OASE
Proceeding the Overseas Academic Study Exchange Program
ISSN 2686-4312 □ ISBN 978-xxx □ 2025 □ Volume 7(1), 178–183. □ DOI: 10.22219

Food Security and Sustainability Amidst Climate, Technology, and Pandemic Crises: A Global Bibliometric Analysis and Implications for Indonesia

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ABSTRACT
The Zero Hunger objective within the framework of the Sustainable Development Goals (SDGs) faces global and national challenges for the 2020–2024 period, the bibliometric analysis method as a medium of approach to 190 scientific articles collected from the Scopus database and analyzed using VOSviewer software. The network visualization results show five main thematic clusters: climate change and Africa, digitalization of agriculture and smallholder farmers, the impact of the COVID-19 pandemic, household food security and gender, and food insecurity in urbanized areas. The analysis reveals that the climate crisis, inequality in access to technology, the pandemic, and socio-economic inequality exacerbate food vulnerability, especially in poor and vulnerable areas. Despite increasing publications and scientific attention to the Zero Hunger issue, structural challenges remain dominant, including minimal technology inclusion for smallholder farmers, limited access to resources for women, and suboptimal policy responses to local conditions. This study recommends community-based transformative strategies, adaptive local approaches, and equitable policies to build resilient, inclusive, and sustainable food systems.

Keywords: Zero Hunger, bibliometrics, Vosviewer, food security, technology inclusion.

1 Introduction

Food security is an important pillar in achieving the Sustainable Development Goals (SDGs), especially the Zero Hunger target. However, the 2020–2024 period shows the complexity of global and national challenges in realizing this target. The climate crisis that has hit vulnerable areas such as Africa has caused extreme drought, crop failure, and famine, which also reflects similar threats in Indonesia (Abdullahi et al., 2024), especially the eastern and interior regions that face the risk of stunting and malnutrition (Fitri et al., 2022). Non-inclusive technological disruption adds to vulnerability, when small farmers, the main actors in national food production, still have difficulty accessing technology, markets, and digital information (Tarigan, 2021).

The COVID-19 pandemic has worsened the situation by widening social inequality and increasing the number of households experiencing food insecurity, especially in urban and semi-urban areas (Sosial et al., 2022). Social factors such as education, employment, and gender roles have been shown to have a significant impact on household food security (Sosial et al., 2022). Women farmers, despite their significant contribution to maintaining family food security, still experience limited access to resources and adaptive training. Regional disparities between developed and underdeveloped regions also widen the gap in access to sufficient and nutritious food (Siagian & Rahmadana, 2020). Through bibliometric analysis, this article identifies five main clusters that illustrate the relationship between climate change, technology, pandemics, poverty, and social roles in the food system. This study emphasizes the need for transformative strategies based on locality, community, and sustainability to build a more resilient, inclusive, and equitable food system for all.

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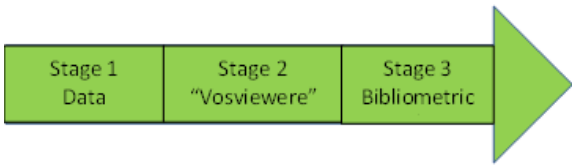
2 Literature Review

Zero Hunger is the Sustainable Development Goal (SDGs) number 2 launched by the United Nations (UN), with a focus on ending hunger, achieving food security and good nutrition, and promoting sustainable agriculture (Selvitri et al., 2021). The Zero Hunger goal not only targets meeting food needs, but also emphasizes aspects of nutritional quality, sustainability of food production, and equity of access, especially for vulnerable groups such as women, children, and small farmers (Wirawan et al., 2025). Food Security in the Global and Indonesian Context is defined by FAO (2009), as a condition when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences. Globally, food security is increasingly threatened by multidimensional crises including climate change, pandemics, and technological disruption (Wuli, 2023). In Indonesia, food security is a national priority, especially due to the geographical conditions of the archipelago and dependence on staple commodities such as rice.

Sustainability and the Three Crises: Climate, Technology, and Pandemics in the food and agricultural system include not only aspects of environmental conservation, but also economic viability and social justice (Anwar, 2022). Climate change causes erratic weather patterns, crop failures, and water scarcity. Technological disruption, although offering solutions through precision agriculture and biotechnology, also creates inequality of access and a digital divide.

3 Research Methods

This study uses a bibliometric analysis method to review scientific literature related to Zero Hunger in the period 2020–2024. The aim is to identify research trends, the most influential authors and institutions, and thematic clusters through keywords and co-citations. Data were collected from the Scopus database with the keyword "Zero Hunger", covering 190 reputable scientific articles analyzed using VOSviewer software, to visualize keyword relationships, author collaborations, and thematic networks (Zakiyyah et al., 2022). The research process consists of three stages: data collection, processing using VOSviewer, and visual analysis in the form of networks, overlays, and density visualizations. The results of the analysis include the number of publications, citation rates, relationships between researchers (co-authors), and relationships between keywords (co-occurrence) (Fiandari, 2022). Cluster visualization of this data is the basis for mapping the dynamics of research related to food security, technology, climate change, and social issues relevant to the goals of Zero Hunger.



Gambar 1. Research Design for Integrating SDGs into Business Model Strategy

Stage 1: Started with the collection of 190 scientific articles from the Scopus database using the keyword "Zero Hunger", which includes reputable international publications during the period 2020–2024. The data includes citations, authors, publishers, and abstracts, then stored in Excel or RIS format for further analysis.
Stage 2 : Involves data processing with VOSviewer software to map the relationship between keywords and authors. Visualization is done through network, overlay, and density visualization, which helps display thematic clusters and patterns of scientific collaboration.
Stage 3 : Focuses on the analysis of results in the form of the number of publications, citations, relationships between researchers (co-authors), and relationships between keywords (co-occurrence). These results describe the trend and development of Zero Hunger research as well as potential gaps in future studies.

4 Results and Discussion

1. Scopus Data Collection Results

The results of collecting articles based on the Google Scopus database using Vosviewer software from 2020-2024 in Table 1, the publication of articles on Student Worksheets contains 190 articles, 3075 citations.

2. Development of Scientific Publications

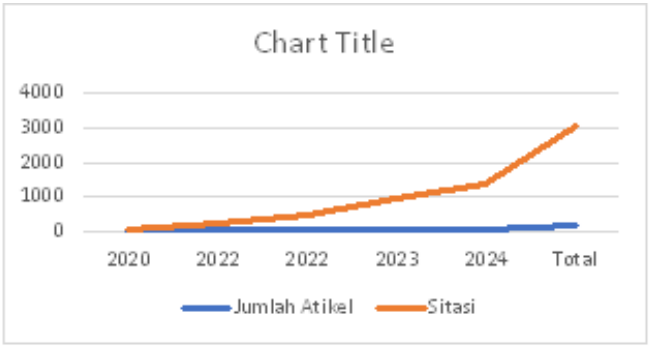
Looking at the results of the development of scientific publications on zero hunger from 2020-2024, there were 190 total publications published on Google Scopus in the following table

Tabel 1. Number of Publications and Citations

Year	Number of Articles	Percentage (%)	Citations	Percentage (%)
2020	21	11.05	29	0.94
2021	34	17.89	235	7.64
2022	38	20.00	483	15.71
2023	44	23.16	940	30.57
2024	53	27.89	1388	45.14
Total	**190**	**100**	**3075**	**100**

Source: Processed Primary Data, 2025

Based on the table above, there were 190 publications (11.05%) in 2020, 34 (17.89%) publications in 2021, 38 (20%) in 2022, 44 (23.16%) in 2023, and 53 (27.89%) in 2024. The citation results have the potential to increase in the observation year, namely 2020 to 2025. Large citations indicate that research is a source of reference for other research.



Gambar 2. Graph Curve of the Development of Scientific

Shows that the graph curve of the development of scientific publications from 2020-2024 always experiences a good increase. So we get the lowest publication in 2020, which is 21 publications, while the highest publication in 2024 is 53 publications

3. Map of Scientific Publication Development

Mapping the development of scientific publications using a binary calculation method with a minimum number of word displays of 10 out of 6059 words and only 99 meet the upper threshold while 59 words are selected. In the visualization there are nodes (circles) to indicate the author while edges (networks) are to determine the relationship between authors. The distance of the circles associated with the network indicates that the larger the circle, the more variables are studied simultaneously (Budianto & Dewi, 2023)

Gambar 3. Based

Based on Figure 3, the center of research related to zero hunger is the country where there are 5 clusters or groups marked with blue in group 1, red in group 2, green in group 3 and yellow in group 4. The results of network visualization using VOS Viewer show the relationship between variables/themes consisting of 59 variables where 23 variables are in cluster 1 dominated by the occurrence of Africa which is relevant to change and sustainability, 10 variables are in cluster 2 dominated by farmers, income and technology., 9 variables are in cluster 3 dominated by Covid, pancemic, and poverty, 9 variables are in cluster 4 Cluster 4 is dominated by the occurrence of household, region, woman. Cluster, 8 variables are in cluster 5 dominated by the occurrence of city, food insecurity, and relationship. Interconnected nodes form new findings from researchers.

Cluster 1 analysis highlights Africa as the region most vulnerable to climate change-induced food crises. Extreme droughts in Somalia and Madagascar, as well as adaptation of livestock production in South Africa, reflect systemic impacts on food security and sustainability. This situation is relevant for Indonesia, which faces similar challenges, especially in the eastern region (Abdullahi et al., 2024). Adaptive strategies such as climate-resilient agriculture, local food diversification, and community approaches are needed to strengthen national food security sustainably. Cluster 2, Digital transformation of agriculture in Indonesia increased between 2020–2024, but has not touched the roots of structural inequality. Modern agricultural technology tends to benefit commercial farmers, while smallholder farmers still face barriers to accessing markets, capital, and information. Digitalization such as the Farmer Card has not had a significant impact on welfare. To achieve Zero Hunger, technological transformation must be inclusive and based on local needs, not just universal solutions that are superficial (Koopman et al., 2023).

Cluster 3, The COVID-19 pandemic exacerbates food security and poverty, especially for poor and vulnerable households. Income declines, layoffs, and food inflation increase food insecurity, especially in semi-urban areas. Despite a decline in the national poverty rate by 2024, extreme poverty and inequality remain structural barriers (Hasudungan et al., 2024). Factors such as low education and informal employment exacerbate vulnerability, requiring more comprehensive social interventions. Cluster 4, Household food security is strongly influenced by education, employment, and gender roles. Women play a critical role in maintaining family food security, especially in vulnerable areas such as Central Java. However, regional disparities and unequal access to assistance and infrastructure are major challenges. Although the food security budget increased in 2024, the effectiveness and distribution of programs remain uneven, especially in areas with limited infrastructure. Cluster 5, Urban areas experienced a spike in food insecurity during the pandemic, with young and low-income households being the most affected. Difficulties in accessing nutritious food are caused by limited income and market dependence. Although the government has increased the food security budget and launched programs such as food estates, their effectiveness is still questionable due to challenges in distribution, infrastructure, and potential environmental and social impacts.

5 Conclusion

A global bibliometric analysis of the 2020–2024 literature on the theme of Zero Hunger reveals that the issue of food security has become a cross-dimensional issue that is heavily influenced by climate change, technological inequality, the pandemic, social inequality, and gender roles. In general, studies from

various regions, both Africa and Indonesia, show that the climate crisis exacerbates food vulnerability, especially in areas with limited infrastructure and resources. Digital transformation in the agricultural sector does show potential, but the distribution of benefits is very unequal, benefiting large agribusiness actors more than small farmers. The COVID-19 pandemic has deepened food insecurity in urban areas and exposed the vulnerability of poor households without adequate social protection. On the other hand, the role of women has proven crucial in maintaining family and community food security, but has not been balanced by policies that strengthen their capacity systemically. Inequality between regions and weak governance of food aid distribution show that national approaches are not yet responsive enough to local realities. Therefore, to truly approach the target of Zero Hunger by 2030, a global and national approach is needed that is inclusive, community-based, sustainability-oriented, and sensitive to social, economic, and ecological diversity.

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masa krisis adalah kelompok yang paling rentan mempertahankan terutama dan dapat konsumsi dalam hal tetap sehat pemenuhan kualitas nutrisi pangan agar menjalankan aktivitas sehari-hari . Pada beberapa kasus kemiskinan di Kota Bandung , pemenuhan nutrisi konsumsi pangan tahun 2021 mengalami penurunan adaptasi menurunnya sebagai bentuk pendapatan makanan olahan dengan gizi rendah (FAO , 2020). Pertumbuhan ekonomi yang begitu pesat di daerah perkotaan tidak sebanding peningkatan asupan gizi penduduk rentan perkotaan , terutama bagi penduduk berpenghasilan rendah yang dalam memenuhi ketahanan pangannya . Pandemi Covid-19 yang melanda dunia berdampak kepada disparitas akses pangan penduduk dan menjadi masalah serius di perkotaan (Kar et al ., 2021 ; O ' Hara Toussaint , tidak terkecuali Kota Bandung yang terjadi sejak pertengahan Maret 2020 sampai keluarga akibat dari pengangguran yang meningkat di perkotaan (Hasanah et al ., 2021 ; O ' Hara & Toussaint , 2021). Kota Bandung pada saat pandemi (tahun 2020) mengalami kenaikan jumlah penduduk miskin sebagai dampak dari peningkatan menganggur . meingkat angkatan Tingkat tinggi kerja yang pengangguran dibandingkan lebih tingkat kemiskinan pada tahun 2020 (lihat Gambar 1). Banyak rumah tangga yang kehilangan mata. 8(2), 680–699.

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CITATION:

Fitri wahyuningsih (2025). Food Security and Sustainability Amidst Climate, Technology, and Pandemic Crises: A Global Bibliometric Analysis and Implications for Indonesia . *OASE, 7*(1), 178–183.