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DEMAND ELASTICITIES OF FRESH FRUITS AMONG URBAN HOUSEHOLDS IN PESHAWAR, PAKISTAN: EVIDENCE FROM A WORKING–LESER DEMAND SYSTEM

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Abstract
This study examined household consumption patterns and demand elasticities for major fresh fruits in Peshawar, Pakistan. Primary data were collected from 120 households residing in the University Campus of Peshawar using a structured questionnaire. Descriptive statistics, multiple regression demand functions, and the Working–Leser demand model were employed to estimate expenditure, own-price, and cross-price elasticities for apple, banana, guava, and orange. Results revealed average monthly household consumption of 5.38 kg of apples, 4.28 dozen bananas, 1.08 kg of guava, and 6.69 dozen oranges. Demand for all fruits was negatively associated with own prices and exhibited statistically significant own-price elasticities ranging from −1.57 to −3.48, indicating elastic demand. Expenditure elasticities ranged from 0.27 to 0.75, suggesting that fruits are normal but necessity goods. Cross-price elasticities revealed both substitution and complementary relationships among fruit categories. The findings imply that price increases may substantially reduce fruit consumption and producer revenues. Policies aimed at reducing production and marketing costs, improving supply chains, and enhancing fruit availability are therefore recommended.

INTRODUCTION

Fresh fruits constitute an important component of a healthy diet because they provide essential vitamins, minerals, dietary fiber, and antioxidants that contribute to disease prevention and overall well-being (Food and Agriculture Organization & World Health Organization, 2019). The World Health Organization recommends a minimum daily intake of 400 g of fruits and vegetables to reduce the risk of cardiovascular diseases, obesity, and micronutrient deficiencies (World Health Organization, 2003). Despite these recommendations, fruit consumption remains below recommended levels in many developing countries due to income constraints, price volatility, and limited market access (Food and Agriculture Organization, 2022; World Health Organization, 2021).

Agriculture remains a vital sector of Pakistan's economy, contributing substantially to employment and rural livelihoods (Pakistan Economic Survey, 2023). Fruit production represents an important subsector, with major fruits including citrus, mango, apple, guava, banana, and pomegranate (Pakistan Bureau of Statistics, 2023). Increasing urbanization, changing dietary preferences, and rising awareness of nutrition have increased the demand for fresh fruits. However, fruit demand is highly sensitive to market prices, household income, demographic characteristics, and consumer preferences (Food and Agriculture Organization, 2022; Organization for Economic Co-operation and Development & Food and Agriculture Organization, 2023).

Economic theory suggests that consumers allocate expenditure among food commodities according to relative prices and income constraints. Consequently, estimating expenditure and price elasticities provides valuable information for producers, marketers, and policymakers regarding consumer responsiveness to market changes (Alyousaf et al., 2026; Lv et al., 2025). Several studies have examined food demand behavior in developing countries and reported that fruit consumption is influenced by income growth, urbanization, and retail market development (Burney & Akmal, 1991; Deaton & Muellbauer, 1980; Durham & Eales, 2006).

Although Pakistan is an important fruit-producing country, empirical evidence regarding household demand elasticities for fresh fruits remains limited, particularly in Khyber Pakhtunkhwa (Pakistan Bureau of Statistics, 2023; Food and Agriculture

Organization, 2023). Understanding consumer responses to price and income changes is essential for designing effective agricultural marketing policies and improving nutritional outcomes (Khattak et al., 2021; Khattak et al., 2016; Angus Deaton & John Muellbauer, 1980; Food and Agriculture Organization, 2022; World Health Organization, 2021).

Therefore, the present study aims to:

1. Analyze household consumption patterns of fresh fruits.
2. Estimate demand functions for major fresh fruits.
3. Determine expenditure, own-price, and cross-price elasticities using the Working–Leser demand model.
4. Derive policy implications for fruit producers and marketers.

Data and Methodology

Study Area

The study was conducted in University Campus, Peshawar, Pakistan. The area comprises residential colonies associated with the University of Peshawar and the University of Agriculture Peshawar. The location was selected because it represents an urban population with diverse socioeconomic characteristics and relatively stable access to food markets.

Research Design

The study adopted a cross-sectional household survey design. Cross-sectional surveys are widely used in food demand studies because they provide detailed information on household consumption behavior, expenditure patterns, and socioeconomic characteristics at a specific point in time (Gujarati & Porter, 2009).

Sampling Procedure

The target population consisted of 706 households residing within the University Campus. A sample of 120 households was selected using proportional allocation sampling. Eighty-three (83) households were selected from the University of Peshawar residential area and thirty-seven (37) households from the University of Agriculture Peshawar.

The sample allocation was determined using:

$$ni = \frac{n}{N} \times Ni$$

where:

- n= required sample size
- N= size of population (Total number of households in the campus)
- Ni= Number of household in the ith campus
- ni= number of households to be taken from the ith campus

Proportionate allocation ensures adequate representation of each subgroup and improves sampling efficiency (Cochran, 1977).

Data Collection

Primary data were collected through face-to-face interviews using a pre-tested structured questionnaire. Information was obtained from female household members because they were primarily responsible for food purchasing and consumption decisions.

Econometric Framework

A number of techniques, from the simple averages to the use of econometric modeling, are applied to analyze the data. More specifically, the following analytical techniques are used.

1. For household size and structure; mean number of children, adults, and aged were estimated along with standard deviation. For income per household and per earner again mean values along with standard deviation and minimum maximum ranges were estimated.
2. For average consumption of fresh fruits, mean values of consumption per month along with related diagnostic statistics including standard deviation, minimum maximum range and coefficient of variation were estimated.
3. For estimation of demand functions of fresh fruits, the following econometric models were specified.

$D_i = f(P_i, P_j, HS, HI, EDU, AGE)$

where: Di = demand for fruit i

Pi = own price

Pj = prices of related fruits

HS = household size

HI = household income

EDU = education of household head

AGE = age of household head

Working–Leser Demand Model

The Working–Leser model is widely used in food demand analysis because of its simplicity and ability to estimate expenditure and price elasticities efficiently (Working, 1943; Leser, 1963).

The model is specified as:

$$w_i = \alpha_o + \alpha_i \log x + \sum_j \beta_{ij} \log P_j + \sum_k \gamma_{ik} H_k + \varepsilon_i$$

Where (i, j) represents fresh fruits;

w_i = expenditure share of i, among fresh fruits,

P_j = price of food j, and

x = total expenditure of all fresh fruits included in the model.

H_k Includes dummy variables where k is__:

AGE = log age of the household head,

SIZE = log of the household size.

εi's are random disturbances assumed with zero mean and constant variance. This model for each fresh fruit can be estimated by the ordinary least squares (OLS).

Demand Elasticity Formulae for Working-Leser Model

It is easy to show the elasticity formulae for the Working-Leser model. The expenditure elasticity (*ei*) can be expressed as:

$$e_i = 1 + [\frac{\alpha_i}{w_i}]$$

Taking a derivative of Equation (3.6.1) with respect to log(pj) yields uncompensated own ($j=i$)

And cross ($j \neq i$) price Elasticities, e_{ij}, are as follows:

$$e_{ij} = -\delta_{ij} + [\frac{\beta_{ij}}{w_i}]$$

$$\forall i, j = 1, \ldots\ldots, n$$

Where δ_{ij} is the Kronecker delta that is unity if $i = j$ and zero otherwise.

In this research, expenditure, own-price, and cross-price Elasticities were evaluated at sample means.

Results and Discussion

Households Characteristics

The average household size was 6.57 persons (see Table-1), reflecting the predominance of extended family structures commonly observed in urban Pakistan. The average monthly household income was Rs. 74,318, indicating a relatively middle-income sample. The low average number of income earners (1.13) suggests substantial dependency within households.

Household size is frequently identified as an important determinant of food demand because larger families generally require greater quantities of food commodities. Similar household sizes have been reported in previous studies on food consumption behavior in Pakistan (Burney & Akmal, 1991; Ali, 1998). The relatively high income level observed in the study area may be attributed to the educational and professional background of university employees residing within the campus.

Fruit Consumption Patterns

The dominance of orange consumption is likely associated with seasonal availability during the survey period (winter season) and relatively lower prices compared with pomegranate. Apples and bananas are consumed throughout the year and therefore maintain stable demand patterns (see table-2).

The findings support previous observations that fruit consumption is strongly influenced by seasonal availability and market accessibility (Marks & Yetley, 1989; Durham & Eales, 2006). The low consumption of

pomegranate may be attributable to its higher retail price and limited availability.

Household Expenditure on Fresh Fruits

Expenditure patterns generally reflect both consumption quantities and prevailing market prices. The higher expenditure (see Table-3) on oranges is consistent with their higher consumption volume. Similar expenditure patterns have been reported in studies examining fruit consumption among urban households where citrus fruits represent an important dietary component (Abdullah, 2004; Sofia, 2005). Orange accounted for the largest share of monthly fruit expenditure, followed by apples and bananas.

Demand Function Estimates

Determinants of Apple Demand

Apple demand exhibited the expected inverse relationship with its own price (see Table-4). The statistically significant coefficient confirms consumer sensitivity to apple price changes. The negative cross-price coefficients suggest complementary relationships with bananas, oranges, and guavas.

The positive coefficients for education and age indicate that more educated and older household heads may place greater value on fruit consumption due to increased nutritional awareness. Similar findings have been reported by Durham and Eales (2006), who observed that demographic characteristics significantly influence fruit purchasing behavior.

Determinants of Banana Demand

Banana demand was highly responsive to price changes. Household size positively affected banana demand, indicating that larger families consume more bananas because of their affordability and year-round availability (see Table-5).

Bananas are often considered a staple fruit among lower- and middle-income households. Similar patterns have been reported by Ali (1998) and FAO (2024), who found that household size significantly influences fruit consumption levels.

Determinants of Guava Demand

The negative and significant own-price coefficient confirms adherence to demand theory. Orange appears to serve as a substitute for guava, as indicated by the positive cross-price coefficient (see Table-6).

The negative income coefficient may indicate changing consumer preferences as income rises, with households shifting toward other fruits perceived as higher quality or more desirable.

Determinants of Orange Demand

The positive cross-price coefficients for apples and bananas indicate substitution effects, implying that consumers switch between these fruits when relative prices

change. Guava appears to act as a complementary fruit (see Table-7).

The strong own-price effect suggests that orange consumption is highly sensitive to market fluctuations. Given the importance of oranges in household diets, maintaining stable prices may be essential for ensuring adequate fruit intake.

Working–Leser Demand System Estimates

The negative expenditure coefficients indicate that as total fruit expenditure increases, the budget share allocated to individual fruits declines (see Table-8). This pattern is consistent with Engel's Law and suggests diversification of fruit consumption as household fruit expenditure expands.

The significant own-price coefficients further confirm the responsiveness of expenditure shares to market prices. Similar outcomes have been reported in Working–Leser demand studies conducted in developing countries (Leser, 1963; Deaton & Muellbauer, 1980).

Expenditure Elasticities

All expenditure elasticities are positive and less than unity, indicating that fruits are normal but necessity goods (see Table-9). A 1% increase in fruit expenditure increases orange consumption by 0.75%, banana consumption by 0.54%, guava consumption by 0.34%, and apple consumption by 0.27%. These findings align with demand theory and previous studies suggesting that fruits are important dietary necessities rather than luxury commodities (Burney & Akmal, 1991; Durham & Eales, 2006).

Own-Price and Cross-Price Elasticities

All fruits exhibited elastic demand (see Table-10). Guava showed the highest price responsiveness, suggesting consumers readily substitute away from guava when prices increase. These findings indicate that price increases may reduce producer revenues because quantity demanded falls proportionately more than price increases.

From a policy perspective, these findings suggest that fruit producers may not benefit from price increases because the resulting decline in quantity demanded could reduce total revenue. Instead, improving productivity, reducing post-harvest losses, strengthening cold-chain infrastructure, and enhancing marketing efficiency may be more effective strategies for increasing profitability.

Comparison with Previous Studies

The findings are broadly consistent with previous food demand studies conducted in Pakistan and internationally. Burney and Akmal (1991) reported income-inelastic demand for food commodities in Pakistan.

Durham and Eales (2006) found that consumers exhibit substantial responsiveness to fruit price changes in retail markets. Nzaku and Houston (2009) also documented significant substitution effects among fruit commodities.

The present study contributes to the literature by providing empirical evidence from Khyber Pakhtunkhwa and demonstrating that fruit demand among urban households is highly price sensitive but relatively income insensitive. These findings have important implications for food security, nutrition policy, and horticultural marketing strategies in Pakistan.

Conclusion

The study demonstrated that fresh fruit consumption among urban households in Peshawar is highly responsive to price changes but relatively insensitive to income changes. Apples, bananas, guavas, and oranges were found to be necessity goods with expenditure elasticities below unity. However, own-price elasticities exceeded unity, indicating elastic demand. Consequently, producers and marketers should focus on reducing production and marketing costs rather than increasing prices.

Recommendations

1. Efforts should be made to reduce production and marketing costs to keep fruit prices affordable.
2. Investments in storage, transportation, and market infrastructure should be promoted to reduce post-harvest losses.
3. Fruit producers should focus on improving productivity rather than increasing prices, as demand is highly price sensitive.
4. Nutrition awareness programs should be encouraged to promote fruit consumption among households.
5. Future studies should use larger samples and cover different regions of Pakistan for broader policy recommendations.

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Tables

Table-1: Household Characteristics

Variable	Mean	SD
Household size	6.57	2.34
Monthly income (Rs.)	74,318	43,514
Number of earners	1.13	0.47
Monthly remittances (Rs.)	1,550	8,180

Table 2. Average Monthly Fruit Consumption

Fruit	Average Consumption
Apple (kg)	5.38
Banana (dozen)	4.28
Guava (kg)	1.08
Orange (dozen)	6.69
Pomegranate (kg)	0.31

Table-3. Monthly Household Expenditure on Fresh Fruits

Fruit	Mean Expenditure (Rs.)	Standard Deviation
Apple	447.6	417.8
Banana	303.3	327.9
Guava	74.0*	124.4
Orange	554.0	426.5

Table-4: Estimated Demand Function for Apple

Variable	Coefficient	t-value	p-value
Constant	19.482	4.248	0.000
Price of Apple	-0.106	-3.451	0.003
Price of Banana	-0.014	-0.401	0.693
Price of Orange	-0.019	-0.788	0.441
Price of Guava	-0.093	-1.944	0.067
Household Size	-0.276	-1.777	0.092
Household Income	-5.511E-6	-0.391	0.700
Education	0.471	1.340	0.196
Age	0.111	1.603	0.125

$R^2 = 0.699$; $F = 5.516$ ($p < 0.01$)

Table-5. Estimated Demand Function for Banana

Variable	Coefficient	t-value	p-value
Price of Banana	-0.205	-4.118	0.001
Household Size	0.714	3.162	0.005
Education	0.987	1.930	0.069
Other Variables	Insignificant		

$R^2 = 0.761$; $F = 7.551$ ($p < 0.001$)

Table-6: Estimated Demand Function for Guava

Variable	Coefficient	t-value	p-value
Price of Guava	-0.096	-2.894	0.009
Price of Orange	0.007	0.425	0.676
Household Size	0.027	0.252	0.804
Income	-6.811E-6	-0.698	0.494

$R^2 = 0.645$; $F = 4.315$ ($p = 0.004$)

Table-7: Estimated Demand Function for Orange

Variable	Coefficient	t-value	p-value
Price of Orange	-0.147	-3.968	0.001
Price of Apple	0.065	1.372	0.186
Price of Banana	0.061	1.148	0.265
Price of Guava	-0.125	-1.691	0.107

$R^2 = 0.632$; $F = 4.086$ ($p = 0.006$)

Table-8: Working–Leser Model Results

Fruit	Expenditure Coefficient	Own Price Coefficient	R^2
Apple	-0.287***	-0.414***	0.327
Banana	-0.140***	-0.310***	0.311
Guava	-0.070**	-0.264***	0.370
Orange	-0.106**	-0.274***	0.364

***p<0.01; **p<0.05

Table-9: Estimated Expenditure Elasticities

Fruit	Elasticity
Apple	0.265
Banana	0.542
Guava	0.341
Orange	0.754

Table 10. Estimated Own-Price Elasticities

Fruit	Elasticity
Apple	-2.059
Banana	-2.012
Guava	-3.483
Orange	-1.572