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Consumer Valuation and Preferences for Sustainably Produced Rice in Ghana

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Consumer Valuation and Preferences for Sustainably Produced Rice in Ghana

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by

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Abstract

Sustainable agricultural production is a systematic concept that integrates environmental health, economic profitability, and social/economic equity goals. Improving the sustainability of food production is of utmost importance to the human race, given the growing population and the increased depletion of natural resources. Improving sustainability is particularly important for rice, a global food staple with a significant environmental footprint. Rice accounts for 10% of global methane emissions. The Sustainable Rice Platform (SRP) standard is the first globally recognized certified sustainable production standard for rice.

This study focuses on consumers' preferences for sustainable rice in Ghana, including consumers' perceptions of different SRP's sustainability themes and their willingness to pay for sustainable rice produced following the SRP standard. A total of 1,168 consumer surveys were administered in Accra, Kumasi, and Tamale, the three largest cities in Ghana. The Best Worse Scaling Method was employed to rank the preferences of participants for each of the SRP sustainability themes. A double-bounded dichotomous choice contingent valuation method was used to elicit consumers' willingness to pay (WTP) for SRP-certified sustainable rice.

The results indicate that consumers' preferences for SRP themes and WTP for sustainably-produced rice are heterogeneous across locations. The results can be used for the development of policy and marketing strategies aimed at improving the marketability of sustainable rice in Ghana.

Acknowledgment

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Dedication

I dedicate this work to my parents, Mr. Etornam Adabrah and Mrs. Doris Adabrah, and siblings, Classic, Sylvia and Simrit. God richly bless them.

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Introduction

Rice (Oryza Sativa L.) is a global staple and the main source of calories for more than half of the world's population (Abdulai et al., 2018), accounting for more than 20% of global calories consumed (Fukagawa & Ziska, 2019). Between 2019 and 2021, roughly 164.3 million hectares were used globally to produce 507.8 million metric tons (mmt) of milled rice a year (United States Division of Agriculture [USDA], 2022).

According to the United Nations (2022), the global population is projected to increase from 7.9 billion people in 2020 to 9.8 billion people by the year 2050, and such growth will demand an even larger increase in food supply, including rice. Global rice consumption is projected to grow by about 7% over the next decade based primarily on population growth (Durand-Morat & Bairagi, 2022). While some regions of Asia are seeing a decline in per capita rice consumption, Sub-Saharan Africa (SSA) has seen a significant increase in rice demand in the last 30 years, supported by population growth and growing per-capita consumption, and is projected to experience further growth in the coming decade (Durand-Morat & Bairagi, 2022). Rice imports into SSA are expected to keep rising as demand outpaces production. According to the USDA (2017), rice imports by SSA will increase from 12.3 mmt in 2017 to 15.4 mmt by 2026. Increased rice consumption in SSA can be traced to population growth, urbanization, changing consumer preferences and economic development (Nasrin et al., 2015). Rice has gradually become a food staple in Ghana over the years. Total rice consumption nearly quadrupled in the last 20 years from an average of 400 thousand metric tons (tmt) a year in 1999-2000 to 1.55 mmt in 2019-2020 (USDA, 2022). Production increased fivefold during the same time period from 138 tmt in 1999-2000 to 660 tmt in 2019-2020, but despite such an impressive performance, Ghana still relies heavily on rice imports, which account for 60 percent of domestic demand (Ankrah et al., 2021).

The projected increase in population and consequent increase in food and rice demand will subject the environment and natural resources to a great deal of pressure. Identifying a development path to achieve a sustainable increase in rice production while reducing environmental costs is an increasing challenge. One of the main challenges facing the global rice sector moving forward will be to foster sustainable growth in order to meet rising demand while not jeopardizing future rice production. Furthermore, sustainability incorporates aspects of social equity, specifically gender equality and women's empowerment that must be addressed in order to meet the future challenge of feeding a growing population.

Globally, the leading causes of environmental pollution in rice production are low production efficiency and excessive use of agrochemicals (Yuan et al., 2021; Nguyen, 2016). Most of the rice globally is produced using traditional continuous flooding production systems, which not only consume large amounts of freshwater but also contribute significantly to methane (CH4) emissions (Liang et al., 2022). Previous research has looked into the ecological and environmental impacts of rice production, such as environmental acidification, eutrophication, heavy metal pollution, as well as other ecological and environmental issues caused by unreasonable straw return and irrigation patterns (Huang et al., 2022).

In Asia and increasingly in greater sub-Saharan Africa (SSA) regions, rice is mostly grown on relatively small farms (less than 2 ha), which are subsistence or semi-subsistence in nature. Although some regions of Ghana, such as the Volta, Northern and Upper East regions have the necessary agronomic conditions for continuous rice production, the country's potential has been underutilized due to structural and technical constraints such as poor agronomic practices, low mechanization, and low adoption of yield-enhancing technologies (Asravor et al., 2019). Increasing the efficiency in the use of available agricultural resources could contribute to the

sustainability and resilience of agricultural production systems. Rice is grown throughout all regions of the country. However, the primary production zones are in Volta, Ashanti, Eastern, Upper East, and Northern regions, with Volta being the largest producer.

Rice Consumption in Ghana

Ghanaian consumers are increasingly becoming aware of food safety with many preferring organic, green, sustainable foods over conventional foods (Awuni et al., 2016; Owusu & Dadzie, 2021). Rice is an important staple food in Ghana, with a growing demand for the grain. Previous studies highlight that Ghanaian consumers have defined preferences for rice quality attributes. Asante et al. (2013) found that consumers in Ghana prefer imported rice because of its perceived higher quality compared to domestic rice, primarily when it comes to cleanliness, whiteness, and aroma. Anang et al. (2011) found that consumers in Ghana value rice taste, cooking quality, cooking time, and aroma the most. Alhassan et al. (2015) found that the physical appearance of rice, including cleanliness, milling degree, packaging, and branding, are all important factors driving consumer preferences for rice. Looking at consumer preferences in the upper east region of Ghana, Ehiakpor et al. (2017) found that the top three traits consumers consider in their choice for local rice were good-looking grains, excellent packaging, and absence of foreign materials in the rice. The authors also found evidence of an increased preference for quality local rice. Moreover, Diako et al. (2010) found that rice quality preferences vary across regions in Ghana depending on the main rice dishes prepared in these regions (e.g., the preparation of jollof rice, the most preferred rice dish in Accra, and plain rice and omotuo (rice balls), the most preferred rice dishes in the Eastern regions, requires different types of rice). A more recent study by Peterson-Wilhelm et al. (2021) revealed that in Ghana the broken percentage and the parboiled nature of

milled rice are associated with price discounts, while the length of the rice kernels carries a price premium only for imported rice.

The findings reported above point to the increasing awareness of Ghanaian consumers for several aspects of rice quality. They also point to the lack of market information about the value of credence attributes, such as organic or sustainably-produced rice. This study attempts to help close that gap and shed light on the extent to which consumers would also value claims about the sustainability of the rice they purchase.

Sustainability

In the 1990s, the United Nations proposed the concept of sustainable development, which included sustainable agriculture. Sustainable agriculture aims to meet society's food and textile needs without jeopardizing future generations' ability to meet their own needs (Keeble, 1988). The concept of sustainable agricultural development is growing in popularity worldwide, with many countries including Ghana embracing sustainability as a key national agricultural policy objective.

According to United States Code Title 7, Section 3103, "sustainable agriculture" is an integrated system of plant and animal production practices with a site-specific application that will, over time, meet human food and fiber needs, improve environmental quality and the natural resource base on which the agricultural economy depends, make the most efficient use of nonrenewable resources and on-farm resources, and improve the quality of life of farmers and society (National Sustainable Agriculture Coalition [NSAC], 2022). It is critical to emphasize that achieving the goal of sustainable agriculture is the responsibility of all system participants, including farmers, laborers, policymakers, researchers, retailers, and consumers. Each group has a specific role and a unique contribution to strengthening the sustainable agriculture community.

Many sustainability assessment tools have been developed to evaluate agricultural production performance in terms of the environmental, social, and economic dimensions. The United Nations Food and Agriculture Organization (UNFAO) has developed a holistic global framework as a guideline for the sustainability assessment of agriculture and food systems based on the supply chain approach, known as Sustainability Assessments in Food and Agriculture (SAFA). SAFA establishes an international reference for assessing trade-offs and synergies between all four sustainability pillars (good governance, environmental integrity, economic resilience, and social well-being) based on 58 indicators (FAO, 2014).

The Sustainable Rice Platform (SRP)

While a number of commodities (e.g., coffee, cocoa, palm oil, and tea) have addressed sustainable production and trade, the rice value chain has been largely under-researched, despite its critical importance for global food security (Demont & Rutsaert, 2017; Lernoud et al., 2018).

The Sustainable Rice Platform (SRP) is the world's first voluntary sustainable production standard for rice, aimed at promoting resource efficiency and sustainability on farms and throughout the rice value chain. SRP was developed by a global alliance convened by the United Nations and the International Rice Research Institute (IRRI), consisting of agricultural research institutions, agri-food businesses, and public sector and civil society organizations.

The first SRP standard was published in October 2015 and later updated in 2020. The Standard comprises 41 requirements structured under 12 indicators and 8 themes (SRP, 2020) (Table 1). These themes and requirements cover the social, economic, and environmental aspects of sustainability. The standard employs a scoring system with a required minimum score and a series of mandatory compliance levels (thresholds) that farmers must meet to assert that they are

"working towards sustainable rice cultivation" (33-90 points/100), or a minimum score of 90/100 to assert "sustainable rice cultivation." Specifically, the SRP guidelines ensure that the rice is environmentally sound, low-emission, economically viable, and produced with ethical considerations. Figure 1 shows the three areas of sustainability and their relation with the SRP themes. There are currently over 20 registered SRP projects reaching 150,000 farmers worldwide, and SRP-labelled rice already being marketed by leading European retailers.

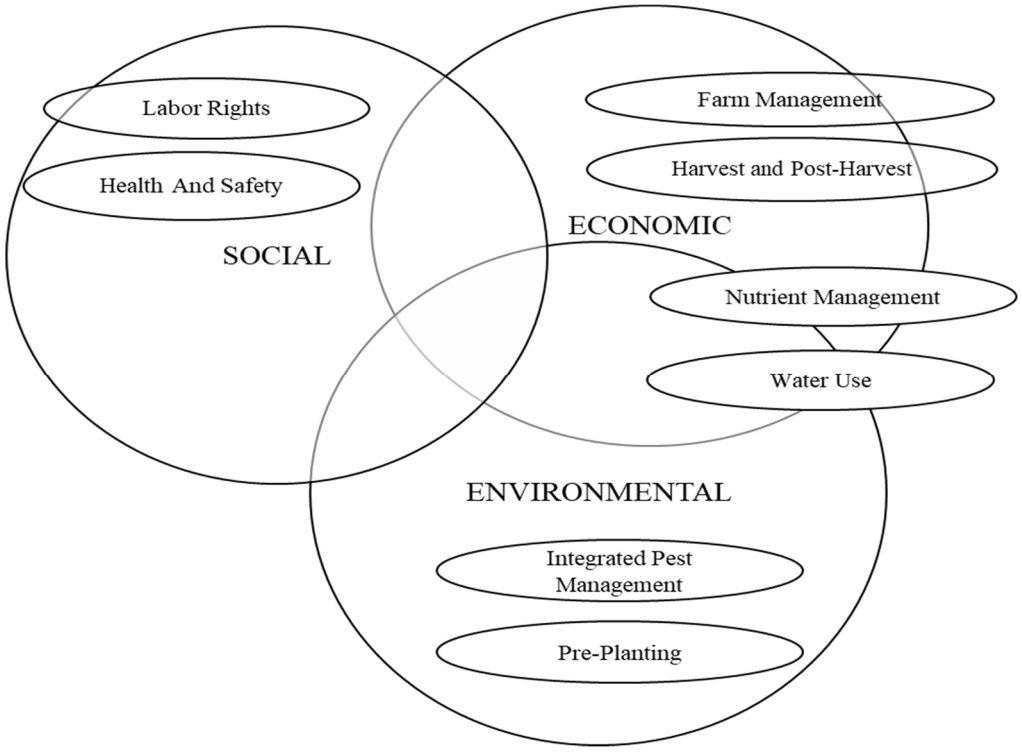
To date, few studies have focused on consumer's preferences and perceptions about SRP. My et al. (2018) assessed consumer preferences for SRP rice in Vietnam, and found that consumers are willing to pay a premium of 9% for SRP-certified rice, which increases up to 33% when information on certification and traceability was provided. In addition to this, Connor et al. (2022) also investigated the relationship between climate change knowledge and consumer willingness to pay for SRP-certified rice in Vietnamese supermarkets, and found that on average consumers were willing to pay a 29% premium for SRP- labelled rice. Okpiaifo (2020) investigated the importance Nigerian consumers place on the SRP 12 indicators, and found that consumers have a strong preference for sustainability indicators related to food safety and health and safety, which has important implications for the policy development and marketing.

Table 1: Definition of SRP themes.

SRP Theme	Definition
Farm management	Organizing and operating a farm for maximum production and profit.
Pre-planting	Activities carried out prior to planting with the goal of producing a good crop while protecting the environment.
Water use	Activities adopted with the goal of producing the most rice possible for each unit of water used.
Nutrient management	Activities adopted with the goal of producing the most rice possible for each unit of fertilizer used.
Integrated pest management	Activities adopted with the goal of managing pests and diseases affecting the rice crop in an effective and environmentally-sensitive manner.
Harvest and post-harvest	Activities adopted to collect, process, and store rice efficiently
Health and Safety	Activities adopted to protect and improve the health and safety of farmers, farmworkers, and their families.
Labor rights	Activities adopted to protect and advance the labor rights of farm workers, including children and women.

Source: (SRP, 2020)

Figure 1: *Three areas of sustainability and the relationship with each of the eight SRP themes.*



Source: Author's Own Construction

The objectives of this study are to elicit consumers' preferences for sustainably produced rice based on the SRP themes, and to estimate the willingness-to-pay (WTP) for sustainably produced rice by Ghanaian consumers. While there have been studies on consumer preferences for rice in Ghana, to our knowledge there have been no studies on Ghanaian consumers' preferences for sustainable rice, including SRP-certified rice. Moreover, this study offers a comprehensive approach by combining methods to assess preferences for different aspects of sustainable rice production (as represented by the SRP themes) and the willingness to pay for both local and imported rice.

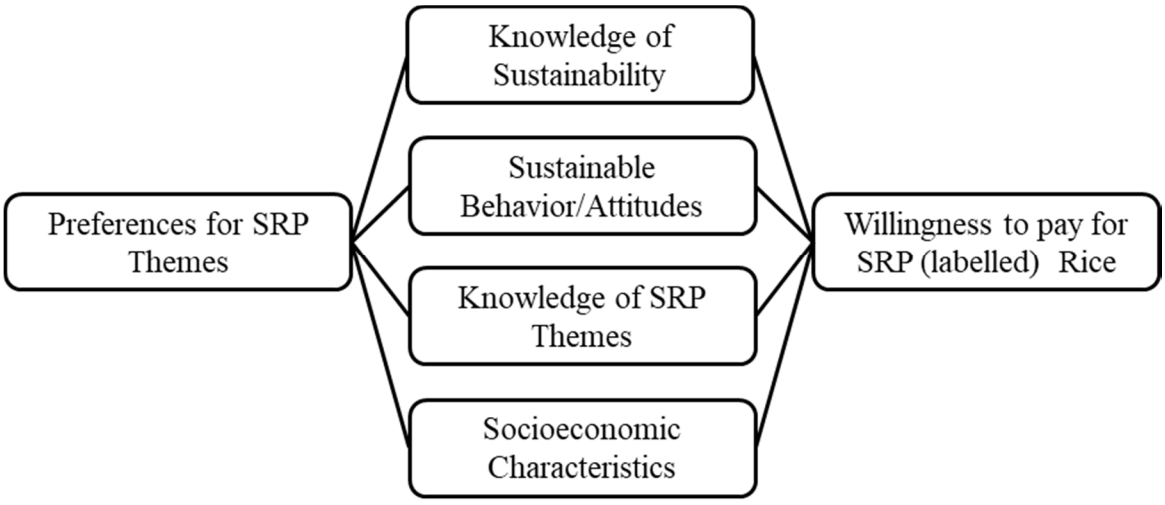
As rice demand in Ghana creates incentives to expand domestic production, it is important to understand whether consumers would value rice produced sustainably and in particular, which aspects of sustainability they value the most. The findings of this study can inform decision-makers about the market opportunities to promote the adoption of sustainable rice practices in Ghana. Specifically, we hope these findings will be useful for guiding future discussions about updating the SRP standard, and for the development of production protocols and marketing strategies that acknowledge the particular aspects of sustainability valued by consumers.

Methodology

Conceptual Framework

Figure 2 shows the conceptual framework for this study. It is assumed that there are four factors that affect consumer preferences for SRP themes and their willingness to pay for sustainably-produced rice, namely, (1) knowledge about sustainability, (2) sustainable behavior and attitudes, (3) knowledge about SRP, and (4) socioeconomic characteristics. The role of knowledge has been evaluated in the context of the nature of product attributes, distinguishing between extrinsic (e.g., price) and intrinsic (e.g., functional) attributes, and was found to play a significant role in consumer decision-making (Alba & Marmorstein, 1987; Ellis, 2015; Peschel et al., 2016). Sanchez-Bravo et al. (2020) also found that sustainable consumption patterns are determined by consumers' perceptions of sustainability, how these perceptions shape attitudes, and how these attitudes influence their behavior. Finally, we hypothesize that socioeconomic characteristics such as income and education also play a crucial role in the preferences of consumers for sustainably produced rice.

Figure 2: Relationship between consumers' preferences and factors that affect these preferences



Source: Author's Own Construction

Sources of data and instruments employed

Primary data was collected in the Summer of 2022 from 1,168 rice consumers in Accra, Kumasi, and Tamale, the three largest urban areas in Ghana, respectively. The sample size for each city was defined considering the size of the population, a confidence level of 95%, and a margin of error of 5%. A team of fifteen local enumerators (four enumerators plus a supervisor in each of the three cities) from the Council for Scientific and Industrial Research (CSIR) Crops Research Institute were assembled to conduct the face-to-face surveys. The team participated in a three-day training session led by the research team at the University of Arkansas, which included (1) an introduction of the research goals and objectives, survey protocols, and survey questionnaires, (2) the implementation of forty-five trial surveys among enumerators, (3) market training section with sixty consumers in which the enumerators applied an average of 5 surveys each, and finally (4) the adjustment of the survey protocols and questionnaires to incorporate the lessons learned in the training sections. The surveys were designed in Qualtrics and the answers were recorded electronically using tablets.

The survey (Appendix 1) included survey instructions, questions about sustainability knowledge, background information about SRP (a table with the eight themes and their definitions as defined in the SRP standard), a set of choice questions, contingent valuation questions, and a socioeconomic questionnaire.

Sampling procedure

Participants were selected from specific markets following a convenience-sampling approach. Only consumers actively purchasing food in the selected open markets (Table 2) were invited to participate. Consumers willing to participate were asked two screening questions to assess whether they were adults (18 years old or older) and whether they were in charge of the rice purchasing

decision at home. Those respondents who did not meet the screening criteria were not allowed to continue the survey and did not count as a response. Respondents were compensated with twenty Ghana Cedis worth of phone credits.

Table 2: Distribution of respondents across cities and their markets

City	Markets	Sample size
Accra	Madina, Adenta, Kaneshie, Makola, Nima and Caneshie Market Complex	380
Kumasi	Asafo, Oforikrom, Bantama, Kejetia and Atonsu	396
Tamale	Lamashegu, Aboabo, Sagnarigu, Jisonayili and Time Markets	392
Total		1168

Participants were asked a total of six questions (Appendix 1, Q5.1 through Q5.6) to ascertain their general behavior and knowledge about sustainability. Next, enumerators briefed participants about SRP and explained the meaning of the eight SRP themes using printed materials as a visual aid (Appendix 2). Enumerators ensured all participants received the basic information about SRP and SRP themes before advancing. Next, participants answered six best-worst choice questions (Appendix 1, Q6-Q11), each including four SRP themes, by selecting the most important and least important theme based on their understanding of the themes and their preferences. Furthermore, participants answered two contingent valuation questions designed to ascertain their WTP for rice produced sustainably following the SRP standard (Appendix 1, Q12-Q14). Finally, participants answered a socioeconomic questionnaire, which also included questions about their rice consuming habits (Appendix 1).

Best-Worst Scaling

Best-worst scaling (BWS) is an alternative method for eliciting preferences that only requires the assumption of ordinality. It was developed by Louviere and Woodworth (1990), and its first application was published in 1992 (Finn & Louviere, 1992). The BWS choice analysis is based on the Random Utility Model (McFadden, 1974), which states that a utility function can be expressed as

$$U_{ijt} = K_{ijt} + \varepsilon_{ijt} \quad (1)$$

where U_{ijt} is the utility derived by individual i from alternative j in choice set t, K_{ijt} is the deterministic (observable) component, and ε_{ijt} is random error for individual i, alternative j, and choice set t (Aoki & Akai, 2022). Assuming that respondents pick the choice that maximizes their utility, respondent i will pick alternative j over alternative k when

$$U_{ijt} > U_{ikt} \; \forall \; j \neq k \quad (2)$$

In the BWS model, respondents are asked to select the pair of most important or best (b) and least important or worst (w) attributes such that

$$U_{ibt} - U_{iwt} > U_{ijt} - U_{ikt} \; \forall \; b \neq w \; and \; j \neq k \quad (3)$$

The probability of a respondent making a choice depends on the distance between the best and worst variables. Assuming that respondents will choose the best-worst pair that have the largest distance between them, we can measure the unobservable distance between the best and worst alternatives (D_{bw}) as

$$D_{bw} = \delta_{bw} + \varepsilon_{bw} \quad (4)$$

Where δ_{bw} equals the measurable distance between alternatives b and w, and ε_{bw} represents a random error term. Thus, the probability of choosing the pair bw in choice set t equals

$$P(bw/t) = P\left(D_{bw} > D_{jk}\right) = P(\delta_{bw} + \varepsilon_{bw} > \delta_{jk} + \varepsilon_{jk}) \; \forall \; bw \; \neq jk \tag{5}$$

Using a Multinomial Logit Model (MNL), with the assumption that the error terms are independent and identically distributed (iid), the probability of choosing pair bw in choice set t is

$$P(bw/t) = \frac{\exp(\delta_{bw})}{\sum_{jk} \exp(\delta_{jk})} \; \forall \; bw \; \neq jk \; in \; t \tag{6}$$

The measurable distance between alternatives b and w can be rewritten as

$$\delta_{bw} = \beta_b - \beta_w \tag{7}$$

Where β_b is the coefficient for attribute b. The probability of choosing pair bw can then be re-written as a function of the attribute-specific coefficients as

$$P(bw/t) = \frac{\exp(\beta_b - \beta_w)}{\sum_{jk} \exp(\beta_j - \beta_k)} \; \forall \; bw \; \neq jk \; in \; t \tag{8}$$

The Random Parameter Logit (RPL) model is used to relax the iid assumption and account for heterogeneity in the preferences of the respondents. The RPL is a discrete-choice model which allows for variations in preferences and uses simulation methods (Maximum Log-likelihood) to provide estimates of mean and standard deviation for each coefficient (Train, 2009). The RPL model assumes that coefficients vary across the population according to some assumed distribution (usually normal). Thus, the coefficient for each attribute in RPL becomes

$$\beta_{ij} = \overline{\beta_j} + \sigma_j \mu_{ij} \tag{9}$$

Where $\overline{\beta_j}$ and σ_j represent the mean and standard deviation of β_j, and μ_{ij} is the random error.

To facilitate the interpretation of the results, we estimate market shares for each attribute, understood as the relative importance of each attribute over all others, as

$$S_j = \exp(\beta_j) / \sum_k \exp(\beta_k) \quad (10)$$

A multivariate normal distribution with the means and standard deviations estimated from our RPL model was used to generate a distribution of 10,000 preference shares for each theme *i* . Following Cerroni et al. (2022), the bootstrapping method proposed by Krinsky and Robb (1986) was used to generate such distributions.

Double Bounded Contingent Valuation Method

The contingent valuation (CV) method directly asks an individual about their willingness to pay (WTP) via a questionnaire. The name of the method comes from the fact that the elicited values are contingent on the hypothetical scenario that is presented to those being interviewed. In our case, we asked respondents to state their WTP for conventional or sustainably-produced rice at seven different price levels. We used a hypothetical CV since SRP sustainably-produced rice is not available in the market in Ghana.

In general, CV can be used to elicit WTP in one of three ways. The first is accomplished through open-ended questions, in which case participants are asked how much they are willing to pay for a previously described good or service, as well as a hypothetical scenario. Another approach is to use payment cards, in which participants are presented with a series of payment amounts and select the one that is closest to their individual valuation. The final method uses dichotomous choice questions (Lopez-Feldman, 2012). WTP can be modelled as the following linear function:

$$WTP_i(z_i, u_i) = z_i\beta + u_i \quad (11)$$

Where z_i is a vector of explanatory variables, β is a vector of parameters and, u_i is an error term.

The problem with the dichotomous choice model is that each individual provides very little information and, consequently, relatively large samples are required to obtain accurate WTP

estimates. Hanemann et al. (1991) propose an alternative to improve estimation efficiency, consisting of a dichotomous question with follow-up or a double-bounded model, which provides more information about each participant's WTP. This is the type of CV method used in this study. If respondents choose (do not choose) to buy sustainably-produced rice at a price t^1 instead of conventional rice at a benchmark price, then a follow-up question asks if they will choose to buy sustainably-produced rice at a higher (lower) price t^2 instead of conventional rice at the benchmark price. This implies that the second question is endogenous in the sense that the amount requested is determined by the answer to the first question. This method gives two answers for each individual, for a total potential combination of four answers (yes-no, yes-yes, no-yes, and no-no). The probability of all four cases of the double-bounded contingent valuation method can be modelled as follows:

1. When $y_i^1 = 1$ and $y_i^2 = 0$

$$\Pr(y,n) = \Pr(t^1 \leq WTP < t^2) = \Pr(t^1 \leq z_i\beta + u_i < t^2) \quad (12)$$

2. When $y_i^1 = 1$ and $y_i^2 = 1$

$$\Pr(y,y) = \Pr(WTP > t^1, WTP \geq t^2) = \Pr(z_i\beta + u_i > t^1, z_i\beta + u_i \geq t^2) \quad (13)$$

3. When $y_i^1 = 0$ and $y_i^2 = 1$

$$\Pr(\mathrm{n},\mathrm{y}) = \Pr(t^2 \leq WTP < t^1) = \Pr(t^2 \leq z_i\beta + u_i < t^1) \quad (14)$$

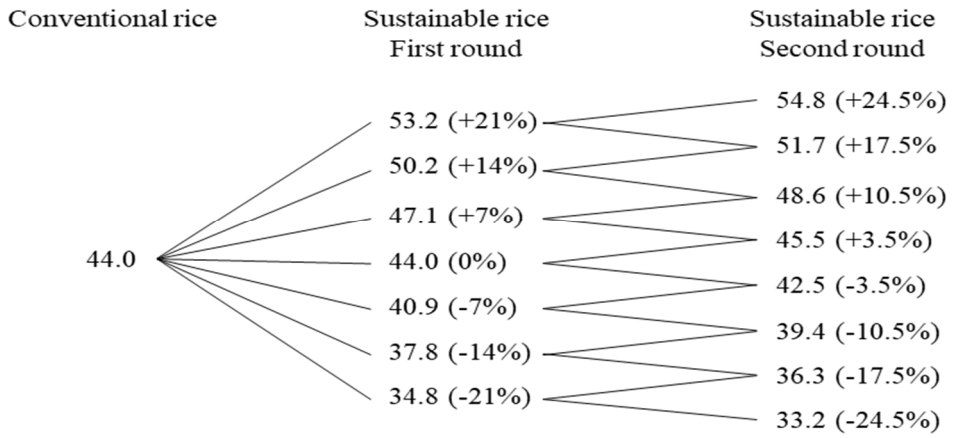
4. When $y_i^1 = 0$ and $y_i^2 = 0$

$$\Pr(n,n) = \Pr(WTP < t^1, WTP \leq t^2) = \Pr(z_i\beta + u_i < t^1, z_i\beta + u_i \leq t^2) \quad (15)$$

where y_i^1 and y_i^2 are dichotomous variables capturing responses to the first and second closed questions.

To account for differences in market prices for domestic and imported rice across the three cities included in this study, we calibrated the CV study to different prices for conventional imported and domestic rice, for a total of 6 different price trees. Figure 3 shows the price tree used in this study for domestic rice in Accra. The percentage changes in prices refer to the change (premium or discount) in price for sustainably-produced rice in each round relative to the price of conventional rice.

Figure 3. Example of price used in the contingent valuation study (prices in Ghanaian Cedis per kilogram, GH$/kg).



Each respondent was asked if they were willing to purchase sustainably produced rice at a randomly assigned price. The same percentage changes were used for all other prices trees, starting with the following reference prices for conventional rice: (1) GH$ 44.0/kg for domestic rice in Accra, (2) GH$ 50.0/kg for imported rice in Accra, (3) GH$ 37.0/kg for domestic rice in Kumasi, (4) GH$ 50.0/kg for imported rice in Kumasi, (5) GH$ 26.0/kg for domestic rice in Tamale, and (6) GH$ 40.0/kg for imported rice in Tamale. The reference prices for conventional rice are the

average market prices observed by the enumerator team a week prior to data collection. Participants were asked which type of rice they usually consume (imported, domestic, or indifferent), which was then used to select the appropriate CV questionnaire. For instance, a participant in Accra that stated that her household usually consumes imported rice would answer the CV questionnaire design for imported rice in Accra. Consumers stating that they are indifferent between domestic or imported rice were assigned randomly to either domestic or imported rice. The double-bounded module in STATA was used to calculate the models (Lopez-Feldman, 2012). The individual WTP outcome is based on the random utility model where respondents maximize utility by choosing to purchase a product at the associated bid amount if the utility derived from this good is higher than from refusing the bid and foregoing the product (Mamadzhanov et al., 2019). The function that needs to be maximized in order to find the parameters of the model is:

$$\sum_{i=1}^{N}[d_i^{yn}\ln(\emptyset(z_i'\frac{\beta}{\sigma}-\frac{t^1}{\sigma})-\emptyset(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma}))+d_i^{yy}\ln(\emptyset(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma})) + d_i^{ny}\ln(\emptyset(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma})-\emptyset(z_i'\frac{\beta}{\sigma}-\frac{t^1}{\sigma}))+d_i^{nn}\ln(1-\emptyset(z_i'\frac{\beta}{\sigma}-\frac{t^2}{\sigma}))] \quad (16)$$

Where d_i^{yn}, d_i^{yy}, d_i^{ny}, d_i^{nn} are indicator variables with values of one or zero depending on the relevant case for each individual, implying that a given individual contributes to the likelihood function's logarithm in only one of its four parts. $\emptyset$ is a cumulative distribution of the normal function characterizing the random components of utility.

Variables used in the maximum likelihood model are described in Table 5. The dummy variable *Knowledge* equals 1 for respondents who had general knowledge of sustainability, understood as those who responded correctly to Q5.1 through Q5.3 in Appendix 1, and zero otherwise. Similarly,

the dummy variable *Behavior* equals 1 for consumers with environmentally friendly attitudes/behaviors, understood as those who answered Q5.4 through Q5.6 in Appendix 1 correctly, and zero otherwise. The dummy variable *High Income* equals 1 for respondents with average monthly household income of more than GHS4500, and zero otherwise. The variable *Middle Income* equals 1 for respondents with household income between GHS1000 and GHS4500 a month, and zero otherwise. The dummy variable *Low Income* equals 1 for respondents with an average monthly household income less than GHS1000, and zero otherwise. The variable *Education* equals 1 for respondents with completed technical or vocational school or above and zero for otherwise. *Gender* was coded 1 for male and zero for female.

Results

Socioeconomic Characteristics

A total of 1,168 consumers from Accra, Kumasi, and Tamale participated in the study (Table 3). Most participants were female (n = 1168, 70.2%), as expected since primarily women are in charge of food purchases in Ghana. There were no differences (P>0.8081) in gender composition across cities. The average age was 40.1 years, with significant differences across cities (P<0.0001) at a one percent significance level (Tamale has the lowest average age of 36.9 years and Accra the highest average age of 43.1). Similarly, there were significant differences (P<0.0001) in household size across cities, with Tamale having the largest average size of 6 members, and Accra the smallest average size of 4.5 members. Regarding education attainment, 33.4 percent of the participants reported having a bachelor's degree, 22.2 percent having a post-high school degree or certificate, 35 percent having a high school certificate, and 4.8 percent having not completed any level of formal education. Compared to the results from the Ghana Living Standard Survey (GSS, 2019), according to which 5 percent of the adult population in Ghana have attained a tertiary or professional level education, our sample is highly educated. The level of educational attainment varies significantly (P<0.0001) across the three cities.

Data from the 2017 Ghana Living Standard Survey round shows that households earned an average of GH$ 33,937 per year, with the highest quintile earning an average of GH$ 54,371 and the lowest quintile earning an average of GH$ 7,783. Looking at sample for this study, the majority of Tamale respondents fall into the two lowest income quantiles, which is consistent with the results from the Ghana Living Standard Survey indicating that the three northern regions have the lowest average annual incomes among urban households. At the regional level, the Living Standard Survey shows that the Ashanti Region (where Kumasi is located) has the highest average annual income,

followed by the Greater Accra Region. However, in our sample we find a higher number of respondents in the highest quantile in Accra as compared to Kumasi.

Table 3: Socioeconomic Characteristics

Variable	Accra	Kumasi	Tamale
N	380	396	392
Gender†			
Male	116 (31%)	120 (30%)	112 (29%)
Female	264 (69%)	276 (70%)	280 (71%)
Age†† (mean years)	43.1[a]	40.2[b]	36.9[c]
Mean household Size††	4.5[a]	5.0[b]	6.3[c]
Highest Level of Education Completed‡			
University (Postgraduate)	47 (12.4%)	26 (6.6%)	29 (7.4%)
University (Bachelor)	120 (31.6%)	70 (17.7%)	99 (25.3%)
Teacher/Training/Agric Training	64 (16.8%)	31 (7.8%)	35 (8.9%)
Technical/Vocational	51 (13.4%)	39 (9.8%)	37 (9.4%)
SHS/SSS	44 (11.6%)	137 (34.6%)	87 (22.2%)
JHS/JSS	30 (7.9%)	70 (17.7%)	42 (11%)
Primary School	17 (4.5%)	14 (3.5%)	23 (6%)
None	7 (1.8%)	9 (2.3%)	40 (10.7%)
Average Monthly Household Income‡‡			
Less than GHS 1000	30 (7.9%)	54 (13.6%)	109 (27.8%)
GHS 1001–2000	96 (25.3%)	95 (24%)	127 (32.4%)
GHS 2001–3000	82 (21.6 %)	138 (34.8%)	76 (19.4%)
GHS 3001 –4500	105 (27.6%)	74 (18.7%)	46 (11.7%)
More than GHS 4500	67 (17.6%)	35 (8.8%)	34 (8.7%)
Share of Household Income Spent on Food£			
Less than 20%	49 (12.9%)	2 (0.5%)	20 (5.1%)
20%-40%	134 (35.3%)	58 (14.6%)	129 (32.9%)
41% - 60%	146 (38.4%)	170 (42.9%)	197 (50.3%)
61%-80%	40 (10.5%)	132 (33.3%)	41 (10.5%)
More than 80%	11 (2.9%)	34 (8.6%)	5 (1.3%)

†. Kruskal-Wallis test results: Chi-squared = 0.427, P-value = 0.808.
††. Different letters for each theme and location represent statistically different means at a 95% significance level.
‡. Kruskal-Wallis test results: Chi-squared = 146.689, P-value = 0.001.
‡‡. Kruskal-Wallis test results: Chi-squared = 119.724, P-value = 0.001.

Best Worse Scaling Model Estimates

Table 4 shows the MNL and RPL model estimates for each SRP theme by city. The estimates are relative to the reference theme Labor Rights, which was selected as the reference because it was the least important theme based on the percentage of times it was selected as worst by participants. The correlated RPL was consistently the best model based on the Log-likelihood, AIC, and BIC goodness-of-fit estimates, and thus the discussion that follows focuses only on the results from the RPL model.

The results from the RPL model show that all the themes were statistically significant at the 1% significance level, except for Harvest and Post-Harvest, which is statistically at the 5 percent level in Accra and not significantly different from zero in Tamale. The standard deviations for all the coefficients were significant at the 1% significance level except for Health and Safety in Kumasi, which is not significantly different from zero. The statistical significance of the standard deviations of the coefficients indicates the presence of substantial heterogeneity in consumer preferences that justifies the use of the RPL model.

Differences in scale parameters by SRP themes between the three cities is examined using a test for equality to assess whether preference shares for the themes among the three cities are different. A Swait and Louviere (1993) test was conducted to test the null hypothesis of no significance in SRP theme differences between cities, and in the three cases (Accra-Kumasi, Accra-Tamale, Kumasi-Tamale) the null hypothesis was rejected[1]. Thus, these test results support the comparison of market shares by theme across cities presented in Table 5. Nevertheless, we include the results for the pooled sample as a reference.

[1]. p = 0.026 for Accra-Kumasi, p = 0.026 for Accra-Tamale, and p = 0.026 for Kumasi-Tamale.

Table 4: MNL and RPL estimates

Themes	Pooled		Accra		Kumasi		Tamale	
	MNL	RPL	MNL	RPL	MNL	RPL	MNL	RPL
Nutrient	0.723***	1.639***	0.675***	0.798***	0.437***	0.623***	0.816***	1.079***
Management	(0.030)	(0.115)	(0.051)	(0.065)	(0.057)	(0.072)	(0.050)	(0.067)
Standard Dev		1.023***		0.979***		1.028***		0.949***
Health and	0.727***	1.350***	0.631***	0.754***	0.9012***	1.265***	0.363***	0.474***
Safety	(0.036)	(0.139)	(0.061)	(0.079)	(0.0615)	(0.088)	(0.058)	(0.076)
Standard Dev		1.127***		0.777***		0.961		0.963***
Integrated Pest	0.531***	1.210***	0.503***	0.636***	0.459***	0.754***	0.480***	0.649***
Management	(0.029)	(0.101)	(0.0491)	(0.636)	(0.0482)	(0.072)	(0.048)	(0.059)
Standard Dev		1.121***		1.057***		1.402***		0.880***
Harvest and	0.314***	0.624***	0.155**	0.240**	0.469***	0.757***	0.0004	-0.023
Post-Harvest	(0.029)	(0.099)	(0.057)	(0.073)	(0.067)	(0.089)	(0.056)	(0.071)
Standard Dev		1.3537***		0.789***		1.455***		-0.948***
Pre-Planting	-0.139***	0.206*	-0.191***	-0.284***	-0.311***	-0.489***	-0.181***	-0.277***
	(0.029)	(0.092)	(0.048)	(0.059)	(0.048)	(0.066)	(0.0474)	(0.064)
Standard Dev		1.016***		1.167***		1.095***		1.069***
Water Use	-0.415	0.193*	-0.204***	-0.309***	-0.282***	-0.521***	0.210***	0.264***
	(0.0277)	(0.087)	(0.048)	(0.060)	(0.0475)	(0.067)	(0.0470)	(0.0606)
Standard Dev		1.247***		1.238***		1.535***		1.323***
Farm	-0.037	-0.315**	-0.344***	-0.514***	-0.186**	-0.349***	0.239***	0.325***
Management	(0.033)	(0.103)	(0.0581)	(0.074)	(0.057)	(0.086)	(0.0559)	(0.072)
Standard Dev		1.259***		1.338***		1.324***		1.081***
Log Lik.	-16656	-2603	-5374.9	-5158.2	-5541.6	-5152.2	-5621.3	-5358.4
AIC	33325.99	5276.525	10763.74	10386.39	11097.29	10374.45	11256.7	10786.78
BIC	33373.97	5454.678	10803.86	10587.01	11137.7	10576.51	11297.04	10988.49

*, **, and *** indicate statistical significance at 0.10, 0.05, and 0.01, respectively.

Preference Shares

The preference shares for each theme was calculated using the estimates from the RPL model according to equation 5. The confidence intervals of the mean of the preference shares were estimated using bootstrapping with 10,000 simulations. For the 10,000 bootstrap resamples of the mean difference, the 250th and 9,750th values of the ranked differences can be used as the 95% confidence interval boundaries.

Table 5 shows the preference shares for each SRP theme and city. The first thing to notice is the difference in the rankings across cities. For instance, Nutrient Management ranks first in Accra and Tamale, with market shares of 20.9 and 24.7 percent, respectively, but fourth in Kumasi, with a market share of 14.8 percent. Moreover, Health and Safety ranked first in Kumasi (28.2 percent market share), second in Accra (20.1 percent market share), and third in Tamale (13.5 percent market share).

Table 5: Preference Shares by SRP themes and location[†‡].

Themes	Pooled	Accra	Kumasi	Tamale
Nutrient Management	0.279^{a}	0.209^{a1}	0.148^{b2}	0.247^{a1}
Health and Safety	0.210^{a}	0.201^{a2}	0.282^{a1}	0.135^{bc3}
Integrated Pest Management	0.182^{a}	0.178^{a1}	0.169^{b1}	0.161^{b1}
Harvest and Post-Harvest	0.101^{b}	0.120^{b2}	0.170^{b1}	0.082^{de3}
Labor Rights	0.054^{c}	0.094^{c1}	0.079^{c2}	0.084^{d12}
Pre-Planting	0.067^{c}	0.071^{d1}	0.049^{d2}	0.064^{e12}
Water Use	0.066^{c}	0.069^{d2}	0.047^{d3}	0.110^{c1}
Farm Management	0.040^{cd}	0.057^{d2}	0.056^{d2}	0.116^{c1}

[†]. Different letters for each theme by location represent statistically different means at 95% significance level.
[‡]. Different numbers for each theme across locations represent statistically different means at 95% significance level

In Accra, Nutrient Management, Health and Safety, and Integrated Pest Management (mean preference shares of 20.9, 20.1, and 17.8 percent, respectively), all rank as the top among the 8 SRP themes since their means are statistically the same ($P<0.05$), followed by harvest and post-harvest with 12.0 percent. Taken together, these four themes represent 70.8 percent of the preference shares.

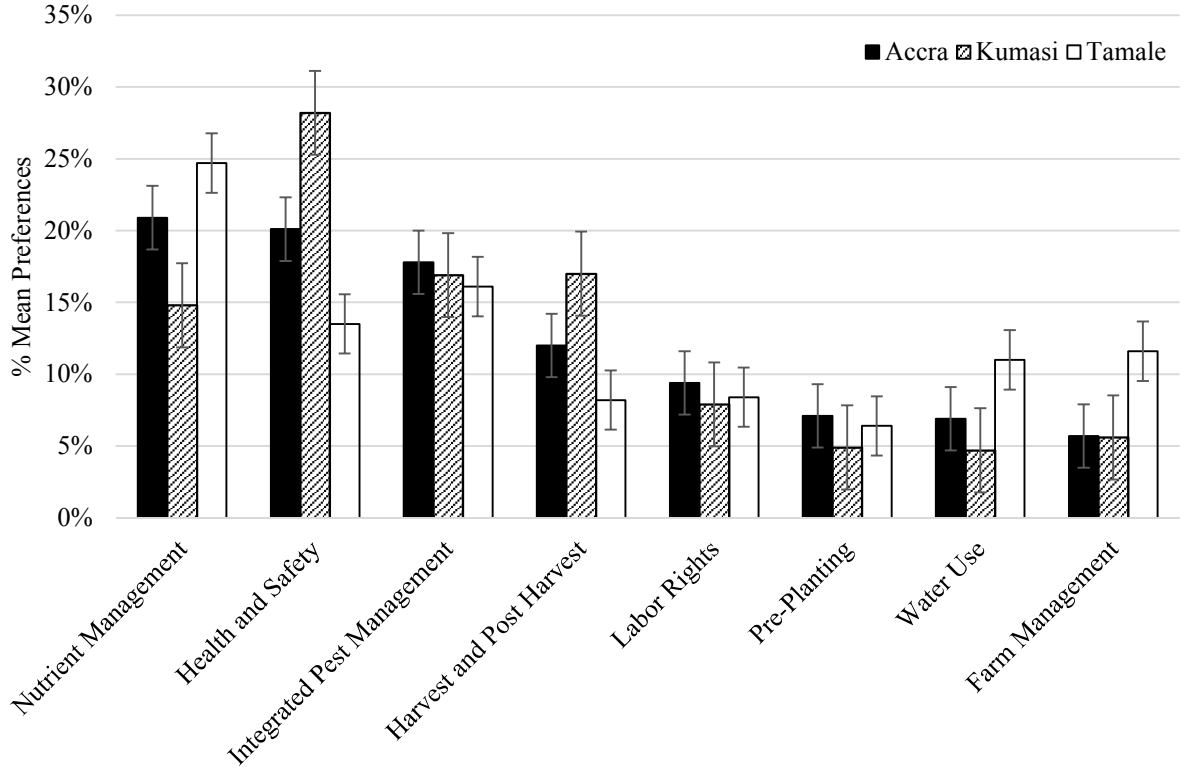
In Kumasi, Health and Safety ranks first with a preference share of 28.2 percent, followed by Harvest and Post-Harvest, Integrated Pest Management, and Nutrient Management (mean preference shares of 17.0, 16.9 percent, and 14.8 percent, respectively), which rank second since their means statistically the same ($P<0.05$). Taken together, these four themes account for 76.9 percent of the preference shares.

In Tamale, Nutrient Management ranks as the most important theme with a preference share of 24.7 percent, followed by Integrated Pest Management and Health and Safety which rank second since their means are statistically the same ($p<0.05$). Farm management ranks fourth with a preference share of 11.6 percent. Taken together, the top four SRP themes account for 65.9 percent of the preference shares.

Preference Shares by Theme Across Locations

Across locations, the preference share for Nutrient Management is statistically the same ($p<0.05$) in Tamale (24.7 percent) and Accra (20.9 percent) but significantly lower in Kumasi (14.8 percent). The preference shares for Health and Safety and Harvest and Post-Harvest are statistically different ($p<0.05$) across the three cities, while the preference shares for Integrated Pest Management are statistically the same ($p<0.05$) across the three cities.

Figure 4: *Mean preference shares by SRP theme and location.*



Subsample analysis was conducted to assess whether the preference shares by themes and location vary by (1) knowledge about sustainability; (2) behavior/attitude toward sustainability, (3) income level, and (4) education. The subsample analysis results are shown in Appendices 4 through 11.

Double Bounded Contingent Valuation and WTP Estimates

A total of six different CV models were built to account for differences in rice market prices for imported and domestic rice across the three cities. The explanatory variables used in the CV models were introduced in the methodology section and reinstated in Table 6.

Table 6: Summary Description of Explanatory Variables in the Model

Variable	Description
Knowledge [a]	1= Knowledge about sustainability; 0 = otherwise
Behavior [b]	1= Display sustainable attitudes or behavior; 0 = otherwise
High Income	1= More GHS 4500 per month; 0 = Otherwise
Middle Income	1=Between GHS 1000 - GHS 4500; 0= otherwise
Low Income	1= Less than GHS 1000; 0= otherwise
Age	Continuous variable ranging from 18 to 80
Gender	1 = Male; 0 = otherwise
Education	Technical School or above; 0 = otherwise

a. The binary variable Knowledge was defined as 1 for respondents who answered correctly Q5.1 through Q5.3 in Appendix 1, zero otherwise.
b. The binary variable Behavior was defined as 1 for respondents who answered correctly Q5.4 through Q5.6 in Appendix 1, zero otherwise. (Appendix 2: Q6)

Table 7 presents the results of the double-bounded dichotomous choice CV model. Having previous knowledge about sustainability has a positive impact on WTP for sustainable imported rice in Kumasi ($p<0.10$) and Tamale ($p<0.05$). Consumers expressing a sustainable behavior/attitude have a higher WTP for imported ($p<0.01$) and local ($p<0.05$) rice in Kumasi, but no statistically significant impact for imported or local rice in Accra and Tamale. High income has a positive impact on WTP for local rice in Accra ($p<0.05$), and negative for imported rice in Kumasi ($p<0.05$). Middle income has a positive impact on WTP for local rice in Accra ($p<0.10$) and Tamale ($p<0.10$), and a negative impact on imported rice in Kumasi ($p<0.05$) and Tamale ($p<0.05$). Education has a significant impact on consumer preferences for imported rice in Accra ($p<0.05$) and Kumasi ($p<0.10$).

It is important to notice that 78 percent and 60 percent of the participants in Accra and Kumasi stated that they usually consume imported rice, while 60 percent of the respondents in Tamale state that they consume domestic rice.

Table 7: Summary of Coefficient Estimates

Variables	Coefficients					
	Accra		Kumasi		Tamale	
	Imported	Local	Imported	Local	Imported	Local
Constant	47.799***	38. 396***	65.356***	57.050***	54.027***	29.130***
	(4.142)	(3.171)	(4.757)	(4.757)	(4.560)	(2.415)
Knowledge	0.638	-1.121	6.479*	-.734	5.408 **	.046
	(1.920)	(1.414)	(3.387)	(4.869)	(2.609)	(1.287)
Behavior	2.237	2.319	7.512***	10.667**	-2.077	-.042
	(1.905)	(1.448)	(2.651)	(4.687)	(2.473)	(2.473)
High Income	4.605	5.032**	-8.186**	5.895	.042	.115
	(2.976)	(2.427)	(4.011)	(7.212)	(3.971)	(3.971)
Middle Income	-2.729	2.589*	-6.477**	1.226	-4.520**	2.888*
	(2.197)	(1.453)	(1.453)	(3.782)	(2.277)	(2.455)
Age	0.142*	0.066	-0.134	-0.218	-0.188*	0.001
	(0.083)	(.0637)	(.104)	(.163)	(.105)	(.055)
Education	4.556**	.628	4.048*	.030	1.336	-.393
	(2.225)	(1.536)	(2.371)	(3.986)	(2.450)	(1.317)
Gender	5.468***	1.220	.635	1.416	3.395	1.742
	(1.951)	(1.770)	(2.329)	(3.731)	(2.544)	(1.396)
Observations	297	83	230	154	148	221
Log Likelihood	-225.50	-219.47	-150.29	-68.02	-88.08	-221.28

*, **, and *** indicate statistical significance at 0.10, 0.05, and 0.01.

Using the results from the double-bounded dichotomous choice CV model, we estimate the mean WTP following the approach by Lopez-Feldman (2012). The mean WTP values are estimated from the double-bounded modeling results taking all i explanatory variables $\overline{Z}_\iota$ at their mean, or at specific selected values for subsample analysis.

$$WTP = \overline{z}_\iota \beta \tag{17}$$

Confidence intervals around the estimated mean WTP are obtained using the delta method3[2] (Greene, 2008)

The subsamples considered in this study include (1) high income, (2) middle income, (3) knowledge about sustainability, (4) sustainable behavior/attitude, and (5) education. Tables 8 and

[2] Confidence intervals were estimated using the nlcom command in Stata®.

9 show the mean WTP for the entire sample and the selected subsamples for sustainably-produced imported and local rice, respectively.

Looking at the WTP for imported rice (Table 7), we find that, on average, participants from Tamale were willing to pay 23.1 percent premium for sustainably-produced rice relative to the conventional rice, followed by respondents in Kumasi (WTP 21.5 percent premium) and Accra (WTP 16.0 percent premium). All subsample mean WTP are also significantly different from zero ($p<0.01$).

The subsample analysis of mean WTP highlights some interesting findings. For instance, high-income households in Accra are WTP significantly ($p<0.05$) more than low and middle income households combined, but the opposite is true in Kumasi, where high income households are WTP significantly ($p<0.01$) less than households from other income brackets, while there is no significant difference in WTP between high income and all other income brackets in Tamale. Having knowledge about sustainability leads to a higher WTP for sustainably-produced imported rice than those without knowledge in Kumasi ($p<0.10$) and Tamale ($p<0.05$) but not in Accra, while having a sustainable behavior/attitude results in a significant ($p<0.01$) WTP premium only in Kumasi.

Table 9 present the estimated WTP values for sustainably-produced local rice. On average, respondents from Kumasi were willing to pay a 44.1 percent premium, while respondents from Tamale were willing to pay a 14.6 percent premium for sustainably-produced domestic rice.

Table 8: Estimates of WTP (in percent premium from the reference price of imported rice)

Sample	**Mean WTP[a]**		
	Accra[b]		
Mean WTP	16.0% ***		95% C.I. (11.4% - 20.6%)
WTP by subsamples	Yes	No	p-value[c]
High Income	23.4%***	13.1%***	0.014**
Middle Income	13.3%***	18.7%***	0.214
Knowledge about Sustainability	16.4%***	15.1%***	0.740
Sustainable Behavior	18.9%***	14.4%***	0.240
Education	18.4%***	7.6%***	0.018**
	Kumasi[b]		
Mean WTP	21.5%***		95% C.I. (14.7% - 28.3%)
WTP by subsamples	Yes	No	p-value[c]
High Income	6.6%***	23%***	0.041**
Middle Income	16%***	28.9%***	0.011**
Knowledge about Sustainability	32.5%***	19.6%***	0.056*
Sustainable Behavior	32.0%***	16.3%***	0.003***
Education	25.9%***	13.0%***	0.001***
	Tamale[b]		
Mean WTP	23.1%***		95% C.I. (15.1% - 31.0%)
WTP by subsamples	Yes	No	p-value[c]
High Income	23.2%***	23%***	0.992
Middle Income	16.3%***	27.6%***	0.047**
Knowledge about Sustainability	27.4%***	13.8%***	0.038**
Sustainable Behavior	20.3%***	25.5%***	0.401
Education	24.1%***	23.2%***	0.819

a. *, **, *** indicate that the difference in premium for each subsample is different from zero at 10%, 5%, and 1% significance level, respectively.
b. The reference price for conventional rice in Accra, Kumasi, and Tamale is GH$ 50.0/kg, GH$ 50.0/kg, and GH$ 40.0/kg, respectively.
c. *, **, *** indicate that the difference in premium for each subsample is different from zero at 10%, 5%, and 1% significance level, respectively.

Respondents from Accra on average, were indifferent between sustainably-produced and conventional domestic rice (WTP not statistically significantly different from zero).

Analysing the WTP by sub-samples, the first thing to notice is the much lower mean WTP values across all subsamples in Accra relative to Kumasi and Tamale, and also relative to imported rice in Accra (Table 8). The results suggest that high income households are WTP a significantly ($p<0.01$) higher price (for sustainably-produced local rice than conventional rice) than households from all other income brackets only in Accra. Having knowledge about sustainability has no

statistically significant impact on WTP for sustainably-produced local rice in any of the cities, while having a sustainable behavior has a significant ($p<0.05$) and positive impact on the WTP only in Kumasi. Highly educated respondents in Accra and Kumasi were WTP a higher price for sustainably-produced local rice ($p<0.05$) and $p<0.01$ respectively) while respondents in Tamale with high education were indifferent between sustainably produced rice and conventional local rice.

Table 9: Estimates of WTP (in percent premium from the reference price of local rice)

Sample	**Mean WTP[a]**		
	Accra[b]		
Mean WTP	-0.50		95% C.I. (-3.6% - 2.6%)
WTP by subsamples	Yes	No	p-value[c]
High Income	9.9%***	-1.6%***	0.038 **
Middle Income	2.6%***	-3.2%***	0.075*
Knowledge about Sustainability	-1.5%***	1.1%***	0.428
Sustainable Behavior	2.7%***	-2.6%***	0.109
Education	-0.1%***	-3.6%***	0.118
	Kumasi[b]		
Mean WTP	44.1%***		95% C.I. (19.5% - 68.8%)
WTP by subsamples	Yes	No	p-value[c]
High Income	58.6%***	42.7%***	0.414
Middle Income	45.9%***	42.5%***	0.746
Knowledge about Sustainability	42.4%***	44.4%***	0.880
Sustainable Behavior	61.3%***	32.5%***	0.023**
Education	44.2%***	32.5%***	0.068*
	Tamale[b]		
Mean WTP	14.6%***		95% C.I. (8.8% - 20.4%)
WTP by subsamples	Yes	No	p-value[c]
High Income	15%***	14.7%***	0.963
Middle Income	22.9%***	11.7%***	0.059*
Knowledge about Sustainability	14.7%***	14.5%***	0.970
Sustainable Behavior	14.5%***	14.7%***	0.974
Education	13.6%***	15.2%***	0.799

a. *, **, *** indicate that the difference in premium for each subsample is different from zero at 10%, 5%, and 1% significance level, respectively.
b. The reference price for conventional rice in Accra, Kumasi, and Tamale is GH$ 44.0/kg, GH$ 37.0/kg, and GH$ 26.0/kg, respectively.
c. *, **, *** indicate that the difference in premium for each subsample is different from zero at 10%, 5%, and 1% significance level, respectively.

Discussions and Implications

The goal of this study was to ascertain Ghanaian consumer preferences for rice produced sustainably following the SRP standard. More specifically, the objectives were to estimate consumer preferences for each of the eight SRP sustainability themes and to assess consumers' WTP for sustainably-produced domestic and imported rice. The study is unique in the sense that (1) to our knowledge, it is the first study looking at consumers' attitudes toward sustainably-produced rice in Ghana, where rice is an important staple from a caloric intake point of view, ranking second after maize, (2) the study is conducted in different urban locations across Ghana to ascertain whether there are geographical variations in preferences for sustainably-produced rice, and (3) it uses a multi-method approach to get a more holistic assessment of consumer preferences by looking specifically at consumer perceptions for specific sustainability themes within the confines of the SRP, and also a more general assessment of consumers' WTP using a contingent valuation approach.

One of the main conclusions from this study is that, with the exception of locally produced rice in the Accra market, Ghanaian consumers are WTP a premium for sustainably-produced rice, and the premium varies by location, rice origin (imported versus domestic), income level of households, previous knowledge about sustainability, and behaviour toward sustainability. A recent study by Hiamey and Hiamey (2018) about Ghanaian consumers indicated that environmental concerns were part of Ghana's major determinants for food consumption, and our study offers support for such statement when it comes to rice consumption. Our findings are also in line with that of Meroz et al. (2011) who found that Ghanaian consumers were WTP a premium for environmentally friendly/sustainable goods. Owusu and Anifori (2012) also stated that Ghanaian consumers were willing to pay higher premiums for organic watermelon. These studies, however, focused mainly

on organic products. A meta-analysis conducted by Li and Kallas, (2021) using eighty publications from around the world on a broad area of sustainable food products and attributes found that, in most cases, consumers were WTP a premium for sustainable products. Leal Filho et al. (2022) examined sustainable consumption patterns and the perceptions of a global group of consumers, of which Ghana was a part, regarding the changes brought on by the second wave of the COVID-19 pandemic and found that eighty percent of the respondents agreed that sustainable production and consumption was important.

The results of this study highlight the geographical variation in consumer preferences for the SRP themes and their overall WTP for sustainably-produced rice, and therefore imply that effective policy and marketing strategies should be tailored to specific regions and socioeconomic conditions. For instance, sustainably-produced local rice may have better market opportunities in Kumasi and Tamale than in Accra, where competition with imported rice is stronger and where consumers stated a much higher WTP for sustainably produced imported rice as compared to no premium offered for sustainably-produced local rice. This finding is in consonance with Piao et al. (2020) who stated that consumers in the Accra metropolitan area generally preferred imported rice to local rice. Diako et al. (2010) also stated that most consumers in Accra were more familiar with imported rice and were willing to pay more for it than for local rice.

Aprile and Punzo (2022) stated that preferences for sustainability-labelled products increase when consumers know about sustainability, and Menozzi et al. (2020) also concluded that in order for consumers to consider sustainability as a purchasing factor, they must be adequately informed about the standard and its requirements. The findings from the CV analysis indicates that knowledge about sustainability only has a positive and significant impact on the willingness to pay for sustainably-produced imported rice in Kumasi and Tamale, and no impact on the WTP for

imported rice in Accra, or for sustainably-produced local rice in any of the three locations considered.

O'Connor et al. (2017) suggest that knowledge is not a major factor in consumer decision-making once other factors like attitude/behavior are taken into consideration. The results from the CV analysis also indicate that respondents who behave sustainably are willing to pay a premium for sustainably produced rice (both domestic and imported) than those who do not only in Kumasi. The premium that consumers stating to have a sustainable behavior were willing to pay in Accra and Tamale was not significantly different from the premium stated by those respondents who state having no sustainable behavior.

The assessment of the SRP themes indicates that Nutrient Management, Health and Safety, Integrated Pest Management, and Harvest and Post-Harvest are the four most important themes to Ghanaian rice consumers. This finding is in line with Ragasa et al. (2019), who report that food safety is a consistently important attribute considered by respondents. Findings are also consistent with recent findings from Vietnam and Nigeria (My et al., 2021; Okpiaifo, 2020), where consumers expressed strong preferences for SRP attributes related to food safety.

According to our research, consumers don't place much importance on sustainability themes related to pre-planting, water use, and other social issues like labor rights. Attitudes towards certain issues such as child labor vary with culture. According to UNICEF (2023), about 21 percent of children between 5-17 years of age in Ghana are involved in child labour, and that share is much higher in rural areas. Given that the majority of households in Ghana depend on agriculture for subsistence (Acheampong et al., 2022), farming households frequently view labor as the primary asset for both adults and children relative to hired human and physical capital. Field research with primary and secondary students interviewed in urban households also shows that they reported

helping with random non-paid household chores like washing clothes, carrying buckets of water, and purchasing household items on average about 1-1.5 hours per day (Krauss, 2013). Our findings may reveal that the prevalence of child labor in Ghana leads to its normalization and therefore diminished its relevance as a pillar for sustainable development.

The findings of this study can inform agriculture policymaking and, consequently, lead to better policies. Advancing sustainable agricultural practices, and in particular rice production practices, is crucial for Ghana as the country expands rice production to cope with growing demand. Previous studies have shown that rice farmers in Ghana adopt sustainable practices for a variety of reasons, including experience with rice farming, access to training, and access to crop insurance (Zakaria et al., 2020a). More generally, the adoption of climate-smart agricultural practices among farmers in Ghana are influenced by farmers' access to climate information services (Djido et al., 2021) and training programs (Zakaria et al., 2020b). The findings of this study could help extension agents develop content focusing on the most preferred SRP themes so that farmers participating in training sections have an easier time adopting SRP when available in their region, which could lead to price premiums, higher economic rewards, and thus reinforce the adoption of sustainable practices.

Our findings can also help SRP administrators in the sense that standards and protocols should be also informed by the preference of consumers. Everything else equal, we could expect that achieving SRP certification based on the themes most preferred by the customers should lead to higher farmer's adoption and satisfaction. The results could also be considered for future SRP labelling changes that could highlight the main themes targeted by the SRP-certified farmers.

The SRP standard is currently being employed by some 150,000 farmers worldwide mostly within the context of projects partially or fully funded by private and public partners, but eventually the

sustainability of a system such as SRP lies on its ability of generating sufficient rewards (economic, social, and others) that farmers will internalize the cost and continue using it. While it is likely that in the short run the change in production practices encouraged by SRP may lead to higher costs for farmers, the fact that consumers with certain backgrounds and in certain locations in Ghana are willing to pay a premium should improve the chances of success of many of the SRP projects if these are targeted to serve the consumers' needs.

References

Abdulai, S., Zakariah, A., & Donkoh, S. A. (2018). Adoption of rice cultivation technologies and its effect on technical efficiency in Sagnarigu District of Ghana. *Cogent Food and Agriculture*, *4*(1). https://doi.org/10.1080/23311932.2018.1424296

Acheampong, P. P., Obeng, E. A., Opoku, M., Brobbey, L., & Sakyiamah, B. (2022). Does food security exist among farm households? Evidence from Ghana. *Agriculture & Food Security*, *11*(1), 1-13. https://doi.org/10.1186/s40066-022-00362-9

Alba, J. W., & Marmorstein, H. (1987). The effects of frequency knowledge on consumer decision making. *Journal of Consumer research*, *14*(1), 14-25.

Alhassan, H., Frimpong, T., & Mohammed, A. S. (2016). Do Ghanaian rural consumers prefer imported rice to local rice? *Applied Research Journal*, *1*(3).

Anang, T.B., Adjetey, S.N., & Abiriwe, A.S. (2011). Consumer preferences for rice quality characteristics and the effects on price in the Tamale Metropolis, Northern Region, Ghana. *International Journal of AgriScience* 1(2): 67-74.

Ankrah, D. A., Agyei-Holmes, A., & Boakye, A. A. (2021). Ghana's rice value chain resilience in the context of COVID-19. *Social Sciences & Humanities Open*, *4*(1), 100210.

Aoki, K., & Akai, K. (2022). A comparison between Spain and Japan with respect to the color, expected taste scale, and sustainability of strawberries: A choice experiment. *Food Quality and Preference*, *103*. https://doi.org/10.1016/j.foodqual.2022.104671

Aprile, M. C., & Punzo, G. (2022). How environmental sustainability labels affect food choices: Assessing consumer preferences in southern Italy. *Journal of Cleaner Production*, *332*, 130046. https://doi.org/https://doi.org/10.1016/j.jclepro.2021.130046

Asante, M.D., Asante, B.O., Acheampong, G.K., Offei, S.K., Gracen, V., Adu-Dapaah, H., & Danquah, Y.E. (2013). Farmer and consumer preferences for rice in the Ashanti region of Ghana: Implications for rice breeding in West Africa. *Journal of Plant Breeding and Crop Science* 5 (12): 229-238.

Asravor, J., Wiredu, A. N., Siddig, K., & Onumah, E. E. (2019). Evaluating the environmental-technology gaps of rice farms in distinct agro-ecological zones of Ghana. *Sustainability (Switzerland)*, *11*(7). https://doi.org/10.3390/su11072072

Awuni, J. A., Du, J., & Yiranbon, E. (2016). Factors influencing green purchasing behaviors: some insights from Tamale, Ghana. *British Journal of Economics, Management & Trade*, *14*(4), 1-12.

Cerroni, S., Nayga, Jr, R. M., Pappalardo, G., & Yang, W. (2022). Malleability of food values amid the COVID-19 pandemic. *European Review of Agricultural Economics*, *49*(2), 472-498.

Connor, M., Cuong, O. Q., Demont, M., Sander, B. O., & Nelson, K. (2022). The influence of climate change knowledge on consumer valuation of sustainably produced rice in Vietnam. *Sustainable Production and Consumption*, *31*, 1-12.

Demont, M., & Rutsaert, P. (2017). Restructuring the Vietnamese rice sector: towards increasing sustainability. *Sustainability*, *9*(2), 325.

Diako, C., Sakyi-Dawson, E., Bediako-Amoa, B., Saalia, F. K., & Manful, J. T. (2010). Consumer perceptions, knowledge and preferences for aromatic rice types in Ghana. *Nature and Science*, *8*(12), 12-19.

Djido, A., Zougmoré, R. B., Houessionon, P., Ouédraogo, M., Ouédraogo, I., & Diouf, N. S. (2021). To what extent do weather and climate information services drive the adoption of climate-smart agriculture practices in Ghana? *Climate Risk Management*, 32, 100309.

Durand-Morat, A., & Bairagi, S. (2022). International Rice Outlook_ International Rice Baseline Projections 2021–2031. *Research Reports and Research Bulletins*. https://scholarworks.uark.edu/aaesrb/53

Ehiakpor, D.S., Apumbora, J., Danso-Abbeam, G., & Adzawla, W. (2017). Households' preference for local rice in the upper East region, Ghana. *Advances in Agriculture*, Vol. 2017, pp. 1-9.

Ellis, D. (2015). Consumer knowledge and its implications for aspects of consumer purchasing behaviour in the case of information-intensive products. *KTH Royal Institute of Technology, Division of Industrial Marketing, INDEK*.

FAO. (2014). *SAFA Sustainability Assessment of Food and Agriculture Systems Guidelines*.

Finn, A., & Louviere, J. J. (1992). Determining the appropriate response to evidence of public concern: the case of food safety. *Journal of Public Policy & Marketing*, *11*(2), 12-25.

Fukagawa, N. K., & Ziska, L. H. (2019). Rice: Importance for global nutrition. *Journal of nutritional science and vitaminology*, *65*(Supplement), S2-S3.

Greene, W. H. (2008). The econometric approach to efficiency analysis. *The Measurement of Productive Efficiency and Productivity Growth*, *1*(1), 92–250.

Ghana Statistical Service. (2019). *Ghana Living Standards Survey Round 7. https://www2.statsghana.gov.gh/nada/index.php/catalog/97/study-description*.

Hanemann, M., Loomis, J., & Kanninen, B. (1991). Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. *American Journal of Agricultural Economics*, *73*(4), 1255–1263. https://doi.org/https://doi.org/10.2307/1242453

Hiamey, S. E., & Hiamey, G. A. (2018). Street food consumption in a Ghanaian Metropolis: The concerns determining consumption and non-consumption. *Food Control*, *92*, 121–127. https://doi.org/10.1016/J.FOODCONT.2018.04.034

Huang, M., Zeng, L., Liu, C., Li, X., & Wang, H. (2022). Research on the Eco-Efficiency of Rice Production and Its Improvement Path: A Case Study from China. *International Journal of Environmental Research and Public Health*, *19*(14). https://doi.org/10.3390/ijerph19148645

Keeble, B. R. (1988). The Brundtland report: 'Our common future.' *Medicine and War*, *4*(1), 17–25. https://doi.org/10.1080/07488008808408783

Krauss, A. (2013). Understanding child labor beyond poverty: the structure of the economy, social norms, and no returns to rural basic education. *World Bank Policy Research Working Paper*, (6513). http://econ.worldbank.org.

Krinsky, I., & Robb, A. L. (1986). On approximating the statistical properties of elasticities. *The review of economics and statistics*, 715-719.

Leal Filho, W., Salvia, A. L., Paço, A., Dinis, M. A. P., Vidal, D. G., Da Cunha, D. A., ... & Ríos, F. J. M. (2022). The influences of the COVID-19 pandemic on sustainable consumption: an international study. *Environmental Sciences Europe*, *34*(1), 54. https://doi.org/10.1186/s12302-022-00626-y

Lernoud, J., Potts, J., Sampson, G., Voora, V., Willer, H., & Wozniak, J. (2016). The state of sustainable markets-statistics and emerging trends 2015.

Li, S., & Kallas, Z. (2021). Meta-analysis of consumers' willingness to pay for sustainable food products. *Appetite*, *163*, 105239. https://doi.org/10.1016/j.appet.2021.105239

Liang, H., Xu, J., Hou, H., Qi, Z., Yang, S., Li, Y., & Hu, K. (2022). Modeling CH4 and N2O emissions for continuous and noncontinuous flooding rice systems. *Agricultural Systems*, *203*, 103528. https://doi.org/10.1016/J.AGSY.2022.103528

Lopez-Feldman, A. (2012). Introduction to contingent valuation using Stata. http://mpra.ub.uni-muenchen.de/41018/

Louviere, J. J., & Woodworth, G. G. (1990). Best worst scaling: A model for largest difference judgments [Working Paper]. *Faculty of Business*.

Mamadzhanov, A., McCluskey, J. J., & Li, T. (2019). Willingness to pay for a second-generation bioethanol: A case study of Korea. *Energy Policy*, *127*, 464–474. https://doi.org/10.1016/J.ENPOL.2018.12.001

McFadden, D. (1974). Frontiers in Econometrics, chapter Conditional logit analysis of qualitative choice behavior.

Menozzi, D., Nguyen, T. T., Sogari, G., Taskov, D., Lucas, S., Castro-Rial, J. L. S., & Mora, C. (2020). Consumers' preferences and willingness to pay for fish products with health and environmental labels: Evidence from five European countries. *Nutrients*, *12*(9), 2650.

Meroz, Y., Morone, A., & Morone, P. (2011). Eliciting environmental preferences of Ghanaians in the laboratory: An incentive-compatible experiment. *International Journal of Environment and Sustainable Development*, *10*(2), 119–136. https://doi.org/10.1504/IJESD.2011.041969

My, N. H. D., Demont, M., & Verbeke, W. (2021). Inclusiveness of consumer access to food safety: Evidence from certified rice in Vietnam. *Global Food Security*, *28*, 100491. https://doi.org/10.1016/J.GFS.2021.100491

My, N. H. D., Demont, M., van Loo, E. J., de Guia, A., Rutsaert, P., Tuan, T. H., & Verbeke, W. (2018). What is the value of sustainably-produced rice? Consumer evidence from experimental auctions in Vietnam. *Food Policy*, *79*, 283–296. https://doi.org/10.1016/j.foodpol.2018.08.004

Nasrin, S., Lodin, J. B., Jirström, M., Holmquist, B., Djurfeldt, A. A., & Djurfeldt, G. (2015). Drivers of rice production: Evidence from five Sub-Saharan African countries. *Agriculture and Food Security*, *4*(1). https://doi.org/10.1186/s40066-015-0032-6

Nguyen, T. T. (2016). *Pesticide use in rice farming and its impacts on climbing perch (Anabas testudineus) in the Mekong delta of Vietnam*. Department of Physical Geography, Stockholm University.

NSAC. (2022). *What is Sustainable Ag? -National Sustainable Agriculture Coalition*. https://sustainableagriculture.net/about-us/what-is-sustainable-ag/1/3

O'Connor, E. L., Sims, L., & White, K. M. (2017). Ethical food choices: Examining people's Fair-Trade purchasing decisions. *Food Quality and Preference*, *60*, 105–112. https://doi.org/10.1016/J.FOODQUAL.2017.04.001

Okpiaifo, G., Durand-Morat, A., West, G. H., Nalley, L. L., Nayga Jr, R. M., & Wailes, E. J. (2020). Consumers' preferences for sustainable rice practices in Nigeria. *Global Food Security*, *24*, 100345.

Owusu, R., & Dadzie, S. K. N. (2021). Heterogeneity in consumer preferences for organic and genetically modified food products in Ghana. *African Journal of Agricultural and Resource Economics Volume*, *16*(2), 112-125.

Owusu, V. (2012). *Assessing consumer willingness to pay a premium for organic food product: Evidence from Ghana* (No. 1007-2016-79546, pp. 1-13).

Paul, J., Modi, A., & Patel, J. (2016). Predicting green product consumption using theory of planned behavior and reasoned action. *Journal of Retailing and Consumer Services*, *29*, 123–134. https://doi.org/10.1016/J.JRETCONSER.2015.11.006

Peschel, A. O., Grebitus, C., Steiner, B., & Veeman, M. (2016). How does consumer knowledge affect environmentally sustainable choices? Evidence from a cross-country latent class analysis of food labels. *Appetite*, *106*, 78-91

Peterson-Wilhelm, B., Nalley, L., Durand-Morat, A., Shew, A., Tsiboe, F., & Mulimbi, W. (2021). Quality determinates of rice price in open bag markets in Sub-Saharan Africa. *Journal of Agribusiness in Developing and Emerging Economies*.

Piao, S. Y., Li, Z. R., Sun, Y. C., Lee, J. I., & Amanor, Y. E. (2020). Analysis of the Factors Influencing Consumers' Preferences for Rice: Locally Produced Versus the Imported in the Ga East Municipality of the Greater Accra Region of Ghana. *Journal of Agricultural, Life and Environmental Sciences*, *32*(3), 177–192. https://doi.org/10.22698/jales.20200016

Ragasa, C., Andam, K. S., Amewu, S., & Asante, S. (2019). *Consumer demand and willingness to pay for safe food in Accra, Ghana: Implications for public and private sectors' roles in food safety management* (Vol. 1795). Intl Food Policy Res Inst. https://doi.org/10.13140/RG.2.2.36693.88805

Sánchez-Bravo, P., Chambers, E., Noguera-Artiaga, L., López-Lluch, D., Chambers IV, E., Carbonell-Barrachina, Á. A., & Sendra, E. (2020). Consumers' attitude towards the sustainability of different food categories. *Foods*, *9*(11), 1608.

SRP. (2020). The SRP Standard for Sustainable Rice Cultivation (Version 2.1). *Sustainable Rice Platform. Bangkok:2020*. www.sustainablerice.org

Swait, J., & Louviere, J. (1993). The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models. *Journal of Marketing Research*, *30*(3), 305–314. https://doi.org/10.1177/002224379303000303

Train, K. E. (2009). *Discrete choice methods with simulation*. Cambridge university press.

UNICEF. (2023). Prevention of Child Labor. https://www.unicef.org/ghana/prevention-child-labour

United Nations. (2022). *The Sustainable Development Goals Report*.

USDA. (2017). USDA Agricultural Projections to 2026 Interagency Agricultural Projections Committee *USDA Long-term Projections*. https://www.ers.usda.gov/publications/pub-details/?pubid=37818

USDA. (2022). Production, Supply and Distribution Database. Foreign Agricultural Service. https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery.

Yuan, S., Linquist, B. A., Wilson, L. T., Cassman, K. G., Stuart, A. M., Pede, V., ... & Grassini, P. (2021). Sustainable intensification for a larger global rice bowl. Nature communications, 12(1), 7163.

Zakaria, A., Alhassan, S. I., Kuwornu, J. K., Azumah, S. B., & Derkyi, M. A. (2020a). Factors influencing the adoption of climate-smart agricultural technologies among rice farmers in northern Ghana. *Earth Systems and Environment*, 4, 257-271.

Zakaria, A., Azumah, S. B., Appiah-Twumasi, M., & Dagunga, G. (2020b). Adoption of climate-smart agricultural practices among farm households in Ghana: The role of farmer participation in training programmes. *Technology in Society*, 63, 101338.

Appendices

Appendix 1:Sample Questionnaire of the Survey

Consumer Preferences for Sustainable Rice in Kumasi

Purpose of this Study
In this study, we are interested in knowing the preference of Ghanaian consumers for rice produced sustainably. In particular, we want to know consumers' attitudes toward the different practices that could be used to produce rice sustainably, such as the correct use and disposal of pesticides, the efficient use of water, and the health and safety of farm workers. The survey consists of questions regarding sustainable rice production, your willingness to pay for rice produced sustainably, and general socioeconomic questions such as age and education.

Description of the Participation.

We want to invite you to take this survey. We expect the survey will take 20 to 25 minutes. There are no anticipated costs, risks, or discomforts expected from participating in this study. All electronic information collected will be securely stored and used for research purposes only. The survey is anonymous so no identifying information will be requested. You will receive a 20 Cedi airtime compensation for your participation in this study.

If you have questions or concerns about this study, you may contact the investigator Alvaro Durand-Morat at adurand@uark.edu or Vera Adabrah at +233 262111828. For questions or concerns about your rights as a research participant, please contact Ro Windwalker, University of Arkansas's Research Compliance Coordinator (irb@uark.edu). Protocol #: 2204397119.

I am willing to take this survey

I am not willing to take this survey

Q1 Are you 18 years or older?
Yes
No

Q2 Do you typically buy the rice for your household?
Yes
No

Q3 Name of Town or City _____

Q4 Name of Market _____

Q5 Please indicate if you think these statements are true, false, or if you do not know

	True	False	Do not know
5.1 Sustainability does not involve agriculture			
5.2 The waste your household generates can be transformed into new energy			
5.3 Sustainability involves meeting the needs of the present without risking future generations' ability to meet their needs			
5.4 I reuse shopping bags			
5.5 I prefer to buy products produced sustainably			
5.6 I am trying to increase sustainability awareness (for example, I support organizations advancing sustainability, I educate my family about the importance of sustainability)			

The sustainable rice platform (SRP) is one of the standards producers can use to certify rice as **sustainable**. The SRP defines sustainable rice as that produced following selected practices listed under the 8 SRP themes listed below.

In the section that follows we will ask you a series of choice questions, which require you to choose the most important and list important characteristics or attributes shown in each question.

Example Choice Question
Here is an example of a choice question. Consider that you are shopping for mangoes, and you can assess their quality based on 4 characteristics: appearance, production methods, price, and packaging. We ask that you select the most important and least important characteristics that you will consider to making a choice.

Most Important	Attribute	Least Important
	Appearance *This refers to how the mango looks. Whether or not there are spots on it or how clean it looks to you*	
	Production Method *Overview of the growing practices from growing/ planting to harvesting*	
	Price *The cost of the fruit at the market at that moment*	
	Packaging *This refers to the presentation of the fruit. Whether it was laid on open trays or put in small transparent boxes*	

We define sustainable rice as that which is produced following good farm management practices aimed at lowering the environmental impact of rice production and protecting the well-being of farmers, farmworkers, and their families.

In the 6 questions that follow, you will be presented with a list of 4 SRP themes from the 8 SRP themes presented before. We ask that you choose the most important and least important theme for you based on your own preferences by checking the respective boxes. You are asked to choose only one theme as the most important, and only one as the least important, so please take your time to understand what each theme means and make your best-informed decision. Please ask the enumerator if you have doubts about the meaning of the themes or questions about the procedure before choosing your answers.

Q6

Most Important	Attribute	Least Important
	Water Use *Activities adapted to produce the most rice possible for each unit of water used. Involves water management, irrigation systems at the community level, inbound water quality, groundwater extraction, and drainage*	
	Nutrient Management *Activities adopted with the goal of producing the most rice possible for each unit of fertilizer used. This involves adopting good fertilizer practices, such as ways to measure the amount of fertilizer needed, timing of application, and type of fertilizer to use.*	
	Integrated Pest Management *Activities adopted to manage pests and diseases affecting the rice crop in an effective and environmentally-sensitive manner. For instance, it involves knowing the species of weeds, insects, and birds present in the field and selecting the right pesticides to control the problem without damaging beneficial organisms*	
	Labor Rights *Activities adopted to protect and advance the labor rights of farmworkers, including children and women. This addresses issues about child labor, hazardous work, forced labor, and discrimination by gender.*	

Q7

Most Important	Attribute	Least Important
	Pre-Planting *It includes checks for the risk of heavy metals in the soil, soil salinity, land conversion and biodiversity, invasive species, leveling, and the use of pure quality seeds.*	
	Nutrient Management *Activities adopted to produce the most rice possible for each unit of fertilizer used. This involves adopting good fertilizer practices, such as ways to measure the amount of fertilizer needed, timing of application, and type of fertilizer to use.*	
	Harvest and Post-Harvest *Activities adapted to collect, process, and store rice in a way that is economically beneficial for farmers (good yield and quality), use rice residues efficiently (for example, using the straw as fertilizer), and use drying and storage practices that reduce the environmental impact and are not a threat to the health of consumers.*	
	Health and Safety *Addresses the health and safety of farmers, farmworkers, and their families. It involves training in pesticide application, the use of PPEs, the use of farm tools and equipment*	

Q8

Most Important	Attribute	Least Important
	Farm Management *Activities adopted to organize and operate a farm for maximum production and profit. Includes activities such as: developing a crop calendar, developing record-keeping habits, and training of farmers in sustainability*	
	Water Use *Activities adapted to produce the most rice possible for each unit of water used. Involves water management, irrigation systems at the community level, inbound water quality, groundwater extraction, and drainage*	
	Harvest and Post-Harvest *Activities adapted to collect, process, and store rice in a way that is economically beneficial for farmers (good yield and quality), use rice residues efficiently (for example, using the straw as fertilizer), and use drying and storage practices that reduce the environmental impact and are not a threat to the health of consumers.*	
	Health and Safety *Addresses the health and safety of farmers, farmworkers, and their families. It involves training in pesticide application, the use of PPEs, the use of farm tools and equipment*	

Q9

Most Important	Attribute	Least Important
	Pre-Planting *It includes checks for risk of heavy metals in the soil, soil salinity, land conversion and biodiversity, invasive species, leveling and the use of pure quality seeds.*	
	Water Use *Activities adapted to produce the most rice possible for each unit of water used. Involves water management, irrigation systems at the community level, inbound water quality, groundwater extraction, and drainage*	
	Integrated Pest Management *Activities adopted to manage pests and diseases affecting the rice crop in an effective and environmentally-sensitive manner. For instance, it involves knowing the species of weeds, insects, and birds present in the field and selecting the right pesticides to control the problem without damaging beneficial organisms*	
	Labor Rights *Activities adopted to protect and advance the labor rights of farmworkers, including children and women. This addresses issues about child labor, hazardous work, forced labor, and discrimination by gender. Activities adopted to protect and advance the labor rights of farmworkers, including children and women. This addresses issues about child labor, hazardous work, forced labor, and discrimination by gender.*	

Q10

Most Important	Attribute	Least Important
	Farm Management *Activities adopted to organize and operate a farm for maximum production and profit. Includes activities such as: developing a crop calendar, developing record-keeping habits, and training of farmers in sustainability*	
	Pre-Planting *It includes checks for risk of heavy metals in the soil, soil salinity, land conversion and biodiversity, invasive species, leveling and the use of pure quality seeds.*	
	Harvest and Post-Harvest *Activities adapted to collect, process, and store rice in a way that is economically beneficial for farmers (good yield and quality), use rice residues efficiently (for example, using the straw as fertilizer), and use drying and storage practices that reduce the environmental impact and are not a threat to the health of consumers.*	
	Integrated Pest Management *Activities adopted to manage pests and diseases affecting the rice crop in an effective and environmentally-sensitive manner. For instance, it involves knowing the species of weeds, insects, and birds present in the field and selecting the right pesticides to control the problem without damaging beneficial organisms*	

Q11

Most Important	Attribute	Least Important
	Farm Management *Activities adopted to organize and operate a farm for maximum production and profit. Includes activities such as: developing a crop calendar, developing record-keeping habits, and training of farmers in sustainability*	
	Nutrient Management *Activities adopted to produce the most rice possible for each unit of fertilizer used. This involves adopting good fertilizer practices, such as ways to measure the amount of fertilizer needed, timing of application, and type of fertilizer to use*	
	Health and Safety *Addresses the health and safety of farmers, farmworkers, and their families. It involves training in pesticide application, the use of PPEs, the use of farm tools and equipment*	
	Labor Rights *Activities adopted to protect and advance the labor rights of farmworkers, including children and women. This addresses issues about child labor, hazardous work, forced labor, and discrimination by gender.*	

Contingent Valuation

In the following 2 questions, we will present you with a hypothetical market situation in which you have the choice of choosing to buy two different rice products: (1) **conventional rice** that is not certified sustainable (like the rice you can find in the market now), and (2) **sustainable rice** certified by SRP. Before you answer the following questions, it is important that you clearly understand the meaning of sustainable rice.

We define "sustainable rice" as that which is produced following good farm management practices aimed at lowering the environmental impact of rice production and protecting the wellbeing of farmers, farmworkers and their families.

*Sustainable rice has the **same quality** **(for instance, appearance, taste, and texture)** and **same nutritional value** (for example, calories, vitamin and mineral content) as "conventional rice." With that said, for you as a consumer, sustainable rice has **indirect benefits** through knowing that you are consuming rice that is better for the environment and for rice farming families and workers than conventional rice.*
The market situation is hypothetical, and you will not be required to purchase the product you choose. With that said, we want you to assume that you are actually making that decision and that your choice will have real consequences (that you will need to buy the product and pay the price you said you would pay for it). So, we urge you to be mindful of your own preferences regarding sustainability and your current budget when selecting the rice price of your choice.

Q12 Do you normally consume imported or local rice?
☐Imported
☐Local
☐I do not know

If Q12 = domestic, then

Q13 Suppose the price of conventional local rice is 37 Cedi per 5 kilos. If the price of sustainable local rice is 29.23 Cedi per 5 kilo, would you be willing to purchase sustainable local rice?
☐Yes
☐No

If Q13 = No, then

Q14 Suppose the price of conventional local rice is 37 Cedi per 5 kilos. If the price of sustainable local rice is 27.94 Cedi per 5 kilo, would you be willing to purchase sustainable local rice?
☐Yes
☐No

If Q13 = Yes, then

Q14 Suppose the price of conventional local rice is 37 Cedi per 5 kilos. If the price of sustainable local rice is 30.53 Cedi per 5 kilo, would you be willing to purchase sustainable local rice?
☐Yes
☐No

Socioeconomic Questionnaire

Q15 Gender

☒Male
☐Female

Q16 How old are you? _____

Q17 How many people live in your home (including yourself)? _____

Q18 Household monthly income
☐Less than GHS 1000
☐GHS 1001–2000
☐GHS 2001–3000
☐GHS 3001 –4500
☐More than GHS 4500

Q19 What share of your income is spent on food every month?
☐Less than 20%
☐20%-40%
☐41% - 60%
☐61%-80%
☐More than 80%

Q20 Highest level of Education Completed
☐None
☐Primary School
☐JHS/JSS
☐SHS/SSS
☐Teacher/Nursing/Agric Training Cert
☐Technical/Vocational/Communication
☐University (Bachelors)
☐University (Post Graduate)
☐Other: _____

Q21 Where do you usually buy your rice?
☐Supermarket
☐Neighborhood store
☐Malls
☐Open Market
☐Other: _____

Q22 How much rice does your household consume in a week?
☐Less than 1 kilo
☐1.0 –1.5 kilo
☐1.5 –2.0 kilo
☐2.0 –2.5 kilo
☐2.5 –3.0 kilo
☐3.0 –3.5 kilo

☐3.5 –4.0 kilo
☐More than 4.0 kilo

Q23 Do you usually wash the rice before cooking?
☐Yes
☐No

If Q23 = Yes, then
Q24 What is the reason?
☐Reducing cooking time
☐Removing bad rice kernels
☐Improving flavor
☐Removing stones and other impurities
☐Other: _____

Q25 If you can choose, do you prefer imported or local rice?
☐Local
☐Imported
☐Indifferent

Appendix 2:SRP themes used in the survey and their definitions

Theme		Definition
1. Farm Management		Activities adopted to organize and operate a farm for maximum production and profit. Includes activities such as: • Developing a crop calendar • Develop record-keeping habits • Training of farmers in sustainability
2. Pre-Planting		Activities carried out prior to planting with the goal of producing a good crop while protecting the environment. It includes checks for risk of heavy metals in the soil, soil salinity, land conversion and biodiversity, invasive species, leveling, and the use of pure quality seeds.
3. Water Use		Activities adopted to produce the most rice possible for each unit of water used. This involves water management, irrigation systems at community level, inbound water quality, groundwater extraction and drainage.
4. Nutrient Management		Activities adopted with the goal of producing the most rice possible for each unit of fertilizer used. This involves adopting good fertilizer practices, such as ways to measure the amount of fertilizer needed, timing of application, and type of fertilizer to use.
5. Integrated Pest Management		Activities adopted to manage pests and diseases affecting the rice crop in an effective and environmentally-sensitive manner. For instance, it involves knowing the species of weeds, insects, and birds present in the field, and selecting the right pesticides so as to control the problem without damaging beneficial organisms
6. Harvest and Post-Harvest		Activities adopted to collect, process, and store rice in a way that: • Is economically beneficial for farmers (good yield and quality) • Uses rice residues efficiently (for example, uses the straw as fertilizer) • Uses drying and storage practices that reduce the environmental impact and are not a threat to the health of consumers.
7. Health and Safety		Activities adopted to protect and improve the health and safety of farmers, farmworkers, and their families. It involves practices such as: • Training in the use of pesticides • Using protective equipment • Storing pesticides properly • Learning to use of farm tools and equipment properly
8. Labor Rights		Activities adopted to protect and advance the labor rights of farm workers, including children and women. This addresses issues such as: • Child labor • Hazardous work • Forced labor • Discrimination by gender, including wage discrimination against women

Appendix 3: Preference Shares for SRP Themes by Knowledge of Sustainability: Knowledge = 1

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	NM	0.224	0.200-0.249	HS	0.632	0.421-0.809	NM	0.253	0.222-0.285
2	HS	0.216	0.185-0.250	NM	0.137	0.071- 0.218	IPM	0.166	0.145-0.188
3	IPM	0.189	0.166-0.213	FM	0.069	0.029-0.130	HS	0.115	0.096-0.135
4	HPH	0.113	0.095-0.133	IPM	0.045	0.020-0.081	WUS	0.114	0.099-0.131
5	LR	0.083	0.075-0.090	WUS	0.038	0.017-0.067	FM	0.104	0.089-0.121
6	WUS	0.070	0.060-0.081	LR	0.032	0.015-0.056	HPH	0.091	0.077-0.107
7	PRP	0.059	0.051-0.068	HPH	0.032	0.013-0.063	LR	0.083	0.076-0.091
8	FM	0.047	0.039-0.056	PRP	0.016	0.007-0.031	PRP	0.074	0.063- 0.085

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 4: Preference Shares for SRP Themes by Knowledge of Sustainability: Knowledge = 0

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	NM	0.191	0.160- 0.225	HS	0.229	0.198-0.262	NM	0.235	0.203-0.268
2	HS	0.182	0.149-0.219	HPH	0.216	0.182-0.252	HS	0.178	0.144-0.216
3	IPM	0.152	0.125-0.184	IPM	0.191	0.167-0.215	IPM	0.154	0.131- 0.179
4	HPH	0.123	0.096-0.154	NM	0.138	0.121-0.156	FM	0.131	0.107-0.159
5	LR	0.111	0.099-0.124	LR	0.081	0.074-0.088	WUS	0.099	0.083-0.116
6	PRP	0.097	0.080-0.115	PRP	0.053	0.045- 0.061	LR	0.083	0.075-0.093
7	FM	0.078	0.061-0.096	FM	0.047	0.039-0.057	HPH	0.070	0.056-0.086
8	WUS	0.068	0.055-0.082	WUS	0.045	0.039-0.052	PRP	0.049	0.039-0.061

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 5: Preference Shares for SRP Themes by Sustainable behavior: Behavior = 1

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	IPM	0.223	0.188-0.261	NM	0.208	0.174-0.245	NM	0.268	0.232-0.307
2	HS	0.216	0.176-0.262	HS	0.188	0.150-0.230	IPM	0.133	0.113-0.154
3	NM	0.210	0.178-0.246	IPM	0.185	0.154-0.221	FM	0.126	0.105- 0.150
4	HPH	0.108	0.085-0.135	HPH	0.168	0.129-0.211	WUS	0.115	0.096-0.135
5	LR	0.075	0.066-0.085	LR	0.088	0.077-0.100	HPH	0.106	0.087-0.127
6	WUS	0.064	0.051-0.080	PRP	0.071	0.056-0.089	PRP	0.091	0.077-0.107
7	PRP	0.057	0.046-0.069	FM	0.049	0.036-0.065	HS	0.086	0.069-0.105
8	FM	0.046	0.034-0.060	WUS	0.043	0.033-0.054	LR	0.077	0.069- 0.085

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 6: Preference Shares for SRP Themes by Sustainable behavior: Behavior = 0

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	NM	0.209	0.185-0.234	HS	0.313	0.223-0.410	NM	0.224	0.198- 0.252
2	HS	0.193	0.166-0.222	HPH	0.242	0.142-0.367	HS	0.192	0.160-0.227
3	IPM	0.155	0.135-0.176	NM	0.134	0.099-0.174	IPM	0.178	0.155-0.203
4	HPH	0.125	0.105-0.148	IPM	0.103	0.072-0.141	FM	0.106	0.089-0.125
5	LR	0.105	0.097-0.114	FM	0.087	0.061-0.119	WUS	0.102	0.089-0.117
6	PRP	0.079	0.069-0.090	LR	0.056	0.044-0.068	LR	0.086	0.078-0.095
7	WUS	0.071	0.062-0.081	WUS	0.042	0.030- 0.055	HPH	0.066	0.054-0.079
8	FM	0.063	0.053-0.073	PRP	0.024	0.017-0.033	PRP	0.046	0.038-0.055

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 7: Preference Shares for SRP Themes by Household Income: Middle Income

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	NM	0.222	0.194-0.252	HS	0.309	0.260-0.361	NM	0.213	0.179-0.250
2	HS	0.215	0.179-0.254	IPM	0.193	0.163- 0.227	IPM	0.197	0.162-0.236
3	IPM	0.156	0.132-0.181	NM	0.167	0.144-0.192	HS	0.154	0.121-0.196
4	HPH	0.109	0.087-0.133	HPH	0.136	0.107- 0.169	FM	0.126	0.101-0.156
5	LR	0.095	0.085-0.105	LR	0.073	0.064- 0.082	WUS	0.106	0.086-0.128
6	WUS	0.076	0.065-0.089	FM	0.049	0.039-0.060	LR	0.088	0.078-0.1001
7	PRP	0.070	0.060-0.082	WUS	0.038	0.031- 0.046	HPH	0.072	0.055-0.091
8	FM	0.057	0.046-0.069	PRP	0.035	0.028-0.043	PRP	0.045	0.035-0.055

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 8: Preference Shares for SRP Themes by Household Income: High Income

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	HS	0.290	0.207-0.385	HS	0.347	0.210-0.505	IPM	0.202	0.145-0.272
2	NM	0.179	0.136-0.230	NM	0.140	0.090- 0.208	NM	0.177	0.126- 0.238
3	HPH	0.157	0.108-0.219	HPH	0.111	0.055-0.194	FM	0.147	0.099-0.206
4	IPM	0.129	0.097-0.167	WUS	0.092	0.056-0.139	HPH	0.110	0.071- 0.162
5	LR	0.090	0.073-0.109	IPM	0.091	0.053-0.141	HS	0.111	0.071-0.162
6	PRP	0.081	0.059- 0.107	FM	0.080	0.042-0.134	LR	0.103	0.082-0.128
7	WUS	0.047	0.032-0.066	LR	0.073	0.052-0.097	WUS	0.103	0.069-0.145
8	FM	0.027	0.016-0.041	PRP	0.066	0.037-0.104	PRP	0.047	0.030-0.071

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 9: Preference Shares for SRP Themes by Educational Level: High Education Group

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	NM	0.222	0.199-0.247	HS	0.409	0.337- 0.485	NM	0.245	0.215-0.277
2	HS	0.202	0.176-0.230	NM	0.168	0.139-0.200	IPM	0.164	0.142- 0.187
3	IPM	0.172	0.152-0.193	HPH	0.101	0.076- 0.129	HS	0.119	0.099-0.141
4	HPH	0.113	0.096-0.131	IPM	0.091	0.072-0.112	WUS	0.116	0.099-0.133
5	LR	0.090	0.082-0.097	FM	0.074	0.057-0.093	FM	0.116	0.098-0.136
6	PRP	0.072	0.063-0.082	LR	0.070	0.060- 0.082	HPH	0.087	0.073- 0.104
7	WUS	0.068	0.060-0.078	WUS	0.046	0.040-0.064	LR	0.083	0.075-0.091
8	FM	0.062	0.052-0.072	PRP	0.041	0.032-0.053	PRP	0.071	0.060-0.083

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 10: Preference Shares for SRP Themes by Educational Level: Low Education Group

Rank	Theme‡	Preference Share (PS) Accra	95% C. I	Theme‡	Preference Share (PS) Kumasi	95% C. I	Theme‡	Preference Share (PS) Tamale	95% C. I
1	HS	0.200	0.154-0.251	IPM	0.237	0.203-0.275	NM	0.246	0.215-0.281
2	IPM	0.195	0.155-0.241	HPH	0.230	0.188- 0.277	HS	0.158	0.130- 0.190
3	NM	0.179	0.145-0.218	HS	0.199	0.166-0.237	IPM	0.158	0.136- 0.182
4	HPH	0.141	0.107-0.182	NM	0.128	0.108-0.150	FM	0.115	0.095- 0.138
5	LR	0.106	0.092-0.121	LR	0.076	0.068- 0.085	WUS	0.102	0.087- 0.119
6	WUS	0.072	0.055-0.091	PRP	0.048	0.039-0.057	LR	0.086	0.0777-0.095
7	PRP	0.063	0.049-0.080	WUS	0.042	0.035- 0.051	HPH	0.078	0.063-0.094
8	FM	0.044	0.032-0.059	FM	0.039	0.029- 0.050	PRP	0.056	0.046-0.068

‡ NM: nutrient management; LR: labor rights; HS: health and safety; WUS: water use; PRP: pre-planting; IPM: integrated pest management; FM: farm management; HPH: harvest and post-harvest

Appendix 11: IRP Approval Letter

UNIVERSITY OF ARKANSAS

To:	Alvaro Durand-Morat
From:	Douglas J AdamsJustin R Chimka, Chair IRB Expedited Review
Date:	04/28/2022
Action:	**Exemption Granted**
Action Date:	04/28/2022
Protocol #:	2204397119
Study Title:	Consumer Preferences for Sustainable Rice in Ghana

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Vera Adabrah - Danquah, Investigator
Lawton L Nalley, Investigator
Wei Yang, Investigator