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How do rice consumers trade off sustainability and health labels? Evidence from Vietnam

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Introduction: Strategies for increasing rice production in the Asian Mega-Deltas have led to environmental degradation, resource overexploitation, and high greenhouse gas emissions. Certified sustainable production labels can support governments in their efforts to render rice value chains more sustainable by simultaneously fostering planetary and human health. Little is known, however, about how consumers trade off sustainability and health attributes in staple crops such as rice. This study aims to fill this knowledge gap by investigating Vietnamese consumers' preferences and willingness to pay for rice characterized by multi-attribute sustainability and health certification labels.

Methods: We collected empirical data from 410 supermarket consumers in Can Tho, Vietnam using a choice experiment survey. The results were analyzed using a mixed logit model to determine consumers' preferences for sustainability and health traits in rice. Four price levels were used to elicit willingness-to-pay for four certification labels: low-emission, eco-friendly, ethically produced, and low glycemic index rice. By separating the components that make up the concept of sustainability and by including a label related to personal health and diet preferences, we are able to gain an understanding of the value consumers place on attributes that benefit the common good vs. attributes that benefit the individual consumer.

Results: The results showed that consumers were willing to pay a price premium for all certification labels, with the highest marginal utility assigned to low glycemic index rice.

Discussion: Certification of eco-friendly and ethical production generated similar utility levels, while low-emission rice was valued lower, although it still fetched a significant price premium compared to the status-quo option of rice with no certifications. The results of this study can help policymakers and value chain actors develop rice value chains that integrate sustainable production practices as well as foster the nutrition and health of rice consumers.

KEYWORDS

certification label, sustainability, health, rice, consumer, choice experiment

Introduction

Rice production is among the most crucial economic operations in the Global South (Global Rice Science Partnership (GRISP)., 2013). Rice is the primary food source for nearly half of the global population, providing 40 to 65 percent of the calories in tropical Asia. In countries like Bangladesh and Myanmar, it accounts for over 60 percent of protein consumption, and in Indonesia, Thailand, and the Philippines, it contributes for 30 to 40 percent (Fairhurst and Dobermann, 2002). However, rice farming is also a substantial source of atmospheric methane emissions, accounting for 5–20 percent of all anthropogenic methane emissions worldwide (IPCC, 2006; McFadden et al., 2013).

Vietnam is the fourth largest producer of rice in the world and the second largest exporter, exporting around 8 million tons (Mt) of milled rice yearly, which accounts for one-fifth of the worldwide trade volume (US$4 billion in rice exports) (Tivet and Boulakia, 2017). Vietnam's rice production has risen significantly from 25 million tons in 1995 to 44 million tons in 2018. Strategies for increasing production have primarily centered on the intensification of rice farming systems, the adoption of high-yielding varieties, intense water utilization, liberal application of agrochemicals, and mechanization of field operations (Berg and Tam, 2012). Traditional paddy rice cultivation is responsible for 50 percent of Vietnam's agricultural emissions and 15 percent of the country's overall greenhouse gas (GHG) emissions (IRRI, 2020).

The persistent emphasis on rice production intensification in the Asian Mega-Deltas has led to environmental deterioration and overuse of natural resources. Rice production systems are incredibly susceptible to the impacts of climate change and are projected to face a future of greatly reduced yields and heavily degraded ecosystems from inundation, salinization, drought, pest outbreaks, and extreme and unpredictable storms. As a result, the Vietnamese government has already taken several steps to transition to more sustainable rice farming practices in which improvements in rice productivity and quality are pursued alongside improvements in environmental protection, farmer welfare, and consumer food safety in order to achieve higher-quality and higher-value rice (Barcella et al., 2018; My et al., 2021).

Food labeling provides information on significant aspects of food items, which may encourage more sustainable food choices and increase demand (Tobi et al., 2019). Product labeling with certification logos is a tool for signaling to consumers that a product is certified (Janssen and Hamm, 2012). Producing and labeling food items as environmentally friendly might be an effective approach to distinguish food items and promote more sustainable agriculture practices (Akaichi et al., 2017). The private sector in Vietnam tends to underinvest in labeling that conveys quality features such as food safety, traceability, and rice production sustainability (Demont and Rutsaert, 2017; My et al., 2021). Certified sustainable production labels are an option for moving toward higher value rice, which is in line with the objectives of the Vietnam government's strategy for transforming the rice value chain (Demont and Rutsaert, 2017). Encouraging sustainability-related labels for quality rice can be an appropriate market-driven mechanism to address Vietnamese consumers' demand for environmentally-friendly, ethically-produced, safer, high-quality rice while simultaneously promoting and incentivizing farmers to transition to sustainable rice cultivation practices (Barcella et al., 2018; My et al., 2021). Additionally, as trade agreements trend toward sustainability requirements, this transition may be a necessity for market entry into higher value international markets, such as Europe. Agricultural sustainability requirements are prevalent in coffee, cocoa, palm oil, tea, cotton, sugar, soybeans, and bananas, but less so in staple crops like rice, corn, and wheat, which comprise more than 50 percent of the world crop area (Okpiaifo et al., 2020). Studies of consumers' perceptions of the sustainability of rice on a global scale have concentrated on individual label standards such as organic, fair trade, and eco-friendly labels (see reviews by My et al., 2018a, 2021), whereas few have investigated the complexity of multi-attribute sustainability labels that are composed of environmental, climate change, social, and economic factors (Okpiaifo et al., 2020; Connor et al., 2022). Even less is known about the preferences of domestic consumers for different types of sustainability traits or health attributes in countries where rice is the main staple food.

According to Vietnam's General Statistics Office, the monthly average rice consumption in 2020 was 7.61 kg per capita (General Statistics Office of Vietnam (GSO)., 2021a). Consumers are becoming more interested in how their food is produced; in addition to the physical features of their food, they are becoming increasingly concerned about its social, ethical, environmental, and climatic impact attributes (Vermeir and Verbeke, 2006; Briggeman and Lusk, 2011). Consumption of food is no longer limited to the satisfying of fundamental necessities; it increasingly entails considerations on the social, environmental, cultural, and ethical sustainability of the production process (Cecchini et al., 2018). However, disentangling the value, as perceived by consumers, that each of these individual attributes contributes to the overall value of product sustainability has not been investigated. Further, little is known on the value of bundling individual sustainability attributes into a single label, compared to the value of single attribute labels that construct the concept of sustainability.

The purpose of this study is to investigate Vietnamese consumers' preferences and willingness to pay for rice that is branded with eco-friendly, low-emission, ethically produced and low glycemic index certification labels. The discrete choice experiment methodology was chosen to test hypothetical product labeling given that not all attributes are currently available on the market and we wanted to avoid brand or label recognition that could influence consumers' choices. The

theoretical basis for health and sustainability attributes in the discrete choice experiment is based on Lancasters' theory of consumer choice. Health and sustainability are intrinsic and extrinsic attributes that build the product's utility. Therefore, to estimate the utility of these attributes, we test them in a discrete choice experiment context. The results are used to develop an understanding of the relative value of different food labels to domestic consumers. By separating the components that make up the concept of "sustainability," and by including a label related to personal health and diet preferences, we are able to gain an understanding of the value consumers place on attributes that benefit the common good, such as ethical treatment and welfare of agricultural workers, food produced with a reduced carbon footprint and reduced negative ecological impacts, vs. attributes that benefit the individual consumer, such as nutrition and health-related food traits.

Literature review

Utility is the ability or power of a product to satisfy a want of a consumer (Wetzstein, 2012). Lancaster's consumer choice theory is based on the assumption that utility is derived from the attributes or characteristics of products, as opposed to the traditional view that products are the direct objects of utility (Lancaster, 1966). Extrinsic and credence attributes such as production method, quality certification, and nutritional information are directly linked with consumers' food choices (Iop et al., 2006; De Steur et al., 2017; My et al., 2018b). Health and sustainability are intrinsic and extrinsic attributes that build the product's utility. Therefore, this study aims to test these attributes' utility in a discrete choice experiment context. With specific preferences for each of the above attributes and a budget constraint, the customer will select the bundle of attributes that maximizes his/her utility. Tebbe and von Blanckenburg (2018) also conducted an experiment to test consumer valuation of six different labels (the European Union's organic logo, the German organic label, the Bioland label, the Naturland label for organic agricultural production; the Demeter label for bio-dynamic agriculture; and fair trade label). The findings revealed that premiums do not change when the number of labels increases, regardless of whether the labels convey alternative or supplementary sustainability information.

The three pillars of sustainable food systems are: environmental, economic, and social sustainability, referring to economic viability, social supportiveness and ecological soundness (Latruffe et al., 2016). Nutrition and health aspects of food generally relate to safe consumption and the nutritional content of food. These health attributes are typically displayed through labeling schemes relaying information about food calories and nutritional content (macro and micro), nutrition-related health statements, and food safety claims. Environmental attributes include labeling programs for carbon footprint, water footprint, agrochemical/pesticide use, biodiversity, and deforestation. Social responsibility attributes relate to human or animal welfare or equity, fair wages, safe working conditions, and no child labor, particularly fair trade and animal welfare certifications (Tobi et al., 2019).

Consumers' willingness to pay for products with low carbon emission attributes has been investigated in several previous studies (Vecchio and Annunziata, 2015; Kim et al., 2016; Tait et al., 2016; Akaichi et al., 2017). Kim et al. (2016) reported that customers who were more concerned about the effect of climate change on their own life were willing to pay more to acquire the same apples with low carbon emission labeling. Akaichi et al. (2017) found that US customers were willing to pay a higher price for rice with reduced greenhouse gas emissions, lower food miles, and being locally cultivated. My et al. (2018a) found that consumers who were willing to pay a premium for sustainably produced rice were typically more environmentally aware. Connor et al. (2022) found that Vietnamese consumers with a greater understanding of the impacts of climate change were willing to pay a premium for sustainably-produced rice.

Previous literature has also assessed consumers' willingness to pay for eco-friendly rice (Khai and Yabe, 2015; Aoki et al., 2017; Liu et al., 2017; Zhou et al., 2017; My et al., 2018a,b). Khai and Yabe (2015) found that Vietnamese consumers were willing to pay an extra VND 11,000 for one kilogram of ecologically certified rice to enhance the number of wild cranes, and VND 1,500 for a 100 percent increase in the degree of biodiversity. Zhou et al. (2017) found that Chinese consumers were willing to pay more for the organic label than the green label, most likely because organic production was assumed to have more stringent standards regarding chemical and fertilizer use, and consumers perceived organic production to mean no application of any pesticide or chemical. Aoki et al. (2017) reported that Japanese consumers were considerably more willing to pay for organic rice than Thai consumers. In another study, Vietnamese consumers were willing to pay a premium for rice produced according to integrated pest management (IPM) guidelines and organic standards compared to conventionally produced rice (My et al., 2018b).

Consumers' willingness to pay for products with ethical attributes has been widely investigated as well (De Pelsmacker et al., 2005; Loureiro and Lotade, 2005; de Magistris et al., 2015; Vecchio and Annunziata, 2015; Sepúlveda et al., 2016; Bissinger and Leufkens, 2017; Ghvanidze et al., 2017). De Pelsmacker et al. (2005) reported that the average price premium paid by Belgian consumers for a fair trade label on coffee was a 10% increase. Vecchio and Annunziata (2015) found that youngsters were willing to pay extra for items with ethical production attributes. Consumers were considerably more likely to pay for food items with corporate social responsibility certification than those without certification (de Magistris et al., 2015). Sepúlveda et al. (2016) reported that ethical consumers in Spain and Colombia placed a high value on fair trade coffee. In the

German market, information on producer social responsibility, such as outreach initiatives for local communities and excellent working conditions, brought positive utility for food consumers (Ghvanidze et al., 2017).

Consumers' willingness to pay for products with health attributes has also been widely researched (De Steur et al., 2010, 2022; Ghvanidze et al., 2017; My et al., 2018a,b; Ballco et al., 2019). De Steur et al. (2010) found that Chinese customers were willing to pay a premium for folate-rich genetically modified rice. Based on a systematic review of 14 studies, De Steur et al. (2022) found high consumer acceptance rates, purchase intentions, and willingness to pay (price premiums up to 67%) for provitamin A-rich "Golden Rice". My et al. (2018a) observed that health conscious consumers were willing to pay a higher premium for sustainably-produced rice. This was confirmed in another study where Vietnamese consumers were willing to pay a premium of VND 12,320 for 1 kg of rice with a claim of health benefits "rich in vitamins and other nutrients," which was equivalent to a premium of 95% over 1 kg of conventional rice (My et al., 2018b). This literature evidence suggests that consumers' perceived utility of health attributes could be of a higher order or magnitude, compared to sustainability attributes.

To the best of our knowledge, however, no studies have examined consumers' willingness to pay for a comprehensive set of attributes that comprise sustainability and health attributes. Further, there are few studies on the acceptance of food sustainability claims in domestic markets of low- and middle-income countries, despite the rapid growth of the middle class (de Koning et al., 2015) with changing food preferences and that the majority of food is grown domestically. This study aims to solve this knowledge gap by investigating consumers' preferences and willingness to pay for rice characterized by multi-attribute sustainability and health certification labels in Vietnam.

Materials and methods

Ethical considerations

The survey of this study was guided and ethically accepted by the International Rice Research Institute's (IRRI) Institutional Research Ethics Committee (IREC no. 2020-0014-A-2016-70). Respondents were informed before each interview that (i) the survey was conducted for research purposes, (ii) their participation was entirely voluntary, (iii) they could withdraw from the survey at any time, and (iv) all private information would be held in absolute confidence. The respondents gave informed consent before the beginning of the interview. When the survey was completed, each respondent received a copy of the consent form.

Choice experiments

Choice experiments are a type of choice modeling in which participants are given a number of options and requested to select their most preferred option (Bateman et al., 2002). Choice experiments involve a more experimental approach and include analysis of choice behavior (Boxall et al., 1996). This type of methodology is often used to value non-market and/or hypothetical goods that have not yet been introduced in the market. Choice experiments allow one to investigate the individual impacts of multiple product or policy alternatives using various combinations of attributes and levels. The stages for designing a choice experiment include (i) selection of attributes, (ii) attribute level assignment, (iii) choice set construction, (iv) preference measurement, and (v) estimating process (Hanley et al., 2001).

Lancaster's theory of consumer choice states that consumption decisions are driven by the utility or value derived from the attributes of a specific good consumed, which is the foundation for choice experiments (Lancaster, 1966). This approach's econometric foundation is the random utility theory, which defines discrete choices within a utility-maximizing framework (McFadden, 1974; Ben-Akiva and Lerman, 1985). Each respondent's utility function comprises a deterministic component (systematic component) composed of attributes that affect each respondent's utility and an unobservable random component (Adamowicz et al., 1994; Boxall et al., 1996; Hanley et al., 1998).

According to Hensher et al. (2015), let U_{nsj} represent the perceived utility of option j by participant n in choice scenario s. It is assumed that U_{nsj} can be divided into two distinct parts, an observable part of utility, V_{nsj}, and an unobservable part, ε_{nsj}, such that:

$$U_{nsj} = V_{nsj} + \varepsilon_{nsj}. \quad (1)$$

Typically, the observed part of utility is related to option j. V_{nsj} is expressed as a function of k variables ($\mathbf{x}_{nsjk}$) with their related preference weights β such that:

$$V_{nsj} = \sum_{k=1}^{K} \beta_k \mathbf{x}_{nsjk}, \quad (2)$$

where $\mathbf{x}_{nsjk}$ is a vector of k attributes denoting option j and/or covariates denoting either the decision maker (e.g., age, income) or certain aspects of the decision context. When an attribute k is changed by a unit, utility changes by an amount equal to β_k. The unobservable part of utility, ε_{nsj}, encompasses factors that influence utility but are not measurable by V_{nsj} and are not directly observed by the analyst. The observable part of utility is commonly supposed to be linearly related to the

observed attribute levels, **x**, of each option j and their related weights, β, with a positive scale factor, σ_n such that:

$$U_{nsj} = \sigma_n \sum_{k=1}^{n} \beta_{nk} \mathbf{x}_{nsjk} + \varepsilon_{nsj}, \quad (3)$$

where β_{nk} denotes the marginal utility or parameter weight related to attribute k for participant n. The unobservable part, ε_{nsj}, is commonly supposed to be independently and identically (IID) distributed with a Type I Extreme Value (EVI) distribution or more flexibly with a normal distribution.

In particular, the probability that participant n in choice scenario s will choose option j is provided as the probability that result j will have the maximum utility:

$$P_{nsj} = Prob\left(U_{nsj} > U_{nsi}, \forall i \neq j\right) = Prob\left(V_{nsj} + \varepsilon_{nsj} > V_{nsi} + \varepsilon_{nsi}, \forall i \neq j\right), \quad (4)$$

which can also be written as:

$$P_{nsj} = Prob\left(V_{nsj} - V_{nsi} > \varepsilon_{nsi} - \varepsilon_{nsj}, \forall i \neq j\right). \quad (5)$$

Equation (5) expresses the probability that the differences in the random parts, $\varepsilon_{nsi} - \varepsilon_{nsj}$, will be lower than those in the observable parts of utility, $V_{nsj} - V_{nsi}$.

Selection of attributes and assignment of levels

Choice experiments rely on a realistic depiction of a choice scenario through a series of attributes. Because the reliability of choice experiments is highly dependent on the correctness and fullness of the traits and features used to depict the situation (Boxall et al., 1996), attributes and levels were selected through in-depth literature review and key informant interviews (KIIs). Selected attributes in this study included low-emission, eco-friendly, ethically produced, low glycemic index, and price.

The *status quo* rice is represented by a high quality Vietnamese premium long-grain fragrant rice, commonly available on the market. The certified products are all shown with a label and a short description. Low-emission certified rice claims a reduced carbon footprint which is beneficial for the global environment. Eco-friendly certified rice claims to meet strict pesticide regulations making it better for the local environment. Certified ethically produced rice claims that it meets safe and fair working conditions and wages so it is better for people producing rice. Certified low glycemic index rice claims a slower release of energy to keep blood sugar levels more stable. The price levels were determined based on the market value for high quality Vietnamese long-grain fragrant rice (VND 20,000/kg) and four increasing price premium levels at 10, 20, 40, and 60% on top of the standard market price. Table 1 presents the attributes, description, and levels, and Figure 1 visualizes the labels.

Choice of experimental design

After identifying the critical attributes and their levels, a full factorial design was created that included all alternatives relying on the combinations of these attributes and their levels. The full factorial design is one in which all treatment combinations are numerically specified (Hensher et al., 2015). Given five attributes, a total of 64 profiles ($2 \times 2 \times 2 \times 2 \times 4 = 64$) can be gained according to the setting represented in Table 1. A profile is a combination of attributes, each with unique levels (Hensher et al., 2015).

Using the orthogonal design from SPSS Statistics 22 software (IBM), a 16-profile orthogonal fractional factorial plan was generated. The choice experiment method employs statistical design theory to create choice scenarios that can provide parameter estimates that are not influenced by other factors. The orthogonal design allows for the isolation of the impact of different attributes on choice, and the ability to "design in" this orthogonality is a significant advantage over revealed preference random utility models, in which attributes are commonly found to be highly correlated with one another in reality (Hanley et al., 1998).

The "shifted" design strategy employs modular arithmetic to append a constant to each attribute level of the original columns, resulting in the creation of one or more additional alternatives. The modular arithmetic shifts the original column so that all attributes have different levels than in the original profile (Bunch et al., 1996). In this study, the original 16 profiles were used to make the first alternative in every choice set (alternative A); the second alternative (alternative B) was created using modular arithmetic. The experimental design used in this study complied with four properties of efficient choice designs: level balance, orthogonality, minimal overlap, and utility balance.

The *status quo* and levels of each of the attributes (Table 1) were explained to consumers in detail before elicitation of their choices. Each choice set included two options and the *status quo* as the opt out scenario (Table 2 and Figure 2). Each choice set often comprises a baseline option corresponding to the *status quo* or "do nothing" situation. This is because one of the alternatives must be in the respondent's currently viable choice set for the outcome to be interpreted in standard welfare economic terms (Hanley et al., 2001).

Each consumer was asked to answer choice set cards in one of four different blocks, namely 0, 1, 2, 3. Each block contained four choice set cards. Separating choice sets into blocks is a common approach to address the trade-off between

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TABLE 1 Selected attributes and attribute levels.

Attribute	Description	Status quo	Levels
Low-emission	This premium long-grain fragrant rice is certified low-emission ensuring it has a reduced carbon footprint so it is better for the global environment	None	1. None 2. Certification
Eco-friendly	This premium long-grain fragrant rice is certified eco-friendly ensuring it meets strict pesticide regulations so it is better for the local environment	None	1. None 2. Certification
Ethically produced	This premium long-grain fragrant rice is certified for ethical production ensuring it meets safe and fair working conditions so it is better for people producing rice	None	1. None 2. Certification
Low glycemic index	This premium long-grain fragrant rice variety is certified low glycemic index ensuring a slower release of energy so it keeps blood sugar levels more stable	None	1. None 2. Certification
Price (VND/kg)	Percent above the market price of premium long-grain fragrant rice (10, 20, 40, and 60%)	20,000	1. 22,000 (10%) 2. 24,000 (20%) 3. 28,000 (40%) 4. 32,000 (60%)

Exchange rate: US$1 = VND23,209 in September 2020.

FIGURE 1
Examples of certification labels representing **(A)** ethical, **(B)** low-emission, **(C)** eco-friendly, and **(D)** low-glycemic index rice.

optimizing each respondent's attention while avoiding learning bias or fatigue among respondents (Adamowicz et al., 1998). The sample was divided into four almost equal shares allocated to each block (Table 3).

Effects coding was used for the coding of explanatory variables. It is generally preferred because it avoids correlation with intercepts and reduces collinearity in estimation matrices used to evaluate interaction effects (Bech and Gyrd-Hansen, 2005; Hoyos, 2010).

Estimation procedure

The mixed logit model (random parameter logit model) was used to determine consumers' preferences and willingness to pay for rice characterized by multi-attribute sustainability and health certification labels. The mixed logit is an extremely versatile model that can be used to approximate any random utility model (McFadden and Train, 2000). Additionally, it examines the sources of respondents' heterogeneity (Train, 2009). It completely relaxes the assumption of independently and identically distributed (IID) and irrelevant alternatives (IIA) (Train, 2009; Hensher et al., 2015). The empirical model is:

$$U_{ni} = \beta_{Low\text{-}emsission} Low\text{-}emission_{ni} + \beta_{Eco\text{-}friendly} Eco\text{-}friendly_{ni} + \beta_{Ethically\text{-}produced} Ethically\text{-}produced_{ni} + \beta_{Low\text{-}glycemic} Low\text{-}glycemic_{ni} + \beta_{Price} Price_{ni} + \varepsilon_{ni} \quad (6)$$

where U_{ni} is the utility for consumer n^{th} from choosing the i^{th} alternative.

Maximum simulated likelihood estimation (MSLE) was used to estimate the mixed logit model (McFadden and Train, 2000). This process is identical to the maximum likelihood method, with the exception that simulated probabilities are employed instead of exact probabilities (Train, 2009). In order to estimate maximum simulated likelihood, the model used Halton draws with 500 replications. All of the attributes, except price, were specified to be independently and normally distributed (Revelt

TABLE 2 Example of choice set.

Attributes	Alternative A	Alternative B	Status quo
Low-emission	None	Certification	No certification VND 20,000/kg
Eco-friendly	None	Certification	
Ethically produced	Certification	None	
Low glycemic index	Certification	None	
Price	VND 24,000/kg	VND 22,000/kg	
I prefer:	☐	☐	☐

and Train, 2000 provide several reasons for keeping the price coefficient fixed).

The estimation of marginal willingness to pay was based on the results of the choice experiment model estimation. The marginal WTP for a single attribute was calculated as the negative ratio of that attribute's coefficient to the price attribute's coefficient.

$$Marginal\ WTP = \left(-\frac{\beta_{attribute}}{\beta_{price\ attribute}}\right) \quad (7)$$

Data collection

McFadden (1984) proposed the following sample size rule of thumb for stated choice experiments: "as a general rule, sample sizes of less than thirty responses per alternative produce estimators that cannot be reliably analyzed using asymptotic methods." Orme (2010) suggested a sample size of at least 200 respondents for research requiring an analysis of sample segment differences, or 300 respondents if no such analysis was conducted. The sample size required for choice experiments can be determined as follows (Orme, 1998; Rose and Bliemer, 2013):

$$N \geq 500\frac{L^{\max}}{JS} \quad (8)$$

where $L^{\max}$ is the largest number of levels for any of the attributes, J is the number of alternatives, and S is the number of choice tasks each respondent faces. With $L^{\max} = 5, J = 3, S = 4$, the required sample size would be at least 208.

Based on these considerations, we surveyed a total sample of 410 consumers in Can Tho city in September 2020. Enumerators interviewed shoppers at the entrance of the supermarket. Consumers were randomly approached by the enumerator and asked to participate in the study. Supermarkets are regarded as reputable sources of not just safe and high-quality food but also accurate information on food quality labels and certifications. Consumers may obtain packaged rice at the supermarket with information such as rice variety, labels, country of origin, expiry date, nutrient composition, production process, and cooking directions, which ensures that rice has been regulated before reaching the shelves (Barcella et al., 2018). Only respondents who were the main food purchaser in their family and consumed rice were allowed to partake. The same eligibility requirements have been widely employed in recent studies (e.g., Van Ittersum et al., 2007; Menapace et al., 2011; Moser and Raffaelli, 2012; My et al., 2018b).

Results and discussion

Characteristics of the sample

A dataset comprising 410 respondents was acquired for investigation. Females accounted for 86%, while males comprised only 14%. This is evident from the fact that women are the primary purchasers of food in Vietnamese households. The major age group was 30–39 years and accounted for 27% of the sample. The percentages of respondents in the age groups of 40–49 and 50–59 years were 17 and 19%, respectively. In the Vietnamese population, 24.44, 19.56, and 16.34% were in the age groups of 30–39, 40–49, and 50–59 years, respectively. The most popular education levels of participants were high school and bachelor's degree; these groups accounted for 35 and 44% of the sample, respectively. In addition, 27 and 25% of respondents' household income ranged from 10.1–15.0 and 15.1–20.0 million VND per month. The socio-demographic characteristics of the sample are presented in Table 4.

Distribution of consumers

Each choice set included two alternatives (alternative A and alternative B) and the *status quo* as the opt-out scenario. Across the four blocks, 34–51% of consumers chose alternative A, 41–60% chose B, while 5–8% chose the *status quo* (Table 5).

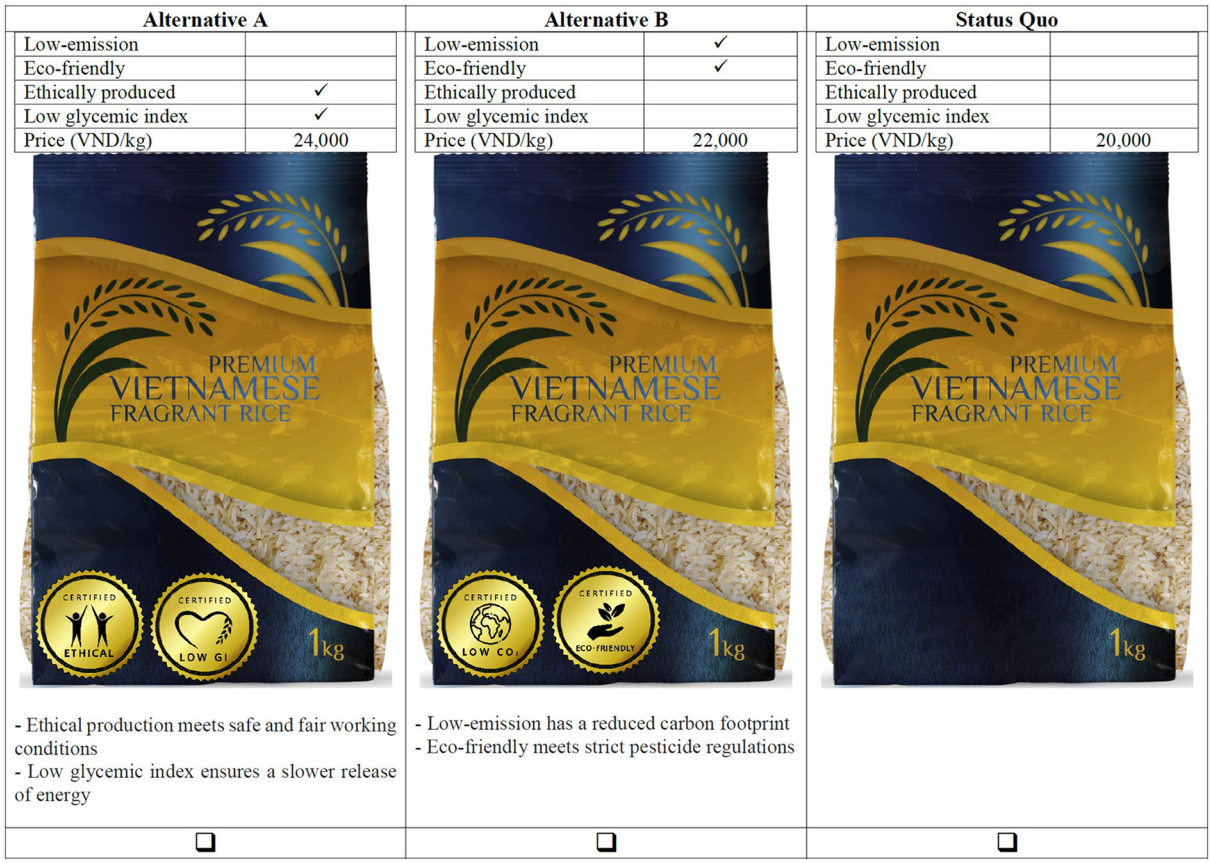

FIGURE 2
Visual depiction of a choice card.

TABLE 3 The distribution of the survey sample by block.

Block	No.	Percent
0	103	25.12
1	104	25.37
2	102	24.88
3	101	24.63
Total	410	100.00

Consumers' preferences for sustainability and health traits of rice

The mixed logit model was used to determine consumers' preferences and willingness to pay for rice characterized by multi-attribute sustainability and health certification labels. The alternative-specific constant was not included in the model since few consumers chose the *status quo* in the choice cards (Table 5). The estimated standard deviations of the random coefficients for all attributes were statistically significant, indicating the existence of unobservable heterogeneity in preferences among consumers. The estimated parameters of the model are presented in Table 6.

The coefficients of all four attributes were positive and statistically significant at 1%, indicating that consumers preferred the premium long-grain fragrant rice that ensured a reduced carbon footprint, strict pesticide regulations, safe and fair working conditions or a low glycemic index over the same packaged rice without any certification labels. The coefficient of low glycemic index had the highest magnitude, suggesting that consumers had the strongest preference for premium long-grain fragrant rice that was certified low glycemic index that has the additional health benefit of a slower release of energy during consumption.

In computing marginal WTP (Equation 7), it is crucial that the coefficients of both attributes to be employed in the estimation must be found to be statistically significant—which is clearly the case (Table 6); otherwise, no meaningful WTP inferences can be made (Hensher et al., 2015). The results of

TABLE 4 Socio-demographic characteristics of the sample ($n = 410$).

Items	Sample ($n = 410$)		Vietnam[c]	
	Number	Percent	Number (1,000 persons)	Percent
Gender				
Male	56	13.66	32,736.3	48.80
Female	354	86.34	34,342.9	51.20
Age		41.72[a] (13.36)[b]		
<30	96	23.41	14,606.5	21.78
30–39	109	26.59	16,395.9	24.44
40–49	71	17.32	13,120.5	19.56
50–59	79	19.27	10,958.9	16.34
≥60	55	13.41	11,997.2	17.89
Educational level			N.A.	N.A.
No school at all	03	0.73		
Primary school	12	2.93		
Secondary school	61	14.88		
High school	142	34.63		
Bachelor's degree	180	43.90		
Post-graduate degree	12	2.93		
Monthly household income (Million VND)			N.A.	N.A.
≤10.0	99	24.15		
10.1 – 15.0	109	26.59		
15.1 – 20.0	102	24.88		
>20.0	100	24.39		

Exchange rate: US$1 = VND23,209 in September 2020.
[a]Mean age measured in years.
[b]Standard deviation of age.
[c]The gender and age of the Vietnamese population in this table only include people from 20 years on (General Statistics Office of Vietnam (GSO)., 2021b); N.A. = not available.

TABLE 5 Distribution of the alternatives chosen by block.

Alternative	Block 0		Block 1		Block 2		Block 3	
	No.	%	No.	%	No.	%	No.	%
A	212	51.46	182	43.75	140	34.32	193	47.77
B	168	40.78	211	50.72	244	59.80	189	46.78
Status quo	32	7.77	23	5.53	24	5.88	22	5.45
Total	412	100.00	416	100.00	408	100.00	404	100.00

Each block contained four choice set cards.

marginal willingness to pay for the attributes are presented in Table 7.

Consumers were willing to pay price premiums for all four certification labels on premium long-grain fragrant rice. Price premiums were in the range of VND 5,587–13,218/kg, i.e. 28–66% on top of the price of packaged Vietnamese premium long-grain fragrant rice with no certification labels at VND 20,000/kg. However, not all certification labels were valued the same. The low-emission certification label generated the lowest marginal WTP premium of VND 5,586.66/kg (which translates into a 28% price premium compared to packaged rice with no certification labels at VND 20,000 per kg). Rice with the eco-friendly certification label garnered a premium of VND 10,453.85/kg (52%), which was comparable to the premium of VND 10,241/kg for ethically produced rice (51%). The results also showed that consumers expressed the highest WTP for rice that was certified to feature a low glycemic index, at a premium rate of VND 13,218 per kg (66%).

The results are consistent with Akaichi et al. (2017) who reported that US consumers were willing to pay a higher price

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TABLE 6 Estimated results of mixed logit model for choice experiment.

Attribute	Coefficient	Standard error	*P*-value
Low-emission	0.42132***	0.05862	0.000
Eco-friendly	0.78838***	0.08407	0.000
Ethically produced	0.77237***	0.09080	0.000
Low glycemic index	0.99688***	0.10759	0.000
Price	−0.00008***	0.00002	0.000
Standard deviation			
Low-emission	0.55112***	0.09996	0.000
Eco-friendly	0.84259***	0.10466	0.000
Ethically produced	0.95671***	0.12465	0.000
Low glycemic index	1.24027***	0.12954	0.000
Log-likelihood	−1,1199. 5963		
LR Chi2(4)	300.48		
Prob > chi2	0.0000		
Number of observations	4,920		
Number of respondents	410		

*** is significant at 1%.

for rice with lower greenhouse gas emissions. If customers prefer and are willing to pay more for rice products labeled as featuring reduced greenhouse gas emissions, then rice producers might profit from implementing low-emission practices that have global benefits (Akaichi et al., 2017). The 51% premium for ethically produced rice is in line with previous findings (Loureiro and Lotade, 2005; Vecchio and Annunziata, 2015; My et al., 2018b). Consumers were willing to pay extra for rice that assured farmers a reasonable price (My et al., 2018b). Loureiro and Lotade (2005) reported that benevolence toward other persons might play an essential role in appraising fair trade items.

This study demonstrated that Vietnamese consumers valued the premium long-grain fragrant rice that was certified eco-friendly more than no labels or low-emission labels. Consumers perceived the marginal utility for ethically produced rice to be the same as eco-friendly rice. The 52% price premium for eco-friendly rice is in line with previous studies (Khai and Yabe, 2015; Liu et al., 2017; Zhou et al., 2017). Khai and Yabe (2015) reported that consumers were willing to pay a higher price for rice without chemical pesticides. Liu et al. (2017) found positive correlations between eco-labeled rice premiums and Chinese consumers' food safety and environmental concerns. Chinese consumers were willing to pay more for the organic label than the green one, most likely because consumers perceive organic to mean no pesticides were used at all, which is a common misconception of organic agriculture (Zhou et al., 2017). It is interesting to note that although we framed "meeting strict pesticide regulations" as eco-friendly, there are also clear human health implications to strictly regulating the amount and types of pesticide residues occurring in food. Nonetheless, eco-friendly labels on rice received a lower marginal utility than the low glycemic index label which has only individual health benefits without added environmental benefits as is represented by eco-friendly rice. These higher WTP estimate for a nutrition and health-related attribute is in line with previous studies (De Steur et al., 2010, 2022; My et al., 2018b).

Vietnam has been struggling with food safety concerns, and certification labels are only emerging in the Vietnamese rice market (My et al., 2021). Since the majority of Vietnamese consumers typically purchase loose rice (Custodio et al., 2019)—which does not facilitate the communication of extrinsic attributes such as labels—we can assume that they are not yet familiar with certification labels. In light of food safety concerns, Vietnamese consumers may have perceived high utility levels for each of the labels presented in our choice experiment, as they may have been perceived as a necessary step toward the modernization of the Vietnamese rice market toward increased governance of production practices, while not yet being subject to "label fatigue." This is confirmed by our data. Overall, there was a stronger choice preference for options that had more labels compared to choice options that had fewer labels, regardless of the combination of labels. When three labels were present, consumers consistently chose this option over fewer labels even if their previous choices showed a preference for certain labels. This resonates with Vietnamese consumers' support for a rice sector that moves from no governance toward increasing certification of sustainable production practices and nutrition and health attributes.

Our findings have implications for bundled attributes that are under a single sustainability label, such as rice that is certified as compliant with the standards of the Sustainable Rice Platform (SRP). Connor et al. (2022) found that Vietnamese consumers are willing to pay a 29% price premium for SRP-certified rice. Although this is within the range of 28–66% we found for the attributes we investigated, it suggests that we cannot assume that the utilities generated by the individual attributes are additive, a common finding in surveys denoted as "part-whole bias" (e.g., Marra and Piggott, 2006). The fact that some attributes generate more consumer utility than others presents an opportunity for segmented labeling in cases where farmers can meet the specific criteria necessary for certification as ethical production, low-emission rice, or eco-friendly rice but may not have been able to meet the criteria for full SRP compliance. This de-bundling of certification labels could motivate farmers to continue on the pathway toward full sustainability if their progress is rewarded with incentives or recognition for achieving sustainability in the social, environmental, and climate domains separately. Alternatively, as carbon credits for reduced emissions in agriculture are gathering more interest, certification for emission reduction in rice production could open new doors for economic returns that can be passed on to farmers in cases where price premiums on rice at the farm level have yet to be realized.

TABLE 7 Marginal WTP (VND/kg).

Attribute	Mean	Standard error	P-value	Min	Max
Low-emission	5,586.66***	1,464.72	0.00	2,715.86	8,457.46
Eco-friendly	10,453.85***	2,342.38	0.00	5,862.88	15,044.83
Ethically produced	10,241.46***	2,393.42	0.00	5,550.44	14,932.48
Low glycemic index	13,218.48***	3,024.24	0.00	7,291.09	19,145.87

*** is significant at 1%. Exchange rate: US$1 = VND23,209 in September 2020.

Conclusion

Efforts to increase agricultural productivity in the Asian Mega-Deltas have led to environmental degradation, resource overexploitation, and high greenhouse gas emissions. Certified sustainable production labels can support governments in their efforts to render rice value chains more sustainable by simultaneously fostering planetary and human health. We investigate how consumers make trade-offs between sustainability and health certification labels through a face-to-face survey and choice experiment with 410 supermarket shoppers in Vietnam. Through a mixed logit model, we determine consumers' preferences for sustainability and health traits for rice based on five attributes, namely, low-emission, eco-friendly, ethically-produced, low glycemic index, and price. We find price premiums in the range of 28–66% of the price of non-certified Vietnamese premium long-grain fragrant rice. Premiums were at the lower end of the spectrum for low-emission certification (28%), in the mid-range for certified eco-friendly and ethically produced rice (51–52%) and highest for rice certified with low glycemic index (66%).

These premiums are consistent with the literature and suggest that consumers are willing to pay most for attributes that directly relate to their personal health and in second order for attributes that relate to planetary health and the welfare of others (e.g., rice farmers in this case). In other words, substituting planetary health for human health attributes engenders a trade-off and comes at a cost for consumers. Human health attributes attract more consumer interest and can therefore be used as a selling point for generating demand for food products that combine planetary with human health attributes. The results of this study can help policymakers and value chain actors develop rice value chains that integrate sustainable production practices as well as foster nutrition and health of rice consumers. In light of Vietnam's struggle with food safety concerns, the introduction of certification labels are a means to increase governance of production practices and food safety. Vietnam's rice sector is in the initial stages of introduction of certification and this may explain why consumers' perceived utility of labels is still high and not yet subject to label fatigue. They may have perceived certification to be a necessary step toward the modernization of the Vietnamese rice market with long-term benefits in terms of planetary and human health.

Similar studies need to be conducted in other countries that host mega-deltas where rice cultivation is productive, but at the expense of environmental and planetary health. These results are important for the Sustainable Rice Platform (SRP), more specifically for supporting the continuous improvement and fine-tuning of its Sustainable Rice Standard (currently version 2.0), but also in terms of bundling of attributes (including health attributes) with the aim of increasing consumer awareness and endorsement of sustainably-produced rice. Finally, our study advances the knowledge on consumer preferences in the context of the complex trade-offs between planetary and human health attributes. These insights can support the development of Planetary Health Diets advanced by the EAT Lancet Commission.

Future studies can explore other health attributes, such as nutritious traits (micronutrients), enriched rice with supplemental micronutrients, genetically modified vitamin A rice (Golden Rice), Fe and Zn biofortification, and low-arsenic rice. Since these attributes can often not be observed (except for Golden Rice), they are credence attributes, and credible labeling needs to be developed (e.g., My et al., 2021). Detailed market intelligence needs to be collected to understand consumers' acceptance, preferences, and needs and identify target groups and market segments that can benefit from health attributes.

This study has limitations that are important to address. The current study investigated consumers in an urban area that shop in a supermarket; hence, the results are not inclusive of all rice consumers in Vietnam. However, it is important to note that packaged rice that can be labeled will also be found in supermarkets. Future research should also investigate consumer preferences in rural areas. Furthermore, female consumers dominated the sample, and all the data was self-reported, making them susceptible to social desirability and overestimation bias due to the hypothetical nature of the study. A future market study using experimental auctions or real purchases would be recommended.

Data availability statement

Publicly available datasets were analyzed in this study. These data can be found here: Harvard Dataverse at https://doi.org/10.7910/DVN/ORLQQ7.

Ethics statement

The studies involving human participants were reviewed and approved by the International Rice Research Institute's (IRRI) Institutional Research Ethics Committee (IREC No. 2020-0014-A-2016-70). The patients/participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization and methodology: OC, MC, MD, and KN. Formal analysis, investigation and, data curation: OC. Resources, supervision, and funding acquisition: BS. Writing—original draft preparation: OC and KN. Writing—review and editing: OC, MC, MD, BS, and KN. Project administration: KN. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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