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DISAGGREGATED DEMAND FOR RICE IN BANGLADESH: AN ANALYSIS USING LA/AIDS MODEL

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ABSTRACT

The study was conducted to examine the income and price elasticities of demand for different types of rice in Bangladesh. Both time series and cross-section data were used to estimate a complete demand system equation. The equation was estimated in three stages to obtain income and price elasticies of demand for rice. The stages were the allocation of household total income on food and non-food items, the allocation of household total food expenditure for cereal, and the allocation of household total cereal expenditure on different types of rice and wheat, respectively. The total budget for cereal food allocated to aromatic, fine, coarse rice, and wheat was 4.0%, *23.3'70*, 65.2%, and 7.5%, respectively. The estimated expenditure elasticities of demand for those types of cereals Here 0.85. 0.79. 0?9, and 0.55. respectively. The expenditure elasticities of demand for aromatic and coarse rice were higher for rural households compared with urban households, while the expenditure elasticities of demand for fine rice and wheat were higher for urban households. Considering all other factors remaining unchanged, the uncompensated and compensated own-price elasticities of demand for coarse rice would fall *by 7*.7% with a 10% increase in its price. These falls were 7.4%, 11.170, and 4.6% for aromatic, line rice, and wheat, respectively. The estimates of uncompensated cross-price elasticities between coarse-to-fine rice showed that a 10% increase in absolute income associated with a 10% increase in real income due to fall in coarse rice price would increase the actual demand for fine rice by 4.6%. A 10% increase in absolute income accompanied by a l07 increase in real income due to fall in coarse rice price would increase the actual demand for aromatic rice and wheat by 7.4% and 4.6%, respectively.

1. INTRODUCTION

The overwhelming importance of rice in Bangladesh as the principal food crop and the major source of rural employment and income can hardly be overemphasized. More than 90% of the population consumes rice and derives 70% of the calories and 54% of the daily protein requirement from it. Rice provides 61% of the agricultural value added, covers $7G^{0}$/r of the total cropped land, and accounts for 95% of total food grain production in the country. More than 40% of the rural labour force is employed by the rice sector (BBS, 2005). Thus, any threat to its price and income of the people may seriously affect the whole economy.

In the rice bowl of Bangladesh, there are very few varieties of tine rice. The coarse varieties available in the markets compete with many other varieties, while the fine and

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aromatic rice hardly have any competition because of limited available varieties. The supply of these fine rice varieties has grown at a slower rate than demand as farmers shifted land to much higher yielding and relatively more profitable modern but coarse and medium rice varieties. The varietal diversity may help Bangladesh compete in the international market, because a number of its traditional rice varieties are difficult to grow elsewhere. Bangladesh's local rice varieties which are fine and scented (aromatic) have especially good export potential particularly among the migrant ethnic Bengalees living abroad. This potential has already been proved by India and Pakistan's success in exporting scented Basmati, a variety which was in fact started to be cultivated long ago in the flood plains of Bangladesh. Ironically it is now grown extensively in the Punjab of India and Pakistan but hardly at all in Bangladesh. The scented rice varieties, which Bangladesh produces, are comparable to *Basinati,* but are not well known internationally. These varieties characteristically have a high consistency and stability in grain aroma. Some of them have excellent elongation ratios and are slender and long, with shiny grain qualities, which are preferred by many rice consumers.

Hossain and Shahabuddin (1997) reported that urban people consume quality rice and more of other rich food compared with rural people. This is one of the prime examples of the positive effect of income on consumption of quality rice.

Kumar and Mathur (1996) found that household income and food prices strongly influenced the pattern of food consumption. However, rapid structural transformation may have an important influence on food demand in the long run. Most previous demand studies have ignored the possible influence of structural shifts on food demand. The paper examines the changes in the consumption pattern and decomposes changes in rice consumption due to price, income, and non-price structural shifts factors.

All studies done in the past related to food-grain demand considered total rice and wheat, and ignored the demand for quality rice. Fine rice has received importance now since people's income is increasing, which led them to buy better quality rice. Some groups who consume quality rice live in rural areas (producers as well as consumers) and some live in urban areas. They belong to the upper middle to higher income group. They eat this type of rice every day, while the rest consume quality rice only occasionally. It is difficult to find people who do not eat quality rice at least twice in a year.

A special type of fine rice (aromatic rice) is generally used for preparation of *Polaw, Biriani, Paish,* and *Fherni,* which are special dishes prepared for special occasions. Demand for aromatic rice in recent years has increased greatly for both domestic consumption and as well as for export (Singh *et al., 2000).* So, the decomposition in the analysis of demand for total rice could help making adjustment in the production and marketing strategies requires for faster development in this sector.

Information on present and future rice demand (consumption) patterns and how they are likely to change as prices and incomes change, is required to assess the welfare and distribution impacts of technological change, infrastructure development, and economic policies. This information must be specific for different types of rice, since the country is facing the problem of looking for a market for its surplus rice production. Past studies

(Shahabuddin and Zohir, *1995;* Alangir and Berlage, *1973;* Mahmud, *1979;* Ahmed, *1981;* Chowdhury, *1982;* Pitt, *1983;* Hossain, *1988;* Goletti, *1992;* Goletti, *1993;* Talukder, *1993;* and Ahmed and Shams, *1994)* have provided information on price and income elasticities for food and nonfood commodities. But none of the studies have estimated demand elasticities for rice by type. Very recently, Dey (2000), and Alam and Kamruzzaman (2000) have estimated disaggregated demand elasticities for fish by type in Bangladesh. Their estimations suggest that price and income elasticity estimates could be used in other policy decision analysis of the country. This study attempts to estimate the income (expenditure) and price elasticities of demand for food with emphasis on cereal food, particularly high quality (aromatic and nonaromatic) rice as a whole as well as coarse rice with a view to suggest necessary policy guidelines for future production and marketing strategies of the country.

2. THE DATA AND EMPERICAL MODEL

The main objective of this study is to examine the demand for fine rice. For better understanding of the methodology used are discussed in each of the following aspects: selection of area, selection of samples and data collection and empirical models used in relation to the estimation of demand for fine rice are presented in this section.

2.1 Selection of area

In view of true representation of total population of Bangladesh, the household expenditure survey (I-IES) for demand estimation has been conducted in both urban and rural areas. The urban areas selected for this study situated in two locations, one in Tejgaon thana of Dhaka and another in Dinajpur sadar thana. Households of different income groups characterized the locations. While the rural areas were in Chirirbandar thana of Dinajpur district. Four villages namely Barobaul, Chotobaul, Mohadhani, and Awliapukur (under Awliapukur union) which are situated within *5* kilometers of thana head quarter were selected purposively.

2.2 Selection of samples and data collection

Multi-stage sampling technique was followed to gather HES data for demand analysis of the study. The first stage is the selection of area, which is discussed in the previous section. The second stage is the selection of households. A household means a group of persons living together and eating in one mess or *chuln (i.e.,* with common arrangement of cooking).

The total sample was *300* households, which were distributed as *200* from rural households and 100 from urban households. The distributions of rural sample households were 68, 106, 23 and 3 as landless, small, medium and large farm families, respectively. The distributions of urban households are *50* from Dinajpur Municipality and *50* from Dhaka Municipality areas. These 50 samples under each urban area were again subdivided into 20 as slum and 30 as non-slum households. All types of households (from slum to rich) were living in these areas. The data were collected during July-September, 2000.

2.3 Empirical models

The consumers demand theory and the most recent developed demand estimation, which is called the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer in 1980a and 1980b, which further refined by introducing a multi-stage budget share for modeling the consumers' behavior by Blundell *et al.* (1993) as shown in the following utility tree (Figure 1) was used for this study. In the first-stage of budget share, the consumer makes decisions on how much of his total income (expenditure) is to be allocated for food consumption, subject to the prices of food, consumption of non-food goods, income, household characteristics and location of household. In the second-stage, the consumer allocates a portion of his food expenditure on each food group (i.e, cereal, pulses, vegetables, fish, meat, cooking oil and other foods). In the third-stage, the consumer allocates his expenditure of each food group for specific types of food within this group.

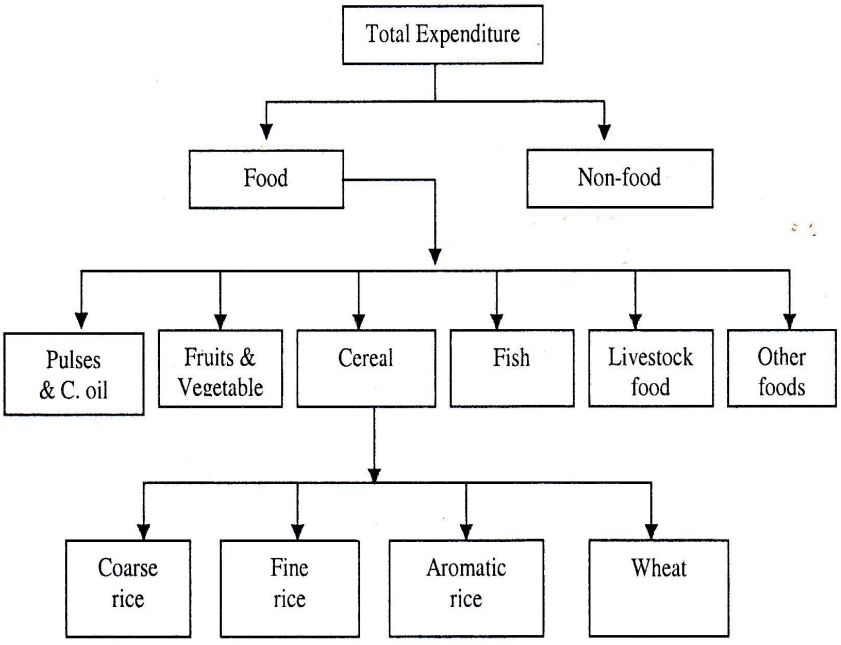

Figure 1. Utility tree of consumers behavior in decision-making process for cereal food expenditure in Bangladesh

Following the consumer's demand theory suggested by Ahuja (1979) as:

$$D_x = f(P_x, Y, P_y, P_z \, etc.) \quad (1)$$

where, D_x stands for the demand of good X, P_x for price of the good X, Y for individual's income, P_y, P_z etc. for the prices of related goods,

and the above utility tree in multi-stage budgeting techniques of Blundell *et al.* (1993), the specific form of consumer food expenditure (F_f) in the first-stage may be expressed in equation as:

$$\text{Ln}(F_f) = \alpha + \gamma \ln(P_f) + \lambda \ln(X_{nf}) + \beta_1 \ln(Y) + \beta_2 \ln(Y)^2 + \Phi \ln(S) + \theta(D) \quad (2)$$

where;

F_f = per capita total food expenditure,

P_f = index of food price,

X_{nf} = per capita non-food expenditure,

Y = per capita total income,

S = adult equivalent family size,

D = urban dummy (1=urban, 0=rural)

α, γ, λ, β, Φ and θ = parameters to estimate. The parameter β is allowed to vary as: $\beta = \beta_0 + \beta_1 \ln(Y)$.

In the second-stage, the equation of expenditure on cereal food (C_f) can be expressed as:

$$\text{Ln}(C_f) = \alpha' + \Sigma \gamma'_{ij} \ln(P_j) + \beta' \ln(F_f) + \beta'' \ln(F_f)^2 + \Phi' \ln(S) + \theta'(D) \quad (3)$$

where;

C_f = per capita cereal food expenditure,

F_f = predicted per capita food expenditure obtained from first-stage,

P_j = prices of jth type of food groups,

α', γ', β', Φ' and θ' = parameters to estimate. The parameter β' is allowed to vary as: $\beta' = \beta'_0 + \beta'_1 \ln(F_f)$.

In the third-stage of the analysis, the share equations developed by Deaton and Muellbauer (1980a and 1980b) which Ahmed and Shams (1994) first applied the complete systems of demand model in estimating foodgrain demand parameters in Bangladesh. The specification of the model is as follows:

$$w_i = a_i + \sum_j b_{ij} \ln P_j + c_i \ln \left(\frac{C_f}{P} \right) \quad (4)$$

where;

C_f = predicted per head total cereal food expenditure in the system obtained from second-stage,

P_j = the price of the ith type of cereal food commodity,
w_i = the budget share of the ith type of cereal food commodity,
c_i = allowed to vary with per capita cereal expenditure as:
$c_i = c_{io} + c_{i1} \ln (C_f/P)$, and
P = the household specific stone price index for cereal food commodities, which is defined as:

$$\ln P = a_i + \sum_j b_{ij} \ln P_j + \frac{1}{2} \sum_j \sum_i c_{ij} \ln P_i \ln P_j \quad (5)$$

The price index from equation (5) makes the equation (4) a non-linear system of equations, raising empirical or estimation difficulties. To avoid non-linear estimation, Deaton and Muellbauer (1980a and 1980b) suggested to use Stone's (geometric) price index (P^*) instead of P:

$$\ln P^* = \sum_j w_j \ln P_j \quad (6)$$

According to Blanciforti and Green (1983) the model that uses Stone's index is called "Linear Approximate AIDS" (LA/AIDS). If prices are highly collinear, P may be approximately proportional to P*, i.e., $P \cong \zeta P^*$. In the extreme case when P is exactly (linearly) proportional to P*, the LA/AIDS model can be used to estimate the parameters of the AIDS model because the LA/AIDS can be written in terms of the AIDS model parameters as:

$$w_i = (a_i - c_i \ln \zeta P^*) + \sum_j b_{ij} \ln P_j + c_i \ln \left[\frac{C_f}{P^*} \right] \quad (7)$$

Green and Alston (1990), and Ahmed and Shams (1994) mentioned that if prices are highly collinear, then the LA/AIDS model can be used to estimate the parameters of the AIDS model because the factor of proportionality of P to P* is incorporated to intercept term.

Household demand for goods not only depends on prices and income but also on other socioeconomic and demographic factors. Ray (1979), Ahmed and Shams (1994) explicitly incorporated family size (S) and Dey (2000) included location dummy in the AIDS model. The resulting LA version of the AIDS is:

$$w_i = a_i + \sum_j b_{ij} \ln P_j + c_i \ln \left[\frac{C_f}{P^*} + \Phi_i \right] \ln (S) + \theta_i (D) \quad (8)$$

where C_f is per capita household expenditure on cereal food, Φ denotes the effect of family size on budget share in addition to the effect of per capita real household expenditure (C_f/P^*) and θ shows the effects of location dummy.

To be consistent with the consumer utility theory, the equation (8) must satisfy the following restrictions for any estimated demand system. The AIDS model automatically satisfies the ***adding-up*** condition, and is capable of satisfying the three other restrictions, but does not necessarily do so. In terms of the parameters in equation (9) the *adding-up* condition implies:

$$\sum_i a_i = 1, \ \sum_i b_{ij} = \sum_i c_i = \sum_i \Phi_i = \sum_i \theta_i = 0 \qquad (9)$$

Homogeneity is satisfied if and only if, for all j,

$$\sum_j b_{ij} = 0 \qquad (10)$$

While *symmetry* is satisfied provided

$$b_{ij} = b_{ji} \ , \qquad c_{11}/c_{10} = c_{21}/c_{20} = \ldots = c_{n1}/c_{n0} \qquad (11)$$

The *negativity* conditions have no obvious parametric representation in the AIDS model. Except for the *adding-up* condition, the AIDS model does not have the restrictive implications such as that of the linear expenditure system (LES) which automatically satisfies all the theoretical restrictions. Thus, the AIDS model offers the opportunity of testing *homogeneity* and *symmetry* restrictions.

From the micro-model in equation (8), the following formulas are obtained for cereal expenditure elasticity (η_i) and uncompensated own and cross-price elasticity (ε_{ij}) of the individual type of cereal.

$$\eta_i = 1 + (c_{i0} + 2\, c_{i1} \ln (C_f/p^*))/ w_i \qquad (12)$$

$$\varepsilon_{ij} = w_i^{-1} (b_{ij} - (c_{i0} + 2\, c_{i1} \ln (C_f/p^*))w_j) - \delta_{ij} \qquad (13)$$

where δ_{ij} is Kronecker delta which takes the value of one for own price elasticity and zero for cross-price elasticity. The budget share of the jth commodity, w_j, is used as weight in Stone's price index in equation (6). Once the expenditure and the uncompensated price elasticities are estimated, compensated own and cross-price elasticities can be computed using the Slutsky equation in elasticity form:

$$\varepsilon_{ij} = \varepsilon_{ij}^{H} - w_j \varepsilon_{ii} \qquad (14)$$

where ε_{ij}^{H} is the compensated (Hicksian) price elasticity.

Income elasticity of demand for an individual type of cereal (η_i^y) was estimated as the product of expenditure elasticity of the individual type of cereal (η_i), cereal expenditure elasticity with respect to food expenditure (η^f), and food expenditure elasticity with respect to total income (η^y):

$$\eta_i^y = \eta_i \times \eta^f \times \eta^y \qquad (15)$$

2.4 Estimation procedures of variables used in LA/AIDS model

As was mentioned in equation *(15)* that per capita household expenditure, C_f (=Ct/S), and family size, S are two important factors affecting demand. So, per capita expenditure and family size have been standardized by per adult equivalent expenditure and adult equivalent family size.

The Stone's geometric price index (P*) in equation *(13)* has been used to deflate the expenditure of the ith household. The price index (P*) has been obtained by summing the products of average budget share of jth good and log of price of jth good faced by the household.

After necessary adjustment of adult equivalent, the equation *(15)* has been estimated for each commodity groups using the Ordinary Least Squares (OLS) method. The commodity groups have been made for food and non-food items. The food items have again been subgrouped into cereal and non-cereal food. The cereal food has been grouped into rice (coarse, fine and aromatic rice) and wheat. The demand elasticities for each food group have been estimated using the elasticity formulas.

3. EMPIRICAL RESULTS 3.1

Analysis of Demand for food grains

This section provides information on major household food expenditure patterns, estimates of food demand system, expenditure (income) elasticities, own and cross-price elasticities of demand for rice (coarse, fine and aromatic).

3.2 **Major household food expenditure patterns**

Table 1 shows per capita major household food expenditure patterns in the study areas, which have been compared with national data. There are some similarities between the two sets of data, particularly for pulses, cooking oil, fruits and vegetables. The budget shares for cereal consumption was found a bit higher compared with national average. The budget shares for fish, livestock products and other foods, on the other hand, were lower compared with national average. Rural households were found to devote more than *53%* of their total food expenditure on cereal followed by other foods *(14.4%),* vegetables (9.1%), livestock products (8.6%), fish (5.6%), cooking oil (3.7%), fruits *(3.3%)* and pulses (2.3%). Urban households, on the other hand, spent less for cereal *(30.8%)* and more for the rest of the food items, e.g., other foods *(18.8%),* livestock products *(14.7%),* fish *(12.2%),* vegetables *(10.9%),* fruits (4.9%), cooking oil *(4.6%)* and pulses *(3.2%)* compared with rural households. This indicates that urban households spent more for high quality food. In an earlier study, Shahabuddin and Zohir *(1995)* also found the same trend in per capita monthly expenditure shares for major food items.

Table 1. Major household food expenditure patterns in Bangladesh, 1999-2000

Food items	Average budget share [a] (%)			National average [b]
	Rural	Urban	Pooled	2005 (%)
Cereal	53.1	30.8	45.7	39.0
Pulses	2.3	3.2	2.6	2.7
Cooking oil	3.7	4.6	4.0	4.2
Fruits	3.3	4.9	3.8	3.2
Vegetables	9.1	10.9	9.7	8.4
Fish	5.6	12.2	7.8	12.2
Livestock products	8.6	14.7	10.6	12.3
Other foods	14.4	18.8	15.9	18.0
Total	100.0	100.0	100.0	100.0

[a]Field survey data, 1999-2000.
[b] Bangladesh Bureau of Statistics HES data for 2005.

However, the share for cereal decreased over the last 20 years [Figure 2(a)]. The trends of budget share for other non-cereal foods are shown in Figure 2(b-d). The higher percentage of budget shares for cereal for both rural and urban areas shows the overwhelming dominance of rice in total household food expenditure. The results also show that rural households have less diversity in high quality food compared with urban households. The marginal budget share, i.e., the marginal propensity to consume (MPC) rice, which was calculated by multiplying expenditure elasticity with average budget share, was 35.9% for rural, 20.1% for urban, and 29.7% for both rural and urban households (Table 2). Shahabuddin and Zohir (1995) found this share to be 29.9%.

Table 2. Marginal budget share (marginal propensity to consume) for major household food items in Bangladesh, 1999-2000

Food items	Marginal budget share (%)		
	Rural	Urban	Pooled
Cereal	35.9	20.1	29.7
Pulses	3.0	2.7	2.9
Cooking oil	4.3	4.0	4.2
Fruits	4.2	3.9	4.1
Vegetables	10.7	8.8	10.4
Fish	8.9	11.4	10.4
Livestock products	13.6	21.4	16.4
Other foods	19.5	27.7	21.9
Total	100.0	100.0	100.0

Source: Field svel survey data, *1999-2000.*

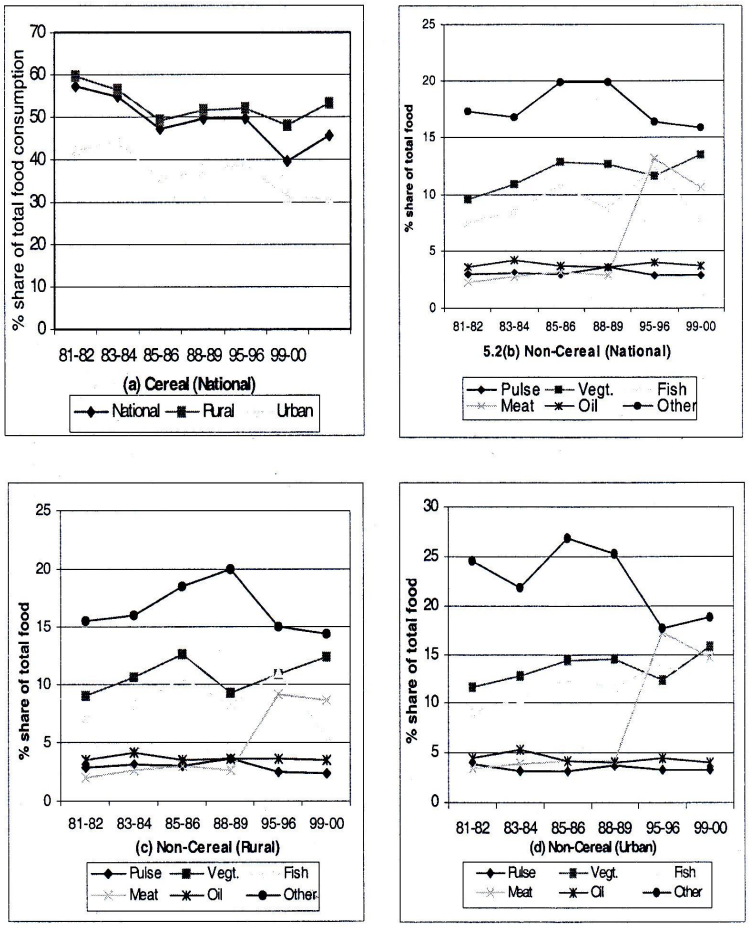

Figure 2 (a-d). Trend of budget shares of food consumption expenditure in Bangladesh, 1981/82 to 1999/2000

3.3 Parameter estimates of food expenditure function

Parameter estimates of total food expenditure function are given in Table 3. The square term of per capita total income variable is negative and significantly different from zero. This suggests that the response of food expenditure to income changes is nonlinear, while the current income level significantly increased food expenditure. This indicated that the increase in income to a certain level increased food expenditure, but an increase in income at a geometrical rate decreased food expenditure. The table also shows that per capita increase in nonfood expenditure and adult family member per family significantly decreased total food expenditure. The parameter estimate for location dummy shows that location/urban dummy has no effect on total food expenditure. The model is a good fit since R^2 (91%) is quite high and the F-value (509.48) is significant at 1% level.

Table 3. Estimated food expenditure function

Variable	**All food expenditure (per capita)**	
	Coefficient	**t-value**
Intercept	-14.55***	-16.78
Ln (Stone price index for food)	0.17***	4.16
Ln (per capita non-food expenditure)	-0.51***	-21.42
Ln (per capita total income)	4.45***	24.06
Ln (per caipta total income)^2	-O.1G***	-18.29
Ln (adult equivalent family size)	-0.11***	-5.26
Location dummy (Urban= 1, Rural=0)	0.02	1.19
Adjusted R^2	0.91	
F-value (6,293)	509.48***	

*** Significant at 1% level.
Source: Field survey data, 1999-2000.

The parameter estimates for cereal food.d expenditure function are shown in Table 4. The predicted value of per capita food expenditure variable obtained in the first-stage and its square term are significant. This suggests that the response, of cereal food expenditure to changes in total food expenditure is significant and nonlinear. The coefficient of cereal price is insignificant, indicating that people are not concerned about its price increase as it is their staple food. While higher is the price of pulses, cooking oil, fruits and vegetable, lower is the expenditure on cereal food. This indicates that these are complimentary commodities to cereal food. The coefficient of urban dummy is negative and significant, implying a lower level of cereal consumption by urban households compared with rural households. The model is also a good fit although R^z value (R^2 = 54%) is not so high. However, the F-value (23.67) is significant at 1 % level.

Table 4. Cereal food expenditure function

Variable	Cereal food expenditure (per capita)	
	Coefficient	**t-value**
Intercept	-16.04***	-2.69
Ln (Cereal food price)	-0.14	-0.85
Ln (Pulses price)	-0.31***	-2.73
Ln (Cooking oil price)	-0.28***	-3.51
Ln (Fruits price)	-0.39***	-3.37
Ln (Vegetable price)	-0.28***	-2.04
Ln (Fish price)	-0.05	-0.71
Ln (Livestock products price)	-0.001	-0.34
Ln (Other food price)	-0.02	-0.75
Ln (Estd. value of food exp.)	4.46***	3.62
Ln (Estd. value of food exp.)^2	-0.24***	-3.16
Ln (Adult family size)	-0.01	-0.20
Location dummy (Urban= 1, and Rura1=0)	-0?9***	-5.23
Adjusted R^2	0.54	
F-value (12,287)	23.67***	

*** Significant at 1 % level.
Source: Field survey data, 1999-2000.

3.4 Parameter estimates of LA/AIDS model for major food expenditures

The parameters of major food demand system (cereal and non-cereal) for rural, urban and Bangladesh as a whole estimated by using linear approximation almost ideal demand system (LA/AIDS) model. It may be recalled that the elasticities estimated by the model are obtained by imposing all the restrictions as mentioned in the methodology. The estimated coefficients of the parameters show the response of share of total expenditure to changes in variables used. The coefficients of expenditures (incomes), deflated by Stone Price Index, are used to derive expenditure (income) elasticities of the concerned commodities.

3.5 Expenditure (income) elasticities for major food items

The expenditure (income) elasticity of demand may be interpreted as the percentage change in quantity demanded when expenditure (income) changes by 1%, with other factors being held constant. For example, the income (expenditure) elasticity of demand for cereal as estimated to 0.65 at the mean level of cereal food expenditures for the entire sample (rural and urban), suggesting that a 10% increase in household expenditure (income) increases the demand for cereal by 6.5% (Table 5). The expenditure elasticities of demand for cereal, livestock products, and other foods were not much different in rural and urban households. However, the expenditure (income) elasticities of demand for pulses, cooking oil, fruits, vegetables, and fish were higher for rural households compared with urban households. Thus, any policy for increasing the income of the rural people is likely to enhance the diversity in a high quality diet.

Table 5. Expenditure (income) elasticity of demand for major household food items in Bangladesh

Food items	Expenditure (income) elasticity		
	Rural	**Urban**	**Pooled**
Cereal	0.68	0.65	0.65
Pulses	1.31	0.85	1.12
Cooking oil	1.16	0.87	1.05
Fruits	1.26	0.80	1.07
Vegetables	1.18	0.81	1.03
Fish	1.59	0.93	1.33
Livestock products	1.58	1.46	1.55
Other foods	1.35	1.47	1.38

Source : Field survey data, 1999-2000.

3.6 Own-price elasticities for major food items

Table 6 provides the estimated uncompensated and compensated own-price elasticities of demand for the major food commodities in Bangladesh. The estimates suggest that households were quite responsive to changes in prices of pulses, cooking oil, and other foods for adjusting their expenditure on consumption of corresponding commodities. In comparing the elasticities between rural and urban households, it was observed that rural households were relatively more responsive to changes in prices of pulses, cooking oal, fish, and other foods compared with urban households when adjusting their consumption expenditure. This is quite similar to the findings of Shahabuddin and Zohir (1995). The inelastic demand for cereal, fruits, vegetables and livestock products as observed in both rural and urban areas might be due to the rural people used from their home produces. As a result, a small change in the price of those commodities did not affect their demand. While the urban people, on the other hand, might be the regular customers of home suppliers who did not change or made a small change in the price of those commodities, which might have little affect on its demand in the shozi run.

Table 6. Own-price elasticities of demand for major food commodities in Bangladesh

Food commodities	Rural		Urban		Pooled	
	Uncompen-sated	Compen-Sated	Uncompen-sated	Compen-sated	Uncomp en-sated	Comp en sated
Cereal	-0.62	-0.26	-0.57	-0.36	-0.58	-0.28
Pulses	-1.16	-1.09	-0.52	-0.45	-0.92	-0.85
Cooking oil	-1.31	-1.10	-0.53	-0.49	-0.93	-0.78
Fruits	-0.55	-0.50	-0.58	-0.55	-0.55	-0.48
Vegetables	-0.58	-0.43	-0.61	-0.48	-0.49	-0.31
Fish	-1.10	-1.01	-0.001	0.11	-0.59	-0.49
Livestock products	-0.79	-0.66	-0.95	-0.73	-0.85	-0.68
Other foods	-1.26	-1.06	-1.04	-0.76	-1.15	-0.93

Source: Field survey *data.* 1999-2000.

The uncompensated own-price elasticities consist of two component effects, i.e., price or substitute effect and income effect. The estimated uncompensated own-price elasticity of demand for cereal at the national level (pooled data) indicates that if the price of cereal falls by 10% then the demand for cereal would increase by 5.8%. Of this total increase in demand, 2.8% is purely due to price effect (i.e., the substitution effect) as the compensated elasticity suggests. The income effect of the price fall accounts for the remaining 3.0% (i.e., 5.8 - 2.8) increase in cereal food demand due to the increase in real income, although the absolute amount of money income remains unchanged. If per capita income also increases by 10% accompanied by 10% fall in cereal price, then the demand for cereal would increase by 12.3% (i.e., 5.8 + 6.5). However, the increase in per capita income results in a shift in the cereal demand curve that normally leads to an increase in cereal price, which is not desirable in a country like Bangladesh where majority of the people belong to the low-income group and are dependent on market. Thus, any policy for increasing the income of a particular group must either has consumers' support price or support by buffer stock of food particularly cereal to protect the low-income people from higher price. However, the estimation of market equilibrium in such situations requires information on supply elasticity of cereal.

The estimates of own-price elasticities in Table 6 reveal that - except for cereal, vegetables, livestock products, and other foods - the income effects of change in prices vary little for the rest of the food items. This is so because the shares of these food items were very small in household expenditure (income) patterns (Table 1).

3.7 Cross-price elasticities for major food items

Like own-price elasticities, cross-price elasticities are also decomposed into uncompensated and compensated cross-price elasticities. Tables 7 and 8 respectively, provide the uncompensated and compensated cross-price elasticity matrices of pooled observations. The uncompensated cross-price elasticity is the "gross" cross effect of both prices, i.e., substitution effect and income effect. The compensated cross-price elasticity, on the other hand, is the pure price effect (i.e., the substitution effect) or the "net" effect of price change on demand. The estimates of cross-price elasticities observed in uncompensated and compensated cross-price elasticity tables are better discussed through a cross-table analysis. The estimates in an uncompensated cross-price elasticity table indicate that the cereal-to-pulse cross-price elasticity is positive, meaning that the price of cereal and the demand for pulses move in the same direction, i.e., if the price of cereal falls by 10%, then the households would decrease their demand for pulses by 1.6% (Table 7). The compensated cross-price elasticity of cereal-to-pulses, i.e., the "net" effect of cereal price change on demand for pulses, indicates that if the price of cereal fall by 10%, then the households would decrease their demand for pulses by 2.3% (Table 8). The first decrease in demand for pulses by 1.6% is the effect of fall in cereal price and increase of real income. The second decrease in demand for pulses by 2.3% is the effect of fall in cereal price only. The results obtained by deducting these two demands and adding to income elasticity (i.e., 1.6 - 2.3 + 1.09 = 0.29%) is the effect of real income change on demand for pulses. The pulse in this case is a complementary food to cereal.

The negative sign of uncompensated cross-price elasticity of demand for fruits due to price change in cereal indicates that the two goods are competitive. That is, the fall in cereal price would result to an increase in demand for fruits. A 10% fall in cereal price will increase demand for fruits by 0.4%. The compensated cross-price elasticity effect on demand for fruits is positive, indicating that the two goods are complementary, i.e., a fall in cereal price will reduce the demand for fruits. A 10% decrease of cereal price would reduce the demand for fruits by 1.0%. Thus, an increase in real income due to the fall of cereal price would contribute to an increase in demand for fruits by 0.43% (i.e., 0.4 - 1.0 + 1.03 = 0.47%).

Table 7. **Uncompensated own and cross-price elasticities of major food items in Bangladesh.**

Price of	**Demand for**							
i	**I Cereal**	**Pulses**	**C. oil**	**Fruits**	**Vegt.**	**Fish**	**L. prods.**	**Other foods**
Cereal	-0.58	0.16	-0.06	-0.04	-0.13	0.14	0.09	0.19
Pulses ,	-0.09	-0.92	-0.12	-0.11	-0.05	-0.10	0.03	-0.02
Cooking oil	-0.13	-0.18	-0.93	-0.09	-0.11	-0.03	0.07	-0.11
Fruits	-0.69	-0.07	-0.03	-0.55	-0.04	-0.02	0.04	0.12
Vegetables	-0.21	0.12	-0.06	-0.10	-0.49	-0.08	0.06	-0.23
Fish	-0.16	-0.11	-0.07	-0.05	-0.03	-0.59	-0.01	-0.25
L. products	-0.36	-0.04	-0.11	0.01	-0.07	-0.04	-0.85	-0.07
Other foods	0.04	-0.07	-0.01	0.05	-0.02	-0.17	-0.07	-1.15

Source: Field survey data, 1999-2000.

Table 8. Compensated own and cross-price elasticities of major food items in Bangladesh.

Price of	~ **Demand for**							
	Cereal	**Pulses**	**C. Oil**	**Fruits**	**Vegt.**	**Fish**	**L. prods,**	**Other foods**
Cereal	-0.28	0.23	0.12	0.10	0.12	0.24	0.25	0.41
Pulses	0.22	-0.85	-0.31	0.22	0.11	0.04	0.19	0.20
Cooking oil	0.11	0.30	-0.78	0.11	0.04	0.06	0.11	0.14
Fruits	-0.29	0.12	0.10	-0.48	-0.10	0.08-	0.20	0.34
Vegetables	-0.13	0.11	0.07	-0.17	-0.31	0.04	0.09	0.20
Fish	0.14	-0.03	-0.13	0.10	0.06	-0.49	0,16	-0.03
L. products	-0.06	0.03	0.04	0.15	0.05	O.OG	-0.68	0.15
Other foods	0.34	0.01	0.05	0.19	0.10	-0.17	0.10	-0.93

Source: Field survey data, 1999-2000.

Some cross-price elasticities changed their signs between the uncompensated and compensated forms. For example, the negative sign of the uncompensated cross-price elasticity of demand for fruits due to fall in cereal price, i.e., the total effect of a change in cereal price and income on demand for fruits, indicates that the two goods are "gross" complements (Table 7). On the other hand, the sign of the compensated cross-price elasticity

between the two goods is positive, indicating that fruits and cereal are "net" substitutes (Table 8). Since fruits have a relatively higher income (expenditure) elasticity of demand (Table 5), increase in real inoome due to fall in cereal price results in an increased demand for fruits.

3.8 Decomposition of cereal food consumption expenditure patterns

In the earlier section, we have discussed expenditure patterns of major household food commodities in Bangladesh. But we do not know yet how the share of total expenditure budget competes among the cereals. This is very much needed in the context of low income as well as economically and politically unstable countries where cereal is considered as the staple food commodity of the majority. The lower income people in an unstable economy always think of their food security, which make them budget expenditure accordingly.

Table 9 shows the distribution patterns of the share of specific types of cereal to households' total cereal food expenditure budget. Households in Bangladesh spent about 65% of total cereal budget on coarse rice, 23% on fine rice, 4% on aromatic rice, and the rest 8% on wheat. Rural households spent more on coarse rice and less on fine rice, aromatic rice, and wheat compared with urban households.

Table 9. Decomposition of household cereal food consumption expenditure patterns

Cereal food commodity	Average budget share (%)			Marginal budget share (%)		
	Rural	Urban	Pooled	Rural	Urban	Pooled
Coarse rice	72.4	60.9	65.2	51.9	24.3	42.8
Fine rice	17.6	25.7	23.3	32.4	53.3	39.3
Aromatic rice	3.7	5.4	4.0	8.0	9.9	8.5
Wheat	6.3	8.0	7.5	7.7	12.5	9.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey data, 1999-2000.

The distribution of marginal budget shares in Table 9 showed that coarse rice occupied a lion share (51.9%) of the total cereal budget of rural households. Urban households, on the other hand, spent the major portion (53.3%) of their total cereal budget on fine rice. The higher percentage of budget spent by rural and urban households on coarse and fine rice, respectively shows the overwhelming importance and/or dominance of coarse and fine rice in cereal food basket of Bangladeshi people.

3.9 Decomposition of expenditure (income) elasticities for cereal food only

The expenditure elasticities of demand for food, particularly cereal food like rice (coarse, fine, and aromatic rice) and wheat, were estimated separately to see the effect of change in income (expenditure) on demand.

Table 10 shows the income (expenditure) elasticities of demand for these four cereal foods. The expenditure elasticity of demand for coarse rice was found to be 0.29, which means that a 10 percent increase in household expenditure on cereal would increase the

demand for coarse rice by 2.9%. This increase was 7.9% for fine rice, 8.5% for aromatic rice, and 5.5% for wheat. The elasticity of demand for coarse rice by rural households (0.31 %) was higher compared with urban households (0.27%). The elasticity of demand for aromatic rice was also higher for rural households. The reason for higher elasticity of demand for aromatic rice by rural people might be that they consumed from their home produces. The elasticities of demand for fine rice and wheat, on the other hand, were higher for urban households. This increased demand due to increased income could result in an inequilibrium in the market. To keep the market equilibrium, production plan should target the production growth rate at least to the level of income growth rate.

Table 10. Decomposition of expenditure (income) elasticities of demand for cereal food consumption in Bangladesh

Cereal food commodity	Expenditure/Income elasticity		
	Rural	Urban	Pooled
Coarse rice	0.31	0.27	0.29
Fine rice	0.77	0.87	0.79
Aromatic rice	0.89	0.77	0.85
Wheat	0.51	0.65	0.55

Source: Field survey data, 1999-2000.

3.10 Own-price elasticities for cereal food

The uncompensated and compensated own-price elasticities for cereal (coarse, fine, aromatic rice, and wheat) were estimated and discussed in this section. The estimations were based on pooled data collected from both rural and urban households in Bangladesh. The estimated elasticities of demand for these four food commodities in rural and urban households are presented in Table 11. The estimates of uncompensated own-price elasticities for coarse rice, when compared with the other three types of cereals such as fine rice, aromatic rice, and wheat, suggest that the Bangladeshi households are quite responsive to change in its price just to make an adjustment in their expenditure in cereal consumption. The high response to change in fine rice price is because this commodity has a substitute, which is the staple food for Bangladeshis. However, except for coarse rice, the estimated elasticities of demand for fine rice, aromatic rice, and wheat were higher for rural households compared with urban households.

Table 11. Own-price elasticities of demand for cereal food commodities in Bangladesh

Cereal food commodity	Own-price elasticity					
	Uncompensated			Compensated		
	Rural	Urban	Pooled	Rural	Urban	Pooled
Coarse rice	-1.41	-2.01	-1.84	-0.89	-1.77	-1.36
Fine rice	-5.09	-4.91	-4.57	-4.76	-4.38	-4.25
Aromatic rice	0.97	-0.28	0.48	1.05	-0.18	0.59
Wheat	1.01	-0.10	0.49	1.09	0.03	0.58

Source: Field survey data, 1999-2000.

The estimated uncompensated own-price elasticity of demand for coarse rice indicates that if the price of coarse rice falls by 10%, then the demand for it would increase by 18.4%. Of this total increase in demand, 13.6% was purely due to price effect (i.e., substitution effect) as the compensated elasticity shows (Table 11). The remaining 4.8% (i.e., 18.4 - 13.6) was the effect of increase in real income resulting from the fall of coarse rice price. This increase in real income did not account for an increase in absolute money income. Rather, the increase in absolute money income was accompanied by gains from the price falls. Hence, the demand for coarse rice was 7.7% (i.e., 4.8 + 2.9), if the per capita absolute real income increase by 10% accompanied by a 10% fall in coarse rice price. The demand for aromatic rice, likewise, was 7.4% (i.e., 4.8 - 5.9 + 8.5). The demand for fine rice and wheat, on the other hand, was 11.1 1% (i.e.45.7 - 42.5 + 7.9) and 4.6% (i.e., 49 - 5.8 + 5.5), respectively.

3.11 Cross-price elasticities for cereal food

In this section uncompensated and compensated cross-price elasticities of demand for cereal food commodities are discussed. The estimates of uncompensated cross-price elasticities as shown in Table 12 indicate that the coarse-to-fine rice price elasticity is positive. That is, if the price of coarse rice falls by 10%, then the households would decrease their demand for fine rice by 14.7%, indicating that the demand for fine rice is affected by the price of coarse rice. The estimates in compensated cross-price elasticities shown in Table 13 indicate that the coarse-to-fine rice price elasticity is also positive. That is, if the price of coarse rice falls by 10%, then the households would decrease their demand for fine rice by 18.0%. The difference between the two decreases, (i.e., 14.7 - 18.0 = - 3.3%), is the effect of real income change on demand for fine rice. This real income effect, however, is not the absolute increased income effect. So, to have the absolute increased income effect, we could add this percentage with the income elasticity, (i.e., - 3.3 + 7.9 = 4.6%), indicating that a 10% increase in absolute income accompanied by 10% increase in real income due to a fall in coarse rice price would increase the actual demand for fine rice by 4.6%.

Likewise, a 10% increase in absolute income accompanied by a 10% increase in real income due to a drop in coarse rice price would increase the actual demand for aromatic rice and wheat by 7.4% (i.e., 0.2 - 1.3 + 8.5) and 4.6% (i.e., 0.1 - 1.1 + 5.5), respectively.

Table 12. Uncompensated own and cross-price elasticities of demand for cereal food commodities in Bangladesh

Price of	**Demand for**											
	Rural				**Urban**				**Pooled**			
	Coarse rice	Fine r'ce	Arom. rice	Whea	Coarse r'ce	Fine rice	Arom. Rice	Wheat	Coarse rice	Fine rice	Arom. rice	Wheat
Coarse rice	-1.41	1.13	0.04	0.05	-2.01	2.08	0.23	0.16	-1.84	1.47	0.02	0.01
Fine rice	3.67	-5.09	0.09	-0.26	3.78	-4.91	-0.50	-0.47	3.56	-4.57	-0.08	-0.27
Arom. Rice	-3.19	1.08	0.97	-0.02	-1.54	-1.11	0.28	1.75	-2.43	0.01	0 48	0.68
Wheat	-1.73	-0.33	-0.01	1.01	-1.59	-0.66	1.18	-0.10	-1.35	-0.59	0.38	0.49

Source: Field Survey Data, 1999-2000.

Table 13. Compensated own and cross-price elasticities of demand for cereal food commodities in Bangladesh

Price of	Demand for											
	Rural				Urban				Pooled			
	Coarse rice	Fine rice	Arom. rice	Wheat	Coarse rice	Fine rice	Arom. Rice	Wheat	Coarse rice	Fine rice	Arom. rice	Wheat
Coarse rice	-0.89	1.46	0.12	0.13	-17G	2.G1	0.33	0.29	-1.36	1.80	0.13	0.11
Fine rice	4.19	-4.7G	0.17	-0.18	4.02	-4 38	0.40	-0 34	4.04	-4.25	0.03	-0.18
Arom. Rice	-2.67	1.40	1.05	0.05	-1.30	-0.58	-0.18	1.88	-1.95	0.34	0.59	0.77
Wheat	-1.21	-0.01	0.08	1.09	-1.35	-0.12	1.27	0.03	-0.8G	-0.26	0.48	0 58

Source: Field survey data, 1999-2000.

3.12 Comparison of results with other studies

In Bangladesh, several studies have been conducted to estimate the elasticities of composite foodgrains. Although some (Pitt, 1983; Bouis, 1992; Ahmed and Hossain, 1990; Goletti, 1993 and Ahmed and Shams, 1994) estimated the elasticities of demand for foodgrains, they were strict to desegregate the estimates into rice and wheat elasticities. None was found to decompose rice by quality. However, the magnitude as well as the value of the estimates in past studies varied from one study to another. The income elasticities of demand for rice for the lower income group in past studies ranged from 0.80 to 1.19, and from 0.03 to 0.94 for higher income groups. A comparison of own-price and income elasticity for rice and wheat is given in Table 14. The positive signs for both price and income elasticies of wheat are due to change in food habits of the working people in the rural and urban areas. The highincome group in urban areas is used to take bread in the breakfast. While the urban and rural wage labourers are used to eat bread (Pouruti and Goor and/or Banana) during lunchtime, which might be the reason for positive income elasticity of wheat.

Table 14. Comparison of own-price and income elasticities of demand for rice and wheat in Bangladesh

Authors	Income/expenditure category	Rice		Wheat	
		Own-price elasticity	Income elasticity	Own-price elasticity	Income elasticity
Pitt (1983)	Low	-1.30	1.19	-0.72	-0.10
	High	-0.83	0.94	-0.06	-0.24
Bouis (1992)	Low	-0.9G	0.83	-0.10	0.19
	High	-0.53	0.34	-0.82	-0.29
Ahmed and Hossain (1990)	Village-I[a]	-	0.94	-	-0.06
	Village-II[b]	-	0.76	-	-0.14
Goletti (1993)	Low	-0.89	0.80	-1.23	-1.37
	High	-0.39	0.03	-0.21	-0.19

Authors	Income/expenditure category		Rice		Wheat	
			Own-price elasticity	Income elasticity	Own-price elasticity	Income elasticity
Ahmed and Shams (1994)	Low		-0.80	1.05	1.92	-0.58
	High		-0.17	0.48	-0.18	0.11
Islam (2002) Present study	Rural	Aromatic	1.05	0.89		
		Fine	-4.76	0.77	1.09	0.51
		Coarse	-0.89	0.31		
	Urban	Aromatic	-0.18	0.77		
		Fine	-4.38	0.87	0.03	0.65
		Coarse	-1.77	0.27		
	Pooled	Aromatic	0.59	0.85		
		Fine	-4.25	0.79	0.58	0.55
		Coarse	-1.36	0.29		

[a] Village-I is under developed, Village-II is developed.

4. CONCLUSIONS AND POLICY IMPLICATIONS

This study examined the households' expenditure patterns and estimated demand parameters of the AIDS model through the estimation of a complete demand system. The higher percentage of budget share of cereal for both rural and urban areas- shows the overwhelming dominance of rice in total household food expenditure. However, rural households have less diversity in high quality food compared with urban households.

The expenditure (income) elasticities of demand for cereal, livestock products, and other foods were found to be almost similar between rural and urban households. However, the expenditure (income) elasticities of demand for pulses, cooking oil, fruits, vegetables, and fish were higher for rural households compared to urban households. Thus, any policy for increasing the income of rural people could enhance their diversity in high quality food.

The estimates of own-price elasticities suggest that households are quite responsive to changes in prices of pulses, cooking oil, and other food commodities to make an adjustment in their food consumption expenditure budget. The estimated elasticities of demand for fruits, vegetables, and livestock products, in rural areas are relatively low compared with urban areas, which indicate that demand of rural households is not market oriented; rather they consume these food commodities from their own production. The estimated elasticities for pulses, cooking oil, fish, and other foods, in rural areas were higher compared with urban areas indicating that their demand was market oriented. On the other hand, the demand for all food commodities of urban households was market oriented. Thus, to maintain food consumption balance between rural and urban households, there should be a constantly open market for selling food commodities such as pulses, cooking oil, and other foods with higher price elasticities. Moreover, increased supply of fish in rural and livestock products in urban households could also help maintain dietary balance between urban and rural areas.

The estimates of decomposed expenditure (income) elasticities of demand for cereal food (i.e., coarse rice, fine rice, aromatic rice and wheat) indicated that the demand elasticities for coarse and aromatic rice in rural areas were higher compared with urban areas. The

expenditure elasticities of demand for fine rice and wheat, on the other hand, in urban areas were higher than in rural areas. However, in both cases, the increased expenditure (income) elasticities of demand for aromatic rice and wheat were prevailing which indicated that an increase in income could result in people including fine quality rice in their diet.

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