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Submission by the Food and Agriculture Organization of the United Nations (FAO) to the United Nations Framework Convention on Climate Change (UNFCCC) in relation to Sharm el-Sheikh mitigation ambition and implementation work programme in accordance with the Decision 4/CMA.4, para 8 and 11

The Food and Agriculture Organization of the United Nations (FAO) welcomes the opportunity to share views on the subject of the fifth global dialogue on enabling mitigation solutions in the waste sector, drawing on national and regional experience, in accordance with the Decision 4/CMA.4, para 8 and 11. Addressing waste within agrifood systems is a central part of any discussion on mitigation solutions. This submission will inform Parties to the UNFCCC with insights from FAO's efforts to optimize the waste footprint of agrifood systems, with benefits for people and the planet.

For FAO, agrifood systems encompass the entire range of actors, and their interlinked value-adding activities, engaged in the primary production of food and non-food agricultural products, as well as in storage, aggregation, post-harvest handling, transportation, processing, distribution, marketing, disposal and consumption of all food products including those of non-agricultural origin.[1] It is often pointed out that, if food loss and waste were a country, it would be the third largest GHG emitter.[2] Around 13.3 percent of the world's food is lost after it is harvested and before it reaches the shops,[3] and around 19 per cent of food that reaches shops and consumers is still wasted.[4] In 2022, waste disposal in agriculture accounted for around 1.2 GtCO2eq globally.[5] Within this, the burning of crop residues accounted for over 44,000 tCO2e.[6] Further to food loss and waste, the waste footprint of agriculture spans diverse domains ranging from agricultural inputs management, biomass produced in agrifood systems that is not consumed or otherwise utilized and instead treated as waste to the use of plastics in agrifood systems.

Sustainable bioeconomy offers a key approach for countries to tackle waste in agrifood systems. Bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, microorganisms and derived biomass, including organic waste), their functions and principles. Bioeconomy offers innovative economic model whereby fossil-based resources (such as oil and gas, conventional plastics, synthetic fabrics, concrete) are replaced by renewable biological alternatives. Furthermore, the bioeconomy's emphasis on sustainable use of natural resources, carbon neutrality, biodiversity conservation, and efficiency or circularity[7] can fundamentally shift paradigms around

1 FAO. 2021. The State of Food and Agriculture. https://openknowledge.fao.org/items/437c1215-556b-4161-9af6-68163f5a1f84
2 FAO, 2014. https://www.fao.org/platforms/green-agriculture/areas-of-work/consumption-food-loss-and-waste/food-loss-and-waste/en
3 FAO, 2021. https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1231-global-food-losses/en
4 UN Environment, 2024. Food Waste Index Report 2024. Think Eat Save: Tracking Progress to Halve Global Food Waste. https://wedocs.unep.org/handle/20.500.11822/45230
5 FAO. 2024. Greenhouse gas emissions from agrifood systems: Global, regional and country trends, 2000–2022. https://openknowledge.fao.org/server/api/core/bitstreams/111b7ee8-282b-42ff-ad95-cccecd90f8ea/content
6 FAOSTAT: https://www.fao.org/faostat/en/#data/GT
7 In 2021, following inclusive consultations over a number of years with leading international bioeconomy experts, FAO published its Aspirational Principles and Criteria for a Sustainable Bioeconomy, where principle 5 states that "Sustainable bioeconomy should rely on improved efficiency in the use of resources and biomass". The following criteria are further specified: Criterion 5.1: "Resource use efficiency, waste prevention and waste re-use along the whole bioeconomy value chain are improved" and Criterion 5.2: "Food loss and waste is minimized and, when unavoidable, its biomass is reused or recycled". Relatedly, the FAO Strategy on Climate Change 2022-2031 "emphasizes the relevance of efficient, inclusive, resilient and sustainable agrifood systems as part of the solutions to climate change"
FAO, 2021: Aspirational Principles and Criteria for a Sustainable Bioeconomy: https://openknowledge.fao.org/items/152324b8-6d78-4d55-b61f-274649c8422d
FAO, 2021: Climate Change Strategy 2022-2031: https://openknowledge.fao.org/server/api/core/bitstreams/f6270800-eec7-498f-9887-6d937c4f575a/content#:~:text=The%20Strategy%20on%20Climate%20Change%20responds%20to%20the%20need%20to,land%2Drelated%20mitigation%20and%20adaptation

how organic waste is viewed and used, potentially reducing its contribution to GHG emissions. Sustainable bioeconomy and circular approaches can reduce emissions associated with the extraction and processing of primary materials, while supporting sustainable development and the creation of green jobs. For example, measures such as waste minimization, recycling, composting, and energy recovery not only directly reduce GHG emissions but also generate indirect climate benefits by conserving raw materials and reducing fossil fuel use. Countries that have implemented ambitious waste policies, such as landfill bans on biodegradable waste and expanded recycling systems, have achieved substantial emission reductions—demonstrating the sector's untapped climate change mitigation potential.[8]

In its Strategic Framework 2021-2031[9], FAO has elevated 'Bioeconomy for Sustainable Food and Agriculture' to the level of a strategic priority and envisions *"A bioeconomy that balances economic value, social welfare, food security and nutrition with environmental sustainability promoted through formulation and implementation of coherent evidence-based policies and practices in micro and macro environments, using technological, organizational and social innovations"*. FAO is collaborating with a growing number of countries to build an enabling policy environment, strengthen the evidence base, foster international cooperation and implement innovative 'waste as resource' projects (see Annex I) to foster the transition to sustainable bioeconomy.

Policy integration and alignment is an important starting point to help realise bioeconomy's potential to reduce GHG emissions from agrifood system waste streams, among other benefits. A growing number of countries are implementing or developing bioeconomy strategies. Launched in 2023, FAO's interactive *Dashboard on bioeconomy strategies and related actions for sustainable development* analyses strategies from 23 countries and three regions, with at least 15 more in development.[3] These strategies, though diverse, all articulate actions or commitments to harnessing biological resources for sustainable development. Of the 1,009 actions extracted from bioeconomy strategies, 503 are mapped as relevant to the Intergovernmental Panel on Climate Change (IPCC)[5] mitigation actions. 63 of these (13 per cent) are mapped specifically to the IPCC mitigation options most relevant to this submission: Waste prevention, minimization and management; Circular economy and industrial waste; Waste-to-energy (WTE); and Reduce food loss and waste.

Switching perspectives, the Dashboard also analyses climate and biodiversity plans. Notably, 22 LT-LEDS highlight bioeconomy. Costa Rica explicitly spotlights the bioeconomy-climate-waste nexus: *"To advance the development of highly efficient agri-food systems with low-carbon export and local consumption goods, Costa Rica aims to transition its agricultural sector to a bioeconomy model. In the short term (2023–2030), Costa Rica will focus on the direct use and sustainable transformation of biological resources, including biomass waste, within a circular economy framework. Looking ahead (2031–2050), the goal is to scale and transform the agricultural system to become a key contributor to the Costa Rican bioeconomy, becoming more productive and resilience while reducing its carbon footprint."*[10] This evidence of growing alignment in objectives across bioeconomy, climate and related planning frameworks is encouraging – yet, there is still far to go. Mainstreaming climate change mitigation into bioeconomy strategies is critical to ensuring low carbon, non-polluting growth strategies – national climate plans should promote the diversification of biomass sources for multiple uses, and the valorisation of waste biomass as animal feed, value-added products or waste-to-energy processes, among other bioeconomy options.[11]

Successful scaling is also contingent on increased investments in bioeconomy science, technology, and innovation, particularly in low- and middle-income countries. Climate funds like the Adaptation Fund, the Global Environmental Facility (GEF), and the Green Climate Fund (GCF) have a critical role to play in scaling up bioinnovations for climate action. Several of the FAO-supported examples shared in Annex I draw on climate finance.

Thanks to its cross-cutting nature, sustainable bioeconomy provides a comprehensive approach to addressing interlinked global challenges, including hunger and poverty, biodiversity loss, and climate change, in line with the

8 European Environment Agency, "Climate change mitigation through policies on waste," ETC/CM Report 2024/01
9 FAO, 2025. Strategic Framework 2022–2031: For the achievement of the 2030 Agenda for Sustainable Development. https://openknowledge.fao.org/server/api/core/bitstreams/62e91f34-65db-448f-af6e-2a5c0ec2667c/content
10 Government of Costa Rica, 2019. National Decarbonization Plan: 2018-2050. https://unfccc.int/sites/default/files/resource/NationalDecarbonizationPlan.pdf
11 FAO, 2023. Sustainable and circular bioeconomy in the climate agenda: Opportunities to transform agrifood systems. https://openknowledge.fao.org/items/79fe360c-71bc-4718-aa9d-28953e641181

Sustainable Development Goals (SDGs), the Paris Agreement and other Multilateral Environmental Agreements. This submission presents FAO's perspectives on the topic, format, and structure of the upcoming global dialogue on enabling mitigation solutions in the waste sector, drawing on FAO's experience in supporting countries to leverage sustainable bioeconomy solutions for climate action, particularly as regards reducing waste streams and valorizing them where possible – and where not, managing them safely.

1. Views on the workshop subject

The updating of countries' Nationally Determined Contributions (NDC 3.0) presents a vital opportunity to strengthen the role of waste reduction and integrated management and sustainable bioeconomy in achieving global climate objectives. The UNFCCC's First Global Stocktake highlights the importance of integrating nature-based and systemic solutions to meet the Paris Agreement goals.[12] Sustainable bioeconomy offers a key approach for countries to reduce GHG emissions from waste, starting with agrifood systems but with important potential to green other sectors, particularly through enhanced waste reduction, recycling, composting, and energy recovery measures.

The key objectives for the dialogue should be to:

- Foster cooperation among stakeholders, including policymakers, municipal authorities, donors, private sector actors, informal workers, civil society, and researchers.
- Build a shared understanding of the mitigation potential of waste reduction and integrated management, including waste in agrifood systems.
- Explore sustainable bioeconomy as a key approach for countries to advance integrated waste management, mitigate GHG emissions and deliver interlinked sustainable development benefits.
- Develop actionable recommendations, policies and financial options for governments to enhance ambition and implementation of waste-related climate change mitigation measures, including in the context of NDC 3.0.

2. Views on the Format and Recommended Speakers

The dialogue could combine expert presentations, plenary discussions and interactive breakout sessions to foster engagement and the exchange of perspectives among all participants. In addition to national government representatives and leading technical experts, the workshop would benefit by including voices from informal sector workers, municipal authorities, private sector actors, and community organizations. FAO recommends including a sectoral focus, to allow for the discussion of specific challenges and opportunities related to the specific types of waste being discussed, including waste within agrifood systems.

The workshop could be structured in three parts:

Part I could open with a series of expert presentations, followed by discussions with workshop participants. This opening session would frame the dialogue around the role of waste management and circularity in meeting the Paris Agreement goals, emphasizing underexplored sectors such as agrifood systems. Suggested presentations include a lead author from the Global Waste Management Outlook, another from the IPCC (e.g. from the IPCC Sixth Assessment Report Chapter 12: *Cross sectoral perspectives – Governance of Land-related Impacts of Mitigation Options, Mitigation and Adaptation via the Bioeconomy*[13]), government representatives that have successfully implemented circularity-based and/or bioeconomy related waste policies, alongside representatives from the private sector to discuss the role of Extended Producer Responsibility (EPR) schemes, the informal waste management sector, community-based and farmers organizations to discuss the role of social inclusion and behavioral change.

Part II could focus on case studies and best practices, again in a presentation and plenary discussion format. This segment could feature regional and local examples of innovative mitigation linked to waste management, sustainable bioeconomy and circular approaches. Examples may include:

12 Paras 33, 55, 61, 63d, Decision 1/CMA.5: Outcomes of the first global stocktake. FCCC/PA/CMA/2023/16/Add.1. https://unfccc.int/sites/default/files/resource/cma2023_16a01E.pdf
13 https://www.ipcc.ch/report/ar6/wg3/chapter/chapter-12/

- Public-private partnerships that create value from agricultural byproducts. An example is the Malaysia bioeconomy corporation quadruple helix programme, that incentivizes scaling up of bio-innovations through matchmaking between primary producers, policy and industry. [14]
- Community-led bioconversion or composting models that enhance food security while reducing methane emissions[15]. An example is rice straw utilization in circular bioeconomy approaches in India where around 30 percent rice straw can provide all the Punjab biogas required.
- Zero-waste city initiatives that close nutrient loops between cities and surrounding agricultural areas. One illustrative case is the BIODAF project in Côte d'Ivoire, which uses Black Soldier Fly larvae to transform organic food waste into high-value agricultural inputs—supporting urban climate action and agrifood resilience simultaneously.[16]

Part III could involve facilitated breakout groups, with final feedback in plenary. This session would focus on designing actionable strategies for enhancing the ambition and accelerating the implementation of waste sector mitigation measures in the context of NDC 3.0. Breakout groups, each facilitated by a neutral expert, could develop recommendations for integrating innovative approaches, such as sustainable bioeconomy and circular principles, into holistic national climate policies, with recommendations for attracting investment.

Conclusion

FAO remains committed to collaborating with the UNFCCC, Parties and partners at all levels to accelerate mitigation solutions in agrifood systems, including through improved waste management and sustainable bioeconomy. As the UN technical agency mandated with achieving food security for all and making sure that people have regular access to enough high-quality food to lead active, healthy lives, FAO supports countries in strengthening policies, building institutional and community capacity, and delivering context-specific solutions. This dialogue presents a strategic opportunity to elevate underrepresented yet high-potential mitigation areas –particularly at the intersection of waste, agrifood systems, and sustainable bioeconomy. FAO recommends a participatory and solution-oriented workshop format that fosters cross-sectoral dialogue, showcases systemic and scalable actions across economic sectors, and builds momentum for integrating waste-related climate actions into NDC 3.0 and beyond.

14 https://openknowledge.fao.org/items/70bac583-f4dd-4b23-838e-8e70e4081d3d
15 https://openknowledge.fao.org/handle/20.500.14283/cd3388en
16 https://www.fao.org/newsroom/story/the-harmless-soldier-fighting-mounds-of-harmful-waste/en

Annex I.

FAO is collaborating with a growing number of countries to articulative innovative 'waste as resource' projects which valorize waste biomass within agrifood systems. One such example is the GEF-supported *Bananas in Pakistan's Bioeconomy: From Waste to Textile* project. A banana pseudostem only bears fruit once and is cut down after harvest, needing disposal. An estimated 2.5 million tonnes of waste biomass from banana production is burned annually in Pakistan, contributing to greenhouse gas (GHG) emissions and air pollution. Instead, converting banana pseudostems into banana fibers that can, in turn, become value-added textiles, can reduce pollution from banana farms and cotton production alike. Preliminary estimates suggest a GHG reduction potential of 845,370 tCO2e direct and 3,340 tCO2e indirect GHG over a 20-year time horizon. Banana fibre also has a lower water and chemical footprint than cotton, and can present a more sustainable alternative also in that context.

While bio-based resources are a promising opportunity for a greener future, many petrochemical based resources remain integral to today's economy. Here, resource and energy efficiency and circularity principles have a vital role to play. In 2025, following an in-depth consultation process with FAO Member Countries, FAO published a *Provisional Voluntary Code of Conduct (VCoC) on the Sustainable Use and Management of Plastics in Agriculture*.[17] The VCoC provides the guiding principles, actions and measures that governments, manufacturers of plastics used in agriculture, and other stakeholders in the agrifood systems may adopt to promote sustainable management practices for plastics used in agriculture. One specific example of an alternative management measure crosses over into bioeconomy: Adopting mulching practices that use organic materials or cover crops, rather than plastic mulching films, avoids the use of plastics. Although these practices may be more costly, savings in inputs, the long-term improvement of the soil, maintenance of yields and access to premium markets could drive change in farming practices. In addition to the avoidance of GHGs associated with plastics, the incorporation of biomass in the soil captures carbon – adding a further climate change mitigation benefit.

At the same time, the waste sector is vulnerable to climate impacts that can disrupt collection, treatment, and disposal systems, especially in rapidly urbanizing and resource-constrained settings. Integrated, circular approaches are needed to build resilience, minimize environmental and health risks, and ensure sustainable waste management for growing populations. In September 2020, FAO launched its Green Cities Initiative (GCI) at the 75th session of the United National General Assembly.[18] The FAO GCI assists cities to identify, develop and implement strategies tailored to their context contributing to green urban regeneration, increasing health and well-being of urban and peri-urban population, supporting mitigation and adaptation to climate shocks and minimization of the carbon footprint, strengthening urban-rural linkages, promoting sustainable urban development and generating green jobs. This is achieved by integrating urban and peri-urban forestry, agriculture, and bioeconomy into the fabric of urban life. Such a multi-functional green infrastructure approach is promoted as lever for sustainable urban development and cities involved can enhance environmental, social and economic well-being of urban population. Through this approach, the initiative is expected to improve the overall resilience of 1000 cities globally by 2030, including small, intermediary, and metropolitan cities and to deliver a wide range of environmental, socio-economic and health benefits to their inhabitants. The urban circular bioeconomy refers to an integrated approach that harnesses biological and natural resources in cities for continuous, regenerative use – delivering environmental and socio-economic benefits. It spans from the valorisation of urban organic waste, the development of bio-based industries and their interaction through industrial biosymbiosis, to the restoration and valorisation of urban natural ecosystems. This includes interventions that recover nutrients from biowaste following the following valorization hierarchy: food for human consumption, animal feed and, at end of cycle, compost/biofertilizer and energy.[19]

In this context, waste-to-energy solutions can enhance urban bioeconomy models by reducing landfill dependence, improving waste collection economics, and supporting low-carbon energy access in urban and peri-urban areas.

17 FAO. 2025. A Provisional Voluntary Code of Conduct on the Sustainable Use and Management of Plastics in Agriculture. Rome. https://doi.org/10.4060/cd3004en

18 https://www.fao.org/green-cities-initiative/en

19 FAO, 2025. Natural resources for resilient, inclusive rural transformation. FAO Inclusive Agrifood Systems Working Papers No. 3. https://openknowledge.fao.org/server/api/core/bitstreams/bc7049b1-aa22-4af9-937a-95ba72218d38/content

These approaches transform unavoidable waste streams into biogas and bioenergy products, helping reduce methane emissions while also improving sanitation and public health. FAO supports a growing number of countries, including Small Island Developing States (SIDS) and Least Developed Countries (LDCs) in this regard. SIDS face severe waste disposal issues, limited land space, and significant energy scarcity. In the Solomon Islands, a 1-hectare farm with over 300 pigs could generate 9,300 m^3 of biogas per year from manure. This biogas plant could produce 20,024 kWh/year, fully covering the farm's energy demand of 4,900 kWh/year. [20] It can also reduce GHG emissions by 106 tonnes CO_2-equivalent per year by avoiding methane emissions, as well as reducing an additional 24 tonnes CO_2-equivalent per year by displacing diesel use for the farm's generator. In Vanuatu, the tourism sector, generates approximately 2,600 tonnes of waste annually, including organic waste. In the context of the GEF-supported *Integrating Bioeconomy and Tourism for Sustainable Vanuatu project,* bioeconomy innovations will be leveraged to secure sustainability certification for tourist resorts. Amongst others, renewable and bioenergy solutions are expected to play an important part.

[20] FAO & UNDP, 2025. Feasibility assessment of biogas potential in the Solomon Islands. https://www.adaptation-undp.org/sites/default/files/resources/Feasibility%2520Assessment%2520of%2520Biogas%2520Potential%2520in%2520the%2520Solomon%2520Islands_final.pdf