Journal of Biotropical Research and Nature Technology
Volume 4 Issue 1 (2025).
Doi : 10.52850/borneo

Article Review

Asian Agriculture, Waste Management, and Sustainable Development Goals

Marzieh Alidoust Pahmedani[1*], Hamed Kioumarsi[2], Awalul Fatiqin[3], Beste Gizem Özbey[4], Zeynab Kazemkhah Hasankiadeh[5], Shabnam M Davani[6]

[1] Department of Horticulture Crops Research, Gilan Agricultural and Natural Resources Research and Education Center, AREEO, Center Education, Iran
[2] Department of Animal Science Research, Agricultural Research, Education and Extension Organization, Gilan, Iran
[3] Department of Biology, Faculty of Mathematics and Natural Sciences, University of Palangka Raya, Palangka Raya, Indonesia
[4] Department of Biology, Faculty of Science, Ankara University, Ankara, Türkiye
[5] Chemical and Biochemical Engineering Department, Faculty of Engineering, University of Western Ontario, Canada
[6] Department of Environmental Science, University of Milan, Italy

Email: [a)*] alidust.marzieh@gmail.com; [b)] h.kioumarsi@areeo.ac.ir; [c)]fatiqin@mipa.upr.ac.id; [d)] beste.ozbey@ankara.edu.tr; [e)] zkazemkhah@gmail.com; [f)] shabnam.mdavani@gmail.com

Submitted: 2025-06-22 Revised: 2025-07-28 Accepted: 2025-07-29

Abstract

This article summarizes the vibrant world of waste management in Asia and its important role in the achievement of sustainable development goals (SDGs). The continent alone has more than 4.5 billion people and produces the greatest amount of waste globally more than 800 million tonnes a year with an estimated increase to 1.8 billion tonnes by 2025 for only urban cities. This is largely attributed to material consumption levels that are high and economic growth as well as urbanization. Third-world countries normally experience infrastructural inadequacies that significantly affect the supply chain of recycling and waste management. Developed countries, however, have recorded outstanding success through investments in technologically developed solutions, effective regulatory frameworks, and waste reduction and recycling schemes. These have compelled them to embrace the 3Rs (reduce, reuse, recycle) and extended producer responsibility (EPR) programs. Waste management in Asia is closely linked with the SDGs, namely, Goal 11 (Sustainable Cities and Communities) and Goal 12 (Responsible Consumption and Production). Effective waste management is at the center of mitigating environmental pollution, protecting public health, and promoting sustainable urbanization. While industrialized nations are concentrating on minimizing waste and advanced treatment technologies, developing nations are leaning toward holistic and decentralized management systems. This review encompasses a number of themes, such as innovations and advancements in waste management, agricultural animal husbandry and waste management, the agriculture products and food industry, waste management strategies and SDG integration in Asian countries, and policy frameworks, technology advances, and institutional arrangements. Asia's waste management sector is currently confronted by a pivotal transformation characterized by enormous disparities between developed and developing nations. Success with sustainable development goals (SDGs) requires the adoption of integrated, inclusive, and innovative approaches reconciling the technical, social, and economic dimensions of waste management processes.

Keywords: *Agriculture; Holistic Solutions; Sustainable Development; Waste Management.*

Introduction

Waste management in Asia today is a key priority issue driven by fast-growing urbanization, a rising population, and economic growth. Solid waste management is key to the success of the achievement of sustainable development goals (SDGs), specifically those addressing environmental sustainability, public health, and the development of urban infrastructure. This review critically reviews recent literature on waste management strategies, the challenges being encountered, and how they relate to the SDGs in Asia. Asia is home to an estimated 60% of the global population and is confronted with increasing waste generation, of which organic waste comprises approximately 45–50% of MSW in most countries. Although more industrialized nations, such as Japan and South Korea, have registered a recent decline in waste creation due to the application of advanced waste reduction and recycling technologies, many developing nations are still grappling with inefficient waste management infrastructure, reliance on open dumping, and landfill-based disposal practices [1−3].

Among the primary problems confronting waste management in Asia include inadequate waste collection and disposal infrastructure particularly in rapidly urbanizing regions—lack of public awareness and incentives to alter consumption and disposal behaviors, widespread reach of informal recycling sector engagement that is not officially acknowledged or institutionally supported, financial limitations where collection accounts for a major portion of expenditures while disposal is ineffective, and significant environmental and health risks associated with open dumping and poor waste management [4–5]. Proper management of solid waste is a critical contribution to supporting a range of SDGs, such as SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Efforts toward Target 11.6, which seeks to reduce the per capita environmental impact of cities, partly through improved waste management, are still limited in most Asian countries [4]. Efforts to align waste management practices with the SDGs involve the adoption of the 3Rs principle (reduce, reuse, recycle) in efforts to reduce waste generation and ensure maximum resource efficiency; the implementation of extended producer responsibility (EPR) measures to hold producers accountable for the resulting waste from their products; the promotion of regional strategic action plans such as the South Asia Roadmap for Sustainable Waste Management (2019--2030), which sets targets for waste minimization, resource circulation, and climate action through waste-related interventions; and the promotion of people-centered and integrated waste management systems addressing technical, regulatory, socioeconomic, and financial dimensions to ensure sustainable outcomes [6–7]. For example (Figure 1), shows composition of municipal solid waste (MSW) in selected Asian countries. This review covers several key themes, including innovations and progress in waste management, the relationship between agricultural animal husbandry and waste management, agricultural products and the food industry, waste management strategies with the integration of sustainable development goals (SDGs) in Asian countries, policy frameworks, technological advancements, and institutional arrangements. This study aims to explore and provide an in-depth discussion of these topics within Asia's waste management sector.

Innovations and Advances in Waste Management

Economic Asian countries have progressed greatly in terms of waste management technologies, particularly waste-to-energy conversion and high-end recycling techniques. Japan is a prime example, with a concentration on waste minimization, sound recycling practices, and stringent regulation systems, which all contribute to high recycling levels and low landfill dependency. Alternatively, emerging Asian nations are rapidly embracing decentralized waste management and circular economy principles, notwithstanding available infrastructural and financial constraints. Most important in overcoming behavioral change at the family level, government enforcement, campaign awareness, and incentive schemes have been instrumental in spreading the perception of waste as an asset rather than a mere trash [3–4].

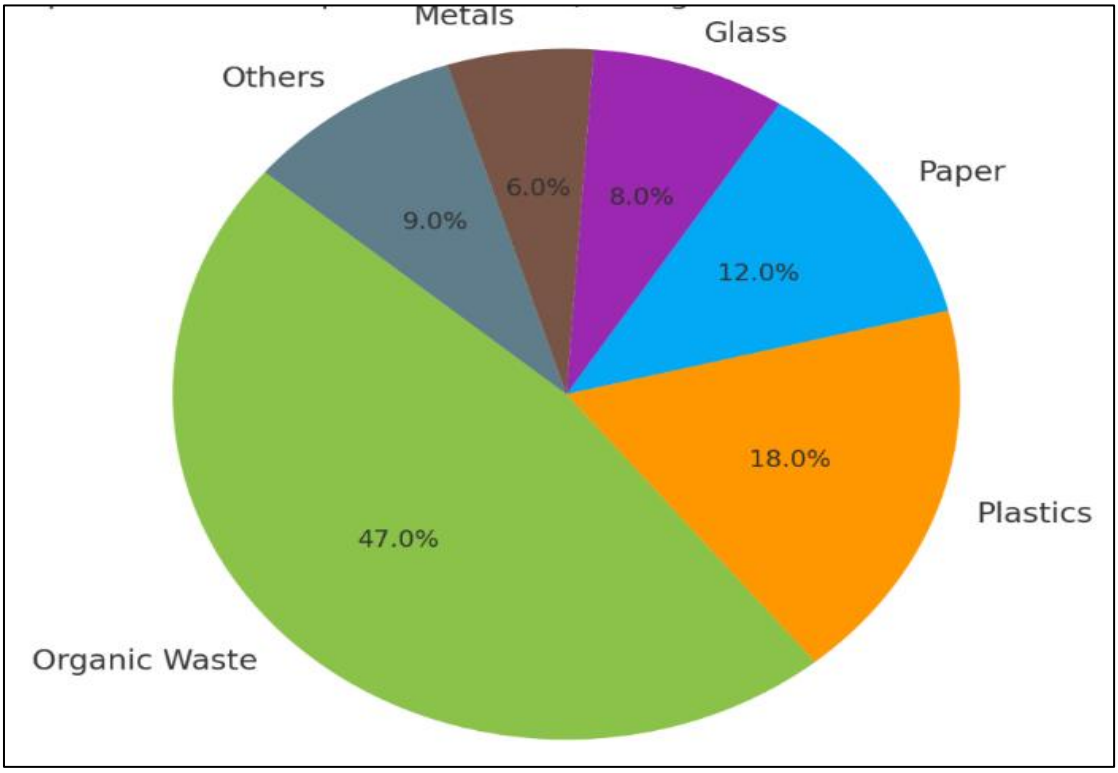

Figure 1. Composition of Municipal Solid Waste (MSW) in Selected Asian Countries. This pie chart illustrates the percentage breakdown of municipal solid waste (MSW) in countries such as India, Indonesia, China, Iran, and Japan. The chart includes categories such as organic waste (45–50%), plastics, metals, glass, paper, and others. Sources: European Commission, ISSOWAMA Final Report Summary 2008; Asian Development Bank 2020.

Agricultural Animal Husbandry and Waste Management

The increasing population and increasing protein demand for animals drive the rapid expansion of agricultural animal husbandry in Asian countries [8–11]. The industry must, however, be managed sensitively to deliver safe food and reduce its environmental impact. Proper animal husbandry coupled with good waste management is crucial for maintaining the integrity of the environment, ensuring food safety, and ensuring sustainability in the context of increasing livestock production globally. Intensive livestock farming is a major source of environmental pollution, such as water contamination through nitrates and eutrophication, air contamination through ammonia and greenhouse gases, including methane and nitrous oxide, and soil pollution through nutrient buildup. Moreover, animal wastes such as feces, wasted feed, and slaughterhouse byproducts carry considerable health hazards through their ability to carry pathogens and antibiotic resistance genes and bacteria, thereby compromising human and animal health. Pathogen contamination of water sources from deposits of fecal material, exposure to infectious microorganisms, airborne toxins (gases, dusts, odors), and zoonotic diseases are significant occupational and public health concerns for animal handlers. The effective control of animal waste aims to lessen such ecological and health risks while availing itself of the intrinsic worth that is found within such wastes. The traditional methods include composting, vermicomposting, and direct application, which utilize the nutrient worth of animal waste for cultivating agricultural crops. Present-day innovations include the production of biogas, invertebrate-derived biorefinery applications, emerging treatment technologies, and approaches toward dealing with the eradication of antibiotic-resistant bacteria (ARB) and antibiotic resistance genes (ARGs), i.e., through the use of ultraviolet and ozone treatments to prevent their spread. The general objectives of animal waste management are to establish ecologically sound, socially acceptable, and economically viable methods of conserving energy, recycling nutrients, and balancing soils, thereby minimizing pollution and health hazards. This is a worldwide requirement, particularly in

the Asian environment [12–16]. Table 1, shows comparison of traditional and innovative livestock waste management techniques.

Table 1. Comparison of Traditional and Innovative Livestock Waste Management Techniques

Composting	**Cost-effective, nutrient recycling**	**Odor, slow process**	**Crop fields**
Vermicomposting	High-quality output	Needs controlled conditions	Organic farms
Biogas production	Renewable energy	Infrastructure cost	Rural energy
UV/Ozone Treatment	Removes pathogens & ARGs	Technologically intensive	Slaughterhouses

Source: [12]; [13]; [14].

Agricultural Products and Food Industry

Agricultural products are extremely varied and provide different industrial sources, such as food, textiles, and pharmaceuticals. However, recent research has identified several challenges and opportunities in the development of sustainability and circular economy strategies in these areas. Nearly 30% of the food that is produced globally is lost or wasted as part of agricultural production and processing, representing approximately 150 billion metric tons each year. This waste stream consists of crop residues, agro-industrial residues, plastic packaging materials, and organic wastes such as manure and vegetable residues, whose inappropriate management accounts for extensive environmental degradation, greenhouse gas emissions, and economic inefficiencies [17–19]. Agricultural waste is diverse and comprises categories such as vegetable waste, processing refuse, plastic packaging, scrap metals, and toxic residues of agrochemicals. The best available waste management techniques emphasize the recovery and valorization of organics through processes such as composting, anaerobic digestion for biogas generation, plastic and metal content recycling, and safe disposal or incineration of toxic waste. These practices are guided by legislation and the European Union's Waste Framework Directive, which aims to reduce landfill use and enhance resource recovery to minimize environmental impacts [17].

In the agri-food industry, waste management targets the recovery of high-value-added compounds from byproducts such as phenolics, dietary fiber, vitamins, and phytochemicals. The recovered components can be utilized to reintegrate functional food components, natural additives, and biofertilizers or as bulk materials for pharmaceutical and cosmetic applications [20]. Valorization technologies such as composting, biofuel production, and biopolymer extraction are major drivers of sustainability and carbon footprint reduction. For example, fruit and vegetable peels have antimicrobial and film-forming activities, which make them useful in new packaging and food preservation strategies [19]. New innovative pathways aim toward realizing a zero-waste circular economy for the agri-food sector through leveraging biotechnological means to convert waste into antibiotics, fermented foodstuffs, and industrial products. Circular bioeconomic strategies emphasize reducing waste, recycling residues, and recycling via biochemical processes such as anaerobic digestion and biochemical extraction, thus reducing environmental contamination while generating new economic opportunities through bioenergy and biobased products [19], [21].

However, there remain significant challenges for waste management, most notably insufficient awareness among generators, inadequate collection and treatment infrastructure, and deficits in supportive policy platforms for green practices [22]. Therefore, education and technology appropriation remain strong drivers of increasing recycling rates and support ecologically sound agricultural practices [17], [19]. Figure 2, shows Dr. Marzieh Alidoust

lecturing at Rajiv Gandhi National Institute of Youth Development (RGNIYD). Workshop on Organic Agriculture 3.0.

Figure 2. Shows Marzieh Alidoust lecturing at Rajiv Gandhi National Institute of Youth Development (RGNIYD). Workshop on Organic Agriculture 3.0. Source: Kioumarsi and Alidoust & Allen,2022.

Synthesis of Waste Management Strategies and Sustainable Development Goals in Asian Scenarios

The synthesis of waste management strategies with sustainable development goals (SDGs) in Asian contexts is an area of utmost importance for realizing environmental sustainability, public health, and economic development. The reinforcement of solid waste management (SWM) infrastructure is most pertinent to the achievement of SDG Target 11.6, which aims to minimize the environmental costs of municipal waste generation—a still-unattained objective in the majority of Asia. Urbanization and population growth throughout Asia have increased the burden on municipal waste facilities. This is further exacerbated by low public awareness and a minimum incentive to practice sustainable waste management. All of them lack adequate information regarding the health and environmental threats caused by employing improper waste management strategies, such as landfill expansion and dumping. To counteract this deficiency, policy enforcement and incentive schemes in combination with education programs have worked toward altering perceptions regarding waste as a resource rather than a byproduct. Asian governments are confronted with serious policy challenges, including inefficacy in national and municipal government coordination, inadequate public financing, and failure to develop robust public–private partnerships for effective SWM. Effective intervention efforts have given great importance to collaborative governance, involving municipalities, local communities, civil society organizations, and private sector actors to render waste segregation and management schemes palatable and viable. Transitioning to the new circular economy paradigm from the traditional linear "*take-make-dispose"* consumption model is imperative. Circular economy models aim at less waste, reuse, and recycling with cost savings estimates of 10% to 35% for Asian cities and advance multiple SDG targets addressing environmental integrity, public health, and economic resilience. For example, well-established systems of waste collection segregation and active citizen cooperation in cities such as Yokohama offer replicable models of environmentally friendly municipal waste management techniques for Asia's diverse urban settings. Current regional efforts underscore the importance of mainstream healthcare waste management in the broader SDG process. In the Asia--Pacific region, momentum for sustainable healthcare waste management through mechanisms such as digital traceability systems, enhanced regulatory compliance, circular economy procedures, and enhanced regional coordination in accordance with climate-smart health system frameworks is increasing. It is one component of a broader paradigm shift in Asia to include comprehensive waste management processes in sustainable development efforts. Despite this, there are perennial issues, including the continuing increase in the amount of

waste projected from 802 million tonnes in 2016 to approximately 1.1 trillion tonnes by 2030 and the unequal enforcement of policies among nations. Hence, policy structures must be reinforced to facilitate innovative financing models, construct heightened public engagement, and provide integrative governance across impacted sectors. The literature converges toward the perception that proper waste management is not just a situation but also a stimulus for realizing the SDGs in Asia. This calls for systemic transformation through policy reform, technological innovation, behavioral alteration, and institutional coordination. Only by implementing such comprehensive, multidimensional steps can Asian countries attain cleaner, healthier, and more sustainable urban futures, which is consistent with the 2030 Agenda [23–25].

Policy Frameworks, Technological Advancements, and Institutional Arrangements

Scholarly discussion emphasizes the necessity of integrated strategies characterized by multistakeholder coordination and adaptive governance systems. For example, Guidi (n.d.) indicated that in developing economies of Asia, sustainable agriculture is promoted through the conception of the multifunctional character of agriculture. Smallholders adopt sustainable agricultural practices and participate in inclusive agribusiness value chains in the context of enabling institutional settings and governance systems. This strategy combines productivity advances in agriculture with poverty alleviation and protection of ecosystem services, stressing the need for cross-sectoral and multiscale policy intervention. Policymaking and institutional settings, as presented, feature an across-the-board Asian Development Bank (ADB) critique [26–27] of previous agricultural development policies in Asia for overstressing technological interventions in favorable agro-ecologies while not addressing needed policy reforms and assisting unfavorable agro-ecologies. The study argues that the future of sustainable food hinges on policies internalizing environmental externalities and promoting integrated action across agriculture and natural resource sectors. Policies should incorporate trade reform, fiscal policy instruments, rural infrastructure, and land institutions to increase sustainability and resilience in diverse ecological environments. In the context of food and agricultural waste management, Indonesian empirical research is a very good example of challenges and success in managing food waste in agricultural value chains. The waste management model used considers behavioral change by way of increased awareness, knowledge sharing, and economic incentives, hence promoting waste valorization and sustainable outcomes. This example underscores the key positions of public education, incentive schemes, and structured tracking in guaranteeing waste management toward sustainability. The Chinese concerted agroecological policy model also provides evidence of the effectiveness of cross-ministerial coordination, whole-incentive systems, and research-farm-marketing service unification to drive ecological agriculture and sustainable land management at scale. This institutional model illustrates how government-led policies and well-established institution systems can facilitate sustainability through diversified production systems and secured land tenure arrangements [26–27].

Challenges

Globally, waste management is confronted with intricate challenges driven by intensified urbanization, population expansion, industrial growth, and shifting consumption patterns. The increasing amount and variety of waste streams such as municipal solid waste, industrial residues, and electronic wastes make significant contributions to environmental degradation, public health hazards, and the exhaustion of natural resources. The lack of proper infrastructure and sluggish adoption of advanced technologies, such as automated sorting plants and waste-to-energy facilities, particularly in the Third World, hamper effective waste treatment and recycling schemes. Mega events, such as Mahakumbh 2025, highlight the complex logistical and technological issues of dealing with massive amounts of waste, such as fecal sludge and graywater, and necessitate end-to-end planning and convergence of both conventional and innovative technologies through institutional coordination. Furthermore, technical and institutional capability deficits at the local government level typically restrict the implementation

of sustainable waste management. Eradicating these challenges demands a shift from traditional linear thinking on waste management to circular economy-oriented strategies focusing on waste minimization, resource recovery, and closed-loop operations. These must be complemented by novel technologies such as artificial intelligence based sorting and Internet of Things (IoT) based smart waste management. In addition, fostering community engagement, developing robust policy mechanisms such as extended producer responsibility and facilitating green packaging standards are essential to accelerate sustainable consumption habits and waste source reduction [28–30].

Conclusion

Asia's waste management is standing at a turning point today, with differentiated disparities between developed and developing nations. The achievement of sustainable development goals (SDGs) calls for holistic, inclusive, and creative solutions that address the technical, social, and economic aspects of waste management. Concerted action at the local, national, and regional levels will become essential to translate waste-related challenges into opportunities for sustainable development. In particular, enhancing agricultural and food processing waste management with integrated recovery and valorization technologies is crucial to environmental sustainability, economic competitiveness, and international sustainability objective compliance. A circular bioeconomy minimizing waste and valorizing residues as valuable resources requires the support of robust multi-industry cooperation supplemented with supportive government policy.

References

[1] P. Agamuthu and S. Babel, Waste management developments in the last five decades: Asian perspective, Waste Manag. Res., vol. 41, no. 12, pp. 1699–1716, Dec. 2023, doi: 10.1177/0734242X231199938.

[2] Z. K. Moradi, M. H. Khomami, H. Kioumarsi, H. Dehghanzadeh, and S. T. Jahromi, Cheese whey recycling, the right approach to prevent environmental damage, J. Environ. Res. Technol., vol. 5, pp. 91–99, 2021.

[3] A. Pariatamby and S. Babel, Waste management developments in the last five decades: Asian perspective, Waste Manag. Res., vol. 41, no. 12, pp. 1699–1716, Dec. 2023, doi: 10.1177/0734242X231199938.

[4] Asian Development Bank, Solid waste management in developing Asia: Prioritizing waste separation, 2020. Available: https://www.adb.org/publications/solid-waste-management-developing-asia.

[5] European Commission, Integrated Sustainable Solid Waste Management in Asia (ISSOWAMA). Final Report Summary, CORDIS, 2008. Available: https://cordis.europa.eu/project/id/211873/reporting.

[6] South Asia Co-operative Environment Programme (SACEP), Roadmap for Sustainable Waste Management and Resource Circulation in South Asia, 2019–2030, 2019. Available: http://www.sacep.org/pdf/Reports-Technical/2019.11.06-Roadmap-for-Sustainable-Waste-Management-and-Resource-Circulation-in-South-Asia, -2019-2030.pdf.

[7] Institute for Global Environmental Strategies (IGES), A Roadmap for Sustainable Waste Management and Resource Circulation in South Asia, 2019–2030, Oct. 2022. Available: https://www.iges.or.jp/en/pub/roadmap-south-asia/en12.

[8] H. Kioumarsi, Z. S. Yahaya, and A. W. Rahman, The effect of molasses/mineral feed blocks and medicated blocks on performance, efficiency and carcass characteristics of Boer goats, Ann. Biol. Res., vol. 3, no. 9, pp. 4574–4577, 2012.

[9] K. J. Khorshidi, A. Karimnia, S. Gharaveisi, and H. Kioumarsi, The effect of monensin and supplemental fat on growth performance, blood metabolites and commercial productivity of Zel lamb, Pak. J. Biol. Sci., vol. 11, no. 20, pp. 2395–2400, 2008, doi: 10.3923/pjbs.2008.2395.2400.

[10] H. Kioumarsi, M. Alidoust, and S. C. Allen, Sustainable development. Avaye Ostad, 2022.

[11] S. M. Mahdavian, F. Askari, H. Kioumarsi, R. Naseri Harsini, H. Dehghanzadeh, and B. Saboori, Modeling the linkage between climate change, CH4 emissions, and land use with Iran's livestock production: A food security perspective, Nat. Resour. Forum, Jun. 2024, doi: 10.1111/1477-8947.12532.
[12] M. N. Pham, F. Nishimura, J. C. W. Lan, and K. S. Khoo, Recent advancement of eliminating antibiotic resistance bacteria and antibiotic resistance genes in livestock waste: A review, Environ. Technol. Innov., vol. 36, p. 103751, 2024, doi: 10.1016/j.eti.2024.103751.
[13] S. Fletcher, Understanding the contribution of environmental factors in the spread of antimicrobial resistance, Environ. Health Prev. Med., vol. 20, no. 4, pp. 243–252, Jul. 2015, doi: 10.1007/s12199-015-0468-0.
[14] F. Girotto and R. Cossu, Role of animals in waste management with a focus on invertebrates' biorefinery: An overview, Environ. Dev., vol. 32, p. 100454, 2019, doi: 10.1016/j.envdev.2019.08.001.
[15] U.S. National Library of Medicine, Uniform requirements for manuscripts submitted to biomedical journals: Writing and editing for biomedical publication, Available: https://www.nlm.nih.gov/bsd/uniform_requirements.html.
[16] S. S. Parihar et al., Livestock waste management: A review, J. Entomol. Zool. Stud., vol. 7, no. 3, pp. 384–393, 2019. Available: https://www.entomoljournal.com/archives/2019/vol7issue3/PartG/6-6-95-692.pdf
[17] E. Bonciu, R. A. Păunescu, E. Roșculete, and G. Păunescu, Waste management in agriculture, Scientific Papers, Series Management, Economic Engineering in Agriculture and Rural Development, vol. 21, no. 3, 2021.
[18] A. Khakpour, N. A. Shadmehri, H. Amrulloh, and H. Kioumarsi, Antibacterial effect of Juglans regia, Citrus sinensis, Vicia faba, and Urtica urens extracts under in vitro conditions, Bioactivities, vol. 1, no. 2, pp. 74–80, 2023.
[19] O. Adejumo and M. Adebiyi, Transforming agri-food waste: Innovative pathways toward a zero-waste circular economy, Food Chem. X, vol. 28, p. 102604, 2025, doi: 10.1016/j.fochx.2025.102604.
[20] P. Kumar et al., Agricultural and food waste: Analysis, characterization and extraction of bioactive compounds and their possible utilization, Foods, vol. 9, no. 6, p. 817, 2020, doi: 10.3390/foods9060817.
[21] B. Koul, M. Yakoob, and M. P. Shah, Agricultural waste management strategies for environmental sustainability, Environ. Res., vol. 206, p. 112285, 2022, doi: 10.1016/j.envres.2021.112285.
[22] O. Ozdemir, I. Yilmaz, and A. Gunay, Strategies for managing agricultural waste and disposal options, SAGE Open, vol. 14, no. 1, 2024, doi: 10.1177/21582440241290008.
[23] L. Arthur and P. J. D. Gamaralalage, Solid Waste Management in Developing Asia: Prioritizing Waste Separation, Asian Development Bank Institute, 2020.
[24] United Nations Development Programme (UNDP), Rethinking healthcare waste management in Asia and the Pacific, 2025.
[25] ASEAN Connectivity, Trashing it out: Waste management in Asia
[26] D. Guidi, Sustainable agriculture enterprise: Framing strategies to support smallholder inclusive value chains for rural poverty alleviation, Harvard DASH.
[27] M. S. Kaosa-ard and B. Rerkasem, The Growth and Sustainability of Agriculture in Asia, Manila: Asian Development Bank/Oxford University Press, 1999.
[28] R. E. V. Sesay and P. Fang, Circular economy in municipal solid waste management: Innovations and challenges for urban sustainability, J. Environ. Prot., vol. 16, no. 2, 2025, doi: 10.4236/jep.2025.162003.
[29] M. Fujimoto, The growing challenge of waste management: A comprehensive analysis, Adv. Recycling Waste Manag., vol. 8, no. 2, 2023, doi: 10.37421/2475-7675.2023.8.272.

[30] V. Rai, Mahakumbh 2025: The challenge of waste management, ISAS, Nat. Univ. Singapore, Mar. 1, 2025. Available: https://www.isas.nus.edu.sg/papers/mahakumbh-2025the-challenge-of-waste-management.