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# Demand and Supply Estimates and Projections for Beef in Pakistan by the Year 2030.

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***Abstract:-***

*The demand and supply for beef in Pakistan has been estimated and projections are made for the year 2030. Seemingly unrelated regression equation by assuming a log-linear specification has been used to analyze the effects of income and prices on the beef demand. Polynomial price lag model has been employed for supply side analysis. Both demand and growth rate models make supply projections for beef. The study is based on field survey data collected in the year 2013, HIES data 2010-11 and time series data for the period 1980-81 to 2011-12. Beef is essential food item, having both positive income/expenditure and price elasticities. Demand for beef is more income elastic in rural areas as compared to urban regions. The results of supply side analysis have shown that price elasticity of beef is positive and statistically significant, implying that higher beef prices stimulate the production. Similarly, total numbers of buffalo and cattle animal units for beef production contribute positively and significantly to the production. The demand projection corresponding to moderate-income growth rate and supply projection based on polynomial price lag model indicate a huge deficit in the beef production by the year 2030. This may results into increase in the prices and decrease in consumption of beef. Thus, immediate policy reforms are required to control the gap between demand and supply of beef for future in the country.*

**Key Words:** Beef; Demand; Estimation; Elasticity; Income; Price; Projections; Pakistan.

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## 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. The sector contributes approximately 55.4% to the agricultural value added much more than the combined contribution of major and minor crops (37.6%). 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. Total meat production in the country is 3231 thousand tones and beef shares more than half in the total meat production in the country (54.7%). Beef production has grown at annual compound rate of 4.5% from 1980-81 to 2012-13 (Anonymous, 2013).

Pakistan is sixth most populous country in the world with an estimated population of 184.37 millions in 2012-13. Pakistan's urban population is expanding rapidly. The population in urban areas increased from 58.74 million in 2008 to 69.87 million in 2013. Thus, urban population is growing at annual growth rate of 3.5 percent. Rural population was 104.17 million in 2008, increased to 114.5 million in 2013 with annual growth rate of 1.9% (Anonymous, 2013). The population growth, increases in per capita income, remittances and export proceeds are fueling the demand for livestock products (Anonymous, 2011). 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 double-digit inflation for the past few years and loss of livelihood due to floods, and power and gas shortages has lowered the public's capacity to purchase meat and other livestock products (Anonymous, 2011a). Official estimates about supply and demand of livestock products in the country made in year 1999-2000 and 2004-05 also depicts a gloomy picture i.e. demands for beef and mutton have already surpassed their production levels, and the supply-demand gaps will get widened with the passage time (Anonymous, 2006).

Thus, information about demand and supply situation of various livestock products is crucial for effective policy formulation for the growth and development of the livestock sector. In this perspective, there is scanty of research work. Few studies have been undertaken solely to analyze demand of livestock products in the country viz. Burney and Akmal (1991), and Bouis (1992). However, Ahmad and Chaudhary (1993) made both demand and supply projections for major livestock products for the year 2000. Similarly, Akmal (1994) made projections for the production and consumption of livestock food in Pakistan for the period 1993-94 through 2004-05. Studies by Bouis, and Ahmad and Chaudhary were based on simple growth models; however, Akmal employed extended linear expenditure system to model the demand for livestock foods, polynomial price lag model to estimate supply response functions for beef, mutton and poultry meat; and stock adjustment model for fish meat production in the country.

In the present study, seemingly unrelated regression equation (SURE) has been used to estimate the effect of various factors on the demand of beef. Both, linear regression and polynomial price lag models have been employed for supply side analysis. This study has been designed to determine beef consumption by income groups, analyze the effect of prices, income and other variables on the demand of beef. Moreover, effects of beef

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prices, fodder prices, number of buffalo and cattle animal units, amount of agricultural credit disbursed by ZTBL and technological progress on beef production have been analyzed. Demand and supply projections of beef towards 2020 and 2030 under different income growth scenarios have been made, prospects of attaining different growth rates in production of beef are examined and policy measures to attain a different set of production growth are suggested.

## 2. Materials and Method

### 2.1 Demand Analysis

The demand analysis of beef is based on Household Integrated Economic survey (HIES) data 2010-11 for the whole country, field survey data collected from rural and urban areas of Faisalabad, Lahore and Rawalpindi/Islamabad districts in the year 2013 and national level time series data (1980-81 to 2011-12). 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 part I of Table 1.

**Table 1. Sample size in the selected districts (field Survey Data-2013)**

| **Districts** | **Regions** | | |
|---|---|---|---|
| | **Rural** | **Urban** | **All** |
| I. | HIES Data 2010-11 | | |
| 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) |
| Balochistan | 1470 (65.4) | 776 (34.6) | 2246 (100.0) |
| Total | 9599 (59.6) | 6508 (40.4) | 16107 (100.0) |
| II. Field Survey Data-2013 | | | |
| Faisalabad | 53 (50) | 53 (50) | 106 (100) |
| Lahore | 47 (46) | 56 (54) | 103 (100) |
| Rawalpindi/Islamabad | 52 (50) | 52 (50) | 104 (100) |
| Total | 152 (49) | 161 (51) | 313 (100) |

**Note:** figures in parenthesis are percentages

Distribution of the sampled households for field survey data collected in the year 2013 by districts and regions is given in part II of Table 1. In total 313 respondents were interviewed, about half of the respondents were interviewed each from rural and urban areas. Respondents were interviewed purposively from different income groups to capture the differences in consumption of beef by income group categories across rural and urban regions. Sampled household were categorized into five income (expenditure) groups 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. Field surveys were conducted during February, 2013 in Rawalpindi/Islamabad districts, during June, 2013 in Lahore district and during December, 2013 in Faisalabad district. Seasonal variations in consumption of beef have

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also been captured by inquiring the respondents separately about beef consumption during summer and winter seasons.

Most of the earlier work on meat demand is based on a single equation models relating consumption, income (total expenditures) and prices. Thus, following log linear model has been used for beef demand estimation. Where '$Y_i$' is quantity of beef 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.), 'Bi's are the price coefficients and 'Bj' is the income coefficient.

$$Y_i = B + B_1 \, logPX_1 + B_2 \, logPX_2 + B_3 \, logPX_3 + B_4 \, logPX_4 + B_j \, logI_j \quad (1)$$

Demand estimation and projection have been made keeping in view per capita beef availability in the country, beef prices, per capita income (at market prices) over time (from 1980-81 to 2011-12). The variables of beef prices and per capita income were converted into factor cost of the year 2000-01. Data collected through field surveys conducted during 2013 and HIES data 2010-11 have not been used for the purposes of demand estimation and projections, as beef consumption reported by the sampled households does not cover its use at social events and religious festivals. Thus, in this way total beef consumption in the country is underestimated. Demand estimation from the year 2012 was made by multiplying per capita beef availability reported in official sources. Thereafter, based on this estimation, projections for the years 2020 and 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 beef in year t,'d' is the per capita beef demand in base year (2012), 'N' is the projected human population in year t, 'y' is the growth in per capita income and 'e' is the expenditure elasticity of demand for beef. Considering, trends of increase in urban and rural populations in the country during last five years population projections are made for year 2020 and 2030. It is projected that total population of the country will be 219.79 million by the year 2020, which will further increase to about 283.95 million by the year 2030. It is expected that from year 2013 onward, rural, urban and total population 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 beef 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 the most realistic future income growth rate. Low and high growth rates are the 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 population growth from income growth. Thus, per capita income growth rates under low, moderate and high-income growth scenarios are 0.2, 1.1 and 1.5%, respectively.

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**Table 2. Alternative income growth rate assumptions used in demand projects (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. Supply Analysis

Supply side analysis of beef is based on time series data about meat production, meat prices, and prices of inputs (fodder/feed), amount of agricultural credit disbursed by Zari Taraqiati Bank Limited (ZTBL), animal population/animal units and the stage of production technology for the period 1980-81 to 2011-12. Prices as well as other monetary variables were converted at the prices of year 2000-01. Moreover, the projection of supply (production) into future requires knowledge of future values of exogenous variables. The variables exogenous to the model are projected using trend growth over the last thirty years (1980-81 to 2011-12). It is estimated that cattle and buffalo animal units available for beef production in the year 2011-12 were 14.9 million, with per animal unit productivity of 120.8 kg per annum. It is projected that cattle and buffalo animal units available for beef production would be 17.0 and 20.4 million by the year 2020 and 2030, respectively. Growth rates in nominal and real prices of beef from 1980-81 to 2010-2011 were 11.1 and 1.7 percent. Same growth rates in prices have been used for the beef supply projection. The linear regression and polynomial price lag models used for the beef supply projections. The linear regression and polynomial price lag models used for the study are given by equations 3 and 4, respectively. Where 'Yt' is quantity of beef production, 'Xt' is price of current period, 'Xt-1' is one lag price, 'Xt-2' is two lag price, 'F' is fodder/feed prices, 'C' is amount of agricultural credit disbursed by ZTBL, 'B' is number of buffalo animal units for beef production, 'A' is number of cattle animal units for beef production, 'T' is the time, which is a proxy for technological change and 'Bi's are the coefficient of the variables. The supply projections for the commodities are obtained by using the expression given by equation 5. Where, 'S' is supply/production of beef in year t, '$S_0$' is the beef production per animal unit in the base year 'Pg' is growth in nominal prices, 'Ps' is price elasticity of supply for beef; and 'Nt' is projected number of animal units for beef production year t

$$Y_t = B_0 + B_1 \log X_t + B_2 \log F + B_3 \log C + B_4 \log B + B_5 A + B_6 T \quad (3)$$

$$Y_t = B_0 + B_1 \log X_t + B_2 \log X_{t-1} + B_3 \log X_{t-2} + B_4 \log F + B_5 \log C + B_6 \log B + B_7 \log A + B_8 T \quad (4)$$

$$S_t = S_0 * N_t (1 + P_g * P_s) \quad (5)$$

## 4. 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 and field survey data-2013 have been given in part I and II of

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Table-3, respectively. 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. As already stated, during field survey conducted in the year 2013, respondents were interviewed purposively from different income groups to capture the differences in consumption of beef by income group categories. However, households categorization into income (expenditure) groups indicated that majority of the households were in low income group both in rural (32.2%) and urban regions (24.8%), followed by in medium, very high, high and very low income groups.

**Table 3. Distribution of the sampled households by monthly income (expenditures) groups and regions in the study area**

| **Regions** | **Income groups** | | | | | |
|---|---|---|---|---|---|---|
| | Very Low (<Rs.15000) | Low (Rs.15001-25000) | Medium (Rs.25001-35000) | High (Rs.35001-50000) | Very High (Rs.50001 & above) | All |
| **I-HIES Data 2010-11** | | | | | | |
| 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) |
| **II-Field Survey Data** | | | | | | |
| Rural | 15(9.9) | 49 (32.2) | 39 (25.7) | 24(15.8) | 25 (16.4) | 152 (100) |
| Urban | 21(13.0) | 40 (24.8) | 36 (22.4) | 29(18.0) | 35 (21.7) | 161 (100) |
| All | 36 (11.5) | 89(28.4) | 75 (24.0) | 53(16.9) | 60 (19.2) | 313 (100) |

Note: figures in parenthesis are percentages

**Per capita Beef consumption by Income Groups and Regions**

Detailed findings about mean per capita beef consumption (kg per annum) by income groups and rural/urban break down have been given in table 4. Analysis of HIES data 2010-11 revealed that per person consumption of beef was high in urban areas than in rural areas of the country. Mean per capita per annum beef consumptions in rural and urban areas and overall basis were 2.4, 3.0 and 2.7 kg, respectively. Per capita beef consumption was the highest by high-income group rural households and very high-

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income group urban households. Analysis of field survey data-2013 showed that per capita beef consumption was high in rural areas than in urban areas of the selected districts. Mean beef consumptions per capita per annum in the surveyed rural, urban areas and on overall basis were 4.2, 3.4 and 3.8 kg, respectively. Per capita beef consumption was the highest by low-income group rural households and very high-income urban households. Per capita beef consumption per annum in the year 2011-12 based on total availability of meat in the country was 8.8 kg. These figures are quite higher than per capita beef consumption estimated based on both HIES data 2010-11 and field survey data-2013. As the former data is based on total meat availability in the country, after deducting quantity of meat exported or smuggled; while later are solely based on household meat consumptions at household level, thus do not take into account meat consumed at social events and religious festivals.

**Table 4. Per capita consumption of beef for rural, urban and pooled population by income groups in the study area (kgs per annum)**

| Regions | Income groups | | | | | |
|---|---|---|---|---|---|---|
| | Very Low | Low | Medium | High | Very High | All |
| **I.** HIES Data 2010-11 | | | | | | |
| 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) |
| **II.** Field Survey Data | | | | | | |
| Rural | 1.6(2.0) | 4.9(6.4) | 4.0(4.0) | 4.6(5.5) | 4.3 (5.0) | 4.2(5.2) |
| Urban | 1.8(2.4) | 1.4(2.7) | 5.3(15.0) | 2.4(2.5) | 5.5 (9.7) | 3.4(8.7) |
| All | 1.7(2.6) | 3.3(5.4) | 4.6(10.7) | 3.4(4.2) | 5.0 (8.1) | 3.8(7.2) |

**Note:** Figures in parenthesis are standard deviations

## 5. Expenditure Elasticities

Expenditure elasticity estimates for beef based on all data types are given in Table 5. The expenditure elasticities for beef have expected positive signs, indicating that it is a normal good. This implies that an increase in consumers' income would create more demand for beef in the country. Bouis (1992) also reported positive expenditures elasticity for beef in Pakistan. Similarly, Haq et al. (2011) also found positive elasticities for meat demand in their study about food demand patterns in Punjab province of Pakistan. Based on both HIES data 2010-11 and field survey data-2013, comparatively high elasticities were obtained in rural regions than urban regions. Thus, it is found that demand for beef is more income elastic in rural areas than in urban regions. Results of field survey data also revealed that demand for beef is highly income elastic (>1.0) for medium and very low-income group households in both rural and urban areas.

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**Table 5. Expenditure (income) elasticities by regions and income groups**

| Regions | Income groups | | | | | |
|---|---|---|---|---|---|---|
| | Very Low | Low | Medium | High | Very High | All |
| I.HIES Data 2010-11 | | | | | | |
| Rural | 0.306* (6.790) | 0.412* (3.687) | 0.310 (0.916) | 0.521 (0.909) | -0.400 (-1.487) | 0.379* (19.987) |
| Urban | 0.447* (5.396) | 0.376* (2.659) | 0.153 (0.477) | 0.358 (0.744) | 0.422** (2.542) | 0.273* (12.314) |
| All | 0.372* (9.360) | 0.446* (5.005) | 0.220 (0.908) | 0.395 (1.066) | 0.259*** (1.790) | 0.373* (26.617) |
| II. Field Survey Data | | | | | | |
| Rural | 1.154 (1.490) | 0.900 (0.451) | 2.285*** (1.853) | 0.537 (0.514) | 0.658 (0.787) | 0.383 (0.459) |
| Urban | 1.240 (0.767) | 0.756 (0.451) | 1.141* (2.853) | 0.537 (0.514) | 0.658 (0.787) | 0.235 (1.531) |
| All | 1.249*** (1.912) | 0.438 (0.506) | 2.183 (1.652) | 0.287 (0.248) | 0.570 (1.189) | 0.332** (1.970) |
| III. National Level time Series Data/economic Survey of Pakistan (1980-81 to 2011-12) | | | | | | 0.642** (2.41) |

Note: Figures in parenthesis are t-values, *, ** and *** indicate 1, 5 and 10% levels of significance, respectively

## 6. 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 are higher in the urban areas than in rural localities. While, prices of chicken are comparatively higher in rural areas than urban regions. Main reasons for prices differences are locus of production, transportation costs i.e. cattle, buffalo, and small ruminants are produced in rural areas and are transported to urban regions; while, chicken in produced mainly in semi-urban and urban areas and transported to rural localities. The estimates of elasticities of own and cross prices are given in Table 7. Own prices elasticities of mutton, chicken and fish have expected negative sign; while, that of beef has a positive sign. This means that instead of increase in beef prices in real terms over time, an increase in its demand has occurred. However, increase in real prices of all other meat types have resulted into reduction in their demand. Most of the cross price elasticities have expected positive signs i.e. an increase in the prices results into a rise in consumption of other commodities.

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**Table 6. Prices for different meat commodities** (Rs./kg)

| Regions | Commodities | | | |
|---|---|---|---|---|
| | Beef | Mutton | Chicken | Fish |
| I.HIES Data 2010-11 | | | | |
| Rural | 215.3 | 387.5 | 202.8 | 180.2 |
| Urban | 233.0 | 401.0 | 199.4 | 182.5 |
| Pooled | 223.0 | 394.7 | 201.3 | 181.3 |
| II. Field Survey Data-2013 | | | | |
| Rural | 289.3 | 546.9 | 219.4 | 269.1 |
| Urban | 309.2 | 582.8 | 217.6 | 285.4 |
| Pooled | 298.3 | 568.1 | 218.5 | 277.7 |
| Economic Survey of Pakistan in the fiscal year 2011-12* | 252.4 | 482.0 | 150.0 | 148.7** |

Notes: *At the base of 2007-08 ** Pakistan Statistical Year Book 2011-12

**Table 7. Own and cross price elasticities** (National level time series data)

| Commodities | Beef | Mutton | Chicken | Fish | $R^2$ |
|---|---|---|---|---|---|
| Beef | **1.096*** **(3.678)** | 0.824* (-2.698) | 0.020 (0.107) | 0.030 (0.339) | 0.92 |
| Mutton | 1.469* (3.372) | **-0.989**** **(-2.214)** | -0.102 (-0.367) | 0.625 (4.765) | 0.80 |
| Chicken | 1.924** (2.148) | -1.766*** (-1.923) | **-0.189 (-0.330)** | 0.571** (2.116) | 0.90 |
| Fish | 0.206 (1.239) | -0.048 (-0.283) | 0.031 (0.290) | **-0.182* (-3.653)** | 0.64 |

**Note:** Figures in parenthesis are t-values, *, ** and *** indicate 1, 5 and 10% levels of significance, respectively.

## 7. Beef Demand Estimation and Projections

Total demand for beef in the year 2012 is estimated at about 1590 thousand tones (Table 8). The demand projections for the year 2020, corresponding to the scenario of 2.7% GDP growth (low-income growth), and 3.6% GDP growth (moderate income growth) and of 4.0% GDP growth (high-income growth) are 2183, 3300 and 3797 thousand tones, respectively. During 2012-2020, the demand for beef will grow at annual compound growth rates of 4.0, 9.6 and 11.5%, respectively under low, medium and high-income growth scenarios, respectively. Total demands for beef for the year 2030 under low, medium and high income growth scenarios are projected at 2820, 4263, and 4905 thousand tones, respectively. During 2012-2030, the demand for beef will grow at annual compound growth rates of 3.2, 5.6 and 6.5% under low, medium and high-income growth scenarios, respectively.

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**Table 8. Demand estimation and projections for meat in Pakistan in different years.**

| Commodity | Years | | | Average growth rates (%) | |
|---|---|---|---|---|---|
| | 2012 | 2020 | 2030 | 2012-2020 | 2012-2030 |
| Low income growth | 1590.2 | 2182.5 | 2819.6 | 4.0 | 3.2 |
| Medium income growth | | 3300.1 | 4263.4 | 9.6 | 5.6 |
| High income growth | | 3796.7 | 4905.1 | 11.5 | 6.5 |

Source: National Level time Series Data Note: The units of beef demand are thousand tones and 2012 is considered as base year

## 8. Beef Supply in Pakistan

### 8.1 Estimates of Linear Regression Model

The estimated coefficients of linear regression model are presented in equation 6. The coefficient of price for beef is positive and statistically significant, implying that higher prices stimulate beef production in the country. Similarly, the coefficient of number of buffalo animal units for beef production is statistically significant with a positive sign, indicating that an increase in buffalo population would increase beef production in the country.

$$Yt = 1.101 + 0.455Xt + 0.084F + 0.044C + 0.455B + 0.109A + 0.007T \quad (6)$$
$$(2.014)^{***}\ (2.560)^{*}\ (1.125)\ (1.072)\ (2.600)^{*}\ (0.754)\ (1.450)$$

$R^2 = 0.983$ Adjusted $R^2 = 0.979$
F-statistic=238.040 Prob (F-statistic) =0.000
Durban-Watson stat=1.030
Note: * and *** are significant at 1 and 5 percent levels, respectively.

The polynomial price lag model estimates are presented in equation 7. Fodder price elasticity for beef production is positive and statistically significant, indicating that in spite of a rise in fodder prices the production has increased. More specifically, it means that buffalo and cattle are good converters of fodder into products of highly nutritive value. According to results of polynomial price lag model, increase in both buffalo and cattle animal units for beef production would increase its supply in the country. Most of the other variables both in linear and polynomial price lag models have expected signs but are statistically insignificant. Time variable have expected positive sign, indicating improvement in beef production technology over time; however, it is non-significant in statistical perspective. Thus, technological improvement in the production, processing and distribution of beef would be required to increase beef production in the country. Technological advancement for increasing livestock production has also been confirmed by past studies (Anonymous, 1995).

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$$Yt = 0.601 + 0.123X_t + 0.032X_{t-1} + 0.555X_{t-2} + 0.095F - 0.005C + 0.904B + 0.330A + 0.003T \quad (7)$$

(1.591) (0.629) (0.123) (3.131)* (1.748)*** (-0.146) (2.858)* (3.287)* (1.051)

$R^2 = 0.992$ Adjusted $R^2 = 0.990$
F-statistic=343.565 Prob (F-statistic) =0.000
Durban-Watson stat=1.664
Note: * and *** are significant at 1 and 5 percent levels, respectively.

## 9. Supply Projections and Demand-Supply Situation

The price elasticity used for making beef supply projection based on linear regression model is 0.455 (equation 6) and obtained by summing elasticity estimates of current year, previous year and year before previous year based on polynomial model (equation 7) is 0.710. In the year 2012, production of beef in the country was 1769.0 thousand tones (Anonymous, 2013). The findings based on linear regression model project that production of beef in the years 2020 and 2030 would be about 2157.3 and 2588.8 thousand tones, respectively. The polynomial price lag model projects that in years 2020 and 2030, beef supply would be 2215.4 and 2658.8 thousand tones, respectively. Thus based on linear and polynomial price lag models, beef supply would grow at annual compound rates of 2.1 and 2.3 percent by year 2030, respectively. During last thirty-two years (1980-81 to 2011-12), beef production has grown at 4.6 percent per annum. Thus, it is projected beef production would grow at about half of the former pace. Dominance of non-commercialized cattle and buffalo farming mainly for milk production with small herd size is the main reason decreasing growth rate in beef production. Pre-feasibilities studies conducted on calf fattening indicate that economical herd size is 24 heads (Anonymous, 2014). While average cattle and buffalo herd sizes in the country are 4.8 and 4.6 respectively (Anonymous, 2006a). Low pace of technological adoption, increasing cost of production and diminishing farmers' capacity to invest in calf fattening are other reasons of decrease in growth rate of beef production.

The base year data (2012) show that there is excess of beef in the country i.e. demand closely followed the supply. Total demand and supply of beef in the country were 1590.2 and 1769.0 thousand tones, respectively. It is projected that by the year 2020, total demand and supply would be 3300.1 and 2215.4 thousand tones, respectively. Therefore, deficit in beef supply would be 1084.7 thousand tones. Total demand and supply of beef by the year 2030 are projected at 4263.4 and 2658.5 thousand tones, respectively. Thus, deficit in beef supply would by 1604.9 thousand tones.

## 10. Conclusion & Recommendations

Beef is an essential food item, having positive income elasticity. The consumption behavior reveals that urban population on an average consumes more beef than rural population in the country. Beef consumption is increasing with income group hierarchies, from very low to very high income groups both in rural and urban regions. The demand for beef is more income elastic in rural areas as compared to urban regions. This implies

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that increase in per capita income of the people would stimulate demand for beef more in rural areas that in the urban regions. Own price elasticity of beef has a positive sign, indicating that instead of increase in beef prices in real terms over time, an increase in its demand has occurred. The demand for beef is expected to increase at higher rate than its production growth rate. This implies that deficiency in beef production would continue and even rise further in next two decades. Thus, policy reforms are required to encourage beef production in the country.

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