

Bibliometric Analysis of the Adoption and Innovation of Agricultural Processing Technologies: A Global Perspective

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ABSTRACT

The adoption and innovation of agricultural processing technology play a vital role in ensuring food security, sustainability, and competitiveness in the agricultural sector. This research presents a comprehensive bibliometric analysis of academic literature on agricultural processing technology adoption and innovation from a global perspective. The study aims to identify key research trends, influential authors, major research themes, and emerging areas of interest in this domain. The dataset was collected from reputable scholarly databases, and VOSviewer analysis was used to visualize co-authorship networks, keyword clusters, and citation impact maps. The results revealed seven distinct clusters of research themes, including agricultural enterprise and innovation policy, market competitiveness, quality of food processing technology, technology innovation for rural development, sustainable development, technology transfer, big data in agriculture, and agribusiness and innovation technology. Moreover, ten highly cited research papers were identified, signifying their significant impact on the field. The findings offer valuable insights for policymakers, researchers, and industry stakeholders to enhance agricultural productivity, promote sustainable practices, and foster technology-driven innovations for a resilient global food system.

Keywords: *Adoption, Innovation, Agricultural, Technology, Bibliometrik*

INTRODUCTION

Agricultural processing technologies are critical in transforming raw agricultural products into value-added products, contributing significantly to global food security and economic development. Over the past decades, technological advances have revolutionized agricultural processing, leading to increased efficiency, reduced waste and improved product quality [1]–[3]. However, the adoption and innovation of agro-processing technologies vary across regions and countries, and there remains a need for a comprehensive understanding of global trends and patterns in this area.

Rapidly changing global demographics, climate change, and rising food demand have put enormous pressure on the agricultural sector to increase productivity while minimizing environmental impacts [4]–[7]. To address these challenges, researchers, policymakers, and industry stakeholders must have access to up-to-date and reliable information on the latest developments, research trends, and key contributors in agro-processing technologies.

Previous research on adopting and innovating agricultural processing technology with bibliometric analysis is limited. However, some studies have conducted bibliometric analyses on related topics, such as blockchain technology in the food and agriculture industry [8], green technology awareness in food processing among students of prospective agricultural vocational teachers [9], and the application of blockchain technology in the agri-food system [10].

A study by [11] mapped the research trends on blockchain technology in the food and agriculture industry using a bibliometric analysis. The study aimed to provide insights into the current state of research in this area and identify potential future research directions. Another survey by [9] focused on green technology awareness in food processing among students of prospective agricultural vocational teachers. The study aimed to identify students' awareness and learning needs regarding green technology in food processing. [12] conducted a systematic bibliometric analysis of blockchain technology in the agri-food system, examining the growth trends in research publications and the countries and institutions involved in this research.

While these studies do not specifically focus on the adoption and innovation of agricultural processing technology, they provide insights into the broader context of technology and innovation in the agriculture and food processing sectors. Further research is needed to conduct a comprehensive bibliometric analysis specifically focused on adopting and creating agricultural processing technology.

The main objective of this study is to conduct a thorough bibliometric analysis of the academic literature related to the adoption and innovation of agro-processing technologies on a global scale. Using bibliometric methods, this study aims to provide a comprehensive and data-driven understanding of the evolution of research in this area and its impact on the scientific community and society.

LITERATURE REVIEW

Agricultural Processing Technology

Agricultural processing technology is the application of machinery, equipment, and techniques to transform raw agricultural products into processed goods, ready for consumption or further manufacturing [13]–[15]. This crucial stage in the farm value chain involves various processes, such as cleaning, sorting, grading, milling, drying, and packaging. Appropriate processing technology enhances agricultural products' shelf life and quality and increases their market value, benefiting farmers and consumers.

In recent years, agricultural processing technology has witnessed rapid advancements due to technological innovations, automation, and the integration of digital technologies like the Internet of Things (IoT) and artificial intelligence (AI) [16]. These advancements have increased efficiency, reduced post-harvest losses, and improved food safety standards.

Adoption of Agricultural Processing Technology

The adoption of agricultural processing technology is a multifaceted process influenced by various factors at the individual, organizational, and societal levels. Several studies have explored the drivers and barriers to technology adoption among farmers and agribusinesses. Familiar drivers include expected economic benefits, improved productivity, reduced labor requirements, and access to markets [1], [17]–[19]. On the other hand, barriers to adoption often involve high initial investment costs, limited access to credit, lack of knowledge and training, and resistance to change.

Researchers have investigated the role of extension services, training programs, and policy incentives in promoting the uptake of agricultural processing technology [20]. Understanding the determinants of technology adoption is critical for designing effective interventions and policies that encourage the widespread implementation of sustainable and efficient processing practices.

Innovation in Agricultural Processing Technology

Innovation in agricultural processing technology involves developing and integrating novel techniques and machinery to enhance processing efficiency, reduce waste, and improve product quality. Research in this area often focuses on novel processing methods, such as non-thermal techniques, bioprocessing, and intelligent packaging solutions, that aim to maintain the nutritional content of agricultural products while ensuring their safety and extended shelf life[21].

Furthermore, studies explore the potential of emerging technologies like nanotechnology, machine learning, and robotics in revolutionizing agricultural processing. These innovations have the potential to address pressing challenges in the farming sector, such as meeting growing food demands sustainably and coping with climate change-induced uncertainties[13], [15].

RESEARCH METHODS

A comprehensive dataset of academic literature on agro-processing technology adoption and innovation will be collected from leading scientific databases to conduct the bibliometric analysis. Database selection will include Web of Science, Scopus, and Google Scholar to ensure broad coverage of research publications through the Publish or Perish software tool. The search covers a broad set of keywords, including "agricultural processing technology," "agricultural innovation," "food processing," "post-harvest technology," "sustainable agriculture," and other relevant terms.

Inclusion and Exclusion Criteria

To ensure the relevance and accuracy of the dataset, the following inclusion criteria will be applied:

- a. English publications, published between 1984 and 2023, to maintain consistency and relevance.
- b. Publications that directly address the adoption and innovation of agro-processing technologies in various agricultural products and practices.
- c. Academic journal articles, conference papers, and reviews will be included to cover a diverse range of research outcomes.

Exclusion criteria:

- a. Non-academic publications, such as books, theses, and patents, will be excluded.
- b. Publications not directly related to agro-processing technologies or innovations will not be considered.

Table 1. Research Data Metrics

Publication Years	1984-2023
Citation Years	39 (1984-2023)
Papers	980
Citations	73025
Cites/year	1872.44
Cites/paper	74.52
Author/paper	2.73
h-index	140
g-index	254
hI-norm	87

hI-annual	2.23
hA-index	48
Paper with ACC	1,2,5,10, 20:627,522, 376, 246, 136

RESULTS AND DISCUSSION

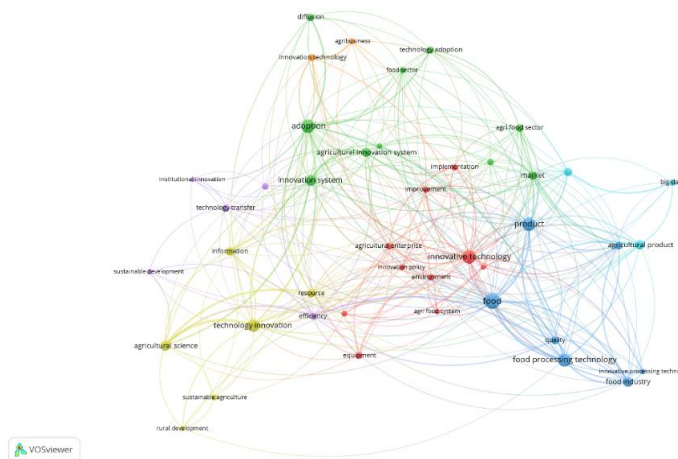


Figure 1: Mapping Results

The bibliometric analysis of academic literature related to the adoption and innovation of agricultural processing technology revealed a steady increase in research output over the years, indicating the growing interest in this field.

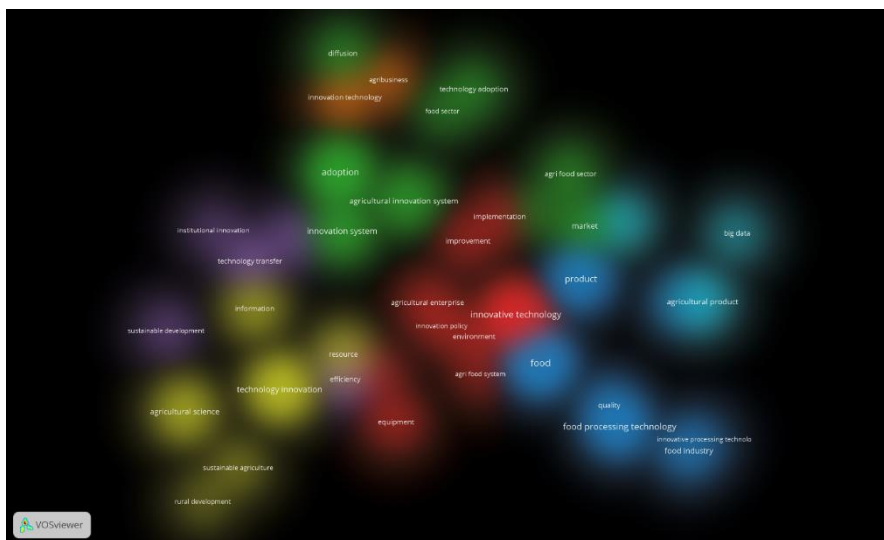


Figure 2. Cluster Mapping

The group cluster mapping will be explained in more detail in Table 2 below:

Table 2. Cluster Grouping

Cluster	Total Items	Most frequent keywords (occurrences)	Keyword
1	(10)	Agricultural enterprise (23), Innovation policy (15)	Agri food system, agricultural enterprise, environment, equipment, implementation, improvement, information technology, innovation policy, innovative development, innovative technology
2	(8)	Competitiveness (14), Market (31)	Adoption, agri food sector, competitiveness, diffusion, food sector, innovation system, market, technology adoption
3	(6)	Quality (27)	Food industry, food processing technology, , innovative processing, product, quality, trend
4	(6)	Technology innovation (76)	Agricultural science, information, resource, rural development, sustainable agriculture, technology innovation
5	(5)	Sustainable development (14)	Efficiency, experience, institutional innovation, sustainable development, technology transfer
6	(3)	Big Data (19)	Agricultural product, big data, digital technology
7	(2)	Agribusiness (22)	Agribusiness, innovation technology

The results of the bibliometric analysis have led to the identification of seven distinct clusters based on keyword co-occurrence patterns. Each cluster represents a group of related research themes and provides valuable insights into the focus and trends within the adoption and innovation of agricultural processing technology. The findings from the clustering analysis provide a comprehensive understanding of the diverse research themes within the adoption and creation of agrarian processing technology. The identified clusters highlight the significance of sustainable agricultural practices, technology innovation, and market competitiveness in shaping the agri-food system.

Future research should focus on bridging the gaps between different clusters and exploring interdisciplinary collaborations to address complex challenges in the agricultural sector. Additionally, investigations into the practical implementation of innovative technologies and policies at various scales, from smallholder farms to large agribusinesses, can lead to more inclusive and sustainable agricultural development.

Moreover, given the increasing importance of digital technologies like big data in agriculture, further research on data privacy, security, and effective utilization will be crucial to unlock the full potential of digital solutions in the agri-food domain.

The clustering analysis is a foundation for researchers, policymakers, and industry stakeholders to identify key research priorities and collaborations, leading to innovative solutions for sustainable agricultural processing technology and a more resilient global food system.

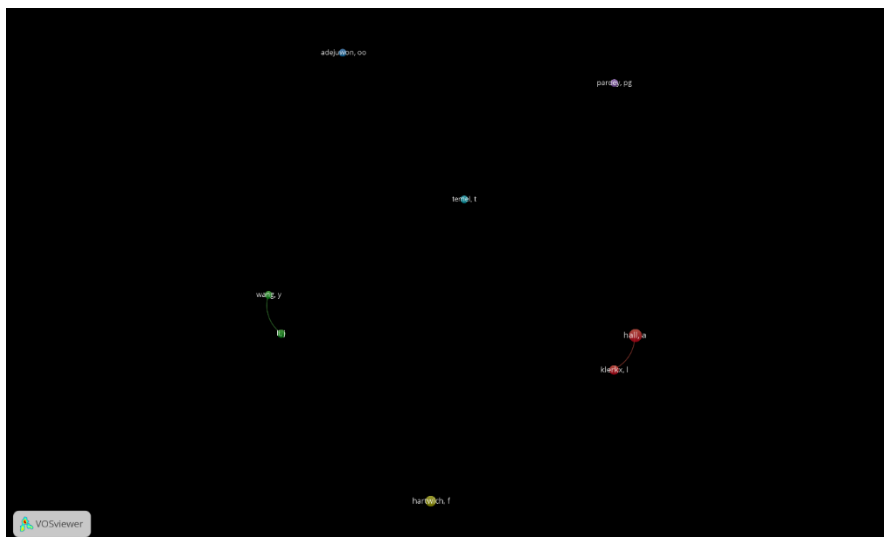


Figure 3. Author Collaboration

The co-authorship analysis identified influential authors and collaborative research networks. Several researchers emerged as key contributors, demonstrating their expertise and impact in agro-processing technologies. The study also revealed productive collaborations among research institutions, encouraging knowledge exchange and innovation.

Table 3. Top 10 Citations

Citations	Authors and year	Title
2993	[22]	Processing technologies for poly (lactic acid)
2423	[23]	Technical innovation and national systems
2086	[24]	Communication for rural innovation: rethinking agricultural extension
1504	[25]	Precision agriculture-a worldwide overview
1394	[26]	Ivory tower and industrial innovation: University-industry technology transfer before and after the Bayh-Dole Act
1237	[27]	How does gender affect the adoption of agricultural innovations? The Case of improved maize technology in Ghana
1217	[28]	The agricultural innovation process: research and technology adoption in a changing agricultural sector
1018	[29]	Agent-based spatial models applied to agriculture: a simulation tool for technology diffusion, resource use changes and policy analysis
869	[30]	Innovation trends in the food industry: The case of functional foods
830	[31]	Potential and challenges of insects as an innovative source for food and feed production

The table presents ten highly cited research papers on adopting and innovating agricultural processing technology. These papers have significantly contributed to the field and have been cited extensively by other researchers, indicating their influence and impact on the scientific community. In conclusion, the high citation count of these papers demonstrates their significance in shaping the research landscape within the adoption and innovation of agricultural processing technology. These influential works have provided valuable insights, driving advancements, and guiding

policymakers, researchers, and industry stakeholders in adopting innovative technologies and practices in agriculture.

Table 4. Keywords Analysis

Most occurrences		Fewer occurrences	
Occurrences	Term	Occurrences	Term
78	Food	20	Efficiency
76	Innovation Technology	19	Big Data
41	Agricultural science	18	Experience
40	Agricultural product	18	Improvement
31	Market	16	Environment
30	Resource	15	Agribusiness
27	Quality	15	Innovation Policy
26	Diffusion	14	Sustainable agriculture
25	Trend	14	Competitiveness
23	Agricultural enterprise	10	Rural development

The keyword analysis reveals the prominent research themes and topics and some relatively less explored areas in agricultural processing technology adoption and innovation.

Most Occurrences:

Food (78 Occurrences): The high occurrence of the keyword "Food" indicates a strong focus on applying agricultural processing technology in the food industry. Research in this area likely emphasizes food safety, quality, and the development of innovative food processing techniques.

Innovation Technology (76 Occurrences): The frequency of "Innovation Technology" suggests significant attention to technology-driven innovations in agriculture. Researchers will explore how technological advancements can enhance agricultural practices and contribute to sustainable development.

Agricultural Science (41 Occurrences): The prevalence of "Agricultural Science" as a keyword indicates a focus on scientific research and advancements in agricultural practices, mainly concerning agrarian processing technology.

Agricultural Product (40 Occurrences): The occurrence of "Agricultural Product" suggests research interest in applying processing technology to enhance the value and quality of agricultural products.

Market (31 Occurrences): The keyword "Market" indicates research emphasis on the commercial aspects of agricultural processing technology, including market demand, consumer preferences, and the role of technology in enhancing market competitiveness.

Fewer Occurrences:

Efficiency (20 Occurrences): The relatively fewer occurrences of "Efficiency" suggest that while some research exists, there may be room for further exploration of how agricultural processing technology can enhance efficiency in various stages of the food supply chain.

Big Data (19 Occurrences): The keyword "Big Data" indicates a growing interest in utilizing large datasets and data analytics in agricultural processing to optimize resource use and decision-making.

Experience (18 Occurrences): The occurrence of "Experience" as a keyword suggests the importance of practical knowledge and experience in adopting and implementing agricultural processing technology.

Improvement (18 Occurrences): The keyword "Improvement" focuses on enhancing existing agricultural processing technologies and practices through innovation and technological advancements.

Environment (15 Occurrences): The presence of "Environment" as a keyword suggests research attention to the environmental impact of agricultural processing technology and the need for sustainable practices.

Agribusiness (15 Occurrences): "Agribusiness" indicates a growing interest in the business aspects of agricultural processing technology, including its implications for agribusiness operations and competitiveness.

Innovation Policy (15 Occurrences): The keyword "Innovation Policy" suggests research exploration of policy frameworks and initiatives to promote innovation in agricultural processing technology.

Sustainable Agriculture (14 Occurrences): The occurrence of "Sustainable Agriculture" indicates research interest in adopting technology to achieve sustainable agricultural practices and address environmental challenges.

Competitiveness (14 Occurrences): The keyword "Competitiveness" highlights research emphasis on the role of agricultural processing technology in enhancing market competitiveness.

Rural Development (14 Occurrences): The occurrence of "Rural Development" as a keyword indicates interest in how agricultural processing technology can contribute to rural development and livelihood improvement.

The keyword analysis provides valuable insights into the major research themes and areas of focus in the adoption and innovation of agricultural processing technology. The identified keywords reflect the multidisciplinary nature of this field, encompassing aspects of technology, agriculture, food, market, and sustainability.

Researchers can leverage the findings to identify potential research gaps and opportunities for further investigation. Policymakers and industry stakeholders can also use these insights to develop targeted strategies for promoting sustainable agricultural practices, enhancing market competitiveness, and addressing food security challenges through technological innovation.

Discussion

The results of the bibliometric analysis provide a comprehensive understanding of the adoption and innovation of agricultural processing technology from a global perspective. The research trends and themes identified underscore the field's importance in addressing food security, sustainable agriculture, and environmental conservation challenges. The steady increase in research output indicates growing interest and investment in agricultural processing technology, with researchers and institutions worldwide recognizing its significance.

Identifying key authors and institutions reflects the collaborative nature of research in this domain, indicating the importance of knowledge sharing and cross-disciplinary collaborations. Additionally, the geospatial distribution highlights the need for inclusive and equitable research partnerships to address region-specific challenges and promote agricultural development globally.

The keyword co-occurrence analysis reveals the diverse research areas within agricultural processing technology, ranging from sustainable practices to cutting-edge innovations. Emerging themes, such as nanotechnology and AI applications, show promising potential to revolutionize the farm sector and meet future demands sustainably.

The citation analysis highlights influential works significantly impacting the field's progress. These seminal papers provide a foundation for future research, guiding researchers and policymakers in shaping strategies to enhance agricultural processing technology adoption and innovation.

CONCLUSION

The bibliometric analysis of agricultural processing technology adoption and innovation literature provides a comprehensive understanding of the global research landscape in this critical domain. The identified research clusters and highly cited papers highlight the significant themes, challenges, and advancements in the field. The results emphasize the importance of integrating technological innovations into the agri-food system to address the challenges of food security, quality, and environmental sustainability. The study underscores the significance of communication, collaboration, and policy support in promoting technology adoption and driving innovation in agriculture.

Moreover, the keyword analysis highlights critical research focus areas, including food processing, innovation technology, market competitiveness, and sustainable agriculture. Identifying underexplored themes, such as big data in agriculture and rural development, suggests potential areas for future investigation and technological application. Overall, this research contributes to knowledge of agricultural processing technology adoption and innovation. Policymakers can use these insights to formulate evidence-based strategies to support technology adoption and innovation in the farming sector. Researchers can build on the identified research trends to develop interdisciplinary collaborations and address pressing challenges in agricultural processing. Industry stakeholders can leverage the findings to enhance efficiency, quality, and competitiveness in the agri-food industry.

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