Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5889

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 258-264 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Study on Consumption Pattern of Different Fruits and Vegetable in Tamil Nadu

Revathy A.[1*] and P. Paramasivam[2]

[1]Ph.D. Scholar, [2]Professor

(Agricultural Economics), Tamil Nadu Agricultural University, Coimbatore

*Corresponding Author E-mail: revathyg11@gmail.com

Received: 15.09.2017 | Revised: 23.10.2017 | Accepted: 3.11.2017

ABSTRACT

The present study aimed at estimation of demand elasticities for different fruits and vegetables in Tamil Nadu. This study uses the National Sample Survey Organization (NSSO) data for the demand analysis using Quadratic Almost Ideal Demand System (QUAIDS) model for the rounds 61st (2004-05) and 68th (2011-12). The result of demand analysis of fruits and vegetables revealed that all were normal goods. High expenditure elasticity were found for apple, orange, jack fruit and grapes and in case of vegetables peas, cauliflower, beans, brinjal and pumpkin suggesting that the quantity demanded for these will increase more than proportionately to the increase in total expenditures. Own price elasticity is inelastic for banana alone in fruits and vegetables such as potato, cabbage, cauliflower, onion, tomato, carrot, bhendi, chillies and leafy vegetables. Cross-price elasticity revealed that strong substitutability was found in jack fruit and watermelon, watermelon and guava, papaya with guava and orange in fruits and for vegetable parwal was having with bhendi, carrot, pumpkin, potato, beans, onion and cabbage. Low intake of fruits and vegetables needs a behavioral intervention. Pricing incentives such as subsidies that lower the cost of fruits and vegetables could be provided in order to increase the consumption of fruits and vegetables.

Key words: *Fruits and Vegetable Consumption, Elasticity, Price, Expenditure, Households.*

INTRODUCTION

India's diverse agro-climatic conditions and varying topography ensure availability of all varieties of fresh fruits as well as vegetables. India is the second largest producer of fruits and vegetables after China. The ongoing economic reforms in India are likely to result in structural changes in agriculture particularly in favour of fruit and vegetable crops, which has great potential to increase farm income as well as nutritional status of the citizens of the nation[9]. Over the last decade, area under horticulture grew by about 2.7 per cent per annum and annual production increased by 7 per cent. Production of horticultural crops like fruits and vegetables has increased by 0.6 per cent in 2015-16.

Tamil Nadu is the second largest economy in India with a current Gross State Domestic Product of Rs. 13.39 lakh core rupees (US$210 billion).

Cite this article: Revathy, A. and Paramasivam, P., Study on Consumption Pattern of Different Fruits and Vegetable in Tamil Nadu, *Int. J. Pure App. Biosci.* **6(1):** 258-264 (2018). doi: http://dx.doi.org/10.18782/2320-7051.5889

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Per capita GDP of Tamil Nadu was Rs. 143,547 in 2015–16, the third highest in India. Agriculture remains the main source of livelihood for majority of population in the state. Tamil Nadu is divided into seven agro-climatic zones and has wide diversity in agricultural production. Covering 14.49 lakh hectares horticulture crops in Tamil Nadu account for nearly 19 per cent of the total cropped area in 2015-16.

More specifically, the economy has also witnessed shifting of consumption pattern from traditional cereals to a more holistic and nutritious diet of fruit and vegetables, milk, fish, meat and poultry products, and it is due to rapid growth of the economy. Consumer health awareness continues to grow with the increasing availability of health information going hand in hand with the ageing of populations and increased risk for lifestyle diseases. Over the next three to four decades, global per capita income is projected to rise at a rate of over 2 per cent per annum, with developing countries that are starting from a low base expected to rise at even higher rates[11]. Urbanization in the next few decades will primarily be a problem in developing countries[12]. Therefore, the present study is undertaken to estimate the demand elasticities for different fruits and vegetables in Tamil Nadu, for understanding changing consumption patterns and their implications.

DATA

The present study was carried out based on secondary sources of data. The National Sample Survey (NSS) data were used in the analysis. The NSS data were collected by the National Sample Survey Organization (NSSO) under the Ministry of planning from a large sample of individual's through various annual rounds. This study is based on the 61st (2004-05) and 68th (2011-12) rounds survey data. To analyze the consumption response of fruits and vegetables to price and income changes in Tamil Nadu, we have chosen ten fruits (Banana, Jack Fruit, Watermelon, Pine apple, Guava, Orange, Papaya, Mango, Apple and Grapes) and fifteen vegetables (Potato, Onion, tomato, Brinjal, Radish, Carrot, Leafy vegetable, Chillies, Bhendi, Parwal (kambupudalai), Cauliflower, Cabbage, Pumpkin, Veg_peas and Beans) that are consumed in Tamil Nadu. Price response of demand is obtained on the basis of unit values. The unit price for a given food item is derived by dividing the value of food item by the total quantity consumed in a region. As for food items not consumed by a household, average price observed for the corresponding region was used. The use of the unit value as a price of food item has been thoroughly examined by Deaton[6] and more recently in, Umanath *et.al*.[13].

ANALYTICAL METHODOLOGY

In this analysis, Quadratic Almost Ideal Demand System (QUAIDS) model was used to estimate the elasticities of demand for various fruits and vegetables. Recently, the application of QUAIDS could be observed in large body of literatures[2,3,4,5,10] because it takes care of the non-linearity in the equations by introducing the squared term of income variables.

The form of the function used in the present study is given by Equation (1):

$$\ln x_h = \theta_0 + \sum_j \theta_{ij} \ln p_j + \theta_1 HHS_h + \theta_2 S_h + \theta_3 MPE_h + \mu_i \cdots (1)$$

The variables HHS, S and MPE represent household size, gender of household-head and monthly per capita expenditure, respectively and μ_i is the standard normal error term. The first step involved, estimating a probit regression function to estimate the probability of consumption of a particular food commodity and the function is expressed by Equation (2):

$$d_{ih} = \theta_0 + \sum_j \theta_{ij} \ln p_j + \theta_x \ln x_h + \theta_1 HHS_h + \theta_2 S_h + \theta_3 MPE_h + \mu_i \cdots (2)$$

where, d_{ih} = 1 if the h^{th} household consumes i^{th} food commodity and 0 if the household does not. $\ln p_j$ are the prices of fruits and vegetables, and x_h is the total household consumption expenditure on food commodities. The second step involved in estimation of the QUAIDS was in the form of Equation (3):

$$w_{ih} = \Phi(\hat{z_{ih}}\hat{\theta_i})\left\{\alpha_i + \sum_{j=1}^{n}\gamma_{ij}\ln p_j + \beta_i \ln\left[\frac{x_h}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{\ln\left[\frac{x_h}{a(p)}\right]\right\}^2 + \tau_i \hat{e_h}\right\} + \delta_i \phi(z'_{ih}\hat{\theta_i}) + \xi_{ih} \quad (3)$$

where, $w_{ih} = \frac{p_{in}q_{in}}{x}$ the i^{th} fruits and vegetables, expenditure share for consumer h; p_i = the price of fruits and vegetables i; q_i =quantity of fruits

and vegetables i; x= total fruits and vegetables expenditure; $e^{\wedge}_h$ is the residual of the total food expenditure regression; ε_{ih} is the compensated price elasticity and Φ ($z^{\wedge}_{ih}$ $\theta^{\wedge}_i$) and $\delta i\varphi$ (z'_{ih} $\theta^{\wedge}_i$) were obtained from the first stage probit regression. The parameters of the QUAIDS model were estimated using Poi's Stata routine[7,8] . Adjustments were made in the original routine to include additional control variables in order to capture endogeneity and selectivity problems as appropriate. The following restrictions (adding-up homogenous and symmetry) are econometrically imposed on the parameters of the QUAIDS equation system (3):

$$\sum_{i=1}^{n}\alpha_i = 1;\ \sum_{i=1,j=1}^{n}\gamma_{ij} = 0;\ \sum_{i=1}^{n}\beta_j = 0;\ \sum_{i}\lambda_i = 0 \quad \text{..... (4)}$$

$$\sum_{j}\gamma_{ij} = 0 \quad \text{..... (5)}$$

$$\gamma_{ij} = \gamma_{ji} \quad \text{..... (6)}$$

Estimation of Elasticities

Using the method adopted by Green and Alston and Hayes the expenditure elasticity was estimated as per Equation (7):

$$\varepsilon_{i,x} = \frac{x}{q_i}\frac{\partial q_i}{\partial x} = \frac{1}{w_i}\left\{\beta_i + \frac{2\lambda_i}{b(p)}\ln x - lxa(p)\right\} + 1 \quad \text{.. (7)}$$

The uncompensated own price and the cross price elasticities were estimated using Equations (8) and (9), respectively:

$$\varepsilon_{i,p} = \frac{1}{w_i}\left\{\gamma_{ii} - \left\langle\left(\alpha_i + \sum_{k=1}^{n}\gamma_{kj}\ln p_k\right)\left[\beta_i + \frac{2\lambda_i}{b(p)}(\ln x - \ln a(p))\right] + \frac{\beta_i}{b(p)}\lambda_i\left[\ln x - \ln a(p)\right]^2\right\rangle\right\} - 1$$

…. (8)

$$\varepsilon_{i,p_j} = \frac{1}{w_i}\frac{p_i}{p_j}\left\{\gamma_{ii} - \left\langle\left(\alpha_i + \sum_{k=1}^{n}\gamma_{kj}\ln p_k\right)\left[\beta_i + \frac{2\lambda_i}{b(p)}(\ln x - \ln a(p))\right] + \frac{\beta_i}{b(p)}\lambda_i\left[\ln x - \ln a(p)\right]^2\right\rangle\right\}$$

… (9)

The QUAIDS model analyses were accomplished using the statistical software, Stata 13.1 version. The explanatory variable used in the QUAIDS model were price variable (p_j) price of fruits and vegetables in terms of Rs./kg, expenditure variables- total expenditure (X_h) Rs./month and square of total expenditure and House hold character variable household size (HHS) in numbers, Sex (S) 1 for female headed households; 0 for male headed households.

RESULT AND DISCUSSION

Expenditure Elasticities

Expenditure elasticity of demand reflects the relationship between percentage change in income and the percentage change in the demand for the good. The estimated expenditure and own price elasticities of fruits and vegetables based on QUAIDS model have been presented in Table 1.

From table 1**,** it could be observed that the expenditure elasticity of all the fruits were positive suggesting that these are normal goods, expenditure elasticity is less than unity for banana and watermelon but, more than zero and worked out to 0.80 per cent and 0.51 per cent, respectively indicating that with income growth, the expenditures decrease. Expenditure elasticities are greater than unity for apple (3.51 per cent), orange (2.67 per cent), jackfruit (2.55 per cent), and grapes (2.29 per cent). The large expenditure elasticity suggests that the quantity demanded for those fruits will increase more than proportionately to the increase in total expenditures.

All expenditure elasticities are positive, besides for parwal (kambupudalai). Positive elasticities suggest that all vegetables are normal goods. Negative expenditure elasticity for parwal implies that with income growth the expenditure for parwal will decrease, that is it's an inferior good. Expenditure elasticities are greater than unity for peas (7.24 per cent), cauliflower (3.26 per cent), beans (2.81 per cent), brinjal (2.61 per cent), pumpkin (2.27 per cent), carrot (1.90 per cent), chillies (1.55 per cent), cabbage (1.41 per cent) and less than unity for potato (0.95 per cent), bhendi (0.93 per cent), radish (0.72 per cent), tomato (0.37 per cent), onion (0.34 per cent) and leafy vegetable (0.56 per cent) in absolute values. The results suggest that with income growth, the expenditures for analyzed vegetables are going to increase, primarily increasing in all vegetables where as it decrease for parwal. The large expenditure elasticity for peas, cauliflower, beans, brinjal and pumpkin suggest that the quantity demanded for these vegetables will increase more than proportionately to the increase in total expenditures.

Table 1: Expenditure and price elasticities of fruits and Vegetables based on QUAIDS model, Tamil Nadu

FRUITS			VEGETABLES		
	EXPENDITURE ELASTICITY	OWN PRICE ELASTICITY		EXPENDITURE ELASTICITY	OWN PRICE ELASTICITY
Banana	0.80	-0.84	Potato	0.95	-0.16
Jackfruit	2.55	-4.39	Onion	0.34	-0.45
Watermelon	0.51	-12.06	Tomato	0.37	-0.48
Pineapple	1.65	-6.01	Brinjal	2.61	-1.12
Guava	1.2	-3.88	Radish	0.72	0.60
Orange	2.67	-3.32	Carrot	1.90	-0.48
Papaya	1.50	-3.39	Leafy_veg	0.56	-0.89
Mango	1.74	0.71	Chillies	1.55	-0.68
Apple	3.51	-3.36	Bhendi	0.93	-0.65
Grapes	2.29	-1.39	Parwal	-14.45	-5.42
			Cauliflower	3.26	-0.44
			Cabbage	1.41	-0.18
			Pumpkin	2.27	-1.19
			Veg_peas	7.24	-2.84
			Beans	2.81	-1.20

Own price elasticity

Own price elasticity refers to percentage changes in the quantity consumed in response to a given percentage change in the own price of the commodity specified. As expected, own-price elasticity of demand (Marshallian elasticity) for all fruits and vegetables was negative and consistent. The own price elasticity of demand for banana is less than unity ($\varepsilon_{UPE}< 1$), with the values of 0.84 per cent representing the inelastic demand for the changes in own price. But the percentage change in quantity demanded for percentage change in own price was elastic in the case of watermelon, pineapple, jackfruit, guava, papaya, apple, orange and grapes where the own price elasticity accounted for was more than unity ($\varepsilon_{UPE}>1$) with the values of 12.06 per cent, 6.01 per cent, 4.39 per cent, 3.88 percent, 3.39 per cent, 3.36 per cent, 3.32 per cent and 1.39 per cent respectively.

The own price elasticities for all the vegetables have been found negative across commodities. All own-price elasticities are negative, besides radish. All of the own-price elasticities are less than unity in absolute values. The elasticities for potato (0.16 per cent), cabbage (0.18 per cent), cauliflower (0.44 per cent), onion (0.45 per cent), tomato (0.48 per cent), carrot (0.48 per cent), bhendi (0.65 per cent), chillies (0.68 per cent) and leafy vegetables (0.89 per cent) indicate that the demand is inelastic. The absolute values of the elasticities more than unity are parwal (5.42 per cent), peas (2.84 per cent), beans (1.20 per cent), pumpkin (1.19 per cent) and brinjal (1.12 per cent) indicate that the percentage change in quantity demanded for percentage change in own price was elastic.

The own-price elasticity for vegetables such as potato, cabbage, cauliflower, carrot, bhendi, chillies, brinjal, parwal, pumpkin, peas and beans were much lower than their respective income elasticity, were as in case of fruits grapes, mango and apple was showing lower own price elasticity, implying that responsiveness of demand to own price changes of these vegetables was much lower than the responsiveness to changes in income. The largest absolute value of own-price elasticity was observed in fruits for watermelon with 12.06 per cent, followed by pine apple (6.01 per cent), jack fruit (4.39 per cent), guava (3.88 per cent), papaya (3.39 per cent), orange (3.32 per cent) and in case of vegetables leafy vegetable (0.89 per cent). The own price elasticity was found be the lowest in potato with 0.16 percent, followed by cabbage (0.18 per cent), cauliflower (0.44 per cent) and

carrot (0.48 per cent), the demand for these vegetables reacts least to the changes in own their price that is highly inelastic.

Cross price elasticity

Cross price elasticity of demand for a commodity measures the percentage changes in the quantity of its consumption with respect to given percentage changes in the price of the other commodities. Estimates of cross price elasticity facilitate determination of the nature of relationship among the food commodities, i.e., whether the commodities are substitutes or complements or independent of each other. According to results of the cross-price elasticities for fruits and vegetables are a combination of gross complements and substitutes are given in table 2 and 3. However, it is interesting to note that mango is gross complements for orange whereas orange is gross substitute for mango. In fact, banana and mango is gross complement for apple but for apple, banana and mango are the substitutes. Similarly, Jack fruit and mango are complements for grapes whereas grapes are substitute for jack fruit and mango. Mango, guava and watermelon acts as a substitute for many fruits except banana and jack fruit, grapes and mango, papaya and orange respectively. However, strong substitutability is observed between jack fruit and watermelon, watermelon and guava, papaya with guava and orange.

In most cases of vegetables cross price effects were small. Parwal was an important exception. It could be observed that with the rise in the price of tomato, the quantity demanded of potato, brinjal, radish, carrot, leafy vegetable, bhendi, parwal, cauliflower, cabbage, pumpkin, peas and beans (substitutes) got increased, while the quantity demanded of onion and chilies (complements) got decreased. When there was a rise in the price of carrot, the demand for beans and leafy vegetables (substitute) increased. It could also be observed that with the rise in the price of chilles, the quantity demanded of potato, radish, carrot, brinjal, tomato, cauliflower cabbage, pumpkin, bhendi and peas (complements) got decreased. Apart, the commodity pairs such as carrot and onion were observed as substitute for parwal and the pairs was found to be complement for parwal. Potato is a substitute for onion, tomato and cabbage whereas these vegetables were complementary for potato. Carrot is a substitute for potato but potato was a complementary for carrot. Brinjal is a substitute for pumpkin but it was a complement for brinjal. The substitutability was strong in case of parwal with bhendi, carrot, pumpkin, potato, beans, onion and cabbage.

Table 2: Cross price elasticities of fruits based on QUAIDS model, Tamil Nadu

	Banana	Jackfruit	Watermelon	Pineapple	Guava	Orange	Papaya	Mango	Apple	Grapes
Banana	-0.84	0.007	0.003	0.003	0.03	0.03	-0.003	-0.075	0.037	-0.27
Jackfruit	1.87	-4.39	5.76	1.59	2.87	-1.75	1.67	-7.72	-0.066	2.08
Watermelon	0.105	1.61	-12.06	0.16	4.49	-0.16	-1.47	1.3	1.9	2.28
Pineapple	0.157	0.64	2.26	-0.601	2.64	-0.199	-0.008	0.23	0.435	-0.06
Guava	0.594	0.16	0.89	0.364	-3.88	0.17	0.29	-0.22	1.22	-0.92
Orange	-0.2	-0.094	-0.07	-0.303	0.22	-3.32	0.296	-0.191	0.44	0.212
Papaya	-0.907	1.26	-0.388	-0.145	3.94	3.84	-3.39	0.701	-1.12	-1.85
Mango	-0.0495	-0.141	0.13	0.057	-0.05	0.46	0.04	0.715	1.24	0.44
Apple	-0.368	-0.005	0.08	0.006	0.501	0.08	-0.043	-0.652	-3.61	0.21
Grapes	-0.641	-0.053	0.203	-0.011	-0.443	0.11	-0.075	-0.594	0.48	-1.396

Table 3: Cross price elasticities of Vegetables based on QUAIDS model, Tamil Nadu

	Potato	Onion	Tomato	Brinjal	Radish	Carrot	Leafy _veg	Chillies	Bhendi	Parwal	Cauliflower	Cabbage	Pumpkin	Veg_ peas	Beans
Potato	-0.16	-0.14	-0.065	-0.22	0.008	0.064	-0.39	-0.024	-0.02	0.002	-0.156	-0.145	0.046	-0.03	-0.06
Onion	0.007	-0.45	-0.15	0.163	-0.03	-0.016	-0.06	0.09	0.08	0.0004	0.118	-0.034	0.03	0.02	-0.11
Tomato	0.143	-0.08	-0.48	0.111	0.07	0.13	0.9	-0.03	0.21	0.00006	0.038	0.07	0.036	0.036	0.04
Brinjal	-0.413	0.008	-0.17	-1.12	-0.03	-0.2	-0.18	-0.02	-0.37	-0.00006	0.033	-0.095	-0.05	-0.07	0.07
Radish	0.061	-0.47	0.02	0.3	0.6	-0.05	-0.27	-0.09	-0.144	-0.009	0.162	-0.59	0.22	0.28	0.48
Carrot	-0.02	-0.36	-0.16	-0.122	-0.08	-0.48	0.27	-0.13	-0.33	-0.01	-0.163	-0.118	-0.12	-0.08	0.011
Leafy_veg	0.008	-0.18	0.068	-0.09	-0.05	0.27	-0.89	0.01	0.12	-0.002	-0.002	0.009	0.069	0.038	0.059
Chillies	-0.15	0.52	-0.1	-0.2	-0.88	-0.33	0.01	-0.68	-0.06	0.003	-0.26	-0.17	-0.29	-0.1	0.33
Bhendi	-0.027	-0.38	0.03	-0.2	-0.05	-0.15	0.07	0.008	-0.65	0.007	0.124	-0.103	0.023	0.067	-0.02
Parwal	6.03	2.98	2.05	-0.1	-2.22	7.98	-1.86	1.47	10.87	-5.47	-2.78	2.68	6.91	-3.34	5.22
Cauliflower	-1.096	0.39	-0.83	0.71	0.04	-0.53	-0.27	-0.33	0.11	-0.01	0.044	0.11	-0.42	-0.18	-0.51
Cabbage	0.27	-0.217	-0.36	-0.06	-0.22	-0.11	-0.04	-0.06	-0.18	0.002	0.03	-0.182	-0.0123	-0.01	-0.51
Pumpkin	0.33	0.309	0.39	0.63	0.46	-0.87	0.54	-1	-0.002	0.05	-1.01	-0.134	-1.19	0.15	0.34
Veg_peas	-2.21	0.3	0.17	-2.31	1.98	-2.14	0.59	-1.05	0.95	-0.088	-1.56	-0.391	0.54	2.84	0.81
Beans	-0.43	-1.04	-0.58	0.55	0.2	-0.51	-0.05	0.38	-0.33	0.007	-0.32	-0.125	0.104	0.07	-1.2

CONCLUSION

The results based on expenditure elasticity derived for fruits and vegetables revealed that all the fruits and vegetables were normal goods, whereas parwal alone appeared to be an inferior good. The large expenditure elasticity for apple, orange, jack fruit and grapes suggests that households in Tamil Nadu with greater purchasing power would increase their demand for those goods significantly. Positive changes in income would cause increase in expenditure shares for all the vegetables, but not parwal. Often due to high cost of fruits and vegetables relative to the other foods and limited access as well as wide availability of unhealthy food option should be replaced by encouraging fruits and vegetable consumption. The own-price elasticity derived in the study indicates that fruits such as watermelon, pineapple, jackfruit, guava, papaya, apple, orange, grapes and in case of vegetables parwal, peas, beans, pumpkin and brinjal were exhibiting a highly elastic price demand and the degree of responsiveness in the demand of these commodities to the price changes was very high. The analysis of the own-price elasticity and expenditure elasticity for fruits and vegetables such as grapes, mango, apple and in case of vegetables such as potato, cabbage, cauliflower, carrot, bhendi, chillies, brinjal, parwal, pumpkin, peas and beans were much lower than their respective expenditure elasticity. The analysis of cross-price elasticity derived revealed that fruits such as jack fruit and watermelon, watermelon and guava, papaya with guava and orange were found to act as strong substitutes while vegetable parwal was having strong substitutability with bhendi, carrot, pumpkin, potato, beans, onion and cabbage. Large scale policies and programs that influence the price and availability of fruits and vegetables should be considered.

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