



Demand Estimates and Projections for Meat in Pakistan by the Year 2030 AD

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Abstract: *The demand for meat in the Pakistan has been estimated for the year 2012 and based on this projections are made for the year 2030. Seemingly unrelated regression equations by assuming log-linear specification have been used to analyze the effects of income and prices on the meat demand. The study is based on Household Integrated Economic Survey (HIES) data 2010-11 and national level secondary data. Analysis of HIES data indicate that meat shares 3.8% in monthly household expenditures in the country. Per capita annual beef, mutton, chicken and fish consumptions in the country are 2.7, 0.8, 3.4 and 0.6 kg, respectively. Consumption of all meat types per person is high in urban areas than in rural localities. Demand for mutton, chicken, and fish are relatively more income elastic in urban areas than rural areas, while opposite is the case with beef demand. Own prices elasticities of all meat types have expected negative signs. Beef and mutton demands are comparatively more price elastic in rural areas, while chicken and fish have more price elastic demands in urban regions. National demand for beef, mutton, chicken and fish in the year 2012 are estimated at about 1590.2, 560.2, 740.9 and 361.4 thousand tones, respectively. The demand projections for beef, mutton, chicken and fish corresponding to 3.6% GDP growth for the year 2030 are 4236.4, 1136.8, 2699.7 and 574.1 thousand tones, respectively. Demand for these commodities is expected to grow by the year 2030 at 5.6, 4.0, 7.4 and 2.6% per annum, respectively. Thus, high growth in demand of all meat types may result into escalation in prices. This may have serious implications for the people to afford consumption of healthy diets in future.*

Keywords: *Meat, Demand, Estimation. Elasticity, Income, Price, Projections, Pakistan*

1-Introduction

The livestock sector has emerged as a priority sector on policy formulation and occupies a unique position in the national agenda of economic development in the country. In the financial year 2017-18, the sector contributed approximately 58.92% in agricultural and 11.11% in GDP, recorded growth rate of 3.76%. The livestock sector has been dominated by small holders to meet their needs of milk, meat, and eggs; enhancing nutrition, ensuring food security and generating cash incomes on daily basis. Meat and meat products are important sources of proteins, iron and vitamins in the diet of the people in the country. In the year 2017-18, total meat, marine and inland fish productions in the country were 4061, 338 and 144 thousand tones. Beef, poultry meat and mutton shared 51.3, 31.4 and 17.3% in the total meat production. Per capita meat availability of meat in the country has increased from 10.5 kg annum⁻¹ in the year 1980-81 to 19.5 kg annum⁻¹ in the year 2014-15. Similarly, availability of fish was 4.0 kg annum⁻¹. Thus, per capita availability of meat and fish is 23.5 kg annum⁻¹ (Government of Pakistan, 2018). Considering this, loss-adjusted consumption is even less, and is very low by world standards of 41.3 kg per capita per annum (FAO, 2015).

Pakistan is sixth most populous country in the world with population of 207.77 million in 2017 with a population growth rate of 2.40%. Pakistan's urban population is expanding rapidly at annual growth rate of 2.7%. The population in urban areas increased from 58.74 million in 2008 to 75.58 million in 2017. Urban population is growing at annual rate of 2.7 percent. Rural population was 104.17 in 2008, increased to 132.19 million in 2017. Rural population is growing at annual rate of 2.23% (Government of Pakistan, 2017). The population growth, increases in per capita income, remittances and export proceeds are fueling the demand for livestock products in the country (Government of Pakistan, 2018). Moreover, in the low-income countries like Pakistan, the demand for livestock products is more elastic than the demand for cereals (Dastagiri, 2004). This implies that with the rise in per capita income, the demand for livestock products would rise faster in the country. However, prevailing poverty exacerbated by inflation for the past few years, and power and gas shortages has lowered the public's capacity to purchase meat and other livestock products (Daily the Express, 2011).

Thus, information about demand of various meat types and fish is crucial to meet the growing consumption demand of meat in the country and for effective policy formulation for the growth and development of the livestock sector. In this perspective, few studies have been undertaken to analyze demand of livestock products in the country. Bouis (1992) and Ahmad and Chaudhary (1993) used simple growth models; however, Burney and Akmal (1991), and Akmal (1994) applied the extended linear expenditure system to model the demand for livestock foods in the country. Seemingly Unrelated Regression Equation (SURE) has been used in this study, to estimate the effect of various factors on the demand of meat (separately for beef, mutton & poultry), and fish. SURE is considered as most appropriate technique as it is widely used to analyze the effects of various factors on demand of food items. This study has been designed to determine meat and fish consumption by income groups; analyze the effect of prices, income and other variables on the demand of meat and fish; and make projections of meat and fish demand towards the year 2030 under different income growth scenarios. The article contains information about per capita meat consumption by income groups for rural, urban and

pooled population of the country, income (expenditure) elasticities by regions, and prices for different meat commodities, own and cross price elasticities, and meat demand projections by the Year 2030.

2- Materials and Method

The demand analysis of meat is based on Household Integrated Economic Survey (HIES) data 2010-11 for the whole country and national level secondary data. The HIES is carried out round the year to capture the seasonal variations in consumption of food and expenditures on non-food items. In the HIES (2010-11), about 60% of the sample households were selected from rural areas and 40% from urban localities. Distribution of sampled households by provinces and rural/urban breakdown is given in Table 1.

Table 1. Sample size for HIES 2010-11

Provinces	Regions		
	Rural	Urban	All
Punjab	3980 (57.7)	2913 (42.3)	6893 (100.0)
Sindh	2270 (56.0)	1784 (44.0)	4054 (100.0)
Khyber Pakhtunkhwa	1857 (64.3)	1032 (35.7)	2889 (100.0)
Baluchistan	1470 (65.4)	776 (34.6)	2246 (100.0)
Total	9599 (59.6)	6508 (40.4)	16107 (100.0)

Note: Figures in parenthesis are percentages

Sampled household were categorized into five income (expenditure) groups to determine per capita meat consumption by income levels viz. very low, having monthly expenditures of less than Rs.15000; low, of Rs.15001 to 25000; medium, of Rs. 25001 to 35000; high, of Rs.35001 to 50000 and very high, of greater than Rs.50000. Most of the earlier work on meat demand is based on single equation models relating consumption, income (total expenditures) and prices. Dastagiri (2004) also used a single equation model to analyze demand of various livestock products in India. Thus, following log linear model has been used for meat demand estimation.

$$Y_i = \beta_0 + \beta_1 \log PX_1 + \beta_2 \log PX_2 + \beta_3 \log PX_3 + \beta_4 \log PX_4 + \beta_j \log I_j + \mu_i \quad (1)$$

Where ‘ Y_i ’ is quantity of beef, mutton, chicken and fish meat consumed per capita over 30 days, ‘ PX_1 ’ is prices of beef (Rs./kg), ‘ PX_2 ’ is prices of mutton (Rs./kg), ‘ PX_3 ’ is prices of chicken (Rs./kg), ‘ PX_4 ’ is prices of fish (Rs./kg), ‘ I ’ is the income (or total expenditure) per household per month (Rs.), ‘ β_i ’s are the price coefficients, ‘ β_j ’ is the income coefficient and μ_i is error term, which may arise due to aggregate effect of variables not included in the model. The demand estimations for the year 2012 have been made by multiplying per capita meat consumption reported in official sources by the total population of the country. Figures about meat consumption obtained through analyzing HIES data 2010-11 have not been used for the purposes of demand estimation and projections, as meat consumption reported by the sampled households in HIES does not cover meat use at social events and religious rituals/festivals. Thus, in this way meat demand in the country is underestimated. Demand projections for the year 2030 are made by using following growth rate model.

$$D = d * N(1 + y * e) \quad (2)$$

Where, 'D' is the total household demand for any meat type in year 2030, 'd' is the per capita demand for a commodity in base year (2012), 'N' is the projected human population in year 2030, 'y' is the growth in per capita income and 'e' is the expenditure elasticity of demand for a commodity obtained from analysis of HIES data 2010-11. Considering, trends of increase in urban and rural populations in the country during last five years population projections are made for year 2030. It is projected that total population of the country will be 283.95 million by the year 2030. It is expected that from year 2013 onward, rural, urban and total populations in the country will increase by about 38, 80 and 54% by the year 2030. Low, moderate and high income growth scenarios were considered for meat demand estimation in the country; these are 2.7, 3.6 and 4.0%, respectively (Table 2). GDP has grown at 3.6% mean annual growth rate during last seven years, thus moderate growth rate is most realistic future income growth rate. Low and high growth rates are most pessimistic and optimistic income growth rates in recent past (during last four years), respectively. Population growth rates are assumed at 1.9, 3.5 and 2.5% for rural urban and total, respectively under all income growth scenarios. The growth rates in per capita income are calculated by subtracting the populating growth from income growth. Per capita income growth rates for the nation under low, moderate and high income GDP growth scenarios are 0.2, 1.1 and 1.5%, respectively.

Table 2. Alternative income growth rate assumptions (percent)

Scenario	Income			Per capita income		
	Rural	Urban	All	Rural	Urban	All
Low growth	2.0	3.7	2.7	0.1	0.2	0.2
Moderate growth	2.5	3.9	3.6	0.6	0.4	1.1
High growth	3.5	4.6	4.0	1.6	1.1	1.5

3-Results and Discussion:

Distribution of the Sampled Households by Income Groups and Regions

Distributions of the sampled household across different income groups by regions based on HIES data 2010-11 has been given Table 3. Analysis of HIES data 2010-11 reflected that one-third of the sampled households (33.6%) were in very low income group in the country. About another one-third of the households (30.5%) were in low income group. While, remaining households (35.6%) were in medium, high and very high income groups. In rural areas, about 41% and in urban areas 23% of the households were in very low income group. Percentage of the households in low income group was quite similar by regions; about 30 and 32% of the households in rural and urban areas were in low income group, respectively. About 15% of the households in rural areas and 20% in urban areas were in medium income group. Percentages of households in high and very high income groups were lower in rural areas than in urban areas.

Table 3. Distribution of the sampled households by monthly income (expenditures) groups and regions in HIES 2010-11

Regions	Income groups					All
	Very Low (Rs.15000)	Low (Rs.15001- 25000)	Medium (Rs.25001- 35000)	High (Rs.35001- 50000)	Very High (Rs.50001 & above)	
Rural	3887 (40.6)	2840 (29.7)	1412 (14.7)	825 (8.6)	613 (6.4)	9577 (100)
Urban	1522 (23.4)	2073 (31.9)	1293 (19.9)	824 (12.7)	793 (12.2)	6505 (100)
All	5409 (33.6)	4913 (30.5)	2705(16.8)	1649 (10.3)	1406 (8.7)	16082 (100)

Note: Figures in parenthesis are percentages

Per capita Meat Consumption by Regions and Income Groups

Detailed findings about mean per capita meat consumption (kg per annum) by income groups and rural/ urban break down based on HIES data 2010-11 have been given in Table 4. Consumption of all meat types per person is high in urban areas than in rural localities. Average meat including fish consumptions per person in rural and urban areas were 5.9 and 9.7 kg, with overall mean for the pooled population of 7.5 kg. Mean per capita per annum beef consumptions in rural and urban areas were 2.4 and 3.0 kg, respectively. Per capita beef consumption was the highest by high income group rural households and very high income group urban households. Mean per capita annual consumptions of mutton were 0.5 and 1.2 kg in rural and urban regions, respectively. Per capita mutton consumption was the highest by very high income group households both in rural and urban areas. Mean per capita per annum chicken consumptions in rural and urban areas were 2.5 and 4.8 kg, respectively. Similar to mutton consumption, per capita chicken consumption was also the highest by very high income group households both in rural and urban areas. Mean per capita fish consumptions in rural and urban areas were 0.5 and 0.7 kg, respectively.

Table 4. Per capita meat consumption by income groups for rural, urban and pooled population (kg per annum)

Meat	Regions	Income groups					
		Very Low	Low	Medium	High	Very High	All
Beef	Rural	2.0 (4.4)	2.5 (3.7)	3.3 (4.2)	4.3 (5.0)	3.4 (4.6)	2.4 (4.3)
	Urban	2.4 (3.8)	3.1 (4.6)	3.3 (4.4)	3.2 (4.0)	4.6 (5.3)	3.0 (4.4)
	All	2.1 (4.2)	2.7 (4.1)	3.3 (4.3)	3.6 (4.5)	4.6 (5.2)	2.7 (4.3)
Mutton	Rural	0.2 (1.5)	0.7 (4.1)	1.1 (2.8)	1.6 (4.3)	2.0 (3.8)	0.5 (2.9)
	Urban	0.4 (2.4)	0.8 (3.2)	1.4 (3.8)	2.8 (6.6)	5.0 (7.4)	1.2 (4.1)
	All	0.3 (1.8)	0.7 (3.8)	1.2 (3.4)	2.3 (5.8)	4.4 (6.9)	0.8 (3.5)
Chicken	Rural	2.0 (3.6)	2.6 (3.8)	3.4 (4.0)	4.4 (5.0)	5.2 (5.4)	2.5 (3.9)
	Urban	2.9 (5.1)	5.2 (7.3)	5.2 (6.5)	6.2 (5.4)	8.7 (7.0)	4.8 (4.5)
	All	2.3 (4.1)	3.7 (3.3)	4.3 (5.5)	5.4 (5.3)	7.9 (6.9)	3.4 (7.1)
Fish	Rural	0.4 (2.0)	0.6 (2.0)	0.7 (2.0)	0.5 (1.7)	0.7 (2.1)	0.5 (2.0)
	Urban	0.5 (2.3)	0.7 (3.4)	0.9 (3.9)	0.7 (1.9)	1.6 (3.3)	0.7 (3.1)
	All	0.4 (2.1)	0.7 (2.7)	0.8 (3.1)	0.6 (1.9)	1.4 (3.1)	0.6 (2.5)
Total	Rural	4.6	6.4	8.5	10.8	11.3	5.9
	Urban	6.2	9.8	10.8	12.9	19.9	9.7
	All	5.1	7.8	9.6	11.9	18.3	7.5

Note: Figures in parenthesis are standard deviations

Analysis of HIES data 2010-11 revealed that share of meat in monthly household expenditures was 3.8 percent in the country. Expenditures on meat were higher than on pulses (1.4%) and eggs (0.5%). A quick look at the data presented in the Table 4 indicates that per capita meat consumption increases with improvement in income group hierarchies. Moreover, standard deviations also increase with income group hierarchies, indicating that variation in meat consumption goes up with rise in household income levels.

As already stated that findings on the basis of HIES data 2010-11 depict that per capita meat consumption in the country is 7.5 kg per annum. The figure is very low as compared to meat availability of 18.1 kg per capita per annum reported in Agricultural Statistics of Pakistan 2011-12. The reason for this difference is that HIES data is solely based on P-ISSN-2415-5284 e-ISSN-2522-3291 © 2019 Shah Abdul Latif University Khairpur- All rights reserved. Vol. 5 | 2019

household meat consumptions and does not take into account meat consumed at social events and religious rituals /festivals. While, availability of the meat reported in above stated official source is calculated by deducting quantity of meat exported/ smuggled from total meat production in the country. Thus, its use has been considered more appropriate for making projections for meat use in the country.

Income Elasticities

Income (expenditure) elasticity estimates for all meat types based on HIES data are given in the Table 5. Meats of all types are normal goods, having positive income elasticities. Comparatively high income elasticities have been obtained for chicken in both rural and urban areas. Demand for beef is more income elastic in rural areas as compared to urban regions. However, demand for mutton, chicken, and fish are relatively more income elastic in urban areas than rural areas. Income group wise income (expenditure) elasticities have also been computed. Though demand for all meat types for all income groups were elastic; however, demand for chicken by medium group consumers in urban areas was highly income elastic (>1.0).

Table 5. Income (expenditure) elasticities by regions

Commodity	Rural	Urban	Pooled
Beef	0.379* (19.987)	0.273* (12.314)	0.373* (26.617)
Mutton	0.262* (24.411)	0.512* (31.835)	0.393* (43.621)
Chicken	0.390* (19.991)	0.658* (30.770)	0.563* (40.194)
Fish	0.110* (9.113)	0.189* (12.990)	0.153* (17.052)

Note: Figures in parenthesis are t-values, * indicates 1 percent level of significance.

Prices for Different Meat Commodities and Price Elasticities

Per unit prices for different meat types by regions are given in Table 6. Prices of beef, mutton and fish were higher in the urban areas than in rural localities. While, prices of chicken were comparatively higher in rural areas than urban regions. Main reasons for prices differences are locus of production and transportation costs i.e. livestock prices for beef and mutton remains low in rural areas; while, chicken is produced mainly in semi-urban and urban areas and transported to rural areas at comparatively higher prices.

Table 6. Prices for different meat commodities

Regions	Commodities			
	Beef	Mutton	Chicken	Fish
HIES Data 2010-11				
Rural	215.3	387.5	202.8	180.2
Urban	233.0	401.0	199.4	182.5
All	223.0	394.7	201.3	181.3
Economic Survey of Pakistan in the fiscal year 2011-12*	252.4	482.0	150.0	148.7**
Economic Survey of Pakistan in the fiscal year 2017-18***	416.0	895.0	235.6	215.2****

Notes:*At the base of 2007-08**Pakistan Statistical Year Book 2011-12 ***In Islamabad in March 2018 **** FAO-Pakistan, 2018

The estimates of elasticities of own and cross prices of all meat types for urban areas, rural areas and pooled data are given in Table 7. Own prices elasticities of all meat types have expected negative signs i.e. an increase in prices results into decrease in demand. Beef and mutton demands are comparatively more price elastic in rural areas, while chicken and fish have more price elastic demands in urban regions. Results of the pooled data reveal that beef and fish demands are highly price elastic (>1.0) in the country. Most of the cross price elasticities have expected positive signs i.e. an increase in the prices of one type of meat results into a rise in consumption of other meat types. This also indicates high price responsiveness of the consumers to demand of these commodities.

Table 7. Own and cross price elasticities

Commodities	Beef & buffalo meat	Mutton & goat meat	Chicken	Fish	R ²
Urban areas					
Beef	-0.119 (-1.326)	0.105 (0.834)	0.198** (2.706)	-0.426 (-5.411)	0.16
Mutton	0.023 (0.350)	-0.466* (-5.080)	0.040 (0.756)	0.176* (3.070)	0.38
Chicken	1.039* (11.954)	-0.216*** (-1.767)	-1.022* (-14.454)	-0.019 (-0.254)	0.42
Fish	0.452* (7.644)	-0.104 (-1.248)	0.257* (5.347)	-1.004* (-19.408)	0.31
Rural areas					
Beef	-1.953 (-26.260)*	-0.199 (-1.712)*	0.061 (1.062)	-0.160 (-1.984)*	0.33
Mutton	0.225 (5.364)*	-1.292 (-19.652)*	0.005 (0.143)	0.170 (3.735)*	0.31
Chicken	0.184 (2.409)**	-0.087 (-0.726)	-0.648 (-11.036)*	0.079 (0.957)	0.23
Fish	0.063 (1.346)	-0.117 (-2.411)**	0.349 (9.663)*	-1.315 (-25.802)*	0.28
Pooled Data					
Beef	-1.068* (-18.674)	-0.013 (-0.156)	0.135* (2.959)	-0.378* (-6.735)	0.24
Mutton	0.204* (5.554)	-0.859* (-15.571)	0.015 (0.516)	0.187* (5.188)	0.35
Chicken	0.687* (12.032)	-0.118 (-1.375)	-0.807* (-17.759)	0.007 (0.127)	0.35
Fish	0.248* (6.798)	-0.131** (-2.390)	0.317* (10.909)	-1.146* (-31.972)	0.29

Estimated Meat Demand in the Year 2012 and Projections by the Year 2030

National demand for beef, mutton, chicken and fish in the year 2012 are estimated at about 1590.2, 560.2, 740.9 and 361.4 thousand tones, respectively. The demand projections for beef by the year 2030, corresponding to scenario of 2.7% GDP growth (low income growth), 3.6% GDP growth (medium income growth) and 4.0% GDP growth (high income growth) are 2819.6, 4263.4 and 4905.1 thousand tones, respectively. During 2012-2030, the demand for beef is expected to grow at annual compound growth rates of 3.2, 5.6 and 6.5% under low, medium and high income growth scenarios, respectively. The demand projections for mutton by the year 2030, corresponding to scenario of low, medium and high income growth are 926.9, 1136.8 and 1230.1 thousand tones, respectively. The demand for mutton will grow at annual

compound rates of 2.8, 4.0 and 4.5% under these income growth scenarios, respectively. The demand for chicken is estimated to reach 1443.4, 2699.7 and 3258.0 thousand tones by the year 2030 under low, medium and high income growth scenarios, respectively. The demand for chicken will grow at annual compound rates of 3.8, 7.4 and 8.6% under these income growth scenarios, respectively. The demand projections for fish corresponding to low, medium and high income growth scenarios by the year 2030 are 569.0, 574.1 and 576.4 thousand tones, respectively. Thus, fish demand will grow at about 2.6% under all income growth scenarios.

4-Conclusion and Recommendations

All kinds of meat are essential food items having positive income elasticities. The consumption behavior has revealed that urban population on an average consumes more meat than rural population. Most types of meat are substituted to each other as suggested by cross-price elasticities. The demand for beef is more income elastic in rural areas as compared to urban regions. However, demand for chicken, mutton and fish are relatively more income elastic in urban areas than rural areas. This implies that an increase in per capita income of urban population would accelerate the demand of chicken, mutton and fish in urban areas of the country. While, an increase in per capita income of rural population would stimulate demand for beef in rural regions of the country. High price elasticities of different meat types reveal high instabilities in their consumption. The demands of chicken and fish are highly price elastic in urban areas and that of beef and mutton is highly price elastic in rural areas. Thus, increase in prices of these commodities would reduce the demand. The prices of meat are high, while intake of all kinds of meat is low by world standards. In the country, demand of meat is expected to grow at high rate, which may result into escalation in prices and further reduction in per capita consumption. On the other hand, higher demand growth rates indicate that meat production industry has bright prospects in the country. Rapidly increasing population and achievement of high income growth rate by stabilizing economic activities in the country would result into higher demand for meat. Thus, effective mechanisms to boost meat production, control meat prices and human population are urgently required to raise per capita consumption of meat in the country. Livestock (cattle and buffalo) fattening and poultry entrepreneurs are required to be supported through provision of technical knowledge and scientific animal husbandry skills, availability of quality inputs (calves, chicks, oil seed cake, vanda, silage, feed, vaccinations and medicines etc.), disease treatment services at controlled prices, and credit supplies at bearable interest rates along with loan insurance etc.

References

- Ahmad, M. and M. A. Chaudhry. (1993). Demand and supply projections for major livestock products for the year 2000 and new policy options. *Pakistan Journal of Agricultural Sciences*. 30 (2): 139-144.
- Akaml, M. (1994). The production and consumption of livestock food in Pakistan: A look into the Future. *The Pakistan Development Review*. 33 (1): 19-39.
- Daily the Express (2011). Per capita poultry meat consumption only 4.2 kg. *The Express Tribune with the International New York Times*. (Available at

<http://tribune.com.pk/story/268438/per-capita-poultry-meat-consumption-only-4-2kg/>)

Last Accessed on 7th October, 2018.

Bouis, H. E. (1992). Food Demand elasticities by income group by urban and rural population for Pakistan. *The Pakistan Development Review*. 31(4): 997-1017.

Burney, N. A., and M. Akmal (1991). Food demand in Pakistan: An application of the extended linear expenditure system. *Journal of Agricultural Economics*. 42 (2): 185-195.

Dastagiri, M. B. (2004). Demand and Supply Projections for livestock products in India. *National Centre for Agricultural Economics and Policy Research*, Policy Paper 21, Chandu Press, Shakarpur, New Delhi, India. VII P.

Government of Pakistan, (2017). *Pakistan Population Census, 2017*. Pakistan Bureau of Statistics, Statistics Division, Ministry of Statistics, Government of Pakistan, Islamabad.

Government of Pakistan, 2018. *Pakistan Economic Survey 2017-18*. Economic Advisor's Wing, Finance Division, Government of Pakistan, Islamabad.

FAO, (2015). *Food outlook; Global market analysis*. Trade and Market Division, Food and Agriculture Organization of the United Nations. Rome, Italy.

FAO, (2018). *National aquaculture sector overview-Pakistan 2017-18*. Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations. Rome, Italy.