Position Paper

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WWF Position: Biobased and Biodegradable Plastic

Background

Plastic is a versatile, diverse, and now ubiquitous material, typically made from fossil fuels. For a technical definition of plastic, please see the following sources: [1], [2], [3] It is used in many industries including packaging, fast-moving consumer goods, textiles, building and construction, transportation, healthcare, and electronics. Large-scale plastic production began in 1950, with nearly half of all global production of plastic occurring since 2000.[4] The production of plastic is projected to double within the next 20 years.[1] Decades of plastic proliferation have not been without serious impacts.

First, the extraction and manufacture of plastic from fossil feedstocks including oil, natural gas, and coal results in significant environmental impacts including greenhouse gas emissions, water consumption, and habitat degradation. In addition, acute events like oil spills often damage both ecosystems and economies.

Global plastic pollution is an increasingly urgent environmental crisis, and one which has amassed significant public attention in recent years. Plastic pollution threatens aquatic and terrestrial ecosystems around the world. An estimated 8 million tons of plastic waste enter the oceans every year.[5] Plastic pollution has been found in even the most remote environments, it takes hundreds or even thousands of years to degrade in nature (plastic has not been around long enough to know for sure), and it affects wildlife through entanglement, ingestion, and habitat impacts. The release of primary microplastics and the abrasion of macroplastic into smaller pieces, called secondary microplastics, are of significant concern because these plastics can more easily access ecosystems and wildlife. The plastic pollution crisis is the result of a multitude of factors including a broken material management system that cannot adequately recover the material entering the system, the underlying "take-make-dispose" model of the economy, and prolonged patterns of overproduction.

Both the production of plastic and plastic pollution affect many WWF goals including climate, oceans, wildlife, and freshwater.

No Plastic in Nature

Plastic does not belong in nature. WWF has a global strategy in pursuit of the vision of **No Plastic in Nature by 2030**. WWF is working to stop the flow of plastic into nature, eliminate unnecessary plastic, and improve the sustainable production and management of the remaining necessary plastic.

WWF approaches all environmental issues from a One Planet perspective which guides better choices for managing, using, and sharing natural resources within the planet's limits– to ensure food, water and energy security for all. This perspective helps to minimize trade-offs as we integrate our materials efforts into broader conservation work.

There are clear applications where plastics (or alternative options) are necessary but we must recognize that our current global consumption patterns are unsustainable and must therefore first ask whether a product or packaging is necessary at all, before asking whether we can find a more environmentally-friendly alternative.

While the first priority is to reduce unnecessary plastic, WWF does not advocate for elimination of all plastic because when one material is reduced or eliminated from the global material system, environmental costs can be transferred to another part of the system. Material substitution can cause its own trade-offs and the benefits of plastic may be lost (for example plastic packaging can keep food fresh, protected and safe, and therefore minimize food waste). Prioritizing reduction is key, but we must take a careful and holistic approach.

Why WWF Needs a Position on Biobased and Biodegradable Plastic

As public concern on this issue mounts, and as more research and attention is devoted to plastic and its impacts, there is an increasing demand for materials that are perceived as solutions to the plastic pollution crisis, including biobased plastic and biodegradable plastic. However, like all materials, these plastics are limited in what they can and cannot achieve as pieces of a larger, holistic solution.

This is a complex topic and WWF needs a position from which the network as a whole can speak clearly and consistently about the role bioplastic can potentially play in a circular economy, how it is used, and in which systems it can be responsibly and sustainably used. There is high demand for a science-based position on this topic that supports the overarching vision of No Plastic in Nature.

High-level WWF Statements

Biobased plastic: *Biobased plastics may offer environmental advantages over their fossil-based counterparts, but they must be sourced and managed responsibly to realize this potential. Metric-based decision making should be used to assess biobased plastic on a case by case basis.*

Biodegradable plastic: *WWF believes that materials should not be designed to end up in nature. As part of a circular economy, materials should be designed with the intention that they will be recaptured and not littered into natural ecosystems. Biodegradable plastic can be valuable when coupled with proper infrastructure, but it is not a solution to litter or marine debris. WWF does not accept any solution where plastic is leaked into nature, even biodegradable plastic. WWF believes that compostable plastic may be appropriate for specific uses, but it will only be advantageous if collection and processing is sufficient to recover the material.*

Definitions and Position Summary

A bioplastic is generally defined as plastic that is biobased, biodegradable, or both. This definition is problematic because these are independent factors. Not all biobased plastics are biodegradable and not all biodegradable plastics are biobased- see Figure 1.

- **Biobased plastic** is plastic derived from plants or other biomass.[6]
- **Biodegradable plastic** is plastic that will degrade completely into substances found in nature. The definition of biodegradable does not include a specific timeframe or specific environmental conditions for breakdown.[7]
- **Compostable plastic** is a subset of biodegradable plastic. Compostable plastic breaks down and becomes usable, non-toxic soil conditioner under controlled conditions, in a timeframe comparable to that of other compostable materials.[8],[9]

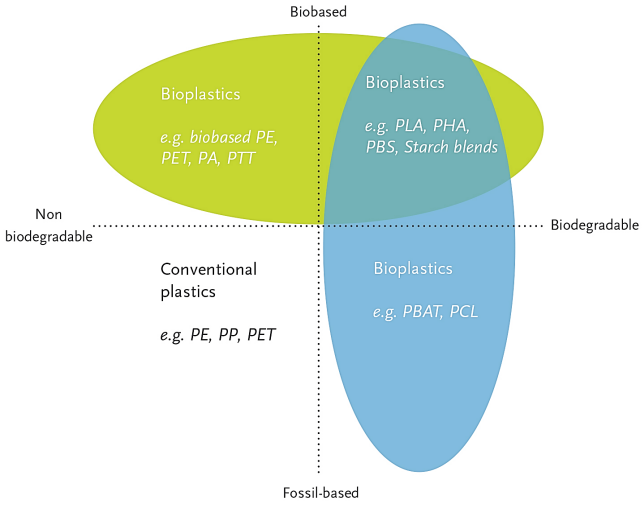

Figure 1. Comparing four categories of plastic [6]

Circular Economy - Biobased and Biodegradable Plastic

- Both biobased and biodegradable plastics should be considered within the context of the Circular Economy.
- Neither biobased nor biodegradable plastic alone will be able to solve the plastic waste crisis. Even when sourced and managed properly, they must be used as part of a larger system of increased circularity.
- The plastic pollution crisis requires a multi-faceted approach to reduce plastic use, improve waste management, increase recycling and composting, and find sustainable alternatives.
- Biobased materials can serve the purpose of replenishing a small but vital amount of resources that cannot be re-circulated infinitely, thereby playing an important role in the success of the circular economy.

Biobased Plastic

- Biobased plastics may offer environmental advantages over their fossil-based counterparts, depending on the specific feedstock used in their production, method of production, product lifetime, and end of life treatment. However, WWF believes that biobased plastic must be sourced and managed responsibly to realize this potential.
    - *Some bioplastics are compatible with existing recycling streams, while others are not. For example – PLA can contaminate rPET mechanical recycling streams, but drop-in bioplastics (biobased plastics that are fully recyclable- they can be "dropped in" to existing infrastructure with no changes to technology or machinery) such as bio-PET or bio-PE can be recycled with conventional plastic. It is imperative that*

bioplastics, like all materials, be paired with the proper collection programs and infrastructure for successful recycling or composting.

- There is no "white list" of sustainable feedstocks. Feedstocks must be evaluated on their regional specific impacts, advantages, and trade-offs with appropriate mitigation actions to ensure sustainability; generalizations will not lead to the desired result of sustainable biomass production systems. Feedstocks should be evaluated in a way that is consistent with WWF's existing approach to measuring the impacts of other agricultural products and activities.
- Metric-based decision-making must be employed to thoroughly evaluate the full range of impacts of a specific feedstock and the system in which it will be used, including potential displacement effects and short-term climate benefits.
- Biobased plastics are not a solution for plastic pollution, as they face the same end-of-life challenges, and in most cases are as likely to become plastic pollution as fossil-fuel based plastics. If appropriately sourced, they may offer environmental advantages over their fossil-based counterparts. However, their overall climate footprint still depends on the entire life cycle of the plastic product, including end-of-life management. WWF does not indiscriminately support all biobased plastics, as the environmental advantages of these materials differ depending on the specific feedstock used and the subsequent product lifecycle.

Biodegradable Plastic

- Biodegradable plastic can be valuable when coupled with proper infrastructure, but it is not a solution to litter or marine debris.
- Materials should not be designed to end up in nature. WWF does not accept any solution where plastic is leaked into nature, even biodegradable plastic.
    - WWF believes that compostable plastic may be appropriate for specific uses but will only be advantageous if collection and processing is sufficient to recover the material.
- Metric-based decision-making must be employed to thoroughly evaluate the full range of impacts of a specific biodegradable plastic feedstock, including potential displacement effects and short-term climate benefits.
- While recognising that there are ongoing developments in this field, in principle WWF will only consider applications of biodegradable plastic in systems where:
    - they have been subjected to metric-based assessments which thoroughly evaluate the full range of impacts of a specific feedstock and systems in which they will be used and,
    - appropriate collection, separation and composting or anaerobic digestion infrastructure exists or
    - the application is necessary, the recovery of the material is not practically feasible, and there is clear scientific evidence that the material will completely degrade into substances found in natural ecosystems within a timespan that will not cause ecological harm.
- Compostable plastic is a subset of biodegradable plastic intended to break down in controlled conditions to become usable soil conditioner. For the remainder of the paper, biodegradable plastic that is intended to be collected and processed through industrial composting or anaerobic digestion will be referred to exclusively as compostable plastic.
    - Reduction and reuse of plastic should be prioritized before compostable plastic, and compostable plastics should not be used to substitute for formats that have high recycling rates.

Oxo-degradable Plastic

- Oxo-degradable additives are substances added to conventional plastics to promote oxidation. Oxidation brittles and fragments the material with the intention to be digestible by microorganisms, but evidence shows that this desired effect is not achieved.
- There is no credible evidence that these additives result in environmentally advantageous outcomes.
- WWF does not support the use of oxo-degradable materials, as they do not result in better environmental outcomes and contribute to microplastic pollution. (WWF Position Paper on oxo-degradable additives under development)

Position Details and Justification

The Role of Bioplastics in a Circular Economy

WWF defines a sustainable Circular Economy as "a regenerative system, driven by renewable energy that replaces the current linear 'take-make-dispose' industrial model. Materials are instead maintained in the economy, resources are shared, while waste and negative impacts are designed out. A sustainable Circular Economy creates positive environmental and society-wide benefits and functions within planetary boundaries, supported by an alternative growth and consumption narrative." (WWF Circular Economy Position). The bioeconomy is one piece of the circular economy through which flows are recycled into "new" material to re-enter the system and replenish material lost from degradation. This "bio-cycled" material is needed in a fossil-free economy because most materials cannot be recycled infinitely.

In a circular economy, materials are constantly reused and recycled to make new goods, cycling through a cascading-value system where materials are used multiple times before they are given a new use. Some materials like glass and aluminum can be recycled infinitely with only a material processing loss and no loss in quality, but plastic and other materials lose important quality aspects when re-processed, and eventually become too degraded to make new items. Because plastic degrades over time, new inputs of plastic will be necessary, and responsibly sourced bioplastics can fill this gap. Although they cannot be recycled in current infrastructure at a global scale, compostable materials, if recovered and processed through systems such as industrial composting or anaerobic digestion, can provide another tool by which we sustainably re-circulate valuable material. As with all materials, both biobased plastics and compostable plastics must be consistently recovered and reprocessed to be part of a truly circular economy.

Material changes alone will not change the system. Developing and integrating new plastics into the system must be tied into larger systemic change to improve global materials management. Bioplastics may serve an important role in the pursuit of No Plastic in Nature, but only if pursued alongside strategies such as reduced single use plastic, improved end-of-life management, and longer-living products.

Biobased Plastic

Biobased plastics offer the opportunity to decouple from fossil resources, achieve greenhouse gas emission savings, and contribute to a resilient local economy. Responsible production of renewable materials is an important piece of the circular economy. It is called out specifically as a key strategy in the New Plastics Economy Global Commitment put forth by the Ellen MacArthur Foundation.[10] However, agriculture has serious impacts on our planet and biobased plastics today are largely made from agricultural commodities. Their production can have complex effects on landscapes.

Responsible sourcing ensures that biomass is grown, processed, and delivered in a way that protects our natural resources so that we can continue to depend upon them in the future.[11] Responsible sourcing also protects the future ability of the agricultural system to operate successfully and builds resilience against climate change, supply shocks, and price volatility. Responsible sourcing depends on the feedstock used, local conditions, and the technology and process of production.[12]

Biobased plastics can have comparatively lower environmental impacts than fossil-based plastics. Incorporating biobased plastics into a local system may even have a positive impact on producer welfare and resilience. The end-of-life impacts of a bioplastic depends on the chemical structure of the plastic and the fate of the material (recycled, landfilled, littered, etc.). Bioplastics can be recyclable, compostable, or neither depending on their chemical structure but they must be part of a circular system, being efficiently reused, recycled, or composted to reduce end-of-life impacts. Pairing all materials with an appropriate waste management system is necessary to advance circularity.

Allocating land use towards a sustainable future is complex and depends on local environmental, social, economic, and policy conditions. There is no silver-bullet solution to land-use optimization. Decision-making around land use must address and balance local needs, potential risks, and potential benefits of incorporating biobased material production into the agricultural and economic system under consideration. Agricultural activity can result in both negative and positive impacts, both of which need to be carefully considered.

The current land-use of bioplastics as a share of total global agriculture area is .016%, and is expected to increase to .021% by 2024. Biofuels currently use 1% of global agriculture area. The majority of global agriculture area is devoted to pasture, followed by food and feed.[13]

Responsible Sourcing of Biobased Plastic – Definition and Criteria

WWF believes that responsibly sourced biocontent at a minimum must be legally sourced; derived from renewable biomass; pose no adverse impacts on food security; have no negative impact on land conversion, deforestation, or critical ecosystems; and provide environmental benefits - including near-term climate benefits - compared with fossil-based plastic.[11] Credible certifications such as the Roundtable on Sustainable Biomaterials can help ensure responsible sourcing.[14] The assessment of RSB as a credible certification is based on the WWF-developed Certification Assessment Tool (CAT). WWF has deep expertise and resources on responsible sourcing.[11], [12], [15] The sourcing advice and requirements for biobased plastic should be consistent with that provided by WWF for responsible sourcing of other agricultural and forest products.[15],[16]

Feedstocks

Biobased plastic feedstocks are sometimes classified by generation. First generation feedstocks are traditional agricultural crops, second generation are typically from cellulosic crops, residue, and agricultural waste, and third generation are based on novel, typically non-land-based sources such as algae. The generation a feedstock belongs to is not necessarily indicative of the broader environmental sustainability of that feedstock. The generation is also no guarantee of climate impact (not least because that depends on the lifetime of the plastic product and whether it is burnt at end-of-life) and cannot predict the effects that the cultivation of the feedstock will have on either the local population or the environment. Biobased plastic feedstocks must be evaluated case by case, on their advantages and trade-offs, including their regionally specific impacts.

Many choices of feedstock options exist for many geographies and for many applications. Biobased plastics can be made from a wide variety of feedstocks, each of which has its own advantages and disadvantages. The impacts of these feedstocks are highly variable across geographies. For example, sugar cane grown in Brazil has different impacts and considerations for sustainability than sugar cane grown in India. The complex nature of choosing a biobased feedstock for a specific application in a specific

geography means that there is no “best” feedstock. Trade-offs must be evaluated to determine the best option for the region and intended use, and whether or not biobased options are suitable at all in the local context. Biomass production systems are complex and interwoven with local economies and livelihoods, and the ecological and social impacts will vary greatly on a case by case basis.

WWF has clear responsible sourcing criteria for biocontent.[11] From these criteria, it is possible to examine a bioplastic’s environmental, social, and economic impacts on a more detailed level, and see how it measures up to the ideal. All feedstocks will have advantages and disadvantages, so the focus should be not on finding a perfect feedstock, but on committing to the continuous improvement of the best available option for that technology and sourcing region. Life Cycle Assessments can be used as a preliminary method of evaluating a feedstock, but these tools do not capture land-use change effects or provide a complete picture of the full range of impacts, especially at a landscape scale.

There is no “white list” of feedstocks that are considered sustainable. WWF supports the use of metric-based decision making (for ex. through the Supply Risk Inquiry methodology) to thoroughly evaluate the environmental and social risks, impacts, and opportunities of biomass sourcing.

A note on waste residue: Utilizing agriculture and forest residues, which are by-products of existing production, offers a potential opportunity to reduce the environmental and social impacts of bioplastic production. However, in using waste residue there must be assurance that the waste is truly waste, and not being displaced from another use. (WWF recommends the RSB methodology for determining wastes and residue, Advanced Products Standard).

Residues used for bioplastic production can displace the original uses, which include ground cover, fuel, fodder, fertilizer, fiber, animal feed, and pulp and paper. It is important to consider the environmental impacts of the substitutes that are used to replace residue materials, as this can significantly influence the environmental footprint of residue-based bioplastics. Furthermore, the removal of cellulosic and agricultural harvest residues from fields (i.e. where they would otherwise be left as ground cover) can have serious impacts on soil health and stability. Sustainable removal rates are highly variable, and currently each case must be considered individually.

Biodegradability

Biodegradable means a material will degrade into substances found in nature under customary disposal conditions within a reasonable time frame. This definition is vague, and there is no universal definition or enforcement of the term “biodegradable” which often leads to greenwashing. The timeframe for degradation is highly dependent on the conditions of the environment (temperature, oxygen, moisture, salinity, etc) and lab tests are insufficient to prove true biodegradability in all potential conditions. If biodegradable plastic is littered in an environment in which the material was not designed to degrade, it will have continuing impacts there. For example, in aquatic environments, biodegradable materials may not biodegrade because the optimal conditions (temperature, UV exposure, oxygen level, microorganisms, physical disturbance) are unlikely.[17] Similarly, the climate impact of biodegradable plastics will depend on things such as the original feedstock used in their production and the rate at which they degrade. Because biodegradability depends entirely on the conditions of the environment where a biodegradable material ends up, which cannot be predicted, WWF believes no plastic of any type should be designed to end up in nature. WWF advocates for a focus on reduction, reuse, and increased circulation (recycling or composting) of plastic.

Biodegradable plastic is not a solution to marine litter. The highly variable conditions in nature means that it cannot be guaranteed that these materials will biodegrade in a timely manner, and these materials still have impacts on the environment while they are degrading. Biodegradability does not support circularity unless recovered and processed by a system that can recapture its value.

Compostability can play a potentially beneficial role in a responsible material system, but it must be paired with the right infrastructure and applications. If the infrastructure is in place to collect and process compostable plastic through industrial composting or anaerobic digestion, potential environmental, social, and economic benefits could be realized.[18],[19] Currently, these systems are not available in much of the world and reduction and reuse of plastic should be prioritized first.

In situations where the application severely limits the option to recover the material and there is an inherent limiting factor that prevents integration of the material into the recycling stream, biodegradable plastic may prove beneficial. For example: agricultural film. Biodegradable characteristics may be beneficial for agricultural film because it is difficult to recover all of the material, and the contamination and degradation of the material makes it very unlikely to be recycled, meaning these films are usually landfilled or burned. Even when removed, some pieces of agricultural film are often left behind in fields and end up ploughed into soil. Also, agricultural film is an example of an application in which plastic is shed during the use phase of the material and is in constant contact with organic material. Therefore, biodegradability may offer net benefits in this specific application because conventional plastic would degrade more slowly. In general, biodegradable film designed to be above or slightly below the surface of the soil may result in less impact than conventional film.

Oxo-degradable additives

Additives can be incorporated into non-degradable plastics to make them “degradable” or “fragmentable” by reaction with oxygen, light or moisture. Although these materials are often touted as a solution to plastic pollution, there is no credible evidence that these additives actually result in environmentally advantageous outcomes.[20] Evidence suggests these materials do not completely break down in nature but instead fragment into smaller pieces and continue to impact wildlife and their habitats. WWF is in alignment with the position paper put forth by The Ellen MacArthur Foundation on this topic. WWF, EMF,

and 150+ organizations agree that oxo-degradable plastic is inconsistent with circular systems and is not a viable solution to any type of pollution.[21]

Conclusion

As the world's leading conservation organization, WWF has a responsibility to communicate clearly and consistently on topics that impact WWF goals. Both biobased and compostable plastics can play a beneficial role in the Circular Economy but only when certain conditions are met to ensure risks are mitigated. Bioplastics are not a panacea for the global plastic pollution crisis but must be integrated along with other strategies towards No Plastic in Nature such as reduced single use plastics, improved collection and recycling/composting systems, and adoption of other sustainable materials.

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