THE CHALLENGES OF FOOD SECURITY - FROM THE PERSPECTIVE OF FOOD LOSS AND FOOD WASTE

AZ ÉLELMEZÉSBIZTONSÁG KIHÍVÁSAI – AZ ÉLELMISZERVESZTÉSÉG ÉS -PAZARLÁS SZEMSZÖGÉBŐL

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Abstract

Food loss and waste is a relatively new crucial research topic accounting for food insecurity, but getting more and more attention nowadays. To better understand the links between food loss and waste and food security, we conducted this research by content analysis, secondary literature review, and report and news study from FAO and the UN. We concluded in our research that food loss and waste include qualitative and quantitative perspectives along the food supply chain at all stages, including the primary or agricultural production, sorting and grading to meet retailer standards, processing and storage, huge waste in households, and waste due to date labeling misunderstanding. All the participnants of food chain has their responsiblitiy in reducing food loss and waste.

Keywords

Food security, Food safety, Sustainability, Food supply chain, Digital education

Absztrakt

A kutatás célja az élelmiszer-veszteség és a pazarlás, valamint az élelmezésbiztonság közötti összefüggések feltárása tartalomelemzéssel, szakirodalom feldolgozásával, továbbá a FAO és az ENSZ jelentések felhasználásával. Kutatásunk során arra a következtetésre jutottunk, hogy az élelmiszerveszteség és -pazarlás minőségi és mennyiségi szempontból vizsgálandó az élelmiszer-ellátási lánc minden szakaszában, beleértve magát a mezőgazdasági termelést, a terméklánc mentén a kereskedelmi szabványoknak megfelelő válogatást és osztályozást, a feldolgozást és tárolást, továbbá a háztartásokban nagy mennyiségben keletkező hulladékot. Az élelmiszerlánc minden szereplőjének kimutatható a felelőssége a veszteség csökkentésében.

Kulcsszavak

Élelmiszerbiztonság, Élelmiszerbiztonság, Fenntarthatóság, Élelmiszer-ellátási lánc, Digitális oktatás

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1. INTRODUCTION

The three most basic elements for human being survival are water, air, and food (food safety and food security), which are also essential to a state's safety. There are two main concerns in food are food safety and food security, which are linked closely with each other. Food safety means the available food for humans is safe, not harmful, and there is no contamination of food. If we talk about food security, we have to highlight that if there is no food safety, there will be no food security. In our research, we mainly focus on the topic of food security.

It is estimated that the world population will increase to 9.1 billion, 34% higher than today in 2050 [1]. When most of us are given enough food, we take it as granted. However, according to the data from 2020, on the same planet, 811 million people are suffering from hunger, and 3.1 billion people do not have access to a healthy diet, 132 million people are threatened by food and nutrition insecurity because of the COVID-19 pandemic [2], [3]. What is worse, the ongoing war started in February 2022 between two important world food suppliers, Russia and Ukraine, depressed world food security [4]. These two countries are the top producers of world foodstuffs and fertilizers, besides Russia is also the main supplier of oil and gas [5]. The so-called "World's bread basket" around the Black Sea has been in trouble since the war outbreak [4], [6]. But these two rigorous and unpredictable problems are not the start of the world food security alarm, catalyst instead [7]. For example, global climate change and extreme weather threaten agriculture through their influence on ecology, the environment, the geographical situation of crop and crop production, the resources and supply chain of agriculture, and the market price [8]. The chronic climate change or extreme weather [9], [10], natural resources scarcity (arable lands and water) [10], [11], agriculture facilities issues (aging farmers and fewer farmers because of urbanization) [11]–[13], food market fluctuation [14] are the main causes of agricultural risks.

Food security is a multi-dimensional topic (in correspondence with SGDs 2: Zero hunger). However, usually, we are used to addressing it by one aspect of the broad food security problem. Food security was defined firstly in the 1970s by World Food Conference and later improved to a more accurate concept by FAO (Food and Agricultura Organization), World Bank, and World Food Summit. Today, the widely accepted definition of food security contains three main dimensions: food availability, food access, utilization, and stability. Food availability means an adequate quantity of food supply with proper safe food. Food access promises all people to access sufficient and nutritional food at the individual, regional, or national levels. Utilization refers to the food supplied to all people to meet nutritional requirements. Food stability requires food availability and stable access for all people, even in the shock of economic crises, climate crises, or seasonal food insecurity [15].

The risks to food security come from agricultural production, market, income, food quality and safety, clean water resources, sanitation issues, and governmental and political stability. The two general types of food insecurity can be understood as Chronic and transitory food insecurity based on the duration and other causes. The intermedia type of food insecurity is seasonal food insecurity, which is similar to chronic food insecurity as it usually can be predicted and follows a sequence of known events, such as extended periods of poverty, lack of assets, and inadequate access to productive or financial resources. But it can also be regarded as recurrent and transitory food insecurity due to the limited duration. The concerns are not only the duration but also the severity, which describes how intense

or severe the problem is on food security and nutrition. The indicator as energy intake (measured in calories) below a threshold of 2,100 kcal per day can be used to classify the intensity of food insecurity to: Food secure, Energy intake (measured in calories), Mild food insecurity, Moderate food insecurity, Severe food insecurity. Besides, a range of livelihood needs (Crude Mortality Rate, Malnutrition prevalence, Food Access/ Availability, Dietary Diversity, Water Access/Availability, Coping strategies, Livelihood Assets) can be used as indicators to calssify food security and humanitarian crises: Generally food secure, Chronically food insecure, Acute food and livelihood crisis, Humanitarian emergency, Famine / humanitarian catastrophe (Integrated Food Security and Humanitarian Phase Classification Framework) [8].

Food loss and waste is a broader topic related to global food security, food safety, quality, and sustainability. From a worldwide view, every year, the food loss and waste is approximatey14%, valued at $400 billion after harvest and before market. And 17% or 931 million tonnes of food is lost between market and consumption, such as households, restaurants, retailers, and other food service types, especially households (11 percent in households, 5 percent in the food service, and 2 percent in retail) [2], [3], [16]–[18]. And 8-10 percent of global greenhouse gas emissions (GHGs) are from food loss and waste, which worsen the unstable climate and extreme weather. Vice versa, the more unstable climate change, and extreme weather negatively impact crop production and crop yields [3], [17]. The greenhouse gas emission ranks after China and the US (figure 1.) [19]. According to the estimation of FAO, every year, lost and wasted food can feed 1.26 billion hungry people. It is obvious to see reducing food loss and waste is a triple win for food security, climate change, and sustainability [17].

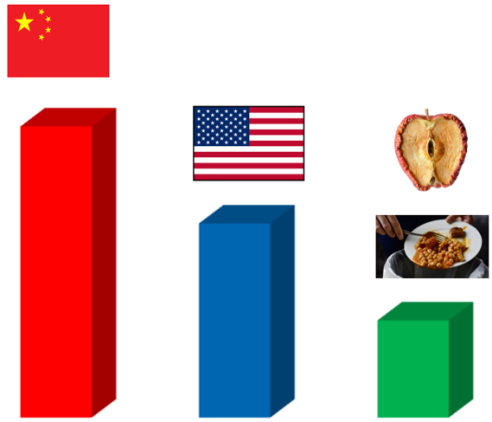

Figure 1: Ranking of greenhouse gas emission
Source: UNEP, 2021

When we learn from the 2030 Agenda for Sustainable Development, it is a great milestone to mention that all the 193 Member States of the United Nations adopted 17 goals on 25 September 2015 [20]. It is a universal action goal including three-dimensional sustainability: economic, social, and environmental for the international community to end

poverty in 2030 [21], where especially highlighted in Goal 2 (End Hunger) and Goal 12.3, „ By 2030, half per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses", under the Goal 12 „ Ensure sustainable consumption and production patterns" [22], [23]. Today, we have eight years to achieve the SDGs. It is urgent for action to be aware food loss and waste reduction is an efficient method to ease the climate change burden and other risks on agriculture to achieve sustainability.

We are warned as personnel consuming food every day that the food insecurity issue is very serious for present and future generations. However, food security is usually regarded as a broader problem [8]. Therefore, in our research, we simplify the food insecurity issues and focus on a small but important point: food loss and waste.

2. RESEARCH METHODOLOGY

Food security is usually regarded as a broader problem, but contributed by small points. To better understand these small points, which made food insecurity, we simplify the food insecurity issues and focus on a small but important point: food loss and waste by content analysis and secondary literature review. The literature study also focuses on extensive reports and news from FAO and the UN website.

3. RESEARCH RESULTS

The 29 November International Day of Awareness of Food Loss and Waste (IDAFLW) was designed by the United Nations General Assembly in 2019, calling all the public and private sectors to work together on cutting food loss and waste to use the limited natural resources more efficiently, mitigate the burden from climate change, and obtain sustainable food and nutrition [18]. As food loss and waste reduction is a crucial topic now and later accounting for sustainable food security, we explored the questions: what is food loss and waste, how it happened, and what are our suggestions for mitigating food loss and waste.

3.1 Definition of food loss and waste

As the State of Food and Agriculture (2019) report from FAO, food loss and waste refer to a decrease in the quantity or quality of food along the food supply chain [24]. The distinctions between food loss and food waste exist in the conceptual framework and a policy aspect. Food loss comes from the food supply chain, excluding any consuming step, including retail, food service offers, and consumers, where there is reducing of food in quantity and quality. The food supply chain contains these steps:

- Agricultural production and harvest/slaughter/catch
- Post-harvest/slaughter/catch operations
- Storage
- Transportation
- Processing
- Wholesale and retail
- Consumption by households and food services

Food waste refers to the step of consuming step where food is decreased in quantity and quality, including the retailers, consumers, and other food service providers.

Quantitative food loss and waste, also called physical food loss and waste means the decrease in the mass of food for human consumption: food is removed from the food supply chain (food loss), and food is decreased from the behaviors and decisions of consumers, retailers and food service providers (food waste). Qualitative food loss and waste mean decrease in food value for the intended use (nutrition and economic value): food value decreases from the food supply chain (food loss), and food value decrease from decisions of consumers, retailers and food service providers (food waste). The conceptual framework (Figure 2) explains the relationship between the intended use of plants and animal products, fragmentation, and destination:

- Intended use: only the loss and waste of animal and plant products that are eaten by people is considered as food loss and waste, excluded the intended use that is eaten by animals, used as seeds, or used in industry.
- Fragments from intended use for human food: only fragments for human consumption from plant and animal products intended use for humans are considered food loss and waste, excluding other fragmented use, such as in inedible parts, feeding animals, and other economic and productive intentions.
- Destination of edible food from fragments: finally, edible food is used for human eating, but there are qualitative food loss and waste or other uses (feeding animal, industrial use, and other non-food economic use). But there may also be quantitative food loss (by suppliers) and food waste (by consumers, retailers, and food service providers). These quantitative food losses and waste will be put into a trash bin or managed by incineration, composting, and anaerobic digestion.

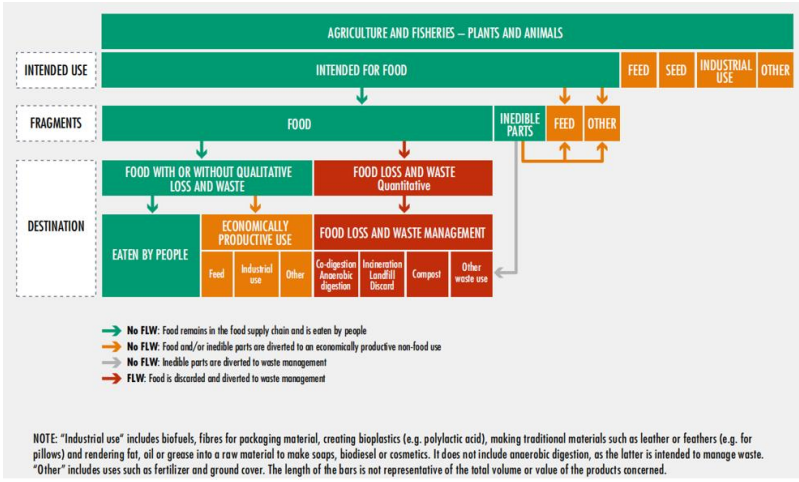

Figure 2: A conceptual framework of food loss and waste (FLW)

Source: FAO

FAO. 2019, p. 31. In Brief: The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Rome.

3.2 The scenarios that food and waste are happening

We have introduced the definition of a food supply chain above. In this chapter, we will discuss how food loss and waste happen in the food supply chain. It is estimated that the food lost and wasted along the food supply chain reaches 30% of the food intended for human consumption [25].

3.2.1 Along the food supply chain, exclude retail

In post-harvest, the fresh food products have to be removed from to supply chain during the sorting operations if they are not optimal at different criteria, such as shape, color, and size [17]. For example, vegetable and fruit loss is in a dominant position in industrialized zone. The losses happen in harvesting, sorting, and grading. Especially in grading, the most loss of vegetables and fruits is due to the deviation of quality standards set by retailers [25]. The losses in developing countries at processing is 14%-21%, while the percentage is less than 2% in developed countries. Improving processing technologies have the opportunity to reduce food loss of vegetables and fruits, such as drying technology (replace sun-drying by hot air, fluidized bed, infrared and solar, freeze-drying).

Another example is taken from the consumer cereal (mainly wheat and rye grain) in Poland, which is one of the most important cereal producers in Europe. It was investigated that during 2017-2018, 219,600 tonnes of consumer cereals were lost at primary or agricultural production, which is 1.7% of annual consumer cereal production and accounts for 608,000 tonnes of CO_2 eq. The main causes of consumer cereal grain loss at the production and storage step are moisture, grain damage, pest disturbance, and weather uncertainty [26].

3.2.2 At customer service

As European Commission estimated that there are 88 million tonnes of food waste generated annually in the EU, and 10% of it is because of the date marking on food products [27]. There are three terms confusing for consumers, which are the cause of date labeling for food loss and waste [27]–[29]:

- Use by Date or Expiration Date: about food safety – foods can be eaten until this date but not after any storage condition due to safety and quality reasons, even if they look and smell fine.
- Best Before Date or Best Quality Before Date: about food quality of the unopened shelf-stable product– the food will be safe to eat after this date but may not be at its best. For example, its flavor and texture, freshness, taste, aroma, or nutrients might not be as good.

However, food products that are close to or beyond „Best Before Date" and „Best Quality Before Date" are usually discarded by retailers and consumers [17].

Besides the date labeling misunderstanding, the waste in households is also very harmful. Huge amounts of wholesome editable food are left over or not used and discarded in households and eating establishments [17].

3.2.3 At household and individual levels – example in Hungary

As we highlighted above that, household food waste is taking a big percentage of food waste at the customer service level [2], [17], [18]. In this subchapter, we take an example from Hungary.

From the data in 2020, the official of Hungary announced that the food waste is more than 300,000 tonnes every year, equal to over 170 billion forints (EUR 480m) and 18,000 HUF per person [30]. The data in 2020 showed that the annual food waste is up to 68 Kg per person [31]. In 2019, the food waste was 65.49 kg per capita annually, and 48.81% of it could have been avoided [32]. While in 2016, the food waste was 68.04 kg per capita annually, and 48.7% of total food waste equals 33.14 kg/per capita/year could be avoidable [33]. It is obvious that food waste is still a crucial issue in Hungary, but we have hope for food waste reduction. Similarly to other countries, the largest food waste percentage is from household throwing away, which is not only a social, environmental, or economic issue but also an ethical problem highlighted by the government [30]. Among the food waste types, the most frequent is meals, bakery, dairy products, vegetable, and fresh fruits [33].

3.3 Suggestions for tackling food loss and waste

We have explored and discussed what food loss and waste is and how and why food loss and waste is a serious problem for food security in our research. In this sub-chapter, we shortly suggested the future to tackle food loss and waste.

3.3.1 Importance of individual behavior in reducing food waste

First of all, due to the fact that everyone consumes food, where the food waste comes from. It can not be overemphasized that individual behavior plays an important role in reducing food waste.

Let us look at it deeply through the example of Hungary. It is proved by a series of surveys that most of the population in Sopron and its surroundings have an awareness of selective waste collection, which, combined with reducing waste, contributes to a circular economy. But their behavior on selective waste collection is influenced by gender and the place of residence, including the village, urban agglomeration, and city center [34]. Income is also a factor influencing Hungarian consumers' food waste behavior [33]. The investigated Hungarian also suggested that buying high quality, good duration, and environmentally friendly products with reasonable and packaging-free is also the way to favor a circular economy [34]. Food waste in households and individual is a bad habit in everyday life, which is hard to improve if it is paid attention to when they are already adults [31]. Therefore, education and attitude information should start from childhood.

3.3.2 From the view of digital education or e-learning

Agrifood is a vital industry related to everyone, as all different fields of people are consumers of agrifood. Especially food waste education should be from childhood, as food waste mainly comes from households and individuals, which is a bad daily habit [31].

According to Roger's Diffusion of Innovation Theory (DOI), the crucial step to make people execute the implementation of food loss and waste reduction is to make people

perceive it [35], [36]. Strengthening the learning and knowledge diffusion is the way to aware all consumers about the necessity to reduce food loss and waste and educate all the consumers to take measures in daily life to execute food loss and waste reduction. And also the other important roles in the food value chain, such as farmers in production, operations in food processing in industries, practitioners in food logistic process, and retailers in the food market. With the rapid development of industry 4.0, advanced and digital technologies penetrate all industries, including agriculture and food [37]–[39]. Digital education means any type of digital technology used in education for any age of the student. Thanks to the development of the internet and other technologies, students can study anytime and anywhere. The same for teachers, they can teach anytime and anywhere as long as there is internet and suitable facilities [40], [41].

Let us take the successful practice from FAO. There is abundant and useful e-learning and training materials in FAO free for anyone who is concerned with the topic of food loss and waste. These e-learning courses aid countries in reducing food losses along production and supply chains. The lessons cover the index and its components, along with strategies and guidelines for collecting, integrating, and modeling the necessary data from a variety of sources [18]. The topics refer to „Food Security Concepts and Frameworks" for those audiences: mid-level managers, technical staff, field personnel who are involved in the collection, management, analysis, and reporting of food security information, and planners, policy formulators and program managers who are involved in monitoring progress in poverty reduction, and meeting food security goals and targets [8], „ Food Loss Analysis Case Study Methodology" for those audiences: field level program officers who wish or need to design, organize, coordinate and implement a food loss analysis, and technical advisors and academics who want to learn more about the topic in order to teach others [42], and so on. Any audience could download the course materials and learner notes and learn them anytime and anywhere [43].

Besides, the UN offers an e-learning course, „Food Waste Prevention" for individual practice in daily life [44]. These education strategies should focus on the food supply chain, such as the producers or farmer communities, processers, logistician operators, retailers, and consumers, reducing on-farm food loss and consumption waste [25], [45].

3.3.3 From the view of research agenda

The links between food loss and food security were investigated by Nyambo in 1993 [46]. The claim of this investigation is that food security can be enhanced by reducing food loss because of post-harvest grain handling technology. Food loss and waste is getting more and more attention nowadays. Food loss and waste seem to be and should be on the research agenda in the next decades. The research needs on food loss and waste and the food security nexus have been emphasized by many researchers in recent years. The research topics are suggested to focus on: understanding the interrelations between food loss and waste and food security by reliable, relevant, and timely data, evidence-based analysis[47], improve harvest techniques in order to reduce food loss in production level [25], manage the food loss and waste and food security nexus, scenario analysis on approach green and circular economy [48], multi-disciplinary research on post-harvest, inter-supply chain, knowledge exchange and skill building on reducing food loss and waste [49], collaborative research on identifying crops with high loss percentage relatively [45].

The research on food loss and waste favors policymakers on better decisions to achieve a sustainable environment, economy, and society [47]. Even this research topic is paid more and more attention in recent years [32], but it is not common among all the world. For example, the topic about household food waste dominates in developed countries [50]. Therefore, we still have space to tackle food waste by enhancing the investment in research on food waste related topic.

3.3.4 From the view of policy and regulations

Reducing food loss and waste is the mission of the country members of the UN, which set up the SDGs 12.3, „ By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" , under the Goal 12 „ Ensure sustainable consumption and production patterns" [22]. Achieving this national and global goal needs corresponding policies and regulations to support it at a regional and national level. In the 2022 United Nations Climate Change Conference (COP27) [51], all governments, businesses, and institutions are called to make voluntary commitments to reduce food loss and waste [17].

Nevertheless, food loss and waste is a highly debated topic that needs effective and sufficient policies and regulations to support and implement. Governments should adopt legislative and non-legislative solutions to reduce food loss and waste to accelerate the transition to a more sustainable and resilient agrifood system and favor the food supply chain to ensure food security through a more green and circular economy [47], for instance, the 3R policy: reduce, reuse, and recycle [52], support the on-farm storage facilities and cooling chains to reduce the food loss from the perspective of post-harvest, and the transportation infrastructure [25], encourage coordinated research on identify crops with high loss percentage relatively [45].

4. CONCLUSIONS, SUGGESTIONS

4.1 Conclusion

World food security has been threatened by many aspects: chronic climate change or extreme weather [9], [10], natural resources scarcity (arable lands and water) [10], [11], agriculture facilities issues (aging farmers and decreasing farmers because of urbanization) [11]–[13], food market fluctuation [14], additionally the unpredicted shock from COVID-19 pandemic and war in Ukraine. Besides, the pressure on food security is also derived from the rapidly increasing population [1] and eight years left to achieve SDGs, especially target SDG 2 and SDG 12.3 [21]. Food loss and waste is a broad topics related to food security. The lost and wasted food can feed 1.26 billion hungry people. It is obvious to see reducing food loss and waste is a triple win for food security, climate change, and sustainability [17]. The topic of food loss and waste is highly debated to favor sustainable economics, environment, and society, and mitigate climate change and extreme weather.

We concluded in our research that the links between food security and food loss and waste. Food loss and waste include qualitative and quantitative perspectives along the food supply chain at all the stages [25], including the primary or agricultural production, sorting and grading to meet retailer standards [17],[25], processing and storage [26], huge waste in households [17] and waste due to date labeling misunderstanding [27].

In the end, we suggested three dimensions to reduce food loss and waste from enhancing digital education on reducing food loss and waste to all the actors in the food chain [8], [18], [42]–[45], investing in research or collaborative research on understanding and reducing food loss and waste [25], [45], [47]–[49], and appeal governments and policymakers to build legislative and non-legislative initiatives on reducing food loss and waste to accelerate agriculture transition to more resilient and sustainable mode [17], [22], [25], [45], [47], [51], [52].

According to the FAO report on „The State of Food Security and Nutrition in the World 2022" [53], our world is moving back to the target of 2030 SDG 2, End Hunger, but we have only eight years left to achieve. It is more challenging for governments to obtain sustainability and achieve SDGs target 2. However, not only the government and other public sectors but also private sectors (business and individual) have to take urgent action to tackle food loss and waste.

4.2 Limitations of the research

We have explored the relationship between the challenges of food security and food loss and waste. Unfortunately, due to the page limitation, we could not extend our research to discuss in depth how we can tackle this issue to obtain a sustainable food future at a personal, regional, national, and global level. For example, the green economy and circular economy is an effective approaches. Food will not be wasted if there is a circular practice implemented. For example, harmful methane emissions can be avoided if lost and wasted food is used for compost or biogas [17]. And how to implement waste management to ease the burden of food loss and waste in food security [19]. But we listed a few general suggestions shortly. Here, we also appeal to more and more researchers to stand on this point to achieve sustainable food and agriculture and planet for future generations.

5. SUMMARY

Food loss and waste are crucial food insecurity topics along the whole food chain, including the supply chain from agricultural production to retailers and retailers, consumers, and other food service providers. We suggest all the actors along the food chain be aware and take urgent actions to reduce food loss and waste, as we mentioned via digital education, extending research, and strengthening policy and regulations.

Achieving a sustainable future is never an independent mission for random personnel or a nation. In contrast, it is a shared project for everyone who is living on this planet and cares about his or her future generations. So here, we appeal not only to the researchers but everyone to pay attention to food loss and waste and take daily actions to reduce it.

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