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Subdimensions matter: Consumer preferences for water footprint information in environmental labels for food

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ABSTRACT

Front-of-pack (FOP) environmental labels have long been used to encourage more sustainable food choices. The wide range of sustainability dimensions relevant to food production and consequently food consumption, has led to an increasing number of FOP labels aiming to provide consumers with sufficient sustainability-related information. Consequently, there is currently a discussion about whether subdimensions should be included as part of an overall sustainability label, or if only an overall score should be shown, as it is the case with the Nutri-Score. This study aims to close this research gap. Focussing on water usage in food production this study investigates consumer preferences for water footprint information as a subdimension of an environmental label compared to an environmental label with no subdimensions. A choice experiment was conducted in autumn 2024 with n = 998 German consumers, representative of the German population in terms of gender, age and education. The results of the random parameter logit model show that consumers' marginal utility is highest for an environmental label that includes a low water footprint subdimension. A sole environmental label as well as the environmental label showing a high water footprint have a negative effect on consumers' purchasing decisions. The study contributes to the scientific discourse on label design and information provision to facilitate sustainable choices. Additionally, practical recommendations can be derived regarding the importance of water footprint information in consumers' food purchasing process.

Introduction

The sustainability transition of our current food system requires demand-side mitigation solutions including behavioural changes (IPPC, 2023). However, changing consumers' consumption behaviour is challenging. Since sustainability is a credence attribute, consumers cannot assess the level of sustainability either before or after purchasing the product. Therefore, consumers need to rely on additional information to evaluate the degree of sustainability of the production process (de Boer, 2003). FOP labelling is a non-intrusive, socially accepted, and widely applied approach in the food industry for providing consumers with concise information about the environmental impact of a product aiming to facilitate sustainable food choices (Dorisse et al., 2025). The wide range of sustainability dimensions relevant to food production and consequently, food consumption (e.g., climate impact, biodiversity, and animal welfare) has led to a growing number of FOP labels. Consequently, some scholars have pointed out that the abundance of sustainability-related information that consumers encounter during grocery shopping can lead to information overload, confusion, and a general sense of scepticism among consumers (Torma and Thøgersen, 2021). This may result in consumers acting in less sustainable ways, such as reducing shopping time and searching (Garaus, Wagner, and Kummer, 2015) or engaging in impulsive shopping behaviour (Fitzgerald, Russo Donovan, Kees, and Kozup, 2019). To overcome these challenges the introduction of an overarching label that condenses existing sustainability dimensions to signal a product's overall sustainability performance (Torma and Thøgersen, 2023) has been proposed. However, it is not fully understood whether this approach reduces consumers' confusion and thus provides a promising approach to foster sustainable choices, and previous scientific research has produced inconsistent findings (Torma and Thøgersen, 2023). Furthermore, it is currently being discussed whether subdimensions should be included as

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part of an overall environmental label or whether only an overall score should be shown, as it is the case with the Nutri-Score.

The question of how to design labels, and whether to provide consumers with a sole environmental label or adding subdimensions, becomes particularly evident when introducing new sustainability-related information not covered by existing FOP labels. One example is information of the water footprint in food production. Although the urgency of sustainable water management has been acknowledged in research (Richardson et al., 2023) as well as on the political agenda (e.g., Sustainable Development Goals by the United Nations), consumers have limited to no information available to them about whether the production processes are characterized by low- or high water footprint.

This study aims to contribute to the ongoing discussion on sustainability labelling in food production by focusing on the water footprint. This crucial yet often overlooked dimension of sustainability is key to communicating the environmental impact of food production to consumers. Therefore, by using water footprint as a concrete case this study investigates (1) whether consumers are willing to pay a price premium for the introduction of an additional environmental dimension (i.e. water footprint) and (2) whether consumers would prefer this information to be communicated via a single overall environmental label or via a subdimension that explicitly include the information (i.e., water footprint). It contributes to the scientific discussion on label design and information provision when a new sustainability dimension is introduced. Based on the results, practical recommendations can be derived regarding the importance of providing water footprint information on food products.

Background and literature review

The effectiveness of labels providing sustainability-related information has been proven in many previous studies (Jürkenbeck, Sanchez-Siles, and Siegrist, 2024; Sonntag, Lemken, Spiller, and Schulze, 2022). In particular, the traffic-light-labelling approach (i.e. a label showing multiple levels, with levels being highlighted with red = high water footprint to green = low water footprint) stands out as one of the most promising labelling approaches to facilitate sustainable choices (Osman and Thornton, 2019). Since food production and thus, consumption is associated with a variety of environmental consequences, a large number of (traffic-light) labels aiming to inform consumers about the environmental impact of products, has been introduced (Janßen and Langen, 2017; Torma and Thøgersen, 2021). Introducing additional environmental dimensions such as - key to this study - water footprint, lead to an even greater number of (traffic-light) labels on the market. This results in products carrying different labels, each informing consumers about different environmental or sustainability-related aspects (Dorisse et al., 2025). The large number of labels has the potential to lead to consumer confusion, in particular, because oftentimes consumer struggle with understanding the meaning of various labels or differentiate between them (Amos et al., 2019). When multiple labels appear on the same product, consumer confusion might intensify since consumers must process multiple pieces of information at the same time (Checco et al., 2026). When consumers are confronted with too many different labels on a specific product, their decision-making confidence may be reduced and they may find it more difficult to understand the information (e.g. Fitzgerald et al., 2019; Kusi et al., 2022;). More, being overexposed to label information can create scepticism and undermine trust in the labelling system (e.g., Cook et al., 2023).

In most cases, these challenges occur independently of consumers' underlying motivational processes. As such, even consumers who are highly interested in environmentally friendly food products, in most cases, cannot entirely process all label information. To relieve consumers' processing capacity and cognitive resources, overall environmental labelling) has been increasingly discussed. It remains unclear to what extent consumers prefer this approach and whether it leads to more sustainable food choices (Torma and Thøgersen, 2023).

Whether introducing a sole overall environmental label or to add subdimensions becomes particularly relevant when introducing environmental information that has not yet been covered by existing FOP labels. One example is the water footprint in food production.The global food system relies heavily on the exploitation and depletion of natural resources, with agriculture having the most significant effect on the quality and quantity of surface and groundwater resources (European Environment Agency, 2024). Food production and consumption are major drivers of freshwater pollution and account for >70 % of global freshwater withdrawals (Halpern, et al. 2022). According to the planetary boundaries' framework, freshwater use has already exceeded a critical threshold which in turn, threatens to destabilize the water cycle as well as the availability and quality of water resources (Rockström et al., 2009). With extreme water conditions, such as droughts and floods, becoming increasingly evident (Rodell and Li, 2023), shifting toward more sustainable water management practices in agricultural production as well as food consumption is crucial. To support such a shift, it is important to make water-related impacts more visible and comparable. In the context of food production, the water footprint is a measure of the amount of water used to produce goods and services (absolute water usage). It can be measured for a single production process, such as growing rice, for a product, such as the packaging of rice, or for an entire multi-national food company. The water footprint can also inform consumers about how much water is being consumed by a particular country or globally (Water footprint network, 2025).

Although the urgency of sustainable water management is widely recognized in research (Richardson et al., 2023) and policy (e.g., the UN Sustainable Development Goals), consumers still have little information on water footprint in food production. Similarly, research into how consumers prefer to receive additional environmental information remains limited.

A recent poll by Zühlsdorf, Jürkenbeck, Schulze, and Spiller (2025) suggested that although many German consumers are aware of the urgency of preserving water resources, when it comes to food choices, only 28–44 % state that they frequently adjust their food choices to save water. Similarly, Grebitus et al., 2015, investigated consumer preferences for water footprint in the production process of potatoes. The authors provided participants with information on the water footprint in litres and found that consumers favoured lower water footprint in food production. Further, research on whether consumers prefer additional subdimensions that provide information on some of the underlying environmental dimensions is lacking.

Material and method

Data collection and experimental design

Data collection took place between October 08–13, 2024 by means of an online questionnaire in Germany. The online access panel provider (Bilendi GmbH) was responsible for recruiting the participants. The University of Goettingen granted ethical approval for this study. Quota sampling was employed with quotas set for gender, age, and education to mimic the German population in these characteristics. To ensure high data quality, two quality check questions (e.g., To check for your continuous attention, please select "agree") were included. Participants who answered incorrectly were directly excluded ($n = 605$). A further 90 participants were excluded due to rapid response behaviour (<1/2 of the median response time). Thus, the dataset consists of 1020 participants for further statistical analysis. For the analysis of the choice experiment, participants who never purchase rice ($n = 22$) were excluded from the dataset.The questionnaire was built up of different parts. In the first part, participants were asked to indicate sociodemographic characteristics, followed by questions regarding participants food shopping behaviour. Subsequently, a discrete choice experiment had to be answered. Due to the hypothetical nature of the choice experiment, participants were given a cheap talk script. Cheap talk scripts are a common approach to reduce hypothetical bias by encouraging participants to answer realistically and honestly (Lusk, 2003).

Choice experiments are based on the Theory of Consumer Behaviour (Lancaster, 1966) and the Random Utility Theory (McFadden, 1986). The Theory of Consumer Behaviour assumes that a consumer derives the utility from various product characteristics and not just from the product itself (Lancaster, 1966) while the Random Utility Theory assumes that an individual, would choose the product that provides the highest utility, when presented with different alternatives (McFadden, 1986). Choice experiments have been widely applied to elicit consumer preferences in terms of sustainable food characteristics (Jürkenbeck and Schulze 2024; Yang et al., 2021).

The choice experiment consisted of four attributes describing product characteristics of basmati rice. Rice was selected due to its high projected global warming potential within the food system, ranking second after meat products (Ivanovich, Sun, Gordon, and Ocko, 2023). Further, it is a food consumed by people of all dietary preferences. The attributes included were price, production method, origin, and an environmental label.

Product price was included due to consumers widely known preferences for economic incentives (Hempel and Roosen, 2024; Steenhuis, Waterlander, and Mul, 2011), to provide participants with as realistic as possible choice scenarios, as well as methodological reasons (i.e., to be able to calculate consumers' willingness-to-pay for each attribute). Price levels ranged from 1.99 to 4.39 €/500 g and were selected according to average prices of organic and conventional rice sold in German supermarkets in autumn 2024. In terms of production methods, both conventional cultivation and organic cultivation were represented as attribute levels. Production method was included due to the well-established evidence that consumers value organic production when it comes to food choices (Jürkenbeck, Hölker, and Spiller, 2023; Rana and Paul, 2020).

Origin was included due to the importance of the water footprint depending on the geographic origin of a food product. To ensure that the characteristics of each country and the water subdimension correspond to reality, the values for blue water scarcity were used for the operationalisation. The selected countries for the attribute origin had to be represented in the top 10 rice import countries to Germany (Statista, 2023). In addition, the selected countries had to realistically represent the water availability (no blue water scarcity) in rice cultivation (Water Footprint Assessment Tool, 2020) to reflect the two score levels for the water subdimension. For this reason, India and Vietnam were selected. India is the fourth most important importing country (Statista, 2023) and there is a severe blue water shortage in rice cultivation (Water Footprint Assessment Tool, 2020). Vietnam is the seventh most important importing country (Statista, 2023) and there is sufficient blue water available in rice cultivation . As the aim of this study was to analyse to what extent the water footprint of food products has an influence on the purchasing decision, an environmental label was integrated (Water Footprint Assessment Tool, 2020).

The study included an environmental label with an aggregated overall score as well as the aggregated environmental label, which was expanded by three subdimensions to show information on specific environmental aspects. The aggregate score always had the rating C (yellow), as research shows that yellow is perceived as neutral in a traffic light label (Jürkenbeck, 2023) and thus the influence that the aggregate score has on the subdimensions can also be considered neutral. The included subdimensions were climate, species diversity and water. The subdimensions were sorted alphabetically and here too, the subdimensions species diversity and climate had the score C (yellow). We have chosen these three subdimensions because they have a major influence on the food system. First, the global food system is a significant contributor to climate change, accounting for approximately 21–37 % of total greenhouse gas emissions. Moreover, it is highly vulnerable to the adverse effects of climate change (Willett et al., 2019). Second, the planetary boundary relating to biodiversity, and specifically genetic diversity, has already been exceeded, highlighting the urgent need for transformative action (Persson et al., 2022; Steffen et al., 2015). The global food system is a major driver of biodiversity loss, accounting for around 70 % of the decline in terrestrial biodiversity and 50 % of the decline in freshwater biodiversity (IPBES, 2019). Third, the food system account for >70 % of global freshwater withdrawals and is a major cause of water pollution (Halpern et al., 2022). In the experimental design, the climate and biodiversity scores always remained the same and only the score levels for the water subdimension varied. These varied between the level dark green (low water footprint) and the level dark red (high water footprint). The participants did not receive any information about the dimensions in which their scores varied; they had to derive this themselves from repeated observations. The water information displayed on the environmental label communicates the product's water footprint, defined as the total amount of water used to produce the product (i.e., absolute water use).

Table 1 provides an overview of the attributes and corresponding levels that were considered in the experiment while Fig. 1 depicts an example of a choice set. A table consisting of the translations of the attributes and levels is in Appendix A, Table A1.

The D-efficient choice design was generated with Stata 17 using the dcreate command. The D-efficiency of the constrained design was 0.995. A restriction was taken into account in the design. The score level for the sub dimension dark green (no scarcity) was only considered with Vietnam and the score level for the sub dimension dark red was only considered with India to provide truthful information. This approach was chosen to represent realistic characteristics. During the experiment, participants evaluated 7 choice sets. Each consisted of three alternative products and a no-buy option. Alternatives in each choice scenario were randomly presented in order as well as sequence. The no-buy option was always presented last.

Subsequent data analysis was performed using Stata 17. Effect coding was used for all attributes except for price, which was metrically coded. A random parameter logit (RPL) model using the 'cmxtmixlogit' command was applied to panel data. The panel-data mixed logit model is used when a decision maker makes repeated choices over time. It calculates the probability of selecting each alternative at each time point (StataCorp, 2026). All attributes, except for price, were modelled as random parameter assuming normal distribution. This was done to account for unobserved preference heterogeneity across respondents, as these attributes are likely to be evaluated differently depending on individual values, norms or prior experiences. In contrast, price was modelled as a fixed parameter. This specification is common in DCE analysis (e.g. Schulze et al., 2021). In order to assess the model fit, a fixed parameter model was also calculated using the command 'cmxtmixlogit'.

Further, willingness-to-pay (WTP) measures using the wtp command were calculated for each attribute level. The confidence intervals of the WTP values were calculated based on the Krinsky and Robb (1986) method. This method is also referred to as parametric bootstrap and is based on Monte Carlo simulation (Hensher et al., 2015). We used 1000

Table 1
Attributes and levels of the choice experiment.

Attribute	Level
Environmental label	Total score
	Total score with subdimension - water green
	Total score with subdimension - water red
	No information
Production method	Organic No information
Origin	India
	Vietnam
	No information
Price (€/500 g)	1.99
	2.79
	3.59
	4.39

Fig. 1. Example of a choice set.

Hammersley pseudo-random draws.

Results

A total of 998 respondents were included in the final data analysis. The sample reflected the German population in the characteristics age, gender and education quite well. Table 2 provides an overview of the sample characteristics.

The estimated RPL model exhibited a good model fit (Pseudo $R^2 = 0.17$). Compared to an RPL model with fixed parameters only, the random-parameters RPL model achieved a better fit, as reflected in lower AIC (15,801.01 vs. 14,968.96) and BIC (15,869.53 vs. 15,078.58) values.Standard deviations for random parameters were highly significant, indicating unobserved preference heterogeneity (Hensher et al., 2005). The overall preference structure is shown in Table 3. All coefficients of the attribute levels had a significant influence on consumer preferences. The attribute 'environmental label' showed a negative utility for 'total score with subdimension – water red' and 'total score' while the 'total score with subdimension – water green' is positive compared to 'no information'. The organic label increases consumers utility. In terms of the origin, India increases consumers utility while Vietnam decreases their utility compared to 'no information'. The price has a negative utility, depicting that consumers' utility decreases when the price of rice increases.

Subsequently, willingness-to-pay (WTP) values were calculated to facilitate comparisons across attributes. Marginal WTP is the amount of money that consumers are willing to pay for a prescribed change in production, assuming that the change in utility is zero (Hensher et al., 2015). WTP values thus show the relative importance of the attribute levels. However, they should not be interpreted as actual market prices. Consumers have the highest WTP for the 'total score with subdimension - water green'. In fact, consumers are willing to pay 0.65€/500 g which is 20,4 % more for rice with such a label. Besides, WTP measures revealed that consumers were willing to pay a price premium for 'organic production', 0.29€/500 g (9.1 %) and for 'India' 0.12€/500 g (3.8 %). For attribute levels with negative utility values, the

Table 2
Sample description.

Variable	Characteristics	Sample (%)	German population* (%)
Gender	Male	50.7	51.5
	Female	49.1	48.5
Age (years)	16–34	25.1	26.6
	35–49	21.3	22.4
	50–64	27.5	27.6
	65+	26.2	23.4
Education	No qualification (yet) & certificate of secondary education	35.6	34.2
	General certificate of education	30.2	30.8
	General qualification for university entrance	34.2	34.8

* Source: Statistisches Bundesamt 2021.

Table 3
Consumer preferences and WTP.

Attribute	Level	ß coefficient	Standard Deviation[1]	p	WTP (relative %)	95 % confidence interval	
Environmental label	Total score	−0.107	0.157	0.037	−0.09 (−2.8)	−0.16	−0.01
	Total score with subdimension - water green	0.813	0.765	0.000	0.65 (20.4)	0.53	0.78
	Total score with subdimension - water red	−0.144	0.704	0.005	−0.12 (−3.8)	−0.20	−0.03
Production method	Organic	0.358	0.739	0.000	0.29 (9.1)	0.21	0.38
Origin	India	0.152	1.015	0.009	0.12 (3.8)	0.03	0.24
	Vietnam	−0.378	0.467	0.000	−0.30 (−9.4)	−0.40	−0.22
Price (€/500 g)		−1.250		0.000			

Log-likelihood: −7468.4781, base alternative: no purchase option, Wald chi2 =1097.68 Prob > chi2 = 0.0000, n = 998, WTP = marginal willingness to pay value calculated using Stata command 'wtp'; 95 % confidence intervals of WTP values using the Krinsky Robb method; relative percentage change (relative %) is calculated by dividing the WTP value by the mean of the four price levels (1.99+2.79+3.59+4.39 = 3.19€) e.g. 0.65€/3.19€ = 20.4 %.

[1] Standard deviations for random parameters were all significant.

corresponding WTP estimates were also negative, indicating a reduced likelihood of purchasing products with these attributes.

Discussion

The aim of this study was to provide insights into consumer preferences regarding water footprint information and to examine whether consumers would prefer a sole environmental label or an environmental label with subdimensions. Overall, consumers' were willing to pay the highest price premium of 0.65€ for the total score with subdimensions where water was labelled green. Thus, consumers appreciate information on (low) water footprint in food production. This is a promising finding, given that 70 % of freshwater withdrawals come from agricultural production. Based on these results and on previous research showing that products with reduced water consumption have a higher WTP than products with regular water consumption (Jürkenbeck and Schulze, 2024), informing consumers about the water footprint in food production is promising to guide consumers toward sustainable food consumption behaviour. However, it should be noted that €0.65 represents a premium of approximately 20 %. This seems high for a food product such as rice with an environmental label and should be considered when launching such labels on the market. In contrast, the negative WTP values show price reductions that would be necessary to market rice with such characteristics. For example, the total score led to a price reduction of 2.8 %. Overall, the results support earlier studies highlighting that environmental labelling is valued by consumers (Torma and Thøgersen 2023). Providing consumers with subdimensions compared to just providing a sole environmental label is even more promising. Consumers seem to value the more detailed information that subdimensions offer. In line with previous research showing that consumers can process (even conflicting) sustainability information (Sonntag et al., 2022), additional subdimensions do not seem to foster consumer confusion. Subdimensions that reveal less environmentally favorable information, such as a high water footprint, reduce consumers' likelihood to buy the product which is promising for the sustainability transition. However, also differences to previous literature could be found: The sole environmental label with the yellow rating (C) showed a negative WTP. This result differs from previous research, which showed that the yellow rating has a neutral influence (Jürkenbeck, 2023) and that the red rating has the strongest influence (Marette, 2022; Zhang, Liu, Gu, Wang, and Chen, 2020).

Importantly, it should be noted that WTP values show the relative importance of attribute levels, though, they should be interpreted as actual market prices. Negative WTP values should not be interpreted as a complete rejection of the respective attribute levels but rather as indicating a required price discount to compensate for the associated loss in utility. These values represent the price reduction necessary for consumers to consider products with less favorable attributes, such as total score, total score with subdimension – water red, or Vietnam origin, as equally attractive as the reference alternative.

This study, thus, provides scientific evidence of the advantages of an environmental label with subdimensions versus a sole environmental label. In contrast, the increasing scientific and public concern that consumers are overwhelmed by information (i.e., labels) and are therefore confused, is not reflected in the results of this study, which show that consumers prefer additional information, such as subdimensions compared to a sole environmental label. This suggests that consumers can engage with more detailed environmental information. However, products that have a negative environmental impact are less attractive to consumers. Previous studies showed that consumers tend to avoid foods with a red label (Carlsson, Kataria, Lampi, Nyberg, and Sterner, 2021; Zhang, Liu, Gu, Wang, and Chen, 2020b), which in turn supports environmentally friendly food choices. Thus, these findings show that labels providing consumers with subdimensions enhance informed decision-making as well as guiding consumption choices away from environmentally harmful products.

In addition to information on water footprint, the choice experiment included other food product attributes, the results of which are discussed below. In line with previous literature, organic production is a favoured product attribute for consumers when purchasing food (Aitken, Watkins, Williams, and Kean, 2020) particularly rice (Fang, Zhou, Wang, and Zhang, 2024). Similar to results from Yuan, Jin, and Wu (2024), organic production achieves the second highest WTP among the attributes. Several reasons may explain why the organic attribute does not outperform the environmental label showing the green water footprint information. First, many consumers are already familiar with organic labelling. Since consumers tend to allocate greater attention to unfamiliar information, well-known attributes such as organic may therefore receive less attention, whereas newly introduced labels, such as the water footprint label, might stand out as more salient resulting in stronger preference effects (Wilson et al., 2016). Second, next to environmental benefits, consumers often associate organic production with additional product benefits such as taste (Fillion and Arazi, 2002) or healthiness (Roy et al., 2023). Consequently, the organic label may not be interpreted as a purely environmental signal. In this context, this broader and less specific meaning may have led to reduced preferences for organic relative to the more narrowly defined information provided by the green water footprint label highlighting reduced water use in production. As highlighted in previous studies, information on the origin of food products impacts consumers' food choices (Thøgersen, 2023). Likewise, in this study, origin and the corresponding levels significantly influenced consumers' purchasing decisions. However, there were differences between India and Vietnam and contradictory results for the respective levels. While consumers valued rice originating from India, consumers rejected rice from Vietnam. As we have a constrained design, it is possible that the observed origin preference may be intertwined with water-related perceptions. Additionally, there is a lack of prior research on how European consumers perceive food and in particular rice from India or Vietnam. As a result, no direct comparisons can be made to previous studies. However, existing research on consumer preferences for information about the origin of foods has shown that consumers value domestic or local products (Feldmann and Hamm, 2015) over other origins. Since rice sold in German supermarket cannot be produced locally, origin information may serve as a proxy for better quality, food safety, environmental friendliness etc. (Thøgersen, 2023). The reason why consumers perceive rice from India positively remains unclear. However, research highlights that consumers often lack a profound understanding of what origin information implied. Thus, the results of this study highlight the relevance of origin information, while also suggesting that the contradicting results regarding rice from Vietnam vs. India, could stem from a knowledge deficit among consumers (Thøgersen, 2023).

Theoretical and practical contribution

This study extends existing research on consumers' responses to environmental labelling. By focusing on consumer preferences for water footprint information, this study is one of the first studies providing scientific evidence on this topic. By operationalizing the water footprint as a subdimension within an overall environmental label, this research contributes to the theoretical understanding of how specific environmental impacts influence consumer preferences. Further, the findings contribute to the scientific discussion on information overload and consumer confusion when confronted with multiple environmental information. The results show that consumers prefer environmental labels that include subdimensions over a sole, aggregated environmental score. This supports and extends prior research suggesting that consumers can process multiple sustainability cues and even conflicting information (e.g., Sonntag et al., 2022). Furthermore, the results contribute to the literature on salience in decision making processes. The finding that green water footprint information generated higher willingness-to-pay than the organic attribute suggests that novel and more specific sustainability information can outweigh well-established labels.

Finally, by identifying unexplained differences in consumer preferences between rice from India and Vietnam, the study highlights the role of knowledge gaps regarding environmentally friendly food choices. This finding highlights that future research on how consumers interpret origin information, in globalized food supply chains is needed.

From a practical perspective, the results have implications for policymakers, retailers, and manufacturers. Consumers' preference for the green water footprint label suggests that communicating reduced water use in food production can be a promising lever to promote more sustainable food choices. Moreover, because environmental labels with subdimensions outperform sole environmental labels, labelling schemes should provide transparent and differentiated information on specific environmental impacts, such as water footprint.

In addition, the results underline the relevance of origin information for consumer decision-making. The counterintuitive findings regarding preferences for rice from different countries of origin suggest that origin labels may be interpreted as proxies for quality, safety, or sustainability, rather than as direct indicators of water scarcity.In the long term, integrating water subdimension into an environmental label can lead to more sustainable rice cultivation. The water subdimension therefore has an impact on the entire rice supply chain. Besides, our results help to inform future eco-labelling policies. Overall, this study is pioneering the operationalization of the water footprint as a subdimension for labels, which will be relevant for upcoming holistic labelling schemes.

Limitations and future research

This research has limitations that are discussed in the following. Although choice experiments have been successfully applied in various studies (Jürkenbeck and Schulze 2024; Yang et al., 2021) and including a cheap talk script has been shown to significantly increases response quality (Lusk, 2003), the results of this study are based on a hypothetical experiment. While this study provides insights into how consumers perceive environmental labelling, it does not investigate the underlying cognitive and motivational mechanisms driving consumers' decision-making process. This should be investigated in future studies to further understand why consumers prefer specific forms of information. Besides, usually the food shopping environment is noisier, therefore the controlled information environment may have increased the impact of the label relative to real-world shelves. As such, the study would have benefited from analysing real-world behavioral data to validate the stated preferences. Collaborating with supermarkets could allow for observing actual purchasing behavior and testing how consumers respond to different water footprint information in real purchase scenarios. Such a field study would not only strengthen the external validity of the findings but also provide deeper insights into how consumers perceive and process information on water footprint in food environments, where additional contextual factors (e.g., product assortment) might influence their purchasing decisions. Additionally, the water footprint concept in food labelling is novel, and therefore stated preferences may change once consumers are more familiar with such labels. Furthermore, cross-country comparisons would be beneficial to enhance the generalizability of the results. Additionally, quotas were set for age, gender, and education but not for region or income. The experimental design only considered one constraint concerning organic production and price. Although this approach had benefits, it risks that participants may have seen combinations where the lowest price of 1.99 € was shown for organic rice. Besides, we cannot completely disentangle preferences for origin from preferences for water footprint information. As this study only investigated rice, the results can only be transferred to other food products to a limited extent. However, the results may be applicable to similar products, such as pasta and cereals, which have comparable consumption contexts and product characteristics from a consumer perspective. Although production-related factors such as the water footprint may differ between these products, we focus on the consumption context, in which consumers tend to perceive rice and pasta as interchangeable sources of carbohydrates. Future research could further examine product-specific differences, for example between locally produced wheat and imported rice varieties such as basmati or arborio. Additionally, more evidence as well as a deeper understanding of underlying mechanisms explaining the counterintuitive findings for consumer preferences for India and Vietnam is needed.

Ethic statement

Ethical approval was granted by the University of Goettingen.

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CRediT authorship contribution statement

Kristin Jürkenbeck: Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Maureen Schulze:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

There is no conflict of interest.

Appendix A. Table A1

Table A1
Translation of the attributes and levels of the choice experiment.

Original German attribute names	Translation of attribute names	Original German level names	Translation of level names
Umweltlabel	Environmental label	Gesamtscore	Total score
		Gesamtscore mit Unterdimension - Wasser grün	Total score with subdimension - water green
		Gesamtscore mit Unterdimension – Wasser rot	Total score with subdimension - water red
Produktionsmethode	Production method	Bio	Organic
Herkunft	Origin	Indien	India
		Vietnam	Vietnam
Preis	Price	1,99	1.99
		2,79	2.79
		3,59	3.59
		4,39	4.39

Data availability

Data will be made available on request.

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