Bulgarian Chemical Communications, Volume 57, Special Issue B (pp. 180-184) 2025 DOI: 10.34049/bcc.57.B.A0014

Integrating media and information tools for enhanced management of food and agricultural waste

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Revised: February 06, 2025

The escalating issue of food and agricultural waste management necessitates innovative approaches to minimize environmental impact and optimize resource use. This paper explores the role of media and information tools in improving waste management practices in the food and agriculture sectors. By leveraging digital technologies, social media platforms, and information dissemination networks, stakeholders can enhance waste reduction, recycling, and reuse strategies. The paper presents case studies, and a methodological approach like vermin compost and recycling into construction materials or the usage of RHA in treatment of water to illustrate the influence of media and information tools in transforming waste management processes. Techniques for managing floral waste, agro-industrial effluent, bagasse, and banana agro-waste have all been illustrated.

Keywords: information technology, sustainability, digital transformation, waste reduction and recycling, resource optimization

INTRODUCTION

The management of food and agricultural waste represents a significant challenge for the global community, with far-reaching implications for environmental sustainability, economic efficiency, and social responsibility [1–3]. As the world grapples with the consequences of waste accumulation, the integration of media and information tools emerges as a promising avenue for enhancing waste management practices.

Food and agricultural wastesencompass a broad spectrum of organic and inorganic materials generated from an assortment ofphases of the food supply chain, from production to consumption [1], [4]. It is estimated that just about one-third of all foodstuff produced for human consumption is lost or wasted (Figure 1), which not only stands for a noteworthy economic loss but also add to the ecologicaldreadful conditions through the emission of greenhouse gases and the inefficient use of natural resources [5]. Media and information tools have the potential to revolutionize the management of food and agricultural waste by providing platforms for knowledge exchange, fostering collaboration among stakeholders, and facilitating the adoption of best practices [3]. These tools can range from mobile applications that track and optimize resource use, to social media campaigns that raise awareness and encourage behavioral change [5].

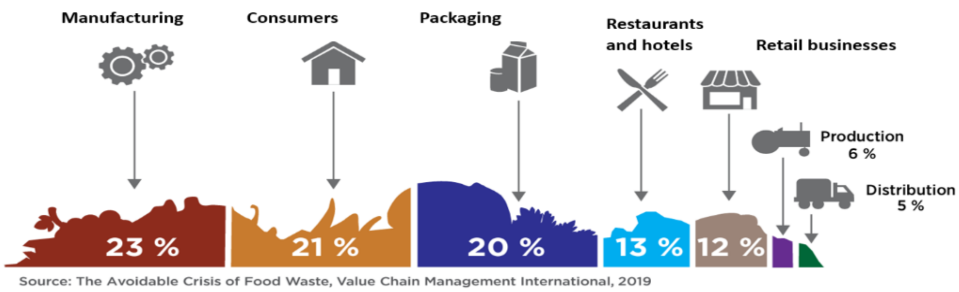

Figure 1. Unplanned (or avoidable) loss and waste of potentially edible food.

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The combination of media along with the information tools in waste management can lead to numerous benefits, including: (i)*Improved effectiveness*: By leveraging data analytics and real-time monitoring, stakeholders can identify inefficiencies and optimize resource allocation; (ii) *Enhanced collaboration*: information sharing platforms can facilitate partnerships across the food supply chain, leading to coordinated efforts in waste reduction; (iii)*Increased awareness*: media campaigns can educate the public on the importance of waste management and promote sustainable consumption patterns; (iv)*Innovation and development*: the use of these tools can spur innovation in waste management technologies and practices, driving progress towards sustainability goals.

Integrating media and information tools for the management of food and agricultural waste is not just a technological endeavor but a holistic approach that encompasses economic, environmental, and social dimensions. As we move forward, it is imperative to harness the power of these tools to create a more sustainable and resilient food system.

INTEGRATION OF MEDIA AND INFORMATION TECHNOLOGIES IN WASTE MANAGEMENT

The burgeoning waste management crisis necessitates innovative solutions to enhance sustainability and resource optimization [6, 7]. Despite the recognized potential of digital tools in sustainability, their application in waste management is not well-documented.

The integration of media and information technologies in waste management is an emerging field that promises to revolutionize traditional practices. While digital tools have been instrumental in advancing sustainability efforts, their role in waste management is yet to be fully realized (Figure 2).

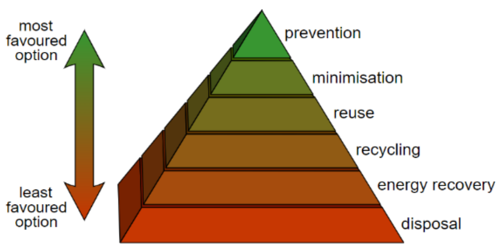

Figure 2. Pyramidal conception of waste management hierarchy.

This literature review examines existing studies to identify gaps and opportunities for leveraging these technologies to foster more efficient waste management systems.

Recent studies have begun to shed light on the transformative prospective of media and information technologies in waste management. Czekała *et al.* [8] discuss modern waste management technologies, emphasizing not only technological advancements but also the sociological impact through media platforms, which can significantly influence ecological consciousness and awareness. Similarly, Gupta *et al*. [9] presents an integrated approach to waste management, highlighting the applications of digital tools in creating sustainable solutions from waste.

Digital platforms and waste management

Efficiency Innovative digital platforms are recognized for making waste management more efficient, transparent, and accessible. The use of technology has become more tech-savvy and humane, allowing for the recovery and recycling of scarce natural resources, reducing landfill waste, and protecting our planet [5, 8]. Different studies further elaborated on how advanced sensors and monitoring systems can track waste generation and disposal practices, offering valuable insights into behavioral trends.

Data-driven waste management

The integration of technology in waste management addresses immediate challenges and unlocks possibilities for optimization [5]. A data-driven approach enables enhanced decision-making and resource allotment, optimizing the entire waste management process. This sentiment is echoed by other studies, that discuss the strategic approach to cost reduction and resource optimization through digital technologies.

AI and IoT in sustainable waste management

The prospective of Artificial Intelligence (AI) and the Internet of Things (IoT) in rebellion waste management put into practice is immense. Sharma [10] explores the effectivenessenhancements crosswaysa variety of aspects of waste management, including observing, compilationpath optimization, and recycling processes, facilitated by AI and IoT technologies.

METHODOLOGICAL APPROACHES

This work uses a mixed-methods approach, combining quantitative data analysis with twoqualitative case studies. The data sources include industry reports, and academic publications on the food and agriculture sectors.

- *Awareness about the method of vermicomposting.* Vermicomposting (worm composting) relies on earthworms/segmented worms'biodegradation/microorganism break down organic matter activity to move nutrients from one classification to the other. All the micro along with macroorganisms in the huge microflora can convert organic waste into usable resources. Earthworms help to break down cellulose, promote soil formation, and accumulate humus. Earthworms have a deleterious impact on the biological, chemical, and physical properties of soil. Earthworms are unique in with the purpose of feeding on natural/organic wastes but only use a small portion of them for growth, excreting the bulk in a partlyabsorbed form. This is due to the presence of microbes, hydrolytic enzymes, and hormones in earthworm intestines that encourage the rapid collapse of partly ingested food. The porosity promotes root saturation, ventilation, water absorption, and drainage. Earthworms and associated microorganisms generate soil aggregates that help to maintain soil ecology[11]. Vermicomposting is a non-thermophilic, bio-oxidative process in which soil-dwelling earthworms and other microbes produce extremely rich compost. Earthworms speed up soil healing by reintroducing beneficial microbes. Vermicompost has a thinlyalienated, peatlike, absorbentquality, good ventilation and drainage, lofty water holding ability, and improved microbial action and buffering competence, among other biophysical properties.
- *Awareness about treatment of groundwater and wastewater using RHA.* Numerous studies have demonstrated the effectiveness of RHA in groundwater treatment. The high silica content and porous nature of RHA make it an excellent adsorbent for various contaminants, including heavy metals and organic pollutants [12]. The utilization of inconsequential materials such as bamboo, condensed earth blocks, fly ash bricks, and glass fiber–unbreakable concrete has the potential to enhance the sustainability and cost-effectiveness of constructed edifices [13].

The biofiltration mechanism plays a crucial role in the elimination of various contaminants during the treatment using rice husk asks.The procedure of biofiltration encompasses several phases in the elimination of contaminants from air or water. Initially, the contaminated air or water is introduced into the biofilter setup, where the contaminants adhere to the biofilm or cellular membrane of the biofilter bed. The contaminants are then elated to the divan media in the aqueous phase [14, 15]. These contaminants serve as a source of carbon, acting as food for microorganisms [16]. Through efficient metabolism, microorganisms thrive and form colonies, ultimately leading to the degradation of the contaminants [14].

CASE STUDIES

Case study 1: Social media and digital platforms for food and agricultural waste recycling

For analyzing social media or platforms that connect farmers with waste processing facilities, enhancing recycling and reuse of agricultural by-products, thecase of rice huskash (RHA) can be considered. Rice husk is an agricultural byproduct available in huge quantities, particularly in the Democratic Republic of Congo [6] (see Table 1). The future of cleaner production is centered around the objective of mitigating the release of solid waste [17].The alleviation of environmental contamination has elicited a growing interest among researchers and scholars, as evidenced by the increasing focus on the advancement and application of solid waste management [18].

Table 1. Storage of crop residues in Africa according to different surveys carried out, difficulties and different management methods

Crop residue storage practice	Yes No	67% 33%
Type of crop residue stored	Cowpea tops Peanut tops Rice straw Cereal tops and straw Cereal stalks Cowpea and peanut tops	22.2% 1.3% 16.7% 38.9% 13.5% 7.4%
Crop residue storage period	Rainy season Cold dry season Hot dry season After harvest Dry season Anytime Rainy season and cold dry season	1.9% 62% 1.9% 13.2% 9% 10.8% 1.3%
General perceptions on the problem of agricultural waste management		
Agricultural waste consists of crop residues, straw, manure, and other organic materials produced by farms and agricultural operations. Agricultural waste can be composted or used to produce energy, but often it is thrown into landfills or burned, which can have negative effects on the environment and human health.		

Agricultural waste can pollute soil and groundwater, release greenhouse gases and harm biodiversity. Burning agricultural waste can also release toxic substances into the air, which can cause respiratory problems for local people.
Key steps to reduce agricultural waste
1 – Crop Planning: Crop planning can help reduce agricultural waste by ensuring that crops are grown efficiently and sustainably. Sustainable agricultural practices, such as crop rotation and water management, can also help reduce agricultural waste. 2 – Reduction of food losses: Reducing food losses can help reduce agricultural waste by ensuring that agricultural products are used efficiently. Food losses can be caused by storage, transportation, and distribution problems. Food preservation technologies, such as refrigerators and freezers, can help reduce food loss. 3 – Recycling and composting: Recycling and composting can help reduce agricultural waste by transforming organic waste into soil nutrients. Agricultural waste can be composted to produce compost, which can be used as a natural fertilizer. Recycling plastics and other non-organic materials can also help reduce agricultural waste. 4 – Use of renewable energy: The use of renewable energy can help reduce agricultural waste by transforming organic waste into energy. Agricultural waste can be used to produce electricity, heat, or biofuel. This approach can help reduce greenhouse gas emissions and promote agricultural sustainability. 5 – Awareness and education: Awareness and education are essential to encourage farmers, producers, and consumers to reduce agricultural waste. Training and education programs can be implemented to encourage sustainable agricultural practices and efficient use of resources. 6 – Collaboration and cooperation: Collaboration and cooperation between farmers, producers, governments, and environmental organizations can help promote the reduction of agricultural waste. Partnerships between agricultural stakeholders can encourage the implementation of sustainable practices and the creation of innovative solutions to reduce agricultural waste.

RHA's pozzolanic properties enhance the strength and durability of construction materials, reducing the dependence on traditional, resource-intensive components. Physically described as grey in color, irregular shape texture, non-crystalline and odorless with particle size of <45 μm, Hossain and Islam [19] assert that the incorporation of RHA as a supplementary cementitious material contributes to the production of newly mixed concrete.

As the phenomenon of global development continues to surge, in conjunction with the rapid growth of the global population, there has been a significant need for the establishment of architectural structures and essential infrastructure. Cement, the fundamental element that binds concrete, serves as its most crucial and costly component [20].

Case study 2: Information systems for waste tracking and management

Bananas, a maincollide crop in India, generate a lot of rubbish. Earthworms (*Eudriluseugeniae*) were employed to blend organic waste with cow manure. It was determined that a combination of 200 g banana waste and 800 g cow dung resulted in the optimum enlargement and duplicate. The earthworm didn'tstay alive during the treatments containing 1000 g banana waste alone or 800 g banana and 200 g cow manure mixed. Furthermore, the mixture of 200 g of banana waste and 600 grammes of cow dung resulted in improved development and reproduction. If the proper amount of cow dung (CD) is added, vermicomposting is a straightforward approach to deal with banana waste. Accordingly, employing a lot of banana waste in nourishing is detrimental [21–23].

Vermicomposting can reduce agro-industrial waste water's C/N ratio by 69-79% and soluble chemical oxygen requirements by 20-88%. Vermicompost was created when extremelytainted wastewater from a palm oil plant was cleansed using earthworms [11, 21]. Rice straw has been shown to be a better amendment and absorbent than soil because of its higher nutritional content, greater reduction in soluble chemical oxygen demand (COD), and lower C/N ratio. The pH, electrical conductivity, and nutritional content all rose drasticallyfor the period of the vermicomposting process [23] According to one study, the most excellentevaluation vermicompost with a high nutritional value was formed by combining rice straw and palm oil mill effluent. Earthworm growth was similarly delayed in all compost piles utilized in the study.

During the vermicomposting process, earthworms are introduced and break down the natural/organic materials, producing castings that can be used as fertilizer. *Eisenia foetida*'s digestive enzymes break down organic matter at a temperature of 26 °C and 62-82% moisture content [24]. In comparison to compost and initial agro-industrial waste, vermicomposting reduces carbon emissions while raising nitrous oxide levels in the soil (bagasse). Additionally, VM costing improves the biological, chemical, and physical properties of soil.

A study in Indore, India [25] investigated how flower debris was treated in temples. Typically, these wastes are biodegradable and readily available for microbial growth. Vermicomposting technology was employed to manage temple waste. The procedure involves combining cow manure and waste items and allowing them to decompose for 45 days at 30 ºC. After 45 days, the ideal conditions for vermicomposting floral waste are: 25 ºC, pH 8.0, electric conductivity 200 microSiemens/cm, and C/N ratio of 12.3. The costs of this system were assessed, and its suitability for the city of Indore was also demonstrated.

CONCLUSION

Integrating media and information tools into food and agricultural waste management offers promising opportunities for enhancing sustainability and efficiency. This paper highlights the need for continued innovation and collaboration to address the pressing issue of waste in these critical sectors. Thus, management of food and agriculture waste relies on crop planning, reduction of food losses, recycling and composting, use of renewable energy, awareness and education, and collaboration and cooperation. Thereat, integrating media and information tools for the enhanced management of food and agricultural waste is a significant step towards sustainable development. By leveraging technology, stakeholders can improve waste tracking, optimize recycling processes, and promote efficient resource use. This integration not only helps in reducing the environmental impact of waste but also contributes to the economic viability of the agricultural sector by transforming waste into valuable products. Ultimately, such initiatives can lead to a more informed and responsible approach to waste management, aligning with global efforts to combat climate change and foster a circular economy.

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