STAR-ProBio

Sustainability Transition Assessment and Research of Bio-based Products

Grant Agreement Number 727740

Deliverable D5.1
Acceptance factors among consumers and businesses for bio-based sustainability schemes

Version 1.0

This project is funded by the European Union's Horizon 2020 Research and innovation action under grant agreement No 727740 with the Research Executive Agency (REA) - European Commission. Duration: 36 months (May 2017 – April 2020).
Work Programme BB-01-2016: Sustainability schemes for the bio-based economy
www.star-probio.eu

REPORT

Deliverable identifier	D5.1
Document status	Final
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Lead Beneficiary	TUB
Deliverable Type	Report
Dissemination Level	Public
Month due (calendar month)	23

DOCUMENT HISTORY

Version	Description
0.1	Inception
0.3	Inclusion results first round Delphi
0.5	Inclusion results second round Delphi
0.6	Final draft for Work package internal review
0.7	Final draft for review by Project Management Committee
1.0	Final version

Abstract

The emergence of the bioeconomy is an important result of the need for a more sustainable economy for the 21st century. However, achieving the paradigm shift from the established fossil-based economy toward a bio-based economy is an ambitious goal. To accelerate the shift, consumers need to understand how and where scientifically proven "sustainability" outputs are available. This will allow sustainability to become a successful market driver. The present study focuses on the market assessment of bio-based products, to gain insight into which sustainability aspects are important to stakeholders. It summarizes the results of different foresight methods, including a two-round Delphi survey, to identify sustainably assessment preferences of end-consumers and professionals and their influence on buying decisions. The results show that both private individuals and professionals consider a broad spectrum of criteria important for sustainability. Being able to prove and communicate that sustainability criteria are met will be a key acceptance driver for bio-based products.

Suggested citation

STAR-ProBio (2019), STAR-ProBio Deliverable D5.1, Acceptance factors among consumers and businesses for bio-based sustainability schemes. Available from Internet: www.star-probio.eu.

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List of Acronyms

Acronym	Definition
B2B	Business-to-business
CO_2	Carbon dioxide
GHG	Greenhouse gas
(non-)GMO	(non-) genetically modified organism
GPP	Green public procurement
EOL	End-of-life
EC	European Commission
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
ILO	International labour standards
ILUC	Indirect Land Use Change
ISO	International Organization for Standardization
LCA	Life Cycle Analysis
LCC	Life Cycle Cost
NGO	Non-governmental organization
RED	Renewable Energy Directive
RSB	Roundtable on Sustainable Biomaterials
SDG	Sustainable Development Goal
SAT-ProBio	Sustainability Assessment Tool for Bio-based Products
SyD-ProBio	System dynamics model of the project STAR-ProBio
SME	Small and medium-sized enterprises
STAR-ProBio	Sustainability Transition Assessment and Research of Bio-based Products
UDHR	Universal Declaration of Human Rights
WTP	Willingness to pay

Executive summary

The bioeconomy is an important emerging phenomenon in the 21st century. To accelerate the market adoption of bio-based products, it is important that consumers can access robust information on products. This deliverable reports on a market assessment of these products, carried out to gain insight into which sustainability aspects are of relevance to stakeholders. The results confirm that both private individuals and professionals consider a broad spectrum of criteria important for sustainability. Being able to prove and communicate that sustainability criteria are met will be a key acceptance driver for bio-based products.

The results presented in this deliverable contribute to understanding the needs, preferences and views of different stakeholder groups. The market assessment has helped identify and confirm the sustainability and communication issues that need to be addressed to ensure market uptake and displacement of fossil-based products.

The development and implementation of robust methodologies, criteria, standards and certification schemes to assess the sustainability impact of bio-based products can support the further development of the bio-based products sector but many gaps still exist (see STAR-ProBio, 2017). Major measurement gaps on the criteria level include for example inappropriate consideration of environmental issues such as greenhouse gas (GHG) emissions, land use efficiency and change, risks related to food prices, thresholds for bio-based content and various end of life aspects.

The market assessment presented in this paper identifies market preferences and provides inputs from a market perspective to guide the later research steps of the STAR-ProBio project, in particular related to STAR-ProBio's Sustainability Assessment Tool for Bio-based Products (SAT-ProBio) and the social life cycle analysis (LCA).

The in-depth analysis of the consumer perspective started with a literature review on consumer preferences. This review showed the importance of seven aspects influencing the adoption of bio-based products: 1. Product information and trust; 2. Functionality, performance and quality; 3. Price and life cycle cost; 4. Environmental factors; 5. Social and socio-economic factors; 6. Individual market drivers; and 7. Specific issues in business to business (B2B) markets and public procurement.

The review also gave more insight into existing information gaps. In particular, more information is needed on the relevance of certificates and sustainability criteria to decisions to buy bio-based products and on the consequent implications for the creation of certification schemes. A two-round Delphi survey was conducted to provide more insight on sustainability preferences and buying decisions. The survey comprised 744 consumers and 344 professionals in the first round and 80 consumers and 100 professionals in the second round. A wide range of drivers considered relevant by the market in the decision to buy bio-based products were identified. The following overview provides key results, conclusions and recommendations.

Key results and conclusions

The two rounds of the Delphi led to interesting findings, summarized in table 1:

Table 1: Overview of results

Topic	Results of round 1	Specifying results of round 2
Willingness to bus bio-based products	Among Procurement professionals, the willingness to buy bio-based products is still significantly lower than their awareness of these products. More willingness to buy these products could be noticed among end-consumers.	Two thirds (62%) of the end-consumers prefers bio-based over fossil-based unconditionally. However, 38% did not express a preference for bio-based, which shows need for additional measures to promote the market for bio-based products.
Sustainability pillars: Environmental, Economic and Social	The majority of all stakeholder groups regard information on the three sustainability pillars as relevant for their decisions on buying bio-based products. Information on environmental issues is clearly regarded as the most important.	-
	For professionals the top three environmental aspects were found to be: 1. Recyclability; 2. Type and origin of raw material; and 3. Percentage of bio-based content. For consumers, the top three environmental issues were found to be: 1. Biodegradability; 2. Recyclability; and 3. Type and origin of raw material.	Proof of sustainability requires consideration of many criteria. Of the 29 environmental, social, economic and additional criteria included in the questions, almost all were considered essential for calling a product sustainable by a majority of respondents; environmental criteria were considered essential by a larger majority of respondents. Even when there is not a majority, all criteria are considered essential by a significant number of respondents. In addition to direct sustainability requirements, criteria with a more indirect impact on sustainability such as quality and lifecycle cost are given great importance by the majority of respondents. Therefore, including both direct and indirect impacts in sustainability certification will be very important to market adoption of bio-based products.
	For professionals the top three social issues were found to be: 1. No child labour; 2. Impact of the product on people's health; and 3. Respect for human rights in the production of raw materials and products. For consumers the top three social issues were found to be: 1. Impact of the product on people's health; 2. No child labour; and 3. Respect for human rights in the production of raw materials and products.	
	Professionals ranked the two economic issues as follows: 1. Fair business practices of the company; and 2. Fair land use rights practices in the production of feedstock. Consumers ranked the two economic issues in the reverse order.	

Additional aspects influencing bio-based products buying decisions	For professionals the top three important aspects to be considered before buying a product in addition to sustainability related characteristics were found to be: 1. Functionality /performance of the product; 2. Price; and 3. Life cycle cost (LCC), while for consumers they are 1. Price; 2. Functionality/performance of the product; and 3. Better performance than alternative fossil-based products	All seven types of influence, which were analysed (Easy availability, Confidence in the environmental benefits, Confidence in the social benefits, Confidence in the economic benefits, Confidence in quality, Confidence in product useful life expectancy, Price) scored similarly highly for all respondent groups. Environmental criteria and quality scored slightly higher than the others. For Procurement professionals, price scored higher as well.
Certification of bio-based products	The majority of professionals (80%) and consumers (84%) regarded sustainability certification for bio-based products as beneficial in selecting which product to purchase.	That proof of sustainability has a significant effect on willingness to buy bio-based product was confirmed by 86% of consumers.
	The majority of respondents answered that environmental and social issues should be mandatory in sustainability certification, while economic issues could be considered on a voluntary basis.	When queried about minimum, typical and misleading[1] percentage of bio-based content and percentage of GHG emissions reduction, all respondent groups gave a wide range of answers. This means that a certain percentage of bio-based content or GHG reduction is above the minimum or typical percentage for some people, while others consider the same percentage misleadingly low and not enough to call a product "bio-based" or "sustainable". This is an important point for public awareness and calls for careful expectation management.
		The place of origin of both raw material and manufacturing are important and should be indicated on a packaging label if possible.

[1] Misleading means here the percentage below which the respondent feels that calling a bio-based product sustainable would be misleading

Additional measures to promote the acceptance of bio-based products	Nine actions by which European policy makers could promote the acceptance of bio-based products were identified: 1. Appropriate information, communication (in general) and awareness increase; 2. Public procurement; 3. Taxation and subsidies; 4. Labels and certificates; 5. Legislation including bans; 6. Standards; 7. Ensuring environmental friendliness; 8. Comparisons with fossil-based products; and 9. Harmonization of definitions.	All nine regulatory options identified in the first round recorded a high score as for their impact on market adoption of bio-based products – legal and financial incentives reported the highest score.

Recommendations

Based on these key findings, the following recommendations can be made about aspects that should be considered in the sustainability assessment of bio-based products:

End-of-life aspects of bio-based products

The End-of-life (EOL) stage is one of the most important environmental aspects to be considered in the sustainability assessment of bio-based products. In this regard, STAR-ProBio (2017) found, for example, that recyclability is not significantly reflected by certification frameworks for bio-based products so far. More specifically, STAR-ProBio (2017) identified gaps related to EOL scenarios (cascading[2], recycling, etc.) and EOL criteria, e.g. minimum recycled content in product, implemented waste management and intended cascade use.

The most appropriate EOL option for a bio-based product is product specific. Therefore, it is important to account for the different EOL options and properly communicate the recommended EOL option to the end-consumer. The results described in this report show that this is an imported issue that needs to be integrated into sustainability certification and standardisation.

Place of origin

One of the highest levels of consensus in our surveys was that consumers and professionals want to know both the origin of raw materials and the manufacturing place. They also indicated that, if possible, this information should be specified on a packaging label.

Minimum percentage of bio-based content and GHG emission reduction

It is important to take into account that there is insufficient awareness of how high the percentage of bio-based content or GHG reduction can be in practice. When queried about minimum, typical and misleading percentage of bio-based content and percentage of GHG emissions reduction, all respondent groups gave a wide range of answers. This means that a certain percentage of bio-based content or GHG reduction is above the minimum or typical percentage for some people, while others consider the same percentage misleadingly low and

[2] Cascading use is the efficient utilization of resources by using residues and recycled materials for material use to extend total biomass availability within a given system. In a single stage cascade, the wood is processed into a product and this product is used once more for energy purposes. In a multi-stage cascade, the wood is processed into a product and this product is used at least once more in material form before disposal or recovery for energy purposes. Source: EC, https://ec.europa.eu/knowledge4policy/glossary/cascading-use_en

not enough to call a product "bio-based" or "sustainable". In order to minimize the risk of a negative impact on market uptake because of unfulfilled expectations, not only more research on reasonable levels of bio-based content and GHG emission reduction are needed, but also awareness raising on such levels is needed.

Product quality

In addition to direct sustainability criteria to measure a reduced negative or positive environmental or socio-economic impact, other product properties and characteristics can indirectly impact the acceptance and uptake of bio-based products (e.g. quality or lifetime of the product compare to the traditional fossil-based version). The results from the survey suggest that quality of the bio-based product could be the leading factor to make the transition from fossil-based products to bio-based ones. It is therefore recommended that at least some indicators relating to quality/functionality/longevity/performance are taken on board in sustainability assessment.

Selection and measurability for socio-economic criteria

On average social and economic criteria were considered essential by half of the consumers and at least a third of professionals. Further considerations on their inclusion in sustainability assessment should also consider existing standards and schemes (e.g. ILO (International labour standards) requirements).

Health aspects

In both Delphi survey rounds topics related to "health" issues score highly, especially with consumers. It is not always clear what health aspects respondents have in mind when answering, therefore this is an important point for further research. Often minimum health standards already exist and therefore won't need to be part of sustainability assessment, or only as more stringent audit rules for existing heath standards. However, transparency on the absence of health risks is shown to be an essential acceptance driver.

Mandatory vs voluntary sustainability criteria

Most participants indicated that environmental and social issues should be mandatory in sustainability certification while voluntary inclusion of economic issues would be enough for about 60% of the respondents. These preferences can be used to guide decisions on whether to make a criterion required or recommended.

Policy instruments to stimulate the adoption of bio-based products

Of the nine listed regulatory options to increase acceptance of bio-based products, survey participants considered that legal and financial incentives would have the strongest effect, but the remaining options (definitions, fossil references, standards, labelling, environmental friendliness, public procurement and information availability) also received a positive score. The recommendation is therefore to keep as many of these types of policy options in mind when working on assessment methodology for bio-based products.

1 Introduction

The European Bioeconomy Strategy aims to pave "the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection" (EC (European Commission, 2018a, p.8). Developed in 2012, the strategy was updated in 2018 to accelerate the deployment of a sustainable European bioeconomy so as to maximise its contribution to the 2030 Agenda, the Sustainable Development Goals (SDGs) and the Paris Agreement (see EC, 2018b).

The STAR-ProBio project (Sustainability Transition Assessment and Research of Bio-based Products, http://star-probio.eu/) supports the EC in the full implementation of European bioeconomy strategy and related sustainability policy initiatives. It aims to cover gaps in the existing framework for sustainability assessment of bio-based products and improve consumer acceptance for these products by identifying the critical sustainability issues in their value chains. The main outcome of STAR-ProBio is the development of a sustainability scheme to assess these products.

STAR-ProBio's research on the sustainability preferences and expectations of private and other end-consumers, as well as of selected additional stakeholders within bio-based products' value chains, relies on foresight methods, including focus group activities and a three-round Delphi study. In this way, the study provides in-depth insight in the preferences of the potential users of STAR-ProBio's intended assessment scheme and initiates a multi-stakeholder roundtable. This roundtable serves as a vehicle for open consultation on the proposed sustainability blueprint and associated tools and contributes to the dissemination of STAR-ProBio outputs.

This document presents the results of the first and second rounds of the Delphi survey in selected European member states. The survey focused on the following topics:

- Awareness of bio-based products and willingness to purchase them;
- Importance of sustainability information and certification in buying decisions;
- Relevance of product characteristics, in particular in the three sustainability pillars, addressing environmental, social and economic issues;
- Relevance of characteristics of sustainability assessment schemes; and
- Additional factors to support decisions to buy bio-based products.

This report is structured as follows: Chapter 2 is an introduction to the Delphi method, which is a cornerstone of the present study. The chapter also provides an overview of the target groups and the steps in the applied methodology. Chapter 3 reports on a literature review on key aspects influencing the acceptance of bio-based products market adoption and describes current research gaps related to market sustainability preferences. Chapter 4 includes details of the different elements of the field research, in particular on the focus group activities and the two Delphi survey rounds. Chapter 5 provides demographic information on the survey participants. Chapter 6 shows specific findings on the importance for buying decisions of product characteristics in the three sustainability pillars and additional product features. Chapter 7 describes the preferences for sustainability assessment in certification schemes. It provides information on specific assessment criteria and presents detailed findings for specific product groups. Augmenting these findings, Chapter 8 describes ten additional factors, which can support buying decisions among Procurement professionals. Chapter 9 concludes and provides recommendations for sustainability assessment and standardisation. It offers general implications as well as specific suggestions for further steps in the STAR-ProBio project.

Various annexes support the descriptions of this report. Finally, an appendix to this report presents a concept document describing the objectives, composition, roles and obligations for the multi-stakeholder roundtable and gives an initial work plan.

2 Research objectives and methodology

The STAR-ProBio project's work package on market assessment aims to identify buying preferences regarding sustainability assessment schemes based on foresight methods, including focus group activities and a three-round Delphi study. As indicated in Figure 1, specific consideration is given to the three pillars of sustainability: environmental, social and economic. The analysis also considers other important product characteristics, for example, performance and quality of a product.

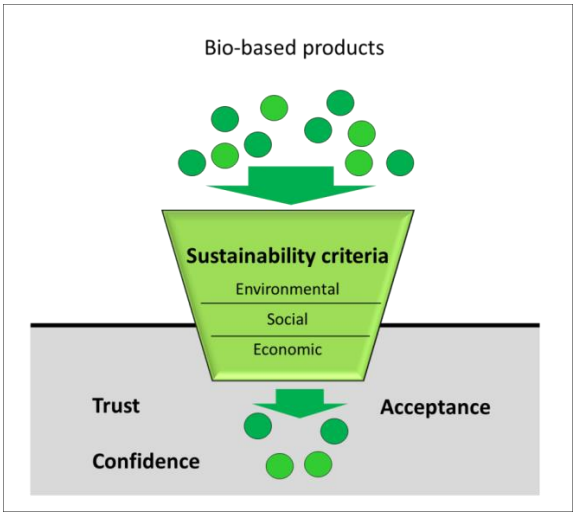


Figure 1: Sustainability pillars in the context of this study

The Delphi method was created in the 1950s, originally to allow large groups of experts to contribute collectively to processes to solve complex problems (Linstone and Turoff, 1975). In the subsequent years, it has been applied to various other areas and, in particular, for predicting the future impact of technical innovations (Turoff et al., 2016). Linstone and Turoff (1975) describe the method's general characteristic as:

> "a process of structuring a written, asynchronous communication process among a large problem solving group so that it is tailored to the nature of the problem (…) and the objectives of the problem solving exercise. (…). Computer based versions (…) eliminate sequential constraints for each individual."

A Delphi study includes two or more rounds to validate and refine the results of the initial communication activity with the participants. The later rounds are used to provide the participants with the opportunity to modify their earlier input in response to the replies of the others. In this way, the Delphi method aims to synthesize the collective expertise of the respondents (see Linstone & Turoff (2002) for further information).

The Delphi method was selected to provide a generalized market-based view on acceptance factors for bio-based products. The first round collected the opinions of the participants on these factors in general and the second and third round are used to rank and refine the results.

The survey addressed two main groups of stakeholders: i) professionals and ii) end-consumers (members of the public), who are described in detail below.

Target group: professionals

The specification of the target group of professionals, and their invitation to participate in the study, adopted general Delphi survey principles as well as the strategy of the OpenBio project's expert survey (see e.g. OpenBio 2015 and Peukert and Quitzow, 2017). Appropriate persons were selected directly and individually. STAR-ProBio's selection included representatives of the following target groups: public procurers, businesses, certification bodies and other institutions such as NGOs and researchers in the relevant field. Specific emphasis was given to professionals tasked with buying decisions (Procurement professionals) due to the importance of their role in creating demand for bio-based products. The selection of professionals from other fields is based on the goal to determine in the second survey round not only relevant acceptance drivers for consumers and Procurement professional but also for other stakeholder groups, for example producers of bio-based products.

Target group: end-consumers (members of the public)

For end-consumer, a specific focus was put on Early Adopters as they play an important role in convincing other groups to adopt innovative products or ideas. The concept of 'Early Adopters' is part of the Diffusion of Innovations theory of Everett Rogers (Rogers, 2003). This theory explains the diffusion of new ideas, products etc. as well as different adopter groups and the time, in which they adopt the innovations. Figure 2[3] shows the different adopter groups and their activities in the lifecycle of a product. As pictured in Figure 2, Early Adopters are the first adopters after the innovators.

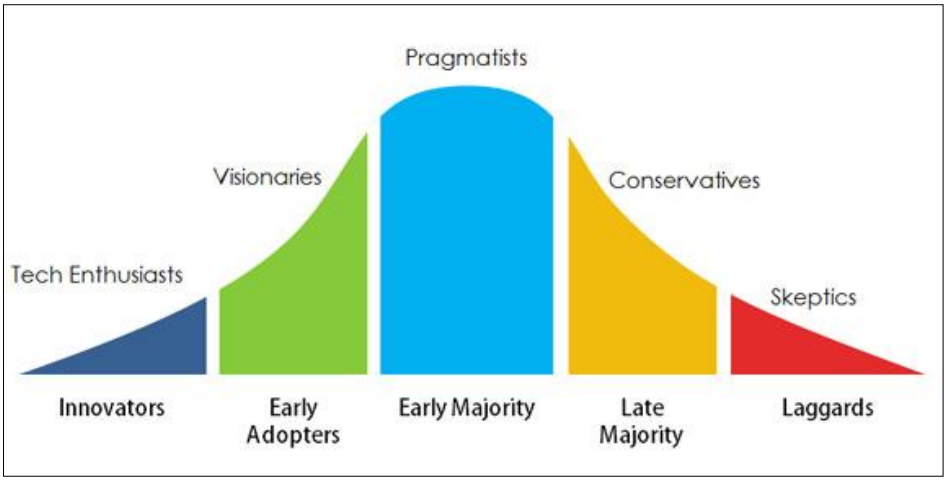


Figure 2: Diffusion of innovations curve of Rogers (2003)

Two typical characteristics of Early Adopters are that they are young and well-educated (see for example the two sources on the adoption of green and environmentally friendly products in Mulvaney and Robbins, 2011 and Hardmana et al., 2016 as well as related sources). Taking this into consideration, contacting students provided attractive opportunities to reach (potential) Early Adopters. For this reason, working with this consumer group was a key part in the survey's dissemination strategy.

In line with the goal to focus on potential Early Adopters, the sample for the consumer survey was on a voluntary basis. Students at different important European Universities were contacted via central mailing lists with invitations to participate in the survey. From a demographic point

[3] Source for the figure from Roger's book: https://www.free-power-point-templates.com/articles/new-product-diffusion-curve-slide-for-powerpoint/

of view, it was therefore expected that most participants reached by this measure would belong to the group of the 21 to 30-year-old ones. As an additional measure of voluntary sampling, invitations to participate in the survey were published in the Internet, e.g. on the project website, via social media and on the STAR-ProBio and student organisation newsletters.

Research steps

As Figure 3 shows, the research methodology included seven steps:

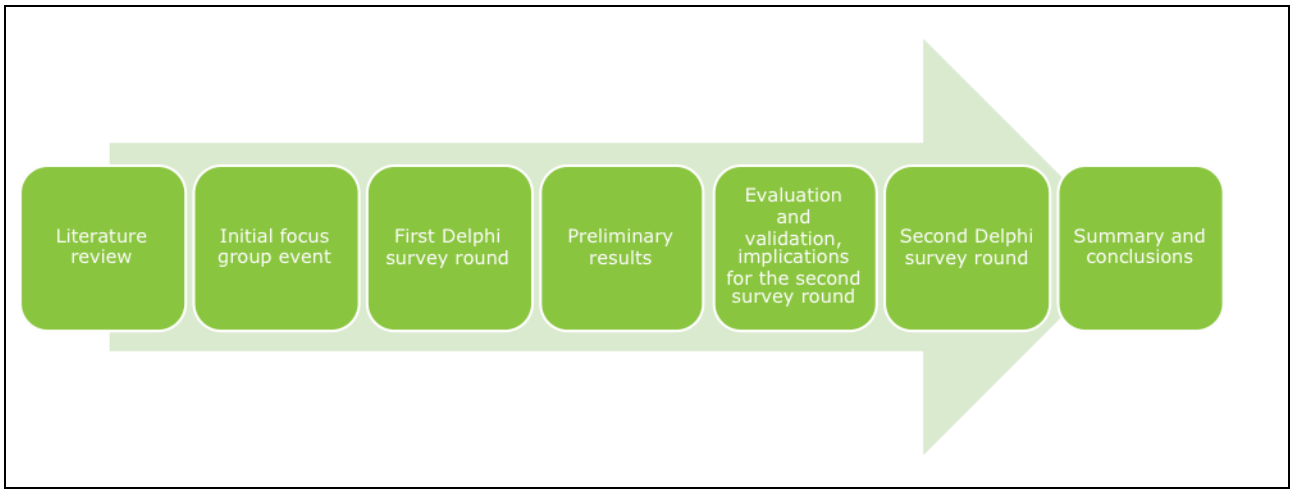


Figure 3: Research steps, TUB 2019

The starting point was a literature review, followed by a first focus group event, respectively described in chapter 3 an 4. The next steps included the first survey round, its analysis and two stakeholder workshops, conducted in September and October 2018 in Turin and Athens to discuss and validate the results. The first round's results and the two workshops led to deepening and validation of various topics in the second survey round.

Through several rounds of revision, the most appropriate phrasing for the second round questions was developed. The questions included in the surveys for professionals and consumers were selected not only on the basis of the expectation to yield the most valuable results but also to form a good basis for the third and final Delphi round to be administered only to professionals, which will be implemented based on the results of this report in spring 2019 and reported in a separate deliverable then, titled "Results of the experiment / Case study."

3 Literature review

To prepare the Delphi survey's questionnaire on the acceptance of bio-based products, an extensive literature review was conducted, including i) research articles, papers and similar documents; ii) projects on EU and national levels and iii) existing sustainability assessment schemes, including eco-labels.

As basis for the literature review, 41 sources were identified based on various keyword-based searches in different databases, shown in Annex 1. The analyses of EU and national level projects included in particular the results and interim results of the projects OpenBio, InnProBio, Bioenergy Promotion and Bioenergy Promotion 2, STAR4BBI, BERST and Bioways. The analyses were supplemented by various analyses on eco-labels in the Eco-Label Index. A detailed overview on STAR-ProBio's work on eco-labels is also provided by STAR-ProBio Deliverable D9.2 (STAR-ProBio, 2018).

From the literature review seven key aspects influencing the acceptance of bio-based products market adoption were identified: 1. Product information and trust; 2. Functionality, performance and quality; 3. Price and life cycle costs; 4. Environmental factors; 5. Social and socio-economic factors; 6. Individual market drivers for different bio-based products; and 7. Specific issues in B2B markets and public procurement:

1. Product information and trust

By referring to the Technology Acceptance Model, which highlights the importance of the product attributes themselves, issues of trust, benefits expected as well as the perceived usefulness and perceived ease of use of a product, Bröring et al. (2017) describe the following trend: "As consumers increasingly value health and sustainability, the importance of trust attributes is raising regarding bio-based products. Companies are increasingly communicating these attributes through quality seals" (p. 170, translated). At the same time, several sources e.g. Albertini and Ferrini (2017) identified that many potential users of bio-based products would need more information on the relevant product characteristics. The literature on how the information should be best presented was sparse and therefore more analysis is needed.

2. Functionality, performance and quality

Gallup (2009) (and also TNS, 2012 for green products) identified the quality of a product as the most important aspect in a buying decision. In the same way, Bröring et al. (2017) and BBMG et al. (2012) highlight the importance of *functionality* and *performance* in the evaluation of bio-based and sustainable products.

There are several ways to test the performance/functionality/fitness for use of product. This is an aspect often addressed in Type I ecolabels, such as the EU Ecolabel, Blue Angel or Nordic Swan. Fitness for use is product specific and generally assessed though laboratory tests or consumer tests. For instance, to be declared 'fit for use' under the Nordic Swan (see Nordic Swan, no date, question 11), "*detergents must clean clothes clean at low temperatures, furniture pass durability tests and toner cassettes must print at the highest quality*". An additional important aspect on the side of the end-users is that the product is long-lasting (see Hanss and Böhm, 2012).

Quantifying functionality or identifying a well-defined reference product may be difficult for certain bio-based products, e.g. regarding the determination of reference products in very new market segments or in market segments with much product variety and should therefore be considered on a case by case basis.

3. Price and life cycle cost

The literature also showed that price of a product is a key purchasing factor. The Gallup group (2009) that conducted 25,633 telephone and face-to-face interviews in EU27 member states on sustainable consumption, found that the majority of buyers regard the price of a product as more important than its environmental impact. Likewise, TNS (2012) reported the importance of this issue based on an EU-wide survey on green products, involving 26,568 people in EU27 countries and Croatia. The importance of this factor for bio-based products is emphasised by Bröring et al. (2017), Whitson et al. (2014), BBMG et al. (2012) and Hanss and Böhm (2012).

There is no information on how much the target groups would be willing to pay extra to get certified bio-based products. Nor is there information on whether people are ready to pay more for products performing better from an environmental and social point of view, and if so, to what extent.

Life cycle costs refer, according to Vertech (2014), to all relevant costs over time the product and are specified by life cycle cost analyses. These analyses account for: initial costs (including capital investment costs, purchase, and installation costs); future costs (including energy costs, operating costs, maintenance costs, capital replacement costs, financing costs); and any resale, salvage, or disposal cost, over the lifetime of the project, product, or measure (Fuller, 2005). Bio-based products can provide various life cycle cost advantages. Regarding the end-of-life stage of plastics, for example, rigid bio-based packaging, together with commercial films, is considered to be the market segment that is likely to have the most attractive recycling cost-benefit balance (see WEF, 2016).

Regarding public procurement, FNR (2017) found that life cycle costs of ten environmentally friendly products are lower than those of alternatives (flooring, office lights, computer, buildings, copy and print paper, refrigerators and freezers, multifunction devices, cars, cleaning supplies and street lighting). However, there is a research gap regarding the question to what extent life cycle cost would be an important criterion in determining the buying decision.

4. Environmental factors

Hanss and Böhm (2012) emphasise the importance of environmental issues in buying decisions in the context of sustainable and green products. According to the Gallup (2009) survey, the most important information gained from environmental labels is whether it is possible to recycle or reuse a product. Likewise, Open-Bio (2015) highlighted the importance of this factor and of biodegradability for end consumers of bio-based products as well as of biodegradability and compostability in B2B markets for these products.

Other important issues are, for example, independence from fossil sources, energy efficiency, savings in CO_2 emissions, reduced human toxicity and appropriate packaging of the product, see e.g. Peukert and Quitzow (2017) and Hanss and Böhm (2011).

With a broader perspective, European regulations and related documents are also important elements in the acceptance framework of the bioeconomy. For example, the Renewable Energy Directive (RED) provides legally binding environmental sustainability criteria for liquid biofuels and bioliquids produced from biomass. The main sustainability requirements are:

- Greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 50% compared to fossil fuels (60% for biofuels produced in plants whose operation started after 1st January 2017) (see EC, 2018b)
- (Sustainable) biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity (such as primary forests or highly biodiverse grasslands)

- (Sustainable) biofuels and bioliquids shall not be made from raw material obtained from land with high carbon stock (such as wetlands or forests)

Modifying these figures, the Renewable Energy – Recast to 2030 (RED II) specifies Greenhouse gas savings thresholds step-wise until 2026 (65% for transport biofuels, 70% for transport renewable fuels of non-biological origin and 80% for electricity, heating and cooling) after January 2026. It adds that Biofuels, bioliquids and biomass fuels from agricultural biomass must not be produced from raw materials originating from: High biodiversity land (as of January 2008), including: primary forests; areas designated for nature protection or for the protection of rare and endangered ecosystems or species; and highly biodiverse grasslands; High carbon stock land that changed use after 2008 from wetlands, continuously forested land or other forested areas with trees higher than five meters and canopy cover between 10% and 30%; Land that was peatland in January 2008 (see EC, 2019).

Various sources suggest to consider the RED criteria for the assessment of bio-based products as well (see e.g. STAR-ProBio, 2017). However, the potential acceptance of these criteria as part of voluntary certification schemes is not appropriately analysed so far.

5. Social and socio-economic factors

Bröring et al. (2017) highlight SCAR's (2015) five social and economic criteria for the bioeconomy:

- Food first: ensure the primacy of food security.
- Sustainable yields: ensure that crops do not affect the regeneration capacity of the acreage (also an environmental issue).
- Cascade use: Use the biomass first for what achieves the highest value.
- Circular economy: Reduce, reuse and recycle production waste (also an environmental issue).
- Diversity: diversify the output, scale, processes and technique of production.

According to BBMG et al.'s (2012) international study, consumers say it is very or extremely important for companies to address

- Safe drinking water as part of their products, services or operations (92%).
- Health care (87%).
- Fair wages and safe working conditions (87%).
- Jobs and economic opportunity (86%).
- waste reduction (86%, an environmental issue).

Hanss and Böhm (2012) also refer to items on the living conditions of the world's poor and equal opportunities for all regarding social issues and economic viability and economic growth that secure human well-being.

Likewise, STAR-ProBio's analysis of European and international 45 certification schemes in the bio-economy, conducted in its work package 1 to prepare the project's deliverable D1.1 (STAR-ProBio, 2017), showed the importance of social factors such as, for example,

- Respect for human rights.
- No child labour.
- The working conditions of the employees meet at least minimum standards.
- The payment of employees meets at least minimum standards.
- Biomass production does not impair food security.
- No genetic modified organisms (GMO).
- Not tested on animals.
- No slash-and-burn to get acreage.

6. Individual market drivers for different bio-based products

According to Luchs et al. (2010), Peukert and Quitzow's (2017) and Open-Bio's (2015) analyses of the B2B market for bio-based products, the importance of market factors varies between the different kinds of bio-based products. One question in OpenBio's (2015) survey in the B2B field discussed, for example, important market drivers in the product sectors of plastics, solvents, lubricants, surfactants, chemicals and wood-based products. More than 50% of the respondents regard biodegradability / compostability as an important market driver for the first four product sectors mentioned above. Other market drivers, which are important for selected products only include: reduced human toxicity (relevant for solvents), the utilization of waste products and the potential to source feedstock locally (relevant for wood-based products) and recyclability (relevant for plastics and wood-based products). Furthermore, market drivers differ significantly across European countries. For example, 24.5% of the consumers in Open-Bio's (2015) analysis regard information on safety impacts important but only 9.4% of the German participants.

7. Specific issues in B2B markets and public procurement

According to Open-Bio (2015) and Peukert and Quitzow (2017), the acceptance of bio-based products in the B2B market depends on them offering additional functional characteristics compared to traditional products. Examples are reduced weight in the case of lightweight bio-based car components which reduce fuel consumption and biodegradability in soil in the case of mulch film, which does not require removals from the fields at the end of the crop cycle or storage in winter (see STAR-ProBio, 2018 for details of these bio-based products). The participants in the surveys of Open-Bio (2015) and Peukert and Quitzow (2017), also highlighted the need for a supportive regulatory environment and certainty about future regulation to increase the demand for bio-based products by Procurement professional.

4 Field research activities

4.1 Focus group event

STAR-ProBio's Focus Group Webinar on Sustainability Assessment Factors for Bio-Based Products aimed to prepare the first survey round and took place on January 29, 2018. It included experts with an EU-wide perspective and representatives from Belgium, Germany, Italy, Spain and The Netherlands from the following stakeholder groups: industry, public procurers, consumer representatives and laboratories.

The event lead to the following conclusions:

1. Fossil-based products should be subject to the same sustainability criteria as bio-based products.
2. Sustainability criteria for biomass for bio-based products should/could be similar to those applying to biomass for energy applications where binding criteria exist. The differentiating characteristic of bio-based products is the fact that the raw material contains biomass. Therefore, additional criteria regarding the production of biomass could/should be added.
3. In regard to whether there should be a minimum percentage of bio-based content, different influencing factors have to be considered; in particular technology issues and consumers' expectations.
4. Environmental criteria typically have a higher visibility than social and economic criteria.
5. The origin of biomass is also of importance (as shown by the bioenergy discussion).
6. Criteria that were explicitly mentioned as to be relevant include: GHG emissions, bio-based content, and health-related aspects.

The results enriched the previous sources for the preparation of the Delphi survey and supported other STAR-ProBio activities.

4.2 Two Delphi survey rounds

Goals

The aim of STAR-ProBio was to receive at least 800 answers in the first survey round. Regarding the version for professionals, contributing partners used their existing networks for the distribution of the survey among potential European respondents. A significant share of the respondents was expected to come from the countries in which the partners involved in the survey operate.

Regarding the survey version for members of the public, the university partners involved in the survey, located in Germany and Italy, reached out to their students. Additional groups of students were approached by STAR-ProBio partner universities in Spain, Greece and the United Kingdom.

The survey was created with the LimeSurvey tool for web-based surveys and available in English, German, Italian and Spanish. The consumer version was also available in French to address additional consumers interested in the survey).

The survey of the first round was available for eleven weeks between May 22 and August 7, 2018 and provided 1,088 responses: 744 from consumers and 344 from professionals (including 85 Procurement professionals), exceeding the goals for the consumer survey significantly.

While the first round was open to any participant, the second round was open to first round participants only who had given their consent and email address, which were 341 consumers, 198 professionals of which 68 Procurement professionals. 80 consumers participated in the second round, as well as 100 professionals, of which 25 are identified as Procurement professionals. 78 professionals gave their consent and email address to be invited to participate in the third and final round. The English versions of the questionnaires of both survey rounds can be found in Annex 2.

Since Procurement professionals are regarded as a key target group, this document presents results for professionals in total, supplemented by separate results for Procurement professionals.

The survey versions of the first round

To cater for the characteristics of the two target groups (end-consumers and professionals), there were two versions of the survey. The questionnaire for end-consumers was shorter due to their more limited knowledge on bio-based products. Both questionnaires included sections on:

- General information
  - For professionals, on the country of residency and the specific stakeholder group (e.g. 'public procurer', 'business') etc.
  - For end-consumers, on the country of residency, the age, gender, education level etc. It also included questions for facilitating the identification of early adopters.
- The awareness and the willingness to buy bio-based products
- The importance of sustainability information and certification in buying decisions
- Relevant product characteristics, in particular in the three sustainability pillars
- Characteristics of sustainability assessment schemes and
- Additional factors to support decisions to buy bio-based products.

The results were used for the development of conclusions and recommendations for the second survey round.

The second round survey

In line with the first survey round, the second round is split in two versions, for end-consumers and professionals. To optimise comparability, the same questions were asked to both groups where possible but some questions were simplified for consumers. Based the analysis of the first-round response and further analysis, the questionnaires included questions on the following topics:

- Procurement professionals were asked about the general relevance of sustainabiltiy in buying bio-based products, consumers were asked for their main driver to buy bio- or fossil-based.
- Different influences on willingness to buy biobased products, in general and per type of bio-based products.
- Whether each of 29 criteria, split in environmental, social, economic and additional criteria, were essential and which were the five most important criteria.
- Indication of the origin of bio-based products.
- The impact of nine categories of regulatory options was asked only to professionals.

The results were used for the development of conclusions and recommendations for sustainability assessment and standardisation presented in chapter 9.

5 Demographic data for the Delphi survey

5.1 Countries involved

Both survey versions contained questions to collect demographic information of the respondents, specified for each stakeholder group. Figure 4 shows the results regarding the country of residence.

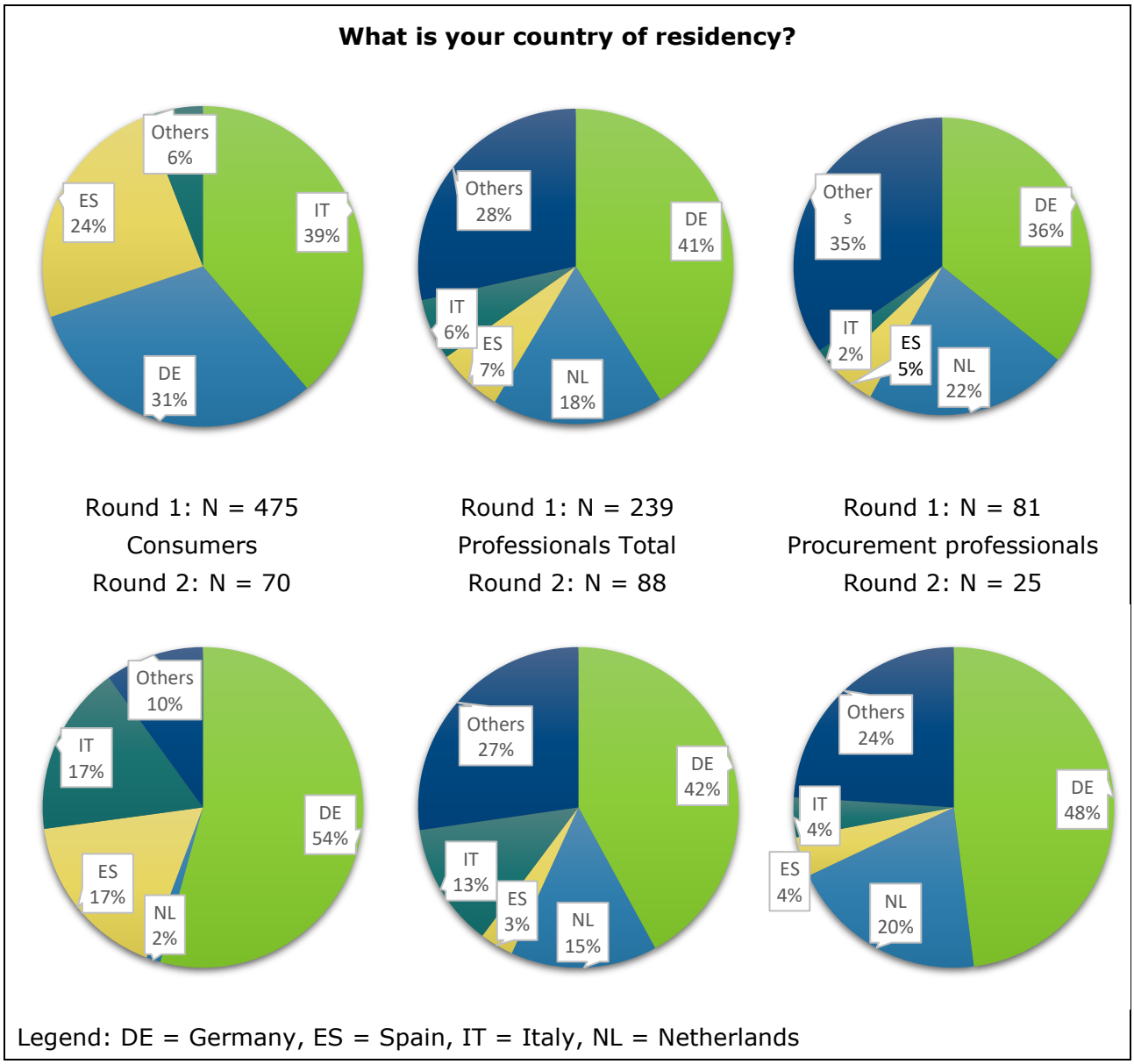


Figure 4: The country of residency of the different stakeholder groups

As mentioned in chapter 4, a key focus of the survey was put on the countries, in which the STAR-ProBio partners involved in the survey are located.

The figure shows that most of the 744 consumers come from Italy and Germany. The goal of reaching 400 consumers was exceeded significantly, in particular due to the 184 participants from Italy, the 148 participants from Germany and the 115 participants from Spain. Most of the 344 professionals come from Germany, from various other countries (including representatives of organizations working on the EU level) and from the Netherlands. These three regions are also the most represented in the sample of Procurement professionals.

While the first round was open to any participant, the second round was open to first round participants only who had given their consent and email address, which were 341 consumers, 198 professionals of which 68 Procurement professionals. Based on these conditions and previous research (see e.g. OpenBio 2015 and Peukert and Quitzow, 2017) a significant drop-off in participation was expected of about half to three quarters. 23% of the first-round consumers (N=80) participated in the second round, 51% professionals (N=100) and 37% of Procurement professionals (N=25), showing a much higher commitment by professionals. Figure 4 shows that the geographic spread of professional respondents did not change much between the two rounds, while the other groups show a higher commitment of participants residing in Germany.

5.2 Participants from the group of professionals

The survey version for professionals also included two specific questions on the type of the organization and the industrial sectors, in which the participants work.

As Figure 5 shows for the question "What kind of an organization do you work for?," the largest group of professionals (31%) work for businesses, followed by participants from universities or research organizations and from governmental organizations or public authorities. Other organizations include, for example, non-profit and international organizations. In the group of Procurement professionals, the percentage rate of businesses is 48% in the first round and 32% in the second round. Specifying the results for businesses. Figure 5 also shows that the majority of business representatives work for SMEs.

Most business representatives of the first round came from the fields of manufacturing, energy and construction. A big stakeholder group belonged to the category "others," which includes consulting, recycling and waste management (see Annex 3-1).

As Annex 3-1 also shows, most Procurement professionals come from the energy, manufacturing and construction sector. In this group, consultants dominate the group "others."

In the second round, the question on the type of business was only answered by 27 business representatives, of which 8 were Procurement professionals, so no conclusions could be drawn on whether there were major shifts in representation.

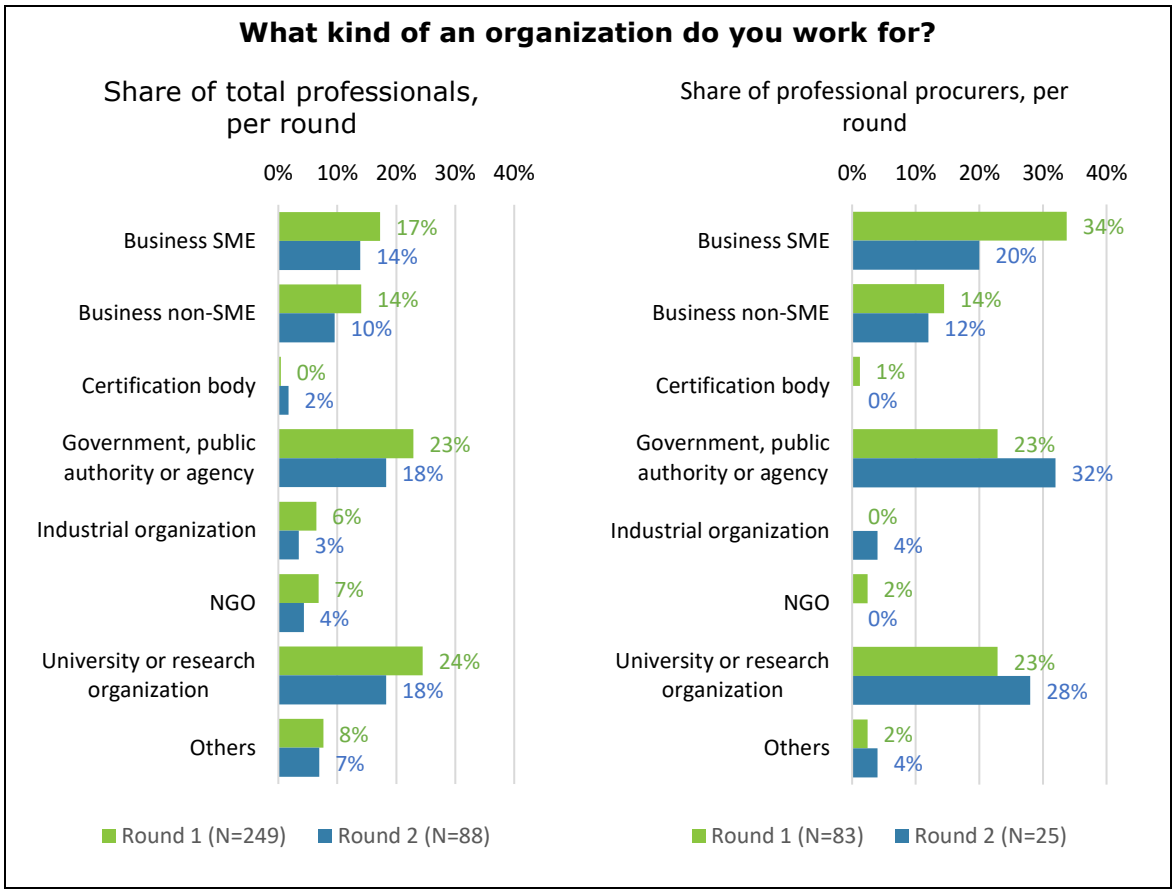


Figure 5: Professional participants' type of organization

In the second round 25 procurement professionals indicated whether they are mostly involved in buying, selling or both, see Annex 3-2. About two thirds indicated buying and about one third indicated buying and selling. When questioned about their organisation's need for a system to assess the sustainability of bio-based products (see Annex 3-3), just under half indicated that they already have a sufficiently good system, while 38% indicated a better system would be welcomed.

5.3 Participants from the group of consumers

Demographic information collected from end-consumers included age, gender, education level and the number of children in the household.

Figure 6 shows participation in all age groups with the biggest group of consumer participants being between 21 and 30 years old. The share of this group even increased in the second round. As mentioned in chapter 4.2, the survey had a specific focus on universities and potential early adopters, which explains the relatively high participation rate of young people. The gender of the consumer participants, depicted in the same figure, shows that females dominate with 61 % in the first round and an almost equal balance of men and women in the second round.

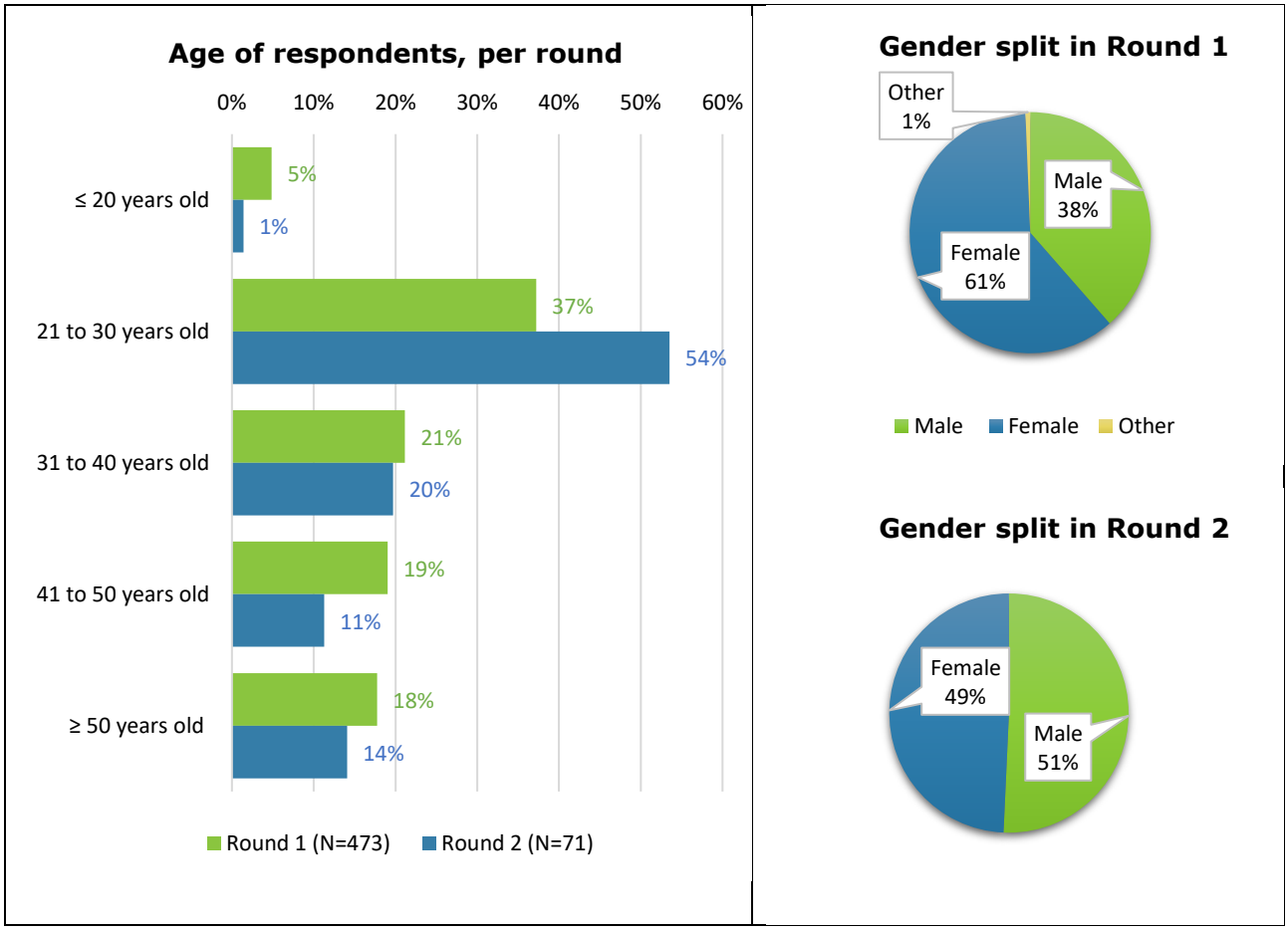


Figure 6: Age and gender of the respondents in the consumer group

Most consumer participants have university education (78 %), followed by secondary education (18 %) and vocational education (4 %) (see Annex 4-1). This is in line with the high rate of students and early adopters targeted as explained in chapter 2.

5.4 Consumer values

Consumers were presented with several statements regarding environmental, social, economic and functional values, and asked to what extent they agreed with each statement. Their feedback provided additional background information for the results in Sections 6-7. As Figure 7 shows, most of the consumers strongly agree on the three statements that current production and consumption models are a threat for the environment. These findings will be discussed further in Chapter 7.

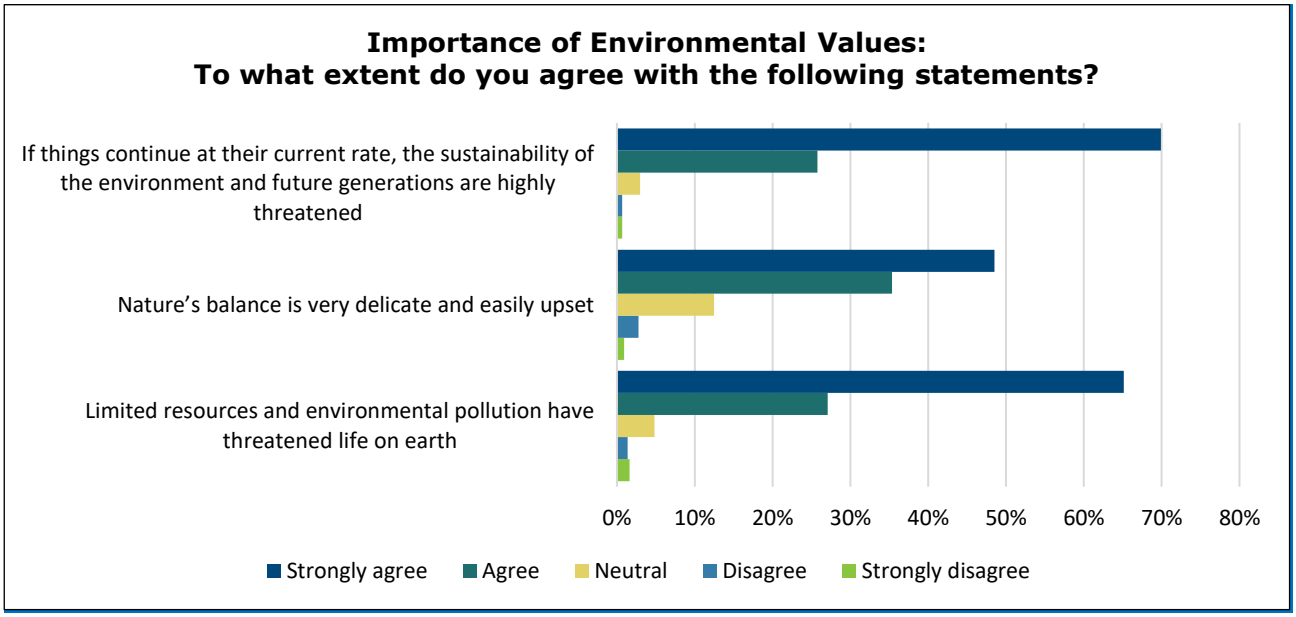


Figure 7: Environmental values of the consumers

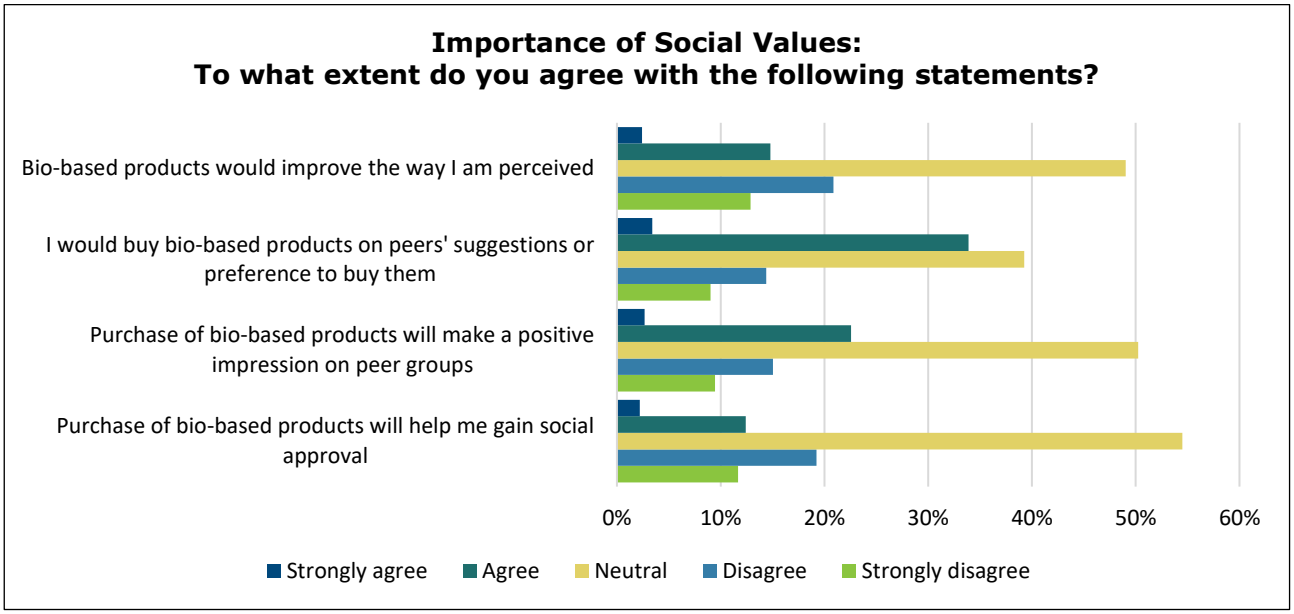


Figure 8: Social values of the consumers

When asked to what extent the consumers agree on a set of statements on the influence of social values on the purchase of bio-based products, the largest group of consumers indicated

they were neutral (i.e. without opinion). The items referred to social approval and the way the consumers would like to be perceived, the impression on peer-groups as well as the peers' suggestions or preferences (see Figure 8).

In addition to the frequency, by which neutrality was indicated, it is to note that more than 30% of the consumers agree to buy bio-based products on peer´s suggestions.

The answers on economic values reflect the importance of price issues. According to Figure 9, most consumers strongly agree to buy bio-based products over conventional substitutes if offered at a discount or with other promotional incentives. More price-related information can be found in Chapters 6 and 7. Most consumers also agree that they would purchase bio-based products over conventional substitutes under unsustainable environmental conditions and if these products are offered where they normally shop.

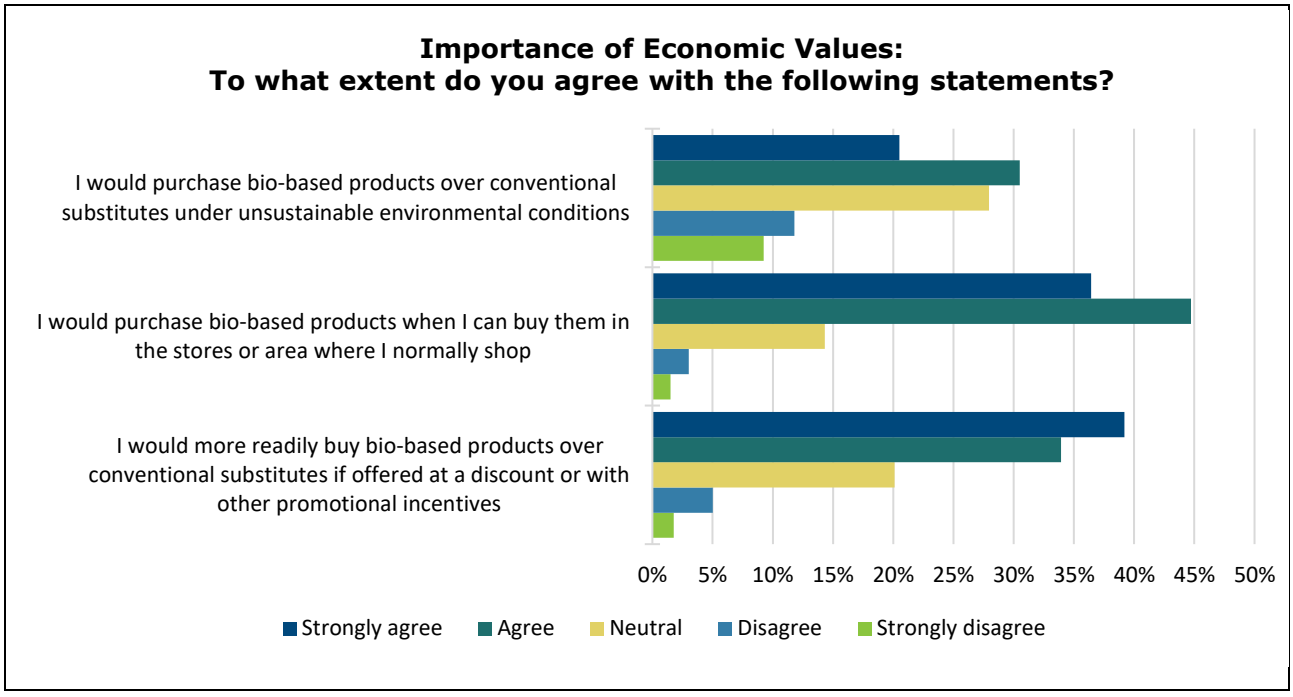


Figure 9: Economic values of the consumers

The discussion on functional values pictured in Figure 10, reflected the need to improve the image of bio-based products when it comes to efficiency. Most of the consumers are neutral regarding the statements that bio-based products are reasonably priced and economical for the attributes they offer. Nevertheless, the results for two items of the question on functional values unveiled areas where the image of bio-based products is very positive: Most of the consumers agree that

- bio-based products have an acceptable standard of quality and
- are made from non-hazardous substances.

In contrast to this, 39% are neutral in their response on the statement on non-hazardous substances and 13% even disagree or disagree strongly. Certifying that bio-based products are made without such substances provides options to improve the image of these products in this regard.

Two items referred to knowledge values. As Figure 11 shows, the majority of the consumers would appreciate more information on the production of bio-based products and on their impact

(e.g. regarding the manufacturing processes of these products) before buying them. Deepening these results, Chapter 7 will show to what extent consumers are in favour of certificates for sustainable bio-based products.

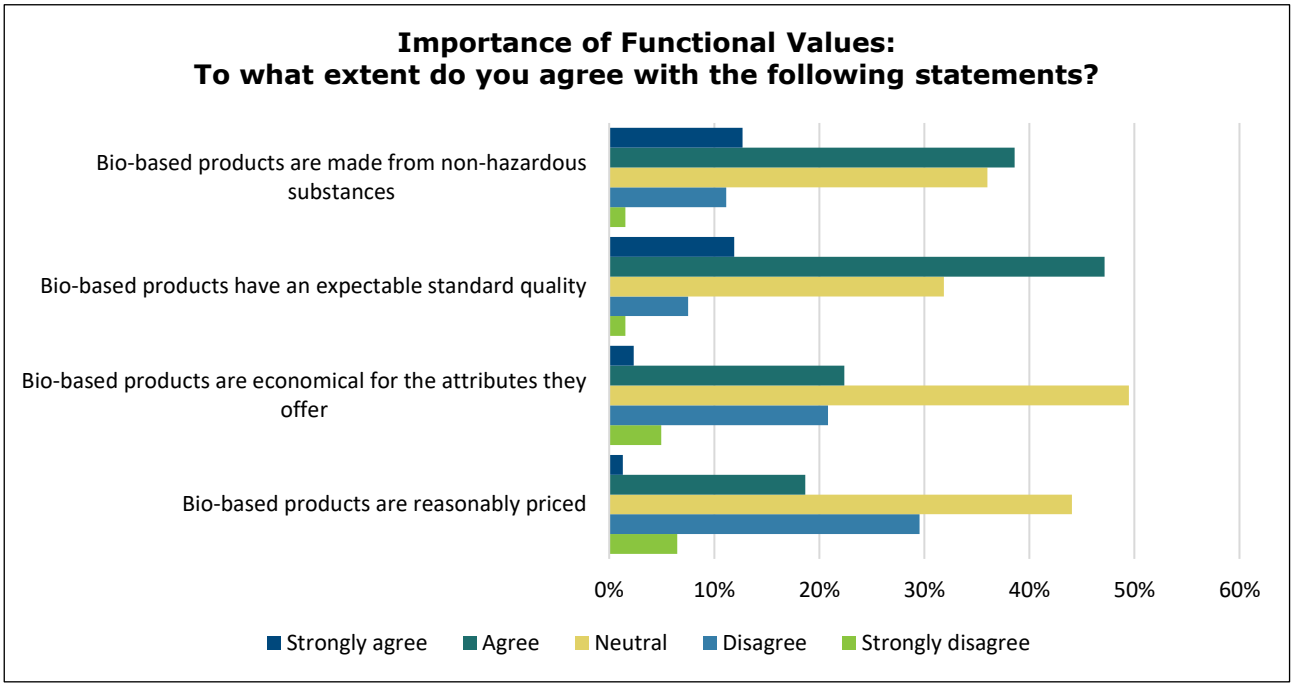


Figure 10: Functional values of the consumers

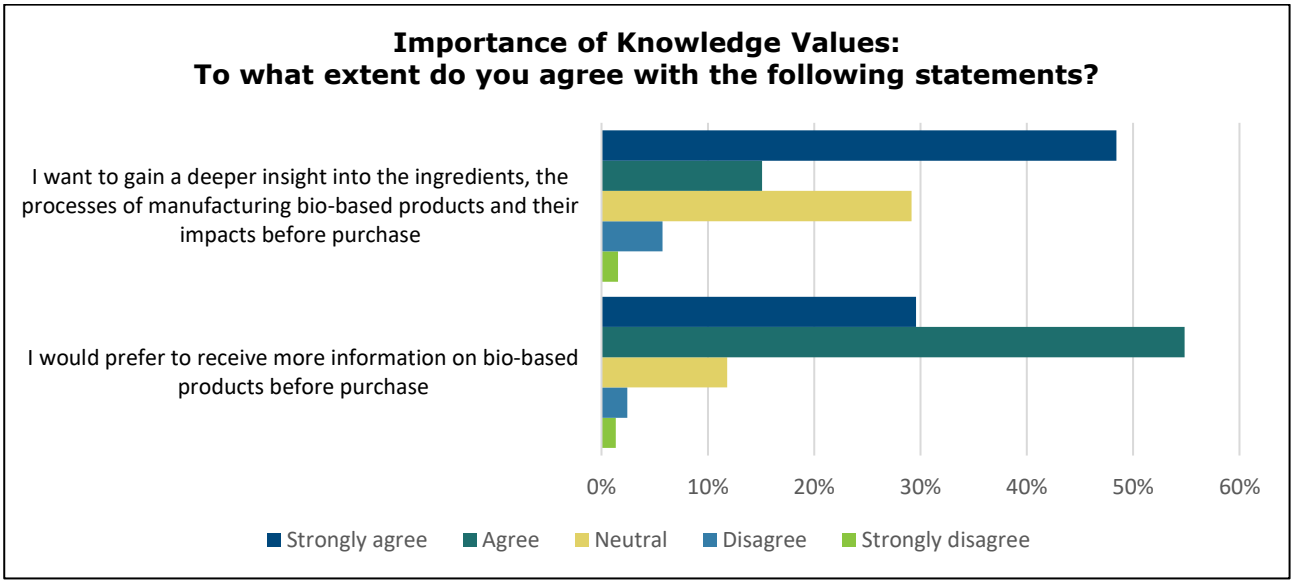


Figure 11: Knowledge values of the consumers

Chapter 6.5 also shows that information on different life cycle stages is important in this context. The responses also show that it is important for the consumers to know more about bio-based products production and origin, especially before buying them. The results on the knowledge values were also deepened by a question about whether the participants regard a certification logo on a product as sufficient for a decision on buying bio-based products or would like to have more information on the test results. This will be discussed in more detail in Section 7.2.

6 Sustainability preferences in decisions to buy bio-based products

6.1 Awareness and willingness to buy bio-based products

A goal of the first survey round was to obtain a deeper understanding of the willingness to buy bio-based products.[4] Two specific questions on a) the awareness of bio-based products and b) the willingness to buy them were used. Due to the focus on specific buying decisions, only consumers and Procurement professionals were considered in the analysis of the answers on this question.

The consumer survey started with a general question on the propensity to purchasing bio-based products. As Figure 12 shows, most of the consumers are inclined to purchase bio-based products. In total, seventy-five percent of them are inclined or even very inclined to buy them.

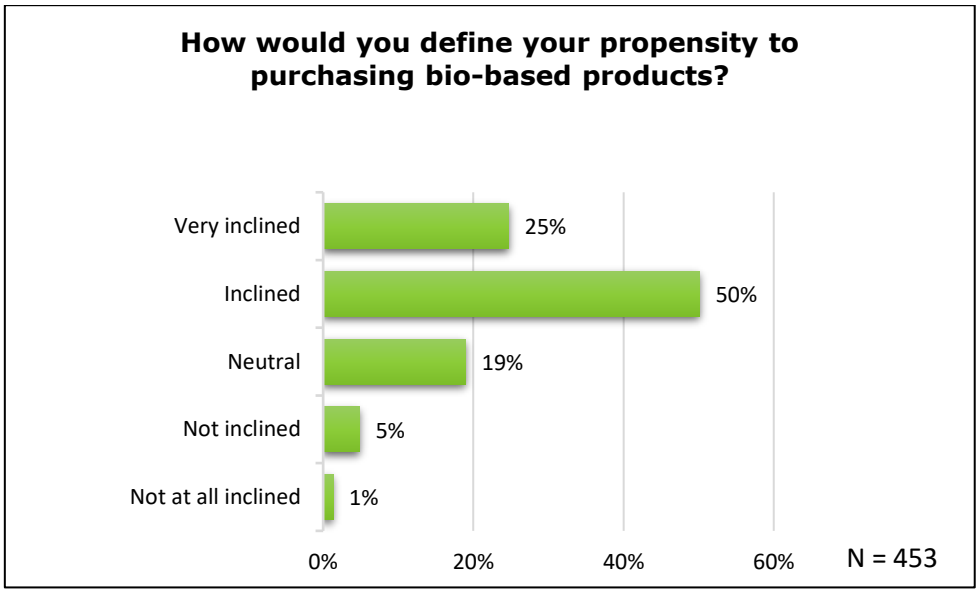


Figure 12: Propensity of the consumers to purchase bio-based products

In addition, specific bio-based products were discussed. As mentioned, the question on the willingness to buy bio-based products addressed only Procurement professionals in the survey for professionals. The relevant question was: "If you are involved in procurement processes, for which of these products would you procure bio-based products?"

Figure 13 and Figure 14 visualize the result for consumers and professionals for both aspects: the question on the awareness and the question on the willingness to buy specific bio-based products.

[4] The survey results also include incomplete and blank answers. The calculation of percentage rates considered this specifically by determining the number of persons who answered a specific block of questions and using this number as divisor for the relevant calculations.

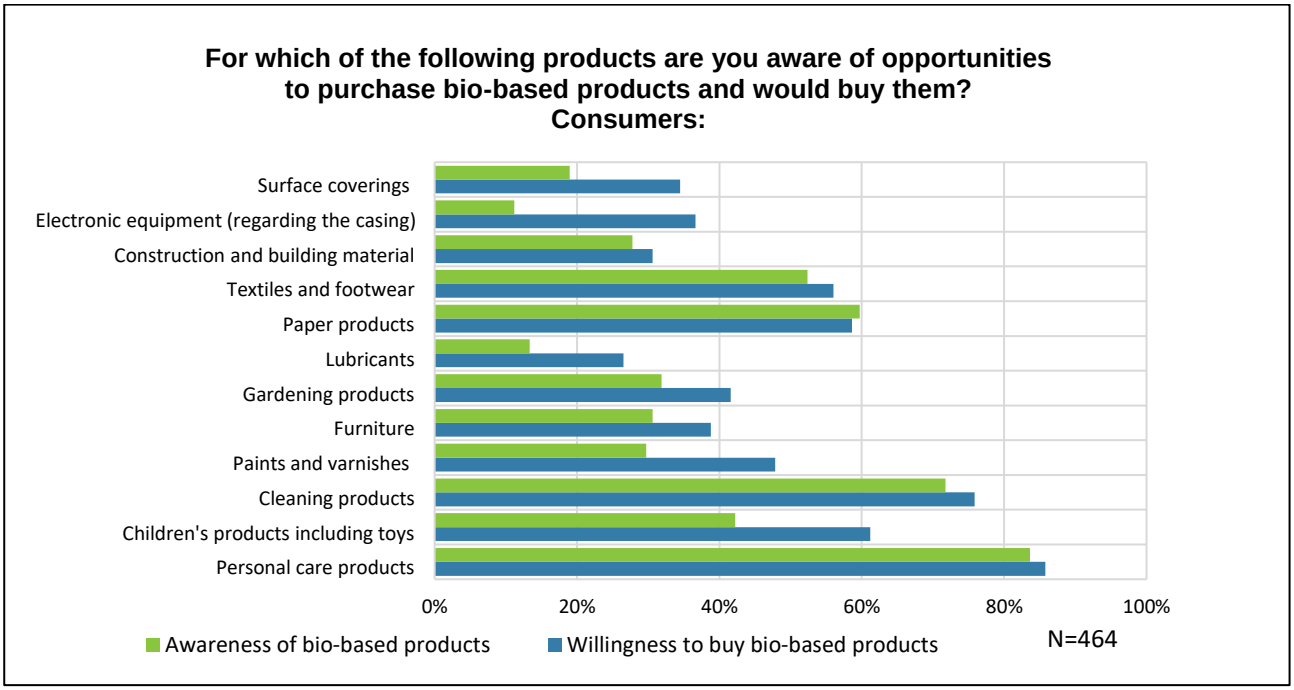


Figure 13: Awareness of bio-based products and willingness to buy them by the consumers

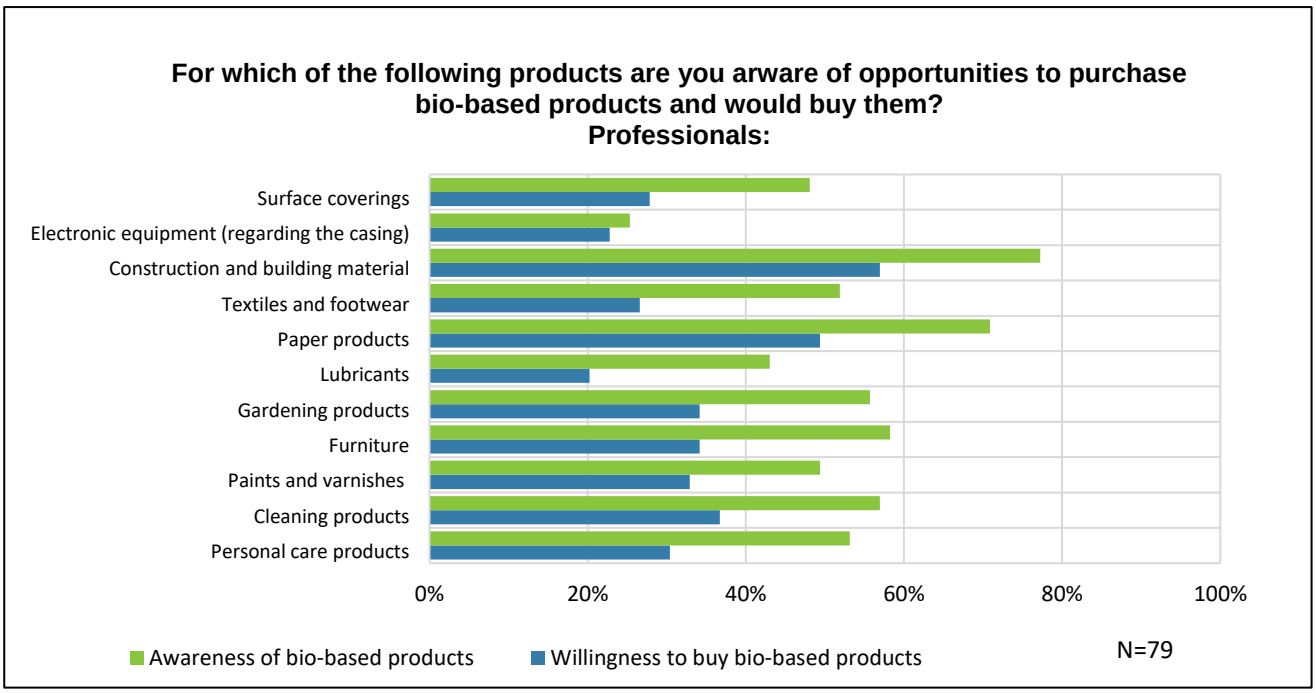


Figure 14: Awareness of bio-based products and willingness to buy them by Procurement professionals

As shown in Figure 13, consumers are most aware of bio-based products for personal care, cleaning and paper products. Lubricants and electronic equipment with bio-based content were the least known products in this context. The willingness of consumers to buy bio-based products is highest for these best-known products and for children's products. A big gap between the willingness to buy bio-based products for children and the awareness of such products is also

visible. Lubricants and construction & building material are the lowest-ranked products in this regard.

The willingness to buy bio-based personal care products even reached 84%, compared to a general willingness to buy bio-based products of 75% (inclined and very inclined).

As can be observed in Figure 14, the results for the Procurement professionals differ, reflecting different buying preferences of the two user groups regarding bio-based products. The Procurement professionals' responses on the question on the awareness of opportunities to purchase these products show that bio-based construction and building material, paper products and furniture are the most well-known products.

According to the answers on the question on which of these products the Procurement professionals would buy bio-based versions, construction and building material and paper products, together with cleaning products are ranked first. This indicates a positive link between the awareness of these products and the willingness to buy them. Nevertheless, the figure also shows that the numbers for awareness and willingness differ in many cases significantly. Among professionals, the awareness of bio-based products is much higher than the willingness to buy them while the consumers' results show the opposite case. The findings require further research and also show a need to improve the awareness of bio-based products among consumers. A lack of easily available bio-based products could also be a possible underlying reason for this result.

To validate and deepen these results, the second survey round addressed the willingness to buy bio-based products again, as well as the underlying motivations.

Consumers were asked with which statement regarding willingness to buy bio-based over fossil-based they most agree with (see Figure 15), and whether proof of sustainability is of influence of willingness (see Figure 16).

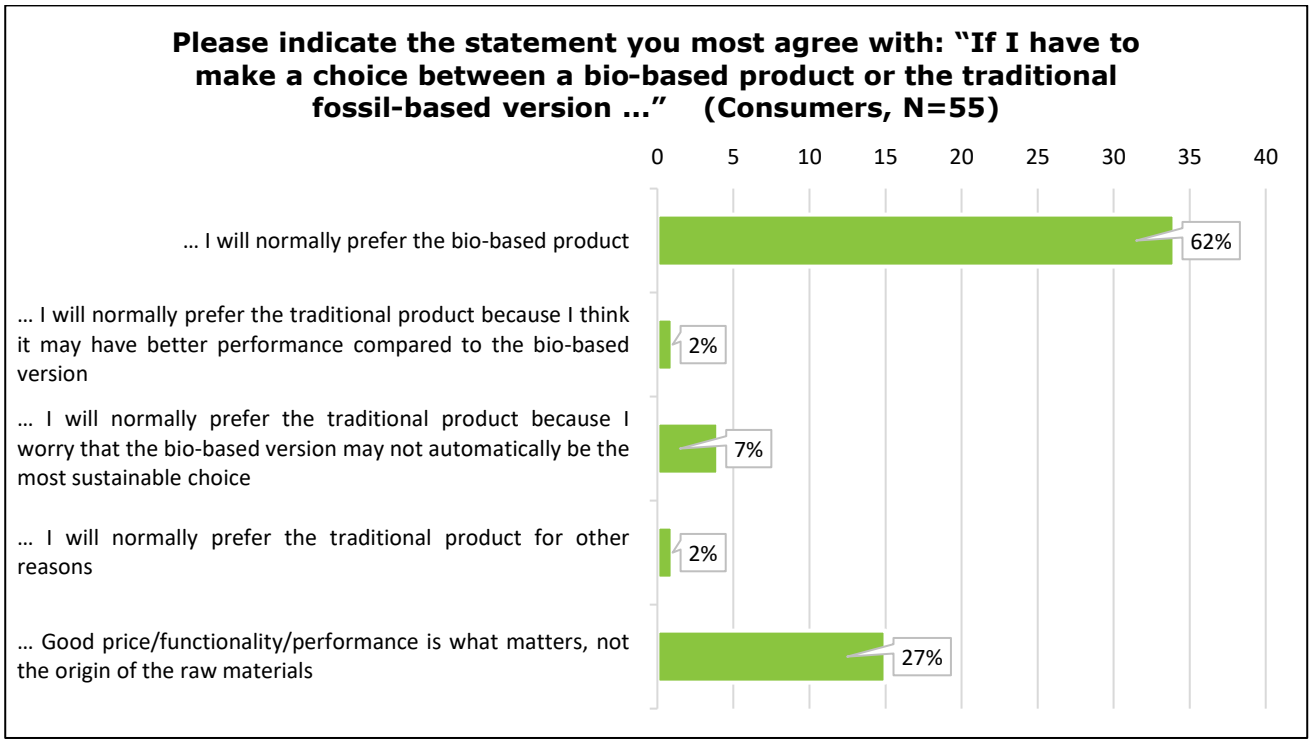


Figure 15: Drivers of consumer willingness to buy bio-based products

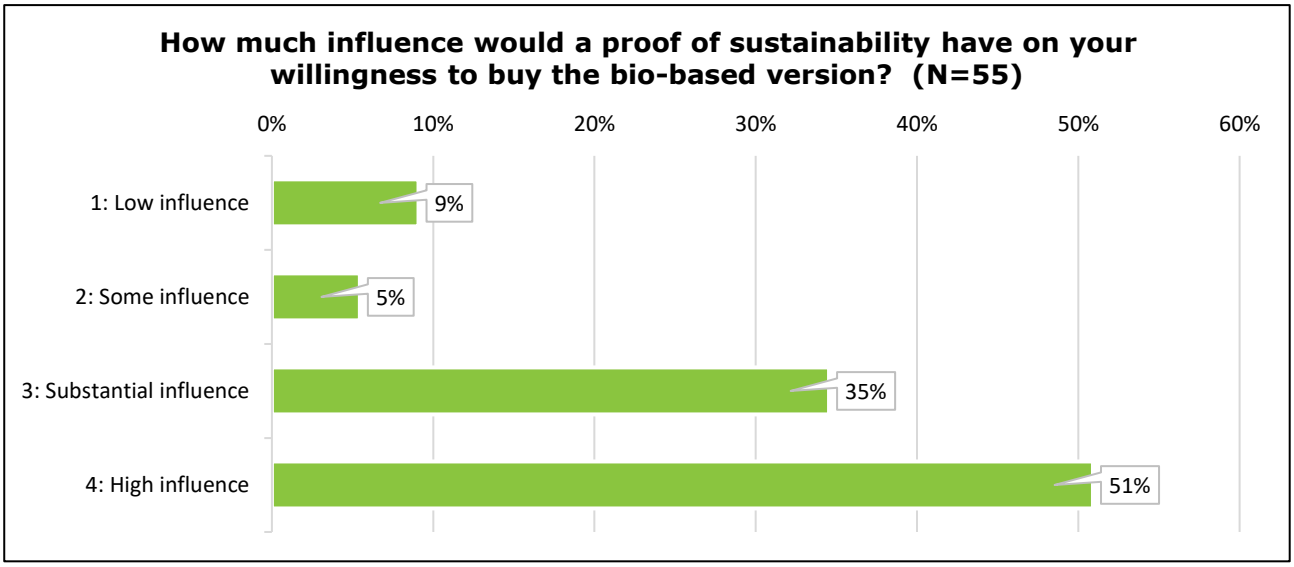


Figure 16: Influence of proof of sustainability reported by consumers

Figure 15 shows that the majority of surveyed consumers prefer bio-based over fossil-based alternatives, about a quarter indicated that the raw material source is insignificant compared to the price and functionality. Of the respondents that prefer the traditional product, most cite doubts on the sustainability of bio-based products as the main reason. In line with this result, Figure 16 shows that the majority of respondents indicate some or high influence of sustainability proof on willingness to buy bio-based.

In the second round, the influence on willingness for different reasons and products was questioned and ranked on a scale of 1 (low influence) to 4 (high influence), with the question "Please rate the importance of each reason for the decision to buy bio-based or not".

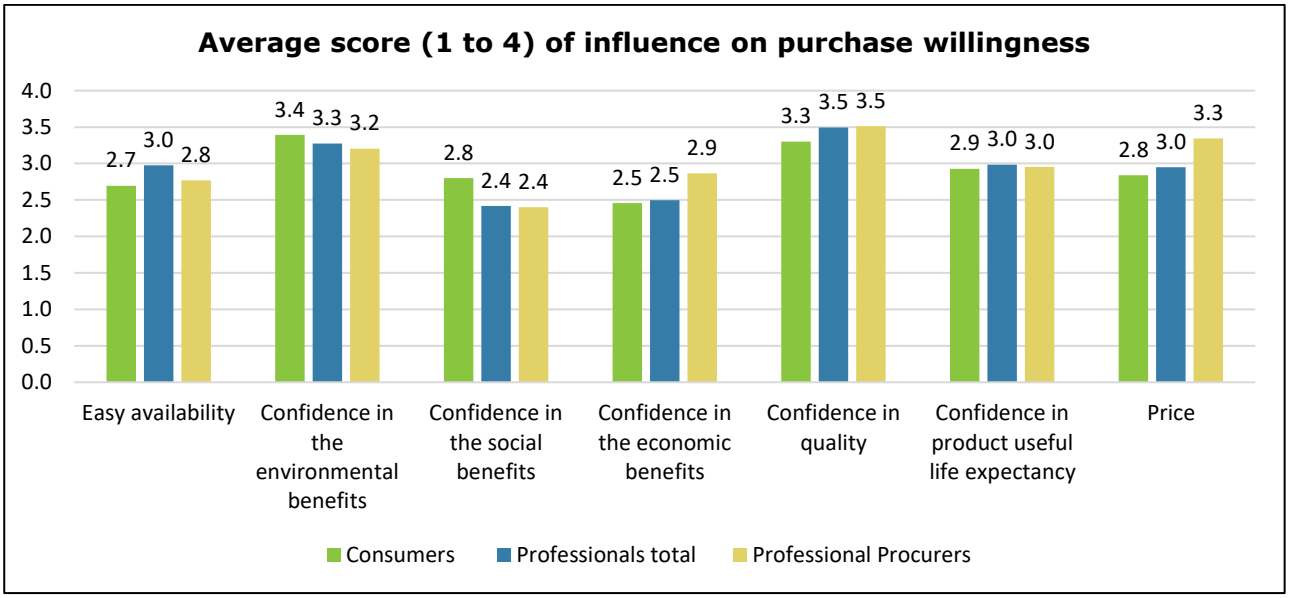


Figure 17: Average score of seven topics that can influence the willingness to buy bio-based products over the traditional product (score can range from 1 (low) to 4 (high))

Figure 17 summarises the weighted average score per topic of influence. It can be observed that while all topics show an almost similar score, the environmental and quality topics score highest. The different respondent groups show similar average scores, with the Procurement professionals scoring the price high. The social and economic benefits score lowest, although this is less pronounced for the social benefits for consumers and economic benefits for Procurement professionals. All topics, including the ones with the lowest score, are shown to have a significant influence on willingness to buy bio-based products. Respondents had the opportunity to rate the influence of each topic for individual product groups as shown in Figure 13 and Figure 14 and/or for bio-based products in general. The results disaggregated per type of product, presented in annexes 9-2 to 9-4, show similar rankings per topic as presented here.

Asked "Are you aware of opportunities to purchase products with bio-based packaging?", most participants in all target groups indicate that they do so as shown in Figure 18.

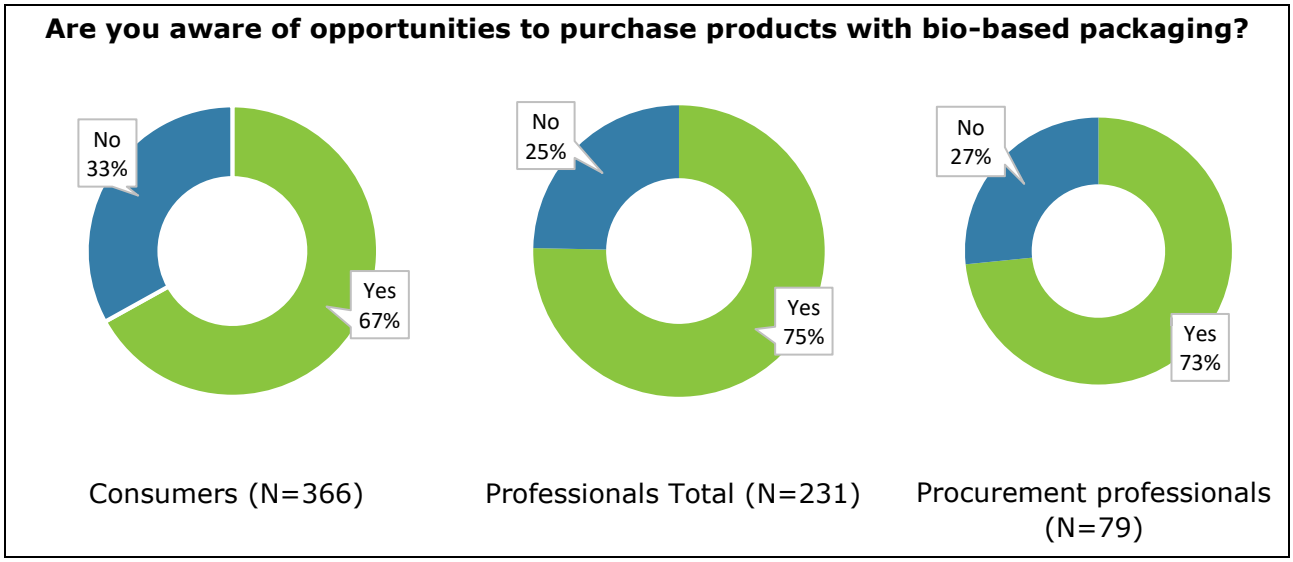


Figure 18: Awareness of products with bio-based packaging

Addressing this interest in bio-based packaging, a block of questions in a later point of the survey discussed labelling issues of packages.

6.2 Relevant types of information

A key objective of both survey rounds was to understand the target groups' preferences on sustainability assessment schemes and therefore what these schemes should include. As a starting point, fundamental issues of sustainability assessment preferences were analysed in the first round. Referring to the three sustainability pillars (environmental, social and economic) the participants were asked which kinds of information they consider relevant for a decision to purchase a bio-based product. The results presented in Figure 19 indicate that information on environmental issues is the most important for all participating stakeholder groups. In addition, all pillars were selected by the majority of participants in each group.

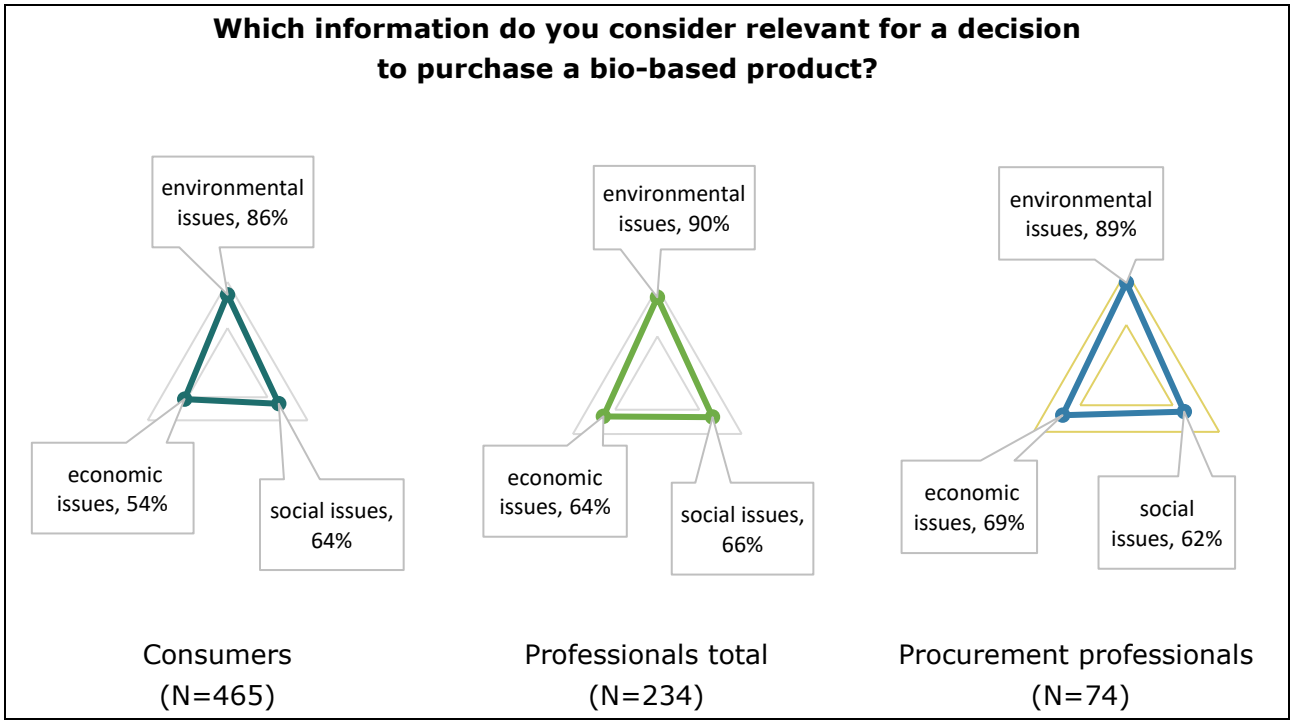


Figure 19: Importance of information on bio-based products for different stakeholder groups

In response to the optional open question to indicate additional information of relevance, 25 consumers and 28 professionals provided an additional statement. Where needed, responses were translated to English (this applies to all the answers on all open questions of the survey).

Topics of key interest for the **end-consumers** are health, quality, price and origin of the product. In detail, ten topics of interest were derived (number of relevant responses in brackets):

- Influence on health (8x)
- Functional characteristics of the product (3x)
- Origin of the product (3x)
- Bio-based content (2x)
- Price & cost (2x)
- Other economic issues (2x)
- Type of material (2x)
- Sustainability in general (1x)
- Certification (1x)
- Advantages compared to traditional products (1x)

Health-related issues refer, for example, to health in general, hazardous substances and allergies. The names of the clusters "**origin of the product," "bio-based content," "price & cost," "sustainability in general," "certification"** and **"advantages compared with traditional products"** were derived from various responses, in which these terms were used frequently. **"Functional characteristics of the product"** refer, for example, to quality and life expectancy. An example for **other economic issues** is the production effort while **type of material** refers, for example to the material's characteristics.

Additional statements by **professionals** show the significance of the price but also the importance of product functionality and origin. In detail, their contributions had the following topics (number of relevant responses in brackets):

- Price & cost (6x)
- End of life issues (5x)
- Functional characteristics of the product (4x)
- Origin of the product (4x)
- Various environmental issues (4x)
- Health impact (2x)
- Type of material (1x)
- Resource efficiency (1x)
- Various additional issues (6x)

Answers in the category **price & cost** include 4x the term price, 1x life cycle costs and 1x financial considerations. Regarding **EOL issues**, recycling was mentioned frequently but also, for example, biodegradability. The category **functional characteristics of the product** refers mainly to functionality but also to benefits and performance. The term **origin** was used in various statements and was therefore chosen as the topic headline of these contributions. **Various environmental issues** include for example, LCA and cradle-to-cradle considerations. "**Health impact**" refers to answers, in which "health" and "safety" was mentioned.

The topic **"type of material**" refers to the source of the material while the importance of "**resource efficiency"** was highlighted in another statement. "**Various additional issues"** include, for example, information on alternative products, the availability of the product as well as the need for appropriate definitions of bio-based products.

Interestingly, there are clear differences between the most frequently mentioned items of both user groups. An unanswered question is whether the statements refer to bio-based products in general or, as the term "health" might indicate, whether participants had specific products in mind when answering this question.

To validate these results and to gauge consensus, all respondents were asked to indicate for updated environmental, social, economic and additional criteria where they see each criterion as essential for assessing sustainability. The results for all groups and sustainability pillars are presented in Table 2.

Table 2: Percentage of respondents judging each criterion as essential

	Response to question: "Please indicate the criteria that are absolutely essential for claiming that a bio-based product is sustainable"	Consumers	Professionals	
			Total	Procure-ment
Environmental	Minimise the use of hazardous substances	90%	85%	89%
	Type of raw materials used.	82%	81%	83%
	Reduced lifecycle greenhouse gas emissions	86%	90%	100%
	Avoid contribution to undesirable changes in the way land is used	84%	67%	56%
	No impact to biodiversity in the production of the raw materials	84%	79%	67%
	No use of genetically modified organisms	35%	29%	56%
	Minimise energy consumption for raw material and product production processes	80%	73%	78%
	Sustainable water use (optimise consumption, minimise pollution no contribution to scarcity)	100%	94%	95%
	Sustainable soil use (prevent erosion, maintain or improve soil carbon content).	94%	84%	79%
	Minimise particulate matter emissions and other air pollution.	96%	65%	67%
	Packaging: use sustainable materials and/or minimise volumes.	94%	72%	78%
	Product should indicate the best disposal method(s) after useful life of bio-based product (recyclable, biodegradable, compostable, reusable, repairable).	80%	87%	95%
Social	Fulfilment of key human rights principles and international labour standards (ILO) in the sourcing of raw materials and the production of the products, for example forbidding child labour.	90%	96%	95%
	No risk to local food security	94%	88%	79%
	Not tested on animals	50%	36%	33%
	The product manufacturer has an occupational health and safety man-agement system in place	86%	70%	68%
Economic	Contribution to the wellbeing of local communities by the product manufacturer	60%	55%	44%
	Fair business practices	77%	88%	89%
	Fair land use rights practices	98%	89%	84%
Additional	Promote further development of production technologies that can use other sustainable input materials	69%	44%	61%
	Promote product design that enables a product to have a long life, re-usable and repairable	81%	80%	94%
	Functionality/performance of the product	85%	74%	68%
	Producer is known as a provider of bio-based products	15%	14%	28%
	Lifecycle cost	70%	63%	79%
	Product useful lifetime	87%	71%	67%
	Influence of the product on people's health	92%	71%	67%
	Colour scale: darker blue means a higher percentage. Examples of minimum and maximum:		*14%*	*100%*

Table 2 shows that the majority of the criteria is considered essential by more than half of the respondents, for some criterial such as GHG reduction, water protection and human rights there is almost full consensus. The criterion receiving the lowest support is that brands should be bio-based-only, followed by GMO avoidance.

Respondents were also asked their top 5 most important criteria. Table 3 shows the summarised results.

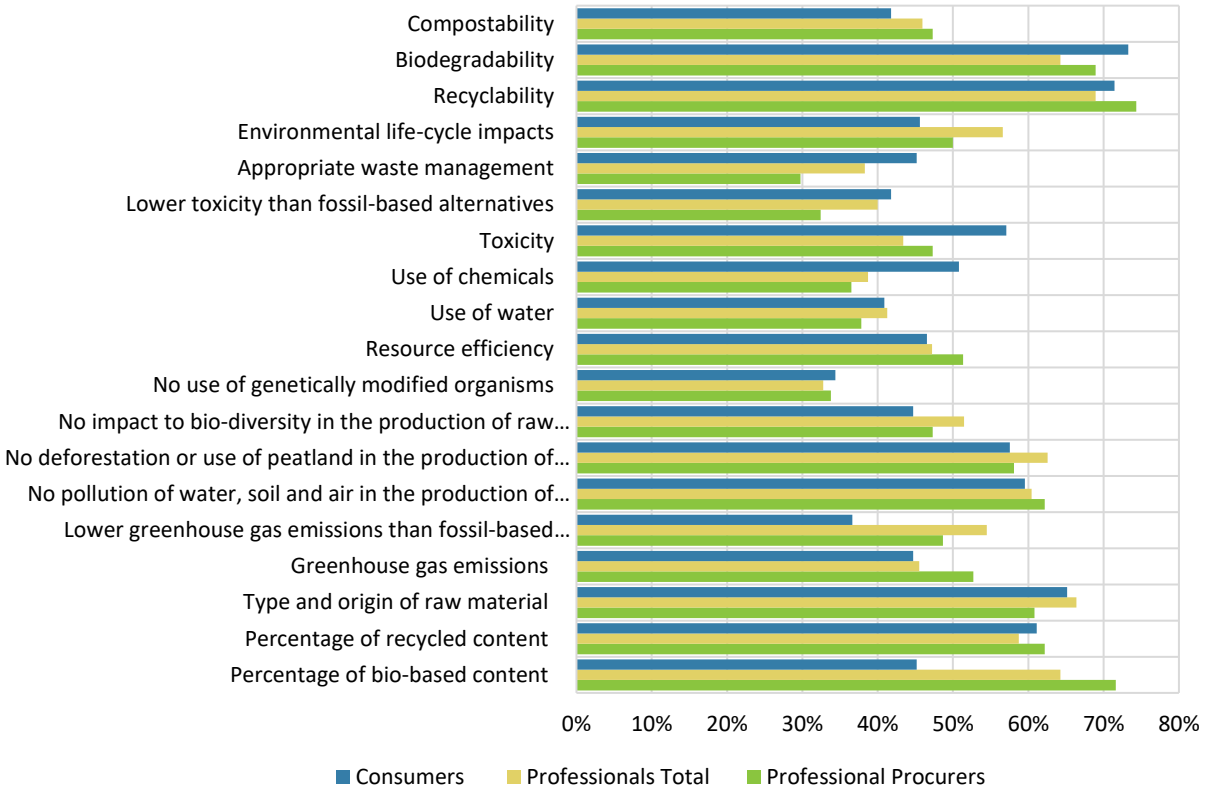
Table 3: Summarised results of the top 5 most important criteria per respondent

		Consumers	Professionals	
			Total	Procure-ment profes-sionals
Top 5	Environmental	62%	59%	63%
	Social	15%	14%	11%
	Economic	6%	6%	6%
	Additional	18%	21%	20%
Each respondent selected a top 5 of the most important criteria, this table shows the results when grouping the criteria in 4 categories; the three sus-tainability pillars and the additional criteria.				
Colour scale: darker blue means a higher percentage. Examples of minimum and maximum:			*6%*	*63%*

Table 3 shows that while almost all criteria are generally considered essential, when ranked in order of importance it is mostly environmental criteria that make the top 5, at the expense of socio-economic criteria. Another interesting observation is that the additional criteria were regarded as more important than criteria of the social and economic pillar.

6.3 Preferences regarding environmental issues

The next set of questions of the first round discussed relevant environmental, social and economic product characteristics. Figure 20 provides an overview on the importance of environmental issues in decisions to purchase a bio-based product. As shown important information for assessing environmental sustainability performance of bio-based products includes recyclability, type and origin of raw material, percentage of bio-based content and biodegradability.



Legend (complete statements)

Percentage of bio-based content ** Percentage of recycled content ** Type and origin of raw material ** Greenhouse gas emissions ** Lower greenhouse gas emissions than fossil-based alternatives ** No pollution of water, soil and air in the production of raw material beyond thresholds ** No deforestation or use of peatland in the production of raw material ** No impact to bio-diversity in the production of raw material ** No use of genetically modified organisms ** Resource efficiency ** Use of water ** Use of chemicals ** Toxicity ** Lower toxicity than fossil-based alternatives ** Appropriate waste management ** Environmental life-cycle impacts ** Recyclability ** Biodegradability ** Compostability

N Consumers: 445, N Professionals Total: 235, N Procurement professionals: 74

Figure 20: Information on environmental issues influencing purchasing decisions

An interesting result of the participant's ranking of environmental information is that "No use of GMO" is ranked as a relatively low priority while this is often regarded as very important for food (see Vidigal et al., 2015 on neophobia regarding gene modified food) and communicated on the packages of various food products. The result indicates that, depending on the specific application field, stakeholders have different views regarding the use of these organisms. While there is much scepticism and opposition regarding GMO-containing food, non-food applications may be accepted more easily. A STAR-ProBio case study on food packaging in work package 9

(see STAR-ProBio, 2018) provided additional insight: if bio-based packaging is used for organic food products, it is important that not only the food but also the packaging is GMO-free.

Various participants used the optional open question to specify additional environmental issues. These include in particular energy issues, which are addressed in a specific product-related section of the survey, but also, for example, regional origin and transportation, modifying the table item "type and origin of raw material" by highlighting regionality.

Following up on the influence of environmental criteria on the willingness to buy bio-based products, the second survey round asked which criteria were considered essential in sustainability assessment. Table 2 shows that environmental criteria were judged to be essential at higher percentages than the percentages indicating an influence on a buying decision. Also, less variation between the individual environmental criteria can be seen when looking if criteria are considered essential compared with whether criteria influence a buying decision. Although the sample size of the second round is smaller, this seems to indicate that even when certain criteria aren't of any real influence for a buying decision, they are still considered to be essential for a product to consider itself sustainable.

Some environmental criteria have quantitative indicators that are commonly used in sustainability assessment: the percentage of bio-based content and the percentage of reduction in GHG emissions compared to fossil-fuel based products. The respondents in the second round were asked about this. Consumers were asked what they would consider the minimum percentage of bio-based content and GHG reduction to qualify as sustainable. Professionals were asked to indicate three different percentage values:

- The percentage you would expect a product labelled as sustainable bio-based product to typically have;
- The percentage below which you feel that calling a bio-based product sustainable would be misleading;
- The percentage about which a bio-based product could deserve a special sustainability class (e.g. gold label).

Table 4 shows the minimum percentage or the percentage or the level under which it is considered misleading. The typical values and special class can be found in Annex 8.

Table 4: Respondent group expectations of % bio-based content and % GHG reduction

	Consumers			All professionals		Procurement professionals	
	Minimum bio-based (%)	Minimum GHG re-duction (%)		Mislead-ing bio-based (%)	Misleading GHG re-duction (%)	Misleading bio-based (%)	Misleading GHG re-duction (%)
0 to 10%	0%	6%	0 to 10%	16%	11%	34%	35%
10 to 20%	4%	12%	10 to 20%	5%	0%	17%	12%
20 to 30%	2%	8%	20 to 30%	16%	33%	12%	18%
30 to 40%	6%	12%	30 to 40%	6%	11%	3%	0%
40 to 50%	6%	37%	40 to 50%	31%	28%	19%	24%
50 to 60%	13%	6%	50 to 60%	10%	11%	0%	0%
60 to 70%	12%	6%	60 to 70%	0%	0%	3%	0%
70 to 80%	25%	4%	70 to 80%	10%	6%	3%	6%
80 to 90%	19%	6%	80 to 90%	3%	0%	0%	0%
90 to 100%	12%	4%	90 to 100%	3%	0%	0%	0%

6.4 Preferences regarding social and economic issues

With regard to the social dimension, the first round included seven items:

- Influence of the product on people's health.
- Respect for human rights in the production of the material and the product.
- No child labour.
- Not tested on animals.
- The working conditions and the payment of the employees meet at least minimum standards.
- Implementation of an occupational health and safety plan for the production of the product.
- Contribution to the economic wellbeing of local communities by the producer[5].

Although "child labour" could be included in the broader category of "Respect for human rights…," and is also covered by the ILO International labour standards,[6] it was decided to present this item separately because of its specific relevance to protect the weakest members of society.

Another issue considered by the human rights item was food security. Food security is addressed by the Universal Declaration of Human Rights (UDHR) in Article 25: (1) "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food…". The RED, sustainability criteria for bio-energy described in chapter 3 does not address food security (although food security is mentioned in its article 23). Therefore, it was decided to keep food security under human rights in general.

For both professional and consumer groups, information on the absence of child labour, respect of human rights and people's health belong to the most important social acceptance factors (see Figure 21).

In line with our expectations, all target groups ranked "no child labour" higher than "human rights…", highlighting the relevance of this specific item in the sustainability assessment context. Likewise, "no child labour" was ranked higher than "working conductions and payment of the employees meet at least minimum standards".

To address the relation between child labour and the two other categories, using the item "Fulfilment of key human rights principles and ILO in the sourcing of raw materials and the production of the products, for example forbidding child labour" was considered for the second round of the survey. A similar approach is used by the Roundtable on Sustainable Biomaterials (RSB) that includes the principle "human and labour rights" (see RSB, 2017).

Additional issues proposed by the participants in the optional open question include food security in the assessment and a suggestion to analyse social issues at each product life cycle stage, i.e. conducting social LCAs. A targeted discussion on food security and the work of Food and Agriculture Organization (FAO)[7] led to the reconsideration of this item separately in the second survey round. An indicator for food security could be that the amount of feedstock sourced from countries where nutrition is below a specific threshold.

[5] This item in the survey was listed under the economic pillar of sustainability but addresses both the social pillar and the economic pillar. In the analyses of the results, this item as treated under the social pillar as suggested by participating experts.

[6] International Labour Organisation (ILO)'s conventions and recommendations

[7] See, for example, http://www.fao.org/economic/ess/ess-fs/en/ for further information

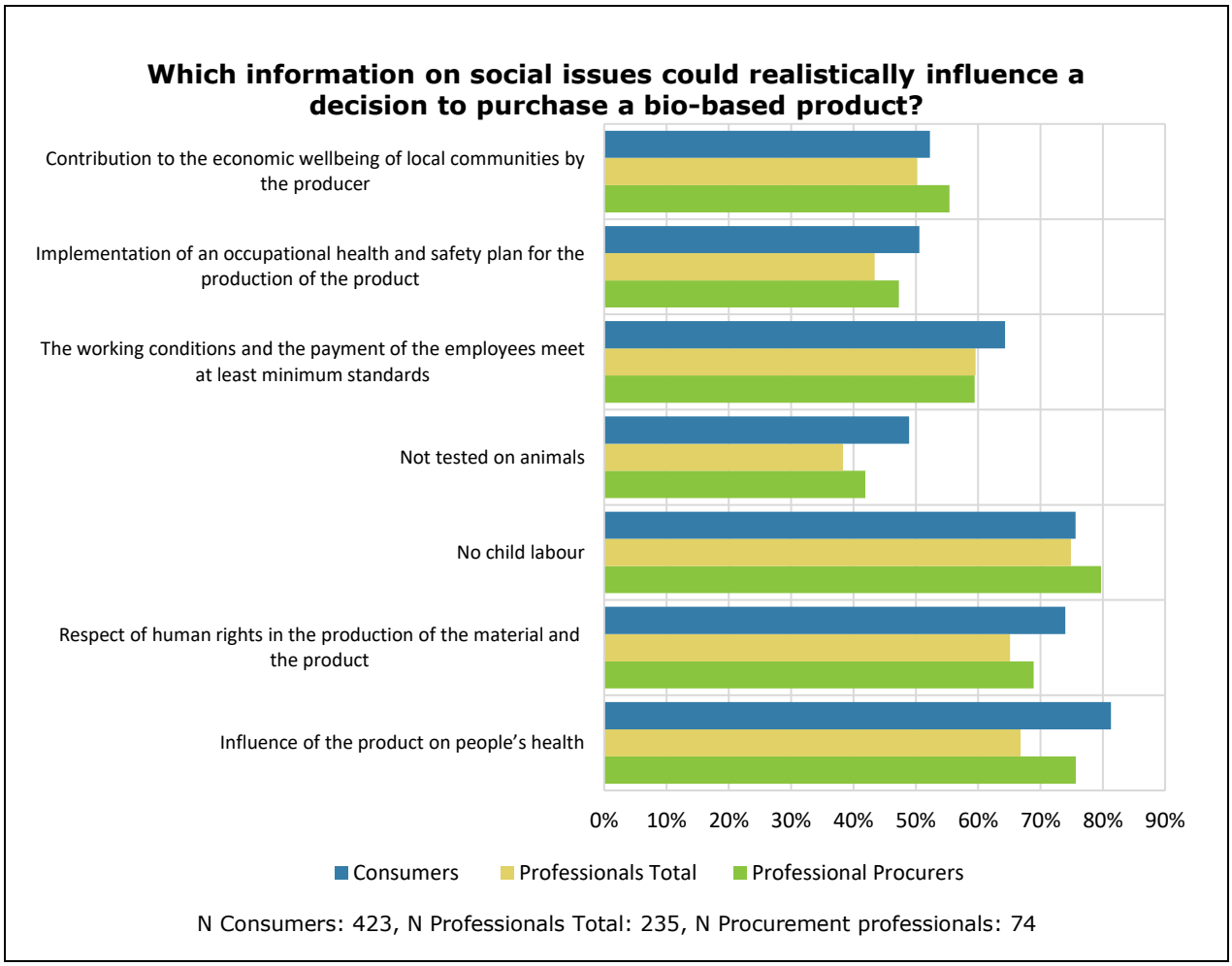


Figure 21: Information on social issues influencing purchasing decisions

As Annex 3-2 shows, the majority of the consumers do not buy bio-based products as a vehicle to be better "perceived" (or accepted) by the society. Social considerations may therefore be linked with ethical consumption behaviour, a conscious and deliberate choice due to personal and moral beliefs (see Carrigan et al., 2004, p. 401).

The economic dimension was analysed through two items: fair business practices of the company and fair land use right practices.[5] For professionals, fair business practices were judged more important with the opposite being true for consumers (Figure 22). An interpretation may be that professionals are aware of the need to consider business practices as a whole in their buying decisions while consumers paid specific attention to an item whose wording suggests a close relation to the material of the products. In addition to this, the importance of the specific business practice item "fair trade" will be shown later in this section.

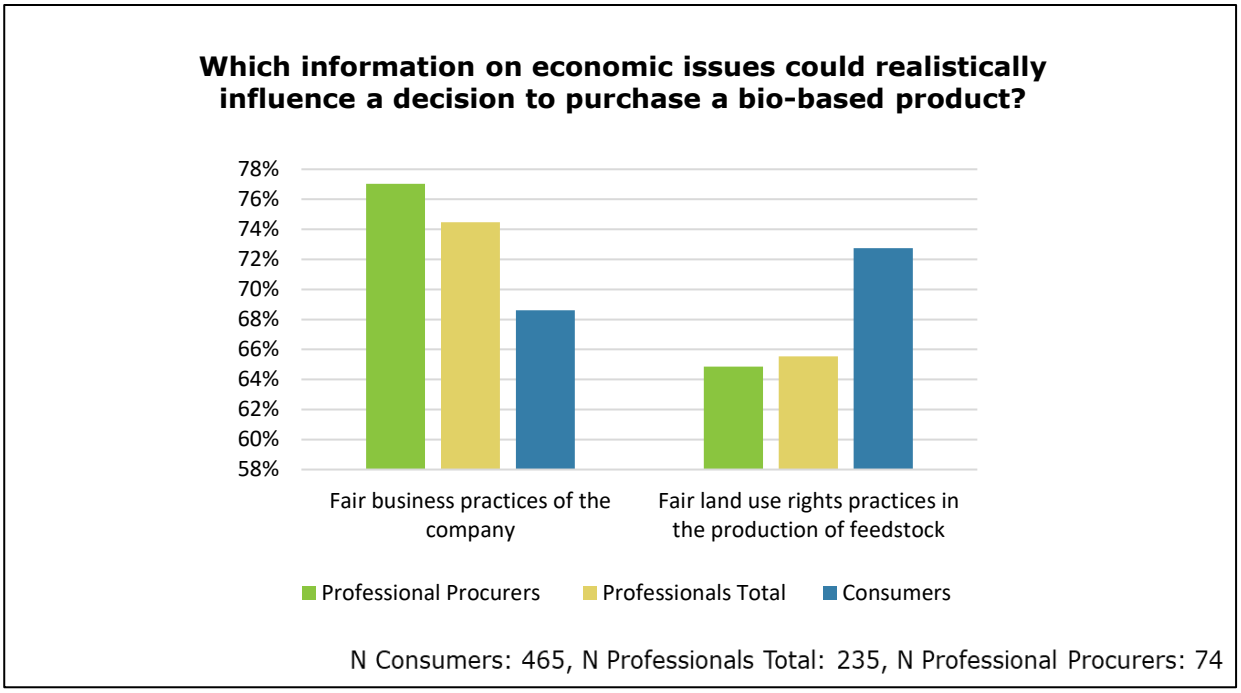


Figure 22: Information on economic issues influencing purchasing decisions

In response to the optional open question for additional economic issues, both professionals and consumers included fair wages and the price of the product. The fact that fair wages, which can be considered under the social and the economic pillar, were mentioned again highlights the importance of information on an appropriate treatment of workers for buying decisions. The existence of issues that are linked with more than one sustainability pillar also shows the importance of considering the various assessment items beyond the boundaries of the three sustainability pillars individually. For this reason, the second Delphi survey round later provided an overview of all sustainability issues without linking them to specific sustainability pillars as summarised in section 6.2.

Based on the follow up in the second survey round on the influence of various criteria on the willingness to buy bio-based products, Table 2 on p. 38 summarized which criteria were considered essential in sustainability assessment. Table 2 shows that even though the percentage of respondents that think that social or economic criteria are essential is lower than for environmental criteria, for each criterion the majority of respondents think they are essential. The only exception is excluding animal testing, only about a third of professionals consider this an essential criterion.

Professionals also mentioned fair trade, which is a specific element of fair business practice. Their use of these related terms may also reflect the existence of a certificate with the name "Fair Trade." To exploit the awareness of the phrase "fair trade" among the target groups, its use could be considered as an alternative to the fair business practice item in sustainability assessment schemes.

Professionals also mentioned life cycle cost (LCC) regarding the economic pillar. Together with the price they were addressed by a specific set of product-related questions (see next section). Both items provide additional examples for the potential benefits of discussing the assessment items beyond the boundaries of the three specific sustainability pillars with the target groups.

6.5 Preferences regarding additional product characteristics

The surveys also included questions on additional product characteristics with a more indirect link to sustainability.

The results of the first round suggest that functionality/performance of the product, price and energy consumption are the top ranked information on additional product characteristics that could realistically influence a decision to purchase a bio-based product both for consumer and professional. Information on life cycle cost, only included in the survey of professional, is also considered relevant (see Figure 23).

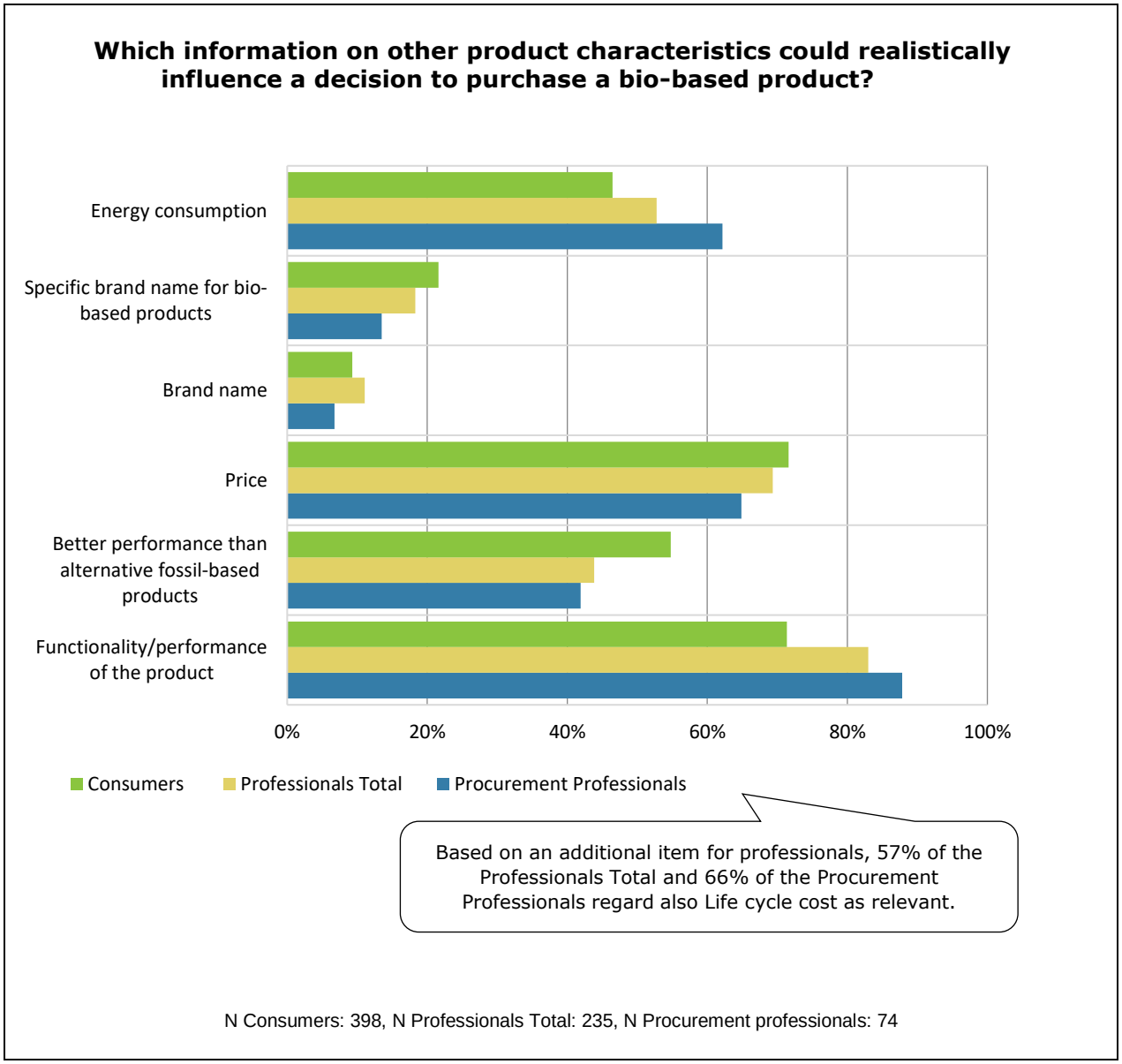


Figure 23: Information on additional characteristics influencing purchasing decisions

Following up on the influence of additional criteria on the willingness to buy bio-based products, the second survey round asked which additional criteria were considered essential in sustainability assessment. Table 2 on page 38 also summarizes these results, which show the updated set of additional criteria rank slightly higher than social or economic criteria but rank lower than environmental criteria. It is worth noting that "Producer is known as a provider of bio-based products" is considered essential at a much lower rate than any other assessed criterion. "Promote product design that enables a product to have a long life, reusable and repairable" is the highest rated.

The importance of bio-based packaging was an additional topic discussed in the survey. Figure 24 shows that for both Procurement professionals and consumers bio-based packaging is a relevant factor influencing buying decisions.

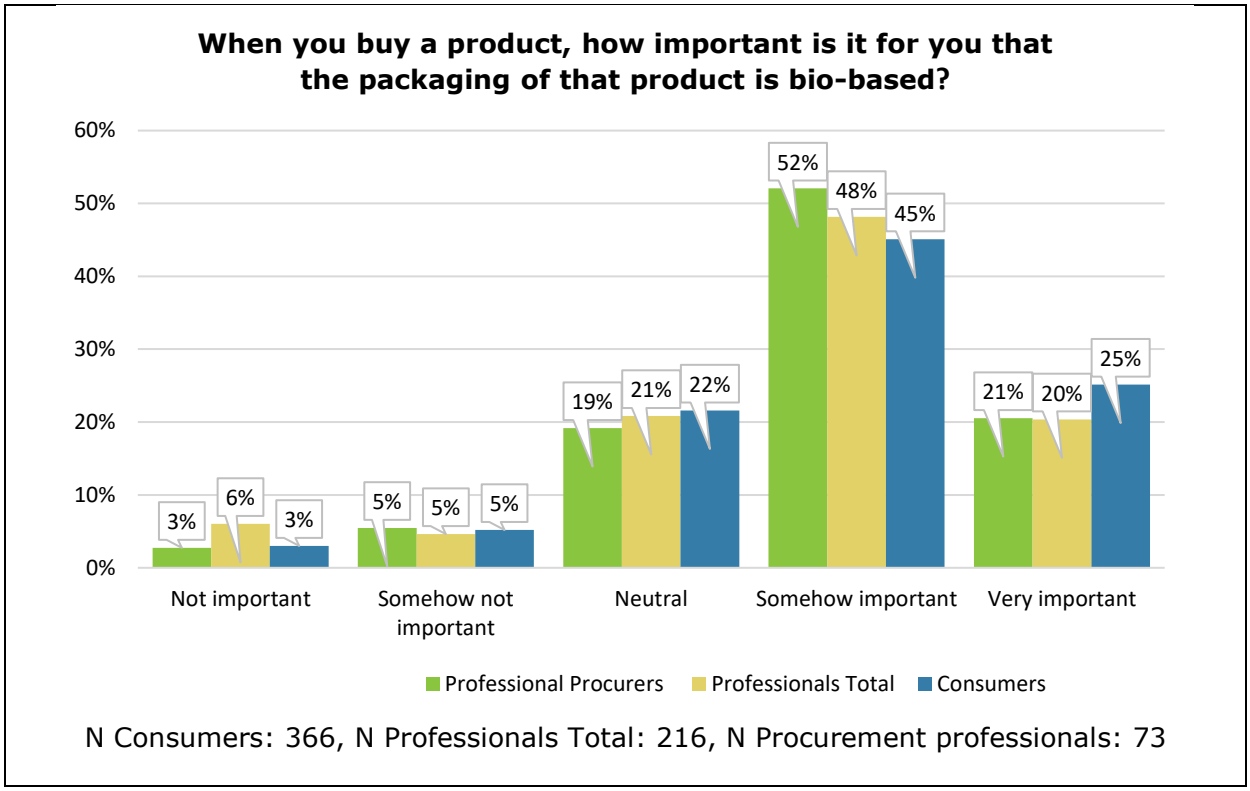


Figure 24: The importance of bio-based packaging in purchasing decisions

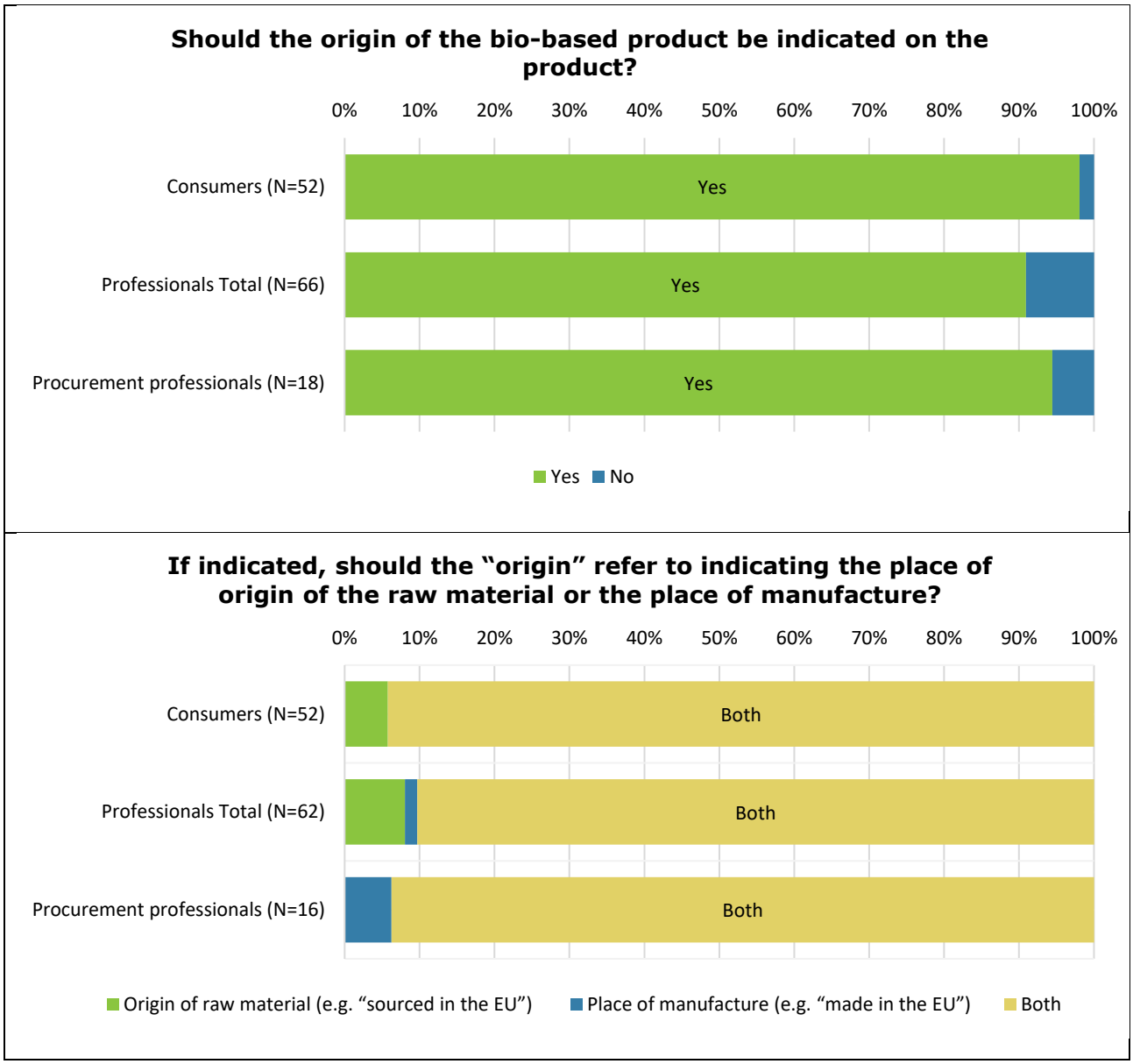


Figure 25: Opinions on the need for indication of product origin

The second round of the Delphi survey included questions related to the origin of bio-based products. Figure 25 shows there is close to consensus that both the origin of raw materials and the place of manufacture should be indicated on bio-based products.

7 Sustainability assessment preferences regarding sustainability certification schemes

7.1 General findings

The benefit of sustainability certification

Starting the discussion on sustainability certification, a set of questions of the first round referred to general certification issues. The initial question of this question group was: "Would you regard sustainability certification for bio-based products as beneficial for your buying decisions?" As the following figure shows, over 75% in each group of respondents answered positively. Within the consumer group 84% gave a positive answer.

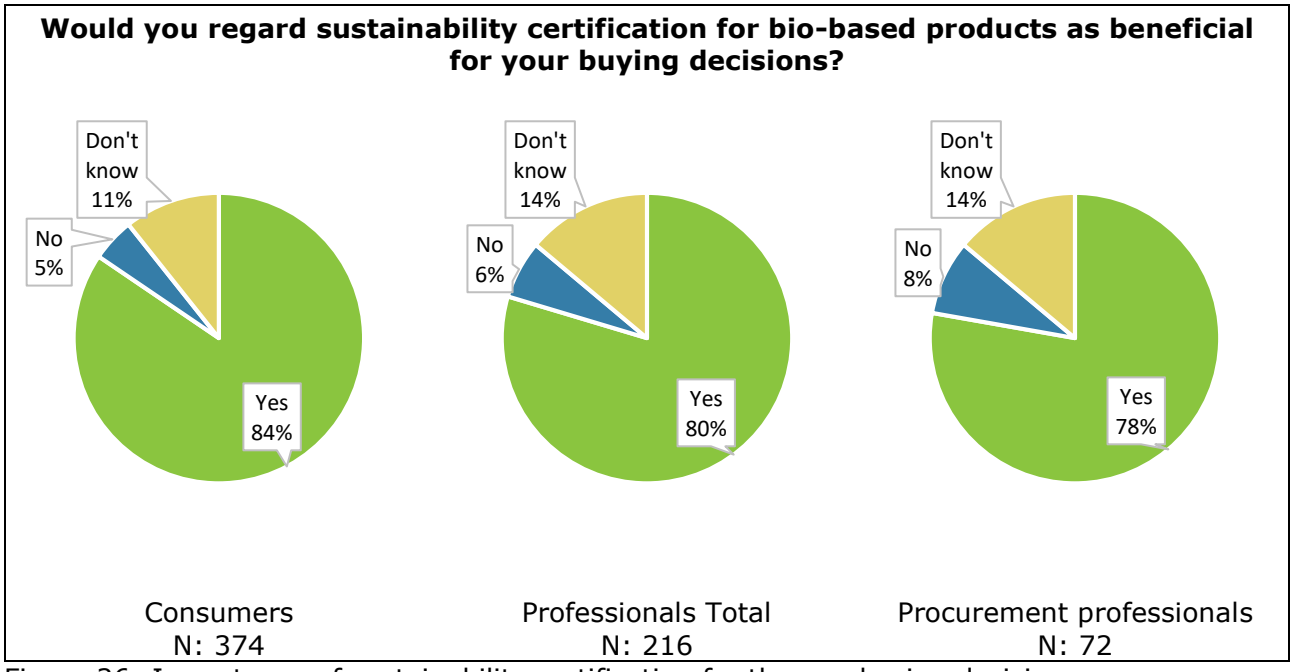


Figure 26: Importance of sustainability certification for the purchasing decisions

Mandatory versus voluntary certification per sustainability pillar

The majority (87-91%) of all groups suggests that the inclusion of information on environmental issues should be mandatory in the certification of bio-based products. However, as shown in Figure 27, the number in favour of mandatory certification is smaller for social issues (56 to 62%) and economic issues (39 to 46%). The percentage of consumers in favour of mandatory inclusion of economic and social issue is slightly higher than the professionals.

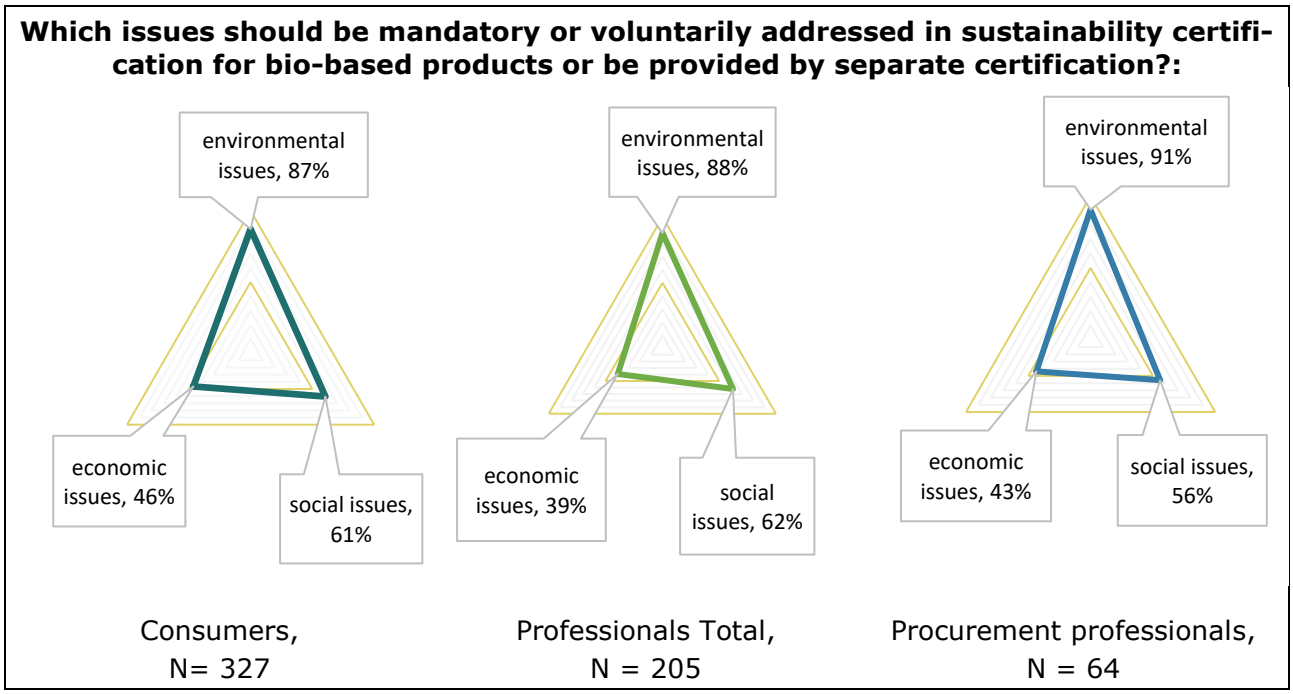


Figure 27: Compulsory nature of sustainability pillars in sustainability certification

In tandem with the low acceptance rate in Figure 27 for including economic criteria mandatorily in sustainability certification, the participants suggest voluntary certification instead (34% of the consumers, 41% of the professionals in total and 35% of the Procurement professionals) or separate certification (20% of the consumers, 19% of the professionals in total and 22% of the Procurement professionals).

Other certification and purchasing issues

Another survey question addressed the inclusion of a functionality criterion in sustainability certification. All respondents, who agreed that information on a products' functionality influences their buying decision (71% of the consumers, 83% of the professionals and 88% of the Procurement professionals) also think that a functionality/performance criterion should be included in the certification for bio-based products. Information on the product's functionality/performance plus information on comparisons with traditional non-bio-based products are preferred.

In addition, an open follow-up question was asked to both user groups: "Which other aspects can support purchasing decisions if an opportunity to purchase a bio-based product exists?" The answers were grouped by 12 categories (number of relevant responses between brackets):

- Specific sustainability criteria (33x)
- General characteristics and added value (18x)
- Certificates and labels (11x)
- Regulatory requirements and procurement rules (9x)
- General communication (9x)
- Additional comments (9x)
- Packaging (8x)
- Availability (7x)
- Price and cost (6x)
- Extensive statements on various issues (5x)
- Bio-based content (3x)
- Demand (3x)

Thirty-three suggestions referred to **specific sustainability criteria,** considering all three pillars as well as sustainability in general. Environmental issues included, for example, durability, recyclability and LCA. Social and economic issues were for example fair trade and the support of local businesses. Suggestions regarding **"bio-based content"** recommended to specify

minimum percentage rates to characterize a product as "bio-based." **"General characteristics and added value"** include issues such as "proven functionality" and "easy to handle", emphasising functionality aspects again. **Regulatory requirements and procurement rules** refer for example to the response "procurement guidelines", which were mentioned several times. Presenting the results of additional questions, Section 8 will discuss these procurement related issues in more detail.

With regard to **demand**, social networks were mentioned: "it might push the decision to buy a product (just because of the reason that an article is 'in vogue')." This statement provides a practical example of a social value discussed in chapter 4.2 ("I would buy bio-based products on peers' suggestions or preference to buy them"). Regarding **general communication** issues, transparency was mentioned frequently. Examples are: "transparency of the supply chain" and "transparency …, traceability of production processes and distribution channels." With regard to **certificates and labels**, "clear labelling" and "traceability and transparency of the certification process" were regarded as important issues. The interest in comparisons with fossil-based products was also mentioned in this context.

Regarding **packaging**, avoidance as well as appropriate EOL options were mentioned as key aspects. Regarding the **availability** of bio-based products, awareness and the supply of bio-based products were mentioned. In addition, the respondents indicated interest in more information on where bio-based products can be bought. With regard to **price and cost**, reasonable premium prices as well as total life cycle costs were mentioned. An interesting **extensive statement on various issues** was, for example: "proof of sustainability advantages, social harmlessness, fair trade, no endangerment of nutritional bases, no competition to nutrition, protection of important protected areas, such as primeval forests, no monocultures". **Additional comments** were, for example: "the preference for bio-based products should be a part of education in schools and kindergartens" and "the important aspect is to explain the negative impact non-bio-based products have."

A detailed overview of the statements can be found in Annex 4.

7.2 Characteristics of the certificates and related product information

With regard to the specific implementation of a sustainability certificate for bio-based products, participants of the first round were asked in both survey versions the open question: "What do you think should be the most important requirements of sustainability certification for bio-based products that should be included in its marketing messages? Please make suggestions for appropriate formulations."

The most common type of marketing message focusses on the reduced use of fossil resources. Beyond this, the answers could be classified by 13 categories:

- Biobased content
- Term "sustainable"
- Considerations of the three pillars
- Various environmental issues
- Avoid "environmentally friendly"
- Origin and type of materials
- End of life
- Social issues
- Comparisons with fossil-based products
- Referencing relevant standards, certificates, regulations
- GMO free
- No animal testing
- Other

An example for suggestions to highlight **bio-based content** is the statement: "the most important information is 'bio-based'". A suggestion on providing quantitative information on bio-based content was "% of bio-based content as a star system".

The statement "made of sustainably managed renewable resources" is an example for suggestions to consider the term "**sustainability**" specifically in a marketing message.

The cluster of suggested marketing messages on **considerations of the three pillars** includes, for example the statement "Products that are produced in an ecologically, economically and socially responsible way."

Suggestions on "**various environmental issues**" include, for example the statements "CO_2 emissions" and "resource efficiency in LCA." Two different positions could be observed regarding the item "environmentally friendly." One group of participants suggested to highlight the attribute "environmentally friendly bio-based products" while others stressed: "Avoid "'environmentally friendly' or 'green'. Make claims that are precise, measurable and verifiable instead." In this way the second group stresses the importance of the characteristic environmental friendliness and emphasize that detailed information has to be given. This was probably suggested also as a way to avoid greenwashing and to be in line with EU guidance on environmental labelling in support of the EU Directive on unfair commercial practices (MDEC, 2016).

Regarding the **type and origin of the material** and **end of life issues**, it was, for example emphasized that "The origin of the raw material and end-of-life options (…) are important."

Suggestions to highlight **social issues** refer, for example to fairness and health aspects.

Two formulations on **comparisons with fossil-based products** where "CO_2 footprint compared to... or CO_2 improvement or CO_2 saving" and "environmentally friendlier compared to fossil-based products".

Referencing relevant standards, certificates and regulations, was an issue in the statement "audited, third party approved". Another suggestion was to highlight that **animal tests** are avoided: "No animal experimentation was included in the developing of this product". This is in particular relevant for cosmetic products.

Another **general suggestion** was to have different messages; like "do you know that with this product you saved XXX trees?" "do you know that the production of this product requested XXX, compared to XXX of a similar fossil-based product?" More examples can be found in Annex 6.

The consumer version also included a question on the information communicated through certification logos. When asked to assess the sufficiency of these logos, most consumers think according to Figure 28 that the logo is not sufficient to support buying decisions. An additional summary on the product characteristics on the package is regarded as necessary.

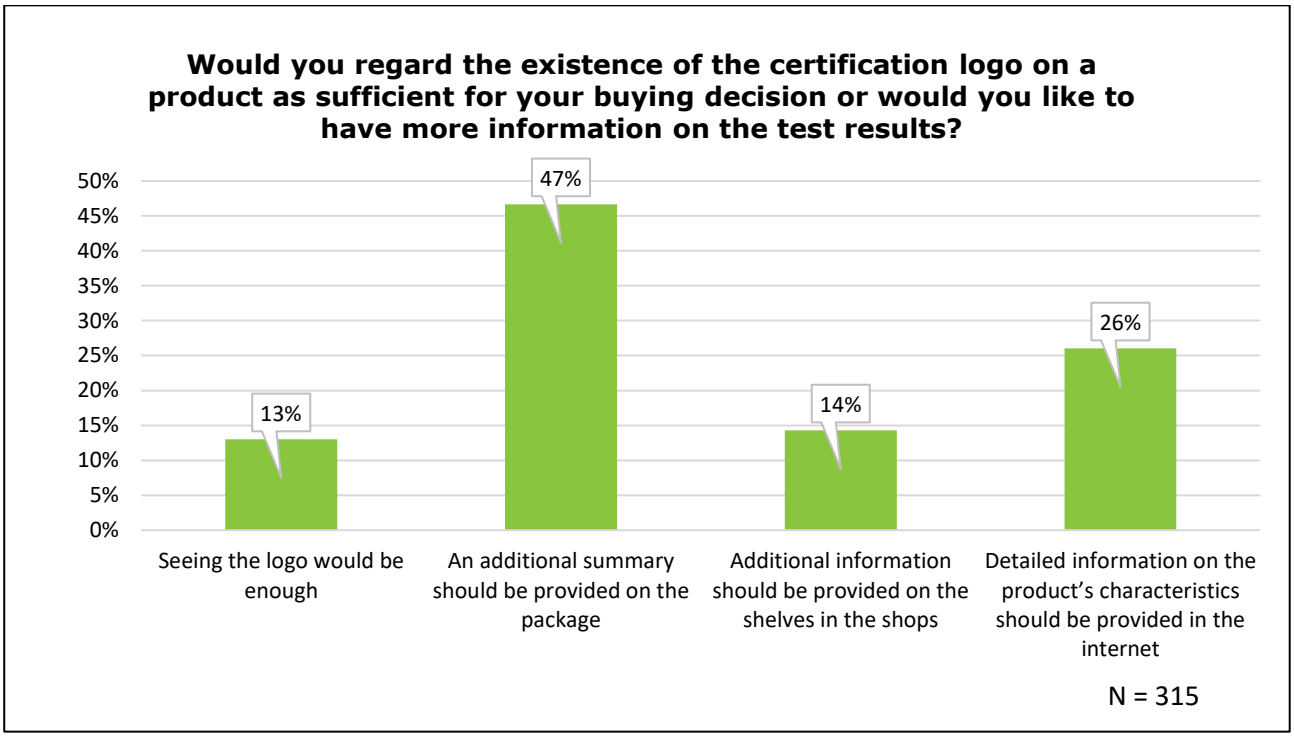


Figure 28: Relevant information on sustainability certification for consumers' decisions

A question at the end of the consumer survey discussed the willingness to pay for certificates. In response to the question "Imagine a bio-based product with a logo indicating that the issues important for your buying decision are considered. How much would you be willing to pay extra?" the biggest group of the consumers would be willing to pay 2.5% extra for a certified product, with another 21% willing to pay up to 5%. The detailed results are shown in Figure 29.

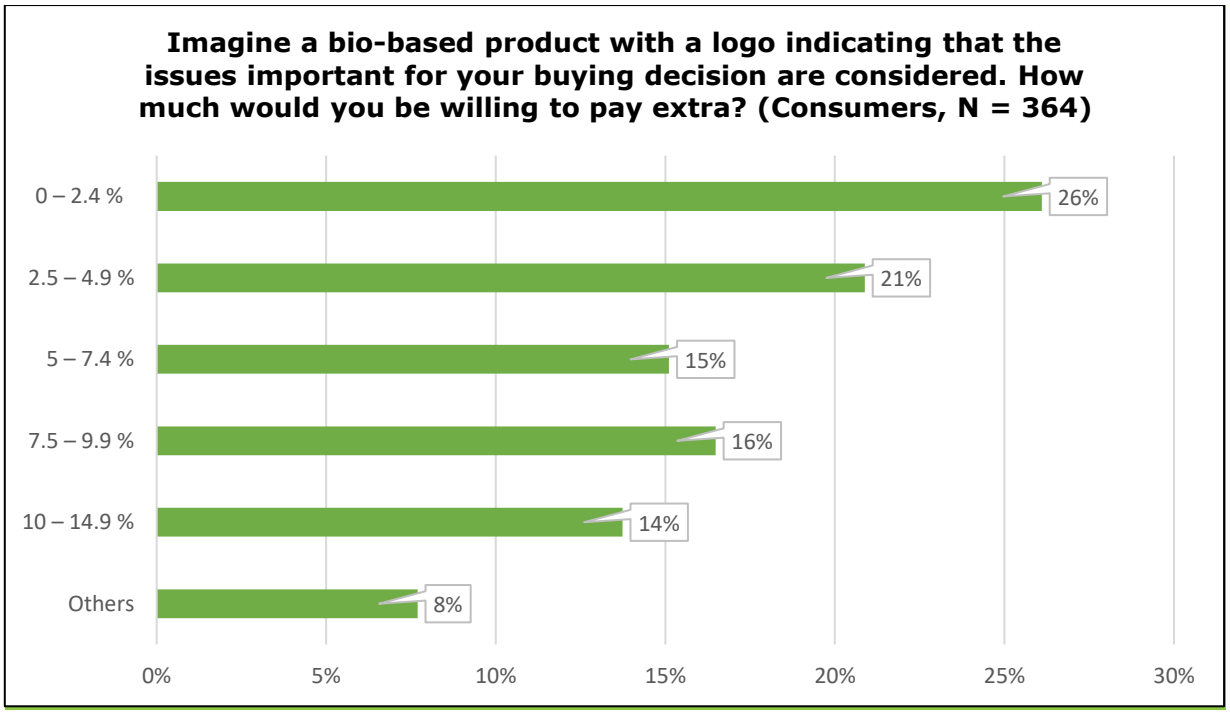


Figure 29: Willingness to pay extra for products with sustainability certificates

A STAR-ProBio experiment will analyse the results in more detail. This field experiment designed to elicit consumers' willingness to pay (WTP) will be carried out to assess market potential. Here, consumers' preferences will be assessed by means of a case study and by the comparison of WTP for a conventional product against an identical bio-based product not carrying the proposed certification scheme and an identical bio-based product carrying the proposed certification scheme. The experiment will be based on an incentive-compatible experiment design in which every participant can achieve the best outcome to themselves just by acting according to their true preferences.

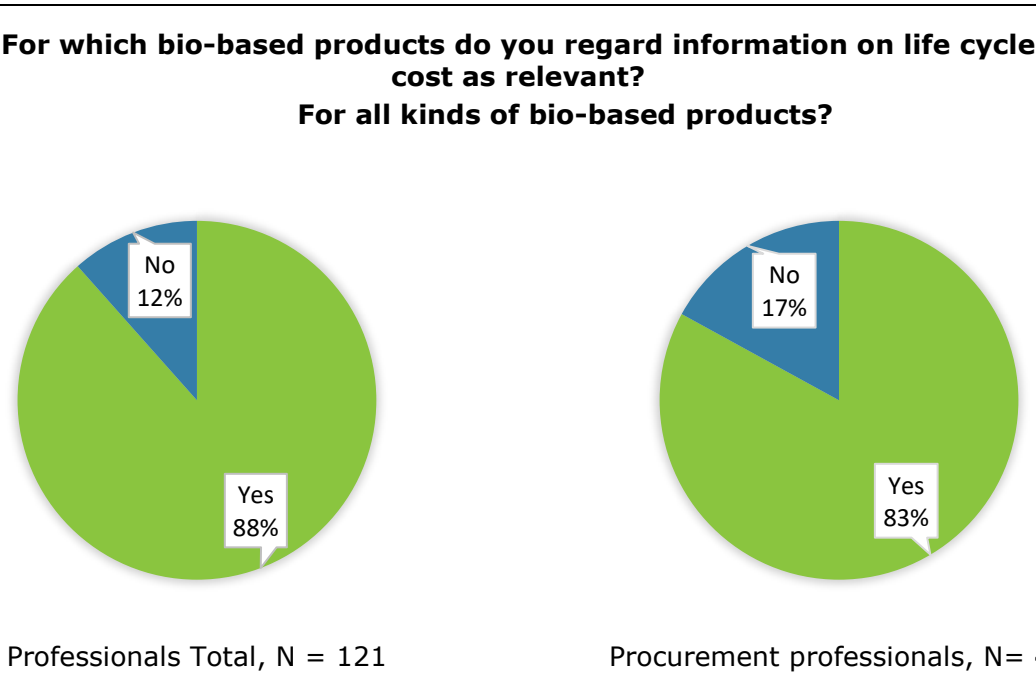
This experimental methodology will provide an estimation of the consumers' attitude towards new certified bio-based products with a minimum risk of overestimating their real willingness to pay and will allow underpinning the real premium assigned by consumers to self-certification and mandatory-certification schemes.

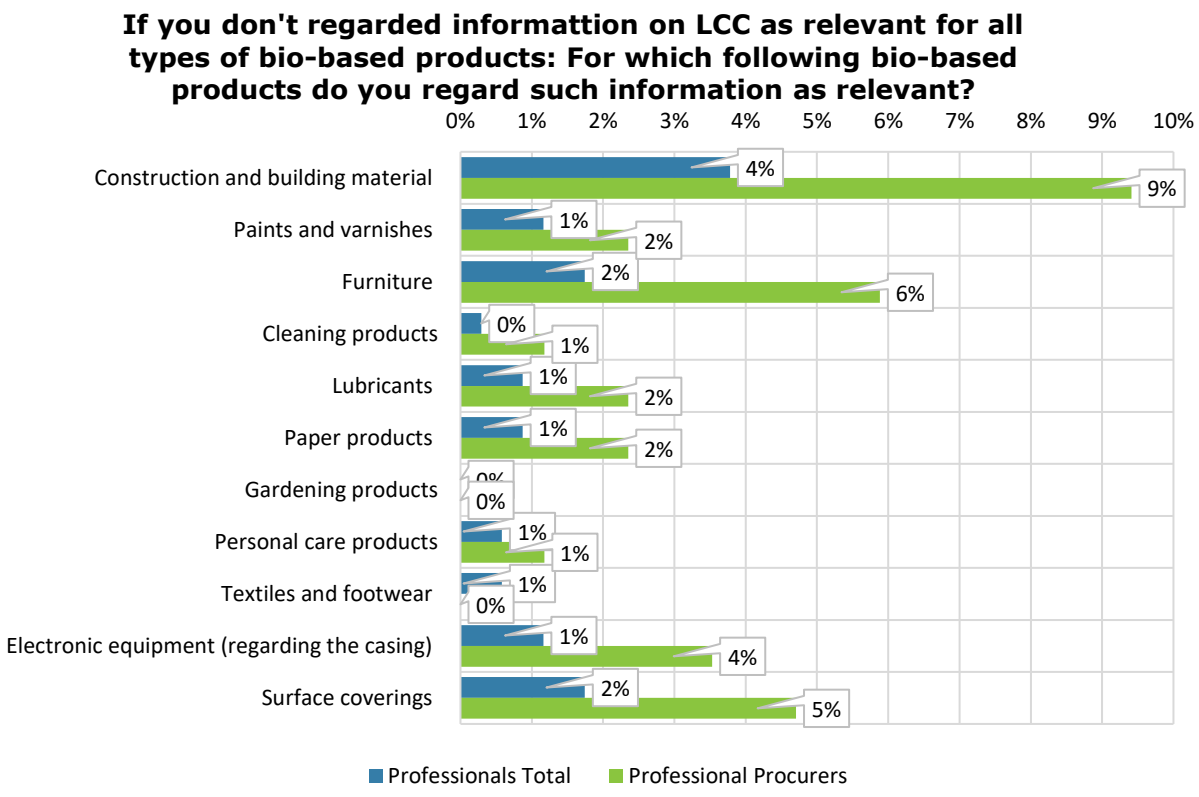
It is planned to include three product categories in the experiment. This experiment, which is not only focused on the green premium but on the willingness to pay for certified bio-based products will be the first of its kind in the given area.

7.3 Findings for specific products

To deepen the results on LCC in Figure 23, in which the importance of additional product characteristics was highlighted, the professional participants of the first round, who selected this item before, were also asked: "For which bio-based products do you regard information on life cycle costing as relevant? The first answer option was: For all bio-based products. The results in Figure 30 show that 83% of the Procurement professionals and 86 % of the professionals in total, who selected LCC before, regard information on LCC as relevant for all bio-based products.

The second part of the figures shows selected categories for which experts recommend providing LCC information in certificates. As the figure shows, providing this information for building and construction products is suggested most frequently by both groups. Certain interest in LCC information was also observed for furniture and surface coverings.





N for this second part of the question: Professionals Total: 14, Procurement professionals: 8

Guidance for the reader: These results of a multiple choice question refer to the previous figure and specify the answers of the 12% of the Professionals total and the 17% of the Procurement professionals who think that information on LCC is NOT relevant for all bio-based products. Example interpretation: the majority of the 17% Procurement professionals, who regard LCC as relevant for selected products only, think this is the case for construction and building material.

Figure 30: Relevance of life cycle cost in the certification of bio-based products

8 Results on additional factors to support buying decisions by Procurement professionals

A specific open question for professionals participating in the first round was: "How do you think European policy makers could promote the acceptance of bio-based products? Please formulate general recommendations as well as product-specific recommendations for products of your choice." The answers were classified by nine categories, ranked by importance below:

1. Appropriate information, communication (in general) and awareness increase.

2. Public procurement.

3. Taxation and subsidies.

4. Labels and certificates.

5. Legislation including bans of unsustainable products.

6. Standards.

7./8. Two items ranked similarly: Ensuring environmental friendliness and Comparisons with fossil-based products.

9. Harmonization of definitions.

Suggestions to ensure **"Appropriate information and communication"** are, for example, "Increasing awareness to the damages that the other products make".

Statements such as, "Green Public Procurement (GPP)" and "public procurement guidelines, example: BioPreferred Program" are included in the cluster of "**Public procurement"** measures.

An item of the cluster "**Taxation and subsidies"** is, for example, "increase taxation on fossil-fuel products. Tax should be levied on negatively impacting products."

The category "**Labels and certificates**" includes, for example, the suggestion to implement a "Europe-wide sustainability certificates within a transparent and comprehensive system".

The cluster "**Legislation including bans**" includes items such as: "mandatory minimum share of biobased products in public procurement!", "non-recyclable, single use plastic packaging should be heavily taxed or banned if immediate alternatives (such as compostables) exist in the market. Specific examples include: multi-material non-recyclable flexible packaging, single use service ware, etc."

In December 2018, the European Parliament and the Council of the European Union have reached a provisional political agreement on the EC's Directive proposal on the reduction of the impact of certain plastic products on the environment. The proposed Directive imposes a ban on singe use plastic products, including cutlery and plates, cotton buds, straws, drink-stirrers and balloon sticks.

A suggestion in the cluster **"Standards"** is "make sure that 'bio' has standards that one can rely on".

"Ensuring environmental friendliness" means, for example, "Good LCA. Biodegradability. No negative impact on biodiversity. No land-use change to less carbon-storing soil."

"Comparisons with fossil-based products" is in particular an issue of the statement "proof of equivalent or better product properties in resource-saving, environmentally friendly and socially responsible production".

Regarding the **"Harmonization of definitions,"** even the implementation of "Clear regulation of what bio-based really means." was suggested.

Last but not least, an example for "**Additional statements"** is: "only promote bio-based products that are better, e.g. based on LCA values."

One respondent summarized the topics of three most important categories as follows: "public green procurement, tax relief, information campaigns." More examples for the different categories can be found in Annex 5.

The regulatory options listed above were further analysed in the second Delphi round by asking professional respondents to (on a scale of 1 to 4) rate the impact of each regulatory option on the acceptance of bio-based products. The results are presented in Figure 31.

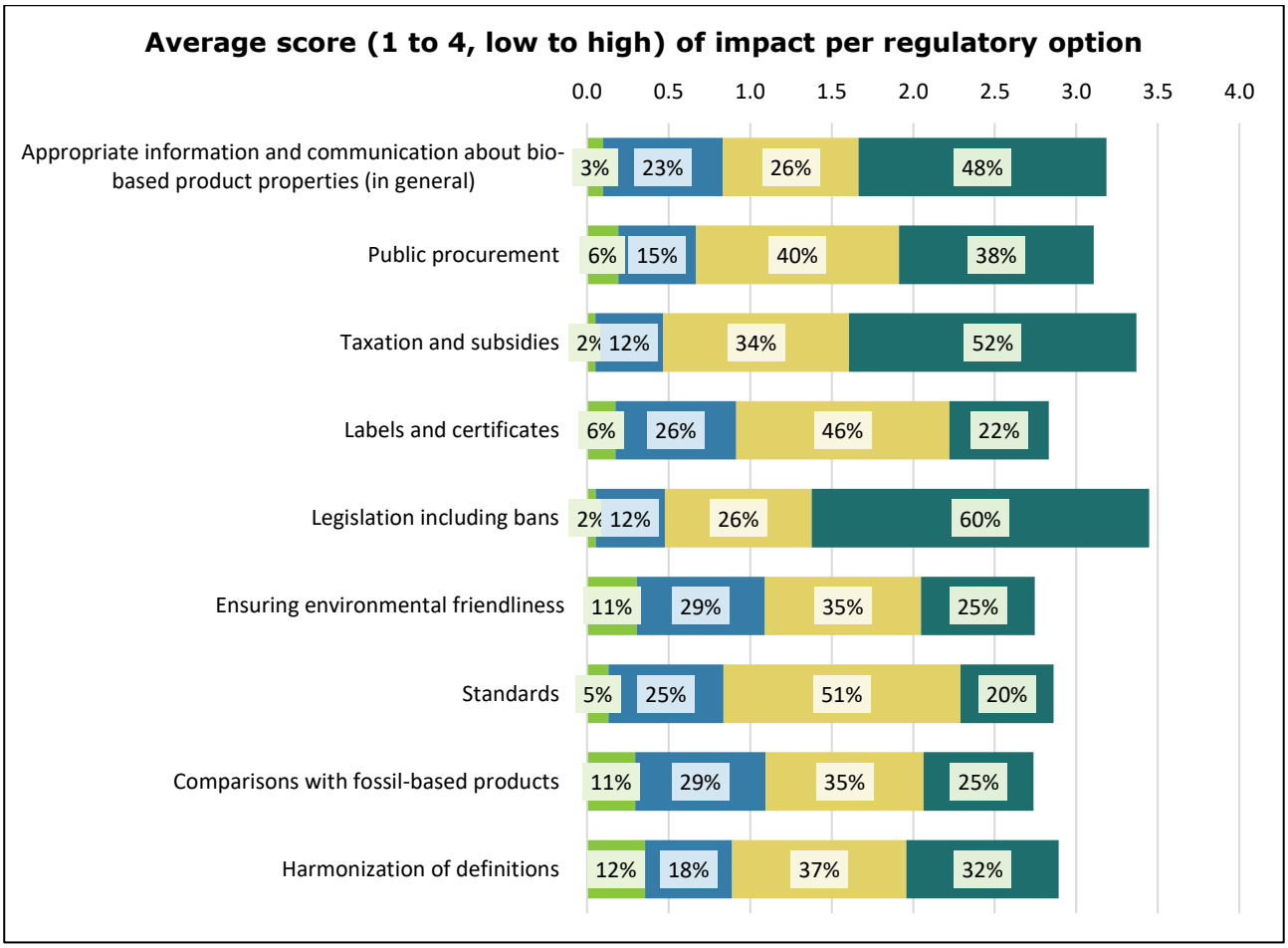


Figure 31: Impact of regulatory options rated 1 to 4; average score and share of each score

Figure 31 shows modest variation in impact score between the regulatory options. The legislative and financial measure both score a 3 or 4 for 86% of the respondents, legislative measures received the highest share of score 4 (high impact).

9 Conclusions and recommendations

The bioeconomy is an important emerging phenomenon of the 21st century. To unlock its potential, there is a need to provide consumers with easily understandable and robust evidence on the sustainability performance of bio-based product throughout the entire value chain. This will help stimulate market demand for bio-based products. However, to achieve this, an important challenge is to identify of the preferences of major stakeholders regarding sustainability assessments.

To overcome this challenge, the present study analysed market preferences of bio-based products, to gain insight into which sustainability aspects are of relevance to stakeholders. The results confirm that both private individuals and professionals consider a broad spectrum of criteria important for sustainability. Being able to prove and communicate that these sustainability criteria are met will be a key acceptance driver for bio-based products.

This section provides an overview of conclusions from the field work and detailed recommendation for developing sustainability assessment and standardisation work on bio-based products.

9.1 Conclusions

Our initial literature review showed the importance of seven aspects influencing the adoption of bio-based products:

1. Product information and trust.
2. Functionality, performance and quality.
3. Price and LCC.
4. Environmental factors.
5. Social and socio-economic factors.
6. Individual market drivers for different bio-based products.
7. Specific issues in B2B markets and public procurement.

Furthermore, gaps were identified. Although information on the importance of sustainability criteria in general existed, more information on their relevance in decisions to buy bio-based products and implications for the creation of certification schemes was needed. Gallup (2009), for example, referred to sustainable consumption and TNS (2012) to green products without focussing on bio-based products specifically. Gaps also existed for social criteria. Although the consumers in the survey reported by BBMG et al. (2012), which was not specific to bio-based products, stressed the importance of these criteria, the direct link to buying decision was not made. The need for more specific insight for bio-based products was reinforced in Sheehan (2015) which highlighted the importance of life cycle costs but without considering bio-based products specifically. These examples showed the need for specific analyses to learn more on the importance of specific product information in markets for bio-based products and their relevance for certification.

To gain additional insight into the influences on the adoption of bio-based products, a two-round Delphi survey was employed. In the first-round, responses were received from 744 consumers and 344 professionals. Respondents that gave permission were invited for the second round, which yielded feedback by 80 consumers and 100 professionals, who showed specific interest in the topic.

The results of the first Delphi round led to nine conclusions:

- Although the majority of stakeholders (in both groups – consumers and professionals) regard information on the three sustainability pillars (environmental, social and economic) as relevant for their decisions on buying bio-based products, information on environmental issues is clearly regarded as the most important.

- For professionals the top three environmental issues were found to be: 1. Recyclability; 2. Type and origin of raw material; and 3. Percentage of bio-based content. For consumers, the top three environmental issues were found to be: 1. Biodegradability; 2. Recyclability; and 3. Type and origin of raw material.
- For professionals the top three social issues were found to be: 1. No child labour; 2. Impact of the product on people's health; and 3. Respect for human rights in the production of raw materials and products. For consumers the top three social issues were found to be: 1. Impact of the product on people's health; 2. No child labour; and 3. Respect for human rights in the production of raw materials and products.
- Professionals ranked the two economic issues as follows: 1. Fair business practices of the company; and 2. Fair land use rights practices in the production of feedstock. Consumers ranked the two economic issues in the reverse order.
- For professionals the top three important asepcts to be considered before bying a product in addition to sustainabiliy related characteristics were found to be: 1. Functionality/performance of the product; 2. Price; and 3. LCC, while for consumers they are 1. Price; 2. Functionality/performance of the product; and 3. Better performance than alternative fossil-based products
- Eighty percent of professionals and eighty-four percent of consumers regarded sustainability certification for bio-based products as beneficial in selecting which product to purchase.
- The majority of respondents answered that environmental and social issues should be mandatory in sustainability certification, while economic issues could be considered on a voluntary basis.
- Among Procurement professionals, the willingness to buy bio-based products is still significantly lower than their awareness of these products.
- Nine actions by which European policy makers could promote the acceptance of bio-based products were identified: 1. Appropriate information, communication (in general) and awareness increase; 2. Public procurement; 3. Taxation and subsidies; 4. Labels and certificates; 5. Legislation including bans; 6. Standards; 7. Ensuring environmental friendliness; 8. Comparisons with fossil-based products; and 9. Harmonization of definitions.

Earlier findings were deepened and validated in the second round. The results, presented in the preceding chapters, led to the following findings:

- The majority (62%) of the consumers prefers bio-based over fossil-based unconditionally.
- That proof of sustainability has a significant effect on willingness to buy bio-based product was confirmed by 86% of consumers.
- There are many factors that influence willingness to buy bio-based products: all seven types of influence (Easy availability, Confidence in the environmental benefits, Confidence in the social benefits, Confidence in the economic benefits, Confidence in quality, Confidence in product useful life expectancy, Price) scored similarly highly for all respondent groups. Environmental criteria and quality scored slightly higher than the others. For Procurement professionals, price scored higher as well.
- When queried about minimum, typical and misleading[8] percentage of bio-based content and percentage of GHG emissions reduction, all respondent groups gave a wide range of answers. This means that a certain percentage of bio-based content or GHG reduction is above the minimum or typical percentage for some people, while others consider the same percentage misleadingly low and not enough to call a product "bio-based" or "sustainable". This is an important point for public awareness and calls for careful expectation management.

[8] Misleading means here the percentage below which the respondent feels that calling a bio-based product sustainable would be misleading

- The place of origin of both raw material and manufacturing are important and should be indicated on a packaging label if possible. Almost complete consensus on this was found among all respondent groups.
- Proof of sustainability requires consideration of many criteria. Of the 29 environmental, social, economic and additional criteria included in the questions, almost all were considered essential for calling a product sustainable by a majority of respondents; environmental criteria were considered essential by a larger majority of respondents. Even when there is not a majority, all criteria are considered essential by a significant number of respondents. In addition to direct sustainability requirements, criteria with a more indirect impact on sustainability such as quality and lifecycle cost are given great importance by the majority of respondents. Therefore, including both direct and indirect impacts in sustainability certification will be very important to market adoption of bio-based products.
- Professionals see many strategies in which policy can stimulate market adoption of bio-based products. All nine regulatory options discussed above recorded a high score as for their impact on market adoption of bio-based products – legal and financial incentives reported the highest score.

9.2 Recommendations for sustainability assessment and standardisation

Based on the results discussed in the previous sections, several recommendations can be made, for STAR-ProBio's future work and also more in general for efforts on standardisation and sustainability assessment pertaining to bio-based products.

End-of-life aspects of bio-based products

According to STAR-ProBio (2017), the EOL stage was found to be one of the main issues in sustainability certification. As shown in Section 6 regarding environmental aspects, the top 3 most important criteria in the survey were:

Professionals:

1 Recyclability.
2 Type and origin of raw material.
3 Percentage of bio-based content.

Consumers:

1 Biodegradability.
2 Recyclability.
3 Type and origin of raw material.

Recyclability and biodegradability are directly linked to EOL and type and origin of raw material and percentage of bio-based content can have links to EOL as well. It is therefore very important to note that EOL was shown in earlier work to be insufficiently addressed in current certification systems. The present work shows it is one of the most important environmental aspects for various types of stakeholders.

The most appropriate EOL option for a bio-based product is often specific to a single product. For example, products with a high percentage of bio-based content and a lower level of transformation may be easily composted or bio-degrade in the soil. Bio-based products in which the raw material underwent significant chemical transformation to increase durability, such as bioplastics, may be recycled along with other single-use plastics. However, it may not always be clear to end-consumers (and waste processors) how bio-based product waste can be treated. Even when multiple EOL options are possible, different options may have a different impact on sustainability, so the EOL phase matters for overall bio-based product sustainability. Therefore, it is important to account for the EOL phase and to communicate the recommended EOL option to the end-consumer. The results described in this report show that this is an important issue to integrate into sustainability certification and standardisation. The same recommendation can be given for the SAT-ProBio tool as well as STAR-ProBio's work on a downstream environmental assessment and research on end-of-life issues.

Place of origin

One of the highest levels of consensus in our surveys was that consumers and professionals want to know both the origin of raw materials and the manufacturing place. They also indicated that this information should be specified on a packaging label if possible. Furthermore "type and origin of raw material" ranked in the top three most important environmental criteria for both professionals and consumers (see EOL recommendation). As sustainability assessment or certification requires the tracking of bio-based products and their raw materials along the entire value chain, information on origin itself is normally readily available. However, often the raw material source and the place of manufacture can be more than one place. Therefore, a careful balance needs to be struck in selecting the largest possible zone (region, country, (part of) continent etc.) without losing too much detail on what sets one origin apart from another.

If and how to address origin-related concerns is an important topic to address in STAR-ProBio's work on the sustainability scheme blueprint for bio-based products, the SAT-ProBio tool and sustainability certification in general. Further STAR-ProBio market assessment research, including the third round of the Delphi survey and the Round Table should be used to try to tease apart the reasons why origin is so uniformly deemed important and it may also be interesting for STAR-ProBio's work on social assessment. STAR-ProBio's upstream environmental assessment and work on the sustainability scheme blueprint should also consider the depth of information on origin that is reasonably possible to provide in sustainability assessment. In terms of acceptance and assurance, it is important that if a certificate states that a product is sustainable, this is true no matter what is the origin of any of its components. Future research and also labelling and standardisation efforts should carefully consider if, and why, origin plays a significant role in establishing sustainability. Possibly origin can serve as a transitional indicator for several sustainability aspects, until a better system or standard is available with a wide geographic scope.

Expectation management of percentage bio-based content and GHG reduction

There is insufficient awareness what "bio-based" really means in practice, which could have a negative impact on market uptake if expectations are not met. When queried about minimum, typical and misleading percentage of bio-based content and percent-age of GHG emissions reduction, all respondent groups gave a wide range of answers. This means that a certain percentage of bio-based content or GHG reduction is above the minimum or typical percentage for some people, while others consider the same percentage misleadingly low and not enough to call a product "bio-based" or "sustainable". This sheds light on a potential mismatch between consumers' expectations and the state of current technologies: for example, for certain product categories, a minimum 50% bio-based content may currently be hard – if not impossible - to achieve. When attempting to stimulate market adoption, the risk of marketing a bio-based product as sustainable but disappointing buyers with the fact that the products isn't as sustainable as they had been led to believe should be avoided as much as possible. There are multiple ways this issue could be addressed, including raising awareness of the percentages that can be realistically be expected, or have different minimum percentages for different product types, or include an indicator range in the label, e.g. "10 to 25% bio-based". This is an important point for public awareness and calls for careful expectation management.

For product categories looked at in STAR-ProBio's techno-economic assessment of bio-based products, information on the range of typical percentages of bio-based content was gathered. This information can be used to identify product categories in which high bio-based contents are hard to achieve. STAR-ProBio's work on the sustainability scheme blueprint for bio-based products, the SAT-ProBio tool will also have to address this complex issue. In addition to research on reasonable levels of bio-based content and GHG emission reduction, research is

needed on how to best communicate what levels can reasonably be expected in any particular product.

Selection and measurability for socio-economic criteria

On average, environmental criteria were considered of higher importance than social and economic criteria. However, even the lowest ranked criterion, exclusion of animal testing, was considered essential by half of the consumers and a third of the professional groups. STAR-ProBio's social assessment plays an important role in informing to which extent socio-economic issues can be translated into measurable and verifiable criteria for the STAR-ProBio's sustainability scheme blueprint. Furthermore, there are existing standards (e.g. ILO standards) and certification systems (e.g. Fair Trade) that cover one or more socio-economic issues. It should therefore be considered if such standards/certification can be used to establish the fulfilment of socio-economic criteria, or if it is better to establish separate criteria and indicators. This issue is faced by sustainability certification schemes in general; a balance must be struck between maintaining reasonable costs and effort needed for certification and getting to a sufficiently high level of assurance that the socio-economic principles and criteria are indeed achieved.

Criteria on additional topics

In addition to direct sustainability criteria to measure a reduced negative or positive impact on the environment or the socio-economic situation, other product properties and characteristics can influence sustainability indirectly or impact the acceptance and uptake of bio-based products. When asked about seven factors influencing willingness to buy bio-based, quality was given the highest average score. Quality and other additional criteria also scored well in a different question about whether an issue is essential for sustainability assessment and in ranking the most important criteria.

Any sustainability standard, tool or system will need to make the fundamental choice whether the goal is to define or prove that a product is "sustainable", "sustainable without compromising the useful lifetime" or "sustainable and the same or better quality and performance". The latter two options are likely to be a stronger driver of market acceptance, but at the same time also mean that a comparison product is needed, so useful lifetime, performance etc. can be compared to a reference product. Selecting the best reference product and the methodologies to determine longevity, performance, functionality and quality of both the bio-based product and the reference product are complex. Price is also relevant in this context, not just the purchase price which is easy for buyers to compare, but especially the LCC[9]. The results described in this report suggest that quality of the bio-based product could be the leading factor to make the transition from fossil-based products to bio-based ones. It is therefore recommended that at least some indicators relating to quality/functionality/longevity/ performance are taken on board in suitability assessment in general and the SAT-ProBio tool specifically. STAR-ProBio's upcoming field experiment should gain additional insight into how strongly direct sustainability drives market acceptance compared to more indirect characteristics like quality.

Health aspects

In both Delphi survey rounds topics related to "health" issues score highly, especially with consumers. The third Delphi round will address the topic of what kind of health aspects respondents would like to see assessed. Even without detailed insight, STAR-ProBio's work on the sustainability scheme blueprint should consider including the avoidance of additional health risks or possibly go for more stringent audit rules for these issues. Health impact is

[9] Cost of purchase, own, operate, maintain and dispose of a product

generally already well covered by existing standards, although the standards themselves may differ from country to country. Therefore, a certification system that relies on a verifiable statement that all health standards are complied with may be sufficient in many cases, with transparency for stakeholders on which health standards apply.

Mandatory versus voluntary sustainability criteria

Most participants indicated that environmental and social issues should be mandatory in sustainability certification while considering economic issues voluntarily would be enough for about 60% of the respondents. This finding echoes on-going decisions within STAR-ProBio's work on the sustainability scheme blueprint for bio-based products and the establishment of a two-tier sustainability system (with required / recommended product characteristics). This shows also that the perception and expectations of consumers and other stakeholders should be a factor in deciding whether to make a criterion required or recommended, should such a two-tier approach be adopted.

Policy instruments to stimulate the adoption of bio-based products

Of the nine listed regulatory options to increase acceptance of bio-based products, survey participants considered that legal and financial incentives would have the strongest effect, but the remaining options (definitions, fossil references, standards, labelling, environmental friendliness, public procurement and information availability) also received a positive score.

The recommendation is therefore to keep as many of these types of policy options in mind when working on assessment methodology for bio-based products, including for SAT-ProBio. This finding will be useful for STAR-ProBio's analysis of regulations, (eco)labelling and policy initiatives when choosing regulatory options to be tested as part of STAR-ProBio's system dynamics model SyD-ProBio.

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Annexes

Annex 1: Identified studies on consumers' preferences on sustainability

Name	**Journal / Editorial / Company / Authors**	**Year**	**Link**
1 Understanding Consumer Behaviour to Reduce Environmental Impacts through Sustainable Product Design	Sheffield Hallam University Research	2008	http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.303.7639&rep=rep1&type=pdf
2 The Sustainability Liability: Potential Negative Effects of Ethicality on Product Preference	Journal of Marketing	2010	https://www.jstor.org/stable/41228571?seq=1#page_scan_tab_contents
3 Understanding Consumer Preferences in Energy Efficiency Accenture end–consumer observatory on electricity management 2010	Accenture	2010	https://www.accenture.com/t20160811T002327__w__/us-en/_acnmedia/Accenture/next-gen/insight-unlocking-value-of-digital-consumer/PDF/Accenture-Understanding-Consumer-Preferences-Energy-Efficiency-10-0229-Mar-11.pdf
4 Sustainability seen from the perspective of consumers	International journal of consumer studies	2011	http://onlinelibrary.wiley.com/doi/10.1111/j.1470-6431.2011.01045.x/full
5 The sustainable consumer: an in-situ study of residential lighting alternatives as influenced by infield education	International journal of consumer studies	2011	http://onlinelibrary.wiley.com/doi/10.1111/j.1470-6431.2010.00987.x/full
6 Full Spectrum Insights: A New Way to Motivate Sustainable Behaviors	Shelton Group and Worldview Thinking	2011	https://sustainability.ncsu.edu/wp-content/uploads/2011/12/WorldviewWhitePaper_SheltonGroup2011-1.pdf
7 Mainstream Green: Moving sustainability from niche to normal	Graceann Bennett & Freya Williams	2011	https://assets.ogilvy.com/truffles_email/ogilvyearth/Mainstream_Green.pdf
8 Investigating Consumer Preference for Organic, Local, or Sustainable Plants	HortScience	2011	http://hortsci.ashspublications.org/content/46/4/610.full.pdf+html
9 Re: Thinking consumption Consumers and the future of sustainability	BBMG, GlobeScan and SustainAbility	2012	https://www.globescan.com/component/edocman/?task=document.viewdoc&id=51&Itemid=0

10 Product labelling in the market for organic food: Consumer preferences and willingness-to-pay for different organic certification logos	Food Quality and Preference	2012	http://www.sciencedirect.com/science/article/pii/S0950329311002631
11 Consumer attitudes towards sustainability aspects of food production: Insights from three continents	Journal of Marketing Management	2012	http://www.tandfonline.com/doi/abs/10.1080/0267257X.2012.658836
12 The Influence of Consumer Preferences on Aquaculture Technology and the Sustainability of Fisheries	Paris School of Economics and University Paris 1 Panthon-Sorbonne	2012	http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/34913/The%20Influence%20of%20Consumer%20Preferences%20on%20Aquaculture%20Technology%20and%20the%20Sustainability%20of%20Fisheries.pdf;jsessionid=1D545DA79F645970322D6523FF829D85?sequence=9
13 Serious Tourism and Consumer Preference for Sustainable Tourism Certifications	Clemson University TigerPrints Dissertation	2012	http://tigerprints.clemson.edu/cgi/viewcontent.cgi?article=1913&context=all_dissertations
14 Social influence on sustainable consumption: evidence from a behavioral experiment	International journal of consumer studies	2013	http://onlinelibrary.wiley.com/doi/10.1111/j.1470-6431.2012.01110.x/full
15 A conceptual framework for analyzing consumers' food label preferences: An exploratory study of sustainability labels in France, Quebec, Spain and the US	International journal of consumer studies	2013	http://onlinelibrary.wiley.com/doi/10.1111/ijcs.12041/full
16 Consumers' willingness to buy products with environmental and ethical claims: the roles of social representations and social identity	International journal of consumer studies	2013	http://onlinelibrary.wiley.com/doi/10.1111/ijcs.12067/full
17 Sustainable Consumption Decisions: An Examination of Consumer Cognition and Behavior	Dissertation Mag. Verena Maria Gruber	2013	https://www.wien.gv.at/umweltschutz/nachhaltigkeit/pdf/gruber-verena-2013.pdf
18 Consumer preferences for sustainability and their impact on supply chain management The case of mobile phones	International Journal of Physical Distribution & Logistics Management	2013	https://www.researchgate.net/publication/236882197_Consumer_preferences_for_sustainability_and_their_impact_on_supply_chain_management_The_case_of_mobile_phones

19 Sustainability of the Agri-food System: Strategies and Performances	Bernardo De Gennaro, Gianluca	2013	https://books.google.de/books?id=gJQtBgAAQBAJ
20 Impact of Ethical Attributes of Services on Consumer Preference	College of Management, Yuan Ze University	2013	http://gebrc.nccu.edu.tw/proceedings/APDSI/2013/proc/P130201014.pdf
21 Consumer Preferences for Local and Sustainable Plant Production Characteristics	HortScience	2013	http://hortsci.ashspublications.org/content/48/2/200.full
22 Consumers' preferences for eco-friendly appliances in an emerging market context	International journal of consumer studies	2014	http://onlinelibrary.wiley.com/doi/10.1111/ijcs.12120/full
23 Sustainability labels on food products: Consumer motivation, understanding and use	Food Policy	2014	http://www.sciencedirect.com/science/article/pii/S0306919213001796
24 Handbook of Research on Sustainable Consumption	Elgar	2014	https://books.google.de/books?id=N07fBgAAQBAJ&pg=PA400&lpg=PA400&dq=consumers+preferences++assessment+sustainability&source=bl&ots=kyMj8eqgJa&sig=e1OgALmkmTWkBqu3kCtO7rTgOXQ&hl=es&sa=X&ved=0ahUKEwjB8tjzyLjWAhXHbxQKHSR3DEQQ6AEITDAG#v=onepage&q=consumers preferences assessment sustainability&f=false
25 Changes in consumer segments and preferences to green labeling	International journal of consumer studies	2014	http://onlinelibrary.wiley.com/doi/10.1111/ijcs.12103/full
26 Consumer Preferences With Regard To Local and Sustainable Seafood	Journal of Environmental and Resource Economics at Colby	2014	http://digitalcommons.colby.edu/cgi/viewcontent.cgi?article=1012&context=jerec
27 Organic Agriculture, Sustainability and Consumer Preferences	INTECH	2014	https://www.intechopen.com/books/organic-agriculture-towards-sustainability/organic-agriculture-sustainability-and-consumer-preferences
28 Product Differentiation and Consumer Preferences for Sustainable Food	Fakultät für Agrarwissenschaften der Georg-August-Universität Göttingen Dissertation	2014	http://d-nb.info/1057776327/34

29 Communicating Sustainability for the Green Economy	Lynn R Kahle,Eda Gurel-Atay	2014	https://books.google.de/books?id=M6NsBgAAQBAJ&pg=PA89&lpg=PA89&dq=consumer+preferences+sustainability&source=bl&ots=r5IOlgZT1K&sig=6QpfKhwV_eRDMflludCr38HUveI&hl=es&sa=X&ved=0ahUKEwir9f7H6b_WAhUMWhQKHZQsDLc4ChDoAQg5MAM#v=onepage&q=consumer%20preferences%20sustainability&f=false
30 The Impact of Sustainability on Consumer Preference Judgments of Product Attributes	Journal of Mechanical Design	2015	https://www.researchgate.net/publication/277622019_The_Impact_of_Sustainability_on_Consumer_Preference_Judgments_of_Product_Attributes
31 Sustainability labels on coffee: Consumer preferences, willingness-to-pay and visual attention to attributes	Ecological Economics	2015	https://www.researchgate.net/publication/280935154_Sustainability_labels_on_coffee_Consumer_preferences_willingness-to-pay_and_visual_attention_to_attributes
32 Style consumption: its drivers and role in sustainable apparel consumption	International journal of consumer studies	2015	http://onlinelibrary.wiley.com/doi/10.1111/ijcs.12185/full
33 Sustainable Marketing and Consumers' Preferences in Tourism	Journal of Tourism & Hospitality	2016	https://www.omicsonline.org/open-access/sustainable-marketing-and-consumers-preferences-in-tourism-2167-0269-1000194.pdf
34 Consumers' Sense of Farmers' Markets: Tasting Sustainability or Just Purchasing Food?	Sustainability	2016	www.mdpi.com/2071-1050/8/11/1157/pdf
35 Organic Farming and Sustainability in Food Choices: An Analysis of Consumer Preference in Southern Italy	Agriculture and Agricultural Science Procedia	2016	http://www.sciencedirect.com/science/article/pii/S2210784316300936
36 Sustainable Competitive Advantages: Consumer Preference	Advisor perspectives	2016	https://webcache.googleusercontent.com/search?q=cache:0nrADzKCN_gJ:https://www.advisorperspectives.com/articles/2016/08/02/sustainable-competitive-advantages-consumer-preference.pdf+&cd=46&hl=es&ct=clnk&gl=de&client=firefox-b-ab
37 Sustainable marketing and consumers' preferences in tourism	European Journal of Tourism, Hospitality and Recreation	2016	http://eprints.ugd.edu.mk/16097/1/%5BEuropean%20Journal%20of%20Tourism%2C%20Hospitality%20and%20Recreation%5D%20Sustainable%20marketing%20and%20consumers%E2%80%99%20preferences%20in%20tourism.pdf

38 Consumer preferences for sustainable aquaculture products: Evidence from in-depth interviews, think aloud protocols and choice experiments	US National Library of Medicine National Institutes of Health	2017	https://www.ncbi.nlm.nih.gov/pubmed/28223237
39 Investigating Consumer Preferences towards Sustainability in Product Packaging	Haaga-Helia University of applied sciences, Lisa Petit Bachelor Thesis	2017	http://www.theseus.fi/handle/10024/122543
40 Sustainable Consumption Dilemmas	Sustainability	2017	http://www.mdpi.com/2071-1050/9/6/942
41 Sustainable Consumer Behaviour: A Collection of Empirical Studies	Sustainability	2017	http://www.mdpi.com/2071-1050/9/10/1686

Annex 2: Delphi survey questionnaires

ANNEX 2-1: SURVEY VERSION FOR CONSUMERS (ENGLISH VERSION) OF THE FIRST SURVEY ROUND

BIO-BASED PRODUCTS SURVEY FOR CONSUMERS

Thank you for having taken a few minutes from your time to participate in this survey. Your valuable input will support our research in promoting and disseminating sustainable bio-based products.

Bio-based products at a glance

The protection of scarce resources is a key issue of modern societies. Did you know that many of the products that you consume daily can be made from materials of renewable, biological origin instead of fossil-based origin? For example, plastic disposable coffee cups can be replaced by bio-based plastic or can be made out of cardboard.

By using materials of renewable origin, materials traditionally made out of crude oil or other fossil resources can be partly or even completely replaced. Countless opportunities to produce such products exist in various markets and pioneering products are already available.

This study is part of STAR-ProBio, a European project of which you can learn more about at www.star-probio.eu. We respect and value your time. Therefore, we will keep the questionnaire short and simple.

If you have any question or experience technical difficulties, please do not hesitate to contact us:

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Data Protection

The collected data is used exclusively for scientific purposes and is scientifically processed by the STAR-ProBio project. It is not passed on to third parties outside the STAR-ProBio project. Your contact details will not be passed on to third parties outside the STAR-ProBio project. Aggregated survey results are used for scientific research and lectures. This work shall be made public. Names and e-mail addresses of participants will not be used for data analysis.

☐ Accept

The outcomes of this survey will be available to all interested participants and the results will be used to prepare a second round survey to strengthen and deepen the conclusions. If you would like to receive the common results of this survey and receive an invitation for the second round after the summer, please enter your name and email address below. Your input in both survey rounds will be highly appreciated.

Name:	Email Address:

GENERAL INFORMATION

A1. How old are you?

A2. What is your gender?

☐ Male

☐ Female

☐ Other

A3. What is your highest educational qualification?

☐ Primary or no education

☐ Secondary education

☐ Vocational education

☐ University education

☐ Other, please specify

A4. What is your current occupation?

☐ Self-employed *Continue on the next page*

☐ Manager

☐ Professional (e.g. in the science, engineering, health, teaching, legal or social area)

☐ Technician or associate professional

☐ Administrative assistant

☐ Services and sales worker

☐ Skilled agricultural, forestry or fishery worker

☐ Craft or related trades worker

☐ Plant and machine operator or assembler

☐ Elementary occupation (e.g. as a labourer in mining, construction, manufacturing or transport)

☐ Student

☐ Retiree

☐ Don't work

☐ Other, please specify

A5. What is your country of residency?

☐ Belgium

☐ Germany

☐ Greece

☐ Italy

☐ Poland

☐ Portugal

☐ Spain

☐ Netherlands

☐ Other, please specify

A6. How many people live in your household?

A7. How many of them are children?

A8. What is your monthly household net income?

☐ < € 1,300

☐ € 1,300 – € 2,599

☐ € 2,600 – € 3,599

☐ € 3,600 – € 4,999

☐ € 5,000 – € 17,999

☐ ≥ € 18,000

A9. How would you describe your attitude to innovative products?

☐ I usually try new products before others do

☐ I wait until I hear about others' experiences before I try new products

☐ I am usually sceptical about new products

SUSTAINABLE CONSUMPTION BEHAVIOUR

B1. How would you define your propensity to purchasing bio-based products?

☐ Not at all inclined

☐ Not inclined

☐ Neutral

☐ Inclined

☐ Very inclined

B2. For which of the following products are you aware of the existence of bio-based versions or contents? *Check all that apply*

☐ Personal care products (e.g. shampoo, face/body cream)

☐ Children's products including toys

☐ Cleaning products

☐ Paints and varnishes

☐ Furniture

☐ Gardening products

☐ Lubricants

☐ Paper Products

☐ Textiles and footwear

☐ Construction and building material

☐ Electronic equipment (regarding the casing)

☐ Surface coverings (e.g. wooden floor coverings)

☐ Other, please specify

B3. For which of these products would you buy bio-based products? *Check all that apply*

☐ Personal care products (e.g. shampoo, face/body cream)

☐ Children's products including toys

☐ Cleaning products

☐ Paints and varnishes

☐ Furniture

☐ Gardening products

☐ Lubricants

☐ Paper Products

☐ Textiles and footwear

☐ Construction and building material

☐ Electronic equipment (regarding the casing)

☐ Surface coverings (e.g. wooden floor coverings)

☐ Other, please specify

B4. Which information do you consider relevant for a decision to purchase a bio-based product? *Check all that apply*

☐ Information on environmental issues

☐ Information on social issues, e.g. on working conditions in the production process

☐ Information on economic issues, e.g. fair business practice

☐ Other, please specify

ENVIROMENTAL VALUE

C1. To what extent do you agree with the following statements?

Limited resources and environmental pollution have threatened life on earth

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

Nature's balance is very delicate and easily upset

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

If things continue at their current rate, the sustainability of the environment and future generations are highly threatened

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

C2. Which information regarding the protection of the environment could realistically influence your purchasing decision when you consider buying a bio-based product? *Check all that apply*

☐ Percentage of bio-based content

☐ Percentage of recycled content

☐ Type and origin of raw material

☐ Greenhouse gas emissions

☐ Lower greenhouse gas emissions than fossil-based alternatives

☐ No pollution of water, soil and air in the production of raw material beyond thresholds

☐ No deforestation or use of peatland in the production of raw material

☐ No use of genetically modified organisms

☐ Resource efficiency

☐ Use of water

☐ Use of chemicals

☐ Toxicity

☐ Lower toxicity than fossil-based alternatives

☐ Appropriate waste management

☐ Environmental life-cycle impacts

☐ Recyclability

☐ Biodegradability

☐ Composability

☐ Other, please specify

SOCIAL VALUE

D1. To what extent do you agree with the following statements?

Purchase of bio-based products will help me gain social approval

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

Continue on the next page

Purchase of bio-based products will make a positive impression on peer groups

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

I would buy bio-based products on peers' suggestions or preference to buy them

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

Bio-based products would improve the way I am perceived

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

D2. Which information on social issues could realistically influence your purchasing decision when you consider buying a bio-based product? *Check all that apply*

☐ Influence of the product on people's health

☐ Respect of human rights in the production of the material and the product

☐ No child labour

☐ Not tested on animals

☐ The working conditions and the payment of the employees meet at least minimum standards

☐ Implementation of an occupational health and safety plan for the production of the product

☐ Contribution to the economic wellbeing of local communities by the producer

☐ Other, please specify

ECONOMIC VALUE

E1. To what extent do you agree with the following statements?

I would more readily buy bio-based products over conventional substitutes if offered at a discount or with other promotional incentives

Strongly disagree	Disa-gree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

I would purchase bio-based products when I can buy them in the stores or area where I normally shop

Strongly disagree	Disa-gree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

I would purchase bio-based products over conventional substitutes under unsustainable environmental conditions

Strongly disagree	Disa-gree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

E2. Which information on economic issues could realistically influence your purchasing decision when you consider buying a bio-based product? *Check all that apply*

☐ Fair business practices of the company

☐ Fair land use rights practices in the production of feedstock

☐ Other, please specify

FUNCTIONAL VALUE

F1. To what extent do you agree with the following statements?

Bio-based products are reasonably priced

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

Bio-based products are economical for the attributes they offer

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

Bio-based products have an expectable standard quality

Continue on the next page

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

Bio-based products are made from non-hazardous substances

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

F2. Which information on the following product characteristics could realistically influence your purchasing decision when you consider buying a bio-based product? *Check all that apply*

☐ Functionality/performance of the product

☐ Better performance than alternative fossil-based products

☐ Price

☐ Brand name

☐ Specific brand name for bio-based products

☐ Energy consumption

☐ Life cycle cost

☐ Other, please specify

KNOWLEDGE VALUE

G1. To what extent do you agree with the following statements?

I would prefer to receive more information on bio-based products before purchase

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

I want to gain a deeper insight into the ingredients, the processes of manufacturing bio-based products and their impacts before purchase

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
☐	☐	☐	☐	☐

G2. The next questions refer to sustainability-related certification for bio-based products, indicating that a product meets relevant sustainability requirements. The fulfilment of these requirements would be shown by a specific certification seal (logo) on the product. Would you regard sustainability certification for bio-based products as beneficial for your buying decisions?

☐ Yes

☐ No

☐ Don't know

If "yes", Would you regard the existence of the certification logo on a product as sufficient for your buying decision or would you like to have more information on the test results?

☐ Seeing the logo would be enough

☐ An additional summary should be provided on the package

☐ Additional information should be provided on the shelfs in the shops

☐ Detailed information on the product's characteristics should be provided in the internet

G3. Should the issues of B4 be mandatory or voluntarily addressed in sustainability certification for bio-based products or be provided by separate certification?

Selected issues of B4 (to be included by the interviewer)	Mandatory	Voluntary	Separate additional certification
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
Other, please specify	☐	☐	☐

G4. Should the items of C2, D2, and E2; be considered in the certification of the product?

☐ Yes

☐ No

If "no", please specify

G5. Please share your view on their relevance in the certification of bio-based products. Do you think that a functionality / performance criterion should be included in the certification for bio-based products?

☐ Yes, mandatory

☐ Yes, voluntary

☐ No

If "Yes, mandatory" or "Yes, voluntary", please continue with G6 and G7.

G6. Should functionality and performance certification apply to every type of bio-based product?

☐ Yes

☐ No

If "no", should product functionality and performance be tested in the certification of the following bio-based products? Please answer product-wise.

	Mandatory	Voluntary	No
Personal care products (e.g. shampoo, face/body cream)	☐	☐	☐
Children's products including toys	☐	☐	☐
Cleaning products	☐	☐	☐
Paints and varnishes	☐	☐	☐
Furniture	☐	☐	☐
Gardening products	☐	☐	☐
Lubricants	☐	☐	☐
Paper Products	☐	☐	☐
Textiles and footwear	☐	☐	☐
Construction and building material	☐	☐	☐
Electronic equipment (regarding the casing)	☐	☐	☐
Surface coverings (e.g. wooden floor coverings)	☐	☐	☐
Other, please specify	☐	☐	☐

G7. Would you prefer just receiving information on the product's performance or would you prefer receiving information in the form of a comparison to traditional fossil-based products? This could be for example "this bio-based product lasts 5 years longer than a fossil-based one" (compared to "this bio-based product lasts 10 years").

☐ I'd prefer information on the product's functionality/performance

☐ I'd prefer information on the product's functionality/ performance compared with traditional products

☐ I'd prefer receiving both kinds of information

G8. What do you think should be the most important requirements of sustainability certification for bio-based products that should be included in its marketing messages? Please make suggestions for appropriate formulations.

Continue on the next page

G9. Imagine a bio-based product with a logo indicating that the issues important for your buying decision are considered. How much would you be willing to pay extra?

☐ 0 – 2.4 %

☐ 2.5 – 4.9 %

☐ 5 – 7.4 %

☐ 7.5 – 9.9 %

☐ 10 – 14.9 %

☐ Other, please specify

PACKAGING RELATED QUESTION

H1. Do you know products with bio-based packaging?

☐ Yes

☐ No

H2. When you buy a product, how important is it for you that the packaging of that product is bio-based?

Not Important				Very Important
-2	-1	0	+1	+2
☐	☐	☐	☐	☐

H3. Our project STAR-ProBio publishes a newsletter twice per year. Check the following box if you would like to subscribe and enter your email address if not done earlier.

☐ Yes

☐ No

Email Address:

Thank you very much for participating!

ANNEX 2-2: SURVEY VERSION FOR PROFESSIONALS (ENGLISH VERSION) OF THE FIRST SURVEY ROUND

BIO-BASED PRODUCTS SURVEY FOR PROFESSIONALS

Thank you very much for taking 10 minutes of your time to participate in this survey! Your valuable input will support our research towards the market up-take and dissemination of sustainable bio-based products.

Scope and aim of this survey

The protection of scare resources is a key issue of modern societies.

The STAR-ProBio project aims at driving market adoption of bio-based products by developing tools to prove product sustainability. This survey focusses on the needs and preferences of the market and how certification and labelling can influence purchasing decisions.

We understand bio-based products to be products which are, wholly or in part, made using resources of biological origin and can substitute products traditionally made with fossil resources. Bioenergy products are left out of this survey because their market and legislation are more mature than those of other bio-based products. You are encouraged to think beyond present time bio-based products when filling out this survey.

We respect and value your time. Therefore, we will keep the questionnaire short.

If you have any question or experience technical difficulties, please do not hesitate to contact us:

Luana Ladu
luana.ladu@tu-berlin.de

Simone Wurster
simone.wurster@tu-berlin.de

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☐ Accept

The outcomes of this survey will be available to all interested participants and the results will be used to prepare a second round survey to strengthen and deepen the conclusions. If you would like to receive the common results of this survey and receive an invitation for the second round after the summer, please enter your name and email address below. Your input in both survey rounds will be highly appreciated.

Name:	Email Address:

General Information

A1. Please indicate what best applies to you:

Making purchasing decisions is part of my job

☐ Yes

☐ No

If "yes", please answer the following questions based on your or your organisation's point of view.

If "no", please share your insight and views regarding any market preferences you are aware of.

Continue on the next page

A2. What kind of an organization do you work for?

☐ Business

- ☐ SME
- ☐ Non-SME

☐ Government, public authority or agency

☐ Industry organisation

☐ Certification body

☐ NGO

☐ University or research organization

☐ Other, please specify

If "yes" for **business**, in which area is your company active?

☐ Agriculture

☐ Manufacturing

☐ Construction

☐ Energy

☐ Trade

☐ Transportation

☐ Information and communication

☐ Financing and insurance

☐ Real estate

☐ Health care

☐ Accommodation or food services

☐ Other, please specify

A3. Which of the following keywords describes your job best?

☐ Management

☐ Administration/accounting

☐ Procurement

☐ Production

☐ Marketing

☐ Sales

☐ Research and development

☐ Conformity assessment

☐ Other, please specify

A4. What is your country of residency?

☐ Belgium

☐ Germany

☐ Greece

☐ Italy

☐ Poland

☐ Portugal

☐ Spain

☐ Netherlands

☐ Other, please specify

Bio-based Product Knowledge

B1. For which of the following products are you aware of opportunities to purchase bio-based products? *Check all that apply*

☐ Construction and building material

☐ Paints and varnishes

☐ Furniture

☐ Cleaning products

☐ Lubricants

☐ Paper Products

☐ Gardening products

☐ Personal care products (e.g. shampoo, face/body cream)

☐ Textiles and footwear

☐ Electronic equipment (regarding the casing)

☐ Surface coverings (e.g. wooden floor coverings)

☐ Other, please specify

B2. If you are involved in procurement processes, for which of these products would you procure bio-based products? *Check all that apply*

☐ Construction and building material

☐ Paints and varnishes

☐ Furniture

☐ Cleaning products

☐ Lubricants

☐ Paper Products

Continue on the next page

☐ Gardening products

☐ Personal care products (e.g. shampoo, face/body cream)

☐ Textiles and footwear

☐ Electronic equipment (regarding the casing)

☐ Surface coverings (e.g. wooden floor coverings)

☐ Other, please specify

B3. Are you aware of opportunities to purchase products with bio-based packaging?

☐ Yes

☐ No

Bio-based Product Information

C1. Which information do you consider relevant for a decision to purchase a bio-based product? *Check all that apply*

☐ Information on environmental issues

☐ Information on social issues, e.g. on working conditions in the production process

☐ Information on economic issues, e.g. fair business practice

☐ Other, please specify

C2. Which information on environmental issues could realistically influence a decision to purchase a bio-based product? *Check all that apply*

☐ Percentage of bio-based content

☐ Percentage of recycled content

☐ Type and origin of raw material

☐ Greenhouse gas emissions

☐ Lower greenhouse gas emissions than fossil-based alternatives

☐ No pollution of water, soil and air in the production of raw material beyond thresholds

☐ No deforestation or use of peatland in the production of raw material

☐ No impact to bio-diversity in the production of raw material

☐ No use of genetically modified organisms

☐ Resource efficiency

☐ Use of water

☐ Use of chemicals

☐ Toxicity

☐ Lower toxicity than fossil-based alternatives

☐ Appropriate waste management

☐ Environmental life-cycle impacts

☐ Recyclability

☐ Biodegradability

☐ Compostability

☐ Other, please specify

C3. Which information on social issues could realistically influence a decision to purchase a bio-based product? *Check all that apply*

☐ Influence of the product on people's health

☐ Respect of human rights in the production of the material and the product

☐ No child labour

☐ Not tested on animals

☐ The working conditions and the payment of the employees meet at least minimum standards

☐ Implementation of an occupational health and safety plan for the production of the product

☐ Contribution to the economic wellbeing of local communities by the producer

☐ Other, please specify

C4. Which information on economic issues could realistically influence a decision to purchase a bio-based product? *Check all that apply*

☐ Fair business practices of the company

☐ Fair land use rights practices in the production of feedstock

☐ Other, please specify

C5. Which information on other product characteristics could realistically influence a decision to purchase a bio-based product? *Check all that apply*

☐ Functionality/performance of the product

Continue on the next page

☐ Better performance than alternative fossil-based products

☐ Price

☐ Brand name

☐ Specific brand name for bio-based products

☐ Energy consumption

☐ Life cycle cost

☐ Other, please specify

C6. When you buy a product, how important is it for you that the packaging of that product is bio-based?

Not Important				Very Important
-2	-1	0	+1	+2
☐	☐	☐	☐	☐

Sustainability Certification 1

D1. Would you regard sustainability certification for bio-based products as beneficial for your buying decisions?

☐ Yes

☐ No

☐ Don't know

D2. Which other aspects can support purchasing decisions if an opportunity to purchase a bio-based product exists (e.g. characteristics of the product, purchasing guidelines etc.)? Please write your answer here.

D3. According to your answers C1; which of these issues should be mandatory or voluntarily addressed in sustainability certification for bio-based products or be provided by separate certification?

☐ Information on environmental issues

☐ Information on social issues, e.g. on working conditions in the production process

☐ Information on economic issues, e.g. fair business practice

☐ Other, please specify

D4. According to your answers C2, C3, and C4; should they also be considered in the certification of the product?

☐ Yes

☐ No

If "no", please specify

Sustainability Certification 2

E1. Do you think that a functionality / performance criterion should be included in the certification for bio-based products?

☐ Yes, mandatory

☐ Yes, voluntary

☐ No

If "Yes, mandatory" or "Yes, voluntary", please continue with E2.

If "No", please continue with E3.

E2. Should functionality and performance certification apply to every type of bio-based product?

☐ Yes

☐ No

If "No", should product functionality and performance be tested in the certification of the following bio-based products? Please answer product-wise.

Continue on the next page

	Mandatory	Voluntary	No
Construction and building material	☐	☐	☐
Paints and varnishes	☐	☐	☐
Furniture	☐	☐	☐
Cleaning products	☐	☐	☐
Lubricants	☐	☐	☐
Paper Products	☐	☐	☐
Gardening products	☐	☐	☐
Personal care products (e.g. shampoo, face/body cream)	☐	☐	☐
Textiles and footwear	☐	☐	☐
Electronic equipment (regarding the casing)	☐	☐	☐
Coverings (e.g. wooden floor coverings)	☐	☐	☐
Other, please specify	☐	☐	☐

E3. What do you think should be the most important requirements of sustainability certification for bio-based products that should be included in its marketing messages? Please make suggestions for appropriate formulations.

E4. How do you think European policy makers could promote the acceptance of bio-based products? Please formulate general recommendations as well as product-specific recommendations for products of your choice.

E5. Our project STAR-ProBio publishes a newsletter twice per year. Check the following box if you would like to subscribe and enter your email address if not done earlier.

☐ Yes

☐ No

Email Address:

Thank you very much for participating!

ANNEX 2-3: SURVEY VERSION FOR CONSUMERS (ENGLISH VERSION) OF THE SECOND SURVEY ROUND

BIO-BASED PRODUCTS SURVEY FOR CONSUMERS ROUND 2

Welcome to the second round of the STAR-ProBio Delphi survey!

You have received an invitation to participate in this survey round because you participated in the first round of our Delphi survey in early summer 2018, from which we obtained valuable results. Only participants of the first round are invited for this second Delphi round, which aims at deepening and validating the results of the first round.

We thank you very much for taking 15 minutes of your time to participate in this survey and your continued support in our research on market up-take of sustainable bio-based products.

Scope and aim of this survey

The protection of scarce resources is a key issue of modern societies.

The STAR-ProBio project aims at driving market adoption of bio-based products by developing tools to prove product sustainability. This survey focusses on the needs and preferences of the market and how certification and labelling can influence purchasing decisions.

We understand bio-based products to be products which are, wholly or in part, made using resources of biological origin and can substitute products traditionally made with fossil resources. Bioenergy products are left out of this survey because their market and legislation are more mature than those of other bio-based products. You are encouraged to think beyond present time bio-based products when filling out this survey.

We respect and value your time. Therefore, we will keep the questionnaire short. Analogous to the previous round, anonymized survey results will be available to all interested participants.

If you have any question or experience technical difficulties, please do not hesitate to contact us:

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Data Protection

In line with the GDPR we need your consent to process your data. Your answers to the survey are used exclusively for scientific purposes and will be scientifically processed by the STAR-ProBio project. Your data or contact details will not be passed on to third parties outside the STAR-ProBio project. Aggregated survey results are used for scientific research and lectures. This work shall be made public. Names and e-mail addresses of participants will not be used for data analysis.

By clicking on 'Accept' you accept the Privacy Agreement, which you can view here. Please indicate your consent below in order to start the survey.

○ Accept

If you would like to receive the survey results, please enter your name and email address below.

Data Protection

In line with the GDPR we need your consent to process your data. Your answers to the survey are used exclusively for scientific purposes and will be scientifically processed by the STAR-ProBio project. Your data or contact details will not be passed on to third parties outside the STAR-ProBio project. Aggregated survey results are used for scientific research and lectures. This work shall be made public. Names and e-mail addresses of participants will not be used for data analysis. By clicking on 'Accept' you accept the Privacy Agreement, which you can view here. Please indicate your consent below in order to start the survey.

Name Email address

1) General information

Your answers from the previous round are processed in an anonymised way; therefore, this first question needs to be repeated. Thank you for your understanding.

a) How old are you?

Only numbers may be entered in this field.

b) What is your gender?

Choose one of the following answers_

- ○ Male
- ○ Female
- ○ Other

c) What is your highest educational qualification?

Choose one of the following answers:

- ○ Primary or no education
- ○ Secondary education
- ○ Vocational education
- ○ University education
- ○ Other

d) What is your current occupation?

Choose one of the following answers:

- ○ Self-employed
- ○ Manager
- ○ Professional (e.g. in the science, engineering, health, teaching, legal or social area)
- ○ Technician or associate professional

- ○ Administrative assistant
- ○ Services and sales worker
- ○ Skilled agricultural, forestry or fishery worker
- ○ Craft or related trades worker
- ○ Plant and machine operator or assembler
- ○ Elementary occupation (e.g. as a labourer in mining, construction, manufacturing or transport)
- ○ Student
- ○ Retiree
- ○ Don't work
- ○ Other

e) What is your country of residency?

Choose one of the following answers:

- ○ Belgium
- ○ Germany
- ○ Greece
- ○ Italy
- ○ Poland
- ○ Portugal
- ○ Spain
- ○ Netherlands
- ○ Other

f) How many people live in your household?

Only numbers may be entered in this field.

Please write your answer here:

g) How many of them are children?

Only numbers may be entered in this field.

Please write your answer here:

h) What is your monthly household net income?

Choose one of the following answers

- ○ < € 1,300
- ○ € 1,300 – € 2,599
- ○ € 2,600 – € 3,599
- ○ € 3,600 – € 4,999
- ○ € 5,000 – € 17,999
- ○ ≥ € 18,000

2) General impression of bio-based products and sustainability

a) Please indicate the statement you most agree with:

"If I have to make a choice between a bio-based product or the traditional fossil-based version ..."

Choose one of the following answers:

- ○ ... I will normally prefer the bio-based product
- ○ ... I will normally prefer the traditional product because I think it may have better performance compared to the bio-based version
- ○ ... I will normally prefer the traditional product because I worry that the bio-based version may not automatically be the most sustainable choice
- ○ ... I will normally prefer the traditional product for other reasons
- ○ ... Good price/functionality/performance is what matters, not the origin of the raw materials

b) How much influence would a proof of sustainability have on your willingness to buy the bio-based version?

Please score from 1 (low influence) to 4 (high influence)

Choose one of the following answers:

- ○ 1 (low influence)
- ○ 2
- ○ 3
- ○ 4 (high influence)

c) The response to the first round of the survey identified multiple reasons that can influence a consumer's willingness to buy bio-based products. Please rate the importance of each reason for the decision to buy bio-based or not.

d) Please fill in the 7 answers for "All bio-based products" and optionally you can give a different score to specific product types.

Please score from 1 (low influence) to 4 (high influence).

	Easy availability	Confidence in the environmental benefits	Confidence in the social benefits	Confidence in the economic benefits	Confidence in the quality	Confidence in product useful life expectancy	Price
All bio-based products							
Personal care products (e.g. shampoo, face/body cream)							
Children's products including toys							
Cleaning products							
Paints and varnishes							
Furniture							
Gardening products							
Lubricants							
Paper products							
Textiles and footwear							
Construction and building material							
Electronic equipment (regarding the casing)							
Surface coverings (e.g. wooden floor surface coverings)							

e) If you want to provide information on additional products, please include it here:

f) Optionally briefly explain your answers below.

3) Selection of environmental criteria for sustainability assessment

In the first survey round, participants were asked to select the environmental issues that could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Biodegradability (73%)
2. Recyclability (71%)
3. Type and origin of raw material (65%)
4. Percentage of recycled content (61%)
5. No pollution of water, soil and air in the production of raw material beyond thresholds (60%)
6. No deforestation or use of peatland in the production of raw material (58%)
7. Toxicity (57%)
8. Use of chemicals (51%)
9. Resource efficiency (47%)
10. Environmental life-cycle impacts (46%)
11. Percentage of bio-based content (45%)
12. Appropriate waste management (45%)
13. No impact to bio-diversity in the production of raw material (45%)
14. Greenhouse gas emissions (45%)
15. Compostability (42%)
16. Lower toxicity than fossil-based alternatives (42%)
17. Use of water (41%)
18. Lower greenhouse gas emissions than fossil-based alternatives (37%)
19. No use of genetically modified organisms (34%)

a) Performing sustainably assessments should be efficient, so the importance of all criteria should be considered. Please indicate the criteria that are absolutely essential for claiming that a bio-based product is sustainable.

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Minimise the use of hazardous substances.	○	○
Type of raw materials used.	○	○
Reduced lifecycle greenhouse gas emissions.	○	○
Avoid contribution to undesirable changes in the way land is used.	○	○
No impact to biodiversity in the production of the raw materials.	○	○
No use of genetically modified organisms.	○	○
Minimise energy consumption for raw material and product production processes.	○	○

	Yes, it is essential	No, it is not essential
Sustainable water use (optimise consumption, minimise pollution no contribution to scarcity).	○	○
Sustainable soil use (prevent erosion, maintain or improve soil carbon content).	○	○
Minimise particulate matter emissions and other air pollution.	○	○
Packaging: use sustainable materials and/or minimise volumes.	○	○
Product should indicate the best disposal method(s) after useful life of bio-based product (recyclable, biodegradable, compostable, reusable, repairable).	○	○

b) Please write below your additional comments (optional).

Please write your answer here:

c) What would you expect the minimum percentage in a sustainable bio-based product to be for the following criteria?

Only numbers may be entered in these fields.

	Minimum %
Percentage of bio-based content	
Percentage of greenhouse gas emissions reduction compared to fossil-based alternatives	

d) Should the origin of the bio-based product be indicated on the product?

Choose one of the following answers:

○ Yes

○ No

e) If indicated, should the "origin" refer to indicating the place of origin of the raw material or the place of manufacture?

Choose one of the following answers:

○ Origin of raw material (e.g. "sourced in the EU")
○ Place of manufacture (e.g. "made in the EU")
○ Both

4) Selection of social criteria for sustainability assessment

In the first survey round, participants were asked to select the social issues could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Influence of the product on people's health (81%)
2. No child labour (76%)
3. Respect of human rights in the production of the material and the product (74%)
4. The working conditions and the payment of the employees meet at least minimum standards (64%)
5. Contribution to the economic wellbeing of local communities by the producer (52%)
6. Implementation of an occupational health and safety plan for the production of the product (51%)
7. Not tested on animals (49%)

a) Performing sustainability assessments should be efficient, so the importance of all criteria should be considered. Please indicate the criteria that are absolutely essential for claiming that a bio-based product is labelled as sustainable.

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Fulfilment of key human rights principles and international labour standards (ILO) in the sourcing of raw materials and the production of the products, for example forbidding child labour.	○	○
No risk to local food security.	○	○
Not tested on animals.	○	○
The product manufacturer has an occupational health and safety management system in place.	○	○
Contribution to the wellbeing of local communities by the product manufacturer.	○	○

b) Please write below your additional comments (optional).

5) Selection of economic criteria for sustainability assessment

In the first survey round, participants were asked to select the economic issues could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Fair land use rights practices in the production of feedstock (73%)
2. Fair business practices of the company (69%)

a) Performing sustainability assessments should be efficient, so the importance of all criteria should be considered. Please indicate the criteria

that are absolutely essential for claiming that a bio-based product is labelled as sustainable.

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Fair business practices.	○	○
Fair land use rights practices.	○	○
Promote further development of production technologies that can use other sustainable input materials.	○	○

b) Please write below your additional comments (optional).

6) Selection of additional criteria for sustainability assessment

In the first survey round, participants were asked to select additional issues which could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Price (75%)
2. Functionality/performance of the product (74%)
3. Better performance than alternative fossil-based products (57%)
4. Energy consumption (48%)
5. Specific brand name for bio-based products (22%)
6. Brand name (10%)

a) Performing sustainably assessments should be efficient, so the importance of all criteria should be considered. Please indicate the criteria that are absolutely essential for claiming that a bio-based product is sustainable.

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Promote product design that enables a product to have a long life, reusable and repairable.	○	○
Functionality/performance of the product.	○	○
Producer is known as a provider of bio-based products.	○	○
Lifecycle cost.	○	○
Product useful lifetime.	○	○
Influence of the product on people's health.	○	○

b) Please write below your additional comments (optional).

7) Ranking across environmental, social and economic pillars

The questions above discuss the ranking of different criteria within the environmental, social and economic sustainability pillars. In this question, all criteria are listed again.

a) Please select the 5 (optionally up to 10) most important.

All your answers must be different and you must rank in order.

☐ Type of raw materials used	☐ Fulfilment of key human rights principles and international labour standards (ILO)
☐ Reduced lifecycle greenhouse gas emissions	☐ No risk to local food security
☐ Avoid contribution to undesirable changes in the way land is used	☐ Not tested on animals
☐ No impact to biodiversity in the production of the raw materials	☐ The product manufacturer has an occupational health and safety management system in place
☐ No use of genetically modified organisms	☐ Contribution to the wellbeing of local communities by the product manufacturer
☐ Minimise energy consumption for raw material and product production processes	☐ Fair business practices
☐ Sustainable water use	☐ Fair land use rights practices
☐ Sustainable soil use	☐ Promote further development of production technologies that can use other sustainable input materials
☐ Minimise particulate matter emissions and other air pollution	☐ Promote product design that enables a product to have a long life, reusable and repairable
☐ Packaging: use sustainable materials and/or minimise volumes	☐ Functionality/performance of the product
☐ Product should indicate the best disposal method	☐ Producer is known as a provider of bio-based products
	☐ Lifecycle cost
	☐ Product useful lifetime
	☐ Influence of the product on people's health

8) Bio-based packaging for packaged goods

The first round survey participants were asked if bio-based packaging influences their buying decisions. The result are presented below:

When you buy a product, how important is it for you that the packaging of that product is bio-based? **Somehow or very important (70%)**

a) For packaged goods, is it important/worthwhile to have a label if bio-based packaging was used?

Choose one of the following answers:

- ○ Yes
- ○ No

b) Do you think sustainability labels on the packaging bear a risk of confusing consumers whether the label refers to the packaging or to the contents of the packaged goods?

Choose one of the following answers:

- ○ Yes
- ○ No

c) Please write below your additional comments (optional).

Please write your answer here:

9) How do you want to receive sustainability information?

In the first survey round, participants were asked about the importance of information before purchase. The results are shown below:

I would prefer to receive more information on bio-based products before purchase: **Agree or strongly agree (84%)** I want to gain a deeper insight into the ingredients, the processes of manufacturing bio-based products and their impacts before purchase: **Agree or strongly agree (64%)**

a) Please describe what for you would be the preferred way to access such information (e.g. only a logo/label on the package, descriptive text on the package, app on smartphone, QR code linking to a website, paper information folder in store etc.).

Please write your answer here:

b) Please describe the most important change(s) you think are needed to help the market share of bio-based products grow.

Please write your answer here:

Thank you very much for participating!

ANNEX 2-4: SURVEY VERSION FOR PROFESSIONALS (ENGLISH VERSION) OF THE SECOND SURVEY ROUND

BIO-BASED PRODUCTS SURVEY FOR PROFESSIONALS ROUND 2

Welcome to the second round of the STAR-ProBio Delphi survey!

You have received an invitation to participate in this survey round because you participated in the first round of our Delphi survey in early summer 2018, from which we obtained valuable results. Only participants of the first round are invited for this second Delphi round, which aims at deepening and validating the results of the first round.

We thank you very much for taking 15 minutes of your time to participate in this survey and your continued support in our research on market up-take of sustainable bio-based products.

Scope and aim of this survey

The protection of scarce resources is a key issue of modern societies.

The STAR-ProBio project aims at driving market adoption of bio-based products by developing tools to prove product sustainability. This survey focusses on the needs and preferences of the market and how certification and labelling can influence purchasing decisions.

We understand bio-based products to be products which are, wholly or in part, made using resources of biological origin and can substitute products traditionally made with fossil resources. Bioenergy products are left out of this survey because their market and legislation are more mature than those of other bio-based products. You are encouraged to think beyond present time bio-based products when filling out this survey.

We respect and value your time. Therefore, we will keep the questionnaire short. Analogous to the previous round, anonymized survey results will be available to all interested participants for validation in a third and final survey round in the spring of 2019.

If you have any question or experience technical difficulties, please do not hesitate to contact us:

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By clicking on 'Accept' you accept the Privacy Agreement, which you can view here. Please indicate your consent below in order to start the survey.

○ Accept

The outcomes of this survey will be available to all interested participants and the results will be used to prepare a final survey round to strengthen and deepen the conclusions. If you would like to receive the common results of this survey and receive

an invitation to the third round in spring 2019, please enter your name and email address below. Your input will be highly appreciated.

(Data Protection In line with the GDPR we need your consent to process your data. Your answers to the survey are used exclusively for scientific purposes and will be scientifically processed by the STAR-ProBio project. Your data or contact details will not be passed on to third parties outside the STAR-ProBio project. Aggregated survey results are used for scientific research and lectures. This work shall be made public. Names and e-mail addresses of participants will not be used for data analysis. By clicking on 'Accept' you accept the Privacy Agreement, which you can view here. Please indicate your consent below in order to start the survey.)

Name Email address

1) General Information

a) What kind of an organization do you work for?

Choose one of the following answers

- ○ Business
- ○ Government, public authority or agency
- ○ Industry organisation
- ○ Certification body
- ○ NGO
- ○ University or research organization
- ○ Other

b) SME?

- ○ Yes
- ○ No

c) In which area is your company active?

Choose one of the following answers

- ○ Agriculture
- ○ Manufacturing
- ○ Construction
- ○ Energy
- ○ Trade
- ○ Transportation
- ○ Information and communication
- ○ Financing and insurance
- ○ Real estate
- ○ Health care
- ○ Accommodation or food services
- ○ Other

d) Which of the following keywords decribes your job best?

Choose one of the following answers

- ○ Management
- ○ Administration/accounting
- ○ Procurement
- ○ Production
- ○ Marketing
- ○ Sales
- ○ Research and development
- ○ Conformity assessment
- ○ Other

e) What is your country of residency?

Choose one of the following answers

- ○ Belgium
- ○ Germany
- ○ Greece
- ○ Italy
- ○ Poland
- ○ Portugal
- ○ Spain
- ○ Netherlands
- ○ Other

2) Professional Procurement Activities

a) Does your job involve tasks related to the procurement of goods?

Choose one of the following answers

- ○ Yes
- ○ No

b) Please select the best option for the scope of your tasks:

Only answer this question if the answer to question 2B was 'Yes'

Choose one of the following answers

- ○ Procurement of goods is one of the main tasks of my profession.
- ○ Some of my work is related to procurement of goods.

c) Please select the best option to describe your role:

Only answer this question if the answer to question 2B was 'Yes'

Choose one of the following answers:

- ○ My normal role is buyer
- ○ My normal role is seller
- ○ I'm involved in buying and selling

d) Please indicate with which statement you most agree:

Only answer this question if the answer to question 2B was 'Yes'

Choose one of the following answers:

- ○ Sustainability of bio-based products is important in our organisation and we already have a good enough system to check sustainability.
- ○ Sustainability of bio-based products should be important in our organisation but we don't have a good enough system to check sustainability.
- ○ Sustainability of bio-based products is not the highest priority in our organisation. If we could assess sustainability of bio-based products, our purchasing decision could be influenced, but not much.
- ○ Competitive price and/functionality/performance what really matters. Sustainability aspects can be interesting but do not really influence decisions at all.
- ○ I don't know.

e) Please write should you have any further comments:

Only answer this question if the answer to question 2B was 'Yes'

f) This question focuses on the extent to which bio-based products currently already play a role in procurement, for different product groups. For each product group please select the answer from the drop-down menu that is most applicable to your organisation, to the best of your knowledge, from the following options:

- **No procurement (No procurement of this product type)**
- **Procurement but no bio-based (There has been procurement of this product type, but no, bio-based was not mentioned in the procurement specification)**
- **Procurement, also bio-based (There has been procurement, and yes, bio-based was mentioned in the procurement specification)**

Only answer this question if the answer to question 2B was 'Yes'

Please choose the appropriate response for each item:

	No procurement	Procurement but no bio-based	Procurement, also bio-based
Construction and building material	○	○	○
Paints and varnishes	○	○	○
Furniture	○	○	○
Cleaning products	○	○	○
Lubricants	○	○	○

	No procurement	Procurement but no bio-based	Procurement, also bio-based
Paper products	○	○	○
Gardening products	○	○	○
Personal care products (e.g. shampoo)	○	○	○
Textiles and footwear	○	○	○
Electronic equipment with bio-based casing	○	○	○
Coverings (e.g. wooden floor coverings)	○	○	○

3) Market's Willingness to Buy Bio-based Products

a) The response to the first round of the survey identified multiple reasons that can influence a consumer's willingness to buy bio-based products. Please rate the importance of each reason for the decision to buy bio-based or not.

Please score from 1 (low influence) to 4 (high influence).

Please fill in the 7 answers for "All bio-based products" and optionally you can give a different score to specific product types.

	Easy availability	Confidence in the environmental benefits	Confidence in the social benefits	Confidence in the economic benefits	Confidence in the quality	Confidence in product useful life expectancy	Price
All bio-based products							
Construction and building material							
Paints and varnishes							
Furniture							
Cleaning products							
Lubricants							
Paper products							
Gardening products							
Personal care products (e.g. shampoo, face/body cream)							
Textiles and footwear							
Electronic equipment (regarding the casing)							
Coverings (e.g. wooden floor surface coverings)							

b) If you want to provide information on additional products, please include it here:

Please write your answer here:

4) Selection of environmental criteria for sustainability assessment

In the first survey round, participants were asked to select the environmental issues could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Recyclability (69%)
2. Type and origin of raw material (66%)
3. Percentage of bio-based content (64%)
4. Biodegradability (64%)
5. No deforestation or use of peatland in the production of raw material (63%)
6. No pollution of water, soil, and air in the production of raw material beyond thresholds (60%)
7. Percentage of recycled content (59%)
8. Environmental life-cycle impacts (57%)
9. Lower greenhouse gas emissions than fossil-based alternatives (54%)
10. No impact to bio-diversity in the production of raw material (51%)
11. Resource efficiency (47%)
12. Compostability (46%)
13. Greenhouse gas emissions (46%)
14. Toxicity (43%)
15. Use of water (41%)
16. Lower toxicity than fossil-based alternatives (40%)
17. Use of chemicals (39%)
18. Appropriate waste management (38%)
19. No use of genetically modified organisms (33%)

a) Please indicate the criteria that are absolutely essential for claiming that a bio-based product is sustainable:

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Minimise the use of hazardous substances.	○	○
Type of raw materials used.	○	○
Reduced lifecycle greenhouse gas emissions.	○	○
Avoid contribution to undesirable changes in the way land is used.	○	○
No impact to biodiversity in the production of the raw materials.	○	○
No use of genetically modified organisms.	○	○
Minimise energy consumption for raw material and product production processes.	○	○
Sustainable water use (optimise consumption, minimise pollution no contribution to scarcity).	○	○
Sustainable soil use (prevent erosion, maintain or improve soil carbon content).	○	○
Minimise particulate matter emissions and other air pollution.	○	○
Packaging: use sustainable materials and/or minimise volumes.	○	○
Product should indicate the best disposal method(s) after useful life of bio-based product (recyclable, biodegradable, compostable, reusable, repairable).	○	○

b) Please write below your additional comments (optional).

c) For each of the following criteria please indicate:

- **The percentage you would expect a product labelled as sustainable bio-based product to typically have;**
- **The percentage below which you feel that calling a bio-based product sustainable would be misleading;**
- **The percentage about which a bio-based product could deserve a special sustainability class (e.g. gold label).**

Only numbers may be entered in these fields.

	Typical %	Misleading %	Special class %
Percentage of bio-based content			
Percentage of GHG emissions reduction compared to fossil-based alternatives			

d) Should the origin of the bio-based product be indicated on the product?

Please choose **only one** of the following:

- ○ Yes
- ○ No

e) If indicated, should the "origin" refer to indicating the place of origin of the raw material or the place of manufacture?

Please choose **only one** of the following:

- ○ Origin of raw material (e.g. "sourced in the EU")
- ○ Place of manufacture (e.g. "made in the EU")
- ○ Both

5) Selection of Social Criteria for Sustainability Assessment

In the first survey round, participants were asked to select the social issues could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. No child labour (75%)
2. Influence of the product on people's health (67%)
3. Respect of human rights in the production of the material and the product (65%)
4. The working conditions and the payment of the employees meet at least minimum standards (60%)
5. Contribution to the economic wellbeing of local communities by the producer (50%)

6. Implementation of an occupational health and safety plan for the production of the product (43%)
7. Not tested on animals (38%)

a) Please indicate the criteria that are absolutely essential for claiming that a bio-based product is labelled as sustainable:

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Fulfilment of key human rights principles and international labour standards (ILO) in the sourcing of raw materials and the production of the products, for example forbidding child labour.	○	○
No risk to local food security.	○	○
Not tested on animals.	○	○
The product manufacturer has an occupational health and safety management system in place.	○	○
Contribution to the wellbeing of local communities by the product manufacturer.	○	○

b) Please write below your additional comments (optional).

Please write your answer here:

6) Selection of socio-economic criteria for sustainability assessment

In the first survey round, participants were asked to select the socio-economic issues could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Fair business practices of the company (74%)
2. Fair land use rights practices in the production of feedstock (66%)

a) Performing sustainability assessments should be efficient, so the importance of all criteria should be considered. Please indicate the criteria that are absolutely essential for claiming that a bio-based product is labelled as sustainable.

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Fair business practices.	○	○
Fair land use rights practices.	○	○
Promote further development of production technologies that can use other sustainable input materials.	○	○

b) Please write below your additional comments (optional).

Please write your answer here:

7) Selection of additional criteria for sustainability assessment

In the first survey round, participants were asked to select additional issues which could realistically influence a decision to purchase a bio-based product. The ranked results are displayed below:

1. Functionality/performance of the product (83%)
2. Price (69%)
3. Life cycle cost (57 %)
4. Energy consumption (53%)
5. Better performance than alternative fossil-based products (44%)
6. Specific brand name for bio-based products (18%)
7. Brand name (11%)

a) Performing sustainably assessments should be efficient, so the importance of all criteria should be considered. Please indicate the criteria that are absolutely essential for claiming that a bio-based product is sustainable.

Please choose the appropriate response for each item:

	Yes, it is essential	No, it is not essential
Promote product design that enables a product to have a long life, reusable and repairable	○	○
Functionality/performance of the product	○	○
Producer is known as a provider of bio-based products	○	○
Lifecycle cost	○	○
Product useful lifetime	○	○
Influence of the product on people's health	○	○

b) Please write below your additional comments (optional).

Please write your answer here:

8) Ranking across environmental, social and economic pillars

The questions above discuss the ranking of different criteria within the environmental, social and economic sustainability pillars. In this question, all criteria are listed again.

Please select the 5 (optionally up to 10) most important.

All your answers must be different and you must rank in order.

☐ Type of raw materials used	☐ Fulfilment of key human rights principles and international labour standards (ILO)
☐ Reduced lifecycle greenhouse gas emissions	☐ No risk to local food security
☐ Avoid contribution to undesirable changes in the way land is used	☐ Not tested on animals
☐ No impact to biodiversity in the production of the raw materials	☐ The product manufacturer has an occupational health and safety management system in place
☐ No use of genetically modified organisms	☐ Contribution to the wellbeing of local communities by the product manufacturer
☐ Minimise energy consumption for raw material and product production processes	☐ Fair business practices
☐ Sustainable water use	☐ Fair land use rights practices
☐ Sustainable soil use	☐ Promote further development of production technologies that can use other sustainable input materials
☐ Minimise particulate matter emissions and other air pollution	☐ Promote product design that enables a product to have a long life, reusable and repairable
☐ Packaging: use sustainable materials and/or minimise volumes	☐ Functionality/performance of the product
☐ Product should indicate the best disposal method	☐ Producer is known as a provider of bio-based products
	☐ Lifecycle cost
	☐ Product useful lifetime
	☐ Influence of the product on people's health

9) Regulatory Options to Promote Bio-based Products

a) An open question on how European policy makers could promote the acceptance of bio-based products resulted in 9 categories of regulatory options, listed below. Please score from 1 (likely low impact) to 4 (likely high impact) each option for regulatory action.

Please choose the appropriate response for each item:

	1 (likely low impact)	2	3	4 (likely high impact)
Appropriate information and communication about bio-based product properties (in general)	○	○	○	○
Public procurement	○	○	○	○
Taxation and subsidies	○	○	○	○
Labels and certificates	○	○	○	○
Legislation including bans	○	○	○	○
Ensuring environmental friendliness	○	○	○	○
Standards	○	○	○	○
Comparisons with fossil-based products	○	○	○	○
Harmonization of definitions	○	○	○	○

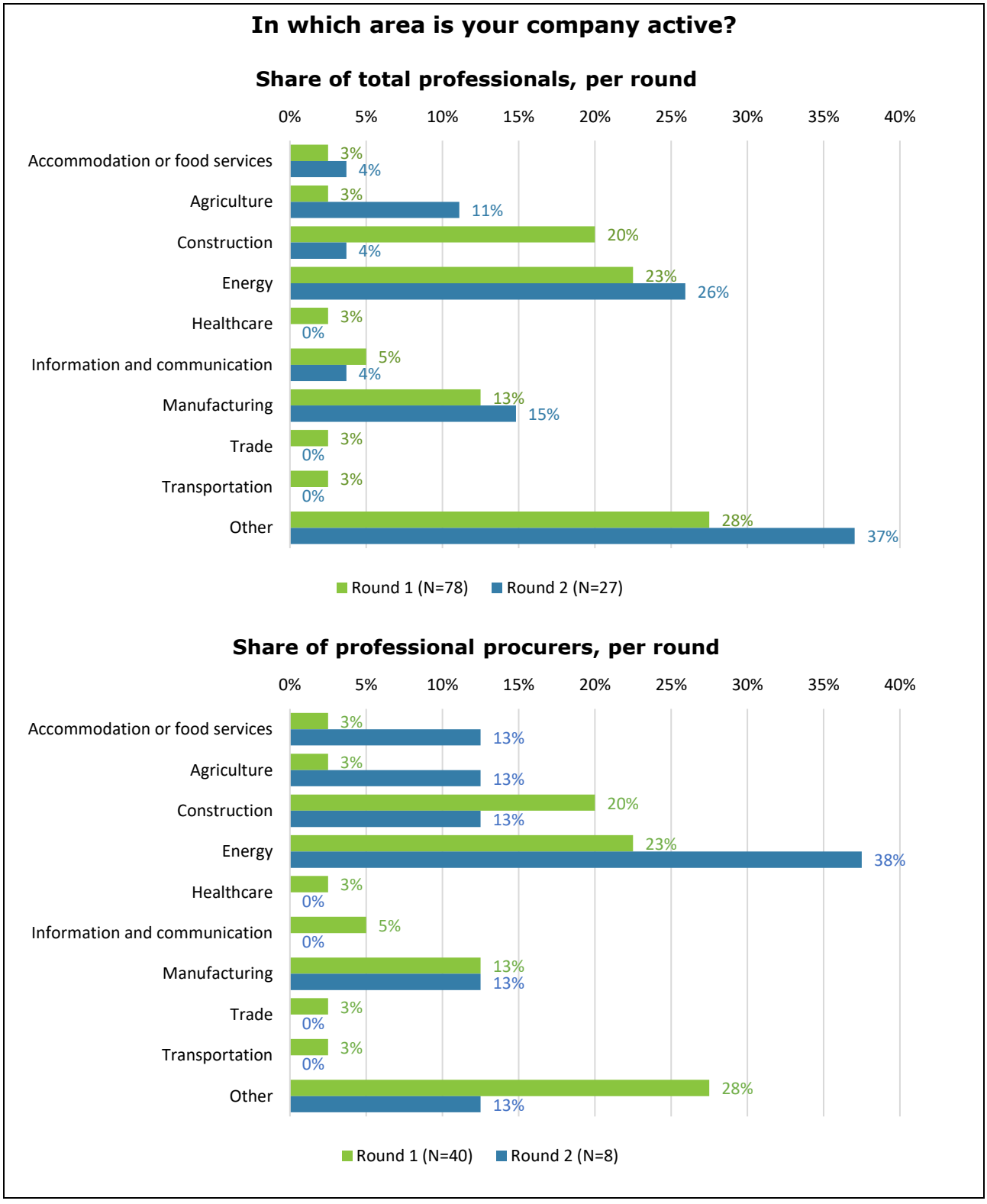
b) Do you have additional recommendations?

Please write your answer here:

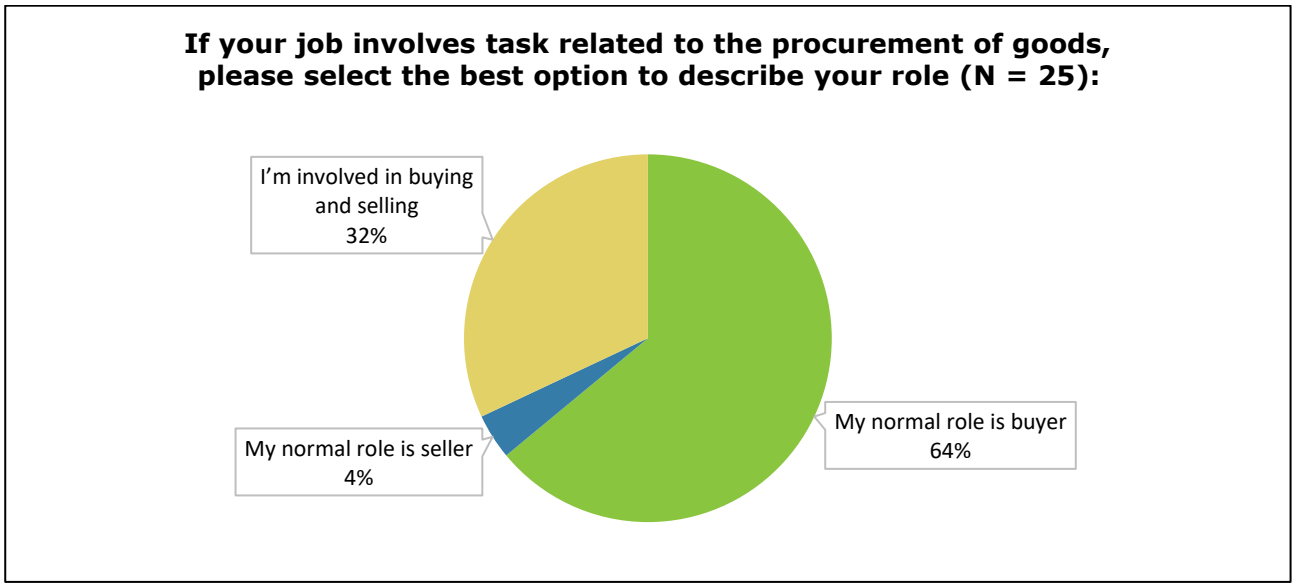
Thank you very much for participating!

Annex 3: Additional demographic information on professional participants

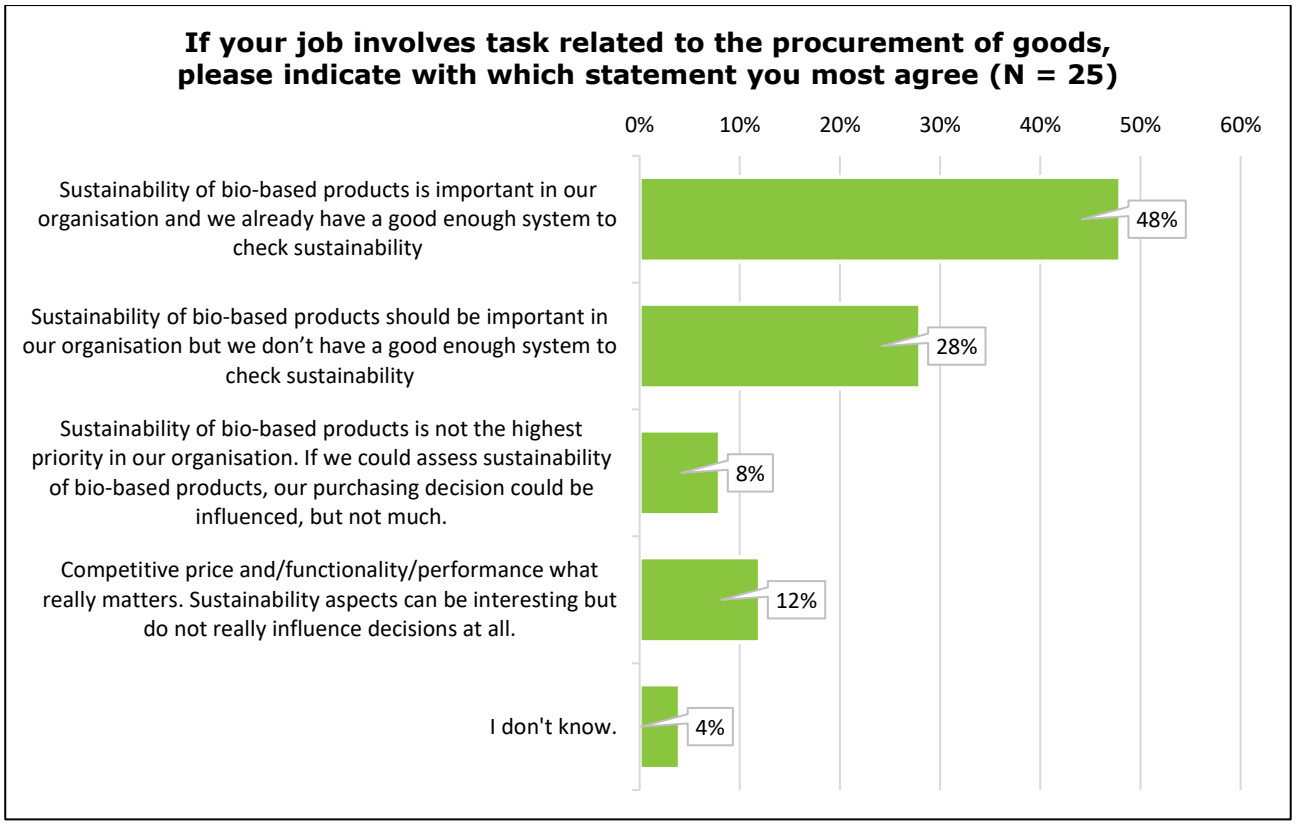
Annex 3-1: Professional participants' industrial sector



Annex 3-2: Procurement professional's type of role

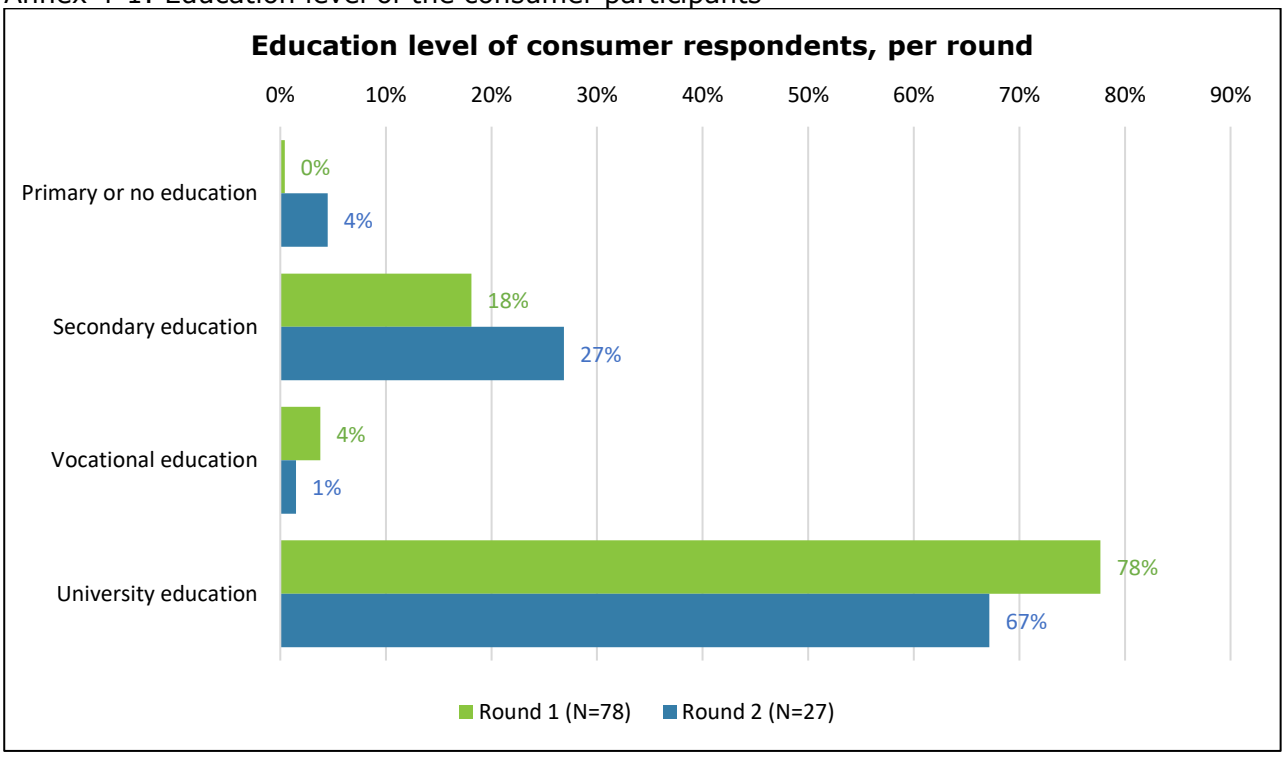


Annex 3-3: Procurement professional's view on the need for a sustainability assessment system



Annex 4: Additional demographic information on the consumers

Annex 4-1: Education level of the consumer participants



Annex 5: Answers on the question "Which other aspects can support purchasing decisions if an opportunity to purchase a bio-based product exists?"

Specific sustainability criteria (often repetitions of previous questions)
General
Indications of advantages with regard to sustainability
Sustainable commitment in supply and logistic chain
Sustainability considerations, internal purchasing requirements (see also other line)
Environmental pillar
Environmental issues
CO_2 footprint; e.g. has the product been dragged around the world, or was it produced locally? Is it a high-profile product that I can support others with by buying it, or that can add to my own positioning?
Characteristic of product (especially if made from by-product)
Characteristics of the product especially with respect to environmental issues.
Transparency of production
Regionality or region of origin
Regional production, manufacture in Germany or the EU
short transport routes, regional cultivation
How the product has been redesigned for low environmental and/or social impact, not just a direct replacement of a synthetic material with a bio-based one. In other words, the overall ecodesign and environmental/social performance of the product, not just the bio-based elements in isolation.
Upcycling and design of products. Is product really needed or solve problems.
Reduction of plastic alternatives
Traceability, i.e. where is it from, who is producing it and what resources have been used.
Toxicity
durability of the products
The durability of the product, usability.
Inclusion of the End of Life
end of life- Statements on pot. recyclability
if the package is recyclable or compostable
Recyclable yes, but if it is indeed recycled. etc.
It's absolutely vital that a bio-based product is bio-degradable under normal conditions (many aren't).
Compostability yes, but only if there are existing infrastructures.
Easy to dispose of
Information on disposal of the product by the end consumer; possible return offer by the manufacturer
LCA indicator
Life cycle assessment results. Biobased does not necessarily equal 'good'. One has to look at the whole life cycle and compare with alternatives.
Energy savings, recyclable materials, circular economy, environmental compliance
Withdrawal strategies for disused/old products
Social and economic pillar
Lower environmental impact and pay the producers a fair price such as "fair trade initiative"
Dealing with wood based-products, legal or illegal wood origin is a critical point and a major point for purchasing decision. Out of the EU and North-America, very few countries are really placing on to the market legal wood from sustainably managed forests. Private sector sustainable forest management certification schemes (FSC and PEFC) are very weak, to compare with national forest administrations. We can stress that it's a scandal to see FSC products made of mixed sources (sustainable/not sustainable, legal/not legal) sold as if they were made of 100% legal and sustainable wood. Consumers are abused. We can

consider fraudulent to put products on to the market with sustainability labels on wood products derived from "mixed sources". Consumers would have better buy products made of wood from legal European or north American wood, rather than buying "mixed sources" from tropical countries with FSC labels.
small minority or women owned local businesses selling the bio-based product (as all things equal our procurement favors such vendors)
Bio-based content
biobased percentage certification and GHG emissions % comparison to fossil equivalent
Biobased portion, including certification of origin via strong system (Mass Balance) as part of a rennet
Saying that has 99% of bio ingredients, for instances.
General characteristics and added value
key aspects are performance and functionality
characteristics of the product
Characteristics of the product and the costs
Characteristics of the product is the main aspect can support purchasing of a bio-based product.
And the added value is acknowledged by independent specialists.
Easy to handle
Purity
Price/performance: Usability not worse than conventional product
quality and performance of the product
Comparison with the usual products that can be substituted by the bio-based products
Genuine comparison of performance versus conventional fossil derived products
Proven functionality, especially regarding paints and lubricants, as these products can impact the performance of the building/machinery on which it is applied to.
Characteristics of the product
- Information on shelf life; product benefits for the consumer as long as possible
innovative product with possibly longer useful life / service life
Information that is provided concerning sustainability + in general the functionality compared to other alternative products.
people need to compare a production to a well-known established benchmark. the public procurement must only be restricted to bio-based product (conditional there is no alternatives). voluntary agreements must be suggested for the private sector
Upcycling and design of products. Is product really needed or solve problems.
Regulatory requirements and procurement rules
Specifications for procurement points
Regulatory requirements
procurement guidelines
Fair chance for biobased products in a procurement: LCC e.g. instead of price.
Sustainability considerations, internal purchasing requirements,
Specifications for procurement points
procurement guidelines
Some companies have restrictions to buy a product that comes from a single source.
backing by management
Demand
Specific demand of our customers (i.e. CO_2 emission, fine dust, etc.)
Awareness level of the product in social networks. Of course, this is not an aspect that treats resources with care but it might push the decision to by a product (just because of the reason that an article is "in vogue".
Consumer awareness and information
General communication
Effective communications on the environmental performance as part of marketing of products
Availability of objective information

Transparency - e.g. proof of origin via QR code, visible on purchase, certification logo, regionality, no long "raw material paths", not even in the case of post-war raw materials, optimising regional raw material cycles (but in contradiction to: exchangeability of raw materials = competition, market access conditions). raw materials, optimise regional raw material cycles (but in contradiction to: exchangeability of raw materials = competition, market access conditions (WTO), production of the end product where sustainability requirements are met and comparative price and cost advantages (labour and investment costs) can be optimised), there remains "global" competition => opportunities for "developing countries"?
Transparency of the supply chain (with regard to the actors involved, the additives used and the process conditions)
Transparency in product presentation/advertising, traceability of production processes and distribution channels
The information provided (feedstock - but in an easy way, and maybe marketing, like "this product is 100% made by sugar cane, a renewable bio-based product ")
Simple colour coding green being fully bio based and red being fully non bio
Access to more info, e.g. website
disposal instructions
Certificates and labels
Certification/ labels, Packaging, information on ingredients
If product has the right certificates for the use in infrastructure.
Clear and transparent labeling, product information, traceability (QR -code)
Clear labelling
Labels (like energy efficiency label, EU eco-label), comparison between products
Clear labelling / recognisability.
If the product had a label and could also be bought in many shops.
uniform labeling
Uniform labeling
Traceability and transparency of the certification process
uniform system/format for characteristics of the product
Packaging
Packaging of the product: much better if no packaging at all
Certification/ labels, Packaging, information on ingredients
as little packaging as possible
packaging of product
my preference will still be to buy without packaging. Avoiding plastics and waste is always better!
Avoidance of unnecessary packaging waste and economical/efficient use of materials/raw materials on the product
Influence of packaging in the shelf-life of the product. Avoidance of food waste.
if the package is recyclable or compostable
Availability
availability and awareness
availability, e.g. there are hardly any traffic signs and road signs biobased available in the Netherlands, the biobased composite material is available at only one producer.
The convenience of buying and easy availability
Availability in stock of the product as well as Delivery time
In most cases the availability and accessibility of the product.
Information about availability. Where can I buy what?
If the product had a label and could also be bought in many shops.
Price and cost
Prices (equal or lower than fossils fuels compound)
in case of food definitely the price that can be higher maximum by 20 %
Regarding the cost, if the premium price is reasonable, I'm happy to pay it. It should be reasonable...

First and foremost, the price will be decisive. This may only exceed the price of a comparable conventional product to a certain extent.
Price/performance: Usability not worse than conventional product
total life cycle costs
Extensive statements on various issues
Expected usage of the targeted product (no need for bio-based packaging if I can choose a no packaging or reusable packaging option for example), sustainable claims supported by transparent and robust evidences, helping clarify possible confusion between biodegradability and bio-base or between bio-base and sustainability
Overall information of the product due to the process from R/M to Finish goods and also the transportation and shelf-life of each product. Other rewards or guarantee or certification from the credible organizations regards to many aspects (Environment (carbon footprint, environment friendly, etc.), Economic, Design and more). Moreover, about the use of the bio-based product after the main use (as for recycle, reuse and reduce). So you can extend the life of the product.
trust in the product, the company; traceability of origin and production method, credibility of any seals and stamps
Proof of sustainability advantages, social harmlessness, fair trade, no endangerment of nutritional bases, no competition to nutrition, protection of important protected areas, such as primeval forests, no monocultures.
Transparency in production, long-term studies on functionality, simple procurement of the product + spare parts / wearing parts, simple handling, appearance (e.g. shoes often have a very alternative appearance...)
Additional comments
Biobased products have to proof to be more, better, environmentally friendlier instead of non biobased products that have to proof how (less) bad the actually are
We only look at longlivety/life span instead of what is good (a product that last for 10 years is better for the economy than one that last for 30 years and is made of raw materials like metal/plastic (oil based)
The packaging usually has a (very) low impact compared to the contents of the package. Therefore, I am against biobased packaging around a polluting product; please beware of this.
The preference of bio based products should be a part of education in schools and kindergartens.
The important aspect is to explain the negative impact non-bio-based products have and not necessarily request more information on bio-based products.
Direct contact to the producer
Easy export without cumbersome formalities
Prefer algae based products
Prescribing by clients

Annex 6: Examples for suggested marketing messages on certificates for sustainable bio-based products

Example answers on the question: What do you think should be the most important requirements of sustainability certification for bio-based products that should be included in its marketing messages? Please make suggestions for appropriate formulations.

Biobased content
"The **most important information is "bio-based"** because this includes the information that fossil resources were likely saved. Information on sustainability is to complex so a simple statement like "ecofriendly" is hardly reliable. This complex information should be available on request, homepage etc."
"% of bio-based content as a star system (like the TUV Austria: one star- 20% to 40%, two stars- 40% to 60%, three stars - 60% to 80% four stars- over 80%"
Term "sustainable"
"Made of sustainably managed renewable resources"
Considerations of the three pillars
"The **three pillars of sustainability must be addressed**. The certificate must be transparent and credible (no self-certification)."
"Product positively evaluated as advantageous according to **environmental, social and economic aspects."**
"Products that are produced in an **ecologically, economically and socially** responsible way."
Various environmental issues
"Zero or x Gram CO_2 emission for bio-based product manufacturing"
"**GHG** and resource efficiency in LCA"
"**environmentally friendly bio-based products**"
""Environmentally friendly" is **not a convincing message**. A specification is necessary."
Avoid "'environmentally friendly' or 'green'. **Make claims that are precise**, measurable and verifiable instead (ex. made out of 100% recycled material)."
Type and origin of the material
"The **origin of the raw material** and end-of-life options (how sustainable are these) are important."
"Use of **sustainable raw materials**, environment-friendly production, Compliance with high social standards".
"(U)se only already **existing materials**. No use of new natural resources."
"1. biobased product with %% lower carbon footprint compared to fossil equivalent 2. **responsibly sourced raw materials** giving benefit to local communities 3. recyclable in main collection, sorting and recycling streams"
End of life
" … recyclable in main collection, sorting and recycling streams…" (see above)
"**compostable** consuming less fossil fuel with the production"
"**degradable**, sustainable, no child labour / animal testing, no petroleum / paraben /...,"
"non-toxic and maximum recyclable or compostable products"
Social issues
"Resource-conserving manufacturing. **Fair** production."
"Climate protection, **health**, sustainability"

Comparisons with fossil-based products
"CO_2 footprint compared to...or CO_2 improvement or **CO_2 saving**"
"environmentally friendlier compared to fossil-based products"
Referencing relevant standards, certificates, regulations
"audited, **third party approved**, GHG emission reduction, sustainable materials"
No animal testing
"No animal experimentation was included in the developing of this product"
Other
"Companies should consider specific marketing. It must be clear that the messages are not accompanied by greenwashing and that these are internationally **recognised sustainability certificates according to ISEAL specifications**."
"Simple classification system, e.g. **sustainability points**"
"This product including its packaging has been produced **according to XXX's definitions of sustainable production**. (This way the consumer can look up the definitions and thus there will be transparency in the certification.)"
"Regarding the marketing campaign, an idea could be to have different messages, one at a time, like "do you know that with this product you saved XXX trees?" "do you know that the production of this product requested XXX, compared to XXX of a similar fossil-based product?". These messages could vary (…)."

Annex 7: Suggestions on how European policy makers could promote the acceptance of bio-based products

Example answers on the question: "How do you think European policy makers could promote the acceptance of bio-based products? Please formulate general recommendations as well as product-specific recommendations for products of your choice."

Appropriate information and communication about bio-based product properties (in general)
"Clear, transparent and correct information needs to be provided. Biobased products are complex, especially in terms of sustainability. Communication to the general public will be **important** and should be consistent."
"**Increasing awareness to the damages that the other products make**"
"Inform the general public that we have a lot of biomass that can be used in a sustainable way."
Public procurement
"**Mandatory minimum share of biobased products in public procurement"**
"Similar approach to **USDA Biopreferred** -> promote the use of biobased products by governmental organizations to stimulate market uptake."
"Promotion of benefits, encourage public procurement (as in **US Biopreferred Programme**), tougher legislation/penalties on end of life disposal to encourage more recycling and reuse"
"Public Procurement Guidelines. Example: **BioPreferred Program**"
"**GPP**, tax benefits"
Taxation and subsidies
Tax exemptions for high-performing (regarding sustainability) biobased products. Competitions/public awards for best-performing (regarding sustainability) biobased products"
"Price is a big barrier to adoption at the moment. There could be incentives (or taxes for fossil fuels)"
"By removing the cost of entry of bio-based products and increase taxation on fossil-fuel products. Tax should be levied on negatively impacting products rather than creating unnecessary burden to bio-based products"
Labels and certificates
"Sustainability certification requirements for all products (…).
"**one** clear certificate and no certificate and logo thicket."
"Europe-wide sustainability certificates within a transparent and comprehensive system".
"Integration into existing Type I eco-labels (e.g. EU_Ecolabel) + tightening of GPP rules (price must no longer be the sole award criterion, at least there must be a justified rejection of more environmentally friendly alternatives)".
"**building materials**: the need for standardization and labeling for resource efficiency and lifecycle impact (based on circular economy principles), public buildings shall only be built from bio materials, voluntary agreements shall be suggested for the private sector, integrate acceptance into early education of children and youth"
Legislation including bans
In line with legislation in the field of energy and for bio fuels regulations for the use of biomass for non-energy applications have to be provided
Non-recyclable, single use plastic packaging should be heavily taxed or banned if immediate alternatives (such as compostables) exist in the market. Specific examples include: multi-material non-recyclable flexible packaging, single use service ware, etc.

Ensuring environmental friendliness of the product
"Good LCA. Biodegradability. No negative impact on biodiversity. No land-use change to less carbon-storing soil (…).” (translated)
Standardisation
“**Standardisation, use of EU-Ecolabel** (e.g. for cleaning products), public procurement, funding of local and regional awareness raising (e.g. product Exhibition)"
“**Enhance CEN mandate** on standardization of products and processes”
“(…) And make sure that "bio" has **standards that one can rely on**, that it doesn't become a greenwashing (…)”
Comparisons with fossil-based products
“Proof of equivalent or better product properties in resource-saving, environmentally friendly and socially responsible production”
Harmonization of definitions
“by clarifying what remains confused in people mind (biodegradability does not necessarily mean bio-based materials; bio-based materials are not necessarily sustainable per se...)”
“Clear regulation of what bio-based really means.” (translated)
“(...) Information on terms such as "biobased", "biodegradable", "bioplastics".” (translated)
Additional recommendations
“**Only promote** bio-based products that are equal/equivalent/**better** than alternative traditional (fossil feedstock derived) products in terms of their performance for this application, particularly environmentally and economically.”
“They should only promote the acceptance of biobased products if an independent LCA shows environmental benefits above other resources.”

Annex 8: Disaggregated results of the second Delphi survey

Annex 9-1: Typical (%), Misleading (%) and Special Class (%) expectations of % bio-based content and % GHG reduction

	Professionals total						Procurement professionals					
	Percentage of bio-based content			Percentage of GHG emissions reduction compared to fossil-based alternatives			Percentage of bio-based content			Percentage of GHG emissions reduction compared to fossil-based alternatives		
	Typical (%)	Misleading (%)	Special Class (%)	Typical (%)	Misleading (%)	Special Class (%)	Typical (%)	Misleading (%)	Special Class (%)	Typical (%)	Misleading (%)	Special Class (%)
0 to 10%	2%	16%	0%	3%	34%	2%	6%	11%	0%	0%	35%	6%
10 to 20%	2%	5%	2%	12%	17%	2%	0%	0%	6%	17%	12%	0%
20 to 30%	9%	16%	0%	23%	12%	3%	6%	33%	0%	22%	18%	6%
30 to 40%	0%	6%	2%	5%	3%	3%	0%	11%	0%	0%	0%	6%
40 to 50%	20%	31%	7%	33%	19%	19%	22%	28%	11%	44%	24%	22%
50 to 60%	13%	10%	0%	3%	0%	8%	22%	11%	0%	0%	0%	0%
60 to 70%	9%	0%	0%	7%	3%	3%	6%	0%	0%	0%	0%	0%
70 to 80%	30%	10%	13%	8%	3%	20%	33%	6%	6%	11%	6%	17%
80 to 90%	8%	3%	38%	3%	0%	27%	6%	0%	39%	6%	0%	22%
90 to 100%	8%	3%	38%	0%	0%	8%	0%	0%	39%	0%	0%	17%

Colour scale: darker blue means a higher percentage. Examples of minimum and maximum:	*0%*	*39%*

Annex 8-2: **Consumers**: factors influencing willingness to buy bio-based products

Question: "Please rate the importance of each reason for the decision to buy bio-based or not. Please score from 1 (low influence) to 4 (high influence)" Respondents could choose to provide a score for all bio-based products or for different product groups. **Average score**	N	Easy availability	**Confidence in…** …the environmental benefits	…the social benefits	…the economic benefits	…the quality	… the product useful life expectancy	Price
All bio-based products	54	2.9	3.4	2.8	2.3	3.6	2.6	2.8
Personal care products (e.g. shampoo, face/body cream)	41	2.7	3.3	3.2	2.4	3.4	3.3	2.5
Children's products including toys	43	3.0	3.6	2.8	2.4	3.1	2.3	2.9
Cleaning products	36	2.4	3.4	2.6	2.4	3.1	2.6	2.8
Paints and varnishes	37	2.1	3.1	2.6	2.4	3.3	3.1	2.9
Furniture	38	2.5	3.5	2.7	2.3	3.3	2.8	2.8
Gardening products	35	2.7	3.4	2.7	2.4	3.1	2.9	2.9
Lubricants	37	3.1	3.6	2.9	2.6	3.0	2.3	2.7
Paper products	39	2.7	3.2	3.1	2.6	3.4	3.4	3.0
Textiles and footwear	34	2.4	3.3	2.7	2.6	3.3	3.5	2.8
Construction and building material	35	2.6	3.4	2.6	2.4	3.2	3.1	2.9
Electronic equipment (regarding the casing)	33	2.5	3.3	2.7	2.7	3.3	3.4	2.9
Surface coverings (e.g. wooden floor surface coverings)	54	2.9	3.4	2.8	2.3	3.6	2.6	2.8

Colour scale: from red (low) to green (high).	*Min*	*Middle*	*Max*
Examples of minimum, maximum and middle point:	2.1	2.9	3.6

Annex 8-3: **Professionals total**: factors influencing willingness to buy bio-based products

Question: "Please rate the importance of each reason for the decision to buy bio-based or not. Please score from 1 (low influence) to 4 (high influence)" Respondents could choose to provide a score for all bio-based products or for different product groups. **Average score**	N	Easy availability	**Confidence in…** …the environmental benefits	…the social benefits	…the economic benefits	…the quality	… the product useful life expectancy	Price
All bio-based products	70	3.1	3.4	2.4	2.5	3.5	2.9	3.1
Personal care products (e.g. shampoo, face/body cream)	37	3.1	3.3	2.6	2.3	3.3	2.4	2.8
Cleaning products	36	3.2	3.4	2.4	2.4	3.3	2.8	2.9
Paints and varnishes	39	2.8	3.4	2.2	2.4	3.5	3.1	2.9
Furniture	37	3.0	3.2	2.3	2.4	3.6	3.0	2.9
Gardening products	35	3.1	3.6	2.3	2.5	3.3	2.8	3.0
Lubricants	36	3.0	3.4	2.4	2.3	3.6	2.7	2.8
Paper products	37	2.9	3.2	2.5	2.4	3.4	2.8	2.9
Textiles and footwear	35	2.9	3.2	3.0	2.7	3.6	3.2	2.8
Construction and building material	42	2.9	3.1	2.1	2.8	3.7	3.6	3.1
Electronic equipment (regarding the casing)	35	2.8	2.8	2.4	2.5	3.5	3.0	3.0
Surface coverings (e.g. wooden floor surface coverings)	34	2.8	3.2	2.5	2.7	3.6	3.5	3.0

Colour scale: from red (low) to green (high).	*Min*	*Middle*	*Max*
Examples of minimum, maximum and middle point:	2.1	2.9	3.7

Annex 8-4: **Procurement professionals**: factors influencing willingness to buy bio-based products

Question: "Please rate the importance of each reason for the decision to buy bio-based or not. Please score from 1 (low influence) to 4 (high influence)" Respondents could choose to provide a score for all bio-based products or for different product groups. **Average score**	N	Easy availability	**Confidence in…** …the environmental benefits	…the social benefits	…the economic benefits	…the quality	… the product useful life expectancy	Price
All bio-based products	21	3.0	3.2	2.4	2.5	3.3	2.7	3.4
Personal care products (e.g. shampoo, face/body cream)	7	2.7	3.6	3.0	2.4	3.4	2.8	3.4
Cleaning products	6	2.6	3.2	2.4	3.0	3.3	2.8	3.3
Paints and varnishes	7	2.8	3.3	2.2	2.8	3.7	3.0	3.4
Furniture	7	3.0	3.1	2.3	3.0	3.4	3.2	3.4
Gardening products	7	2.3	3.4	2.6	3.0	3.3	2.8	3.3
Lubricants	6	3.0	2.8	1.8	3.2	3.5	3.0	3.2
Paper products	7	2.5	3.4	2.2	2.8	3.7	2.3	3.0
Textiles and footwear	6	2.6	3.3	2.8	3.2	3.5	3.0	3.5
Construction and building material	11	3.2	3.1	2.0	3.3	3.7	3.5	3.5
Electronic equipment (regarding the casing)	7	2.5	3.0	2.7	3.0	3.7	3.0	3.3
Surface coverings (e.g. wooden floor surface coverings)	6	2.2	3.0	3.0	3.2	3.7	3.6	3.3

Colour scale: from red (low) to green (high).	*Min*	*Middle*	*Max*
Examples of minimum, maximum and middle point:	1.8	2.8	3.7