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Analysis of Public Behavior Regarding Food Waste

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Abstract. *In this study, bibliometric analysis using VOSviewer and Publish or Perish was employed to identify dominant trends in the analysis of community behaviors related to food waste. The analysis results indicate an increasing interest among researchers in understanding and addressing the social, cultural, and psychological factors influencing food waste behaviors within communities. There has been a paradigm shift in research emphasis from individual factors towards a more comprehensive understanding of the social and cultural contexts that affect food waste behaviors. This research focuses more on developing effective and sustainable food waste reduction strategies at the community level through promoting supportive policies, public education, social campaigns, and participatory approaches. In conclusion, this study contributes significantly to understanding the dominant trends in community behavior analysis related to food waste. The findings provide valuable insights for researchers and practitioners in further research development and assist in formulating policies and strategies for more effective community-level interventions against food waste, with a focus on the social and cultural factors influencing food waste behaviors.*

Keywords: *Bibliometric Analysis; Scientometrics; Food Waste; Vos Viewer; Publish Or Perish; Community Behavior.*

1. INTRODUCTION

Food waste is a serious global issue with significant impacts on the environment and society, causing substantial resource losses and contributing approximately 15-16% of the total environmental impact of the food supply chain, equivalent to about 186 million tons of CO2 per year. Specific process-oriented and technology-based innovations are often identified as suitable strategies to reduce waste production and enhance waste management.There is a need to increase public awareness of the social and environmental impacts of food waste to enhance awareness of the consequences of wasteful behavior. Food waste involves materials that should be consumed by humans but are ultimately neglected, lost, spoiled, or contaminated.Food waste, a sustainability issue that needs addressing, has negative impacts on the economy, environment, and society, primarily caused by excessive consumption in developed countries. Food waste generated in households is one of the major contributors to the total amount of food waste.The fundamental factors influencing global food waste require solution approaches focused on direct communication and increasing consumer awareness to reduce it. Roughly one-third of the total global food production each year is lost or wasted. Between 2012 and 2015, ISuN implemented participatory concepts in three projects to reduce food waste and losses in production and consumption. Food waste management involves various stakeholders and levels to prevent and reduce food waste through diverse

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measures. Food waste impacts society, the environment, and the economy in both developing and developed countries. The COVID-19 pandemic has increased public awareness of food waste, prompting efforts to reduce it. Effectively managing food waste can reduce costs, enhance brand reputation, and demonstrate commitment to environmental sustainability for hotel owners and culinary managers. Intention to reduce waste and wise food shopping habits during promotions are associated with economic reductions in food waste during the COVID-19 pandemic. Impulsive purchasing behavior, often occurring without careful consideration, can exacerbate food waste by triggering unplanned and unnecessary purchases. Some processes were previously discontinued or continued with significantly different requirements. Bibliometric analysis is a quantitative method for analyzing bibliographic data of articles and journals, including formulating research questions, searching for studies, selecting studies, and evaluating as well as analyzing selected papers. Bibliometrics is a method involving statistical analysis of published articles and their citations to assess their impact Bibliometric analysis uses mathematics and statistics to quantitatively measure the impact of research, facilitating objective comparisons over other subjective methods. Bibliometric analysis uses online data to evaluate the impact of research and raises questions about its potential usefulness as a relevant data source for scientists. The profile page lists publications and links to co-authors' profiles, and provides email notifications to follow new research in the specialization field or updates in article citations. VOSviewer is software for constructing and visualizing bibliometric networks, as well as for identifying potential topics and highly cited references in specific fields. When creating a bibliometric map, keyword frequencies are adjusted as desired, and irrelevant or less relevant keywords are deleted. Based on the connections between existing items, VOSviewer creates three different types of mappings: network visualization, density visualization, and overlay visualization.

2. LITERATURE REVIEW

Food Waste

Food waste involves materials that should be consumed by humans but are ultimately ignored, lost, spoiled, or contaminated(Girotto et al., 2015). Food waste, as a complex issue affecting sustainability, has significant economic, environmental, and social impacts, especially due to the substantial contribution of consumers in developed

countries. Food waste generated in households is one of the major contributors to the total amount of food waste. Global factors influencing post-consumption food waste demand solutions focused on direct communication and increasing consumer awareness about reducing food waste. According to the Food and Agriculture Organization, about a quarter of the food wasted each year could meet the food needs of all hungry people worldwide. The participatory concept has been developed and implemented in three projects by iSuN between 2012 and 2015 with the aim of reducing food waste and food losses at the production and consumer levels. Food waste management is seen as an effort involving multiple stakeholders and various levels to prevent and reduce food waste through diverse measures. Food waste is influenced by environmental factors such as climate change and pollution of air, water, and soil, as well as social factors such as population growth and new consumerism trends.

Bibliometric Analysis

Bibliometric analysis uses a quantitative approach to analyze bibliographic data of articles and journals, including formulating research questions, literature search, study selection, as well as evaluation, analysis, and synthesis of selected papers. Bibliometrics involves statistical analysis of published articles and their citations to evaluate their impact. Bibliometric analysis utilizes mathematical and statistical analysis to quantitatively measure the impact of research, enabling easier objective comparisons compared to other subjective methods.

Google Scholar as a Research Data Provider

Google Scholar, as a research data provider, facilitates searching educational materials in various publication formats. Its launch marked the beginning of a significant change in the scholarly information market. Unlike conventional databases, this search engine automatically indexes information from sources on the academic web, allowing for easy and fast access. The presence of citation counts in search results and additional products like Google Scholar Metrics and Google Scholar Citations raise questions about its potential as a data source for bibliometric analysis.

VOS Viewer as a Research Tool

VOSviewer is software for constructing and visualizing bibliometric networks, exploring new research opportunities and frequently citing references in specific fields. It includes creating author or journal maps based on citation data, and keyword maps based on their frequency of occurrence, highlighting different aspects in various ways.

VOSviewer is used to create maps of publications, countries, or journals based on citation networks, and to construct keyword maps based on relationships between items. When creating bibliometric maps, keyword frequencies can be adjusted and less relevant keywords can be removed. VOSviewer uses item networks to create three different types of mappings: network visualization, density visualization, and overlay visualization. Before analysis, items that are less relevant to the topic are removed from the search results data in VOSviewer.

3. METHODS

This study utilized bibliometric analysis with the keyword "food waste" in September 2023 using Publish or Perish (PoP) software and Google Scholar (GS) database, limiting the search to articles from 2019 to 2023 with a maximum of 500 entries including scholarly journals and conference papers. Search results data, including author names, article titles, publication years, publisher names, citations, and article rankings, were saved in Research Information System (RIS) format. From the initial 500 articles, 303 relevant journal articles were filtered and saved in RIS files, with updated data to ensure accuracy regarding publication years, volume, issue number, and journal article pages.

4. RESULTS AND DISCUSSION

This section describes the findings of this study, including publications and citations, visualizations, authors, and networks.

Table 1. Matrix Comparison

Data	Initial Search Results	Refined Search Results
Database	Google Scholar	Google Scholar
Publication Year	2019-2023	2019-2023
Citation Year	5	5
Number of Articles	500	303
Total Citations	36589	25153
Citations per Year	9147.25	6288.25
Authors per Year	3.93	3.64
H-index	118	95
G-index	168	149
hI Normal	53	47
Annual hI	13.25	11.75

Source: Research data (2023)

From Table 1 above, it can be seen that over of 5 years (2019-2023), a total of 500 articles were obtained with 36,589 citations. Subsequently, we refined and reselected these search results by examining each article related to food waste. We obtained 303 selected articles with a total of 25,153 citations, averaging 6,288.25 citations per year and an average of 8806.49 authors each year. The productivity or impact measurement index of the published works by scientists or academics (Hirsch's h-Index) is 95.

Table 2. Publication Years

Year	TP	% (N=100)	NCP	TC	C/P	C/CP	h	g
2019	87	28.71%	87	9020	103.67	103.67	54	87
2020	99	32.67%	99	11941	120.61	120.61	54	99
2021	83	27.39%	83	3456	41.63	41.63	34	55
2022	29	9.57%	29	711	24.51	24.51	16	26
2023	5	1.65%	5	25	5	5	1	5
	303	**100%**		**25153**				

Note: TP = total number of publications; NCP = number of publications cited; TC = total citations; C/P = average citations per publication; C/CP = average citations per cited publication; h = h-index; and g = g-index.

Source: Research data (2023)

From Table 2 above, it can be seen that in 2020 had the highest number of publications, with 99 publications, while 2023 had the fewest publications, with only 5. The year 2020 also had the highest number of citations, with 11,941 citations, whereas 2023 had the fewest citations, with only 25.

Table 3. Document Types

Type	Number	Percentage
Article	295	97.35%
Conference Paper	0	0%
Book Chapter	0	0%
Book	8	2.65%
Note	0	0%
Editorial	0	0%
Erratum / corrigendum	0	0%
Survey	0	0%
	303	**100%**

Source: Research data (2023)

Based on Table 3, the document types we presented consist of original articles and book chapters. Summarizing in Table 4 above, 97.35% of the total publications amount to 295 journal articles, followed by 8 document sources originating from books (2.65%).

Table 4: Source Type

Tipe	Jumlah	Persentase
Journal	295	97.35%
Book	8	2.65%
	303	100%

Source: Research data (2023)

From Table 4 above, it can be observed that journals comprise the majority of documents, accounting for 97.35% or a total of 295 articles, while book chapters constitute only 8 articles, equivalent to 2.65%. To identify the most significant contributions in the related field, we selected the top 20 articles with the highest citation counts, the results of which are shown in Table 5.

Table 5. Top 20 Ranking of Articles with the Highest Citations

No	Cites	Authors	Title	Year	Journal Name	Publisher
1	870	CM Galanakis	The Food Systems in the Era of the Coronavirus (COVID-19) Pandemic Crisis	2020	Foods	MDPI
2	778	Serpil Aday, Mehmet Seckin Aday	Impact of COVID-19 on the food supply chain	2020	Food Quality and Safety	Oxford
3	578	Hari Bhakta Sharma, *et.al*	Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic	2020	National Library of Medicine	Elsevier
4	460	Sarra Jribi, *et.al*	COVID-19 virus outbreak lockdown: What impacts on household food wastage?	2020	Environment, Development and Sustainability	Springer Nature
5	433	Catherine Hua, *et.al*	The Future of Aquatic Protein: Implications	2019	One Earth	Cellpress

No	Cites	Authors	Title	Year	Journal Name	Publisher
			for Protein Sources in Aquaculture Diets			
6	427	Zhaoyu Zhai, *et.al*	Decision support systems for agriculture 4.0: Survey and challenges	2020	Computers and Electronics in Agriculture	Elsevier
7	379	Hannah Ritchie, *et.al*	Environmental Impacts of Food Production	2022	Our world in data	Our world in data
8	362	Rattan Lal	Home gardening and urban agriculture for advancing food and nutritional security in response to the COVID-19 pandemic	2020	Food Security	Springer
9	339	Charlene Li, *et.al*	Review of Online Food Delivery Platforms and their Impacts on Sustainability	2020	Sustainability	Springer Nature
10	327	Dieter Gerten, *et.al*	Feeding ten billion people is possible within four terrestrial planetary boundaries	2020	Nature Sustainability	Nature.com
11	317	P Sharma, JK Nayak	Review:Consumption-stage food waste reduction interventions – What works and how to design better interventions	2019	Food Policy	Elsevier
12	278	A. Nayak, Brij Bhushan	An overview of the recent trends on the waste valorization techniques for food wastes	2019	Journal of Environmental Management	Elsevier
13	271	Rovshen Ishangulyyev, *et.al*	Understanding Food Loss and Waste—Why Are We Losing and Wasting Food?	2019	Foods	MDPI
14	270	V Filimonau, A Delysia	Astro-tourism conceptualisation as special-interest tourism (SIT) field: A phenomenological approach	2019	Tourism management	Elsevier

No	Cites	Authors	Title	Year	Journal Name	Publisher
15	270	Carla Caldeira*,et.al*	Quantification of food waste per product group along the food supply chain in the European Union: a mass flow analysis	2019	Resources, Conservation and Recycling	Elsevier
16	265	Nitya Bhargava,*et.al*	Active and intelligent biodegradable packaging films using food and food waste-derived bioactive compounds: A review	2020	Trends in Food Science & Technology	Elsevier
17	264	Dominika Alexa Teigiserova, *et.al*	Towards transparent valorization of food surplus, waste and loss: Clarifying definitions, food waste hierarchy, and role in the circular economy	2020	Science of The Total Environment	Elsevier
18	262	R. Aldaco,D. Hoehn, *et.al*	Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach	2020	National Library Medicine	Elsevier
19	243	Patricia Müller, Markus Schmid	Intelligent Packaging in the Food Sector: A Brief Overview	2019	Foods	MDPI
20	238	Antonella Zucchella, Pietro Previtali	Circular business models for sustainable development: A “waste is food” restorative ecosystem	2019	Business Strategy and Environment	Wiley

Source: Research data (2023)

Based on the data in Table 5 above, it is known that an article titled "The Food Systems in the Era of the Coronavirus (COVID-19) Pandemic Crisis" by CM Galanakis, published in the journal Foods in 2020, has been cited the most by other authors, with 870 citations. The journal article "Circular business models for sustainable development: A 'waste is food' restorative ecosystem" by Antonella Zucchella, Pietro Previtali, published by Wiley in 2019, has the lowest number of citations, with 238 citations. Elsevier is the publisher with the highest number of journal publications, totaling 152,

followed by MDPI with 43 publications, Springer with 27 publications, Wiley with 10 publications, and Taylor&Francis with 6 publications.

Table 6. Top Five Publishers

No	Publisher	Number of Articles	Percentage
1	Elsevier	152	63.86%
2	MDPI	43	18.06%
3	Springer	27	11.34%
4	Wiley	10	4.20%
5	Taylor&Francis	6	2.52%
		238	100%

Source: Research data (2023)

From Table 6 above, we found that 63.86%, totaling 152 articles, were published by Elsevier, which is one of the leading international journal publishers focusing on food waste. The second-highest number of articles, 43 in total or 18.06%, were published by MDPI. Additionally, we identified 27 articles published by Springer, accounting for 11.34%. Wiley contributed 10 articles, equivalent to 4.20%, and Taylor&Francis published 6 articles, equivalent to 2.52%.

Table 7. Top Five Ranked Journals

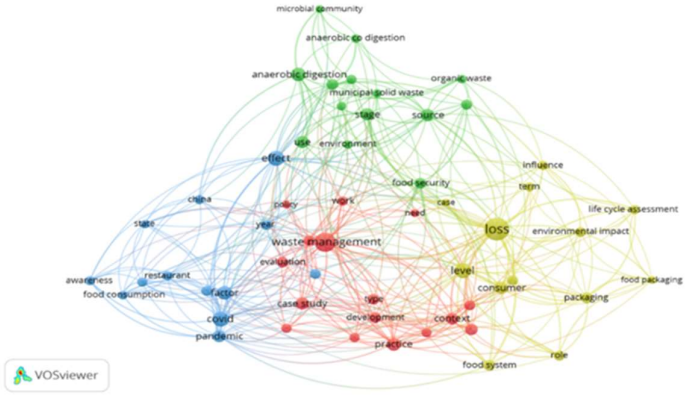
No	Journal Name	Number of Articles	Percentage
1	Journal of Cleaner Production	30	9.90%
2	Sustainability	23	7.59%
3	Resources, Environment and Sustainability	16	5.28%
4	Science of The Total Environment	14	4.62%
5	Waste Management	11	3.63%
6	Jurnal Lainnya	209	68.97%
		303	100%

Source: Research data (2023)

From Table 7 above, it is evident that the Journal of Cleaner Production is the most active journal in publishing articles related to the field of food waste, specifically the theme "Food waste," with a percentage of 9.90%. Sustainability follows with a percentage of 7.59%, and Resources, Environment, and Sustainability have 16 articles, totaling 5.28%. The Science of the Total Environment contributed 14 articles, equivalent to 4.62%. Waste Management contributed 11 articles, accounting for 3.63%. A total of

209 articles detailed in other journals, or 68.97%, were published by managed journals from a higher education institution.

Figure 2. Visualization of topic areas using network visualization



Source: Research data (2023)

Visualization using networks indicates that in this context, waste management, especially concerning food utilization, is the primary focus or has a significant impact in the analysis conducted.

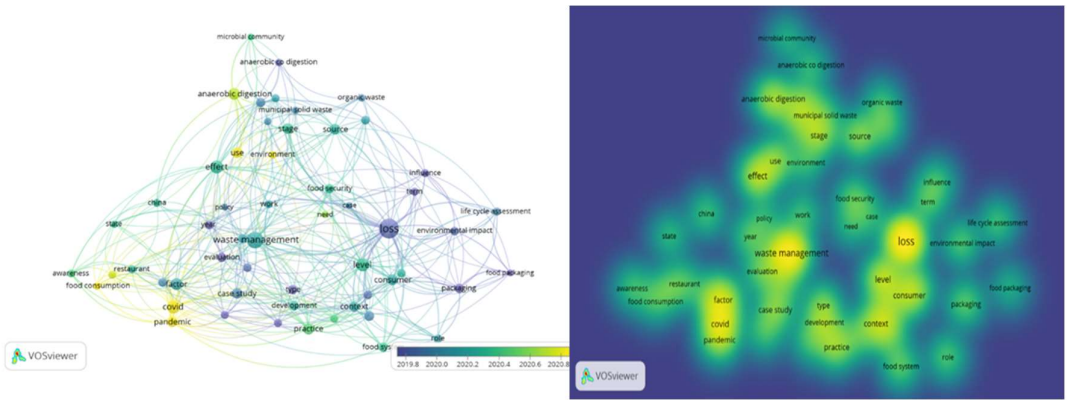
Table 8. Keywords Representing Each Cluster

No	Cluster Item Count	Element
1	10	Agricultural waste, Anaerobic co-digestion, Anaerobic digestion, Biochar, Biogas, Food wast anaerobic digestion, Municipal solid waste, Organic waste, Sewage sludge, Treatment
2	14	Consumer, Environmental impact, Food chain, Food insecurity, Food loss, Food packaging, Food production, Food sector, Food security, Food system, Food supply, Lifecycle assessment, Loss, Packaging
3	9	Agri-food waste, Food industry, Food processing waste, Food waste prevention, Food waste reduction, Human consumption, Kitchen waste, Policy, Systematic review
4	7	Circular economy, Critical review, Food waste composting, Food waste treatment, Food waste valorization, Influence, Opportunity
5	7	Attitude, Awareness, Covid, Food consumption, Food waste behaviour, Food waste generation, Restaurant

Source: Research data (2023)

From Table 8 above, there are a total of 5 clusters formed, each with their respective terms. Furthermore, Figure 5 below presents the visualization of topic areas based on overlay visualization.

Figure 3. Visualization of topic areas using overlay visualization and density visualization



Source: Research data (2023)

From Figure 3 above, it can be seen that food waste remains relevant during the COVID-19 pandemic and continues to be the focus of intensive research. Recent research in this field highlights aspects such as food security, food systems, awareness, life cycle assessment, and food packaging, while older research tends to focus on waste management, losses, consumer behavior, and environmental impacts. The data includes country locations and research domains, providing information on where the research was conducted and the fields or topics studied.

Table 9. Research Location Countries and Research Domains

No	Country	Number of Articles	Research Domain
1	Canada	2	Accounting and policy analysis for reducing food waste.
2	United Kingdom	13	Sustainable strategies for waste.
3	Switzerland	3	Evaluation of daily per capita food waste, technological innovations in the HORECA sector to reduce food waste, and the use of self-report methods such as questionnaires and journals in food waste research.
4	Italy	14	Causes, mitigation, strategies, evaluation, systematic approaches, consumer behavior, factors, management, innovative business models, reverse logistics, valorization through technology, and the impact of nudge related to food waste.
5	India	9	Innovations in food waste management through microorganism technology, eco-friendly packaging, conversion into fuel, and supply chain optimization using IoT and Machine Learning technologies.

No	Country	Number of Articles	Research Domain
6	US	13	Consumer behavior and knowledge, impact of food waste on emissions, reduction campaigns, COVID-19 impact, supply chain analysis, technology, food distribution networks, as well as psychological and educational aspects.
8	Findland	4	Management of food waste in hotels, circular economy to reduce household food waste, startup communication on food waste solutions, and efforts to reduce food disposal in agriculture and horticulture sectors.
9	Pakistan	2	Factors driving household consumer participation in food waste reduction.
10	Turkey	2	Limbah makanan di Turki dan sistem inovatif pengelolaannya memiliki dampak lingkungan yang signifikan.
11	Spain	5	Valorization of food waste for value-added products, omnivore-univore theory in food tourism, and the impact of COVID-19 on food wastage and greenhouse gas emissions are key topics of discussion.
12	German	6	Gender and attitudes towards food wastage, utilization of insects to reduce waste, self-reporting interventions in hotel kitchens, the impact of COVID-19 and digital technology on food waste, as well as prevention of food waste disposal at food service and municipal levels.
13	Denmark	5	Prevention of wastage, utilization of food waste, sustainability analysis, and anaerobic digestion microbiology.
14	Republic of Korea	1	Pyrolysis of food waste as an environmentally friendly solution to produce high-value products.
15	Norway	2	Household food waste and reduction by consumers.
16	Australia	6	Food wastage in niche tourism and households in Australia, holistic approaches, consumer roles and acceptance, and anaerobic digestion trends.
17	China	10	Reduction and recycling of food waste, anaerobic digestion in China, restaurant awareness, environmental impact, and biogas plant design.
18	Sweden	3	Food waste reduction in Swedish retail and catering units using smart scale technology, and utilization of waste in the circular economy.
19	Netherlands	4	Validity of measurement methods, influence of religious beliefs, and retailer strategies and partnerships in the hospitality industry to reduce food waste.
20	Mexico	1	Aquafaba, the liquid waste from cooking chickpeas, is utilized as a

No	Country	Number of Articles	Research Domain
			sustainable food additive, enhancing the value and sustainability of the chickpea industry.
21	Lebanon	1	Utilization of food waste as animal feed.
22	Uruguay	1	Perceptions and driving factors influencing household food waste in Uruguay.
23	Serbia	1	Respondents' attitudes towards food waste, the amount of food and packaging waste discarded in Serbia.
24	Bosnia and Herzegovina	1	The campaign to reduce food waste in the university dining hall was successful through the collection, sorting, and weighing of customers' food waste over one semester.
25	France	2	Comparison of household food waste interventions and the use of photography to measure it.
26	Malaysia	4	Composter design, factors and identification of causes of food waste in island hotels, and recommendations for reduction strategies.
27	Sovakia	1	The issue of food waste and solutions to reduce it within the context of environmental sustainability.
28	Moldova	1	The issue of food waste as a global problem that is increasingly important on the public and political agenda.
29	Czech	1	The issue of food waste affecting entire communities.
30	Hungary	1	Exploring behavioral patterns behind household food disposal using PLS-SEM (Partial Least Squares Structural Equation Modeling).
31	Portugal	2	Measuring food waste in care institutions and valorizing food waste to reduce global hunger.
32	Pakistan	1	Identifying and prioritizing barriers in the transition process from a linear economy to a circular economy in food waste management.
33	Japan	1	Utilizing food waste for plant growth.
34	Brasil	1	The role of technology in reducing food waste in supply chains in developing countries.
35	Taiwan	1	Processing household food waste to produce organic fertilizer using a kitchen waste disposer device.
36	Colombia	1	Environmental technology, focusing on organic food waste processing

Source: Research data (2023)

Based on the analysis in Table 9, research on food waste is most conducted in Italy with 14 articles, focusing on factors causing food waste, interdisciplinary

collaborations, strategies for reducing food waste in food service outlets, and frameworks for evaluating food waste prevention.

5. CONCLUSION

Research on food waste remains a relevant and intensively studied topic, especially in the context of the COVID-19 pandemic. This topic encompasses various aspects, including waste management, losses, consumer behavior, environmental impacts, as well as strategies for reducing and preventing food waste. While issues related to waste management and losses still dominate attention, research is also beginning to broaden its focus to other aspects such as food security, food systems, life cycle assessment, and food packaging. Major publishers like Elsevier, MDPI, and Springer publish a significant portion of research related to food waste. Journals like the Journal of Cleaner Production, Sustainability, and Resources, Environment, and Sustainability serve as important platforms for publishing research in this domain. Italy and the United States show high research activity related to food waste. However, other countries also contribute to research in this domain, albeit to a lesser extent.

6. LIMITATION

Further research is needed to understand new aspects of food waste, including food security, food systems, and life cycle assessment. Interdisciplinary collaboration should be encouraged to generate holistic solutions to address this issue. Public education on the importance of reducing food waste needs to be enhanced, while educational and research institutions should provide greater support in terms of funding and facilities. Research findings can serve as a basis for developing more effective policies to tackle food waste at local, national, and international levels.

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