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ORIGINAL PAPER

THE ISSUE OF FOOD LOSSES AND WASTE AND ITS DETERMINANTS

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ABSTRACT. **Background:** The study was initiated because managing the problem of food losses and waste seems to be essential in terms of reducing pressure on natural environment, growing world population, millions of undernourished people, and economic wellbeing of food operators. The aim of the paper is to analyze and evaluate the problem of food losses and waste, and its consequences. The author has made an attempt to indicate the main determinants of this phenomenon and identify areas of improvement to prevent and combat food losses and waste more effectively.
Materials and results: The paper is based on recent literature review, professional research and publications, data collected by FAO and EUROSTAT, EC technical report and regulations. Analysis based on the literature review, secondary data sources and Internet sources helped to indicate the main determinants of FLW and to identify some areas of improvement in preventing and combating FLW. The paper by Kołożyn-Krajewska et al. was the main inspiration for the author to make an extended list of determinants of FLW.
Conclusions: Food losses and waste are highly unethical while millions of people are undernourished worldwide. FLW means that resources used in food production have been used in vain. FLW places an unnecessary burden on the environment. The author underlines that the extent, causes and prevention of food losses and waste are different in low, medium and high income countries. The author divides the determinants of food losses and waste into two groups: determinants occurring along a food chain and external conditions effecting FLW. Coherence of food losses and food waste definitions and data collecting are indispensable for proper estimation and effective prevention of the problem.

Key words: food losses, food waste, food losses and waste, food supply chain.

INTRODUCTION

Food and Agriculture Organization of the United Nations (FAO) has reported that one third of all the food produced for human consumption is wasted. It would be enough to feed three billion people. There is even an estimate that half of all the food grown is lost or wasted before and after it reaches the consumer [Parfitt et al. 2010]. It is an issue because the eradication of food waste and losses and the reallocation of saved food would help to solve the problem of 795 million of undernourished people living in other regions of the world (10.9% of the global population in 2014-2016). Food waste means that huge amounts of the resources used in food production are used in vain (land, water, labor, fuel, raw materials, energy and so on). Greenhouse gas emissions caused by production of food that gets lost could also be entirely avoided. 10% of greenhouse gas emissions of highly developed countries come from growing food that is never eaten [www.fao.org; www.feedbackglobal.org]. What is more, uneaten food and its packaging must be disposed of appropriately. Utilizing food costs time, energy and money, and is usually, to a greater or lesser extent, harmful to the environment.

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Food losses and waste (FLW) have a tremendous impact on societies, economies, climate and other aspects of natural environment. FLW endangers food and nutrition security and hinder sustainable development. When the population of Earth is still facing the problem of global undernourishment, hunger and underweight children, allowing food losses and waste seem to be highly unethical. World population is still growing and the question is: how can the world adequately feed more than 9 billion people projected to live in 2050 in a manner that advances social and economic development while reducing pressure on ecosystems, climate, and water resources [Lipinski et al. 2013]. The problem of food losses and waste appears along entire food supply chains (agriculture, post-harvest, processing, distribution, consumption, end of life). FLW happening at one stage of the food chain can have their cause at another stage [HLPE 2014]. Managing this problem should help to feed more people, increase farmers' incomes and decrease consumers' expenses for food and so on.

The question is what actions should be taken within food supply chains and around them to minimize food losses and waste at each stage of the chain. Another problem is: whose responsibility should it be to prevent and combat food losses and waste? The interested parties include governments, businesses and civil societies. Who should take responsibility for the problem of FLW? Would coordinated actions be more effective, efficient and efficacious? There are several food quality management systems, both obligatory (GMP/GHP, HACCP) and voluntary, optional (ISO 22000) or additional (BRC, IFS, GlobalGAP) for the operators in a food chain, which inevitably influences minimizing food losses and waste. However, the question is if there is a need for developing and introducing a system suitable for food losses and waste management in the whole of a food chain. There are many Regulations of the EU legislative bodies in the area of food safety which have an impact on food losses and waste, and food security. The question is if there is a need to establish specific laws concerning the issues of food losses and waste.

The aim of the paper is to analyze and evaluate the problem of food losses and waste, to indicate the main determinants of this phenomenon and identify the areas of improvement in preventing and combating food losses and waste. The analyses are based on recent literature review, professional research and publications, data collected by FAO and EUROSTAT, EC technical report and regulations.

DEFINING FOOD LOSSES AND FOOD WASTE

Different definitions of food losses and waste and a lack of common standards for data collections around the world make it difficult to understand and identify the causes and extent of FLW, and to suggest solutions and actions to reduce the problem. The most popular definitions related to the issue of food losses and waste are presented in table 1.

The term food waste generally relates to behavioral issues, and food losses relate to systems that require investment in infrastructure and knowledge. The proposition is to use the term "food losses and waste" (FLW) to get rid of the problem of different meanings of the terms: "food losses" and "food waste" and to emphasize the importance and uniqueness of the waste part of food loss (the term "food loss" encompasses "food waste"). Food waste is usually a result of negligence or a conscious decision to throw food away, and takes place in catering businesses and households.

FLW issue covers food that is redirected as animal feed, compost or biofuel at different stages of a food supply chain or even before it enters food supply chains. This food might be intentionally discarded or redirected to non-food use in the pre-harvest phase. This situation may be appraised as a negative or positive proceeding depending on the conditions of particular countries, farmers and other stakeholders.

Table 1. Defining food losses and waste
Tabela 1. Definiowanie strat i odpadów żywnościowych

Food loss (food spoilage)	– is **a decrease in quantity or quality of food** reflected in nutritional value, economic value or food safety of all food produced for human consumption but not eaten by humans [http://www.fao.org/food-loss-and-food-waste/en/ 2016]; – is the **unintended result of an agricultural process or technical limitation in storage, infrastructure, packaging, or marketing**. In particular, this phenomenon refers to food that spoils, spills, incurs an abnormal reduction in quality such as bruising or wilting etc. [Lipinski et al. 2013]; – refers to a decrease, **at all stages of a food chain prior to the consumer level**, in mass, of food that was originally intended for human consumption, regardless of the cause [HLPE 2014].
Food waste	– is part of food loss and **refers to discarding or alternative (non-food) use of safe and nutritious food for human consumption** all along food supply chains [http://www.fao.org/food-loss-and-food-waste/en/ 2016]; – refers to **food that is of good quality and fit for human consumption** but that does not get consumed because it is discarded – either before or after it spoils. Food waste is **the result of negligence or a conscious decision to throw food away** [Lipinski et al. 2013]; – refers to food appropriate for human consumption being discarded or left to spoil **at the consumer level** – regardless of the cause [HLPE 2014].
Food losses and waste (FLW)	– refers to a decrease, at all stages of a food chain from harvest to consumption in mass, of food that was originally intended for human consumption, regardless of the cause [HLPE 2014].
Food quality loss or waste (FQLW)	– refers to the decrease in a quality attribute of food (nutrition aspect, etc.), linked to the degradation of the product, at all stages of a food chain from harvest to consumption [HLPE 2014].

Source: own elaboration

THE ISSUE OF FOOD LOSSES AND WASTE

The extent of FLW and the appraisal of this phenomenon depends on the level of development and certain conditions of particular countries. There is a well-known global tendency of under-production and under-consumption of food in less and the least developed countries where natural conditions restrain farming, and economic, political and religious issues are not supportive of food security of the society. FLW occurs usually in initial steps of a food supply chain and is caused by underinvestment in farming, processing and storage and lack of skills. On the other side of the globe, the countries of the 'Rich North' overproduce and overconsume foodstuffs. The scale of food losses and waste in highly developed countries is wide and enlarges, especially at the consumer stage.

The problem of FLW may be also estimated and appraised with reference to commodity groups and stages of a food supply chain. Depending on products and regions, the distribution of losses and waste along a food chain is different. Globally, in middle and high income countries a great share of food losses and waste occurs at distribution and consumption level; in low income countries – during agricultural and post-harvest stages. In Africa, cereals are lost mostly in the first stages of a food supply chain, in Europe – at the consumer stage. In Africa, processing and distribution are the weak stages for fruits and vegetables losses, in Europe – consumption again. The biggest FLW per capita is indicated in Europe and North America (280-300 kg a year), and the lowest FLW is indicated in sub-Saharan Africa and South/Southeast Asia (120-170 kg a year) [HLPE 2014]. Food wasted by consumers in Europe and North-America equals 95-115 kg/year per capita, while this figure in sub-Saharan Africa and South/Southeast Asia is only 6-11 kg/year [Gustavsson et al. 2011b]. FLW can be also distributed as follows: 45% of roots and tubers produced globally is lost or wasted, 45% of fruit and vegetables, 35% of fish and seafood, 30% of cereals, 20% of meat, 20% of oil crops and pulses and 20% of dairy products (milk and eggs) is lost or wasted [http://www.fao.org/save-food/resources/keyfindings/infographics/roots/en/ 04.2016].

In 2010 Eurostat evaluated that 42% of food waste across EU27 take place in households, 39% - in manufacturing, 14% - in

food service and catering, and 5% - in retail and wholesale. European food waste attributed to household consumption amounts to about 76 kg/year/person. It is predicted that 60% of it could be avoided. EU countries where food waste figure is the biggest are: Netherlands (579 kg/year/person), Belgium (399 kg) and Cyprus (334 kg). Data collected by Eurostat in 2010 show that European countries where food waste figure is the smallest are: Greece (44 kg/year/person), Malta (62 kg) and Czech Republic (71 kg). Poland is in the middle with the level of 235 kg/year/person of food waste occurring during processing, distribution, sale, preparation, catering, serving and consumption [Buchner et al. 2012].

The differences among regions and countries regarding food waste are determined in general by economic, organizational and behavioral conditionings, and in particular by the amount of resources in the region and regional patterns of behavior. For example, if everyone behaved as an average American, we would already need five planets to ensure all the resources needed [Filipova et al. 2014]. Food waste is expected to rise together with the growth of an average disposable income. Most probably, this prediction will come true if additional prevention policy and activities are not undertaken. European Commission suggests that such policies as: EU food waste reporting requirements, data labelling coherence and target awareness campaign be developed [European Commission 2010].

The causes of food losses specific for low income countries are: poor storage facilities (warm and/or humid climate, rodents, parasites and fungi), poor infrastructure and transportation, lack of refrigeration, inadequate market facilities (unsanitary, crowded) and poor packaging [Gustavsson et al. 2011a]. These determinants of food losses in the poorest countries are crucial but not the only ones. Malnutrition and FLW problems coexist in low income countries and this is still a weighty research proposal. The food situation in sub-Saharan Africa is very complicated and really hard to solve. Conflict of interest between Western donators and the world's biggest corporations hinders the process of fighting hunger [Kasprowicz 2015].

In medium income countries, like countries which used to be part of the USSR, the common reasons for FLW come from: underinvested farming, insufficient knowledge of farmers mostly running small holdings; poor storage facilities, techniques and know-how; underequipped factories, out of date technologies (implying short expiration dates); underdeveloped marketplaces, long distances from main food markets, inability to sell own produce, inadequate selling conditions [Urutyan 2013]. Participants of late stages in the supply chain are usually responsible for food waste in high income countries.

The main causes of food waste in high income countries are: lack of purchase and consumption planning and limited focus on waste; expiration date policy; leftovers from cooking, preparing and serving [Gustavsson et al. 2011a]; huge portions of packaged food (the USA versus Poland). Most common reasons for the disposal of food by Polish consumers are: expiry of the product, improper storing and inappropriate amount of food products [Achremowicz 2012].

Thus, the instruments used to prevent food losses will be different in low income, medium income and high income countries and actually need to be adjusted on each occasion. To reduce food losses and waste in low income countries it is crucial to support local investments in farming, initial handling, storage, transport, processing and retail. It is important to educate the operators acting in food chains, promote cooling chains, improve packaging and market facilities. The most difficult part of the process of preventing FLW in less developed countries is to change the traditional behaviors and habits of people and to find sources of funding. To prevent FLW problem in medium income countries, education and technical support of farmers and processors are needed, and improving processing and packaging technologies is unavoidable. The role of governments is to support establishment of farmer cooperatives and marketplace development. It is important to educate consumers and promote proper storage, food purchase and consumption planning. Most of FLW in high income countries takes place in households, so to prevent food waste, communication in supply chains and awareness of consumers should be

improved. Consumers should be educated in terms of expiration dates, purchase and consumption planning [Gustavsson et al. 2011a; Urutyan 2013]. In the age of consumerism, when people aim for high levels of consumption, while food is relatively cheap in highly developed societies, preventing and combating food waste is really a problem. How to reduce food waste when selfish and frivolous purchasing of products is so common?

The United States of America is a good example of a country where food waste is quite common, especially at food service and household stages. Regulations on food matters sometimes unintentionally contribute to food waste. Methods of food preparation at catering services quite often contribute to food waste. For instance, food served in American students' cafeterias is constantly heated at the time of a meal. Thus, to ensure food safety, the food which has not been eaten has to be thrown away after some time.

Rob Greenfield, a man who combats food waste in his everyday life, gives some facts about food waste to help understand the issue [http://feedbackglobal.org/2016/01/the-food-waste-fiasco-you-have-to-see-it-to-believe-it/]:

- We throw away food worth 165 billion dollars per year in America. That's more than the budgets for America's national parks, public libraries, federal prisons, veteran's health care, the FBI, and the Food and Drug Administration (FDA) combined.
- About 50 million of our 317 million Americans are food insecure, yet we produce enough food to feed over 500 million Americans.
- To create just the amount of food that ends up in the landfills we waste enough water to meet the domestic water needs of every American citizen.

Jonathan Bloom, in his book American Wasteland: How America Throws Away Nearly Half of Its Food (and What We Can Do About It) from 2010, points out that if we took all the tomatoes that are unsuitable for sale but would be fine for human consumption, we could fill a 10 000 kg lorry every 40 minutes [https://www.barillacfn.com].

Food losses and waste have many negative implications. Economically, FLW means wasted investment, which reduces the economic wellbeing of main participants in a food chain. It is most harmful for farmers whose income is relatively low comparing to other professions and whose income is often realized at different stages of a food supply chain. Due to food losses and waste food prices are growing. It is particularly severe for the societies where families spend a big part of their income on food. And it is unacceptable while a big number of citizens are undernourished. Environmentally, food losses and waste cause unnecessary gas emissions, and wasteful usage of water, land and other natural resources. Managing uneaten food and its packaging is usually a burden for the environment. Socially, food losses and waste cause a greater feeling of social inequality and injustice. Wasting food may be judged as irresponsible behavior of people, whose background is created by such social trends as consumerism, expansion of MacDonald's and other fast food chains, problems with overweight. Food losses and waste affect food security of vulnerable groups, food quality and safety, economic growth and causes environmental degradation which leads to the problem of global warning and climate change.

All the actors of food supply chains share the responsibility for food losses and waste. Therefore, joint initiatives should be undertaken to prevent and reduce FLW phenomenon [Kołożyn-Krajewska et. al 2014].

FACTORS INFLUENCING FOOD LOSSES AND WASTE

Determinants of food losses and waste may be put in two groups of factors:

- factors that occur along a food supply chain (FSC),
- factors that come from the surroundings of a food supply chain.

Kołożyn-Krajewska et al. listed the following determinants of FLW occurring along food supply chains: Machines, Materials, Management, Methods and People [Kołożyn-Krajewska et al. 2014]. The proposition is to determine the following order of these

determinants: People (the most important resource of any organization, decision-makers, often guilty whenever/wherever FLW occurs), Management (W.E. Deming: 94% of problems arise from limitations of Management System), Methods, Materials and Machines.

1. People. Knowledge, awareness and other attitudes of people engaged in a food supply chain determine a level of food losses and waste. Mistakes made by managers or staff may cause FLW. On the other hand people learn from their mistakes so they have to be allowed to make minor mistakes in any learning organization. Managers should be good leaders and make their subordinates get engaged in organizational functioning. It is crucial to assign responsibility for particular processes. It is essential to inform, educate and train managers, staff and consumers in terms of food losses and waste. Employees should be effectively trained in terms of management systems that are introduced in their organization. Managers working for food industry have to pay particular attention to health conditions of all the employees (also their own health) and its official confirmation, and to observing workplace procedures (no jewelry, no nail polish, protective clothing and hats etc.). Consumers should also be effectively educated by anti-food waste supporters e.g. via mass media. According to the literature, consumers are often fully aware of the social and environmental effects of food waste, however, it is not reflected in their behavior [Radzymińska et al. 2016].
2. Management. EU food law (Regulation (EC) No 852/2004 of the European Parliament and the Council of 29 April 2004 on the hygiene of foodstuffs) obligates all the entities in food industry (except for primary producers) to develop and implement quality management systems that include Hazard Analysis and Critical Control Point (HACCP), Good Hygienic Practice (GHP) and Good Manufacturing Practice (GMP) which are prerequisites for HACCP. HACCP identifies, evaluates and controls hazards which are significant for food safety, and which consequently may decrease food losses and waste [Kołożyn-Krajewska, Sikora 2010; Kowalska 2010]. Food supply chain operators may also implement other quality management systems on a voluntary basis, such as ISO 22000:2005, ISO 9001:2015, ISO 28000, TACCP and so on [Bilska and Kowalski 2014]. ISO 22000:2005 is an international standard which specifies the requirements for a food safety management system. It combines HACCP plan with prerequisite programs and is aligned with ISO 9001 (new release of ISO 22000 will be publicized in 2017). ISO 9001:2015 should increase the efficiency of management system in any organization. A new release of this standard promotes an approach based on risk management. The concept of preventive actions is fundamental for continuous development of the system. ISO/PAS 28000:2007 is a specification for the requirements of a security management system particularly dealing with security assurance in supply chains. Getting involved in security risk management along with ISO 28000 should improve (food) supply chain performance. TACCP (Threat Assessment Critical Control Points) is a risk management methodology, which aligns with HACCP, and improves the resilience of food supply chains to fraud or other forms of deliberate attacks. However, HACCP is not adequate for detecting and mitigating deliberate attacks on systems or processes [BSI 2014; Manning et al. 2016]. A threat can cause food loss or harm. Managing threats should reduce food losses and waste. It seems to be important to underline product management issues in terms of preventing food losses and waste (e.g. FIFO principle).
3. Methods. These determinants of food losses and waste include managing issues, proper technologies (packaging technologies, processing technologies and so on), methods and procedures. It is crucial to follow general rules for food sector enterprises in the area of food hygiene determined by four EC Regulations (no. 852/2004, no. 882/2004, no. 853/2004, no. 854/2004). The role of packaging in minimizing FLW across food supply chains is undisputed. There are many opportunities to reduce food losses and waste through improved packaging. The example of such packaging is intelligent packaging which can extend shelf life and thus prevent food

losses. The following types of intelligent packaging that have positive impact on food waste can be listed: packages with radio-frequency identification (RFID) tag (smart tag), which can be used to trace products through FSC, to improve inventory control or to record the temperature history of the product, and thermal sensors on packaging. There are also disadvantages of introducing intelligent packaging. For instance, new technologies usually increase packaging costs and infrastructure costs. The examples of primary-packaging technologies that extend shelf life are: multi-layer barrier packaging, modified atmosphere packaging, edible coatings, ethylene or oxygen scavengers, moisture absorbers and aseptic packaging. The examples of primary-packaging design which should reduce food waste in households are: reclosable packs, smaller packs, subdivided packs and detailed storage advice on the label [Verghese et al. 2015; Dobrucka et al. 2015]. Such packaging quite often requires greater use of materials and higher technologies, thus, such a design increases the cost of packaging and consequently product prices. Consumers always have a choice. Their awareness of the problem and disposable income determine their decisions concerning a type of packaging for purchased products. An essential objective at any stage of a food supply chain is to ensure that packaging is "fit-for-purpose" and meet market and consumer needs at minimal costs. Packages should contain necessary quantities to limit re-packing which can lead to damage and unnecessary waste of foodstuffs [Verghese et al. 2015]. Proper food labelling should also reduce FLW. It is particularly important to inform recipients about appropriate method of storage. Methods of preparing, serving and storing food used in fast food chains are particularly prone to food losses and waste. It is a specific type of waste encountered in fast food chains where e.g. sandwiches, which, being constantly heated, are not suitable for consumption after 10-15 minutes [Śmiechowska, Kłobukowski 2015]. Testing food commodities is another source of food losses and waste. It is crucial to choose such a testing method (e.g. laboratory method) which does not lead to disposing of testing material.

4. Materials. FLW determinants in the area of materials cover also packaging issues. Quality of raw materials and careful selection of them significantly contribute to the outcome of food industry. Partnership with suppliers is very important where FLW is considered. Each enterprise operating within a food supply chain should establish a process of identifying, selecting and evaluating its suppliers, and should develop thorough quality specification for acceptable materials. It is crucial to depend on trustworthy suppliers to avoid failures. Some business entities operating along a food supply chain require from their suppliers' implementation and certification of specific quality management systems (GlobalGAP, BRC, IFS and so on). The primary goal of packaging is to protect a product while it is transported, stored, presented, retailed and consumed. However, it is possible to design appropriate packaging systems to minimize FLW phenomenon. Materials used for primary and secondary packaging should ensure high product protection and provide ventilation and temperature control. It is essential to develop and use packaging materials and technologies that extend shelf life, e.g. edible coatings based on proteins and lipids and polysaccharides used on fruit, vegetables and meat, or multi-layer barrier packaging (using combinations of polymers, aluminum foil and coatings) which delays product degradation by keeping out moisture and oxygen [Verghese et al. 2015].
5. Machines. Investing in advanced technologies and new machinery is crucial for food losses and waste management, especially in agricultural production and food processing. Food chain operators from low and medium income countries need particular technical support while old machinery is often the main reason for FLW. Bad condition of machinery, lack of servicing and frequent breakdowns may result in unnecessary losses in raw materials, half-finished products and final products. Maintenance and servicing should be a part of management system in every organization.

It seems to be very important to consider the factors influencing FLW that come from the surroundings of food supply chains. A list of them may include: Political issues (e.g. EU Common Agricultural Policy, national and local food and agricultural policies), Regulations, Food and Quality Management Standards (ISO, HACCP etc.), Financial and Substantive Support for FSC Operators (public funds, preferential credits, professional training and education, and so on), Consumer Trends, Consumer Education, Professional Training, Food Market Development.

EU Common Agricultural Policy (CAP) was initialized in 1957. European countries were still destroyed after World War II, and therefore, they did not assure food security for their citizens. Thus, financial support under CAP supported farmers and encouraged them to increase agricultural production, to produce more and more. Europe faced a problem of overproduction very quickly. It caused overexploitation of natural resources and degradation of natural environment as a whole. The issue of food losses and waste arose. In response to this, European Union started supporting extensive agricultural production, e.g. organic farming. Farmers were paid for excluding farm land from exploitation, milk quotas were introduced and so on. Such activities were supposed prevent FLW.

There are 118 different Rural Development Programs in 28 EU countries which consist of various activities aimed at agriculture, food industry and rural administration [http://ec.europa.eu/agriculture/rural-development-2014-2020/index_en.htm]. In Poland Rural Development Program was established for the period of 2004-2006, 2007-2013, and now for 2014-2020. The aim of the program is to implement structural changes in rural areas, by modernization of farms, extensification of agricultural production, food quality improvement, supporting non-agricultural activities in rural areas, supporting cooperation, quality and knowledge management, including innovations in the food sector, and so on. Many of these activities should reduce the problem of food losses and waste in Poland. The Program is financed mostly by the European Agricultural Fund for Rural Development, but also by Polish government's budget.

The example of Polish regulation that supports food waste and losses management is the Act on Value Added Tax Amending from 26th of July, 2013 which eliminated a necessity of paying VAT on food donation. Food donations for institutions of public utility are key tools while reducing FLW phenomenon in Poland and other medium and high income countries. There is also an action called MOST, The Model of Reducing Food Losses and Waste for the Benefit of Citizens, coordinated by Polish Society of Food Technologists. The model supports food operators in developing procedures that enable rational use of food and cooperating with other stakeholders [Kołożyn-Krajewska et al. 2014].

Another example of a Regulation which supports a reduction of FLW is Regulation (EU) No 1169/2011 on the provision of food information to consumers. Two definitions of expiry dates: "Best before…" and "Expiry date (to be consumed not later than)…", were included in this Regulation. The first date is connected with quality of food product, and the second one with its safety. It is recommended to put two expiry dates on food product labels and sell some damaged products or close to expiry products at reduced prices [Śmiechowska and Kłobukowski 2015].

Another example of a project which affects the reduction of FLW is a two year European project, EFFECT, Europe Figh effect LOGO V1 ts Food waste through Effective Consumer Training, made possible through an Erasmus+ grant awarded by the National Office in Poland. The aim of the project is to develop an innovative multifunctional platform, hosting informative and educational content to raise awareness of food waste and encourage citizens to actively reduce their food waste footprint. The platform will include: training materials (e-learning content links, check-lists, tips, etc.), web-TV (hosting interesting short videos about food waste and solutions to reduce food waste footprint), a board game (available as an online game, for downloading and as a "do-it yourself construction" at home), and events to spread the word.

It is essential to raise awareness and educate food and packaging supply chain stakeholders on consumer behaviors and consumer trends which influence food waste.

Households are getting smaller, demand for convenient food grows, consumers are quite often confused about date markings and the role of packaging. The marketplace has to adjust to these realities.

Another problem is that nowadays, a food supply chain is longer and longer, and there is an increasing number of operators. The organizational structure of FSC is usually complicated and it is difficult to manage it efficiently. It is a challenge to prevent and reduce food losses and waste in such a long and compound FSC.

Those determinants may create conditions under which preventing and combating food losses and waste is more resultful, efficient and effective. Unfavorable conditions may increase FLW phenomenon that may have a lot of grievous economic, social and environmental consequences.

SUMMARY

Food losses and waste problem seems to be highly unethical in the light of the fact that the world population is still facing a problem of undernourishment, hunger and underweight children. FLW means that natural environment is exploited in vain and big amounts of resources used in food production go to waste (land, water, labor, fuel, raw materials, energy and so on). Food losses and waste, both intended and unintended, contradict a concept of sustainable development. All the food and packaging supply chain stakeholders are responsible for FLW. What's more, food losses and waste happening at one stage of a food chain can have their cause at another stage.

The main tendency is that in low income countries a great share of FLW occurs during agricultural and post-harvest steps and is mainly caused by severe climate conditions, underinvestment of farming, processing and storage, old technologies and machinery, lack of skills, inadequate market facilities and poor packaging. In high income countries FLW mostly occurs at distribution and consumption level and is often caused by lack of purchase and consumption planning and limited focus on waste, expiration date policy, leftovers from cooking, preparing and serving, and unsuitable packaging. Data collected by EUROSTAT proves that food waste rises together with the growth of an average disposable income.

Coherence of food losses and food waste definitions and data collecting is necessary for proper estimation of the problem and making suggestions about actions that could be undertaken to prevent and reduce FLW. For sure, suggestions and recommendations on food losses and waste reduction are different for high, medium and low income countries and vary among different recipients, placed along a food supply chain. They can be aimed at several stakeholders of food and packaging supply chains. Packaging has a significant role in minimizing food losses and waste across supply chains.

The determinants of food losses and waste may come from the inside of a food supply chain. These are: people, management, methods, materials and machines. However, the surroundings of FSC influence significantly its efficiency. A list of such determinants of FLW may include: political issues, regulations, food, quality and safety management standards, financial and substantive support for FSC operators, consumer trends, consumer education, professional training and food market development. It is crucial to manage food losses and waste within every stage of food supply chain and to create conditions which are unfavorable for such behavior or unintended situations. Preventing and reducing FLW should increase farmers' incomes, decrease food prices, increase food quality, safety and security, lower negative pressure of food production on ecosystems, climate and water resources.

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PROBLEM STRAT I MARNOTRAWSTWA ŻYWNOŚCI I JEGO WYZNACZNIKI

STRESZCZENIE. **Wstęp:** Rozwiązanie problemu strat i marnotrawstwa żywności wydaje się być niezwykle istotne w odniesieniu do redukowania negatywnego wpływu wszelkiej działalności na środowisko naturalne, rosnącej światowej populacji ludności, milionów niedożywionych ludzi na świecie, i dobrobytu ekonomicznego operatorów branży rolno-spożywczej. Celem artykułu jest analiza i ocena problemu strat i marnotrawstwa żywności oraz jego skutków. Autorka podjęła się próby wskazania głównych wyznaczników tego zjawiska oraz zidentyfikowania obszarów doskonalenia działań podejmowanych w celu efektywniejszej prewencji i walki ze stratami i marnotrawieniem żywności.
Materiały i rezultaty: Praca powstała w oparciu o przegląd najnowszej literatury, badania, raporty i publikacje ekspertów, dane zebrane przez FAO i EUROSTAT, techniczne sprawozdanie Komisji Europejskiej i akty prawne. Analiza danych pochodzących ze źródeł wtórnych oraz zasobów internetowych pomogła wskazać główne determinanty strat i marnotrawstwa żywności (FLW) oraz pozwoliła wyznaczyć obszary doskonalenia działań służących prewencji i walce z FLW. Artykuł autorstwa Kołożyn-Krajewska i inni z 2014 r. był główną inspiracją dla autora podczas diagnozowania czynników sprzyjających stratom żywnościowym.
Wnioski: Straty i marnotrawstwo żywności (FLW) jest wysoce nieetyczne w sytuacji, gdy miliony ludzi jest niedożywionych na świecie. FLW oznacza, że zasoby potrzebne do produkcji żywności były wykorzystane na próżno. FLW niepotrzebnie obciąża środowisko naturalne. Autorka podkreśla, że rozmiary, przyczyny i metody zapobiegania stratom i marnotrawstwu żywności są odmienne w krajach o niskich, średnich i wysokich dochodach. Autorka dzieli determinanty strat i marnotrawstwa żywności na wyznaczniki pojawiające się wzdłuż łańcucha żywnościowego oraz uwarunkowania zewnętrzne determinujące zjawisko FLW. Spójność definicji i metod zbierania danych jest nieodzowna dla właściwej oceny i efektywnej prewencji zjawiska.

Słowa kluczowe: straty żywnościowe, marnotrawstwo żywności, straty i marnotrawienie żywności, łańcuch dostaw żywności

DAS PROBLEM DER VERLUSTE UND VERSCHWENDUNG VON NAHRUNGSMITTELN UND SEINE DETERMINANTE

ZUSAMMENFASSUNG. Einleitung: Verluste und die Verschwendung von Nahrungsmitteln stellen ein Problem dar, dessen Lösung besonders relevant zu sein scheint hinsichtlich der Reduktion von negativen Einflüssen der menschlichen Tätigkeit auf die Umwelt, des raschen Bevölkerungswachstums in der Welt, ferner der Millionen von unterernährten Menschen und des ökonomischen Wohlergehens von Marktbetreibern im Agrar- und Ernährungssektor. Der vorliegende Artikel bezweckt die Analyse und Bewertung des genannten Problems und seine Folgen. Die Autorin hat den Versuch unternommen, auf wesentliche Determinante dieser Erscheinung hinzuweisen und diejenigen Gebiete zu ermitteln, in

denen gewisse Maßnahmen getroffen werden können, die Verluste und die Verschwendung von Nahrungsmitteln effektiv vorbeugen und bekämpfen.
Methoden und Resultate: Die vorliegende Arbeit ergab sich aus der Prüfung der einschlägigen wissenschaftlichen Literatur, professionellen Forschungen und Berichten und stützt sich auf die von FAO und EUROSTAT gesammelten Daten, technische Berichte der Europäischen Kommission und andere Rechtsakte.
Fazit: Verluste und die Verschwendung von Nahrungsmitteln (eng. FLW) sind in höchstem Maße unethisch, zumal Millionen von Menschen in der Welt unterernährt leben. Das FLW beruht darauf, dass die für die Nahrungsmittelproduktion erforderlichen Ressourcen umsonst genutzt wurden. Darüber hinaus belastet das FLW unnötig die Umwelt. Die Autorin der vorliegenden Arbeit unterstreicht in ihren betreffenden Ausführungen, dass das Ausmaß, Ursachen und Vorbeugungsmethoden gegen die Lebensmittelverluste und Nahrungsmittelverschwendung in Ländern mit niedrigen, durchschnittlichen und hohen Einkommen unterschiedlich sind. Sie klassifiziert weiter Determinante des FLW in den Faktoren, die sich entlang der Ernährungskette ermitteln lassen, und in den äußeren Faktoren, die diese Erscheinung determinieren. Für die richtige Bewertung und effektive Vorbeugung der genannten Erscheinung scheint die Kohärenz zwischen den Definitionen von FLWs und den entsprechenden Methoden der Datensammlung unentbehrlich zu sein.

Codewörter: Lebensmittelverluste, Nahrungsmittelverschwendung, Verluste und Verschwendung von Nahrungsmitteln, Nahrungsmittellieferungskette.

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