sciendo

Management
2020
Vol. 24, No. 1

DOI: **10.2478/manment-2019-0043**

EWA ŻMIEŃKA
JAKUB STANISZEWSKI

Food management innovations for reducing food wastage – a systematic literature review

1. Introduction

With the beginning of the 21st century we face a great challenge of increasing the global food supply. A massive population growth, resulting in growing demand for food, requires new methods of intensifying food production. While there are areas in the world still lacking in food supply, increasing competition for the use of energy, water and land, combined with a growing consumption of animal products, may limit further increase in food production (Godfray et al., 2010). Also, a sufficient amount of food produced globally does not translate into reducing world hunger and the problem is only deepening. Already in 2009 the amount of produced food could feed well over 1 ½ times more people than lived on the planet and yet, since then, the number of undernourished people only has increased (FAO 2009, FAO 2018). It means that problem lies in food distribution and global inequalities. While in some countries (mostly of Global South) millions of people suffer from hunger, in other parts of the world staggering amounts of produced food are wasted. According to FAO (2011), each year 1.3 billion tons of food (about a third of all that

Ewa Żmieńka, B.A.,
Poznań University of Economics and Business,
Student Scholarly Association of Food Economics,
Poland,
ORCID: 0000-0002-4965-8984.

Jakub Staniszewski, Ph.D.,
Poznań University of Economics and Business,
Department of Macroeconomics and Agricultural Economics,
Poland,
ORCID: 0000-0001-8074-0911.

is produced) is wasted. Furthermore, 1.4 billion hectares - 28% of the world's agricultural land area is used to produce this food.

However, scientists still work on finding solutions to reduce global food wastage. The goal of this paper is to assess current trends in research into food waste management innovations in social sciences and to map them. To achieve this we extracted 107 articles from the Web of Science database using keywords: "food waste" and "innovations" or "technologies". Then we grouped them by the part of supply chain they concern and type of innovation they include.

This paper consists of five parts. In this part we introduce our research idea and goal and provide grounds for it. Research background including latest data and economic theories is presented in the next part. Part three extends the justification of our research and explains the method of systematic literature review we followed. In part four we present synthetic results of our review. In the last part we draw conclusions about the latest research trends and potential research gaps.

2. Research background

It is necessary to define what exactly is considered as "food waste". Following FAO (2011), after Parfitt et al. (2010), we could introduce here distinction between "food waste" and "food loss". According to these sources, "food losses" refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. "Food losses" take place at production, postharvest and processing stages in the food supply chain. "Food losses" occurring at the end of the food chain (retail and final consumption) are rather called "food waste", which relates to retailers' and consumers' behaviour. Similar definition of these terms is followed by Kummu et al. (2012). On the other hand Hodges et al. (2010) proposes to distinguish term "postharvest loss", which refers to measurable quantitative and qualitative food loss in the postharvest system; "food loss", which is a subset of above mentioned and represents the part of the edible share of food that is available for consumption at either the retail or consumer levels but not consumed for any reason; "food waste" which is the subset of food loss that is potentially recoverable for human consumption. Finally, in some papers "food loss" and "food waste" terms are treated as synonyms (Halloran et al. 2013) or combined into one term "food losses and food waste" (Xue et al. 2017).

In this paper we decided to analyse the widest category, treating "food waste" and "food loss" as synonymous and concentrating not on the product but

the process of food wastage. In particular, to analyse potential innovations in whole food supply chain which avoid wastage of food products intended to be consumed. Our review revealed that many authors do not follow any particular distinction and analyse "food waste" even at the earlier stages of supply chain, which in accordance to FAO (2011) should be treated as a "food loss". As a keyword for review "wast*" has been used due to the fact that it returned more records (107) than loss (40). Furthermore, both categories overlapped almost completely (111 records in the option "food wast*" or "food loss").

Food wastage can occur in many situations. Food can be lost on the way between the producer and the market. It may be result of pest infestations or other problems at different stages of farming, such as pre-harvesting, harvesting, handling, processing, storage, packing or transportation. In the later food supply chain stages food wastage occurs by discarding or alternative (non-food) use of food that is safe and nutritious for human consumption. For instance, when fresh produce is removed from the supply chain during sorting operations because of its unsatisfying shape, size of colour, it is considered food waste. Many food products are also discarded by retailers and consumers when they are close to "best-before" dates. Lastly, significant amounts of wholesome edible foods and leftovers are thrown away (wasted) in households and restaurants.

As it was mentioned before, the amount of food wasted varies considerably by region. The countries with highest food wastage are those with higher GDP. For instance, the per capita food wastage in Europe and North America reaches volumes of around 280-300 kg per capita per year, while it is around 120–170 kg per cap per year in Sub-Saharan Africa and South/Southeast Asia. The difference is also noticeable in carbon footprint. To produce food lost or wasted in North America and Oceania 860 kg of CO2 equivalent per year per capita is emitted. In Sub-Saharan Africa this value is equal to 20 kg (FAO 2018).

Also, different amounts of food and resources are wasted at different parts of the supply chain. At the consumer stage the wastage is the highest in countries of medium/high income (FAO 2011). In comparison to other goods, the demand for food in countries with higher GDP is generally steady. With the growth of income, the average household expenditure on food grows insignificantly and its share in total expenditure structure lowers. This law is known in economics as Engel's law (Dudek et al. 2012). This means that after buying enough food to satisfy its needs, the average family still has a significant part of their income to spare. Therefore the possible loss from buying some extra products that may be wasted is relatively lower. Also, the availability of food in rich countries impacts consumer preferences. High expectations of produce quality and appearance

cause a greater percentage of total post-harvest losses (Kader, 2005). Wastage may also be a result of poor adjustments of the agricultural production. Low elasticity of supply characteristic of agriculture means that farmers are not able to react quickly to a slump in demand and prices. This often results in overproduction (Czyżewski, Staniszewski 2015).

In countries with low GDP, where poverty is more common, the loss usually occurs at the distribution and storage stages. The lack of sanitation and proper heating systems are the main barriers in storing food for a necessary amount of time before product is provided to consumers. Addressing food waste is therefore not only about resource losses, but also about food availability and self-sufficiency (FAO 2011). These are essential for the developing countries (of lower GDP) to achieve resilience against global prices shocks. Another issue is that developing country regions of the world are also susceptible to water scarcity, and in the future the ongoing climate change poses a threat of serious shortages there (Scialabba 2011).

This polarisation of problems between different countries and continents adds to the complexity of food wastage dilemma. The countries of higher GDP must concentrate on reducing qualitative losses (result of consumer preference and behaviour), while in low-GDP countries the quantitative losses are of higher priority (Kader 2005). Therefore, different stages of distribution need to be improved or even re-designed. It is, however, in the general interest of entities at each part of the chain, to avoid any loss or waste. For this reason, a lot of time and resources is invested in search for innovations that can reduce food wastage.

Innovation plays a significant role in social and economic development. It is, however, often incorrectly associated only with technological advancements. Many definitions of the term take from Schumpeter's idea of innovation, according to which it can be either a new product, service or method of production, new way to organise business or open up new markets - both purchasing and sales markets (Hospers 2005). In this sense, a combination of old ideas, a copy or imitation of existing ideas would still, in fact, be an innovation. Jacobs (2009) noticed that innovations are embedded in cultural and social contexts and perceiving them as only technology-based can suppress their diffusion. He stated that innovations can be divided into two types: those basing on new technologies and non-technical ones, requiring human skills or intervention. With non-technological innovation, a change requires implementing new ideas or approaches either within innovator's organization, or between different supply chains. It is worth mentioning that in case of food wastage, the general statement is that both technological and behavioural changes need to be introduced to tackle the problem (Dorward 2012).

3. Motives for undertaking and methodology of the research

The role of innovation is crucial for resolving an issue as complex as food wastage. In recent years the number of articles concerning food wastage innovations has grown significantly. Articles extracted for research that were published in 2017 and 2018 accounted for 58% of the total (62 out of 107) while in previous years the share of publications was 11.2% (12 articles) in 2016 and 6.5% in 2015 and 2014 (7 articles each year). Our goal was to see what innovations are the most popular and what parts of the chain are addressed most often in research.

A similar review was done by Weltin et al. (2018), with literature concerning sustainable intensification of food production. Scientific articles were explored and demonstrated in a map, where they were grouped by their fields of action. The authors developed a conceptual framework that provided a holistic understanding of a broad field of study after two decades of research.

The division proposed by Jacobs (2009) presented earlier is especially interesting for food supply chain, where wastage occurs at each part and involves many factors. We decided to group innovations in 2 dimensions: by their type and part of the supply chain involved. However, to be more precise, we decided to extend this division of innovations to three categories:

- technology-based innovations,
- expanding the use of existing technologies,
- strategic planning, policy and social practices - regarding actions of producers and retailers, as well as consumer behaviour.

The research was based on the Web Of Science database, and the articles with phrases: TS=("food wast*" and (technolog* or innovat*)). Results were taken from all years and limited to social science databases: SSCI (Social Sciences Citation), CPCI-SSH (Conference Proceedings Citation Index - Social Science & Humanities) and BKCI-SSH (Book citation index. Social sciences & humanities).

Given phrase resulted in the query of 107 articles which were analysed. Among them, 24 were rejected for the following reasons:

- focus on food waste, but no solutions were presented (11 articles). Some articles gave comprehensive background on the problem of food wastage, but without mentioning actual solutions;
- not relevant (13 articles). Articles concerning malnutrition, sustainable diet or observations of food wastage in particular world regions which did not cover the key topic.

In other 83 articles, at least one solution, technology or practice was identified and grouped by the part of the supply chain and type of innovation it involves. Summary of the research is presented in tables 1., 2. and 3. Numbers on the left indicate the number of times the innovation was mentioned in the articles. Numbers in brackets following some solutions show how many of all articles included this particular example.

Many articles addressed the importance of strategic planning, improving the flow of information or political incentives generally and on each level. However, it was not counted unless the article did not refer to any specific solution. If the importance of particular solutions was a highlight of the article, but still none was named, it fell under a more general category, e.g. ”policies impacting consumer behaviour”.

Also, some articles pointed at such techniques as vertical farming, drip irrigation or even anaerobic digestion which are known and commonly used in agriculture and utilisation of biomass for biogas. In this sense, the techniques have been exemplified as ways of making the production systems more efficient.

Some of the articles did not address food waste directly, but had to do with municipal waste disposal, which is also a part of waste management. As most of the organic municipal waste is biomass, a significant part of which is coming from food waste, they also were included. The organic fraction of municipal food waste can be used for energy recovery and was included in the final stage of the food chain (utilisation).

4. Results

The result of grouping is presented in tables 1., 2. and 3., presenting different types of innovation. The greatest concentration can be observed at the final links of the chain: 5 - retail (23), 6 - households (26) and 7 - utilisation (43). 23.3% of innovations were classified as technology-based (24 out of 103), 45.6% involved expanding the use of existing technologies (47 out of 103) and remaining 31% included solutions other than technological (32 out of 103).

Firstly, let us consider solutions on the first part of the supply chain. At the stage of agricultural production no other innovations were found except for possible improvements in production efficiency. Changes of policy in donating surplus may include for instance making it compulsory for supply chains (as introduced lately in Poland).

In part 2, few articles point at the existence of solutions improving food packaging. Kouwenhoven et al. (2012) presented a case of profitable business based on converting the horticulture waste into fresh vegetable juices and

natural food colours. It enables reprocessing class 3 greenhouse vegetables into consumer products. McDowall et al. (2017) mention the Eco-design directive and Action Plan, both designed by European Union to implement circular economy policies. The directive sets minimum energy efficiency standards for different products to reduce their impact on the environment. The Action Plan proposes extending produce responsibility rules. It is set to reward products that are designed for easier repair, remanufacture, or recycling. Even if it is doubtful to treat directive as an innovation, it encourages innovativeness in food packaging. That is why it has been mentioned here.

Table 1. Types and popularity of anti food wastage technologies by part of supply chain - technology-based innovations

1 - Agricultural production	2 - Processing & packaging		3 - Storage	4 - Transport	5 - Retail & restaurants		6 - Households		7 - Utilisation	
	4	innovative food packaging			1	robotics technologies (automating quick-service operations in fast foods)	3	**weight-based system to quantify the amounts of food waste (1), e.g. Household-Based Food Waste Charging System (RHWC) through RFID (2)**	1	new techniques of valorising biomass: valorisation of Forage Opuntia
	1	biopolymers as food packaging (seafood by-product)					2	smartphone applications	1	**refuse paper and plastic fuel (RPF)**
	1	packaging that absorbs ethylene (a hormone that speeds fruit ripening)					1	Time and Temperature Indicator Labels	1	insects bred on organic waste as animal feed
	1	**converting horticulture waste into fresh vegetable juices and natural food colours**					1	**observational technology to study In-Store Behaviour: Shopper Flow Tracking System**		
							1	smart fridges and smart shopping trolleys		
							1	mobile food record (mFR)		
							1	**BinCam - trash bin capturing disposed trash**		

Source: original study based on the Web of Science

Table 2. Types and popularity of anti food wastage technologies by part of supply chain - expanding the use of existing technologies

1 - Agricultural production		2 - Processing & packaging		3 - Storage	4 - Transport	5 - Retail & restaurants		6 - Households		7 - Utilisation	
1	drip irrigation	1	heat transfer, cleaning and sanitation improvements			6	food donating channels			11	composting
2	vertical farming technology	2	real-time temperature monitoring with wireless networks			1	improving operative conditions of refrigerators			11	technologies in anaerobic digestion: to produce energy
2	IT - integrating information for improving efficiency of resources							1	**Design for Sustainable Behaviour (DfSB);**	3	networks of waste by-products, electricity and heat (waste-to-energy - WtE technologies)
								1	food waste grinders	3	incineration (1), methane fermentation and feedstock recycling (2)
										3	anaerobic digesters provided to households
										2	producing fertilizers
1	system dynamics model for energy use									1	gasification for biogas

Source: original study based on the Web of Science

Table 3. Types and popularity of anti food wastage technologies by part of supply chain - strategic planning, policy and social practices

1 - Agricultural production		2 - Processing & packaging		3 - Storage	4 - Transport	5 - Retail & restaurants		6 - Households		7 - Utilisation	
2	change of policies for donating surpluses	1	supplier - retailer take-back practices: policy improvement					6	policies impacting consumer behaviour	4	food waste as animal feed
		1	**rewarding products that are designed for easier remanufacture, or recycling (Eco-design directive)**			2	marketing physically unappealing food (1) or crops of low demand (1)	5	alternative distribution systems, food sharing systems	1	strengthening deconcentration of recycling centres

				2	marketing food of higher value, such as fruit, vegetables and other nutrient-dense crops (1) or long-lasting food (1)	1	experiments done to raise consumer awareness	
				1	discounts and secondary discount markets			
				1	date labelling standard that eliminates disparate and unclear labelling standards			
				1	doggy bags in restaurants			
				1	contractor's submission of an annual report detailing the weight of food donated, composted or discarded			
				2	CSR practices (1) and sponsorships (1)			
				1	policies impacting retailer's behaviour			
				1	internal distribution to employees			
				1	remanufacturing and repackaging			

1	EU funded projects for sharing knowledge such as Engage 2020,2 RRI Tools,3, INPROFOOD4 or CIMULACT,5 the RRI, European Technology Platform (ETP) "Food for Life," 2016

Source: original study based on the Web of Science

There were no innovations concentrated strictly on the parts of the chain involving storage and transportation. Many more articles were dedicated to improvements at the stage of retail and restaurants. At this stage a lot can be achieved through strategic planning and marketing. There is also an example of a policy called The Protecting Americans from Tax Hikes (PATH) Act. It enables US food businesses to receive tax benefits when donating food to charitable organizations (Evans and Nagele 2018). Donors can deduct the cost of production and half the difference between the cost and full fair market value of the donated food from their taxable income. Such tax incentives, if popularised, could motivate retailers to foster more such actions.

Food waste in households showed the biggest potential for improvements through technology-based innovations (10 articles). It can start from monitoring customer's choices while shopping, e.g. through In-Store Tracking System. Observing shopper's journey through the store and further behavioural analysis allow to assess customer routines and what triggers them to buy excess food (Larsen, Sigurdsson, Beivik 2017). Other articles involve financial penalties. For instance, two types of food waste charging systems: household-based and community-based were implemented in district of Seoul in South Korea (Lee and Jung 2017). It is designed to electronically charge every household depending on the weight of biomass they disposed through Radio Frequency Identification. That requires regulations forcing citizens to sort their waste. Although the policies may work well in the Korean society, introducing them in other countries could start protests. Evans and Nagele (2018), from the USA, note that more politically conservative societies may resist heavy-handed governmental involvement due to their privacy concerns. For instance, The Universal Recycling Law requires all state residents in Vermont to separate food waste from trash may be impossible to introduce in other states.

Another technology-based solutions were mentioned by Tu et al. (2018). They proposed effective product design programs that promote sustainable behaviour of the new poor during product use (Design for Sustainable Behaviour). Repertory Grid Technology, which takes from theory of personal construction, is used to establish human behaviour that can be then used to design home appliances in a more "smart" way. Using them was proven to significantly reduce food wastage. That can be achieved for instance by using refrigerators designed with eco-information and eco-technology, that are be able to print expiry date alerts or shopping lists and send them by text or email. However, advancements do not necessarily need to be technology-based. The authors mention that even a small intervention such as resizing plates can significantly reduce household food waste.

A great part of articles was dealing with wasted food, proposing or promoting ways of utilising or recycling the biomass. This includes different usages of anaerobic digestion. The variety of food processes globally each year generate waste on a multi ton scale. A lot of the lost material is biomass, which is a valuable resource for a biorefinery. One of the proposals is also to provide households with home digesters and encourage composting (Nandhivarman et al. 2015). Another field of study deals with combined recovery systems, which allow for efficient recovery of the resources. For instance, refuse paper and plastic fuel (RPF), a system in which separated paper, plastic, and RPF is incinerated and

used for wet methane fermentation. The amount of energy recovered from the system was 54.5 kWh/t, and the efficiency reached 33.4%. The technology may improve efficient waste management systems that is particularly important in the transition to low-carbon cities (Ohnishi et al. 2016). Efficient energy recovery occurs through a combination of waste-to-energy systems for a low-carbon city.

There is a noticeable disproportion between research activities at the first and last parts of the supply chain. Apart from integrated systems that engage the whole supply chain, not much attention is brought to transport or storage, which are areas with possible potential for further improvements.

5. Conclusions

The problem of food waste and food loss affects all parts of the world and requires integrated global solutions. Despite growing interest among scientists in this area, over the last years the amount of waste has been gradually increasing. The goal of this research was to map food management innovations for reduction of food wastage and to assess the current trends in developments at different parts of the supply chain.

The review revealed that most of studies proposed dealing with the problem of food wastage not by prevention, but by mitigating negative consequences. It is reflected in the fact that the most of the proposed solutions was supposed to be implemented at the last stage of food chain and concerned the topic of utilising waste by, for example, converting it to energy or composting. A lot of attention gathered also other two final stages of food chain – "retail and restaurants" and "households". Here particularly popular were solutions based on IT, policy changes and awareness-raising campaigns.

However, our study revealed also significant research gap in the topic of innovations reducing food wastage at earlier parts of the supply chain. It is even more surprising, knowing that wastage at these stages is more common in countries of lower GDP, where well addressed innovations may help fight the problem of hunger and malnutrition. The focus on the later stages of the supply chain can be explained to some extent by the country of origin of the analysed papers. They mostly came from the developed countries - in 20% from USA, in 19% England, in 13% Italy and in 10% Sweden. First developing country on this list is China with 9,3%. It seems that researchers from developed countries concentrate at the first place at problems more common in their countries. Another explanation might be the logic that the more fundamental problems of food waste in developing world do not require innovation but the implementation of

technologies already in use in developed economies. Exploring this thesis might be an interesting starting point for further research.

Summary

Food management innovations for reduction in food wastage – a systematic literature review

The goal of this paper is to assess the current trends in research on food waste management innovations in social sciences and mapping them. To achieve this, 107 articles were extracted from the Web of Science database with the keywords food waste and innovations/technologies. Then, we grouped them in accordance with part of supply chain they concern and type of innovation they propose. We identified that the majority of the innovations concern the final stages of the food supply chain. It makes them more suitable for developed countries, where the wastage is the greatest in this phase of production. It also indicates a research gap in waste-reduction technologies in the initial stages of the food supply chain. Improvements in this field may be particularly beneficial from the food security point of view, because countries suffering from food shortages waste most of their supplies in the early stages of production.

Keywords: *food waste, food chain, innovations, systematic literature review.*

Streszczenie

Innowacje w zakresie zarządzania żywnością ograniczające jej marnotrawstwo – systematyczny przegląd literatury

Celem niniejszego opracowania jest ocena aktualnych trendów w badaniach społecznych, poruszających kwestię innowacji w dziedzinie zarządzania produkcją żywności, wprowadzanych dla ograniczenia jej marnotrawstwa. Aby osiągnąć ten cel, z bazy danych Web of Science wyselekcjonowano 107 artykułów zawierających słowa kluczowe „marnotrastwo żywności" oraz „innowacje/technologie". Następnie zaproponowane w nich rozwiązania pogrupowano zgodnie z etapami łańcucha dostaw, których dotyczyły oraz rodzajem innowacji. Ze stworzonej „mapy innowacji" wynika, że większość rozwiązań dotyczyło końcowych etapów łańcucha dostaw żywności. Sprawia to, że są one bardziej

przydatne dla krajów rozwiniętych, w których marnotrawstwo jest największe w tej fazie produkcji. Wskazuje to również na lukę badawczą w technologiach redukcji odpadów na początkowych etapach łańcucha dostaw żywności. Usprawnienia w tym obszarze mogą być szczególnie korzystne z punktu widzenia bezpieczeństwa żywnościowego, ponieważ kraje cierpiące na niedobory żywności marnują większość swoich zasobów właśnie na wczesnych etapach produkcji.

Słowa kluczowe: *marnotrawstwo żywności, łańcuch dostaw, innowacje, systematyczny przegląd literatury.*

JEL Classification: Q16, Q55

References

1. Czyżewski, A., Staniszewski, J. (2015). Cenowe uwarunkowania zmian struktury czynników wytwórczych w rolnictwie polskim w latach 1999-2013. *Roczniki naukowe ekonomii rolnictwa i rozwoju obszarów wiejskich, 102(4),* pp. 7-17.
2. Dorward, L.J. (2012). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? A comment, *Food Policy, 37(4),* pp. 463-466. DOI: 10.1016/j.foodpol.2012.04.006.
3. Dudek, H., Koszela, G., Landmesser, J. (2012). Wpływ sytuacji dochodowej na strukturę wydatków gospodarstw domowych, *Zeszyty Naukowe SGGW w Warszawie. Ekonomika i Organizacja Gospodarki Żywnościowej*, vol. 97, pp. 237-246.
4. Evans, A., Nagele, N. (2018). A Lot to Digest: Advancing Food Waste Policy in the United States, *Natural Resources Journal, Vol. 58, Iss. 1,* pp. 175-249.
5. FAO (2009). *The state of food insecurity in the world.* Rome. http://www.fao.org/3/i0876e/i0876e.pdf 2.11.2019 - access date).
6. FAO (2011). *Global food losses and food waste. Extent, causes and prevention.* Rome. http://www.fao.org/3/a-i2697e.pdf (2.11.2019 - access date).
7. FAO (2018). F*ood loss and waste and the right to adequate food: Making the connection.* Rome. http://www.fao.org/3/ca1397en/CA1397EN.pdf (2.11.2019 - access date).
8. Godfray, H.C., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir J.F., Pretty J., Robinson, S., Thomas, S.M., Toulmin, C. (2010). Food

security: the challenge of feeding 9 billion people. *Science, 327(5967),* pp. 812-818. DOI: 10.1126/science.1185383.
9. Halloran, A., Clement, J., Kornum, N., Bucatariu, C., & Magid, J. (2014). Addressing food waste reduction in Denmark. *Food Policy, 49,* pp. 294–301. DOI:10.1016/j.foodpol.2014.09.005.
10. Hodges, R. J., Buzby, J. C., & Bennett, B. (2010). Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. *The Journal of Agricultural Science, 149(S1),* pp. 37–45. DOI:10.1017/s00218596100009.
11. Hospers, G.J. (2005). Joseph Schumpeter and his legacy in innovation studies. *Knowledge, Technology & Policy, Vol. 18, Iss. 3,* pp. 20–37.
12. Jacobs, D. (2009). Adding values: the cultural side of innovation. Zwolle: WBOOKS.
13. Kader, A.A. (2005). Increasing Food Availability by Reducing Postharvest Losses of Fresh Produce. *Acta horticulturae, Vol. 682,* pp. 2169-2176. DOI: 10.17660/ActaHortic.2005.682.296.
14. Kouwenhoven, G., Reddy Nalla, V., Lossonczy von Losoncz, T. (2012). Creating Sustainable Businesses by Reducing Food Waste: A Value Chain Framework for Eliminating Inefficiencies. *International Food and Agribusiness Management Review, 15(3), pp.* 119-137.
15. 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,* pp. 477–489. DOI:10.1016/j.scitotenv.2012.08.092
16. Larsen, N., Sigurdsson, V., Breivik, J. (2017). The Use of Observational Technology to Study In-Store Behavior: Consumer Choice, Video Surveillance, and Retail Analytics. *The Behavior Analyst. Vol. 40, Iss. 1,* pp. 309-313. DOI: 10.1007/s40614-017-0121-x.
17. Lee, S., Jung, K. (2017). Exploring Effective Incentive Design to Reduce Food Waste: A Natural Experiment of Policy Change from Community Based Charge to RFID Based Weight Charge. *Sustainability, Vol. 9, Iss. 11,* pp. 1-17. DOI: 10.3390/su9112046.
18. McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., Kemp, R. and Doménech, T. (2017). Circular Economy Policies in China and Europe. *Journal of Industrial Ecology, Vol. 21*, No. 3, pp. 651-661. DOI: 10.1111/jiec.12597.
19. Nandhivarman, M, Gopalsamy, P., A. Edwin, G., Ramaswamy, A.P. & Boruah, D. (2015). Evolving and Implementing Energy Recovering Strategy from Food Wastes at Jawahar Navodaya Vidhyalaya (JNV). *Fostering Campus Sustainability In Implementing Campus Greening Initiatives: Approaches, Methods and Perspectives,* pp. 1-12.
20. Ohnishi, S., Fujii, M., Ohata, M., Rokuta, I., Fujita, T. (2016). Efficient energy recovery through a combination of waste-to-energy systems for

a low-carbon city. *Resources, Conservation and Recycling, Vol. 128,* pp. 394-405. DOI: 10.1016/j.resconrec.2016.11.018.
21. Parfitt, J., Barthel, M. & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050, *Phil. Trans. R. Soc., vol. 365*, pp. 3065-3081.
22. Scialabba, N.E. (2011). Food Availability and Natural Resource Use, RIO 20. http://www.fao.org/fileadmin/user_upload/suistainability/Presentations/Availability.pdf (2.11.2019 - access date).
23. Tu, J.-C., Nagai, Y., Shih, M.-C. (2018). Establishing Design Strategies and an Assessment Tool of Home Appliances to Promote Sustainable Behavior for the New Poor. *Sustainability, Vol. 10, Iss. 5,* pp. 1507. DOI: 10.3390/su10051507.
24. Weltin, M, Zasada, I., Piorr, A., Debolini, M., Geniaux, G., Moreno Perez, O., Scherer, L., Marco, L.T., Schulp, C.J.E. (2018). Conceptualising fields of action for sustainable intensification – A systematic literature review and application to regional case studies. *Agriculture, Ecosystems & Environment, Vol. 257*, pp. 68-80. DOI: 10.1016/j.agee.2018.01.023.
25. Xue, L., Liu, G., Parfitt, J., Liu, X., Van Herpen, E., Stenmarck, Å., O'Connor, C., Östergren, K., Cheng, S. (2017). Missing Food, Missing Data? A Critical Review of Global Food Losses and Food Waste Data. *Environmental Science & Technology, 51(12),* pp. 6618–6633. DOI:10.1021/acs.est.7b00401.