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Multifunctional agriculture in the framework of the Sustainable Development Goals (SDGs): Bibliometric review

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Abstract: The aim of this work was to analyse the systemic structure of multifunctional agriculture (MFA) and its nexus with sustainability through a bibliometric review of existing literature. By monitoring articles published on the Web of Science platform, a sample of 432 documents was identified. Two software packages, Bibliometrix and VOSviewer, were used to map scientific collaboration networks. The results made it possible to identify the authors, journals, and countries that had given rise to the current structure of knowledge. Four broad thematic clusters were identified: a) MFA and sustainability; b) ecosystem services and biodiversity; c) European public policies; d) governance and urban agriculture. It is concluded that despite an increase in publication rates research is concentrated in Europe, and, furthermore, there are few collaborative networks between different disciplines, suggesting that SDG17 is not being achieved.

Keywords: ecological planning, scientific production, sustainable agriculture, systematic review

1. Introduction

Multifunctional agriculture (MFA) is interpreted as the property of agriculture to create a co-production of marketable and non-marketable goods [1]. Although some argue that agriculture has always been multifunctional, it was not until the 1970s that it was recognized in the literature that agriculture plays multiple roles, where, in addition to producing food and fibre, it contributes to the development of multifunctional landscapes [2].

The multifunctional nature of agriculture allows links to be made between society, the economy, and the environment. As such, it is intrinsically linked to sustainability. These concepts are key in the current debate on agricultural policy reform and rural development in many countries and international platforms [3]. Several authors [3, 4] suggest that sustainable development is a global goal that includes multifunctional agriculture.

However, to date, there are gaps in the knowledge frontier regarding the synergies between the concepts of MFA and sustainability [5, 6]. In addition, researchers come from different disciplines and develop different definitions, approaches, and scales to assess and measure multifunctionality. This leads to fragmentation of information and lack of collaboration between multidisciplinary groups.

Cooperative networks are key to achieving the ambitions of the 2030 Agenda, as partnerships, transnational and interdisciplinary research are essential to achieve progress towards the 17 Sustainable Development Goals (SDGs) [7]. Specifically, SDG17 recognizes the importance of partnerships and collaborative governance to improve coherence between national and international policies and initiatives.

This study is based on the hypothesis that scientific production related to MFA is Eurocentric and lacks integration of the different disciplinary approaches, and therefore Goal17 of creating partnerships and cooperative networks is not being met.

Bibliometrics makes it possible to visualize international networks between countries, authors, and institutions, which is of particular interest for SDG17, which emphasizes the importance of analysing these partnerships to achieve progress towards the other SDGs [7]. Other authors find it useful to use bibliometrics to analyse the intellectual structure and its connection to the SDGs [8, 9].

Bibliometrics is a discipline that analyses bibliographic material from a quantitative perspective. One of its main advantages is that it allows the analysis of a specific research area, considering articles, journals, authors, institutions, and countries, thus providing a general picture of a research area. There are several bibliometric studies in the literature [10]. However, no article has been published that provides an overview of research on MFA and sustainability.

Therefore, the aim of the present work was to perform a quantification, systematization, and mapping of the scientific production published in the field of MFA and its link with sustainability in the framework of the Sustainable Development

Goals; to provide a holistic view of the existing literature, identifying: (a) the main areas of study; (b) the authors, journals, and countries that have conducted most of the research; (c) the main collaborative networks in this area; (d) emerging areas.

Multifunctional agriculture as a tool for understanding sustainability

The relationship between multifunctionality and sustainability is generally considered implicit and is rarely mentioned in research. This often leads to confusion between the two concepts [11]. For example, definitions of multifunctional agriculture and sustainability are similar, including the phrase "social, environmental, and economic development".

The Organization for Economic Cooperation and Development [1] prepared an analytical framework for studying the concept of multifunctionality, which is a reference document for understanding how these concepts are tied. It states that MFA leads to the study of the foundations of positive policy, as opposed to the concept of sustainability, which leads to foundations that lead to normative policy. MFA and sustainable development are related concepts in the sense that the latter provides the framework for describing and evaluating all the economic, social, and environmental objectives associated with MFA since MFA is not an objective but contributes to the understanding and realization of the different aspects of sustainable development in an agricultural and rural context.

These concepts are integrated under the branch of welfare economics, where the integration of both concepts in turn implies a shift from previous perspectives on productivity to the new perspectives introduced by the sustainability discourse [3].

The notion of MFA is thus a way of operationalizing sustainable development and reintroducing a range of different perspectives on agricultural development. However, the question of what types of functions are accepted as components of multifunctional agriculture for sustainable development remains open. Member countries of the World Trade Organization (WTO) do not agree on what constitutes multifunctional agriculture. This issue is territorially intrinsic, as each society wants to create favourable living conditions for its members, and the criteria for quality of life are planned in different ways. Research on multifunctional agriculture must therefore be multidisciplinary [12] since no single discipline can encompass all these different perspectives.

Multifunctional agriculture and the Sustainable Development Goals

Multifunctionality inherently implies a plurality of perspectives that are denoted in the various disciplines that study it such as economics, sociology, political science, geography, ecology, and industrial engineering, among others [13, 14]. Since no single discipline can fully incorporate the different nuances, research into multifunctional

agriculture must be analysed from interdisciplinary [15], transdisciplinary [16], multidisciplinary and interdisciplinary [17], or integrated approaches.

This scientific approach of multidisciplinary, interdisciplinary, or transdisciplinary teams is the way forward to address pressing issues facing our planet [18]. This is relevant when considering the SDGs because there are no simple answers to achieving any of them. After all, interdisciplinary research approaches are required for problems that have significant societal implications, along with diverse opinions and interests of the groups involved [19].

SDG17 – *Strengthen the means of implementation and revitalize the global partnership for sustainable development* is key to realize the aspirations of the other SDGs, as it recognizes stakeholder partnerships as important means to mobilize and share knowledge, experiences, technologies, and financial resources to support the achievement of the Sustainable Development Goals in all countries, especially in developing ones [21, 22].

MFA is a promising topic for territorial development, not only in rural areas and developing countries but also in urban areas and in developed countries. Partnerships are needed to implement an integrated approach to understanding MFA and its contribution to achieving the SDGs [22, 23].

2. Methodological design

Data collection

In this work, as a first step, the metadata were collected, consisting of citation information, bibliographic information, abstract and keywords, as well as funding details, for which the Web of Science (WoS) database of Clarivate Analytics was used since it is one of the most important digital repositories [23].

To compile the metadata, the search string was constructed using the following as part of the title, abstract, or keywords: "multifun* agri*" OR "agri* multifun*" OR "multifun* farm*" AND "sust*". Boolean operators (OR) and (AND) were adopted, as well as different combinations of the selected keywords and both plural and singular forms. The search included papers published before the year 2022. (This restriction is to improve comparability during the bibliometric analysis, as more recent publications had not had time to receive an adequate number of citations [24].)

Bibliometric analysis

Two main techniques were used for bibliometric analysis: performance and scientific mapping. Performance analysis can adopt several indicators, mainly related to the number of publications or citations of the documents within the

dataset and classifying them by authors, journals, countries, and affiliations [23], while mapping gives the researcher the hidden links or patterns in conceptual, social, or intellectual structures, providing an overview of the most important research [25]. In this paper, the number of articles and citations were used as performance indicators, and the type of analysis used for mapping was co-occurrence and co-citation.

To carry out these bibliometric analyses, two software programs with relevance in scientometrics were used: Biblioshiny, an R-based application [26], and VOSviewer [27].

For the realization of bibliometric networks, VOSviewer allowed the execution of different clustering algorithms to position and classify co-citations and pairings in similar groups.

Co-occurrence analysis is a technique based on the number of articles in which two keywords occur together. The size of the keyword node indicates weight, that is, how many documents a keyword appears in. Thicker lines mean more co-occurrences (how many documents a keyword appears in together with another keyword). The smaller the distance between the nodes, the stronger the relationship between them (how many articles these two keywords appear together and compare their relative co-occurrence with other keywords). The same colour of nodes and keywords means that they belong to the same cluster [28]. This allows for a more advanced description of the research, creating a mapping of the relationships between different terms and their association in thematic clusters [29].

Co-citation occurs in two units of analysis (they can be references, sources, or authors), which in turn are cited by other documents published after them; that is, it measures joint citations and assumes that the observed citation patterns reveal how multiple authors typically recognize the documents to promote important concepts [30].

3. Results and discussion

Performance analysis

This section presents the general evolution of the field. Thus, it is possible to know how the literature on MFA and sustainability has evolved and what impact it has had on the scientific community.

A total of 432 documents were found in WoS, of which 126 are case studies. This agrees with Parra-López et al. [31], who point out that in the literature one can find mostly papers on theoretical discussions but few reports that integrate case studies. The most studied subjects are maize, olive trees, and the wine industry.

No bibliometric work analysing MFA was found, while more than a hundred bibliometric studies refer to sustainability [33, 34], but none address sustainability and multifunctionality, which again highlights the relevance of this construct.

Journals

All 180 journals were found to contain at least one article published in the field. This indicates that the contribution is low, representing less than 1% of the universe of journals indexed in WoS [34]. Only 20 journals have published over 5 articles on this topic, with a contribution of 202 out of the 432 articles found in WoS; therefore, 230 are scattered in 160 journals.

The *Journal of Rural Studies* is the most cited one with 1,531 TC (total citations received retrievable in WoS). *Land Use Policy* is the journal that published the highest number of articles of the sample, representing 7.17% of the total published. However, it occupies the second place in terms of number of citations, with 1,409 (*Table 1*).

Table 1. Journals with higher impact

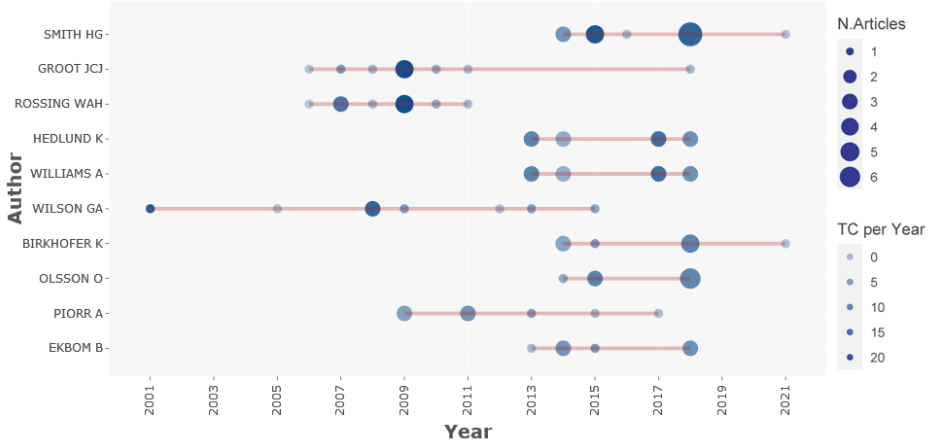
Number	Journals	TC	Articles
1	*Journal of Rural Studies*	1,531	26
2	*Land Use Policy*	1,409	31
3	*Agricultural Systems*	662	8
4	*Transactions of the Institute of B. G.*	626	2
5	*Journal of Environmental Management*	623	12
6	*Agriculture Ecosystems & Environment*	478	11
7	*European Review of Agricultural Economics*	352	6
8	*Proceedings of the National Academy of S. U.*	277	1
9	*Global Environ. Change – Human and Policy D.*	239	1
10	*Journal of Applied Ecology*	224	4

Authors

According to Forliano et al. [23], evaluating an author's relevance in a field should consider two relevant aspects: productivity and impact. In this work, both measures were considered to summarize the 10 most productive authors in this field (*Fig. 1*), where productivity was evaluated by the number of articles published per author, and impact was evaluated by the number of citations received per year.

It was found that Wilson G. A. is a pioneer in this field since from 2001 to 2015 he has had 8 publications as first author. His first publication is the most cited one: *From Productivism to Post-Productivism … and Back Again? Exploring the (Un)changed Natural and Mental Landscapes of European Agriculture*, where the author debates productivist/post-productivist thinking and opens a thread on the concept of agricultural multifunctionality, which encapsulates the heterogeneity

of rural societies. Similarly, in his later contributions, he provides a normative framework where he delimits multifunctional agriculture by productivist and non-productivist actions in a spectrum of weak, moderate, and strong multifunctional agriculture. The strongest form is manifested when the dimensions of social, economic, cultural, moral, and environmental capital are fulfilled.



Note: The larger and darker the circle, the more articles and citations the author had in that year.

Figure 1. Production of the authors with the greatest impact on MFA and sustainability over time

Other important authors are Groot, J. C. J. and Rossing, W. A. H. Their research contributes to decision making on the best alternative land uses while respecting agrobiodiversity.

It was revealed that the authors' disciplinary backgrounds belong to an ecological perspective, which is in line with Nowack et al. [15], who state that the "social functions" of multifunctional agriculture have received little attention, are rarely conceptualized, and are inconsistent compared to studies on ecological functions.

Countries

There were 54 countries represented by at least one paper. The 15 with the highest impact represent almost 92% of the total number of citations (*Table 2*). The remaining 8% of citations are distributed among 39 countries.

Table 2. Top 15 most cited countries based on the WoS 2022 dataset

Number	Country	Times cited	Articles	Average of citations	R&D (%GDP)
1	United Kingdom	2,708	51	84.62	1.71
2	Netherlands	1,847	89	52.77	2.18
3	USA	1,440	140	33.49	3.17
4	Germany	1,087	57	41.81	3.17
5	Sweden	771	86	30.84	3.39
6	France	668	72	41.75	2.19
7	Spain	534	65	17.23	1.25
8	Italy	378	94	8.22	1.46
9	Australia	338	26	30.73	1.83
10	Czech Republic	282	71	7.23	1.93
11	Norway	211	20	30.14	2.15
12	China	184	35	13.14	2.24
13	Austria	179	15	22.38	3.13
14	Switzerland	172	23	21.50	3.15
15	Belgium	146	9	36.50	3.16

Note: An article may represent more than one country. Research and development (R&D) expenses – 2019 value assumed.

Authors from the United Kingdom stand out; not because they are the country that generates the most documents, but because they are the origin of the greatest number of citations. The United States, despite being the country that generated the most documents, ranks third in terms of the impact of its contributions.

Applied research is mainly based in the European Union and China, where specific policies on MFA have been implemented to support rural development and promote sustainable rural communities; in contrast, MFA has rarely appeared explicitly in rural development policies in America or Australasia [2]. In the United States, there are still debates about the use of this policy [37].

Based on data from the World Bank, it can be seen that the countries in the table allocate a higher percentage of GDP to research and development (R&D) than the average expenditure of countries in Latin America and the Caribbean (.67%). This is consistent with Guerrero-Casado [38], who found that the countries with more articles in the agricultural sector are the ones with greater economic resources and not those where agricultural activities are more important.

Bibliometric network analysis

Co-occurrences

Four clusters were created, and each cluster was named according to the keywords of greatest importance. The terms MFA and sustainability belong to the same cluster and are at the centre of the analysis. The clusters were as follows: red (MFA and sustainability), green (ecosystem services and biodiversity), yellow (European public policies), and blue (governance and urban agriculture) (*Fig. 2*).

The number of research approaches coincides with Renting et al. [17], as they classify MFA into four main categories but differ along the lines of market regulation, land use approaches, public regulation, and stakeholder-oriented approaches, as they use the specific governance mechanisms and level of analysis for their classification.

The cluster in red includes the terms: MFA, agriculture, sustainability, landscape, rural development, producers, food security, post-productivism, organic agriculture, diversification, and environment. Because of the words that prevail in this cluster, it can be said that it is the theoretical root that gives rise to the other clusters since the concept of multifunctionality helps to explain the agricultural change concerning the productivist/post-productivist model [14]. On the other hand, Filepné Kovács et al. [39] found that the balanced diversification of the landscape limits the exodus and is a factor of rural development. This cluster is broad, but it basically seeks sustainable agriculture; and although agriculture is only explicitly mentioned in SDG 2 (zero hunger), most of the 17 SDGs can be related to agriculture in some way [40].

The cluster in green is formed of 10 keywords: ecosystem service, biodiversity, management, land use, conservation, economic valuation, diversity, trade-offs, agricultural landscapes, and indicators. The concept of ecosystem service prevails, as this is closely linked to MFA; they are two important concepts in the current debate on sustainable resource use [41]. This group is oriented towards case studies on the multiple options presented by landscapes and the conservation and sustainable use of soil, which have a direct impact on the SDGs of zero hunger (2), health and well-being (3), clean water and sanitation (6), responsible production and consumption (12), climate action (13), and life of terrestrial ecosystems (15). These studies are a priority, as land degradation is a threat to the fulfilment of the SDGs [19].

The cluster in yellow has two keywords: Europe and policies. Cheng et al. [42] highlight that policy studies and their impact on SDG realizations are prevalent in Europe. It should be noted that policy implementation is a critical and leading measure to achieving the SDGs.

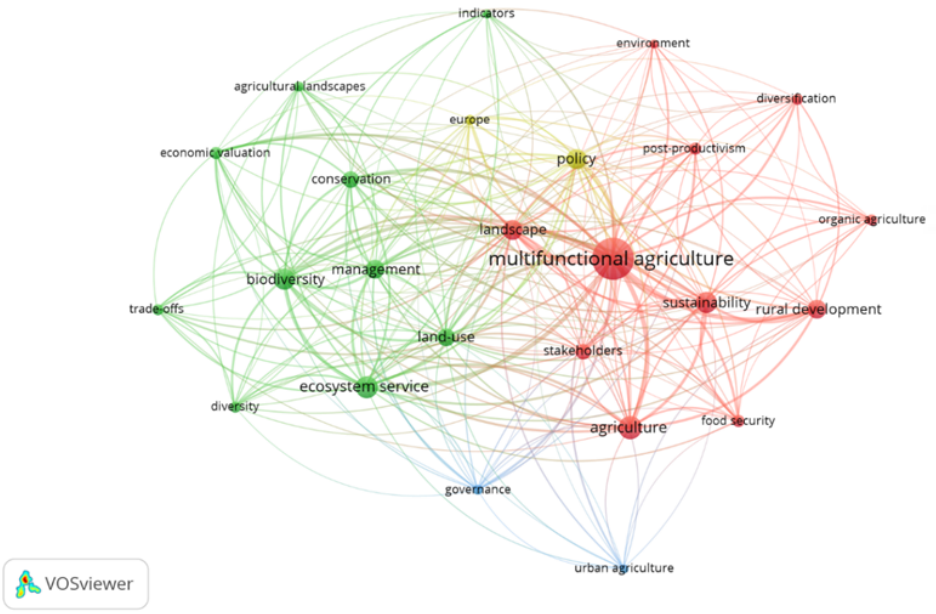


Figure 2. Co-occurrence links with all keywords, considering 12 words as the minimum number of occurrences of a word

The blue cluster consists of two keywords: governance and urban agriculture. The governance mechanism helps to organize the provision of public goods and services produced by agriculture. Governance is key to achieving the 17 SDGs; for while the SDGs have great potential, collective success will depend on several factors such as the extent to which states formalize their commitments, so strengthening global governance helps translate global ambitions into national and local contexts [43].

The five keywords that appeared most often in the search and that define MFA and sustainability are ecosystem service, landscape, biodiversity, rural development and policy.

To know the conceptual trajectory, a temporality network was used from the beginning of 2010 to the end of 2020, where the nodes in purple are the oldest words, and the nodes in yellow the most recent ones (*Fig. 3*). The keywords that appear in the first studies are post-productivism, optimization, and the European Union, among others. This analysis recognizes which are the emerging lines in the topic of MFA and sustainability. Eight emerging words were found: soil organic carbon [44], climate change [45], agroecology [16], case studies [46], Italy and agritourism [47], urban agriculture [48], social agriculture [49], and "trade-offs" [50].

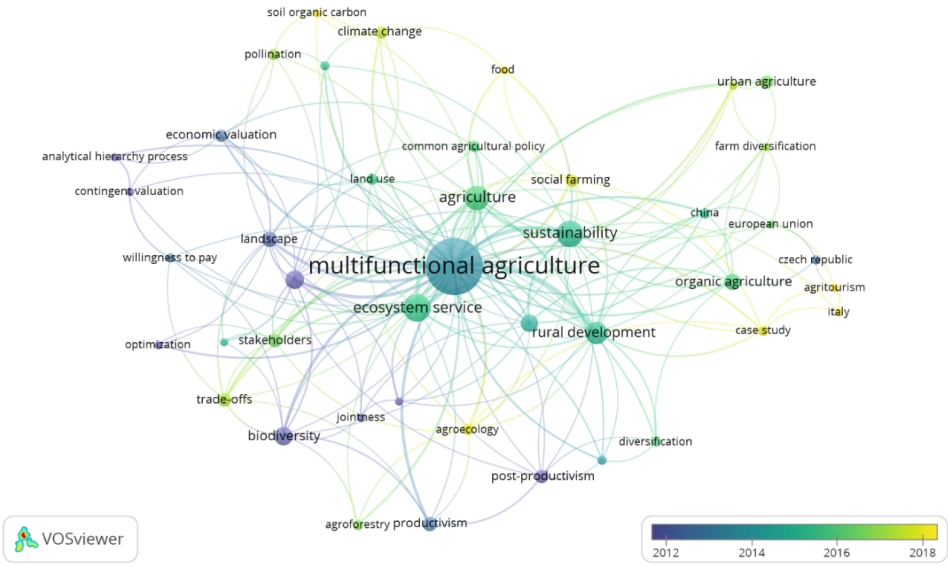


Figure 3. Overlay visualization by year of co-occurrence links with author keywords, considering four words as the minimum number of occurrences of a word

Author co-citation

Four main clusters of author co-citation are observed (*Fig. 4*), as visualized in the keyword co-occurrence map.

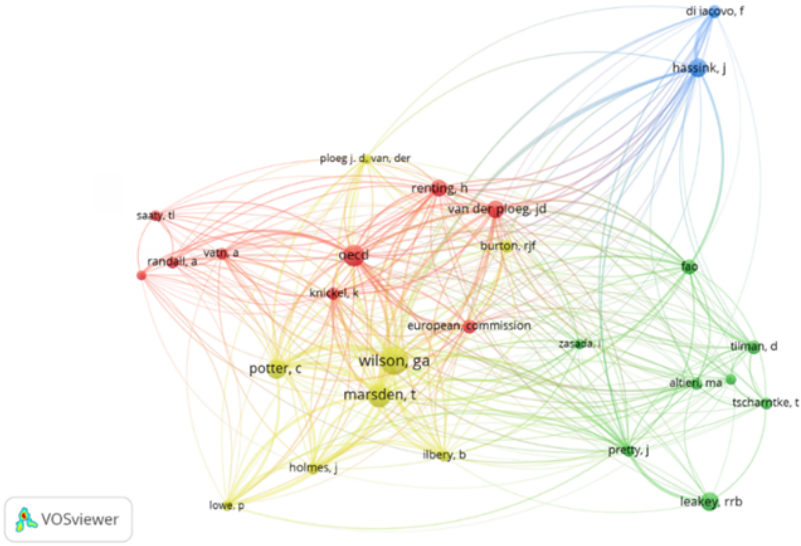


Figure 4. Author co-citation links, considering a minimum of 30 citations per author

The red cluster (MFA and sustainable development) is closely linked to the cluster in yellow (European public policy). At the centre of the map is the OECD paper *Multifunctionality: Developing an Analytical Framework*. This work [1], together with previous works by the European Commission [51, 52], laid the foundations for subsequent studies linked to European public policies, such as the work of Wilson, Potter, and Marsden. In the green group (Ecosystem services and biodiversity), authors such as Leakey stand out, who have works oriented towards agroecology [50], Zasada has works oriented towards agricultural diversification [53], and in the blue group (governance and urban agriculture) two authors, Di Iacovo and Hassink, stand out. These authors talk about social agriculture for global change [54] and "care agriculture" [55].

4. Conclusions

It was observed that primary and secondary studies on MFA in Latin America, Asia, and Africa are scarce, confirming the hypothesis that the scientific production on MFA is Eurocentric, which leads to the following question: Is MFA a reality outside the European context? The importance of generating more studies for the Global South region is highlighted, considering the European Union's experience with MFA.

To move beyond theory, empirical work needs to address the specific needs of each area, considering each country's capacity, budgetary constraints, and agricultural patterns. In addition, studies need to combine multiple disciplinary perspectives as a basis for building new interdisciplinary understandings. Although there is currently no unified conceptualization of sustainable development, most perspectives share the similarity that sustainable development should be committed to the coordinated development of the social economy and the environment, where MFA is increasingly recognized as a key concept in realizing the SDGs. It was found that research on MFA has made significant progress in recent decades; however, most studies have focused on historical changes, and future spatiotemporal changes have not been sufficiently explored. Therefore, it is suggested that future studies address MFA as a means of rural development planning, as well as a framework for assessing existing agricultural activities to determine the extent to which they contribute to the achievement of the 169 global goals or directly to any of the 17 SDGs.

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