Wheat Supply Response in Pakistan

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CERTIFICATE

This is to certify that this thesis entitled: **"Wheat Supply Response in Pakistan"** submitted by Mr. Asim Hussain is accepted in its present form by the Department of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Philosophy in Economics**.

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ABSTRACT

Wheat is not only import cereal which used for food, but it is also important in terms of its contribution in GDP and it is biggest crop in terms of its contribution in cropping sector. In recent past government has significantly increased the wheat prices and the objective was to stimulate output. This study has estimated the short run and long run elasticity of wheat by using district level data for wheat production, area and yield in Pakistan by using data 1981-82 to 2013-14. The study has extended Nerlovian model to panel data. Study has used Dynamic panel GMM technique to estimate the short run and long run elasticity of wheat. We found that price of wheat, price of competing crop, price of fertilizer, rainfall and temperature devotions are the important determinates of wheat production, area cultivation and yield in Pakistan. The study estimate that the short run elasticity of wheat production with respect to its own price is 0.25 and long run elasticity is 0.28. The short run and long run elasticity of cultivated area under wheat is 0.11 and 0.29 respectively and the elasticity for yield is 0.13 and 0.19 for short run and long run respectively. Based on findings study suggest that Government should focus on input price policy rather than output price policy.

CHAPTER I

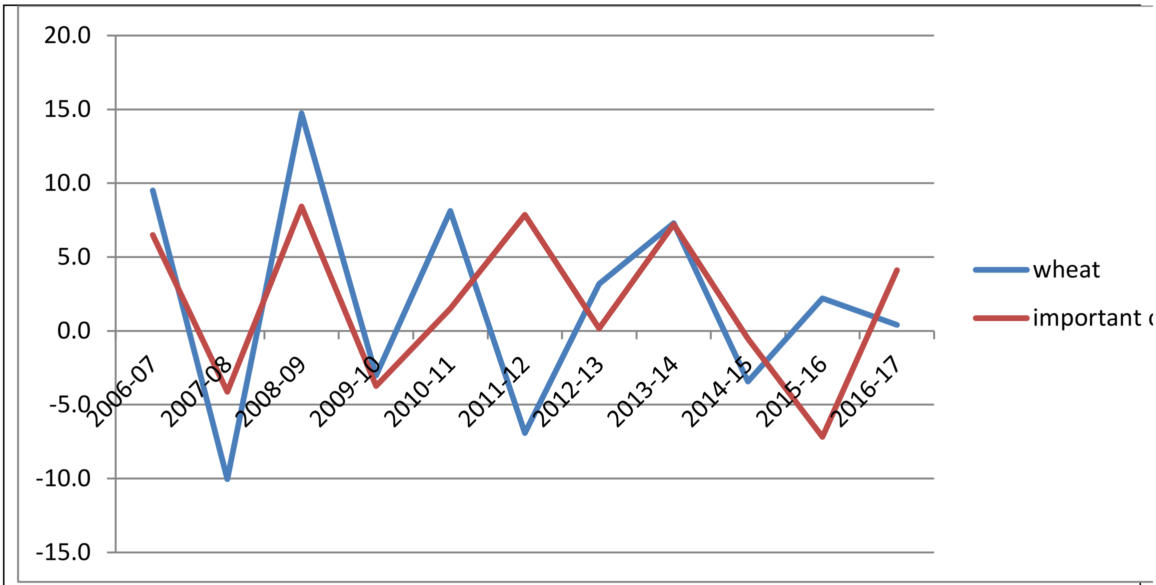
INTRODUCTION

1.1 Introduction

Agriculture is the largest sector of Pakistan's economy. It not only provides food, raw material for industrial sector, foreign exchange due to exports, but also provides employment to a large number of people. It serves large number of people directly or indirectly, on this sector. According, to latest economic survey the share of agriculture in Pakistan's GDP is almost 20 per cent and it provides employment to 43 percent of total employed labour force in the country (Government of Pakistan, 2017). It also stands out as one of the largest component of foreign exchange earnings. It feeds the whole population of the nation. Due to this vast importance of agriculture sector in Pakistan, the economic performance of this sector decides the growth trend of Pakistan's economy.

The share of crop sector in total agriculture value added is 40 per cent and share of important crops within crop is 65 per cent. The share of wheat in important crops is 42 per cent. The average annual growth of cropping sector of Pakistan during 2006-07 to 2016-17 was only 1.1 per cent and the average annual growth of important crops was 1.8 per cent and the average annual growth rate for wheat was 2.0 per cent(Government of Pakistan, 2017). The yearly growth rate of important crops and wheat highlight that the good performance of wheat is necessary for the high growth of crop sector and agriculture sector of Pakistan (Figure 1.1).

Figure 1.1: Growth rate of important crops and wheat



Source: Government of Pakistan, Various Issues

Historically the policy makers use input and output price policy as a primary tool to effect domestic production of agriculture commodities. Many researchers try to find the impact of such policies under trade liberalization and free markets (Rao, 2003 & Mythili, 2006) the economies where output prices are lower trade liberalization has benefited the farmers considerably from the increased market incentives (Rao, 2003). So, the impact of agriculture price policy on the growth of agriculture under liberalization critically depends on how the farmers respond to various price incentives. The literature on supply response shows that over time the response of agriculture to price became weaker. Non-price factors are becoming more important and dominate over price factors in farmers' decision problem (Krishna, 1962; Narain, 1965; Askari and Cummings, 1976; Gulati and Kelly, 1999).

Like other countries Pakistan also use output price policy to control the domestic production of certain agriculture crops. The objective is to ensure a certain level of production by eliminating agriculture price uncertainty. The announcement of support price before sowing season creates an incentive for the farmer to increase production either by increasing cultivating area and/or intensive farming. In the last decade, we have seen a big increase in wheat support price in 2009 when price was increased from Rs. 625 to Rs. 950 per 40 kg. This implies an increase of 52 per cent in the wheat price.

The impact of this price increase on production, area and yield of wheat in Pakistan (Table 1.1). It is clear from the table that as compare to 1981-2008 the average production of wheat, average cultivated area has increased by 51 per cent and 13 per cent respectively during 2009-2017. Since, the growth in production is greater than growth of area, so yield has also increased. This indicates that rise in support price encourage farmers to use inputs. But, it is important to note that the growth of production and area is less than the growth rate of price of wheat. During the same period on average annual change in wholesale price index was 265 per cent. This shows that change in output and area is far less than the change in prices. No study yet has tried to estimate the impact of the recent price increase on output produced, area and yield of wheat. Does the response of farmers to price change have increased? Or does the non-price factors are more important than output price factors. The analysis will reveal that still we need to use the standard output price policy to control domestic production or we have to find some other policy tools to stimulate agriculture growth. We have selected wheat for this analysis because it is not only the biggest crop in terms of contribution into GDP, but government is consistently announcing output prices for wheat. The size of support price list varies over time in 1990-91 there were 14 items in Pakistan support list, means government of Pakistan announce support prices for 14 agriculture crops, in 2016-17 government announced support price only for 2 products.

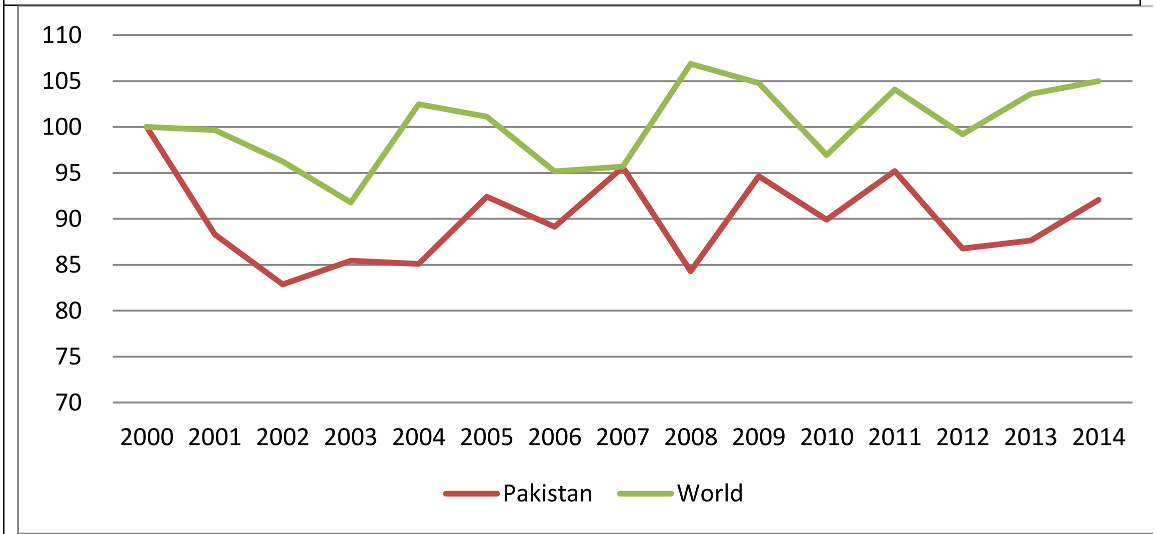
Table: 1.1 Average wheat production, area, yield and price from 1981 to 2017					
		Average			
		1981-2008	2009-2017	1981-2017	Growth rate*
Production	000 tones	16,358	24,743	17,981	51%
Area	000 hectare	7,945	9,008	8,203	13%
Yield	Kg/Hec	2,059	2,747	2,192	33%
Price of wheat	Growth rate (%)	3.35	12.23	5.57	265%

*growth rate is the change in average value for 2008-2015 as compare to average value of 1981-2008.

Source: Government of Pakistan, various issues

Although increasing support prices has raise the output and cultivated area for wheat, but if we compare it with world production we will see that this increase in price fails to reduce the gap in between Pakistan and world production. Overall, world production shows higher growth in the last decade or so as compare to Pakistan. It is important to see that up to what extent our wheat's production is responsive to changes in prices and other production (Figure 1.2).

Figure 1.2: Per Capita wheat production (1999-00=100)



Source: http://www.fao.org/faostat

The state of food security in Pakistan is dismal. According to latest food security report, almost 22 per cent of the population is undernourished. Within South Asia in terms of population undernourished Pakistan rank 5 out of 7 countries. Pakistan not only rank lowest in terms of population undernourished, but also in last 24 years population undernourished decline by only 3 percentage point (Table 1.2). Wheat is one the most important cereal and source of nutrients. Its share in total household consumption is about 9 per cent. It accounts for 53 per cent of calories and 59 percent of protein intake daily. About 60 per cent of daily diet consumption comes through wheat. In terms of per capita consumption is around 125 kg in Pakistan [FAO (Various Issues)]. This explains that how much wheat is important for improving food security in Pakistan.

Table 1.2: Proportion of undernourished in total population

Country	**1990–92**	**2014–16**	**Percentage point Change**	**Rank**
Afghanistan	29.5	26.8	-2.7	6
Bangaldesh	32.8	16.4	-16.4	4
India	23.7	15.2	-8.5	3
Maldives	12.2	5.2	-7	1
Nepal	22.8	7.8	-15	2
Pakistan	25.1	22.0	-3.1	5
Sri Lanka	30.6	22.0	-8.6	5

Source: Food Security Report, FAO 2014-2016

1.2 Wheat Situation Analysis

Wheat is the most popular staple food crop of Pakistan. It occupies a central position in Pakistan's agrarian economy. Wheat crop is planted in winter season during the months of November-December and harvested in the months of April-May. Wheat is an important Rabi crop. Wheat is planted in both irrigated and un-irrigated areas and in all four provinces of Pakistan. It is grown in this region of the world from ancient times. Some experts say that wheat firstly cultivated in the Indus Valley. In terms of wheat production Pakistan numbers at 4 in Asia and 9th in the world.

Government provides more incentive such as remunerative prices to protect farmers' interest, availability of credit facilities, improving irrigation facilities, improving markets of both output and input, more investment in agricultural research and extension services, etc. to farmers to produce more. After these developments, it is expected that farmers would become more price responsive.

By the facts presented above, it is revealed that wheat production is under great pressure of population growth and climate threat. Global food crisis of 2007-2008 is an evidence. Under developing countries agriculture systems are much vulnerable in this situation. Farmer in Pakistan is also facing such problem. Low technological development, illiteracy and poor infrastructure make it tough for farmers to get desired agriculture growth. In this scenario, there is dire need of coordination between policy makers and farmer's. As wheat is a principle staple food of Pakistan, finding true indicators of its supply response will help both farmer and policy maker to fight against upcoming food challenges.

Wheat is cultivated over more than 240 million hectares in the world which is larger than any other crop. In terms of trade its volume is more than all other crops combined. In 2013-14 world wheat production remained at 726.5 million tones which is 4.3 percent more than previous year 690.6 million ton. Wheat acreage is also increasing every year to meet the demands of growing population. Europe Union is world largest producer of wheat (FAO, 2014).

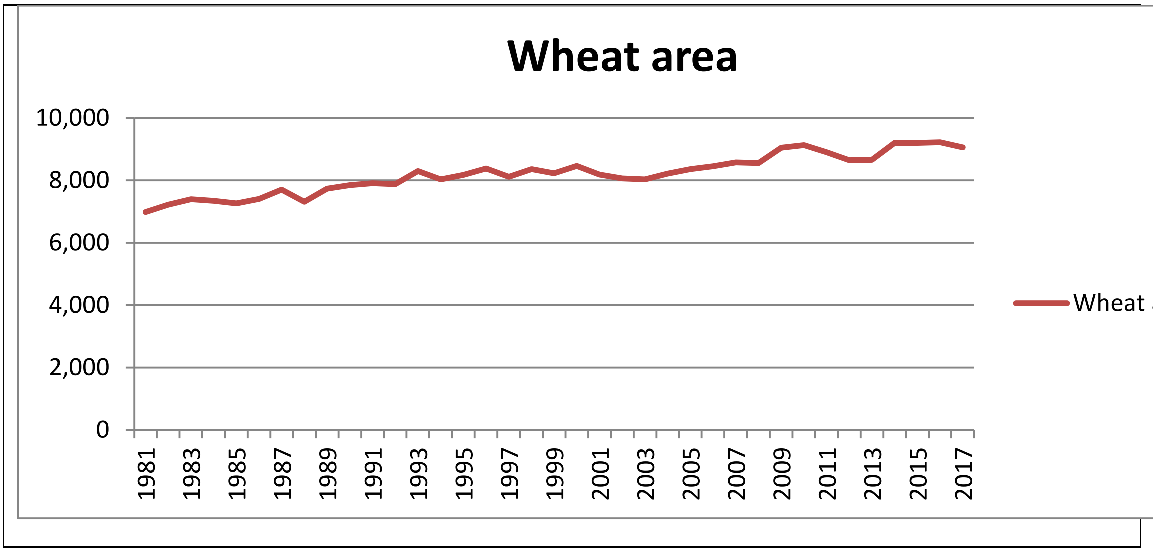
During world food crisis 2007-2008 high and volatile food prices were observed. This food crises raised a question 'How countries can protect themselves from supply shortages?'. This forced some major exporting countries to review their trade policy and impose some restrictions. Once again governments focus on self-sufficiency and food shortage (Brockhaus *et al.*, 2015).

Agricultural productivity increased largely, over past three decades. This increase is due to the development to high-yielding varieties and increases fertilizers use. With the introduction of semi-dwarf wheat cultivars productivity of wheat increased in all cropping systems of the world. Although Pakistan has potential of 7-8 t/ha but our national average yield is 2.8 t/ha which is below par. So, there is a need to increase production. If area under wheat remain same around (9 m ha) than wheat requirement in 2030 will be 34.25 million tones. So, 10-million ton extra wheat is required to produce in next 20 years. This require national average yield at 3.8 t/ha (PARC, 2014).

Wheat Area

The total cultivated area under wheat in 1981 was 7 million hectare. It shows a slow increase over time and in 2017 it is around 9 million hectare. This shows an average annual growth of 0.7 per cent. According to economic survey of Pakistan the total cropped area in 1981 was 19.3 million hectare and it has increased to 22.3 million hectare in 2017. The share of area under wheat as a % of total cropped area has increased from 36 per cent in 1981 to 39 per cent in 2017 (Figure 1.3).

Figure 1.3: Cultivated Area under Wheat in Pakistan 1981 to 2017 (000 Hectares)

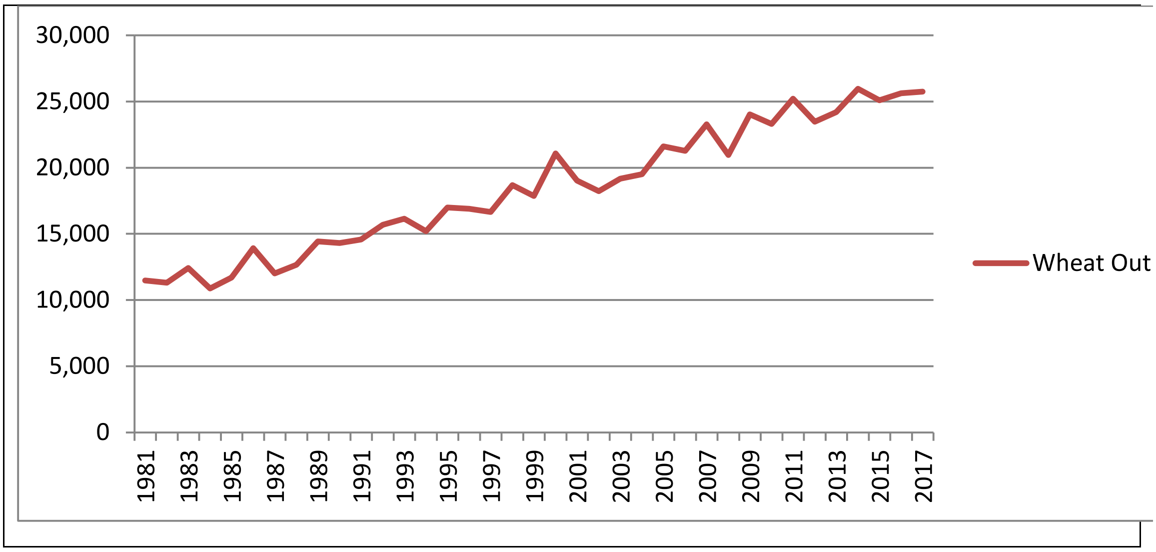


Source: Government of Pakistan, Various Issues

Wheat Output

The total wheat production of Pakistan shows an increasing trend during 1981 to 2017. According to economic survey of Pakistan the annual wheat production in 1981 was 11.4 million tones and by 2017 it has reached to 25.7 million tones. This shows an average annual growth of 2.3 per cent. It is important to note the growth in output is greater than growth in area (figure 1.4).

Figure 1.4: Wheat Output in Pakistan 1981 to 2017 (000 tones)

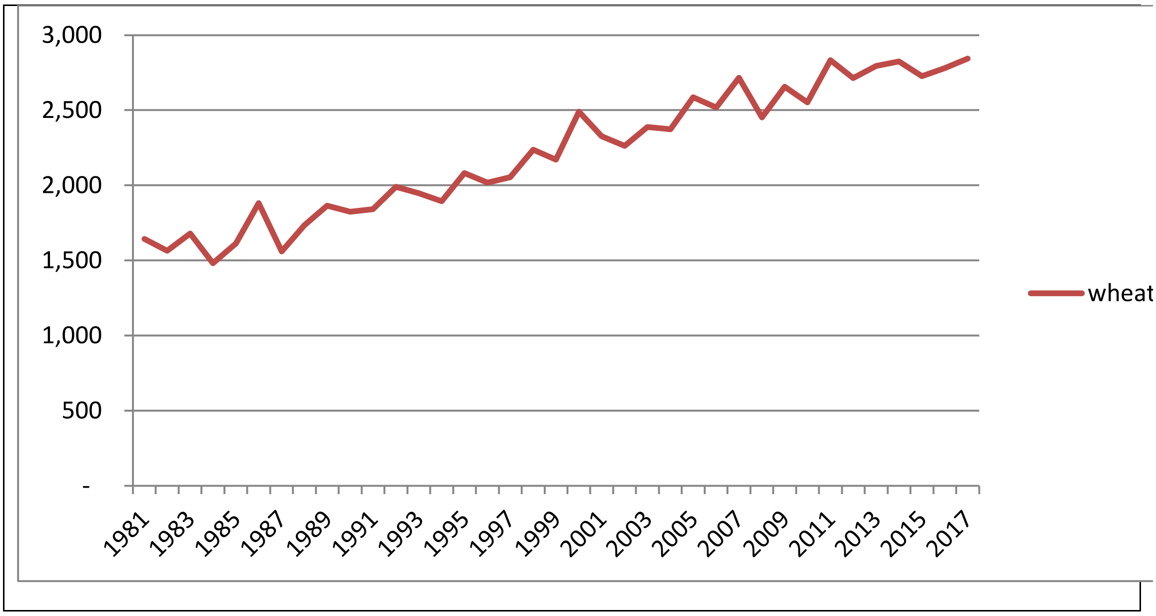


Source: Government of Pakistan, Various Issues

Wheat Yield

As it is mentioned above that growth rate of output is greater than growth rate of area under wheat in Pakistan. This indicates that the yield has also increased. The average yield of wheat in 1981 was 1643 kg per hectare and in 2017 it is 2845 kg per hectare. This implies an average growth of 1.5 per cent in the yield (Figure 1.5).

Figure 1.5: Wheat Yield in Pakistan 1981 to 2017 (Kg per hec)



Source: Government of Pakistan, Various Issues

Most of the studies have used time series data at aggregated level to compute the price elasticity because there are significant variations in production area and more importantly in yield. Punjab's share in the total output and area are 76.9 and 78.6 respectively and yield 2762 kg per hectare. Sindh's shares in output and area are 14.6 and 12 per cent respectively and yield is 3317 kg per hectare. KP's shares in output and area are 5 and 8 per cent respectively and yield of 1720 kg per hectare. The share of Balochistan in output and area are only 3.2 and 4 per cent respectively and yield of 2265 kg per hectare (table 1.3). This clearly shows that there are visible and significant variations not only in terms of area and output, but also in yields. These variations are more prominent at district level in Pakistan. Such variations highlight the importance of disaggregated analysis as compare to aggregated analysis.

Table 1.3: Province wise wheat production, area and yield, 2014-15

	Output	Area	Yield
Province	000 Tones	000 Hec	Kg/Hec
Punjab	19,282	6,981	2,762
Sindh	3,672	1,107	3,317
KP	1,260	733	1,720
Balochistan	872	385	2,265
Pakistan	25,086	9,206	2,725

Source: Agriculture Statistics of Pakistan 2014-15

1.3 Objectives of the Study

The above analysis reveals that wheat is important for reducing food deprivation and it is also very important in terms of its contribution into GDP. In the recent year's government has significantly raise the output prices which has an impact on wheat production, but the growth in prices is greater than the growth in output. It is difficult to see that either price fluctuations have a dominating role as compare to non-price factor.

Objectives of the Study:

The overall objective of the study is to find out the wheat supply response in Pakistan. The specific objectives of the study are as following:

a) to find out the output price policy effectiveness in stimulating domestic production and yield of wheat.

b) to update the estimates of the short run and long run elasticity of wheat production in terms of output, area and yield.

1.4Research Questions

The study has following questions:

a) Does the output price policy have a significant impact on wheat response function in Pakistan?
b) Does Pakistani farmers are more or less responsive to changes price and non-price factors?

1.5 Significance of the Study

This study is important in the following dimensions:

Most of the studies, those estimate wheat supply response function for Pakistan, have used time series aggregated data. The use of time series data has certain limitations. First, it conceals variations across regions. The region-specific characteristics and their contribution to the varying supply response would provide better information for drawing inferences at the national level. Panel data has a distinct advantage of providing regional and temporal variations for dynamic models. This study first in nature that tries to estimate short run and long run elasticity of wheat production by using district level data for Pakistan. This will allow us to control the heterogeneity across districts. Further since most important factor of production is land and it is immovable, so it is more sensible to use disaggregated data to control location wise limitation of area.

CHAPTER II

REVIEW OF LITERATURE

The main objective of this chapter is to review the current literature available to highlight the research gap. This chapter also overviews the existing state of wheat production in Pakistan. This chapter is divided into 3 sections. Section I highlights the issues and problem associated with supply response function. Sections II review the literature specific to Pakistan and the last sections review the historical variations in the state of wheat in Pakistan.

2.1 Supply Response Function

The pioneering work of Nerlove (1958) on supply response functions allow various researchers to determine short run and long run estimates of elasticity of agriculture crops, all across the world. The studies by Askari & Cummings (1977) &Rao (1989) provides the historical estimates of crop wise and country wise estimates of short run and long run elasticity estimates.

Most of the studies given like Askari & Cummings (1977) &Rao (1989) are done at either country level or at a sub-regional level, but always used a time series analysis. Since the model developed by Nerlove (1958) gives flexibility to introduce price and non-price factors in the model simultaneously.

In the 1960s and 1970sKrishna (1962), Behrman (1966) and Medani(1975) made some changes in the Nerlovian model and used to estimate the income elasticity of consumers for major food crops in developing countries. They have use marketed surplus as the primary variable rather than total output.

During 1970s to up till now most of the work has been done to improve the estimation procedure rather than application to different concept. Nerlove(1971) and Eckstein (1984) will give a nice debate on how to made distributed lag models formulation econometrically relevant and how to incorporate rational expectations into the model rather than adaptive expectations. Hallam &Zanoli(1993), Townsend &Thirtle(1997) & Schimmelpfennig, et. al (1996) used error correction approach along with Johansan cointegration analysis to estimate the partial adjustment Nerlove model. These studies have extended and examining the impulse responses in order to see the long run dynamics. Kumar and Rosegrant (1997), Gulati & Kelley(1999) have attempted to extend the Nerlove model to use it for panel data.

2.2 Supply Response Function for Pakistan

Krishna (1963) has estimated the short run and long run elasticity of supply (acreage) for the major crops for Indian and Pakistan Punjab, for the pre partition period from 1915 to 1942. He has used Nerlove model and estimated by simple OLS method. He included Cotton, Maize, Wheat, Sugarcane, Rice, Jowar, Gram and Barley in the analysis. He found that for wheat the own price short run and long run elasticity was 0.08 and 0.14 and the adjustment coefficient was 0.58. The important thing to note that incase of wheat the price factor was marginally significant. He found that acreage response of wheat in Punjab was much lower as compare to the world.

Nosheen& Iqbal (2008)used the Nerlovian model to estimate the response of cotton, wheat and sugarcane crops area by using OLS method. The study has used the data from 1971 to 2007. The variables included in the study are real price of wheat at time t-1, real price of cotton at time t-1, yield of wheat at time t-1. The short run own price elasticity of wheat area was estimated around 0.045 and the long run elasticity comes to 0.105. the adjustment coefficient is 0.44.

Mushtaq & Dawson (2002attempts to estimate the acreage response of wheat, cotton, sugarcane and rice by using Johansan co-integration analysis and estimate the impulse response function of above given crops. The study has used annual data for the following variables for each crop individually: area, real wholesale price of the crop, irrigated area, and sowing season rainfall. Results shows that acreages of wheat and do not respond significantly to shocks in own-price and that long-run equilibrium is re-established after about 4 years.

Bhatti, *et. al* (2011) has estimated the supply response of farmers in Pakistan. They have used the data from 1961-62 to -2007-2008. The study has estimate the wheat production response function and wheat area response function for above given time separately. The have used lagged wholesale price of wheat, cotton, area under wheat and dummy variable for 1966. The own price short run and long run elasticity of wheat for domestic output was 0.184 per cent and 0.44 per cent respectively. In case of acreage response, the short run own price elasticity was 0.080 per cent and the long run elasticity was 0.110.

2.3 Research Gap

The above review of literature shows that the latest estimates for wheat elasticity was available for 2007-08. Since, after 2008 we have witnessed a significant increase in wheat output prices in Pakistan, so there is a strong need to update the estimate of wheat elasticity. It is important to note that the above studies did not include fertilizer prices in the analysis, which is a major input and may have significant impact on wheat response in Pakistan. Neither study included climate variables. The studies used time series analysis an aggregated data for Pakistan; none of the studies has used disaggregated data for example province level or district level data in Pakistan.

CHAPTER III

METHODOLOGY AND DATA SOURCES

The review of literature shows that there are two frameworks developed for estimating supply response function for agriculture crops. The Nerlovian model is the most widely used model and almost all the studies those carried out for time series has used same model (Nerlove ,1958). The second is by estimating input and output demand function for a profit maximization approach. This is mostly used for cross section data analysis. The limitation of this approach that it requires detailed information for all the inputs and outputs prices and consumption. In other words, crop level input and output tables. The reliable estimates of such data is not readily available, many authors used this approach by carrying out survey of specific area. Second limitation of this approach is that it is very difficult to collect data for certain inputs like land and labor, because in developing countries like Pakistan agriculture markets are not complete.

This chapter is divided into three sections. Section 1 describes the methodological framework used for estimating domestic response function of wheat. Section 2 outlines the data sources and description of variables. Sections 3 describes the estimation procedure.

3.1 The Model

The main objective of this section is to develop a methodology to estimate the short run and long run elasticity of wheat response functions for Pakistan by using data from 1981 to 2015. The study used Nerlovian model to calculate the short run and long run elasticity of wheat supply in Pakistan for above mentioned time and secondly the study also analyze. Leaver (2004) has used the same framework to estimate the tobacco response function, but he is used for time series data. Mythili (2006) has estimated the supply response function by using Nerlovian model for panel data. We have extended the Leaver (2004) and Mythili (2006) models to estimate the response function for wheat. The equation 1 below gives the standard Nerlovian model.

$$X_{it}^{*} = \alpha_{\circ} + \alpha_{1} P_{it}^{*} + Z_{it}\gamma' + \varepsilon_{it} \quad (1)$$

$$X_{it} = X_{it-1} + \beta(X_{it}^{*} - X_{it-1}) \quad (2)$$

$$P_{it}^{*} = P_{it-1}^{*} + \delta(P_{it-1} - P_{it-1}^{*}) \quad (3)$$

Where:

X_{it}^{*} = the desired area under cultivation in district i at time t

X_{it}= the actual area under cultivation in district i at time t

X_{it-1}= the actual area under cultivation in district i in district i at time t-1

P_{it-1}= the actual price of crop in district i at time t-1

P_{it}^{*}= the expected price of crop in district i at time t

Z_{it-1}= a vector of controlled variables in district i in district i at time t

β and δ are the measure of adjustment coefficient, high value of these indicated high speed of adjustment. Equation 2 and 3 show the adaptive expectation process.

Rewriting equation 2 and 3 in the following way:

$$X_{it} = \beta X_{it}^{*} + (1-\beta)X_{it-1} \quad (2)'$$

$$P_{it}^{*} = (1-\delta)P_{it-1}^{*} + \delta P_{it-1} \quad (3)'$$

Substituting equation 1 into 2', we will get the following;

$$X_{it} = \beta\{\alpha_{\circ} + \alpha_1 P_{it}^{*} + \gamma Z_{it} + \varepsilon_{it}\} + (1-\beta)X_{it-1}$$
$$X_{it} = \beta\alpha_{\circ} + \beta\alpha_1 P_{it}^{*} + \gamma\beta Z_{it} + \beta\varepsilon_{it} + (1-\beta)X_{it-1} \quad (4)$$

Substituting 3' into 4 we will get the following;

$$X_{it} = \beta\alpha_{\circ} + \beta\alpha_1\{(1-\delta)P_{it-1}^{*} + \delta P_{it-1}\} + \gamma\beta Z_{it} + \beta\varepsilon_{it} + (1-\beta)X_{it-1} \quad (5)$$

$$X_{it} = \beta\alpha_{\circ} + \beta\alpha_1(1-\delta)P_{it-1}^{*} + \beta\alpha_1\delta P_{it-1} + \gamma\beta Z_{it} + (1-\beta)X_{it-1} + \beta\varepsilon_{it} \quad (5)'$$

Lag 4 by one-time period

$$X_{it-1} = \beta\alpha_{\circ} + \beta\alpha_1 P_{it-1}^{*} + \gamma\beta Z_{it-1} + \beta\varepsilon_{it-1} + (1-\beta)X_{it-2} \quad (6)$$

Multiply 6 by $(1-\delta)$

s

(6)'

Subtracting 6' from 5'

$$X_{it} - (1-\delta)X_{it-1} = \beta\alpha_{\circ} + \beta\alpha_1(1-\delta)P_{it-1}^{*} + \beta\alpha_1\delta P_{it-1} + \gamma\beta Z_{it} + (1-\beta)X_{it-1} + \beta\varepsilon_{it} - \{(1-\delta)\beta\alpha_{\circ} +$$
$$(1-\delta)\beta\alpha_1 P_{it-1}^{*} + (1-\delta)Z_{it-1}\gamma\beta + (1-\delta)\beta\varepsilon_{it-1} + (1-\delta)(1-\beta)X_{it-2}\}$$

Simplifying the above equation

$$X_{it} = \delta\beta\alpha_{\circ} + \beta\alpha_1\delta P_{it-1} + \{(1-\delta) + (1-\beta)\}X_{it-1} + \{\gamma\beta Z_{it} - Z_{it-1}\gamma\beta(1-\delta)\} - (1-\delta)(1-\beta)$$
$$X_{it-2} + (\beta\varepsilon_{it} - (1-\delta)\beta\varepsilon_{it-1}) \quad (7)$$

The following is the reduce form of above equation:

$$X_{it} = \pi_\circ + \pi_1 P_{it-1} + \pi_2 X_{it-1} + \pi_3 X_{it-2} + \pi_4 Z_{it} + \pi_5 Z_{it-1} + \mu_{it} \quad (8)$$

Where;

$$\pi_\circ = \delta\beta\alpha_\circ$$
$$\pi_1 = \delta\beta\alpha_1$$
$$\pi_2 = (1-\delta)+(1-\beta)$$
$$\pi_3 = -(1-\delta)(1-\beta)$$
$$\pi_4 = \gamma\beta$$
$$\pi_5 = \gamma\beta(1-\delta)$$

The short run elasticity of price is equal to

$$\in_{op} = \pi_1 * \frac{P}{X} \quad (9)$$

The long run elasticity of price is equal to

$$\in_{op} = \frac{\pi_1}{1-\pi_2-\pi_3} * \frac{P}{X} \quad (10)$$

A similar model has been developed for estimating the supply response function for wheat production and wheat yield. The main reason for estimating yield response along with area is due to the two reasons. First, that farmers may show response by using improved technology of production without any change in the cultivated area when price level increase. Second, because of increase in price farmer may go for intensive cultivation by using more or better quality of inputs. These two will raise the output even without cultivating more area, this thing is not captured by acreage model (Mythili, 2006).

Equations 11 have been used to estimate the response function of wheat in terms of output.

Different studies use production as supply while estimating supply response of agricultural products. Bhatti *et al.* (2011) use quantity produced as dependent variable in his model while analyzing supply response of Pakistani wheat growers. Ozkan, Ceylan & Kizilay (2011) also used output as dependent variable in estimating supply response of wheat in Turkey. Ali & Abedullah (1998) supply function of pulses use production as dependent variable in their model. Saikh& Shah (2008) for supply function of rice growers and Magrini, Baile & Opazo (2016) for supply response of staple food also used output as dependent variable. So, in the paper total output is taken as supply.

$$Q_{it} = \pi_{\circ} + \pi_1 P_{it-1} + \pi_2 Q_{it-1} + \pi_3 Q_{it-2} + \pi_4 Z_{it} + \pi_5 Z_{it-1} + \mu_{it} \quad (11)$$

Equations 12 have been used to estimate the supply response of wheat in terms of yield.

$$Y_{it} = \pi_{\circ} + \pi_1 P_{it-1} + \pi_2 Y_{it-1} + \pi_3 Y_{it-2} + \pi_4 Z_{it} + \pi_5 Z_{it-1} + \mu_{it} \quad (12)$$

Q_{it} = is the output of wheat in district i at time t.

Y_{it} = is the yield in district i at time t.

The short run and long run elasticity has been calculated in similar ways as given above.

Coefficient of each logical variable specifically gives short run elasticity and the long run elasticity is estimated by dividing coefficients of each variable by (1-coefficient of the lag dependent variable). This procedure automatically assumes that long run elasticity must equal or greater than short run elasticity. In the case if 1-coefficient of the lag dependent variable (adjustment coefficient) is near 1, then it indicates that adjustment of actual area to desired area is fast and if the value is close to 0 shows that adjustment of actual area to desired area is slow.

The district level data for the period 1981-82 to 2013-14 have been used for the analysis. District wise area cultivated under wheat, district wise output of wheat and district wise yield of wheat, national wholesale price of wheat, national wholesale price of gram is used as a competing crop, rainfall in a province in which district is located, the deviation in temperature from historical mean value is taken at province level in which district is located and national price of urea, DAP and nitrogen phosphate are the variables used for analysis.

In area response function equation, price of wheat, price of competing crop, rainfall, maximum temperature, minimum temperature value of production has been used as explanatory variables. For output response function, along except value of production and maximum and minimum temperature, we have used cultivated area under wheat and temperature deviation from the historical level. For yield response function, variables of both above equations have been used. By using learning by doing, final set of variables was chosen. All the variables except temperature deviation are used in logarithms.

3.2 Data and Variables

The detailed description of each variable, level of aggregation, time period and data source is given in table 3.1.

Table 3.1: Data and Variables

Variable Name	**Description**	**Level of Aggregation**	**Data source**
Area	Cultivated area under wheat (000 hectare)	District Level	District wise agriculture Statistics of Pakistan
Output	Wheat domestic production (000 tones)	District Level	
Yield	Output/Area (kg per hectare)	District Level	
Temperature	Maximum and Minimum average temperature in the selected stations	Province level	Economic Survey of Pakistan various issues
Wheat Price	Wholesale price index of wheat (2007-08 =100)	National Level	
Competing Price	Wholesale price index for Gram (2007-08 =100)	National Level	
Price of Urea	Average retail price of Urea (Rs per 50 Kg)	National level	
Price of DAP	Average retail price of DAP (Rs. Per 50 Kg)	National level	
Price of Nitrogen Phosphate	Average retail price of NP (Rs. Per 50 Kg)	National Level	
Rainfall	Average rainfall recorded at different stations (mile meter)	Provincial level	

Some variables or indexed are computed the detailed description of each variable is given below:

Fertilizer Index

We have constructed an index for fertilizer price. first we take the simple average of three important fertilizer prices, urea, DAP and NP and then consider 2007-08 as base year to convert the price into index form. The equation below describes the method:

$$Fertilizer = \frac{\text{Price of urea} + \text{Price of DAP} + \text{Price of NP}}{3}$$

Since the district level data for fertilizer prices is not available so we have used the national fertilizer price index for each district.

Rainfall

Economic survey of Pakistan gives rainfall data for selected stations. It includes 3 stations Lahore, Multan and Islamabad from Punjab, 2 stations Karachi and Jacobabad from Sindh, Peshawar from KP and Quetta from Balochistan. We have computed province wise average rainfall by taking the simple average of the stations located in that province in case of KP and Balochistan used value for Peshawar and Quetta as provincial averages.

Temperature

We have used the similar methodology as explained above. Economic survey of Pakistan gives average minimum temperature and average maximum temperature data for selected stations. It includes 3 stations Lahore, Multan and Islamabad from Punjab, 2 stations Karachi and Jacobabad from Sindh, Peshawar from KP and Quetta from Balochistan. We have computed province wise average minimum temperature and average maximum temperature by taking the simple average of the stations located in that province in case of KP and Balochistan used value for Peshawar and Quetta as provincial averages.

To construct the temperature deviation variable, we have done following steps.

First compute the average temperature for a province in year t by simply taking the average of maximum and minimum temperature. Then we compute the historical average from 1981-82 to 2013-14 for each province. In the last stage, we have subtracted the average temperature in the province in year t from historical average.

3.3 Estimation Technique

Mythili (2006) has used the dynamic panel data modeling approach by GMM for estimating the state wise response function in India. So, we have also used the same method for estimating the response functions for wheat. This section, discuss the estimation procedure used to estimate the equations given in the previous section. The basic difference in panel data analysis as compare to time series analysis is the different structure of error term and the error term may have any or all of the following characteristics:

a) Errors may have varying variances across cross section this leads to a problem of heteroscedasticity.
b) Error terms may be correlated across time.
c) Errors can be contemporaneously correlated across cross sections.

The ordinary least squares (OLS) method in the presence of any of the above problems will never give efficient estimators. As long as serial autocorrelation or heteroscedasticity is concerned these can be resolved by using generalized least square (GLS) technique and contemporaneous correlation can be resolved by seemingly unrelated regression (SUR). It is important to decide on the nature of district specific effects of the model fixed effect vs. random effect. We have used langrangian multiplier (LM) test to decide between fixed and random effect. The test fails to reject null hypothesis, so it indicates the test accepted fixed district specific effects. Arellano and Bond(1991) developed generalised method of moments' (GMM) and it shows that estimator is robust to differences in the specification of data generating process. They are consistent and asymptotically efficient. In this particular model, the regressor is correlated with error terms of all the previous years. The GMM estimator is a dynamic one that estimates the model in case if number of cross sections is greater than number of time values. This method uses lagged values of the variables as instruments.

Taking the First difference of the variables automatically eliminates the district specific effects and will leave only pure random terms. This differencing will also resolve the problem of non-stationarity of the series, since we have data for more than 30 years for each district so there will be a problem of unit root in the data. This estimation technique fully achieved all the moment conditions. This is also suitable technique for estimating reduced form equations that involve lagged dependent variables. IV are in the form of lag and difference of the explanatory variables or dependent variables can be used, hence this technique is chosen for this study.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter presents the estimated results for the model given in the previous chapter. The chapter has divided into two sections. Section 1 gives the results for area cultivation and yield equations for the time period 1981-82 to 2013-14 and the second section provides the pre 2009 and post 2009 results for the given equations.

4.1 The Domestic Area Response Function

This section presents the domestic supply response function for the wheat by using district level data from 1981-82 to 2013-14. We have estimated the following equation by using Arellano-Bond dynamic panel-data estimation in STATA for the area supply response function for Pakistan.

$$\ln area_{i.t} = a_i + \beta_1 L.\ln price_t + \beta_2 L.\ln oprice_t + \beta_3 L.\ln rain_{j.t} + \beta_4 L.\ln ferti_t + \gamma L.\ln area_{i.t}$$

$lnarea_{i.t}$ =*log of area under wheat cultivation in district i in year t*

$L.lnprice_t$ = *log of wheat wholesale price in year t-1*

$L.lnoprice_t$= log of competing crop price in year t-1

$\mathrm{L.lnrain}_{j.t}$= *the average rainfall in year t-1 in province j*

$\mathbf{L.lnferti}_{\boldsymbol{t}}$ =*log of fertilizer prices in year t-1*

$\mathbf{L.lnarea}_{\boldsymbol{i.t}}$ =*log of area under wheat in district i in year t-1*

The detailed description of each variable is already discussed in the previous chapter. Along with these variables we have tried some other variables like rural literacy rate and temperature deviation from average in previous year the province j, but these turns out insignificant.

The model 1 intable 4.1 gives the results for the area equation. We have used robust command it gives the parameters controlled for hetrosecdasticity. It turns out that all variables are significant except for price of competing crop. These parameters are the short run elasticity as explained in the previous chapter.

The positive and significant value of L.lnprice shows that own price of wheat has a significant impact on area cultivation. The coefficient values are 0.105 shows a 1 per cent increase in price of wheat leads to 0.105 per cent increase in cultivated area under wheat. The coefficient is significant at10 level of significance. Krishna (1963) for Punjab estimate that the own price coefficient was 0.08. Nosheen & Iqbal (2008) found that the own price effect for wheat area is estimated around 0.045. it seems that our model has estimate a relatively higher coefficient for the own price effect on wheat area. The main reason is the use of disaggregated data.

The coefficient of L.lnopriceis negative but insignificant, it shows that price of competing crop has a negative impact on the area cultivated for wheat. Nosheen & Iqbal (2008) has also found the same results. The price of competing crop has negative, but insignificant impact on the wheat area.

This is very strange and contradictory to the standard explanation, which is that at the time of sowing the farmer decide about a particular crop on the basis of the difference in prices of both crops, if other things remain same. The only explanation for this is the uncertainty about future prices of both crops the farmer not only cultivates that crop for which price is higher, but it also cultivates that crop where price variations are less and we found that price variations in case of Gram are higher than price variations in wheat. This is the only possible reason for the insignificance of price of competing crop. Since the coefficient is insignificant, so we did not interpret the results.

The price of fertilizer has a negative impact on area cultivation. The variable is significant at 10 per cent level of significance and its value shows that a 1 per cent increase in fertilizer prices leads to 0.088 per cent decrease in cultivated area. It is important to note that impact of fertilizer prices is relatively higher as compare to all other factors. The L.lnrain is a proxy variable for water availability in the province in which district is located has a positive and significant impact on area cultivation. The coefficient is significant at 5 per cent level of significance and shows a 1 per cent increase in rain in the previous year leads to 0.026 per cent increase in cultivated area for wheat. Mythali (2006) in case of India also find this significant and the value for India was 0.041.

The value of L.lnarea is the lag of the dependent variable it is significant at 1 per cent level of significance. The coefficient value is 0.64 indicates how much current value of area depends on the previous year's value. The value of 1- coefficient of L.lnarea is the adjustment coefficient and it is 0.36, it shows the speed of farmers' adjustment of actual acreage to desire acreage level and it turns out that in case of area this speed of adjustment is relatively slow in Pakistan. Krishna (1963) has found that the adjustment coefficient for Punjab is 0.58 and Nosheen & Iqbal (2008) have also found that the adjustment coefficient is 0.436. it seems our model has estimated a relatively slow adjustment by farmer and this is again due to the fact because we have used disaggregated data.

The table 4.2 gives the short run and long run estimates of domestic supply response function for wheat. As explained in the previous chapter the coefficients of regression model are the short run elasticity. We can estimate long run elasticity by dividing particular coefficient with 1- coefficient of L.lnarea.

The short run and long run domestic area elasticity of wheat with respect to own price is 0.11 per cent and 0.29 per cent respectively, shows a 1 per cent increase in wheat price leads 0.11 per cent increase in area cultivation in short run and 0.29 per cent in the long run. Since, the coefficient of competing crop price is insignificant, so we did not report the short run and long run elasticity of wheat area with respect to competing crop.

Since fertilizer is the main input, so we have used fertilizer prices to compute elasticity of wheat area with respect to fertilizer prices. The short run elasticity of wheat area with respect to fertilizer prices is -0.09 per cent and long run elasticity is -0.25 per cent. 1 per cent increase in fertilizer price leads to 0.09 per cent and 0.25 per cent decrease in area cultivation for wheat area in short run and long run respectively.

4.2 The Domestic Output Response Function

This section presents the domestic production response function for the wheat by using district level data of wheat production from 1981-82 to 2013-14. We have estimated the following equation by using Arellano-Bond dynamic panel-data estimation in STATA for the area supply response function for Pakistan.

$$\ln output_{i,t} = a_i + \beta_1 L.\ln price_i + \beta_2 L.\ln oprice_i + \beta_3 \ln rain_{i,t} + \beta_4 L.\ln ferti_i + \beta_5 tempdev_{i,t} + \beta_6 \ln area_{i,t} + \gamma L.\ln output_{i,t}$$

$\ln output_{i,t}$ = *log of output of wheat produced in district i year t*

$lnarea_{i.t}$ = *log of area under wheat cultivation in district i in year t*

$L.lnprice_t$ = *log of wheat wholesale price in year t-1*

$L.lnoprice_t$= log of competing crop price in year t-1

$\text{lnrain}_{j.t}$ = *the average rainfall in year t in province j*

$\boldsymbol{L.lnferti_t}$ =*log of fertilizer prices in year t-1*

$tempdev_{j.t}$ =*the deviation of temperature from mean value in year t for province j*

$\boldsymbol{L.lnoutput_{i.t}}$ =*log of production of wheat in district i in year t-1*

The model 2 in table 4.1 gives the results for the output equation. We again used robust command to control the problem of hetrosecdasticity. It turns out that all variables are significant and the intercept term is insignificant. As explained above, the parameters are the short run elasticity.

The L.lnprice is the lag of wheat wholesale price in Pakistan has a positive and significant impact on domestic wheat production The coefficient values is 0.25 implies that a 1 per cent increase in price of wheat leads to 0.25 per cent increase in domestic production of wheat in Pakistan. The coefficient is significant at 1 per cent level of significance.

In case of output the impact of lagged competing crop price has a significant impact. The value of the coefficient is -0.056 implies that a 1 per cent increase in the price of competing crop leads to a reduction in wheat production by 0.056 per cent and it is significant at 1 per cent level of significance. It is important to note that although the coefficient of price of competing crop was negative, but insignificant in area equation and it is significant impact on production.

This shows that small changes in area has a huge impact on production of wheat that is why in this model we have included area as an explanatory variable. The lnarea in the area under wheat has a positive and significant impact on wheat output. The coefficient values show that a 1 per cent increase in area leads to 0.9 per cent increase in output. The area variable is significant at 1 per cent level of significance.

The next variable is the price of fertilizer like in area equation it has a negative impact on output of wheat. The variable is significant at 1 per cent level of significance and its value shows that a 1 per cent increase in fertilizer prices leads to 0.042 per cent decrease in output of wheat. It is important to note that fertilizer prices have relatively large impact on area as compare to output. This confirms that fertilizer intensity of a crop has a very important role in determination of area, but once a farmer decided about a crop and sown it than it is compulsory for them to use of fertilizer, so the elasticity of output become less responsive to fertilizer prices.

The lnrain is a proxy variable for water availability in the province in which district is located has a positive and significant impact on output. The coefficient is significant at 1 per cent level of significance and shows that a 1 per cent increase in rain in the current year leads to 0.04 per cent increase in output of wheat. It is important to note that in area equation we have used the lag value of rain and in output we have used the current value of rain. The tempdev is the deviation in temperature from long run averages. The negative value shows that large variations in temperature have a negative and significant impact on the production. The coefficient values show that a 1 per cent increase in variations leads to 0.04 per cent decrease in output of wheat.

The value of L.output is the lag of the dependent variable it is significant at 1 per cent level of significance. The coefficient value is 0.106 indicates how much current value of output depends on the previous year's value. The value of 1- coefficient of L.lnoutput is the adjustment coefficient and it is 0.894, it shows the speed of farmers' adjustment of actual output to desired output level and it turns out that in case of output this speed of adjustment is very fast as compare to area.

The table 4.2 gives the short run and long run estimates of domestic output response function for wheat. As explained above the coefficients of the estimated model are the short run elasticities and we estimated long run elasticity by dividing particular coefficient with 1- coefficient of L.lnoutput. It is important to note that high value of speed of adjustment indicates less difference in short run and long run elasticity.

The short run and long run domestic production elasticity of wheat with respect to its own price is 0.25 per cent and 0.28 per cent respectively, shows a 1 per cent increase in wheat price leads 0.25 per cent increase in wheat production in the short run and 0.28 per cent in the long run. According to Bhatti, *et. al* (2011), the own price short run and long run elasticity of wheat for domestic output was 0.184 per cent and 0.44 per cent respectively. the main reason of these differences in elasticity estimates is the use of disaggregated data that enable the farmer to adjust quickly. Bhatti, *et. al* (2011) finds the adjustment coefficient of 0.65 where our study found

It is important to note that short run elasticity of wheat production with respect to price is greater than area, but long run elasticities are more or less same. This shows that in the long run both gave us the same results as mentioned by Mythali (2006) in the article.

The short run and long run cross price elasticity of wheat production are -0.06 and -0.07 respectively. This implies a one per cent increase in the price of competing crops leads to 0.06 per cent and 0.07 per cent reduction in output of wheat in the short and long run respectively.

The change in wheat production with respect to changes in fertilizer prices gave us the elasticity of wheat with respect to input prices. The short run elasticity and long run elasticity of wheat production with respect to fertilizer prices is -0.04 per cent. 1 per cent increase in fertilizer price leads to 0.04 per cent decrease in wheat production in the short run and long run. This finding confirms the above discussion that both in short run and long run wheat production elasticity with respect to fertilizer prices is low as compare to area elasticity.

4.3 The Domestic Yield Response Function

This section presents the domestic yield response function for the wheat by using district level data from 1981-82 to 2013-14. The main objective is to find the impact of price and non-price factors jointly on output and area. We have estimated the following equation by using Arellano-Bond dynamic panel-data estimation in STATA for the area supply response function for Pakistan.

$$\ln yield_{i,t} = a_i + \beta_1 L.\ln price_t + \beta_2 L.\ln oprice_t + \beta_3 \ln rain_{j,t} + \beta_4 L.\ln rain_{j,t} + \beta_5 L.\ln ferti_t + \beta_6 tempdev_{j,t} + \gamma L.\ln yield_{i,t}$$

$\ln output_{i,t}$ = *log of output of wheat produced in district i year t*

$L.lnprice_t$ = *log of wheat wholesale price in year t-1*

$L.lnoprice_t$ = log of competing crop price in year t-1

$\ln rain_{j.t}$ = *the average rainfall in year t in province j*

$L.\ln rain_{j.t}$ = *the average rainfall in year t-1 in province j*

$\boldsymbol{L.lnferti_t}$ =*log of fertilizer prices in year t-1*

$tempdev_{j.t}$ =*the deviation of temperature from mean value in year t for province j*

$\boldsymbol{L.lnyield_{i.t}}$ =*log of yield of wheat in district i in year t-1*

The model 3 in table 4.1 gives the results for the yield equation. We again used robust command to control the problem of hetrosecdasticity. We have incorporated all the varibles of production and area equation into yield equation. It turns out that all variables are significant. As explained above, the parameters given in the table 4.1 are the short run elasticity with respect to a varibles.

The L.lnprice is the first lag of wheat price in Pakistan, similar to area and production it also has a positive and significant impact on domestic wheat yield. The coefficient values are 0.13 implies that a 1 per cent increase in price of wheat leads to 0.13 per cent increase in wheat yield in Pakistan. The coefficient is significant at 1 per cent level of significance.

The coefficient of L.lnoprice shows the impact of competing crop price on yield and it turns out that it has a negative and significant impact on yield. The value of the coefficient is -0.08 implies that a 1 per cent increase in the price of competing crop leads to a reduction of 0.08 per cent in the wheat yield and it is significant at 1 per cent level of significance. It is important to note that the coefficient of price of competing crop was insignificant in area equation, but it has significant impact on production and yield of wheat.

The next variable is the price of fertilizer since it has a negative impact on area and production; it also has a negative impact on yield. The variable is significant at 1 per cent level of significance and its value shows that a 1 per cent increase in fertilizer prices leads to 0.07 per cent decrease in output of wheat. It is important to note that fertilizer prices have relatively large impact on area and relatively small impact on output as explained in previous sector the impact on yield is between the impact on area and output.

The lnrain and L.lnrain are the proxy variables for water availability in the province in which district is located. These two variableshave a positive and significant impact on area and output, so we have included them into yield equation as well. The coefficients of lnrain and L.lnrain are significant at 1 per cent level of significance and shows that a 1 per cent increase in rain in the current year leads to 0.034 per cent increase in yield of wheat and a 1 per cent increase in rain in previous year leads to a 0.02 per cent increase in yield. These two coefficients respectively show impact on output and area.

The tempdevwas included only in production equation, so we have included this into yield as well. We found that it has a significant impact on wheat yield. The deviation in temperature from long run averages has a negative impact on wheat yield shows that large variations in temperature have a negative and significant impact on the yield. The coefficient values show that a 1 per cent increase in temperatures deviation leads to 0.03 per cent decrease in yield of wheat.

The value of L.lnyield is the lag of the dependent variable it is significant at 1 per cent level of significance. The coefficient value is 0.311 indicates how much current value of yield depends on the previous year's value. The value of 1- coefficient of L.lnyield is the adjustment coefficient and it is 0.69, it shows the speed of farmers’ adjustment of actual yield to desired yield level and it turns out that in case of yield this speed of adjustment is fast as compare to area.

The table 4.2 gives the short run and long run estimates of yield response function for the wheat. As explained above the coefficients of the estimated model are the short run elasticity with respect to individual variable and we have estimated long run elasticity by dividing each coefficient with 1- coefficient of L.lnyield. It is important to note that high value of speed of adjustment indicates less difference in short run and long run elasticity and small speed of adjustment leads to significant differential impact in short and long run.

The short run and long run yield elasticity of wheat with respect to its own price is 0.13 per cent and 0.19 per cent respectively, shows a 1 per cent increase in wheat price leads 0.13 per cent increase in the yield of wheat in the short run and 0.19 per cent in the long run. The short run and long run cross price elasticity of wheat production are -0.084 and -0.09 respectively. This implies a one per cent increase in the price of competing crops leads to 0.084 per cent and 0.09 per cent reduction in yield of wheat in the short and long run respectively.

The change in wheat yield with respect to changes in fertilizer prices give us the elasticity of wheat with respect to input prices. The short run elasticity and long run elasticity of wheat yield with respect to fertilizer prices is -0.07 per cent and -0.1 per cent respectively. This implies that a 1 per cent increase in fertilizer price leads to 0.07 per cent decrease in wheat yield in the short run and 0.1 per cent decrease in the long run. This finding confirms the above discussion that both in short run and long run wheat production elasticity with respect to fertilizer prices is low as compare to area elasticity.

The above results show that wheat own price, price of competing crop, availability of water, variations in temperature and price of fertilizer all has a significant impact on the wheat response functions in terms of area, output and yield. The own price elasticity of wheat is less than 1 both in short and long run indicates that wheat response is very low in term of price changes in wheat. The yield is least responsive in the long run to changes in price level. This implies that changes in yield are not much responsive to changes in output price.

Table 4.1: Domestic Supply Response Function for Area, Output and Yield, 1981-82 to 2013-14

	Model (1)	Model (2)	Model (3)
VARIABLES	**lnarea**	**lnoutput**	**lnyield**
L.lnprice	**0.105***	**0.247*****	**0.130*****
	(0.0579)	(0.0270)	(0.0287)
Tempdev		-0.0366***	-0.0296***
		(0.00573)	(0.00527)
L.lnrain	**0.0260****		**0.0188*****
	(0.0104)		(0.00665)
Lnrain		0.0385***	0.0347***
		(0.00568)	(0.00600)
L.lnoprice	-0.0250	**-0.0558*****	**-0.0845*****
	(0.0198)	(0.0138)	(0.0120)
L.lnferti	**-0.0880***	**-0.0420***	**-0.0697*****
	(0.0474)	(0.0261)	(0.0225)
Lnarea		0.908***	
		(0.0250)	
L.lnarea	0.641***		
	(0.0544)		
L.lnoutput		0.103***	
		(0.0241)	
L.lnyield			0.311***
			(0.0325)
Constant	1.510***	-0.138	4.310***
	(0.239)	(0.158)	(0.217)
Observations	2,768	2,768	2,768
Number of districts	110	110	110

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.2: Short Run and Long Run Price Elasticity Estimates for Wheat

	Short Run Elasticity			**Long Run Elasticity**		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
VARIABLES	Lnarea	lnoutput	Lnyield	lnarea	lnoutput	Lnyield
Own Price	0.11	0.25	0.13	0.29	0.28	0.19
Cross Price	-0.03	-0.06	-0.084	-0.07	-0.07	-0.09
Input price*	-0.09	-0.04	-0.07	-0.25	-0.04	-0.10

*% change in dependent variable due to % change in fertilizer prices

Source: Authors Estimates

CHAPTER V

CONCLUSION AND POLICY RECOMMENDATIONS

This chapter give an over view of the work and highlight the main findings emerging from the study. This chapter is divided into two sections. Section 1 will give an overview and highlight the main findings of the study. Section II will presents policy recommendation emerge from the study.

5.1 Conclusion

This section presents the overview of the study and highlight the main findings emerge from the study. Study shows that wheat is not only important for reducing food deprivation, but it is also very important in terms of its contribution into GDP. The share of wheat in important crop sector is more than 42 per cent and its total contribution in GDP is around 2 per cent.

The average annual growth rate of cropping sector of Pakistan during 2006-07 to 2016-17 was only 1.1 per cent and one of the main reasons is the slow growth of wheat production. The average annual growth rate of wheat during 2006-07 to 2015-16 was 2 per cent only. This is slightly above than population growth rate. This highlights the problem of food security.

According to latest food security report, almost 22 per cent of the population is undernourished. Within South Asia in terms of population undernourished Pakistan ranked 5 out of 7 countries. The poor state of food security is partially explained by slow performance of wheat in Pakistan.

During 2009 to 2017 we have seen an average increase of 51 per cent and 13 per cent in wheat production and area under wheat cultivation as compare to average value of 1981-2008. In the same period the wholesale price on an average has witnessed an increase of almost 265 per cent, this implies that in last 10 years the wheat price has increased by almost 3 times. This increase in price explains the variation in output and area.

This study has used a district level data of wheat production, area cultivated and yield to estimate the response function of each variable in terms of own price, cross price, fertilizer prices and other factors. We used data from 1981-82 to 2013-14 because after that data at district level is not available.

We did not include districts from FATA in the analysis; we also drop those districts in which wheat area or production was zero throughout thetime period and those time periods in which the wheat production was zero for a district. The above data cleaning exercise leads our sample of 110 districts rather and total observations of 2768.

The study has extended Nerlovian acreage supply response model to find response of wheat area, output and yield separately. The study also extended the Nerlovian time series model to panel data analysis. By using the framework developed by Leaver (2004) &Mythili (2006).

Study has used Arellano and Bond, (1991) dynamic panel data, Generalize Method of Moments. The basic assumption to apply this model that number of cross sections should be greater than the number of time period. We have decided on fixed and random effect based on LM test. The result shows that there is district specific heterogeneity exist. This also advocated the need to use the above given estimation procedures.

In area response function equation, price of wheat, price of competing crop, rainfall, value of production has been used as explanatory variables. For output response function along except value of production and maximum and minimum temperature, we have used cultivated area under wheat and temperature deviation from the historical level. For yield response function, variables of both above equations have been used. All the variables except temperature deviation are used in logarithms.

The result shows that in case of area, the lag own price has positive and significant impact, the lag price of competing crop has insignificant and negative impact, the lag value of rain has a positive and significant impact on area cultivation and the lag price of fertilizer has a negative impact on area cultivation. The adjustment coefficient is low in Pakistan. The short run and long run domestic area elasticity of wheat with respect to own price is 0.11 per cent and 0.29 per cent respectively and the short run elasticity of wheat area with respect to fertilizer prices is -0.09 per cent and long run elasticity is -0.25 per cent.

The result for output equation shows that the lag of wheat wholesale price in Pakistan has a positive and significant impact on domestic wheat; the lag value of competing crop price has a negative and significant impact on output. The area under wheat has a positive and significant impact on wheat output. The lag price of fertilizer has a significant and negative impact on output of wheat. The current value of rain has a positive and significant impact on output. The large variation in temperature has a negative and significant impact on the production. The adjustment coefficient for wheat output is very high shows quick speed of adjustment from actual to desired production level.

The short run and long run domestic production elasticity of wheat with respect to its own price is 0.25 per cent and 0.28 per cent respectively. The short run and long run cross price elasticity of wheat production is -0.06 and -0.07 respectively. The short run and long run elasticity of wheat production with respect to fertilizer prices is -0.04 per cent.

In case of yield equation, the results are similar to the area and output equation. The signs are validating the theory. They only differ in terms of magnitude. It is important to note that as compare to area the speed of adjustment is higher for yield. The short run and long run yield elasticity of wheat with respect to its own price is 0.13 per cent and 0.19 per cent respectively. The short run and long run cross price elasticity of wheat production is -0.084 and -0.09 respectively. The short run elasticity and long run elasticity of wheat yield with respect to fertilizer prices is -0.07 per cent and -0.1 per cent respectively.

The overall results show that wheat elasticity with respect to price is very low in Pakistan. It ranges from 0.11 to 0.25 in the short run in case of area, output and yield and in the long run it ranges from 0.19 to 0.29. This low elasticity of wheat domestic production shows that output price policy is not effective in stimulates output of wheat in Pakistan.

5.2 Policy Recommendation

Based on above analysis the study outline following recommendations:

A study by Pakistan agriculture research council has estimated the wheat requirements by 2030. It shows that to achieve the required level of wheat production, we have to increase our wheat production from 24 million tons to 34 million tons by 2030. To achieve this, we have to increase the yield from 2.6 tons per hectare to 3.8 tons per hectare by 2030 (Wheat in Pakistan a status paper, PARC). This can be done by making output and input price policy more effective. A very low output price elasticity of wheat will not able to full fill this wheat requirement, so we recommend that government should emphasis on input price policy rather than output prices.

In the 2008 government has significantly increase the wheat price. During 2009 -2017 the wholesale price of wheat has shown an average annual growth rate of 12.2 per cent as compare to 3.4 per cent during 1981-2008. This implies an increase of 265 per cent in wheat prices. But as we have seen in table 1.3 the increase in output is only 51 per cent. The average annual price of urea (which is a main fertilizer) has shown a growth rate of 15.5 per cent (Government of Pakistan, Various Issues). This mean that price of fertilizer has increased quickly as compare to price of wheat. This higher increase in price of fertilizer as compare to output price offset the full effect of output price policy.

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