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Consumer Preferences for Quality Attributes of Rice: A Conjoint Analysis

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ABSTRACT

Rice production in Sri Lanka has already achieved the self sufficiency status with an average per capita annual consumption of 110 kg. The production will be further enhanced with input supports, land expansion and technological breakthroughs. At the same time, the changes occurred in the Sri Lankan society such as increase in per capita income and urbanization have modified the consumer preferences. In this context, consumer preferences for different quality attributes of rice were assessed based on conjoint methodology. The appropriate attributes and levels were identified from a focus group discussion and subsequently a conjoint questionnaire was administered using a sample of 185 consumers under a fractional factorial design. ANOVA and part worth utility models were estimated. The relative importance of attributes was calculated using part-worths. ANOVA results indicate that of the four attributes, type, color and purity were significant, but price was not significant. Part worth estimates revealed that the purity is the most important attribute when selecting a type of rice.

Introduction

Rice production in Sri Lanka has achieved a remarkable growth after the independence mainly due to high input use, technological development, expansion of the land area, input subsidies and policy supports. The average productivity has reached to 4.2 mt/ha while the annual per capita consumption is 110 kg (Census and Statistics, 2008). Given the land use, employment and food security concerns the rice production, processing and marketing continue to be the dominant in the food production sector of the country. It has been argued that rice development has potentially been the best driver of development, the engine for growth and poverty reduction (Seck , 2007).

In a competitive market, new products are accepted only if the customer expectation is fulfilled (Danaher, 1997). Hence understanding

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consumer preference is useful in positioning products favorably in the market and aids in product matching. Consumer preference is also valued as a proxy for product design and formulating pricing strategies. If a marketer successfully can understand the needs of the consumer, he can anticipate the product features in order to target customer segments (Brassington and Pettitt, 2003). In economic terms, identifying consumer choice is desirable in assessing the substitution possibilities of a product. Moreover, economists use consumer choice as a proxy for interpreting income and price elasticities of a particular good or service

The Sri Lankan rice market is well established which is characterized by producers, millers, commission agents, whole sellers, retailers and finally the consumer. During the past few decades, the Sri Lankan society has undergone major structural changes due to poverty reduction, growth of the middle class and urbanization that altered their food preferences (Rupasena, 2003). It is a timely need to determine the consumer preference for rice and to gauge consumers' expectations for the product, which will eventually enable us for assessing the market potential in terms of product acceptability and consumers' willingness to pay for various rice quality attributes. Many products fail as they are dumped in the market without a priori investigation (Huang and Fu, 1995). In such a context, it is believed that the results of this study would enable marketers to enhance their product offerings through identifying specific as well as general preference requirements of different market segments.

The main objective of this study is to assess the consumer preference for various rice attributes using conjoint analysis methodology. The specific objectives are to identify the most important product attributes and levels, and to estimate the part worth utilities of attributes that consumers place for rice.

The paper is organized as follows. Firstly the theoretical background is provided, which is followed by the methodology adopted in this study and the results and discussions. Finally, the conclusions and implications of the study are presented.

Theoretical Framework

A number of models are available to explain the consumer product purchases based on the characteristics of the products (Housthakkar, 1952; Lancaster, 1966) and these models are referred to as Lancaster characteristics demand model or Lancaster's characteristics theory of value. As per the Lancaster's characteristics theory of value choice modeling approaches assume that any good can be described in terms of its attributes or characteristics and the levels they take. This involves eliciting people's stated preference for different options in a hypothetical setting. However, this is valid for many goods and services, but the validity is questionable for certain goods because the utility that they receive depends not only on observable attributes but also in all sorts of intangible and hard-to-measure facts. There is a chance of making errors in measuring attributes and people's subjective views on the values of the attribute will vary. In this context, Random Utility Theory suggests a theoretical base for choice experiments (Bateman *et al*., 2002; Lancaster, 1966).

Random Utility Theory

Once the data are choice-based, researchers use random-utility models in which the basic idea is the assumption of utility maximization (Hauser and Rao, 2002). Many specifications of random utility models lend themselves to maximum likelihood estimation. The most common models are logit models (Gumbel errors), the probit model (multivariate normal errors) and nested logit model (generalized extreme value errors). Under the random utility model hypothesis, utility is partitioned into a systematic observable deterministic component (V) and a random unobserved component (ε). Thus the indirect utility function of i^{th} individual for the j^{th} alternative can be represented as

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

Suppose that alternative j is superior to alternative k, then

$$U_{ij} > U_{ik}$$

Then the individual would choose alternative j instead k. When the error component is present, the prediction cannot be made with certainty. At this juncture, the analysis becomes one of probabilistic choices. Hence the probability of choosing alternative j over k can be expressed as,

$$P\,[(U_{ij} > U_{ik})] = P\,[(V_{ij} + \varepsilon_{ij}) > (V_{ik} + \varepsilon_{ik})] = P\,[(V_{ij} - V_{ik}) > (\varepsilon_{ik} - \varepsilon_{ij})] \qquad (2)$$

This indicates that the respondent i would choose alternative j over alternative k if the difference in the deterministic parts of their utilities exceeds the difference in the error parts. It is of vital importance to identify the distribution of the error term, in order to derive explicit distribution of this probability. If the error term is assumed to be distributed independently and identically (IID) with an extreme value (Gumbel) distribution, the probability of any alternative j being chosen as the most preferred is given by logistic distribution referred to as Conditional Logit Model or Multinomial Logit Model.

Methodology

Conjoint Analysis (CA) is based on the notion that consumers value products based on the utility provided by its attributes. It involves a series of interrelated steps which can be categorized into three main steps. The first step in conducting CA is to identify appropriate attributes and levels as stimuli for consumer choice. The second is to select an experimental design and to formulate a survey instrument to collect conjoint data. Finally, the CA involves choosing an appropriate composition model and estimating buyer part-worth utilities (Harrison *et al*., 1998).

Selection of Product Attributes and Their Levels

Product profile consists of different attributes and levels and such attributes form the basis for decision criteria that a respondent uses to choose a product or a service. According to Lancaster's model of consumer behavior, the theory of brand preferences states that goods are valued for the attributes and that differentiated products are merely different bundle of attributes (Ara, 2003). Hence, researchers can assess the cognitive component of the preference by analyzing attributes. Therefore, the attributes and their levels have to be selected with care as it influences the accuracy of the results and the relevance of the stimuli (Mclennon, 2002). After selecting the attributes and their levels, they have to be triangulated to define the product profile.

In this study, four key informants, a research officer, a nutritionist, a bakery producer and a marketing agent were used to identify the critical attributes and their levels for consumer evaluation. Subsequently they were presented in a focus group discussion that was conducted with a set of housewives. The identified attributes and levels for rice is given in Table 1 bellow.

Table1: Selected product attributes and levels

Attribute	**Level**
Type (TY)	Raw
	Nadu
	Samba
Colour (CO)	Red
	White
	Pure White
Purity (PU)	With dark grains & sand
	Only with dark grains
	Without dark grains & sand
Price/kg (PR)	Rs. 50-60
	Rs. 60-70
	Rs. 70-80

Selection of Experimental Design and Formulation of Survey Instrument

Second stage was mainly focused on planning the experimental design and constructing the questionnaire for implementing the conjoint analysis technique. Determining attribute combinations after selecting the attributes, produces a full set of stimuli (North and Vos, 2002) which cannot be evaluated by a respondent at once (Since there are four attributes and three levels each, there will be $3^4 = 81$ treatment combinations). This might lead to information overload that will eventually reduce the accuracy of the respondent's preference evaluation. Moreover, respondents cannot provide meaningful evaluations when presented with a large number of choice sets. Consequently the number of profiles was reduced and a fractional factorial design (Cochran and Cox, 1957) was used to define the optimal number of choice sets. Hence, this study used one third replicate of 3^4 fractional factorial design to describe the product profile for rice for response evaluation.

Sampling and the Field Survey

A random sample of 185 consumers (i.e. household purchasing decision makers) from Kandy and Kurunegala districts was drawn representing three segments based on the occupation and salary. The sample composed of three different categories namely block1, block 2 and block 3. The block 1 included technical and support staff, the block 2 comprised of middle level managers and the senior managers were considered for the block3. Structured interviews were conducted using pre-tested CA questionnaire. The respondents were asked to sort the nine cards of one choice set from one to nine selecting the most preferred combination of attributes in the first place. Sample pictures were shown to the respondents with the aim of enhancing the clarity of the choice cards. The survey was conducted during May-August 2008.

Composition Model and Estimation

ANOVA model

Product profile consists of different attributes as previously defined by the focus group discussion. The significance of the main attributes and the interaction effects were tested using Analysis of Variance (ANOVA).

$$R_{ijkln} = G + S_i + C_j + T_k + P_l + (SC_{ij}) + (ST_{ik}) + (SP_{il}) + (CT_{jk}) + (CP_{jl}) + (TP_{kl}) + B_s + e_{ijkln} \quad (3)$$

Where R_{ijkln} = n^{th} respondent's rating for ijkl th combination of attribute levels for a particular product
G = overall response mean

S_i = ith treatment effect of attribute 1
C_i = jth treatment effect of attribute 2
T_k = kth treatment effect of attribute 3
P_l = lth treatment effect of attribute 4
SC_{ij} = ijth two-way interaction effect of attribute 1 and attribute 2
ST_{ik} = ikth two-way interaction effect of attribute 1 and attribute 3
SP_{il} = ilth two-way interaction effect of attribute 1 and attribute 4
CT_{jk}= jkth two-way interaction effect of attribute 2 and attribute 3
CP_{jl}= jlth two-way interaction effect of attribute 2 and attribute 4
TP_{kl} = klth two-way interaction effect of attribute 3and attribute 4
B_s = sth block effect
e_{ijkn} = random error term

Part-worth utility model

It is assumed that, total utility of a consumer is a function of part-worth utilities (Harrison *et al.*, 1998). Part-worth values can be estimated using a linear regression analysis. A mean deviation dummy variable coding of additive preference function is assumed ignoring the interaction effects. This study estimated part-worths using Multinomial Logistic Regression technique having the ordered ranks of preferences (Harrison *et al*., 1998; Rao, 2002).

$$R_i = G + W_1D_1 + W_2D_2 + W_3D_3 + W_4D_4 + W_5D_5 + W_6D_6 + W_7D_7 + W_8D_8 + e_i \qquad (4)$$

Where R_i= preference rating for the ith respondent
W_i , i= 1,2..n are part-worth estimates associated with respective levels of product attributes.
D_i , i= 1,2..n are dummy variables for significant levels of attributes
e_i = random error term

Levels of attributes were re-coded using dummy variables (D_1, D_2….) and effect codes were used instead of typical 0,1 dummy variable coding (Adamowicz *et al*., 1994; Harrison *et al.*, 1998; Mclennon, 2002; Lusk *et al*., 2002), because it allows for recovery of the “left out” dummy variable while preserving the orthogonality of the design.

Relative importance (RI) of product attributes

Part-worth estimates were used to calculate relative importance of the product attributes (Halbrendt *et al.*, 1991). The relative importance of the attribute (RI) is defined as,

RI = (Utility Range/ Σ utility ranges of all attributes) *100

Results and Discussion

Testing the Significance of Product Attributes

The results of the ANOVA are presented in Table 2. Of the four product attributes tested, the main effects of attributes, except price, were statistically significant at P = 0.05. Therefore, the interaction terms with price were not included into the full model estimation. Since the interactions (i.e., type and color interaction and color and purity interaction) were significant, the main effects were not subjected to further analysis. The mean separation was done at a fixed level of one factor. Least Square (LS) means were used here as the design was incomplete.

Table 2: ANOVA results for selected rice attributes

Source	Degrees of Freedom	Sums of Squares	Mean Sums of Squares	F value	Pr > F
Blocks	2	0.0047	0.00	0.00	0.9996
Type (TY)	2	661.9885	330.99	59.12*	0.0001
Color (CO)	2	298.9217	149.46	26.70*	0.0001
Purity (PU)	2	745.1362	372.57	66.55*	0.0001
Price /kg (PR)	2	19.2193	9.61	1.72	0.1800
TY*CO Interaction	4	87.3534	21.84	3.90*	0.0037
TY*PU Interaction	4	33.5583	8.39	1.50	0.2001
CO*PU Interaction	4	61.0263	15.26	2.73*	0.0280
Error	1,642	9,192.5700	5.60		
Total	1,664	11,099.7784		15.42*	0.0001

* 5% level of significance, N=185

Table 3: Results of mean separation for type and color interaction

	Color	Red	White	Pure white	LS Mean
Type 1 = Raw	Red	_	NS	*	5.394
	White	NS	_	NS	5.178
	Pure white	*	NS	_	4.891
Type 2 = Nadu	Red	_	*	*	6.448
Nadu	White	*	_	NS	5.313
	Pure white	*	NS	_	5.275
Type 3 = Samba	Red	_	*	*	4.956
	White	*	_	*	3.524
	Pure white	*	*	_	4.005

"*" denotes significantly different at 5% level: NS: not significant

Table 3 presents the results of the mean comparison for color attribute at given levels of attribute type. With Type I (raw) red and white are equally preferred, while pure white is least preferred. With type 2 (*nadu*) red color was preferred over white and pure white is least preferred. However, with type 3 (*samba*) contrary to the general expectations and red is the most preferred, followed by pure white.

Table 4 depicts the mean difference of purity levels at different levels of color. In all grain colors, the choice "without dark grains and sand" is mostly preferred over the others. However, contrary to the expectations, in white colored grains, purity was not a concern of the consumers.

Table 4: Results of mean separation for the interaction of "seed color" and "purity"

	Purity	**With DG& S**	**Only DG**	**Without DG & S**	**LS Mean**
Red	Without DG& S	_	*	*	6.475
P value = 0.000	Only DG	*	_	*	5.491
F value = 19.74	With DG & S	*	*	_	4.832
color 2 =					
White	Without DG& S	_	*	*	5.600
P value = 0.000	Only DG	*	_	NS	4.259
F value = 20.19	With DG & S	*	NS	_	4.156
color 3 =					
Pure white	Without DG& S	_	*	*	5.508
P value = 0.000	Only DG	*	_	*	4.929
F value = 26.28	With DG & S	*	*	_	3.735

"*" denotes significantly different at 5% level: NS: not significant . DG – dark grains, S- sand

Part Worth Utilities

The part worth estimates were obtained by using the Ordered Logit regression model specified earlier. The part worth estimates for different levels of rice attributes are given in Table 5. The models possessed a satisfactory Pseudo R^2. The part worth estimates were significant for all the three levels of type and color attributes. The negative sign attached to the part worth value indicates a negative preference and the value represents the magnitude of the utility from consuming that specific level. For instance, *samba* type has a positive effect for buyer preference and its contribution to the total utility is 0.644. Of the three grain colors, white is the most preferred and rice without dark grains and sand fetches the highest preference in terms of purity attribute. The lowest price level also has a positive effect for the consumer preference although the price is not significant.

Table 5: Part-worth estimates for rice

Attribute	Level	Part worth estimate	Standard error	Z value
Type	Raw	-0.140*	0.060	-2.29*
	Nadu	-0.504*	0.062	-8.12*
	Samba	0.644*	0.062	10.38*
Colour	Red	-0.465*	0.062	-7.49*
	White	0.246*	0.060	4.04*
	Pure White	0.220*	0.060	3.61*
Purity	With dark grains & sand	-0.648*	0.062	-10.35*
	Only with dark grains	0.075	0.060	1.24
	Without dark grains & sand	0.573*	0.060	9.41*
Price Rs/kg	Rs 50-60	0.064	0.060	1.06
	Rs 60-70	-0.078	0.060	-1.28
	Rs 70-80	0.014	0.060	0.23

* 5% significance level: n= 185.

Relative Importance of Rice Attributes

Findings reveal that purity is the most important attribute (37.88%) whereas price is the least important (4.42%). Type of rice (whether raw, *nadu* or samba) is also a relatively important attribute (35.63%). The price differences are not significant between the levels, hence the price attribute is not significant mainly because the people are price insensitive for an essential good like rice.

Conclusions

In this study conjoint analysis was used to examine the consumers' trade-offs with respect to rice quality attributes by using ANOVA and part worth score models. Of the four attributes studied, price was not found to be significant when making purchasing decisions of rice as it is essential and less price sensitive commodity.

The study revealed that, of the selected quality attributes, consumers place a high value for purity of than that of the other attributes. The particular market segment had a high preference for samba type compared to *nadu* and raw rice because of its grain size. Even though there were some consumers who eat red rice owing to health concerns**,** the most preferred grain color is found to be white. The preference is not placed to a single attribute, but it is the interaction of several attributes as tested in this study.

In Sri Lanka, rice production, processing, marketing and value addition will further expand with the income growth, technological advancement, changes in the preferences and lifestyles together with urbanization and scale effects. With the market surplus, rice processors and marketers could utilize this information to fetch high prices in different market segments. In that context, the study findings are quite useful in developing appropriate production plans and market positioning.

References

Ara S. (2003). Consumer Willingness to Pay for Multiple Attributes of Organic Rice: A Case Study in the Philippines, Paper presented at the 25th International conference of Agricultural Economists at South Africa, Department of Agricultural, Environmental and Development Economics, The Ohio State University, USA.

Adamowicz W., J. Louviere and M. Williams (1994). Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities. *Journal of Environmental Economics and Management*, 26(3):271-292.

Bateman, I.J., R.T. Carson, B.Day, M. Hanemann, N. Hanley, T. Hett, M. Jones-Lee, G. Loomes, S. Mourato, E. Ozademiroglu, D.W. Pearce, R. Sugden and J. Swanson (2002). In Economic Valuation with Stated Preference Techniques: A Manual, E. Elgar (ed.). UK: Edward Elgar Publishing.

Brassington F. and S. Pettitt (2003). Principles of Marketing, Third ed., England: Pearson Education Ltd.

Census and Statistics of Sri Lanka (2007), Department of Census and Statistics, Sri Lanka.

Census and Statistics of Sri Lanka (2008), Department of Census and Statistics, Sri Lanka.

Cochran, W.G. and G.M. Cox (1957). Experimental Designs, 2nd Ed. New York: Wiley Publications.

Danaher P.J. (1997). Using Conjoint Analysis to Determine the Relative Importance of Service Attributes Measured in Customer Satisfaction Surveys. *Journal of Retailing*, 73:235-260.

North E. and R. De Vos (2002). The use of Conjoint Analysis to Determine Consumer Buying Preferences: A Literature Review. *Journal of Family Ecology and Consumer Sciences*, 30:32-38.

Green P.E. and A.E. Krieger (1991). Segmenting Markets with Conjoint Analysis, *Journal of Marketing*, 55:20-31.

Halbrendt, C.K., F.F. Wirth and G.F. Waughn (1991). Conjoint analysis of the Mild-Atlantic Food-fish market for farm raised Hybrid Striped Bass. *Southern Journal of Agricultural Economics*, 23(1):155-163.

Harrison, R.W., A. Ozayan and S.P. Meyers (1998). A Conjoint Analysis of New Food Products from Underutilized Small Crawfish. *Journal of Agricultural and Applied Economics*, 30(2):257-265.

Hauser J.R., and V.R. Rao (2002). Conjoint Analysis, Related Modeling, and Applications. Chapter prepared for Advances in Marketing Research: Progress and Prospects ,A Tribute to Paul Green's Contributions to Marketing Research Methodology, Massachusetts Institute of Technology, Cornell University.

Huang, C.L. and J. Fu (1995). Conjoint Analysis of Consumer Preferences and Evaluations of a processed Meat. *Journal of Food and Agribusiness Marketing*, 7:62-75.

Housthakkar, H.S. (1952). Compensated Changes in Quantities and Qualities Consumed. *Rev. Econ. Stud.*, 19:155-164.

Lancaster, K.J. (1966). A New Approach to Consumer Theory. *Journal of Political Economy*, 74:132-157.

Lusk, J.L., M. Moore, L.O. House and B. Morrow (2002). Influence of Brand Name and Type of Modification on Consumer Acceptance of Genetically Engineered Corn Chips: A Preliminary Analysis. International Food and Agribusiness Management Review, 4:373-383.

Mclennon, E.A. (2002). Analysis of Consumer Perceptions toward Biotechnology and their Preferences for Biotech Food Labels: A Thesis. Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College, The Department of Agricultural Economics and Agribusiness, B.S. Louisiana State University USA.

Rupasena, L.P. (2003). Domestic Marketing System for Paddy and Rice. In Rice Congress 2000, Department of Agriculture, Peradeniya.

Seck, P.A. (2007). Rice Crisis: Myth or Reality, Africa Rice Center (WARDA), WARDA Council of Ministers, Abuja, Nigeria.