9
Editorial materials	3
Letters	2
Research reviews	78
Book chapters	6
Total	1,068

Analysis and discussion

General information about the data

Table 1 provides general information about the data under study. From 2002 to 2021 a total of 1068 documents, from the 314 contributing sources with 18,379 global citations were found under the topic of Organic farming. A total of 3203 authors contributed to research in this field for two decades (2002–21). The single-authored records count was 45. Various document types reporting research on organic farming in India included 959 articles, 11 early access articles, 9 conference proceedings, 3 editorial materials, 2 letters, 78 research reviews and 6 book chapters. All records retrieved were published in English.

Research yield in the field of organic farming

Tables 2 and 3, and Figure 1 depict the annual research productivity in this field. In the initial years, research productivity is low, i.e. only 10–20 papers per year. The research productivity plot shows an increase after 2006–07 (3–4%). The mean total citation score per record is high in the initial years due to the citing years period is comparatively long compared to recent years. For example, during 2002–10, this mean total citation score per record is between 10 and 40 citations, but in recent years 2015–21 it is low (3–20). Research productivity shows an exponential growth after 2016–17.

Most productive authors contributing to research in organic farming

Table 4 depicts the most relevant authors who contributed to organic farming research during the last two decades. Kumar, A. is the most productive author with 46 records and 779 global citations. Singh, R. is second in the list with 29 records and 459 global citations, Kumar, S. and Singh, A. K. are both at third in the list with 26 records. Average global citation score per year (TGCS/t) was analysed for the prolific authors. Kumar, A., topped the list (TGCS/t: 109) followed by Lal, R., Singh, S., Singh, R. and Bhattacharyya, P.

Major contributing sources

Table 5 depicts the most relevant contributing sources. The *Indian Journal of Agricultural Sciences* tops the list

Table 2. Annual scientific production of organic farming research (2002–21)

Publication year	Records	Percentage	TLCS	TGCS	Mean TC/ records	Mean TC/year	Cit_Years
2002	11	1	4	246	22.36	1.12	20
2003	14	1.3	22	587	41.93	2.21	19
2004	11	1	17	147	13.36	0.74	18
2005	24	2.2	39	749	31.21	1.84	17
2006	21	2	13	608	28.95	1.81	16
2007	37	3.5	63	1,374	37.14	2.48	15
2008	46	4.3	45	819	17.80	1.27	14
2009	42	3.9	30	1,463	34.83	2.68	13
2010	39	3.7	47	756	19.38	1.62	12
2011	48	4.5	37	1,099	22.90	2.08	11
2012	59	5.5	71	1,243	21.07	2.11	10
2013	56	5.2	35	1,130	20.18	2.24	9
2014	62	5.8	71	2,211	35.66	4.46	8
2015	57	5.3	31	1,091	19.14	2.73	7
2016	63	5.9	37	880	13.97	2.33	6
2017	71	6.6	44	1,469	20.69	4.14	5
2018	59	5.5	28	623	10.56	2.64	4
2019	84	7.9	16	700	8.33	2.78	3
2020	102	9.8	15	630	6.18	3.09	2
2021	162	15.1	4	554	3.42	3.42	1
Total	1,068	100	669	18,379	–	–	20 years

TLCS, Total local citation score; TGCS, Total global citation score; Mean TC/records, Average citations per record; Mean TC/year, Average citations per year.

Table 3. Annual scientific production of organic farming research (annual growth pattern, 2002–21)

Time-period	Frequency (records)	Percentage of contribution
2002–06	81	7.58
2007–11	212	19.85
2012–16	297	27.81
2017–21	478	44.76
Total	1,068	100.00

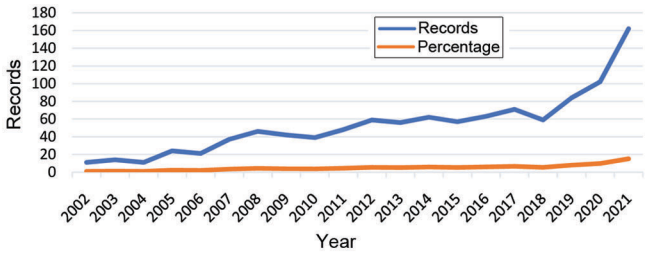

Figure 1. Annual research productivity: organic farming (2002–21).

with 98 records and a global citation score of 305 (CPP = 3). The is followed by *Communications in Soil Science and Plant Analysis* which has contributed 55 research records with 368 global citations (CPP = 7). The *Journal of Legume Research* is ranked third in the list with 32 contributed records and 49 global citation score (CPP = 2). The fourth source on the list is the *Journal of Plant Nutrition* with 29 records and 198 global citation score (CPP = 7). When ranked according to CPP, the top sources are *Agricultural Ecosystems and Environment* (CPP = 48), *Field Crops Research* (CPP = 45), *Soil and Tillage Research* (CPP = 44), and *Current Science* (with CPP = 24).

Figure 2 illustrates the share of major contributing sources in organic farming research during 2002–21.

Major contributing institutions

Table 6 shows the major contributing academic and research institutions to organic farming research in India from 2002 to 2021. ICAR-Indian Agricultural Research Institute tops the list with 152 published records and a global citation score of 2492. This is followed by Punjab Agricultural University with 56 published research records and global citation scores of 989. The third in the list is Banaras Hindu University with 43 published records and global citation score of 689. The fourth institution is ICAR Research Complex for North Eastern Hill Region (ICAR RC NEH) with 40 research records and global citation score of 335.

On considering CPP from major contributing institutions, the list is as follows: Ohio State University (CPP = 32), followed by International Crops Research Institute for the Semi-Arid Tropics (CPP = 20), Punjab Agricultural University (CPP = 18), ICAR-Indian Agricultural Research Institute and Banaras Hindu University both having CPP = 16, Tamil Nadu Agricultural University (CPP = 12), Chaudhari Charan Singh Haryana Agricultural University (CPP = 11), Bidhan Chandra Krishi Vishwavidyalaya (CPP = 9), ICAR RCNEH Research Complex for North Eastern Hill Region (CPP = 8) and ICAR-Indian Institute Soil Science (CPP = 4).

Table 4. Most productive authors in organic farming research (2002–21)

Authors	Records	Percentage	TLCS	TLCS/t	TGCS	TGCS/t	TGCS/t ranking
Kumar, A.	46	4.3	44	5.06	779	109.29	1
Singh, R.	29	2.7	20	3.53	459	72.38	4
Kumar, S.	26	2.4	2	0.13	131	20.93	10
Singh, A. K.	26	2.4	40	3.69	547	56.7	6
Bhattacharyya, P.	22	2.1	23	2.62	673	69.59	5
Lal, R.	22	2.1	34	4.42	713	99.22	2
Singh, S.	21	2	10	0.82	251	74.89	3
Das, A.	19	1.8	34	4.03	238	35.26	7
Singh, A.	17	1.6	2	0.39	95	21.45	9
Yadav, G. S.	17	1.6	11	1.84	123	30.55	8

TLCS/t, Total local citation score per year; TGCS/t, Total global citation score per year.

Table 5. Major contributing sources of organic farming research (2002–21)

Journal	Publisher/origin	Impact factor (IF)/ NAAS (2020)	Records	TLCS	TGCS	CPP
Indian Journal of Agricultural Sciences	Indian Council of Agricultural Research, New Delhi	5.17 (NAAS)	98	52	305	3
Communications in Soil Science and Plant Analysis	Taylor and Francis Ltd, Oxfordshire, UK	1.327 (IF)	55	33	368	7
Legume Research	Agricultural Research Communication Centre, Karnal, Haryana, India	6.59 (NAAS)	32	6	49	2
Journal of Plant Nutrition	Taylor and Francis Ltd, Oxfordshire, UK	1.707 (IF)	29	19	198	7
Soil and Tillage Research	Elsevier B.V., NX Amsterdam, The Netherlands	7.366 (IF)	27	48	1184	44
Research on Crops	Gaurav Pub. Ltd, Hisar, India	1.06 (IF)	26	1	17	1
Archives of Agronomy and Soil Science	Taylor and Francis Ltd, Oxfordshire, UK	3.092 (IF)	25	16	192	8
Current Science	Indian Academy of Sciences, Bengaluru, India	1.102 (IF)	24	53	587	24
Agriculture Ecosystems and Environment	Elsevier B.V., NX Amsterdam, The Netherlands	4.241 (IF)	18	39	868	48
Environmental Monitoring and Assessment	Springer, Dordrecht, The Netherlands	2.513 (IF)	16	6	321	20
Indian Journal of Horticulture	Indian Academy of Horticultural Sciences, New Delhi	6.16 (NAAS)	15	4	23	2
Field Crops Research	Elsevier B.V., NX Amsterdam, The Netherlands	6.145 (IF)	11	24	497	45
Indian Journal of Traditional Knowledge	CSIR-National Institute of Science Communication and Policy Research, New Delhi	1.091 (IF)	11	4	37	3
Journal of Sustainable Agriculture	John Wiley, New Jersey, USA	1.636 (IF)	11	2	107	10
Sustainability	Multidisciplinary Digital Publishing Institute, Basel, Switzerland	3.251 (IF)	11	4	219	20

NAAS, National Academy of Agricultural Sciences; CPP, Citations per paper.

Co-authorship network between major contributing institutions (organic farming: 2002–21)

Co-authorship patterns between major contributing institutions shown using VOSviewer networks are as follows (Figure 3): (i) ICAR-Indian Agricultural Research Institute (cluster 1, bluish-cyan in colour): shows collaboration with Indian Institute of Soil Science, Orissa University and Institute of Agricultural Technology. (ii) Banaras Hindu University (cluster 2, purple colour): shows collaboration with University of Allahabad, Delhi University, University of Calcutta, International Rice Research Institute, ICAR-Central Soil Salinity Research Institute and Assam Agricultural University. (iii) Punjab Agricultural University (cluster 3: orange colour): shows collaboration with ICAR-Central Arid Zone Research Institute, Punjab Agricultural University, ICAR-Indian Institute of Farming Systems, Maharana Pratap University of Agriculture and Technology and ICAR-Indian Agricultural Research Institute. (iv) CCS-Haryana Agricultural University (cluster 4, orange–red colour): shows collaboration with ICAR-Central Soil Salinity Research Institute, Assam Agricultural University, Indian Institute of Technology, Kharagpur and University of Calcutta. These are the four clusters representing major collaborating networks in organic farming research between 2002 and 2021.

Major contributing countries

Table 7 shows that India has the highest number of contributed records, i.e. 1059 with 17,979 global citations. This is followed by USA with 72 records and 3529 global

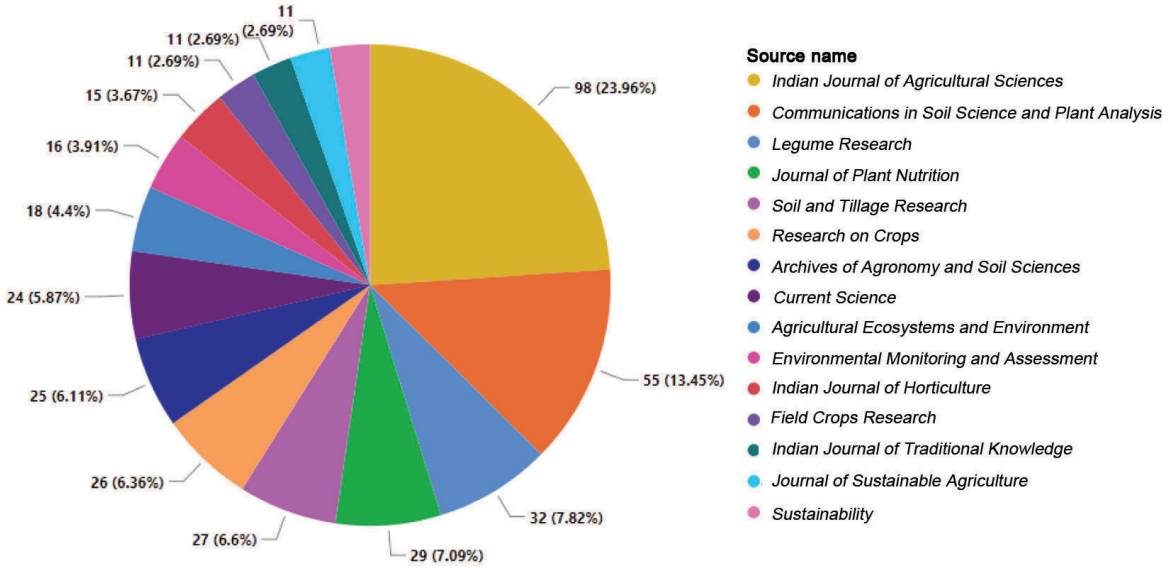

Figure 2. Major contributing sources in organic farming research (2002–21).

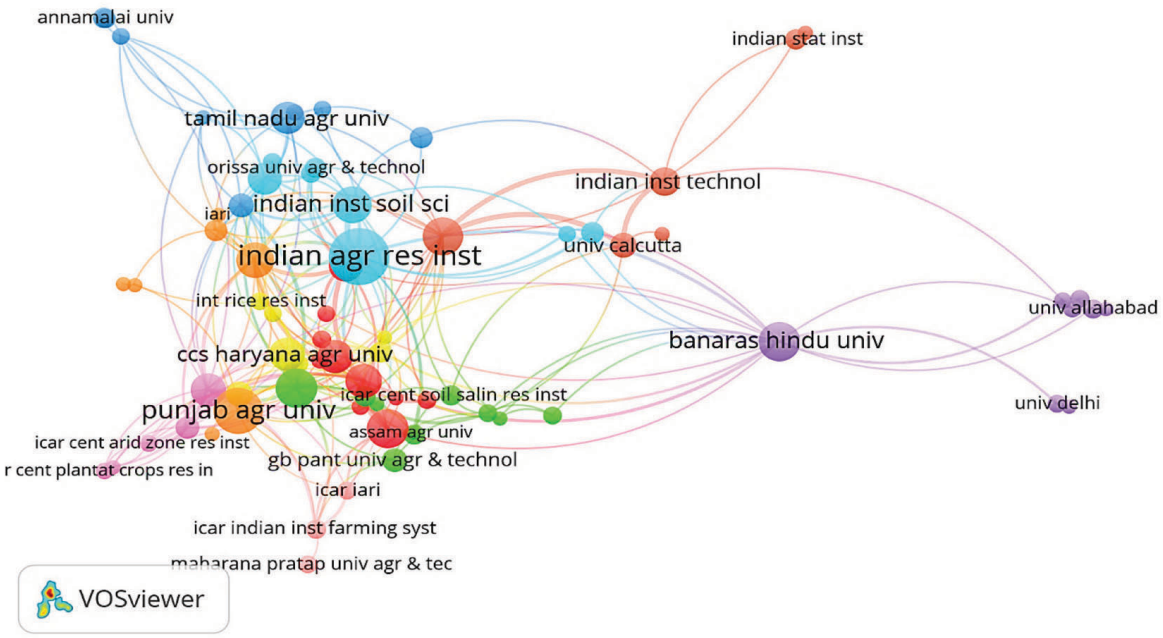

Figure 3. Co-authorship network between major contributing institutions to organic farming research (2002–21).

Table 6. Major contributing institutions to organic farming research (2002–21)

Affiliation	Articles	Percentage	TLCS	TGCS	CPP
ICAR-Indian Agricultural Research Institute, New Delhi	152	14	112	2492	16
Punjab Agricultural University	56	5	35	989	18
Banaras Hindu University, Varanasi	43	4	16	689	16
ICAR Research Complex for North Eastern Hill Region	40	4	42	335	8
Chaudhary Charan Singh Haryana Agricultural University	31	3	15	328	11
ICAR-Indian Institute of Soil Science	31	3	27	128	4
Tamil Nadu Agricultural University	29	3	17	334	12
International Crops Research Institute for the Semi-Arid Tropics	27	3	27	553	20
Ohio State University, USA	27	3	41	869	32
Bidhan Chandra Krishi Vishwavidyalaya	26	2	36	244	9

Table 7. Major contributing countries to organic farming research (2002–21)

Country	Records	Percentage	TLCS	TGCS	CPP
India	1,059	99.2	661	17,971	17
USA	72	6.7	87	3,529	49
Australia	40	3.7	17	645	16
China	21	2	1	891	42
Germany	20	1.9	5	740	37
UK	17	1.6	9	1,302	77
Switzerland	13	1.2	4	142	11
Bangladesh	12	1.1	3	135	11
The Netherlands	12	1.1	3	673	56
Canada	11	1	3	325	30

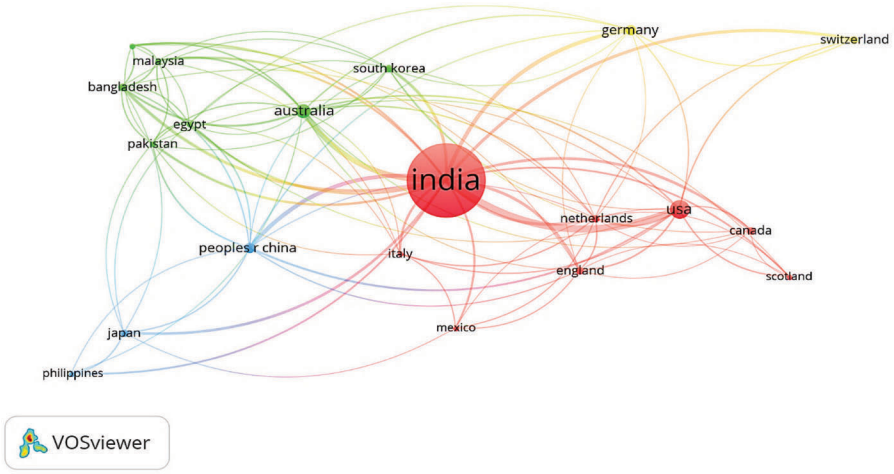

Figure 4. Network diagram of major contributing countries to organic farming research (2002–21).

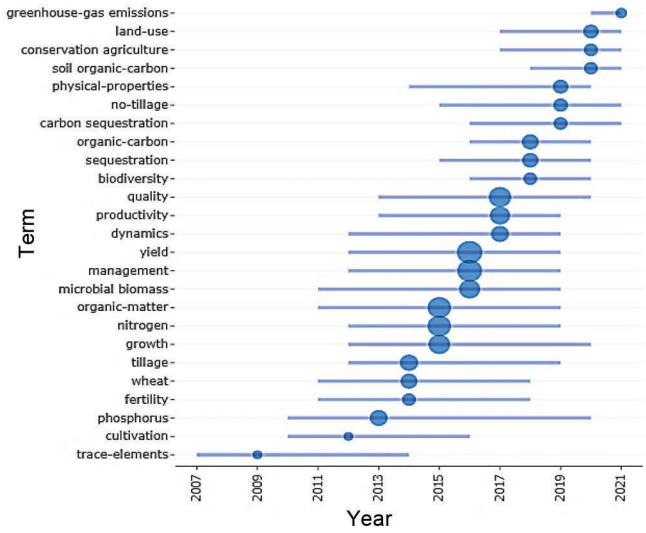

Figure 5. Trend dynamics in organic farming research (2002–21).

citations. The third in the list is Australia with 40 published documents and 645 global citations. Figure 4 depicts the collaboration network of major contributing countries in organic farming research from 2002 to 2021.

Research trend dynamics

Figure 5 shows the trend dynamics in organic farming research. Different keyword and term patterns were identified in the study of organic farming within the specified time-span, as specifically used by the researchers. As seen from the word map prepared using Biblioshiny 'greenhouse gas emission' is the most recent (2020–21) trend topic/keyword in organic farming research. 'Land use' and 'conservation agriculture' were trending from 2017 through 2021, while 'physical properties', 'no-tillage' and 'carbon sequestration' were trending topics between 2016 and 2020. 'Trace elements', during 2007–14, 'cultivation' during 2010–16, and 'phosphorus' during 2010–20 were the most trending terms/keywords in the organic farming research.

Results and conclusion

From this analytical study, conclude the following about organic farming research from 2002 to 2021: considering annual growth, the period between 2017 and 2021 (44.96%) is the most productive, while and the period between 2002 and 2006 (7.58%) is the least productive in organic farming

research. Kumar, A. (46 records) is the most productivity author in organic farming research from 2002 to 2021. The most relevant contributing sources are the *Indian Journal of Agricultural Sciences*, *Communications in Soil Sciences and Plant Analysis* and *Legume Research*. Most of the major contributing sources (9 out of 15) preferred by researchers originated from foreign countries. Considering major contributing institutions, the top in the list from India are ICAR-Indian Agricultural Research Institute, Punjab Agricultural University, Banaras Hindu University, ICAR-RCNEH and CCS Haryana Agricultural University.

Suggestions for improvement in organic farming research in India

After reviewing the research productivity and its impact, the following suggestions are made for improvement in this field.

(a) Encouraging interdisciplinary research: To improve organic farming research, we suggest promoting collaboration among researchers from different disciplines like agriculture, environmental science, biotechnology and chemistry. This will help address the complex challenges in organic farming and enhance our understanding of its practices and their impact.

(b) Increase in funding for organic farming research: Allocate more financial resources to support organic farming research in India. This would facilitate the implementation of large-scale research projects, encourage innovation and attract talented researchers to the field.

(c) Promotion of international collaborations: Promote partnerships and collaborations with international institutions and researchers working organic farming. International collaborations can facilitate knowledge exchange, access to advanced technologies, and global best practices in organic farming research.

(d) Focus on farmer participation and adoption: Research must involve active participation from practicing organic farmers to understand their perspectives, challenges and needs, in order to develop practical and farmer-centric solutions. Encourage farmer-to-farmer knowledge exchange and promote the adoption of organic farming.

(e) Establish a national organic farming research network: Collaborative platform or network must be established that brings together researchers, farmers, policymakers, academia and other stakeholders to exchange knowledge, share best practices and collectively address the challenges in organic farming. Such a network can facilitate coordinated research efforts and policy development in the field.

(f) Strengthen research dissemination: By emphasizing the dissemination of research findings through conferences, workshops and publications in reported national and international journals, increased visibility of research outcomes will facilitate knowledge sharing, encourage further studies and attract more researchers to the field.

Conflict of interest: The authors declare that there is no conflict of interest.

1. FAO, Organic agriculture: what is organic agriculture? https://www.fao.org/organicag/oa-faq/oa-faq1/en/ (accessed on 28 June 2023).
2. FAO, Titulo: introduction to organic agriculture, 2020; https://teca.apps.fao.org/teca/pt/technologies/8359 (accessed on 28 June 2023).
3. India PIB, Bhartiya Prakritik Krishi Padhati, 2021; https://pib.gov.in/PressReleasePage.aspx?PRID=1737751 (accessed on 15 June 2023).
4. NITI Aayog, Natural Farming: NITI Aayog initiative, 2020; https://www.niti.gov.in/natural-farming-niti-initiative (accessed on 15 June 2023).
5. Aleixandre, J. L., Aleixandre-Tudó, J. L., Bolaños-Pizarro, M. and Aleixandre-Benavent, R., Mapping the scientific research in organic farming: a bibliometric review. *Scientometrics*, 2015, **105**(1), 295–309; doi:10.1007/s11192-015-1677-4.
6. Bartol, T., Drnovsek, S. and Cernic-Istenic, M., Scientific and technical information on organic farming: assessment of selected bibliographic indicators in database CAB Abstracts. *Acta Agric. Slov.*, 2005, **85**, 3–13.
7. Pinheiro, A. and Govind, M., Emerging global trends in urban agriculture research: a scientometric analysis of peer-reviewed journals. *J. Sci. Res*., 2020, **9**(2), 163–173.
8. Mouret, J., Hammond, R., Bayot, M., Fabre, D. and Thomas, C., French lag in scientific research on organic farming: a scientometric approach. *Carrefours de l'Innovation Agronomique*, 2009, **4**, 363–375.
9. Clarivate Analytics, Web of Science Core Collection; 2023; https://www.webofscience.com/wos/woscc/basic-search (accessed on 15 June 2023).
10. Olle, P., BibExcel, 2017; https://homepage.univie.ac.at/juan.gorraiz/bibexcel/ (accessed on 15 June 2023).
11. Banihashemi, L. and Dabestani, Z., BibExcel, 2018; doi:10.13140/RG.2.2.21143.21921 (accessed on 15 June 2023).
12. Clarivate Analytics, HistCite 12.3. https://clarivateanalytics.my.salesforce.com/sfc/p/41000001O1D5 (accessed on 15 June 2023).
13. Aria, M. and Cuccurullo, C., Bibliometrix: an R-tool for comprehensive science mapping analysis. *J. Inform.*, 2017, **11**(4), 959–975; doi:10.1016/j.joi.2017.08.007.
14. Van Eck, N. J. and Waltman, L., Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 2010, **84**(2), 523–538; doi:10.1007/s11192-009-0146-3.

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