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Can consumers understand that there is more to palm oil than deforestation?

Sophie-Dorothe Lieke [a,b,*], Achim Spiller [b], Gesa Busch [c]

[a] Department of Agricultural Economics and Rural Development, RTG2654 Sustainable Food Systems, University of Göttingen, Heinrich-Düker-Weg 12, 37073 Göttingen, Germany
[b] Department of Agricultural Economics and Rural Development, Marketing for Food and Agricultural Products, University of Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany
[c] Food Consumption and Wellbeing, Hochschule Weihenstephan-Triesdorf, Am Staudengarten 1, 85354 Freising, Germany

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ABSTRACT

Environmental factors, such as climate change, with an array of social conflicts from labour conditions to land rights continue to refocus the spotlight on palm oil. Often depicted alongside deforestation, habitat destruction and biodiversity loss, palm oil tends to be viewed critically, especially by societies in palm oil importing countries. Oil palm cultivation, when poorly managed, can have severe ecological effects. However, the fact that it is the highest yielding vegetable oil complicates discussions around palm oil. Even if all palm oil was replaced with the second highest yielding vegetable oil, soybean oil, a six-fold amount of land would be required to make ends meet. Aspects such as these are not often at the forefront of consumers' minds. Using an online survey, this paper explores what German consumers (n = 1220) associate with palm oil and what they know about the geography of its production. Building on this, we investigate how society deals with the concept of indirect land use change and the role that information can play in encouraging a move away from a binary (good/bad) opinion of palm oil, and instead towards one that considers both the indirect effects related to oil palm cultivation and the feasibility of alternatives. Results show that while the effect size for different variables varies, the provision of information can especially influence how individuals understand issues of indirect land use change. However, when comparing the perceived sustainability of certified palm oil to other vegetable oils, it does not fare much better. Hence, while information can be useful to raise awareness about specific aspects, it alone is generally insufficient to encourage deeper thinking related to the complexity of different sustainability dimensions compared to more readily understandable aspects such as biodiversity loss. These findings are salient as they highlight the risk that perceptions of vegetable oil sustainability may not be in keeping with actual environmental sustainability, whereby alternatives are more glorified than their reality. This is especially important when considering which vegetable oil is capable of continuing to supply our increasing demands while doing so in the most environmentally- and socially benign way possible.

1. Introduction

Coupled with a continued rise in their demand, vegetable oils are facing increased scrutiny over the sustainability of their production and consumption. The average production of a kilogram of refined vegetable oil emits 3.81 kg of carbon dioxide-equivalent emissions (Alcock et al., 2022). Nonetheless, a lot of diversity exists, with some oils such as sunflower and rapeseed oil frequently faring more environmentally friendly than soybean and palm oil (Parsons et al., 2020). Physical and contextual geography, the type of production and processing methods, as well as the consideration of different sustainability domains (greenhouse gas emissions, water use, land use) contribute to further variations in vegetable oils' environmental performance (Schmidt, 2015). From a sustainable production perspective, this variability can be favourable as it could allow for production intensification and closure of yield gaps in areas where environmental footprints are lowest (Beyer and Rademacher, 2021). Nonetheless, with that comes the risk that increased productivity could incentivise farmers to convert and expand more agricultural farmland. This expansion can exacerbate environmental impacts especially when it happens at the expense of food crops, the

* Corresponding author.
E-mail addresses: sophiedorothe.lieke@uni-goettingen.de (S.-D. Lieke), a.spiller@agr.uni-goettingen.de (A. Spiller), gesa.busch@hswt.de (G. Busch).

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displacement of which can result in grassland, wetland or forest conversions elsewhere (Meijaard et al., 2018; Saswattecha et al., 2016). While direct effects may be more causally linked to spatial or temporal scales, indirect effects defy such boundaries (Valin et al., 2015). Capturing these indirect effects, particularly those resulting from indirect land use change (ILUC), has been subject to research across disciplines. Nuanced differences in quantifying ILUC show disproportional strength in influencing the environmental performance of vegetable oils (Searle and Giuntoli, 2017). The stark variations depending on situational differences make conveying harmonious and unequivocal sustainability agendas, policy recommendations and practices to scientists and society challenging.

For everyday consumers, the variability in the environmental performance of commodities is less welcomed, as society as a whole craves more straightforward and binary (good/bad) recommendations on what is more or less sustainable (D'Antone and Spencer, 2015; Guthman, 2003; Johnston, 2008; Lu and Sinha, 2019; Mäkiniemi et al., 2011). Despite its benefits and solution-oriented potential, citizens rarely conceptualise sustainability trade-offs from a systems-thinking perspective (Hu et al., 2019). Instead, it is often direct product information through labels and claims that are used to aid decision-making (Ghvanidze et al., 2016). This, however, can risk misleading consumers who believe that products with certain claims or labels are better for the environment, when in fact from a system perspective, the reality of overall sustainability proves to be more complex.

Palm oil is an example commodity, where its image from a sustainability perspective has asserted itself with such controversy and criticism (Sundaraja et al., 2021b). Palm oil is the world's most produced and consumed vegetable oil. Situated at the nexus of health and environmental discourses, with contested perceptions that it is linked to cardiovascular diseases and cancers (Borrello et al., 2019), the 'free from' palm oil claim on products has garnered more attention than labels highlighting the use of certified sustainable palm oil (CSPO). The problem with the disproportionate proliferation of some labels is that they draw attention away from less prominent alternatives which may disguise the most feasible option in the pursuit towards sustainable production. Understanding consumer responses is important, as the demand for palm oil continuously grows and is expected to increase by 46 % by 2050 (Meijaard et al., 2020b). This trend is driven by a multitude of factors including growing economies and populations, energy consumption, as well as climate-induced poorer harvests of alternative oil crops such as soybean or rapeseed oil (Chew et al., 2021). Additionally, Russia's war of aggression against Ukraine has immobilised important exports of these sunflower oil- producing countries (Pilorgé, 2020), exerting additional pressure on other oil producing countries such as Indonesia, the world's largest palm oil producer. As Indonesia juggles delivering international demands, it also seeks to become more independent and is diversifying its own energy use. This balancing act has been criticised, insofar that the 6 million additional hectares required to meet domestic and international demands will not be possible without contributing to some degrees of deforestation, biodiversity loss and greenhouse gas emissions (Khatiwada et al., 2021).

It is therefore unsurprising that for consumers in the Global North, palm oil is laden with negative connotations (Aguiar et al., 2017; Disdier et al., 2013; Hinkes and Christoph-Schulz, 2019). With its production often criticised for undermining global sustainability goals particularly related to environmental degradation and social exploitation, responses have included boycotting, or industries replacing palm oil with alternative oils (Parsons et al., 2020). When individuals hold strong opinions rationalised by one dimension, it can result in premature certainty as to which option is most sustainable, especially when these lie outside of realistic feasibility. Despite its frequent mention in production discourses, to the best of our knowledge, no study has explored how society understands, conceptualises or navigates trade-off issues related to ILUC when making decisions about the overall perceived sustainability of vegetable oils.

Against this background, we used an online survey to explore how effective information treatments are at informing German society on issues related to ILUC using palm oil as an example. This is underpinned by an exploration into what initial associations German people have towards palm oil as a commodity as well as the oil's cultivation. Understanding these underlying perceptions is relevant in the pursuit of achieving sustainable consumption, as misinterpreted actions and false beliefs can lead to behaviours which are thought to be more environmentally friendly (such as assuming that all palm oil is bad, and therefore boycotting it), when in reality purchasing sustainably produced palm oil may be the most environmentally beneficial course of action (Sundaraja et al., 2021a). Findings from this study are important as they provide insights into how to encourage society to grapple with complex and often controversial food choices.

The paper is organised as follows: after a literature review on ILUC, its association with palm oil and society, the ways in which information treatments have previously been applied are discussed. An overview of the methodological approach follows, before delving into the results and discussions. The paper finishes with conclusions and scope for further research.

2. Literature review

Amidst a context of rising food prices affecting food accessibility and availability, underpinned by efforts to improve food system sustainability, understanding the direct and indirect impacts of food commodities is vital. This understanding helps to achieve outcomes that are feasible and suitable for both the planet and people. To this end, the following literature review begins with an overview of ILUC before discussing its significance in relation to vegetable oils, specifically palm oil. The review then explores society's associations with palm oil and the role information can play in shaping perceptions towards it, setting the premise of this study.

2.1. Indirect land use change

While the concept of ILUC stems from the biofuel and energy sector, its applicability and relevance span beyond this domain. Within biofuel policy, ILUC refers to the transition when existing agricultural land formally used for crop or feed production is replaced with crops destined for biofuels or biomass (Gawel and Ludwig, 2011). This shift increases the expansion of agricultural area required for food and feed production elsewhere, often involving the transformation of pre-existing forests and grasslands, draining wetlands or intensifying production on existing agricultural land (El Takriti et al., 2016). Hence, emissions and environmental impacts are not solely restricted to the former conversion of land, soil or carbon stocks at the point of production, but also further downstream (Daioglou et al., 2020; Schmidt et al., 2015). This gives the phenomenon its indirect effect. Considering ILUC is important in the biofuel debate as the indirect effects may be so significant that these have the power to skew the perceived and actual environmental benefits of substituting fossil fuels with biofuels. A severe limitation of ILUC is its difficulty in conceptualisation and quantification. ILUC cannot be directly observed or measured at local or global scales. Instead, it can only be estimated (Valin et al., 2015). To date, quantification approaches and methodologies are still highly rudimentary, leaving many unanswered questions concerning the lifecycle assessments and environmental performance of vegetable oils (Gawel and Ludwig, 2011; Malins, 2011; Muñoz et al., 2015). One of the most criticised and debated vegetable oils with respect to ILUC is palm oil.

2.2. Palm oil and indirect land use change

There is an abundance of literature showing how the cultivation of oil palm directly influences deforestation and forest fragmentation (Austin et al., 2019; Busch et al., 2022), the release of carbon emissions

from peatlands (Azhar et al., 2021; Daioglou et al., 2020; Meijaard et al., 2020b; Srisunthon and Chawchai, 2020), as well as its influence on biodiversity and habitat loss (Barnes et al., 2017; Chaudhary and Kastner, 2016; Teuscher et al., 2015). Between the selected study period of 2000–2010, Többen et al. (2018) found that despite only occupying 10 % of global cropland area, the cultivation of oil palm was responsible for 37 % of the total impact on global biodiversity loss resulting from the four considered oil crops (palm, rapeseed, soybean and sunflower oil).

Nonetheless, assessments can change considerably depending on the data, the spatial context and the timeframes considered. For example, though also dependent on clearance mechanisms, plantations cultivated at the expense of forests take between 30 and 120 years to achieve net carbon gain, yet if cultivated on degraded grasslands, net savings can be achieved within 10 years or less (Barthel et al., 2018). Cultivating oil palm on *Imperata* grasslands may provide a low ILUC opportunity, as crop displacement from such areas is seen to be less severe (Searle and Giuntoli, 2017). With palm oil being a near to irreplaceable commodity, finding such low ILUC scenarios is important (Parsons et al., 2020). The most realistic option is to harbour these less environmentally degrading options to continue to meet market demands (Hansen et al., 2014; Tapia et al., 2021).

While the impacts of palm oil are undeniable, in order to not falsely glorify alternative vegetable oils, considering the implications of substitution oils, especially related to their land use, is crucial. Even though palm oil accounts for 40 % of annual vegetable oil production, and has the highest yield per hectare output, it occupies only 5–5.5 % of the worldwide oil crop area (Meijaard et al., 2020b). Rapeseed and sunflower oil may be presented as 'more sustainable' given their lower (9 % and 4 %, respectively) impacts on biodiversity loss while occupying land in less ecologically rich regions (19 % and 13 %, respectively) (Többen et al., 2018). However, their yields are substantially lower than that of palm oil, with rapeseed producing at 0.8 t/ha and sunflower at 0.7 t/ha compared to 3.8 t/ha of palm oil (Meijaard et al., 2018). If all palm oil was replaced with soybean oil, the second highest-yielding vegetable oil, nearly six times as much land would be required to adequately cover the demand (Meijaard et al., 2020b). While coconut oil does not account for a significant proportion of global vegetable oil consumption, its impact on biodiversity, particularly on tropical islands, is disproportionally high. Despite considering taxonomic incompleteness, its cultivation has been found to compromise 18.33 species per million tons of oil produced, which is higher than the 3.79 species threatened by oil palm (Meijaard et al., 2020a). Even when fluctuations are considered, given their starkly lower unit output, alternative oils will always require more land (Qaim et al., 2020). With the demand for palm oil unlikely to decelerate and arable land globally reaching its limits, it is important to consider how demands can still be met in a manner that marries efficiency, suitability and sustainability- something rarely considered by society when making sustainability judgements.

2.3. Palm oil and society

While not as powerful as industry-led action, considering citizen and consumer perceptions and sentiments is important as these can translate to behaviours that drive specific trends (D'Antone and Spencer, 2015). While cultural and contextual differences exist (Giam et al., 2016; Guadalupe et al., 2019), western society often views palm oil negatively (Aguiar et al., 2017; Wassmann et al., 2023). These tainted views exist despite relatively poor and limited knowledge about palm oil itself (Lange and Coremans, 2020). Undesirable connotations solely based on selected direct effects of palm oil may stymie sustainability targets as a whole, as banning palm oil or emphasizing its substitution will simply move the direct environmental problems elsewhere (Daioglou et al., 2020). This can become problematic when citizens use their agency to act in a way which they believe to be most sustainable, when reality may prove otherwise. A response has been boycotting palm oil and prioritising products where palm oil has been substituted by other oils and are now 'free from' palm oil (Vergura et al., 2019). Many environmental organisations including the World Wildlife Fund (Raghunathan and Beitien, 2021), the London Zoological Society (ZSL, 2019) and the International Union for Conservation of Nature (IUCN, 2018) are encouraging the use of CSPO. The Roundtable on Sustainable Palm Oil (RSPO) is the most important international organisation in palm oil certification. However, since its founding in 2004, the RSPO's overt presence in the form of its trademark on products has been limited. This has left many consumers unaware and untrusting that CSPO is not the same as conventional palm oil (Hobbs et al., 2022). While the benchmark of sustainable palm oil has already been moved through certification schemes and zero-deforestation commitments, its negative image has remained steadfast in society. In light of this, companies are continuously harbouring 'free from' palm oil claims. With such claims more noticeable on products compared to those containing CSPO, it may create a misleading perception of sustainability. The literature also reflects this trend as many studies primarily concentrate on the perceived health associations of these labels, giving comparatively less attention to the environmental perceptions (Capecchi et al., 2019; Hartmann et al., 2018; Verneau et al., 2019).

2.4. The role of information in addressing environmental issues

Disseminating information through campaigns is a relatively cheap and easy intervention which has been applied to increase ecological literacy, environmental knowledge and sustainability awareness (Steg and Vlek, 2009). However, the extent to which the provision of information can encourage certain ways of sustainability-related thinking or the direct result of information treatments on the execution of environmentally friendly behaviours shows variability.

Knowledge, education and awareness are some of the most significant predictors of environmental and sustainable consumption practices (Meyer, 2015; Saari et al., 2021; Tonkin et al., 2016). The provision of environmental information has shown to enhance recycling practices (Wang et al., 2020), positively influence consumer choices in engaging with lower carbon emitting behaviour (Motoshita et al., 2015), and increase energy efficiency in the household (Fornara et al., 2016). Information treatments are also believed to have better welfare effects than other instruments such as taxes (Disdier et al., 2013). However, while Cerri et al. (2018) show that information can shape pro-environmental attitudes, beliefs and norms which can increase tendencies towards purchasing green products, O'Rourke and Ringer (2016) find that sustainability information does not have an effect on purchase intention and instead could even reduce such tendencies. Indeed, despite exposing participants to information, 4 out of 5 consumer clusters still showed a preference for palm oil-free products compared to those containing palm oil (Hinkes and Christoph-Schulz, 2020). While the mere provision of information may be too weak to enforce long lasting pro-environmental, behavioural changes (Sánchez-Jiménez et al., 2021), understanding the role of information treatments still retains merit as these are often the first, cheapest and most feasible mechanisms implemented (Steg and Vlek, 2009).

3. Methods

This exploratory study was conducted using an online survey, whereby participants were recruited via an online panel provider. The following section elaborates on the procedure and techniques applied, concluding with an overview of how the data was analysed.

3.1. Participants

This study was approved by the Ethics Commission at the Georg-August-University Göttingen. Participants were recruited through an online platform via a panel provider throughout June and July 2022. Quotas based on gender, age, income, residency and education were set

using data from the Statistisches Bundesamt (2021). This provided a sample reflective of the German population regarding those characteristics. Due to recruitment limitations, some quotas (such as low education attainment) were unattained and thus potential sample biases should be considered. Respondents who failed quality checks, repeatedly provided the same response to over five consecutive questions, or those who provided irrelevant responses to open-answer questions were excluded from the sample (1247 respondents before cleaning, 49 % response rate). A total of 1220 participants were included in the analysis. A balance table (see Supplementary Materials, Table S1) confirmed that all groups had the same distribution of characteristics.

3.2. Survey questions

This survey is part of a larger research project where initial survey questions were created in English. These were translated to German and back-translated, to ensure that the essence and meanings were retained. The survey had a mix of open-ended and choice-based questions, partially adapted from scales previously used in the literature. However, given the exploratory and palm oil-specific nature of the questionnaire, many items were newly developed. One question was asked on the overall importance of palm oil in the food industry (Importance). Four questions investigated the understanding and trust of the 'free from' palm oil claim and the RSPO label (Understanding & Trust). Three items addressed indirect land use change (ILUC1–3), while four questions focussed on certified palm oil in comparison to alternative vegetable oil (ProCSPO1–4). Respondents answered on a five-point Likert scale based on their level of agreement with the different statements. All questions asked with a reverse positive were adjusted for analysis. Association techniques (Eldesouky et al., 2015) were used to ask participants what they link to palm oil and their perceptions of its geographic cultivation. Participants could respond in as many or as few words as they pleased. Synonymous words and phrasings were grouped for analysis. An overview of the survey outline can be found in the Supplementary Materials, Table S2.

3.3. Information treatments

Following the association techniques, participants were randomly assigned into one of three groups. 401 respondents received an information treatment regarding the general direct aspects associated to oil palm cultivation, such as yields, emissions and ecological impacts. This information was presented in comparison to aspects of three other popular vegetable oils: soybean, rapeseed and sunflower oil (Group 1). 408 respondents received an information treatment specifically on ILUC and its relationship with palm oil (Group 2) and 411 respondents were in the control group and did not receive any additional information (Group 3). The digital information treatments, each one page long, presented data through graphics, icons and with minimal supportive text. Information treatments within experiments moderate relationships and help shed light on whether perceptions can be changed as a result of providing more case-specific knowledge (Haaland et al., 2021). Data used in the information treatments came from peer-reviewed studies. Respondents who received information treatments were shown an additional content-related quality check question to ensure sufficient engagement. Respondents could also opt to listen to an audio version of the information treatments, with 20 % of the respondents in Group 1 and 16.4 % in Group 2 listening to it in its entirety. The information treatments can be found in the Supplementary Materials, Fig. S1.

3.4. Analysis

Perceptions of where palm oil is grown were analysed with bubble maps using R 4.1.1, where the size of the bubble represents the frequency of perceived production country stated. Word associations were analysed qualitatively and were grouped into cross-validated categories of meaning. Word association techniques are useful in reflecting inner thoughts and expectations and have been increasingly used in food and consumer studies (Gambaro, 2018; Rojas-Rivas et al., 2022; Varela and Fiszman, 2013; Vidal et al., 2013). It is assumed that the initial words that come to participants' minds (in this case the stimuli are questions), are the best predictors to understand attitudes, beliefs and expectations towards an entity. The unstructured response eliminates restrictions for participants, making it easier for them to express their opinions or points of view (Eldesouky et al., 2015).

Treatment effects on how respondents understand palm oil- related labels and claims, and how they conceptualise ILUC amongst vegetable oil alternatives were also explored. Given the Likert scale type questions, nonparametric measurements were used. The Kruskal-Wallis Test was used if the null hypothesis, that there are no differences across the three groups, was rejected ($p < 0.05$). This test is appropriate as it allows for the comparison of differences across group means of three or more random and independently sampled groups with a nonparametric distribution (Ostertagová et al., 2014). The Dunn Test (with the Bonferroni adjustment) was used as a post hoc test to identify intra-group differences.

4. Results

Results from this study provide insights into how consumers in a palm oil importing country such as Germany perceive this commodity and its sustainability. The section begins by presenting general

Table 1
Socio-demographic overview of survey participants in total (n = 1220), distributed across the two infographic treatment groups and the control group.

Characteristic		Total	Group 1[a]	Group 2	Control
	n=	1220	401	408	411
Residence (%)	Northern Germany	18.5	17.2	18.6	19.7
	Eastern Germany	21.2	21.2	21.3	21.2
	Southern Germany	29.1	27.7	30.4	29.2
	Western Germany	31.2	33.9	29.7	29.9
Gender (%)	Female	52.8	50.4	53.4	54.5
	Male	47.2	49.6	46.3	45.5
	Other	0.08	0	0.3	0
Age (years)	Mean $\bar{x}$ (Standard Deviation)	48.5 (16)	47.8 (15.9)	48.8 (15.4)	48.9 (15.2)
Income (%)	Low	20.8	18.0	22.3	22.1
	Lower medium	36.6	37.9	34.8	37.0
	Upper medium	30.5	31.6	30.6	29.2
	High	12.1	12.5	12.3	11.7
Education (%)	Low	1.8	1.7	1.5	2.2
	Medium	62.5	59.4	65.7	62.5
	High	35.7	38.9	32.8	35.3

[a] Group 1 (general palm oil infotreatment), Group 2 (indirect land use change specific infotreatment), Group 3 (control).

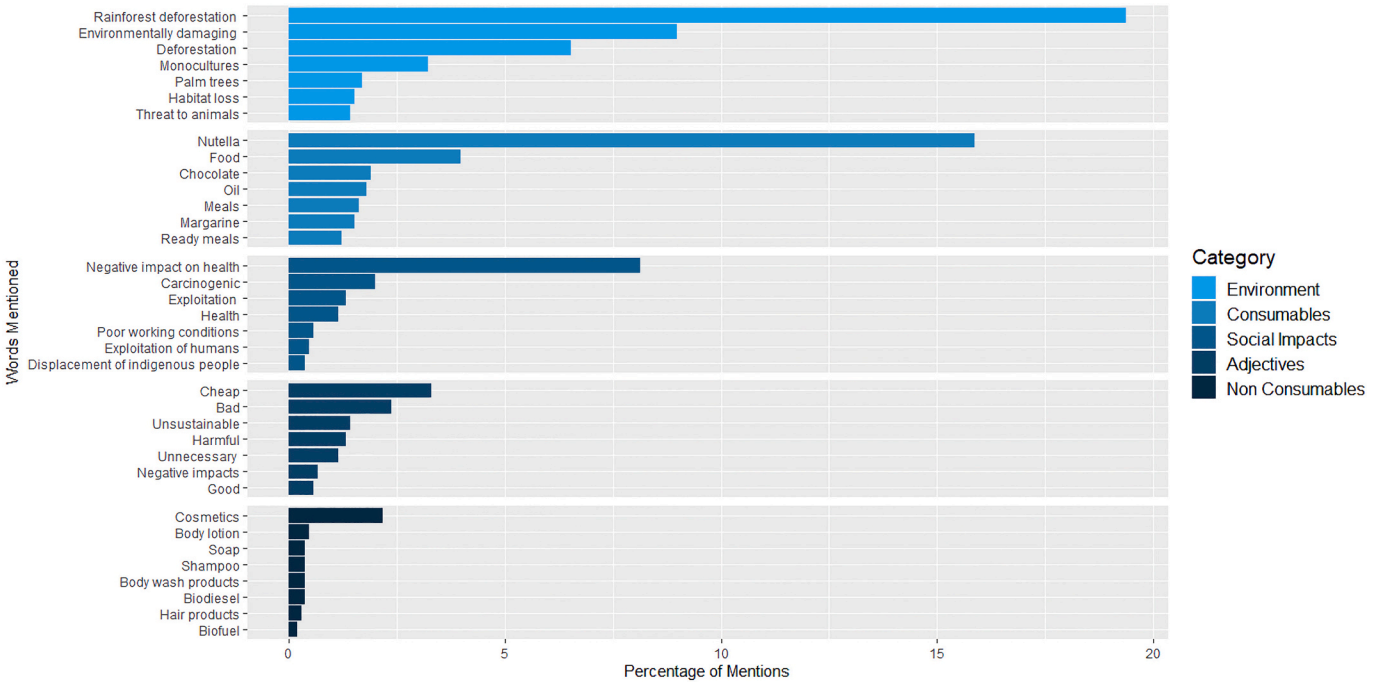

Fig. 1. Frequency analysis of 1058 words associated with palm oil by 1220 participants ("*I associate palm oil with:__*").

associations to palm oil and the perceived geographic distribution of oil palm cultivation. The subsequent results show the effect that the information treatments had on shaping considered perceptions.

4.1. Associations to palm oil

The distribution of participants can be seen in Table 1.

The association question ("*I associate palm oil with: _*") provided insights into perceptions held by German respondents towards palm oil. The following five thematic categories emerged from a total of 1058 words listed by the participants: (1) environment, (2) consumables, (3) social impacts, (4) adjectives (describing palm oil as a commodity or related to oil palm cultivation) and (5) non consumables (Fig. 1).

Supporting existing literature, most respondents associate palm oil with the environmental impacts of its cultivation. Over 28 % of all written responses were 'rainforest deforestation' (19.4 %) or 'environmentally damaging' (9.0 %). Negatively weighted connotations and associations are much more frequent with respect to environmental impacts, but also expressed towards social and health outcomes. These touch on issues such as poor working conditions, cause of social displacement and palm oil being unhealthy. The most common consumable product people associate with palm oil is '*Nutella*', accounting for 15.9 % of all responses. Consumables were more frequently mentioned than non-consumables, with cosmetics being the most common association of the latter. Despite the fact that in 2018, 45 % of the palm oil imported to the European Union (EU) was used as a biofuel (Oosterveer, 2020), this association was only mentioned twice.

4.2. Geography of oil palm cultivation

Fig. 2 illustrates the differences of where palm oil is actually produced (Fig. 2-A) compared to perceived countries of production (Fig. 2-B). While there is consensus that Indonesia is both the biggest actual and perceived producer of palm oil globally, there is more divergence between the perceived shares of other palm oil producing countries. Malaysia, accounting for the second highest actual global share of palm oil production, comes after Brazil which was perceived to be the second largest palm oil producing country. Additionally, participants' perceptions revealed that many non-producing countries were suspected of cultivating oil palm, including countries in Europe such as Spain, Portugal and Italy.

4.3. The role of information treatments

The grouped differences in participant responses can be seen in Table 2. Effect sizes are based on Tomczak and Tomczak's (2014) recommendations where 0.01–<0.06 denotes a small effect size, 0.06–<0.14 a medium effect, and ≥0.14 a large effect.

4.3.1. Overall effect

The results in Table 2 show that the two information treatments had varying effects on the indicators. Understanding the RSPO logo, trusting it, and evaluating vegetable oils sustainability (ILUC3) showed no difference between the control group and those who received either information treatment (Kruskal-Wallis adjusted p *value* > 0.05). Between the general and specific information treatments (Groups 1 & 2) as well as between the specific and the control (Group 2 & control), there were seven positively significant differences in how respondents answered the prompts. There were six statistically significant instances between the general information treatment group and the control (1 & 3) (Dunn Test adjusted p *value* < 0.05). Overall, while variation depending on the question and the extent of effect sizes does exist, the provision of information about palm oil and ILUC did influence participant responses.

4.3.2. Understanding and trust in the 'free from' claim and RSPO label

Findings reveal that understanding only the 'free from' claim (Kruskal-Wallis p *value* $= 0.01$) and not understanding the RSPO logo (Kruskal-Wallis p *value* $= 0.99$) was influenced by the information treatments. This also applied to trust ('free from' claim: Kruskal-Wallis p *value* $= 0.04$; RSPO label: Kruskal-Wallis p *value* $= 0.75$). The effect however was small, with the post hoc test showing that for both questions there was no difference between Group 1 and the control (3). The absence of effect for understanding and trusting the RSPO label is relatively unsurprising as the information treatments were more content-based, rather than being directly about labels.

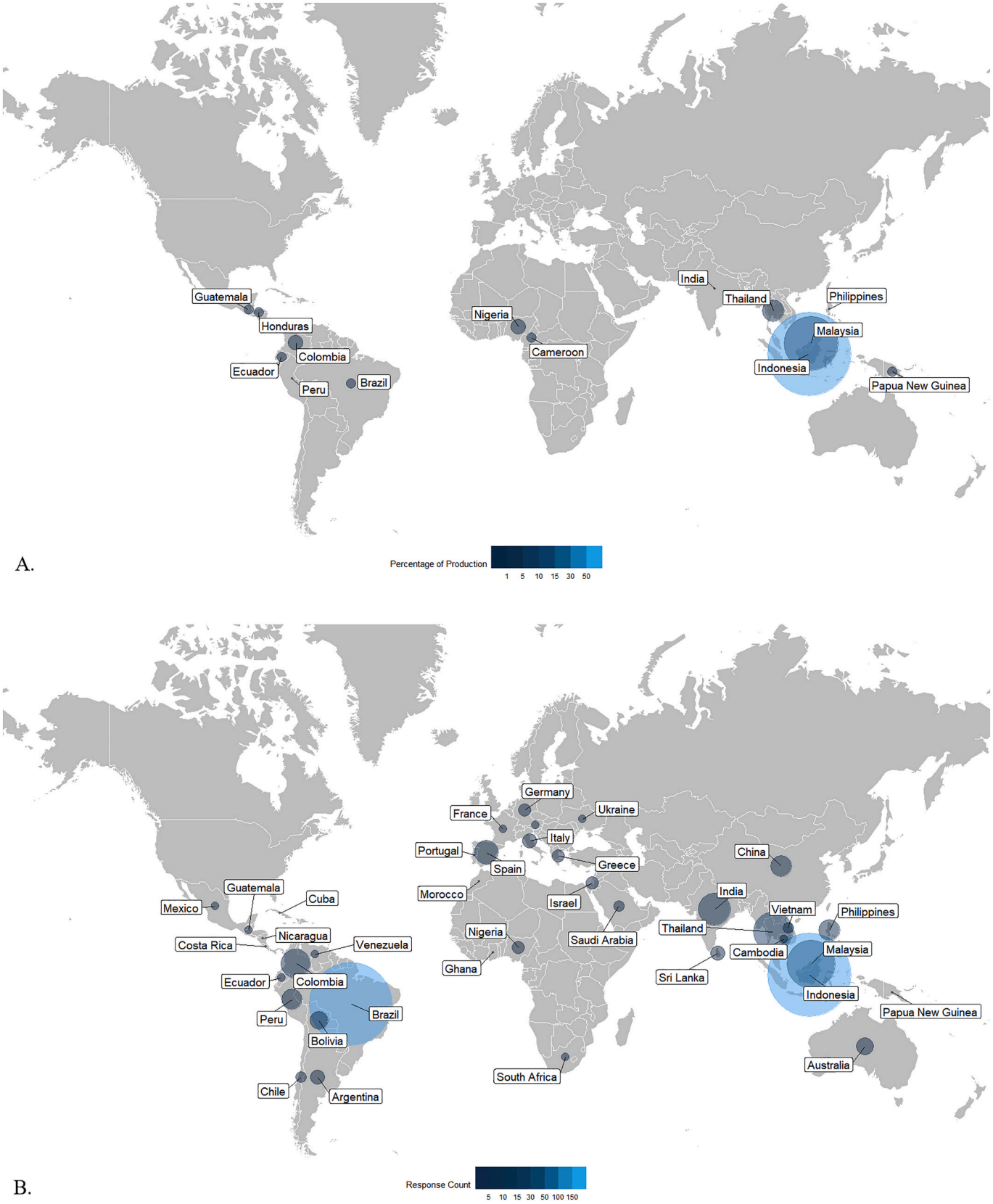

Fig. 2. Graphical distribution of actual (A) and perceived (B) production of global palm oil, actual production based on United States Department of Agriculture (2022) data, Total production: 79,161 (1000 Metric Tons).

Table 2
Comparison of treatment and control groups regarding importance, understanding, trust, and perceptions towards indirect land use change (ILUC) and certified sustainable palm oil (ProCSPO) using the Kruskal-Wallis and Post hoc Dunn Test.

Item	X^2 Kruskal-Wallis	Kruskal-adjusted *p value*	Significant?	Group	Dunn Test- *p value* adjusted	Significant?	Group	Effect size
Importance: Palm oil is an important part of the food industry	43.69	<0.01	Y	1&2	<0.01	Y	1	0.105 moderate
				1&3	<0.01	Y	2	0.103 moderate
				2&3	<0.01	Y	3	0.102 moderate
Understanding: 'free from' claim	8.96	0.01	Y	1&2	0.018	Y	1	0.018 small
				1&3	1	N	2	0.017 small
				2&3	0.049	Y	3	0.017 small
Understanding: 'RSPO' label	0.02	0.99	N					
Trust: 'free from' claim	6.46	0.04	Y	1&2	0.044	Y	1	0.011 small
				1&3	0.2	N	2	0.011 small
				2&3	1	N	3	0.109 moderate
Trust: 'RSPO' label	0.57	0.75	N					
ILUC1: Oil palms are the highest yielding crop for vegetable oils.	239.43	<0.01	Y	1&2	<0.01	Y	1	0.597 large
				1&3	<0.01	Y	2	0.586 large
				2&3	<0.01	Y	3	0.582 large
ILUC2: A reduction in tropical oil palm plantations means that elsewhere more land is needed for oil alternatives.	68.72	<0.01	Y	1&2	<0.01	Y	1	0.168 large
				1&3	<0.01	Y	2	0.165 large
				2&3	<0.01	Y	3	0.164 large
ILUC3: It is hard to say which vegetable oil is most sustainable.	0.15	0.93	N					
ProCSPO1: In the absence of deforestation, palm oil is the most sustainable oil used in food production.	41.2	<0.01	Y	1&2	<0.01	Y	1	0.099 moderate
				1&3	0.453	N	2	0.097 moderate
				2&3	<0.01	Y	3	0.096 moderate
ProCSPO2: Products containing alternative oils to palm oil (such as rapeseed, soy, sunflower oil) are not always more environmentally sustainable.	12.67	<0.01	Y	1&2	1	N	1	0.027 small
				1&3	0.011	Y	2	0.026 small
				2&3	0.004	Y	3	0.026 small
ProCSPO3: Replacing palm oil with rapeseed, soy or sunflower oil is not always better for the environment.	7.35	0.03	Y	1&2	1	N	1	0.013 small
				1&3	0.054	N	2	0.013 small
				2&3	0.061	N	3	0.013 small
ProCSPO4: Sourcing sustainable palm oil is the best option to address the environmental issues resulting from its production.	29.28	<0.01	Y	1&2	1	N	1	0.069 moderate
				1&3	<0.01	Y	2	0.067 moderate
				2&3	<0.01	Y	3	0.067 moderate

4.3.3. Indirect land use change

When participants were asked which aspect mentioned in the general information treatment was most important to them, 40.4 % of respondents most valued the impacts palm oil has on biodiversity. This was followed by emissions (34.4 %), and the role of palm oil in the food industry (17.3 %). Only 7.9 % of the participants valued yields as the most important aspect. Despite the perceived lack of importance to the participants, the information treatments had the largest effect sizes on questions related to indirect land use change (ILUC 1 & 2). We see that for ILUC-related content questions such as ILUC1 or ILUC2, both general and specialised information showed a statistically significant difference in participant responses across all 3 treatments (Dunn Test *p value* < 0.01). However, when asking more of an overall question (ILUC3), no difference between the groups exists (Kruskal-Wallis *p value* = 0.93). This highlights respondents' indecisiveness when evaluating the sustainability of oils ($\bar{x}_{Group\ 1} = 3.42$; $\bar{x}_{Group\ 2} = 3.41$; $\bar{x}_{Group3} = 3.41$, where 3 is '*neither agree nor disagree*').

4.3.4. The case with certified sustainable palm oil

Even after engaging with the information treatments, participants still expressed doubt whether certified sustainable palm oil (ProCSPO) can be more ecologically viable than other vegetable oils. While at the 0.05 significance level, the Kruskal-Wallis Test indicated that there were differences across the 3 groups (Kruskal-Wallis *p value* < 0.05) for all the questions, the post hoc tests did not always support this (e.g. ProCSPO2 & ProCSPO3). For both of these questions and ProCSPO4, there was no difference between the information treatments (Groups 1 & 2), and only small effect sizes between treatment groups and the control. Both of these questions deal with the perceived sustainability of palm oil alternatives, highlighting the fact that the provision of general or specific information will not influence responses in a statistically significant manner. In spite of the information treatments highlighting some environmental impacts of the other oils, there is still a tendency to disagree that palm oil alternatives are not always better for the environment ($\bar{x}$ for ProCSPO 2 & 3 ranging from 2.3 to 2.8 '*somewhat disagree*'). The only question for which the type of information showed to have a different effect was for ProCSPO1, where those who received the ILUC information treatment (Group 2) showed more indecisiveness rather than disagreement ($\bar{x}_{Group\ 1} = 2.71$; $\bar{x}_{Group\ 2} = 3.06$; $\bar{x}_{Group3} = 2.63$).

5. Discussion

In summary, our results emphasise the intricacy required when introducing frequently neglected and overlooked aspects of palm oil to members of the German public, a society within which palm oil is viewed critically. To encourage balanced and informed judgements, the narrative around palm oil needs to be specific, contextualised amidst other vegetable oils, and importantly should not lose sight of what is

most ecologically, economically and socially feasible in a climate of increasing resource demands.

5.1. Associations to palm oil

While sustainably produced palm oil, which focuses on good agricultural practices and low direct and indirect land use change, tailored with intensification on carbon-poorer lands, is often seen as the superior alternative to conventional palm oil (Austin et al., 2017; Awang et al., 2021; Chew et al., 2021; Gerssen-Gondelach et al., 2017), the extensive publicity palm oil has received has resulted in lingering negative perceptions amongst many in palm oil-importing countries (Yu et al., 2019). With our results supporting this notion, it is particularly evident with regards to environmental associations, but also spans to consumables. It is therefore relatively unsurprising that *Nutella,* which has been subjected to extensive palm oil related press across mainstream European media (see for example Worland (2015)), was so prominent in the respondents' minds. This is in spite of the fact that *Ferrero* and *Nutella* specifically claim to use 100 % RSPO certified palm oil in their products and are committed to a zero-deforestation policy (Nutella, 2022). In the past, consumer perceptions towards this brand were strongly influenced by the press, resulting in a sluggish response to adapt and align with current progress. D'Antone and Spencer (2015) suggest that when palm oil is viewed as a threat, responses can be manifested in either detachment (through boycotting) or discontentment (negative views towards a company or product). Together, these responses can be used as leverage for companies to pledge to solely use CSPO. While current consumer perceptions towards the use of palm oil in *Nutella* may be more of a relic of past campaigns, these perceptions are not convincing enough to stop most consumers from buying it (boycotting) (Cova and D'Antone, 2016). In this case, the brand name simply acts as an underlying heuristic which is powerful in shaping consumer perceptions and sustainability judgements towards a particular entity. However, corresponding actions do not follow in the wake of these perceptions. DelVecchio (2001) finds that the more knowledgeable consumers are about products, the weaker their dependency on heuristics (such as brand names) is in informing judgements. Yet given overall poor consumer knowledge and low involvement with the commodity, this does not seem to be the case with *Nutella* as of now.

5.2. Consumers and oil palm geography

Relying heavily on heuristics can have implications, such as discrepancies between actual and perceived knowledge and practices. Heuristics are not only relevant to product judgement, but as our results show, are also called upon when asked about oil palm's production geography. While most respondents acknowledged that the majority of oil palm cultivation happens in South East Asia, many believe that its cultivation is also prevalent in South America, particularly Brazil. This may be because Brazil, the world's largest soybean producer (Sauer, 2018; Zaks et al., 2009), has frequently been associated with vegetable oil cultivation and environmental issues, in particular deforestation (Lathuillière et al., 2017; Lima et al., 2011). Although we can only speculate, individuals may therefore transfer this knowledge, use heuristic reasoning of the contextual environment (presence of tropical rainforests) and assume that it is also a large producer of palm oil.

Additionally, large-scale commercial plantations located in South East Asia have received more media coverage, with less attention paid to oil palm cultivation in other regions, such as Latin America. Here plantations are smaller in scale and more recent in their expansion. Although true reasoning can only be postulated, this resonates with findings by Huang (2020), who looked at the interplay between heuristics, the media, and how these shape public opinion with regards to genetically modified organisms. Media representation can alter social realities and assumptions drawn by the public, and in doing so create unrecognized blind spots (Lyytimäki and Petersen, 2014). These can shape incomplete and biased judgements about the environmental impact of consumption habits. With the perceived environmental impact acting as a co-predictor of purchasing intentions, understanding these discrepancies in consumer and citizen perceptions of the food system is important (Wunderlich et al., 2018). This asymmetry alludes to a lack of transparency, access or availability of scientifically- robust and accurate information, while simultaneously showing that consumers rely on their heuristics of other knowledge areas (Schulte-Mecklenbeck et al., 2013). There is a risk that when environmental misconceptions cumulate, they contribute to a larger and often binary judgement upon which individuals base their environmental decision-making. Hence and despite the limitations of information treatments, it is crucial to disseminate factually balanced information through various media channels and campaigns that reach both consumers and policymakers. This is necessary to prevent unintended negative outcomes that may arise when trying to meet the continuously growing demand for resources.

5.3. The role of information

While information provision can somewhat influence specific perceptions and encourage society to compare palm oil to other vegetable oils across direct and importantly indirect domains, the extent to which information can sway status quo opinions remains nuanced. The complexities of ILUC and understanding of yields are beyond what people consider when trading off different sustainability aspects. While our study assumed more of a traditional information dissemination procedure, our findings are in keeping with results from other contexts. For example, Sundaraja et al. (2022), who through their interactive study encourage Australian citizens to engage with content related to sustainable palm oil through websites and videos, find that simply increasing knowledge combined with motivation is not enough to exceed a threshold where critical thinking is required. This is even more pronounced when superseding the general aspects of sustainable palm oil and instead taking it to the next level and linking it more directly to an organisation such as the RSPO. Hobbs et al. (2022) found that even after visiting an interactive exhibit, over 80 % of the respondents were unable to recall the name of the RSPO, even when stimulated by its logo. The low levels of knowledge towards the RSPO (Ostfeld et al., 2019), as confirmed by our study, imply that building trust in an organisation requires increased interactions, improved experiences and transparency (Siegrist and Hartmann, 2020). With certification schemes and labels handling credence attributes, organisations must establish more presence and trust so that social and scientific thinking can be married. This can be implemented through different mechanisms. For example, Richartz and Abdulai (2022) suggest leveraging sustainable palm oil with the 'organic' attribute, which is more widely accepted and trusted by consumers. However, the practicality of this approach is debatable from a production standpoint. Alternatively, a more informative strategy could involve incorporating the type of oil and its means of production into a more comprehensive eco-label (Dihr et al., 2021). Despite the inherent challenges of cost, measurement complexity and lack of harmonisation across countries, implementing a standardised environmental labelling system would enable greater differentiation between production mechanisms and also tackle the abundance of labels that consumers encounter (Grunert et al., 2014). Nonetheless, when the impacts of a commodity are considered from a broader sense such as through an eco-label, it is still important to disseminate factual information and continue to engage society on these topics. Given that such labels will most likely continue to rely on third-party certifying organisations, trust and consumer acceptance cannot be assumed. There certainly is validity to social scepticism of third-party certification organisations. Studies find that the trustworthiness of overall food production systems can outweigh the significance of individualised certification schemes (van Truong et al., 2021a; van Truong et al., 2021b). This emphasises the need for continued efforts to raise awareness and educate the public about the environmental impacts of

different ingredients and their production processes. Simultaneously, since such eco-labels are still in their early stages, it is crucial that they are developed with a comprehensive consideration of issues such as geographic leakage effects, rigorous quality and audit checks, and enhanced transparency from the outset.

Alternatively, it could be argued that voluntary certification schemes such as the RSPO should be given less credibility due to the criticisms and limitations they face (Cazzolla Gatti et al., 2019; Ogahara et al., 2022). Instead, greater value should be placed on higher regulatory bodies and their policies such as the EU's due diligence law. However, while their role cannot be ignored, solely relying on such top-down policies has yielded only minor results in terms of curbing deforestation (Pendrill et al., 2022). Thus, no single policy should be complacent, and instead, a collaborative approach should be encouraged. In doing so, a greater emphasis would be placed on enhancing and implementing good agricultural and agronomic practices, with less focus on whether these are initiated by voluntary certification schemes or state-based regulatory units. Such a collaborative approach could provide mutual benefits, including the improved adoption of more stringent scientific methods by both the private and public sectors.

5.4. Limitations and scope for further research

There are several limitations to this study that should be acknowledged. Considering the low levels of awareness about palm oil, we did not distinguish between oil palm plantations and production schemes, despite clear variations in socio-ecological impacts (Atiqah et al., 2019; Azhar et al., 2015). Not differentiating between production systems and limiting the types of oil considered to the four most produced oils was done to not overburden the participants. Instead, exploring social understanding and acceptance of different production mechanisms presents itself as a scope for future research. As a short-term study, we cannot comment on how respondents' knowledge was assimilated in the first place. We are also unable to comment on how information provision and retention may influence judgements, perceptions and subsequent actions in the longer term. Given that it is an exploratory study, internal and external validity may be compromised. Nonetheless, our findings still offer valuable insights that can serve as the basis for more robust research.

6. Conclusions

In the pursuit of a more sustainable future, it is essential to consider not just food production but also the participation and engagement of consumers. As the world's most produced and consumed vegetable oil, palm oil plays an important part in these discussions. Despite its efficiency in terms of output, its production has faced criticism from palm oil importing countries for its direct ecological impacts, which include tropical rainforest deforestation. However, critics often neglect the indirect land use change trade-offs that would arise if alternative vegetable oils were produced in the same quantities to meet global demands.

This study aimed to explore the role that information can play in informing individuals about such trade-offs. Providing society with appropriate and balanced information, even if it is specialised, is crucial for promoting sustainable vegetable oil consumption. Individuals struggle to fully understand the indirect trade-offs and complexities related to vegetable oil sustainability, often reverting to their instinctive sustainability judgements. While highlighting that for certain specialised content, information is valuable, results also emphasise the limitations of mere information provision. This calls for composite approaches including the dissemination of balanced information through media and policies, encouraging consumers to remain involved in the discussion. This is required to prevent further unintended social and environmental spill-over effects. However, this is becoming increasingly challenging due to the widespread adoption of a binary lens (good/bad, unsustainable/sustainable) in social judgements of sustainability. While attractive and simple, they may oversimplify the complexities of reality.

While not without challenges and far from being a silver bullet, Europe's move towards the adoption of stricter zero-deforestation and due diligence laws has the potential to push the political discourse towards more sustainable products' while lifting the burden off the shoulders of consumers. Incorporating palm oil into an eco-or climate label would allow different production systems to be considered, which could further drive this shift and make it easier for consumers to make informed judgements on product sustainability. Alongside this is an opportunity to mobilise social thinking in a similar fashion whereby palm oil is seen as a vehicle towards achieving social, economic and environmental sustainability, rather than being the roadblock.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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