QUANTIFYING FOOD LOSS AND WASTE: A BIBLIOMETRIC ANALYSIS FROM 1970 TO 2023

Paul-Alexandru ȘTEFAN

"Alexandru Ioan Cuza" University, 11, Carol I Boulevard, Iași, 700506, Romania, Phone: +40757068817; E-mail: stefan.paul.alexandru@gmail.com

Corresponding author: stefan.paul.alexandru@gmail.com

Abstract

This study conducts a bibliometric analysis of food loss and waste (FLW) research from 1970 to 2023, aiming to map key trends, influential authors, and foundational papers. Using Scopus and Web of Science databases, quantitative citation and co-citation analyses were employed to identify core themes and research clusters. The analysis revealed a significant increase in FLW publications post-2015, indicating heightened global awareness. China, the USA, Italy, and India emerged as leading nations in FLW research. The study highlights key journals, with "Waste Management" and "Bioresource Technology," are identified as central to disseminating influential research. Keyword analysis reveals "food waste" and "anaerobic digestion" as the most recurrent terms, indicating significant research focus areas. This study not only maps the current state of FLW literature but also identifies critical gaps and suggests future research trajectories. It underscores the imperative for interdisciplinary collaboration, integrating technological, ecological, and socio-economic perspectives to address the multifaceted challenges posed by FLW.

Key words: *food loss and waste, FLW, food supply chain, bibliometric analysis, sustainability*

INTRODUCTION

There has been a global increase in food waste and loss trends, especially in China and Asia. Research on energy-value systems utilizing food loss and waste (FLW) has risen since 2010 [18]. Parfitt et al. [30] provided crucial insights into food waste within food supply chains (FSCs) and strategies to address it by 2050, establishing a foundational basis for further research. The Food and Agriculture Organization (FAO) reports that 1.3 billion tons of food, or one-third of the food produced for human consumption, is wasted annually. This waste includes 45% of fruits and vegetables, 35% of fish and poultry, 30% of cereals, and 20% of meat and dairy products, resulting in 3.3 billion tons of CO_2 emissions and financial losses exceeding $800 billion [10]. Food losses (FL) involve crops and livestock removed from the supply chain due to various methods, while food waste (FW) includes food and inedible components removed from the human FSC through various waste disposal methods [39]. The primary determinants of FLW include macroeconomic conditions, policy frameworks, socio-cultural norms, urbanization trends, infrastructure investments, globalization dynamics, industry consolidation, and prosperity. These factors influence all stages of the FSC, contributing to inefficiencies and pressures that significantly cause FLW. Additionally, infrastructure adequacy, waste management services, cultural identity, health considerations, and lifestyle choices at the retail and consumer levels further drive FLW [35]. Recognizing the urgent environmental, social, and economic concerns of FLW, multiple sectors, including governments, businesses, NGOs, academia, and the public, are increasingly collaborating to address these challenges [24]. Raising public awareness and providing education on the issue of food waste are essential tactics in tackling the problem of FLW [26].

Up to the present time, there is no universally accepted definition of FLW [1], making it challenging to quantify FLW, carry out related research, and establish specific policy goals. Various terms, such as food waste, food loss, post-harvest loss, spoilage, food and drink waste, bio-waste, and kitchen waste, are

utilized interchangeably [33]. These terms may represent distinct concepts. A significant issue arises when translating such terms into another language, particularly from the original language of the author to English for global dissemination [33]. Nonetheless, numerous organizations have introduced and employed their own definitions in their research endeavors.

The definitions are similar in conveying the reduction in the quantity or quality of food intended for human consumption. Nonetheless, variations exist in the consideration of external factors and in defining the connection between Food Waste (FW) and FL [19]. As per the FAO, FL occurs in the initial three stages of the FSC, while FW denotes the wastage at the concluding stage. Under this definition, FW is associated with the behavior of retailers and consumers [12]. In the context of FUSIONS EU, all losses and waste are categorized as FW without the use of FL terminology. Food Use for Social Innovation by Optimising Waste Prevention Strategies EU (HLPE) identifies FL as a decline in the initial four stages of the FSC, with FW referring to a decrease solely in the final stage, linked exclusively to consumer behavior [17]. United States Department of Agriculture (USDA) views FW as a subset of FL, with FL representing a reduction in food across the FSC [6].

Despite valuable insights into FLW quantification, several knowledge gaps and future research directions remain. Comprehensive and standardized methods for quantifying food waste across FSC stages are needed. Understanding the socio-economic and cultural determinants of FLW is crucial for developing targeted interventions. Future research should also explore technological innovations, supply chain optimizations, and policy interventions to reduce FLW.

Generally, FL is a greater concern in developing nations, while FW is more common in industrialized nations [11], indicating that in developed nations, the primary emphasis ought to be placed on the reduction of food wastage, while in developing countries, the focus should be on the minimization of food losses [29]. A 2008 U.S. study estimated FL at retail and consumer levels cost $165.6 billion, translating to 124 kilograms of food lost per person [7]. In the hospitality industry, 20% of prepared meals were wasted, with an average of 192 grams per person per meal in Finland, Germany, Sweden, and Norway [24]. Household FW per person was approximately 136 grams in the UK, 50 grams in Germany, and 76 grams in Italy [14], [22], [23].

Five primary clusters associated with patterns of behavior regarding food waste were identified through a study in Romania via statistical analysis. These clusters show differences in eating habits and various factors studied [27]. These findings provide valuable insights for policymakers and stakeholders to develop targeted interventions for specific demographic groups [27].

The focus on FLW has greatly impacted low to middle-income nations, emphasizing the need to reduce harvest and post-harvest losses. This focus has led to incentives to minimize consumer waste. Research and international bodies are developing frameworks, methodologies, and policies to reduce FLW. The Malabo Declaration and the 2030 Sustainable Development Agenda aim to halve post-harvest losses and reduce global FW by 2030 [9]. Economic growth, rising incomes, and a declining Engel coefficient have contributed to increased FW, while sustainable development demands emphasize reducing FW and utilizing waste resources [20].

FW prevention studies and initiatives focus on the final stages of the supply chain, addressing household FW practices and policy implications [4], [30], [32]. The UN's 17 Sustainable Development Goals (SDGs) include Goal 12, focusing on responsible consumption and production, aiming to reduce FL and FW along the production and supply chains by 2030 [38]. Collaborative efforts across governments, businesses, civil society, and individuals are crucial to achieve these targets, impacting other SDGs like ending hunger and tackling climate change.

This study maps specialized literature on FLW, identifying key research trends and features.

MATERIALS AND METHODS

A bibliometric analysis was conducted using resources from Scopus [34] and Web of Science (WoS) [40] databases, employing quantitative approaches to citation and co-citation evaluations. This technique relies on the idea that citations indicate intellectual communication between scholars and academic organizations [2]. Coauthorship is highlighted as a significant form of scholarly cooperation [42]. The methodology includes designing the research, gathering data, analyzing data, and visualizing findings to identify publication clusters, authors, and journals [3].

The analysis utilized Microsoft Excel and RStudio with the Bibliometrix package [3], which supports researchers by transforming data into R data frames and facilitating structured data management. The analysis involved descriptive analysis of publication datasets, co-citation, coupling, and collaboration analyses using matrices for network analysis, factorial analysis, and multidimensional scaling. These methods help examine and visualize relational structures within scholarly datasets, enhancing understanding of academic interconnections and collaborative patterns. Co-word analysis was also performed to explore relationships and thematic trends within the textual data.

The search criteria for this study included parameters such as subject area, publication language, geographical region, publication timeframe, and literature type. The focus was on English-language literature covering environmental, economic, and societal aspects, with a timeframe from 1970 to December 2023. Keywords used in the search included "food waste," "food loss," and "FLW", applied to the title, abstract, and author keywords. Additional keywords such as "measur*", "report*", "quanti*", "estimat*", "account*", and "assess*" ensured coverage of articles addressing the quantification of FLW.

The OR disjunctive logic connector was used to broaden the search, capturing a wide range of relevant articles. This resulted in 6,387 articles from the Scopus database and 6,324 articles from the WoS database, ensuring a comprehensive collection of literature relevant to the research topic.

The search outcomes from Scopus and WoS were exported in "bibtex" format for examination in Bibliometrix. Of the 12,711 articles found, 3,841 duplicates were removed using the "remove.duplicated" function in Bibliometrix. Further refinement using Biblioshiny eliminated 350 articles published in 2024 and 23 articles with missing data, resulting in 8,497 articles available for analysis.

RESULTS AND DISCUSSIONS

To address the research questions on food loss and waste (FLW), the data analysis was organized into key segments, focusing on: publishing year (Q1), associated authors' countries (Q2), the leading authors (Q3), most relevant sources (Q4), and most cited papers (Q5).

Up until 2002, the annual publication rate on food loss and waste (FLW) was low, peaking at 13 papers in 1997 (Fig.1), with some years, such as 1978 and 1985, having no publications. From 2002 to 2014, the annual publication count varied between 22 and 168 papers. A significant increase began in 2015, with publications rising from 306 to 1,348 papers in the year 2023. This indicates that 2015 marked a notable rise in FLW research, with over 1,000 papers published annually after 2020.
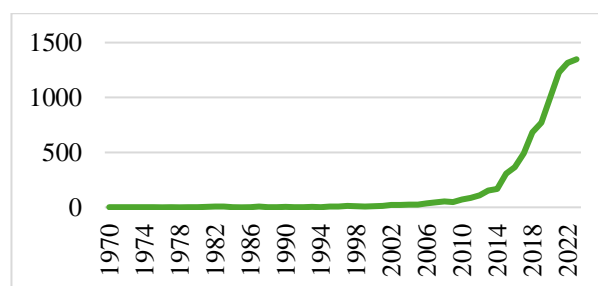

Fig. 1. Annual scientific production spanning from 1970 to 2023
Source: Own calculation on the basis of data from Scopus and WoS [34, 40].

It is important to note that a corresponding author's affiliation, including their country, can change over time. For this research, the

submission and/or acceptance date of the paper was used as a reference point, as it is often closely related to the research funding. By analyzing the data based on the corresponding author's country of origin (Fig. 2), it was possible to map out a global perspective on where FLW research is most concentrated. This analysis offered valuable insights into the geographical distribution of academic interest and expertise in the field.
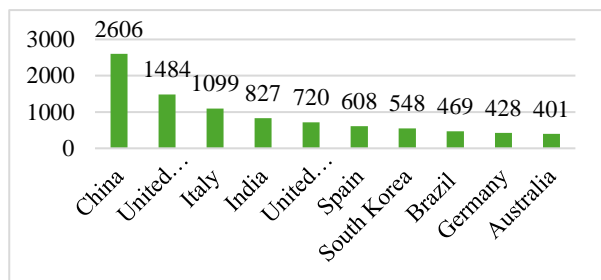

Fig. 2. Top 10 scientific production by country
Source: Own calculation on the basis of data from Scopus and WoS [34, 40].

As a result, when examining the criterion of the corresponding author's country, it was observed that with 2,606 publications, China has the highest number of scientific publications, suggesting a significant investment in the field of FLW, followed by USA (1,484), Italy (1.099), India (827), the United Kingdom (720), Spain (608), South Korea (548), Brazil (469), Germany (428) and Australia (401).

In the domain of FLW, scholars such as Li Y., Zhang Y., and Wang Y. (Table 1) have distinguished themselves through their prolific scholarly output, as evidenced by the enumeration of articles attributed to them.

Table 1. Top 10 most productive authors

Author	No. of Articles
Li Y.	125
Zhang Y.	102
Wang Y.	99
Liu Y.	96
Wang X.	75
Chen Y.	69
Li X.	67
Liu X.	64
Wang J.	63
Kim S.	59

Source: Own calculation on the basis of data from Scopus and WoS [34, 40].

The prevalence of such surnames intimates a possible geographical concentration of these academics in regions commonly associated with these surnames, potentially alluding to a robust contribution to the field emanating from nations such as China. This supposition is corroborated by the data presented in Fig. 2, which denotes China as the preeminent nation in terms of scholarly publications within this research area.

Fig. 3 provides a longitudinal depiction of scholarly productivity within the realm of FLW, showcasing the publication trajectories and the accrued citations annually for a cohort of eminent researchers. The durational breadth of the dataset implies a sustained academic tenure for the authors in question. Notably, the scholar Wang Y. manifests the genesis of their publishing efforts in the year 1997 [8] within the databases under analysis, culminating in a prolific zenith in 2023 with a total of 17 articles and a citation tally of 18 for that year. In a similar vein, the academic Li Y. reached an apogee in scholarly output in 2020, with 21 articles and an impressive citation count of 160,6 for the year, indicative of significant influence and recognition in the field.
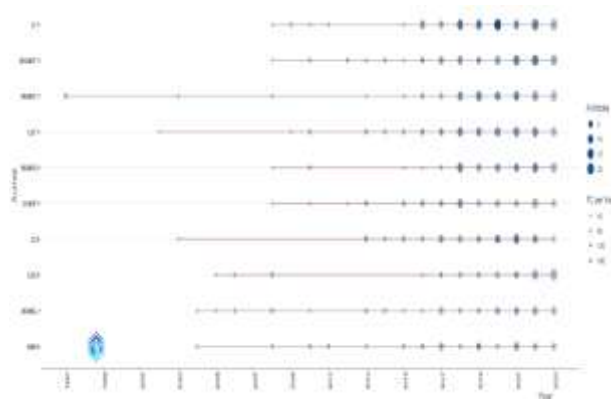

Fig. 3. Authors' production over time
Source: Visualization using Biblioshiny on the basis of data from Scopus and WoS [34, 40].

The temporal aggregation of the publication peaks across the top 10 authors, particularly within the years 2020 to 2023, suggests a crescendo in FLW research output. This surge aligns temporally with the promulgation of global sustainability objectives, which have galvanized academic inquiry into FLW,

emphasizing the nexus between food waste management and overarching environmental and sustainability imperatives.

The analysis of Scopus and WoS databases identified the most prominent journals in FLW research (Table 2). A few journals dominate the field, with "Waste Management" leading with 437 papers, highlighting its prominence and influence. This is followed by "Bioresource Technology" with 404 papers, "Journal of Cleaner Production" (395), "Sustainability Switzerland" (287), "Science of the Total Environment" (242), "Resources, Conservation and Recycling" (172), "Journal of Environmental Management" (164), "Foods" (114), "Sustainability" (113), and "Waste Management and Research" (94).

Table 2. Top 10 most relevant sources

Journal	No. of Articles
"Waste Management"	437
"Bioresource Technology"	404
"Journal of Cleaner Production"	395
"Sustainability (Switzerland)"	287
"Science of the Total Environment"	242
"Resources, Conservation and Recycling"	172
"Journal of Environmental Management"	164
"Foods"	114
"Sustainability"	113
"Waste Management and Research"	94

Source: Own calculation on the basis of data from Scopus and WoS [34, 40].

The variety of these journal titles, such as "Bioresource Technology," "Journal of Cleaner Production," and "Science of the Total Environment," indicates that FLW research is interdisciplinary, encompassing technology, environmental science, and sustainable practices.

Focusing on citation counts provides insight into the influence and reach of specific articles in the field of FLW (Table 3). It highlights key contributions that have shaped the discourse and research, as well as the most recognized and referenced papers by the academic community. By identifying these highly cited articles, we gain a clearer understanding of the pivotal research and seminal works driving advancements in FLW quantification.

The paper "Options for keeping the food system within environmental limits" by Springmann et al. [36] tops the list with 1,561 citations. It is followed by "Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use" by Kummu et al. [21] with 843 citations, and "Characterization of food waste as feedstock for anaerobic digestion" by Zhang et al. [41] with 823 citations. The highest citation counts come from "Nature" (1,561 citations), "Science of the Total Environment" (843 citations), and "Bioresource Technology" (823 citations), indicating the significant impact and relevance of these journals in the research community.

Table 3. Top 10 most frequently cited articles

Scopus titles	Authors	Citations
"Options for keeping the food system within environmental limits" [36]	Springmann, M. et al. (2018)	1,561
"Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use" [21]	Kummu, M. et al. (2012)	843
"Characterization of food waste as feedstock for anaerobic digestion" [41]	Zhang, R. et al. (2007)	823
"The food waste hierarchy as a framework for the management of food surplus and food waste" [28]	Papargyropoulo, E. et al. (2014)	785
"Hydrogen production from agricultural waste by dark fermentation: A review" [15]	Guo, X.M. et al. (2010)	658
"Determinants of consumer food waste behaviour: two routes to food waste" [37]	Stancu, V. et al. (2016)	618
"Diversification practices reduce organic to conventional yield gap" [31]	Ponisio, L.C. et al. (2014)	537
"The Food Systems in the Era of the Coronavirus (COVID-19) Pandemic Crisis" [13]	Galanakis, C.M. (2020)	523
"Importance of food-demand management for climate mitigation" [5]	Bajželi, B. et al. (2014)	514
"The Progressive Increase of Food Waste in America and Its Environmental Impact" [16]	Hall, K.D. et al. (2009)	505

Source: Own calculation on the basis of data from Scopus and WoS [34, 40].

There is an overlap between the top 10 most relevant sources and the journals listed in the top 10 most cited papers. Specifically, "Bioresource Technology" with 404 papers, "Journal of Cleaner Production" with 395 papers, "Science of the Total Environment" with 242 papers, and "Foods" with 114 papers are on both lists. The most cited articles cover themes such as the environmental impact of food waste, sustainable food systems, food waste hierarchy, and food-demand management. This diversity emphasizes the blend of environmental, technological, and socio-economic perspectives in FLW research. The international authorship of these papers signifies global concern and collaborative efforts in addressing FLW.

Aria and Cuccurullo [3] proposed a mathematical framework for analyzing bibliometric networks, which is instrumental in understanding various relational aspects in bibliometric studies. Their approach is encapsulated in several equations, each tailored to analyze a different type of bibliometric network:

Equation for coauthorship/collaboration network (B_{coll}):

$$B_{coll} = A \times A^t \quad [3] \dots\dots\dots\dots\dots\dots\dots(1)$$

Here b_{ij} demonstrates the quantity collaborations between countries i and j, highlighting coauthorship networks.

Equation for keyword co-occurence network (B_{coocc}):

$$B_{coocc} = A \times A^t \quad [3] \dots\dots\dots\dots\dots\dots\dots(2)$$

where:
A and A^t are matrices of the type "Document x Word", where "Word" may be terms taken from the titles or abstracts, authors' keywords, or keywords. The element b_{ij} shows the quantity of occurrences between words i and j, hence mapping the network of co-occurrences of keywords.

These equations are fundamental in bibliometric analyses for constructing and interpreting various bibliometric networks, such as bibliographic coupling, cocitation, collaboration, and keyword co-occurrence networks. They offer a quantitative way to analyze and visualize the relationships and interconnections within a set of documents, authors, or keywords.

The concept of a scientific network of authors, where nodes represent specific authors grouped by criteria such as country or institution [25]. Links between these nodes indicate collaborative relationships, typically shown by coauthorship on research papers. In this study, coauthorship analysis was conducted to illuminate collaborative links between authors across different countries. Using Biblioshiny, 8,497 records were examined to map the international landscape of author collaborations. The analysis identified authors from 123 countries, with 50 countries chosen for representation, showing the strongest interconnections in collaboration.

The analysis revealed (Fig. 4) that authors from China, the USA, the UK, and Italy have the highest levels of international collaboration. Four author collaboration clusters were identified:
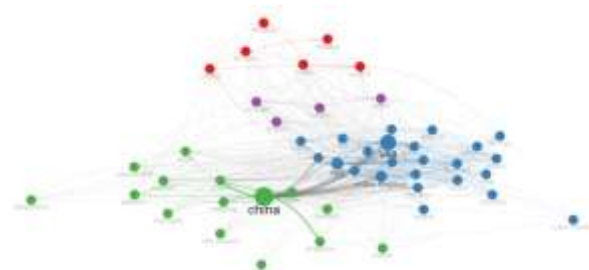

Fig. 4. Countries collaboration
Source: Visualization using Biblioshiny on the basis of data from Scopus and WoS [34, 40].

Green cluster: China, India, Thailand, Singapore, Finland, New Zealand, South Korea, Pakistan, Bangladesh, Saudi Arabia, Egypt, Indonesia, and Malaysia.
Blue cluster: USA, UK, Italy, Ireland, Netherlands, Switzerland, Austria, Belgium, Japan, Australia, Spain, Canada, Colombia, Sweden, Mexico, Norway, France, Denmark, Germany, Chile, South Africa, Nigeria, and Iran.
Red cluster: Poland, Romania, Lithuania, Serbia, Slovenia, and Croatia.

Purple cluster: Portugal, Brazil, Greece, and Hungary.

This study's keyword co-occurrence analysis aimed to explore and highlight relationships between essential keywords used by authors in research papers, referred to as Author Keywords (AKs). Unlike other bibliometric analyses that start with bibliographic references, this analysis focused directly on these keywords. The co-word network visualization showed how frequently certain keywords appeared together, creating a network of related terms.

The primary goal was to define the conceptual framework for the FLW topic. By analyzing patterns of keyword co-occurrence, core themes and subthemes were identified within the field. The study examined keywords in the 8,497 articles indexed in Scopus and WoS, selecting the top 50 most used keywords for representation.

Within this scholarly context, "food waste" and "anaerobic digestion" emerged as prominent terms (Fig.5), indicating key themes and subjects frequently explored by authors. Two main keyword clusters were identified:
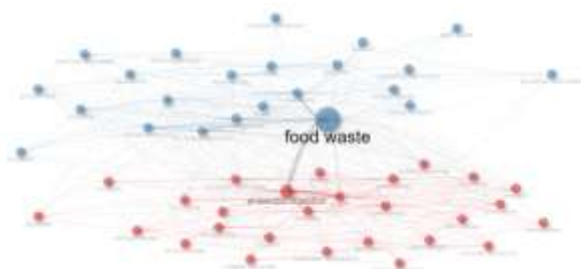

Fig. 5. The occurrence of keywords
Source: Visualization using Biblioshiny on the basis of data from Scopus and WoS [34, 40].

Blue cluster: food waste, waste, carbon footprint, household food waste, plate waste, consumer behavior, food loss, environmental impact, Covid-19, food, food security, sustainability, agriculture, food supply chain, food loss and waste, climate change, environment, recycling, waste management, circular economy, life cycle assessment (LCA), and biodiesel.

Red cluster: anaerobic digestion, biowaste, municipal solid waste, compost, bioenergy, composting, sewage sludge, kitchen waste, organic waste, optimization, microbial community, biogas, biochar, methane, biohydrogen, anaerobic co-digestion, fermentation, biomass, biomethane, co-digestion, hydrogen, volatile fatty acids, digestate, biorefinery, energy, and renewable energy.

These clusters encapsulate the principal investigative interests and thematic concentrations of FLW research.

The study has illuminated the evolution of FLW research, noting a substantial increase in scholarly interest and publication volume starting from 2015. This trend underscores a growing recognition of the socio-economic and environmental implications of FLW, reflecting heightened global awareness and academic engagement.

The analysis identified China, the United States, Italy, and India as the leading nations in FLW research, indicating their pivotal roles and investment in addressing FLW challenges. These countries host established research communities and collaborative networks, making them focal points for future funding and cooperative efforts.

Prominent authors such as Li Y., Zhang Y., and Wang Y. have made substantial contributions to the FLW discourse, shaping the academic landscape with their prolific research output. Their work, along with the key journals like "Waste Management," "Bioresource Technology," and "Journal of Cleaner Production," highlights the interdisciplinary nature of FLW research, integrating technological, environmental, and socio-economic perspectives.

Highly cited papers, such as Springmann et al. [36] study on environmental limits, have significantly influenced the field, covering diverse themes including the environmental impact of food waste, sustainable food systems, and food-demand management. These foundational works provide critical insights and directions for future research.

The coauthorship analysis revealed strong international collaborations, particularly among researchers from China, the USA, the UK, and Italy. This network of collaborations underscores the global effort and interconnectedness in tackling FLW issues.

The identified collaboration clusters demonstrate the presence of robust national and international research networks dedicated to FLW.

Keyword analysis further defined the conceptual framework of FLW research, with "food waste" and "anaerobic digestion" emerging as central themes. The identified keyword clusters encompass a broad range of research topics, reflecting the comprehensive scope of FLW studies.

CONCLUSIONS

The bibliometric analysis of quantifying food loss and waste (FLW) has successfully addressed the research purpose by responding to five key questions, producing a comprehensive bibliographic mapping of FLW studies with significant socioeconomic implications. The study identified a limited number of literature reviews on FLW in Scopus and WoS databases, highlighting the need for further comprehensive analyses.

Key contributions of the study include identifying gaps and new directions for future research. Providing a roadmap for navigating the complex FLW research landscape. Guiding researchers in identifying potential collaborators and understanding geographic distribution of research activity. Outlining main research areas, key publications, and influential authors to shape future research focus and methodologies.

The analysis focused on rigorously reviewed and indexed research papers, ensuring academic credibility. However, this methodology limits the study to sources in Scopus and WoS, suggesting future studies should include a broader range of sources for a more comprehensive understanding of FLW. The study advocates for an integrative research agenda spanning technological, ecological, and socio-economic domains. Future research should leverage big data and AI, emphasize waste valorization, foster consumer awareness, and implement scalable policy-driven solutions. Strengthening dialogue between developed and developing nations is essential for sustainable global food systems, requiring cross-disciplinary collaboration and innovation.

In summary, this bibliometric analysis has mapped out the primary trends and features of FLW research, offering valuable insights for academics, policymakers, and stakeholders. It underscores the need for continued interdisciplinary and international collaboration to effectively address the multifaceted challenges of FLW. Future research should focus on refining quantification methods, exploring socio-economic determinants, and leveraging technological innovations to reduce FLW and promote sustainable food systems.

Additionally, a systematic appraisal of FLW studies is recommended to enhance understanding of theoretical developments and ensure future research is built on a robust analytical foundation.

REFERENCES

[1]Abdelradi, F., 2018, Food waste behaviour at the household level: A conceptual framework. Waste Management, 71, 485–493.

[2]Andrade-Valbuena, N. A., Merigo-Lindahl, J. M., Olavarrieta, S., S., 2019, Bibliometric analysis of entrepreneurial orientation. World Journal of Entrepreneurship, Management and Sustainable Development, 15(1), 45–69.

[3]Aria, M., Cuccurullo, C., 2017, Bibliometrix : An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975.

[4]Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, T., Oostindjer, M., 2015, Consumer-Related Food Waste: Causes and Potential for Action. Sustainability, 7(6), 6457–6477.

[5]Bajželj, B., Richards, K. S., Allwood, J. M., Smith, P., Dennis, J. S., Curmi, E., Gilligan, C. A., 2014, Importance of food-demand management for climate mitigation. Nature Climate Change, 4(10), 924–929.

[6]Buzby, J., Farah-Wells, H., Hyman, J., 2014, The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States. United States Department of Agriculture; Washington, DC, USA: 2014.

[7]Buzby, J. C., Hyman, J., 2012, Total and per capita value of food loss in the United States. Food Policy, 37(5), 561–570.

[8]Eleazer, W. E., Odle, W. S., Wang, Y.-S., Barlaz, M. A., 1997, Biodegradability of Municipal Solid Waste Components in Laboratory-Scale Landfills. Environmental Science & Technology, 31(3), 911–917.

[9]Fabi, C., Cachia, F., Conforti, P., English, A., Rosero Moncayo, J., 2020, Improving data on food

losses and waste: From theory to practice. Food Policy, 98, 101934.

[10]FAO, 2019, Food Wastage Footprint. Food & Agriculture Organization of the UN (FAO).

[11]FAO, 2019, The state of food and agriculture. 2019, Moving forward on food loss and waste reduction. Rome, Italy: Food And Agriculture Organization Of The United Nations.

[12]FAO, 2013, Food Wastage Footprint. Rome, Italy: FAO.

[13]Galanakis, C. M., 2020, The Food Systems in the Era of the Coronavirus (COVID-19) Pandemic Crisis. *Foods*, 9(4), 523.

[14]Giordano, C., Alboni, F., Falasconi, L., 2019, Quantities, Determinants, and Awareness of Households' Food Waste in Italy: A Comparison between Diary and Questionnaires Quantities'. Sustainability, 11(12), 3381.

[15]Guo, X. M., Trably, E., Latrille, E., Carrère, H., & Steyer, J.-P., 2010, Hydrogen production from agricultural waste by dark fermentation: A review. International Journal of Hydrogen Energy, 35(19), 10660–10673.

[16]Hall, K. D., Guo, J., Dore, M., Chow, C. C., 2009, The Progressive Increase of Food Waste in America and Its Environmental Impact. PLoS ONE, 4(11), e7940.

[17]High Level Panel of Exeperts on Food Security and Nutrition, 2014, Food Losses and Waste in the Context of Sustainable Food Systems. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Committee on World Food Security; Rome, Italy: 2014.

[18]Hoehn, D., Margallo, M., Laso, J., Fernández-Ríos, A., Ruiz-Salmón, I., Aldaco, R., 2022, Energy Systems in the Food Supply Chain and in the Food Loss and Waste Valorization Processes: a Systematic Review. Energies, 15(6), 2234.

[19]Ishangulyyev, R., Kim, S., Lee, S. H., 2019, Understanding food loss and waste—why are we losing and wasting food? Foods, 8(8), 297.

[20]Jia, L., Qiao, G., 2022, Quantification, Environmental Impact, and Behavior Management: A Bibliometric Analysis and Review of Global Food Waste Research Based on CiteSpace. Sustainability, 14(18), 11293.

[21]Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., Ward, P. J., 2012, Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. Science of the Total Environment, 438, 477–489.

[22]Langley, J., Yoxall, A., Heppell, G., Rodriguez, E. M., Bradbury, S., Lewis, R., Luxmoore, J., Hodzic, A., Rowson, J., 2009, Food for Thought? — A UK pilot study testing a methodology for compositional domestic food waste analysis. Waste Management & Research, 28(3), 220–227.

[23]Leverenz, D., Moussawel, S., Maurer, C., Hafner, G., Schneider, F., Schmidt, T., Kranert, M., 2019, Quantifying the prevention potential of avoidable food waste in households using a self-reporting approach. Resources, Conservation and Recycling, 150, 104417.

[24]Malefors, C., Callewaert, P., Hansson, P.-A., Hartikainen, H., Pietiläinen, O., Strid, I., Strotman, C., Eriksson, M., 2019, Towards a Baseline for Food-Waste Quantification in the Hospitality Sector—Quantities and Data Processing Criteria. Sustainability, 11(13), 3541.

[25]Moed, H. F., Glänzel, W., Schmoch, U., 2005, Handbook of Quantitative Science and Technology Research: the Use of Publication and Patent Statistics in Studies of S & T Systems. Dordrecht: Springer Netherlands.

[26]Nijloveanu, D., Tita, V., Bold, N., Fintineru, G., Smedescu, D., Chiurciu, I.A., Smedescu, C., Patrachioiu,G., 2023, Dynamics of food loss and waste causes along the agrifood chain in Romania. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", 23(4). 569-580. https://managementjournal.usamv.ro/pdf/vol.23_4/Art56.pdf, Accessed on 28 June, 2024.

[27]Nijloveanu, D., Tita, V., Bold, N., Smedescu, D., Fintineru, A., Tudor, V., Smedescu, C., Jerca, E., 2024, A statistical study analysis on exploring consumption patterns regarding food loss and waste. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 24(1), 685-694. https://managementjournal.usamv.ro/pdf/vol.24_1/Art69.pdf, Accessed on 28 June, 2024.

[28]Papargyropoulou, E., Lozano, R., K. Steinberger, J., Wright, N., Ujang, Z. bin., 2014, The food waste hierarchy as a framework for the management of food surplus and food waste. Journal of Cleaner Production, 76(76), 106–115.

[29]Paraschivu, M., Cotuna, O., Matei, G., Sarateanu, V., 2022, Are food waste and food loss a real threat for food security? Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 22(1), 479-484. https://managementjournal.usamv.ro/pdf/vol.22_1/Art56.pdf, Accessed on June 28, 2024.

[30]Parfitt, J., Barthel, M., Macnaughton, S., 2019, Food waste within food supply chains: quantification and potential for change to 2050. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 3065–3081.

[31]Ponisio, L. C., M'Gonigle, L. K., Mace, K. C., Palomino, J., de Valpine, P., Kremen, C., 2014, Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society B: Biological Sciences, 282(1799), 20141396–20141396.

[32]Schanes, K., Dobernig, K., Gözet, B., 2018, Food waste matters - A systematic review of household food waste practices and their policy implications. Journal of Cleaner Production, 182(1), 978–991.

[33]Schneider, F., 2013, Review of food waste prevention on an international level; Proceedings of the Institution of Civil Engineers-Waste and Resource

Management, London, UK: ICE Publishing, (pp. 187–203).

[34]SCOPUS, https://www.scopus.com/home.uri, Accessed on February 26, 2024.

[35]Spang, E. S., Moreno, L. C., Pace, S. A., Achmon, Y., Donis-Gonzalez, I., Gosliner, W. A., Jablonski-Scheffield, M.P., Momin, m.a., Quested, T., Winans, K.S.,Tomich, T. P., 2019, Food Loss and Waste: Measurement, Drivers, and Solutions. Annual Review of Environment and Resources, 44(1), 117–156.

[36]Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., de Vries, W., Vermeulen, S.J., Herrero, M., Carlson, K.M., Jonell, M., Troell, M., DeClerck, F., Gordon, L.J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., Godfray, H. C. J., Tilman, D., Rockstrom, J., Willett, W., 2018, Options for Keeping the Food System within Environmental Limits. Nature, 562(7728), 519–525.

[37]Stancu, V., Haugaard, P., & Lähteenmäki, L. (2016). Determinants of consumer food waste behaviour: Two routes to food waste. Appetite, 96(96), 7–17.

[38]United Nations, 2023, Goal 12: Ensure sustainable consumption and production patterns. Retrieved from United Nations Sustainable Development website: https://www.un.org/sustainabledevelopment/sustainable-consumption-production/, Accessed on March 15, 2024.

[39]United Nations Environment Programme, 2021, Food Waste Index.

[40]Web of Science, https://access.clarivate.com/login?app=wos&alternative=true&shibShireURL=https:%2F%2Fwww.webofknowledge.com%2F%3Fauth%3DShibboleth&shibReturnURL=https:%2F%2Fwww.webofknowledge.com%2F&roaming=true, Accessed on February 26, 2024.

[41]Zhang, R., Elmashad, H., Hartman, K., Wang, F., Liu, G., Choate, C., Gamble, P., 2007, Characterization of food waste as feedstock for anaerobic digestion. Bioresource Technology, 98(4), 929–935.

[42]Zupic, I., Čater, T., 2015, Bibliometric Methods in Management and Organization. Organizational Research Methods, 18(3), 429–472.