

# Trends within Sustainability in Food Loss and Waste in EU27 Countries

*Rajko Odoša*

*Faculty of Law Osijek, Osijek, Croatia*

*Katarina Marošević*

*Faculty of Law Osijek, Osijek, Croatia*

## Abstract

One third of today's global food production ends up uneaten. In the European Union, more than 100 kilograms of food waste per capita are generated annually across retail, food services, and households. In addition to being unethical, wasting food is environmentally harmful and economically irrational. Reducing food waste would significantly contribute to protecting and more rationally using rare natural resources (water, land, forests) in agricultural production, lowering waste and related greenhouse gas emissions, and supporting a successful transition to organic agriculture and the restoration of biodiversity. Better utilisation of produced food would lower production costs and stabilise food prices, while also strengthening the population's food security and reducing nutrition costs. The purpose of the paper is to critically review the progress (or lack thereof) made by the European Union and its Member States, tracked for the period from 2020 to 2022, according to available relevant data and sources, such as food waste per capita, food waste sector of activities and consumption footprint per inhabitant. We provide recommendations on technological, organisational, managerial, and social value changes to achieve more sustainable food waste management.

**Keywords:** Food waste; EU Green Deal; Sustainable Development Goals; EU food waste policies and regulations; EU27

**Paper type:** Research article

**Received:** Oct 10, 2025

**Accepted:** Mar 26, 2026

**Acknowledgements:** This work was funded by the Faculty of Law, Osijek, Josip Juraj Strossmayer University in Osijek, internal project no. IP-PRAVOS-No. 1 "Analysis of food insecurity and realisation of the right to food in Croatia", project manager Rajko Odoša.

**DOI:** 10.2478/crdj-2025-0003

## Introduction

The primary goal of the paper is to analyse and offer guidelines for reducing the rate of unethical, irrational, and environmentally harmful food waste in the EU27, and to increase the utilisation of food produced globally for human nutrition. The research starts from the assumption that reducing food waste, along with other benefits, can help address the lower average yields in organic agriculture compared to industrial agriculture. To achieve the research goal, in the second part of the paper, the reasons for the necessary transformation of unsustainable industrial agriculture into ecologically and socially acceptable organic agriculture are presented and interpreted by demonstrating how organic agriculture's productivity is compensated for through reduced food waste. The third chapter analyses food waste in the EU27 countries. The fourth chapter presents recommendations for activities whose implementation at all levels of social organisation and by all actors throughout the agri-food chain would change people's attitudes towards food, nutrition, and food waste, thereby leading to lower food waste rates. The conclusion summarises the research's previous results. It concludes that reducing global food waste is necessary for ethical, ecological, economic, and social reasons, as well as for broader sustainability. The research results show that the interconnectedness of changes in the way food is produced, people's attitudes towards the food produced, and the structure of people's diets will lead to the construction of an efficient, socially just, and environmentally friendly agricultural and food system.

The research is based on secondary sources. To determine the research's preliminary results, the methods of synthesis and descriptive-logical modelling were used. The research objectives were to track changes during the observed period, 2020-2022, for the indicators under research and analysis, especially given the existing gap between scientific research and the aims of activities to reduce food waste. Additionally, the outcomes of the proposed measures are unique, as they can be implemented regardless of the size of the community or the level at which they are implemented – local, regional, national, or subnational.

## Literature review: Productivity and food waste challenge

Narrowly focused on the economic dimension of sustainability, short-term profit and growth, while ensuring a high level of food security, industrial agriculture (synonyms are conventional, commercial, intensive agriculture) takes little or no account of the ecological and social dimensions of sustainability. Industrial agriculture inadequately assesses the contributions of small- and medium-sized primary farmers to food production and environmental preservation, thereby encouraging the displacement of rural areas. Food production has reached its natural limits, as it already uses about 25 per cent of the Earth's habitable surface area and about 80 per cent of total drinking water. Technological changes in agricultural production intensify the use of other natural resources, causing pollution and degradation of soil and drinking water, greenhouse gas emissions, pest resistance, loss of biodiversity, deterioration in

consumer health, and exposure of millions of farmers daily to the toxic effects of herbicides and pesticides. The expansion of agriculture into new areas is responsible for 90 per cent of the global loss of 10 million hectares of forests annually, and for the loss of their beneficial ecological, economic, and social functions. More than half of forest loss results from conversion to cropland, while almost 40 per cent is attributed to livestock grazing (European Parliament & Council of the European Union, 2023). Food production and food waste decomposition together account for as much as 34 per cent of global greenhouse gas emissions and more than 10 per cent in the EU (Bock et al., 2022, p. 10; Aminetzah et al., 2019). With increasing risks to agricultural systems, weather extremes inflict the most damage on small and medium-sized farmers, as well as low-income communities that cannot afford adequate insurance against damage and effective fire and flood protection systems. The destruction of our own ecological and social foundations reduces the resilience and adaptability of agricultural production to changing natural conditions, making the replacement of agricultural production with a different way of producing and consuming food necessary. However, balancing the relationship among growing food needs, food production methods, and environmental protection is difficult, and a partial, imperfect solution has emerged in the transition from industrial to organic food production (Chomsky & Pollin, 2023, p. 41).

According to its characteristics and effects, organic agriculture (synonyms include ecological, biological, traditional, and sustainable agriculture) is, under certain conditions, more ecologically and socially advanced and, economically, more acceptable than industrial agriculture. Organic agriculture effectively preserves and restores soil, water quality and quantity, other natural resources, biodiversity, climate, rural areas, human health, and animal welfare. The organic paradigm in food production is incorporated into the overarching development strategy, the European Green Deal, and the From farm to fork for a fair, healthy and environmentally-friendly food system, adopted in 2020 (European Commission, 2020). From farm to fork is a strategy for developing the Union's agricultural-food system that clearly sets out the direction of transitional changes and measurable objectives. This implementation will ensure sufficient, safe, nutritionally high-quality and affordable food for European consumers in all social circumstances, as well as a fair income for European small and medium-sized farmers. In addition to reducing greenhouse gas emissions and increasing the share of organic agriculture to 25 per cent of total agricultural land in the Union, the strategy envisages reducing the use of pesticides and sales of antimicrobials, the use of artificial fertilisers, and the loss of nutrients in the soil by 2030 (Odobáša, 2022, pp. 35-36). The spread of organic farming and aquaculture is also encouraged by the measures outlined in the EU Action Plan for the Development of Organic Production, adopted in 2021 (European Commission, 2021). The success of the agricultural transition also depends on the application of broader social policies and programs that promote the preservation and improvement of rural areas' quality of life, the localisation of food production for domestic needs, and the shortening of supply chains. Targeted policies should lead to changes in the structure of the population's diet, with future diets relying more on plants and plant substitutes for

animal products. Due to different production techniques and positive social-ecological effects, organic agriculture is a real alternative to industrial food production, processing, and consumption, which is why some consider it the second agricultural revolution. However, the transition to organic agriculture is hampered by controversy over its overall productivity compared to industrial agriculture. A reasonable average of estimates indicates that the efficiency of organic agriculture is 10-15 per cent lower than that of industrial agriculture (Chomsky & Pollin, 2023, p. 41). Some comparisons assume the difference is almost non-existent, especially in the agricultural production of developing countries, which do not use significant amounts of synthetic materials anyway. Moreover, under conditions of drought and other environmental pressures, organic yields can even surpass those of industrial agriculture (Chomsky & Pollin, 2023, p. 99). If the estimate of lower average productivity of organic production proves to be correct in further analyses and comparisons of yields, a possible and at the same time dangerous compensation for lost yields and income could be found in the expansion of organic agriculture to new areas, almost exclusively at the expense of cleared forests and biodiversity (Chomsky & Pollin, 2023, pp. 36-37). Given the Food and Agriculture Organisation estimate that 60 per cent more food will have to be produced to feed the expected world population of 9.3 billion by 2050, this potential pressure is understandable but ecologically, economically, and socially unacceptable (The Economist, 2021).

Therefore, reducing food waste as a multidimensional social-ecological problem becomes an excellent alternative to the ecologically unacceptable expansion of arable land into new areas to avoid new deforestation, biodiversity loss, and ecosystem degradation. In other words, the growing global demand for food needs to be met by increasing the efficiency of already produced food, i.e., by reducing waste at all stages of the agri-food chain: from production, storage, transport, and processing to distribution, retail, and final consumption. Food loss needs to be distinguished from food waste. Namely, food loss refers to the reduction in the availability of edible food in the stages preceding retail sale, including agricultural production, harvesting, storage and transportation. Causes of losses include the harmful effects of microorganisms such as mould, pest infestations, inappropriate temperature conditions, poor ventilation during storage, and the use of outdated or inefficient machinery that damages or incompletely harvests crops.

According to the United Nations, around 13.2 per cent of all food produced for human consumption globally is lost between the field and retail. The largest share of loss is recorded in sub-Saharan Africa, where it reaches approximately 20 per cent, while in Europe and North America, the loss is around 9 per cent (United Nations, 2023c). These data clearly indicate the need for investments in technological modernisation, improved storage conditions, and logistics systems, as well as the importance of integrating food waste reduction policies into sustainable agriculture and food security strategies, and ultimately into the awareness and daily lives of inhabitants. According to the second concept, food suitable for consumption and intended for the consumer is deliberately discarded at the retail or consumption stage, resulting in food waste (Harvard T.H. Chan School of Public Health, 2023). Globally, 931 million tons of food, or

about 17 per cent of total food production, is wasted each year (United Nations, 2023b). The monetary value of lost food is estimated at around 936 billion US dollars (Ishangulyyev et al., 2019, pp. 6-7). FAO and the World Resources Institute (WSI) highlight significant differences among countries in per capita food waste. About 56 per cent of global food waste occurs in developed countries, while the remaining 44 per cent takes place in developing countries. However, in developing countries, food waste is more pronounced in production and storage (loss), while in developed countries, more food is wasted in the consumption phase (waste). At the stages of food processing, distribution and sale, levels of food waste are fairly similar in both groups of countries (Ishangulyyev et al., 2019, pp. 6-7). Throwing away food during consumption is generally considered the most environmentally harmful, as it consumes the most resources along the entire production and supply chain. Annually, there is much more food per person wasted in the United States and the EU (an average of 95 to 115 kg) than in less developed countries in sub-Saharan Africa and South Asia (an average of 8 to 11 kg) (United Nations, 2024).

The amount of food wasted is enough to feed two billion people (World Food Programme, 2020) and twice as much as is needed to feed the hungry, whose numbers ranged between 691 and 783 million in 2022 (United Nations, 2023b). Uneaten food could have improved the nutrition of millions of people and lifted them out of food insecurity, alleviating or eliminating the suffering of children caused by insufficient or poor-quality nutrition (Von Grebmer et al., 2020, p. 11). Due to irrational and environmentally harmful food waste during consumption in households and service industries, approximately 222 million tons of food waste are generated annually in developed countries. This amount of food waste is almost equal to the total annual net food production in sub-Saharan Africa, which is 230 million tons (Ishangulyyev et al., 2019, p. 1). 20% of food produced in the EU (around 88 million tonnes of food) is wasted annually (Vlada Republike Hrvatske, 2022, p. 1), and over 50 per cent of food waste comes from households, while at the same time, 36 million citizens of the Union cannot afford a quality meal every day. In the United States, up to 40 per cent of all food produced ends up as waste (United States Environmental Protection Agency, 2023). Only 5 per cent of food waste is diverted from landfills and incinerators for composting (Harvard T.H. Chan School of Public Health, 2023). Food waste is worth \$430 billion annually, an amount that could have been saved or spent more profitably (ReFED, 2023). In addition, 10% of total energy consumption is used for the production and delivery of food to American consumers (Gunders, 2012, p. 4). At a global level, the production of lost and wasted food 'swallows' 38 per cent of total global energy consumption within the agricultural system (Grain, 2021). In the Republic of Croatia, over 286 thousand tons of food ends up in waste annually, of which the edible part, whose waste could be prevented, amounts to 106 thousand tons. Households generate about 76 per cent of food waste; 14 per cent is generated in primary production, including family farms; 5 per cent in the hospitality industry; 3 per cent in processing and manufacturing; and 2 per cent in retail and other food distribution. For the same period, according to data from the Central Bureau of Statistics, 19.2 per cent of Croatia's population in 2021 was at risk of poverty (Vlada Republike Hrvatske, 2022,

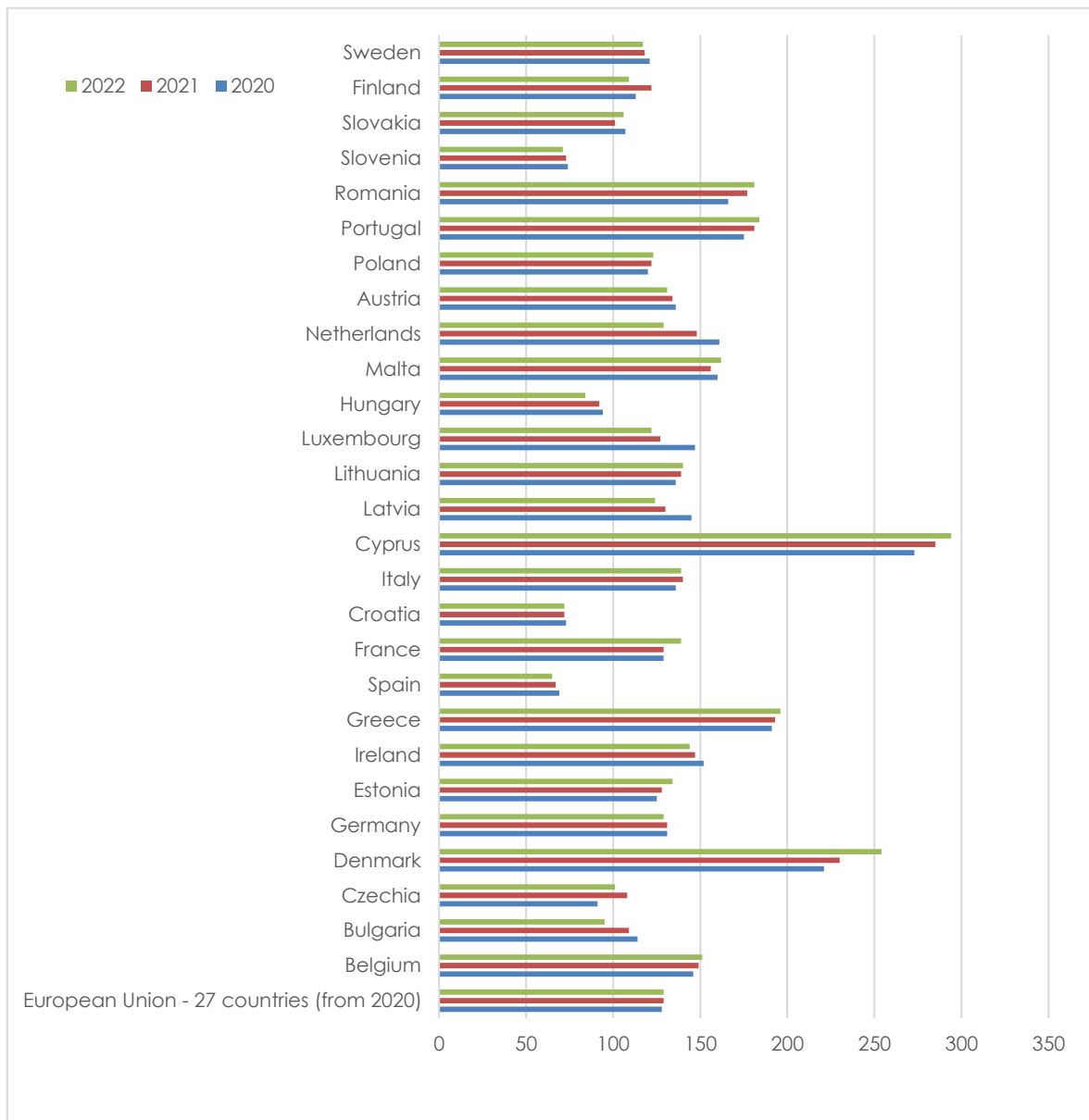
p. 1), possibly indicating food insecurity among this population. The amounts of food wasted in developing countries are significantly lower than those in more economically developed countries, due to limited household incomes, rationalised and daily-planned food purchases, and the lack of large surpluses and waste. In humble living conditions and remote places where food is scarce, people's relationship to food is strongly shaped by a moral imperative to avoid inedible leftovers (Ishangulyyev et al., 2019, p. 7). On the contrary, a wasteful attitude towards food is prevalent among the wealthier strata of the populations of developed countries, under the influence of modernisation, consumerism, the values of the consumer society, the advertising and marketing industries, and the "secularisation of renunciation and sacrifice". In the developed world, there has been a change, even a complete disappearance, in ecological and ethical attitudes towards food, nutrition, and food leftovers (Cifrić, 2003, pp. 222–226). Regardless of regional differences in material living conditions, attitudes and practices related to food and nutrition, in all countries of the world, there is a clear need for priority action to reduce economically irrational, ethically questionable and environmentally harmful food waste.

## Analysis of the food waste in the European Union Countries

During 2018 (on May 30, 2018), all EU Member States adopted revised *Waste Framework Directive* to reduce food waste at each stage of the food supply chain, monitor food waste level and report on the progress made in the following manner – preparing food waste prevention programmes, encouraging food donation and proving incentives for the application of the waste hierarchy (European Commission, 2025). In 2022, compared to 2020, the food waste per capita indicator increased slightly at the EU27 average level – in 2020, the average for EU27 countries was 128 kg. p.c. and in 2022 it was 129 kg p.c. Countries with the lowest food waste per capita in 2022 were Spain (65 kg p.c.), Slovenia (71 kg p.c.), and Croatia (72 kg p.c.). (Figure 1).

Although there are unified measures at the EU27 level, differences in some indicators, e.g., waste per capita, remain. Some countries even show an increase in waste per capita in the last available period, 2022, compared with 2020 (Figure 1). The increase in waste per capita from 2020 to 2022 is seen in the following countries: Denmark, Cyprus, Romania, Czechia, France, Estonia, Portugal, Belgium, Greece, Lithuania, Italy, Poland, and Malta. According to European Commission data, per capita waste decreased in the Netherlands, Luxembourg, Latvia, Bulgaria, Hungary, Ireland, Austria, Finland, Sweden, Spain, Slovenia, Germany, Croatia, and Slovakia.

Figure 1  
Food Waste per Capita in the EU27, 2020-2022



Source: Authors' illustration according to European Commission (2025)

According to Eurostat, households generated 54% of food waste in 2022. The remaining 46% was waste generated in primary production (8%), the manufacture of food products and beverages (19%), the restaurant sector (11%), and food services, retail, and other food distribution (8%) (Eurostat, 2024). Looking at food waste by sector activities in 2022, as stated earlier, it is evident that households produce the highest waste across almost all EU27, except Denmark, and are again the second-highest sector for food waste (Table 1).

Table 1

Food Waste Sector of Activities, 2022 (Tonnes of Fresh Mass)

	Total food waste	Primary production	Processing and manufacturing	Retail and other distribution of food	Restaurants and food services	Households
<b>EU</b>	59 200 000	4 600 000	11 100 000	4 800 000	6 600 000	32 100 000
<b>Belgium</b>	1 758 589	33 863	737 026	125 564	111 250	750 886
<b>Bulgaria</b>	614 928	63 904	145 918	38 149	99 792	267 165
<b>Czechia</b>	1 080 608	14 670	165 414	67 296	180 773	652 455
<b>Denmark</b>	1 497 958	116 629	695 475	100 355	75 634	509 865
<b>Germany</b>	10 781 835	177 766	1 564 071	773 598	1 977 549	6 288 851
<b>Estonia</b>	180 747	21 555	39 088	19 681	12 930	87 493
<b>Ireland</b>	749 243	52 837	230 100	89 103	157 045	220 158
<b>Greece</b>	2 044 324	362 275	403 568	149 911	214 559	914 011
<b>Spain</b>	4 260 845	845 620	1 419 257	348 219	213 023	1 434 726
<b>France</b>	9 450 000	1 179 000	2 406 000	830 000	1 091 000	3 944 000
<b>Croatia</b>	278 838	39 084	9 424	4 086	14 736	211 508
<b>Italy</b>	8 201 419	652 914	540 442	629 154	474 241	5 904 668
<b>Cyprus</b>	268 398	47 887	65 916	54 517	30 131	69 947
<b>Latvia</b>	232 442	27 226	29 917	15 759	25 183	134 357
<b>Lithuania</b>	390 645	81 202	29 271	33 951	4 651	241 570
<b>Luxembourg</b>	79 406	7 582	11 430	8 614	9 626	42 154
<b>Hungary</b>	810 600	11 847	139 135	57 862	21 869	579 887
<b>Malta</b>	86 295	555	7 371	4 716	26 934	46 720
<b>Netherlands</b>	2 290 000	322 206	884 373	152 732	83 035	847 654
<b>Austria</b>	1 184 447	6 226	204 358	83 138	256 040	634 683
<b>Poland</b>	4 545 178	724 875	552 823	474 461	264 546	2 528 473
<b>Portugal</b>	1 926 484	110 980	64 572	227 908	239 000	1 284 025
<b>Romania</b>	:	:	:	:	:	:
<b>Slovenia</b>	150 839	58	10 587	14 070	55 839	70 285
<b>Slovakia</b>	574 824	36 225	141 776	30 144	11 918	354 760
<b>Finland</b>	607 709	29 439	139 297	52 828	81 182	304 963
<b>Sweden</b>	1 230 000	92 000	305 000	102 000	144 000	587 000

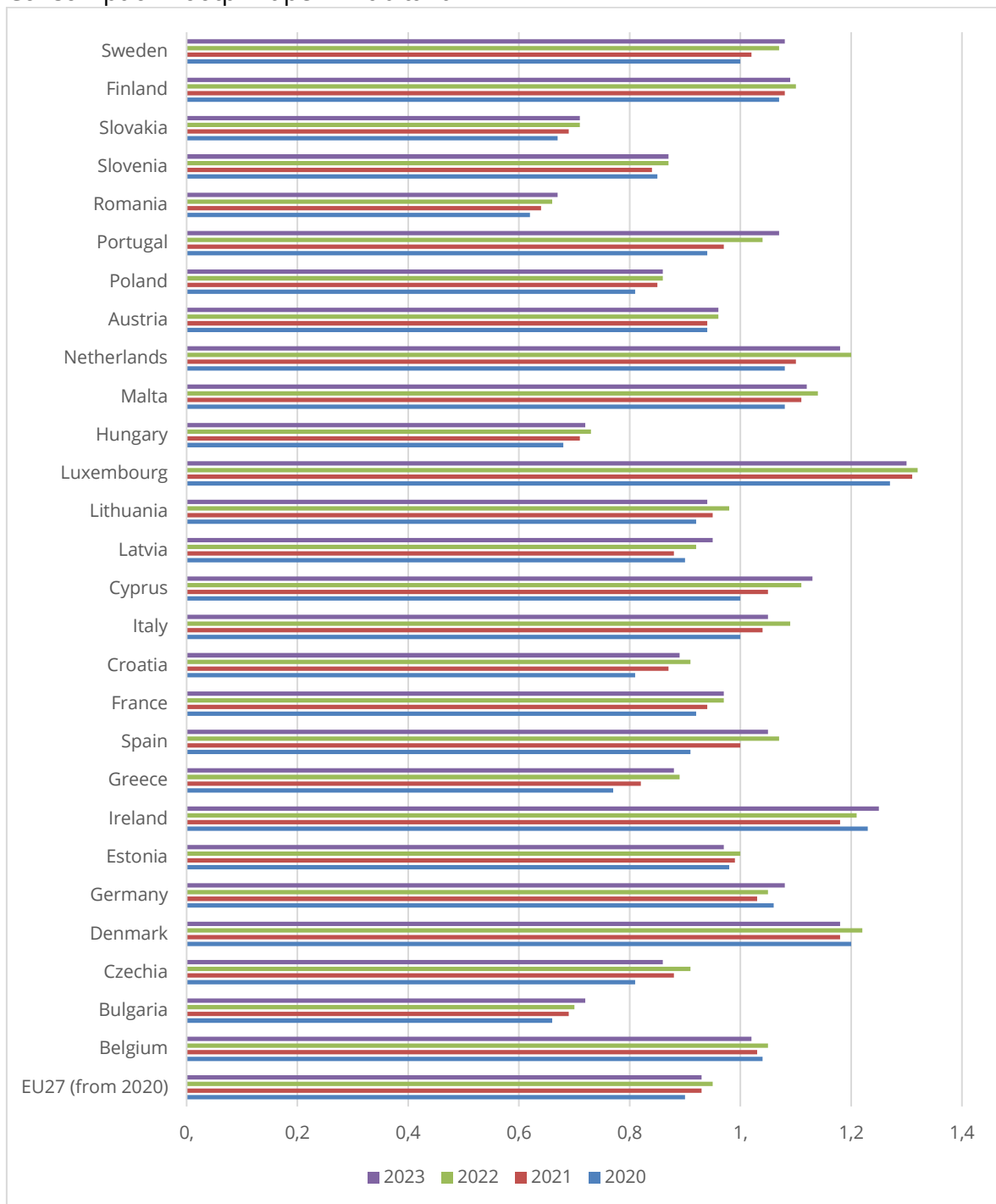
Note: Data for Romania were not available.

Source: Eurostat (2024).

During 2015, the United Nations adopted 17 Global Goals, known as the Sustainable Development Goals (SDGs), aiming to ensure balanced development for social, economic, and environmental prosperity by 2030 (United Nations Development Programme, 2025). For the sustainability overview of the EU27, a consumption footprint indicator was selected as one of the indicators tracked for the 12th of 17 Sustainable Development Goals, under Goal 12 – Responsible consumption and production. The consumption footprint, according to Eurostat, outlines the environmental impact of consumption in EU countries, considering consumption intensity and the environmental impacts of representative products. Therefore, the Environmental Footprint, as a single weighted score, measures the number of times that the planetary boundary has been crossed (Eurostat, 2025). The consumption footprint per inhabitant for the EU27 is presented in Figure 2.

Figure 2

Consumption Footprint per Inhabitant



Source: Eurostat (2025), Consumption footprint – single weighted score (SDG\_12\_31).

According to Figure 2, many EU27 countries are above the EU 2020 average, and some are even above the 1.0 level in consumption footprint per inhabitant, based on the results for the period from 2020 to 2023.

## Discussion and recommendations: Policy measures and activities in achieving a society without food waste

In developing countries, the most influential cause of food loss is the lack of effective refrigeration systems for storing harvested food, along with a wider range of infrastructure deficiencies, including poor transport connectivity, limited access to electricity and insufficient logistical support, all of which make it difficult to maintain the quality and safety of food products from field to market.

Investments in modernising roads and other transport infrastructure are key to reducing food losses caused by inadequate transport from producers to markets (Bridle, 2019, pp. 49–53). A greater amount of food saved in developing countries would significantly reduce malnutrition and related diseases and increase incomes, especially for small and medium-sized farmers (United Nations Environment Programme, 2022). Furthermore, reducing food spoilage rates in the mentioned countries would also have global effects. It is estimated that global demand for agricultural land could be reduced by approximately 5 per cent, thereby slowing deforestation and preserving natural ecosystems (Chomsky & Pollin, 2023, pp. 41–42). The United Nations Environment Programme (UNEP) and the Food and Agriculture Organisation (FAO) further emphasise that cooling food supply chains is critical to meeting the challenge of feeding an additional 2 billion people by 2050. In addition, they are crucial for preserving biodiversity, stabilising rural communities, increasing food security, and reducing greenhouse gas emissions, noting that cooling infrastructure should be based on renewable energy sources. All actors in the agro-food chain should actively contribute to lower rates of food waste - from producers, processors, distributors and retailers to the catering sector and consumers. However, public authorities and other institutionalised forms of social organisation at all levels of governance - local, national, regional, and global - also play a key role, with developed countries bearing particular responsibility, as food waste rates are highest there. Programs and measures aimed at reducing food waste at the consumption stage show the fastest and most far-reaching positive effects on the environment, economic efficiency, and social justice (Ishangulyyev et al., 2019, p. 7).

The most important goal in the hierarchy of waste management is prevention, since it decreases the spread of sales at reduced prices of food that does not meet aesthetic standards ('ugly' or damaged food), as well as food that approaches its expiration date, with a clear distinction between the labels 'best before' and 'use by'. Rationalising purchases and avoiding unnecessary stockpiling, buying frozen and canned food, which is thrown away in households up to 47 per cent less than fresh food (Harvard School of Public Health, 2023), the use of more economical cooking methods and proper storage of leftovers (eg, by freezing), further contribute to reducing waste. Changes in eating habits - such as controlling portion sizes, reducing portions in restaurants, and using smaller plates and refrigerators in households - are also important and can change attitudes towards food in the long term. Supermarkets can further reduce waste by offering ready-made meals made from less-than-ideal-looking

products, thereby making more efficient use of resources. As stated by the Harvard School of Public Health, in addition to the above operational measures, continuous marketing and educational campaigns are necessary to raise awareness of the importance and benefits of food waste prevention, encourage more responsible consumer behaviour, and foster new social norms grounded in sustainability. In the design and implementation of waste prevention plans, the roles of non-governmental organisations, the academic community, and agricultural, processing, and commercial entities that need to prepare and apply sectoral guides to prevent food waste are significant.

Food that is thrown away in stores or remains uneaten in households and restaurants, and that is not unavoidable waste, can be reused through connecting and donating to food banks, public supermarkets, and kitchens that help the hungry. Governments should encourage this practice by granting tax breaks to farmers, retailers, and caterers who donate surplus produce or sell it at a below-market price to local food banks and public kitchens (Harvard T.H. Chan School of Public Health, 2023). Organic food waste can be used by households and local farms, for example, for composting or as additional feed for livestock and farm animals, thus contributing to the principle of recycling food waste (Food and Agriculture Organisation of the United Nations, 2020). Systematic composting of organic matter is an important tool for preserving and improving soil quality, serving as a key carbon sink and a key factor in mitigating climate change. At the same time, it helps reduce methane emissions from municipal waste landfills and encourages the development of organic food production rich in nutrients (The Economist, 2021). The industrial sector can also play a significant role in recycling food waste. For example, used fats and oils from the food industry can be processed into bioenergy or natural fertilisers, further closing the resource loop and reducing dependence on fossil energy sources.

Food waste prevention programs, organised collection of food scraps from households, restaurants, and shops, and local composting systems should be systematically encouraged and coordinated by local authorities. The effectiveness of such programs depends on stable funding, citizen education, and cooperation with the private sector. At the national level, it is necessary to establish legally binding frameworks that include clear objectives, deadlines, and monitoring systems for implementing measures to prevent and reduce food waste (Vlada Republike Hrvatske, 2022, p. 1). All these measures should be integrated into broader sustainability and circular-economy policies and supported by scientific research and international cooperation in the transfer of best practices.

Preventing food waste has been recognised as a priority area of public policy at the EU and UN levels. Among the UN Sustainable Development Goals (United Nations, 2023a), goal 12 addresses responsible food production and consumption and a sustainable future for human nutrition. Its three sub-goals, especially target 12.3, set out a course of action to halve global food waste per capita at the retail and consumer levels and reduce food losses along the production and supply chain, including post-harvest losses, by 2030. The same priority is reflected in international monitoring frameworks through the food loss index and the food waste index (United Nations, 2023a).

In 2019, the EU adopted a common methodology for measuring food waste levels, and member states must submit annual data on total food waste quantities to the European Commission, expressed in metric tons of fresh weight across all stages of the agri-food chain. Given that only a few years remain to achieve the SDGs, the Sustainable Development Goals Report 2023 shows an urgent need for accelerated action to reduce food loss and waste (United Nations, 2023c). To raise awareness of the need to achieve the goal of reducing food loss and waste more quickly and to influence sustainable food systems, September 29th is marked as the International Day of Awareness on Food Loss and Waste.

Food waste is a complex social-ecological problem that requires an urgent, systematic solution on a global scale. It is unethical and inhumane, especially in a context where two billion people around the world continue to face hunger and food insecurity. Food waste results in unnecessary consumption of agricultural resources, including arable land, fertilisers, pesticides, seeds, fuel, agricultural machinery, human labour, transportation, and processing infrastructure. Unused food often wastes in fields or is disposed of in landfills, where it contributes to climate change through its greenhouse gas emissions and pollutes terrestrial and aquatic ecosystems. In developed countries, consumers directly lose money on wasted food that could have been saved or used more effectively.

In contrast, in developing countries, food loss results in both reduced income for small- and medium-sized producers and preventable food shortages. These losses can be significantly reduced by expanding efficient cooling, transport, and other infrastructure networks, as well as by technological and energy modernisation in developing countries. A much more complex challenge is to change people's attitude to food, nutrition, food waste, and the environment in general, which is especially difficult to achieve in developed societies with an abundance of relatively cheap food. Irrational and uninformed consumers often fail to realise that food prices today do not reflect the true environmental and social costs of production. Initiatives, programs, and policies to reduce food waste have shown limited success, partly because they have failed to revitalise traditional patterns of people's relationship to food and nutrition that existed before the modernisation of rural areas, the industrialisation of agriculture, and urbanisation. This paradigmatic pattern can be summarised through the phrase 'there is no surplus or shortage, everything is usable and used' (Cifrić, 2003, pp. 222–226), which reflects a deeply rooted ecological-ethical awareness of the limited nature of resources. Unfortunately, contemporary secularised, detraditionalised, and nature-alienated societies do not sufficiently recognise the importance of producing healthy, safe food through traditional and organic methods that simultaneously preserve rural landscapes, natural resources, and the well-being of all living beings.

The ethics of food responsibility have given way to the ethics of unlimited economic growth, and the human values necessary for sustainable development are neither strongly implemented through regulation nor transmitted through normative values. Such a state of mind and reasoning makes it difficult to adopt ecological norms and reflect on social-ecological patterns of behaviour regarding food and its remains. Still, there is a reason for cautious optimism. Surviving oases of traditional attitudes towards

food, combined with growing environmental awareness, ethical thinking and strategies to return to organic agriculture, can serve as catalysts for necessary transformations in food production and consumption systems. It is also encouraging that numerous elements of the former social and ecological practices of traditional agricultural societies have already been integrated into modern concepts of sustainable development and organic production, where they have been recognised as valuable contributions to all dimensions of social development (Cifrić, 2003, pp. 253–257). In any case, it is necessary to address food waste, restructure modern eating patterns, and generally adopt the principles of sustainable living.

## Conclusion

Sustainable production and consumption of food can only be achieved after the transition from the dominant industrial model of agriculture to a more ecologically acceptable, socially more just and long-term sustainable organic model. In most cases, organic agriculture meets the ecological and social criteria for sustainability. However, according to scientific estimates, its average productivity is 10-15% lower than industrial productivity. In the face of growing global food demand, the limited yields of organic production raise questions about its economic sustainability. A hypothetical increase in total production by expanding organic areas would often be at the expense of forests, resulting in the loss of valuable ecosystems and their multiple functions, thereby neutralising the positive effects of organic production, which is not acceptable from the perspective of sustainable development. Therefore, solutions should focus on a significant increase in the utilisation of already produced food, primarily by reducing losses and waste across the entire agro-food chain, given that waste occurs at all phases, from production and storage through distribution to final consumption. Causes include inadequate storage and transport conditions, irrational shopping planning, excessive portions and lack of awareness of the value of food. Globally, the amount of food lost and wasted is enough to feed two billion people, twice the number of people who are hungry and food-insecure today. Reducing food waste would have multiple benefits. Ecologically speaking, the footprint of food production would be reduced: consumption of natural resources, soil and water pollution, and greenhouse gas emissions. In developing countries, this would mean higher incomes for small and medium-sized producers and increased food security for the population. In developed countries, reducing food waste can lower production costs, reduce consumer spending, and improve the efficient use of available financial resources. At the same time, stabilising the supply-and-demand relationship for food can mitigate market price fluctuations and increase the resilience of food systems to economic and environmental shocks. Furthermore, higher food utilisation rates would significantly reduce the need to expand organic production areas to compensate for their lower productivity, thereby preserving forests, natural ecosystems, and biodiversity. Organic agriculture, while simultaneously reducing food waste, can meet the long-term need for safe, nutritious, and affordable food. Therefore, reducing food waste is a prerequisite for achieving the triple sustainability of organic agriculture: ecological, social and economic.

The role of reducing food waste in alleviating hunger, protecting the climate, protecting the environment, preserving biodiversity, supporting human health, and enabling a sustainable transition to organic food production is unquestionable. Achieving this goal requires urgent mobilisation of all levels of social organisation – from local communities to international organisations. All actors in the agro-food chain must be actively involved in reducing food waste: agricultural producers, processors, distributors, traders, consumers, policymakers, non-governmental organisations, and the academic community. It is necessary to take into account regional specificities: while in developing countries, priority should be given to investing in the construction of refrigeration and transport infrastructure, in developed countries, it is crucial to change consumer behaviour patterns, strengthen ethical and ecological values, and promote a culture of responsible attitude towards food, nutrition, and food waste. The analysis of EU27 data confirms the following: there are significant differences between EU Member States in waste per capita, with households remaining the largest single source of food waste. These results confirm the need for targeted, sector-specific measures, especially in developed countries, where changing consumer behaviour is crucial. Additionally, future research could include upcoming years in the analysis, thereby making the analysis available for a longer period and providing an overview of the most recent data.

## References

1. Aminetzah, D., Bartels, E., Denis, N., Henderson, K., Katz, J., & Mannion, P. (2019, September 23). *Agriculture plays a critical role in limiting the impact of climate change*. McKinsey & Company. <https://www.mckinsey.com/industries/agriculture/our-insights/agriculture-plays-a-critical-role-in-limiting-the-impact-of-climate-change>
2. Bock, A.-K., Bontoux, L., & Rudkin, J. (2022). *Concepts for a sustainable EU food system: Reflections from a participatory process*. Publications Office of the European Union. <https://doi.org/10.2760/381319>
3. Bridle, J. (2019). *Novo mračno doba: Tehnologija i kraj budućnosti*. Jesenski i Turk.
4. Cifrić, I. (2003). *Ruralni razvoj i modernizacija: Prilozi istraživanju ruralnog identiteta*. Institut za društvena istraživanja.
5. Chomsky, N., & Pollin, R. (2023). *Klimatska kriza i globalni zeleni New Deal: Politička ekonomija spašavanja planeta*. Naklada Ljevak.
6. European Commission. (2020). *A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system* (COM/2020/381). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0381>
7. European Commission. (2021). *Action plan for the development of organic production* (COM/2021/141). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0141>
8. European Commission. (2025). *EU actions against food waste*. [https://food.ec.europa.eu/food-safety/food-waste/eu-actions-against-food-waste/food-waste-measurement\\_en](https://food.ec.europa.eu/food-safety/food-waste/eu-actions-against-food-waste/food-waste-measurement_en)

9. Eurostat. (2024). *Food waste and food waste prevention*. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food waste and food waste prevention - estimates](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates)
10. Eurostat. (2025). *Consumption footprint – single weighted score (SDG\_12\_31)*. [https://doi.org/10.2908/SDG\\_12\\_31](https://doi.org/10.2908/SDG_12_31)
11. European Parliament & Council of the European Union. (2023). *Regulation (EU) 2023/1115 on deforestation-free products*. <https://eur-lex.europa.eu/eli/reg/2023/1115/oj>
12. Food and Agriculture Organisation of the United Nations. (2020). *15 quick tips for reducing food waste and becoming a food hero*. <https://www.fao.org/faostories/article/en/c/1309609/>
13. GRAIN. (2021, June 7). *The global food system: A waste of energy*. <https://grain.org/en/article/6688-the-global-food-system-a-waste-of-energy>
14. Gunders, D. (2012). *Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill*. Natural Resources Defense Council. <https://www.nrdc.org/sites/default/files/wasted-food-IP.pdf>
15. Harvard T.H. Chan School of Public Health. (2023). *Food waste*. <https://www.hsph.harvard.edu/nutritionsource/sustainability/food-waste/>
16. Harvard T.H. Chan School of Public Health. (2024). *Tackling food waste at home*. <https://www.hsph.harvard.edu/nutritionsource/sustainability/food-waste/food-waste-home/>
17. Ishangulyyev, R., Kim, S., & Lee, S. H. (2019). Understanding food loss and waste: Why are we losing and wasting food? *Foods*, 8(8), 297. <https://doi.org/10.3390/foods8080297>
18. Odoša, R. (2022). Refleksije Europskog zelenog plana i Strategije „Od polja do stola“. In D. Duić & U. Čemalović (Eds.), *Zakonodavstvo zaštite okoliša i održivi ekonomski razvoj u EU* (pp. 25–60). Pravni fakultet Osijek.
19. ReFED. (2023). *Our food system is radically inefficient*. <https://refed.org/food-waste/the-problem>
20. Salemdeeb, R., Vivanco, D. F., Al-Tabbaa, A., & zu Ermgassen, E. K. H. J. (2017). A holistic approach to the environmental evaluation of food waste prevention. *Waste Management*, 59, 442–450. <https://doi.org/10.1016/j.wasman.2016.09.042>
21. The Economist. (2021, November 17). *The dirty truth about wasted food*. <https://impact.economist.com/sustainability/ecosystems-resources/data-point-the-dirty-truth-about-wasted-food>
22. United Nations Development Programme. (2025). *Sustainable Development Goals*. <https://www.undp.org/sustainable-development-goals>
23. United Nations Environment Programme. (2022). *Investing in sustainable food cold chains*. <https://www.unep.org/news-and-stories/press-release/amid-food-and-climate-crises-investing-sustainable-food-cold-chains>
24. United Nations. (2023a). *Goal 12: Ensure sustainable consumption and production patterns*. <https://sdgs.un.org/goals/goal12>
25. United Nations. (2023b). *Reducing food loss and waste: Taking action to transform food systems*. <https://www.un.org/en/observances/end-food-waste-day>

26. United Nations. (2023c). *The Sustainable Development Goals Report 2023*. <https://unstats.un.org/sdgs/report/2023/>
27. United States Environmental Protection Agency. (2023). *Food waste research*. <https://www.epa.gov/land-research/food-waste-research>
28. Vlada Republike Hrvatske. (2022). *Plan sprječavanja i smanjenja nastajanja otpada od hrane Republike Hrvatske za razdoblje 2023.-2028*. Narodne novine, 156/2022.
29. von Grebmer, K., Bernstein, J., Wiemers, M., Acheampong, K., Hanano, A., Higgins, B., Ní Chéilleachair, R., Foley, C., Gitter, S., Ekstrom, K., & Fritschel, H. (2020). *Global Hunger Index 2020*. <https://www.globalhungerindex.org/pdf/en/2020.pdf>
30. World Food Programme. (2020). *5 facts about food waste and hunger*. <https://www.wfp.org/stories/5-facts-about-food-waste-and-hunger>

## About the authors

Rajko Odobaša, PhD, was a full professor at the Faculty of Law, Josip Juraj Strossmayer University in Osijek, in the Department of Economic Sciences. He was teaching subjects such as Political Economy, Economic Policy, Environmental Law, Sustainable Development, Right to Food, Poverty and Human Rights, and Globalisation and Human Rights, including courses for international students through the Erasmus+ program. His research focused on the links between economic theory, social justice, and environmental protection. His main interests included sustainable development, poverty and food insecurity, the right to food, human rights in globalization, and the green and digital transition in the EU, especially climate justice and environmental responsibility. He was the Head of the Department of Commercial Law and Economic Sciences, Deputy Head of the Green Law Clinic, and leader of a research project on food insecurity and the right to food in Croatia.

Katarina Marošević, PhD, is an Associate Professor at the Faculty of Law, Osijek, J. J. Strossmayer University in Osijek, and since 2022/2023 also a professor at the Fakultät für Wirtschaft und Recht in Pforzheim, Germany. She is fluent in English, German, and Italian (C level), with B1-level French. She graduated from the Faculty of Economics in Osijek in 2008, completed postgraduate specialist studies in Organisation and Management in 2010, graduated from the University of Mostar in 2013, and earned a PhD in Management in 2015. In 2021, she published the monograph *Regional Development and Imbalances in the Republic of Croatia*, and in 2024, co-edited *In This World Together: Global Social Work and Social Development* with colleagues from Indiana University, USA. She has also been a guest professor at universities in Germany, Spain, and Italy. The author can be contacted at [katarina.marosevic@pravos.hr](mailto:katarina.marosevic@pravos.hr).