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Editorial

Recycling of Agro-Food and Urban Wastes According to the Circular Economy and Sustainable Paradigms

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1. Introduction

In the era of eco-sustainability, it is crucial to recognize the importance of treating agro-food and urban wastes; by transforming what might be considered waste into valuable resources, we can combat environmental degradation while promoting economic growth, environmental sustainability, and public health [1]. Therefore, a new economic model based on sharing, reusing, repairing, and recycling in a closed loop (reduce, reuse, recycle—RRR) has recently been established that is capable of surpassing the traditional linear economic model of "take, make, and dispose". This is a fundamental aspect of a circular economy (CE). A CE is defined by technologies in the production system that reduce losses, environmental pollution, inputs, and costs by implementing resource recovery, reuse, and waste recycling measures [2]. From this perspective, authorities have begun introducing CE frameworks, such as the RRR, the polluter pays principle, and Sustainable Consumption and Production (SCP) [2–4].

In the CE model, two types of materials have been identified: biological and technical. Microorganisms can decompose biological material, while technical material cannot be reintegrated into the biosphere. Biological waste can enhance soil quality, recycle nutrients, improve soil organic matter, mitigate erosion, and preserve water when properly handled [5].

However, according to European Union statistics [6], in 2020, the European Union (EU-27) had a waste recycling rate of 48.7%, with Germany, Austria, and Slovenia having rates of 70.3%, 62.3%, and 59.3%, respectively. Meanwhile, according to OECD estimates, in 2020, approximately 40.5% of waste generated in all OECD countries was still disposed of in landfills, including 56.6% in America, 20% in Asia/Oceania, and 26.8% in Europe [7]. These percentages highlight the need for efforts to establish proper management abandon landfill disposal.

In this context, the main goal of this Special Issue (SI) was to promote sustainable agriculture and alternative urban and agro-food waste treatment technology following a sustainable circular economy approach. The contributions collected in this SI focus on two main themes: (i) agro-food waste valorization [8–12] and (ii) human perception of and behavior toward the circular economy paradigm [13–15].

The following section presents the main results from the reported investigations.

2. Principal Results of this Special Issue

This Special Issue collected eight original articles focused on various aspects of diminishing the consumption and depletion of non-renewable resources and advocating for extending the life cycle of such resources and products.

The first group includes five papers and explores methods to extract value from agro-food and urban wastes and minimize their environmental impact. Diatta and colleagues [8]

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evaluated the effect of using fish effluents as fertilizer in tomato production in northern Senegal. As a result, it was found that adopting such effluents significantly enhanced tomato plant growth, increasing the plant height, stem diameter, and fruit count per plant, which led to a higher overall crop yield. This suggests that fish effluents can serve as a sustainable fertilizer, reducing dependency on chemical alternatives. Moreover, the authors suggested that integrating aquaculture with tomato cultivation could diversify crop growth and economically benefit regional farmers. However, they also acknowledged that further research is necessary to evaluate the long-term sustainability of this practice.

Illankoon et al. [9] and Assandri et al. [10] examined the recycling of agricultural wastes. Specifically, Illankoon et al. [9] focused on treating rice waste, while Assandri et al. [10] focused on by-products from maize production and livestock effluents. Illankoon et al. [9] used an analytical hierarchy process (AHP) in conjunction with multi-criteria decision analysis (MCDA) to examine sustainable methods of rice husk and rice straw valorization in Sri Lanka. The evaluation was based on four criteria: environmental, social, technical, and economic elements. Indeed, although the rice industry produces a significant amount of waste, if properly managed, it can be used in various sustainable applications. According to the study, biochar production offers the most sustainable way to manage rice by-products, improving soil fertility and reducing carbon dioxide and other greenhouse gas emissions. It also provides business benefits, such as cost savings in waste collection and disposal. The authors argued that this approach mitigates the negative impacts of agricultural waste and increases the value of by-products, opening up new economic and commercial opportunities and encouraging sustainable agricultural practices.

Assandri et al. [10] examined the possibility of replacing diesel with biomethane derived from agricultural waste at the regional level as an alternative fuel for tractors. By assessing the average annual availability of agricultural waste between 2015 and 2021, the authors found that the Piedmont region (North-west Italy) could potentially produce a volume of biomethane 3.8 times higher than the amount necessary to power all tractors within the region. From an environmental and economic point of view, adopting biomethane from agricultural waste could significantly mitigate greenhouse gas emissions and promote energy self-sufficiency among local farmers. However, the article emphasizes the importance of implementing appropriate policies and infrastructure and fostering collaboration between farmers, institutions, and energy industries to facilitate this transition.

Rana et al. [11] explored a sustainable method for producing lignocellulolytic enzymes using agro-industrial waste through solid-state fermentation (SSF). Their study focused explicitly on different combinations of wheat bran, wheat straw, and rice bran as dry solid substrates fermented using *Fusarium oxysporum*. Additionally, the produced enzymes were tested to determine their effectiveness in the clarification of pumpkin juice. As a result, the authors found that the process of producing lignocellulolytic enzymes from agro-industrial waste not only addresses the issue of waste disposal, but also provides an economically advantageous raw material for enzyme production. These two benefits demonstrate the potential of these enzymes in the food and beverage industry for juice clarification and other processing applications.

Finally, the review published by Pérez-Burillo et al. [12] seeks to offer a thorough grasp of the application of used coffee grounds as an organic amendment in soils, discussing their benefits and limitations. Specifically, factors including coffee grounds' chemical and physical properties, impact on soil properties, effects on plant growth, and environmental implications were considered. However, the study emphasizes that to balance the effects of used coffee grounds on soil pH and nutrient availability, they should be used sparingly and in conjunction with other organic fertilizers. Therefore, to avoid negative consequences, the establishment of guidelines for their appropriate adoption is strongly recommended. Despite this, it is undeniable that their use adheres to the principles of a circular economy principle by converting waste into a valuable resource.

The second group of papers in this SI includes three original research papers that consider stakeholders' perspectives on organic food waste, investigating the complex in-

terplay between socio-economic considerations, societal demands, and environmental sustainability. Specifically, two out of three of these papers focused on the need for food reduction. Sobaih [13] identified the three leading causes of food waste in food service organizations, like restaurants and banquet halls, in Saudi Arabia: consumer behavior, a lack of legal/strategic frameworks, and ineffective food management systems. This study highlights how consumers' behavior, shaped by Saudi culture's emphasis on generosity (providing very large portions of food for friends, visitors, or guests), often results in oversized portions and indifference toward food waste. Also, the lack of legislation and penalties reduces people's sense of responsibility, perpetuating wasteful habits. Effective management systems and restaurant staff training are crucial in waste reduction efforts. Firstly, introducing measures like portion control and redistribution initiatives for leftover food could foster responsible consumption. In addition, collaborating with civil organizations to redistribute surplus food to those in need also could increase consumers' awareness and sense of social responsibility. Lastly, implementing comprehensive strategies for reducing the amount of food sent to landfills is pivotal in mitigating food waste across food service sectors.

Similarly, Chereji et al. [14] stated that each actor involved in the food chain is responsible for reducing food waste; they compared consumer behaviors, distinguishing between those living in urban areas and those living in rural areas in Romania. In particular, eating out at restaurants, much more common among people living in urban areas, seems to contribute to increased food waste and leftovers. Unfortunately, the situation is also far from positive in a household context. Indeed, although about two-thirds of the respondents in Chereji et al.'s study stated that they strive to avoid food waste by storing leftovers for the following day or eating them later the same day, when it comes to disposing of no longer edible food, there was a significant difference between the two surveyed groups. While only 7% of rural respondents reported throwing leftover food in the trash, the percentage among participants living in urban areas exceeded 50% in most cases. In contrast, when considering the age of participants, the authors found that the majority of food waste was generated by those from rural areas and those between the ages of 18 and 25. Overall, these results indicated that individual decisions are the predominant factor in reducing food waste.

Bagagiolo et al. examined stakeholders' perceptions of the valorization and management of urban organic waste [15]. Throughout the composting process, this type of waste can be reused as a soil fertilizer or conditioner, enriching soil organic content, reducing soil degradation, and serving as an economical alternative to chemical fertilizers. The study investigated attitudes toward composting through a survey. Both farming professionals (such as farmers and gardeners, who are expected to have a deeper understanding of compost due to their occupation) and hobbyists (who are engaged in gardening or farming as a leisure activity) were recruited as potential participants in the investigation. As a result, the authors found that personal and social factors are pivotal in promoting sustainable behavior. Specifically, education levels and information received by peers, neighbors, family members, and consultants positively influence the decision-making process regarding the adoption of innovative and sustainable practices. Users with a more community-focused mindset seemed to be more inclined to adopt sustainable behaviors in this setting of social engagement and information exchange.

3. Conclusions

To solve the issue of sustainable resource and waste management, this SI emphasizes the need for multidisciplinary and cooperative methods that go beyond the conventional linear economic model and toward a circular one. The solutions proposed in the eight papers presented demonstrate how the valorization of agricultural and industrial by-products, alongside effective strategies for reducing food waste and managing urban waste, can significantly contribute to greater environmental and economic sustainability. The transition towards more sustainable practices requires not only technological innovation

but also behavioral changes, adequate policies, and strong cooperation among all the stakeholders involved. This highlights how even social sustainability is a critical component in the sustainability debate. Indeed, the promotion of sustainable behaviors is strongly influenced by bureaucratic and legislative factors and personal and social factors such as education, information, and communication between users and potential users involved in this process.

In conclusion, embracing these circular economy-based approaches reduces environmental impact and unlocks new economic and social opportunities, promoting more responsible resource management for a sustainable future.

Conflicts of Interest: The authors declare no conflicts of interest.

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