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Food Loss and Food Waste: A Literature Review in 2009-2018

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Abstract--- *In almost the last decade, food waste and food losses have become interesting topics among researchers. This review of literacy is carried out in order to determine the extent to which research on food loss and food waste is carried out and the use of what methods are most often used. In this study the main sources of research data are sixty scientific articles over the last few years starting from 2009 to 2018 relating to food waste and waste. Search for scientific articles is done by using online search via (via ProQuest, Elsevier and Google Scholar) and using the keywords 'Food loss and food waste'. The results of the review found that research on food loss and food waste experienced an upward trend from 2011 to 2014. The comparison of the highest number of articles discussing food loss and food waste was in 2014 with seventeen scientific articles and in 2011 was the year which had the fewest articles, namely only one article. The results of the review also show that the most frequently used method is quantitative methods. There are thirty-four articles using quantitative methods and twenty-six articles using qualitative methods. It is strongly recommended further research to use qualitative methods regarding food loss and food waste.*

Keywords--- *Food Loss & Food Waste, Literature Review, Use of Methods.*

I. BACKGROUND

Food waste and food losses are an interesting topic in almost the last decade. Food waste and food losses can be defined from a variety of individual and group perspectives, whether by type, food waste formation process or origin of food waste and existing food losses (Mena et al. 2011). Food waste in the world is currently about one-third of food for human consumption produced in the world, every year around 1.3 billion tons are lost or just wasted. Then, food that is wasted is causing enormous losses in various countries, both developed and developing countries. In industrialized countries it is estimated that 670 million tons of food are wasted and 630 million tons of food is wasted in developing countries with the highest levels of food coming from tubers, vegetables and fruit (FAO, 2011).

Food waste can come from intentional or unintentional behavior. Foods that spill or rot before reaching the final product or retail stage are called food losses. These food losses can be caused by various things such as problems at harvest, storage, packaging, transportation, market mechanisms, and institutional and legal frameworks. While food that is suitable for human consumption but not consumed because it is damaged or disposed of by consumers is called food waste. Because the occurrence of food waste is due to the poor rules for marking food in and out, so that a lot of food is wasted because of expiration, improper storage, and buying or processing (Kophi Sulsel, 2018).

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Food waste and waste that occur not only causes losses in the economic sector, but also in other sectors such as the environment and social. This research was carried out by looking at and sorting the results of previous studies on food waste and waste and aimed at finding out about the trend of food waste throughout the world.

II. METHOD

This research was conducted with the aim to determine the extent to which research on food loss and food waste is carried out and the use of what methods are most often used. The reading sources or literature used to review the literature in this study used sixty scientific articles over the past few years starting from 2009 to 2018 relating to food waste and waste as the main source of research data. Article search is done using online search (via ProQuest, Elsevier and Google Scholar) and uses the keywords 'Food loss and food waste'. Scientific articles that are used as reading material are expected to be able to find out more about waste and food waste and it will be recommended that future research is needed on food loss and food waste.

III. LITERACY

The following is a mapping of scientific articles and journals as references related to topics in research on food waste and waste.

Author	Year	Title
Griffin et al.	2009	An analysis of a community food waste stream
Hall et al.	2009	The Progressive Increase of Food Waste in America and Its Environmental Impact
Cu´Ellar& Webber	2010	Wasted Food, Wasted Energy: The Embedded Energy in Food Waste in the United States
Kumar et al.	2010	Co-composting of green waste and food waste at low C/N ratio
Parfitt et al.	2010	Food waste within food supply chains: quantification and potential for change to 2050
Buzby and Bennett	2011	Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use
Nahmana et al.	2012	The costs of household food waste in South Africa
Buzby& Hyman	2012	Total and per capita value of food loss in the United States
Kummu et al.	2012	Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use
Oelofse&Nahman	2012	Estimating the magnitude of food waste generated in South Africa
Nahman& Lange	2013	Costs of food waste along the value chain: Evidence from South Africa
Grizzetti et al.	2013	The contribution of food waste to global and European nitrogen pollution
Ki Lin et al.	2013	Food waste as a valuable resource for the production of chemicals, materials and fuels. Current situation and global perspective
Beretta et al.	2013	Quantifying food losses and the potential for reduction in Switzerland
Liu J. et al.	2013	Food Losses and Waste in China and Their Implication for Water and Land
Whitehair et al.	2013	Written Messages Improve Edible Food Waste Behaviors in a University Dining Facility
Gjerris&Gaiani	2013	Household food waste in Nordic countries: Estimations and ethical implications
Opara and Mditshwa	2013	A review on the role of packaging in securing food system: Adding value to food products and reducing losses and waste
Stefan et al.	2013	Avoiding food waste by Romanian consumers: The importance of planning and shopping routines
Gille	2013	From risk to waste: global food waste regimes
Martinez et al.	2014	Food loss in a hungry world, a problem?
Papargyropouloua et al.	2014	The food waste hierarchy as a framework for the management of food surplus and food waste
Graham-Rowe et al.	2014	Identifying motivations and barriers to minimising household food waste
Kiran et al.	2014	Bioconversion of food waste to energy: A review

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Katajajuuri et al.	2014	Food waste in the Finnish food chain
Cohen et al.	2014	Impact of the New U.S. Department of Agriculture School Meal Standards on Food Selection, Consumption, and Waste
Bräutigam et al.	2014	The extent of food waste generation across EU-27: Different calculation methods and the reliability of their results
Guo et al.	2014	A comparison of microbial characteristics between the thermophilic and mesophilic anaerobic digesters exposed to elevated food waste loadings
Yin & Li	2014	Anaerobic digestion of food waste for volatile fatty acids (VFAs) production with different types of inoculum: Effect of pH
Park et al.	2014	Photoluminescent Green Carbon Nanodots from Food-Waste-Derived Sources: Large-Scale Synthesis, Properties, and Biomedical Applications
West et al.	2014	Leverage points for improving global food security and the environment
Chen et al.	2014	Comparison of high-solids to liquid anaerobic co-digestion of food waste and green waste
Jiang et al.	2014	Effects of ultrasound pre-treatment on the amount of dissolved organic matter extracted from food waste
Chandrasekhar & Mohan	2014	Solid phase bio-electrofermentation of food waste to harvest value-added products associated with waste remediation
Kim et al.	2014	A pilot scale two-stage anaerobic digester treating food waste leachate (FWL): Performance and microbial structure analysis using pyrosequencing
Gou et al.	2014	Effects of temperature and organic loading rate on the performance and microbial community of anaerobic co-digestion of waste activated sludge and food waste
Zhang et al.	2014	Reviewing the anaerobic digestion of food waste for biogas production
Witzel et al.	2015	Consumer-Related Food Waste: Causes and Potential for Action
Parizeau et al.	2015	Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario
Dung Thi et al.	2015	An overview of food waste management in developing countries: Current status and future perspective
Schott &Andersson	2015	Food waste minimization from a life-cycle perspective
Charlebois et al.	2015	"Back of house" – focused study on food waste in fine dining: the case of Delish restaurants
Costello et al.	2015	Food waste in campus dining operations: Inventory of pre- and post-consumer mass by food category, and estimation of embodied greenhouse gas emissions
Munesue	2015	The effects of reducing food losses and food waste on global food insecurity, natural resources, and greenhouse gas emissions
Scholzetal.	2015	Carbon footprint of supermarket food waste
Girotto et al.	2015	Food waste generation and industrial uses: A review
Pham et al.	2015	Food waste-to-energy conversion technologies: Current status and future directions
Priefer et al.	2016	Food waste prevention in Europe – A cause-driven approach to identify the most relevant leverage points for action
Cicatiello et al.	2016	The value of food waste: An exploratory study on retailing
Visschers et al.	2016	Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households
Chan et al.	2016	Reducing nitrogen loss and salinity during 'struvite' food waste composting by zeolite amendment
Porpino	2016	Household Food Waste Behavior: Avenues for Future Research
Papargyropoulou et al.	2016	Conceptual framework for the study of food waste generation and prevention in the hospitality sector
Corrado et al.	2017	Modelling of food loss within life cycle assessment: From current practice towards a systematisation
Alexander et al.	2017	Losses , inefficiencies and waste in the global food system
Liljestrand	2017	Logistics solutions for reducing food waste
Gokarn&Kuthambalayan	2017	Analysis Of Challenges Inhibiting The Reduction Of Waste In Food Supply Chain
Conrad et al.	2018	Relationship between food waste, diet quality, and environmental sustainability
Salihoglu et al.	2018	Food loss and waste management in Turkey
Bradford et al.	2018	The dry chain: Reducing postharvest losses and improving food safety in humid climates

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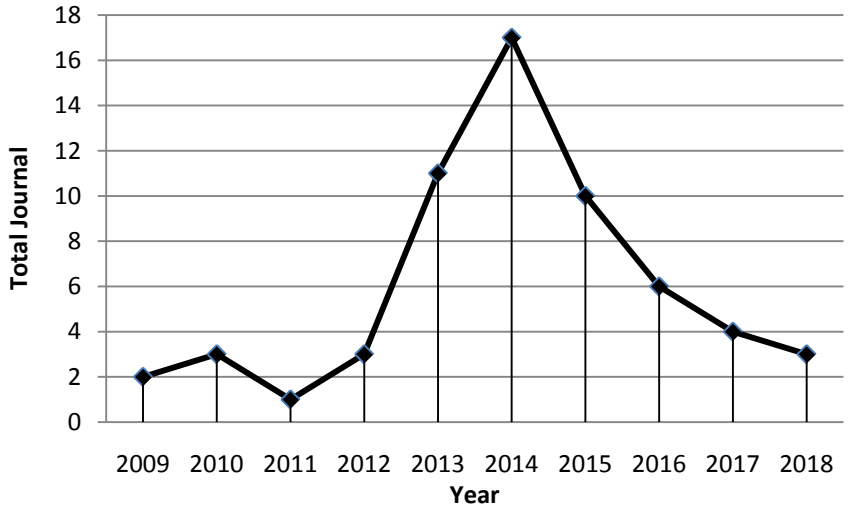
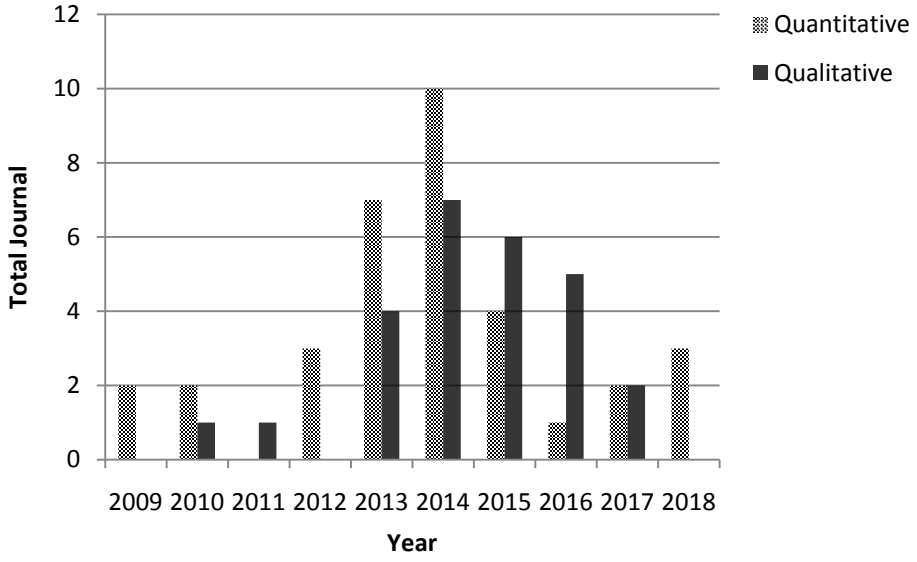
Based on the table above, we can see several types of research on food waste and waste with different topics. There is research that focuses on the tendency of waste and food waste, research that focuses on reducing food waste and waste, research on substances found in food waste, the dangers of substances caused by food waste and there is also research that focuses on the processing of waste and waste food.

IV. DISCUSSION

Research on food loss and food waste in the last decade has increased and decreased. Based on literacy studies conducted on sixty journals and scientific articles for ten years, the most research on food loss and food waste was found in 2014 and the least research was in 2011. The presentation of existing literature reviews can be seen in the following graph:



Based on a review of the literature conducted, it was found that the use of quantitative methods was more dominant than qualitative methods. This difference can be seen in the following histogram:



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Author	Title	Quantitative	Qualitative
Griffin et al. (2009)	An analysis of a community food waste stream	**x**	
Hall et al. (2009)	The Progressive Increase of Food Waste in America and Its Environmental Impact	**x**	

There were two studies in 2009 that used quantitative methods. First Griffin et al. (2009) suggested that around 10,205 tons of food waste were produced each year in the community food system. Of all food waste, production waste consists of 20%, 1% processing, 19% distribution, and 60% food waste produced by consumers. Less than one third (28%) of the total leftovers were recovered through composting (25%) and food donations (3%), and more than 7,000 tons (72%) were backfilled. The second article is research from Hall et al. (2009) who calculated the energy content of national food waste from the difference between US food supply and food consumed by the population. The study found that US per capita food waste has increased, 50% since 1974 to reach more than 1400 kcal per person per day or 150 trillion kcal per year.

Author	Title	Quantitative	Qualitative
Cu´Ellar& Webber (2010)	Wasted Food, Wasted Energy: The Embedded Energy in Food Waste in the United States	**x**	
Kumar et al. (2010)	Co-composting of green waste and food waste at low C/N ratio	**x**	
Parfitt et al. (2010)	Food waste within food supply chains: quantification and potential for change to 2050		**x**

The scientific articles obtained in 2010 consisted of two articles using quantitative approaches and one using qualitative methods. Cu´llar& Webber (2010) estimate that energy embedded in food is wasted every year in the United States. It was found that the energy contained in wasted food represents about 2% of annual energy consumption in the United States, which is very large compared to conservation proposals and other energy production. Kumar et al. (2010) conducted a study by composting together food waste and green waste with a low ratio of initial carbon to nitrogen (C / N) and investigated using a composting reactor. The results show that the optimal water content for compost with food waste and green waste is 60%, and the substrate with a C / N ratio of 19.6 can be decomposed effectively to reduce 33% of the total volatile solids (TVS) in 12 days. The last article is from Parfitt et al. (2010) by conducting literature studies and finding that losses are much higher at the immediate post-harvest stage in developing countries and higher for perishable foods in industrialized and developing countries. For a prosperous economy, food waste after consumers is the biggest overall loss.

Author	Title	Quantitative	Qualitative
Hodges,Buzby and Bennett (2011)	Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use		**x**

In 2011 there was one study conducted by Buzby and Bennett (2011) using qualitative methods by comparing and distinguishing the loss of postharvest food (PHL) and waste in developed countries (especially the United States and Britain) with those in less developed countries (LDC). According to Buzby and Bennett (2011) in the future (eg Up to 2030), the main drivers for reducing SFM are different: in developed countries, they include carefully targeted consumer, tax education campaigns and private and public sector partnerships that share responsibility responsible for loss reduction. The LDC drive includes broader farmer education about the causes of SFM; better infrastructure to connect small farmers to markets; more effective value chains that provide adequate financial incentives at the

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producer level; opportunities to adopt shared marketing and better technology are supported by access to micro credit; and the public and private sectors share investment and risk costs in market-oriented interventions.

Author	Title	Quantitative	Qualitative
Nahman et al. (2012)	The costs of household food waste in South Africa	**x**	
Buzby& Hyman (2012)	Total and per capita value of food loss in the United States	**x**	
Kummu et al. (2012)	Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use	**x**	

In 2012 there were three scientific articles on food loss and waste which all used quantitative methods. Beginning Nahmana et al. (2012) whose research article aims to calculate the economic value of food waste in South Africa. Research conducted found that for household food waste alone, the costs to the community associated with problems related to food waste are estimated at around R21.7 billion (around US $ 2.7 billion) per year, or 0.82% of Africa's annual GDP South. Next is an article from Buzby& Hyman (2012) whose results show that in 2008, the estimated total loss of food at the retail and consumer level in the United States purchased at retail prices was $ 165.6 billion. The top three food groups in terms of food loss values at this level are: meat, poultry and fish (41%); vegetables (17%); and dairy products (14%). The last one is Kummu et al. (2012), in their study used publicly available global databases to estimate the loss of global food supplies due to lost and wasted food crops, and the resources used to produce them, the study also measured the potential for food supply and the savings in resources that could be made by reducing food loss and waste. The results found that about a quarter of the supply of food produced (614 kcal / cap / day) was lost in the food supply chain. The production of lost and wasted food crops accounts for 24% of the total freshwater resources used in food crop production (27 m3 / cap / yr), 23% of the total global agricultural land area (31 × 10− 3 ha / cap / yr), and 23% of total global fertilizer use (4.3 kg / cap / year).

In the following year, namely in 2013 there were eleven studies on waste and waste. Quantitative research dominated this year with a total of seven scientific articles and four scientific articles using qualitative methods.

Author	Title	Quantitative	Qualitative
Oelofse&Nahman (2012)	Estimating the magnitude of food waste generated in South Africa	**x**	
Nahman& Lange (2013)	Costs of food waste along the value chain: Evidence from South Africa	**x**	
Grizzetti et al. (2013)	The contribution of food waste to global and European nitrogen pollution	**x**	
Ki Lin et al. (2013)	Food waste as a valuable resource for the production of chemicals, materials and fuels. Current situation and global perspective		**x**
Beretta et al. (2013)	Quantifying food losses and the potential for reduction in Switzerland	**x**	
Liu J. et al. (2013)	Food Losses and Waste in China and Their Implication for Water and Land	**x**	
Whitehair et al. (2013)	Written Messages Improve Edible Food Waste Behaviors in a University Dining Facility	**x**	
Gjerris&Gaiani (2013)	Household food waste in Nordic countries: Estimations and ethical implications		**x**
Opara (2013)	A review on the role of packaging in securing food system: Adding value to food products and reducing losses and waste		**x**
Stefan et al. (2013)	Avoiding food waste by Romanian consumers: The importance of planning and shopping routines	**x**	
Gille (2013)	From risk to waste: global food waste regimes		**x**

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Research that uses quantitative methods, namely: 1) Oelofse&Nahman (2013) who found that the initial estimate of the amount of food waste generated in South Africa was around 9.04 million tons per year. On a per capita basis, overall food waste in South Africa in 2007 was estimated to be 177 kg / capita / year and consumption waste was 7 kg / capita / year; 2) Nahman& Lange (2013), the research whose object of research is South Africa found that the total cost of food waste throughout the food value chain in South Africa is estimated at R61.5 billion per year (around US $ 7.7 billion); equivalent to 2.1% of South Africa's annual gross domestic product; 3) Grizzetti et al. (2013), this study was carried out with Europe as an object and can be known globally 2.7 Tg nitrogen (N) is lost per year due to food waste consumed (ie 9% of global food consumption), and that of virtual nitrogen (nitrogen sent to the environment) associated with global food waste is 6.3 TgN / year; 4) Beretta et al. (2013), in Switzerland the study was conducted and it was found that energy balance showed that 48% of the total calories produced (edible crops harvested during harvest and animal production, including cutting waste) were lost throughout the chain food value. Half of these losses will be avoided given the right mitigation measures; 5) Liu J. et al. (2013), the impact of food loss and food waste on water and land in China is the focus of this study. The results showed that the grain loss rate (FLR) in the entire supply chain was 19.0% ± 5.8% in China, with the consumer segment having the largest single portion of leftovers, ie 7.3% ± 4.8% . The total water footprint (WF) associated with loss of food and waste in China in 2010 was estimated at 135 ± 60 billion m3, equivalent to Canada's WF with losses of 26 ± 11 million hectares of land used in vain, equivalent to the total fertile land in Mexico; 6) Whitehair et al. (2013), this study conducted in America found results that students had a higher level of trust than neutral, but did not show a strong belief in environmental sustainability or food waste; 7) Stefan et al. (2013), a study of 244 Romanian consumers was conducted to see the effect of intentions not to waste food, planning and shopping routines, as well as moral attitudes and lack of concern for food waste, subjective norms of disagreement with food waste, and perceptions of behavioral control of Romanian consumers . The results show that planning routines and consumer spending are important predictors of food waste. Planning and shopping routines are determined by moral attitudes towards food waste and perceived behavioral control.

In 2013 there were three studies using qualitative methods, namely: 1) Ki Lin et al. (2013), from his research, it can be seen that the energy lost at land filling sites is equal to 43% of the energy sent used for food preparation in the US, 37% of Japan's hydroelectric power plants, and more than 100% of annual renewable energy demand currently from the British industry; 2) Gjerris&Gaiani (2013), research whose object of research is Nordic countries get results that reduce food waste at the household level, which impacts on issues such as climate change and distribution of food resources that are unfair, needs to be based on understanding appreciative and relational about nature and food and not only in economic and moral arguments; 3) Opara (2013), after conducting a qualitative analysis of the research, it can be seen that the role of cost-effective and resource-saving packaging design is very important to overcome the problem of food contaminated with packaging; 4) last is Gille (2013) with the results of the study showing that the relationship between risk and waste stretches not only geographically but also scalar boundaries, revealing that solutions to food waste problems are limited to technological innovations and some sites or even countries will prove inadequate and likely to exacerbate existing inequalities.

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Author	Title	Quantitative	Qualitative
Martinez et al. (2014)	Food loss in a hungry world, a problem?		**x**
Papargyropouloua et al. (2014)	The food waste hierarchy as a framework for the management of food surplus and food waste		**x**
Graham-Rowe et al. (2014)	Identifying motivations and barriers to minimising household food waste		**x**
Kiran et al. (2014)	Bioconversion of food waste to energy: A review		**x**
Katajajuuri et al. (2014)	Food waste in the Finnish food chain	**x**	
Cohen et al. (2014)	Impact of the New U.S. Department of Agriculture School Meal Standards on Food Selection, Consumption, and Waste	**x**	
Bräutigam et al. (2014)	The extent of food waste generation across EU-27: Different calculation methods and the reliability of their results		**x**
Guo et al. (2014)	A comparison of microbial characteristics between the thermophilic and mesophilic anaerobic digesters exposed to elevated food waste loadings	**x**	
Yin & Li (2014)	Anaerobic digestion of food waste for volatile fatty acids (VFAs) production with different types of inoculum: Effect of pH	**x**	
Park et al. (2014)	Photoluminescent Green Carbon Nanodots from Food-Waste-Derived Sources: Large-Scale Synthesis, Properties, and Biomedical Applications	**x**	
West et al. (2014)	Leverage points for improving global food security and the environment		**x**
Chen et al. (2014)	Comparison of high-solids to liquid anaerobic co-digestion of food waste and green waste	**x**	
Jiang et al. (2014)	Effects of ultrasound pre-treatment on the amount of dissolved organic matter extracted from food waste	**x**	
Chandrasekhar & Mohan (2014)	Solid phase bio-electrofermentation of food waste to harvest value-added products associated with waste remediation	**x**	
Kim et al. (2014)	A pilot scale two-stage anaerobic digester treating food waste leachate (FWL): Performance and microbial structure analysis using pyrosequencing	**x**	
Gou et al. (2014)	Effects of temperature and organic loading rate on the performance and microbial community of anaerobic co-digestion of waste activated sludge and food waste	**x**	
Zhang et al. (2014)	Reviewing the anaerobic digestion of food waste for biogas production		**x**

In 2014 there were seventeen studies on food loss and food waste. The seventeen studies were dominated by quantitative methods with ten studies and the rest using qualitative methods. Research that uses quantitative methods, namely: 1) Katajajuuri et al. (2014), the study was conducted in a case study in Finland and showed that around 130 million kg of food waste is produced annually (23 kg per capita / year) from the household sector and the entire food industry is estimated to produce around 75–140 million kg of food waste per year; 2) Cohen et al. (2014), conducted a study by collecting food waste data from four schools in one city in the US and conducted a regression to estimate differences in the selection and consumption of school food before (autumn 2011) and after application (fall 2012). The study found that fruit selection increased by 23.0% and food and vegetable choices remained unchanged. In addition, appetite consumption after implementation increased by 15.6%, vegetable consumption increased by 16.2%, and fruit consumption remained the same; 3) Guo et al. (2014), a study conducted in China compared between thermophilic and mesophilic anaerobic digestion reactors (TR and MR) which used food waste as a substrate with emphasis on microbial responses to increased organic loading rates (OLR); 4) Yin &

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Li (2014), research conducted in China shows that the hydrolysis of food waste increases clearly when AN Inoculum is used relative to Inoculum AE at each pH investigated after it is carried out Fermentation of anaerobic food waste is carried out under acidic conditions using an inoculum based on aerobic activated sludge (Inoculum AE) or anaerobic activated sludge (AN Inoculum) for the production of fatty volatile acids (VFA); 5) Park et al. (2014), a simple method for the synthesis of large-scale water-soluble green carbon nanodot (G-dots) from various types of large food waste sources was carried out in the Republic of Korea and it was found that combined green synthesis has advantages, high aqueous stability, photostability high, and low cytotoxicity, and G-dots show a lot of hope in various fields, including biomedical imaging; 6) Chen et al. (2014), research conducted by digestion with food waste and green waste carried out with six mixing ratios of raw materials to evaluate biogas production shows that the yield of methane from high solid anaerobic digestion (15-20% TS) is higher than the output of liquid anaerobic digestion (5-10% TS), while methanogenesis is inhibited by increasing TS content to 25%; 7) Jiang et al. (2014), researchers from China conducted research by integrating food waste using ultrasonic generators and the production of volatile fatty acids (VFA) by anaerobic hydrolysis. The results show that ultrasound treatments can significantly increase COD [chemical oxygen requirements], protein and reduce sugar, but reduce lipids in food waste supernatants; 8) Chandrasekhar & Mohan (2014), the research was carried out by operating a new solid state bio-electrofermentation system (SBES) with food waste as a substrate and evaluated for simultaneous production of electrofuels namely, bioelectricity, biohydrogen (H2) and bioethanol. This research conducted by Indians shows the ongoing evolution of volatile fatty acids as intermediate metabolites resulting in a decrease in pH and a negative effect on SBES performance; 9) Kim et al. (2014), originated from serious environmental problems in Korea regarding Food waste leachate (FWL) from food waste recycling facilities, a synthetic analysis was carried out to investigate the dynamics of microbes. The results obtained showed that associated acetoclastic methanogens and bacteria were more efficient for removing volatile acids in the pilot scale anaerobic digestive system, providing useful information for the treatment of FWL in the anaerobic digestive system; 10) Gou et al. (2014), The anaerobic digestion of activated sludge and food waste is investigated semi-continuously using a tank reactor which is stirred continuously. The results show that the performance of the system co-digestion is clearly influenced by temperature and organic loading rate (OLR) in terms of gas production level (GPR), methane yield, efficiency of solid volatile removal (VS) and system stability.

Research that uses qualitative methods is: 1) Martinez et al. (2014), with the results of research showing that in developed countries, the most important losses are at the consumption stage; in developing countries, losses occur in the growth and harvest phase; 2) Papargyropouloua et al. (2014), the study interprets the boundary between surplus food and food waste, food waste is avoided and unavoidable, and between waste prevention and waste management and the results obtained indicate that the first step towards a more sustainable resolution of food waste problems is adopting a method sustainable production and consumption and dealing with surplus and food waste throughout the global food supply chain; 3) Graham-Rowe et al. (2014), this study was conducted in the UK on 15 household food buyers by means of semi-structured interviews. Existing findings reveal potential potentially conflicting personal goals that can hinder efforts to reduce existing food waste; 4) Kiran et al. (2014), research conducted with the aim of testing the latest food waste fermentation technology for renewable energy generation; 5) Bräutigam et al. (2014),

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the results obtained show that in reducing food waste individual stages of the food chain and differentiated by product groups, depending on the selected data source and assumptions made; 6) West et al. (2014), the results of the study found that a relatively small number of sites and actions could provide enough new calories to meet the basic needs of more than 3 billion people, overcome many environmental impacts with global consequences, and focus on reducing food waste in commodities with the greatest impact on food safety; 7) Zhang et al. (2014), the results show a promising way to improve the performance of anaerobic digestion is the co-digestion of food waste with other organic substrates, as confirmed by various studies, where higher buffer capacity and optimal nutritional balance increase the yield of biogas/methane from co-digestion system.

Author	Title	Quantitative	Qualitative
Witzel et al. (2015)	Consumer-Related Food Waste: Causes and Potential for Action		**x**
Parizeau et al. (2015)	Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario		**x**
Dung Thi et al. (2015)	An overview of food waste management in developing countries: Current status and future perspective		**x**
Schott &Andersson (2015)	Food waste minimization from a life-cycle perspective	**x**	
Charlebois et al. (2015)	"Back of house" – focused study on food waste in fine dining: the case of Delish restaurants		**x**
Costello et al. (2015)	Food waste in campus dining operations: Inventory of pre- and post-consumer mass by food category, and estimation of embodied greenhouse gas emissions	**x**	
Munesue dan Fushima (2015)	The effects of reducing food losses and food waste on global food insecurity, natural resources, and greenhouse gas emissions	**x**	
Scholz etal. (2015)	Carbon footprint of supermarket food waste	**x**	
Girotto et al. (2015)	Food waste generation and industrial uses: A review		**x**
Pham et al. (2015)	Food waste-to-energy conversion technologies: Current status and future directions		**x**

Research using qualitative methods in 2015: 1) Witzel et al. (2015), the study said to successfully reduce food waste associated with consumers, it is necessary to have a clear understanding of the factors that influence consumer perceptions and behavior related to food waste and the results show that consumers' motivation to avoid waste of food, their management skills in food supply and food handling and their trade-offs among priorities have a broad influence on the behavior of their food waste; 2) Parizeau et al. (2015), a study aimed at combining observations on the level of production of organic waste, recyclable, and waste to survey the results of beliefs, attitudes, and behaviors related to food waste at the household level in the municipality of Guelph, Ontario. food waste production and household shopping practices, food preparation behavior, household waste management practices, and lifestyle-related attitudes, beliefs and behaviors; 3) Dung Thi et al. (2015), the results of observations conducted show that Taiwan is considered a successful case in terms of food waste management, and therefore a typical model that must be followed by developing countries; 4) Charlebois et al. (2015), research with a case study in one restaurant in Canada showed that when considering food procurement, supplier relations were found to be insignificant for prevention of food waste, so the company needed to make initial agreements with suppliers of raw materials so as

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not to waste raw materials; 5) Girotto et al. (2015), argued in solving the problem of food waste the most sought-after solution is represented by avoidance and donation of edible fractions for social services, using food waste in industrial processes for biofuel production or biopolymers. The next step is predicting nutrient recovery and carbon fixation by composting. The last option and less desirable options are incineration and stockpiling; 6) Pham et al. (2015), recommends the use of more effective food waste for renewable energy generation after a review of the literature conducted.

Whereas research using quantitative methods in 2015 were: 1) Schott &Andersson (2015), a case study in South Sweden towards investigating the potential and environmental impacts associated with minimizing household food waste. In this study, the unavoidable and unavoidable amount of food waste currently disposed of by households was assessed through an analysis of the composition of waste and various types of avoidable classified food waste and the results of waste composition analysis showed that on average 35% of food waste households can be avoided; 2) Costello et al. (2015), this scientific study found that overall, 5.6% of foods that reached the retail level were lost at the pre-consumer stage and 10.7% were lost at the post-auction stage. For the food category examined, fruits and vegetables are the largest sources of food waste based on weight, with seeds as the second largest food source based on weight; 3) Munesue (2015), Quantitative research carried out results that reduced food loss in developed regions reduced the number of malnourished people in developing regions to 63 million, which resulted in reduced harvest area, water use and home gas emissions glass associated with food production; 4) Scholzetal. (2015), a study conducted to analyze the differences between the amount of waste and carbon footprint profiles regarding perishable food product wastes wasted in Swedish supermarkets. Over a period of three years, it can be seen that 1570 tons of fresh food (not including bread) are wasted in six supermarkets in Sweden.

In 2016 research on food loss and food waste was reduced again. In the previous year, there were ten articles in six articles. Of the six articles, five of them used qualitative analysis and only one used quantitative.

Author	Title	Quantitative	Qualitative
Priefer et al. (2016)	Food waste prevention in Europe – A cause-driven approach to identify the most relevant leverage points for action		**x**
Cicatiello et al. (2016)	The value of food waste: An exploratory study on retailing		**x**
Visschers et al. (2016)	Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households		**x**
Chan et al. (2016)	Reducing nitrogen loss and salinity during ‘struvite’ food waste composting by zeolite amendment	**x**	
Porpino (2016)	Household Food Waste Behavior: Avenues for Future Research		**x**
Papargyropoulou et al. (2016)	Conceptual framework for the study of food waste generation and prevention in the hospitality sector		**x**

Research articles that use qualitative methods from six studies are: 1) Priefer et al. (2016), the analysis carried out in the study revealed that most of the preventive measures implemented in EU Member States to date are soft instruments such as awareness campaigns, round tables, networks and information platforms; 2) Cicatiello et al. (2016), the study was conducted by analyzing the results of food waste recovery projects held in Italian supermarkets and, by drawing on data collected in case studies, then evaluating the value of wasted food. The results showed that the level of food waste in retail is certainly quite large, both in terms of quantity and economic value; 3)

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Visschers et al. (2016) after a survey in Switzerland, it was found that to reduce food waste in households, interventions should focus on increasing control of perceived consumer behavior on food waste and convincing them that they can become good providers without disposing of food; 4) Porpino (2016), studies that aim to provide a framework and solutions for conducting future research show that further theories are needed related to consumer food waste, in addition to studies aimed at testing the impact of communication initiatives on behavior change and providing standard methodologies to measure consumer food waste; 5) Papargyropoulou et al. (2016), a case study of food waste deposits in a hotel restaurant in Malaysia was used as an example to illustrate how the conceptual framework in the study could be applied, the results showed that food waste is intrinsically related to the way we provide and consume food, the material context and social culture from food consumption and food waste generation. Articles that use quantitative methods namely Chan et al. (2016) with research on composting food waste. The results of his study found that the addition of Mg and P salts effectively supported pH to -8.0 but also increased the electrical conductivity of compost to 6.45 mS / cm and amendments along with 10% zeolite to effectively reduce electrical conductivity to 2.82 mS / cm and increase compost maturity.

Author	Title	Quantitative	Qualitative
Corrado et al. (2017)	Modelling of food loss within life cycle assessment: From current practice towards a systematisation		**x**
Alexander et al. (2017)	Losses , inefficiencies and waste in the global food system	**x**	
Liljestrand (2017)	Logistics solutions for reducing food waste		**x**
Gokarn&Kuthambalayan (2017)	Analysis Of Challenges Inhibiting The Reduction Of Waste In Food Supply Chain	**x**	

Furthermore, in 2017 research from Corrado et al. (2017) who used this qualitative method aimed at providing an initial analysis of how food loss modeling had been done so far in the LCA study and the second suggested definitions for food loss for adoption. The most relevant recommendations are: i) systematic calculation of the loss of food produced along the food supply chain; ii) modeling waste treatment in accordance with certain food characteristics; iii) sensitivity analysis on the modeling method adopted to model multi-functions; and iv) the need for transparency in describing the formation and management of food loss modeling. Then, there are studies from Alexander et al. (2017) with the results of the study showing that due to cumulative losses, the proportion of global agricultural dry biomass consumed as food was only 6% (9.0% for energy and 7.6% for protein), and 24.8% from harvest biomass (31, 9% for energy and 27.8% for protein). The highest loss rate is related to livestock production, although the greatest loss of dissolved biomass occurs before harvest. Loss of yield is also very large. 44.0% of the dry matter of the plant (36.9% energy and 50.1% protein) is lost before human consumption. Research with the next quantitative method by Gokarn&Kuthambalayan (2017) whose main purpose of research is to identify and analyze the effectiveness of challenges that hinder the reduction of waste in India's agrifood supply chain. It can be seen that food characteristics, supply chain uncertainty, market infrastructure, and food policies and regulations are challenges that have a higher driving force and low dependency, and require maximum attention. The last study is research that uses qualitative methods from Liljestrand (2017). His results reveal that to efficiently reduce food waste in the food supply chain, solutions have been applied to the three stages of the food supply chain, and that these solutions differ in their integration from six logistics activities and four coordination mechanisms.

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Author	Title	Quantitative	Qualitative
Conrad et al. (2018)	Relationship between food waste, diet quality, and environmental sustainability	**x**	
Salihoglu et al. (2018)	Food loss and waste management in Turkey	**x**	
Bradford et al. (2018)	The dry chain: Reducing postharvest losses and improving food safety in humid climates	**x**	

In the last year, all scientific articles obtained in 2018 used quantitative methods. The results of the analysis conducted by Conrad et al. (2018) found that US consumers waste 422 g of food per person every day, with 30 million hectares of agricultural land used to produce this food every year. This accounts for 30% of the daily calories available for consumption, a quarter of daily food (by weight) available for consumption, and 7% of the annual agricultural land area. Salihoglu et al. (2018) conducted a study with the aim of reviewing the state of the field in Turkey and identifying potential food waste as a resource. Then it was found that the total amount of biodegradable waste was found at around 20 million tons / year, of which more than 8.6 million tons / year of this waste were food loss and food waste from distribution and consumption in the food supply chain. Bradford et al. (2018) propose climate-based and drying methods for applying dry chains to minimize accumulation of mycotoxins and insect infestations in dry products, reduce food loss, improve food quality, safety and security, and protect public health.

V. CONCLUSION

This research was conducted by means of a literature study, namely the search for literacy within ten years starting from 2009 until 2018. The study of literacy that has been carried out for a decade is limited to using only sixty scientific articles. After reviewing existing articles, research on food loss and food waste has experienced an upward trend from 2011 to 2014 which afterwards experienced decline. The year 2014 is the year with the most articles numbering seventeen scientific articles, while the Year 2011 is the year which has the fewest articles, namely only one article.

The method most often used in that decade is quantitative methods. There are thirty-four articles that use quantitative methods and twenty-six articles use qualitative methods. Based on sixty articles, the research is dominated by developed countries and little is done on developing countries. Therefore, it is suggested that further research be carried out using qualitative methods and use more scientific articles.

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