Determinants of Consumer Preferences for Rice Attributes: Evidence from South and Southeast Asia

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Abstract

Consumers' preference toward rice that has the aroma trait is evolving. In this article, we investigate rice attributes that are valued by the urban and rural consumers of seven countries in South and Southeast Asia. In addition, the factors that influence consumers' decisions on choosing from a set of rice attributes are identified. We fit a rank ordered logistic regression with an incomplete ranking choice data gathered from a stated-preference survey. This survey was conducted from 5168 urban and rural consumers of 32 cities in seven countries during 2013-14. The results show that preferences for rice traits vary significantly among consumers in South and Southeast Asia. Bangladeshi and Indian rice consumers prefer rice that has great appearance and taste attributes. Conversely, Southeast Asian consumers' first choice is more likely to be texture traits. Their second and third most-preferred traits are aroma and appearance. The results also show that empowered women choose rice that has great appearance and aroma attributes. Finally, we find that preference for rice is influenced by the respondents' education, family size, and their income, amount of rice consumption, and rice expenditure share. Geographic segmentation significantly affects consumers' decision in choosing preferred rice traits. Consumer preference is also positively and significantly affected if women are a principal grocery shopping decision maker in a household.

Key words: attributes, consumer, probability, rank-ordered logistic model, rice, stated-preference, South and Southeast Asia.

JEL codes: D12, C25, O53

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1. Introduction

Across Asia, rice is the staple food for the majority of the households and is the main source of energy and protein intake (Papademetriou, 2000; GRiSP, 2013; Dawe et al. 2014). More than 90% of global rice is produced and consumed in this region (Rejesus et al., 2012; Mohanty et al., 2013). However, the per capita consumption of rice in many Asian countries has witnessed a significant decline (e.g., Japan, Taiwan) and in many other Asian countries it has started to decline (e.g., India, China). This could be because of undergoing structural transformation in their economies and rapid urbanization (Huang and Bouis, 2001; GRiSP, 2013). During the last one and a half decades, the number of urban living population increased significantly in both South and Southeast Asia.[1] Urban living is the likely cause of changing taste and lifestyle, and preferences for food choices are likely to be affected by these changes (Huang and Bouis, 1996; Kearney, 2010). For example, Bunyasiri and Sirisupluxana (2017) found that consumers in Sichuan Province of China, who have comparatively higher income and education, and have a more cheerful lifestyle, prefer imported aromatic rice.

Global demand for high-quality rice grain is evolving (Calingacion et al., 2014). It is evident in South and Southeast Asia that consumer preferences for rice have been changing toward fine and aromatic rice[2] (Custodio et al., 2016). This could be simply because the preferences of the new cohort of population are different or preferences over time are evolving with trade liberalization because importers are the ones who are actually bringing the new preferences. Another important reason could be income growth. As income rises, diversification away from non-aromatic rice to

[1] Around 50% and 20% increases in urban population are found in South and Southeast Asia, respectively, during the last one and a half decades (FAOSTAT, 2017).

[2] Aromatic rice is categorized into two: basmati and jasmine, which is characterized by the presence of a popcorn-/baked bread-like flavor compound called 2-acetyl-1-pyrroline (2AP) (Napasintuwong, 2012; Calingacion et al., 2014). A survey of global preferences for aromatic rice can be found in Napasintuwong (2012).

aromatic rice in the diet is expected to increase. We argue that consumer preferences for rice are expected to converge to aromatic rice, resulting in a further increase in demand for this rice. As rice importers are the ones bringing these preferences in from the exporting countries, we call this convergence of preferences toward aromatic rice Jasminization.

The impacts of Jasminization are expected to be enormous. The direct impact is the expansion of the share of aromatic rice in the pie of international rice trade, which resulted in the distribution of a larger share of the product value among stakeholders in the global value chain. The idea of Jasminization is mainly based on the following: demand for aromatic rice is expected to evolve more rapidly with urbanization,[3] millers/importers will introduce preferences for aromatic rice to local consumers, and a considerably higher price premium is expected over non-aromatic rice. Because of the higher price premium, aromatic rice is expected to be traded significantly from rural to urban and from domestic to international consumers. Therefore, the aromatic rice market is expected to become bigger and bigger. Note that the international rice market is still very thin; currently, aromatic rice occupies 15-18% of the total rice internationally traded (Giraud, 2013). Traditionally, India, Thailand, and Pakistan are the countries that have been exporting most of the aromatic rice to the world. Recently, Cambodia and Vietnam have entered into the aromatic rice market. Nonetheless, India and Thailand are still the leaders of the aromatic rice market.

Rice grain diverges in its characteristics, which can be categorized as intrinsic (e.g., taste, texture) and extrinsic (e.g., price, packaging, branding) attributes. Throughout the world, consumer preferences for these attributes are heterogeneous (Cuevas et al., 2016). Therefore, varietal development programs should focus on incorporating national preferences for rice

[3] The likely growth in urbanization in African countries may cause further demand for aromatic rice. African consumers have already developed a strong preference for imported rice that has the traits quality, taste, and aroma over local rice varieties (Opoku and Akorli, 2009; Diako et al. 2010; Rutsaert et al., 2013). In Senegal, urban demand for aromatic rice has been rapidly increasing recently (Diagne et al., 2017).

attributes (Unnevehr, 1986). However, most rice breeding programs primarily focused on incorporating yield-enhancing traits (farmer-preferred traits). A number of studies suggested that rice breeding programs should focus on consumer-targeted preferred rice traits along with other traits, for example, Cuevas et al. (2016) for the Philippines, Demont et al. (2015) for West Africa, and Custodio et al. (2016) for Asia. We argue that importance should be given to developing rice that has both consumer-preferred and farmer-preferred traits. Therefore, to examine consumers' perceptions of a product in terms of specific attributes is crucial.

Now, the question is whether consumers are willing to pay more for preferred traits. Previous studies in the African countries noted that indeed consumers' willingness to pay for certain rice attributes (e.g., quality) is higher (Naseem et al., 2013; Fiamohe et al., 2013; Demont and Ndour, 2015; Diagne et al., 2017). Because these countries are mainly rice importers, lessons learned from these countries might not be applicable for South and Southeast Asian countries' context.[4] Therefore, it is in our interest to investigate rice attributes that are valued mostly by the urban consumers of this region and the factors influencing their purchasing decision.

To investigate consumer preferences for rice attributes in seven South and Southeast Asian countries, we used a set of pre-defined characteristics of rice and interviewed the respondents to identify their top three preferred traits (Table 2). The major finding of our study is that preferences for rice attributes are geographically segmented. In other words, preferences for rice attributes differ among consumers in the different studied countries, which is not new. However, our finding on women being a principal grocery decision maker having a strong preference for rice with the attribute aroma over other rice attributes is novel.

[4] Note that Rachmat et al. (2006) found consumers in Indonesia are willing to pay more for specific quality of rice.

The rest of the article is organized as follows: Section 2 discusses the sampling technique and data collection methods. Section 3 explains the empirical models used to investigate consumers' preferences for rice traits. Section 4 reports the findings drawn from the survey data and econometric analysis and provides discussion. Finally, conclusions are drawn in the last section.

2. Sampling Technique and Data Collection

To elicit the stated-preference survey conducted in seven countries (Bangladesh, India, Indonesia, Cambodia, Philippines, Thailand, and Vietnam), a multi-stage stratified sampling technique was employed. First, based on the secondary information, a total of 32 cities were selected from these seven countries, of which only eight rural cities were from Bangladesh and India (Table 1). The urban cities were selected according to population size and the rural cities were selected conditional on the importance of rice production in the respective region. Second, each city was divided into five geographic areas, called strata (e.g., north, south, east, west, and center). Third, in each stratum, a number of primary sampling units (PSU) (e.g., villages in Bangladesh and India) were randomly selected. Fourth, two starting points in each PSU were selected based on a prominent social establishment (e.g., school, government office) to find a preferred household.

A preferred household was selected based on the following three criteria: (i) to prepare and cook meals for the household (fully or partly), (ii) to involve in the grocery shopping decision-making process, and (iii) to consume rice at least once in the past six months. If multiple members in a household met these conditions, then one was randomly selected. After the first preferred respondent was found and interviewed, a sampling interval of two households from the first household was used to find the next respondent. Finally, a total of 5168 respondents were

interviewed using a semi-structured questionnaire, in which the main question was their top three preferred rice traits. Additionally, respondents' rice purchase, consumption, and price of rice they pay, and other socioeconomic characteristics, were included in the questionnaire. The surveys were conducted in different months of 2013 and 2014 in the different countries. Note that these surveys were designed and conducted by the Market Research Group (MRG) of the Social Sciences Division (SSD), International Rice Research Institute (IRRI), Philippines.

3. Empirical Models

3.1 Choice-based model

The respondents were asked to rank their three most-preferred rice traits from a larger set of choices but to leave the rest unranked. For example, if a sample respondent's first most-preferred trait is taste, then aroma = 1; if appearance and nutritional benefits are the second and third most-preferred traits, respectively, then appearance = 2 and nutritional benefits = 3; the rest of the choices are left unranked. This is a classic example of an incomplete choice ranking problem. In our data, we find a total of 104 rice traits chosen either as the first most-preferred or second or third most-preferred traits. It is very difficult to analyze the preferences by each trait because of the small sample size under the majority of the traits. Thus, we categorize all of these traits into six: taste, texture, aroma, appearance, nutritional benefits, and cooking characteristics (details are in Table 2). Because only the top three traits were recorded, respondents' fourth, fifth, and so forth preferred traits were unknown. In addition, ties in ranking were not considered and whether consumers were indifferent between the top three and others was also unknown. Under such circumstances, a standard model is to use the rank ordered logit (ROL) model, first introduced in the economic literature by Beggs et al. (1981) and further developed by Hausman and Ruud

(1987).[5] We apply this model to investigate the probability of a rice trait being selected and the factors that influence consumers' perceptions in selecting that trait. The following section describes the ROL model, adopted from Long and Freese (2006), Fok et al. (2012), Touza et al. (2014), and Hossiso et al. (2017).

Suppose a representative respondent i prefers the alternative rice attributes j from a set of alternatives, where $i = 1, 2, \ldots, N$ and $j = 1, 2 \ldots . J$. And each respondent i gives to rice attributes j a rank r_{ij} that takes any integer value from 1 to j, where 1 represents the first most-preferred choice and J the least-preferred choice. For notational convenience, we use the equivalent notation for rank and attributes. Thus, if a respondent's rank of choices is $r_{ij} = j_1 > j_2 > j_3$, the utility of j_1 for that person is greater than all other alternative choices. The ROL model can be defined in a setting of a random utility framework such that a respondent i associates a level of impact on his/her utility for each attribute j, U_{ij}, which can be written as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad (1)$$

where the first term of equation (1) is a deterministic component, and can be explained by a set of explanatory variables, X,

$$V_{ij} = X_i' \beta_j \qquad (2)$$

where β is a vector of parameters related to X to be estimated. The last component in the equation is a random error term, which is independent and identically distributed with a Type-I extreme value distribution.

[5] In the psychology and economic literature, this type of model has been extensively used and can be traced through Thurstone (1927), Luce (1959), and Lancaster (1966) to McFadden (1974) and Green (1974). Other names of this model are the Plackett–Luce model (Marden 1995), the exploded logit model (Punj and Staelin, 1978), and the choice-based method of conjoint analysis (Hair et al., 2010). This is a generalization of the conditional logit model for ranked outcomes (details can be found in Punj and Staelin, 1978; Beggs et al., 1981; Allison and Christakis, 1994).

Although the level of impact U_{ij} is unobserved, it is possible to observe consumer choices of rice traits. A complete set of rankings of rice traits from a consumer indicates a complete ordering of the underlying utilities, $U_{ir_{ij}} > \cdots .. > U_{ir_{ij}}$. To develop the model, we can consider data as a sequence of choices assuming that consumers choose a trait and give the first-most importance to the set of *J* traits. When the first choice is made, consumers choose the second-most importance in *J-1* traits, and so on. Therefore, the observed ranking orders of the *J* traits are exploded into *J-1* independent observations. Note that the ranking of least-preferred alternatives is assigned with probability one. The ROL model can be realized as a series of conditional logit (CL) models, and thus the probability of a complete ranking is the product of separate CL probabilities, one for each trait ranked. For example, ranking orders provided by an individual consist of these three traits, aroma, appearance, and nutritional benefits. The probability of rank ordering can be computed as:

$$\Pr(r_1 = ar, r_2 = ap, r_3 = nb|X) = \Pr(r_1 = ar|X) \times \Pr(r_2 = ap|X, r_1 = ar) \times \Pr(r_3 = nb|X, r_1 = ar, r_2 = ap) \quad (3)$$

where *ar*, *ap*, and *nb* are the first letter of each preferred trait, respectively. Equation 3 indicates that the probability of the specific rank orderings is the product of (a) the probability of aroma being chosen from a choice set that includes four alternatives, (b) the probability of appearance being chosen from a choice set that excludes aroma, and (c) the probability of nutritional benefits being chosen from a choice set that excludes both aroma and appearance. The base case, b, here is another trait and, once the first three are known, the last one is determined. The likelihood function for a single respondent can be written as:

$$\Pr(r_1 = ar|X) = \frac{\exp(x_k\beta_{ar|b})}{\sum_{j=1}^{J}\exp(x_k\beta_{j|b})} \qquad (4)$$

For all the respondents, the ROL model assumes the same valuation function.[6] We used STATA software to estimate the model parameters and calculate the probabilities of alternative choices. Note that, to fit the ROL model, a data matrix is required to reshape into the long format. As we had a total of 4541 respondents and six traits, the new long format data matrix consisted of 27246 (=4541 × 6) observations.

3.2 Sampling weights

To achieve consistent parameter estimates, we used the estimated sampling weights of the Market Research Group of SSD, IRRI. Even though a random sampling method was used to select the household, the resulting sample could overrepresent one preferred trait and underrepresent another relative to the population distribution of choices on rice traits. This is called an endogenous sampling problem. If this is not accounted for, parameter estimates with the choice model could result in inconsistent estimation (Solon et al., 2013). Additionally, because around 90% of the respondents were female, results drawn from the causal relationship without controlling could provide misleading estimates. Thus, we incorporate sampling weight in the regression to investigate how certain explanatory variables of interest affect the probability of choosing one rice trait over another.

To calculate sampling weights, we used population size by cities by socioeconomic classes. Mathematically, weight is calculated as $w_{mn} = \frac{s_{mn}^{p}}{s_{mn}^{s}}$, where w_{mn} is the weight for the m-th city of

[6] Because consumers may not be able to rank their choices properly and may be indifferent between choices, the ROL model could provide biased estimates. Therefore, Fok et al. (2012) proposed a latent class ROL model, to be explored later, that can capture these issues.

the n-th socioeconomic class; s_{mn}^{p} is the share of population in the m-th city of the n-th socioeconomic class; and s_{mn}^{s} is the share of population in the m-th city of the n-th socioeconomic class that was surveyed. In other words, this relationship defines a probability of being sampled from a population. Figure 1 illustrates the distribution of sampling weights by countries.

4. Results and Discussion

4.1 Findings from the survey data

4.1.1 Overview of sample characteristics

Even though a total of 5168 sample respondents were interviewed, we used 4472 samples in this study. Because of missing information and outliers, we did not include all the samples. Table 4 presents the summary statistics of the sample characteristics, including respondents' socioeconomic profiles and household rice consumption-related information, across countries. Table 4 shows that the majority of the respondents surveyed are women, 82-98% of the total respondents. Recall that the criterion to select a sample respondent was whether the respective respondent is involved in cooking a meal and engages in grocery shopping. The presence of a higher percentage of women in the sample indicates a higher involvement in cooking and preparing a meal in the household and in household grocery shopping decisions. In Table 4, we find that women consumers in South Asia (Bangladesh and India) are less empowered (in terms of grocery shopping decisions) than Southeast Asian consumers. The majority of the sample women in Vietnam said that they were the principal grocery decision maker (93% of the total), whereas, in Bangladesh, about 60% of the total women said that they were the major grocery decision maker in the household.

Table 4 also shows that the mean age of the sample respondents is, on average, 37 years, which shows a small difference in the average age of the respondents among the studied countries' respondents. Vietnamese respondents had the highest age (41 years), whereas Bangladesh had the youngest (34 years old). With regard to education, the highest illiteracy rate was to be found among Bangladeshi and Indian consumers interviewed. On the other hand, consumers interviewed in Thailand, the Philippines, and India have the highest level of education (university or postgraduate degree) compared to other countries. Note that the mean schooling years of the consumers interviewed is significantly lower, between 3.0 and 6.0. The major occupation of the sample respondents was housewife, with the highest percentage in Bangladesh and India and the lowest percentage in Thailand and Vietnam.

Per capita income and rice consumption across countries, estimated by dividing mean income and consumption by household size, are also shown in Table 4. We find that the average household size is between 3.6 and 5.1 in the studied countries. We also find that consumers in Bangladesh consume the highest quantity of rice (119 kg/capita/year) among the studied countries, followed by the Philippines, Cambodia, India, Indonesia, and Thailand. And, they spend 14-31% of the total food expenditure budget on rice consumption. Finally, consumers' willingness to pay (the price they pay for rice) is lower in South Asia (Bangladesh and India) than in Southeast Asia, which might be because the governments of these countries use different policy instruments to control the domestic rice price.

4.1.1 Preference ranking

Recall that consumers were asked to rank their top three rice attributes, from most-preferred (= 1) to least-preferred (= 3) choices. Unranked choices are set to zero. For example, if a

respondent's first choice is aroma, it equals 1; if appearance is second, it equals 2; if he/she leaves any choices out of the rank, this is set to 0. Additionally, if a respondent is able to rank the top two choices, the rest of the choices for that respondent are set to 0. Table 5 presents the preference rankings by the sample respondents across choices and across countries. These rankings are shown in terms of percentage, which conveys the important information about what percentage of the total respondents ranked their rice trait aroma as the first most-preferred choice, for example.

Table 5 reveals that approximately one-half of the total sample respondents ranked the rice trait appearance as the first most-preferred trait (row 14 and column 15, Table 5). However, country-specific results show that the rice trait appearance is the most-preferred for Bangladesh, India, Thailand, and Vietnam, whereas the rice trait texture is the most important trait for other countries. We expect that similar results could be found when the predicted probability is estimated using the ROL model. Table 5 also reveals that the least-preferred choices were nutritional benefits and cooking characteristics, implying that most of the respondents did not mention these two traits as the important rice traits they would prefer. However, urban consumers in Thailand ranked the trait nutritional benefits as their second most-preferred trait. For the rice trait aroma, a fairly good number of consumers in Indonesia, Cambodia, and the Philippines ranked it as their second most-preferred trait.

4.2 Findings from the choice-based model

4.2.1 Determinants of consumers' decision in choosing a rice attribute

We identify a set of factors or determinants (explanatory variables) that influence consumers' perceptions in selecting their preferred rice attributes using the ROL model. Table 6 presents the

estimated coefficients and their standard errors related to these factors. The signs of these coefficients describe the direction of the causal relationship between the explanatory variables and the preferred choices. Note that these are not the coefficients that describe the marginal effect; therefore, inferences about the magnitudes of the coefficients are meaningless.

As before, the preferred choices by sample respondents were categorized into six: taste, texture, aroma, appearance, nutritional benefits, and cooking characteristics. The ROL model provides the maximum likelihood estimates according to these choices (Table 6). These coefficients could be explained in terms of probability of a rice trait being more/less preferred by consumers. For example, the variable age is significant at the 10% level under appearance (row 1 and column 7, Table 8). This implies that older people are more likely to choose rice that has the trait appearance, for example.

Recall that we used the explanatory variables that describe respondents' individual characteristics (age, education, work status), their consumption pattern (income, quantity of rice consumption, share of rice budget, and rice purchasing frequency), and women's perceptions in being a principal grocery decision maker (Tables 3-4). In addition, country dummies are added to capture the geographic heterogeneities assuming that preferences are geographically segmented. In this following section, we describe only those coefficients that are statistically significant at least at the 10% level of significance.

Let us first describe the location variables that tell us about the geographic heterogeneities of preferences for rice attributes/traits. This variable is defined in terms of incorporating a set of country dummies in the regression. As before, because consumers in seven countries were interviewed, including five dummies could have captured the geographic differences. However,

we use nine dummies, dividing Bangladesh into two groups (rural and urban) and India into three regions (east, west, and rural). Because rural consumers were not interviewed in other countries, this would capture the rural and urban differences. We consider Thailand as the base case because it is a leader as the aromatic rice exporter to the world. Therefore, the related coefficients would be described compared with Thailand.

In Table 6, the coefficients and their standard errors related to location variables are reported in rows 15-22. We find that, out of 54 coefficients (nine dummies under six preferences), 43 are statistically significant, but the signs of these coefficients differ. Thus, we infer that the preferences for rice attributes vary significantly among the countries. However, a similar pattern of choosing rice traits is to be found in Bangladesh and India, compared with Thailand. Consumers in Bangladesh and India are more likely to choose rice that has the traits taste and nutritional benefits and are less likely to choose appearance and texture.[7] We also find that preferences for rice traits are different among South Asian vs Southeast Asian consumers compared to Thailand. Cambodian and Philippine consumers are more likely to prefer taste and aroma and are less likely to prefer cooking characteristics than Thai consumers. Indonesian and Vietnamese consumers are more likely to prefer taste and nutritional benefits and are less likely to prefer the rice trait appearance. These results convey only the information compared to Thailand. Country-specific preference rankings were calculated from the predicted probabilities, and are described in Section 4.2.2.

Second, the coefficient related to the variable decision maker in Table 6 (row 12), if women only make the principal decision on grocery shopping, is positively correlated with aroma and

[7] Note that the signs of the coefficients related to rural and urban Bangladesh do not differ and the magnitudes do not vary much; thus, we can conclude that there may not be any significant differences in preferences for rice traits between urban and rural consumers in Bangladesh. However, the magnitudes of the coefficients for east, south, and rural India vary to some extent, which indicates that consumers prefer different rice traits within India.

cooking characteristics but negatively associated with taste, appearance, and nutritional benefits. This implies that, if women in a household are major decision makers for grocery shopping, then rice that has the traits aroma and cooking characteristics is more likely to be chosen. In contrast, taste, appearance, and nutritional benefits are less likely to be important.

Third, among the respondents' individual characteristics, we find that respondents who have a primary and below level of schooling are less likely to choose aroma and nutritional benefits than more highly educated respondents. This is consistent with the fact that educated persons are more likely to be better informed and aware of health concerns so they may choose rice that has nutritious value (e.g., brown rice) as a preferred trait. Additionally, education and income may be positively correlated so that more highly educated people may tend to buy aromatic rice as their willingness to pay is higher for quality rice.

Household size and total number in a household also positively influence consumer preferences for rice that has the traits aroma and nutritional benefits. Table 6 reveals that the coefficient related to variables other than occupation is significant and negatively associated with the traits texture and cooking characteristics. This implies that respondents who are retired, students, and unemployed are more likely to choose rice that has the traits texture and cooking characteristics (easy to cook).

Finally, consumer preference for rice attributes is also influenced by household income, quantity of rice consumption, and the share of total food expenditure spent on rice. Furthermore, the factor whether respondents buy rice more frequently, or purchase rice at least once a week, is affected by consumer preference. Frequent buyers tend to choose rice that has the traits taste,

nutritional benefits, and cooking characteristics, compared with respondents who buy rice bi-weekly and monthly.

4.2.2 Predicted probability of choosing alternative rice attributes

We also estimated predicted probability (using equation 4) to identify consumers' first, second, and third most-preferred rice traits.[8] This following section describes the predicted probability of a trait being chosen as the first, second, and third most-preferred trait by South vs Southeast Asia, rice importers vs exporters, and women's perceptions.

Figure 2 illustrates consumers' perceptions in choosing alternative rice traits in South and Southeast Asia. We find that South Asian rice consumers are completely different from Southeast Asians in terms of prioritizing their preferred rice traits. This is consistent with the parameters of the country dummies (in Table 6) being statistically significant. We argue that even though rice is the staple food for South and Southeast Asians, the preferred choices are likely to be geographically different. This finding is consistent with the results of Custodio et al. (2016), who established evidence of geographic segmentation of urban consumer preferences for rice traits.[9] We find that the predicted probability of choosing the first most-preferred trait as appearance for South Asians is 60%, whereas taste had a probability of being chosen as a second and third most-preferred trait (bars 2-3, Figure 1). For Southeast Asia, the trait texture was ranked as the first most-preferred trait (probability is 52%), whereas the second and third most-preferred traits were aroma and appearance (29% vs 31%).

[8] Based on the predicted probabilities for sets of four ranks, estimated from the ROL model, we calculate probability for the first, second, and third most-preferred choices by different categories.

[9] A similar finding was made by Deveriya (2007), who noted that consumer preferences for aromatic vs. non-aromatic rice vary widely among different nationalities. Even within a country, consumer preferences were found to differ significantly (Naseem et al. (2013) found this evidence for Beninese consumers; Musa et al. (2011) found this for Malaysian consumers).

We also investigate the predicted probability of a trait when categorizing the studied countries as rice importers and exporters (Figure 3). We find that both the importers (Bangladesh, Indonesia, and the Philippines) and the exporters (India, Cambodia, Thailand, and Vietnam) choose appearance as their first and third most-preferred trait. The second most-preferred trait for exporters is aroma. This is consistent with the fact that these four rice-exporting countries are indeed the largest aromatic rice exporters. The Philippines and Indonesia are heavily rice import dependent on Thailand and Vietnam. Thus, we argue that importers are likely to bring preferences from the exporting countries. As Thailand and Vietnam are the two largest jasmine rice exporters, importing countries' preference for this rice trait might converge to aromatic rice.

Finally, we examine the predicted probability of selecting a rice trait as first, second, and third most-preferred choice by women who are major grocery shopping decision makers in a household (Figure 4). We find that, if women are the major grocery decision makers, then the likelihood of choosing rice that has the trait appearance is first (predicted probability is 43%). The third most-preferred choice for them is appearance. However, the trait aroma was chosen as second (24%). Thus, we conclude that empowered women prefer rice that has a great appearance and aroma.

5. Conclusions

In this article, we argue that, because of Jasminization, a convergence of preferences toward aromatic rice, demand for aromatic rice is expected to evolve significantly in the future. Previous studies suggest that rice breeding programs should focus on widely preferred attributes (Calingacion et al., 2014; Demont et al., 2015; Cuevas et al., 2016; Custodio et al., 2016). Therefore, examining consumers' perceptions of a product in terms of certain attributes (e.g., aroma, quality) is essential. In this article, we investigate the rice attributes that are valued most

by the urban consumers of South and Southeast Asia and the factors that influence their purchasing decisions.

We fit a rank ordered logit regression with incomplete ranking choice data gathered from a stated-preference survey conducted in seven countries (Bangladesh, India, Cambodia, Indonesia, Philippines, Thailand, and Vietnam). The results show that preferences for rice traits differ significantly by country, by region (SA vs. SEA), and by a country being an importer or exporter. Consumers in Bangladesh and India prefer rice that has great appearance and taste attributes. On the contrary, consumers in Southeast Asia are more likely to choose rice that has the trait texture. Their second and third most-preferred traits are aroma and appearance. Thus, we conclude that preferences for rice attributes are geographically segmented, so this should be emphasized in varietal development programs.

One of our striking findings is that women, being principal grocery decision makers, have a strong preference for rice that has the attribute aroma over other rice attributes. We find that a majority of the women surveyed in both South and Southeast Asia are empowered in terms of being a principal grocery shopping decision maker in the household. This is consistent with the respective regression parameter being statistically significant. The findings here underscore the importance of developing rice varieties that incorporate women's preferred traits. In addition, the views of paddy farmers and rice millers regarding these rice traits may need to be taken into consideration.

Our results also show that preference for rice is influenced by the respondents' education, family size, and their income, amount of rice consumption, and rice expenditure share. Preferences are also affected by whether consumers are frequent buyers or not. Finally, geographic segmentation significantly affects consumer decisions when choosing preferred rice traits.

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Table 1. Sampling distribution of stated-preference survey

Region	Country	Rural/ urban	Number of cities	Households surveyed		Samples used in this study ⊥	
				Freq.	%	Freq.	%
South Asia	Bangladesh	Urban	3	499	9.7	406	9.1
		Rural	4	801	15.5	576	12.9
	India	East	5	619	12.0	613	13.7
		South	3	500	9.7	538	12.0
		Rural	4	350	6.8	428	9.6
Southeast Asia	Indonesia	Urban	3	500	9.7	427	9.6
	Cambodia	Urban	2	500	9.7	292	6.5
	Philippines	Urban	3	300	5.8	423	9.5
	Thailand	Urban	3	499	9.7	480	10.7
	Vietnam	Urban	2	600	11.6	289	6.5
Total			32	5168	100	4472	100

Notes: Authors' computation from consumers' preference for rice survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI); ⊥ a total of 696 samples were excluded because of missing information and outliers.

Table 2. Description of rice attributes elicited from the stated-preference survey in South and Southeast Asia

Trait category		Attributes of rice/rice traits
Appearance	Size of uncooked rice	Short, medium, longer
	Shape of uncooked rice	Bold, medium, slender
	Homogeneous grain	Uniform size and shape
	Color of cooked and uncooked rice	White, yellowish, brown, red, black
Aroma		Jasmine, popcorn-like, *pandan*-like, rice cake-like, vanilla-like, fruit-like, ginger-like, sweet, and unspecified
Cooking characteristics (CC)		No need for excessive amount of water, easy to cook as it takes short time, volume expansion (volume increases after cooking)
Nutritional benefits (NB)		Non-fattening, whole grain, high-fiber, vitamins, and calcium
Taste		Good taste, tasteful, delicious
Texture	Cooked rice	Rough, smooth, chewy, sticky, non-sticky, firm, soft, slippery, loose, and mushy

Source: Consumer preference survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI).

Table 3. Definition of the variables used in this regression analysis

Variables	Unit	Description of the variables
Discrete variables		
Gender		Dummy (1 = male, 0 = female)
Education	%	
No schooling		Dummy (= 1 if respondents had no schooling, otherwise 0)
Primary schooling		Dummy (= 1 if respondents had primary or below level of schooling)
Secondary schooling		Dummy (= 1 if respondents had junior/middle, senior/high school education, and technical or vocational training)
Higher studies		Dummy (= 1 if respondents had university or postgraduate-level education)
Occupation	%	
Employed		Dummy (= 1 if respondent is a full-time or part-time employee)
Housewife		Dummy (= 1 if respondent is a housewife)
Other		Dummy (= 1 if respondent is unemployed, or a student, or retired)
Internet	Yes/no	Dummy (yes = 1, 0 = otherwise)
Decision maker	%	Dummy (1 = if respondents are the main grocery decision maker in the family, 0 = otherwise)
Frequent buyer	%	Dummy (1 = if rice was bought at least once a week for household consumption, otherwise 0)
Continuous variables		
Age	Years	Age of the respondents
Household size	No.	Total number of members in a family
Rice consumption	kg/year	Annual per capita rice consumption
Rice price	USD/ton	Price of rice that the consumer paid
Income	USD	Annual per capita income
Rice share	%	Consumers' spending on rice consumption in total food expenditure

Source: Consumers' preference for rice survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI).

Table 4. Socioeconomic profiles of sample respondents †

Variables	Percentage of total frequency						
	Bangladesh	India	Indonesia	Cambodia	Philippines	Thailand	Vietnam
Sample size	982	1579	427	292	423	480	289
Gender							
Female	97.3	81.7	93.0	98.0	86.8	88.3	97.2
Male	2.8	18.3	7.0	2.1	13.2	11.7	2.8
Education							
No schooling	10.5	7.7	0.2	10.6	0.7	3.5	0.7
Primary schooling	23.1	12.4	12.9	36.0	12.8	18.3	6.6
Secondary schooling	55.6	60.7	80.8	41.4	64.3	50.2	78.2
Higher studies	10.8	19.2	6.1	12.0	22.2	27.9	14.5
Occupation							
Employed	6.4	22.0	25.8	39.0	30.7	67.5	43.9
Housewife	88.0	72.4	70.7	56.5	60.3	28.1	43.9
Other	5.6	5.6	3.5	4.5	9.0	4.4	12.1
Internet (access)	6.9	6.7	18.7	18.2	37.6	43.1	12.1
Decision maker (women only)	60.0	62.8	82.7	91.4	82.7	78.8	93.1
Frequent buyer	12.7	13.2	32.6	11.3	74.5	31.0	7.6
Age	33.8	37.2	37.8	34.5	39.5	37.7	41.4
Household size (no.)	4.5	4.0	4.5	4.7	5.1	3.6	4.4
Rice consumption (kg/per capita/year)	119.3	96.5	65.1	97.6	109.5	55.7	79.7
Rice price (USD/ton)	528.6	545.3	909.0	636.8	836.8	1125.4	753.8
Income (USD/year)	699.3	667.8	654.3	1121.9	1073.8	3772.0	1471.3
Rice share (% of total food budget)	24.0	23.3	27.6	17.1	31.3	18.2	14.2

Notes: †Definition of the variables and units of measurement are in Table 3; Data sources are the consumers' preference for rice survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI).

Table 5. Preference ranking (response rate, %) by sample respondents in South and Southeast Asia

Rice attributes	Preference ranking	Bangladesh		India			Indonesia	Cambodia	Philippines	Thailand	Vietnam	SA	SEA	All
		Urban	Rural	East	South	Rural	Urban	Urban	Urban	Urban	Urban			
Taste	0	36.7	60.5	39.4	76.8	42.5	88.2	99.8	78.9	48.4	55.7	52.0	73.2	62.4
	1	23.9	14.4	14.3	7.3	12.3	3.1	0.0	2.1	18.2	10.1	14.5	7.1	10.8
	2	31.0	15.7	33.3	9.4	28.8	2.6	0.0	11.4	29.9	25.9	23.1	14.6	18.9
	3	8.4	9.5	13.0	6.6	16.4	6.1	0.2	7.6	3.5	8.3	10.5	5.1	7.8
Texture	0	64.5	68.8	55.2	23.4	23.6	19.9	9.2	13.8	80.6	55.0	50.5	37.8	44.3
	1	8.6	6.7	12.3	35.6	44.9	43.3	64.2	51.2	2.6	5.7	18.7	31.1	24.8
	2	17.2	17.5	22.3	31.1	17.5	24.8	22.1	24.6	13.6	31.3	21.1	23.7	22.4
	3	9.6	7.0	10.2	9.8	14.0	12.1	4.6	10.4	3.3	8.0	9.7	7.4	8.6
Aroma	0	77.1	57.7	83.5	60.7	36.6	26.5	54.2	46.4	76.6	81.1	65.1	59.2	62.2
	1	5.7	8.2	3.5	5.6	15.1	16.8	5.0	12.1	1.4	1.7	7.0	6.6	6.8
	2	10.1	31.5	6.9	16.4	26.7	37.1	26.0	28.0	18.9	11.6	18.4	23.3	20.8
	3	7.1	2.6	6.1	17.3	21.6	19.6	14.8	13.5	3.0	5.6	9.4	10.8	10.1
Appearance	0	15.3	13.9	9.7	13.6	58.9	28.1	21.3	49.1	6.5	5.9	18.8	19.4	19.1
	1	53.2	65.4	60.0	43.3	16.8	25.8	21.9	23.2	67.8	79.5	51.6	46.9	49.3
	2	19.2	13.9	21.7	31.9	13.0	22.5	31.3	17.6	9.3	10.6	19.9	18.1	19.0
	3	12.3	6.9	8.6	11.2	11.3	23.6	25.6	10.0	16.4	4.0	9.6	15.7	12.6
NB	0	80.0	83.0	79.2	78.7	78.8	95.7	94.8	67.5	70.3	82.8	80.2	83.5	81.8
	1	4.9	1.8	5.9	6.8	5.1	0.9	1.7	9.3	2.6	0.9	4.7	2.5	3.6
	2	10.3	10.6	9.7	7.7	7.9	1.7	1.3	12.8	22.0	10.6	9.4	9.3	9.4
	3	4.7	4.6	5.2	6.8	8.2	1.7	2.3	10.4	5.1	5.7	5.6	4.7	5.2
CC	0	77.3	80.6	85.7	89.2	77.4	72.3	60.6	91.3	78.0	82.8	82.4	76.1	79.3
	1	2.7	3.4	3.7	0.9	5.8	9.9	7.3	2.1	7.5	1.9	3.2	5.7	4.4
	2	11.8	9.5	5.8	2.1	6.2	10.4	18.5	4.8	6.3	8.5	7.2	10.2	8.7
	3	8.1	6.5	4.8	7.7	10.6	7.3	13.5	1.7	8.2	6.8	7.2	8.0	7.6

Notes: 1, 2, and 3 are the first, second, and third most-preferred attributes, respectively; 0 refers to a choice being unranked; NB and CC are nutritional benefits and cooking characteristics, respectively.

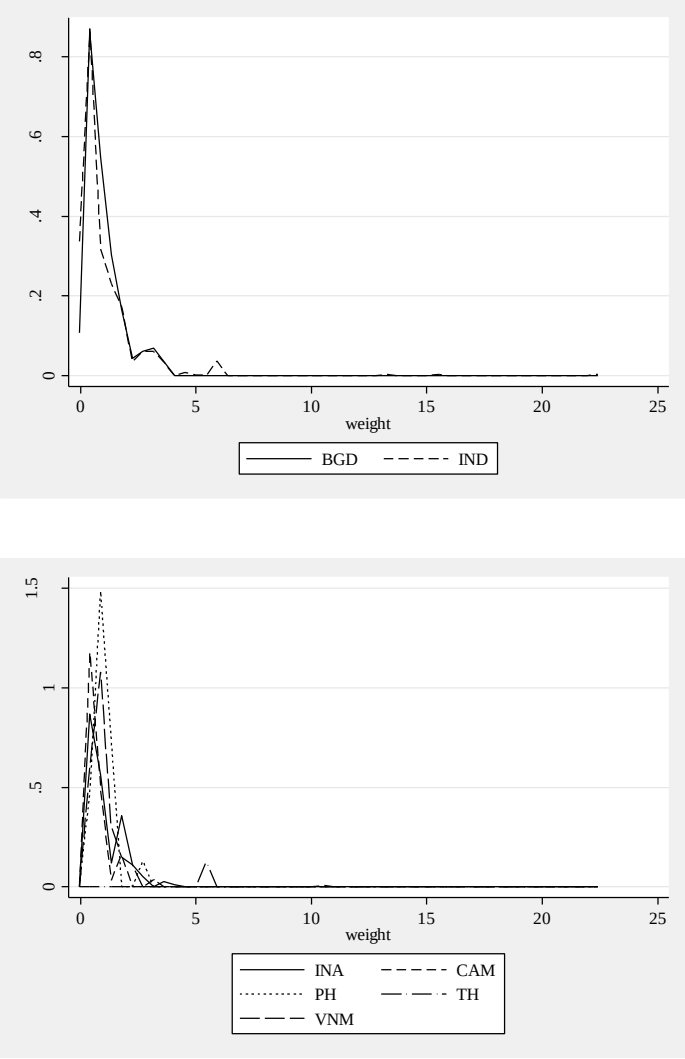
Table 6. Estimated parameters from the rank ordered logit regression

(Dependent variable = rank of the choices)

Independent variables	Taste		Texture		Aroma		Appearance		Nutritional benefits		Cooking characteristics	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Age (years)	0.002	0.002	-0.002	0.002	-0.003	0.002	0.003*	0.002	0.003	0.004	0.001	0.003
No schooling ‡	0.022	0.119	0.054	0.110	-0.206***	0.137	-0.015	0.082	0.014	0.179	0.144	0.166
Primary schooling ‡	0.113	0.101	-0.047	0.082	-0.265	0.098	0.042	0.066	-0.271*	0.159	0.099	0.133
Secondary schooling ‡	-0.001	0.087	-0.061	0.067	-0.027	0.075	0.011	0.056	-0.153	0.132	0.065	0.110
Household size (no.)	-0.016	0.018	-0.019	0.014	0.037**	0.016	-0.003	0.012	0.049*	0.027	-0.022	0.023
Employed (yes = 1) §	-0.073	0.066	0.000	0.052	-0.073	0.061	0.001	0.045	0.084	0.095	0.153*	0.087
Other occup. (yes = 1) §	-0.258**	0.112	0.259***	0.082	-0.107	0.105	-0.066	0.071	-0.172	0.156	0.273*	0.136
Internet (yes = 1)	-0.001	0.093	-0.078	0.064	0.000	0.074	-0.042	0.058	-0.057	0.132	0.283***	0.107
Ln (rice consumption)	-0.129*	0.069	-0.036	0.051	-0.007	0.063	0.005	0.044	0.515***	0.108	-0.069	0.082
Ln (income)	0.063**	0.025	0.035	0.023	-0.007	0.022	-0.007	0.017	-0.110***	0.034	-0.008	0.030
Rice share (%)	0.007***	0.003	0.002	0.002	-0.014***	0.003	-0.004**	0.002	-0.011***	0.004	0.005	0.004
Decision maker (women only = 1) ⊥⊥	-0.286***	0.060	-0.032	0.055	0.154**	0.066	-0.078*	0.041	-0.282***	0.093	0.399***	0.088
Frequent buyer (yes = 1)	0.251***	0.066	0.061	0.054	-0.019	0.064	-0.014	0.045	0.236**	0.096	0.146*	0.086
Location variables††												
Bangladesh	6.642***	1.235	-1.038***	0.122	-0.793***	0.142	-0.334***	0.090	1.071***	0.297	-0.293*	0.163
Rural Bangladesh	5.902***	1.236	-0.461***	0.108	-1.078***	0.150	-0.364***	0.091	0.801***	0.297	-0.246	0.166
East India	5.943***	1.234	-1.244***	0.110	-0.102	0.111	-0.410***	0.081	0.603**	0.288	-0.859***	0.160
South India	6.491***	1.234	-0.525***	0.098	-1.173***	0.143	-0.178**	0.081	1.616***	0.275	-0.960***	0.163
Rural India	6.226***	1.235	-1.576***	0.140	-0.549***	0.142	-0.169*	0.088	1.557***	0.282	-0.380**	0.164
Indonesia	5.134***	1.237	0.071	0.086	-0.134	0.116	-0.091	0.081	1.816***	0.271	-1.137***	0.173
Cambodia	6.737***	1.235	0.047	0.101	0.404***	0.119	-1.233***	0.121	1.115***	0.304	-0.581*	0.180
Philippines	4.575***	1.242	0.025	0.095	0.598***	0.114	-0.247***	0.091	-0.283	0.351	-0.274***	0.151
Vietnam	5.513***	1.239	0.101	0.094	-0.014	0.120	-0.909***	0.106	2.102***	0.275	-1.496	0.226
Diagnosis												
Log likelihood	-13615.07		-19607.79		-13797.15		-30060.66		-6041.77		-7299.02	
LR (chi^2)	956.29***		688.82***		603.65***		250.67***		325.90***		201.58***	
N	4472	4472	4472	4472	4472	4472	4472	4472	4472	4472	4472	4472

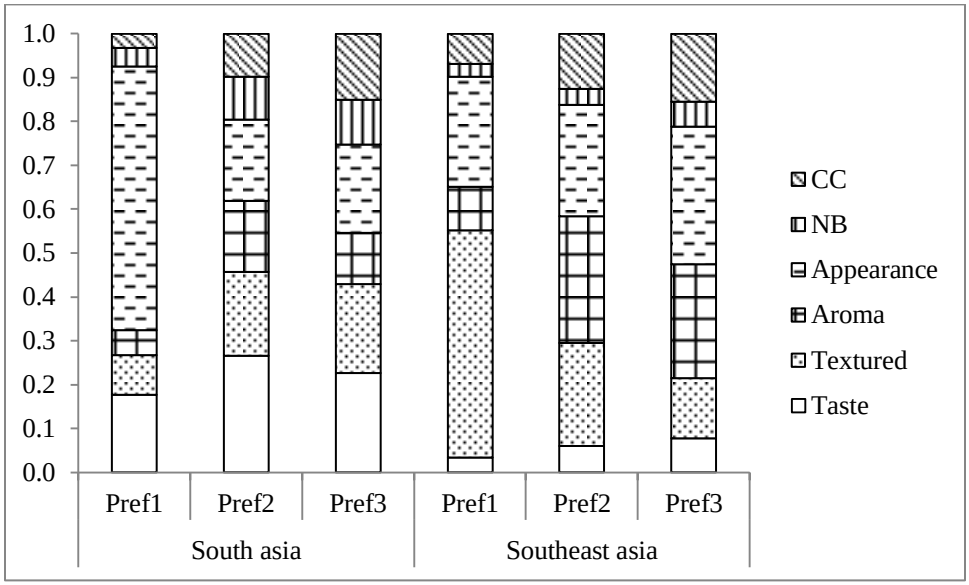
Notes: ***, **, and * indicate 1%, 5%, and 10% level of significance; Base cases: ‡higher studies (university or postgraduate), § housewife, ⊥⊥ if grocery decision was made by others in the family, †† location: residents live in Thailand; NB stands for nutritional benefits; CC stands for cooking characteristics.

Figure 1. Distribution of sampling weights



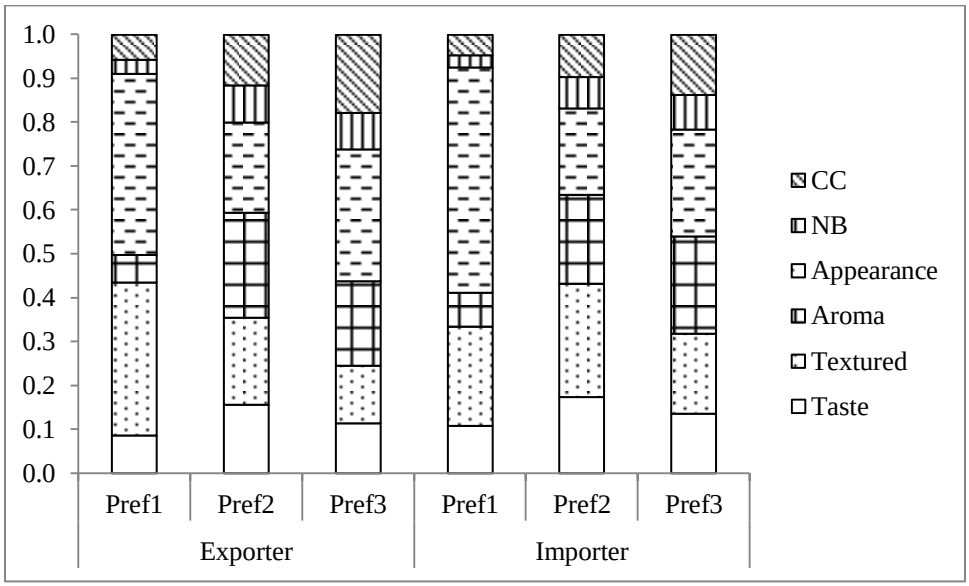
Notes: Authors' computation based on data gathered from the Market Research Group, Social Sciences Division, International Rice Research Institute (IRRI), Philippines. BGD = Bangladesh, IND = India, INA = Indonesia, CAM = Cambodia, PH = Philippines, TH = Thailand, VNM = Vietnam.

Figure 2. Urban consumers' perceptions in choosing alternative preferences for rice traits in South and Southeast Asia



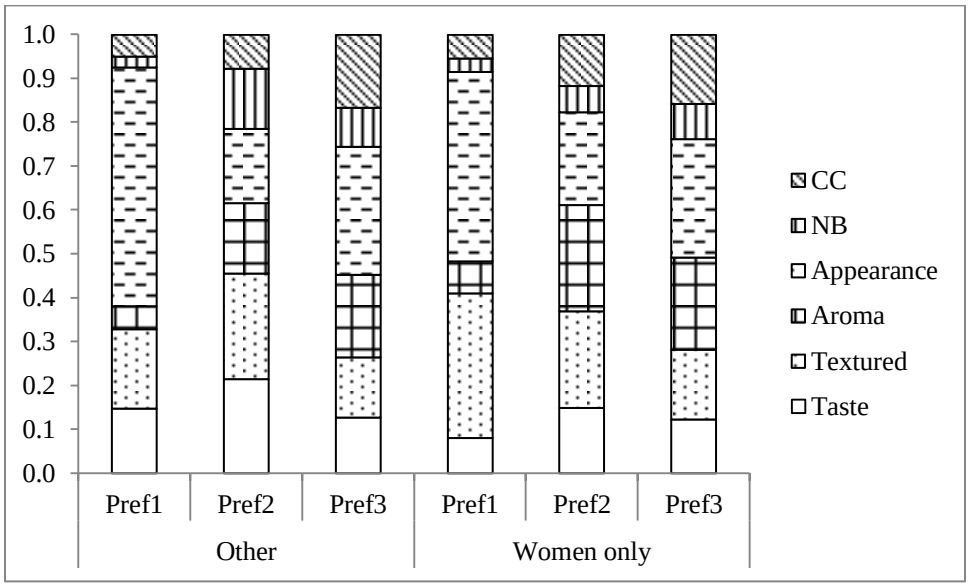
Notes: Authors' computation based on consumer preference survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI); NB stands for nutritional benefits; CC stands for cooking characteristics; Rural respondents in Bangladesh and India were excluded. Pref1, Pref2, and Pref3 are the first, second, and third ranking of the choices, respectively. Unranked responses were excluded from the estimated predicted probabilities.

Figure 3. Consumers' perceptions in choosing alternative preferences for rice traits: importers vs exporters in South and Southeast Asia



Notes: Authors' computation based on consumer preference survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI); NB stands for nutritional benefits; CC stands for cooking characteristics; India, Cambodia, Thailand, and Vietnam are rice exporters, whereas Bangladesh, Indonesia, and the Philippines are importers. Pref1, Pref2, and Pref3 are the first, second, and third ranking of the choices, respectively. Unranked responses were excluded from the estimated predicted probabilities.

Figure 4. Women's perceptions in choosing alternative preferences for rice traits in South and Southeast Asia



Notes: Authors' computation based on consumer preference survey in seven countries in South and Southeast Asia (2013-14), International Rice Research Institute (IRRI); NB stands for nutritional benefits; CC stands for cooking characteristics. Pref1, Pref2, and Pref3 are the first, second, and third ranking of the choices, respectively. Unranked responses were excluded from the estimated predicted probabilities.