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Research Article

Food Grain Production in Pakistan: Influencing Factors and Future Outlook

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Abstract

The present study focuses on the influencing factors of food grain production and forecasting of food grain production in Pakistan. To this end, time series data from the year 1980 to 2014 has been used taken from Pakistan Economic Survey. Augmented Dickey Fuller (ADF) test has been used to check the stationarity of the time series data while the food grain production function has been estimated using Regression model. Furthermore, ARIMA model have been used for forecasting the food grain production up to 2030. The results show that the main determinant for food grain production in Pakistan are area under food grain, credit disbursement, agriculture employment and fertilizer off-take. The forecasting results showed that food grain production has an increasing trend over the study horizon. The food grain production may further be increased through bringing more under cultivation, disbursing more agricultural credit and properly utilizing the fertilizer which will help in ensuring food security and coping with the growing demand of the economy.

Keywords: Food grain; Production function; ARIMA Model; Forecasting; Inputs

Introduction

The role of food grain productivity in Pakistan's economy cannot be neglected. Most of the rural population is either directly or indirectly related to it. In Pakistan, wheat is the single largest grain crop. From the year 1980-2014, significant variation in food grain productivity and its area under cultivation took place. During the year 1980-81, the total area under wheat and maize crops was 6,984 and 769 thousand hectares, while it increased to 9,199 and 1,168 thousands hectares in the year 2013-14. This has led to the increase of total wheat and maize production from 11,475 and 970 thousand tonnes in 1980-81 to 25,979 and 4,944 thousand tonnes in 2013-14 [1]. Since the year 2000, Pakistan's population has been increased at the rate of 2.42 percent, while its domestic food grain production on 1.5 percent only [2]. Because of high population growth rate and lower food production, the economy of Pakistan faces food inflation of about 26.16 percent in the year 2008-09, while it is 11.1 percent in the year 2011-12 [1]. From policy perspective, it is essential for the policy makers to have some systematic forecasts about food grain production which help them in eliminating food inflation and ensuring food grain security in the country. This also necessitates to estimate the impact of various policy variables such as credit disbursement, area under food grain crops, fertilizer off-take and agriculture employment. In the past, different studies about the different directions of food grain crops' have been conducted. They used various policy variables which were necessary for their particular regions. Mahran [3] used an exponential function for the production of three important crops, namely sorghum, wheat, and millet in Sudan. It was concluded that policies should stress upon the improvement on agricultural productivity through introducing new varieties and to applying technological packages. Negatu [4] studied the impact of improved wheat production technology on food status of farm households in two districts of Ethiopia while Karim [5] used seven regression models for the forecasting of wheat production of different districts of Bangladesh. Iqbal [6] forecasted that in the year 2022, the wheat area under production will be 8475.1 thousands hectares while wheat production will be 29774.8 thousand tons in Pakistan. Hsu and Chang [7] studied China's agricultural productivity growth using Malmquist productivity indexes, Data Envelopment Analysis (DEA) approach and Tobit regression model. They found that the technical progress is a major source of agricultural growth. Hamid [8] used the Cobb-Douglas production function and found that technological change and efficiency on employment generation has negative impact on agriculture sector of Pakistan.

Many policy variables (inputs) influencing agricultural productivity were used in literature. Tuong, Bouman, Mortimer [9] and Cabangon, Tuong and Abdullah [10] found that the declining water is threat for irrigated rise system sustainability and food security. Cabangon et al. [10] further added to save water of floods in rice cultivation. Fertilizer has also been used an important input for agriculture production [11-13]. Some researchers also included agricultural credit in the agricultural production function [14-16]. They were of the view that credit is instrumental for agricultural productivity and its non-availability can restrict agricultural production. Besides area and labour used are also the typical inputs used for the production of agricultural productivity.

The present study aims to

1. Estimate the effect of main farm inputs such as area under food grain, credit disbursement, employment and fertilizer off-take food grain production in Pakistan

2. Forecast the food grain production upto 2030.

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Table 1: Descriptive Statistics of the study variables.

	Total food grain production in Pakistan (Tonnes)	Area under food grain crops in Pakistan (Hectares)	Credit disbursement in Pakistan (Rs. in million)	Fertilizer off-take in Pakistan (000, N/T)	Agriculture employment in Pakistan (million)
Mean	24475.20	12213.17	84811.27	2550.17	17.55
Median	22969.00	12191.00	21965.00	2515.05	16.12
Maximum	38208.00	13900.00	391353.00	4360.00	25.14
Minimum	15592.00	10745.00	2859.18	1044.30	12.72
Std. Dev.	6702.54	852.47	110006.10	1009.47	4.01
Observations	35	35	35	35	35

Materials and Methods

This research is based on time series annual secondary data ranging from 1980 to 2014. The data has been taken from various issues of Pakistan Economic Survey. For checking the stationarity of the data, Augmented Dickey Fuller (ADF) test has been used. To estimate the major factors of food grain production in Pakistan, this study estimated the following Cobb-Douglas Production function using the method of least square:

$$\text{I n PTFG} = b_o + b_1 \ln ATFG + b_2 \ln CD + b_3 \ln FO + b_4 \ln AG \quad (1)$$

where

PTFG = Total Food Grain Production in Pakistan (Tonnes)

ATFG = Area Under Food Grain Crops In Pakistan (Hectares)

CD = Credit Disbursement in Pakistan (Rs. in million)

FO = Fertilizer Off-Take in Pakistan (000, N/T)

AG= Agriculture Employment In Pakistan (million)

More specifically, the variable CD has been obtained by multiplying the total credit disbursement with the ratio of area under total food grain to total cropped area in Pakistan. Similar method has been applied to construct the FO and AG variables. This will help to estimate how much credit, fertilizer and labor force is used for total food grain production in Pakistan.

For estimating such relationship, the Cobb-Douglas functional is mostly used, because it has good trace, simple form, limited degrees of freedom and logical theoretical assumptions [17]. To estimate the effect of various farm input on agricultural output has been estimated by various researchers [18-20]. This model has varied application and in literature it has been used in various fields [21-23].

Furthermore, the Autoregressive Integrated Moving Average (ARIMA) model has been used to forecast the future level of food grain production in Pakistan. The Box-Jenkins [24] ARIMA model is well known for the econometric forecasting and the researchers in the past used it for long term projects [24-26]. The ARIMA model is the combination of Moving Average (MA), Autoregressive (AR) and order of differencing.

The general form of autoregressive process is given by:

$$z_t = \rho_1 z_{t-1} + \rho_2 z_{t-2} + \rho_3 z_{t-3} + \ldots\ldots\ldots\ldots + \rho_p z_{t-p} + \mu_t \quad (1)$$

The general form of moving average is

$$z_t = \mu_t - \alpha_1 \mu_{t-1} - \alpha_2 \mu_{t-2} - \alpha_3 \mu_{t-3} - \ldots\ldots\ldots - \alpha_q \mu_{t-q} \quad (2)$$

by combining equation 1 and 2.

$$z_t = \rho_1 z_{t-1} + \rho_2 z_{t-2} + \rho_3 z_{t-3} + \ldots\ldots\ldots\ldots + \rho_p z_{t-p} + \mu t - \alpha_1 \mu_{t-1} - \alpha_2 \mu_{t-2} - \alpha_3 \mu_{t-3} - \ldots\ldots\ldots - \alpha_q \mu_{t-q}$$

For non- stationary series the unit root test takes the form:

$$z_t = z_{t-1} + \mu t$$

The successive differences will be taken up to the stationarity of the series.

The estimation of Autocorrelation Function (ACF) and Partial Autocorrelation (PACF) function is also important for the ARIMA model.

Formula for ACF is given by:

$$\theta_k = \rho_n / \rho_0$$

where ρ_v and ρ_0 represents covariance and variance respectively.

For the optimum lag, the Aikake's Information Criterion (AIC) have been used:

$$AIC = \ln (ESS/T) + (2j / T)$$

where ESS and j represents the sum of square errors and the number of parameters estimated.

The ARIMA model shows three different results for the accuracy of the model, which are upper limits, lower limits, and forecasted values [28].

Statistical packages Minitab and Eviews were used to derive the results.

Results and Discussion

The descriptive statistics of the study variables are given in Table 1. The area under food grain crops and production of food grain crops has substantial contribution in the overall agricultural economy of Pakistan. Besides, agricultural sector also absorbs the largest share of labour force. The other inputs such as credit and fertilizer are the key instruments for the total food grain production.

The trends of these variables are given in Figure 1-5. All the variables have increasing trend. Besides, the growth in the area under food grain crop is low but also has an increasing trend. The growth in the credit disbursement is low initially but shows substantial hike

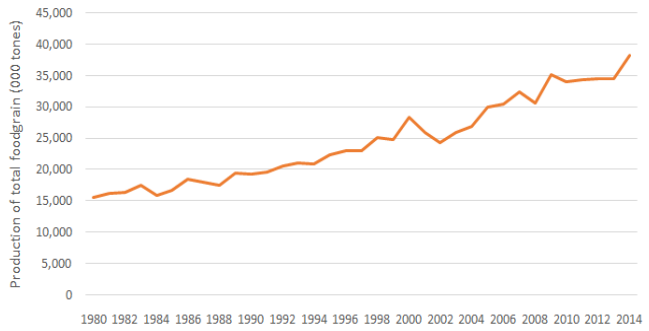

Figure 1: Trends in the Production of total food grain in Pakistan.

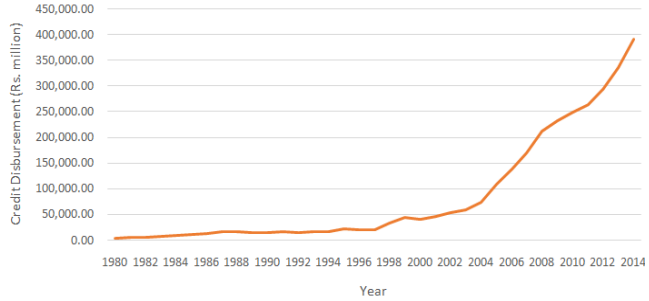

Figure 2: Trends in Credit Disbursement in Pakistan.

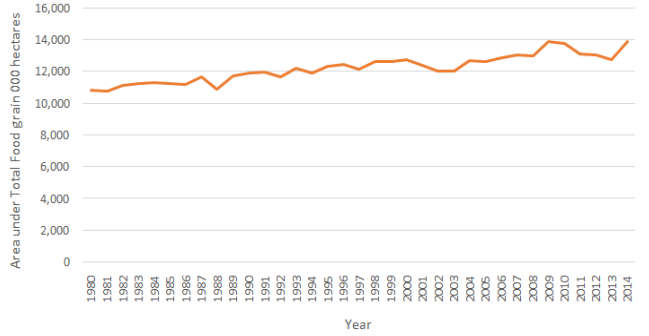

Figure 3: Trends in the area under total Food grain in Pakistan.

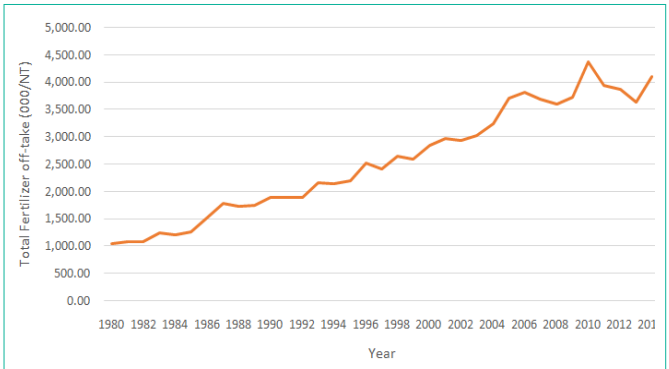

Figure 4: Trends in the total fertilizer off-take in Pakistan.

after the year 2004. The variation in these variables definitely affect the total food grain production. So, this study estimate the impact of such policy variables on the total food rain production in Pakistan. Furthermore, to look over the prospects, the total food grain production is also forecasted.

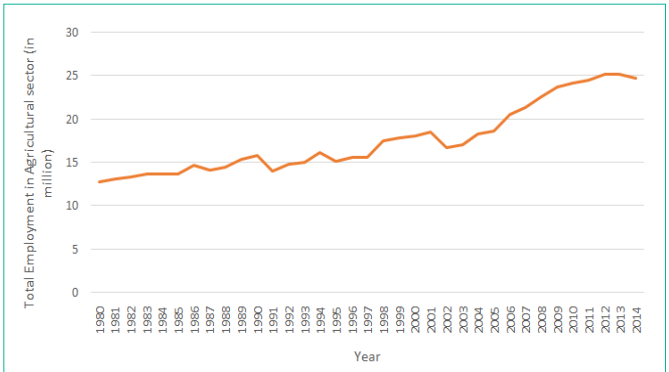

Figure 5: Trends in the total employment in the agricultural sector in Pakistan.

Table 2: ADF test results for stationarity.

ADF test results for stationarity (including intercept and not trend)					
Variable	I(0)		I(1)		Results
	Test Statistic	Critical value	Test Statistic	Critical value	
PTFG	0.769 [1]	-3.65	-8.436[0]	-3.65	I(1)
ATFG	-1.168 [1]	-3.65	-7.564 [0]	-3.65	I(1)
FO	-0.242[1]	-3.65	-6.623[0]	-3.65	I(1)
CD	7.959[0]	-3.65			I(0)
AG	1.044[1]	-3.65	-6.215[0]	-3.65	I(1)
ADF test results for stationarity (including both intercept and trend)					
Variable	I(0)		I(1)		Results
	Test Statistic	Critical value	Test Statistic	Critical value	
PTFG	-2.399[1]	-4.26	-8.573 [0]	-4.26	I(1)
ATFG	-4.459 [0]	-4.26			I(0)
FO	-4.474[0]	-4.26			I(0)
CD	4.643[0]	-4.26			I(0)
AG	-1.017[1]	-4.26	-6.591[0]	-4.26	I(1)

Source: Author's calculation.

Table 2 shows the results of ADF test in which the stationarity of the data including intercept and both intercept and trend have been checked. Variables which are stationary at level, first difference and the second difference if needed denoted by I(0), I(1) and I(2) respectively. The values of optimum lags selected on the basis of AIC criterion are given in the brackets. According to the Table, in both cases (including intercept and not trend) the variables PTFG, ATFG, FO and AG are made stationary after taking first difference except CD which is stationary at level. While in both cases (including intercept and trend) the variables PTFG, and AG, are also made stationary after taking first difference except ATFG, FO and CD which are stationary at level.

Table 3 indicates that the elasticity of ATFG is 0.58 showing positive relationship between total food grain production and area under food grain crops. In other words 1% increase in area under food grain crops will lead to increase total food grain production by 0.58%. Pakistan has 8 thousand hectares cultivable waste which if utilized properly, will further increase the total food grain production. The elasticity of FO is 0.307 indicating positive relationship between

Table 3: Regression results of food grain production function.

Dependent Variable: lnTP				
Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	1.476	2.699	0.547	0.58
ATFG	0.577	0.327	1.761	0.00
FO	0.307	0.078	3.921	0.00
CD	0.007	0.033	0.194	0.84
AG	0.396	0.145	2.738	0.00
R-squared	0.63	F-statistic		338.09
Adjusted R-squared	0.97	Prob(F-statistic)`		0.000
Durbin-Watson stat	1.89			

Source: Author's calculation.

fertilizer off-take and total food grain production. In other words 1% increase in Fertilizer off-take will lead to increase total food grain production by 0.307%. The elasticity of AG is 0.396 showing positive relationship between total food grain production and agriculture employment. In other words 1 % increase in agriculture employment will lead to increase total food grain production by 0.31%. The result also shows that the variables ATFG, FO and AG are statistically significant at 1%, 5% and 10% level of significant. While the elasticity of CD is 0.007 indicating positive relationship between credit disbursement and total food grain production. In other words 1% increase in credit disbursement will lead to increase total food grain production by 0.01%. Moreover, the values of R-squared, Durbin-Watson Statistics and F-Statistics support the model estimated. Agriculture sector is still contributing about 21% to GDP and absorbs 45% of the total labour force employment. The proper usage of these farm inputs will not only increase the food grain production but will also stimulate the labour force employment and ensure the food security for the poor population living in rural areas.

Table 4: Forecasting of food grain production in Pakistan (in tonnes).

	95 Percent Limits		
Year	Forecast	Lower	Upper
2015	37323.1	34804.9	39841.3
2016	37828.7	35102.4	40555.1
2017	38427.3	35541.5	41313.2
2018	39032.2	35997.2	42067.2
2019	39637.5	36460.5	42814.4
2020	40242.8	36929.9	43555.6
2021	40848.1	37404.7	44291.5
2022	41453.4	37884.2	45022.5
2023	42058.6	38368.0	45749.3
2024	42663.9	38855.7	46472.2
2025	43269.2	39346.9	47191.6
2026	43874.5	39841.3	47907.7
2027	44479.8	40338.7	48620.9
2028	45085.1	40838.9	49331.4
2029	45690.4	41341.6	50039.3
2030	46295.7	41846.6	50744.8

Source: Author's calculation.

The forecasting of food grain production has been detailed in Table 4. The results show that the total food grain production in 2020 would be 40242.8 tones whose 95% lower and upper limits are 36929.9 tones and 43555.6 tonnes respectively. The forecasted food grain production for the year 2030 would be 46295.7 which possess 95% lower and upper limits as 46295.7 tones and 50744.8 tonnes respectively. It is encouraging that the total food grain production has increasing trend overtime. But, the growth in the total food grain production is still not in line with the growing population and this much production will not be enough to feed the growing population at rate 1.95%. This imbalance in future will definitely impact the food security in the country.

Conclusion and Recommendations

This study concludes that the major influencing factors of food grain production are area under food grain crops, credit disbursement, agriculture employment and fertilizer off-take. The study also forecasted total food grain production up to 2030 and found that food grain production has increasing trend. The study suggests that the government should take initiatives to utilize the cultivable waste which will increase the production of food grains which will ensure food security and self sufficiency in food crops in both present and future in Pakistan.

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