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Household demand analysis for major fruits in Guntur District of Andhra Pradesh, India

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Abstract
To estimate the demand for main fruits in the Guntur district of Andhra Pradesh, household-level primary data were fitted to the Working-Leser and Linearized Almost Ideal Demand System (LA/AIDS) model. For the purpose of collecting data, 300 families were chosen following convenience sampling technique. The findings of the Working-Lesser model and LA/AIDS model showed that all fruits' expenditure elasticities had positive signs, suggesting that there exists direct relationship between income and demand. Further expenditure elasticity for apple, orange, pomegranate, muskmelon and pineapple were greater than one showing that these fruits are regarded as luxury goods in the research area. The relative low expenditure elasticity for banana, guava, papaya and sapota indicates that they were considered as necessity goods in the study area. The calculated own price elasticity coefficients were negative, which means that as the price of fruits rises, the relative share of household expenditures declines in tandem and that they were hence regarded as normal goods. Furthermore, the cross-price elasticity estimates showed that the chosen fruits had both positive and negative signs, suggesting that certain fruits were substitutes and others were complimentary. On the basis of the study's findings, suggestions to increase demand for these fruits were formulated.

Keywords: demand analysis, fruits, la/aids and working-leser model

1. Introduction
Agriculture is the backbone of the Indian economy involving around three fourth (58%) of the total country's population. India's share in the world production of fruits and vegetables stands at 11.38% and 11.78% respectively. Further, the production in the horticulture sector gained a steep rise during the year 2020-21 with an average of 331.05 million tonnes which are 10.5 million tonnes higher than the last year. During 2020-21, India exported fruits and vegetables worth Rs. 9,940.95 crores/1,342.14 USD Millions which comprised of fruits worth Rs. 4,971.22 crores/ 674.53 USD Millions and vegetables worth Rs. 4,969.73 crores/ 667.61 USD Millions.

Andhra Pradesh ranks first among all states in the country in terms of fruit production with total production of 18 million tonnes in the 2021-22 fiscal years. Horticultural crops are farmed on over 1.8 million hectares, with fruit plantations covering about 0.75 million hectares. Over the last few years, there has been a structural shift in the state's cropping patterns. Area under fruit crops in Andhra Pradesh increased from 0.74 million hectares in 2019–20 to 0.75 million hectares in 2021–22 (INDIASTAT), which suggests that there has been an increase in demand for fruits as a result of people's changing eating patterns as they become more health conscious. Also, households are more concerned about nutrition security in order to build immune systems due to the COVID epidemic. Knowledge of household demand for fruits is very important both for the firms and processing firms. It also helps to analyse the fruit consumption pattern in tune with both prices and income of the households. Price and income elasticity estimates for various foods can help to design subsidies and tax policies, and measuring the impact of these policies on poverty.

The lack of economic studies on the estimation of fruit demand in the Guntur district of Andhra Pradesh is the basis for this study. As a result, it can be claimed that estimates for the fruit demand elasticities required for fruit demand projections do not exist. Consequently, the main objective of this study is to estimate the parameters of fruit demand in the Guntur district of Andhra Pradesh. In the context of food security, the predicted elasticities can be used to forecast future consumption in terms of fruit quality, access, availability, and stability.

2. Materials and Methods

In the present study, Guntur district was purposively selected for the study because no previous studies on local fruit consumption patterns have been carried out. In Guntur district, Chirala and Bapatla mandals were selected purposively. Convenience Sampling technique was used to collect data from a sample of 300 households. Primary data was collected to fulfill the formulated objectives during 2020-21. Fruits selected for the study are apple, banana, orange, pomegranate, grapes, guava, muskmelon, papaya, sapota and pineapple.

2.1 Working-Leser model

Demand function can be expressed as:

$$w_i = \alpha_o + \alpha_i \log x + \Sigma_j \beta_{ij} \log P_j + \varepsilon_i$$

Where,

i, j represents selected fruit types; w_i is the budget share of selected fruit; P_j is the price of the fruit j; X is the total expenditure on fruits

Expenditure elasticity $e_i = 1 + \left[\frac{\alpha_i}{w_i}\right]$

Own and Cross price elasticities $e_{ij} = -\delta_{ij} + \left[\frac{\beta_{ij}}{w_i}\right]$

Where,

w_i is the mean share of each fruit type; α_i is the log of total expenditure of each fruit type; β_{ij} is the log of prices; δ_{ij} is the Kronecker delta, in own price elasticity it is equal to one, in cross price elasticity it is equal to zero.

2.2 Linear Approximated Almost Ideal Demand System (LA/AIDS) model:

LA/AIDS model is specified as

$$w_i = \alpha_i + \Sigma_j \gamma_{ij} \log P_j + \beta_i \log \left[\frac{x}{P}\right]$$

Where,

w_i is the budget share of fruit i; P_j is the price of the fruit j; x is the total expenditure on selected fruits and P is price index

The Expenditure elasticity is given by

$$E_i = 1 + \left[\frac{\beta_i}{w_i}\right]$$

The Marshallian (or uncompensated) elasticity of fruit i with respect to the price of fruit j was given by

$$e_{ij} = \left[\frac{\gamma ij - \beta i \gamma_j}{w_i}\right] - \delta_{ij}$$

The Hicksian (or compensated) elasticity of fruit i with respect to the price of fruit j was given by

$$e_{ij} = \frac{\gamma_{ij}}{w_i} + w_j - \delta_{ij}$$

Where, δ_{ij} is the Kronecker delta, in own price elasticity it is equal to one, in cross price elasticity it is equal to zero.

3. Results and Discussion

3.1 Monthly expenditures of households on fruits

Table 1 showed that in the study area average monthly expenditure of households on fruits was Rs. 1600 with maximum and minimum expenditures of Rs. 600 and Rs. 5,700 respectively. Household's average expenditure share on fruits was highest in case of apples followed by grapes, oranges and pomegranate which was 0.18, 0.13, 0.12 and 0.11 respectively.

From the table we can also see that, among the selected fruits, price was highest in case of apples which was Rs. 150 per kg followed by pomegranate, oranges and grapes which was 115 and 100 respectively. While price of all other selected fruits i.e., banana, muskmelon, papaya, guava, sapota and pineapple were below Rs.100.

3.2 Estimated results of Working-Leser model

Working-Leser model was used to estimate own price, cross-price and expenditure elasticities. The results infered that expenditure elasticities are positive which indicates that all are normal goods, and the expenditure elasticities of the selected fruits range between 1.27 (apple) to 0.59 (sapota). Own price elasticities of all fruits were negative which showed the inverse relationship of price and quantity demanded. The estimated own-price elasticities range between -1.50 (apple) to -0.44 (sapota).

All cross-price elasticities with positive signs were considered as substitutes (price of one fruit and quantity demanded of the other fruit move in the same direction), those with negative sign were complements (price of one fruit and quantity demanded of the other fruit move in the opposite direction). Cross-price elasticities indicated that most of the fruits were complements to each other, but a few have shown substitution (weak) like Banana with prices of Guava, Grapes with prices of Sapota, Sapota with prices of Banana.

With this model, compensated price elasticities i.e., after removing the income effect of price change cannot be estimated. So, Linear Approximated Almost Ideal Demand System (LA/AIDS) model was used to estimate both compensated and uncompensated elasticities of demand.

3.3 Estimation of elasticities of demand for fruits using LA/AIDS model: Tables 2 showed the Marshallian (uncompensated) and Hicksian (compensated) price elasticities of demand.

3.3.1 Expenditure elasticity: Percentage change in the quantity demanded of a group of fruits when income changes by one percent holding every other variable constant is defined as expenditure elasticity. Fruits can be categorized into luxuries and necessities based on expenditure elasticity. Fruits are considered as luxuries if the expenditure elasticity is greater than one, and necessity if unity or less than unity.

From table 2, we can see that expenditure elasticity of all the fruits was positive, which indicated that all the fruits are normal goods. Further expenditure elasticity for apple, orange, pomegranate, muskmelon and pineapple were greater than one indicating that they are considered as luxury goods in the study area. The relative low expenditure elasticity for banana, guava, papaya and sapota indicates that they were considered as necessity goods in the study area.

The results also revealed that 1 percent increase in the household's income would lead to 1.2, 1.9, 1.09, 1.04 and 1.03 percent increase in demand of apple, orange, pomegranate, pineapple and muskmelon respectively. Further, with 1 percent increase in the household income, the demand

for banana, guava, papaya and sapota will increase by 0.77, 0.67, 0.84 and 0.48 percent respectively.

Table 1: Monthly expenditures of households on fruits

Variables & Units	n	Mean	SD	Min	Max
Apple price (Rs/kg)	300	134.65	8.97	120	150
Banana price (Rs/kg)	300	31.93	7.43	20	45
Orange price (Rs/kg)	300	89.82	6.17	80	100
Pomegranate price (Rs/kg)	300	100.06	8.71	85	115
Grape price (Rs/kg)	300	89.75	5.78	80	100
Guava price (Rs/kg)	300	42.59	4.69	35	50
Muskmelon price (Rs/kg)	300	52.64	4.51	45	60
Papaya price (Rs/kg)	300	44.75	6.14	35	55
Sapota price (Rs/kg)	300	40.06	3.14	35	45
Pineapple price (Rs/kg)	300	76.90	7.38	65	90
w1 (%) - Apple	300	0.18	0.09	0.02	0.66
w2 (%) - Banana	300	0.11	0.08	0.008	0.57
w3 (%) – Orange	300	0.12	0.08	0.02	0.45
w4 (%) – Pomegranate	300	0.11	0.06	0.03	0.40
w5 (%) – Grapes	300	0.13	0.07	0.02	0.45
w6 (%) – Guava	300	0.07	0.05	0.008	0.42
w7 (%) - Muskmelon	300	0.06	0.04	0.011	0.32
w8 (%) - Papaya	300	0.06	0.05	0.008	0.36
w9 (%) – Sapota	300	0.04	0.035	0.007	0.32
w10 (%) - Pineapple	300	0.06	0.03	0.01	0.28
Monthly expenditure on fruits (EXP) (Rs)	300	1613.08	806.20	684	5750

3.3.2 Own-price elasticity of demand: The degree of responsiveness of the budget share allocated to different fruits to changes in their own prices is measured by own price elasticity.

From the table 2 we can see that, own-price elasticities are negative indicating that there exists inverse relationship between price and quantity demanded of all fruits. This result was in accordance with that of Huq and Arshad 2010, and Mustafa *et al.* 2022. Marshallian (uncompensated) price elasticity describes the percentage change in the quality demanded of fruits as a result of its price change and it is greater than the Hicksian compensated price elasticity because Marshallian elasticity contains both income and substitution effects whereas Hicksian price elasticity contains only substitution effect.

Own-price elasticities for apple, pomegranate, orange and guava are greater than one implying that their prices have elastic relationship with their quantities demanded. On the other hand, own-price elasticity of banana, grapes, muskmelon, papaya, sapota pineapple was less than unity indicating inelastic relationship. 1 percent increase in prices of apple, pomegranate, orange and guava would lead to 1.5, 1.3 and 1.09 percentage reduction in demand of the respective fruits. Hence, the results satisfy, a priori theoretical expectation. Similarly with 1 percent increase in prices of banana, muskmelon, papaya, grapes, sapota and pineapple would lead to 0.45, 0.48, 0.45, 0.43, 0.33 and 0.30 percent reduction in demand of the respective fruits.

3.3.3 Cross-price elasticity of demand: The degree of responsiveness of the budget share allocated to different fruits to changes in the prices of other fruits is measured by cross price elasticity. Regarding cross-price elasticities of the compensated demand system, the results revealed that there exists both complementarity and substitution among fruits. The values other than diagonal of the matrix indicates cross-price elasticities measuring the change in demand of a selected fruit due to one percent change in the price of other fruit. All cross-price elasticities with positive signs are considered as substitutes (price of one fruit and quantity demanded of the other fruit move in the same direction), those with negative sign are complements (price of one fruit and quantity demanded of the other fruit move in the opposite direction).

From table 3, we can see that cross-price elasticities indicate that most of the fruits are substitutes to each other, but a few have shown complementarity like, apple have complementary relationship with banana and papaya as they are used combinedly in salads by the households in the study area. With 1 percent increase in the prices of banana and papaya, the demand for apple will decrease by 0.40 and 0.50 percent respectively. Apple showed strong substitution relationship with the price of pomegranate which indicates that with 1 percent decrease in the price of pomegranate, the demand for apple will decrease by 0.8 pe rcent. Banana showed complementary relationship with prices of papaya which indicates that 1 percent increase in prices of papaya would lead to 0.02 percent decrease in the quantity demanded of banana. The complementarity holds good in case of reverse direction also. With 1 percent increase in prices of banana would lead to 0.0019 percent decrease in quantity demanded of papaya (weak complementarity).

Pomegranate showed complementarity with the prices of grapes and grapes also showed complementarity with the prices of pomegranate. 1 percent increase in prices of pomegranate would lead to 0.71 percent decrease in demand for grapes and with 1 percent increase in prices of grapes the demand for pomegranate would reduce by 0.8 percent. Papaya and pineapple also showed complementarity relationship i.e., with 1 percent increase in prices of pineapple would lead to 0.10 percent decrease in quantity demanded of papaya and with 1 percent increase in price of papaya, the demand for pineapple would reduce by 0.02 percent. The results further revealed that sapota and muskmelon, sapota and orange are considered as independent goods as the changes in the prices of them had nearly zero cross-price elasticity with respect to quantity demanded of other fruit.

4. Summary and Conclusion

The results revealed that the expenditure elasticities of all fruits have positive signs, implying that as income increased demand also increased. Further expenditure elasticity for apple, orange, pomegranate, muskmelon and pineapple were greater than one indicating that they are considered as luxury goods in the study area. The relative low expenditure elasticity for banana, guava, papaya and sapota indicates that they were considered as necessity goods in the study area. Also the estimated own price elasticity coefficients were negative indicating that as the prices of fruits increases, the relative share of household expenditure decreases accordingly, which implying that they satisfy a priori demand theory and are thus normal goods. Own-price elasticities for apple, pomegranate, orange and guava are greater than one implying that their prices have elastic relationship with their quantities demanded. On the other hand, own-price elasticity of banana, grapes, muskmelon, papaya, sapota and pineapple is less than unity indicating inelastic relationship.

Furthermore, the estimates of the cross-price elasticity revealed that the selected fruits had both positive and negative

signs implying that some fruits were complementary while others were substitutes. The results revealed that apple have complementary relationship with banana and papaya as they are used combinedly in salads by the households in the study area. Banana showed complementary relationship with prices of papaya and the complementarity holds good in reverse direction also. Pomegranate showed complementarity with the prices of grapes and grapes also showed complementarity with the prices of pomegranate. Papaya and pineapple also showed complementarity relationship. The results further revealed that sapota and muskmelon, sapota and orange are considered as independent goods as the changes in the prices of them had nearly zero cross-price elasticity with respect to quantity demanded of other fruits.

It is interesting that the estimates of total expenditure and price elasticities in this study appear to be consistent with expectations and with those in previous studies reviewed earlier. As majority of the fruits enjoy more expenditure elastic demand, the Department of Horticulture should encourage the farmers to go for their cultivation so that the consumers can purchase them at affordable prices. In fact, during post-COVID regime the twin problems *viz*., higher prices of fruits from the supply side and fluctuating income levels of the consumers on the demand side can be effectively checked through increasing area under cultivation of those fruits that enjoy higher expenditure elasticities. To achieve this, efforts should be geared at increasing capital investments in the fruits sector, loans and subsidies should be provided to encourage fruits cultivation and strengthening of e-market outlets should deserve special attention. Farmers should also be encouraged to take membership in Farmer Producer Organization (FPO) to produce and transact large-scale output through enjoying the benefits of economies of scale. Even the FPOS should be motivated to start small scale fruit processing units through availing financial assistance under Small Farmers' Agriculture-Business Consortium–Agriculture-Business Development scheme of Government of India.

Table 2: Expenditure and Own-price elasticities of selected fruits under Working-Leser and LA/AIDS models

Fruits	Expenditure Elasticities		Own Price elasticities		
	W-L Model	LA/AIDS Model	W-L Model	LA/AIDS Model	
				Uncompensated	Compensated
Apple	1.2746	1.2903	-1.5039	-1.5178	-1.2449
Banana	0.7309	0.7720	-0.5200	-0.5801	-0.4550
Orange	1.1491	1.1923	-1.2421	-1.3656	-1.0998
Pomegranate	1.1151	1.0924	-1.5159	-1.5177	-1.4176
Grapes	0.8373	0.7923	-0.5433	-0.5833	-0.4393
Guava	0.7200	0.6736	-0.0601	-1.0978	-1.0469
Muskmelon	1.0513	1.0303	-0.5405	-0.5515	-0.4865
Papaya	0.8659	0.8411	-0.5581	-0.5311	-0.4536
Sapota	0.5972	0.4869	-0.4481	-0.3238	-0.3059
Pineapple	1.0048	1.0450	-0.4750	-0.3656	-0.3355

Table 3: Hicksian Compensated price elasticities

		Apple	Banana	Orange	Pomegranate	Grapes	Guava	Muskmelon	Papaya	Sapota	Pineapple
		pFood1	pFood2	pFood3	pFood4	pFood5	pFood6	pFood7	pFood8	pFood9	pFood10
Apple	q-wFood1	-1.2449	-0.4029	0.0960	0.3069	0.0676	0.0366	0.0229	-0.5010	0.0113	0.0394
Banana	q-wFood2	0.1344	-0.4550	0.0495	0.0481	0.0161	0.0946	0.0173	-0.0245	0.0364	0.0596
Orange	q-wFood3	0.1264	0.0402	-1.0998	0.050	0.0731	0.0435	0.0379	0.0139	0.0010	0.0129
Pomegranate	q-wFood4	0.6020	-0.4083	0.0624	-1.4176	-0.8046	0.0364	0.0503	0.0370	0.0151	0.0229
Grapes	q-wFood5	0.0924	0.0136	0.0759	-0.7109	-0.4393	0.0705	0.0570	0.0336	0.0116	0.0368
Guava	q-wFood6	0.0686	0.1093	0.0619	0.0419	0.0967	-1.0496	0.0108	0.0651	0.0370	0.0269
Muskmelon	q-wFood7	0.0626	0.0292	0.0788	0.0843	0.1141	0.0158	-0.4865	0.0804	0.0038	0.0489
Papaya	q-wFood8	0.1276	-0.0019	0.0265	0.0568	0.0614	0.0868	0.0735	-0.4536	0.0489	-0.0263
Sapota	q-wFood9	0.0512	0.1015	0.0041	0.0419	0.0384	0.0894	0.0062	0.0885	-0.3059	0.0387
Pineapple	q-wFood10	0.0949	0.0879	0.0236	0.0337	0.0644	0.0343	0.0428	-0.0252	0.0205	-0.3355

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