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ESTIMATION OF DEMAND FOR COCONUT IN SRI LANKA: AN APPLICATION OF ALMOST IDEAL DEMAND SYSTEM (AIDS)

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Abstract

Coconut is the second most important food and it is a highly demanded agricultural commodity in Sri Lanka. Supply shock and the price fluctuation is one of the major problem faced by coconut consumer. Therefore, estimating coconut demand is a needful topic to predict coconut production. The study estimated the domestic coconut income demand elasticity, uncompensated and compensated price elasticities using the Almost Ideal Demand System (AIDS). Secondary time-series data from 1995 to 2016 were collected from secondary sources. Coconut consumption was fluctuating and the price showed an increasing trend throughout the years. Further, the demand was relatively the same for any price held in time. Estimated income (expenditure) elasticity of coconut is 0.825; the Marshallian (uncompensated) and Hicksian (compensated) price elasticity of coconut are 0.758 and 0.725 respectively. Indicate that, the price and expenditure demand for coconut was inelastic. Therefore, it is considered as an essential good in Sri Lanka. However, the demand would increase shortly with the population growth in Sri Lanka. Hence, it is necessary for increasing the coconut production in the country.

Key Words: AIDS Model, coconut, demand, Hicksian, Marshallian

1 Introduction

Coconut (*Cocus nucifera* L.) is an important daily used commodity in Sri Lankan kitchen and found as a principal ingredient in Asian and Western kitchen. Nearly 25 per cent of arable land is occupied by coconut cultivation in 2016, which is 466,000 hectare of size, and contribution for GDP is two per cent where whole coconut sector contributes 49,000.00 million USD to GNP (Central Bank of Sri Lanka, 2016). Sixty-three percentage of coconuts are consumed domestically and the rest of them are exported as value-added coconut products to earn foreign currency. Coconut export income was increased by three per cent in 2017 (Coconut Development Authority of Sri Lanka, 2017). The foreign income is mainly generated from desiccated coconut product and coconut oil production; 72,000 metric tons of desiccated coconut was exported in 2016 at the selling rate of Rs. 265.27 per kilogram (Coconut Development Authority of Sri Lanka, 2016). Similarly, coconut is used to produce coconut oil, kernel, shell and fiber products.

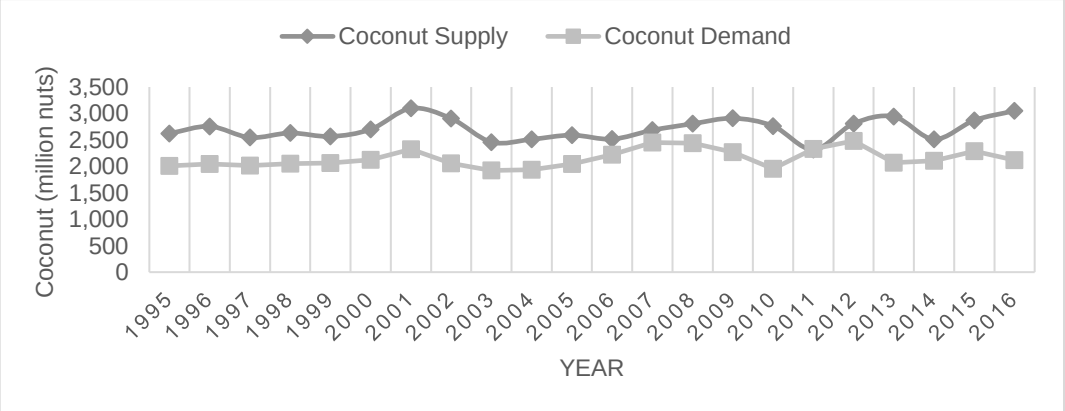

Fig. 1: Coconut Supply and Demand in Sri Lanka

Coconut supply and demand of the country is fluctuating. The existing data indicate that the supply was sufficient to meet the coconut demand of the country except 2011 and 2012 during which supply shock occurred (Fig 1). Coconut is the second most important food in the Sri Lankan diet (where rice is the first) and it is a highly demanded agricultural commodity (Pathiraja et al., 2015). Per capita consumption is annually changing in a fluctuating manner (Fig 2). Thus, the per capita consumption of coconut remains same during the period, meantime the population growth, which was 0.8 – 0.9% in 2013 to 2015 while 1.1% in 2016 and 2017 (Department of Census and Statistics Sri Lanka, 2018). However, the increase in population and consequent reduction on coconut land produces a supply shock resulting in a sharp rise in the price of coconut. Hence, prediction of demand for coconut would help to formulate a suitable plan by relevant government agencies and policymakers for increasing the supply of coconut to meet growing demand in Sri Lanka.

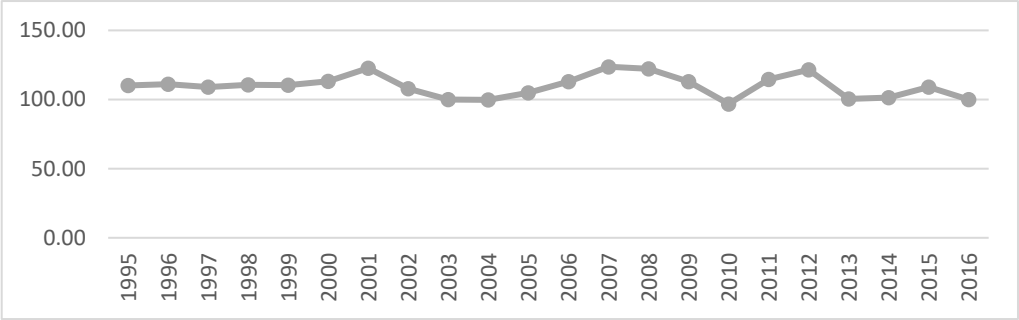

Fig. 2: Per capita consumption of coconut from 1995 to 2016

Demand estimation studies have been conducted mostly for fruits and vegetables, meat, eggs, milk, wheat, rice and cooking oils. Revoredo-Giha (2013) analyzed the demand for fresh fruits in Scotland for six fruits, found that long term price elasticity demand more than one for all six fruits. The complementary study was done by Ul-Haq et al. (2009) and found that wheat, fruits, vegetables, milk, and cooking oil are normal good as these price and expenditure elasticities are inelastic and rice, meat, and other food products were found to be expenditure elastic.

Further studies were conducted to estimate different types of meat demand in various countries in the world, for an instance; Wang & Bessler, (2000), Ortega, Wang & James (2009), and Jabarin (2005) have estimated the meat demand in United States, China and Jordan respectively. As well as Yang & Koo (1994) estimated meat import demand in Japan. The AIDS demand estimation was used to estimate the demand of other commodities like; Crawford (2018) has estimated the demand for storable consumer goods in the United Kingdom. Fan, Wailes & Cramer (1995) has estimated the demand for food, clothing, fuel, housing, and other commodities.

AIDS (DAIDS) model is used to estimate the demand for commodities using longitudinal and crossectional data to study the variation in expenditure over time and the individuals (Tiffin et al., 2011). Cranfield et al., (2003) investigate five demand estimation models to estimate cross-sectional data with a wide variety of income level, estimated models are; Directly Additive Demand System (AIDADS), Quadratic Almost Ideal Demand System (QUAIDS), Quadratic Expenditure System (QES), Linear Expenditure System (LES) and Almost Ideal Demand System (AIDS), result exposed that AIDADS was the best model for less restrictive income effect cross-sectional data. Almost all studies used AIDS model for estimating the demand for agricultural products and the same model can be used to estimate the demand of non-agricultural products and services for an instance; Linear AIDS model is used to estimate tourism demand in a country, Gang Li, Song, & Stephen (2004). The current study was an attempt for estimating coconut demand using AIDS model with time-series where the literature on demand estimation for coconut is lacking in Sri Lanka.

2 Methodology

Time series data from 1995 to 2016, includes coconut price, population, per capita coconut consumption, per capita household consumption expenditures and consumer price index (CPI) were collected from Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI), Department of Census and Statistics, World Bank, Coconut Research Institute and Central Bank of Sri Lanka respectively. A typical Almost Ideal Demand System (AIDS) demand estimation model was used to find the domestic demand for coconut in Sri Lanka.

$$W_i = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln(P_t) + \beta_i \ln(\frac{X_t}{P_{ct}}) + \varepsilon_t \quad (1)$$

Where N is the number of commodity categories considered in the whole system, W_i and P_t are expenditure share for coconut and retail price of the coconut at time t respectively. α, β and γ are parameters to be estimated, and Pct is Consumer Price Index (CPI) used to deflate the prices and household income, the effect of inflation can be solved by dividing CPI has given real household expenditure. It is a type of weighted aggregate price index given by;

$$P_{ct} = \frac{\sum_{i=1}^{n} P_{jt}.Q_0}{\sum_{i=1}^{n} P_{j0}.Q_0} \quad (2)$$

Where P_{jt} Price of j^{th} commodity at a particular time, P_{jo} price of other j^{th} commodity at the base year and Qo is the per capita consumption of jth commodity in the base year. 2013 was considered as the base year for the present study. The expenditure share for coconut can be calculated according to the equation (3)

$$W_t = \frac{(P_t \cdot Q_t)}{X_t} \quad (3)$$

Where P_t is the price of the coconut at the time t, qt is coconut quantity demanded at the same year and Xt is total consumption expenditure on all N commodities. The basic demand restrictions are adding-up, homogeneity and negativity which can be expressed in terms of coefficients (Ortega, et al., 2009).

Adding up: $\sum_i \alpha_i = 1; \sum_i \gamma_{ij} = 0; \sum_i \beta_i = 0$

Homogeneity: $\sum_i \gamma_{ij} = 0$

Negativity: $\sum_{i=1} \sum_{j=1} X_i W_i \varepsilon_{ij} X_j < 0$

Homogeneity refers that the consumption of one good is not changed by proportional changes occurred in income and price of all goods. The problem of inconsistent choice between products is overcome by this restriction. The convexity behaviour of utility function supports the negativity restriction, which is due to the utility maximization in the Marshallian demand function, alternatively, that costs minimization in the Hicksian demand function (Seale, Regmi, & Bernstein, 2003).

Augmented Dicky Fuller (ADF) test was carried out to find the autocorrelation or existence of unit root in selected variables. test statistics for the variable (Y_t) and the first difference of the variable (dY_t) were found using the intercept only model. Intercept the only model for D-F test;

$$Y_t = \beta_0 + dY_t + \alpha_i + e_t \quad (4)$$

Expenditure, Mashalian and Hicksian demand elasticity for coconut were estimated, using parameters α, β and γ in AIDS model. The elasticities were estimated using the below formulas.

$$\mu_i = 1 + \frac{\beta_i}{\check{N}_i} \quad (5)$$

$$e_{ij}{}^{u} = -\theta_{ij} + \frac{\gamma_{ij}}{\check{N}_i} - \frac{\beta_i \check{N}_j}{\check{N}_i} \quad (6)$$

$$e_{ij}{}^{c} = -\theta_{ij} + \frac{\gamma_{ij}}{\check{N}_i} - \check{N}_j \quad (7)$$

Where μ_i expenditure elasticity, e_{ij}^{u} is uncompensated price elasticity, e_{ij}^{c} is compensated price elasticity and Ň are the average expenditure share of coconut. βi and γ_{ij} are parameters to be estimated. And i=j, θ_{ij} become one otherwise zero.

3 Results and Discussion

Following chart (Fig 3) shows Sri Lanka's domestic coconut demand was fluctuating between 2,000 million nuts and 2,500 million nuts per annum. Accurate forecasting of annual national coconut production in 2005 was 2,715 million nuts (Peiris, et al., 2008) when the domestic coconut demand was 2,047 million nuts.

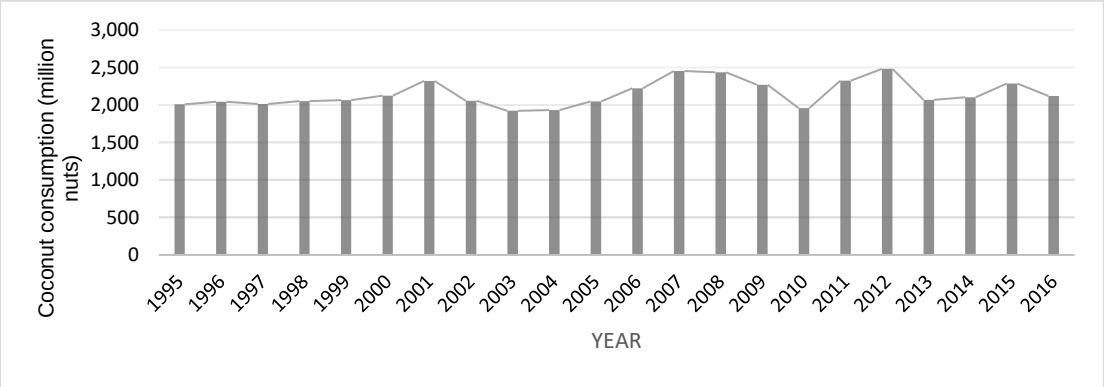

Fig. 2: Yearly domestic coconut demand in Sri Lanka from 1995 – 2016

The average price within the time 1995 to 2016 was varying between Rs. 8.40 to Rs. 51.2 (Fig. 4). The result revealed that the price level of coconut was increasing annually and in 2018 retail prices of large and small coconut were increased by 19% and 16% respectively in comparison to 2017. Coconut can be substituted by many other value-added products in developed countries. Nevertheless, substitution for coconut is not existing in Sri Lanka because it is one of the main ingredient used for the Sri Lankan food further, coconut provided 22 per cent of the per capita calorie intake in the diet while the rice was in first (Fernando et al., 2007).

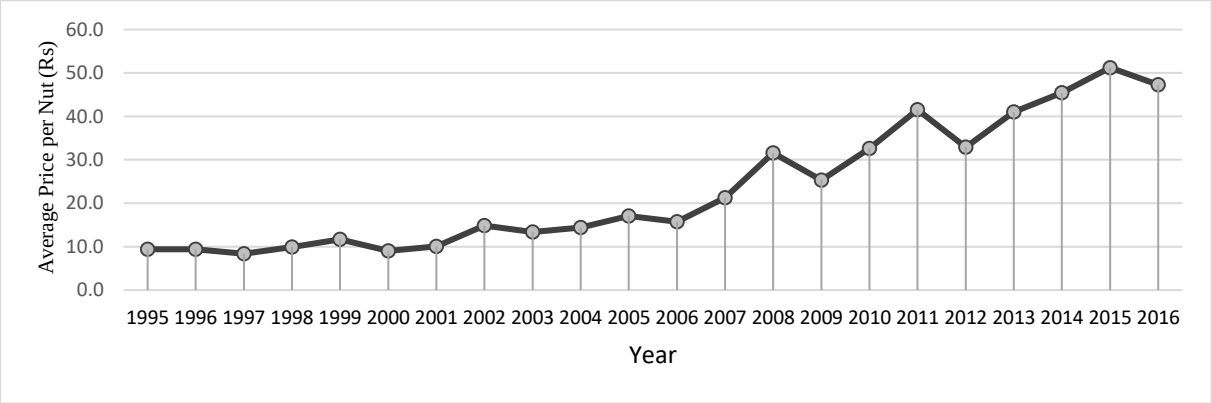

Fig. 4: Annual average coconut price level change

The highest price change occurred in 2002 and 2008 with 33% from the previous year during that period, the increased domestic coconut demand showed in the country (See Fig 3). Further, in 2006, 2009, 2010

and 2012 coconut price declined considerably. On the other hand, the lowest price occurred in 1999 when the 23 percentage price reduction was observed from 1998, also 2008 and 2011 coconut price was changed by remarkable percentages (Fig 5).

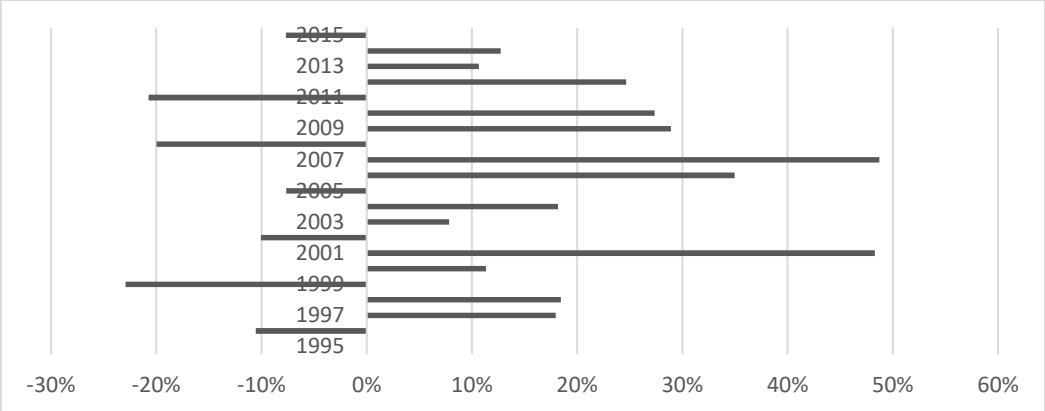

Fig. 5: Yearly price change of coconut

The results of ADF test are presented in the following Table 1 shows the test statistics for the variable (Y_t) and the first difference of the variable (dY_t) were found using the intercept only model. ADF for unit root test reveals that log-level of coconut expenditure share, total consumption expenditure and consumer price index ($2010 = 100$) contain unit-root, on the other hand, the first difference of all log variables do not have a unit root, therefore first difference form of the variables were hired to the estimated model. The parameters of the AIDS were estimated using Linear Approximate (LA) version of AIDS model, AIDS model (with linear in logarithms equations), with constant elasticity assumption (Seale, et al., 2003).

Augmented Dicky Fuller test was done to find the autocorrelation or existence of unit root in variables, the following Table 1 shows the test statistics for the variable (Yt) and first difference of the variable ($dY_{(t-1)}$) were found using intercept only model.

Intercept only model for D-F test $Yt = \beta_1 + dY_{(t-1)} + a_i + e_t$

Table 1. Augmented Dickey Fuller (ADF) test results

Variables	D-F Statistics	First Differences	D-F Statistics
W_t	3.288	d_W_t	5.611
ln_W_t	2.893	dln_W_t	5.461
ln_X_t	0.178	dln_X_t	5.057
ln_P_t	0.456	dln_P_t	6.156
ln_P_{ct}	1.868	dln_P_{ct}	3.295
		Critical Value	
1%	3.750	1%	3.750
5%	3.000	5%	3.000
10%	2.630	10%	2.630

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$$d\ \ln W_t = \alpha_0 + \sum_{i=1}^{N} \gamma_i d\ \ln P_t + \beta_i \left[d\ \ln X_t - d\ \ln P_{ct} \right] + \varepsilon_t \quad (8)$$

The first difference form of the LA/AIDS model was estimated using OLS. The result reveals that the average price of coconut significantly influences the expenditure share of coconut at 5% significant level, which explains that there was a unit relationship between them, further elaborates that, one percentage change in the average price of a coconut causes approximately one percentage change in its expenditure share. Meanwhile, the per capita household expenditure significantly affects the expenditure share on the coconut at 10 % significant level, means that if per capita household expenditure increased by one percentage, 0.7 percentage drop was observed in coconut expenditure. An increment in coconut price increased the coconut demand and raise in per capita household expenditure decreased the coconut demand (Table 2).

Table 2: Coefficient Significant Level

Variable	**Coefficient**	**P-Value**
dln P_t (γ_i)	0.939	0.000
dlnXt-dlnPct (β_i)	-0.697	0.081
Constant (α_0)	-0.093	0.003

The result of expenditure elasticities, uncompensated (Marshallian) and compensated (Hicsian) price elasticities of coconut were estimated using equation (4), (5) and (6). The result discloses that expenditure elasticity for coconut was approaching to unit elastic (0.86), indicates that, increasing the household expenditure shows the small significant upsurge on coconut consumption (Table 3).

Table 3. Income and Price Elasticity

Elasticity	**Value**
Expenditure	0.825
Uncompensated (Marshallian) Price elasticity	-0.758
Compensated (Hicsian) Price elasticity	-0.725

Observed expenditure (income) elasticity of coconut was inconsistent while the expenditure share of coconut was relatively same (Fig 6). According to Table 3, compensated (Marshallian) and uncompensated (Hicksian) price elasticities for coconut were - 0.758 and - 0.725 respectively, which utters that compensated and uncompensated price elasticities were inelastic for coconut, both compensated and uncompensated own-price elasticities were relatively same as well.

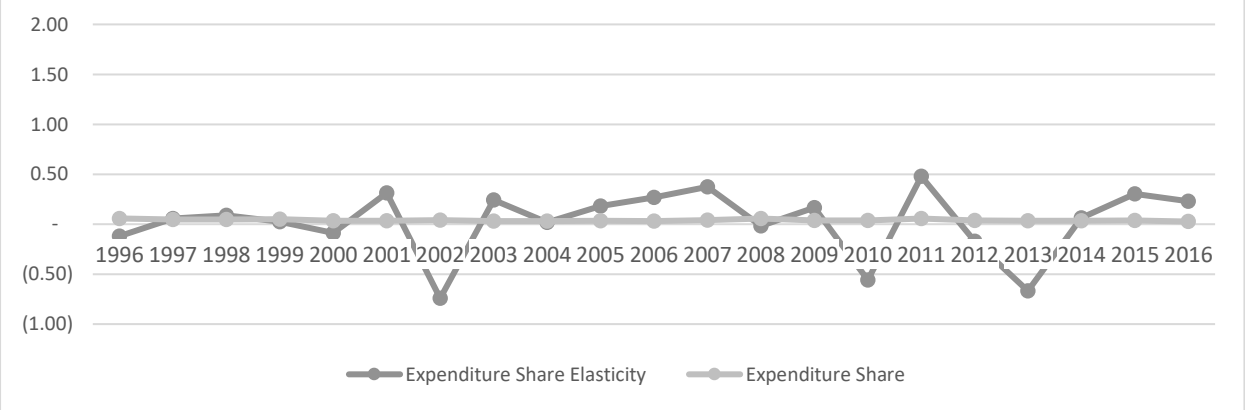
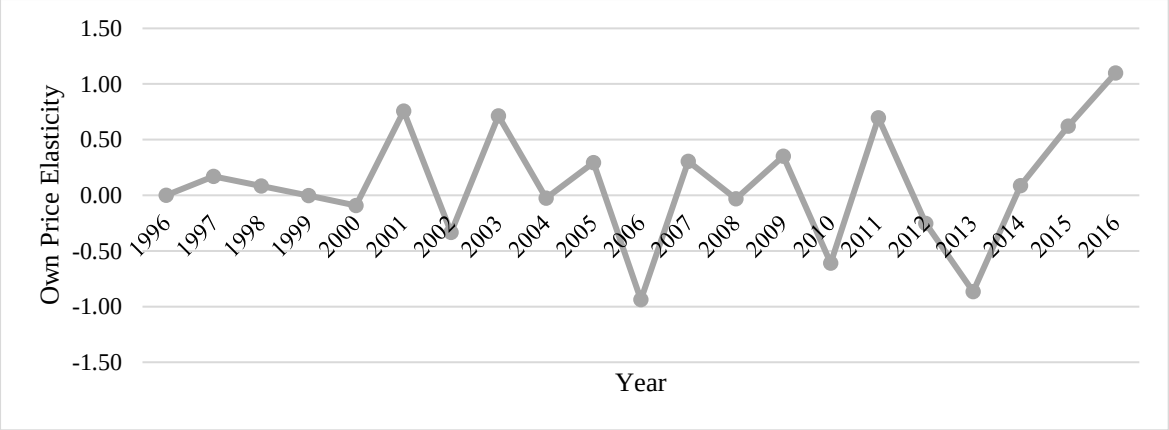


Fig. 6: Expenditure Elasticity and Expenditure Share of Coconut

Observed uncompensated own price elasticity (ε) was changing between zero and one. The own-price elasticity of coconut during this period was unpredictable. However, the price elasticity was inelastic from 1996 to 2015 thus, the absolute value of own-price elasticity (ε) is less than one, reflects that consumers were more dislike to change their coconut consumptions along with the average price changes of coconut. Own-price elasticity approached unit elastic in 2006 eventually 2016 it became elastic, reveals that the coconut consumption in 2016 could change with the price of the coconut because the price of the coconut was relatively high in 2015 and 2016.



4 Conclusion

The empirical study concluded that coconut is the most important commodity consumed on a day-to-day basis in Sri Lanka. The own-price elasticity of demand for coconut was inelastic nature for a long period thus, the coconut consumption of Sri Lankan is less sensitive to the coconut price since the coconut is considered as essential goods in Sri Lanka. However, the coconut price is increasing with the time and the increasing rate was relatively higher in some years. Therefore, the government needs to take actions to control the price of coconut without affecting both buyers and sellers. Even though the per capita coconut consumption remains the same, the aggregated coconut demand increases with raising population in Sri Lanka. Furthermore, the income elasticity of coconut is positive which informs that increasing income level lead to increase coconut demand in Sri Lanka. Therefore, both private and state institutions related to improving coconut production need to turn their advertence to find out strategies to increase the coconut production to meet the coconut demand in future. The estimation method used in the present study predicted the countrywide demand for coconut. The same estimation method could be used to estimate regional level coconut demand within the country. Further, this estimation model could be useful to estimate the demand for the agricultural commodity like fruits, vegetables, meat, and dairy products as well.

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