Insights from global research on inter-row cultivators for cotton

Baxtiyor Khurambaev[1] and *Otabek* Mirzayev[2*]

[1]Scientific Research Institute of Agriculture Mechanization Republic of Uzbekistan
[2]Urgench State University named after Abu Raykhan Beruni, 14, Kh. Alimdjan Street, Urgench, 220100, Uzbekistan

Abstract. Researchers worldwide are conducting scientific studies on inter-row cultivators for cotton. However, to date, no comprehensive bibliometric analysis on inter-row cultivators for cotton has been conducted in English within the Scopus database. The purpose of this study is to analyze the scientific outcomes of researchers in the field of inter-row cultivators for cotton, based on data collected from the Scopus database, and to observe global development trends. The article presents a bibliometric analysis of global scientific publications related to comprehensive inter-row cultivators for cotton. A total of 295 articles published between 1986 and 2025 were analyzed in this study. The results indicate that the number of scientific works in the database is increasing year by year. China, the United States, India, Germany, and Russia occupy leading positions, with the scientific contributions from these countries accounting for 47% of the total globally published articles. This article summarizes several research ideas, reflects the results of systematic bibliometric analysis, and provides researchers with insights into the research trends on pre-sowing soil preparation machinery. It highlights the importance of focusing on these directions in future studies. Additionally, by utilizing statistical and visual bibliometric analyses, the article systematically reviews publications on pre-sowing soil preparation, offering significant and detailed information for researchers engaged in this field.

1 Introduction

Technological Process of Soil Cultivation The technological process of soil cultivation is based on mechanical impact on the soil, which is carried out through crushing, loosening, mixing, turning, compacting, leveling, cutting the roots of weeds, mulching, and other methods [1-3].

Currently, in our country, inter-row cultivation of agricultural crops is performed using cultivator-fertilizers such as KXU-4A (manufactured by Chirchikselmash) and UKM (manufactured by Urgenchkormmash).

The KXU-4A hoeing unit is considered obsolete and inefficient when used with high-powered tractors due to its four-row configuration. This is because the tractor's coefficient

* Corresponding author: lidermirzayev@gmail.com

of performance is not fully utilized, leading to increased fuel consumption and soil compaction caused by the tractor wheels. Such compaction negatively impacts soil productivity. Even when soil cultivation is performed at the optimal moisture level (16–18%), the results do not meet agro-technical requirements.

Furthermore, it should be noted that with an inter-row spacing of 90 cm, cultivation is carried out by installing up to 10 working components. This increases both the metal consumption and energy intensity of the process [2].

Purpose of Inter-Row Cultivation for Agricultural Crops the purpose of inter-row cultivation for agricultural crops is to eliminate weeds, loosen the soil, retain moisture for as long as possible, conserve water, create irrigation furrows, provide plants with mineral fertilizers, improve aeration, and create the necessary conditions for microbiological processes.

Using SPSS 25 to diagnose variable collinearity in carbon footprint composition factors in major cotton-growing regions in China revealed significant correlations between remixing and phosphorus fertilizers, as well as between labor, diesel fuel, and irrigation electricity [1].

Mechanical soil cultivation positively affects its physical properties and improves the air and nutrient regimes for plants. Mixing soil layers increases the biological activity of the cultivated horizon, thereby enhancing plant productivity.

Efficient use of irrigation water and the importance of inter-row cultivation in the proper growth and development of cotton are critical. Inter-row cultivation improves the soil's water-physical and microbiological properties, enhances air exchange and nutrient distribution, and eliminates weeds. Inter-row cultivation is carried out considering soil characteristics, local topography, and water availability, with the depth, frequency, and timing of the cultivation determined accordingly.

Failure to perform inter-row cultivation on time and with quality leads to moisture loss in the soil, damages plant roots, slows growth and development processes, delays growth stages by 10–15 days, prolongs vegetation periods, and reduces yields by 6–8 c/ha.

Based on global scientific achievements and the results of previous research conducted in our country, it can be concluded that the shortcomings in inter-row cultivation mentioned above can be addressed through the development of working tools that ensure high-quality fragmentation and mulching of the soil at minimal energy costs. Such tools must meet agro-technical requirements, avoid bringing the lower moist layers of the soil to the surface, and effectively break up the treated layer.

The application of such working tools in inter-row cultivation reduces resistance, thereby significantly decreasing fuel consumption and other costs. At the same time, it enhances work productivity, improves soil treatment quality, preserves accumulated soil moisture, and ensures timely harvesting of agricultural crops.

2 Methodology

This article this article is based on a bibliometric analysis of scientific publications from the Scopus database, utilizing data retrieved from Scopus. The collected data pertains to publications released between 1986 and 2025.

The scientific works were searched using the following three key terms: cultivator AND shovel AND soil. According to the objectives of the study, 295 articles published between 1986 and 2025 across four scientific disciplines were selected. These disciplines and the corresponding number of publications are as follows:

1. Agriculture and Biological Sciences – 82 articles
2. Engineering – 61 articles
3. Earth and Planetary Sciences – 14 articles

4. Environmental Sciences – 14 articles

All data were exported in CSV format. A total of 295 publications were downloaded and analyzed using MS Excel and VOSviewer software, with the results visualized on maps. The maps were generated using the Mapchart.com platform. VOSviewer was employed to analyze large bibliometric datasets and conduct a more detailed examination.

Using the ALL search parameter in Scopus enabled the inclusion of all desired fields for the search, such as the title, abstract, keywords, affiliation, funding information, references, and conference details [2–9].

In Figure 1, you can see the schematic representation of the research methodology selected for this study.

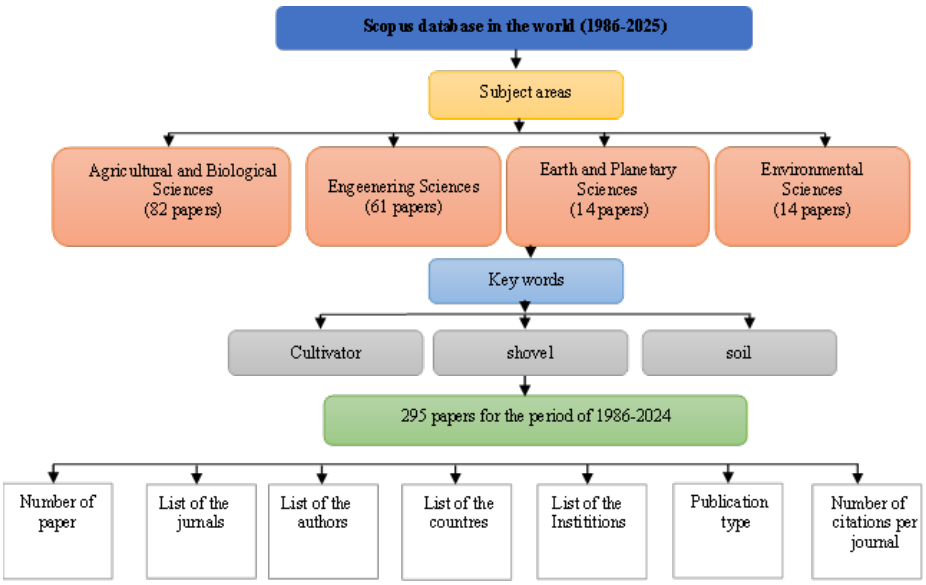

Fig. 1. Methodology flowchart for the research

3 Results

3.1. Published papers on inter-row cotton cultivators

Global Publications on Comprehensive Inter-Row Cultivators for Cotton (1986–2025) The number of publications dedicated to comprehensive inter-row cultivators for cotton globally during the period 1986–2025 is significantly substantial. Figure 2 presents the trends in the growth and decline of scientific publications over the years. From 1986 to 2008, the number of published scientific works remained almost unchanged, with a total of 24 articles published during this period. This accounts for 18% of the total number of articles. During these years, no more than two articles were published annually. However, by 2008, this figure tripled, with six articles published in that year alone.

Between 2008 and 2020, the demand for comprehensive inter-row cultivators for cotton increased, as evidenced by the number of published articles. During this period, approximately 57 articles were published, representing a 60% increase compared to the previous period. The only exception within this timeframe was 2017, where the number of articles slightly decreased to three. As shown in the graph, by 2021, the number of scientific publications rose sharply, with 10 articles published in a single year. This is a

notable increase compared to previous years. Between 2022 and 2025, a total of 20 scientific works were published. The number of articles published in the last three years accounts for approximately 15% of the total number of publications.

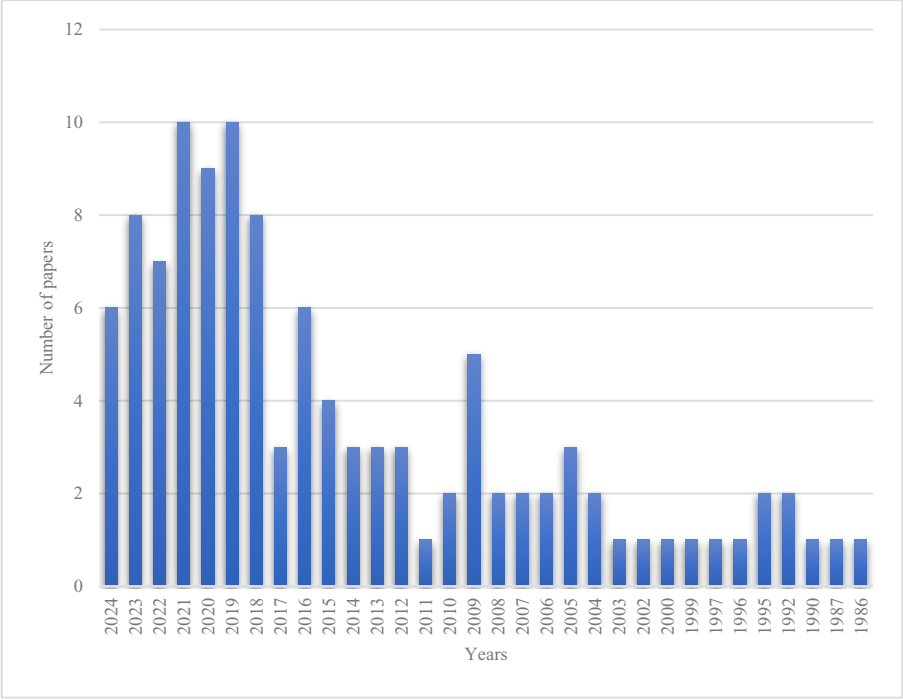

Fig. 2. Number of papers on inter-row cotton cultivators by the year of publication in the world

3.2 Journals on inter-row cotton cultivators

Scientific Journals Publishing Research on Inter-Row Cultivators for Cotton Table 1 provides an overview of the scientific journals that have published research on inter-row cultivators for cotton. According to the analysis, a total of 99 articles have been published across 56 journals. The journals with the highest number of publications are Soil and Tillage Research and Engineering for Rural Development, each publishing 19 articles.

Following these, the journals Nongye Jixie Xuebao Transactions of the Chinese Society for Agricultural Machinery, Journal of Chinese Agricultural Mechanization, and Nongye Gongcheng Xuebao Transactions of the Chinese Society of Agricultural Engineering have published five articles each. Further details about the remaining journals can be found in Table 1. An interesting aspect of the analysis is that the top 10 journals account for 50% of the total number of articles published.

Table 1. List of the journals inter-row cultivators for cotton in the world

Title of journal	Number	Title of journal	Number
Soil And Tillage Research	12	Applied Bionics And Biomechanics	1
Engineering For Rural Development	7	Applied Mechanics And Materials	1
Nongye Jixie Xuebao Transactions Of The Chinese Society For Agricultural Machinery	7	Biosystems Engineering	1
Journal Of Chinese Agricultural Mechanization	5	Canadian Biosystems Engineering Le Genie Des Biosystems Au Canada	1
Nongye Gongcheng Xuebao Transactions Of The Chinese Society Of Agricultural Engineering	5	Canadian Journal Of Soil Science	1
AMA Agricultural Mechanization In Asia Africa And Latin America	3	Earth Surface Processes And Landforms	1
Agriculture Switzerland	3	Environmental Geology	1
Inmateh Agricultural Engineering	3	Environmental Science And Technology	1
Journal Of Friction And Wear	2	Fizika Goreniya I Vzryva	1
Landtechnik	2	Fme Transactions	1
Research In Agricultural Engineering	2	Hydrological Processes	1
Tractors And Agricultural Machinery	2	Indian Journal Of Ecology	1
Transactions Of The American Society Of Agricultural Engineers	2	International Agricultural Engineering Journal	1
Weed Science	2	Iop Conference Series Earth And Environmental Science	1
Acta Horticulturae	1	Irish Journal Of Agricultural And Food Research	1

3.3 Top authors on inter-row cotton cultivators

Analysis of Authors' Publications the analysis of the authors' publications revealed that a total of 159 authors have published 212 articles (Figure 3). According to the analysis, Li J, Liu Z, and Lü J lead the field with four scientific publications each on inter-row cultivators for cotton.

Following them, Li Z has three publications, and Abbaspour Y has published two articles in journals indexed in the Scopus database. The total number of articles authored by the aforementioned researchers accounts for 19 articles or 8% of the total publications.

Their scientific research primarily focuses on improving the quality of processing while reducing the energy consumption of the machines.

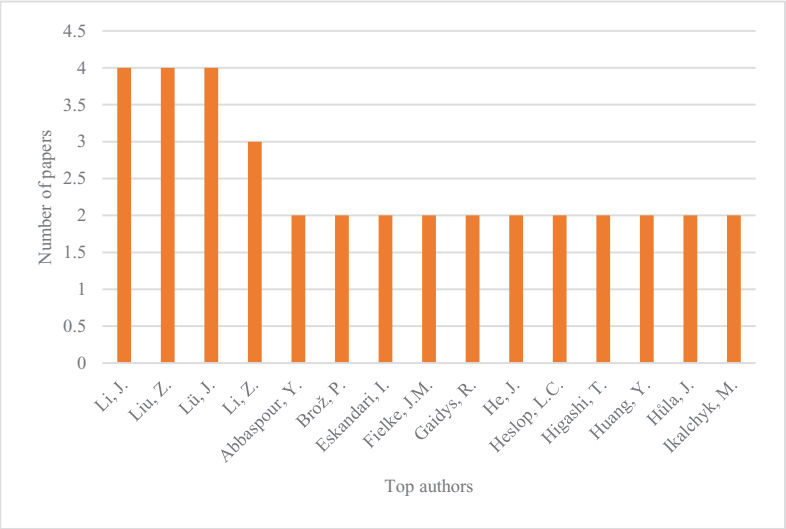

Fig. 3. The top authors on inter-row cotton cultivators in the world

3.4 Top published countries on inter-row cotton cultivators

Global Research on Inter-Row Cultivators for Cotton (1986–2025). Between 1986 and 2024, researchers from 35 countries conducted scientific studies on inter-row cultivators for cotton (Figure 4). Among these countries, China leads with the highest number of publications (29), followed by the United States (10) and India (7). Germany, Russia, and Ukraine each produced six scientific works.

Data retrieved from the Scopus database was processed using the Mapchart.net platform and visualized in Figure 5. The analysis shows that countries across Asia, Europe, North America, Australia, and South America have carried out research on inter-row cultivators for cotton. In contrast, fewer scientific developments are observed in African countries.

It was also found that representatives from the southern regions have published relatively fewer articles on this topic in the Scopus database.

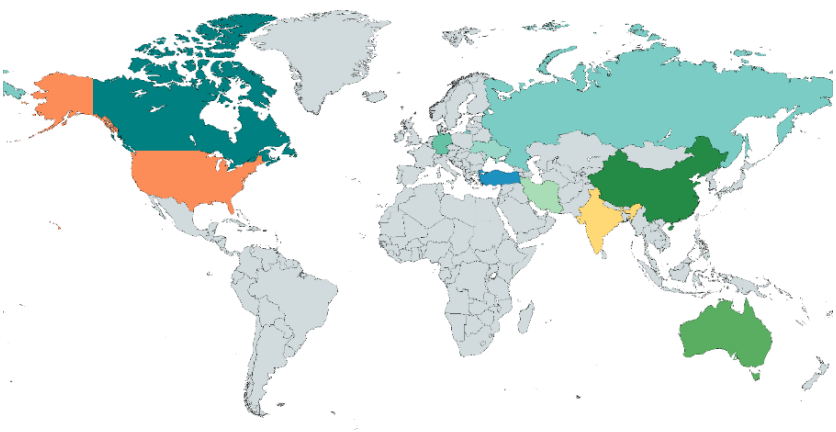

Fig. 4. Graphical distribution of top countries on inter-row cotton cultivators in the world.

3.5 Top institutions on inter-row cotton cultivators

Institutional rankings are primarily determined by the number and quality of articles published worldwide by researchers affiliated with the institution. From 1986 to 2025, a total of 295 articles on inter-row cultivators for cotton were published globally, involving collaboration among 142 different institutions. In this study, the 12 top-performing institutions were selected, and the number of articles they published is shown in Figure 5.

The selected institutions have published 43 articles on this topic, accounting for 15% of the total publications. The most productive institution globally in this field is Northeast Agricultural University, which alone has published 7 scientific articles. Following Northeast Agricultural University, the National University of Life and Environmental Sciences of Ukraine, Agriculture and Agri-Food Canada, and the Czech University of Life Sciences Prague each published 4 articles. The Indian Institute of Technology Kharagpur and China Agricultural University follow with 3 articles each. Among the remaining selected institutions, each published 2 scientific articles. Globally, other institutions contributed 64% of the total, with each publishing between 1 and 2 articles.

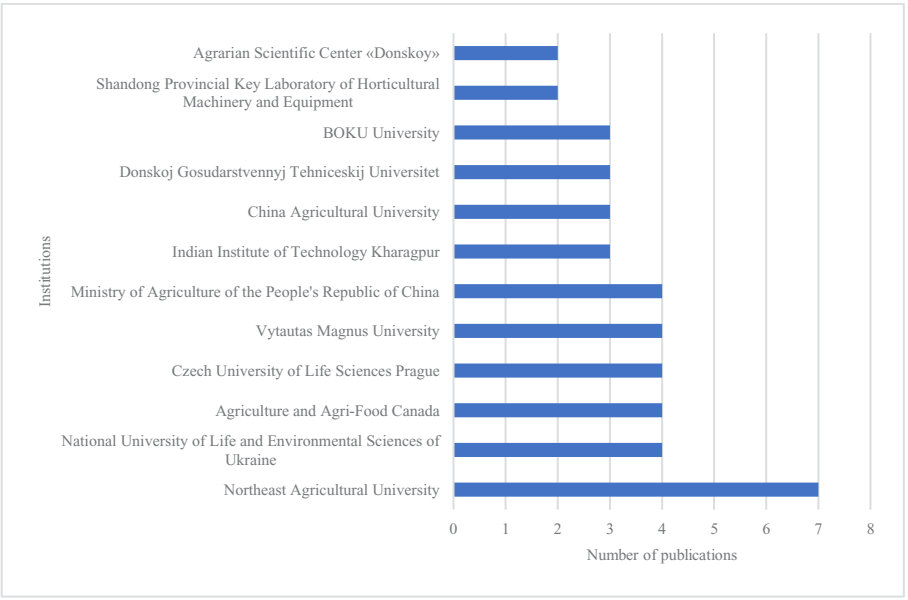

Fig. 5. List of top institutions on inter-row cotton cultivators in the world

3.6 Publication type on inter-row cotton cultivators

In this study, we can observe four different types of publications collected from various sources. Figure 6 illustrates the distribution of these publications, which include articles, conference presentations, book chapters, and conference reviews.

There is no doubt that the majority of publications on this topic are in the form of articles, totaling 81. Following this, 25 conference presentations have been identified. Additionally, there is one book chapter and one conference review included in the dataset.

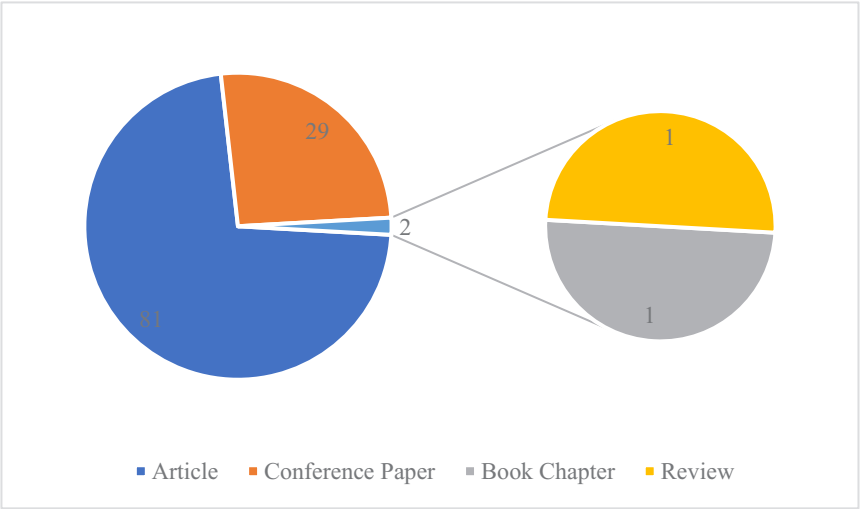

Fig. 6. List of publication type on inter-row cotton cultivators in the world

3.7 Top cited journals on inter-row cotton cultivators

Data from the Scopus database indicates that between 1983 and 2023, a total of 3,867 citations were made from various journals. The journals with the highest number of citations were selected and are presented in Figure 7.

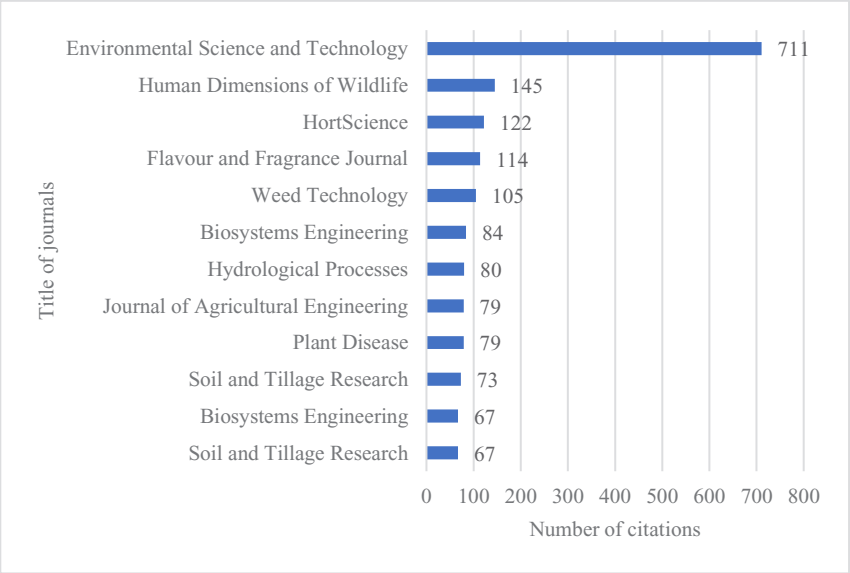

Fig. 7. List of top cited journals on inter-row cotton cultivators in the world

Nearly half of the citations, totaling 1,726 (45%), were attributed to articles published in these 12 journals. The journal "Environmental Science and Technology" leads the list,

having received 711 citations throughout the period, accounting for 18% of the total citations.

The next two most-cited journals are "Human Dimensions of Wildlife", with 145 citations, and "HortScience", with 122 citations, contributing 3% and 2% of the total citations, respectively.

3.8 Subject area inter-row cotton cultivators in the world

The classification of pre-sowing soil preparation machinery by scientific fields is presented in Figure 8. According to the data, 40% of the scientific research falls under the field of Agricultural and Biological Sciences, while 29% is attributed to Engineering. Additionally, Earth and Planetary Sciences account for 25%, and Environmental Sciences represent 6% of the research in this area.

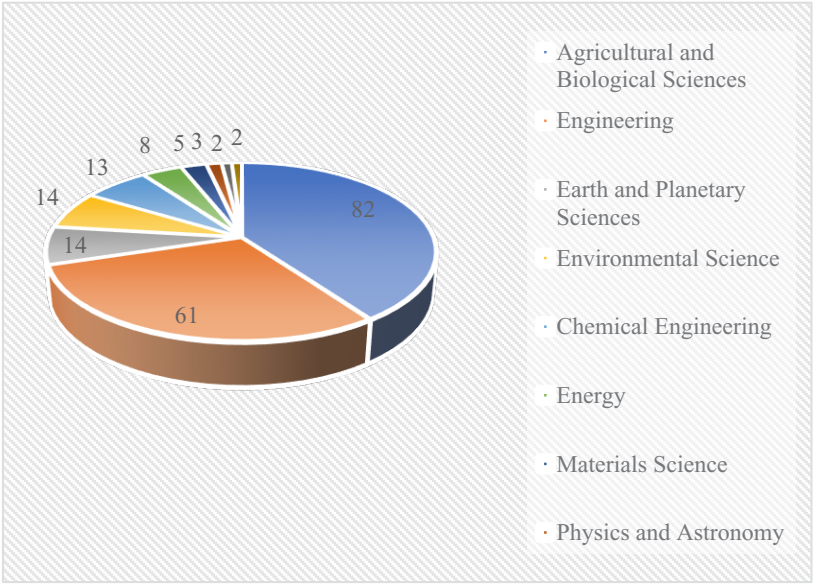

Fig. 8. Analysis by subject area inter-row cotton cultivators in the world

4 Conclusions

Bibliometric analysis is the most effective method for studying the characteristics of this field. It also provides insights into the scientific volume, growth, and dissemination of publications, as well as identifying the top authors and institutions in the field.

The analysis of inter-row cultivators for cotton is based on publication data retrieved from the Scopus database. According to our analysis, the fields with the highest contributions are Agricultural and Biological Sciences, Engineering, Earth and Planetary Sciences, and Environmental Science.

Northeast Agricultural University has taken the lead in publishing articles relevant to our research.

Researchers primarily disseminate their scientific findings through articles and conference presentations.

The analysis indicates that attention to inter-row cultivators for cotton has significantly increased in recent years. This surge is due to the growing challenges in efficient utilization of food and water resources, which have substantially heightened the demand for the systems and machinery discussed above.

References

1. D. F. Al Husaeni and A. B. D. Nandiyanto, ASEAN J. Sci. Eng. **2**, 1, 19–46 (2021) DOI: http://dx.doi.org/10. 17509/xxxxt.vxix
2. N. J. Van Eck and L. Waltman, Scientometrics **84**, 2, 523–538 (2010) https://doi.org/10.1007/s11192-009-0146-3
3. J. Lü et.al., Nongye Jixie Xuebao Transactions of the Chinese Society for Agricultural Machinery **52(8)**, 27 – 3925 (2021)
4. Abbaspour-Gilandeh, Yousef, Fazeli, Masoud, Roshanianfard Ali, Hernández-Hernández, Alejandro Fuentes, Herrera-Miranda. Agriculture **10**, 145; 2-19 (2020) DOI: 10.3390/ agriculture10050145
5. W. Huang, F. Wu, et.al., Science of the Total Environment **821**, 153407 (2022) DOI:10.1016/j.scitotenv.2022.153407
6. J. Dai, H. Dong, Field Crops Research **155**, 99 – 110 (2014) DOI:10.1016/j.fcr.2013.09.017
7. M. E. Umedova, O. S. Turaev, D. J. Komilov, et alSabrao Journal of Breeding and Genetics **56 (3)**, 988 – 1000 (2024) DOI: 10.54910/sabrao2024.56.3.8
8. Y. Xu, J. Lyu, H. Liu, Y. Xue, A Bibliometric and Visualized Analysis of the Global Literature on Black Soil Conservation from 1983–2022 Based on CiteSpace and VOSviewer. DOI: 10.3390/agronomy12102432
9. J. Chen et.al., Measurement: Journal of the International Measurement Confederation **248**, 116857 (2025) DOI: 10.1016/j.measurement.2025.116857