DEMAND AND SUPPLY PROJECTIONS FOR FOOD GRAINS IN PAKISTAN: 2015-2030

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IN THE NAME OF

ALLAH

The Most Beneficent

The Most Merciful

"To Allah belongs whatever is in the heavens and whatever is in the earth. Whether you show what is within yourselves or conceal it, Allah will bring you to account for it. Then He will forgive whom He wills and punish whom He wills, and Allah is over all things competent."

(Al-Baqarah, 2:284)

GOLDEN SAYING OF

THE HOLY PROPHET

(Peace and Blessings of Allah be Upon Him)

“Do not wish to be like anyone except in two cases. (The first is) A person, whom Allah has given wealth and he spends it righteously; (the second is) the one whom Allah has given wisdom (the Holy Qur'an) and he acts according to it and teaches it to others”.

(Al-Hadith)

DEDICATED

TO

THE CHILDREN DIED DUE TO

MALNUTRITION IN THAR

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LIST OF ABBREVIATIONS

MDGs	Millennium Development Goals
SDGs	Sustainable Development Goals
GDP	Gross domestic product
FAO	Food and agriculture organization
LA-AIDS	Linear Approximate Almost Ideal Demand System
CSPI	Corrected stone price index.
SPI	Stone price index
CES	Constant elasticity of Substitution
HIES	Household Integrated Economic Survey
AIDS	Almost Ideal Demand System
PIGLOG	Price independent general linear log functions
NSS	National sample survey
QUAIDS	Quadratic Almost Ideal Demand System
ARIMA	Auto regressive integrated moving average
FCDS	Food characteristic demand system
PSLM	Pakistan social and living standard Measurement
OLS	Ordinary least square
CD	Cobb Douglas
SUR	Seemingly unrelated regression
R&D	Research and development

ABSTRACT

This study presents projections for demand and supply of food grains (wheat and rice) for 2015, 2020, 2025 and 2030 as these are the two main staple foods for majority of Pakistani population. The LA-AIDS model is used to calculate expenditure elasticities of different food groups by taking HIES data set (2010-11). By using the estimates the demand for food grains is projected under different scenarios: pessimistic, business-as-usual and optimistic. The supply of food grains is projected by Cobb Douglass production function using time series data (GOP, 2010-11) on agriculture variables. The results of this study show that there will be demand and supply gap (deficit) for the wheat and it will be mainly due to increase in population and economic growth. Other factors important to determine food demand are urbanization and income distribution. There will be surplus in case of rice but it will reduce year by year resulting in reduction of rice' exports in the years to come. There will be deficit of 12978 thousand tons for wheat while surplus of 1094 thousand tons for rice when the population and per capita income will grow at the rate of 2 percent, 3 percent and 4 percent respectively, in 2030, due to increasing population and economic growth. To cope with projected deficit the findings of this study recommended to formulate food production policy based on investment in R&D for provision of improved inputs (seed, fertilizer, technology and pesticides) along with construction of new water reservoirs for area expansion in long run.

CHAPTER 1

INTRODUCTION

Pakistan joined the United Nations Millennium summit and adopted the millennium declaration in the year 2000 to make efforts for achieving the Millennium Development Goals (MDGs).The achievement of MDGs is the numerical measurement of the development efforts made by any country. In particular, the first millennium development goal out of eight is to "*eradicate extreme poverty and hunger*". The target set under this goal is to "*Halve, between 1990 and 2015, the proportion of people who suffer from Hunger*" (UN, 2000). As one year is remaining, in the achievement of MDGs, it is of grave importance to investigate the current as well as future situation of food security in Pakistan. The importance of food security could also be judge by its inclusion in Sustainable Development Goals (SDGs); an agreement among 192 UN member states to develop future international development goals beyond the 2015.

Pakistan is the 6th most populous country of the world and it would retain same position by 2050 (Government of Pakistan, 2014). Its population is growing at fast rate; therefore, it will be a big challenge for Pakistan to feed its ever growing population. Moreover, floods and food price inflation have also adversely affected the food security situation in Pakistan. The food supply is the source of feeding Pakistan's rapidly increasing population. The critical questions which arise here are: what would be the growth rate of demand for food? And how long we shall take time to reach the demand and supply equilibrium? The growth in income and population are very crucial for projecting the demand for food grains. According to the Engle's law the increase in income results in the increase in demand for food but less than proportionately, so as the households' incomes increases their spending on food decreases up to a saturation point, after which any rise in income becomes non responsive to the demand for food. Hence the income distribution will be the most important determinant of the demand for food of the household. The poorer households' expenditure on food will increase faster when their income will grow faster because the poor households spend large share of their income on food. In case of Pakistan, we don't have equalitarian income growth scenario in near future, we would have sustained demand growth in the long run due to the high population growth rate, while there would be slower demand growth in short term as well as in midterm. The forecasting precision of future food demand will depend on population and income growth.

Pakistan has very high population growth rate, high concentration of poor households, low per capita income, and a moderate rate of GDP growth rate. Given these limitations it is important to analyze the demand and supply of main staple crops *i.e.* wheat and rice. Availability of food is the first requirement of food security. Definition of food security adopted at 1996 World Food Summit: "*Food security …[achieved] when all people, at all time, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (FAO 1996b).

The supply of food grains has been impressive in Pakistan for the period 1960-90 but in the last two decades, unfortunately, adequate availability of food grain has also become a serious concern. One important element of national food availability is the move toward food self-sufficiency for Pakistan which has very large population and limited resources in terms of arable land, water and energy. Moreover, considerable increase in gross domestic product (GDP) has been observed over the last decade. An increase in real per capita GDP leads to higher per capita expenditures level which leads to consumption of higher valued consumer ready products (e.g. fruits, meat and dairy products). In a country like Pakistan where majority of population is poor, so it is expected that only a fraction of people will be in a position to switch from food grains to high calorie food. Most of the population will need to spend more on food grains to meet its calorie need with rise in their income level. There has been marginal decline in per capita food consumption of food grains over a period of last 10 years. Demand for food consumption is increasing over time mainly due to increasing population.

Undoubtedly, agriculture is the backbone of many economies in this world. It has large share in the GDP of many growing economies. Currently, agricultural sector accounts for 21 percent of GDP of Pakistan (GOP, 2014). Irrespective of the fact that the share of agriculture sector in GDP of Pakistan has decreased from 53 percent in 1950-51 to 21 percent in 2013-14 yet it is still foremost sector of Pakistan' economy. Agriculture sector in general and crop sub sector in particular, has been suffering from sharp decline since last two decades in spite of its importance to economic growth, food security and exports. The low productivity and high population growth rate is raising question mark on food security in general and availability of food grains in particular, for Pakistan. Therefore, it is of grave importance to investigate food grain demand and supply position for the years to come. The factors like growth in population, rise in per capita income, increase in urbanization, economic growth, shifts in preferences and tastes, etc. would affect the future food demand.

Food security provision both at household level and national level should be the major policy concern for the government.

Keeping in view the above discussion this study is designed to include the estimation and projection of food grains' demand and supply situation in 2015, 2020, 2025 and 2030 for Pakistan.

1.1 STATEMENT OF THE PROBLEM

This study is designed to project the demand and supply of food grains in Pakistan for the years: 2015, 2020, 2025 and 2030

1.2 OBJECTIVES OF THE STUDY

The principal objectives of the study will be as under:

- To assess the demand and supply of food grains (wheat and rice) for the year 2015, 2020, 2025 and 2030 in Pakistan.
- To use and compare the elasticities estimates via LA-AIDS results using Stone Price Index (SPI) & Corrected Stone Price Index (CSPI) for assessment of demand.
- To develop possible scenarios (optimistic, business as usual and pessimistic) for analysis based on different assumptions about per capita income and population growth rates.

1.3 RESEARCH QUESTION

This study would test the following research question

Will Pakistan be able to feed its population, or will it need to import food grains in next 15 years?

1.4 SIGNIFICANCE OF THE STUDY

This study contributes to the existing literature in a way that, it estimates demand and supply of cereals and forecast the food availability situation by assuming different scenarios of income and population growth rates like optimistic, business as usual and pessimistic scenarios as for raising the future supply of food grains by making investment in research and development, the accurate measure of future demand for food grains is essential and the reliable estimates of expenditure/income elasticities are perquisite for projecting the future demand for food grains. Since the demand projections are based on most recent data and realistic assumptions about population and income growth rate so the findings of this study *"portray better picture of future food availability situation"* and offer base to policy makers for formulization of sound policies to meet the future food grains' demand.

1.5 DELIMITATION OF THE STUDY

This study is limited to include only the demand and supply projections of food grains namely wheat and rice. Present research will not incorporate the detail analysis (demand and supply gap) of other food commodities like pulses, fruits, vegetables, milk, oil and meat etc.

1.6 ORGANIZATION OF THE STUDY

The remaining study is organized as:

The review of the existing related literature is discussed in Chapter 2. The demand modeling and forecasting is included in Chapter 3 while the supply modeling and forecasting is narrated in Chapter 4. The results and their interpretation is given in Chapter 5. Chapter 6 includes conclusion of the study and policy recommendations.

CHAPTER 2

REVIEW OF LITERATURE

There exists lot of literature on the food consumption pattern of rural as well as urban households of Pakistan. However, there is need to work on projections of food grains' demand and supply. There are only few studies available in Pakistan and some other parts of the world which projected food grains' demand and supply using appropriate econometric modeling, but of all these studies, only few, the most relevant studies are narrated in the literature review.

Azhar *et al* (1972) developed the econometric model for estimating and predicting the wheat production in Pakistani Punjab. They formulated linear model by taking the production of wheat in thousands ton as dependant variable and area under Mexi-Pak wheat, area under local varieties, nutrients of fertilizer and total rain fall in inches (in the month of November, December and January) as independent variables. The regression was run for barani, partial barani and irrigated zone separately. They compared their results with actual output and found them very close to the predicted output by using the model which they developed but there was found a problem of auto correlation which was not removed and they ignored temperature, irrigation water and wheat prices which have significant impact on wheat production.

Chaudhry and Kemal (1974) determined the wheat output by using different production functions. In an earlier study by Azhar *et al.*, (1972) it was found that the linear relationship between wheat production and the set of independent variables is the best predictor for wheat forecast. They used CES (constant elasticity of Substitution) and Cobb Douglas production function. By comparing the value of R^2 they reported the linear relationship model as a best fit. Further, they found that the seven month rain fall (July-January) yields more favorable results as compared with three months rain fall in wheat production.

Khan (1975) conducted the study to project the demand of important food items in case of Pakistan. He analyzed the importance of demand estimates for food items in agricultural development of Pakistan by using the data of HIES (House hold integrated Economic survey) for 1963-64. He used the Engel's curve for demand projections. He explored that the growth in population, per capita income, industrialization, changes in preference of food items and urbanization are main the factors which affects the demand for food. However, the analysis was done by taking into consideration only population growth and per capita income growth. He ignored the grave role of expenditure elasticity in the projections of demand for food.

Siddique (1982) analyzed the food consumption pattern in Pakistan and validity of Engel's law. She used the HIES data set for the year 1971-72 however, in order to test the stability of consumption behavior she pooled the data from 1968-69 to 1971-72. By specifying log-linear relationship she estimated the elasticities on urban/rural level and on country level. She also estimated the demand growth rate for urban area, rural area and overall Pakistan. She concluded that the Pakistani data do not validate the Engel's law in case of clothing, light & fuel and housing. She did not took in consideration population and income growth rate in making the projection of demand, although population and income growth rates have significant impact on projection of demand for food.

Alderman (1988), a very comprehensive study for Pakistan, obtained the estimates of price elasticities by using HIES (1979) data through almost ideal demand system. He used the price variations for four quarters from published series in which

HIES data were collected due to the non-availability of price in data sets. He used the linear approximated almost ideal demand system but he employed the elasticity formula of AIDS while Green and Alston (1990) reported that the use of AIDS elasticity formula in LA-AIDS is not valid. Furthermore, non-reporting of standard errors made the statistical significance of his elasticities estimates ambiguous.

Burney and Khan (1991) analyzed the consumption patterns of urban and rural sector of Pakistan separately by using HIES data set for the 1984-85 with help of Engel's law. This study endorsed the validity of Engel's law. They found that the expenditure elasticities vary with income groups for different commodities. This study suggested that the degree of economies of scale vary across the commodities, sector and income groups within a sector. They recommend for meeting future demand policy makers should focus on households via expenditure elasticities of rural and urban sector.

Ahmed and Siddiquie (1995) projected the demand and supply of wheat and rice for the period 2009-10. They estimated that demand for wheat would grow from 17.4 mt to 26.5 mt from the 1994-95 to 2009-10 respectively, while production of wheat would increase from 14.8 mt to 20 mt from 1991-92 to 2009-10 respectively. They found that there would need to import wheat around 7 mt in 2009-10. There was a big difference between their forecasted value and the actual value irrespective of the fact that they had used the economic theory and good econometric modeling technique. Why their results were so poor? One main reason was about the assumptions they made for the future. Population is one of the main drivers of demand for food; therefore, it is all the important that one has very reliable population projections based on assumption of credible population growth rate. Their assumptions for population growth rate of 3.1 percent, prices to grow by more than 7 per cent and food supply not to grow beyond a certain margin were flawed. This also indicates another important lesson that causal forecasting many a times results into poor forecasts. Assumption of population growth rate is one of the most critical in nature as demand is mainly driven by it.

Kumar (1997) found that due to urbanization the changes in the basket of food will improve the standard of life by enriching nutritional status of the population. Due to diversification, the increase in income or the fall in prices gives opportunity to the consumer to change their consumption patterns.

Bhalotra and Attfield (1998) investigated the food expenditure pattern of rural households of Pakistan by semi parametric Engel curves based on the Household Integrated Economic survey (1987-88). They used the estimated coefficients of household consumption to draw inference about intra-household consumption pattern and found little gender biasness among children but adult males having more than adult females. They found the non linear Engel Curve for food, child goods, and adult goods. Further, they suggested that "PIGLOG" type demand models are not appropriate.

Farooq *et al* (1999) investigated the farm households' consumption pattern using almost ideal demand system. They used the data set of 177 farm households from Gujranwala, Daska and ferzowala districts (irrigated rice-wheat zone) of Punjab and divided the members in to three categories: children (< 5 Years), adolescents (5-15 years) and adults (over 15 years). They found that all the own price elasticities had expected signs (negative) and statistically significant. In this study meat and pulses were found to be gross substitute whereas paddy and wheat determined as gross complements while dairy products and meat attributed as luxuries by the farm households.

Haung *et al* (1999) examined the demand and supply trends of China's economy and projected the future demand and supply trends by using sophisticated econometric models. They explored the factors that may be responsible for alternative projections. On demand side they have incorporated income, population, urbanization along development of rural markets while on the supply side they have included impact of change in prices, investment in irrigation and research, environmental and institutional changes. They concluded that china will be neither empty, nor become larger exporter of grains in near future.

Goyal and Singh (2002) assessed the existing food supply situation, change in the consumption pattern and demand for food pattern along the projections of food demand and supply for next three decades. They used different data sources including economic survey of India, agricultural statistics at glance, agriculture statistic at brief and five rounds data set of NSS (National sample survey). On supply side they used compound growth rate to predict the values of area, production and yield while on demand side they calculated the income elasticity by using double logarithmic function. The growth in population, per capita income, consumption pattern and urbanization was at the root of projection of demand for foods. They assumed .05 percent decline in population growth rate while 0.3 percent increase in urbanization per annum. Further they recommended the past growth rate may not continue in future so to meet future demand the increase in productivity is essential as area is limited.

Mittal (2006) assessed the structural shift in demand pattern for food items and projected the food demand scene for the year 2020 in India. She used different rounds of National Sample Survey data (NSS) of different periods for estimating demand elasticities with the help of QUAIDS model. The total demand was calculated by adding the direct demand and indirect demand. She forecasted that there would be surplus in case of cereals up to the year 2020.

Ahmad and Arshad (2007) investigated the household budget of both rural and urban households by using Spline Engle equations and taking Household Integrated Economic Survey (HIES) data set for the year 2000-01, in case of Pakistan. They estimated the elasticities of 22 commodities consisted of 12 food and 10 non food commodities. They found that the expenditure elasticities of all commodities positive .The data confirm the validity of Engel's law by and large. The results of this study indicate that urban households are more inclined towards the goods like fish, poultry, meat, edible oils, sugar, dairy and health care. On the basis of changing slopes of Engels curve they recommended that a uniform tax structure like General sales tax could have varying implication on the households' budget and welfare belonging to different income classes.

Abbas *et al* (2007) estimate the wheat productivity and its implication on food security in Pakistan. They used primary data at farm level from Punjab province and secondary data. The farm level survey in Faisalabad, T.T Singh and Jhang districts was conducted in 2003 and again information was collected in 2005 from the same households. They found small farmers did not use weedicides while hailstorm, rainy days in March 2005 along with poor management practices resulted in low productivity of wheat from 2002-03 to 2004-05. This study argues the low domestic production of wheat as compared with domestic consumption resulted in food security. The proper econometric modeling and analysis was missing in this study.

Sher and Ahmed (2008) forecasted the production of wheat by using univariate ARIMA models in case of four provinces as well as of Pakistan. They used the Cobb Douglas production function while the values of inputs were found by ARIMA models. The forecasted values of wheat production for next two years were quite good but for forecasting purposes (more than two to three years) the univariate models are not very useful.

Mittal (2008) projected the demand and supply of wheat, rice, total cereals, pulses oils (edible oil and seed oil) and sugar (sugar and sugar cane) for the year 2011, 2016 and 2021 by using data of various rounds of NSS (National Sample Survey). She estimated the elasticities with help of AIDS model and made a comparison of projections provided by the other scholars. The growth in population as well as per capita income found to be main determinants of demand for food and the low yield was constraint in way of production of cereals. This study recommended the increase in productivity and investment in research and development is inevitable to meet the future demand.

Haq and Arshid (2009) examined the inequality and welfare via food expenditure in both rural and urban areas of Pakistan. They used Gini index, Kakawani(1980), and welfare function, sen (1974) for their analysis taking HIES data set for the year 2005-06. This study confirms the importance of basic food (cereal and dairy products) in welfare of both urban and rural sector of Pakistan. They found the higher value of Gini index indicates that rich families spend more expenditure on meat, dairy and readymade products as compared to the whole

Pakistan. The value of price elasticity of cereal was 0.269 for all Pakistan which depicts welfare is high responsive to the changes in the prices of cereals. They concluded that the current increase in the prices of the food stuff has adversely affected the bottom 20 percent population proportionately than rich families of Pakistan. They recommend that the subsidy given on food items (cereals and pulses) would help poor proportionately more than the rich families.

Kumar *et al* (2009) estimated the demand for food grains for the year *i.e.*, 2011-12, 2016-17 and 2021 in India by incorporating the factors responsible for the change in the demand like urbanization, changes in consumption pattern of regions, dietary pattern, taste, preferences, income and energy requirements. They used households' data conducted by NSS organization to estimate the income elasticities. The FCDS (Food characteristic demand system) model was selected among the other demand systems (Linear expenditure demand system, transcendental logarithmic demand system and normalized quadratic demand system) on the basis of the estimated parameters of demand, as FCDS having lowest income elasticities. They found it to be very difficult for India to meet future demand by only domestic production and suggested enhancement in productivity.

Ahmad (2009) estimated that the net per annum need of wheat is more than 21mmt for 165 million populations plus seed requirement is more than 21 mmt above and beyond the unavoidable post-harvest losses. He determined that the annual per capita availability of wheat for consumption is 128kg per capita per annum. He claimed that international standard of 126kg per capita per person endorses the creditability of his estimates.

Begum and Haese (2010) explored the demand and supply of food items in case of Bangladesh. They used secondary data and Ohkawa's equation for estimation purposes. The Ohkawa's equation incorporated the population growth rate, per capita income growth rate and income elasticity in projecting demand for food items. On supply side they used growth rate for projections of production of food grains. They calculated the price and income elasticity for rice and used income elasticity of wheat (0.71); by Alam (2005) and price elasticity of wheat (-0.88), by Talukder (1989). This study found the production and consumption growth rate of rice and wheat and concluded that there would be greater demand than supply in case of both wheat and rice for the year 2021.

Zulifqar and Chisti (2010) used the simultaneous equation model to estimate demand and supply of wheat crop at Pakistan level. They used time series data for the 1979-80 to 2004-05. They found that the impact of price of wheat is positive and significant on the supply of wheat while it has statistically insignificant impact on the demand for wheat. The supply of wheat is also affected by the use nutrient of fertilizer positively and significantly while demand for wheat is significantly and positively affected by the size of household. They recommended that nutrients of fertilizer attach great importance to future input use.

Kumar *et al* (2011) estimated demand elasticities by using Quadratic Almost Ideal Demand System (QUAIDS) and Food Characteristic Demand System (FCDS) taking NSS data (1983, 1987-88, 1993-94, 1999-00 and 2004-05). This study found that income elasticities vary across income slabs ranging from lowest to highest for cereals group and horticulture respectively. They concluded, increasing trend in price of food would not affect demand for food grains adversely but high value items may be affected adversely so if food price inflation continues it can lead to undernourishment because of shifting of households towards more dietary commodities (wheat and rice).

Haq *et al* (2011) examined the food demand pattern of rural and urban households in Punjab, Pakistan. They used the HIES data set for the year 2004-05 and estimated the elasticities of food items with help of LA-AIDS model by dividing the all the food items into eight groups. They found that demand for all commodity groups was price inelastic and all the expenditure elasticities were positive indicating the normal goods. They determined highest expenditure elasticity for milk group followed by fruits, other foods group, meat group, rice group, vegetables group, wheat group and cooking oil group. They suggested, for food demand analysis, the price and income elasticities should be determine for poor and rich across urban and rural areas at province as well as country level.

Hina *et al* (2012) projected demand and supply of two major cereal in Pakistan from 2010-30 by using Linear Approximate Almost Ideal Demand System (LA-AIDS). They also used the three different scenarios for making projections of cereal demand based on the different assumption about the per capita income growth rate ranging from 2 percent to 4 percent by taking indirect demand also in consideration. The supply of both cereals was estimated by using Cobb Douglas production function for data of the period 1970 to 2009, while to remove the problem of autocorrelation they used Prais-Winsten regression. They concluded that there would be deficit in case of wheat while surplus in case of rice is expected in Pakistan in next 20 years.

Kumar *et al* (2102) projected the demand and supply of the rice and wheat up to 2025 in India. They used the Quadratic Almost Ideal Demand System (QUAIDS) to estimate household demand by using data of National Sample Survey (NSS) for 2004-05. They found negative elasticity for wheat, rice and pulses and checked forecasting ability of the model by comparing the values with the actual values of 1993-94 and 2007-08 which show that forecasting errors are less than 3 percent. By taking in consideration different income growth scenario they forecasted that per capita consumption of wheat and rice would decrease from 6.1 kg to 4.4kg and 5.5 to 4.1kg respectively from 2004-05 to 2025. They incorporated the official population growth forecast and indirect demand to calculate total demand projections and concluded that total demand of wheat and rice would be 91.4–101.7 and 104.7–108.6 million tons respectively in 2025. On supply side they used two approaches for estimating supply of wheat and rice. Firstly, they used Cobb Douglas production function to determine crop output by using national level data of price of competing crops, fertilizer, rain fall and total fertilizer consumption from 1981-82 to 2007-08. Secondly, they determined the crop acreage and crop yield by using data of the period 1981-82 to 2007-08 separately and then estimated crop output as the product of crop acreage and crop yield. By using these models they forecasted the supply of wheat and rice to 93.6-114.4 million tons and 135.5-165.6 million tons respectively based on different scenario of growth in fertilizer and investment. They concluded that in 2025 there would be surplus of rice in range of 26.9-60.9 million tons while there may be surplus or deficit in case of wheat. They suggested that to manage surplus is more big challenge than deficit in India, especially in case of rice.

Mudassar *et al* (2012) estimated the consumer demand for seven food items namely wheat, rice, chicken, mutton, fish, milk and oil in Pakistan by using Household Integrated Economic Survey (2007-08).They used Linear Approximated Almost Ideal Demand System (LA-AIDS) to measure elasticities for urban and rural regions. They found that the uncompensated own price elasticity of all the commodities were negative and less than one except for mutton and fish which were greater than one. They claimed that their results are consistent with other studies which employed the LA- AIDS model for analysis.

Kiani (2013) examined the household consumption pattern and forecasted the future consumption. She used the Household integrated Economic survey (HIES) and Pakistan Social and Living Standard Measurement (PSLM) data sets. The ordinary least square (OLS) was used as econometric technique to estimate the expenditure elasticities by double log model. This study found that the future consumption expenditure would grow at the rate13.8 percent from 2007-16.

Malik *et al* (2014) investigated the food consumption pattern of households and its implication on deterioration of poverty for Pakistan. They used HIES data set of 2010-11 and LA-AIDS model for calculation of the demand elasticities of each food group. They found the expenditure elasticity of wheat, rice, other cereals, pulses, fruit and vegetables, dairy, meat, cooking oil, sugar and other found as 0.77, 0.913, 0.890, 0.713, 0.910, 1.696, 0.823, 0.606, 0.939 and 0.718 respectively which indicates that all goods are normal and the goods having elasticities greater than unity found to be luxury. They concluded the wheat is an important ingredient of dietary needs of all the households notwithstanding their residence area and incomes status. The Increase in the prices of wheat has adversely affected the skill and unskilled workers' purchasing power. They suggested the evaluation of the effects of rise in the price of wheat on malnutrition and food security in Pakistan.

To estimate reliable projections of demand and supply by using appropriate econometric modeling this study is conducted.

CHAPTER 3

MODELING AND FORECASTING DEMAND FOR FOOD GRAINS

This chapter includes the econometric model used to estimate and forecast the total demand for food grains in Pakistan for different periodical segments *i.e.*, 2015, 2020, 2025 and 2030. The following steps are involved in estimating the projections of total demand:

STEP-1: The estimation of demand (expenditure) elasticities of the major food groups by using appropriate (demand model selection) methodology.

STEP-2: The estimation of per capita food expenditure.

STEP-3: To forecast Pakistan's total household demand (direct demand) for food grains by using the estimated expenditure elasticities.

STEP-4: The estimation of Indirect demand requirements of food grains (feed, seed and wastage) in Pakistan.

STEP-5: The computation and projections of total demand at country level (aggregate of households demand and indirect demand). The detail procedure of each step is discussed in the following subsections.

3.1 STEP-1: THE ESTIMATION OF EXPENDITURE ELASTICITIES

In the first step the data and econometric model used for estimation of expenditure elasticities is discussed in detail.

3.1.1 DATA SOURCES AND MINING

This section of step 1 is consisted of the sources and manipulation of data used for purpose of estimation.

3.1.2 SOUCRES OF DATA

In this study we have used survey data recently released by Pakistan Bureau of Statistics; under Household integrated Economic Survey (HIES) for the period 2010-11(most recent data available) in order to evaluate food consumption Pattern of Pakistan's population. The HIES 2010-11 is consisted of 16,341 households taken form 1180 primary sampling units (564 urban & 616 rural). It provides information about the key characteristics like income, education, social indicators and consumption expenditure on different commodities disaggregated by expenditure group in terms of value and quantities of commodities at household level of 6589 urban and 9752 rural households.

3.1.3 THE FORMATION OF FOOD GROUPS

As we are in need of the data of only food items so in the first step the irrelevant items were dropped by using the item code assigned to each item. The data are separated into two major groups *i.e.*, food items group and non food items group. In order to assess the food demand pattern, the data on food commodities are aggregated in to eight food groups as done by other studies (Haq *et al*, 2008; Haq *et al*, 2011and Nazli *et al*, 2012)

(i) wheat group (ii) rice group (iii) fruit group (iv) vegetable group (v) milk group (vi) cooking oil group (vii) meat group (viii) other food group

3.1.4 DATA MINING

To put the HIES data set into use able format the following manipulations are adopted.

i. There are some households having missing values in the HIES data set for food items (value). It is inevitable to fill these missing values because analysis is done via STATA 12. So the "zeros" are put instead of missing observation (dots) either in values or quantities.

ii. We are in need of the prices of food items consumed by the household for estimation purpose. The per unit price is calculated as the ratio of food expenditure and quantity of particular good consumed by the household.

iii. The values of per unit price which were found beyond the lower and upper bounds determined by [mean (per unit price) ± 3 sd (per unit price)] are replaced by lower and upper bounds respectively to remove the outlier. These adjusted prices per units were multiplied by the total quantity to get the adjusted expenditures.

iv. In HIES 2010-11 data sets there are some households who did not consume any particular commodity, so the price of that particular commodity is missing. But for the estimation purposes we are in need of missing observations. For this purpose the missing prices are being replaced by the average prices (Cox and Wohlgenant, 1986).

v. It is a pre-requisite to maneuver the data into the same duration and unit for combining the food items into groups of as survey reports data on monthly and fortnightly basis for different commodities. So the expenditures are calculated for same duration and unit for each group in this study.

3.1.5 DEMAND ELASTICITIES

The demand elasticities are very important factor in determining the projections of demand for food grains. Actually, the methodology adopted for computation of elasticities is the key determinant of the magnitude of demand elasticities. So it is of great importance to use appropriate methodology in estimation of elasticities.

3.1.6 SELECTION OF DEMAND MODEL

The demand for food grains in any country depends upon several factors like growth in population, age, sex, per capita real income, urbanization along changes in preferences and tastes. One of the major issues in economics is to model appropriately the demand of consumers and supply of producers. In empirical analysis the selection of the appropriate model among the all available models for estimation purpose is very crucial step. In case of demand models the researchers have defined many selection criteria however the most important criteria are mentioned below (Wang, halberd and Johnson, 1996):

1. The theoretical consistency.
2. The explanatory (relative) power of model.
3. The simplicity and ease of estimation.

Among demand models the Almost Ideal Demand System (AIDS) model, Rotterdam model and Linear Expenditure System (LES) model have been used widely to estimate consumer demand in applied econometrics. Deaton and Meullbauer (1980) described the superiority of their model “Almost Ideal Demand System (AIDS)” on the basis of following advantages:

1. It satisfies adding-up, homogeneity and symmetry properties.
2. It can be approximated linearly in parameters irrespective of being non linear in parameters.
3. The AIDS model is a first order approximation.
4. The functional form of AIDS model is consistent with household budget data.
5. It is simple and easy to estimate.

Moreover the classical paper of Deaton and Meullbauer (1980) was cited in the social science citation index by 237 times from the 1980 to the 1991 (Buse, 1994). By having Close eye he found out that mostly studies used the LA-AIDS for estimation of the demand system. Especially, in the agriculture economics the demand functions were estimated by using LA-AIDS model. By keeping in view the relative advantages of AIDS model over other models, in this study the Linear Approximate Almost Ideal Demand system (LA-AIDS) model is used for estimation of demand elasticities as used by other studies(Haq *et al*, 2008; Haq *et al*, 2011; Nazli *et al*, 2012 and Malik *et al*, 2014)

3.1.7 THEORETICAL FOUNDATION OF MODEL

Deaton and Muellbauer (1980) were first to introduce the "Almost Ideal Demand System (AIDS). Their primary goal was to improve the "flexible functional form" in the analysis of consumer demand. The "flexible function form approach" used in modeling could be written as

$$F(X) = \sum_n C_n f_n \ (x) \qquad (1)$$

Where:

$F(X)$ = Estimated values of some system

C = Parameters attached to f (Specified by modeler)

n = Number of effects in the model

As the analysts are interested, generally, in two kinds of effects *i.e.*, substitution effect and income effect so the "n =2". The equation (1) is called linear because it sum the equations and remain linear in term of parameters even if the equations which are added to make equation(1) may be non linear. The functions f should be at least twice differentiable to find out the solution. The approximations are called "first order" if the approximations involve just first order differential of equation (1), even if selected functions are or more twice differentiable. The approximations are called "second order" if the approximations involve second order differential which include first order approximations. The AIDS model is a first order approximation.

The neoclassical postulate that consumers maximize their choices is the basic principle of flexible functional form in demand analysis. The equation (1) includes all the usual parameters of consumer behavior *i.e.*, intercept, own and cross price elasticities and income elasticities. The Cobb Douglas (CD) utility function reflecting additive preferences between subsistence level and above subsistence level consumption is at the base of AIDS. By using the notations of Deaton and Muellbauer (1980) when the consumption is divided between subsistence level (a) and above subsistence level or "bliss level" (b) then the Cobb Douglas utility function would become as follow

$$V(q) = a^{1-u}\, b^{u} \qquad (2)$$

Where:

$1-u$ = The proportion of subsistence level consumption

u = The proportion of bliss level consumption

The indirect cost function consisted of utility level derived from consumption may be written as:

$$C(U,p) = (p.a)^{1-u}\ (p.b)^{u} \qquad (3)$$

Where:

p= The price vector

By replacing "$p.a$" and "$p.b$" with general function the in equation (3)

$$C(U,p) = a(p)^{1-u}\ b(p)^{u} \qquad (4)$$

The new specified cost function remains linearly homogeneous in the functions "a" and "b" which, in turn, remain linearly homogeneous in prices, the demand equations derived from it will be homogeneous to a degree zero in prices. The cost functions are called "general linear cost functions" since Cobb Doulas utility function is closely related to Linear Expenditure System (LES). As these cost function and expenditure share are independent of prices so it may be called "Price Independent General Linear Cost Functions" (PIGL).The order of utility level assigned to numerous commodities in a utility function does not change by monotonic transform. Hence the price independent general linear cost function may be written in following form

$$lnC(U,p) = (\,1-u)lna(p) + (u)lna(p) \qquad (5)$$

The above functions are called "Price Independent General Linear Log Functions" or "PIGLOG". Deaton and Meullbauer (1980) started the derivation of AIDS by specifying a (p) and b (p) for this version of "PIGLOG" cost function and specified functions by incorporating Greek letters for parameters.

$$lna(p) = \alpha_0 + \sum_k \alpha_k \, lnp_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \, lnp_k \, lnp_j \tag{6}$$

The equation (6) is called translog price index.

$$lnb(p) = lna(p) + \beta_0 \, \Pi_k \, {p_k}^{\beta_k} \tag{7}$$

By combining equation (6) and (7) and plugging it in to equation (5) it gives AIDS cost function.

$$lnC(U,p) = \alpha_0 + \sum_k \alpha_k \, lnp_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \, lnp_k \, lnp_j + u \, \beta_0 \, \Pi_k \, {p_k}^{\beta_k} \tag{8}$$

The equation (8) describes general flexible form corresponding to equation (1). According to Shepard's Lemma; the first derivative of cost function with respect to price of a commodity yields the demand for equation for same commodity.

$$\frac{\partial C(U,p)}{\partial p_i} = q_i \tag{9}$$

As the demand functions are first order approximation and the AIDS model involve budget share of commodities so by multiplying both sides of equation (9) with $\frac{p_i}{C(U,p)}$ we get equation (10)

$$\frac{\partial C(U,p)}{\partial p_i} \, \frac{p_i}{C(U,p)} = \frac{q_i \, p_i}{C(U,p)} = w_i \tag{10}$$

As the left hand side of equation 10 is elasticity type so equation (10) can be written as:

$$\frac{\partial lnC(U,p)}{\partial ln \, p_i} = q_i \tag{11}$$

The logarithmic differentiation of equation (8) gives market shares

$$w_i = \alpha_i + \sum_j \gamma_{ij} \, lnp_j + \beta_i \, u \, \beta_0 \, \Pi \, {p_k}^{\beta_k} \quad (12)$$

3.1.8 ECONOMETRIC MODEL

By setting equation (8) equal to total expenditure (x), expressing utility (U) and by substituting the results in to equation (12). The budget share equation of AIDS model will be as follow:

$$\boldsymbol{w_i = \alpha_i + \sum_j \gamma_{ij} \, lnp_j + \beta_i ln \left(\frac{x}{P}\right) + \varepsilon_i} \quad (13)$$

Where:

$\boldsymbol{w_i}$ **=** budget share of good i

$\boldsymbol{p_j}$ = price of good j

$\boldsymbol{x}$ **=** expenditure

$\boldsymbol{P}$ **=** Price Index approximated by stone price index ($\ln(P) = \sum_j w_j \ln(P_j)$)

$\boldsymbol{\alpha_i, \gamma_{ij}, \beta_i}$ are parameters

The restrictions imposed for estimation of **AIDS** model are the following

3.1.9 ADDING UP

According to this property the total income/total expenditure should be aggregate of the values of Marshallian demand function as the consumer is assumed to spend all of their incomes. The origin of this restriction is monotonic property of preference and budget restrictions. It is formally written as:

$$P_1 q_1 + P_2 q_2 + \dots + P_n q_n = Y$$

In terms of elasticity this property is expressed as

$$w_1 e_{1y} + w_2 e_{2y} + \ldots + w_n e_{ny} = 1$$

Where

$w_1 =$ budget share of group/commodity one

$e_{1y} =$ Inome/expenditure elasticity of group/commodity one

By this condition the sum of weighted share of income elasticities should equal to 1 or in other words adding up property is satisfied if $\sum_i \propto_i = 1$, $\sum_i \beta_i = 0$, $\sum_i \gamma_i = 0$

3.1.10 HOMOGENEITY

According to this property Marshallian demand functions are homogeneous of degree zero in price and income which implies that optimal level of quantity demanded of commodities remains unchanged when all the prices and incomes are multiplied by a constant. Homogeneity is satisfied if $\sum_j \gamma_{ij} = 0$

3.1.11 SYMMETRY

This restriction means the increase in the price of ith commodity will cause an increase in the compensated quantity demanded of jth commodity equal to the increase in the compensated quantity demanded of ith commodity caused by an increase in the price of jth commodity. Symmetry is satisfied if $\gamma_{ij} = \gamma_{ji}$

Marshallian (uncompensated), Hicksian (compensated) and expenditure elasticities could be derived from equation (2) as follow.(Haq *et al.*, 2008).

Marshalian (ε_{ij}) price elasticity for good *i* with respect to good *j* is

$$\varepsilon_{ij} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} - \delta_{ij} \qquad (14)$$

Hicksian elasticity (e_{ij}) for good *i* with respect to good *j* is

$$e_{ij} = \frac{\gamma_{ij}}{w_i} + w^j - \delta_{ij} \qquad (15)$$

Where δ_{ij} is the Kronecker delta and equals 1 for own price and 0 for cross-price elasticities.

The expenditure elasticity (ηi) is

$$\eta_i = \frac{\beta_i}{w_i} + 1 \qquad (16)$$

3.1.12 STONE PRICE INDEX VS CORRECTED STONE PRICE INDEX

Deaton and Muellbauer (1980) suggested the use of stone price index for linear approximation of the Almost Ideal Demand System (AIDS). The many researchers used and supported the stone price index because it provides better results than translog index (Anderson and Blundell, 1983). But later on, many studies criticized the use of stone price index for the reason that it provides inconsistent parameters (Pashardes, 1993; Buse, 1994 and Moschini, 1995). They argued that stone price index does not satisfy commensurability property (invariant to unit of measurement) of a price index. There were generated many indices by (Moschini,1995) and he gave an easy and simple solution to this issue by making the use of corrected stone price index to get consistent parameter of LA-AIDS model. We have estimated the Linear Approximate Almost Ideal Demand System by using stone price index as well as corrected stone price index. We have also make the comparison of the income elasticities estimated by stone price index (SPI) and corrected stone price index (CSPI).

Stone price index

$$\ln(\mathrm{P}) = \sum_j w_j \ln(\mathrm{P}_j) \qquad (17)$$

Corrected stone price index

$$\ln p^s = \sum_i w_i \ln \frac{p_i}{p_i^0} \qquad (18)$$

p^s = corrected stone price index

p_i^0 = base period price or mean price

3.1.13 Seemingly Unrelated Regression (SUR)

Zellner (1962) introduced the concept of Seemingly Unrelated Regression (SUR). This methodology is based on notion that the regression equations which seem apparently independent but in fact these regression equations are related because the error terms of these equations are correlated. So the equations are called are seemingly unrelated. In SUR the more efficient estimates of regression coefficients and predictions are obtained from the joint analysis of these regression equations. when the two or more unrelated dependent variables are regressed on a set of independent variables (which are not highly correlated and only error terms highly correlated) , than the separate equation by equation estimation through Ordinary Least Square (OLS). It also allows imposing the test restrictions on the parameters involved in equations (Moon and Peron, 2006).

The basic version of SUR model is presented as:

$$Y = X\beta + \mu \qquad (19)$$

The mathematical equations of the LA-AIDS model are written as:

$$\boldsymbol{W}_{(wheat)} = \boldsymbol{\alpha}_{(wheat)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(wheat)} \qquad (20)$$

$$\boldsymbol{W}_{(rice)} = \boldsymbol{\alpha}_{(rice)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(rice)} \qquad (21)$$

$$\boldsymbol{W}_{(fruit)} = \boldsymbol{\alpha}_{(fruit)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(fruit)} \quad (22)$$

$$\boldsymbol{W}_{(vegetables)} = \boldsymbol{\alpha}_{(vegetables)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(vegetables)} \quad (23)$$

$$\boldsymbol{W}_{(milk)} = \boldsymbol{\alpha}_{(milk)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(milk)} \quad (24)$$

$$\boldsymbol{W}_{(cooking\ oil)} = \boldsymbol{\alpha}_{(cooking\ oil)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(cooking\ oil)} \quad (25)$$

$$\boldsymbol{W}_{(meat)} = \boldsymbol{\alpha}_{(meat)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(meat)} \quad (26)$$

$$\boldsymbol{W}_{(other)} = \boldsymbol{\alpha}_{(other)} + \boldsymbol{\gamma_1 lp}_{(wheat)} + \boldsymbol{\gamma_2 lp}_{(rice)} + \boldsymbol{\gamma_3 lp}_{(fruit)} + \boldsymbol{\gamma_4 lp}_{(vegetables)} + \boldsymbol{\gamma_5 lp}_{(milk)} + \boldsymbol{\gamma_6 lp}_{(cooking\ oil)} + \boldsymbol{\gamma_7 lp}_{(meat)} + \boldsymbol{\gamma_8 lp}_{(other)} + \boldsymbol{\beta lp}_{(food)} + \boldsymbol{\varepsilon}_{(other)} \quad (27)$$

The table 3.1 reports the variables and their description used in estimated equations (20) to (27).

Table 3.1: The description of variables

Variables	**Description**
$W_{(wheat)}$	Budget share of wheat group
$W_{(rice)}$	Budget share of rice group
$W_{(fruit)}$	Budget share of fruit group
$W_{(vegetables)}$	Budget share of vegetables group
$W_{(milk)}$	Budget share of milk group
$W_{(cooking\ oil)}$	Budget share of cooking oil group
$W_{(meat)}$	Budget share of meat group
$W_{(other)}$	Budget share of other food group
$lp_{(wheat)}$	Log price of wheat group
$lp_{(rice)}$	Log price of rice group
$lp_{(fruit)}$	Log price of fruit group
$lp_{(vegetables)}$	Log price of vegetables group
$lp_{(milk)}$	Log price of milk group
$lp_{(cooking\ oil)}$	Log price of cooking oil group
$lp_{(meat)}$	Log price of meat group
$lp_{(other)}$	Log price of other food group
α	Parameter(intercept coefficient)
β	Parameter(Total food expenditure)
γ	Price Parameter(coefficient of log prices)
ε	Error term

3.1.14 DESCRIPTIVE STATISTICS

The descriptive statistics about the share of food groups are presented in Table 3.2. The mean of budget share of food groups is 0.19, 0.04, 0.02, 0.10, 0.20, 0.12, 0.09 and 0.24 for the wheat, rice, fruit, vegetables, milk, cooking oil, meat and other food groups respectively. The total observations included in the analysis are 16174 out of total 16341observation in HIES (2010-11) because we dropped the observation which includes the "zero" share of wheat, vegetable, oil and others food. Similarly we have dropped the observation in which the food share contributes more than 70 percent in budget share of households (e.g Grimard, 1996).

Table 3.2: Descriptive statistics about the share of food groups.

Food shares	Total Observations	Mean	Standard Deviation	Minimum	Maximum	Variance
Wheat Share	16174	0.19	0.08	0.01	0.63	0.01
Rice Share	16174	0.04	0.04	0.00	0.37	0.00
Fruit Share	16174	0.02	0.03	0.00	0.37	0.00
Vegetables Share	16174	0.10	0.04	0.01	0.63	0.00
Milk Share	16174	0.20	0.10	0.00	0.67	0.01
Cooking oil Share	16174	0.12	0.04	0.00	0.45	0.00
Meat Share	16174	0.09	0.07	0.00	0.64	0.01
Other Foods Share	16174	0.24	0.07	0.07	0.65	0.01

The figures in table 3.2 show that share of other food group is maximum (0.24) in total food expenditure while wheat share has mean value 0.19. The share of rice has mean value .04 which indicates households spend almost 5 times more on wheat than rice. The share of fruit has minimum mean value 0.02 so the fruit group contributes least in total food expenditures.

The prices of commodities are not directly reported in the HIES data set. It includes the quantities and values of the commodities. The log prices are required in the estimation of LA-AIDS model. For this purpose the value (expenditure) of a commodity is divided by its quantity to calculate the price of a commodity. The descriptive statistics about log prices of all the food groups as well as the total food expenditures (calculated by stone price index and corrected stone price index) are given in the table 3.3.

Table 3.3: Descriptive statistics about the log prices of food groups.

Prices	Total Observations	Mean	Standard Deviation	Minimum	Maximum	Variance
lwheatp	16174	3.32	0.11	2.83	3.61	0.01
Lricep	16174	4.09	0.20	3.53	4.68	0.04
Lfruitp	16174	3.75	0.53	1.23	5.11	0.28
Lvegp	16174	3.53	0.26	2.85	5.01	0.07
Lmilkp	16174	3.87	0.19	3.11	4.28	0.04
Loilp	16174	5.08	0.17	4.61	6.05	0.03
Lmeatp	16174	5.40	0.16	5.00	5.85	0.02
Lotherp	16174	5.20	0.15	4.73	6.47	0.02
lfoodx1*	16174	4.65	0.46	2.19	6.76	0.21
lfoodx1**	16174	9.00	0.47	6.15	11.10	0.22

*Stone price index
** Corrected Stone price index

The figures in table 3.3 show that the mean value of log price is maximum for meat group and minimum for wheat group. The mean log prices of rice, fruit, vegetables, milk, cooking oil and other food groups are 4.09, 3.75, 3.53, 3.87, 5.08 and 5.20 respectively. The log price ranges 2.83 to 3.61 for wheat while it ranges from 3.53 to 4.68 for rice.

3.1.15 ESTIMATED PARAMETERS OF LA-AIDS MODEL

The estimated parameters of LA-AIDS model using stone price index from equation (20) to (27), based on the HIES data (2010-11) are given table 3.4.

Table 3.4: Parameters of LA-AIDS model using stone price index (SPI).

Estimated Parameters of LA-AIDS Model by SPI								
Explanatory Variables	**Budget Share**							
	Wheat	**Rice**	**Milk**	**Fruit**	**Vegetable**	**Oil**	**Meat**	**Other Food**
Constant	0.4495 (0.000)	-0.0194 (0.000)	-0.0551 (0.000)	-0.0191 (0.000)	0.2391 (0.000)	0.1702 (0.000)	-0.1278 (0.000)	0.3626 (0.000)
Wheat Price	0.0924 (0.000)	0.0470 (0.000)	-0.0022 (0.462)*	-0.0185 (0.000)	-0.0027 (0.108)*	-0.0050 (0.009)	-0.0871 (0.000)	-0.0239 (0.000)
Rice Price	0.0470 (0.000)	-0.0868 (0.000)	0.0099 (0.000)	0.0048 (0.000)	-0.0077 (0.000)	-0.0025 (0.019)	0.0175 (0.000)	0.0179 (0.000)
Milk Price	-0.0022 (0.462)*	0.0099 (0.000)	-0.0932 (0.000)	0.0115 (0.000)	0.0115 (0.000)	0.0207 (0.000)	0.0010 (0.713)*	0.0409 (0.000)
Fruit Price	-0.0185 (0.000)	0.0048 (0.000)	0.0115 (0.000)	0.0109 (0.000)	-0.0060 (0.000)	-0.0086 (0.000)	-0.0045 (0.000)	0.0104 (0.000)
Vegetable Price	-0.0027 (0.108)*	-0.0077 (0.000)	0.0115 (0.000)	-0.0060 (0.000)	0.0442 (0.000)	-0.0210 (0.000)	-0.0120 (0.000)	-0.0063 (0.000)
Oil Price	-0.0050 (0.009)	-0.0025 (0.019)	0.0207 (0.000)	-0.0086 (0.000)	-0.0210 (0.000)	0.0606 (0.000)	-0.0531 (0.000)	0.0089 (0.000)
Meat Price	-0.0871 (0.000)	0.0175 (0.000)	0.0010 (0.713)*	-0.0045 (0.000)	-0.0120 (0.000)	-0.0531 (0.000)	0.1589 (0.000)	-0.0207 (0.000)
Other Food Price	-0.0239 (0.000)	0.0179 (0.000)	0.0409 (0.000)	0.0104 (0.000)	-0.0063 (0.000)	0.0089 (0.000)	-0.0207 (0.000)	-0.0272 (0.000)
Total food Expenditures	-0.0114 (0.000)	0.0119 (0.000)	0.0375 (0.000)	0.0074 (0.000)	-0.0148 (0.000)	-0.0150 (0.000)	0.0027 (0.017)	-0.0182 (0.000)
R^2	0.06	0.22	0.10	0.08	0.11	0.20	0.17	0.05
The figures in parentheses are P-values. All the parameters are statistically significant except*								

Source: Author's own calculation

The results of LA-AIDS model using stone price index are displayed in table 3.4 which provide some ideas about the magnitude and signs of the estimated parameters. In the table, one observes the coefficient of each parameter and their corresponding statistical significance as indicated by p-values. The expenditure elasticities are computed for each group on the basis these estimated parameters in next section.

The estimated parameters of LA-AIDS model using corrected stone price index, from equation (20) to (27), based on the HIES data (2010-11) are given in table 3.5.

Table 3.5: Parameters of LA-AIDS model using corrected stone price index (CSPI).

	Estimated Parameters of LA-AIDS Model by CSPI							
	Budget Share							
Explanatory Variables	**Wheat**	**Rice**	**Milk**	**Fruit**	**Vegetable**	**Oil**	**Meat**	**Other Food**
Constant	0.7455 (0.000)	-0.0359 (0.000)	-0.0630 (0.000)	-0.0668 (0.000)	0.3678 (0.000)	0.2405 (0.000)	-0.3795 (0.000)	0.1914 (0.000)
Wheat Price	0.0968 (0.000)	0.0496 (0.000)	-0.0023 (0.441)*	-0.0187 (0.000)	-0.0028 (0.094)	-0.0059 (0.002)	-0.0833 (0.000)	-0.0334 (0.000)
Rice Price	0.0496 (0.000)	-0.0867 (0.000)	0.0090 (0.000)	0.0046 (0.000)	-0.0068 (0.000)	-0.0022 (0.038)	0.0157 (0.000)	0.0169 (0.000)
Milk Price	-0.0023 (0.441)*	0.0090 (0.000)	-0.0961 (0.000)	0.0108 (0.000)	0.0127 (0.000)	0.0223 (0.000)	0.0029 (0.267)*	0.0406 (0.000)
Fruit Price	-0.0187 (0.000)	0.0046 (0.000)	0.0108 (0.000)	0.0109 (0.000)	-0.0059 (0.000)	-0.0084 (0.000)	-0.0046 (0.000)	0.0113 (0.000)
Vegetable Price	-0.0028 (0.094)	-0.0068 (0.000)	0.0127 (0.000)	-0.0059 (0.000)	0.0435 (0.000)	-0.0216 (0.000)	-0.0099 (0.000)	-0.0092 (0.000)
Oil Price	-0.0059 (0.002)	-0.0022 (0.038)	0.0223 (0.000)	-0.0084 (0.000)	-0.0216 (0.000)	0.0600 (0.000)	-0.0524 (0.000)	0.0083 (0.000)
Meat Price	-0.0833 (0.000)	0.0157 (0.000)	0.0029 (0.267)*	-0.0046 (0.000)	-0.0099 (0.000)	-0.0524 (0.000)	0.1475 (0.000)	-0.0158 (0.000)
Other Food Price	-0.0334 (0.000)	0.0169 (0.000)	0.0406 (0.000)	0.0113 (0.000)	-0.0092 (0.000)	0.0083 (0.000)	-0.0158 (0.000)	-0.0188 (0.000)
Total food Expenditures	-0.0377 (0.000)	0.0086 (0.000)	0.0198 (0.000)	0.0090 (0.000)	-0.0218 (0.000)	-0.0156 (0.000)	0.0309 (0.000)	0.0070 (0.000)
R^2	0.11	0.21	0.09	0.14	0.08	0.21	0.21	0.04
Note: The figures in parentheses are P-values. All the parameters are statistically significant except*								

Source: Author's own calculation

3.1.16 SPECIFICATION TEST

In order to detect whether the errors across the equations (budget share equations formulated by the AIDS model) are correlated or not, the Breusch-Pagan test of independent errors is applied for the SUR model.

H_o: No correlation across the equations

H_1: Correlation across the equations

Table 3.6: Breusch-Pagan test of independent errors

	CSPI		SPI	
Test Statistic	Value	Probability	Value	Probability
chi2(21)	13087.825	0.0000	14687.749	0.0000

The results presented in table 3.6 indicate that we reject null hypothesis and accept alternative hypothesis. So it is concluded that the errors across the equation formulated by AIDS model are correlated. As the SUR model provides efficient estimates and prediction when the errors across the equations are correlated so in this study the demand system (LA-AIDS) is estimated using SUR model.

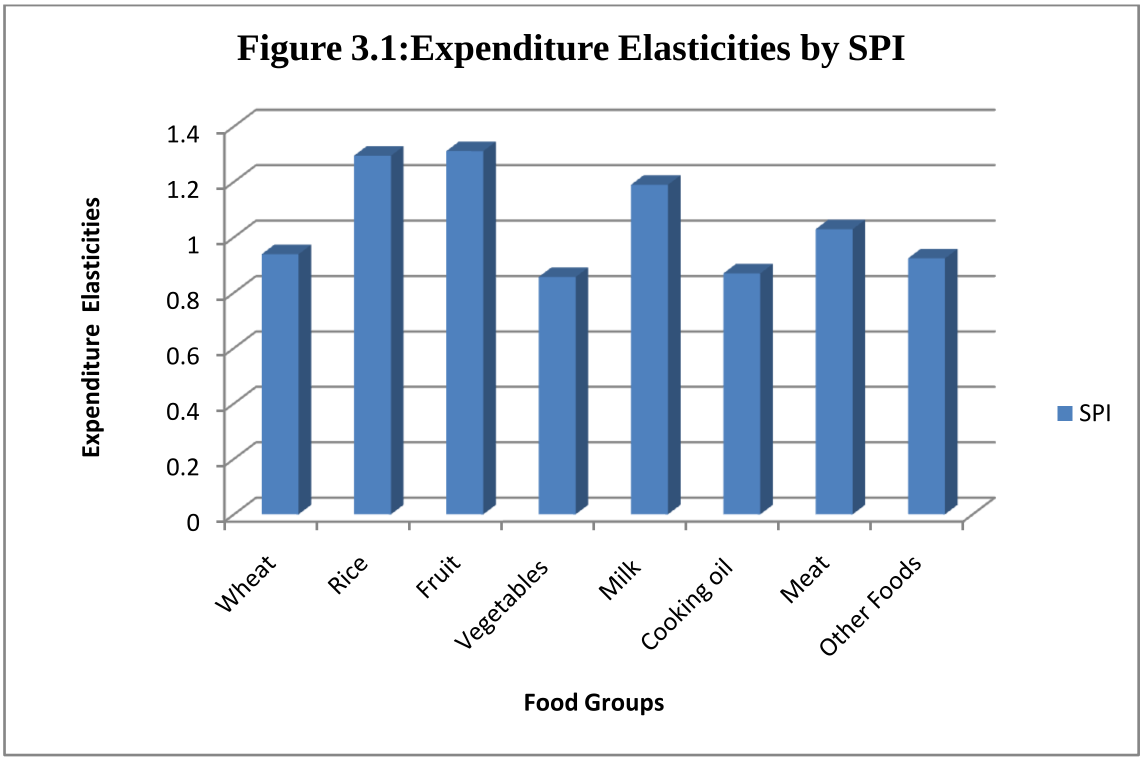
The expenditure elasticities calculated by the Linear Approximate Almost Ideal Demand System(LA-AIDS) using the stone price index and corrected stone price index for the major food groups are given in table 3.7.

Table 3.7: Expenditure elasticities of food groups by SPI and CSPI

Food groups	**Expenditure Elasticities**	
	Corrected Stone price index	**Stone price index**
Wheat	0.80 (0.000)	0.94 (0.000)
Rice	1.21 (0.000)	1.29 (0.000)
Fruit	1.38 (0.000)	1.31 (0.000)
Vegetables	0.79 (0.000)	0.86 (0.000)
Milk	1.10 (0.000)	1.19 (0.000)
Cooking oil	0.86 (0.000)	0.87 (0.000)
Meat	1.33 (0.000)	1.03 (0.000)
Other Foods	1.03 (0.000)	0.92 (0.000)

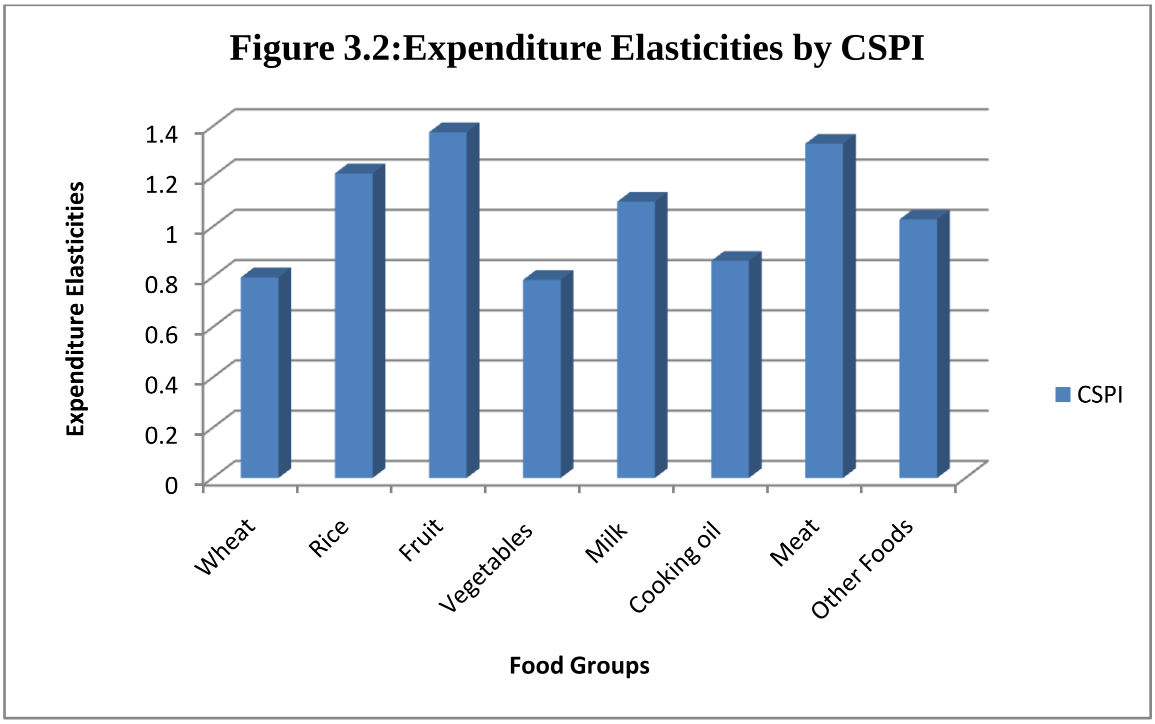
Source: Author’s own calculation based of HIES (2010-11)
Note: The figures in parentheses are P-values.
All the expenditure elasticities found to be statistically significant

There is significant difference between the magnitude of elasticities estimated by the corrected stone price index (CSPI) and the stone price index (SPI) as shown in table 3.7 so the appropriate methodology adopted by the analyst is worthwhile in projecting demand for food grains.



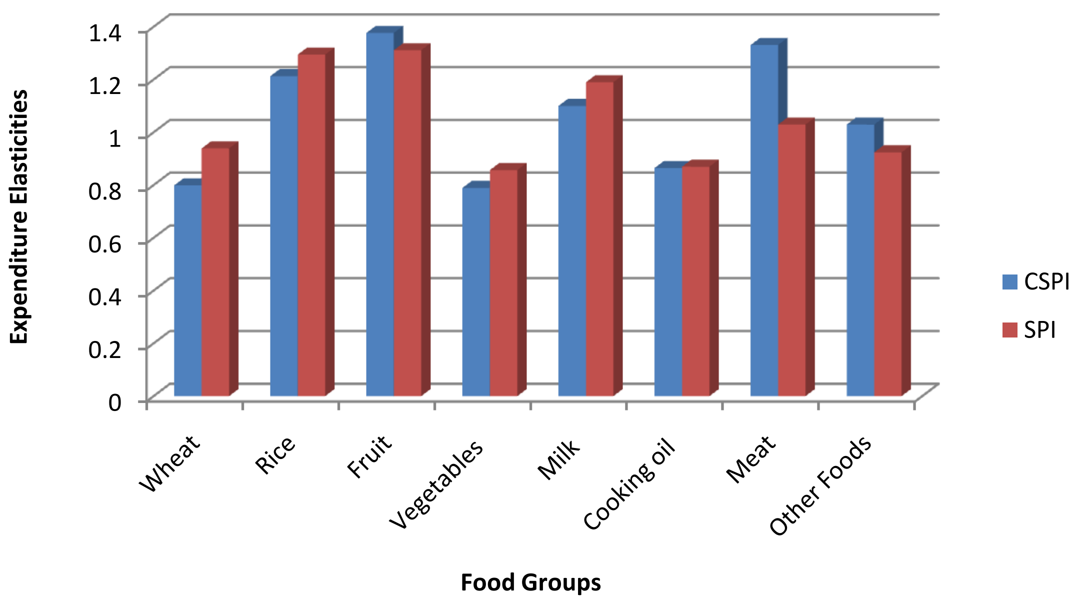
The figure 3.1 shows the elasticities of different food groups calculated by the stone price index ranging from 1.31 to 0.86 for the fruit, rice, milk, meat, wheat, other foods, cooking oil and vegetables respectively. All estimated income/expenditure elasticities are positive. The values of elasticities estimated by stone price index are high relative to the elasticities estimated by Haq *et al*, 2008; Haq *et al*, 2011; Nazli *et al*, 2012 and Malik *et al*, 2014 due to the stone price index used in the estimation of LA-AIDS model.

The figure 3.2 shows the elasticities of different food groups calculated by the corrected stone price index ranging from 1.38 to 0.79 for the fruit, meat, rice, milk, other foods, cooking oil wheat and vegetables respectively.



The figure 3.3 depicts the comparison of the two index (stone price index and corrected stone price index) used for the calculation of the expenditure elasticities. The magnitudes of expenditure elasticities computed by the stone price index are high for the wheat, rice, vegetables, milk and cooking oil groups than the elasticities computed by the corrected stone price index. Whereas the expenditure elasticities are less, for the fruit, meat and other food groups than the elasticities estimated by the corrected stone price index for these groups. The estimated expenditure elasticities of wheat, vegetables and cooking oil are less than one which implies that these items are necessities while estimated income elasticities of rice, fruit, milk, meat and other foods are greater than one which implies that these items are luxuries.

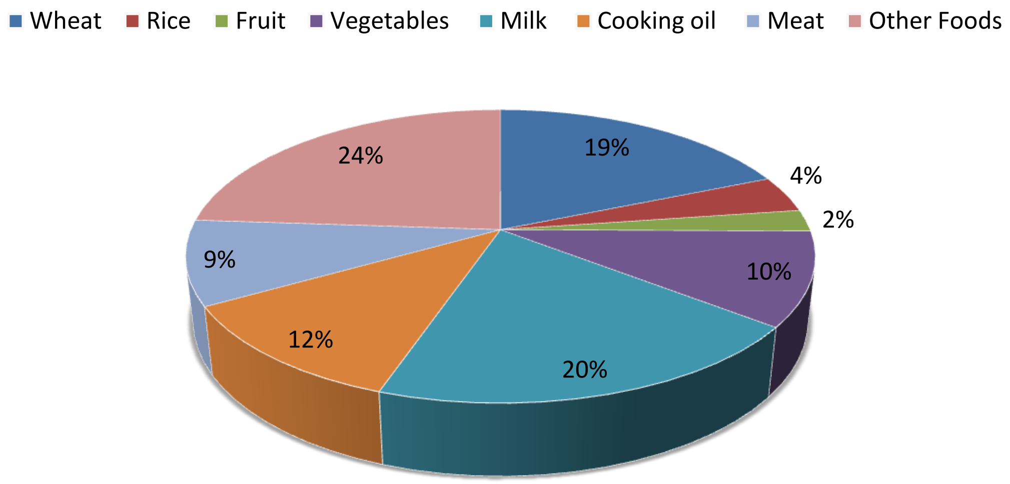
Figure 3.3:Expenditure Elasticities by SPI VS CSPI



All the expenditure elasticities found to be positive. As the elasticities estimated by the corrected stone price index are consistent with other studies in case of Pakistan (Haq *et al*, 2008; Haq *et al*, 2011; Nazli *et al*, 2012 and Malik *et al*, 2014).So for demand projections the elasticities calculated by the corrected stone price index are used instead of expenditure elasticities calculated by the stone price index.

The figure 3.4 reveals the share of food groups in the total budget allocated for food consumption. The share of food groups are calculated on the basis of Household Integrated Economic Survey (2010-11); the most recent data available. The households' share on wheat, rice, fruit, vegetable, milk, cooking oil, meat, and other food found to be 19 percent, 4 percent, 2 percent, 10 percent, 20 percent, 12 percent, 9 percent and 24 percent respectively.

Figure 3.4:Share of Food Groups in Total Budget for Food Consumption using CSPI for Overall Pakistan, 2010-11



3.2 STEP 2: THE ESTIMATION OF PER CAPITA FOOD CONSUMPTION

The monthly per capita consumption of the different food commodities calculated from HIES (2010-11) are give in table 3.8.

Table 3.8: Monthly per capita consumption of food commodities

(Kilogram per month)

Food groups	Per Capita Consumption
Wheat	8.50
Rice	1.10
Fruit	0.84
Vegetables	2.09
Milk	2.83
Cooking oil	0.18
Meat	0.29
Other Foods	2.92

Source: Author's own calculation based on HIES (2010-11)

Pakistan is 6th most populous county of the world and it is expected that it would remain at same position (sixth) by 2050. Currently, Pakistan's population is growing approximately at the rate of 1.95 percent and the figure for the base period (2010-11) taken in this study is 177.10 million (GOP, 2014). As the population is the one of the major determinant of demand for food items so we have developed three scenarios for making the projection about population. According to these scenarios the population of Pakistan is assumed to grow at rate of 1.5 percent, 1.9 percent and 2.4 percent under three situations. The table 3.9 shows the figures about population projections by 2030.

Table 3.9: Projected population based on different growth rates.

(Million)

Year	**Growth Rates**		
	1.5 percent	**1.9 percent**	**2.3 percent**
2015	187.97	190.95	193.96
2020	202.49	209.79	217.32
2025	218.14	230.49	243.49
2030	235.00	253.24	272.81

Population was projected by using the following formula.

$$P_f = P_p \times (1 + i)^n$$

Where:

P_f = Future population

P_p = Present Population

i = Growth rate *i.e.*, 1.5 percent, 1.9 percent and 2.3 percent

n = Number of years

3.3 STEP 3: FORECASTED HOUSEHOLDS' DEMAND FOR FOOD GRAINS

The per capita income plays key role in estimating demand for food grains at household level. But the time series data on households' incomes are not available. We have used per capita income in this study for projecting the future income level. In the recent past the per capita income growth rate has been very low in Pakistan. We have developed three scenarios on the basis on per capita income growth rate in last decade. First, the "pessimistic scenario" which assumes that per capita income will grow at rate of 2 percent per annum. Second, the "business-as-usual scenario" which assumes that per capita income will grow at the rate of 3 percent per annum in future. The third scenario is "optimistic scenario" which assumes that the per capita in will grow at the rate of 4 percent per annum in future. We have projected demand for wheat and rice till 2030 based on the following equation under three scenarios of population and per capita growth rates as Goyal and Singh (2002), Mittal (2008) and Kumar et al (2009) have also used the same equation for projecting demand for food grains in case of India.

Households' demand for food grains is projected by using the following formula.

$$D_t = d_0 * N_t(1 + y * e)^t$$

Where:

D_t = Household demand of a food group in a year t

d_0 = Per capita demand of a food group in base year

N_t = Projected population in a year t

y = Per capita income growth rate *i.e.*, 2 percent, 3 percent and 4 percent

e = Expenditure elasticity for a food items

t = Number of years

The direct demand (households demand) for food grains (wheat and rice) is calculated in the following tables by taking different scenarios in consideration.

Table 3.10: Projected household demand for wheat and rice by assuming population will grow at rate of 1.5 percent.

('000' tons)

Year	Pessimistic		Business-as-usual		Optimistic	
	Wheat	Rice	Wheat	Rice	Wheat	Rice
2015	20429	2730	21081	2862	21747	2998
2020	23826	3315	25569	3684	27424	4090
2025	27788	4024	31013	4744	34583	5581
2030	32408	4886	37616	6108	43610	7615

Source: Author's own calculation

Table 3.11: Projected household demand for wheat and rice by assuming population will grow at the rate of 1.9 percent.

('000' tons)

Year	Pessimistic		Business-as-usual		Optimistic	
	Wheat	Rice	Wheat	Rice	Wheat	Rice
2015	20753	2774	21415	2907	22092	3045
2020	24685	3434	26490	3817	28412	4237
2025	29361	4252	32769	5012	36540	5897
2030	34923	5265	40535	6582	46994	8206

Source: Author's own calculation

Table 3.12: Projected household demand for wheat and rice by assuming population will grow at the rate of 2.3 percent

('000' tons)

Year	Pessimistic		Business-as-usual		Optimistic	
	Wheat	Rice	Wheat	Rice	Wheat	Rice
2015	21081	2817	21753	2953	22441	3093
2020	25571	3557	27441	3954	29432	4390
2025	31016	4492	34616	5295	38601	6229
2030	37622	5672	43667	7090	50626	8840

Source: Author's own calculation

3.4 STEP 4: THE ESTIMATION OF INDIRECT DEMAND REQUIREMENTS OF FOOD GRAINS (FEED, SEED AND WASTAGE) IN PAKISTAN.

The data on production of wheat and rice is reported by Agriculture Statistics of Pakistan however it does not report data separately on demand for feed, seed and wastage. The 10 percent of wheat and 6 percent of rice is taken as indirect demand (feed, seed and wastage) out of the total production (GOP, 2011). The data report that indirect demand grew at the rate of 3 percent in the last decade. We have assumed that this trend will continue in future so we have projected indirect demand for wheat and rice for 2015, 2020, 2025 and 2030 on the basis of same growth rate as of last decade in the table 3.13.

Table 3.13: Projected Indirect demand (feed, seed and wastage) for wheat and rice.

('000' tons)

Year	Wheat	Rice
2015	2822	325
2020	3249	375
2025	3740	434
2030	4306	501

Source: Author's own calculation

The table 3.13 shows that the indirect demand for wheat will be 2822, 3249, 3740 and 4306 thousand tons in the year 2015, 2020, 2025 and 2030 respectively. While the indirect demand for rice will be 325, 375, 434 and 501 thousand tons in the year 2015, 2020, 2025 and 2030 respectively.

3.5 STEP 5: THE ESTIMATION OF TOTAL DEMAND FOR FOOD GRAINS IN PAKISTAN.

The total demand for food grains is aggregate of direct demand (household demand) and indirect demand (feed, seed and wastage). The table 3.14 represents the projections of total demand for food grains when population will grow at the rate of 1.5 percent under three scenarios: pessimistic (per capita income grows at the rate of 2 percent), business-as-usual (per capita income grows at the rate of 3 percent) and pessimistic (per capita income grows at the rate of 4 percent). The figures indicates that the total demand for wheat will increase from 23251 to 36714, 23903 to 41922 and 24569 to 47916 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively, from 2015 to 2030, while the demand for rice will increase from 3055 to 5387, 3187 to 6609 and 3323 to 8116 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively, from 2015 to 2030.

The table 3.15 shows the projected household demand for wheat and rice assuming that population growth rate will be 1.9 percent in future. The figures in the table 3.14 indicate that the total demand for wheat will increase from 23575 to 39229, 24237 to 44841 and 24914 to 51300 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively, from 2015 to 2030, while the demand for rice will increase from 3099 to 5766, 3232 to 7083 and 3370 to 8707 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively, from 2015 to 2030.

The table 3.16 narrates the projected household demand for wheat and rice assuming that population growth rate will be 2.3 percent in future. The figures in the table 3.15 depict that the total demand for wheat will increase from 23903 to 41928, 24575 to 47973 and 25263 to 54932 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively, from 2015 to 2030, while the demand for rice will increase from 3142 to 6173, 3278 to 7591 and 3418 to 9341 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively, from 2015 to 2030.

Table 3.14: Projected total demand for wheat and rice assuming population growth rate 1.5 percent.

('000' tons)

Year	Pessimistic						Business-as-usual						Optimistic					
	WHD	WID	WTD	RHD	RID	RTD	WHD	WID	WTD	RHD	RID	RTD	WHD	WID	WTD	RHD	RID	RTD
2015	20429	2822	23251	2730	325	3055	21081	2822	23903	2862	325	3187	21747	2822	24569	2998	325	3323
2020	23826	3249	27075	3315	375	3690	25569	3249	28818	3684	375	4059	27424	3249	30673	4090	375	4465
2025	27788	3740	31528	4024	434	4458	31013	3740	34753	4744	434	5178	34583	3740	38323	5581	434	6015
2030	32408	4306	36714	4886	501	5387	37616	4306	41922	6108	501	6609	43610	4306	47916	7615	501	8116

Source: Author's own calculation
Note: WHD =Wheat household demand, WID = Wheat Indirect demand, WTD = Wheat total demand, RHD = Rice household demand, RID = Rice indirect demand, and RTD = Rice total demand

Table 3.15: Projected total demand for wheat and rice assuming population growth rate 1.9 percent.

('000' tons)

Year	Pessimistic						Business-as-usual						Optimistic					
	WHD	WID	WTD	RHD	RID	RTD	WHD	WID	WTD	RHD	RID	RTD	WHD	WID	WTD	RHD	RID	RTD
2015	20753	2822	23575	2774	325	3099	21415	2822	24237	2907	325	3232	22092	2822	24914	3045	325	3370
2020	24685	3249	27934	3434	375	3809	26490	3249	29739	3817	375	4192	28412	3249	31661	4237	375	4612
2025	29361	3740	33101	4252	434	4686	32769	3740	36509	5012	434	5446	36540	3740	40280	5897	434	6331
2030	34923	4306	39229	5265	501	5766	40535	4306	44841	6582	501	7083	46994	4306	51300	8206	501	8707

Source: Author's own calculation
Note: WHD =Wheat household demand, WID = Wheat Indirect demand, WTD = Wheat total demand, RHD = Rice household demand, RID = Rice indirect demand, and RTD = Rice total demand

Table 3.16: Projected total demand for wheat and rice assuming population growth rate 2.3 percent.

('000' tons)

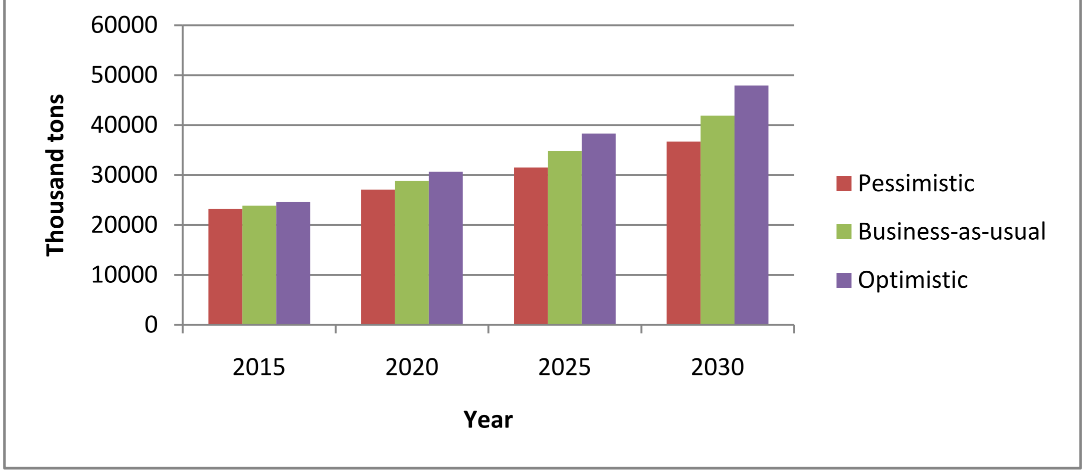
Year	**Pessimistic**						**Business-as-usual**						**Optimistic**					
	WHD	WID	WTD	RHD	RID	RTD	WHD	WID	WTD	RHD	RID	RTD	WHD	WID	WTD	RHD	RID	RTD
2015	21081	2822	23903	2817	325	3142	21753	2822	24575	2953	325	3278	22441	2822	25263	3093	325	3418
2020	25571	3249	28820	3557	375	3932	27441	3249	30690	3954	375	4329	29432	3249	32681	4390	375	4765
2025	31016	3740	34756	4492	434	4926	34616	3740	38356	5295	434	5729	38601	3740	42341	6229	434	6663
2030	37622	4306	41928	5672	501	6173	43667	4306	47973	7090	501	7591	50626	4306	54932	8840	501	9341

Source: Author's own calculation

Note: WHD =Wheat household demand, WID = Wheat Indirect demand, WTD = Wheat total demand, RHD = Rice household demand, RID = Rice indirect demand, and RTD = Rice total demand

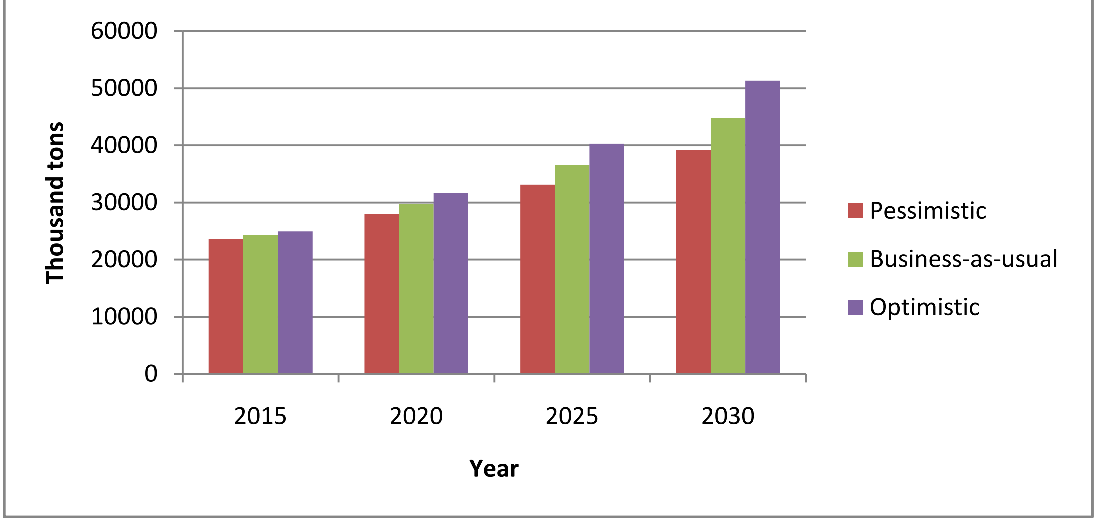
The change in total demand for rice and wheat due to the change in growth rate of per capita income and population is graphically represented in the following graphs.

Figure 3.5: Projected demand for wheat based on 1.5% population growth rate



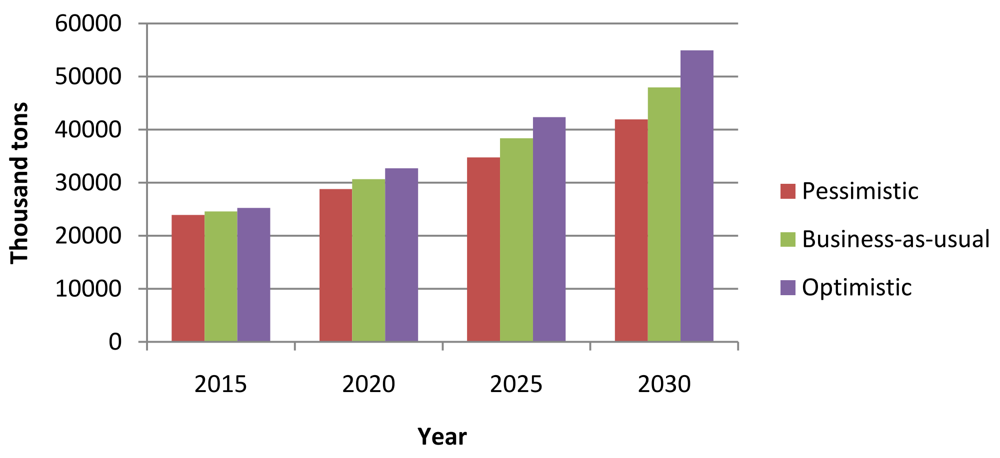
The figure 3.5 reveals the change in the projected total demand for wheat by assuming that population will grow at the rate of 1.5 percent in future. The demand will increase from 23251 to 36714, 23903 to 41922 and 24569 to 47916 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively from 2015 to 2030

Figure 3.6: Projected demand for wheat based on 1.9% population growth rate



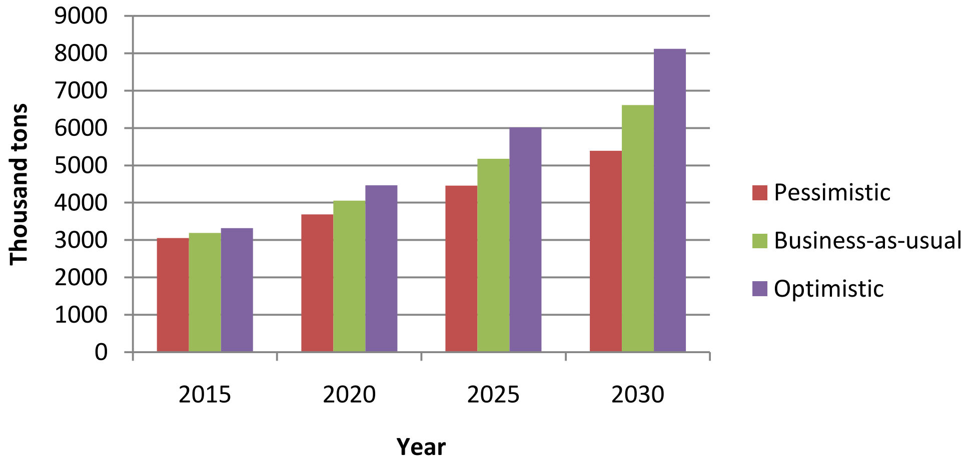
The bar graphs in figure 3.6 show the change in the projected total demand for wheat by assuming that population will grow at the rate of 1.9 percent in future. The demand for wheat will increase from 23575 to 39229, 24237 to 44841 and 24914 to 51300 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively from 2015 to 2030. So the demand for wheat will be more than double in 2030 as compared with demand in 2015.

Figure 3.7: Projected demand for wheat based on 2.3% population growth rate



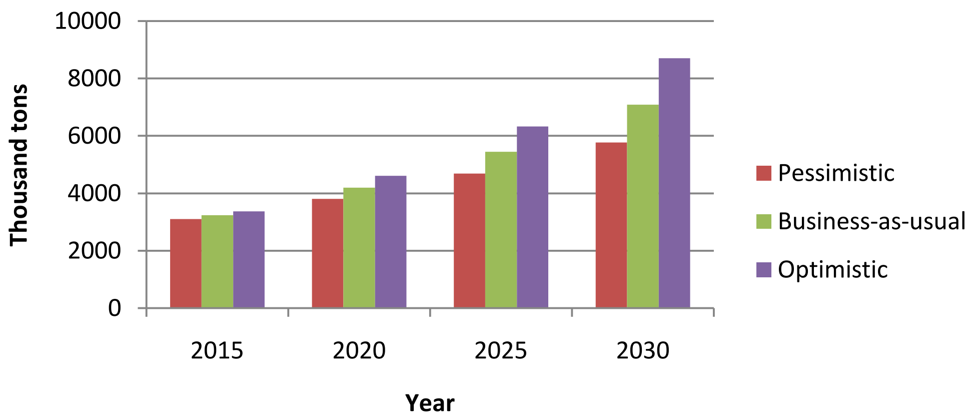
The figure 3.7 shows the projected demand for wheat in 2015, 2020, 2025 and 2030 by assuming that population will grow at the rate of 2.3 percent in future. The demand for wheat will increase from 23903 to 41928, 24575 to 47973 and 25263 to 54932 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively from 2015 to 2030. The figure 3.7 tells that demand for wheat will be almost double in 2030 as compared with demand in 2015 under pessimistic as well as business-as-usual scenarios while the demand for wheat will be more than double under optimistic scenario in 2030 as compared with demand for wheat in 2015.

Figure 3.8: Projected demand for rice based on 1.5% population growth rate



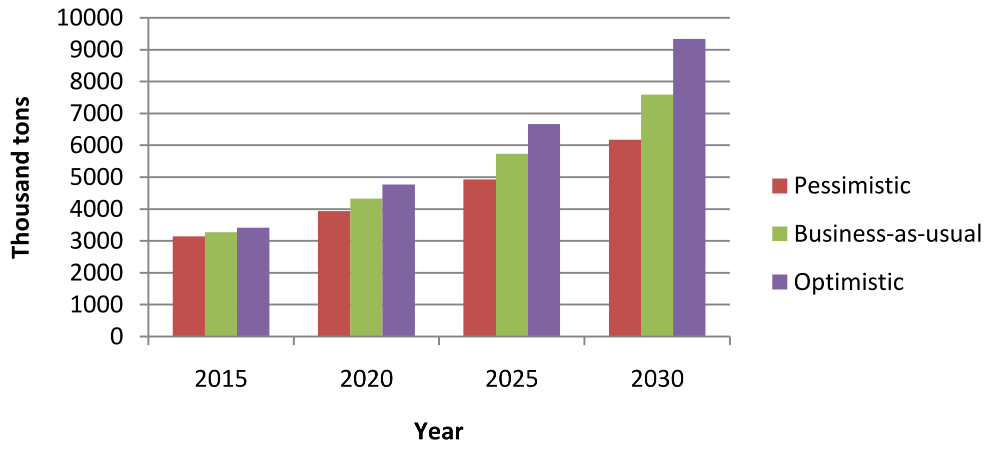
The figure 3.8 shows the change in the projected total demand for rice by assuming that population will grow at the rate of 1.5 percent in future. The demand for rice will increase from 3055 to 5387, 3187 to 6609 and 3323 to 8116 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively from 2015 to 2030. So the demand for wheat will be more than double in 2030 as compared with demand in 2015.

Figure 3.9: Projected demand for rice based on 1.9% population growth rate



The figure 3.9 reveals the change in the projected total demand for rice by assuming that population will grow at the rate of 1.9 percent in future. The demand will increase from 3099 to 5766, 3232 to 7083 and 3370 to 8707 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively from 2015 to 2030.

Figure 3.10: Projected demand for rice based on 2.3% population growth rate



The figure 3.10 shows the projected demand for rice in 2015, 2020, 2025 and 2030 by assuming that population will grow at the rate of 2.3 percent in future. The demand for rice will increase from 3142 to 6173, 3278 to 7591 and 3418 to 9341 thousand tons under pessimistic, business-as-usual and optimistic scenarios respectively from 2015 to 2030. The figure 3.10 tells that demand for rice will be almost double in 2030 as compared with demand in 2015 under pessimistic scenario while the demand for rice will be more than double under business-as-usual as well as optimistic scenario in 2030 as compared with demand for rice in 2015.

CHAPTER 4

MODELING AND FORECASTING SUPPLY OF FOOD GRAINS

This chapter includes the modeling and forecasting the supply of food grains for 2015, 2020, 2025 and 2030 based on different approaches.

4.1 PRODUCTION OF FOOD GRAINS

The wheat, rice and maize are main staple food grain crops of Pakistan. Irrespective of fact the share of agriculture in GDP has gradually shrunk to 21 percent in 2013-14 from 25.9 percent in1999-2000 and 53 percent in 1950-51 but it is still known as leading sector of Pakistan's economy. The share of wheat in agriculture valued added is 10.3 percent, while it contributes 2.2 percent in GDP. Rice contributes 3.1 percent in agriculture valued added and 0.7 percent in GDP. Maize is also enriched food grain and accounts 2.1 percent to agriculture value added and 0.4 percent to the GPD. The share of wheat and rice consumption in total food share of households is 19 percent and 4 percent respectively. We have not included maize in our projections as less than 4% households have shown their expenditure on maize as food share. The produce (output) of a crop depends upon several factors: the price of other competing crops, the prices of inputs used in production of crop like, fertilizers, pesticides, weedicides, farm yard manure, labor, irrigation, machinery and the climate conditions(temperature and rainfall). The profit function approach is an ideal methodology which determines the optimal level of output using the prices of crop's output and inputs along with certain technology. This approach requires data on quantities as well as prices of both inputs and outputs. The major obstacle for projecting the supply of food grains by using this methodology is the non availability of data at national level.

The production function approach is used by several studies as an alternative to profit function approach for modeling the supply of crop output. A production function relates the output of a crop to various inputs. In this study, we have adopted two approaches for projecting the supply of food grains. Firstly, the supply of wheat and rice is forecasted through production function approach and secondly, growth models are used for projection by analyzing the past pattern of area, production and yield of food grains.

4.2 PRODUCTION FUNCTION APPROACH

Idealistically in production function approach the physical output of a crop depends upon a number of factors: Rain fall, temperature, fertilizer, pesticides, irrigation prices, share of irrigated area, price of seed, total area under that particular crop, price of competing crop, amount of machinery and labor used for particular crop etc. For using econometric model we are in need of time series data on all above mentioned. But the absence of times series data constrained us to include all of these variables in the model.

4.2.1 SPECIFICATION OF MODEL

In Pakistan many studies have developed the model to forecast the wheat production like Azhar *et al.,* (1972), Chaudhry & Kemal (1974), Qureshi (1974), Ahmed & Siddiquie (1995) and Sher & Ahmed (2008). But their forecast found to be misleading in long run due to the inappropriate methodology and assumptions (population and income growth rates). We have specified following Cobb Douglas type production separately for estimating the supply of wheat and rice as by other studies (Nazli et al, 2012 & Kumar et al, 2012).

Thus the specified model is of the following form:

$$\mathbf{Y = B_o X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} e^{\varepsilon}} \qquad (28)$$

Where:

Y= Crop output

X_1= Cultivated area

X_2= Share of irrigated area

X_3= Seed

X_4= Water availability

X_5= Price of competing crop

X_6= Fertilizer

b_o, $b_1 \ldots b_6$= Parameters of the model

ε = White noise error term

The most recent available data on agriculture variables is taken from various issues of Agriculture Statistics of Pakistan and Pakistan Economic Survey for the period 1970-71 to 2010-11. The regression results of estimated Cobb Douglas production function for wheat and rice are presented in table 4.1

Table 4.1: Regression results of estimated production function for wheat and rice

Variables	**Wheat**	**Rice**
Constant	-4.0048 (0.050)	-4.0695 (0.000)
Cultivated area	1.5174 (0.000)	1.6067 (0.000)
Share of irrigated area	1.9175 (0.001)	
Seed	0.0965 (0.001)	
Obs.	41	41
Adj.R^2	0.97	0.98
DW(transformed)	1.98	2.01

Source: Author's own calculation
Note: The figures in parentheses are P-values.

4.2.2 RESULTS AND THEIR INTERPRETATION

The equation (28) is estimated in double log form (by taking log on both sides of equation) for wheat and rice separately using Ordinary Least Square (OLS) technique with robust standard errors. The results in table 4.1 indicate that both models emerge as a good fit of the data due to the high values of adjusted R-square. In both models there was found the problem of autocorrelation with the help of Durbin-Watson test. The problem of autocorrelation was removed by using Paris-Winston regression and results are reported in table 4.1 by correcting for autocorrelation because the results may be misleading, in the presence of autocorrelation. Only the significant variables are retain and reported in the table 4.1 while the insignificant variables were dropped. In case of wheat model all the explanatory variables *i.e.*, area under wheat, share of irrigated area of wheat and quantity of improved seeds of wheat contribute positively and significantly in the production of wheat. In case of rice model, only area under the rice crop has positive and significant effect on the rice output.

4.3 FORECASTING SUPPLY OF FOOD GRAINS

The forecasting supply of wheat and rice through production function approach is based upon the explanatory variables of the model. So for projecting the output we are in need of reasonable projected inputs. The inputs of wheat and rice models are projected by using time trend models (growth rates). The table 4.2 reports the estimation results of time trend models. The time period taken is 2000-01 to 2010-11 as it more representative of current and possible future trends. The values for all explanatory variables are projected by using time trend model till 2030 then plugged in to production function to get the future crop output.

Table 4.2: Estimation results of time trend models

Variables	Time(Year)	Constant	Observations
Area under rice	.019476 (0.032)	7.707156 (0.000)	11
Area under wheat	.0125802 (0.003)	8.971438 (0.000)	11
Share of irrigated area of wheat	.0003683 (0.083)	-.1449345 (0.000)	11
Quantity of improved seed (wheat)	.0919268 (0.001)	4.688646 (0.000)	11

Source: Author's own calculation
Note: The figures in parentheses are P-values.

4.4 MODEL EVALUATION

To check the reliability of specified production function for forecasting the future output the values are projected for wheat and rice using the estimated regression result and then compared with the actual output values. The model validation results for wheat and rice are presented in table 4.3 and 4.4 respectively

Table 4.3: Wheat production function validation results

Year	Projected output	Actual output	Forecast Error	Forecast Error (%)
2011-12	25039	23473	-1566	-6.7
2012-13	25767	24211	-1556	-6.4
2013-14	26517	25286	-1231	-4.9

Source: Author's own calculation

The projected output of wheat by production function and actual output for latest three years (2011-12, 2012-13 and 2013-14) are reported in table 4.3.The figures in table 4.3 show that the forecast errors are less than 7 percent which indicates that this model (double log Cobb Douglass production) can be used for projecting the output of wheat.

Table 4.4: Rice production function validation results

Year	Projected output	Actual output	Forecast Error	Forecast Error (%)
2011-12	5941	6160	219	3.6
2012-13	6130	5536	-594	-10.7
2013-14	6325	6798	473	7.0

Source: Author's own calculation

The figures in table 4.4 reveals the projected output of rice by production function and actual output for latest three years 2011-12, 2012-13 and 2013-14. The table 4.4 shows that the forecast errors are less than 11 percent which indicates that this model (double log Cobb Douglass production) can be used for projecting the output of rice. As it is concluded that we can use production function for projecting future output of wheat and rice on the basis of forecast errors so after predicting inputs by trend model till 2030 these values are plugged in production function which leads to projected output of wheat and rice. The projected supply of wheat and rice by production function for 2015, 2020, 2025 and 2030 is given in table 4.5.

Table 4.5: Forecasted wheat and rice supply using production function approach

('000' tons)

Year	Rice Supply	Wheat Supply
2015	6526	27288
2020	7631	31495
2025	8924	36351
2030	10435	41954

Source: Author's own calculation

The table 4.5 indicates that the forecasted supply of rice by production function approach will be 6526, 7631, 8924 and 10435 thousand tons in the year 2015, 2020, 2025 and 2030 respectively. The figures in table 4.5 show that the forecasted supply of wheat by production function approach will be 27288, 31495, 36351 and 41954 thousand tons for the year 2015, 2020, 2025 and 2030 respectively. The production function approach assume that the technology will remain same so if there would be any change in technology in future it may lead to higher production.

4.5 GROWTH MODEL APPROCAH

As it has been earlier discussed that for using econometric model we need crop wise data on all inputs like labor, fertilizer, water and rain fall etc. but the non availability of data is main hurdle in modeling. So some researchers have preferred to project the supply of food grains by using annual compound growth rates. Therefore, we have projected the production of wheat and rice for the next 15 years by calculating annual compound growth rates for area, yield per and production. Goyal and Singh (2002) and Mittal (2008) have projected the food grain supply in case of India by using same procedure. The data on production, yield and area of food grains are taken from various issues of Agriculture Statistics of Pakistan (GOP) to estimate the supply of food grains. The share of area and production of wheat, rice, maize and coarse grain has been presented in the table 4.6

Table 4.6: Average area and Production of food grains in Pakistan

Crops		Wheat	Rice	Maize	Coarse Grain	%age
1960s	Area	5379.1(61.28%)	1362.2(15.52%)	536.6(6.11%)	1500.2(17.09%)	100
	Production	4934.5(64.15%)	1450.8(18.86%)	568.3(7.39%)	738.9(9.61%)	100
1970s	Area	6214.2(62.95%)	1697.4(17.19%)	641.6(6.50%)	1319.1(13.36%)	100
	Production	8311.9(66.78%)	2635.4(21.17%)	770.5(6.19%)	728.3(5.85%)	100
1980s	Area	7419.9(65.62%)	1992.6(17.62%)	810.8(7.17%)	1083.5(9.58%)	100
	Production	12312.3(71.45%)	3277.67(19.02%)	1044.22(6.06%)	597.778(3.47%)	100
1990s	Area	8182.7(66.77%)	2216.4(18.09%)	905.4(7.39%)	950.3(7.75%)	100
	Production	16981(74.20%)	3949.7(17.26%)	1393.2(6.09%)	563(2.46%)	100
2000s	Area	8387.11(65.90%)	2486.33(19.53%)	997.778(7.84%)	857(6.73%)	100
	Production	20721.9(71.37%)	5170.78(17.81%)	2619.67(9.02%)	523(1.80%)	100

Source: Author's own calculation

Table 4.7: Annual compound growth rates of area, production and yields of food grains in Pakistan

(Percent)

Decades		Crops	
		Wheat	Rice
1960s	Area	2.47	3.03
	Production	6.44	9.21
	Yield	3.86	5.99
1970s	Area	1.06	2.29
	Production	4.06	2.97
	Yield	2.25	0.16
1980s	Area	1.26	0.35
	Production	2.80	0.01
	Yield	1.53	0.54
1990s	Area	0.76	1.79
	Production	3.94	4.82
	Yield	3.16	2.98
2000s	Area	0.76	1.37
	Production	1.01	2.93
	Yield	0.25	1.53

Source: Author's own calculation

The growth in production is a cumulative effect of area expansion, investment in R&D, development of irrigation, enhanced use of fertilizers and plant protection measures. Nevertheless, this production is on average decelerating slowly over decades. Trends in area growth, yield growths and production from 1960-2010 are shown in table 4.7

In table 4.7 the annual compound growth rates of area, production and yield for wheat and rice have been calculated. There is an increase in wheat and rice area of 2.47 percent and 3.03 percent respectively in the 60s, and then area grew at the rate of 1.06 percent of wheat and 2.29 percent of rice in 1970s. The growth in area of staple crops slowdown in 1980s as the area of wheat grew at the rate of 1.26 percent, while there was 0.35 percent increase in area of rice. In decade of 1990s the area expansion was not impressive as there was increase of 0.76 percent in wheat area and 1.79 percent in rice area. In 2000s there was growth of 0.76 percent and 0.37 percent in the area of wheat and rice respectively. The area growth rate for wheat and rice in 60s and 70s was quite encouraging but in later decades there was significant decline in area growth. So long as area growth increase is concerned we don't have many options left.

On yield growth rates we found significant increase in the decades of 60s and 70s *i.e.,* in a period of green revolution but later on performance on this parameter has not been very consistent. Supply projections are made by assuming that yield growth and area will grow at the same rate as in the past decade. Supply projections for wheat and rice by growth model are presented have been presented in table 4.8.

Table 4.8: Forecasted wheat and rice supply using growth model approach

('000' tons)

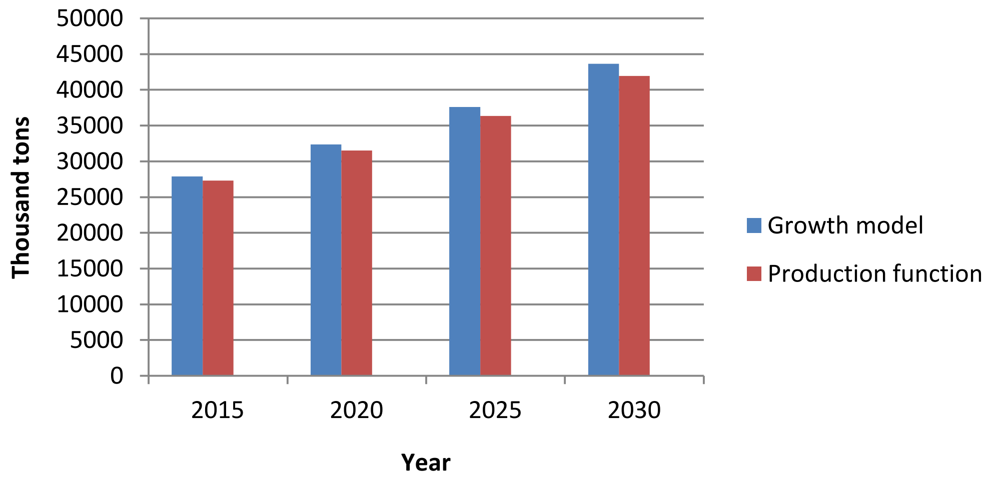
Year	Rice Supply	Wheat Supply
2015	7235	27887
2020	8672	32383
2025	10394	37604
2030	12457	43666

Source: Author's own calculation

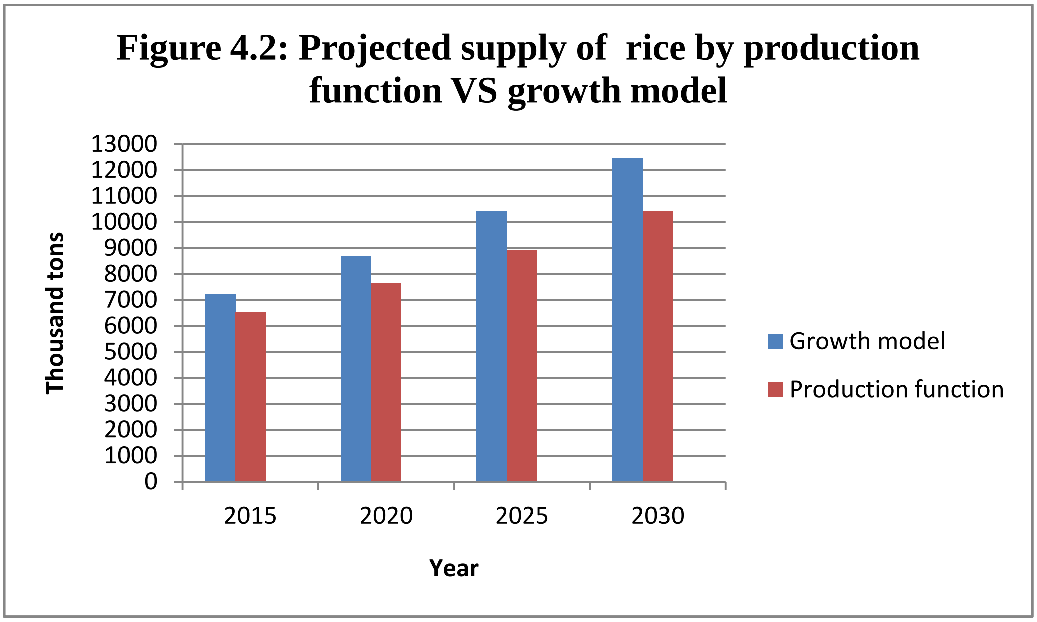
The table 4.8 narrates the projected supply of wheat and rice for 2015, 2020, 2025 and 2030 under growth model approach. The figures in table 4.8 indicate that the supply of wheat will be 27887, 32383, 37604 and 43666 in the year 2015, 2020, 2025 and 2030 respectively. While the supply of rice will be7235, 8672, 10394 and 12457 in the year 2015, 2020, 2025 and 2030 respectively using growth model.

We have compared the projected supply of wheat and rice under both production function approach and growth model approach.

Figure 4.1: Projected supply of wheat by production function VS growth model



The figure 4.1 depicts the projected supply of wheat by two approaches: production function approach and growth model approach. The projected supply by growth model found to be slightly high than production function approach in every considered year.



The figure 4.2 portrays the projected supply of rice by production function approach and growth model. The supply of rice projected by growth model found to be significantly high than the supply of rice projected by the production function approach. So the projection made by growth model are high than the production approach. In growth model approach the growth rate is simply calculated by taking just two years values. For example the first year 2000-01 and last year 2010-11.This methodology ignores the production level of crops between these years. The growth model provides misleading results if the two selected years show irregular behavior of production when the first year is the year when crop out remains low due to any reason and the last year is a year in which there was bumper crop due to any reason. So the projection by production function found to be more reliable than growth model. Furthermore, the forecast errors reported in table 4.3 and 4.4 confirm the validation of production function approach.

CHAPTER 5

RESULTS AND DISCUSSION

This Chapter contains results and discussion based on projected demand and supply gap for food grains (wheat and rice) in 2015, 2020, 2025 and 2030. The total demand for food grains consisted of direct demand(households demand) and indirect demand (feed, seed and wastage) is estimated and projected for the year 2015, 2020, 2025, and 2030 in Chapter 3 while the supply of the food grains is estimated and projected for the year 2015, 2020, 2025 and 2030 in chapter 4 of this study. On demand side to estimate household demand for food grains the demand elasticity was computed on the base of HIES data set (2010-11) via LA-AIDS model using corrected stone price index. The LA-AIDS model was estimated by seeming unrelated regression. The three scenarios have been created based on the assumptions about the growth rate of per capita income. The pessimistic scenario assumes that the per capita income will grow at the rate of 2 percent per year while, the business-as-usual scenario assumes that the per capita will grow at the rate of 3 percent per year in future year. The optimistic scenario assumes that the per capita income will grow at the rate of 4 percent per year in future. As the population also affects the demand for food grains we have also developed three scenarios about population growth. Currently, the population of Pakistan is growing at the rate of 1.95 percent (GOP, 2014). The first scenario assumes that population will decline in future so it is assumed that population of Pakistan will grow at the rate of 1.5 percent per annum in the future under first scenario. The second scenario assumes that future population growth will be same as of the past. So the population will grow at the same trend and it is assumed that population will grow at the rate of 1.9 percent in future under second scenario. The third scenario assumes that growth in population will be fast as compared to current trend so the population will grow at the of 2.3 percent per year in future. On the supply side we have projected the production of food grains by two approaches. First, the production function approach in which double log Cobb Douglass production was estimated for wheat and rice. After plugging the projected inputs by time trend model in to production function the projected output of wheat and rice for the year 2015, 2020, 2025 and 2030 is reported in table 4.5. Second, the supply of wheat and rice is projected through the growth model approach in which the output was estimated and projected by using annual compound growth rate. The projected output of wheat and rice by growth model for 2015, 2020, 2025 and 2030 is reported in table 4.8. In both approaches the technology is assumed to be same in future, while innovation in technology and production methods will lead to higher productivity. For calculation of gap between demand and supply of food grains for the year 2015, 2020, 2025 and 2030, *the supply of wheat and rice projected by production function approach is used as it is more reliable than growth model*. The gap between the total demand and supply of food grains under all the scenarios are given in the following tables for the considered years.

Table 5.1: Projected demand and supply gap by assuming that Population will grow at the rate of 1.5 percent in future.

(‘000’ tons)

Year	Pessimistic						Business-as-usual						Optimistic					
	WTD	WS	GAP	RTD	RS	GAP	WTD	WS	GAP	RTD	RS	GAP	WTD	WS	GAP	RTD	RS	GAP
2015	23251	27288	4037	3055	6526	3471	23903	27288	3385	3187	6526	3339	24569	27288	2719	3323	6526	3203
2020	27075	31495	4420	3690	7631	3941	28818	31495	2677	4059	7631	3572	30673	31495	822	4465	7631	3166
2025	31528	36351	4823	4458	8924	4466	34753	36351	1598	5178	8924	3746	38323	36351	(-)1972	6015	8924	2909
2030	36714	41954	5240	5387	10435	5048	41922	41954	32	6609	10435	3826	47916	41954	(-)5962	8116	10435	2319

Source: Author’s own calculation
Note: WTD=Wheat total demand (direct demand + indirect demand), WS= wheat supply, RTD= Rice total demand (direct demand + indirect demand) and RS= Rice supply

Table 5.2: Projected demand and supply gap by assuming that Population will grow at the rate of 1.9 percent in future.

(‘000’)

Year	Pessimistic						Business-as-usual						Optimistic					
	WTD	WS	GAP	RTD	RS	GAP	WTD	WS	GAP	RTD	RS	GAP	WTD	WS	GAP	RTD	RS	GAP
2015	23575	27288	3713	3099	6526	3427	24237	27288	3051	3232	6526	3294	24914	27288	2374	3370	6526	3156
2020	27934	31495	3561	3809	7631	3822	29739	31495	1756	4192	7631	3439	31661	31495	(-)166	4612	7631	3019
2025	33101	36351	3250	4686	8924	4238	36509	36351	(-)158	5446	8924	3478	40280	36351	(-)3929	6331	8924	2593
2030	39229	41954	2725	5766	10435	4669	44841	41954	(-)2887	7083	10435	3352	51300	41954	(-)9346	8707	10435	1728

Source: Author’s own calculation
Note: WTD=Wheat total demand (direct demand + indirect demand), WS= wheat supply, RTD= Rice total demand (direct demand + indirect demand) and RS= Rice supply

Table 5.3: Projected demand and supply gap by assuming that Population will grow at the rate of 2.3 percent in future.

('000' tons)

Year	Pessimistic						Business-as-usual						Optimistic					
	WTD	WS	GAP	RTD	RS	GAP	WTD	WS	GAP	RTD	RS	GAP	WTD	WS	GAP	RTD	RS	GAP
2015	23903	27288	3385	3142	6526	3384	24575	27288	2713	3278	6526	3248	25263	27288	2025	3418	6526	3108
2020	28820	31495	2675	3932	7631	3699	30690	31495	805	4329	7631	3302	32681	31495	(-)1186	4765	7631	2866
2025	34756	36351	1595	4926	8924	3998	38356	36351	(-)2005	5729	8924	3195	42341	36351	(-)5990	6663	8924	2261
2030	41928	41954	26	6173	10435	4262	47973	41954	(-)6019	7591	10435	2844	54932	41954	(-)12978	9341	10435	1094

Source: Author's own calculation

Note: WTD=Wheat total demand (direct demand + indirect demand), WS= wheat supply, RTD= Rice total demand (direct demand + indirect demand) and RS= Rice supply

The table 5.1 shows total demand and supply along with the gap between demand and supply for the year 2015, 2020, 2025 and 2030 by assuming that population will grow *at the rate of 1.5 percent* while per capita income will grow at the rate of 2, 3 and 4 percent under pessimistic, business-as-usual and optimistic scenarios respectively. There will be surplus of 4037, 3385 and 2719 thousand tons for wheat under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2015 while there will be surplus of 3471, 3339 and 3203 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2015. The figures in table 5.1 reveals that there will be surplus of 4420, 2677 and 822 thousand tons for wheat under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2020 while there will be surplus of 3941, 3572 and 3166 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2020. There will be surplus of 4823 and 1598 thousand tons under the pessimistic and business-as-usual scenarios while there will be deficit of 1972 thousand tons under optimistic scenarios for the wheat in 2025. The situation for rice will be satisfactory as there would be surplus of 4466, 3746 and 2909 thousand tons under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2025. There will be surplus of 5240 and 32 thousand tons for wheat under the pessimistic and business-as-usual scenarios while the situation will be adverse as there will be deficit of 5962 thousand tons for wheat under optimistic scenario for the year 2030. Whereas, there will be surplus of 5048, 3826 and 2319 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2030.

The table 5.2 shows total demand and supply along the gap between demand and supply for the year 2015, 2020, 2025 and 2030 by assuming that population will grow at *the rate of 1.9 percent* while per capita income will grow at the rate of 2, 3 and 4 percent under pessimistic, business-as-usual and optimistic scenarios respectively.

The figures in table 5.2 show that there will be surplus of 3713, 3561, 3250 and 2725 thousand tons for wheat in 2015, 2020, 2025 and 2030 under the pessimistic scenario while there will be surplus of 3427, 3822, 4238 and 4669 thousand tons for rice in 2015, 2020, 2025 and 2030 under the pessimistic scenario.

There will be surplus of 3051 and 1756 thousand tons in 2015 and 2020 respectively while, there will be deficit of 158 and 2887 thousand tons for wheat in 2025 and 2030 respectively under the business-as-usual scenario while there will be surplus of 3294, 3439, 3478 and 3352 thousand tons for rice in 2015, 2020, 2025 and 2030 under the business-as-usual scenario. The situation would be adverse for wheat when the per capita income will grow at the rate of 4 percent under optimistic scenario as there will be surplus of 2374 thousand tons only in 2015 while there will be deficit of 166, 3929 and 9346 thousand tons for wheat in 2020, 2025 and 2030 under the optimistic scenario while there will be surplus of 3156, 3019, 2593 and 1728 thousand tons for rice in 2015, 2020, 2025 and 2030 under the optimistic scenario.

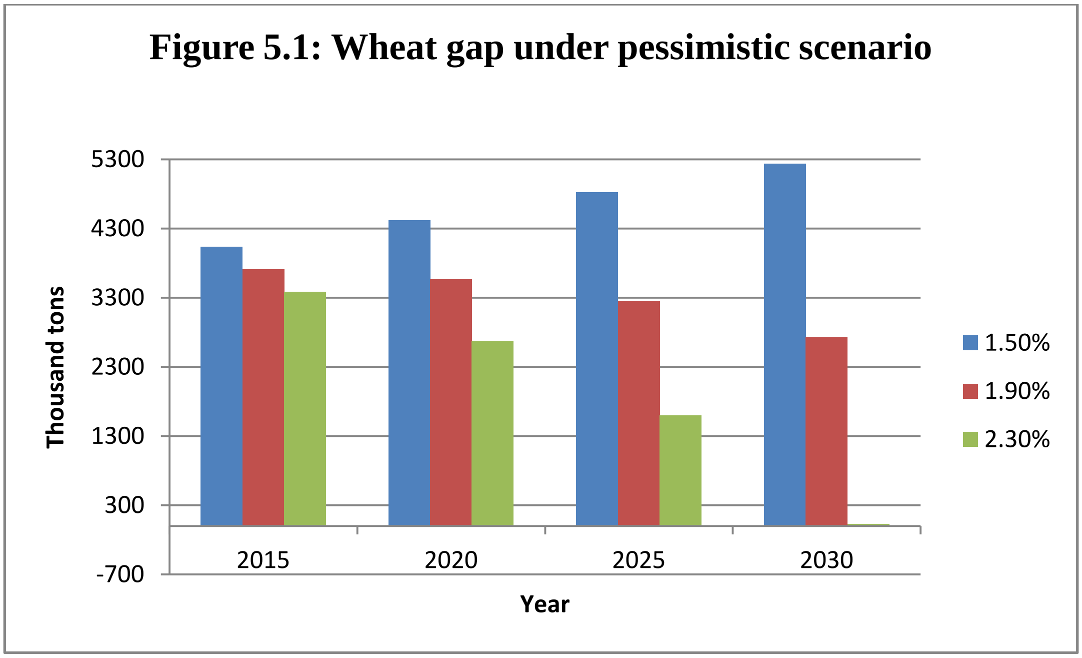
The table 5.3 presents the total demand and supply along the gap between demand and supply for the year 2015, 2020, 2025 and 2030 by assuming that population will grow *at the rate of 2.3 percent*. There will be surplus of 3385, 2713 and 2025 thousand tons for wheat under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2015. There will be surplus of 3384, 3248 and 3108 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2015. There will be surplus of 2675 and 805 thousand tons for wheat under the pessimistic and business-as-usual scenarios respectively while there will be deficit 1186 thousand tons for wheat under optimistic scenario for the year 2020. There will be surplus of 3699, 3302 and 2866 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2020. There will be surplus of 1595 thousand tons, under the pessimistic scenario; while there will be deficit of 2005 and 5990 thousand tons under business-as-usual and optimistic scenarios respectively for wheat in the 2025. There will be surplus of 3998, 3195 and 2261 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2025. There will be surplus of just 26 thousand tons for wheat under pessimistic scenario, while there will be deficit of 6019 and 12978 thousand tons for wheat under business-as-usual and optimistic scenarios respectively for the year 2030. There will be surplus of 4262, 2844 and 1094 thousand tons for rice under the pessimistic, business-as-usual and optimistic scenarios respectively for the year 2030.

The results of table 5.1, 5.2 and 5.3 depict that there will be surplus of rice under all scenario when population will grow at the rate of 1.5 percent, 1.9 percent and 2.3 percent while there will be deficit for wheat in the years to come(2020 and onwards).

5.1 DETERMINANTS OF GAP

The comparison of gap (demand and supply) of the already defined population growth rate (1.5 %, 1.9% and 2.3%) for wheat as well as rice is made under different scenarios for per capita income growth (2%, 3% and 4%). The following graphs portray that how GAP is affected by growth in population and per capita income.

The figure 5.1 depicts the gap for wheat by making comparison of population growth rates under pessimistic scenario. In general when the population growth rate is low (1.5 %) the gap (surplus) is high while population growth rate is high (2.3%) the gap (surplus) comes down. In figure 5.1 when the population growth rate is low (1.5 %) the surplus is 5240 thousand tons while at high population growth rate (2.3 %) the surplus is just 26 thousand tons in the year 2030.



The figure 5.2 shows the gap for wheat under business-as-usual scenario by making comparison of population growth rates. When the population growth rate is low (1.5 %) there is surplus of 1598 thousand tons while at high population growth rate (2.3 %) there is deficit of 2005 thousand tons in the year 2025.

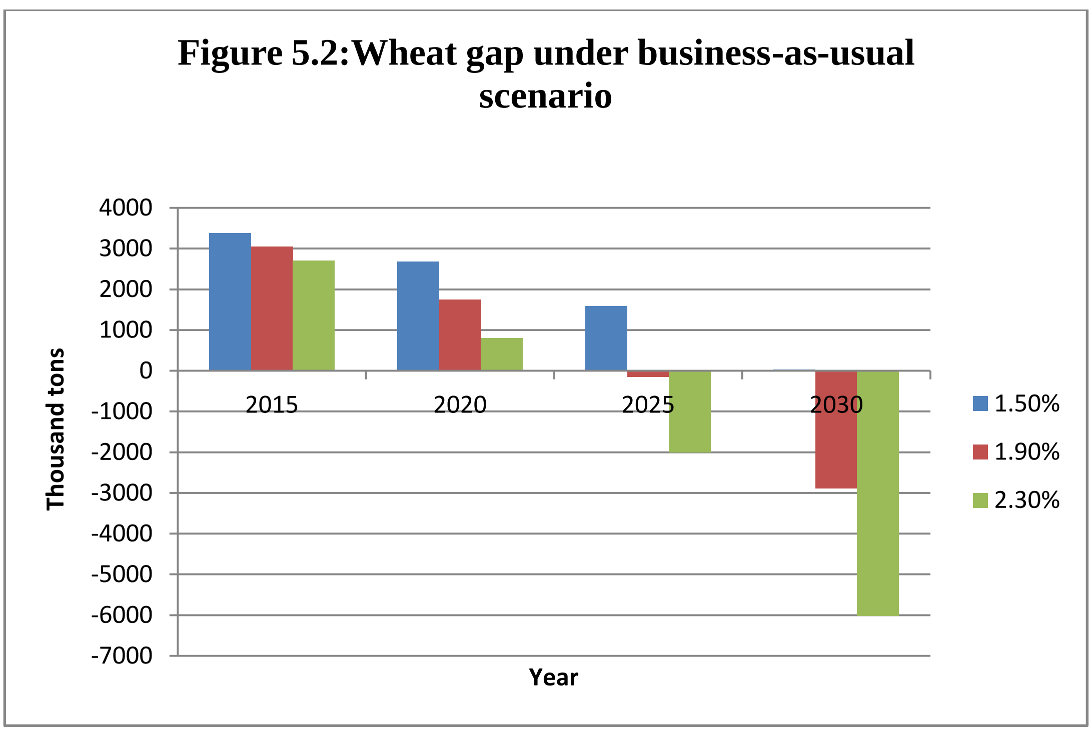
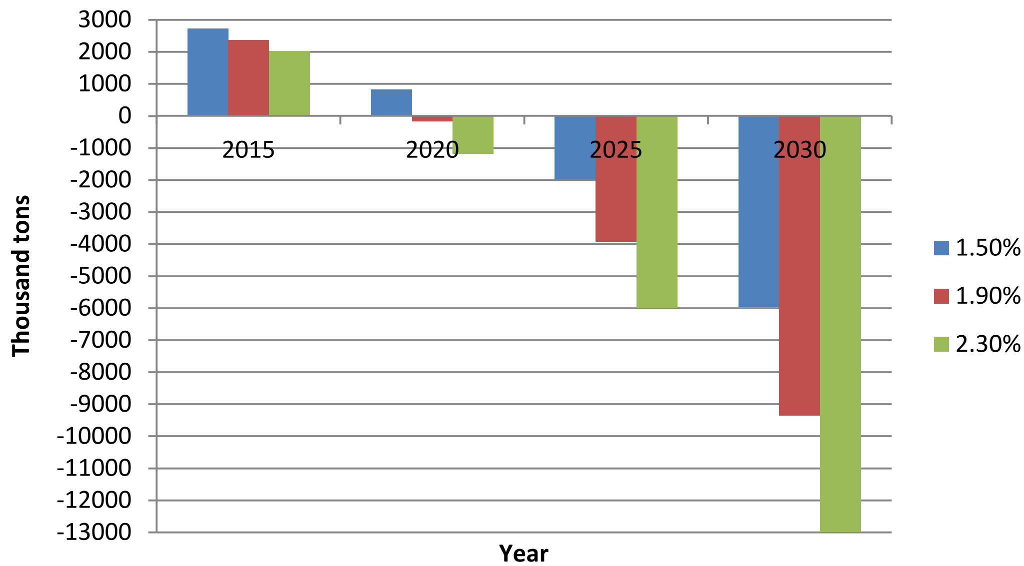
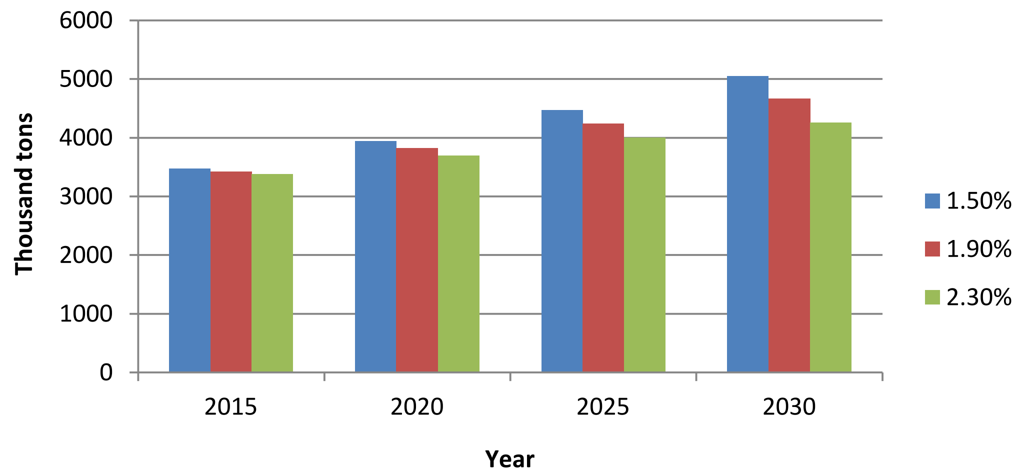


Figure 5.3: Wheat gap under optimistic scenario



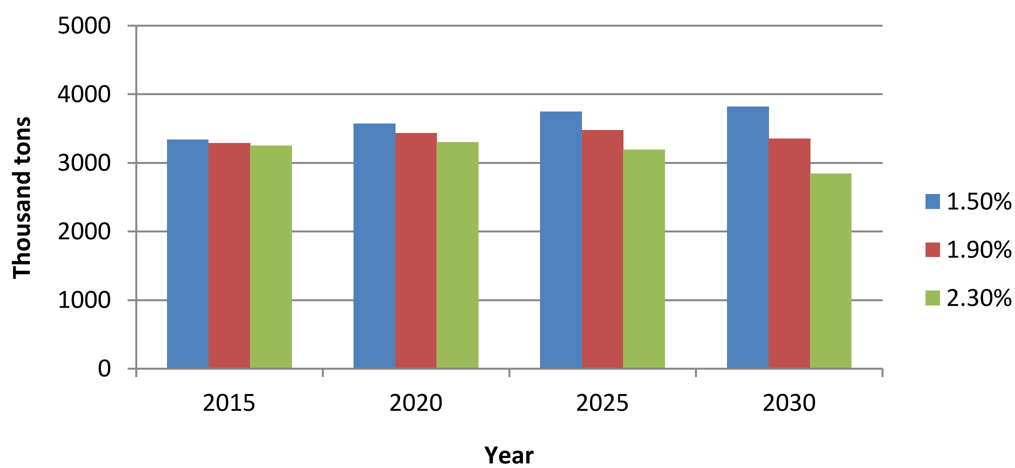
The figure 5.3 reveals the gap for wheat by making comparison of population growth rates under optimistic scenario. When the population growth rate is low (1.5 %) the there is deficit of 5962 thousand tons while at high population growth rate (2.3 %) there is deficit of 12978 thousand tons in the year 2030.The deficit will be more than double just due to change of population growth rate in 2030. So it is concluded population growth rate is major determinant of demand and supply gap of food grains. As population increase new mouths are open to be fed so there will be need of more food grains for ever increasing population.

Figure 5.4: Rice gap under pessimistic scenario



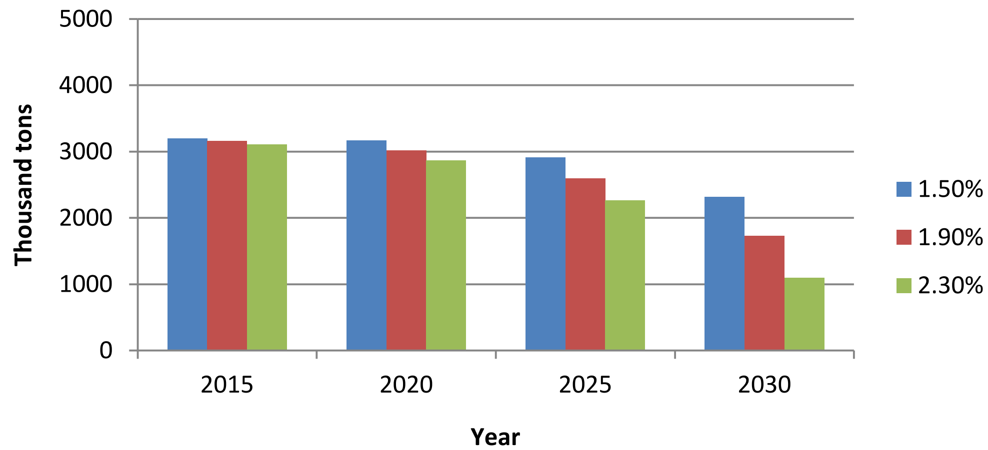
The figure 5.4 portrays the gap for rice by making comparison of population growth rates under pessimistic scenario. When the population growth rate is low (1.5 %) there is surplus more than 5000 thousand tons while at high population growth rate (2.3 %) the surplus will be less than 4300 thousand tons in the year 2030.

Figure 5.5: Rice gap under business-as-usual scenario



The figure 5.5 describes the surplus for rice by making comparison of population growth rates under business-as-usual scenario. There will be surplus of 3826, 3352 and 2844 thousand tons at 1.5 %, 1.9 % and 2.3% population growth rate respectively in 2030.

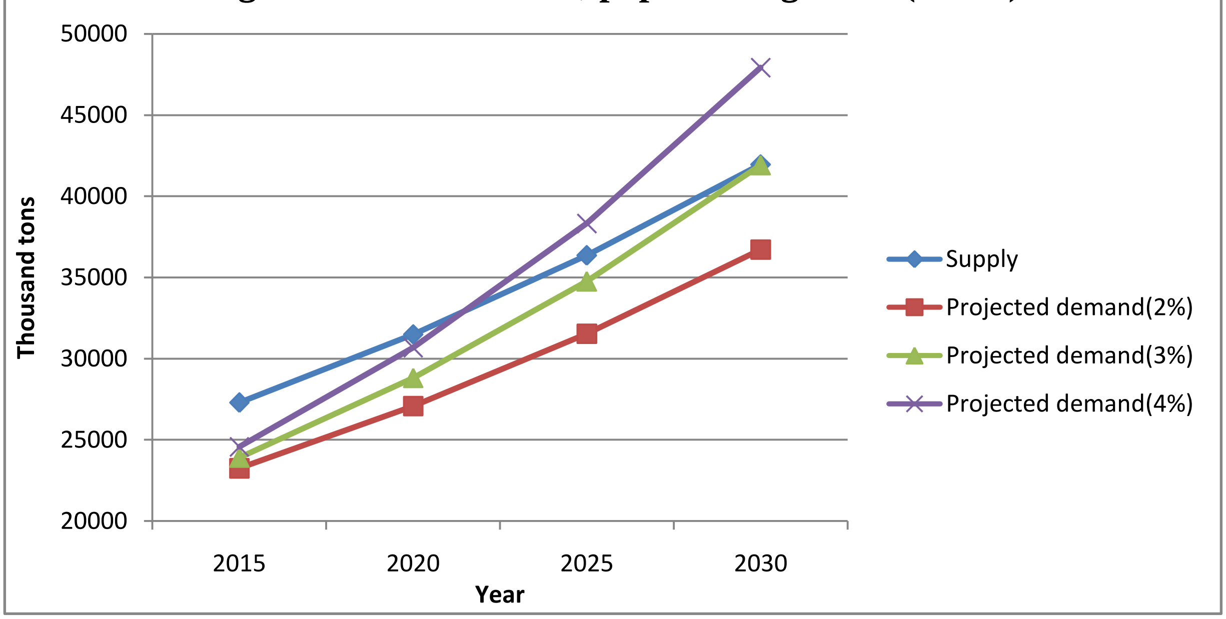
Figure 5.6: Rice gap under optimistic scenario



The figure 5.6 reveals the gap under pessimistic scenario for rice by making comparison of population growth rates. There will be surplus of 2319 and 1728 thousand tons when the population growth rate will be 1.5% and 1.9% respectively; while there will be surplus of 1094 thousand tons for rice when the population growth rate will be 2.3% in the year 2030. The figures 5.1 to 5.6 describe the changes in demand due to increase in population and it is concluded that growth in population is main determinant for increase in the demand for food grains in case of Pakistan.

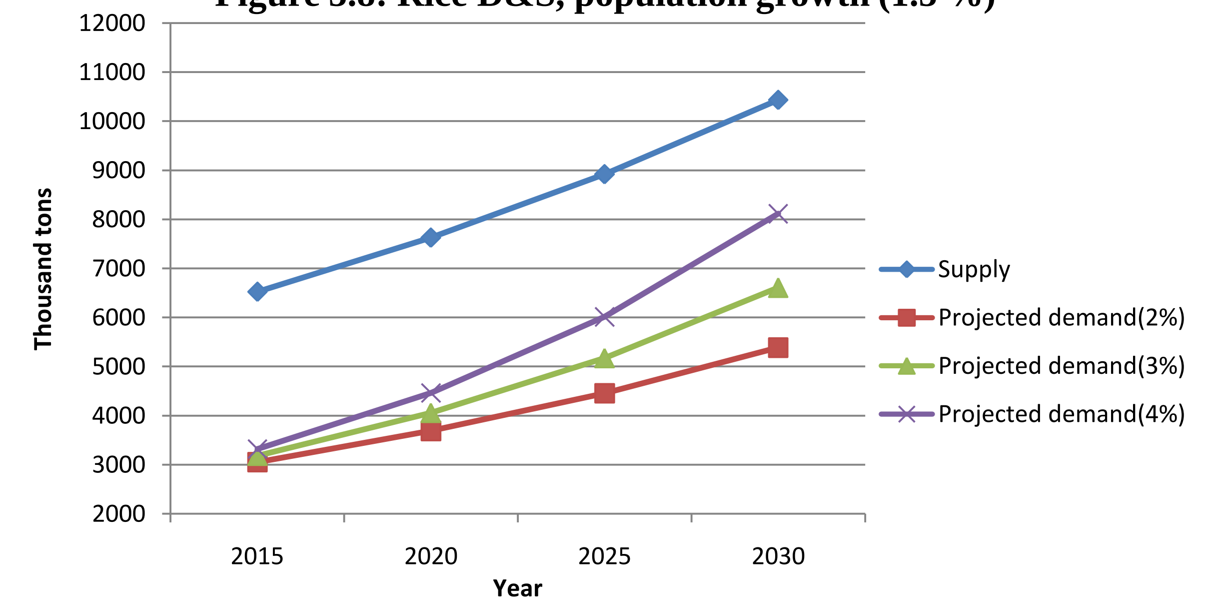
The growth in per capita income is also one of the main drivers for increase in the demand for food grains because as the income increases the demand for food grains increases as per Engel's law. The shift in demand for food grains changes due to the rise in per capita income base on considered growth rates is shown with the help of following graphs. We have projected demand for wheat and rice under already mentioned scenarios: pessimistic (2%), business-as-usual (3%) and optimistic (4%).

Figure 5.7: Wheat D&S, population growth (1.5 %)

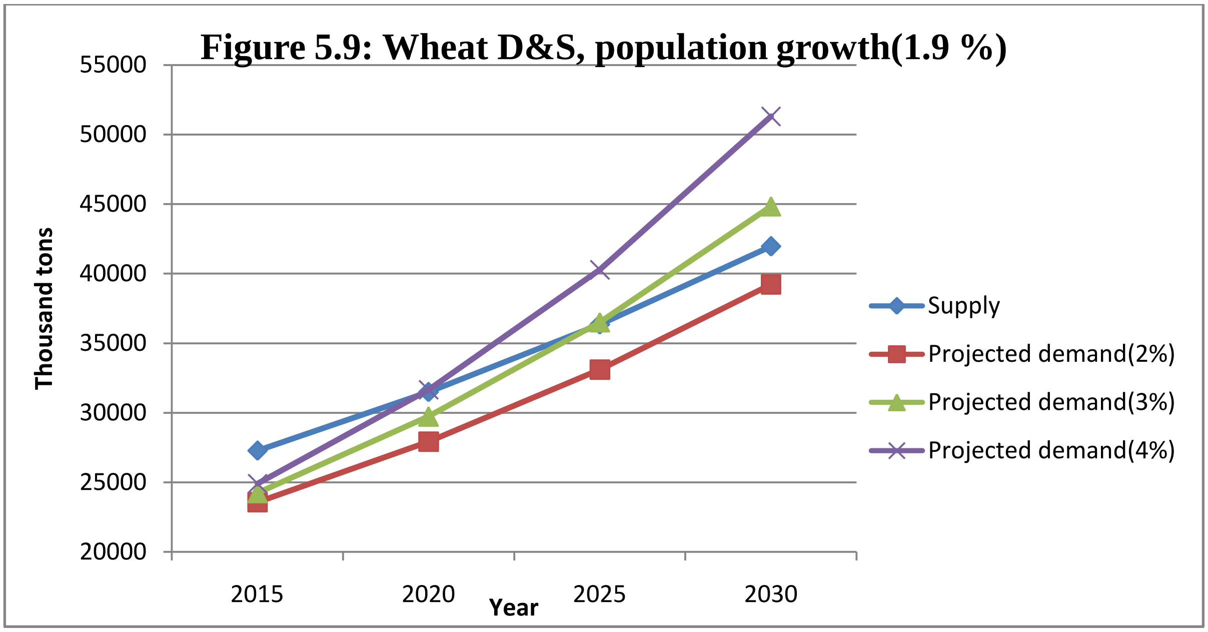


The figure 5.7 shows the projected demand (at the rate of 2 percent, 3 percent and 4 percent per capita income growth rate) and supply when the population will grow at the rate of 1.5 percent in future. The projected gap will increase with growth in per capita income which results in more deficit.

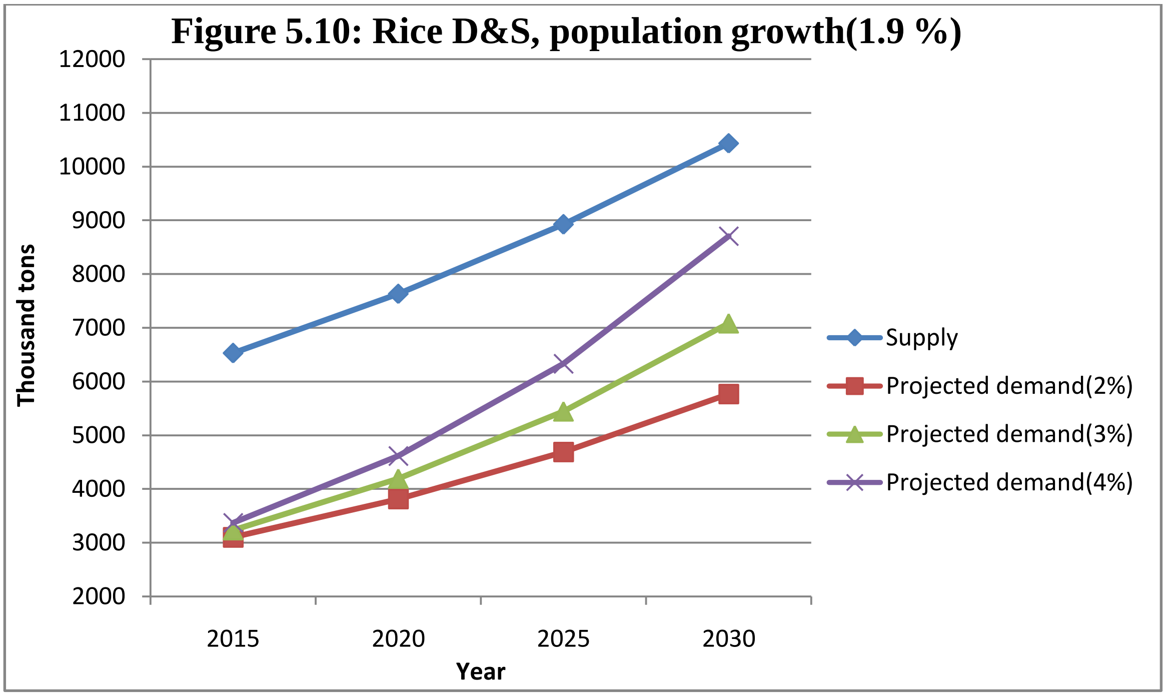
Figure 5.8: Rice D&S, population growth (1.5 %)



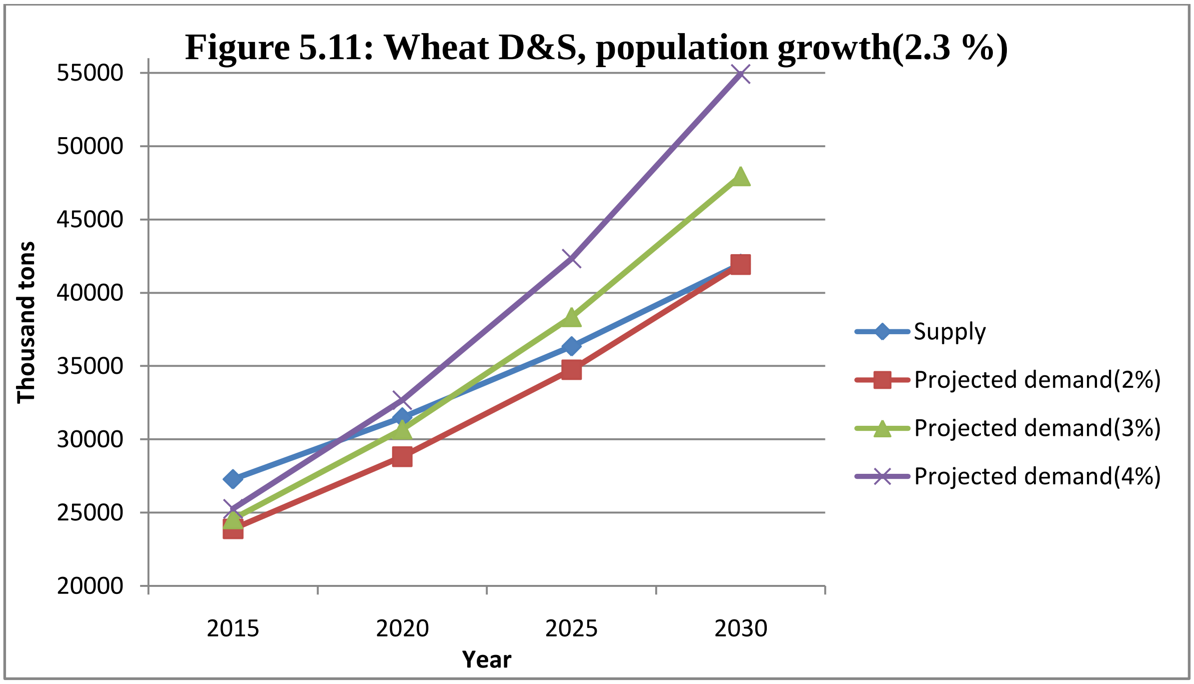
The figure 5.8 portrays demand and supply projections of rice by assuming population will grow at the rate of 1.5 percent. As the per capita grows the surplus between demand and supply of rice will decrease.



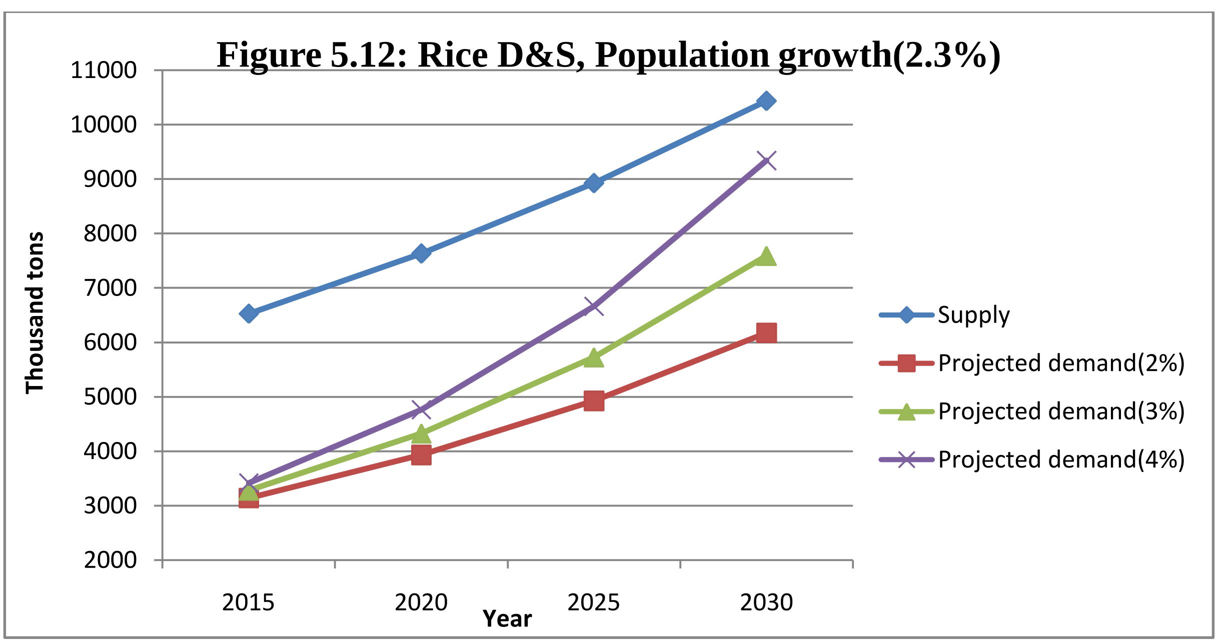
In figure 5.9 the projected demand and supply of wheat for the considered years 2015, 2020, 2025 and 2030 is presented by assuming population will grow at the rate of 1.9 percent. The demand increases year by year with increase in per capita income .The more growth in per capita income results in more demand for food grains which widen gap between demand and supply of wheat. The figure reveals all other being constant if the per capita income will increase from 2% to 4% there will be increase of more than 10000 thousand tons in projected demand for wheat in 2030. It is visible from the scene that by the 2019 the situation will start get worsening and any natural disaster (flood and famine) would be fatal.



The scene for the rice's future demand and supply is set in figure 5.10. Currently, Pakistan is net exporter of rice and would continue to export the rice by 2030 if the population will grow at the of 1.9 percent. But the surplus would decrease with growth in per capita income and there would be surplus of just 1728 thousand tons in 2030 if the per capita income and population will grow at the rate of 4 and 1.9 percent respectively.

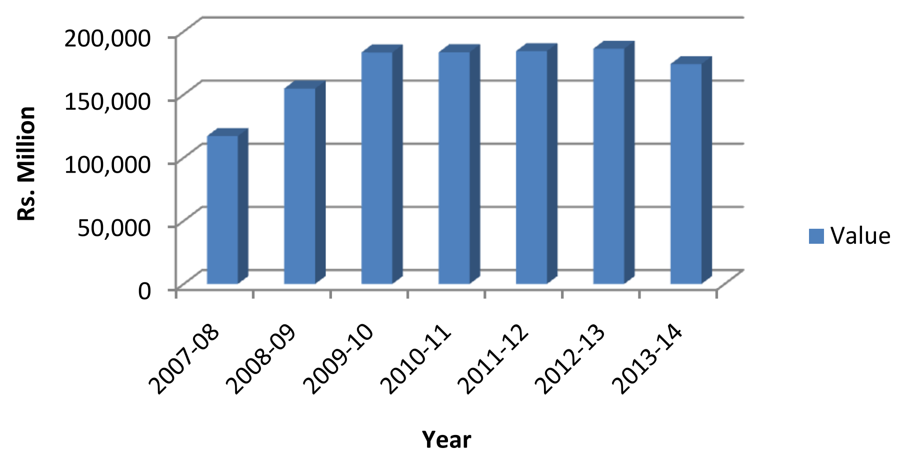


The figure 5.11 tells the story of projected demand and supply by assuming that population will grow at the rate of 2.3 percent. The gap between demand and supply would be maximum when the per capita will grow at the rate of 4 percent. This indicates the worst situation as demand would be approximately doubled in 2030 as compared with demand for wheat in 2015(under 1.5% population growth rate and 2% per capita income growth rate).



The impact of per capita income growth on the demand for food grain (rice) is shown in figure 5.12 which depicts that would be surplus for rice by 2030 when per capita income growth rate will be 2%, 3% or 4 % and population growth will be 2.3 percent. Pakistan is net exporter of rice and rice is major sources of foreign earnings after cotton in case of Pakistan (GOP, 2014). The figure 5.13 shows foreign earnings by rice's exports in the recent years.

Figure 5.13:Value of Rice's Exports



As it is clear the value from figure 5.8, 5.10 and 5.12 the gap (surplus) will reduce with the increase in projected demand that will lead to reduction in exports of rice and in turn the foreign earnings will decrease. So irrespective of the fact that there will be surplus of rice by 2030 under each scenario but this surplus will deteriorate year by year and by the 2030 there will be surplus of 1094 thousand tons only when the per capita will grow at the rate of 4 percent and population at the rate of 2.3 percent.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

This study presents the future projections about demand and supply of food grains (wheat and rice) for 2015, 2020, 2025 and 2030 in case of Pakistan. On demand side the LA-AIDS model was estimated from HIES data set for the year 2010-11. The estimates of expenditure elasticities found to be consistent with other studies (Haq *et al*, 2008; Haq *et al*, 2011; Nazli *et al*, 2012 and Malik *et al*, 2014) for Pakistan. The population estimate for base year 2010-11 was 177.10 million (GOP, 2013-14) while the monthly per capita consumption of wheat and rice found to be 8.50kg and 1.10kg respectively. The total demand for wheat was estimated by adding up the direct demand (human demand) and indirect demand (feed, seed and wastage). The demand is projected by assuming that population will grow at the rate of 1.5 percent, 1.9 percent and 2.3 percent whereas the three scenarios have been created for each population scenario based on growth in per capita income *i.e.*, pessimistic, business–as-usual and optimistic scenario. The result of this study indicates that the increase in total demand is mainly due to growth in population (figure 5.1 to 5.6) and per capita income (figure 5.7 to 5.12).

On supply side, we have projected the output of wheat and rice by production function approach and growth model approach. The production function (double log Cobb Douglass production function) results were checked on prior model validation criteria (on the basis of forecast errors). So we have used the projected supply of wheat and rice by production function approach which assumes the technology will be same in future and area will grow at the same rate as that of the past decade, as there are very serious limitations in area expansion and yield growth. Moreover, the high population growth rate is increasing pressure to bring more and more cultivatable land into housing sector not only in urban area but also in rural area.

No matter, whatever scenario is taken among all the above mentioned scenarios (including pessimistic, business-as-usual and optimistic scenarios) there would be surplus in case of rice. But this surplus will decrease year by year due to the rising demand which will result in the reduction of rice's exports. The range of surplus for rice is 3471-3108 thousand tons in 2015 while it ranges from 5048 to 1094 thousand tons in 2030. The results show that there will be surplus for wheat under pessimistic scenario (per capita income will grow at the rate of 2%) when the population will grow at the rate of 1.5 %, 1.9 % or 2.3 %. But there will be deficit under business-as-usual scenario and optimistic scenario. The range of deficit for wheat is 158-5990 thousand tons in 2025 while it ranges from 2887-12978 thousand tons in 2030.The figures show that the deficit will increase in case of wheat while the surplus as well as export of rice will decrease in the years to come.

RECOMMENDATIONS

The following recommendations are suggested based upon the findings of this study.

Due to very high population growth rate, there is an increasing pressure to bring more and more cultivatable land into housing sector not only in urban area but also in rural area therefore the agricultural land is deteriorating day by day as a result of urbanization and industrialization. So the only way for area expansion is to build new water reservoirs.

The increase in prices of crops received by farmers is a great incentive to induce and motivate them to work hard and produce more which leads to increase in per acre yield. Output prices of the major crops are too low in comparison with the investment made by farmers in farm inputs. If the cereal pricing will be left to market force the small producer will shift land cultivation from wheat and rice to non cereal crops so Govt. should announce minimum/floor prices of major crops before cultivation season (not at the time of bumper crop) to motivate farmers to invest in farms to increase profitability and farm productivity, but making it sure that this would not favor only to the influential farmers along avoiding food inflation.

The major share of households' budget is spent on wheat to meet the dietary needs whereas find that Pakistan self sufficiency in wheat is on a border line. Any natural calamity like floods, drought, bad management of stock and smuggling can put it in a very precarious situation. So policy makers should take in consideration these issues as any decision to export wheat without having proper assessment of total wheat output or smuggling may create lot of unrest at any time.

In the past, a number of measures including price and trade policies, public investment in research and development, irrigation and market infrastructure and credit program have raised farm productivity significantly in Pakistan. However, a fast rate of population growth, the low productivity of land, an insufficient use of mechanical inputs and low productivity of labor due to inadequate investment in human capital have not helped in consolidating the productivity gains. There is dire need of a food production policy complemented by investment in R&D for increasing farm production through provision of improved inputs (seed, fertilizer, technology and pesticides).

There are certain limitations of this study. As we discussed earlier that income distribution patterns are very important in analyzing food demand projection because when income is transferred from upper class to poorer people, there is an increase particularly in staple food demand for the lower income strata of income. We have not been able to include this aspect in our study. Other limitations also include impact of rising prices on food demand and role of urbanization in determining food consumption patterns. So the study in future might take these factors into account for demand projections over the next three to four decades.

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