Bibliometric Analysis of Farmland Abandonment: Trajectory and Prospects Postprint

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Abstract

Based on literature data with farmland abandonment as the research theme from the Web of Science (SCI) and CNKI databases, this study employs CiteSpace software to conduct data mining and quantitative analysis of research papers in the field of farmland abandonment from 1990 to 2021 (data updated on March 20, 2022), systematically reviews and comparatively analyzes the number of papers, citations, leading authors, relevant academic journals, and keywords in the field of farmland abandonment both domestically and internationally, and further explores future research directions for farmland abandonment in China. The results indicate: (1) Over the past nearly 32 years, the number of papers on farmland abandonment has increased, scholars domestically and internationally have demonstrated varying degrees of concern for farmland abandonment, the development trajectories of farmland abandonment research differ between China and abroad, and the research emphases at various stages are not identical. (2) Farmland abandonment, abandoned farmland, land use, landscape, carbon sink, and soil degradation are high-frequency keywords in the field of farmland abandonment in recent years. (3) Research hotspots in the field of farmland abandonment in China mainly concentrate on research directions such as formation causes and influencing factors of farmland abandonment, whereas foreign research focuses more on aspects like community diversity and farmland landscape dynamics. (4) Research by scholars both domestically and internationally mostly concentrates on aspects such as causes, mechanisms, impacts, and recommendations of farmland abandonment at small scales, with fewer studies at large scales, and research on remote sensing, big data, network data simulation, dynamic monitoring, and other aspects remains lacking. This study recommends that future research should adopt a global perspective, further systematically and thoroughly explore the content, causes, evolution mechanisms, and impacts of farmland abandonment, while fully utilizing artificial intelligence technology to detect and acquire spatiotemporal dynamics of farmland abandonment, and attempt agricultural models such as high-quality development through the inte-

gration of forestry and grassland, in order to formulate reasonable and effective measures for governing abandonment.

Full Text

Bibliometric Analysis of Cultivated Land Abandonment: Context and Prospect

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Abstract

Based on literature data from the Web of Science (SCI) and CNKI databases focusing on cultivated land abandonment as the research theme, this study employs CiteSpace to conduct data mining and quantitative analysis of research papers in the field of farmland abandonment from 1990 to 2021 (data updated on March 20, 2022). The paper systematically reviews and comparatively examines the number of publications, citation counts, leading authors, relevant academic journals, and keywords in the field of cultivated land abandonment both domestically and internationally, thereby exploring future research directions for farmland abandonment in China. The results indicate: (1) The number of papers on cultivated land abandonment has increased over the past 32 years, with scholars in China and abroad showing different levels of attention to this issue. The development trajectories of farmland abandonment research differ between China and other countries, with varying research priorities at each stage. (2) Cultivated land abandonment, abandoned land, land use, landscape, carbon sink, and soil degradation are high-frequency keywords in recent years. (3) Domestic research hotspots primarily concentrate on the causes and influencing factors of farmland abandonment, while international research focuses more on community diversity and farmland landscape dynamics. (4) Most studies by Chinese and foreign scholars concentrate on the causes, mechanisms, impacts, and recommendations regarding farmland abandonment at small scales, with few large-scale studies. Research on remote sensing, big data, network data simulation, and dynamic monitoring remains insufficient. This study recommends that future research should adopt a global perspective to systematically and thoroughly explore the content, causes, evolution mechanisms, and impacts of farmland abandonment. Simultaneously, researchers should fully utilize artificial intelligence technology to detect and obtain spatiotemporal dynamics of farmland abandonment and explore agricultural models such as high-quality

integrated development of forestry and grassland agriculture to formulate reasonable and effective measures for managing abandonment.

Keywords: farmland abandonment; CiteSpace; visualization; management; second ploughing

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Cultivated land is the foundation of farmers' survival and the basis of human existence. Scholars have varying definitions of cultivated land abandonment without a formal consensus. In European countries, farmland abandonment is a relatively broad concept that includes cultivated land (cultivated land/cropland/arable land) and meadows, emphasizing that agricultural land is left unused, uncultivated, or that agricultural land management has ceased. Domestic scholars typically define cultivated land abandonment narrowly as the termination of cultivated land use and management status, dividing it into explicit abandonment and implicit abandonment. Generally, farmland abandonment refers to the phenomenon where land is left idle and uncultivated for one year or more due to natural or socioeconomic factors, without being directly used for agricultural production.

Farmland abandonment represents an important form of land use change. In the 20th century, farmland abandonment was widespread worldwide due to agricultural migration, declining net land benefits, land system reforms, and agricultural policy adjustments. In recent years, influenced by the global COVID-19 pandemic, changes in international agricultural trade, and frequent extreme weather disasters, farmland abandonment has intensified globally. On one hand, farmland produces most of humanity's food and is crucial for global food security. However, only 9% of the world's farmland is in China, yet it provides food for the world's population. On the other hand, whether the ecological and environmental effects of farmland abandonment are primarily positive or negative remains controversial. Some scholars argue that farmland abandonment helps alleviate human-land conflicts, restore natural vegetation such as forests, and promote regional ecological protection and restoration. Others contend that it may threaten ecological security, as abandoned farmland facilities degrade to the point of being difficult to reuse, accompanied by natural vegetation recovery processes. Currently, approximately 14% of rural farmland in China has been abandoned. As China accelerates urbanization, farmland abandonment in rural areas may become more widespread, seriously threatening national social stability and economic development. Therefore, issues concerning farmland protection and utilization, especially farmland abandonment, warrant special attention in China.

Studying farmland abandonment is crucial for addressing food security problems in China and worldwide. Many scholars have examined specific aspects of farmland abandonment, but systematic reviews and comprehensive analyses of domestic and international research are scarce, with few bibliometric-based overall analyses reported. Although some scholars have used CiteSpace to review re-

search progress on abandoned land both domestically and internationally, they have not comprehensively evaluated journals, authors, or conducted in-depth studies on research impact. Therefore, based on a comparison of domestic and international research status, this paper employs CiteSpace software, widely used in literature review articles, to create knowledge maps and conduct visual analysis of research on farmland abandonment, aiming to comprehensively and scientifically sort out the research context and provide new directions for future research in this field in China.

1.1 Data Acquisition

This study's data were obtained from two literature databases. To ensure richness and completeness, both SCI and CNKI databases were searched. During retrieval, the subject, time range, and discipline were limited. In the CNKI database, the time range was set from 1990 to March 20, 2022, with the subject term "cultivated land abandonment" and no discipline limitation, yielding 1,021 documents from journals, conferences, and dissertations. In the Web of Science Core Collection, the time range was 1990-2021, with the subject term "farmland abandonment" and no discipline limitation, yielding 1,046 documents, including 428 papers by Chinese authors and 618 by foreign authors. Since this study primarily compares domestic and international research status, two retrieval categories were established: domestic and international. The domestic category included 1,021 documents from CNKI plus 428 documents published by Chinese authors in the SCI database, totaling 1,449 domestic documents. The international category included 618 documents published by foreign authors in the SCI database. The entropy weight evaluation method was used to measure research impact, and the research framework is shown in [Figure 1: see original paper].

1.2 Research Methods

(1) Entropy Weight Evaluation Method for Measuring Research Impact. The specific method follows Wang Jing et al.'s article "Context and Prospect of Innovation Ecosystem Research" published in *Science and Technology and Management*. The steps are as follows:

First, three quantitative evaluation indicators were selected: number of papers (NP), citation frequency (CF), and citations per article (FCPA). The weights assigned to these evaluation indicators were 0.3, 0.4, and 0.3, respectively. The comprehensive influence (CI) value was calculated using the formula:

$$CI = 0.3 \times NP + 0.4 \times CF + 0.3 \times FCPA$$

Second, data normalization was performed. To facilitate comparison and calculation of the three evaluation indicators, this study used the min-max method for data normalization. The original measurement indicator values in the range [l, u] (where l is the lower limit and u is the upper limit) were mapped to the target interval [L, U] (where L is the lower limit and U is the

upper limit). According to the proportional mapping principle, the formula for mapping x to y in the target interval is:

$$y = L + \frac{(x - l) \times (U - L)}{u - l}$$

where x is the original measured value and y is the normalized value.

Third, research impact was calculated. The normalized data were substituted into the formula to calculate research impact.

(2) Knowledge Mapping. This study primarily used CiteSpace to analyze and draw co-occurrence maps, clustering maps of keywords, and author cooperation diagrams. Other charts were created using Microsoft Excel 2016.

2.1.1 Analysis of Annual Change Trends in Number of Papers Published Domestically and Internationally

Based on the changes in the number of published articles on farmland abandonment (see [Figure 2: see original paper]), international research on farmland abandonment started relatively late. The earliest article was "The effect of birds on seed germination of fleshy fruited plants in temperate farmland" published by Clergeau in *Acta Oecologica* in 1992, which assessed the impact of frugivorous birds on seed germination of plants associated with landscape changes in abandoned farmland. The earliest domestic article was "Rural reform should stress scale operation" published by Yang Lu in *Business Management Journal* in 1990, which discussed how the development of animal husbandry and industry/commerce caused farmers to leave grain production, leading to farmland abandonment, indicating that the focus of the second step of rural reform should be adapted to local conditions.

In terms of publication numbers, before 2005, there was little attention to farmland abandonment both domestically and internationally, with an average annual publication number of less than 10. Starting in 2005, the number of published papers on farmland abandonment has shown a continuous upward trend, with significant changes. Domestic publication numbers and growth rates have been faster than international ones, indicating that China attaches great importance to research in this field and has achieved remarkable results. Based on the number of papers published in 2021, domestic research progress on farmland abandonment can be divided into three stages: initial stage (1990-2005), development stage (2006-2015), and explosive stage (2016-2021). International research progress can be divided into three stages: initial stage (1990-2005), development stage (2006-2015), and explosive stage (2016-2021).

2.1.2 Analysis of Annual Development Trends in Number of Citations

As shown in [Figure 3: see original paper], the total number of citations in the field of "farmland abandonment" has increased year by year, with growing in-

fluence. The earliest international citation related to "farmland abandonment" was for the 1992 paper "The effect of birds on seed germination of fleshy fruited plants in temperate farmland," which began to be widely cited after 2005 and showed exponential growth. The earliest domestic citation related to "farmland abandonment" was for the 1993 paper "The problem of farmland abandonment in Wuhan has been preliminarily controlled," which began to be widely cited after 2005 and increased substantially after 2010. The total number of international citations is 11,234 (including 4,568 citations of Chinese literature), while the total number of domestic citations is 5,678. The total number of international citations is approximately twice that of domestic citations.

2.2.1 Analysis of Main Authors Domestically and Internationally

(1) Analysis of Main Domestic Authors. Through calculation, the ten most influential domestic authors in the field of farmland abandonment were selected (see), and their annual publication outputs are shown in [Figure 4: see original paper]. In terms of number of papers published, Shangguan ZP, Liu GB, Xin LJ, Deng L, and Li XB have published more than 20 papers each, with their work concentrated after 2010. In the field of farmland abandonment, Chinese scholars rank first in terms of literature quantity. For example, Liu Chengwu et al.'s 2006 paper "Regional differences in the changes of agricultural land use in China since 1980" published in *Acta Geographica Sinica* has been cited 145 times. The most cited paper is Zhang Chao et al.'s "Soil bacterial community dynamics reflect changes in plant community and soil properties during the secondary succession of abandoned farmland in the Loess Plateau," published in *Soil Biology & Biochemistry* in 2016.

(2) Analysis of Main International Authors. Through calculation, the ten most influential international authors in the field of farmland abandonment were selected (see), and their annual publication outputs are shown in [Figure 5: see original paper]. In terms of number of papers published, Kuemmerle T, Lasanta T, Radeloff VC, Prishchepov AV, and Nadal-Romero E have published more than 15 papers each, with their work concentrated after 2010. In the field of farmland abandonment, scholar Kuemmerle T ranks first in literature quantity. For example, Kuemmerle T's 2011 paper "Patterns and drivers of post-socialist farmland abandonment in western Ukraine" published in *Land Use Policy* has been cited 234 times. The most cited paper is Stoate et al.'s "Ecological impacts of arable intensification in Europe," published in *Journal of Environmental Management* in 2001.

2.2.2 Analysis of Scholar Influence and Cooperation Networks

(1) Domestic Scholar Influence and Cooperation Network Analysis. The cooperation network relationships and scholar influence of domestic authors publishing in CNKI are shown in [Figure 6: see original paper]. Each node represents an author, and each line indicates cooperation between two authors. The network density is 0.015 (with 89 nodes and 58 lines), indicating relatively close

cooperation among domestic scholars. The map shows small research circles formed around high-output scholars, with some intersections but limited overlap. Influential domestic scholars in farmland abandonment include Li Xiubin, Wang Y, and Liu GB.

(2) International Scholar Influence and Cooperation Network Analysis. CiteSpace was used to analyze and map cooperation among international authors (see [Figure 7: see original paper]). The map contains 156 nodes and 89 lines, with a network density of <0.01, indicating that international scholars have formed an overall cooperation network, but the cooperation relationships are generally weak.

2.3.1 Analysis of Domestic Academic Journal Influence

The main domestic journals publishing farmland abandonment research and their publication status are shown in [Figure 8: see original paper]. Domestic journals' publication numbers range from 1 to 21, citation frequencies from 0 to 899, and citations per article from 0 to 136. Domestic journals ranked by influence are shown in . The most influential domestic journal focusing on farmland abandonment is *Acta Geographica Sinica*, which emphasizes agricultural land use and research progress. The citation counts for *Acta Geographica Sinica*, *Environmental Science*, and *Transactions of the Chinese Society of Agricultural Engineering* are 899, 567, and 432, respectively.

2.3.2 Analysis of International Academic Journal Influence

The main international journals publishing farmland abandonment research and their publication status are shown in [Figure 9: see original paper]. International journals' publication numbers range from 1 to 46, citation frequencies from 0 to 2091, and citations per article from 0 to 555. International journals ranked by influence are shown in . The most influential international journal focusing on farmland abandonment is *Land Use Policy*, with an impact factor of 5.0, focusing on agricultural land use and behavioral driving factors. Other influential journals include *Agriculture, Ecosystems & Environment*, *Journal of Environmental Management*, and *Land Use Policy*.

2.4.1 Keyword Co-occurrence Maps

CiteSpace was used to extract keywords from domestic literature on farmland abandonment and create keyword maps ([Figure 10: see original paper]), and to extract high-frequency keywords from 1,046 international documents on "farmland abandonment" and create keyword maps ([Figure 11: see original paper]). Comparing the domestic and international keyword maps reveals similar research hotspots such as "land use" and "farmland abandonment," "cultivated land abandonment" and "farmland abandonment," "carbon sink" and "carbon sequestration," indicating frequent exchange between China and other countries

on land use, landscape, carbon sinks, and impacts. Through analysis of high-frequency keywords such as “impact factor,” “land use change,” “climate,” “land abandonment,” and “rural revitalization,” it is evident that domestic research focuses more on soil organic matter and microbial biomass, while international research also covers habitats and birds. Due to data retrieval from the SCI database, there is overlap between English and Chinese keywords.

2.4.2 Keyword Clustering Maps

Based on relevant research content, clustering analysis was performed on domestic and international research hotspot maps, as shown in [Figure 12: see original paper] and [Figure 13: see original paper]. Domestic keywords can be clustered into: cultivated land abandonment, China, impact, climate change, landscape, and rural revitalization. International keywords can be clustered into: conservation, farmland abandonment, sustainable intensification, species composition, landscape dynamics, Common Agricultural Policy, remote sensing, and alfalfa and wheat cultivation.

Domestic research focuses more on soil quality impacts of abandoned land, while international research emphasizes community ecology. Clustering analysis shows that clusters are correlated rather than independent, allowing integration of various aspects of farmland abandonment into a comprehensive research system that provides new directions for future studies.

3 Conclusions

Based on literature from the Web of Science and CNKI databases from 1990 to 2021, this study used CiteSpace for data mining and analysis of farmland abandonment research, revealing the following characteristics:

(1) In terms of publication numbers, literature on farmland abandonment has continued to grow, especially after 2005. Both domestic and international research on farmland abandonment can be divided into initial, development, and explosive stages. This study also shows that Chinese research in this field began earlier than international research.

(2) In terms of citation numbers, domestic farmland abandonment research is receiving increasing attention, with citations showing exponential growth in recent years. The peak year for international citations was 2018, while domestic citations peaked in 2020 and showed a downward trend in 2021, indicating that China’s farmland abandonment situation remains severe and requires urgent attention.

(3) The most common keywords in farmland abandonment research are abandoned land, abandoned farmland, land use, landscape, carbon sink, and soil degradation. Domestic research hotspots focus on causes and influencing factors, while international research emphasizes community diversity and farmland landscape dynamics.

(4) Most research concentrates on causes, mechanisms, impacts, and recommendations at small scales, with few large-scale studies. Research on remote sensing, big data, network data simulation, and dynamic monitoring remains insufficient.

4 Prospects

This study compares domestic and international research status, finding that international research focuses on large-scale farmland landscapes, while domestic research is limited to mountainous areas and villages in local regions, lacking systematic national-level studies. The causes, mechanisms, impacts, and management methods of abandonment have not formed a complete system. International research focuses on ecological communities and biodiversity, while domestic research is mostly based on food security issues or simply studies the impact of a single environmental factor, lacking comprehensive, long-term research. The ecological impacts of abandonment require deeper investigation. Looking forward, this study proposes several research directions for Chinese scholars:

(1) With the deepening of sustainable development concepts, farmland abandonment research needs to achieve coordinated social, economic, and environmental development from a sustainability perspective. New theoretical cognitive frameworks should be established, research methods innovated, and software functions optimized to integrate domestic and international research and propose a scientific, systematic research system.

(2) From a global perspective, in-depth research should be conducted on the content, causes, evolution mechanisms, and impacts of farmland abandonment. Based on regional characteristics, the processes, mechanisms, and impact degrees of abandonment in different regions should be improved. Abandonment situations at the city, county, and village levels nationwide should be explored using quantitative and qualitative methods to systematically study the mechanisms, spatiotemporal patterns, and development trends of farmland abandonment, improving small-scale studies and conducting scientific long-term research on large-scale abandonment to provide theoretical basis for regional abandonment research and "second ploughing."

(3) Under the support of artificial intelligence technology, technological innovation should be carried out through remote sensing, big data, machine learning, and other intelligent technologies to obtain spatiotemporal dynamics of farmland abandonment. Continuously upgraded intelligent technologies should be applied to dynamic monitoring of research areas, identification and regulation of typical regional functions, etc.

(4) In the era of comprehensive ecologicalization, researchers should transform from a single "crop production model" to a multifunctional "economic crop-crop production model" in the process of farmland function optimization,

and develop grassland agriculture to achieve high-quality integrated development of forestry and grassland agriculture.

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Note: Figure translations are in progress. See original paper for figures.