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The Romanian Paradox of the Transition from Severe Food Crisis to Massive Food Waste: Chrono-evolution and Bio-approaches Promoted for the Sustainability of the Agri-Food System

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Abstract: Romania's agri-food system reveals a striking paradox, evolving from chronic scarcity and rationing under the communist regime to the present challenge of extensive food waste. This transformation has profound implications for sustainability, social equity, and the country's transition toward a bioeconomy-based model. The study examines this paradox by identifying the historical, economic, and social determinants of food insecurity and waste in Romania, and by assessing bioeconomic measures to strengthen agri-food sustainability. Drawing on an integrative review of 68 academic, institutional, and legislative sources (2020–2025), the research applies comparative, historical, and policy analyses to evaluate Romania's position within the European context. The results indicate that weak institutional coordination, fragmented legislation, inefficient resource use, and wasteful consumer behaviour have driven the shift from food crises to food waste. Although

temporary price caps and the 2024 law on food waste reduction provided short-term relief, systemic issues—poor enforcement, limited infrastructure, and low circular bioeconomic integration—persist. With over 6,000 tons of food discarded daily, nearly half of which comes from households, Romania must enhance bioeconomic practices such as waste valorisation and organic farming. The study offers practical insights for policymakers by linking food waste reduction to innovation, thereby supporting the EU Green Deal and the Sustainable Development Goals 2, 10, and 12.

Keywords: food (in)security, food waste, bioeconomy, environmental justice, circular economy, sustainable agri-food systems, Romania, social equity.

Introduction

At a global level, the cumulative effects of population growth, changing dietary habits, depletion and overexploitation of natural resources, environmental degradation, climate change, and migration create unprecedented challenges, demanding profound reform of the agri-food system. Current methods of food production and consumption are largely unsustainable. In certain regions, a double crisis of malnutrition manifests, characterised by the simultaneous presence of undernutrition and obesity, alongside other nutritional imbalances and metabolic issues. Today, it is important for food systems to ensure food security by providing sufficient quantities of safe, healthy, and high-quality food in a manner that maximises resource-use efficiency and promotes sustainability (EC, 2016). Globally, food waste is a serious problem (Ramanathan et al., 2024; Pocol et al., 2020; Adamashvili et al., 2019). One-third of the food produced worldwide is wasted, resulting in economic losses of 1 trillion dollars per year. This means that, from planting through consumption, approximately 1.3 billion tons of food are wasted. Fruits and vegetables, as well as roots and tubers, have the highest waste rates among all foods. Proportionally, global food waste per year is approximately 40-50% for root vegetables, fruits, and vegetables, 30% for cereals, 20% for oilseeds, meat, and dairy products, and 30% for fish (Ecosynergy, 2022). Households waste the most food (60% of the total), followed by restaurants (28%) and retailers (12%). In 2022, an individual wasted an average of 79 kilograms of food globally, equivalent to at least 1 billion meals wasted worldwide each day. In Romania, a person wastes 67 kilograms of food annually, and a household wastes over 1.32 tons of food (UNEP, 2024).

The European Commission emphasises that food losses and waste not only amplify the risk of food insecurity but also significantly impact the environment and contribute to climate change. Approximately 16% of the EU food sector's total greenhouse gas emissions are directly attributable to food losses and waste (RG, 2024a). According to the Food and Agriculture Organisation, the production and transportation of food that is subsequently thrown away account for 8% of global greenhouse gas emissions. In this context, the „Farm to Fork Strategy" (EC, 2020) was introduced, aimed at reducing food waste. European institutions are increasingly concerned with achieving the UN's Sustainable Development Goal, which aims to reduce food waste by 50% by 2030 (UN, 2015). This initiative runs parallel to the creation of a new food safety system and the development and implementation of technologies and digital solutions that provide clear advantages to consumers while improving the competitiveness and sustainability of the food chain. Furthermore, promoting

behavioural changes in food production and consumption, taking into account cultural and social aspects, is very important. All parties must be involved in this collective effort: primary producers, the food industry, distributors, the food service sector, consumers, and public services (EP, 2019; Pascariu, 1999).

Thus, the sustainability of the agri-food sector is a major global challenge with significant implications for food security and environmental protection. Bioeconomy, which signifies „the set of economic activities in which biotechnology contributes centrally to primary production and industry, especially where the advanced life sciences are applied to the conversion of biomass into materials, chemicals, and fuels" (OECD, 2018), represents an important pillar in the transition to a more sustainable food system. It „encompasses all sectors and services associated with, as well as investments that produce, use, process, distribute, or consume biological resources, including ecosystem services. Therefore, it is a catalyst and a natural outcome of the transformation envisaged in the European Green Deal" (EC, 2022). In fact, at the European level, the European Commission launched the EU Bioeconomy Strategy as early as 2012, defining it as „the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food products, animal feed, bioproducts, and bioenergy" (EC, 2012). Through this strategy, Europe has established the theoretical foundations for a resource-efficient economy, with the bioeconomy (Figure 1) designed to focus on converting raw materials into value-added products, aiming to achieve an innovative, knowledge-based economy with low emissions (Rodino, 2018).

Figure 1

Graphical representation of the bioeconomy concept



Source: Lutzeyer (2019).

Bioeconomy at the European Union level already generates a turnover of over €2 trillion and provides over 22 million jobs, equivalent to 9% of the EU's total employed workforce (INCDSB, 2018). Regarding Romania, although it has a fairly developed agri-food sector, it continues to rely

on traditional practices and outdated infrastructures. The country faces numerous sustainability challenges, including farm fragmentation, a lack of innovative technologies, and deficiencies in education and training in the field. Romania stands out for the lowest productivity in the bioeconomy within the European Union, despite this sector accounting for a significant share of the active workforce. Approximately 29.10% of the active population is involved in agriculture, forestry, and fishing, while only 2.23% are engaged in industries processing bioresources (INCDSB, 2018). Economic activities focused on bioresource production (agriculture, forestry, fishing) dominate, while the processing of these resources adds relatively low value, as is the case in the food industry.

It is expected that implementing bioeconomy principles and rules can increase resource efficiency, reduce waste, and improve the quality of food products, with positive effects on the environment and the national economy. Among these principles, directly applicable in the agri-food sector, we find those concerning the circular economy, sustainable use of biological resources, with a focus on the efficient and renewable use of natural resources (soil, water, biodiversity), as well as those regarding innovation and technology, integration of value chains, etc. (Leal Filho et al., 2018; Sillanpää & Ncibi, 2017; Buşu, 2021; Chelmu & Istudor, 2012; Diaconăşu et al., 2022; Şerban, 2013; Dediu, 2014). As a member state of the European Union, Romania aims to actively promote the bioeconomy in line with sustainable growth strategies. This situation originated from the fact that in 2012, the EU launched the bioeconomy strategy titled „Innovating for Sustainable Growth: A Bioeconomy for Europe" (EC, 2012), which aims to support economic growth and reduce greenhouse gas emissions by integrating biological processes into the European economy. At the national level, several regulations address bioeconomy aspects; however, they are fragmented and not always implemented effectively. For example, legislation on the management of agricultural and food waste, as well as legislation promoting renewable energy sources, should play an important role in developing a more sustainable agri-food sector. However, in Romania, the lack of coordination and clear policies regarding the bioeconomy limits the effectiveness of these regulations. In the future, emphasis should be placed specifically on these aspects, especially given the numerous opportunities for the Romanian agri-food sector (INCDSB, 2018). In this regard, we note that Romania can access significant funds from the European Union for bioeconomy and sustainability projects, the country possesses important agricultural and biological resources, and there is considerable innovation potential (MADR, 2023).

Our advocacy for the implementation of bioeconomy principles and rules in the Romanian agri-food sector, reflected in several scientific works, some carried out in collaboration with other researchers (Onofrei et al., 2020; Roman & Bostan, 2020; Bostan et al., 2019; Bostan, 2016a, 2015; Mateş et al., 2015; Burciu et al., 2010), is justified by the significant benefits that can arise. In this sense, we consider the reduction of environmental impact, as the use of ecological technologies and sustainable agricultural practices can help reduce greenhouse gas emissions, water pollution, and soil degradation (Topliceanu et al., 2023). Furthermore, there is an increase in resource efficiency, as precision agriculture (e.g., using drones to monitor crops) and optimising production chains can reduce resource waste and improve productivity. Lastly, from the perspective of contributing to the circular economy, it should be noted that better management of agricultural and food waste can transform these resources into energy, compost, or other useful products (Bogdan et al., 2012; Curtean-Bănăduc & Oprean, 2012; Georgescu-Roegen, 1977; Venkatesan & Peters, 2010). We

emphasise that this study is necessary as it addresses a paradoxical issue specific to Romania—the transition from severe food crisis to massive food waste—from a complex perspective, offering solutions for the sustainability of the agri-food system. Its importance for readers and researchers lies in providing a detailed analysis of the macro-decision errors that led to famine during the centralised economy period, as well as the current challenges related to food waste, and in complementing this with an assessment of both implemented and proposed bioeconomic strategies.

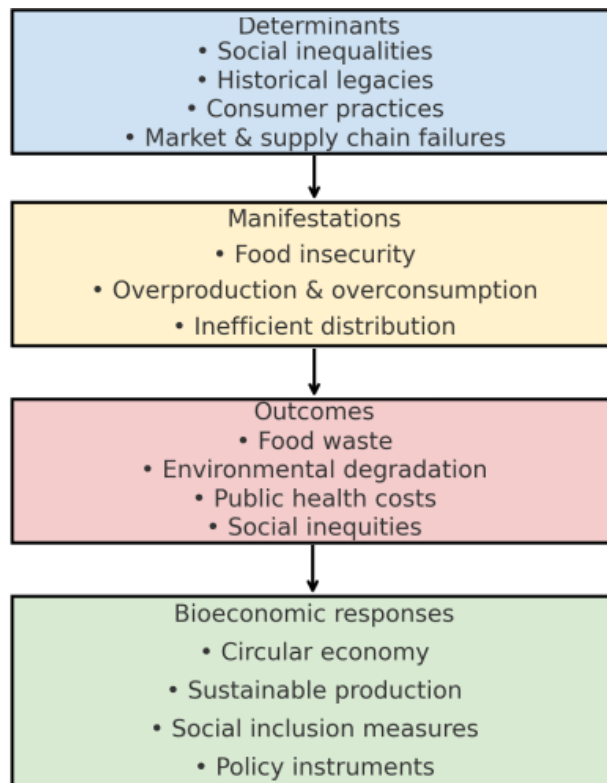
To strengthen the analysis, a sociological perspective offers additional insights into how historical and social processes shape the current agri-food system. This transition can be explained through several theoretical lenses. Food regime theory situates local consumption and waste within broader shifts in agri-food governance. Social practice theory highlights how daily routines—shopping, cooking, storage—embed and normalise wasteful behaviours. The capability approach reframes food security as the real freedom to access and use food adequately, rather than merely focusing on caloric intake. Finally, environmental justice emphasises that the negative impacts of food waste disproportionately affect vulnerable groups. Together, these perspectives underscore that food waste is not only an economic or environmental failure but also a social issue requiring bioeconomy-oriented corrective policies. The study's contribution to the specialised literature is an integrated approach to these aspects, highlighting both Romania's historical and economic particularities and innovative solutions to enhance the sustainability of the agri-food sector within a broader European context.

Against the background of the above, we note that we approach the topic of this paper—based on a vast and valuable specialized literature—in a structure that includes, after an introductory part, sections such as: (i) Romanian agriculture resources – exploitation, valorization, errors of the past; (ii) The current agri-food system and the necessity of increasing its sustainability; (iii) Strengthening the sustainability of the Romanian agri-food system through bio-economic measures. Combating food waste; (iv) Institutionalised efforts regarding organic agriculture and a sustainable agri-food system aimed at providing healthy food in sufficient quantities. The final part of our paper is dedicated to formulating Practical implications and Conclusions, as well as noting the research's limitations and the future directions of study we have in mind.

The Romanian agri-food system illustrates a paradoxical trajectory: from decades of scarcity and rationing under the communist regime to the present-day challenge of severe food waste in a market economy. This paradox has profound implications for sustainability, social equity, and the development of bioeconomy-oriented policies. From a sociological perspective, theories such as food regime theory, social practice theory, the capability approach, and environmental justice provide useful lenses for understanding how historical legacies, daily practices, inequalities, and power relations shape the current food system. Building on these insights, this paper reviews past errors and examines current orientations towards bioeconomic solutions in Romania. To guide the analysis, Figure 2 presents a conceptual framework that links the main determinants of food insecurity and waste, their manifestations and outcomes, and the range of bioeconomic policy responses.

Figure 2

Conceptual framework linking determinants, manifestations, outcomes, and bioeconomic responses in the Romanian agri-food system



Source: Author's development.

Research problem

Romania's agri-food system embodies a profound paradox: within a few decades, the country has shifted from severe food scarcity and rationing under the communist regime to massive food waste in the contemporary market economy. This contradictory evolution exposes deep structural and institutional weaknesses, raising concerns about the long-term sustainability of the national agri-food sector. Despite the country's substantial natural resources and agricultural potential, Romania continues to face inefficient resource management, fragmented policies, low technological adoption, and weak coordination among stakeholders. These systemic deficiencies have hindered the transition to a circular bioeconomy that can reduce waste and improve food security.

The research problem thus centres on understanding how Romania's historical, economic, and social trajectory has generated this paradoxical coexistence of abundance and waste, and on identifying the bioeconomic strategies that can reverse current unsustainable trends. Addressing this issue is crucial not only for improving food system efficiency and reducing environmental impact but also for ensuring social equity and compliance with the European Green Deal and the UN Sustainable Development Goals.

Research focus

This study focuses on the paradoxical evolution of Romania's agri-food system, from chronic food shortages and rationing during the communist period to the current challenge of massive food waste. The analysis emphasises the historical, institutional, and socio-economic mechanisms that have shaped this trajectory and examines how they continue to affect food production, distribution, and consumption patterns today. The research specifically explores the interconnections between food insecurity, waste, and bioeconomic development, situating Romania within the broader European context. It also evaluates the effectiveness of recent policy and legislative frameworks—including the 2024 Law on Food Waste Reduction and national strategies for the circular and bioeconomy—in addressing these systemic problems.

By integrating historical analysis with contemporary policy evaluation, the study aims to clarify why Romania remains one of the European countries most affected by food waste and how the application of bioeconomic principles—such as resource valorisation, circularity, and sustainable agriculture—can strengthen the resilience and sustainability of the agri-food sector.

Research aim and Research questions

The main aim of this research is to analyse the paradoxical transformation of Romania's agri-food system—from food scarcity to food waste—and to identify bioeconomic measures to enhance its long-term sustainability. The study seeks to connect the historical roots of food insecurity to present-day inefficiencies, proposing integrated solutions aligned with the European Green Deal, the Farm to Fork Strategy, and the UN Sustainable Development Goals.

To achieve this aim, the paper addresses the following key research questions: (RQ1) How can the paradox of food crises in Romania be explained in light of the country's rich natural resources and agricultural potential? (RQ2) What are the main structural and institutional weaknesses that limit the sustainability of Romania's agri-food system? (RQ3) What economic, environmental, and social impacts result from the high level of food waste in Romania? (RQ3) How are bioeconomic principles and circular economy strategies currently applied in Romania's agri-food sector, and to what extent are they effective? (RQ4) What policy adjustments and innovation pathways could facilitate Romania's transition toward a sustainable and bioeconomy-based agri-food model?

Research methodology

The methodological framework of this paper reflects its conceptual, comparative, and analytical nature and is designed in accordance with the requirements for review-type studies published in MDPI journals. The research adopts an interdisciplinary perspective, integrating approaches from economics, law, history, political science, and environmental studies to provide a comprehensive understanding of the paradoxical evolution of Romania's agri-food system.

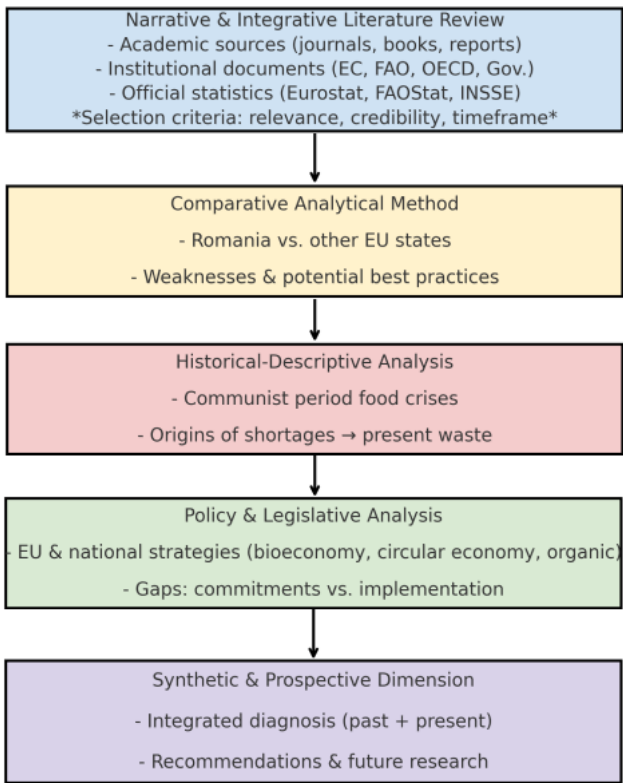
The study is based primarily on a narrative and integrative literature review, complemented by a critical evaluation of the institutional, legislative, and strategic frameworks relevant to the sustainability of the agri-food sector. Academic sources (peer-reviewed journal articles, books, and scientific reports), institutional documents (from the European Commission, FAO, OECD, Romanian

Government, and national agencies), and official statistics (Eurostat, FAOStat, INSSE) were systematically consulted. Selection criteria included: (i) direct relevance to the themes of agri-food sustainability, bioeconomy, and food waste; (ii) scientific credibility and institutional authority of the sources; and (iii) publication timeframe, with priority given to materials published in the last 10-12 years, but without excluding fundamental works needed for historical context. A comparative analytical method was employed to evaluate Romania’s situation in relation to other EU member states, particularly those that have made significant progress in reducing food waste and implementing bioeconomic strategies. This comparative perspective allows both the identification of weaknesses specific to Romania and the highlighting of potential best practices that could be adapted to the national context.

The research also integrates a historical-descriptive analysis of the communist period to explain the origins of food crises in Romania and their implications for the present-day agri-food sector. This historical contextualization provides the basis for understanding the paradox of moving from food shortages to excessive food waste. A graphical representation of the research methodology is provided in Figure 3.

Figure 3

Design of the research methodology applied in this study



Source: Author's development.

Furthermore, a policy and legislative analysis was conducted, assessing European and national strategies for the bioeconomy, organic agriculture, and the circular economy. This approach enabled the identification of gaps between Romania’s formal commitments and the level of implementation in practice.

Finally, the study employed a synthetic and prospective dimension, aiming not only to diagnose past and current vulnerabilities but also to formulate recommendations and to outline potential directions for future research. By combining these methodological layers—literature review, comparative analysis, historical contextualization, and policy evaluation—the paper aspires to offer an integrated perspective on how bioeconomic measures can strengthen the sustainability of Romania's agri-food sector.

Resources of Romanian agriculture - exploitation, valorisation, errors of the past

Brief historical overview

In the current territory of Romania during the Middle Ages, agriculture was the primary activity in the economy, characterised by a predominantly subsistence farming system and feudal estates (Ilinca et al., 2013). In the 9th to 15th centuries, agriculture was organised in systems of feudal estates, where peasants were bound to the land owned by the nobles (Vasiliu, 1996; Băltărețu, 1971; Mewes, 1969). Large tracts of land were cultivated by peasants who paid taxes and tribute to their lords, and agricultural practices were often rudimentary, with cultivation techniques based on crop rotation, vineyards, and pastures. It was only in the 19th century that the beginning of a period of modernisation and agricultural reforms was marked, during the reign of Alexandru Ioan Cuza (1859-1866). Important reforms were carried out, such as the establishment of agricultural credit banks, land reform, and the distribution of land to peasants, aimed at improving efficiency and equity in the agricultural sector (DGAS, 2022; Corfus, 1992).

During the interwar period, Romania experienced significant agricultural modernisation, with the introduction of new technologies, such as tractors and harvesters, as well as investments in irrigation and agricultural infrastructure, which contributed to a significant increase in agricultural production. The country became known as the „granary of Europe" due to its high agricultural potential. Exports of grains, especially wheat and corn, were very important for the country's economy. Although agriculture was the main source of income, government policies on food production were uneven, largely due to unequal distribution of agricultural land and outdated technologies. Production intended for foreign markets was prioritised, while internal access to staple foods was not always sufficient for the rural population, which represented the majority.

After World War II, Romania fell under the influence of the Soviet Union, and the economy was reorganised based on a centralised planning model. During this period, the communist regime introduced land reform and forced collectivisation, confiscating farmers' land and organising it into Agricultural Production Cooperatives (CAPs) and State Agricultural Enterprises (IASs) (Kligman & Verdery, 2015). The main goal of these policies was to increase agricultural production to support the country's rapid industrialisation and to pay war reparations to the Soviet Union. However, collectivisation led to decreased productivity and a food crisis, as farm workers were deprived of motivation and the means to produce efficiently. Thus, the structural problems of Romanian agriculture intensified, leading, in the 1980s, to insufficient production to meet both internal needs and export requirements. The situation persisted until 1989, with recognition today that it was

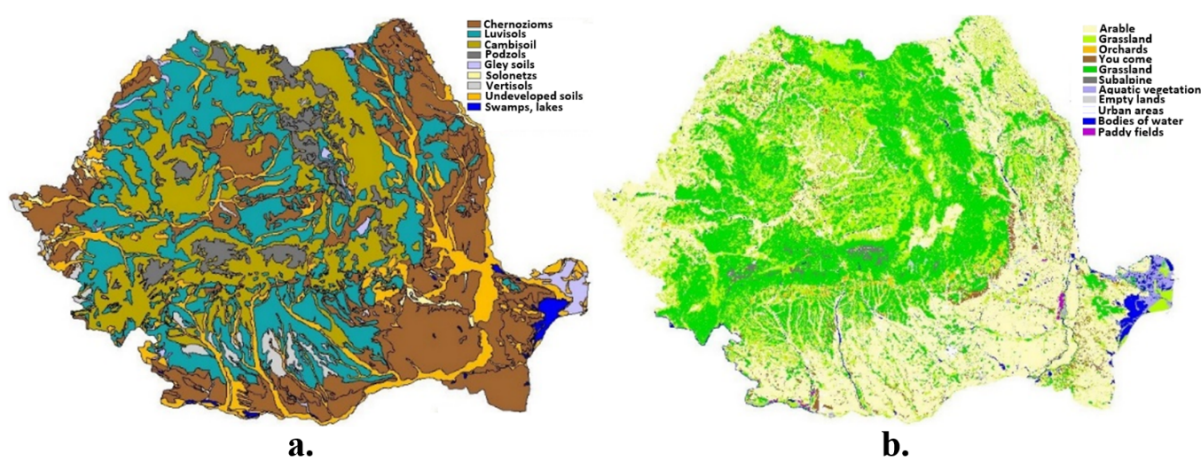
exacerbated by export policies and resource rationing, which generated a near-constant food shortage and long queues at grocery stores (Bejenaru, 2008; Tismăneanu, 2006).

Abundant natural resources and high productive potential vs. Deficient exploitation and utilisation. Food crises

Agriculture has historically been a fundamental sector of Romania's economy, contributing significantly to GDP and providing employment for a large share of the rural population (Muresan & Muresan, 1998). The sector's strengths lie in Romania's diverse natural resources, which offer high agricultural potential (Bran, 2014). In addition to having over 14 million hectares of arable land, placing it among the top countries in Europe for agricultural area, the soils—particularly the chernozems in the Romanian Plain and the hilly regions—are among the most fertile in Europe. Romania's soils, according to the FAO classification, are presented in Figure 4.

Figure 4

Soils of Romania according to FAO classification (a) and land cover map (b)



Source: (INCDPAPM-ICPA, 2023).

Of course, equally important is the favourable temperate climate, with moderate precipitation that allows for the diversification of crops. Although Romania has always benefited from fertile land and significant natural resources, at certain times, its agricultural potential has not been effectively exploited, either economically or socially. This is evident from the major food crises that have affected the country in recent decades. We will not detail the period of severe famine during and after World War II, when Romania, like many other Eastern European countries, suffered greatly. It is worth mentioning that after four years of war, Romania was in a state of total collapse, having to contribute \$7.4 billion to war expenses (Stănila, 2021). Although it ended the war alongside the Allies, at the 1946 Peace Conference, Romania was declared defeated and forced to pay enormous reparations, mainly to the USSR: thousands of wagons of meat, dairy products, cereals, etc. Additionally, the costs of maintaining the Soviet troops remaining in the country under the pretext of wintering in barracks exacerbated the situation.

The lack of food and water led to epidemics of typhus and other diseases. Subsequently, Romania, like other European countries, entered a new food crisis characterised by defective distribution and inefficient agricultural policies. The situation was worsened by the forced

industrialisation and collectivisation of the communist period, which we refer to as „the errors of the past”. These, combined with the regime's misguided objective of rapidly repaying external debt under Ceaușescu, intensified the imbalances in food production and distribution. For these reasons, we will refer more extensively to the food crisis in Romania during the communist regime, one of the most dramatic experiences in this country's recent history. This crisis was particularly pronounced in the 1980s and resulted from a combination of economic policies that were wholly inadequate to the realities of the time (Burakowski, 2011). In this context, ensuring the food supply for the population became a critical issue, while internal resources were largely directed towards exports. To better understand the situation, it is necessary to mention that in the 1960s and 1970s, a policy of forced industrialisation was adopted, aimed at transforming Romania into an industrial power. To this end, numerous external loans were contracted to finance large industrial projects, modernise agriculture, and develop infrastructure. Initially, these measures seemed effective; however, with the rise in external debt and the global economic instability caused by the 1970s oil crisis, Romania's economy began to face major difficulties.

Against this backdrop, the regime set an ambitious objective: the full repayment of external debt, and to achieve this, it resorted to massive exports of resources, including agricultural products, to obtain the necessary foreign currency. This policy was extremely costly for the domestic economy as it affected the supply of basic foodstuffs in the internal market (Anton, 2015). As part of its export policy, Romania focused on selling key agricultural products in high demand on international markets and capable of generating revenue quickly. Wheat and cereals were among the top priorities, as the country had significant agricultural potential to produce enough grain for both domestic use and export. However, the political regime at the time prioritised external markets, sending large quantities of wheat, corn, and barley primarily to countries in Europe and the Middle East. Similarly, meat exports, particularly pork and beef, were pushed to maximum levels, even though this created noticeable shortages within the domestic market. The Romanian government favoured external sales due to strong demand and attractive prices from Western European and Middle Eastern buyers. In the same vein, dairy products and eggs were exported in large quantities, leaving the local population with increasingly limited access to these basic food items. The lack of milk, cheese, and eggs became a deeply felt issue, adding to the growing discontent among Romanian citizens (Țimonea, 2019). Each citizen received rationing cards (Figure 5, regarding bread), and the quantities of food that could be purchased were cynically limited by the communist regime, which invoked the Scientific Nutrition Program for the Population (MAN, 1984).

Figure 5

Rationing card for bread in Romania (1980s)



Source: (Istorie-pe-scurt., 2015).

Published in 1984, this document provided a pseudo-scientific justification for the drastic measures of rationing food for the population (Măgrădea, 2020). Often, even under these conditions, food could not be obtained (grocery stores being empty; Figure 6), resulting in a devastating impact on the population's quality of life.

Figure 6

Empty grocery stores in Romania during the 1980s



Source: Author's processing based on photo materials sourced from open sources (Țimonea, 2019; Ungureanu, 2015; Comănescu, 2022; Pinterest, 2020).

It should be noted that the Romanian population had to develop a series of survival strategies. In addition to raising small animals and growing vegetables in their households, Romanians frequently relied on family and friendship ties in rural areas for their supply needs. Many people also used the natural resources near their homes to supplement their diets—picking mushrooms, hunting, and fishing were practices that helped the population cope with the crisis. Furthermore, the lack of basic food items in the official market led to the development of a black market, where the population turned to informal networks to obtain food unavailable in state stores, paying exorbitant prices (Anton, 2015). Evidently, a decree was immediately issued (October 1981) stating that those who engaged in speculation would face imprisonment.

This decree stipulated that individuals who obtained basic food products (such as flour, sugar, oil, cornmeal, and rice, with vegetables and fruits for winter being exempt) in quantities greater than what they deemed necessary for their family for a month would face imprisonment for a period ranging from six months to five years (CS, 1981). Contrary to expectations, all of this led to an increase in social inequalities and corruption, as well as negative effects on the health of the population (Tismăneanu, 2006; Burakowski, 2011; Banu, 2012). The Romanian diet significantly deteriorated, with malnutrition and limited access to food (the lines of people waiting to obtain food were interminable; Figure 7) severely affecting the development of children and the overall health of the adult population. Statistics indicated that nutritional deficiencies led to a higher rate of diseases and a decrease in life expectancy.

Figure 7

Long queues of people waiting to purchase food in Romania (1980s)



Source: Author's processing based on photo materials sourced from open sources: (Țimonea, 2019; Ungureanu, 2015; Comănescu, 2022; Pinterest, 2020).

We aim to highlight the extreme cynicism of the state policy at the time, which responded to the food crisis with arguments grounded in the Program for the Scientific Nutrition of the Population. Among other things (Georgescu, 1992), the Program aimed „to combat obesity and ensure a rational and scientific diet by reducing the average food intake among the population from 3,300 to 3,000-2,800 calories/day” (Stanciu, 2012). At the same time, it sought to „contribute to maintaining optimal health conditions, eliminate degenerative diseases, and (...) substantially extend the average lifespan” (Constantin, 2020). Certainly, asking a starving population to adopt a diet based on „scientific” studies was an act of contempt toward them.

On the other hand, in the long run, the policy of prioritising agricultural export over Romanian agriculture. The depletion of internal resources, intensive use of agricultural land without adequate investment in modern technologies and infrastructure, and the lack of an efficient irrigation system led to a decline in agricultural productivity. We must note that in 1988-1989, the 4,200 agricultural cooperatives had accumulated debts and arrears to the state totalling 117 billion lei (Giurescu, 2010). The lack of vision, the adoption of annual plans that predicted unrealistic production, false reports on the quantities of harvested crops, and the coercive measures taken against agricultural producers ensured the collapse of agriculture, which, as previously mentioned, explains the food shortages of the 1980s. After the fall of the communist regime in 1989, Romanian agriculture faced major challenges in transitioning to a market economy, and the legacy of the communist period remained problematic for years.

Romania today ranks 6th in Europe in terms of agricultural area, and agriculture plays an important role in the national economy, having a significant impact on rural areas, which account for

44% of the country's total population (RG, 2022a). Romania's primary economy includes agriculture, forestry, and fishing. Given the increasing competition for water, energy, and land resources needed for these activities, the transition from a linear to a circular economy is becoming important. In the context of this transition, we emphasise the need to capitalise on agricultural waste from crops, livestock, forestry, and fishing, motivated by the goal of protecting the environment, maintaining soil and groundwater quality, and increasing the efficiency of agricultural activities.

The current agri-food system and the need to increase its sustainability

The concept, importance, and key components of a sustainable agri-food system

Given its importance (INCE&CIDE, 2002; MADR, 2024), the agri-food system urgently requires a continuous increase in sustainability. In fact, a sustainable agri-food system represents a holistic approach to food production and distribution that aims to minimise environmental impact, efficiently utilise resources, and promote social equity. Sustainability principles are applied at every stage of the agri-food chain, from raw material production, processing, and distribution, to final consumption and waste management.

An agri-food system can be considered sustainable when it uses natural resources rationally and sustainably (promoting responsible consumption and reducing food waste), reduces greenhouse gas emissions and its impact on biodiversity, and ensures fair incomes for farmers and decent working conditions (MADR, 2024; Stoleru, 2013). Regarding the importance of a sustainable agri-food system from an EU perspective (Robu et al., 2009), it plays a key role in several areas. First, it contributes significantly to ensuring long-term food security, as the system must be able to produce sufficient food to meet the needs of a growing population without jeopardising the ability of future generations to do the same. At the same time, it is very important for environmental protection. Intensive agricultural practices have caused serious environmental damage, including deforestation, biodiversity loss, soil erosion, and water pollution. A sustainable agri-food system seeks to mitigate these effects by encouraging environmentally friendly farming methods, such as crop rotation, the use of organic fertilisers, and agroforestry techniques. Moreover, it supports economic and social development, particularly in rural areas. Creating jobs, sustaining local communities, and promoting fair trade practices help ensure that farmers are fairly compensated for their work and products.

Regarding the key components of a sustainable agri-food system (INCE&CIDE, 2002; MADR, 2024), several interconnected elements must be considered. Sustainable agricultural production is the foundation of this system, as farming practices must be adapted to local conditions and focused on the efficient use of resources. Both innovative technologies, such as precision agriculture, and traditional methods, like polyculture and composting, play a very important role in minimising environmental impact. Another important component is the efficient processing and distribution of food products. Reducing losses and waste throughout the entire supply chain is fundamental to achieving sustainability. Encouraging local markets and limiting the distance food travels also helps lower transport-related carbon emissions. At the same time, responsible consumption becomes a core aspect of a sustainable system. This involves a shift in consumer behaviour towards a more balanced, diverse diet that prioritises seasonal, local, and organic products. Educating the population about food waste and the importance of thoughtful consumption supports more

sustainable patterns of demand. Finally, efficient waste management is indispensable across all stages of the agri-food chain. Using food scraps for compost, recycling packaging materials, and converting organic waste into renewable energy are all practices that reduce the system’s environmental footprint.

From the points above, it is clear that a sustainable agri-food system is essential to ensuring a healthy and balanced future for both people and the planet. Implementing such systems requires collaboration between farmers, consumers, governments, and the private sector to develop policies and practices that reduce environmental impact, support rural development, and promote social equity (Zahiu & Dachin, 2001). By transforming how food is produced, distributed, and consumed, a sustainable agri-food system can be built that is long-term viable, providing food security and other economic, social, and environmental benefits for all stakeholders (Istudor et al., 2014). In Romania, such a system should balance agricultural traditions that have supported the rural economy for centuries with the need to implement modern practices that minimise environmental impact and contribute to long-term economic development.

A critical approach to the Romanian agri-food system from a sustainability perspective

Sustainability in agriculture and the food industry entails achieving efficient production that minimises negative environmental impacts, ensures social equity, and is economically viable (Rădulescu & Ioan, 2015). In Romania, the agri-food system is far from achieving this balance, facing pressures on natural resources, inefficient land use, and growing disparities between rural and urban areas (Table 1).

Table 1

The levels at which the weaknesses of the Romanian agri-food system are manifested

Ecological	Economic	Social
• Soil degradation, water pollution, and biodiversity loss are among the main issues affecting the agri-food system. • Intensive use of pesticides and chemical fertilizers has led to groundwater pollution and a decline in soil quality, compromising long-term productivity. • Climate change has begun to impact crops, making Romanian agriculture more vulnerable to extreme events such as droughts and floods.	• The agricultural economy is polarized between large modern farms and small subsistence farms. • This disparity affects the competitiveness of the agri-food sector in the European market, where large producers optimize efficiency, while small farmers are left to cope with limited resources. • The lack of access to markets, capital, and modern technologies limits their ability to invest in sustainable practices.	• Social equity issues, such as the migration of young people from rural areas to cities and the decreasing access to resources for small farmers, contribute to the decline of rural communities. • The lack of infrastructure and access to modern services makes these regions more vulnerable to poverty and economic inequalities, exacerbating the challenges within the agri-food system.

Source: Author's elaboration.

Improving the sustainability of Romania's agri-food system poses a considerable challenge (Ionescu et al., 2019). Among the major issues in this area are soil and water pollution, caused by the excessive use of chemical inputs such as fertilisers and pesticides, which have degraded soil quality

and contaminated groundwater. Additionally, agricultural practices such as extensive monocultures, particularly of corn and wheat, have negatively impacted biodiversity and the soil’s regenerative capacity (Danci, 2015; INCDS, 2020). Romania also faces one of the most fragmented agricultural structures in Europe, which affects the efficiency and productivity of small farms (PWC, 2017). Currently, the country has a large number of small farms, with approximately 2,480,770 holdings covering up to 2 hectares and 660,000 farms with areas between 2 and 5 hectares (RG, 2023).

This land fragmentation hinders the adoption of modern technologies and sustainable agricultural practices, which contributes to the declining international competitiveness of Romanian agriculture. The lack of investment in sustainable technologies, such as precision farming, efficient irrigation, and biofertilizers, further exacerbates the situation. This deficiency in innovation limits farmers' ability to implement methods that reduce water consumption, improve soil health, and increase long-term productivity. Furthermore, despite Romania's abundant natural resources, the agri-food system faces difficulties in ensuring long-term food security. It is essential to highlight that there is a significant reliance on imports (Table 2).

Table 2

The reliance on agri-food imports in Romania (%)

Product groups	2015-2017	2018-2020
Cereals and cereal products, including:	22,7	16,5
• <i>Wheat and rye</i>	33,6	26,0
• <i>Corn</i>	11,6	8,4
Potatoes	10,6	15,0
Vegetables and vegetable products	17,7	20,9
Fruits and fruit products	37,9	33,9
Sugar and sugar products	40,9	85,0
Milk and dairy products	13,0	17,6
Eggs	69,8	7,4
Meat and meat products, including:	35,1	39,2
• <i>Pork</i>	38,9	48,2
• <i>Poultry</i>	31,6	29,1
Vegetable and animal fats	29,5	31,2
Fish and fish products	83,9	87,9

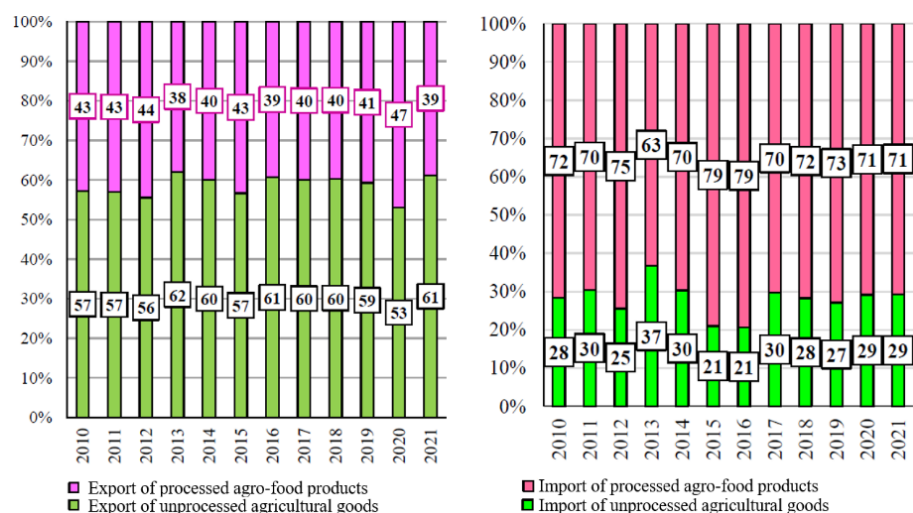
Source: Luca (2022).

The high dependence on wheat imports in Romania, a country with a predominantly cereal-based agriculture, is partly due to large farmers’ strategy of selling their wheat on external markets at harvest time. This represents a vulnerability for food security due to fluctuations in international prices, which can be influenced by severe events such as armed conflicts or pandemics (Luca, 2022). It is important to note that this significant reliance on imports stems from Romania exporting unprocessed wheat while importing processed cereal products, such as bakery goods, pastries, and

pasta. Between 2010 and 2021, the value of processed product exports increased 2.8 times, from 1.3 billion euros to 3.7 billion euros; however, their share in total exports remains relatively low, averaging 41%. In contrast, processed products account for the largest portion of Romania's agri-food imports (Gavrilescu, 2014). During the same period, the value of these imports rose 4.3 times, from 0.7 billion euros to 3.1 billion euros, with their share in total agri-food imports averaging 73% (Figure 8).

Figure 8

The ratio of unprocessed agricultural goods to processed agri-food products in Romania's trade exchanges



Source: Luca (2022).

In addition to exporting agricultural raw materials (unprocessed goods) and importing processed agri-food products, it is essential to note that logistical and infrastructure issues affect the efficient distribution of agricultural products, and small farmers often face difficulties accessing both domestic and foreign markets. This leads to significant economic losses and an increasing dependence on food imports.

The impact of food waste on the Romanian agri-food system

The Food and Agriculture Organisation of the United Nations (FAO) defines food waste as „food and inedible parts associated with it that are discarded from the supply chain intended for human consumption in the following sectors: food production (under certain conditions); retail trade of food products; food service sector; and households.” (UNEP, 2021). This means that food waste includes food and associated waste that do not reach human consumers in these areas.

Food waste represents a major global challenge in the agri-food system, with significant economic, social, and environmental impacts (Stanciu et al., 2022). The issue of food insecurity persists even in EU member states, where 33 million people cannot afford a quality meal every other day, according to 2018 Eurostat data. This situation necessitates a change in food consumption behaviour, including reducing food waste (Luca, 2022). In Romania, food waste, which occurs throughout the agri-food chain—from production and processing to distribution and consumption—

is a pressing issue, with negative effects on the national economy and the surrounding environment (Nijloveanu et al., 2023; Dumitru et al., 2021, 2012), driven by several factors (Table 3).

Table 3

The main factors contributing to food waste

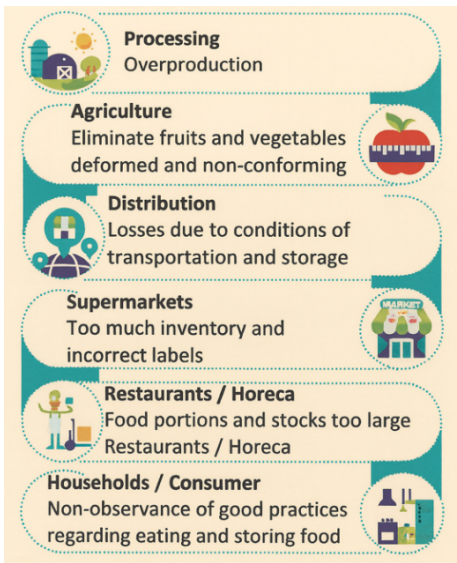
Inefficiencies in agricultural production	Inadequate food processing	Distribution issues	Consumer behavior
Significant losses occur in the production stage due to: - Traditional methods - Lack of infrastructure - Limited access to modern preservation technologies.	The lack of modern processing and food preservation equipment contributes to their premature deterioration.	Inefficiencies in transportation and storage: The lack of adequate refrigeration systems leads to massive food losses, especially in the case of perishable products.	Overestimating food requirements: - Inadequate management of food products - Lack of education regarding food waste among consumers, all contribute to increased quantities being discarded.

Source: (Author's elaboration).

Food waste refers to all food products that are not consumed and ultimately end up in the trash. The term encompasses food and beverages that are produced but lost or discarded—either during production, in stores, or in households (Neamțu, 2022). According to recent estimates, approximately 6,000 tons of food are wasted daily in Romania (INSP, 2019), indicating that significant amounts of natural and financial resources are squandered. The leading causes of food waste are illustrated in Figure 9.

Figure 9

Causes of food waste



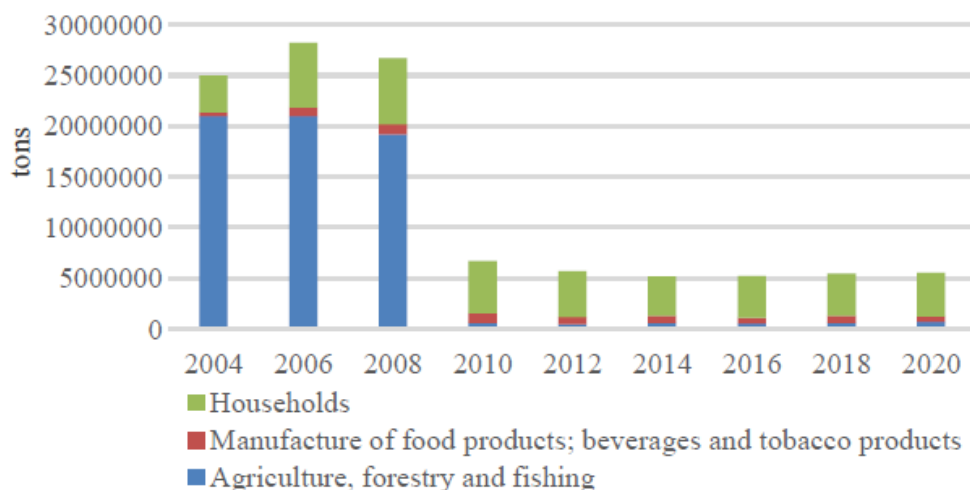
Source: FWC (2021).

The National Strategy for the Circular Economy (RG, 2022b) addresses various issues related to food waste, highlighting in the section „Problems and Challenges” that food waste is significant, averaging 129 kg per inhabitant, which is over four times higher than the level in France. Additionally, the collection and recycling of biodegradable waste is very low, estimated at around 15% (BIOREGIO, 2019). Of the total 129 kg of food wasted annually, 24% is cooked food, 22% is fruits, 21% is vegetables, and 1% is meat (INSP, 2019). The majority of food waste occurs in urban areas, while rural communities use traditional methods to utilise food scraps. In cities, over 95% of household waste ends up in landfills. The costs associated with food waste encompass both economic and environmental aspects. According to a study (EEA, 2020), biodegradable waste accounts for the largest share of municipal waste in Europe, reaching up to 34%, but in Romania this proportion exceeds 50%, amounting to approximately 150 kg per inhabitant. Food waste accounts for about 67% of total municipal biodegradable waste, with the remainder being garden waste (RG, 2022b).

Thus, in Romania, only 18 kg of biodegradable waste is recycled per inhabitant, representing just 6% of municipal waste, compared to the European Union average of 90 kg per inhabitant. This suggests that most biodegradable waste is disposed of in landfills without being recovered as secondary materials, thereby contributing to high greenhouse gas emissions. The evolution of the total food waste quantity in three main areas (households, food production, and agriculture) in Romania from 2004 to 2020 is illustrated in Figure 10.

Figure 10

Total food waste between 2004-2020 in Romania



Source: (Eurostat, 2023).

Food waste has serious and wide-ranging consequences for the economy, the environment, and society. From an economic standpoint, it causes losses throughout the agri-food value chain. Farmers lose income when products remain unsold or spoil during transport, while processors waste resources like raw materials, energy, and labour on food that never reaches consumers. For households, throwing away food also means wasting money. Environmentally, food waste implies the unnecessary use of vital natural resources such as water, energy, and fertile soil. In Romania, this contributes to soil degradation and the exhaustion of water reserves, while the discarded food

further emits methane in landfills, a greenhouse gas significantly more harmful than CO₂. Additionally, the energy consumed in producing, transporting, and processing wasted food intensifies the carbon footprint of the agri-food sector.

Biodiversity is also under pressure, as land expansion to produce surplus food disrupts ecosystems, leads to deforestation, reduces forested areas, and damages aquatic habitats. On the social side, food waste exacerbates food insecurity, as large quantities of edible food are lost. At the same time, parts of the population continue to face shortages, deepening inequality and depriving vulnerable groups of essential resources.

Consolidating the sustainability of the Romanian agri-food system through bioeconomic measures. Combating food waste

Bioeconomic measures represent key solutions for reducing ecological impact, optimising resource use, and stimulating sustainable economic development. To understand how these measures can enhance the sustainability of the agri-food sector in Romania, it is essential to note that the bioeconomy is based on the use of renewable biological resources, including agricultural and food waste, to produce sustainable products, energy, and materials (Mihai, 2008). In agriculture and food, the bioeconomy encourages the development of technologies and practices that effectively and ecologically harness renewable resources, reducing dependence on fossil fuels and promoting a circular economy (Tamasiga, 2022). Applying bioeconomic principles allows farmers to turn agricultural waste into valuable resources, such as using plant residues for compost or biogas and treating wastewater for reuse in irrigation. These approaches help lower carbon emissions, preserve natural resources, support biodiversity, and improve soil quality. At the same time, technologies such as precision agriculture boost sustainability by enabling better monitoring and management of inputs such as water, fertilisers, and pesticides. Through tools such as sensors, drones, and GPS, farmers can reduce chemical and water use, limiting environmental damage while maintaining productivity. Another key aspect of the bioeconomy is converting agri-food waste into bioenergy. Producing biogas from organic waste cuts greenhouse gas emissions and creates alternative energy sources, gradually reducing reliance on fossil fuels and contributing to a more sustainable agri-food system.

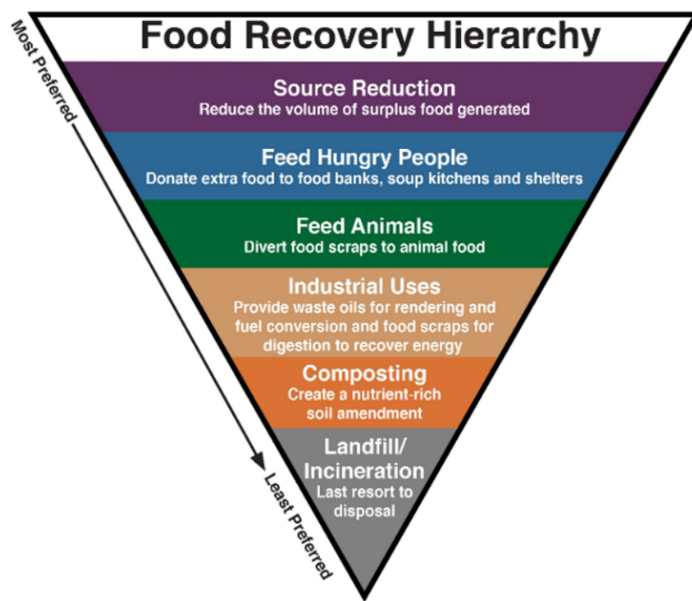
Advantages of implementing bioeconomic measures

The importance of preventing/combating food waste and applicable public policies

Reducing food waste is one of the most effective measures to increase the sustainability of the agri-food system, as combating this phenomenon has direct implications for the efficient use of resources, the reduction of ecological impact, and improved food security (Pocol et al., 2023). The United States Environmental Protection Agency, through the graph below, explains ways to manage excess food, including food waste (Figure 11).

Figure 11

Ways to manage excess food, including food waste (Food recovery hierarchy)

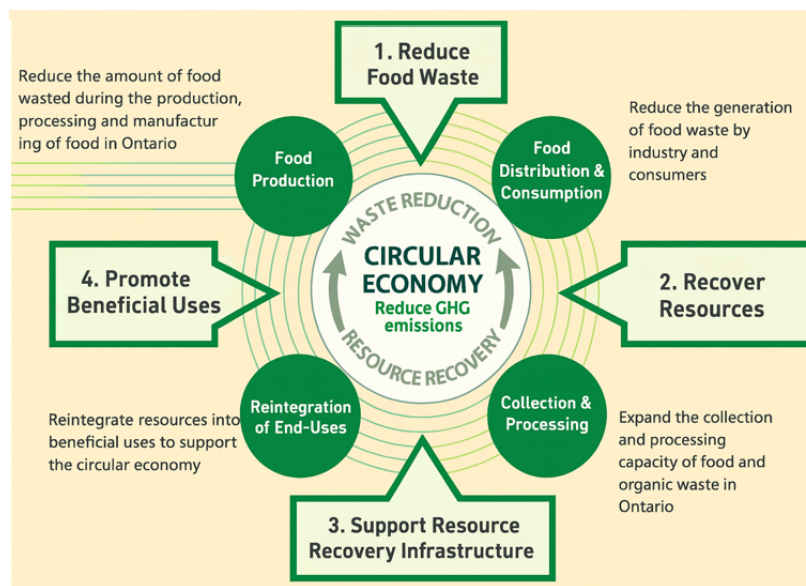


Source: EPA (2021).

Improving the efficiency of the production and distribution chain is particularly important in the context we have analysed, as it requires significant investments in modern infrastructure—such as cold storage facilities and efficient transportation systems—ultimately preventing massive losses of perishable food. Additionally, precision agriculture can help optimise production to generate optimal quantities of food, thereby reducing surplus. In the same vein, consumer education plays a central role in combating food waste. Awareness campaigns on the importance of reducing waste, proper food management, and shopping planning can lead to a decrease in food waste. Furthermore, promoting food donation and responsible consumption can help reduce food waste in restaurants, retail, and households. Regarding the circular economy and the reuse of food waste, we note that the bioeconomy offers innovative solutions for managing food waste by integrating it into the circular economy. Figure 12 is illustrative in this regard.

Figure 12

The role of the circular economy in minimising food waste

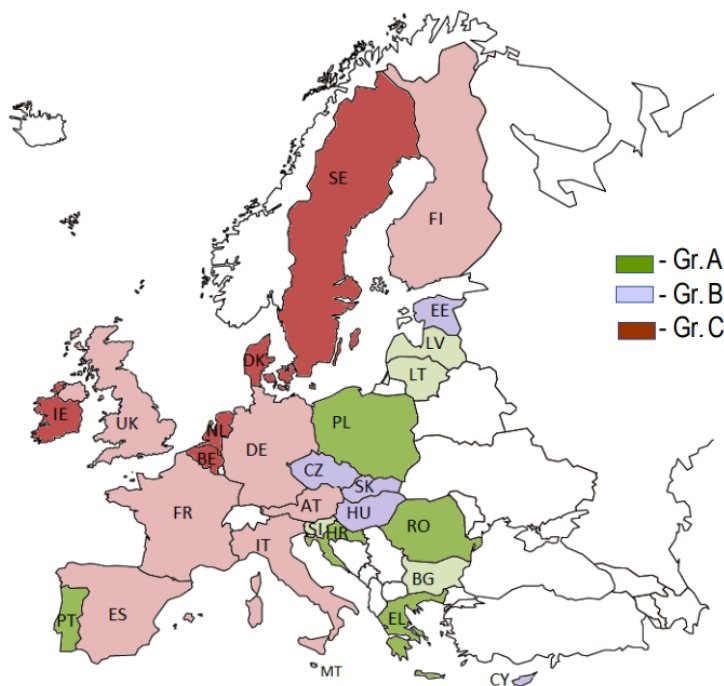


Source: Smart.md (2022).

Food waste can be utilised to produce energy (biogas), compost, or other biological materials, thereby reducing environmental impact and transforming waste into a valuable resource (Pocol et al., 2023). By harnessing these wastes, the pressure on natural resources is alleviated, supporting the sustainability of the agri-food sector. The design of public policies and integrated solutions for enhancing sustainability is also of great importance, with governmental authorities and European institutions playing a significant role in promoting bioeconomic measures and combating food waste. Reforming agricultural policies to support the adoption of bioeconomic technologies, subsidising organic farming, and stimulating bioenergy research are essential measures to increase sustainability, as are environmental policies that encourage the use of renewable resources and reduce greenhouse gas emissions. Although these approaches are well-known and have been implemented for several years, the results have not been encouraging. The bioeconomy in most Eastern European countries is predominantly concentrated in the primary sectors of bioresource production. An analysis comparing the concentration of labour in bioresource production versus its processing, along with the average turnover generated by employees in the bioeconomy, allows for the classification of countries in the European Union into three distinct categories (Figure 13).

Figure 13

EU countries in terms of labour productivity and the share of high-profitability bioeconomic sectors



Source: INCDSB (2018).

The significance of the groups is as follows: Group A includes countries with labor productivity in the bioeconomy below the European average, but with a share of bioresource production sectors above this average; Group B encompasses countries that have labor productivity in the bioeconomy below the European average, but a share of bioresource processing sectors greater than the average; Group C includes countries that exceed the European average in both labor productivity in the bioeconomy and the share of bioresource processing sectors. Equally important is the creation of markets for bioeconomic products; promoting products and materials derived from bioresources can stimulate demand and increase investments in the bioeconomy.

Establishing strategic objectives

Developing strategies to reduce food waste requires an integrated approach to the food supply chain. These strategies must involve collaboration among all relevant stakeholders, promote community participation, support the circular economy, and integrate technological innovations, along with necessary adjustments in regulations. A multidisciplinary approach to food waste, coupled with prompt and intersectoral interventions, is important for reducing it and developing sustainable food systems (Stanciu et al., 2022; Moldovan et al., 2024). Recognising the imperative to ensure food safety and security for the population, and considering the ecological potential of Romania's agricultural resources to provide high-quality agri-food products for both domestic and international markets, the Romanian Academy formulated a strategy for the period 2016-2035, starting in 2014 (RG, 2018).

The strategy addressed the key roles of the rural economy, rural space, and the agri-food sector, aiming to ensure food security by meeting domestic demand for quality food and creating

export surpluses. It emphasised the protection and sustainable use of natural resources, especially soil, while supporting climate change mitigation policies. A priority was maintaining ecological balance in rural areas through investments in protective and land-planning infrastructure. The plan also sought to strengthen farms, modernise agricultural technologies, and improve farming activities. Another objective was to encourage the transition from subsistence farming to private family farms. At the same time, it aimed to develop the rural economy by supporting agri-food and non-agricultural SMEs, thus generating jobs and stabilising rural populations. Finally, the strategy is intended to improve access to European funds, enhance Romania's agri-food trade balance, and increase exports. The main goal of Romania's agri-food strategy was to establish a framework for the sustainable development of the agri-food system and rural environment as a fundamental element for resuming economic growth and achieving the well-being of the population (Oțiman, 2014).

Highlighting the ecological advantages of Romanian agricultural resources in producing quality food, it is important to refer to two key strategies:

A. The National Strategy for Sustainable Development of Romania 2030 (RG, 2018) aims to transition towards a true circular economy, in line with Sustainable Development Goal 12: Responsible Consumption and Production (UN, 2015). It envisions a gradual shift towards a development model based on the rational use of resources, the integration of circular economy principles, and raising public awareness about sustainable lifestyles. Through an important document for the implementation of this strategy (RG, 2022ab), the following objectives have been established for the year 2030: (i) Reducing per capita food waste in retail and consumption, as well as minimizing food losses throughout the production and supply chain, including post-harvest losses; (ii) Recycling 55% of municipal waste by 2025 and 60% by 2030; (iii) Recycling 65% of packaging waste by 2025 (plastic 50%; wood 25%; ferrous metals 70%; aluminum 50%; glass 70%; paper and cardboard 75%) and 70% by 2030 (plastic 55%; wood 30%; ferrous metals 80%; aluminum 60%; glass 75%; paper and cardboard 85%); (iv) Separate collection of hazardous household waste by 2022, bio-waste by 2023, and textile waste by 2025.

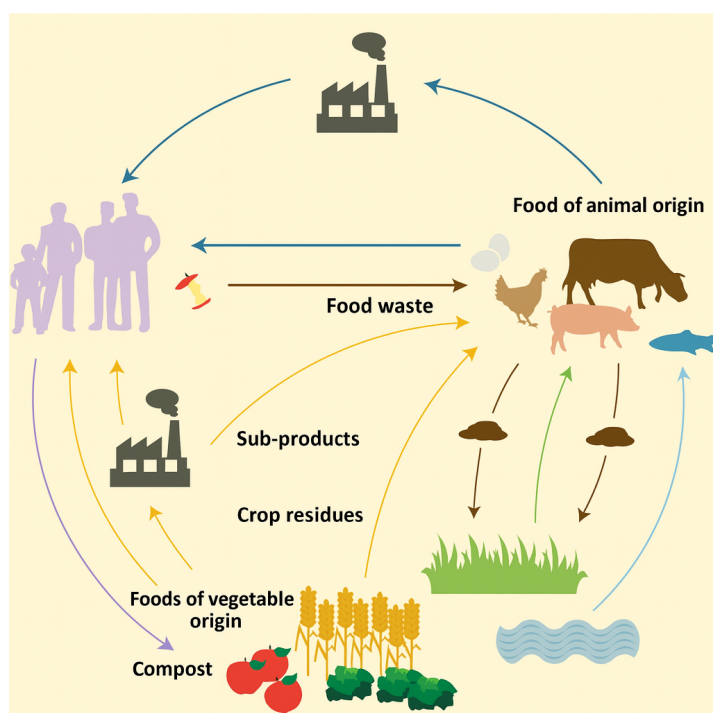
B. The National Strategy for the Circular Economy (RG, 2022ab) addresses various aspects related to food waste, highlighting that the greatest circularity in this sector can be achieved through reducing food waste, using eco-labelling, implementing sustainable packaging, and Extended Producer Responsibility systems for packaging, as well as composting waste. During the production and distribution process, it is important to minimise packaging use while promoting the use of secondary materials. This can be facilitated by establishing mandatory eco-design requirements for industrial packaging, alongside eco-labelling of products containing recycled materials. During consumption, there is a need for improved food-waste prevention measures, encouraging food donations through economic instruments. Such a strategy must adapt production models based on available resources. This involves feeding animals with by-products or waste to reduce the „competition“ between humans and animals for food and feed production, thus contributing to resource savings (FiBL, 2021).

Examples of by-products include whey generated from cheese production and spent grains from beer manufacturing. Permanent pastures represent a natural source of fodder for herbivorous animals, and their use, tailored to local conditions, helps maintain biodiversity and optimise marginal

land for food production. If animals are fed not only with byproducts and waste but also with grass, a significant reduction in the livestock population (cattle, pigs, poultry, etc.) will be necessary. Modifying animal diets would lead to a considerable reduction in the consumption of animal-based foods (Van Zanten, 2019). A circular strategy, when implemented correctly in the field of nutrition, can bring numerous environmental benefits, including reducing greenhouse gas emissions, diminishing soil exploitation, and lowering the risk of biodiversity loss, as well as preventing water eutrophication. Figure 14 illustrates the configuration of a food system that embodies circularity principles.

Figure 14

Circular food system



Source: FiBL (2021).

This simplified presentation illustrates how by-products and waste from the food industry can be utilised to close the biomass and nutrient cycles. On the other hand, policies that encourage the reuse of food surpluses aim either to create economic benefits or to eliminate barriers that hinder donations. Common benefits include VAT exemptions for donated food, tax credits and deductions, and adjustments to waste fees so that donating becomes more cost-effective than disposal. Additionally, green public procurement criteria can support the transition to more sustainable food consumption in the public sector.

Regulatory framework for reducing food waste. Progress made

Romania, as a signatory of the Paris Agreement on December 12, 2015 (UN, 2015), has committed, alongside other EU member states, to reduce food waste by 50% by 2030, in accordance with the objectives set out in the 2030 Agenda for Sustainable Development. In this context, in 2016, Romania adopted a voluntary legal framework to prevent and reduce food waste throughout the supply chain, regulated by a law of that year (RP, 2016). Subsequently, in 2019, a government

regulation (RG, 2019) established details regarding the food donation mechanism and other measures that economic operators could adopt to reduce waste. However, the lack of clear European-level regulation, combined with the voluntary nature of national law and the limited interest among economic operators in engaging in food donations, has led to modest results. This context prompted changes to the legal framework in 2024. Under a new law (RP, 2024ab), all operators in the agri-food sector are required to implement at least two measures to prevent food waste, helping Romania meet the sustainable development goals set at the European and international levels (RP, 2024ab). Regarding the Romanian legislator's rationale for updating the legislation, in addition to the urgent need to align with European Union directives, it was based on the United Nations' estimate that approximately 17% of the food produced annually worldwide is wasted (UNEP, 2021). In Europe, annual food waste reaches approximately 89 million tons, equivalent to 178 kilograms of wasted food per capita (Gustavsson, 2011), while in Romania, 70 kg of food per capita is thrown away annually (UNEP, 2021), placing the country among those with the highest levels of waste in Eastern Europe (Table 4).

Table 4

Household food waste estimates (from measured data points or extrapolation) for each country - Region Eastern Europe

M49 code	Country	Household food waste estimate (kg/capita/year)	Household food waste estimate (tonnes/year)
112	Belarus	68	646 356
100	Bulgaria	68	478 667
203	Czech	70	746 894
348	Hungary	94	908 669
616	Poland	56	2 119 455
498	Republic of Moldova	76	307 419
642	Romania	70	1 353 077
643	Russian Federation	33	4 868 564
703	Slovakia	70	381 301
804	Ukraine	76	3 344 904

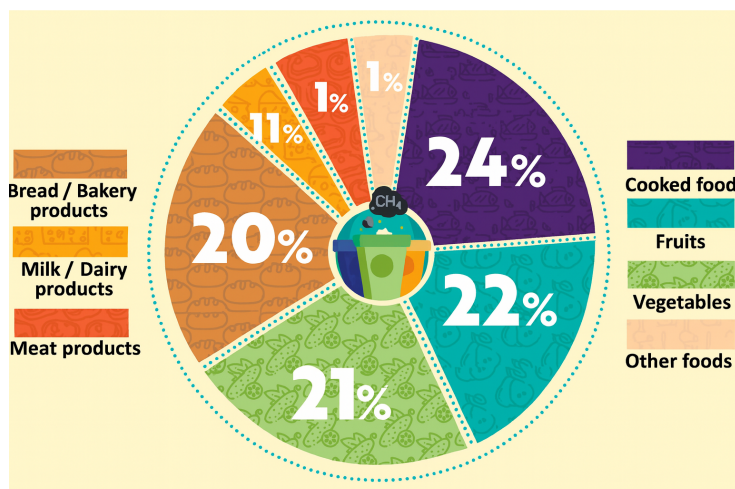
Source: (Forbes et al., 2021).

On the other hand, in 2023, the number of Romanians affected by poverty reached 3.97 million people, with the most severe form of poverty being the lack of material resources, which is reflected in the high percentage of individuals who cannot afford to consume meat, fish, or protein once every two days (INS, 2023). According to recent statistics, Romanians waste approximately 6,000 tons of food daily, equivalent to one meal per inhabitant. Over 2.2 billion kilograms of food end up in landfills in Romania each year, contributing to increasing environmental pressure (EEA, 2023). The largest quantities of food waste are recorded at the household level (49%), followed by industrial processes (37%), while the retail (7%) and agricultural (5%) sectors contribute less. An alarming aspect is that Romanians spend, on average, over 40% of their household income on food,

compared with the EU average of around 10% (Cantaragiu, 2019). The main categories of food waste at the consumer level in Romania are illustrated in Figure 15.

Figure 15

Structure of foods intended for waste/garbage (Categories of waste at the consumer Level)



Source: FWC (2021).

From an ecological perspective and in the context of combating climate change, the Romanian legislator has recognised that once food is discarded, all resources used in its production, processing, transportation, preparation, and storage are also wasted (RP, 2024ab). Food loss exacerbates the climate crisis by generating greenhouse gas emissions from food waste. The production, transportation, and management of food significantly contribute to carbon dioxide emissions, and when food ends up in landfills, it releases methane, an extremely potent greenhouse gas (EP, 2011).

The European Parliament warns that the effects of climate change will become increasingly frequent and severe in the coming decades. These changes can transform the planet, severely affecting health and food and water supplies, with the poorest and most vulnerable being the most affected (EU, 2023). Additionally, Romania is facing an infringement procedure initiated by the European Commission in the field of environmental protection. In a warning letter from June 2021, the Commission emphasised that Romania has not fulfilled its obligations regarding waste management in a manner that protects public health and the environment (EC, 2021). Through this procedure, the Commission is requesting that Romania align its legislation and practices to ensure that resources are properly reused or recycled. Furthermore, these norms contribute to reducing the number of people without access to sufficient, regular, and healthy food, thereby diminishing the social risks associated with material shortages and having a positive impact on the health of vulnerable populations.

Very important, the amending law (RP, 2024b) aims to improve the efficiency of measures to reduce food waste by introducing obligations for both operators in the agri-food sector and competent authorities. Operators in the agri-food sector will be required to adopt measures to prevent and reduce food waste, while public authorities will assume new responsibilities to support

this effort. These include raising awareness and ensuring that economic operators are held accountable for their role in combating food waste, increasing the volume of food redistributed free of charge, and developing a National Strategy dedicated to this issue. In addition, the authorities will need to manage and monitor these efforts efficiently by establishing the National Platform for Preventing and Reducing Food Waste, which must be operational by June 30, 2025. Clear regulations will also be put in place to govern the free transfer of food to beneficiaries and final consumers.

Starting in 2026, economic operators in this sector will be required to report their activities related to food waste as follows: (i) By March 31, they will upload their annual plans for reducing food waste for the previous year to the NPPRFW; (ii) Within the same timeframe, recognized economic agents acting as recipient operators will report the amount of food transferred for free; (iii) Those recognized as donors will upload to the NPPRFW reports detailing the quantity and value of food transferred for free (also by March 31). It is worth mentioning that, to better implement the recently amended law on reducing food waste, specific methodological norms have also been updated (RG, 2024), thereby improving efficiency.

Institutional efforts regarding organic agriculture and a sustainable agri-food system aimed at ensuring healthy and sufficient food

Since organic agriculture has been defined (as a production system that avoids or largely excludes the use of synthetic fertilisers, pesticides, growth regulators, and animal feed additives), we must demonstrate that specific systems rely on crop rotation, the use of crop residues, animal waste, manure, and organic waste from outside the farm (Samuil, 2007). It is important to note that „organic agriculture” is a protected term assigned by the EU to Romania to define this agricultural system and is similar to the terms „ecological agriculture” or „biological agriculture” used in other member states. An essential requirement in this context is that during the production period on the farm, the use of genetically modified organisms, synthetic fertilisers and pesticides, growth stimulators and regulators, hormones, antibiotics, etc., is prohibited (Stoica, 2023). The model of ecological (or sustainable) agriculture has several important objectives: (i) maintaining soil fertility in the long term; (ii) avoiding any form of pollution caused by agricultural techniques; (iii) producing sufficient food with high nutritional value; (iv) minimizing fossil energy consumption in agricultural practices; and (v) raising animals in conditions that respect their physiological needs.

Today, the principles of organic agriculture are gaining ground in the global food market and are becoming an integral part of agricultural policy in developed countries. These states regulate organic agriculture through clear laws, ordinances, and regulations. Organic agriculture promotes land cultivation through methods that maintain the balance between agricultural ecosystems and the environment, generating so-called „specific agroclimaxes” (Puia & Soran, 1981). This form of agriculture relies on the use of available resources and scientific and technological methods, allowing for high, consistent, and high-quality production while also protecting the surrounding environment. In this context, organic agriculture becomes equivalent to the agriculture of the future, ensuring the integrity of the biosphere, maximising the production potential of agricultural ecosystems, and producing high-quality products (Ionescu, 1988). This approach will require more

careful and creative work while ensuring abundant food production, reducing fossil energy consumption, maintaining or improving soil fertility, and protecting the overall environment.

Considering the question of how Romania can contribute to achieving the target set by the European Green Deal's Farm to Fork, which stipulates that by 2030, European agriculture should be 25% organic, we highlight the key clarifying aspects. First, we observe that the area cultivated under organic conditions in Romania has increased over the past decade, from 182,706 ha (2010) to 578,718.45 ha (2021)(MADR, 2023). This trend is also evident overall in EU states, with the European Court of Auditors noting that „EU policy, as well as national policies for the organic sector, have certain gaps. CAP funds have been used to increase the area dedicated to organic farming, without sufficiently considering the environmental and market objectives set out in the EU policy on organic agriculture.” (ECA, 2024). Between 2010 and 2022, the number of registered processors in organic agriculture nearly doubled, reaching 205. In the same period, the number of distributors registered in organic agriculture grew from 112 to 403 (RRN, 2024). Regarding the structure of organic production and its share in Romania's total agricultural production, we note that cereals, oilseeds, fodder, and wine hold the most critical positions. Referring specifically to organic vegetable production, which is in high demand, we note that it increased between 2015 and 2020, as shown in Figure 16.

Figure 16

Organic vegetables production (Romania 2015-2020)



Source: (Eurostat, 2022).

It is important to note a particularity: the majority of production consists of raw materials, and the only processed product with a significant share is wine–17% of production is certified organic. Honey also plays a vital role in organic production, accounting for 18% of total certified production (MADR, 2023, 2024). Referring to achievements in the commercial sphere, we note that the organic market in Romania exceeded 250 million euros in 2022, with organic products accounting for nearly 2% of food sales in supermarkets (which constitutes over two-thirds of this market in the country). It is worth noting that in 2022, organic products accounted for approximately 4% of the EU food market, generating sales of 45 billion euros (ECA, 2024). Romania imports between 80% and 90% of the organic products it consumes, mainly from Western Europe, with families with children being the main purchasers of organic products such as dairy, eggs, or other foods for children (AGENCEBIO, 2024). Factors affecting the development of organic consumption include prices, limited consumer awareness of the benefits of organic products, and the fact that many organic

products are imported. Romania exports a large portion of its organic production, with the main markets being Austria, the USA, Japan, Germany, France, Italy, and Denmark. In 2022, Romania exported organic products estimated at 200 million euros (with the USA purchasing about 36 thousand tons of organic products) (AGENCEBIO, 2024).

Given the modest figures presented, specific tools from the European Commission play an important role in improving the situation, including the European Action Plan for the Development of Organic Production (EC, 2021), which is based on the axes of consumption, production, and sustainability. This plan includes actions to stimulate, promote, and raise awareness of the importance of developing the organic sector. Regarding the period 2014-2022, a recent audit of activities related to supporting organic agriculture reported on the effects of the use of funds received from the European Commission, highlighting several critical aspects (ECA, 2024). For example, although Romania ranked eighth in terms of spending allocated under the Common Agricultural Policy (CAP) for the conversion and support of organic agriculture, only 5.1% of agricultural land (out of a total of 12.6 million hectares) is cultivated organically, managed by approximately 13,000 farmers. These farmers received subsidies for organic pastures, but not for the animals raised in this way, which led to a 75% decrease in the number of animals and an increase in the area allocated for grazing.

Regarding the consumption of organic products, a Romanian spends an average of only 2 euros per year, representing the lowest level in the European Union (ECA, 2024). Although Romania has invested significantly in organic agriculture, the first national action plan for this sector was adopted only in May 2023. Despite this delay, there is no clear 2030 target, and the national target for 2027 is only 6% of agricultural land.

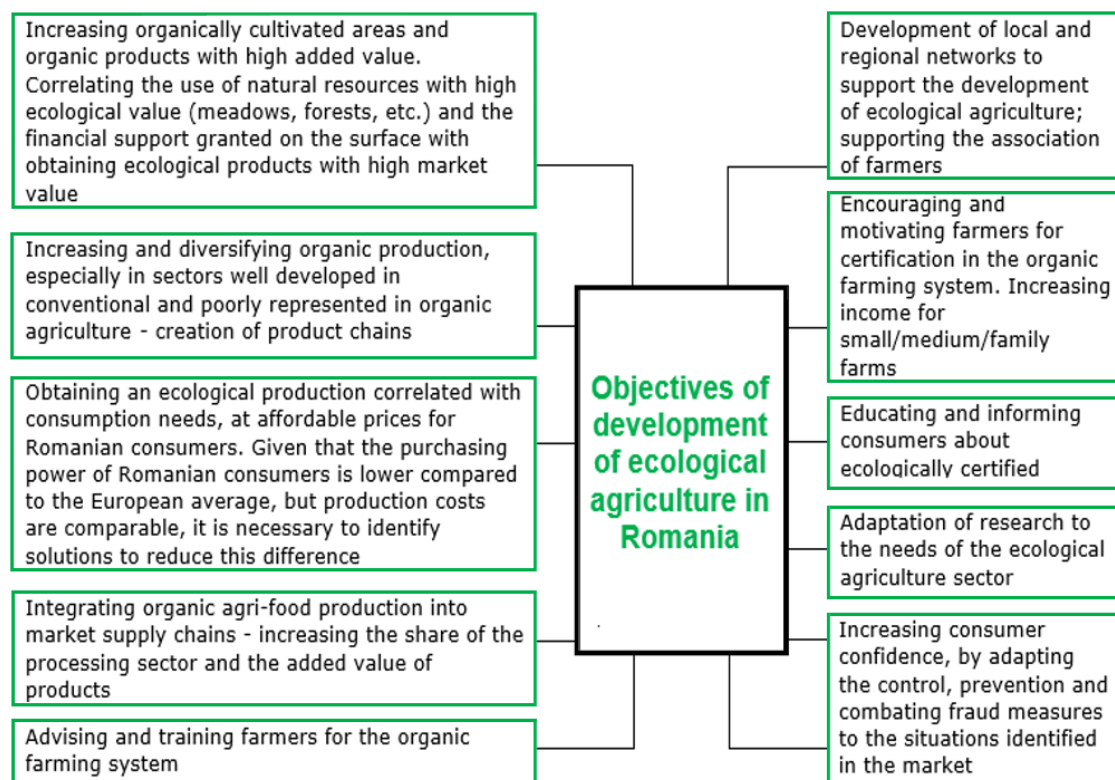
Another problematic aspect is the lack of training and advisory services for farmers practising organic agriculture. No registered farmer has benefited from specialised training, as there has been no response from trainers or advisors. Additionally, the extra costs associated with transitioning to this type of agriculture, such as certification and inspections, have been considered „transactional” and included in support from CAP. Although the 2022 organic agriculture regulation allows small farmers to certify in groups to reduce costs, this option is not utilised in Romania due to legal ambiguities and vague definitions. Furthermore, Romania remains last in the EU in terms of organic product consumption, with only 2 euros spent per inhabitant, compared to 365 euros in Denmark (ECA, 2024). For the 2023-2027 financial period, the CAP Strategic Plan allocates €389.12 million to organic agriculture. Of this amount, €162.6 million is intended to finance commitments during the conversion period to organic agriculture, while €226.52 million is allocated to support commitments to maintain organic practices (MADR, 2023, 2024). The mentioned document states that „Considering the unpredictability of factors that can influence organic agriculture, as well as fluctuations in the number of operators, it can be deduced that the area used in the organic agriculture system in 2030 could reach a minimum of 800,000 hectares, which represents 6% of the utilised agricultural area. From this target, 3.53% of the utilised agricultural area, or 488,325 hectares, represents the objective established by the CAP Strategic Plan 2023-2027 to support commitments to organic agriculture.” (MADR, 2023, 2024).

In the context of sustainability, we note that a strategy for the development of the agri-food sector until 2030 (MADR, 2015) aims at the smart and sustainable exploitation of agri-food potential and the development of rural areas, ensuring that agriculture and rural development in Romania by the mentioned horizon will lead to a level of coherence between agriculture, the environment, and rural development through the smart and sustainable use of agricultural land, labor, and capital. Against this background, the following strategic objectives have been established (MADR, 2015): (i) accelerating the transition to economically viable agriculture, alongside the implementation of organic agricultural practices and the gradual reduction of labor in agriculture; (ii) increasing the capacity to meet domestic food consumption through local production and regaining the position of a net agri-food exporter, in line with the sector's potential and responding to global food demand; (iii) reducing the carbon footprint of agriculture, promoting organic agriculture and those adapted to climate change, efficient water management, and stimulating renewable energy production; (iv) improving living conditions in rural areas by providing infrastructure and basic services comparable to urban levels, while reducing the income gap between rural areas and the EU average; (v) developing partnerships for education, consultancy, ICT, and research and innovation, along with optimizing the performance of agricultural administration to support a knowledge-based competitive agriculture. The agri-food strategy is aligned with sectoral objectives in areas such as environmental protection, climate change, health and food safety, research and innovation, and regional and social development.

Recently, Romanian authorities have identified both the needs and opportunities to expand organic agriculture. These efforts focus on increasing the cultivated areas and production in the organic sector, enhancing added value through processing agricultural and food products, and developing organic livestock farming. Additionally, priorities include promoting organic farming practices, encouraging farmer associations, offering specialised consultancy, and improving the connection between agricultural research and practical implementation by facilitating farmers' access to research findings. Based on all of these points, several objectives have been established for the development of organic agriculture (Figure 17).

Figure 17

Objectives for the development of organic agriculture in Romania



Source: Prepared by the author based on (MADR, 2024).

Strictly regarding the actions to be undertaken in the medium term to achieve the objectives for the development of organic production (focused on three axes), within the first Axis (1), we emphasise the importance of stimulating demand and increasing consumer trust through various initiatives. These include information and education campaigns on the benefits of organic agriculture, promotion of the EU organic logo, and support for projects through European funds. Collaborations among authorities, the business environment, and educational institutions aimed at promoting healthy, organic eating are also targeted. Other measures include green public procurement, reducing fraud, and increasing the visibility of organic products in the market, thereby supporting the sector's sustainable development.

Axis 2 of the National Action Plan for the Development of Organic Production (MADR, 2024) focuses on stimulating production and strengthening the organic agriculture value chain. Among the proposed measures are: (i) providing compensatory payments for organic farmers to cover additional costs and income losses; (ii) simplifying administrative procedures for operators in organic agriculture and supporting farmers' associations in cooperatives for better negotiation and sale of products; (iii) diversifying production and supporting small farmers, especially in mountainous areas, to adopt modern technologies and ecological practices; (iv) processing organic food by prioritizing investments in local units, supporting the production of high value-added products, and creating local brands. These actions aim to improve farmers' market positions, increase incomes, and promote sustainable production.

Finally, Axis 3, „Research and Sustainability”, focuses on resource efficiency, reducing packaging and waste, and waste management (MADR, 2024). The first action proposed here involves disseminating research results in organic agriculture through accessible events and publications for farmers, promoting innovations for adapting to climate change and utilising

ecological technologies. Furthermore, other actions emphasise the importance of studies and partnerships for the development of organic agriculture. The impact on the environment and health is also highlighted, with subsequent efforts to facilitate farmers' access to results through digital platforms and events, promoting the exchange of information and feedback.

Certainly, progress in all the actions mentioned can ensure the sustainability of organic agriculture in Romania and, implicitly, the national agri-food sector.

Practical implications

The findings of this review have several practical implications for policymakers, practitioners, and stakeholders across the Romanian agri-food system. First, the analysis highlights the urgent need to consolidate the legislative framework on food waste by moving from voluntary guidelines toward binding, enforceable measures. Clear obligations and efficient monitoring mechanisms are required to prevent food losses at the source and to make redistribution and recycling standard practices throughout the food chain. Second, fiscal and financial instruments must be designed to create tangible incentives for the adoption of bioeconomic practices. Reduced VAT rates for organic products, tax credits for investments in sustainable technologies, and targeted subsidies for renewable energy in agriculture can accelerate the transition to a circular, resource-efficient economy. These measures would not only encourage innovation but also improve the financial stability of farmers and food processors. Third, infrastructure modernisation should be treated as a strategic national priority. Investments in storage facilities, cold chains, and logistics are critical for reducing post-harvest losses, particularly in perishable products such as fruits and vegetables. Such improvements would help bridge the gap between production and consumption, reduce dependence on imports, and strengthen Romania's competitiveness in the European market. Fourth, consumer behavioural change is a cornerstone of sustainable transformation. Awareness campaigns, educational programs, and food literacy initiatives can reshape attitudes toward food purchasing, consumption, and disposal. By fostering responsible consumption patterns, Romania can significantly reduce household waste, where nearly half of the losses occur.

Finally, this study underscores the importance of cooperation across the entire agri-food chain. Building resilient, integrated value chains requires strong collaboration among farmers, processors, distributors, retailers, and consumers. Public-private partnerships and multi-stakeholder platforms can provide the institutional framework for sharing knowledge, promoting innovation, and scaling up best practices.

Taken together, these practical implications reveal that the transition to a sustainable agri-food system in Romania is not only about adopting new technologies but also about reshaping policies, incentives, and social behaviour. If implemented effectively, the proposed measures can transform Romania's agricultural potential into a long-term advantage, securing both food security and environmental sustainability.

Conclusions

The findings of this integrative review emphasise the paradoxical evolution of Romania's agri-food system—from the chronic scarcity and rationing that defined the communist period to a present characterised by overproduction, excessive consumption, and widespread food waste. This transition, while reflecting the country's economic modernisation and market liberalisation, simultaneously reveals persistent inefficiencies and systemic imbalances that threaten the long-term sustainability of the agri-food sector. The paradox illustrates how progress, when not accompanied by coherent governance and social awareness, can generate new vulnerabilities, particularly in the context of resource overuse and environmental degradation.

Food waste in Romania emerges as a complex socio-economic phenomenon, deeply rooted in historical legacies, weak institutional coordination, and inconsistent policy implementation. Although legislative frameworks addressing food waste and bioeconomic development have been adopted in line with European standards, their practical enforcement remains insufficient. Temporary governmental interventions—such as price caps on basic food products or targeted subsidies—have provided short-term relief for households but have failed to produce structural change. The persistence of inefficient distribution systems, inadequate storage and transport infrastructure, and limited consumer awareness continues to fuel food loss along the supply chain. To overcome these structural weaknesses, Romania's agri-food system must embrace a comprehensive bioeconomic transition that redefines the relationship between production, consumption, and waste. Bioeconomic measures—ranging from valorising organic waste into biogas, compost, or bio-based materials, to stimulating innovation in food preservation, packaging, and processing—represent a key pathway for reducing environmental impact and improving resource efficiency. The adoption of circular economy principles within agriculture and food industries could transform waste into a valuable input, fostering both ecological balance and economic competitiveness.

However, technological and policy reforms alone are not sufficient. The success of a sustainable bioeconomic model depends equally on behavioural change, consumer education, and the strengthening of social responsibility across all levels of the agri-food system. Public institutions, private stakeholders, and civil society must collaborate to develop integrated strategies that promote sustainable consumption, reduce inequality in access to food, and stimulate local initiatives such as food banks, cooperatives, and community-supported agriculture. At the macro level, Romania's bioeconomic agenda must align with the strategic objectives of the European Green Deal and the Sustainable Development Goals—particularly SDG 2 (Zero Hunger), SDG 10 (Reduced Inequalities), and SDG 12 (Responsible Consumption and Production). This alignment will ensure not only policy coherence but also access to financial instruments and technological support that can accelerate the green transformation of the agri-food sector. Furthermore, embedding digitalisation—through traceability systems, big data analytics, and artificial intelligence—can enhance transparency, efficiency, and adaptive governance in the management of food resources.

Ultimately, the Romanian case demonstrates that sustainability in the agri-food sector cannot be achieved solely through economic or environmental interventions; it must be built upon a foundation of ethical responsibility, social inclusion, and long-term resilience. The transition from

food crisis to food waste offers a valuable lesson on the unintended consequences of rapid transformation and the necessity of systemic, multidisciplinary responses. By reframing food waste not merely as a technical or economic issue but as a societal challenge, Romania can transform its paradox into an opportunity for renewal—establishing a sustainable, equitable, and bioeconomy-driven agri-food model that serves as an example for other transitional economies.

Suggestions for Future Research

This review relies exclusively on secondary sources—academic literature, institutional documents, and statistical reports—without primary data from producers, retailers, or consumers. As a result, it captures institutional, legal, and sociological aspects but less of the behavioral dynamics along the food chain. The focus on Romania as a transitional economy further limits generalizability, although the findings offer transferable lessons for other Eastern European and Global South contexts. Finally, the study documents short-term effects more clearly than long-term consequences, which remain uncertain.

Future research should apply mixed-method approaches, combining econometric modeling with interviews and surveys, to better capture interactions between consumer practices, governance, and markets. Comparative studies across EU states and beyond could illuminate how different national trajectories affect food waste and bio-economic strategies.

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