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BIBLIOMETRICS STUDY ON AGRO-ECONOMY OF BIOCHAR

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Abstract

The use of fossil fuels is closely related to environmental issues that produce pollution from combustion. Various methods have been used to reduce the use of fossil fuels, including bioenergy, primarily bio-carbon. This research aims to map bio-carbon production and its relationship to agroeconomic growth scientifically and to provide a comprehensive picture of the relationship between bio-carbon and agroeconomics. In this study, 987 articles were used from the Google Scholar database from 2013 to 2023, and this bibliometric analysis was used to synthesize and document literature related to the research topic. In this bibliometric research, the impact of literature is analysed by looking at the most cited articles, the most productive journals, articles citing biochar and agroeconomics, total citations and publication trends, and keyword analysis based on occurrences. This review produces a literature trend in biochar production towards agroeconomic growth that has developed rapidly from 2018 to 2022. Findings on the network map for the keywords biochar, agroeconomics, and economics reveal 5 clusters. The newest and still hot topics to be researched include food society, climate change, economic growth, agroforestry, economic return, manure, soil property, agro-economy, bioeconomy, sustainable agriculture, circular economy, biochar application, biochar amendment, and biochar addition.

Key words: Agro-economy, Bibliometric, Biochar, Soil, Water.

1. Introduction

National energy needs until 2050 will continue to increase due to economic growth, population, and government policies. However, this differs from the growth in available fossil energy reserves and is predicted to run out in the next nine years [1]. Fossil fuels are closely related to environmental issues that produce pollution from the combustion process [2].

Various methods have been used to reduce the use of fossil fuels, one of which is by using bioenergy, especially biocarbon, as an alternative to active carbon, which cleans pollutants in water [3, 4]. Biocarbon sources originating from agricultural waste have begun to be developed; this is also related to the use of agricultural waste for environmental sustainability. Many reports regarding biocarbon have been reported [5-7].

In Indonesia, many agricultural wastes have been used to produce biocarbon, including using cocoa shell waste [8], banana peels [9], rice waste [10], candlenut shells [11], cassava peels [12], and fruit waste [13]. Utilizing agricultural waste into biocarbon is one step to reduce environmental waste, and its use by the community can provide economic value that can improve community welfare.

Utilization of agricultural waste on a large scale can also open up employment opportunities for the community and increase income, especially for business actors [14, 15]. The production costs of processing biocarbon from waste can also be reduced compared to carbon originating from fossil fuels because processing can be more accessible [16].

Several previous studies regarding the processing of agricultural waste products as biocarbon and its economic use have been carried out, and the results showed positive results [17, 18]. The use of alternative fuels can reduce fuel costs from previously used gas which costs 1,722,838.00 to 938,060.00 rupiah per hour by using alternative palm shell fuel.

In calculating the sensitivity analysis this engine procurement project is feasible to continue provided that the price of alternative fuel does not exceed IDR 1,128.22 per kilogram, the reduction in production does not exceed 44.22% of the prediction, the reduction in gas prices is not lower than 6 .02 US dollars per MMBTU, the dollar exchange rate is not lower than IDR 10,345.00 per US dollar, and the bank interest rate is not more than 49.03% [14].

In this study, the role of biocarbon in agroeconomic growth is the main topic in the last ten years. VOSviewer from bibliometrics is used to quantitatively analyse the relationship between various countries and institutions in the world through visual analysis based on representative authors, literature, and research trends that are widely cited to clarify the structure of knowledge and its context as a whole [19, 20].

The results of bibliometric analysis are significant for researchers to track the popularity of biocarbon research topics from an agroeconomic perspective [21] This agroeconomic perspective is important because every farming or agricultural business carried out from upstream to downstream is related to community economic activities, especially income which indicates prosperity [22]. Biocarbon has the potential to substitute carbon energy which is very useful for improving soil or water quality.

Based on previous research on biochar bibliometric analysis [23-25] there has been no analysis of opportunities and potential improvements in economic aspects that can be obtained through the application of biochar. So the purpose of this study is to present opportunities in introducing a new and more sustainable biochar system for global agriculture and open up opportunities for a green economy that is in line with the SDGs program so that it can help improve the community's economy.

2. Methods

This paper's data sources are articles relevant to the research topic based on the specified keywords. The data analysed came from Google Scholar from 2013 to 2023 [26]. The keywords used were "agroeconomics" and "bio carbon", with the data collection time being October 14, 2023. After screening, comparison, and weighting, 987 articles were obtained. After that, manual methods were used to screen the data, especially to delete articles that were irrelevant to the research topic so as not to influence the analysis results [17].

The analysis method used is bibliometrics to see trends in the development of research focus and changes in scientific disciplines, thus providing valuable information for scientific research and as a basis for decision-making [18, 19]. VOS Viewer is a computer application that is useful for visualizing bibliometric maps. The text mining feature can be used for visualizing a continuous network or relationship in a fragmented article. This bibliometric analysis benefits greatly from computer data processing and the number of publications has increased significantly in recent years.

In this research, bibliometrics is used to carry out co-citation analysis and explosion trend detection analysis in agroeconomics related to biocarbon literature to obtain more apparent visual research conclusions in this field. Detailed information regarding the use of bibliometric is explained elsewhere [27, 28].

3. Result and Discussion

3.1. Results of the most cited related articles

Based on the results of searching for articles on Google Scholar, which was used as a database in this research, relevant research data was obtained based on the highest number of citations. Table 1 shows the ten published articles on agroeconomic biochar that were most cited from 2013-2023. Table 1 shows that the articles with the most citations are related to limited agricultural land due to climate change, which is encouraging the development of biocarbon production, with a total of 812 citations.

As for ranks 2 to 10, articles with the highest number of citations are generally related to the role or function of biocarbon as part of solution steps to reduce emissions. And its relation to aspects of environmental and climate change. Articles with many citations are highly useful for the studied science [29]. The number of citations for all articles used in this research was 19,521.

3.2. Research developments in the agro-economy of bio charbon

The article publication trend in Fig. 1 shows that the research on Biochar and agro-economy over the last ten years has been increasing and widely researched. This happened because it was driven by the urgent need for climate mitigation in the last ten years [30]. Research on the provision of biocarbon is part of the contribution to providing carbon reserves that can be obtained, one of which is waste from agricultural commodities [31], especially when viewed from an agroeconomic perspective in a region [21, 32].

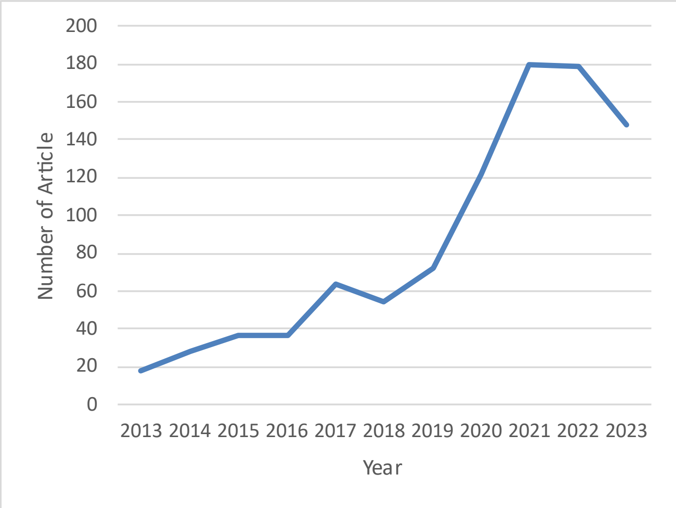

Fig. 1. Publication trends 2013-2023.

Table 1. Article publication data regarding the agro-economy of bio charbon.

Cites	Author	Title	Journal	Year
812	DS Powlson, CM Stirling, ML Jat	Limited potential of no-till agriculture for climate change mitigation	Nature Climate Change	2014
465	G Tamburini, R Bommarco, TC Wanger	Agricultural diversification promotes multiple ecosystem services without compromising yield		2020
460	CI Kammann, HP Schmidt	Plant growth improvement mediated by nitrate capture in co-composted biochar	Sciences Advances	2015
407	DA Bossio, SC Cook-Patton, PW Ellis	The role of soil carbon in natural climate solutions	Nature Sustainability	2020
315	EW Bruun, CT Petersen	Biochar amendment to coarse sandy subsoil improves root growth and increases water retention	Soil Use and Management	2014
248	Z Xie, Y Xu, G Liu, Q Liu, J Zhu, C Tu	Impact of biochar application on nitrogen nutrition of rice, greenhouse-gas emissions and soil organic carbon dynamics in two paddy soils of China	Plaint and Soil	2013
243	BA Oni, O Oziegbe, OO Olawole	Significance of biochar application to the environment and economy	Annals of Agricultural Sciences	2019
199	MV Barros, R Salvador, AC de Francisco	Mapping of research lines on circular economy practices in agriculture: From waste to energy	Renewable and Sustainable Energy Reviews	2020
179	SS Akhtar, MN Andersen, M Naveed	Interactive effect of biochar and plant growth-promoting bacterial endophytes on ameliorating salinity stress in maize	Functional Plant Biology	2015
119	J Zheng, J Han, Z Liu, W Xia, X Zhang	Biochar compound fertilizer increases nitrogen productivity and economic benefits but decreases carbon emission of maize production	Agriculture, Ecosystems and Environment	2017

This published data also proves the existence of a relationship between biocarbon and the agro economy of a region or country. The increase in the number of publications in recent years has been driven by progress in the development of knowledge carried out by researchers to understand the vital role of biocarbon production and its benefits for agroeconomic growth [33].

Results of network visualization analysis in research development Biochar and Agro-economy shown in Fig. 2 using VOSviewer software using mapping analysis based on number occurrences that are. This paper is based on quite recent automatic clustering approaches, which are a subset of the clustering approaches. Therefore, for the research methodology, we chose the keyword query to be ‘‘clustering algorithms’’. This query will return all those publications where any of these keywords appear in the title, abstract, or authors’ keywords. The keyword is mentioned seven times in total thresholds is 40, and then 3 clusters are obtained as follows:

- Cluster 1 is shown in red, with nine keyword items: culture, agro economy, bioeconomy, circular economy, economy, food, nature, society, and sustainable agriculture.
- Cluster 2 is shown in green, with eight keyword items: agroforestry, climate change, economic development, economic growth, economic return, food security, manure, and soil property.
- Cluster 3 is in blue, with six keyword items: biochar addition, amendment, application, plant, rice, and Soil.

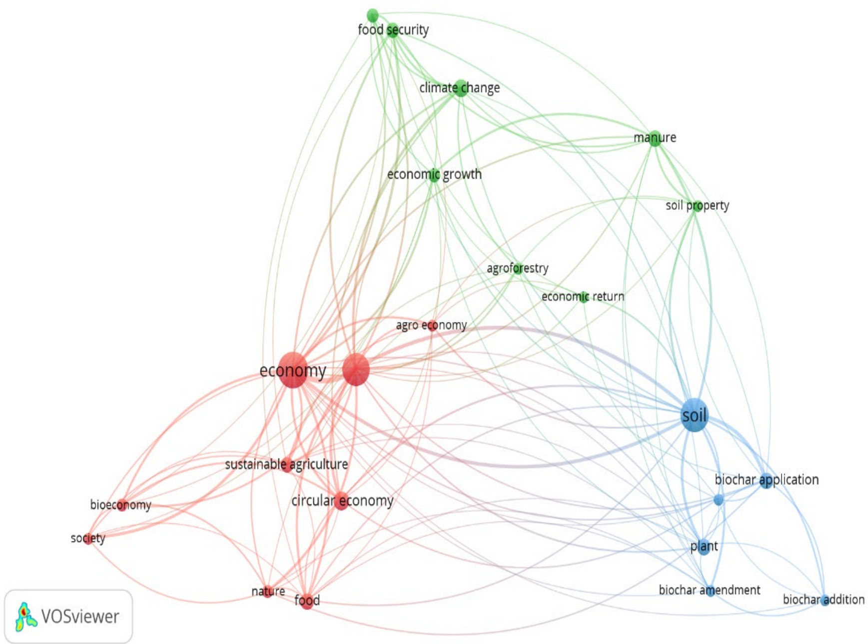

Fig. 2. Network visualization.

Figure 3 is an Overlay Visualization that shows research trends and historical traces of Biochar and Agro-economy research from 2013-2023. The brighter colour in the image shows that the research is the most recent in 2022 and 2023, while the darker colour or blue colour indicates that the research is old. Some keywords in the latest research include economic return, bioeconomy, sustainable agriculture, circular economy, nature and plants.

Research on these topics has only begun to be carried out since 2021 and is developing to date, so these topics still need to be analysed, especially regarding agro-economic or agricultural economic conditions on biocarbon, waste biomass in the framework of circular economy and bioeconomy where the ultimate goal is for sustainable agriculture.

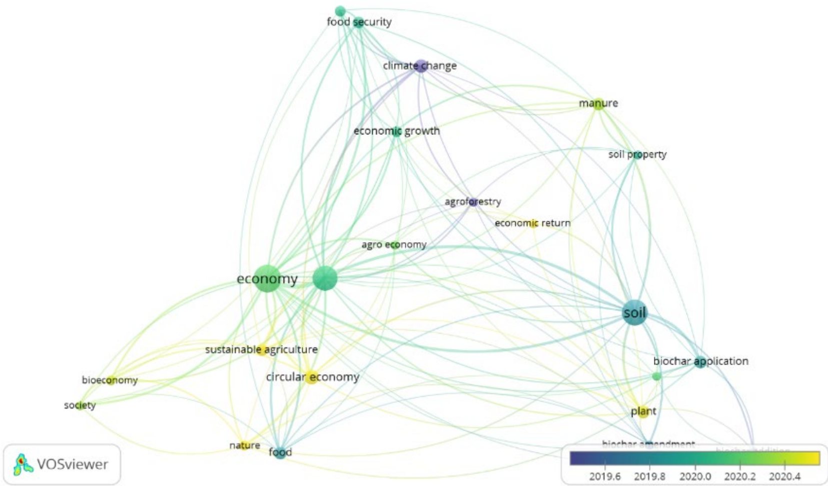

Fig. 3. Overlay visualization.

Research that discusses these topics includes energy generation, such as biomass produced from fields, and the challenges of biowaste for renewable energy [34]. Apart from that, an analysis of the benefits obtained from alternative charcoal production was also developed [35], the relationship between bio enzymes and agricultural soil stabilization, the impact of which will reduce agricultural land production and reduce national income [36]. The role of biochar and NIs on the growth and yield of papermill and charcoal have been reported in the literature [37, 38] Among the direct and indirect impacts of biochar, the indirect impacts are more prominent [38].

According to [39] the biochar application to the soils changes the natural state and thermal dynamics of the soil thereby promoting crop growth. They further reported that biochar supplementation with the NI had a promising role in the germination and phenology of plants. Overall, the use of biochar improves soil health, especially in poor soils of arid and semiarid regions [40]. Based on the experimental findings, the applied potential of the study treatments, and the results of economic analysis, it can be said that biochar has an important role to play in the circular economy in the future.

Density Visualization can find which research topics are rarely carried out [23], as shown in Fig. 4. Density visualization of keywords biochar and agroeconomic shows two colours that indicate keywords that have been widely researched or not. First, there is a yellow colour for the keywords economy, agriculture, and soil. The yellow colour in this density visualization shows that these keywords have been widely researched or are currently being widely used as research topics.

In contrast, green keywords show that these keywords are still rarely used as topics. The research includes food society, climate change, economic growth, agroforestry, economic return, manure, soil property, agro-economy, bioeconomy, sustainable agriculture, circular economy, biochar application, amendment, and Biochar addition [41]. Based on the overlay visualization analysis in Fig. 2 and trend analysis in Fig. 3, the keywords colour red, green in Density Visualization are still the newest research topic, and their development will be of increasing interest [42].

The topic of agro-economic Biochar can be linked to one of the keywords that appear in the density visualization: bioeconomy and economic return. Studies on Biochar are discussed regarding its application and production as a source of soil remediation and bioeconomy [43].

Biochar has made breakthroughs in reducing greenhouse gas emissions and global warming, as well as reducing soil nutrients, leaching losses, sequestering atmospheric carbon into the Soil, increasing agricultural productivity bioavailability, reducing environmental contaminants, and so on, become a sustainable value-added product in the bioeconomy. Biochar is a bioproduct that can be marketed and used in agriculture, industry, and the energy sector. Thus, biochar production can improve soil properties and provide opportunities to earn additional income [44-48]. This study adds ideas and new information regarding biochar production [43].

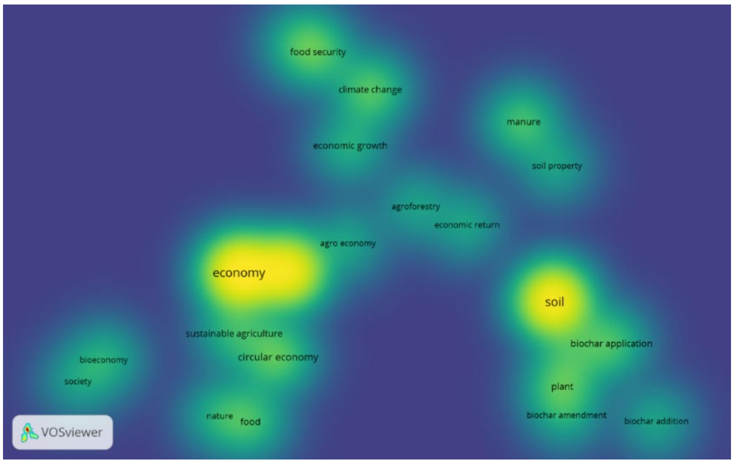

Fig. 4. Density visualization.

4.Conclusion

The bibliometric results on the agronomic theme of bio charbon with the keywords "agroeconomics", "economics," and "bio charbon" show that from 2018 to 2022, the trend is the development of literature regarding increasing bio charbon production and its impact on improving agroeconomics. This happens because, since 2018, several countries in the world have had a mission to reduce the effects of carbon release so that the growth of biocarbon will be beneficial for improving the environment and improving the economy of the region that produces it.

This research also proves a relationship between bio-carbon production and agroeconomic growth. Topics that are still limited to exploration and provide opportunities for future research are food society, climate change, economic growth, agroforestry, economic return, manure, soil property, agro-economy, bioeconomy, sustainable agriculture, circular economy, biochar application, amendment, and Biochar addition.

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