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BRIEF REPORT

Bioplastics, from promise to reality: Policy recommendations to accelerate industry adoption

[version 1; peer review: 2 approved with reservations]

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Abstract

Background

In the context of the European Green Deal and the European Union's transition towards a circular and sustainable economy, bioplastics are emerging as a promising alternative to fossil-based plastics. However, despite increasing interest from industry and society, their large-scale adoption remains limited. This policy report synthesizes challenges, risks, and opportunities for the sustainable scaling of bioplastics.

Methods

It draws on evidence from an online multi-country survey with 18 stakeholders across the bioplastics value chain, including manufacturers, processors, retailers, and R&D centres, predominantly based in Europe.

Key Results

The findings reveal an acceptance-adoption paradox: while stakeholders express high acceptance of plant- and waste-based bioplastics, this positive perception does not translate into widespread market uptake. Key barriers include limited availability and unstable

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supply chains, high production and commercialization costs, technical and environmental performance concerns, regulatory challenges, and lack of consumer demand. Market volatility and regulatory uncertainty were identified as the most significant business risks, constraining long-term investment and strategic planning. Waste- and insect-based bioplastics, although recognised for their high sustainability potential and alignment with circular bioeconomy principles, are perceived as particularly challenging to work with and face additional trust and acceptance hurdles.

Conclusions

Based on these insights, the report advances with evidence-based policy recommendations to accelerate bioplastics adoption. These include strengthening regulatory harmonisation and legal clarity, incentivising innovation focused on cost reduction, performance improvement and safety assurance, reinforcing supply chains through targeted economic incentives, and promoting transparency through certified life cycle assessments and robust communication strategies. The report also highlights the importance of public engagement, participatory approaches, and multidisciplinary collaboration to counter misinformation and greenwashing. Overall, the findings suggest that with coherent policies, targeted investments, and trust-building measures, bioplastics – especially those derived from waste valorisation – can play a strategic role in Europe's sustainable plastics transition.

Plain Language Summary

- Online survey with 18 bioplastics industry stakeholders (e.g., manufacturers, processors, retailers, and R&D centres), mostly from Europe (89%).

- Findings show that stakeholders expect moderate yet steady growth of the bioplastics industry in the next decade.

- Key challenges to bioplastics adoption include limited supply, high production and commercialization costs, concerns about performance and safety, and regulatory and legal challenges (e.g., regulatory uncertainty).

- Stakeholders' acceptance of plant- and waste-based bioplastics is strong (although lower for insect-derived ones), but market volatility (i.e., abrupt changes in prices) remains a concern.

- Bioplastics are still perceived as more challenging to work with than traditional plastics, with waste- and insect-based bioplastics being rated as the most challenging.

- Legislative harmonisation and fair policies, economic incentives to production and commercialization, investment in R&D funding, and

multidisciplinary inter-organizational collaborations are crucial to accelerate bioplastic market growth.

• Greater transparency and tailored evidence-based communication (e.g., on bioplastic regulatory approvals and product safety), coupled with stronger public engagement strategies, can counteract greenwashing and boost industry and consumer trust.

Keywords
Bioplastics, EU policy, Circular economy, Sustainability, Waste valorisation, Plastics transition, Market Recommendations, Acceptance–adoption paradox

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Context of the issue

In the context of the European Green Deal (European Commission, 2019), the plastics transition (European Commission, 2018), and the shift to a more circular and sustainable economy (European Commission, 2020), bioplastics are emerging as a promising alternative to fossil-based plastics (Di Bartolo *et al.*, 2021; European Bioplastics, 2023; European Commission, 2022a; Rosenboom *et al.*, 2022). This policy report, based on a survey of 18 industry stakeholders, reveals a strong interest from the sector: the acceptance of plant- and waste-based bioplastics is notably high.

However, a significant gap exists between this perceived potential and market reality. Consistent with the literature on industry barriers to the production and commercialization of biopolymers (see Possidónio *et al.*, 2025), the findings presented in this policy report show that the plastics transition is still being hampered by economic, regulatory, and technological challenges that limit adoption and large-scale implementation. Companies face a dilemma: while they are willing to innovate towards sustainably, they are confronted with unstable supply chains, high production and commercialization costs, product performance challenges, scalability issues, lack of specialized workforce, and unfair competitiveness from other sectors (Possidónio *et al.*, 2025). The lack of regulatory clarity and fair policies that acknowledge the differentiating factor of bioplastics, coupled with abusive misinformation about sustainability and environmental performance (e.g., mislabelling and misleading marketing campaigns), and activist claims of greenwashing undermines market and consumer trust, delaying an urgent transition (Ammendolia & Walker, 2024; Persakis *et al.*, 2025).

In particular, the implications for waste- and insect-based bioplastics are especially relevant. These emerging feedstock streams hold significant potential to address multiple systemic challenges simultaneously, notably waste management challenges, the need to diversify raw material sources in the plastics transition, and the European Union strategic goal of reducing dependency on imported fossil resources as part of its broader energy security agenda (European Commission, 2022b). Specifically, waste- and insect-based bioplastic solutions can valorise organic, food, and agricultural waste streams that would otherwise contribute to environmental burdens, thereby supporting European Union Waste Framework Directive principles (European Parliament, 2008; European Parliament, 2025), enhancing sustainability and resource circularity. Through the conversion of low-value organic residues these offer an innovative route to generate biopolymers while reducing dependency on land-intensive crops or fossil-based resources. This capacity to transform waste into value-added materials positions waste- and insect-based bioplastics as strategic solutions that align with European Union ambitions for a circular bioeconomy (European Commission, 2024)

In this context, the present policy report synthesizes findings from an online multi-country survey of stakeholders across the bioplastics value chain, including manufacturers, processors, retailers, and R&D centres, to identify challenges, risks, and opportunities for the sustainable scaling of bioplastics.

Policy recommendations

Based on evidence from the multi-country survey, the following actions are proposed to accelerate the adoption of bioplastics and capitalize on their potential:

- ***Mitigate market volatility and regulatory uncertainty:*** Market volatility and regulatory instability were the top risks identified by the sector (M = 3.89/5; SD = .76 and M = 3.78/5; SD = .88 respectively).

  Action: Building on the European Union policy framework on biobased, biodegradable and compostable plastics (European Commission, 2022a), there is the pressing need to establish a comprehensive, long-term European regulatory framework for bioplastics that mitigates regulatory uncertainty and reduces market volatility. This framework should prioritize a stronger harmonization of definitions, standards, and certification schemes for terms such as "biodegradable", "compostable" and "bio-based", including clear rules for using these terms in marketing campaigns, and penalizations for companies that do not comply. As proposed by the Green Claims Directive (European Commission, 2023) and the subsequent legislative resolution of the European Parliament (2024), adopting clear and consistent criteria would help to eliminate confusions and misconceptions, increase accountability, and strengthen both industry and consumer trust in performance and sustainability claims, an area where 38.9% of the respondents were currently neutral.

- ***Incentivize innovation focused on cost reduction, performance improvement, and product safety:*** High cost was highlighted by stakeholders as a critical barrier and a significant production risk. At the same time, belief in the performance of bioplastics is fragile, with 27.8% (n = 5) of respondents feeling neutral and 22.2% (n = 4) disbelieving in their performance.

  Action: Following European strategic recommendations for the sector (European Commission, 2022a), it is crucial to reinforce public and private funding for bioplastics R&D with specific targets: (a) scaling up production to improve cost-competitiveness; (b) optimizing the technical properties of bioplastics, especially for waste-based and insect-based, that have the potential for higher sustainability benefits but are considered the most challenging to work with (M = 3.39/5; SD = 1.24 and M = 3.28/5; SD = 1.07 respectively); (c) developing an efficient network of infrastructure for the end-of-life recovery, recycling, and composting of bioplastics; (d) strengthening product-safety assessments, particularly regarding on long-term environmental and human-health impacts, to ensure robust safety standards that foster both

industry and consumer trust; and (e) promoting effective and truthful public engagement and participation through the development evidence-based frameworks and interventions grounded in robust and methodologically sound social-science research.

- ***Strengthen the value chain and market access:*** The primary barrier for industry stakeholders' non-adoption was "lack of availability or supply" (M = 4.00/5; SD = .63), with "supply chain instability" also being considered a relevant risk (M = 3.61/5; SD = .98).

  Action: In line with the long-standing recommendations of the Organisation for Economic Co-operation and Development (OECD, 2013) and more recent guidance from the European Investment Bank (Brzezicka *et al.*, 2025), there is a pressing need to establish tax incentives or other financial mechanisms that reward the adoption of certified environmentally sustainable technologies. Particular focus should be given to supporting Small and Medium-sized Enterprises (SMEs) that invest in technology adoption, bioplastics procurement, feedstock processing, and supply chain development. Concurrently, incentives and tools should be implemented to foster and strengthen multi-sector collaboration platforms, initiatives, and networks, as partnerships between industry stakeholders were rated as the second-most effective strategy for managing risks (M = 4.22/5; SD = 1.06).

- ***Promote consumer trust in bioplastics from waste valorisation:*** Insect-based products face stakeholder scepticism, showing lower levels of acceptance (M = 3.22/5; SD = 1.11), notably below traditional plastics (M = 3.33/5; SD = 1.37). Likewise, waste- and insect-based bioplastics were rated as the most challenging to work with (M = 3.39/5; SD = 1.24 and M = 3.28/5; SD = 1.07 respectively). Waste- and insect-based bioplastics are critical for the success of the plastics transition and the implementation of sustainable circular business models. This is accomplished by tapping into the valorisation of waste streams, supported by innovative bioprocessing pathways, without the risk of competing with food production resources. Promoting trust through clear knowledge-building practices, transparent policies, robust data-based evidence, and well-designed regulations is crucial to overcome misconceptions and encourage acceptance, positioning these sustainable alternatives as safe and environmentally beneficial.

  Action: Given the growing reliance of many bioplastics industries on food and other waste valorisation processes, it is essential to establish clear and consistent regulatory pathways that allow the bioplastics sector to utilize waste stream resources. At the same time, promoting consumer engagement with these products is crucial to dispel misconceptions and ensure, through tailored and evidence-based interventions, that products derived from waste or insects are recognized as safe, complying with rigorous safety standards that protect human health and the environment. Transparent, evidence-based policies and regulations are also needed to build consumer trust and facilitate the adoption of these sustainable alternatives (European Parliament, 2024). Complementary to this, participatory, co-production, and citizen science initiatives should be encouraged to foster collaboration between industry and consumers, facilitating a shared understanding of waste- and insect-based bioplastics (European Commission, 2024). These initiatives must be supported by comprehensive research on the long-term impacts and benefits of waste- and insect-based bioplastics, including those arising from scaled-up production and widespread consumer adoption, areas where data is currently lacking. By bridging the gap between industry and consumers, such initiatives can help contextualize and address the challenges of bioplastics production and commercialization, thereby reducing the risk of greenwashing.

- ***Build trust through transparency:*** Overall, survey results suggest that mistrust and misinformation are key challenges, not only for public perception, but also for industry stakeholders' willingness to adopt bioplastics. For example, 38.9% (n = 7) of respondents were uncertain about claims of sustainability, 33.3% (n = 6) were uncertain about health and environmental safety claims, and 27.8% (n = 5) were uncertain about performance claims. If stakeholders do not trust the product, they will not invest. For that, companies need clear proof of material performance, safety, and sustainability, including certified Life Cycle Assessments (LCAs).

  Action: To promote adoption and consumer trust in bioplastics, it is essential to implement European certification programs based on transparent and mandatory LCAs that independently verify and attest for the lower environmental footprint and safety of bioplastic products (European Commission, 2022b). These efforts should be complemented by consumer engagement actions that raise awareness, build trust, assure safety, and drive demand for bioplastics. Literature in the field (Domingos *et al.*, 2025) suggests several key actions to achieve this: (a) developing targeted and tailored communication campaigns to increase consumer awareness and familiarity with bioplastics; (b) addressing knowledge gaps through customized materials and engaging industry stakeholders and consumers in co-creating the future of bioplastics; (c) ensuring that all claims are truthful, accurate, and supported by certified standards; (d) pre-testing and monitoring communications and interventions to assess their impact and effectiveness on consumer understanding and engagement; and (e) identifying and addressing misconceptions and information gaps that may arise (e.g., on production aspects, safety, benefits, risks, and disposal procedures) following consumer-centred evidence-based approaches. Additionally, companies can strategically utilize traditional and social media platforms, not only as communication channels but also as tools to monitor and understand consumer behaviour, and to inform future engagement strategies (Cruz *et al.*, 2025).

Evidence and analysis

This policy report is based on an online survey of 18 stakeholders from the bioplastics sector, including manufacturers, processors, retailers, and R&D centres. All data is available on Open Science Framework (Farias *et al.*, 2025). Participants' ages ranged between 30 and 68 years old (M = 44.5; SD = 12.1), with the majority being female (n = 10; 55.6%). Most participants were from Europe (n = 16; 89%), predominantly Portuguese (n = 12; 67%), with others from Italy, Spain, the Netherlands, and Cyprus; two participants were from outside Europe (Brazil and India). Most reported working in Portugal (n = 13; 72%), while others worked in Greece, Italy, the Netherlands, Spain, and India. The study assessed barriers, risks, acceptance, and future scenarios for bioplastics. All participants reported having higher education degrees, with the majority (n = 11; 61.1%) reporting holding a PhD or equivalent. Two-thirds of the participants (n = 12; 66.7%) reported that their companies already work directly with bioplastics, while 27.7% (n = 5) expressed future interest. Participants had an average of 8.72 years of experience working with bioplastics (SD = 6.49), with most (n = 16; 88.9%) having over one year of experience and the majority (n = 14; 77.8%) having between 1 and 10 years of experience. On average, participants rated that their companies work more frequently with packaging-related products (M = 3.94/5; SD = 1.73), followed by food-related products (M = 3.22/5; SD = 1.83), agri-products (M = 2.17/5; SD = 1.58), cosmetic products (M = 1.94/5; SD = 1.47), health-related products (M = 1.78/5; SD = 1.22), and pharmaceutical products (M = 1.39/5; SD = .70).

The acceptance vs. adoption paradox: Figure 1 shows a high acceptance of plant- (M = 4.28/5; SD = .90) and waste-based bioplastics (M = 4.00/5; SD = 1.03). Acceptance levels were moderate for traditional plastics (M = 3.33/5; SD = 1.37), and lower for insect-based plastics (M = 3.22; SD = 1.11). However, this positive attitude towards plant- and waste-based bioplastics does not necessarily translate into widespread adoption due to practical barriers. As shown in Figure 2, stakeholders identified as main barriers to bioplastics adoption the lack of availability or supply (M = 4.00/5; SD = .63), high cost (M = 3.83/5; SD = .98), and performance concerns (M = 3.33/5; SD = .82). Moreover,

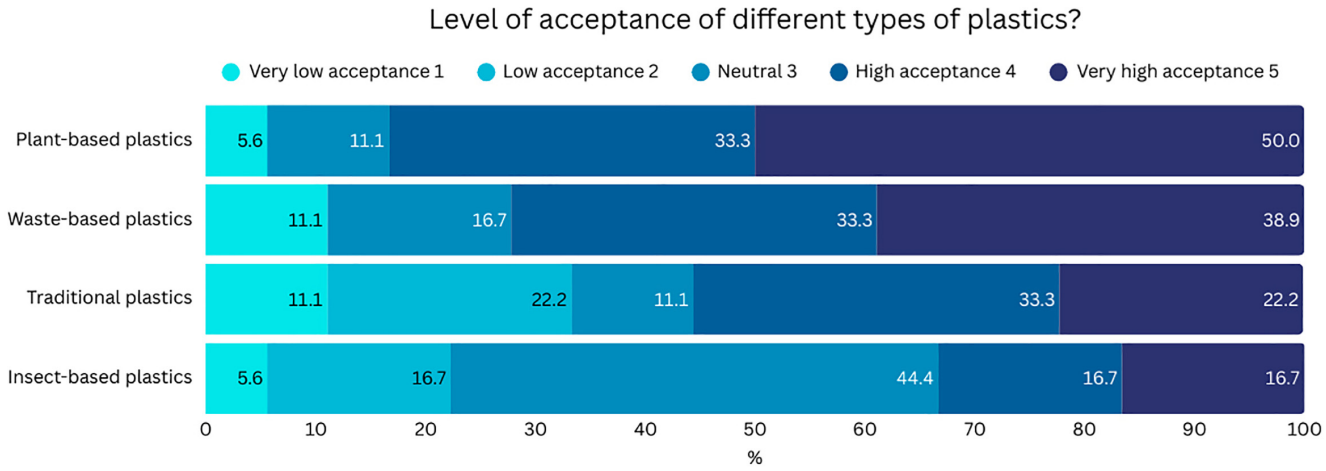


Figure 1. Stakeholders level of acceptance of different types of plastics.

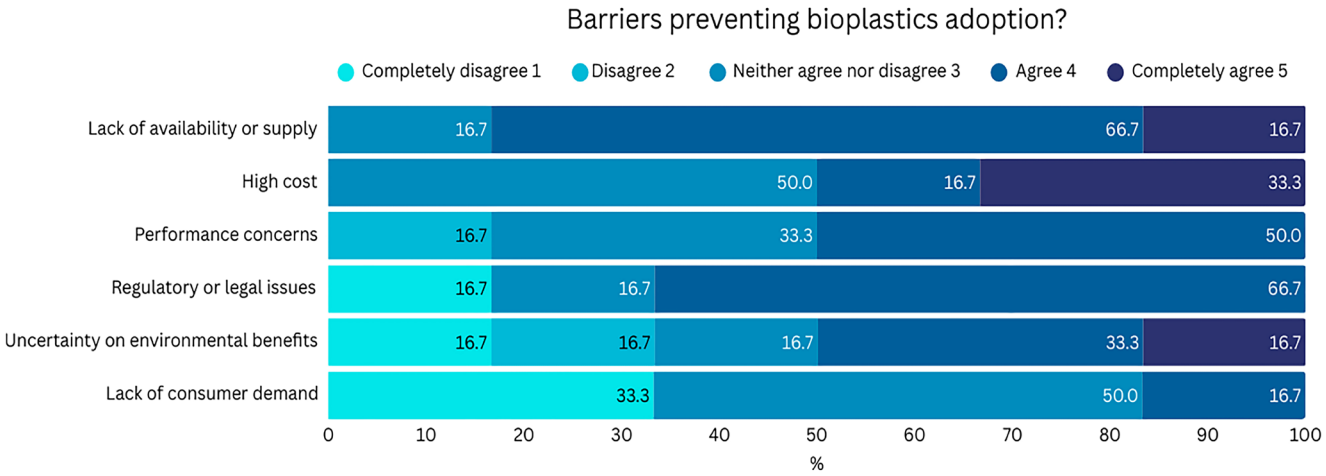


Figure 2. Barriers preventing bioplastics adoption by stakeholders.

participants also considered waste-based and insect-based bioplastics as the most challenging to work with (M = 3.39/5; SD = 1.24 and M = 3.28/5; SD = 1.07 respectively), and traditional plastics as the least challenging (M = 2.00/5; SD = 1.28).

Uncertainty as the main business risk: For companies already operating in the sector, the greatest risks are not technical but rather economic and regulatory. Market volatility (M = 3.89/5; SD = .76) and the absence of a clear legal framework (M = 3.78/5; SD = .88) were identified as critical risks that hinder long-term planning and investment, keeping the sector in a state of moderate, rather than rapid, growth (see Figure 3). Most participants perceived bioplastics as safe for human health (n = 12; 66.7%) and the environment (n = 12; 66.7%), but some also noted uncertainties about human safety claims (n = 6; 33.3%) and environmental safety claims (n = 6; 33.3%). Moreover, 7 (38.9%) participants reported that their companies are uncertain (neutral – do not trust nor distrust) about bioplastics claims of sustainability, and 5 (27.8%) reported that their companies are uncertain (neutral – do not trust nor distrust) about the technical performance of bioplastics (e.g., durability; flexibility; barrier properties).

The future of bioplastics: As shown in Figure 4, participants reported that the most effective strategies to manage the risks companies face when working with bioplastics is resorting to internal test trials (M = 4.33/5; SD = 1.14), followed by collaborating with industry partners (M = 4.22/5; SD = 1.06), conducting market research (M = 3.56/5; SD = .86), and relying on certifications or third-party evaluations (M = 3.50/5; SD = .99). Following this, participants rated that they were most confident that in 5–10 years biopolymer production capacity will grow significantly (M = 4.22/5; SD = .73), specialized technology for biopolymer production will become significantly more available (M = 4.22/5; SD = .81), and industrial applications of biopolymers will grow significantly (M = 4.17/5; SD = .71). Comparatively, they were less confident that in 5–10 years properties of bioplastics will match those of conventional plastics (M = 3.39/5; SD = .98), pricing of bioplastics will decrease significantly, making them more cost-competitive with conventional plastics (M = 3.28/5; SD = 1.07), and taxes on biopolymer products will decrease significantly (M = 3.17/5; SD = .92). According to participants, key challenges influencing bioplastics business strategy and decision-making in the next 5–10 years (see Figure 5) will be economic uncertainties (M = 3.94/5; SD = .87), followed

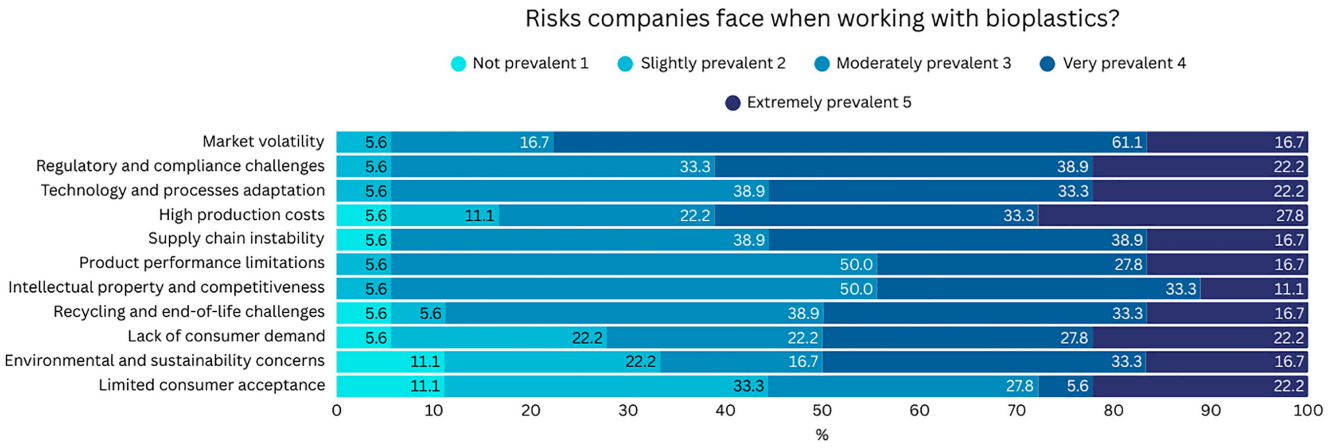


Figure 3. Risks companies face when working with bioplastics.

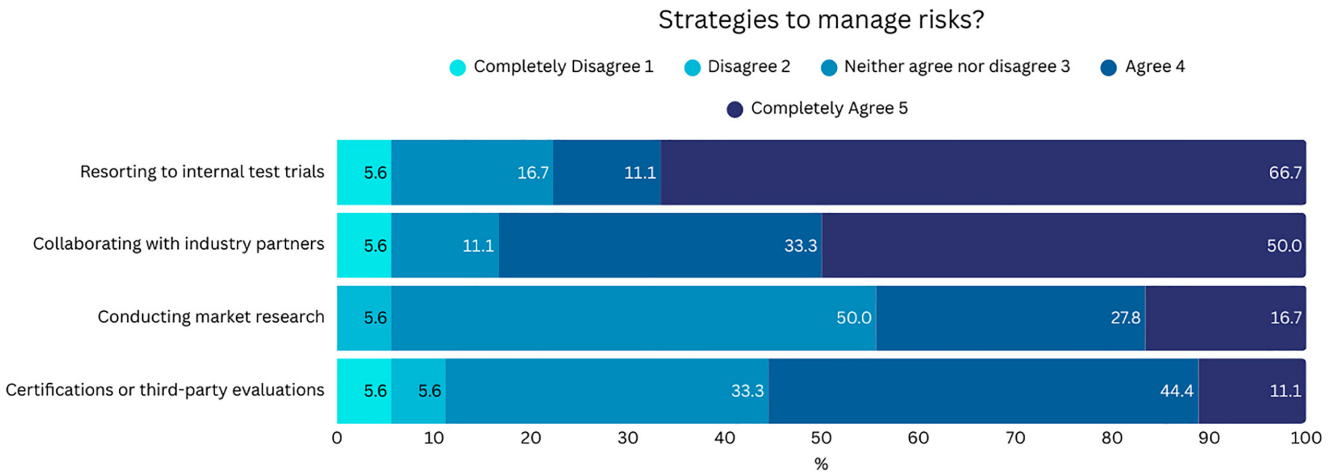


Figure 4. Strategies to manage the risks companies face when working with bioplastics.

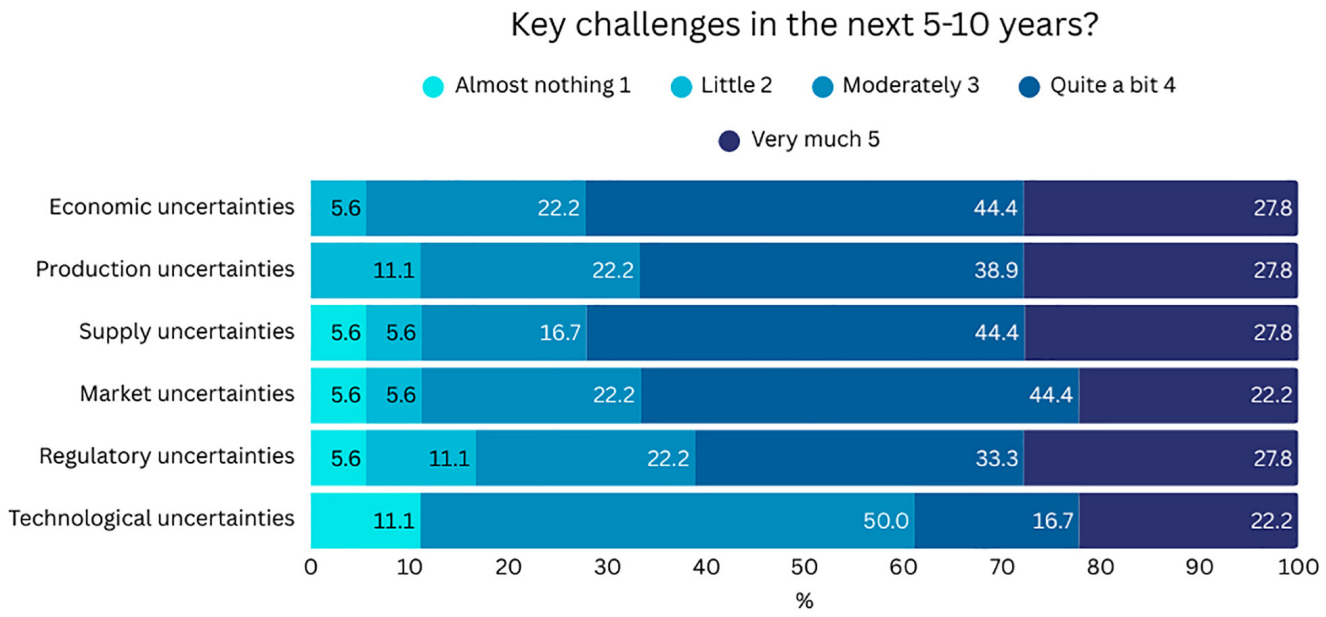


Figure 5. Key challenges influencing bioplastics business strategy in the next 5–10 years.

by production uncertainties (M = 3.83/5; SD = .99), supply uncertainties (M = 3.83/5; SD = 1.10), market uncertainties (M = 3.72/5; SD = 1.07), regulatory uncertainties (M = 3.67/5; SD = 1.19), and technological uncertainties (M = 3.39/5; SD = 1.20). Sectors leading bioplastics adoption are projected to be food packaging (n = 15; 83.3%), controlled-release fertilisers (n = 12; 66.7%), and industrial packaging (n = 10; 55.6%). Overall, the sector is optimistic that, with the right policies, challenges will be overcome and optimism will turn into tangible growth.

Reporting guidelines

This brief report was written following European Commission guidelines for policy reports (European Commission, 2025).

Ethics and consent

This study was carried out in accordance with the recommendations of the Portuguese Psychological Association (OPP) and the American Psychological Association (APA). The protocol was fully approved by the Lusófona University Ethics Committee (CEDIC) with the reference CEDIC-2024-2-24. All subjects gave informed consent in accordance with the Declaration of Helsinki. Informed consent was obtained digitally. When accessing the online survey participants first read the informed consent form and were given the option to accept or decline participation. Only after reading the informed consent form and accepting to participate were the participants able to procced to the survey questions.

Data availability statement

All data and materials are available on Open Science Framework: BioLamer - Policy Report. https://osf.io/9xy6r

The project contains the following underlying data:

- BD BioLaMer 18 valid_PolicyReport.jasp (database with raw data on all the study variables reported in this policy report in JASP format)
- BD BioLaMer 18 valid_PolicyReport.csv (database with raw data on all the study variables reported in this policy report in CSV format)

Data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 1.0 Public Domain Dedication). Data analysis was conducted using JASP 0.95.4.

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This brief report is generally well written, and the appropriate level of contextual background is provided. The report describes the results of a survey of 18 stakeholders across the bioplastics value chain, providing useful descriptive statistics and summary data visualizations using bar graphs.

The report might benefit from some critical reflection on sampling being added. Extrapolating from a sample of 18 people, 12 of whom are from Portugal makes EU-wide claims somewhat challenging. It is fine that this is a limitation, but it should be acknowledged as one. Indeed, as a general point, the quantative style of reporting contrasts with the rather low quantity of data points.

Related to the above point, the readability of the report would be enhanced by removing some of the statistical detail, which is needlessly accurate anyhow (reporting means and standard deviations to two decimal places does not improve readability, and inded duplicates what the reader can see in the bar graphs). Indeed, in most cases the exact numbers do not really add much to the readers comprehension of the point being made. We would recommend focusing more on the narrative itself.

In some cases, the language is slightly too definitive. Generally we would suggest using terms like "should" or "could consider" rather than direct terms like "must". And related to the above point, we think that the policy recommendations should not include quantitative data summaries in this case, as doing this implies a level of precision that is not really appropriate for the data presented.

Regarding the final policy recommendation (on building trust), it is not really possible to extract

much about public acceptance based on this survey of 18 stakeholders. However, the issue raised is important, so it is appropriate to mention, but again, keeping it more at the general level. The recommendations have quite reasonably been inspired by the data, but we would suggest that caution should be applied in terms of placing too much weight on such a small number of data points.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: We are social scientists

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Reviewer Report 28 February 2026

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Dear authors and editors,

Thank you for the opportunity to read and review this policy report. The text reads well and the topic is relevant and timely. Please find below my feedback and suggestions, which are intended to help strengthen and further clarify the key takeaways of the report.

- Since the analysis is based on an online survey, I would expect that reaching out to a larger number of participants should be possible. 18 does not seem like a huge number. If reaching out to more respondents is not possible, then this could be noted as a potential limitation of the results' generalizability.
- The text includes a reference to OSF which includes a list of the respondents (including personal data such as age or years of working experience), and a second file which I was not able to open. I suggest including a "read me" file to explain more clearly how the source data could be checked for replicability.
    - I would also expect to find here a copy of the questionnaire that was filled in by the respondents
    - All respondents seem to be private/industrial stakeholders, which of course makes sense given the goal to investigate industry's perspectives on bioplastics adoption. At the same time, I wonder if other stakeholders (e.g. waste management companies) might also have interesting perspectives on what an increased adoption of bioplastics might entail, and potential risks that carefully designed policies and regulations could prevent. Did you consider getting their perspectives too? It would be good to mention (in one line) at the end of the report that more perspectives would be needed for drafting a policy that won't lead to unintended consequences.
- I fully agree that harmonized definitions and standards for bioplastics are needed. I would add that these should also include the following aspects:
    - Harmonization and standardization of waste management systems. Different countries might have different rules concerning biodegradable/compostable plastics (i.e. should they be collected with other plastics, organic waste, or a different waste collection stream?) – see for instance Gonella & de Gooyert (2024) and Van Roijen & Miller (2022). This point is briefly mentioned under "Incentivize innovation focused on cost reduction, performance improvement, and product safety" but should be stressed more.
    - Furthermore, regulations should consider bioplastics production too when discussion the prioritization of biomass feedstock. Current regulations (e.g. the new RED III) include constraints for the use of food-grade biomass for biofuels, but such or similar constraints are not applied to bioplastics and biochemicals too. I believe this should be brought up as a point of discussion in standardization and regulation efforts.
- I think a clarification should be made when discussing the (perceived) performance of bioplastics. Drop-in bio-based plastics have the same molecular structure of traditional polymers, thus they perform equally good to fossil plastics. New bio-based and/or biodegradable polymers present different properties that might be more or less fitting depending on the application. This can be both an advantage or a disadvantage: they might lack mechanical strength, but also reduce microplastics dispersion; they might require less/more/different chemical additives than the fossil polymers they could replace (see for instance Gonella et al (2025), OECD (2021), Geyer et al (2017))

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Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

Are all the source data and materials underlying the results available?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
I cannot comment. A qualified statistician is required.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Plastics, sustainable plastics, sustainability transitions, socio-technical transitions, environmental assessment

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.