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# A Bibliometric Analysis of Chickpea Agronomic Practices in the World During 45 Years of Scientific Research

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## ABSTRACT

Chickpea (*Cicer arietinum* L.) cultivation practices underwent significant transformation in recent decades due to advancements in scientific knowledge and the need for sustainable, productive farming systems. In this study, a bibliometric analysis of scientific publications from 1977 to 2023 on chickpea agronomic practices was conducted, revealing critical insights. India, as the world's leading chickpea producer, plays a pivotal role, not only in production but also as a significant contributor to scholarly research and international collaborations. The choice of journals for publication is found to influence research impact.

Analysis of research trends using co-occurrence networks of keywords reveals evolving focuses, with a recent shift towards qualitative aspects, such as protein content and nutritional quality, as well as sustainable agricultural practices. The study also emphasizes the necessity for further research on chickpea quality characteristics, strategies to mitigate antinutritional factors, yield optimization, and the impact of climate change on chickpea cultivation. Ultimately, chickpea cultivation research holds great promise in contributing to global food security and environmental sustainability. This bibliometric analysis provides a comprehensive overview of chickpea cultivation research and offers valuable insights for researchers, policymakers, and stakeholders as they navigate the future of sustainable agriculture and the quest for protein-rich food production while minimizing the environmental footprint.

## 1 | Introduction

Today, a third of the world's soils is considered to be degraded due to a number of factors, such as erosion, salinization, nutrient depletion, urbanization, and pollution that threaten the long-term sustainability of agriculture (FAO 2016). The incorporation of pulses into cover crop, intercropping, and crop rotation practices can help in restoring soil health by increasing organic matter content, enhancing soil structure, and promoting beneficial microbial activity (De Mastro et al. 2022; Vidigal, Manuel Romeiras, and Monteiro 2020; Xue et al. 2016). These benefits translate into improved long-term soil fertility and reduced erosion risks (Phiri, Njira, and Chitedze 2023).

The introduction of legumes, of which pulses are a part, into traditional cropping systems holds great potential for making agricultural practices more sustainable (Stagnari et al. 2017). In the family of Fabaceae, there are species able to thrive with limited nutrient availability than many other plant families yet concurrently enriches soil with essential compounds such as nitrogen and soluble phosphates (Mulissa et al. 2016; Stagnari et al. 2017; Xue et al. 2016). Pulses, such as chickpeas, possess specific soil bacteria that enable biological nitrogen fixation (Hirsch, Lum, and Downie 2001; Sellami, Lavini, and Pulvento 2021). Many scientific studies (Fikre 2016; Yirga & Rashid 2010) show that the use of leguminous plants allows a saving of nitrogen for the next crop in a range from 30% to 60%, also in different tillage system (Tedone, Alhajj Ali, and De Mastro 2022). Some scholars estimate that globally, legumes contribute about 5–7 million tons of nitrogen that crops can use in the following season (Kebede 2020; Vidigal, Manuel Romeiras, and Monteiro 2020). In addition, the deep root systems of legumes also improve water infiltration and enhance drought tolerance, making them suitable for areas with limited water availability (Tar'an 2015). On the other hand, they are considered as inherently climate-smart since they adapt to climate change and help mitigate its effects by increasing soil carbon sequestration capacities (Jensen et al. 2012). Moreover, the inclusion of legumes in crop rotations helps break disease and pest cycles, reducing the need for chemical pesticides and fostering natural pest control (Idate et al. 2021; Kroeck 2011; Yigezu et al. 2019).

Chickpeas (*Cicer arietinum* L.) also known as garbanzo beans is already cultivated in ancient times by the Egyptians, and they are widely consumed around the world (Sharma et al. 2013). They are the second most common legume species globally after the common bean (*Phaseolus vulgaris* L) and constitute ~18% of the global legumes production (FAO 2021). Chickpea-cultivated area accounts 15 Mha, with an annual production of ~16 Mt (FAO 2021). It is estimated that approximately 80% of the world's chickpea production is concentrated in Asia. Countries such as India, Pakistan, Myanmar, and Türkiye have been major contributors to chickpea production in the region (FAO 2021). World average production per hectare is about 1 t $ha^{-1}$, which is much lower than the theoretical yield of 6 t $ha^{-1}$ (Varshney et al. 2013; Zwart et al. 2019). This difference between the effective and theoretical yield is due to biotic and abiotic stress that affect chickpea production in different cultivated areas (Roorkiwal et al. 2016; Vidigal, Manuel Romeiras, and Monteiro 2020; Xue et al. 2016).

In recent years, especially after the 68th United Nations General Assembly designated 2016 as the International Year of Pulses (A/RES/68/231; United Nations 2014), there has been an increase in interest in the cultivation of legume crops in order to meet the growing global demand for high-quality, protein-rich foods while reducing those of animal origin in the human diet (Alandia et al. 2020; Sellami et al. 2019). This can help meet the needs of a growing global population (Chojnacka, Moustakas, and Witek-Krowiak 2020) while maintaining environmental sustainability, compatible land use practices, and food security (Abhilash et al. 2016; L. Dubey, Dubey, and Jain 2015).

Chickpeas are considered a highly nutritious food due to their rich content of protein, folate, vitamins, and various minerals such as calcium, phosphorus, zinc, iron, and magnesium (Diapari et al. 2014; Jha 2015; Tripathi et al. 2012). Due to its high protein content (Boukid 2021; Sellami, Lavini, and Pulvento 2021) and low costs of production, the chickpeas are considered an excellent source of livelihood in low-income countries.

Chickpeas can be used in various culinary creations, such as hummus, salads, soups, and curries. Its taste is similar to nut flavor and if combined in food preparations with cereals give a complete and rich protein food (Yigezu et al. 2019). Additionally, ground chickpeas, in the form of chickpea flour or besan, are used in gluten-free and vegan baking, as well as savory dishes (Guimarães et al. 2022).

They come in different varieties, including Desi and Kabuli (Ruta et al. 2020), each with its own characteristics. Consumption of chickpeas has been associated with digestive health, blood sugar regulation (Zafar et al. 2015; Zafar & Kabir 2017), heart health, and weight management (Harini et al. 2015). They are particularly favored by those following vegetarian and vegan diets due to their high protein content (Boukid 2021; Sellami, Lavini, Calandrelli, et al. 2021).

The cultivation of chickpeas has undergone substantial changes in agronomic practices over time, driven by advancements in scientific knowledge and the need for sustainable and productive farming systems. Conventional practices have been replaced by enhanced varieties (Sellami, Pulvento, and Lavini 2021), precise planting methods (Thenkabail 2003), and refined nutrient management practices (Begna Sisay et al. 2023; S. Dubey, Raghav, and Singh 2017). Disease and pest management systems have evolved, using integrating cultural practices as well as biological control methods (Aljuboori, Ibrahim, and Mohamed 2022). The adoption of conservation agricultural concepts (Mishra, Singh, and Kumar 2012), as well as the investigation of digital technology (Jat et al. 2020), contributes to the evolution of chickpea agronomic practices. Through the integration of these technological and methodological developments, farmers can enhance productivity, mitigate risks, and ensure the long-term sustainability of chickpea cultivation.

Therefore, it has been useful to examine the evolution of scientific production on chickpea cropping practices from 1977 to 2022 in the Scopus database and to determine the significance of this subject as a research domain. Consequently, there are posed the following main research questions: What are the major areas of research based on the input dataset? Has there been a significant shift in chickpea agronomic practices during the period analyzed? Are there critical transitions in the history of the development of the research field? Where are the "turning points"?

For this purpose, a bibliometric approach has been employed to synthesize the knowledge base concerning the various chickpea cropping methods used on a global scale. The bibliometric method is a valuable tool for analyzing and understanding scientific literature. By quantitatively examining factors such as citations, authorship patterns, and journal impact factors, researchers can gain insights into research productivity, impact, and collaboration within a field. Bibliometric analysis helps identify influential researchers and journals, reveals emerging trends, and provides a historical perspective on the development of scientific fields (Glänzel & Moed 2002; Glänzel & Schubert 2004; Joshi 2015; Stea et al. 2023).

The findings of this investigation provide valuable insights for agricultural practitioners, academics, and other relevant stakeholders to discern research trend, knowledge gaps as well as potential new lines of research.

## 2 | Materials and Methods

### 2.1 | Methodology

A bibliometric analysis was conducted to evaluate the scientific literature related to the field of study. Bibliometric analysis is a powerful tool that can be used to gain insights into the scientific literature, by using statistical techniques to analyze significant amount of scientific data. It can be used to track the evolution of a field of study, identify emerging trends, and measure the impact of individual researchers or publications (Donthu et al. 2021). Regardless of its merits, bibliometric analysis remains relatively new in Agricultural and Biological research, and according to the Web of Science database, only 276 research papers on bibliometric analysis were published in Agriculture science over a last 45-year period (1977–2022).

### 2.2 | Data Source and Search Criteria

The bibliometric analysis was conducted using Scopus database, to identify studies related to the chickpea cropping practices under the world and that were written in English. Scopus is a large abstract and citation database of peer-reviewed literature and quality research from across the sciences, social sciences, and arts and humanities (Baas et al. 2020). Scopus enables users to calculate bibliometric indicators such as the number of publications per scholar, number of citations, number of institutions and journals, and H-index as well as the journal impact factors (Haeffner-Cavaillon & Graillot-Gak 2009). The bibliometric indicators take into account various factors to evaluate the impact and importance of scholarly publications. These indicators are commonly used to assess the influence and productivity of researchers, institutions, or scientific journals.

A search was conducted on August 1, 2022 using the following search string:

TITLE-ABS-KEY ({FIELD} AND ((RHIZOB* OR INOCUL*) OR (FUNGI OR MYCORRIZ* OR {PGPR} OR {PLANT GROWTH PROMOT*} OR BIOSTIMULANT* OR FERTIL* OR FULVI* OR HUMI*) OR (TILL* OR {CONSERVATION AGRICULTURE}) OR (SOWING AND (DATE* OR DENSIT*)) OR INTERCROP* OR (BREED* OR CULTIVAR* OR LANDRACE* OR GENOTYPE* OR ACCESSION* OR ECOTYPE*) OR (IRRIGATION OR {DEFICIT IRRIGATION} OR DROUGHT OR ((WATER OR SALT) AND STRESS) OR SALIN* OR (WATER AND (QUALITY OR MANAGEMENT))) OR (NITROGEN OR POTASSIUM OR PHOSPHORUS) OR (DISEASE OR FUNG* OR BIOTIC* OR BACTER*) OR (PEST* OR INSECT* OR ACARI*) OR (WEED* OR HERBICIDE) OR ROTATION) AND (CHICKPEA* OR GARBANZO OR {CICER ARIENTINUM}) AND ((PROTEIN AND (YIELD OR CONTENT)) OR YIELD)).

Upon conducting the initial search, a total of 1086 articles were obtained. Two selection criteria were evaluated for selecting papers for the bibliometric analysis: (I) studies conducted only under field conditions, but not under greenhouse conditions, pots, and in vitro culture, and (II) studies that focused on chickpea productivity. The time span indicated 1977–2022 was automatically selected from the number of articles identified from the search string. The year 2022 was selected as the last year because the year 2023 had not ended when the search string was produced. In addition, the 673 articles resulting from the screening were used to obtain numerical data within the methodologies used to draw up tables, graphs, and concept maps.

### 2.3 | Screening

Figure 1 describes the procedure for selecting articles. Eighty-six documents were excluded during the identification phase because they were neither journal articles nor written in a language other than English. Subsequently, in the screening of titles, abstract, and full-text studies, 327 articles were excluded because they were irrelevant to the topic, not accessible, no field experiment, or no effect size (yield or protein content) was available. As a result, only 673 documents satisfied the eligibility requirements and were included in the bibliometric analysis.

### 2.4 | Data Analysis

In this study, to examine the evolution of scientific production on chickpea cropping practices over a 45-year period (1977–2022), the bibliometric indicators such as the number of publications per scholar, number of citations, number of countries, number of institutions and journals, H-index, the journal impact factors as well as co-citation analysis, or keyword/terms co-occurrence analysis per periods are applied. The quantitative analysis was carried out utilizing the comprehensive science mapping analysis tools, bibliometrix package in R (Aria & Cuccurullo 2017). VOSviewer (van Eck & Waltman 2010), a conceptual network mapping software designed by scientists, was used to generate keywords and term maps. Citespace (Chen 2006) was also utilized to construct a co-cited reference network.

## 3 | Results and Discussion

### 3.1 | General Aspects of References

#### 3.1.1 | Scientific Production and Authors

The screening revealed 673 papers that satisfied the inclusion and exclusion criteria selected in the first phase of the study. Figure 2 shows the development of scientific production over the last 45 years (1977–2022). Scientific research in the field of chickpea cultivation has grown at an average rate of 27, 25%, as confirmed by the trend line. At the end of the 1990s and in the last decade, significant increases compared to the average trend were recorded, in particular, 15 papers in 1999, 28 papers in 2009, and 35 papers in 2021. Figure 2 shows also two peaks in number of citations on 1991 and 2006.

The most important author who first published an article on chickpea cultivation was Sigh G. (Figure 3) in 1980. While the scientist who produced most articles in 1 year was Siddique Khm in 1999.

As shown in Figure 4, 57% of the scholars identified by the screening step published only one article in 45 years in this research area, followed by 30.5% of the scholars who published more than 3 articles, while the authors who published only 2 articles were 9.9%; 2.7% of scientists wrote 3 articles.

Table 1 illustrates the five most productive authors in field of chickpea cultivation practices. These five authors have written 50 articles and have been cited 1.485 times. An analysis of the

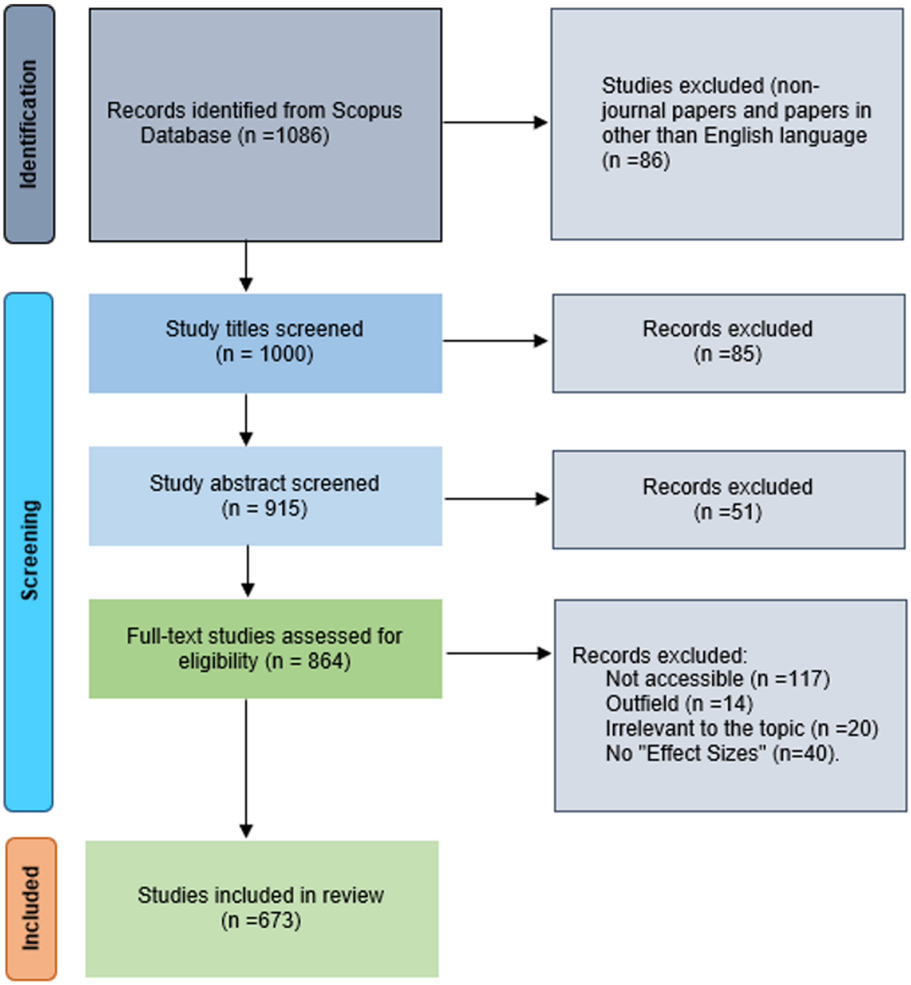


**FIGURE 1** | PRISMA flowchart depicting the article selection procedure (n represent the number of studies).

bibliometric data shows that Sigh G. is the leading researcher, having published 13 articles and received 147 citations.

The 687 articles counted 1520 authors; 16 scholars contributed articles as single authors, and 17 articles were wrote by only two authors. The 22.22% of analyzed papers showed international co-authorship (Table 2).

#### 3.1.2 | Scientific Production by Countries and Collaborations

Figure 5 shows the countries with the highest scientific production. It also shows which nations have collaborated with other countries. India is the most productive country in this area, followed by Pakistan. India is also the country with the highest number of collaborative articles with other international research institutions. Tunisia and Algeria despite having a low number of publications on chickpea show a high level of cooperation with international research organizations.

The 35 countries involved in international collaboration on chickpea cultivation research are grouped into four clusters (Figure 6), determined by the areas of cooperation. The closer two countries are on the map, the greater the collaboration between them. However, one of the most significant examples of international collaboration is the partnerships between India, Australia, and the United States.

#### 3.1.3 | Trend and Analysis of Citation

The top 10 cited publications account for 18% of the total citations (8069 citations). Most of the cited articles (6/10) have as first author a researcher working for an Indian research institution. The article with the highest number of citations is entitled “Wheat and chickpea intercropping systems in an additives experiment: Advantages and weed smothering” and was cited 185 times (Figure 7). The following article is “Variability of root length density and its contributions to seed yield in chickpea (*Cicer arietinum* L.) under terminal drought stress,” which received 168 citations (Figure 7).

Figure 8 represents the evolution of search terms focused on chickpeas. In recent years, the trend terms were protein, seed yield and herbicides, biofortification, and biofertilizers. Some terms like pulse, crop rotation, row spacing, and weed control were more frequent until 2010.

#### 3.1.4 | Analysis of Sources Where Articles on Chickpea Have Been Published

Table 3 shows the 10 journals with the highest number of published articles and citations. The first journal is *Legume Research* with the highest number of published articles (24%). The journal *Field Crops Research* has the highest number of citations (31%). *Field Crops Research* is ranked in a higher quartile compared to *Legume Research*.

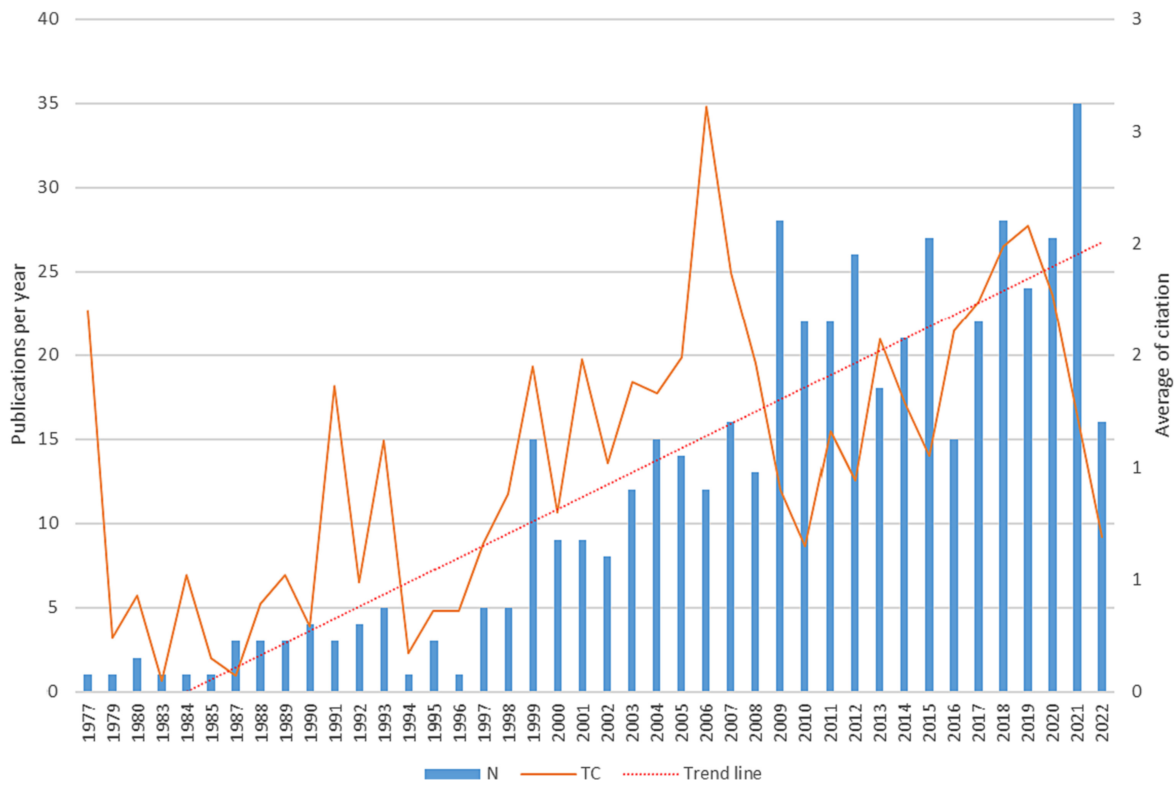


**FIGURE 2** | This figure shows the number of total citations per year and the number of articles. The trend line is related to the number of articles. Number of publications (N) and total citation per year (TC).

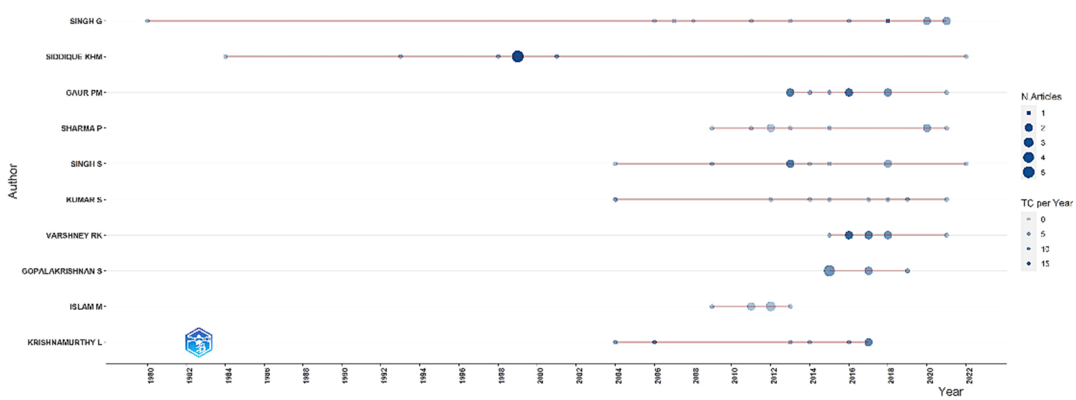


**FIGURE 3** | The most productive authors by linking the period of production and the points at which the authors wrote the most papers. TC (Total Citation) and Number of articles are indicated.

Table 4 displays the top 10 institutions on chickpea research. In the first place is ICRISAT located in India with a total of 61 articles. Furthermore, 4 out of 10 institutes are Indian and account for 50.3% in terms of number of scientific articles.

Figure 9a shows the co-occurrence network analysis of the 132 most relevant terms that appeared at least 10 times in the title and abstract fields of 673 articles. It comprises 132 nodes, 4190 links, and 11,721 total links. Each node in the network represents a term and the size of the node reflects the number of times the term appeared. The connections between terms are determined by the frequency of their occurrence in the 673 publications. The higher the frequency with which two terms appear together, the closer they will be positioned on the map. There are three clusters of terms that share common topics. The co-occurrence network data show that the green term cluster is related to genetic improvement and selection of lines resistant to biotic and abiotic factors, for example, resistance to Ascochyta blight. The terms with the highest frequency in this cluster are "genotype" (frequency = 78), "pod" (frequency = 78), "cultivar" (frequency = 71), "trait" (frequency = 66), "environment" (frequency = 57), and "variation" (frequency = 50). The cluster of red terms is related to cropping systems and cultivation practices (fertilization, intercropping, and tillage) researched mainly in Indian territory. The terms in this cluster with the highest occurrences are "system" (frequency = 91), "fertilizer" (frequency = 60),

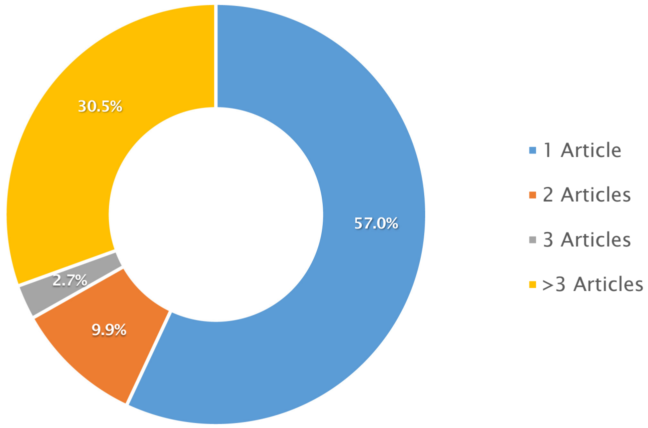


**FIGURE 4** | Percentages of authors per published articles.

**TABLE 1** | Top 5 authors in the period 1977–2022.

| Authors | Articles | H_index | TC | PY_start |
|---|---|---|---|---|
| SINGH G | 13 | 6 | 147 | 1980 |
| SIDDIQUE KHM | 10 | 9 | 786 | 1984 |
| GAUR PM | 9 | 8 | 311 | 2013 |
| SINGH S | 9 | 5 | 185 | 2004 |
| SHARMA P | 9 | 4 | 56 | 2009 |

Abbreviations: PY_start, publication year start; TC, total citation.

**TABLE 2** | Number of authors and author collaboration.

| Description | Result |
|---|---|
| Authors | |
| Authors | 1520 |
| Authors of single-authored docs | 16 |
| Authors collaboration | |
| Single-authored docs | 17 |
| Co-authors per doc | 4.05 |
| International co-authorships % | 22.22 |
| Document types | |
| Article | 497 |
| Article; early access | 2 |
| Article; proceedings paper | 5 |

"wheat" (frequency = 45), "india" (frequency = 44), "dose" (frequency = 38), "tillage" (frequency = 30), and "nutrient uptake" (frequency = 26). The cluster of blue terms is related to agronomic techniques and protection of the chickpea crop (field, inoculation, and phosphorus). The terms in this cluster with the highest occurrences are 'field' (frequency = 85), 'inoculation' (frequency = 61), 'phosphorus' (frequency = 60), 'nodulation' (frequency = 45), 'species' (frequency = 41), 'disease' (frequency = 35), and 'rhizobium' (frequency = 29). The analysis revealed that the relative terms in the 1977–2022 timeframe, shown here in Figure 9b, focus on the evolution of the terms in the co-occurrence network between 2008 and 2014. The analysis revealed that the terms related to water use, tillage, tillage system, fixation, and grain legume appeared earlier than the other terms (in 2008, purple cluster). Field condition, trait, accession, drought stress, and drought tolerance appeared later than their predecessors (2014, yellow cluster). Between 2010 and 2012, the most frequently used terms were inoculation, cultivar, fertilizer, phosphorus, and environment.

Figure 10a depicts the co-occurrence network analysis of the terms of the 90 most relevant keywords that appeared at least 5 times in 673 articles, with 90 nodes, 507 links, and 1100 total links. Each node in the network denotes a keyword, and the node size reflects the amount of times the keyword appeared. The structure of the network is divided into 6 clusters of keywords that share related topics. The topic of the red cluster is nodulation and nitrogen fixation. The yellow cluster comprises all those keywords related to production characteristics. The green cluster represents and focuses on economic aspects and how these can be influenced by the agricultural practices adopted. The blue cluster focuses on biotic abiotic tolerance traits. The purple cluster is based on weeds and the pale blue cluster discusses elements used in chickpea cultivation such as zinc phosphorus and FYM (farmyard manure).

The evolution of the authors' keywords in the co-occurrence network is demonstrated in Figure 10b. This network map is based on the average number of times each keyword appears in our literature. In the beginning, the most used keywords were sowing date, nitrogen fixation, and tillage, and then around 2016, the research shifted towards aspects related to weed management, control of some diseases, biofertilizers, and the amount of nutrients absorbed. Economic aspects are compared to different farming systems between 2010 and 2014.

## 4 | Discussion

According to the results of the quantitative analysis, the number of scientific papers on the cultivation and quality characteristics of chickpeas is continuously increasing. This is probably because, in recent years, legumes have been at the center of the political debate for the achievement of the 2030 Agenda goals (UNRIC 2015). This is due to the capacity of legumes to fix 5–7 tons of atmospheric N per year (Kebede 2020; Vidigal, Manuel Romeiras, and Monteiro 2020). It is estimated that, on average, the environmental impact generated animal protein is 12–46 times greater than the legume proteins production (Arrigoni et al. 2023). All the positive aspect of pulses production have been highlighted by FAO in 2016 during the International Year of Pulses (FAO 2016); it is possible to see from the results how from 2016 onwards we have a growth in scientific research focused on the cultivation of pulses, all of which is surely favored by the increase in funds used for these crops.

Among the main active journals, it is essential to look at the relevance and reliability of the sources employed (Ahmad & Ayub Jan 2019; Sorenson 2016). The Agricultural research communication center has the highest number of published papers even though it is not in the first quartile. It is

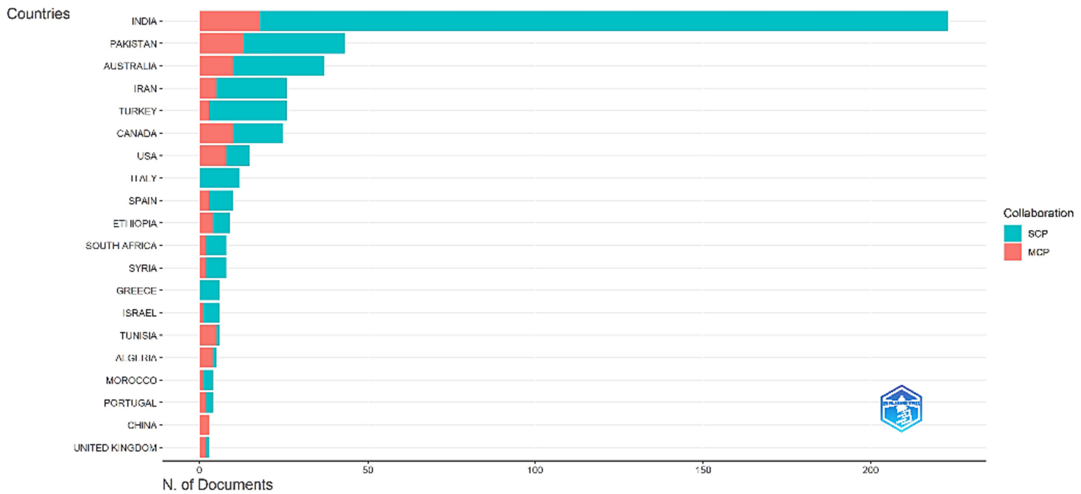


**FIGURE 5** | The graph relates the number of papers to the country of production and it cooperation. MCP: multiple country publications; SCP: single country publications.

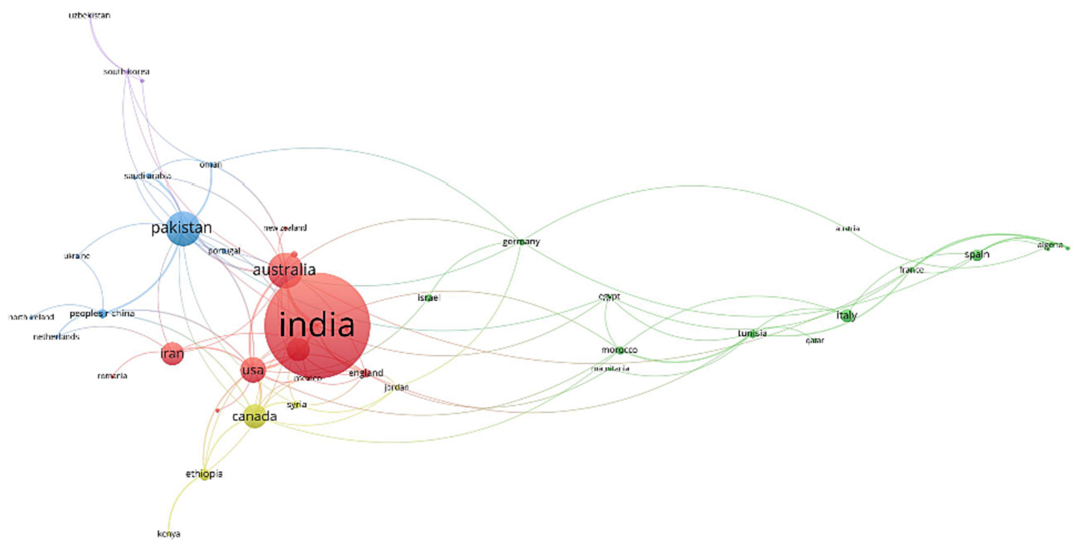


**FIGURE 6** | Collaboration network of countries. The different colors represent the clusters of collaboration between countries in the field of chickpea research; nodes indicate countries (the size of nodes is based on several publications); links represent a collaboration between two countries. *Source:* VOSviewer (cluster resolution 0.5; minimum cluster size 1 and no merging of small clusters).

possible to remark that researchers prefer to cite articles in well-known and important journals, often falling in the first quartiles. Although some journals published few papers on the topic, these are distinguished by their high number of citations.

The analysis of terms and keywords helps understand the connections between the various issues in the research field (Molinillo et al. 2016). In recent years, the most common terms used focus on qualitative aspects (such as proteins) and agronomic traits such as herbicide use, biofertilizers, biocontrol, and so forth. In earlier years, research focused on the agronomic and genetic characteristics of chickpeas. Subsequently, the various studies focused on nitrogen fixation, Ascochyta control, and fertilization. From the keywords, it is further confirmed how research topics changed in a decade. In particular, the initial reference subjects were focused on traditional agricultural practices. Later, the focus was on economic analyses related to agricultural practices and in the last period on weed management and the use of sustainable practices that aim to reduce environmental impact.

The trend of last years in chickpea publications are probable due to the technological evolution of agricultural practices. The introduction of chickpea in cropping systems is important for (i) stabilizing food production (Renard & Tilman 2019), (ii) contributing to the reduction of synthetic fertilizers (Jensen et al. 2012) thanks to the organic N-fixation (Peoples et al. 2009; Steen Jensen, Carlsson, and Hauggaard-Nielsen, n.d.), (iii) support sustainable phytosanitary management (Voisin et al. 2014), and (iv) improve agricultural profitability (MacWilliam, Wismer, and Kulshreshtha 2014).

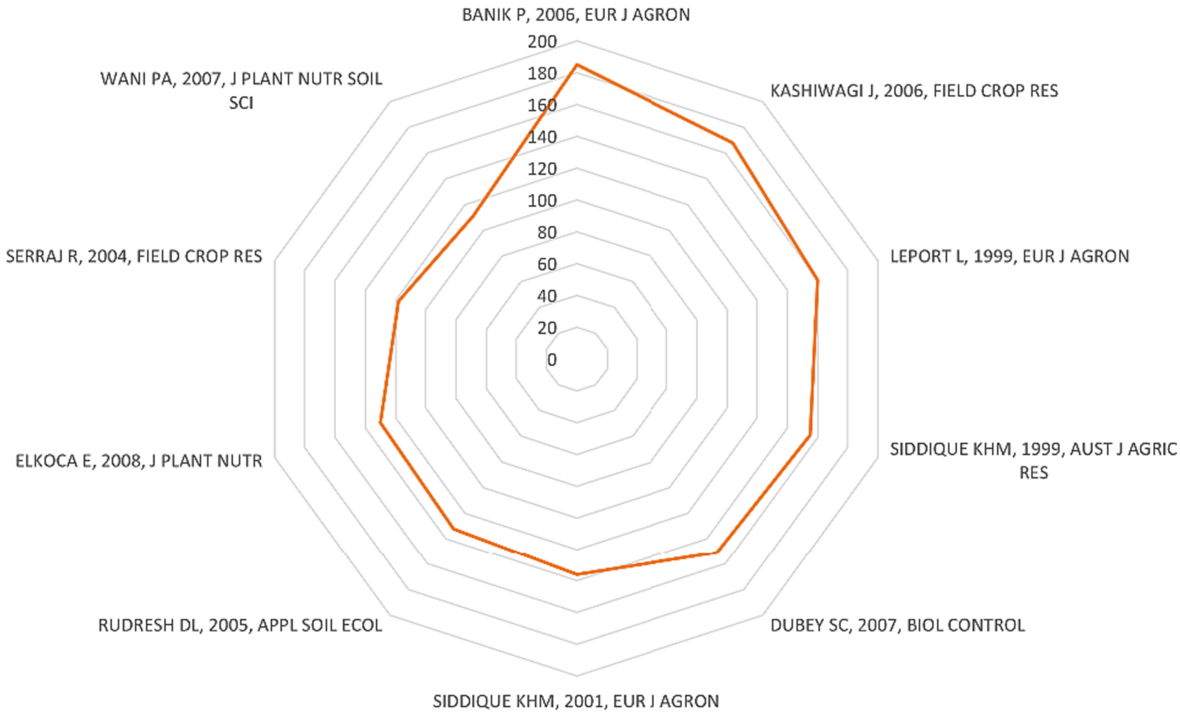


**FIGURE 7** | Top 10 cited articles in the chickpea literature.

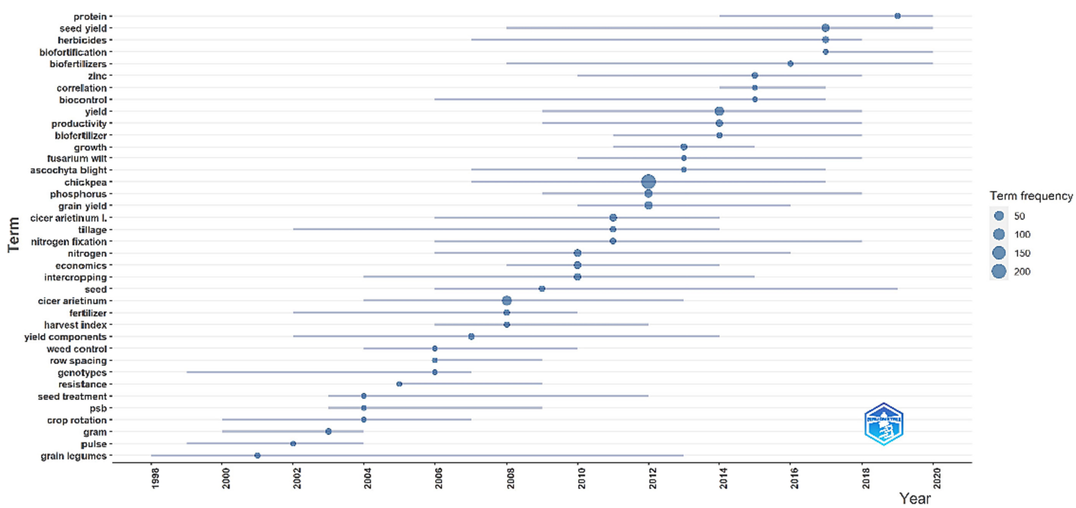


**FIGURE 8** | Trend topics of the last 45 years.

This bibliometric analysis provides important information regarding chickpea cultivation practices. One of the most obvious gaps is the need for in-depth investigations into the quality characteristics of chickpeas needed to address the challenges of processing this product. In addition, there is a need for further investigation of cultivation-related issues in particular weed control, use of biofertilizers, and production characteristics, which are affected by both climate change (Phiri, Njira, and Chitedze 2023) and the low production yields of this crop (around 1 t/ha) far from the potential yields (Varshney et al. 2013; Zwart et al. 2019).

This bibliometric analysis shows the progress made in research towards the most common agricultural practices. The next research trends should focus on aspects related to biostimulants and agricultural practices that can significantly influence the qualitative aspects related to protein content, protein yield, reduction of antinutritional factors (Carbonaro 2011; Idate et al. 2021), bioactive properties, and polyphenolic compounds (Nartea et al. 2023). In addition, a further objective that research will have to achieve is to reduce inputs by ensuring greater environmental and economic sustainability aimed at circular agriculture (Reckling et al. 2016).

**TABLE 3** | Top 10 most productive journal.

| No. | Element | NP | TC | H-index[a] | SJR[a] | Quartiles[a] | Publisher |
|---|---|---|---|---|---|---|---|
| 1 | *Legume Research* | 53 | 168 | 18 | 0.39 | Q2 | Agricultural Research Communication Centre |
| 2 | *Indian Journal of Agricultural Sciences* | 44 | 143 | 30 | 0.18 | Q4 | Indian Council of Agricultural Research |
| 3 | *Field Crops Research* | 29 | 1153 | 174 | 1.4 | Q1 | Elsevier |
| 4 | *Indian Journal of Agronomy* | 25 | 133 | 25 | 0.21 | Q3 | Indian Society of Agronomy |
| 5 | *Canadian Journal of Plant Science* | 17 | 357 | 66 | 0.33 | Q2 | Agricultural Institute of Canada |
| 6 | *Journal of Plant Nutrition* | 13 | 201 | 85 | 0.54 | Q2 | Taylor and Francis Ltd. |
| 7 | *Experimental Agriculture* | 10 | 240 | 51 | 0.52 | Q2 | Cambridge University Press |
| 8 | *European Journal of Agronomy* | 9 | 697 | 131 | 1.14 | Q1 | Elsevier |
| 9 | *Pakistan Journal of Botany* | 9 | 66 | 67 | 0.3 | Q3 | Pakistan Botanical Society |
| 10 | *Australian Journal of Agricultural Research* | 8 | 512 | 56 | 0.83 | Q1 | Wiley-Blackwell Publishing Ltd |
| | Subtotal | 217 | 3670 | 70.3 | 0.584 | | |

Abbreviation: SJR, SCImago Journal Rank.
[a]*Source:* SCImago Journal & Country Rank 2022 (www.scimagojr.com).

**TABLE 4** | The 10 best institutes for the chickpea cultivation.

| No. | Affiliation | Country | Articles |
|---|---|---|---|
| 1 | International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) | India | 61 |
| 2 | The University of Western Australia | Australia | 54 |
| 3 | Punjab Agricultural University | India | 53 |
| 4 | Indian Agricultural Research Institute (ICAR) | India | 50 |
| 5 | University of Agriculture Faisalabad (UAF) | Pakistan | 35 |
| 6 | University of Saskatchewan | Canada | 31 |
| 7 | Islamic Azad University | United Arab Emirates | 24 |
| 8 | Akdeniz University | Turkey | 19 |
| 9 | Banaras Hindu University | India | 19 |
| 10 | University of Venda | South Africa | 18 |
| | Subtotal | | 364 |

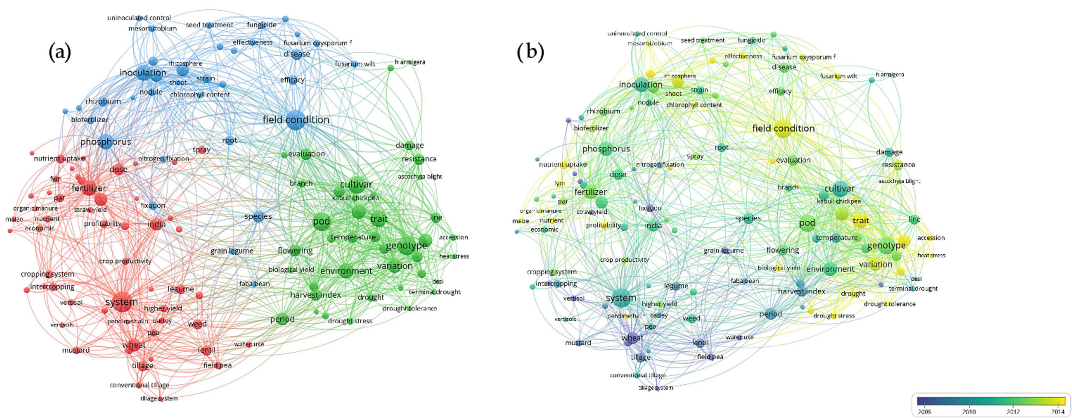


**FIGURE 9** | (a) Co-occurrence network and (b) overlay visualization of 132 relevant terms which appeared at least 10 times in the title and abstract fields of 687 article.
*Source:* VOSviewer.

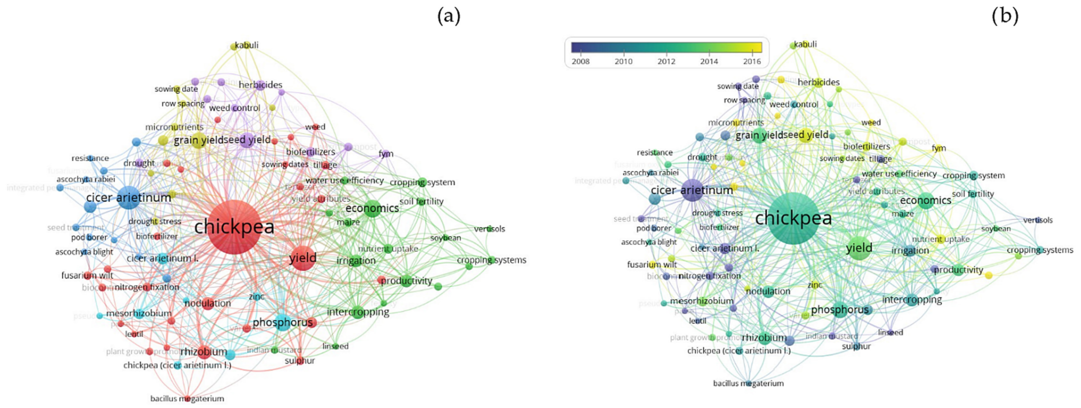


**FIGURE 10** | (a) Co-occurrence network and (b) overlay visualization of 90 relevant keywords, which appeared at least 5 times in the title, and abstract fields of 687 articles.
*Source:* VOSviewer.

## 5 | Conclusions

The extensive bibliometric analysis conducted on chickpea cultivation practices spanning from 1977 to 2023 reveals several key insights and trends in the field of sustainable agriculture.

Research on chickpea cultivation has seen a significant increase over the years, and this growth can be attributed to the global recognition of pulses, as vital contributors to food security and sustainability goals.

India emerges as a central player in this research landscape, not only as the largest chickpea producer but also as a hub for scholarly contributions and international collaborations, emphasizing the field's global reach.

The choice of journals for publishing research findings plays a crucial role in determining the research's impact and reach, with high-impact journals being the preferred platforms for dissemination.

The evolving research focus, as reflected in the changing trends of research keywords, underscores the field's adaptability to emerging challenges. Recent research has shifted its emphasis towards qualitative aspects such as protein content and nutritional quality, alongside addressing environmental sustainability and circular agricultural practices.

The papers analysis also showed that cultivation practices such as biostimulants, fertilization, nodulation, genetic selection, weed control, and the management of some pathogens had a greater influence with a focus on improving yield, quality and sustainability. Furthermore, the literature shows that there is a growing interest in plant-derived proteins and extractable yield per hectare. Indeed, among the outputs of this research is the influence that agronomic practices have on protein yield.

Looking ahead, there are promising research avenues to explore, including a deeper investigation into chickpea quality characteristics, strategies to mitigate antinutritional factors, and improving yield. Climate change impacts and optimizing chickpea production will continue to be significant areas of concern.

This comprehensive bibliometric analysis not only highlights the evolution of chickpea cultivation practices but also underscores its growing importance in sustainable agriculture. It offers valuable insights for researchers, policymakers, and stakeholders, shaping the future of chickpea cultivation. This is vital in the quest for sustainable, protein-rich food production to meet global needs while minimizing the environmental footprint.

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### Conflicts of Interest

The authors declare no conflicts of interest.

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