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Products**

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Abstract

Efforts to promote a sustainable bioeconomy seek to enable markets that create value from renewable resources while satisfying sustainability requirements. Despite recent progress in several European countries in launching strategies to support a bioeconomy, market demand for bio-based products remains moderate. More analysis is required to better understand the drivers and barriers for enabling consumer demand for bio-based products, in particular as this relates to consumers' sustainability concerns. A previous report developed within the scope of the STAR-ProBio project has presented the results of two rounds of a Delphi survey aimed at better understanding the sustainability preferences of procurement professionals and end consumers. Building on these results, the following tasks were completed: a third and final round of the Delphi survey was conducted with procurement professionals and a framed field experiment was conducted with end consumers to identify their willingness to pay a premium for different types of bio-based products with and without sustainability certification. This report presents the results from these tasks. In particular, it covers findings on the following: i) the relevance of information on final disposal and ii) preferences regarding information on the bio-based raw materials used, including questions related to the share and origin of bio-based raw materials and the form in which this information is communicated. In addition, the report discusses survey results on sustainability principles and potential policy options to promote the demand for bio-based products. The field experiment conducted on three products, i.e. coloured pens, hand soap and food storage bags shows that on average end consumers assign a higher price for bio-based products than conventional ones.

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Executive Summary

The bioeconomy seeks to create value from renewable resources by developing products whose objective is successful market adoption, satisfying at the same time sustainability requirements. Despite recent progress in several European countries that adopted bioeconomy strategies or interlinked policies, more efforts are needed to support the demand of bio-based products by increasing awareness among consumers. A number of studies concerned with the demand side of bio-based products have been published in recent years, however this emerging field requires further analysis.

Against this background, the objective of this deliverable is twofold. The first objective is to finalize a Delphi exercise based on the results that emerged from the rounds conducted in previous research on market assessment (see D5.1). This third Delphi round involved only procurement professionals in order to better understand their purchasing behaviour in the context of bio-based products, especially with reference to sustainability related issues. In particular, we presented to the respondents the most interesting findings that emerged from the previous two rounds in order to deepen our understanding on: i) relevance of information on final disposal; ii) preferences regarding the receipt of information on the type of raw materials; iii) preferences regarding the transfer of information on the origin of raw material; and iv) preferences regarding minimum share of raw material for which the type and origin details should be communicated. In addition, participants were asked to rank the sustainability principles identified and selected by the STAR-ProBio project. Lastly, participants provided an opinion on a set of policy options to promote bio-based products, differentiating between the short- and long-run.

Since we also aimed at increasing our understanding of end-consumers' behaviour related to bio-based products, the second objective of the report was achieved by developing a framed field experiment involving consumers in an Ikea store located in Bari (Italy). We obtained 1080 observations by interviewing 360 consumers. As shown in Figure 1, three types of products were presented to each consumer, in order to elicit the consumers' willingness to pay (WTP): i) a set of coloured pens, ii) a set of food storage bags and iii) a hand soap bar.

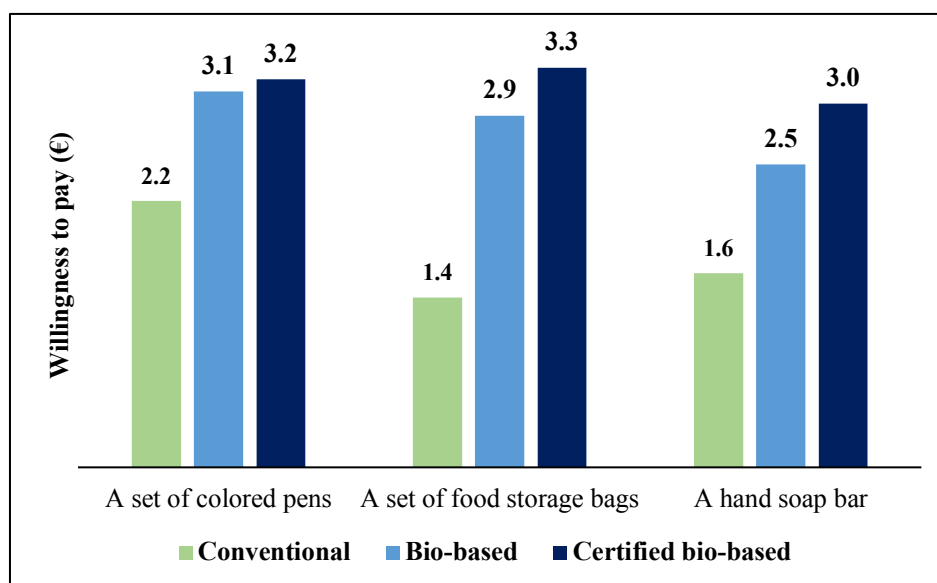


Figure 1 Consumers' willingness to pay



These three type of products were compared considering three different variants, i.e. conventional, bio-based and certified bio-based.

One of the most important finding that emerged from the third Delphi round is that higher prices and ambiguity over sustainability issues along with complicated procurement procedures and policies seem to inhibit buyers from opting for bio-based products. Results from the field experiment shows the presence of a “green premium” for both bio-based and certified bio-based products. In particular, the presence of a sustainability certification (label) favours a greater consumers’ WTP. Specifically, the analysis highlights that health and safety of consumers significantly influences their willingness to pay for eco-friendly alternatives. This aspect already emerged as a relevant acceptance driver for consumers in the market assessment of bio-based product (i.e. D5.1).

The experimental analysis revealed that the estimated aggregated demand curves for conventional products showed convexity (i.e. price reductions only increase quantity demanded slightly), while the estimated aggregated demand curves for certified goods showed concavity (i.e. it reveals an increase in quantity demanded when low prices drop even slightly lower). Consequently, it is confirmed as the price of bio-based products influences significantly its market.

Both research methodologies showed that bio-based products must prove the achievement of a number of sustainability requirements in order to balance their higher price. Accordingly, a certified bio-based product including the principles selected by the Star-ProBio project can address this issue, provided that targeted policy support is ensured. For instance, we would suggest considering implementing a policy mix involving both a tax on conventional goods and a subsidy on certified bio-based goods to maximise the impact on market uptake of certified bio-based goods.



1. Introduction

Investing in new technologies is crucial for tackling climate change and improving social cohesion in the European Union (Demertzis, Sapir, & Wolff, 2019). In this respect, the bioeconomy in general and, in particular, innovative bio-based products, gained attention throughout world since no less than 50 countries have fully fledged bioeconomy strategies and/or intertwined policies (OECD, 2018).

Indeed, boosting the production of innovative and sustainable bio-based products is a much needed action to be jointly undertaken by industries and policy makers; however, this effort on the supply side should be matched by a growing acceptance on the demand side. This report focuses precisely on this latter aspect by assessing consumers' acceptance and measuring their willingness to pay for sustainable bio-based products.

Despite a growing number of studies investigating consumer behaviours with respect to bio-based products (Carus, Eder, & Beckmann, 2014; Delioglani, Tzagkaraki, & Karachaliou, 2018; Peuckert & Quitzow, 2017; Russo, Confente, Scarpi, & Hazen, 2019), there are still knowledge gaps on what drives consumers' acceptance and willingness pay a green premium for sustainable bio-based products (Sanz-Hernández, Esteban, & Garrido, 2019; Sijtsema et al., 2016).

The deepening of this specific field of analysis, thereby understanding the purchasing behaviour of different type of consumer categories, is a key driver to boost market demand and is a core aim of the STAR-ProBio market assessment research. The objective of this report is therefore twofold. We aim firstly to further deepen our understanding on the level of social acceptance, i.e. understanding sustainability acceptance factors for bio-based products and related potential market pull of the measures proposed by STAR-ProBio for assessing the sustainability of bio-based products. Subsequently, we seek to elicit consumers' willingness to pay, in order to give a first overview of what the market structure (namely the demand curve) of some types of bio-based products could be. The first objective was achieved by conducting the third and final round of a Delphi exercise (see D5.1 which presents the results of the previous rounds), specifically targeted to procurement professionals. The second objective was realized by conducting a field experiment involving consumers of an Ikea store to elicit their willingness to pay for bio-based products (against conventional fossil-based products) and whether sustainability certifications/labels on bio-based products affect consumers' willingness to pay.

The report is structured as follows. Section 2 provides a description of the third round of Delphi exercise and its findings. Section 3 describes the methodology of the field experiment and its results. Section 4 summarizes and combines the findings of the two research activities. Finally, section 5 concludes the report and suggests further developments of the study.



2. Part I: Delphi Survey

2.1 Methodology

The Delphi method is a technique aimed at reaching a shared vision on a number of topics under investigation by involving stakeholders of interest (Eder, 2003). In order to build towards consensus-based results of the Delphi exercise, it is important that the same respondents are questioned in multiple rounds, which is most often addressed through the administration of several questionnaires (Tseng, 2013). In each new round the individual respondents are presented with overall results of the previous round and have the opportunity to adjust and refine their initial opinion (Förster, 2015).

The results of STAR-ProBio's first two Delphi rounds are available in the STAR-ProBio Deliverable 5.1 (STAR-ProBio, 2019). The survey comprised 744 consumers and 344 professionals in the first round, and 80 consumers and 100 professionals in the second round. The survey focused on the following topics: (i) awareness of bio-based products and willingness to purchase them; (ii) importance of sustainability information and certification in buying decisions; (iii) relevance of product characteristics, in particular the three sustainability pillars (environmental, social and economic issues); (iv) relevance of characteristics of sustainability assessment schemes; and (v) additional factors to support decisions to buy bio-based products.

This third round aimed at strengthening and deepening the conclusions of the previous rounds as well as the findings that emerged from the technical research of the project. Therefore, it represents the final synthesis of STAR-ProBio's investigation to identify sustainability assessment preferences of different consumer groups and their influence on buying decisions. Specifically, this third round was targeted to procurement professionals that represent some of the main users of sustainability assessment schemes.

The questionnaire was structured in four parts (see Annex 1). The first part aimed at collecting socio-demographic information of the respondents. The second part was designed to gather additional information regarding key results that emerged from the previous Delphi rounds relating to bio-based feedstocks, final disposal and procurement experts' willingness to pay. The third part of the questionnaire aimed at ranking, by level of perceived importance, a set of sustainability principles that were identified through research conducted in technical WPs of the STAR-ProBio project and complemented by inputs from previous rounds of the Delphi exercise. Finally, the fourth and final part included questions relating to policy measures to be applied in the short and long run to boost the market uptake of bio-based products.

The survey was conducted in June 2019 and open only to second round participants who had given their consent to participate in the third round. Forty-one respondents answered the invitation and participated in the survey. The drop-off in respondent numbers between the three Delphi rounds was expected since it is a time consuming activity and the participants were already been involved in the first two rounds. It's important to note that the lower number of respondents in the third round means that it becomes less likely that the group of respondents is a representative sample of the whole market, but it is assumed that are more engaged, interested and impacted by the topic being researched.

Overall, this Delphi study allowed for the validation of results and the strengthening of conclusions drawn during the first two Delphi rounds, as well as the opportunity to gather experts' views on the proposed sustainability criteria as a way of promoting market pull of sustainable bio-based products.

2.2 Results

2.2.1 Socio-demographic data

The survey started with several questions on the socio-demographic background of the interviewed professionals. The participants came from different Southern, Central and Northern EU countries. As Figure 2 shows, about a quarter of the respondents are involved in businesses and another quarter in academia and research institutes, followed by a slightly smaller share from the public sector. The respondents representing “other” category work in: international and national associations and policy consulting organizations. With specific reference to businesses, 70% indicated to be Small Medium Enterprises and to be mainly involved with the manufacturing and energy sectors (results not shown).

Question: What kind of an organization do you work for?

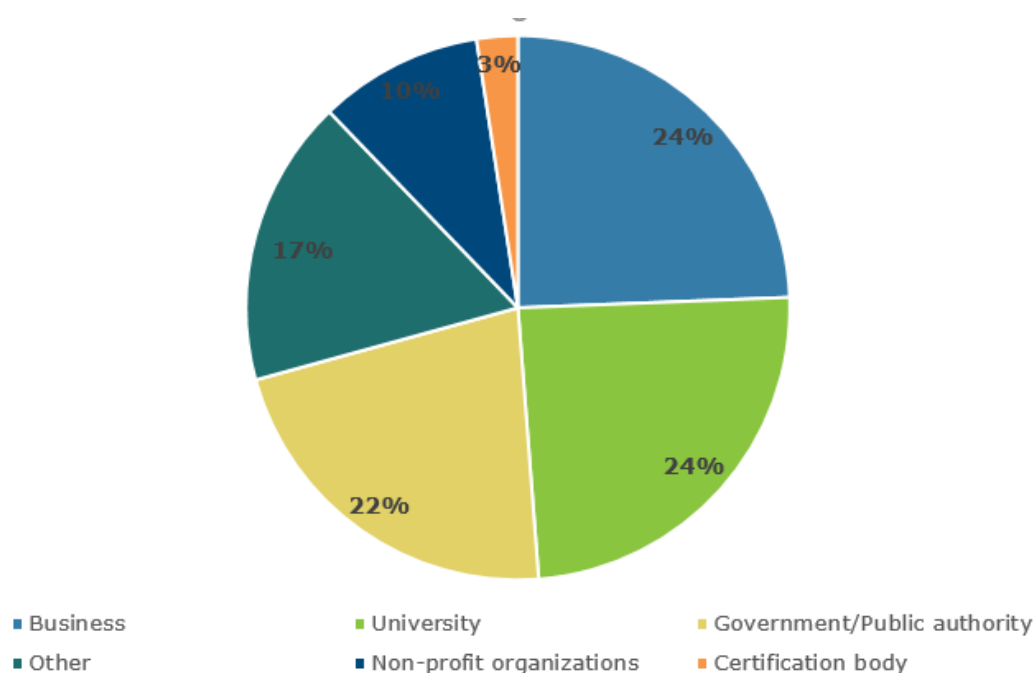


Figure 2 Professional participants' type of organization

2.2.2 Bio-based feedstock and end of life options

According to the results of previous rounds of the STAR-ProBio Delphi survey, the environmental aspects of bio-based materials that were perceived by respondents as most important were recyclability, type of raw material, origin of raw material and percentage of bio-based content. The 3rd survey round was thereby used to deepen the results regarding all these four aspects:

Importance of information on final disposal

With reference to recyclability and other end of life options, participants were asked whether they think that providing precise information on how the product must be disposed of should be mandatory.

Question: With reference to recyclability and other end of life options, do you think that providing exact information on how the product must be disposed of should be mandatory?

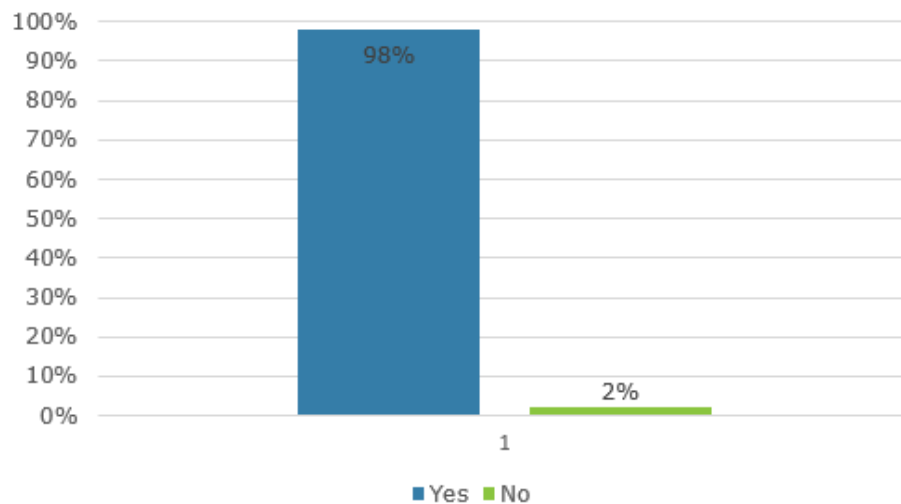


Figure 3 Relevance of information on how a product must be disposed

Figure 3 illustrates that almost all of the participants believe that this information should be mandatorily provided.

Preferences regarding the receipt of information on the type of raw materials

Respondents were also asked for which types of raw materials should information be provided. They could choose up to three of the following items:

- By indicating the type of bio-based raw material [bio]
- By indicating the type of non-bio-based raw material [non-bio]
- By indicating the presence of secondary (e.g. recycled) materials [secondary]

Question: With reference to the type of raw materials used, how should this information be given?

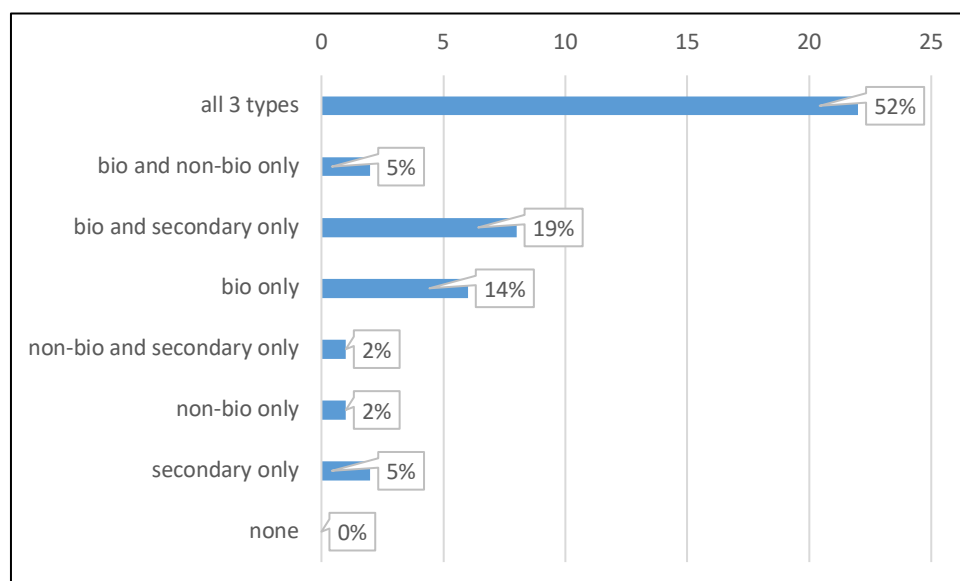


Figure 4 Preferences regarding the receipt of information on the type of raw materials



As shown by Figure 4, the majority of respondents explicitly would like all three types of information to be indicated on the bio-based product. The remainder of respondents have selected various combinations of options, mostly containing the bio-based content option. It is relevant to note that none of the respondents wants no information of this type.

Preferences regarding the transfer of information on the origin of raw material

Based on two items to choose from, participants were asked to indicate their preferences regarding the receipt of information on the origin of raw material. Specifically, they were asked whether the specific country/ies or the region (e.g. the EU or outside of the EU) should be indicated. According to Figure 5, the majority of respondents prefer to know the country of origin of the raw material; for the remainder, knowing the region is sufficient.

Question: With reference to the origin of raw material, how should this information be given?

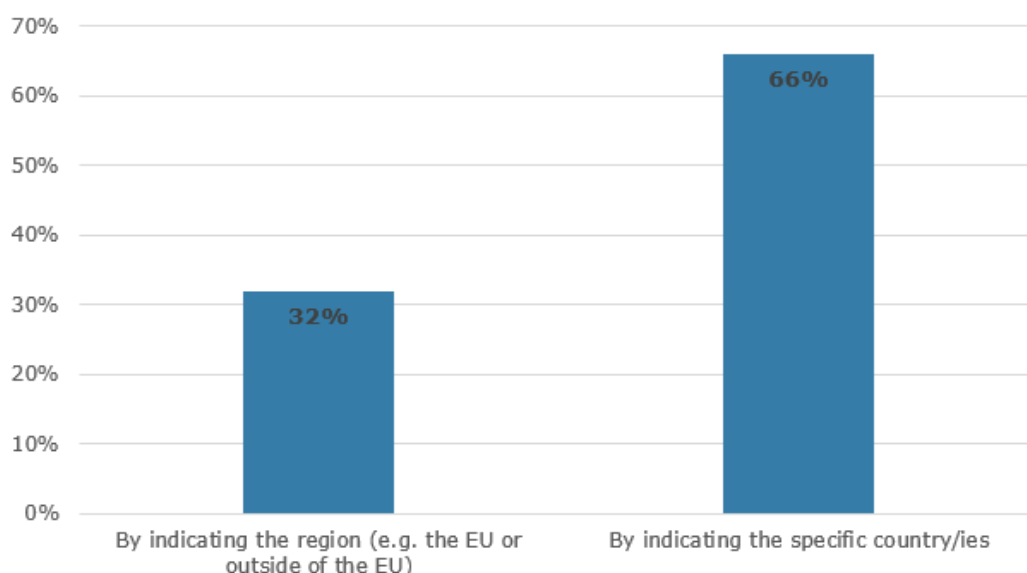


Figure 5: Preferences regarding the receipt of information on the origin of raw material

Preferences regarding minimum share of raw material for which the type and origin details should be communicated

When considering preferences regarding the minimum percentage rate at which the communication on details of a feedstock should start, if a product consists of multiple feedstock, participants could choose between five options: $\geq 50\%$, $\geq 25\%$, $\geq 10\%$, $\geq 5\%$ or $\geq 1\%$ of the total feedstock. The results are shown in Figure 6.

In the case of multiple feedstocks being used to produce a product, starting at what percentage of the total product should details of a feedstock be communicated?

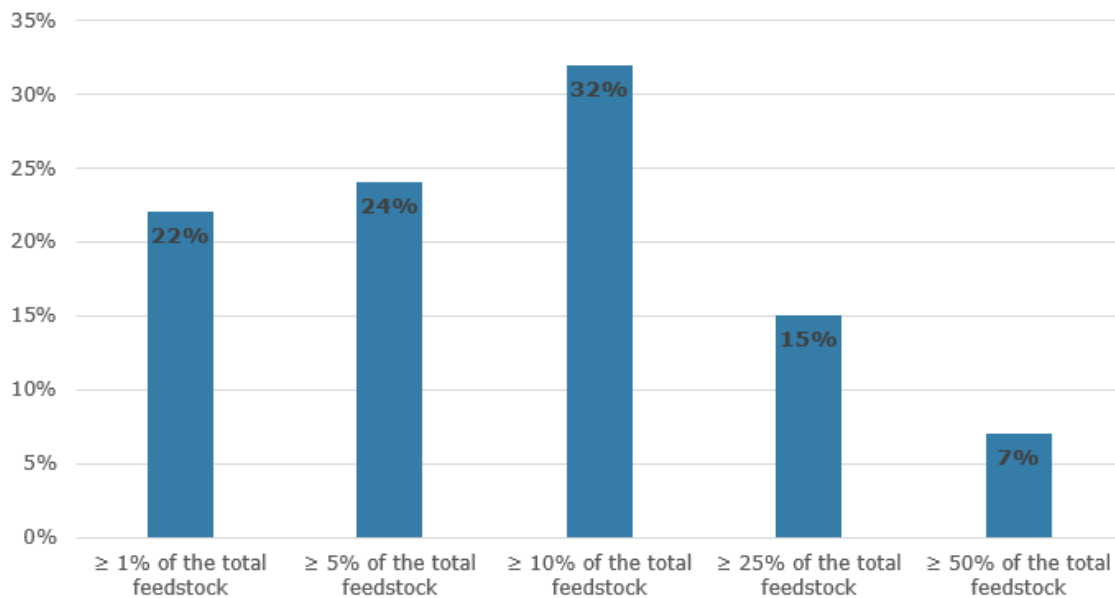


Figure 6: Preferences regarding information on individual feedstock, if products consists on multiple feedstock

Figure 6 shows that opinions on an appropriate minimum percentage vary strongly within our relatively small group of expert respondents, so it appears likely that a minimum that pleases the majority of the market will be difficult to set. Most participants indicated $\geq 10\%$ while the items $\geq 50\%$ and $\geq 25\%$ were the least chosen. This suggests that information should be provided even if the percentage of the raw material is low.

2.2.3 Willingness to pay bio-based products

One interesting finding that emerged from the previous rounds of the Delphi (STAR-ProBio 2019) is that, among procurement professionals, the willingness to buy bio-based products is still significantly lower than the awareness of these products. Participants were asked through an open question to comment on this result. Based on their answers, several common reasons explaining this finding have been identified. The most common reason cited was the higher price of many bio-based products in conjunction with the lack of information on the sustainability of these products, as demonstrated by the limited presence of standards and certifications. Another reason cited was missing information on technical characteristics of bio-based products in comparison to other products, since products purchased by procures must meet requirements / functionalities that are not (yet) achievable with alternative raw materials. Therefore, higher prices, ambiguity over sustainability issues, along with complicated procurement procedures and policies seem to inhibit buyers from opting for bio-based products.

2.2.4 Sustainability principles

Socio-economic principles

Based on the research conducted in the technical WPs (WPs 2, 3, 4, 6 and 7) and inputs coming from the previous rounds of the Delphi, 15 principles are proposed to qualify a bio-based product sustainable from a social and economic point of view. Participants were asked to indicate the relevance of each indicator from 1 (low relevance) to 5 (high relevance). In addition, they had the opportunity to add additional principles. Figure 7 shows the results.

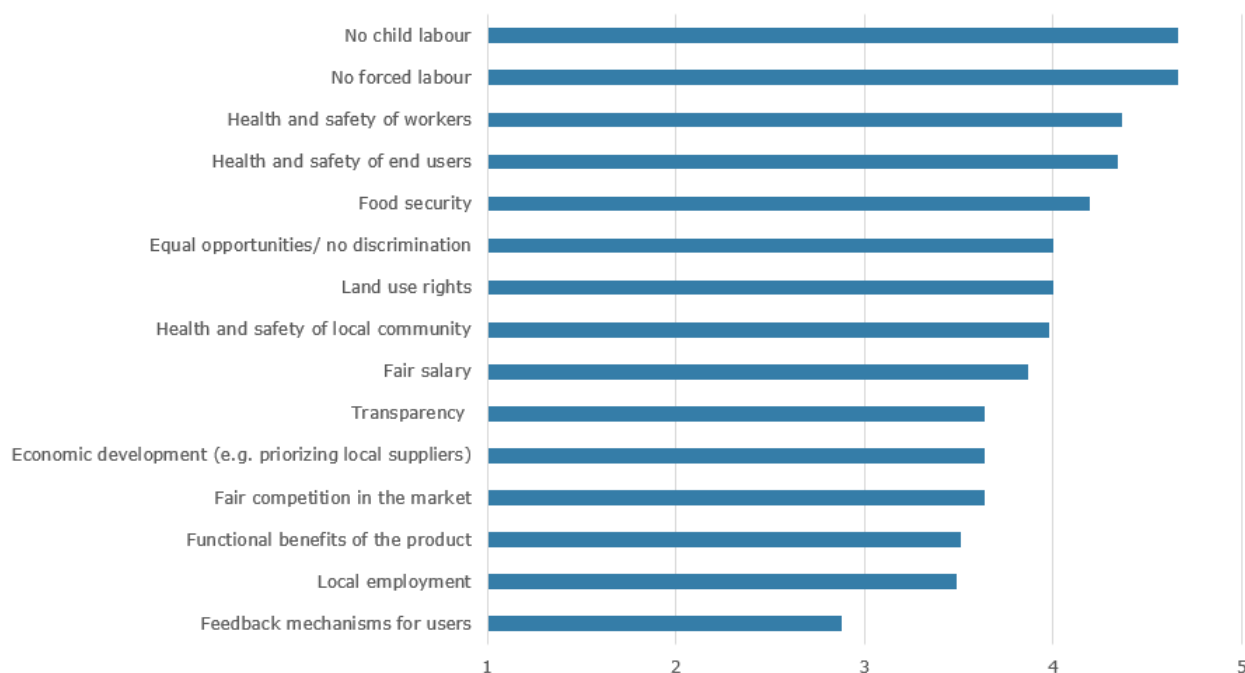


Figure 7: Preferences regarding socio-economic sustainability principles

The key observation from Figure 7 is that none of the principles has, on average, a low importance: all principles range from medium to very important. No child labour and no forced labour are the top ranked principles followed by health and safety of workers and end users. Moreover, also food security obtained a very high ranking. Notably, the first four indicators would also apply to conventional counterparts (and in general to any kind of economic activity), whereas the fifth ranked indicator is bio-based specific, suggesting that food security issues related to first generation feedstocks, are well-known and yet perceived as highly relevant by procurement professionals.

Environmental principles

Besides the social and economic principles presented above, research in the STAR-ProBio project also identified eight principles to qualify a bio-based product sustainable from an environmental point of view. Participants were asked again to indicate the relevance of each principle and add additional principles, if relevant. Figure 8 shows the results.

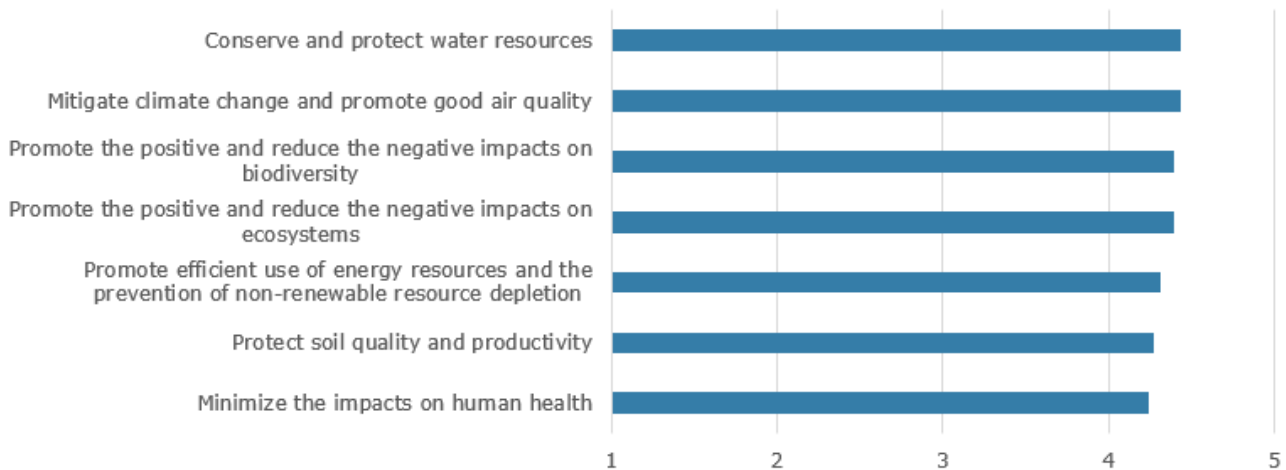


Figure 8: Preferences regarding environmental sustainability principles

Again the Figure 8 results show that none of the principles has, on average, a low importance and that all principles range from important to very important, with only minor differences between the different principles.

Circularity principles

Complementing the previous criteria, the STAR-ProBio project also proposed six principles to qualify a bio-based product as circular. Participants were asked again to indicate the relevance of each principle and add additional principles, if relevant. Figure 9 shows the results.

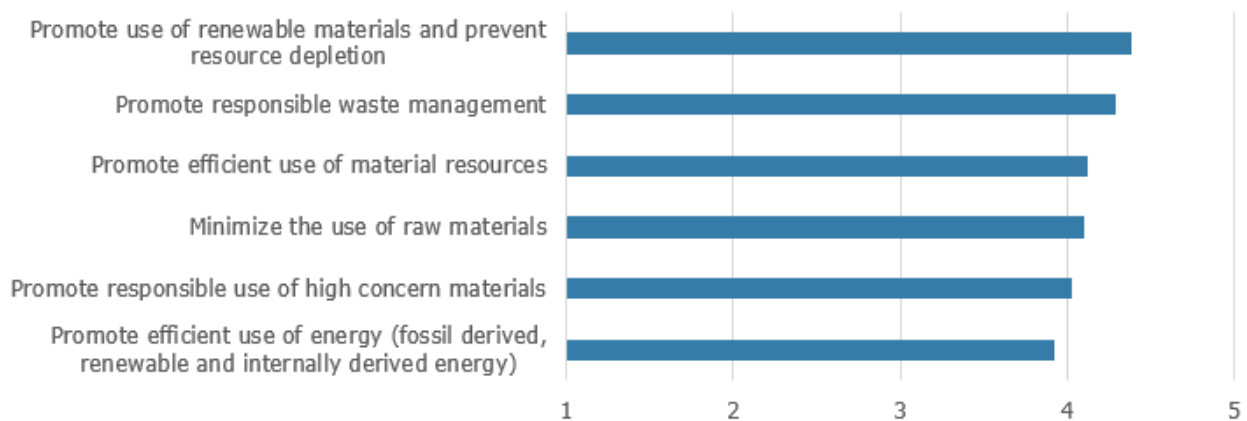


Figure 9: Preferences regarding circularity principles

Figure 9 shows once more that also all circularity principles score, on average, as important, with minor differences between the individual circularity principles. Notably, when considering all sustainability criteria together (see Annex 1), all groups of principles score, on average, as important. The environmental and circularity principles all score high and similar to each other. The socio-economic principles show more variation between them, and this group contains both the highest ranking of all principles, i.e. absence of child labour and absence of forced labour and the lowest ranking, i.e. consumer feedback mechanisms and local employment. The next highest rankings are two environmental principles, i.e. mitigate climate change and promote good air quality, and conserve and protect water resources.

2.2.5 Policy options to promote the acceptance of bio-based products

To promote the acceptance of bio-based products, nine actions were identified in previous rounds of the survey:

1. Increase in appropriate information, communication (in general) and awareness
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
9. Harmonisation of definitions

Legal and financial incentives reported the highest score. Participants were asked to select the most effective policy options to promote bio-based products in the short term and in the long term. Figure 10 shows the results.

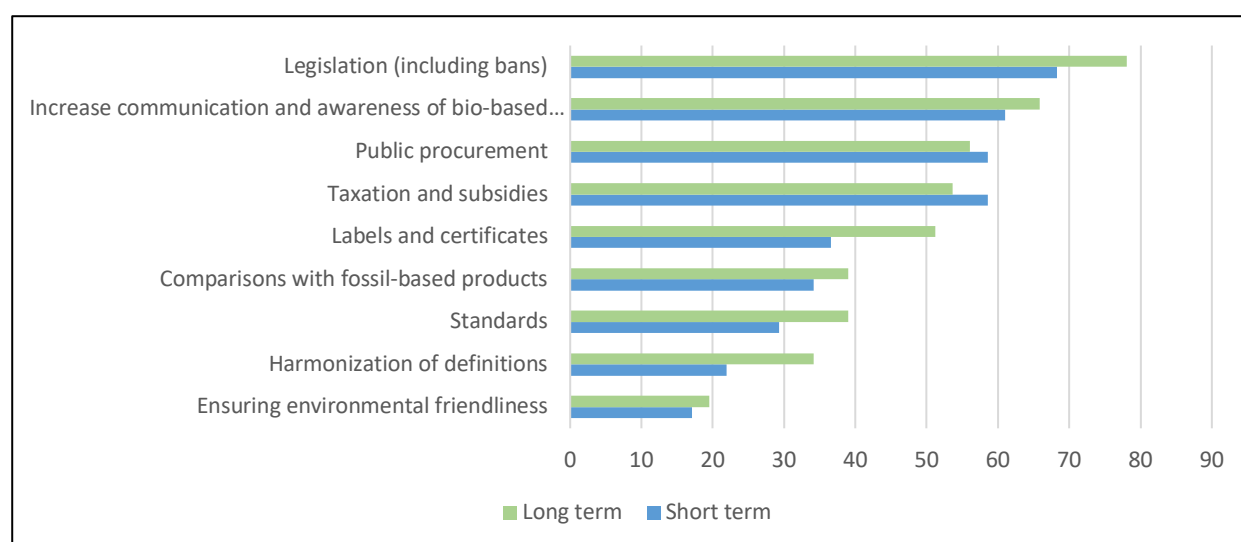


Figure 10: The most effective policy options to promote bio-based products (short-term and long-term)

As can be observed, respondent's opinions with regard to the policy options vary somewhat between short-term and long-term, even though in both cases, legislation (including bans) is the most preferred option in both, short-term and long-term.



3 Part II: Experiment

3.1 Methodology

3.1.1 Experimental methodology: framed field experiment

Field experimentation represents the conjunction of two methodological strategies: experimentation and fieldwork (Gerber and Green, 2008). Field experiments offer researchers a way to test theories and answer questions with higher external validity because they simulate real-world occurrences (Duflo, 2009). Several studies that collect data via field experiments have complemented laboratory and naturally occurring data research (Harrison and List, 2004). Some researchers argue that field experiments are a better guard against potential bias and biased estimators (Gerber, Huber, & Washington, 2010; Nickerson, 2005). As well, field experiments can act as benchmarks for comparing observational data to experimental results (Broockman, Kalla, & Sekhon, 2016). Using field experiments as benchmarks can help determine levels of bias in observational studies, and, since researchers often develop a hypothesis from an a priori judgment, benchmarks can help to add credibility to a study (Levitt and List, 2007). Field experiments necessarily take place in a specific geographic and political setting, therefore there are limitations in generalizing findings to formulate a valid theory regarding the population of interest. However, accessing information from larger sample size, and accounting and modeling for treatment effects heterogeneity within the sample, field experiments can provide an effective generalizations and avoid acquiescence effects (Dehejia, Pop-Eleches, & Samii, 2015).

Harrison & List (2004) classified field experiments into three main categories: artefactual field experiments (which are the same as conventional lab experiments but with a non-standard subject pool), framed field experiments (artefactual field experiments with field context in either the commodity, task or information set subjects can use), and natural field experiment (framed field experiments in which subjects do not know that they are participants in an experiment).

As previously mentioned, this deliverable builds upon framed field experiments. Framed field experiments show common characters with lab experiments, but incorporate significant elements of the context under investigation. Specifically, they are carried out in a way that allows the behavior of subjects to be successfully studied and analyzed while the subject is aware that they are participating in an experiment. The obtained results arise in a natural environment rather than in a laboratory setting, meaning that this class of experiment has having greater external validity than laboratory experiments (Camerer, 2011). This class of experiment is hence well suited to address our research aim to elicit consumers' willingness to pay (WTP) for bio-based products.

There exist various methods to elicit subjects' preferences (see e.g. Farquhar (1984) for a review). The prominent methods considered in recent literature are:

1. elicitation of preferences through pairwise choice preference questions;
2. elicitation of certainty equivalents through the statement of WTP in a second-price auction;
3. elicitation of certainty equivalents through the statement of willingness-to-accept in a second-price offer auction; and
4. elicitation of certainty equivalents using the Becker-DeGroot-Marschak mechanism.

According to Tversky, Sattath, & Slovic (1988) the latter three mechanisms can be categorized as matching procedures. In most practical applications preferences are elicited by matching procedures, e.g. willingness-to-pay and willingness-to-accept in contingent valuation studies or the time-trade-off method in health economics. Many empirical studies have shown that choices and matching procedures may lead to fundamentally different results. These phenomena are generally referred to as response mode effects. A well-known response mode effect in decision-making under risk is the preference reversal phenomenon first observed by Lichtenstein & Slovic (1973). This phenomenon occurs if a subject prefers a safe lottery to a risky one in direct choice,

but assigns a higher certainty equivalent to the risky lottery. Response mode effects also occur when comparing the single matching procedures. Most prominent in this context seems to be the disparity between willingness-to-pay and willingness-to-accept discussed by Coursey, Hovis, & Schulze (1987). This disparity is often explained by a status-quo bias (Samuelson & Zeckhauser, 1988) and leads to the question which of both measures should be used in contingent valuation studies. Hey, Morone, & Schmidt (2009) compared the four standard elicitation methods – pairwise choice, willingness-to-pay, willingness-to-accept, and certainty equivalents obtained by the BDM mechanism – in terms of noise and bias induced by the single methods. Their experimental study showed that maximal buying prices induce the highest noise and, at the same time, the largest bias. Altogether, they found evidence that pairwise choice may be regarded as the one least affected by noise and bias issues and, in this regard, can be considered the best performing method.

Bearing this finding in mind and following Hey et al. (2009), in order to ascertain subjects' evaluation of the conventional products, bio-based products and certified bio-based products, we carried out a choice task field experiment with an incentive structure similar to Holt & Laury (2002) (Figure 11). Specifically, the experiment is repeated, for each considered good, three times to account for the product features (i.e. conventional, bio-based and certified bio-based).

Choice	Good	Money
1	A	0.50
2	A	1
3	A	1.50
4	A	2
5	A	2.50
6	A	3
7	A	3.5
8	A	4
9	A	4.5
10	A	5

Figure 11 The choice between a good and a monetary amount

3.1.2 Experimental data and design

Our framed field experiment was conducted in a store located in Bari (Italy) of a multinational company (IKEA) that sells furniture, furnishing accessories and household articles. The experiment was performed in the first week of April 2019. Altogether, 360 customers participated in the experiments. Members of the research team randomly approached customers immediately after the checkout barrier. Before running the incentive compatible field experiment, a short set of questions was administrated to each participant, including some questions on their environmental attitude.

Specifically, the questionnaire was composed of three sections: section 1, composed of six questions, was aimed at collecting socio-demographic information (i.e. age, education, employment, etc.); section 2, composed of three questions, was aimed at gathering first information about environmental behavior and attitudes of the people interviewed (i.e. life-style and diet of the subjects), and then also with respect bio-based products (i.e. desirable characteristics for purchasing a sustainable product). In this regard, participants were asked to

appraisal according to a five-option Likert scale¹ (from 1 = not at all to 5 = much) whether the proposed statements (see Annex 2) concerning the product quality, price and characteristics of disposal would convince them to buy a sustainable product (Fonseca et al., 2018). At the end of the survey, we conducted the incentive compatible experiment (see Figure 11) in order to estimate subjects' WTP for conventional products, bio-based products and certified bio-based products.

The analysis was carried out using three groups of products for which all different variants (i.e. conventional, bio-based and certified bio-based) are available: i) a set of coloured pens, ii) a set of food storage bags and iii) a hand soap bar (Figures 12-13). These products were carefully selected as they pertain to three complementary dimensions of the broad consumption spectrum – i.e. personnel care, food and nutrition, office/work material – hence activating different reasoning in determining consumers choices.

A set of coloured pens



A set of bags



A hand soap bar



Figure 12 Different products employed

¹ A Likert scale is a type of rating scale used to measure attitudes or opinions by asking people to respond to a series of statements about a topic in terms of the extent to which they agree with them.

I ^o group	II ^o group	III ^o group
<ul style="list-style-type: none"> • Conventional coloured pens • Bio-based food storage bags • Bio-based and certified hand soap bar 	<ul style="list-style-type: none"> • Conventional food storage bags • Bio-based hand soap bar • Bio-based and certified coloured pens 	<ul style="list-style-type: none"> • Conventional hand soap bar • Bio-based coloured pens • Bio-based and certified food storage bags

Figure 13 Different groups of products employed

Each participant was associated to a single group of products. This allowed us to derive the values they assign to each product and avoided direct comparison of the same product but with different features (bio-based, conventional, certified) (Figure 13). Within each group, participants had to choose between a “good” (Option A) and a “monetary amount” (Option B) (Figure 11). When the monetary amount is smaller than subject’s WTP he/she will choose Option A, when the monetary amount is bigger than subject’s WTP he/she will choose Option B. Switch from choosing Option A to Option B will allow us to determinate subjects’ WTP.

The incentive compatible experiment design of our analysis allows deriving an equilibrium in which each agent’s best response is to select the option corresponding to its natural action. Specifically, respondents received an incentive in participating to the experiment given by a product or, alternatively, an amount of money. Purposely, each respondent took part to a lottery in which they first randomly select the product within the set of the aforementioned products and then selected a number from 1 to 10 corresponding to a monetary amount reported in Figure 11. They received the product when the number extracted in the lottery was lower than their stated value of the product. Conversely, in the case they randomly picked a number higher than their stated value of the product, they received the corresponding amount of money.

3.2 Results

3.2.1 Socio-demographic data

Socio-demographic variables refer to a set of information including age, gender, residence, education, employment and number of family members. They were collected during our experiment and showed in Figure 14. Age is distributed along five groups with the highest represented group being “45-64” with 29% followed by “25-34 group” with 24%. As for gender distribution, 62% of participants are women and 38% men. 65% percent of participants are resident in the city of Bari and its surrounding area. Indeed, the geographic location of the store also attracts customers from other cities located in Puglia region or neighbouring regions. Data collected on educational levels shows that about one quarter of participants has a university degree and 55% of them have completed secondary school. For the purpose of our study, it is also valuable to collect data on employment (Laibach, Börner, & Bröring, 2019). The largest group is represented by employees (36%) followed by independent workers (17%). Finally, the number of family members could also influence consumers’ choices (due, for instance, on budget constraints). Our sample shows that 80% of participants live in families composed by 2 to 4 members.

Overall, the collected data on socio-demographic characteristics show how the randomly selected sample is aligned with similar statistics referred to Italy (and western European countries, in general) – hence minimising problems associated with sample selection biases.

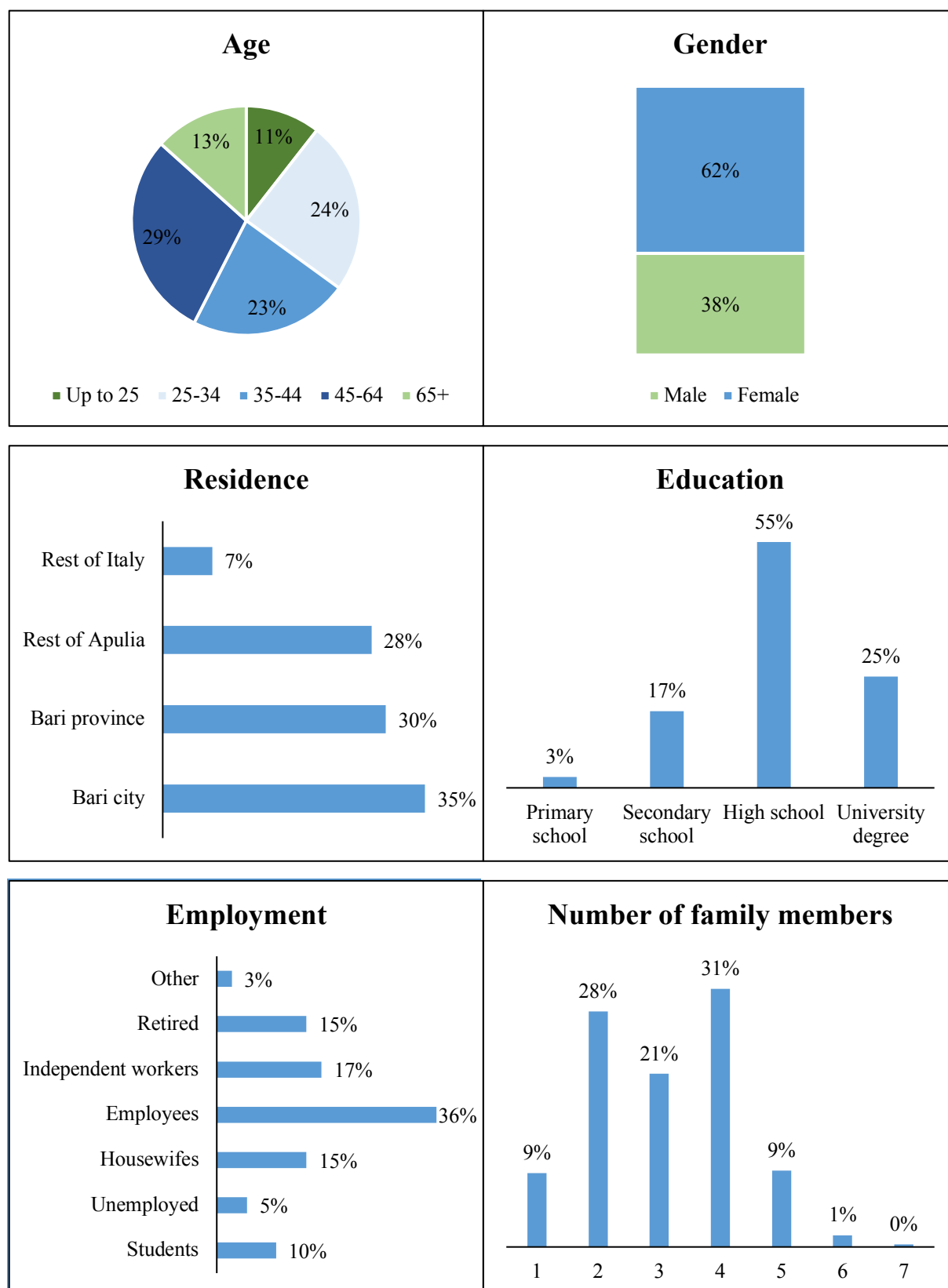


Figure 14 Socio-demographic variables



3.2.2 Life-style data and perceptions of sustainable products

The second part of the questionnaire evaluates consumers' behaviours, including their life style and their perception on sustainable products.

As it seems, almost all participants (91%) declared to be engaged in separate waste collection, and those not engaged stated that this was due to lack of facilities provided by local governments. This positive attitude towards the environment is well reflected also in the large share of participants (82%) stating to pay attention to the "waste of water, energy and food". Additional information gathered includes use of public transports and/or bicycle (34%) and the practice of sport activities (45%). Finally, about two thirds of participants considered their own diet to be healthy or very healthy. Responses are shown in Figure 15.

In the last question of this part of the questionnaire, we asked participants which of a predefined set of eight product characteristics would convince them to buy a sustainable product. Indeed, as pointed out by some scholars (Siddique & Hossain, 2018), consumers' perception of green products is relevant to purchase green products. A Likert scale was used to measure the importance of the eight characteristics on purchasing decisions. Results show that "advantage for consumers' health" is considered the main characteristic that would induce participants to buy a sustainable product. In addition, other six characteristics are defined as "enough" relevant in shaping participants' decisions to buy a sustainable product, as shown in Figure 16.

Answers to this part of the questionnaire clearly indicates the awareness of participants towards health and environmental issues. Indeed, results show that the concept of a sustainable product is not only associated to the protection of the environment but also to social aspects (e.g. health and well-being). The use of natural resources gives, in the eye of the participant to the experiment, a value added to the final product, hence affecting positively the perceived functionality of the product. The price has a lower relevance, which is in agreement with existing studies suggesting that consumers believe that the use of environmental-friendly practices entails higher production costs, therefore resulting in higher selling prices (Portnov et al., 2018; Singh & Pandey, 2018).

Another interesting result emerging from this section of the questionnaire is that a higher price is acceptable if the products minimise the negative effects on health often associated to conventional fossil-based products. Moreover, consumers want information on the labels presented in an easy and transparent way. In this regard, package labelling is an important communication tool that supports product comparisons and selections (Zhu, Lopez, & Liu, 2019). At the same time, the availability of additional information in the store on how to dispose of sustainable products can play an important role, as would help reducing the lack of data often perceived by consumers.

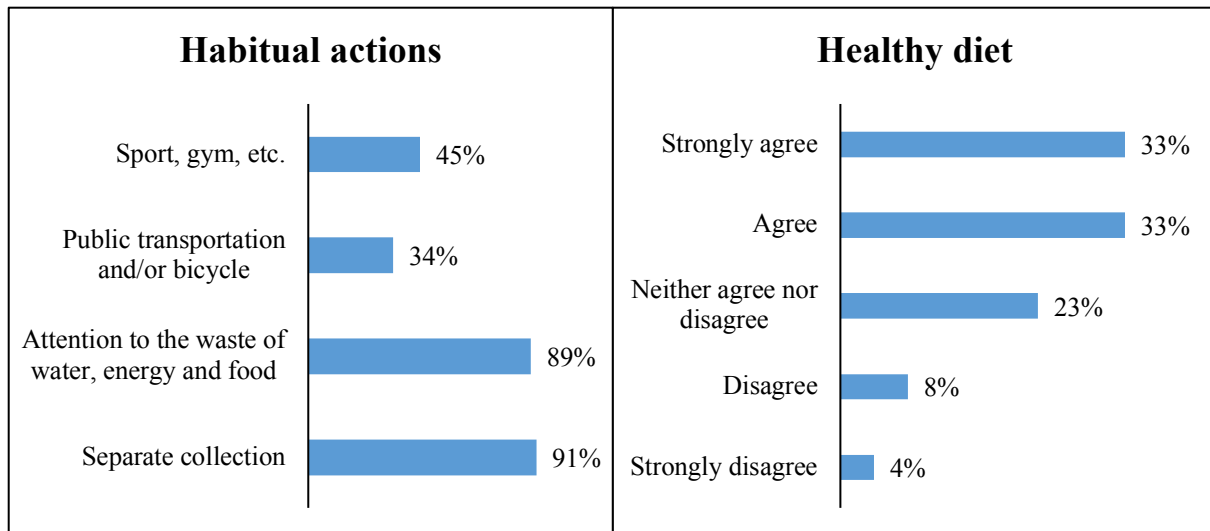


Figure 15 Life-style variables

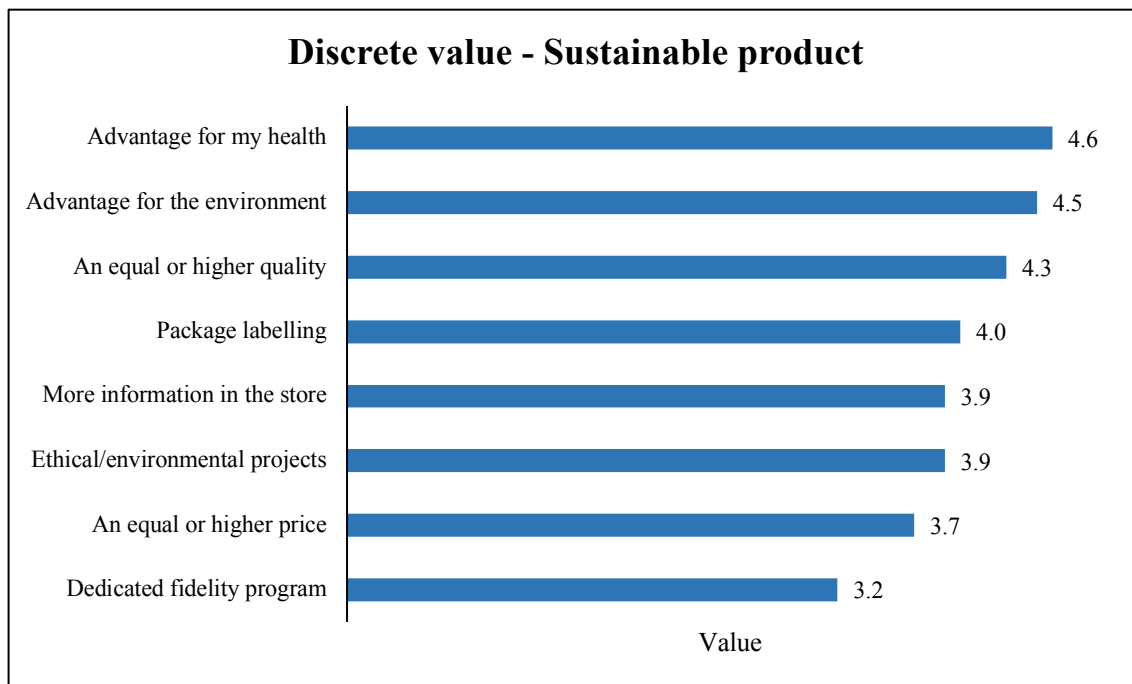


Figure 16 Characteristics of a sustainable product

3.2.3 Consumers' willingness to pay for bio-based products

As discussed in section 3.1, the last part of the questionnaire consisted of an incentive compatible experiment designed to elicit consumers' WTP for three groups of products, each containing a mix of three products: a conventional product, a bio-based product and a bio-based certified product. For each product group, we collected 360 observations that were equally distributed among the three products. Consequently, 120 observations were collected for each of the nine products for a total of 1080 observations.

The percentage distribution of the willingness to pay for the set of coloured pens is proposed in Figure 17. This represents the frequency distribution of subjects' WTP for the three varieties (conventional, bio-based, certified) of this good. For example, 21 participants stated a WTP equal to 2€ for the conventional variant (about 18%). The analysis of responses underlines that the conventional product presents the highest frequency up to a value of 2.5€ included. Both bio-based variants showed a higher WTP with respect to the conventional product; this is what we shall refer to as "green premium". In particular, in the range 3 to 3.5€ the bio-based set of coloured pens displays the higher frequency, whereas the certified bio-based set of coloured pens shows the highest frequency in the range 4 to 5€ (maximum value analysed in this experiment).

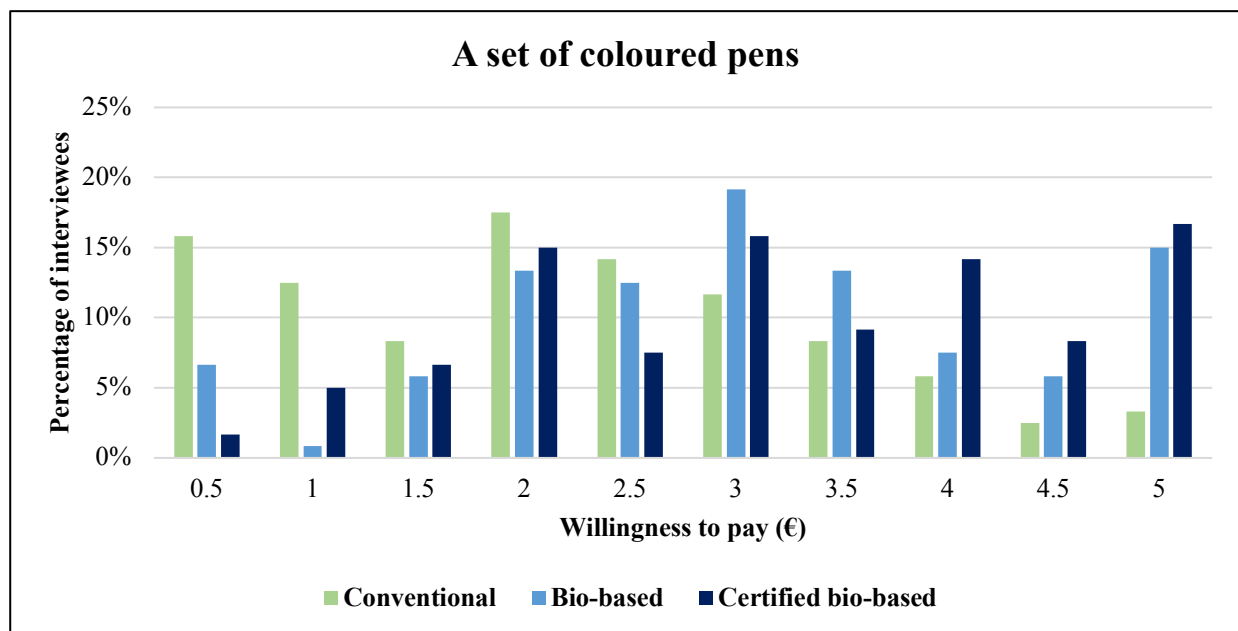


Figure 17 WTP – Product I (a set of coloured pens)

The set of food storage bags is the second product considered in this analysis (Figure 18). For example, in this case, 25 interviewees have assigned a WTP equal to 2.5€ (about 21%) for the bio-based product. Similarly to what we observed for coloured pens, there is the presence of a "green premium" between bio-based and conventional products which is more significant for the certified product. Specifically, about 56% of observations attributed a value in the range 0.5 to 1€ to the conventional set of food storage bags. The bio-based version of the product shows the highest frequency in the range from 1.5 to 3€ and another 56% of subjects stated a WTP in the range from 3.5 to 5€ for the certified food storage bags.

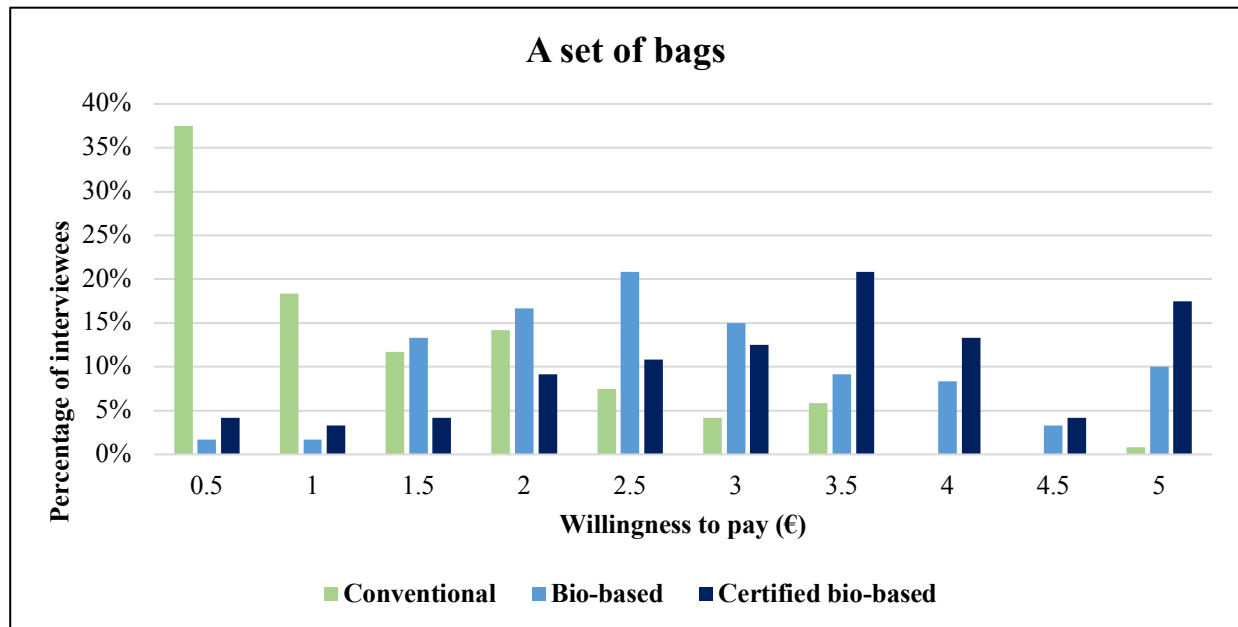


Figure 18 WTP – Product II (a set of food storage bags)

The percentage distribution of frequencies of WTP values for the hand soap bar is reported in Figure 19. For example, 22 subjects assigned a WTP equal to 5€ for the certified bio-based hand soap bar (corresponding to about 18% of the whole sample). The number of subjects assigning a value in the range of 2.5 to 5€ to this variant of the product adds up to about 69%. An opposite situation occurred for conventional product: about 67% of participants to the experiment stated a WTP in the range from 0.5 to 1.5€.

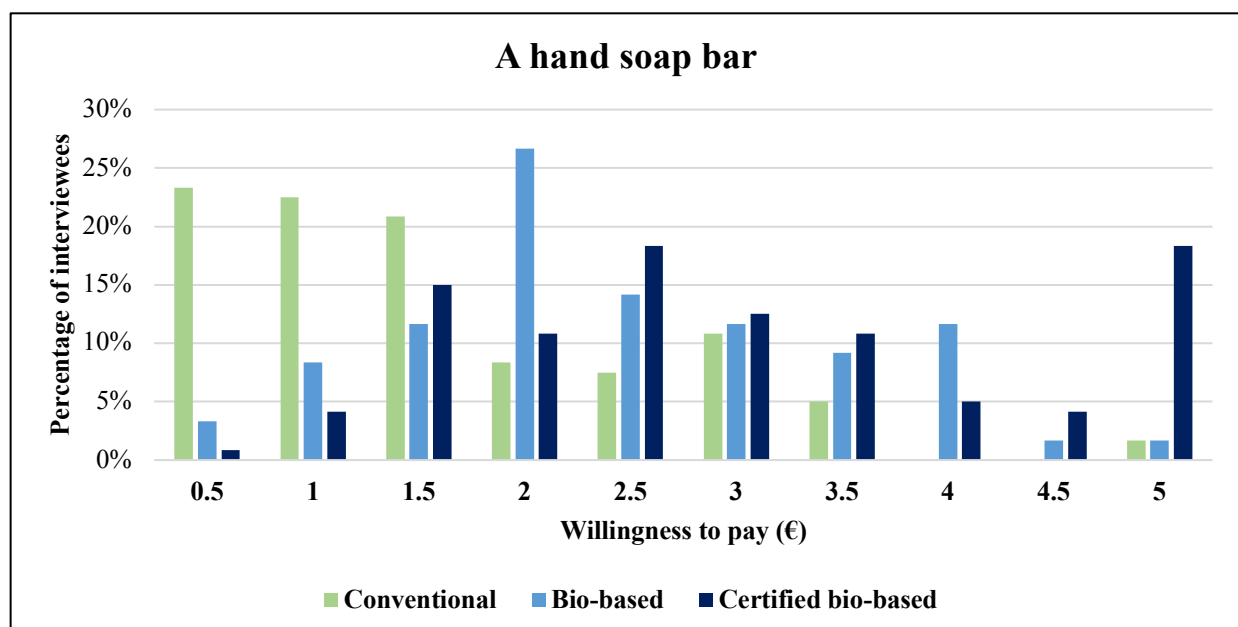


Figure 19 WTP – Product III (a hand soap bar)

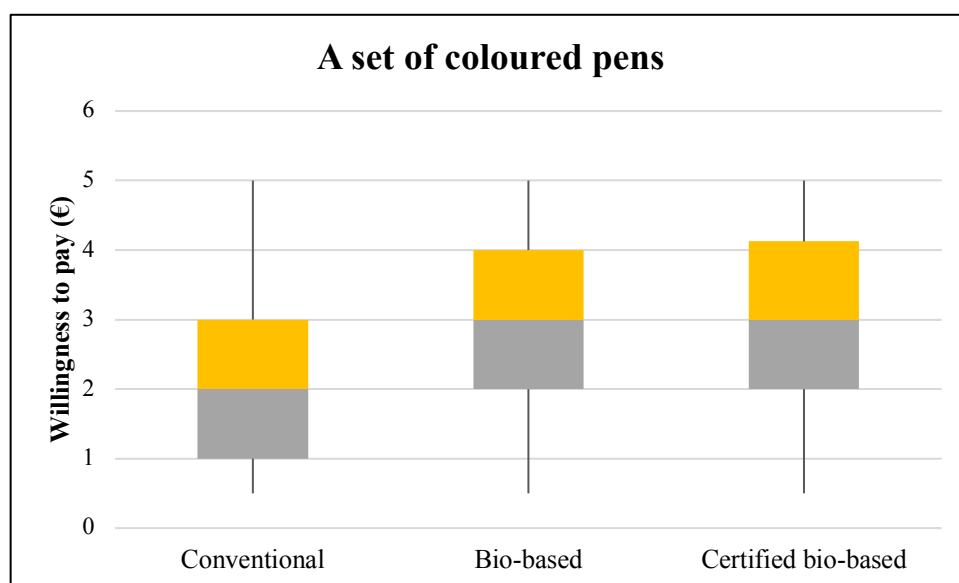
As a further step of our analysis, the data is pooled and analysed. This analysis will be based on two statistical parameters: i) the average value and ii) the standard deviation. This is shown in Figure 20.

Regarding the set of coloured pens, the average WTP value is equal to 3.2€ for the certified bio-based version, which is slightly greater than the value obtained for the bio-based version (3.1€). Instead, the difference is more significant in comparison to the WTP for the conventional set of coloured pens (2.2€). The standard deviation is the same for three variants and it is equal to 1.25€. This demonstrates that the maximum value of the WTP for the conventional product (equal to 3.5€) is greater than the average value of both bio-based versions.

Concerning the set of food storage bags, there is a significant difference between the WTP value for the bio-based version and one for the conventional product (2.9€ vs 1.4€). The WTP value of the certified bio-based product is equal to 3.3 €, which is greater than the bio-based and conventional products. The standard deviation is 1€, 1.1€ and 1.25€ for conventional, bio-based and certified bio-based products, respectively. Hence, the maximum WTP value of the conventional product (equal to 2.4€) is lower than the average value of both bio-based versions. For this of product, we found the most significant increase of WTP compared to the conventional version for both the certified bio-based product and the bio-based product.

A similar trend emerges when considering the hand soap bar. The certified bio-based product has an average WTP value of 3€, which is higher than that observed for the bio-based one (2.5€). Conversely, the average WTP for the conventional hand soap is 1.6€. The standard deviation ranges from 1€ (conventional) to 1.3€ (certified bio-based) with a value of 1.05€ for the bio-based version.

Finally, in all three cases we confirm the existence of a "green premium" for both bio-based and certified bio-based products. This premium is larger for certified goods suggesting, therefore, that subjects participating to the experiment did value the presence of a certification (label) on bio-based product as a means of gathering needed information to assess their WTP. Moreover, the comparison among the three products highlights the difference between a certified bio-based product and a conventional product is more marked for the set of food storage bags and soap than the set of coloured pens. These two products pertain to the food and nutrition category and the personal care respectively, hence suggesting that the impact on human health plays a role in determining the "green premium" associated with bio-based products.



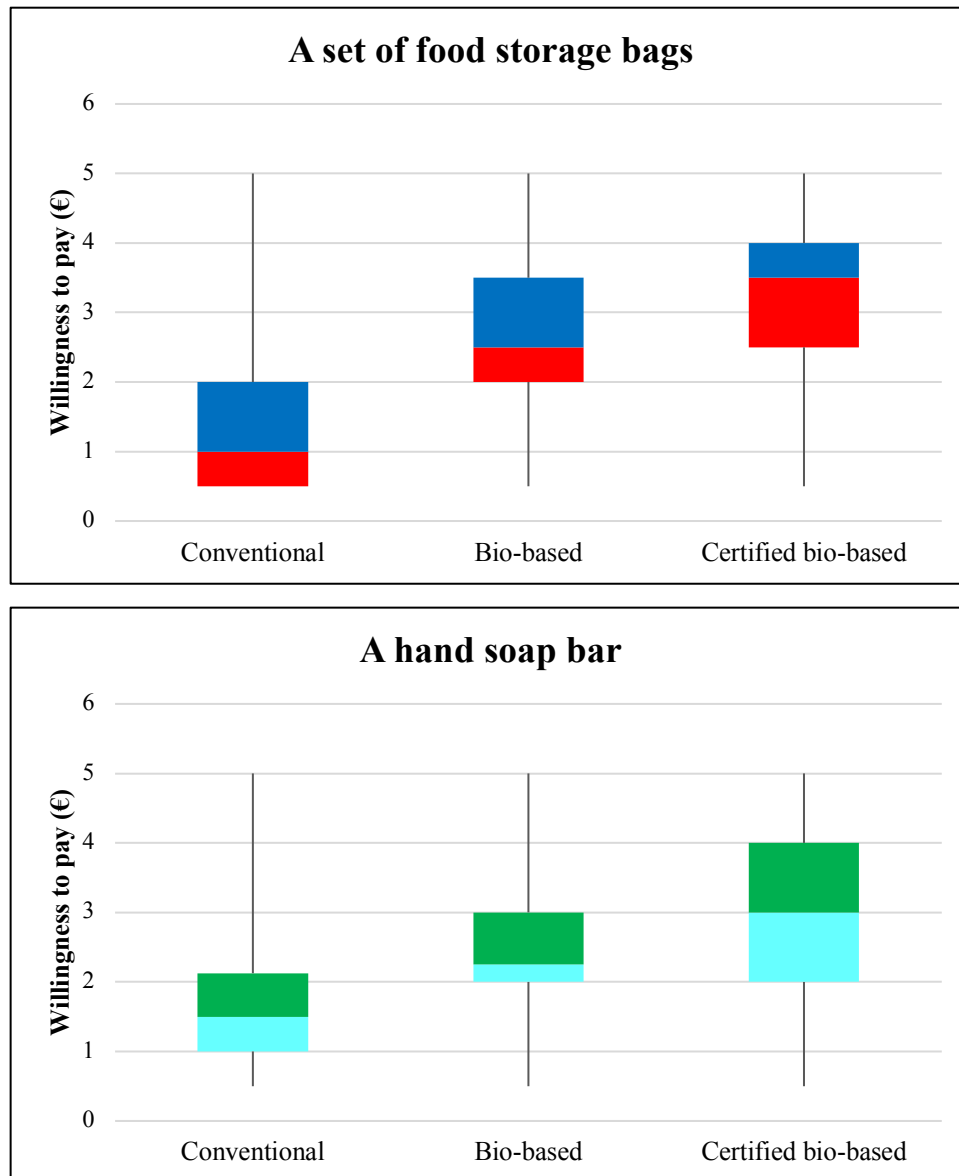
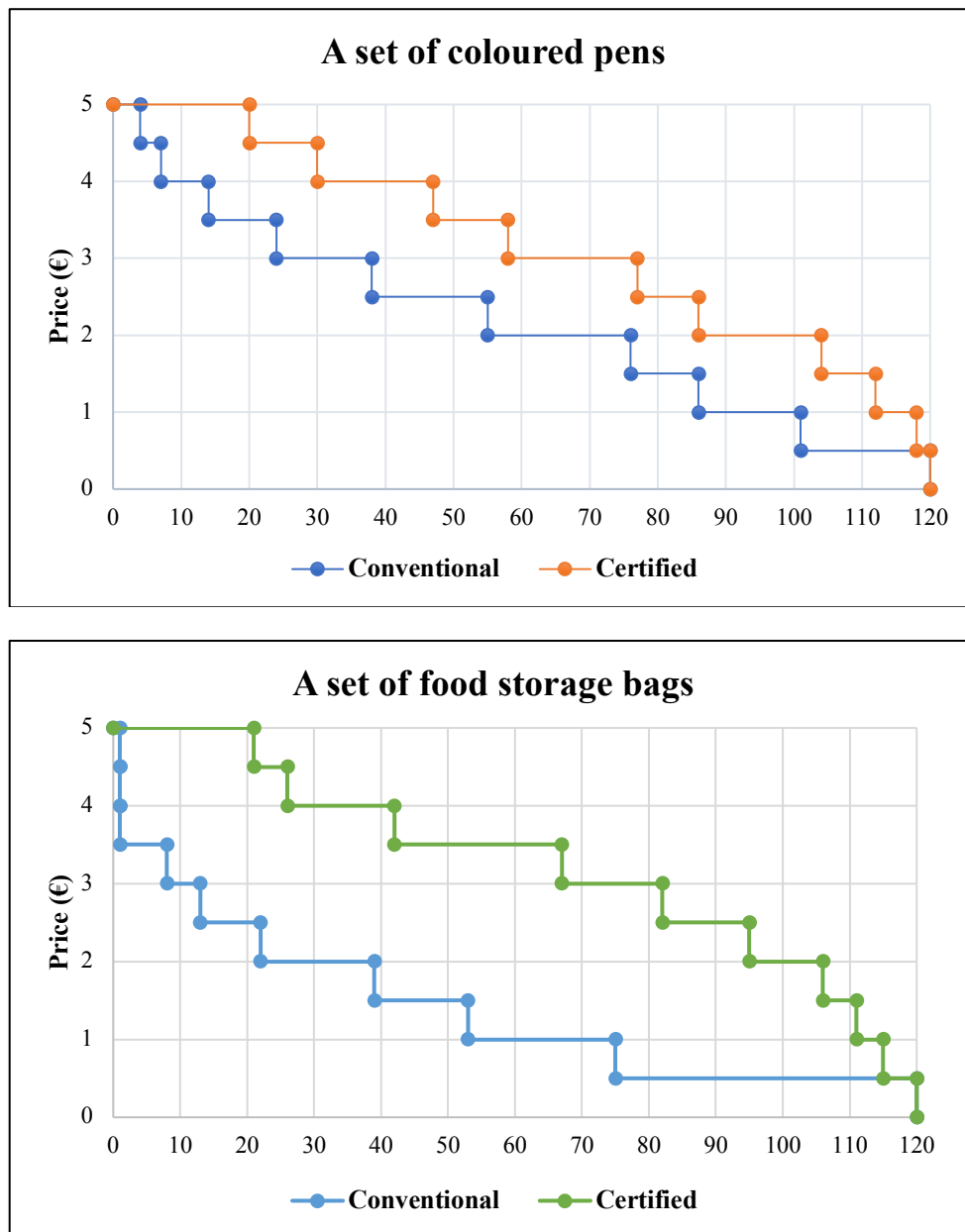


Figure 20 WTP – Average values and standard deviation for the three goods

Overall, we observed that conventional goods display a stronger negative relation between price and demand – i.e. as prices increase, demand decreases sharply. Conversely, bio-based goods and certified bio-based goods display a growing frequency in the number of buyers as price increases. To further investigate the implications associated with this finding, aggregated demand functions for the three considered goods were constructed (as shown in Figure 21). For the sake of clarity, we shall concentrate on conventional and certified bio-based goods (indeed, bio-based and certified goods display similar patterns, which are just more accentuated in the case of certified goods).

As shown in Figure 21, the aggregated demand curves for conventional goods are convex, hence showing a higher elasticity for lower prices and becoming more rigid for higher prices. Conversely, the aggregated demand curves for certified goods are concave and therefore rigid in the low-price range and elastic in the high-price range. This is a rather interesting outcome as it shows how a relatively small reduction in the (typically high) price of certified goods would lead to a significant increase the demand whereas a relatively small increase in the (typically low) price of conventional goods would lead to a significant reduction in their demand. This occurrence is verified for the three considered goods, but it is more accentuated for food storage bags and hand soap – i.e. those products typically associated with environmental and health issues.



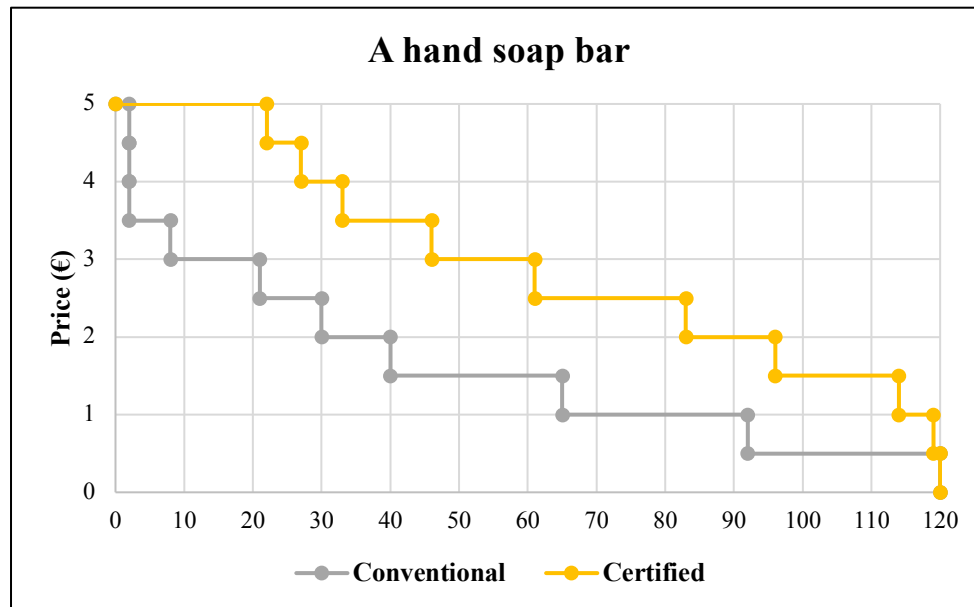


Figure 21 Aggregate demand functions for conventional and certified goods

As a preliminary policy implication, it would be reasonable to consider the need for going beyond a simple one-fits-all approach based on the combination of policy drivers². Indeed, a policy mix involving a tax on conventional products accompanied by subsidies for certified sustainable goods could help deploying the synergistic effect of the policy drivers' interaction. Specifically, due to the varying elasticities of the two demand curves discussed above, this policy mix would have the combined desired effect of inducing a (high) reduction in the demand for conventional goods and an (high) increase in the demand for certified goods, hence maximising impact and prompting market uptake for certified sustainable goods.

² Borrás and Edquist (2013), defined a policy mix as a set of different and complementary policy instruments to address the identified problems.



4. Discussions

The analysis of the results of both the third round of the Delphi survey and the framed field experiment reveals a number of interesting findings. Overall, we observed in the Delphi survey and confirmed in the field experiment a general willingness to pay a higher price for bio-based products, provided that some sustainability requirements are verified. Health and safety as well as several environmental aspects are perceived both by procurement professionals and end consumers as the most important sustainable criteria. For professionals in particular, a broad and complex set of criteria must be achieved before switching to bio-based products. Indeed, it emerged that there is still large scepticism around these products. Specifically, besides their quality and durability compared with long standing conventional products, there are many concerns surrounding their sustainability. The food security debate regarding the use of primary feedstocks was one of the most cited critical issues by respondents when asked about procurers' willingness to pay, followed by concerns on the final disposal of bio-based products. Procurement professionals clearly stated that information on the end of life of bio-based products must be provided, but also argued that it is still not clear how separation in the waste collection should be conducted. For example, it is not clear where bio-based plastics should be disposed of (Commission Expert Group on Bio-based Products 2017). End consumers also devote particular attention to disposal. This is demonstrated by the importance assigned to having more information at the place of purchase on the disposal of sustainable products. In addition, attention towards the protection of the environment was demonstrated in several instances.

Indeed, Experimental findings show that end consumers perceive separate waste separate collection to be one of the most environmentally sustainable behaviours. In addition, there are concerns regarding the waste of water, energy and food. The analysis of consumers' WTP identifies that they were willing to pay a "green premium" for bio-based products with respect to conventional counterparts – an occurrence that applied to all products analysed (i.e. a set of coloured pens, a hand soap bar and a set of food storage bags). Furthermore, the observed "green premium" is higher for certified bio-based products, a finding confirming earlier results reported in literature for which consumers are willing to recognise a higher premium if sustainability criteria are effectively verified and information is provided in a clear and transparent way. Finally, as a preliminary policy implication stemming from our investigation, we would suggest considering implementing a policy mix involving both a tax on conventional goods and a subsidy on certified bio-based goods. Given the different elasticities of the two estimated demand functions, such a policy mix would maximise its impact on market uptake of certified bio-based goods, hence contributing to the establishment of a level-playing field between conventional and bio-based products.



5. Conclusions

Studies on the demand side of bio-based products' have been receiving increasing attention, though it is still an emerging field of research.

The results of this report have provided some significant insights into sustainability acceptance factors proposed by the STAR-ProBio project for assessing the sustainability of bio-based products, with specific reference to procurement professionals. In addition, interesting findings on end consumers' willingness to pay for sustainable bio-based products are presented.

The Delphi analysis, used for assessing the social acceptance of bio-based products from procurement professionals, and the framed field experiment employed for eliciting consumers' willingness to pay show that several barriers limit the market potential of bio-based product. In particular, it emerged that procurement professionals are aware of several critical sustainability issues related to bio-based products and state that more precise information needs to be collected on the functional, socio-economic and ecological characteristics of bio-based products to balance the (often observed) higher price. This latter occurrence, in fact, is still perceived by the majority of respondents as a main challenge for the market uptake of bio-based products.

However, one critical consideration relates to the reduced number of professional groups that participated in the third round of the Delphi exercise. Yet, given the strong support for all the sustainability principles proposed by STAR-ProBio in the relatively small group of respondents, it can be expected that a large group of supporters for each of the principles can be found in the wider market, so the inclusion of all principles in sustainability assessment of bio-based products can be justified.

With reference to all bio-based products considered, a positive relationship between an increased willingness to pay and sustainable certified bio-based products has been also shown by end consumers involved in the framed field experiment. Limitations of this study are the restricted number of bio-based products considered as well as the limited geographical extent. The experience acquired through this experiment will provide a valuable starting point for running a larger scale experiment in other countries with the aim of corroborating the relevance of the findings and therefore define a set of policy actions for supporting the market uptake of bio-based products. In this regard, results from both the two research activities seem to suggest that adopting a targeted policy mix approach involving a tax on conventional goods and a subsidy on certified bio-based goods can boost the demand of sustainable bio-based products.

Finally, an interesting future avenue of research could be the extent of these issues outside of the EU. Indeed, comparisons between for example the United States and Europe could reveal insight and open up new or neglected market opportunities.



6. Reference list

- Borrás, S., & Edquist, C. (2013). The choice of innovation policy instruments. *Technological Forecasting and Social Change*.
- Broockman, D. E., Kalla, J., & Sekhon, J. S. (2016). *The Design of Field Experiments With Survey Outcomes: A Framework for Selecting More Efficient, Robust, and Ethical Designs*. SSRN.
- Camerer, C. (2011). The promise and success of lab-field generalizability in experimental economics: A critical reply to Levitt and List. *Available at SSRN 1977749*.
- Carus, M., Eder, A., & Beckmann, J. (2014). GreenPremium Prices Along the Value Chain of Biobased Products. *Industrial Biotechnology*, 10(2), 83–88. Mary Ann Liebert, Inc. 140 Huguenot Street, 3rd Floor New Rochelle, NY 10801 USA .
- Coursey, D. L., Hovis, J. L., & Schulze, W. D. (1987). The disparity between willingness to accept and willingness to pay measures of value. *The Quarterly Journal of Economics*, 102(3), 679–690. JSTOR.
- Dehejia, R. H., Pop-Eleches, C., & Samii, C. (2015). Local to Global: External Validity in a Fertility Natural Experiment. *SSRN Electronic Journal*.
- Delioglani, I., Tzagkaraki, E., & Karachaliou, E. (2018). Public perception of bio-based products and the bioeconomy—Findings from BIOWAYS project public survey. *Journal of Biotechnology*, 280, S9–S10. Elsevier.
- Demertzis, M., Sapir, A., & Wolff, G. (2019). Promoting sustainable and inclusive growth and convergence in the European Union. *Policy Contribution7*.
- Duflo, E. (2009). Field experiments in development economics. *Advances in Economics and Econometrics: Theory and Applications, Ninth World Congress, Volume II*.
- Eder, P. (2003). Expert inquiry on innovation options for cleaner production in the chemical industry. *Journal of Cleaner Production*, 11(4), 347–364. Elsevier.
- Farquhar, P. H. (1984). State of the art—utility assessment methods. *Management science*, 30(11), 1283–1300. INFORMS.
- Fonseca, L., Domingues, J., Pereira, M., Martins, F., Zimon, D., Fonseca, L. M., Domingues, J. P., et al. (2018). Assessment of Circular Economy within Portuguese Organizations. *Sustainability*, 10(7), 2521. Multidisciplinary Digital Publishing Institute.
- Förster, B. (2015). Technology foresight for sustainable production in the German automotive supplier industry. *Technological Forecasting and Social Change*, 92, 237–248. North-Holland.
- Gerber, A. S., Huber, G. A., & Washington, E. (2010). Party affiliation, partisanship, and political beliefs: A field experiment. *American Political Science Review*, 104(4), 720–744. Cambridge University Press.
- Harrison, G. W., & List, J. A. (2004). Field experiments. *Journal of Economic literature*, 42(4), 1009–1055.
- Hey, J. D., Morone, A., & Schmidt, U. (2009). Noise and bias in eliciting preferences. *Journal of Risk and Uncertainty*, 39(3), 213–235. Springer.
- Holt, C. A., & Laury, S. K. (2002). Risk aversion and incentive effects. *American economic review*, 92(5), 1644–1655.
- Laibach, N., Börner, J., & Bröring, S. (2019). Exploring the future of the bioeconomy: An expert-based scoping study examining key enabling technology fields with potential to foster the transition toward a bio-based economy. *Technology in Society, in press*. Pergamon.



- Levitt, J. A., & List, S. (2007). Viewpoint: On the generalizability of lab behaviour to the field. *Canadian Journal of Economics-Revue Canadienne D Economique*, 40, 347370.
- Lichtenstein, S., & Slovic, P. (1973). Response-induced reversals of preference in gambling: An extended replication in Las Vegas. *Journal of Experimental Psychology*, 101(1), 16. American Psychological Association.
- Nickerson, D. W. (2005). Scalable protocols offer efficient design for field experiments. *Political Analysis*, 13(3), 233–252. Cambridge University Press.
- OECD. (2018). *Meeting Policy Challenges for a Sustainable Bioeconomy*.
- Peuckert, J., & Quitzw, R. (2017). Acceptance of bio-based products in the business-to-business market and public procurement: Expert survey results. *Biofuels, Bioproducts and Biorefining*, 11(1), 92–109. John Wiley & Sons, Ltd.
- Portnov, B. A., Trop, T., Svechkina, A., Ofek, S., Akron, S., & Ghermandi, A. (2018). Factors affecting homebuyers' willingness to pay green building price premium: Evidence from a nationwide survey in Israel. *Building and Environment*, 137, 280–291. Pergamon.
- Russo, I., Confente, I., Scarpi, D., & Hazen, B. (2019). From trash to treasure: The impact of consumer perception of bio-waste products in closed-loop supply chains. *Journal of Cleaner Production*. Elsevier.
- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of risk and uncertainty*, 1(1), 7–59. Springer.
- Sanz-Hernández, A., Esteban, E., & Garrido, P. (2019). Transition to a bioeconomy: Perspectives from social sciences. *Journal of Cleaner Production*, 224, 107–119. Elsevier.
- Siddique, M. Z. R., & Hossain, A. (2018). Sources of Consumers Awareness toward Green Products and Its Impact on Purchasing Decision in Bangladesh. *Journal of Sustainable Development*, 11(3), 9–22.
- Sijtsema, S. J., Onwezen, M. C., Reinders, M. J., Dagevos, H., Partanen, A., & Meeusen, M. (2016). Consumer perception of bio-based products—An exploratory study in 5 European countries. *NJAS - Wageningen Journal of Life Sciences*, 77, 61–69. Elsevier.
- Singh, G., & Pandey, N. (2018). The determinants of green packaging that influence buyers' willingness to pay a price premium. *Australasian Marketing Journal (AMJ)*, 26(3), 221–230. Elsevier.
- STAR-ProBio. (2019). (2019), *STAR-ProBio Deliverable D5.1, Acceptance factors among consumers and businesses for bio-based sustainability schemes*.
- Tseng, M.-L. (2013). Modeling sustainable production indicators with linguistic preferences. *Journal of Cleaner Production*, 40, 46–56. Elsevier.
- Tversky, A., Sattath, S., & Slovic, P. (1988). Contingent weighting in judgment and choice. *Psychological review*, 95(3), 371. American Psychological Association.
- Zhu, C., Lopez, R. A., & Liu, X. (2019). Consumer responses to front-of-package labeling in the presence of information spillovers. *Food Policy*, in press. Pergamon.



7. Annex

Annex I - Delphi survey questionnaire

Bio-Based Products Survey For Professionals - Final Round

Welcome to the 3rd and final round of the STAR-ProBio Delphi survey!

You have received the invitation to participate in this activity because of your contributions to the first two rounds of our survey, from which we obtained valuable results.

This 3rd round represents the final synthesis of STAR-ProBio's investigation to identify sustainability assessment preferences of professionals and their influence on buying decisions.

Accordingly, you will only be asked a few questions in order to dive deeper into some points relating to the final key results which emerged from the two earlier rounds.

Anonymized survey results will be available to all participants in autumn 2019.

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.

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



General information

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

Additional questions for businesses:

SME?

Choose one of the following answers

- ☐ Yes
- ☐ No

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

Which of the following keywords describes your job best?

Choose one of the following answers

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

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

Choose one of the following answers



- ☐ Yes
- ☐ No

What is your country of residency?

Choose one of the following answers

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

Bio-based material and end of life options

According to the results of previous rounds of the STAR-ProBio Delphi survey, the most important environmental aspects of bio-based material were the following:

- recyclability;
- type of raw material,
- origin of raw material and the manufacturing place; and
- percentage of bio-based content.

With reference to recyclability and other end of life options, do you think that providing exact information on how the product must be disposed of should be mandatory?

Choose one of the following answers

- ☐ Yes
- ☐ No

With reference to the type of raw materials used, how should this information be given?

Check all that apply

Please choose **all** that apply:

- By indicating the type of bio-based raw material
- By indicating the type of non-bio-based raw material
- By indicating the presence of secondary (e.g. recycled) materials

With reference to the origin of raw material, how should this information be given?

Choose one of the following answers

- By indicating the specific country/ies
- By indicating the region (e.g. the EU or outside of the EU)

In the case of multiple feedstocks being used to produce a product, starting at what percentage of the total product should details of a feedstock be communicated?



Choose one of the following answers

- ☐ $\geq 50\%$ of the total feedstock
- ☐ $\geq 25\%$ of the total feedstock
- ☐ $\geq 10\%$ of the total feedstock
- ☐ $\geq 5\%$ of the total feedstock
- ☐ $\geq 1\%$ of the total feedstock

Willingness to buy bio-based products

One interesting finding of the STAR-ProBio survey is that, among procurement professionals, the willingness to buy bio-based products is still significantly lower than the awareness of these products.

Please provide a comment on this result.

Social and economic sustainability principles

Based on the research in the STAR-ProBio project, the following principles are proposed to qualify a bio-based product sustainable from a social and economic point of view. Please indicate the relevance of each indicator from 1 (low relevance) to 5 (high relevance):

Please choose the appropriate response for each item:



	1	2	3	4	5
No child labour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No forced labour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fair salary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Equal opportunities/ no discrimination	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health and safety of workers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health and safety of end users	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feedback mechanisms for users	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Transparency (e.g. the company publishes sustainability reports)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Functional benefits of the product	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health and safety of local community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Local employment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Land use rights	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Food security	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Economic development (e.g. prioritizing buying goods and services from local suppliers)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fair competition in the market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please write below your additional comment (optional):

Environmental sustainability principles

Based on the research in the STAR-ProBio project, the following principles are proposed to qualify a bio-based product sustainable from an environmental point of view. Please indicate the relevance of each indicator from 1 (low relevance) to 5 (high relevance):

Please choose the appropriate response for each item:

	1	2	3	4	5
Mitigate climate change and promote good air quality (e.g. by minimizing greenhouse gas emissions and air pollutants)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conserve and protect water resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Protect soil quality and productivity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Promote efficient use of energy resources and the prevention of non-renewable resource depletion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



	1	2	3	4	5
Promote the positive and reduce the negative impacts on ecosystems (e.g. freshwater and terrestrial acidification and eutrophication)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Promote the positive and reduce the negative impacts on biodiversity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Minimize the impacts on human health	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please write below your additional comment (optional):

Circularity principles

Based on the research in the STAR-ProBio project, the following principles are proposed to qualify a bio-based product as circular. Please indicate the relevance of each indicator from 1 (low relevance) to 5 (high relevance):

Please choose the appropriate response for each item:

	1	2	3	4	5
Promote responsible use of high concern materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Minimize the use of raw materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Promote responsible waste management	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Promote use of renewable materials and prevent resource depletion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Promote efficient use of material resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Promote efficient use of energy (fossil derived, renewable and internally derived energy)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please write below your additional comment (optional):

Policy options to promote the acceptance of bio-based products

To promote the acceptance of bio-based products, nine actions were identified:

1. Increase in appropriate information, communication (in general) and awareness;
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. Harmonisation of definitions.

Legal and financial incentives reported the highest score.

Please choose the most effective policy options to promote bio-based products in the short term:

Check all that apply

- Increase in appropriate information, communication (in general) and awareness of bio-based products
- Harmonization of definitions
- Public procurement
- Taxation and subsidies
- Labels and certificates
- Legislation (including bans)
- Ensuring environmental friendliness
- Standards
- Comparisons with fossil-based products

Please choose the most effective policy options to promote bio-based products in the long term:

Check all that apply

- Increase in appropriate information, communication (in general) and awareness
- Harmonization of definitions
- Public procurement
- Taxation and subsidies
- Labels and certificates
- Legislation (including bans)
- Ensuring environmental friendliness
- Standards
- Comparisons with fossil-based products

Thank you very much for participating!

Comments on the willingness to buy bio-based products

<To update by person 44 and following ones, if the person(s) contributed something<

Since often no information is given, it is very difficult to buy biobased products. We partly need 3 offers for one procurement request. "Soft" criteria such as origin or material play a subordinate role to **price**. If the biobased product costs only marginally more, a purchase is in order.

"The **price** of biobased products is often higher. When purchasing a public institution, the cheapest product should always be purchased. If a higher-priced biobased product is to be purchased, a sound justification is required and thus causes additional expense. If instead the biobased nature of a product were to be given a higher priority than the price and if a justification for the procurement of a non-biobased product were required, the willingness would certainly be significantly higher.

Another aspect may be "brand loyalty" and convenience. If you are used to a product and have had good experiences with it, then you need a special impulse to switch to an alternative (biobased) product, especially since obtaining information and selecting the suitable biobased



product in advance, contacting new suppliers and convincing other users of the new biobased product mean additional work.

Perhaps there is also some fear that when buying a bio-based product, the high demand for particularly responsible/sustainable action, which one imposes on oneself, will not be met because any negative consequences of the bio-based product will only come to light later (**e.g. poor social standards in production, land grabbing for the production of the organic raw material, intensive land management in production ...**). And one wants to avoid this disappointment, especially since it is hardly possible to argue against it when one is confronted with it".

information on **technical characteristics** of bio-based products, in comparison to other products, could help the decisions of procurement professionals. Moreover, certifications on key technical characteristics of bio-based products might lower the risk of switching from other products to bio-based products.

really depends on the type of product. For example, if it's food, it's very easy. But as far as the other types of products are concerned, I don't think there is much awareness... even if you can buy furniture made from organic wood.... besides food and drinks, jeans made from organic cotton, and cosmetics/shampoos, I don't know of other organic products that may be relevant to public procurement.

Result is not surprising, awareness about the existence of the products may exist, but not the will to pay an (usually) additional price for bio-based products.

Here the heads of department should be informed comprehensively.

Bio-based products are controversial, so I find this professional scepticism understandable. Fossil based are still far more attractive **money wise**

Price and cost related considerations prevail

The products must fulfil requirements/**functionalities** that cannot (yet) be fulfilled with alternative raw materials, the functionality "biodegradability" is not necessarily linked to the origin of biomass - see lubricants (synth. ester), disposal is regulated, e.g. waste oil regulation, mixed plastics can either be recycled or/and incinerated (energ. use), separation in waste sorting? - makes sense, important for consumers: sustainability (raw material origin/certification life cycle, GHG balance - e.g. incineration CO2 cycle closed as optimally as possible)

Procurement professionals are a bit conservative, which has more to do with their hesitation to buy something new or materials and products that are less established in the market. This has probably nothing to do with bio-based as such.

Lack of knowledge and dissemination of technical and regulatory standards to support, it is necessary to promote a progressive cultural growth on the subject.

Unfortunately, especially in the logic of public administration, the criterion of the most economically advantageous offer prevails and there are no incentives such as sustainability certificates etc. that justify different choices.

This may be due to the selection criteria that have been practiced so far and have therefore turned into behaviour.

One reason clearly is the uncertainty around the sustainability, and the lack of "easy" labelling.

Higher **price** and less availability of the bio-based products

This could be related to the **price** of bio-based products, which most of the times is higher than that of non-bio-based products. Alternatively, a lack of certification or at least clarity on origin,



composition, quality could lead to hesitation among procurement professionals, as it is their job to procure the best product.

The willingness to purchase biobased products will increase in the future. Climate change and marine pollution will contribute to this.

"with new products there is always more promotion needed and it benefits from positive characteristics (more durable, longer usage, less impact, ..., ...). Especially biobased products have to make up and even outperform (nowadays) traditional non biobased products.

Also it would help procurement professionals to help tick off company/organizational sustainability goals with buying biobased products"

Higher prices, ambiguities about sustainability aspects, complicated tendering procedures and guidelines (public procurement) - all this inhibits buyers from opting for bio-based products.

The traditional is reluctantly abandoned (especially in the administrative sector), independent of possibly more suitable or equivalent products. Voting leaders are usually old men who have been working in their field forever and do not want to get involved in innovations. Since they often lead specialist departments, it is difficult to introduce biobased products here. This would be possible by means of service instructions.

No surprise. Other surveys also show a clear difference between assessment and concrete action, e.g. on the question of buying organically produced food.

More actions on awareness raising are needed

This lack of willingness is probably due to the **price factor**. Furthermore, **life cycle costs are not known or the concept behind them**. The purchase price counts - not the price that is paid "unknown".

Price might be higher. Unproven not known products

There is still a lack of knowledge regarding this topic in the public. Simplified communication will be necessary, i.e. communicate about the fact that this is a bio-based product, the amount of renewable content and the disposal option.

Willingness is probably related to some stories about use of primary biomass (food) for energy purposes. This gave a lot bad publicity for bio-based in general.

Biobased products are not necessarily more sustainable and do have a significant higher price. We recommend buyers to look for recycled content rather than biobased material.

To solve this issue, it could be helpful to focus on the quality of bio-based products (which cannot be lower than the quality of alternative traditional products)

This result is probably due to the fact that biobased products - **often wrongly - are assumed to have a poorer technical quality and stability**.

I guess that procurement professionals doubt of the quality/reliability/durability of bio-based products compared with long standing conventional ones.



Relevance of indicators

No child labour	No forced labour	Conserve and protect resources and water	Mitigate climate change and promote good air quality	Promote positive and the the reduce negative impacts on biodiversity	Promote positive and the the reduce negative impacts on ecosystems	Promote use of renewable materials and prevent resource depletion
4.6585	4.6585	4.439	4.439	4.3902	4.3902	4.3902
Health and safety of workers	Health and safety of end users	Promote efficient use of energy resources and the prevention of non-renewable resource depletion	Promote responsible waste management	Protect soil quality and productivity	Minimize the impacts on human health	Food security
4.3658	4.3414	4.317	4.2926	4.2682	4.2439	4.1951
Promote efficient use of material resources	Minimize the use of raw materials	Promote responsible use of high concern materials	Equal opportunities/ no discrimination	Land use rights	Health and safety of local community	Promote efficient use of energy (fossil derived, renewable and internally derived energy)
4.1219	4.0975	4.0243	4	4	3.9757	3.9268
Fair salary	Economic development (e.g. prioritizing local suppliers)	Transparency	Fair competition in the market	Functional benefits of the product	Local employment	Feedback mechanisms for users
3.8636	3.6341	3.6341	3.6341	3.5121	3.4878	2.878



Annex II – WTP questionnaire

1. AGE:

- ☐ UP TO 24
- ☐ 25 -34
- ☐ 35-44
- ☐ 45 - 64
- ☐ 65+

2. GENDER

- ☐ M
- ☐ F
- ☐ OTHER _____

3. RESIDENCE PROVINCE _____

4. EDUCATION

- ☐ PRIMARY SCHOOL
- ☐ SECONDARY SCHOOLS
- ☐ HIGH SCHOOL
- ☐ UNIVERSTY DEGREE

5. EMPLOYMENT

- ☐ STUDENTS
- ☐ UNEMPLOYED
- ☐ HOUSEWIFES
- ☐ EMPLOYEES
- ☐ INDEPENDENT WORKERS
- ☐ RETIRED
- ☐ OTHER _____

6. FAMILY MEMBERS

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6 O MORE

7. WHICH OF THE FOLLOWING ACTIONS YOU USUALLY TAKE? (MULTIPLE ANSWERS ARE ALLOWED)

☐ I DIFFERENTIATE WASTE DISPOSAL

☐ I PAY ATTENTION TO THE WASTE OF WATER, ENERGY AND FOOD

☐ I USE PUBLIC TRANSPORTATION AND/OR BICYCLE

☐ I DO SPORT, GYM ETC.

- AVERAGE NUMBER OF HOURS PER WEEK _____

-



8. THE DIET YOU FOLLOW IS HEALTHY - WITH RESPECT TO THIS STATEMENT YOU:

- ☐ **STRONGLY DISAGREE**
- ☐ **DISAGREE**
- ☐ **NEITHER AGREE NOR DISAGREE**
- ☐ **AGREE**
- ☐ **STRONGLY AGREE**

9. WHICH OF THESE CHARACTERISTICS WOULD CONVINCE YOU TO BUY A SUSTAINABLE PRODUCT? (PLEASE INDICATE HOW MUCH THE FOLLOWING STATEMENTS CONVINCE YOU, WHERE 1: SCARCELY CONVINCED - 5: VERY CONVINCED)

-	NO AT ALL	LITTLE	INDIFFERENT	ENOUGH	MUCH
1. AN EQUAL OR HIGHER QUALITY, INDEPENDENTLY FROM THE PRICE	1	2	3	4	5
2. AN EQUAL OR LOWER PRICE, INDEPENDENTLY FROM THE QUALITY	1	2	3	4	5
3. A PACKAGE WITH THE FEATURES OF SUSTAINABILITY AT A GLANCE	1	2	3	4	5
4. MORE INFORMATION IN THE STORE ON THE DISPOSAL OF SUSTAINABLE PRODUCTS	1	2	3	4	5
5. WHEN I PERCEIVE AN ADVANTAGE FOR MY HEALTH	1	2	3	4	5
6. WHEN I SEE AN IMMEDIATE ADVANTAGE FOR THE ENVIRONMENT	1	2	3	4	5



7. DEDICATED FIDELITY PROGRAM (COLLECTION OF POINTS / DISCOUNT VOUCHERS)	1	2	3	4	5
8. KNOWING THAT A PART OF THE PRICE IS DESTINED BY THE COMPANY IN SUPPORT OF ETHICAL AND / OR ENVIRONMENTAL PROJECTS	1	2	3	4	5