Ending Plastic Waste Symposium 2024

Impact of Bioplastics on Environment from Its Production to End-of-life

A Comprehensive Life cycle Assessment study of Bioplastics: Benefits, Challenges, and Sustainability

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Bioplastics, derived from renewable resources, offer a promising alternative to conventional plastics, but their environmental impact must be assessed from production to end-of-life to determine their sustainability.

Background

- To mitigate the plastic pollution, researchers have suggested bioplastics as an alternative.
- Bioplastics can be produced either from biobased resources or biodegradable or made through biological process or combination of the above.
- There are several advantages of bioplastics, such as-
  - reduces the pressure on fossil fuel.
  - biodegradable in short time under proper conditions.
  - reduce the emission of CO_2 and toxic substances.
  - secondary raw materials can be acquired from disposal for further use.
  - enhance microbial activity and thus positively affect the soil respiration.
- The global bioplastics production capacity is set to increase significantly from around 2.23 million tonnes in 2022 to 6.3 million tonnes in 2027.

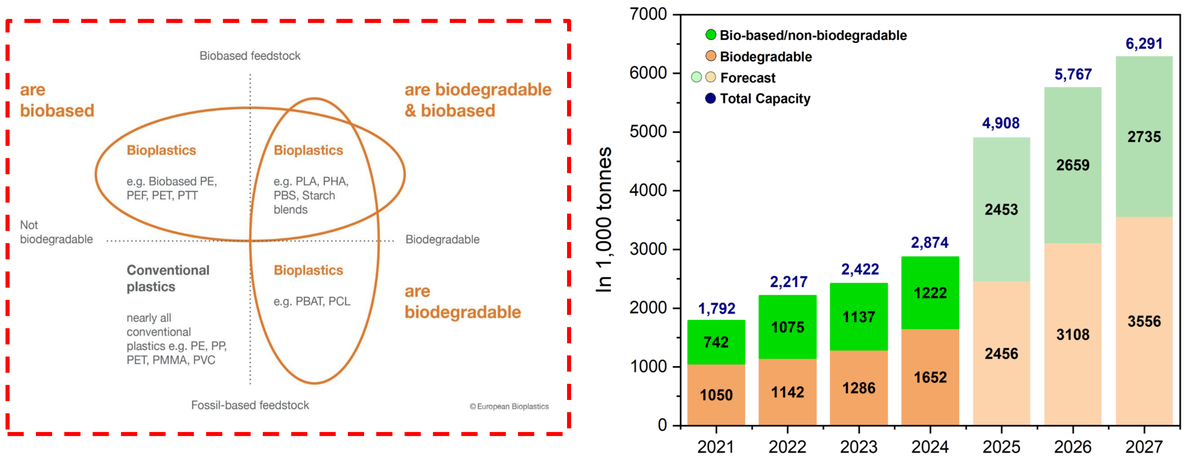

Figure 1: Definition of bioplastics and estimated global production of bioplastics till 2027.

Land and Water Consumption for Bioplastic Production

- The cultivation of crops for bioplastic production requires significant agricultural land, potentially leading to land use changes and competition with food production.
- Irrigation during biomass cultivation can result in high water consumption, raising concerns about water resource depletion.
- To globally replace annual plastic packaging with bioplastic it would require 61 million ha land and 388.8 billion m^3 water.

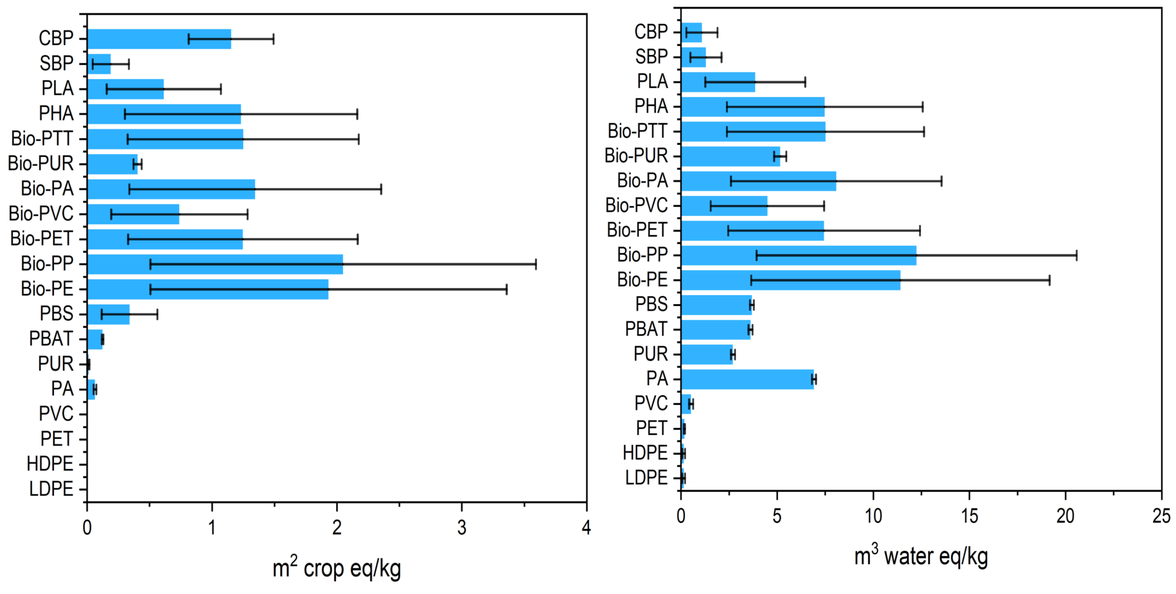

Figure 2: Adverse consumption of land and water during the cultivation of biomass to produce bioplastics

EoL Options for Bioplastics and Their Consequences

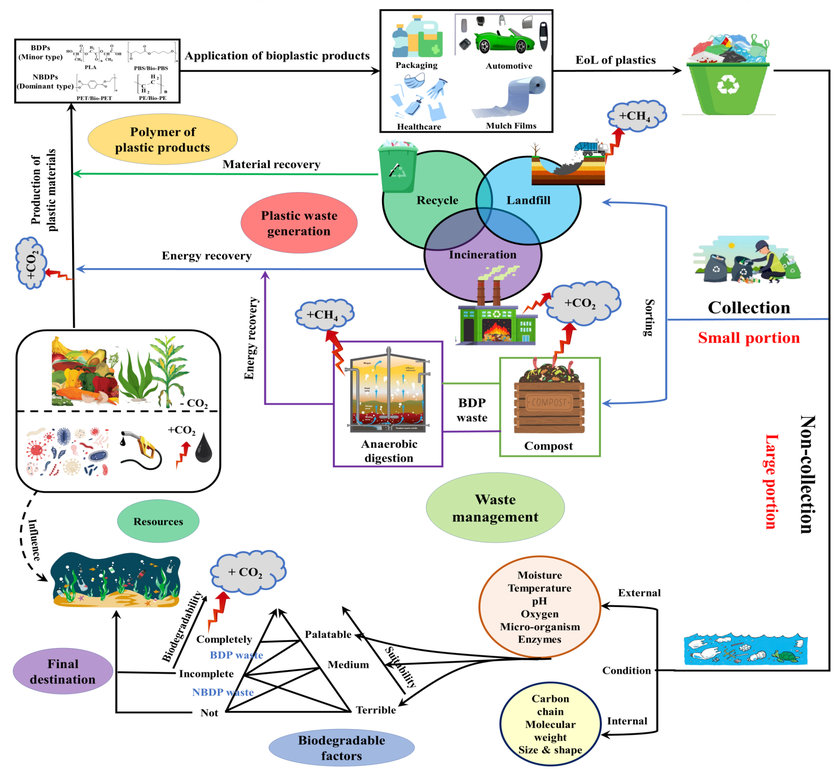

Figure 3: Life cycle of bioplastics illustrating different EoL options and their consequences, such as production of CO_2 and GHG during recycling and environmental pollution may occur if bioplastic wastes are not managed properly.

Key Environmental Concerns

- Bioplastics can show higher GWP than petro-plastics due to emissions from land use changes, deforestation for feedstock cultivation, and energy-intensive agricultural practices.
- Bioplastics can show higher GHG emissions than petro-plastics at end-of-life due to methane emissions from anaerobic landfill degradation and limited composting or recycling infrastructure.
- Acidification and eutrophication potential occurs due the consumption of chemicals during the cultivation of biomass and the degradation of bioplastics involves the release of organic acids and nutrients.

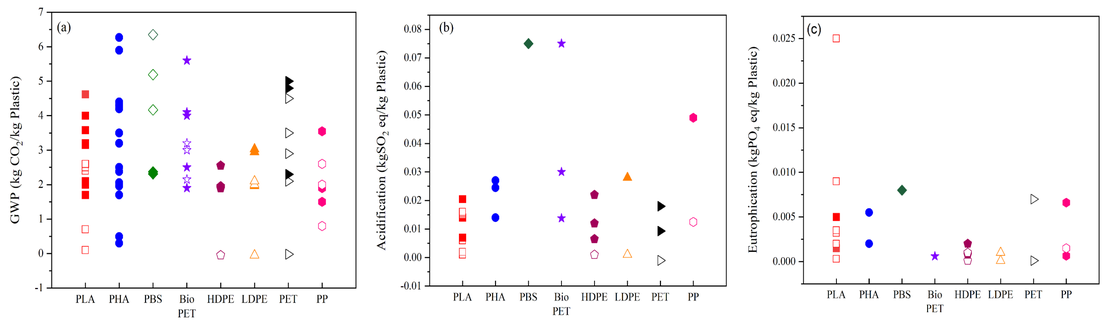

Figure 4: Comparison between bioplastics and conventional plastics in terms of (a) global warming potential ($kgCO_2$ eq/kg) (b) acidification ($kgSO_2$ eq/kg) and (c) eutrophication ($kgPO_4$ eq/kg). Filled markers and open markers indicate cradle-to-gate and cradle-to-grave studies, respectively.

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FOR FURTHER INFORMATION

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